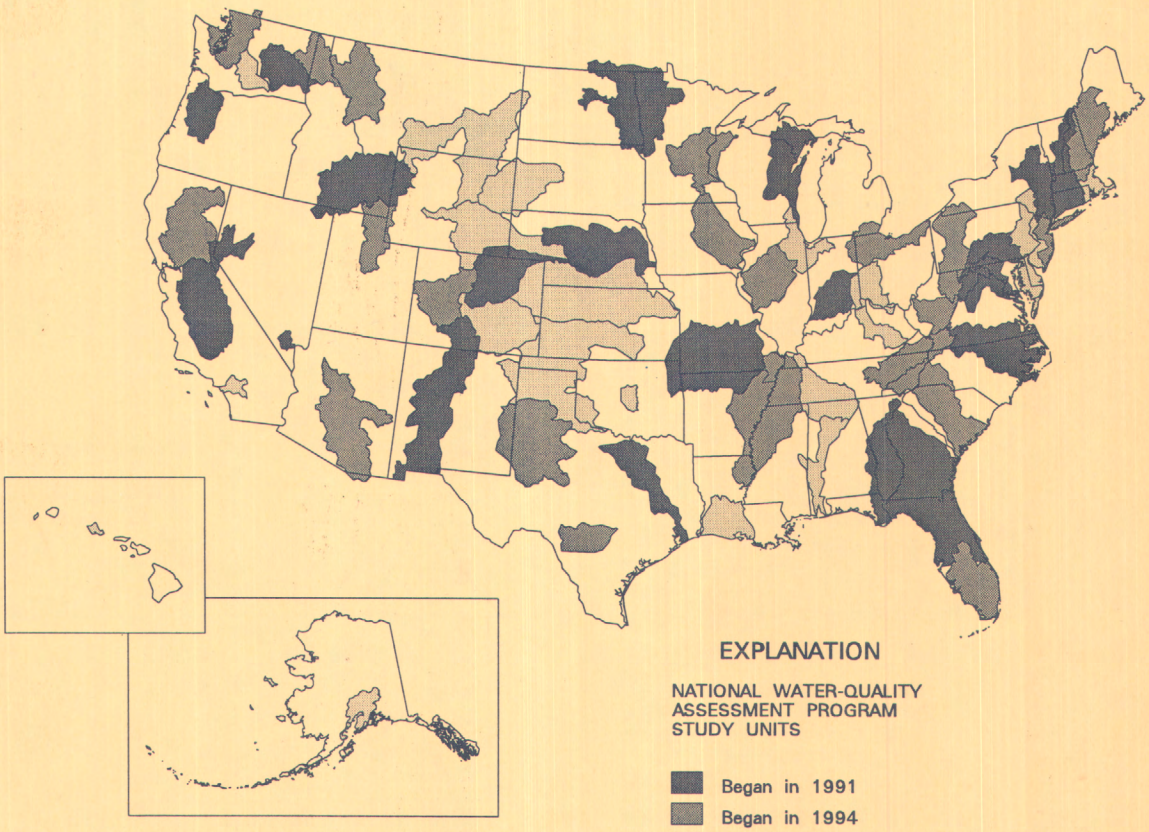
SUMMARY OF NATIONAL STANDARDS AND GUIDELINES FOR PESTICIDES IN WATER, BED SEDIMENT AND AQUATIC ORGANISMS AND THEIR APPLICATION TO WATER-QUALITY ASSESSMENTS



U.S. GEOLOGICAL SURVEY
Open-File Report 94-44

ed in cooperation with the
VIRONMENTAL PROTECTION AGENCY

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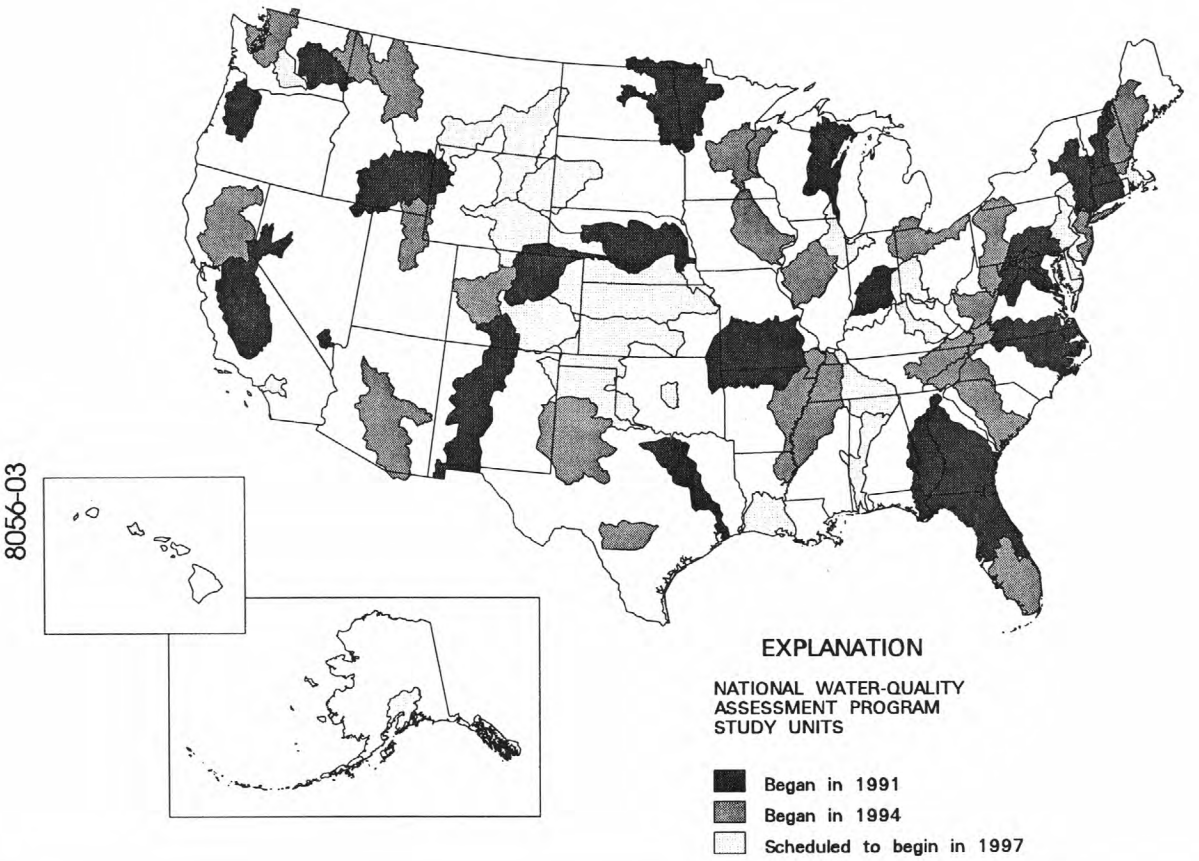
By Lisa H. Nowell *and* Elizabeth A. Resek



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Sacramento, California
1994

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

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CONVERSION FACTORS, VERTICAL DATUM, WATER-QUALITY INFORMATION, AND ABBREVIATIONS AND ACRONYMS

Conversion Factors

Multiply	By	To obtain
gram (g)	0.03527	ounce avoirdupois
gram per day (g/d)	0.002205	pound per day
kilogram (kg)	2.205	pound avoirdupois
liter (L)	0.2642	gallon
milligram (mg)	0.00003527	ounce
square kilometer (km^2)	0.3861	square mile (mi^2)

Temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F=1.8(°C)+32.$$

Vertical Datum

Sea Level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Water-Quality Information

Pesticide concentrations in water samples are given in milligrams per liter (mg/L). One milligram per liter is equivalent to 1,000 micrograms per liter (µg/L), 10^6 nanograms per liter (ng/L), and 10^9 picograms per liter (pg/L). Milligrams per liter is equivalent to "parts per million" when suspended sediment concentrations are less than 10,000 mg/L. Water consumption rates are given in liters per day (L/d).

Pesticide concentrations in bed sediments are given in milligrams per kilogram of sediment dry weight (mg/kg sediment) or in milligrams per kilogram of sediment organic carbon (mg/kg-sediment-OC).

Pesticide concentrations in fish and shellfish tissues are given in milligrams per kilogram (mg/kg) wet weight. One milligram per kilogram (mg/kg) is equivalent to 1 microgram per gram (µg/g) and 1,000 micrograms per kilogram (µg/kg). Milligrams per kilogram is equivalent to "parts per million." Fish and shellfish consumption rates are given in grams per day (g/d).

Reference dose (acceptable daily intake) levels are given in milligrams of contaminant per kilogram of body weight per day [(mg/kg)/d]. Fish and shellfish consumption rates are given in grams per day (g/d).

Abbreviations and Acronyms

A, Intermediate value used in calculation of Final Acute Value (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
ADI, Acceptable Daily Intake (NAS Drinking-Water and Health Recommendations)
APA, Administrative Procedures Act
ASTM, American Society for Testing and Materials
BAF, Bioaccumulation Factor (EPA Proposed Water-Quality Guidance for the Great Lakes System)
BCF, Bioconcentration Factor (EPA Water-Quality Criteria for the Protection of Human Health)
BW, mean body weight
C, Concentration of a contaminant (medium specified in brackets [...])
Cancer Group A, human carcinogen (EPA Carcinogenicity Classification)
Cancer Group B, probable human carcinogen (EPA Carcinogenicity Classification)
Cancer Group C, possible human carcinogen (EPA Carcinogenicity Classification)
Cancer Group D, not classified (EPA Carcinogenicity Classification)
Cancer Group E, no evidence of carcinogenicity (EPA Carcinogenicity Classification)
CAS No., Chemical Abstracts Services Registry Number
CCC, Criterion Continuous Concentration (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
CL, Confidence Limit
CMC, Criterion Maximum Concentration (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
COE, U.S. Army Corps of Engineers
CR, mean daily consumption rate of fish and shellfish (EPA Recommended Screening Values)
CWA, Clean Water Act
DWEL, Drinking Water Equivalent Level (EPA Drinking Water Health Advisories)
EPA, U.S. Environmental Protection Agency
FAV, Final Acute Value (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
FCV, Final Chronic Value (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
FDA, Food and Drug Administration
FIFRA, Federal Insecticide, Fungicide, and Rodenticide Act
FFDCA, Federal Food, Drug, and Cosmetic Act
FWPCA, Federal Water Pollution Control Act
FWS, U.S. Fish and Wildlife Service
GMAV, Genus Mean Acute Value (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
GMCV, Genus Mean Chronic Value (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
IRIS, Integrated Risk Information System, EPA's data base for risk assessment and risk management information
K_{oc}, organic-carbon partition coefficient for a chemical substance

LC_{50}, median lethal concentration
LOAEL, Lowest-Observed-Adverse-Effect Level
LPC, limiting permissible concentration (EPA/COE tiered-testing procedure for determining the suitability of dredged material for ocean disposal)
MCL, Maximum Contaminant Level (EPA Primary Drinking Water Regulations)
MCLG, Maximum Contaminant Level Goal (EPA Primary Drinking Water Regulations)
NAS, National Academy of Sciences
NAS/NAE, National Academy of Sciences and National Academy of Engineering
NAWQA, U.S. Geological Survey National Water Quality Assessment Program
NOAA, National Oceanic and Atmospheric Administration
NOAEL, No-Observed-Adverse-Effect Level
NPDES, National Pollutant Discharge Elimination System
OGWDW, Office of Ground Water and Drinking Water
OPP, Office of Pesticide Programs, within OPPTS, EPA
OPPTS, Office of Prevention, Pesticides, and Toxic Substances, within EPA
OST, Office of Science and Technology, within OW, EPA
OW, Office of Water, within EPA
P, cumulative probability (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
PAHs, polycyclic aromatic hydrocarbons
PCBs, polychlorinated biphenyls
PDWRs, EPA Primary Drinking Water Regulations
PP, priority pollutant
q_1*, cancer potency factor, also called oral slope factor
RCRA, Resources Conservation and Recovery Act
R, rank (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
RfD, Reference Dose (EPA Drinking Water Health Advisories)
RL, assigned risk level (EPA Recommended Screening Values)
RSC, relative source contribution (EPA Drinking Water Health Advisories, EPA Recommended Screening Values)
RSD, Risk Specific Dose, associated with a specific cancer risk (EPA Drinking Water Health Advisories)
s, sample standard deviation
s^2, sample variance
SDWA, Safe Drinking Water Act
SMCL, Secondary Maximum Contaminant Level (EPA Primary Drinking Water Regulations)
SNARL, Suggested-No-Adverse-Response Level (NAS Drinking Water and Health Recommendations)
SMAV, Species Mean Acute Value (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
SMCV, Species Mean Chronic Value (EPA Water-Quality Criteria for the Protection of Aquatic Organisms)
SQC, Sediment-Quality Criteria (EPA Sediment-Quality Criteria for the Protection of Aquatic Organisms)
SQC_{oc}, Sediment-Quality Criteria expressed on an organic-carbon basis (EPA Sediment-Quality Criteria for Protection of Benthic Organisms)
SV, Screening Value (EPA Recommended Screening Values)
SV_c, Screening Value for carcinogens
SV_{nc}, Screening Value for noncarcinogen
UF, uncertainty factor
WHO, World Health Organization

SUMMARY OF NATIONAL STANDARDS AND GUIDELINES FOR PESTICIDES IN WATER, BED SEDIMENT, AND AQUATIC ORGANISMS AND THEIR APPLICATION TO WATER-QUALITY ASSESSMENTS

By Lisa H. Nowell *and* Elizabeth A. Resek

Abstract

Current (1993) national standards and guidelines pertaining to pesticide contaminants in water, bed sediment, and fish and shellfish tissues are summarized to provide a condensed reference source for definitions and current values applicable to pesticides in aquatic environmental media. This report facilitates comparison of measured concentrations of pesticides in environmental samples with applicable standards and guidelines. For each standard or guideline, the following is provided: (1) Definition, including the underlying assumptions and mathematical derivation; (2) originating agency; (3) statutory authority; (4) regulatory status and, for standards, the agency responsible for enforcing the standard; (5) applicable sampling medium; (6) beneficial use and resource protected, and (7) full citations of published documentation. The report emphasizes the appropriate application of national standards and guidelines to water-quality data on pesticides to aid in assessing potential adverse effects on human health, aquatic organisms, and wildlife.

INTRODUCTION

The effects of pesticides on water quality commonly are assessed by comparing measured concentrations of individual pesticide compounds in the environment with concentrations that have been determined to have potential adverse effects on humans, aquatic organisms, or other beneficial uses of water. Direct evaluation of the adverse effects of every pesticide present in a given hydrologic system is beyond the scope and budget of most water-quality studies. Many studies rely on standards or guidelines set by Federal or State agencies or other institutions to indicate what concentrations may have adverse effects on human health, aquatic organisms, or wildlife. Such standards and guidelines generally are based on laboratory or field studies that document the effects of individual pesticides on specific aspects of water quality. Single-species toxicity tests (using a single species of a test organism) under various laboratory conditions are the most common type of study; whereas, artificial ecosystem studies (using multiple species of a test organism) and field studies are relatively uncommon. Such studies rarely consider the effects of exposure to more than one chemical at a time. Technical information from such studies has been used by the U.S. Environmental Protection Agency (EPA) in issuing national standards, such as drinking-water regulations (for example, see U.S. Environmental Protection Agency, 1991a) and guidelines, such as ambient water-quality criteria for the protection of human health and aquatic organisms (for example, see U.S. Environmental Protection Agency, 1980a) to meet its statutory requirements under the Safe Drinking Water Act (SDWA) and the Clean Water Act (CWA). The Food and Drug Administration (FDA) also has used its authority under the Federal Food Drug and Cosmetic Act (FFDCA) to set action levels (enforceable regulatory limits) for unavoidable residues of pesticides in foods (Food and Drug Administration, 1990).

Although there are limitations associated with applying national standards and guidelines developed for a single contaminant to varied mixtures of pesticides and other contaminants in individual water bodies, these standards and guidelines facilitate Federal and State regulation, as well as consistent comparison and evaluation of water-quality conditions among different hydrologic systems. National standards and guidelines are used widely to assess the potential water-quality significance of pesticide concentrations measured in the aquatic environment, even when measured concentrations do not exceed a standard or guideline or when concentrations are measured using a different sampling or analytical method than that stated or implied for the standard or guideline.

Effective use of standards and guidelines in water-quality assessment requires an understanding of how individual standards and guidelines were derived, as well as information about the specific hydrologic system being studied. Specifically, questions need to be answered to make meaningful comparisons of measured pesticide concentrations in environmental samples with standards and guidelines. Such questions are addressed in this report:

1. What factors should be considered in selecting the appropriate standards and guidelines for comparison with the type of water-quality data being assessed?
2. What aspect of the hydrologic system does each standard or guideline protect and what does it mean when these values are exceeded?
3. What is the technical basis for each available standard and guideline, and how does this affect assessment of the water-quality data?
4. What assumptions were made in deriving each available standard or guideline, and are they appropriate for the hydrologic system being assessed?
5. When more than one standard or guideline is available for a given type of pesticide data, which one should be used?

This report provides a summary of current (1993) national standards and guidelines and their derivations for pesticide contaminants in water, bed sediment, and fish and shellfish tissues. The summary and associated explanations are designed to facilitate comparison of measured concentrations of pesticides in these media with appropriate standards and guidelines for assessing water-quality conditions. The report provides a nationally consistent framework for comparison of pesticide levels in hydrologic systems with national standards and guidelines. This report is one of a series of reviews of current information and knowledge about pesticide contamination of hydrologic systems being done as part of the Pesticide National Synthesis project of the U.S. Geological Survey National Water-Quality Assessment (NAWQA) program (Hirsch and others, 1988). Other reviews in the series will focus on the occurrence and distribution of pesticides in the atmosphere, ground water, stream water, and bed sediments and aquatic biota, and on the chemical and physical properties of pesticides relative to water-quality assessment. These national topical reviews will complement detailed studies being done during 1991-2002 in 60 NAWQA study units, which are major hydrologic basins of the United States, each typically 10,000 to 30,000 mi^2 in size.

PREVIOUS COMPILATIONS OF NATIONAL STANDARDS AND GUIDELINES

A number of previous compilations of national standards and (or) guidelines for pesticides and other contaminants are available. Most previous compilations are limited in scope, covering only one or two types of standards or guidelines for a single environmental medium: for example, drinking-water health advisories (U.S. Environmental Protection Agency, 1987a,b; 1988a-c; 1989a,b); ambient water-quality criteria (U.S. Environmental Protection Agency, 1986a; 1991b; 1992a); or FDA action levels (Food and Drug Administration, 1990; 1992). A few compilations contain standards and (or) guidelines for multiple media (U.S. Environmental Protection Agency, 1992b; 1993a,b).

The previous compilations of national standards and guidelines take the form of (1) a data base, (2) summary tables, or (3) publications containing technical information.

1. Data base. Integrated Risk Information System (IRIS) is EPA's data base of risk-assessment and risk-management information (U.S. Environmental Protection Agency, 1993b). This information represents an agency consensus, unless otherwise indicated for a specific data entry. The IRIS data base includes EPA drinking-water regulations, drinking-water health advisories, ambient water-quality criteria, toxicity assessment (reference dose), and carcinogenicity assessment for individual chemical contaminants. IRIS also contains the technical basis for carcinogenicity and toxicity assessments. IRIS is updated frequently; however, records for an individual pesticide may not be complete or fully up-to-date. Because all data entries are dated and references provided, information can be verified and out-of-date information identified.

2. Summary tables. Some summary tables of standards and (or) guidelines are periodically updated and contain the most recent values (U.S. Environmental Protection Agency, 1992c; 1993a,c,d). Of these summary tables, only U.S. Environmental Protection Agency (1993a) contains references to primary sources or information on the technical basis for the values provided. U.S. Environmental Protection Agency (1992c; 1993d) lists the office or group within EPA that is the source for each data entry; U.S. Environmental Protection Agency (1993d) also provides the date for each entry. Without references to primary sources, or at least dates for individual data entries, the information in these tables is difficult to verify and errors are difficult to identify. Other summary tables were published as a wall poster (U.S. Environmental Protection Agency, 1991b) and as part of EPA's final rule promulgating numeric water-quality criteria necessary to bring all States into compliance with the Clean Water Act, commonly known as the Toxics Rule (U.S. Environmental Protection Agency, 1992a). The Toxics Rule applies only to 14 States and Territories that were without EPA-approved criteria when the final rule was published, namely Alaska, Arkansas, California, Florida, Idaho, Kansas, Michigan, Nevada, New Jersey, Rhode Island, Vermont, Washington, District of Columbia, and Puerto Rico. For these States and Territories, one or more Federal criteria in the Toxics Rule will be the legally enforceable standards for all purposes and programs under the CWA (see U.S. Environmental Protection Agency (1992a) for discussion applicable to individual States and Territories).

3. Publications containing technical information. U.S. Environmental Protection Agency (1987a,b; 1988a-c; 1989a,b) has published several compilations of drinking-water health advisories for pesticides or other groups of organic compounds. EPA's water-quality criteria for protection of human health and aquatic organisms are published in "Quality Criteria for Water--1986," commonly known as the "Gold Book" (U.S. Environmental Protection Agency, 1986a). This publication, updated twice in 1987, also provides limited technical information on the criteria and includes references to water-quality criteria documents. This publication is being revised, and the revision ("Silver Book") is expected to be published in 1994 (Kenneth Potts, Office of Science and Technology, U.S. Environmental Protection Agency, oral commun., 1994). U.S. Environmental Protection Agency (1992b) contains profiles for target analytes in EPA's National Study of Chemical Residues in Fish. These target analytes include several organochlorine insecticides, chlorinated dioxins and furans, and other hydrophobic organic compounds. Profiles of individual analytes include the following national standards and guidelines: EPA drinking-water regulations, EPA drinking-water health advisories, ambient water-quality criteria, EPA tolerance levels, and FDA action levels.

Because many guidelines are updated frequently and errors are probable in a compilation of any breadth, most compilations contain some information that is incorrect or out-of-date. Nonetheless, the previous compilations are valuable sources of information that were used in the development of this report. In reviewing these compilations, the most useful are those in which references to primary sources are provided. Otherwise, it is difficult to verify that the values provided are current, and the technical basis is difficult to determine for the values provided. An understanding of the technical basis of a standard or guideline is essential for its use in interpreting environmental data.

This summary report differs from previous compilations in several ways: It (1) focuses on pesticides; (2) covers a wide range of national standards and guidelines, encompassing drinking water, ambient surface water, bed sediment, edible fish and shellfish tissue, and whole fish tissue; (3) provides the

technical basis and underlying assumptions for each standard or guideline; (4) includes references to primary source documents; and (5) focuses on the application of standards and guidelines to interpreting environmental data. Like previous compilations, this report eventually will contain out-of-date information as standards and guidelines are revised or new ones introduced. Because this report provides references to primary source documents and the technical basis for current values, however, it will be possible to verify at any time whether the values listed herein are current and based on current scientific information.

SCOPE OF REVIEW

The standards and guidelines within the scope of this report are listed in table 1, along with the following descriptive information: issuing agency; statutory authority; regulatory status and, for standards, the agency responsible for enforcing the standard; applicable sampling medium; resource protected; and primary source reference. For standards, primary source documents are the official references. For guidelines, the primary sources generally contain the technical basis for current values. Figure 1 illustrates how the national standards and guidelines in this report apply to various environmental media.

In this report, the term "national" refers to all standards and guidelines established for the United States by agencies of the U.S. Government or by the National Academy of Sciences and National Academy of Engineering. Pesticides include organic pesticides for which national standards or guidelines have been determined, even if their use has subsequently been restricted or canceled. Standards and guidelines also are provided for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD), which is present as a contaminant in some pesticides.

The terms "standards," "criteria," and "guidelines" are used in different ways by different authors, and thus require careful definition. In this report, standards refer to threshold values that are legally enforceable by agencies of the U.S. Government: EPA maximum contaminant levels (MCLs) for drinking water, and FDA action levels and EPA tolerances for pesticides in edible fish and shellfish tissues. Although these standards are established with a human-health-based component, other factors also may be considered. For example, MCLs are based on consideration of health effects, organoleptic effects (effects on taste and odor), treatment feasibility, cost of treatment, and analytical detection. The term "standard" as used in this report differs from a water-quality standard as defined in the CWA. Sections 303(a) and (b) of the CWA require each State to formulate water-quality standards. Section 303(c)(2) specifies that such standards "shall consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based on such uses."

As used in this report, guidelines refer to threshold values that have no regulatory status but are issued in an advisory capacity. The issuing agency may use a different term to describe a given set of guidelines (for example, criteria, advisories, guidance, or recommendations). In the tables accompanying this report and in the specific descriptions of individual standards and guidelines, the actual terms used by the issuing agencies are listed. However, in general discussion in this report, the term "guidelines" encompasses all such advisory levels.

To avoid confusion, it must be recognized that the term "criteria" appears in the CWA with two separate definitions. In Section 303(c), criteria and part of the definition of a water-quality standard. Thus, States are required to adopt regulations or statutes that contain legally achievable criteria. In Section 304(a), criteria is used in a scientific sense in that EPA is mandated to develop and publish criteria for water accurately reflecting the latest scientific knowledge on the effects of priority pollutants on health and welfare, including effects on aquatic life, plants, wildlife, biological communities, and various beneficial uses of water (Section 304(a)(A),(C) of CWA). The resulting criteria issued by EPA (commonly referred to as 304(a) criteria) must undergo notice and comment procedures under the Administrative Procedures Act (APA) [5 U.S.C. 553(b)]. This public notice and comment requirement is a substantive difference between EPA criteria and the other guidelines addressed in this report. The National Academy of Sciences and National Academy of Engineering (1973) recommended maximum concentrations in water for protection of aquatic life are sometimes called criteria. These National Academy of Sciences and National Academy of Engineering (NAS/NAE) recommendations were precursors to EPA aquatic-life criteria, but are not EPA criteria and have not undergone APA notice and comment procedures. The regulatory status of each set of standards or guidelines addressed in this report is provided in table 1.

Table 1. Description of national standards and guidelines for pesticides

Issuing agency: OW, Office of Water. OGWDW, Office of Ground Water and Drinking Water. OST, Office of Science and Technology. OPPTS, Office of Prevention, Pesticides and Toxic Substances. OPP, Office of Pesticide Programs.
Statutory authority: Sec., section. na, not applicable. SDWA, Safe Drinking Water Act. CWA, Clean Water Act. FFDCA, Federal Food, Drug, and Cosmetic Act.
Regulatory status: Agency responsible for enforcing standard shown in parenthesis. MCL, maximum contaminant level. G, guideline, not enforceable at the Federal level; N, subject to Administrative Protections Act notice and comment procedures; S, standard, enforceable regulatory limit.
Applicable medium: Type of environmental sample that should be compared with the standard or guideline.
Resource protected: Resource that the standard or guideline was designed to protect. Beneficial use of hydrologic system shown in parentheses: AL, aquatic life. DW, drinking water consumption. FS, fish and shellfish consumption. W, wildlife.
Acronyms: EPA, U.S. Environmental Protection Agency. FDA, Food and Drug Administration. NAS, National Academy of Sciences. NAS/NAE, National Academy of Sciences and National Academy of Engineering. NRC, National Research Council.

Type of standards or guidelines	Issuing agency	Statutory authority	Regulatory status	Applicable medium	Resource protected	Primary source
EPA primary drinking-water regulations	EPA:OW:OGWDW	Sec. 1401, 1412 of SDWA	S,N:MCLs only (EPA) G,N:other	Drinking water	Human health (DW)	([1]) EPA (1991a,c; 1992d)
EPA drinking-water health advisories	EPA:OW:OST	na[2]	G	Drinking water	Human health (DW)	([3])
NAS drinking water and health recommendations	NAS	na	G	Drinking water	Human health (DW)	NRC (1977; 1980b, 1983; 1986)
EPA ambient water-quality criteria for human health	EPA:OW:OST	Sec. 304(a) of CWA	G,N	Ambient water	Human health (DW, FS)	EPA (1980a-k; 1984a)[4]
EPA ambient water-quality criteria for aquatic organisms	EPA:OW:OST	Sec. 304(a) of CWA	G,N	Ambient water	Aquatic life (AL)	EPA (1980a-i; 1984a; 1986c-f)
NAS/NAE recommended maximum concentrations in water	NAS/NAE	na	G	Ambient water	Aquatic life (AL)	NAS/NAE (1973)
EPA sediment-quality criteria (interim, tentative, and proposed)	EPA:OW:OST	Sec. 304(a) of CWA	G,N	Bed sediment	Benthic organisms (AL)[5]	EPA (1988d; 1990a; 1993f,g; 1994)
FDA action levels	FDA	Sec. 402, 406 of FFDCA	S,N (FDA)	Fish and shellfish (edible)	Human health (FS)	FDA (1989)
EPA tolerances	EPA:OPPTS:OPP	Sec. 402, 408 of FFDCA	S,N (FDA)	Fish and shellfish (edible)	Human health (FS)	([6])
EPA fish-tissue concentrations	EPA, Region IV[7]	Sec. 304 (a) of CWA	G	Fish and shellfish (edible)	Human health (FS)	EPA (1993a)[8]
EPA recommended screening values	EPA:OW:OST	na	G	Fish and shellfish (edible)	Human health (FS)	EPA (1993e)
NAS/NAE recommended maximum tissue concentrations	NAS/NAE	na	G	Fish (whole)	Fish-eating wildlife (W)	NAS/NAE (1973)

[1]Code of Federal Regulations, v. 40, Parts 141.50 and 141.61.
[2]EPA's Health Advisory Program was initiated to provide information to individuals or agencies concerned with potential risk from drinking-water contaminants for which no national regulations currently exist. Health advisories comprise guidance that can be used for risk assessment if a contamination incident occurs (EPA, 1988e). For some pesticides, primary drinking water regulations were subsequently implemented.
[3]Individual health advisory documents, updated as necessary (for example, EPA 1990c; 1992e-g).
[4]Published values only. Recalculated (updated) values are in EPA (1992a).
[5]Interim criteria for some pesticides are based on their potential to bioaccumulate and therefore also protect humans or wildlife that consume aquatic organisms.
[6]Code of Federal Regulations, v. 40, Part 180.
[7]Based on water-quality criteria for human health, established by EPA:OW:OST.
[8]Values are intermediate in the calculation of recalculated (updated) EPA human-health criteria.

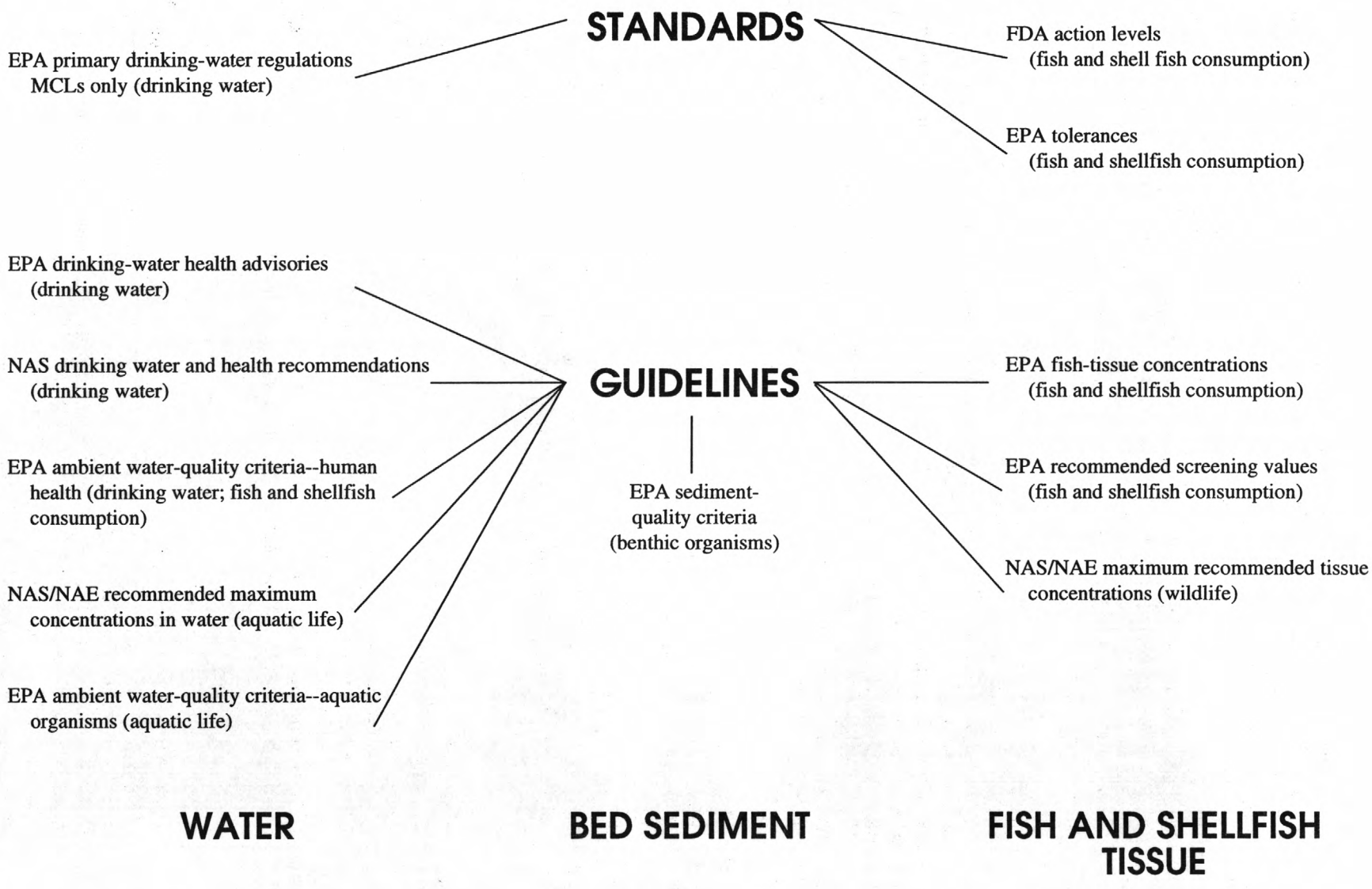


Figure 1. National standards and guidelines for pesticides in water, bed sediment, and fish and shellfish tissue. Beneficial use is listed in parentheses. **Acronyms**: EPA, U.S. Environmental Protection Agency. FDA, Food and Drug Administration. MCLs, maximum contaminant levels. NAS, National Academy of Sciences. NAS/NAE, National Academy of Sciences and National Academy of Engineering.

Many States use Federal guidelines as the basis for State standards. Federal guidelines generally are designed to protect human health, aquatic organisms, or wildlife, and do not reflect factors such as economic feasibility or analytical detection limit. Examples include EPA drinking-water health advisories, ambient water-quality criteria for the protection of human health (also called EPA human-health criteria), and ambient water-quality criteria for the protection of aquatic organisms (also called EPA aquatic-life criteria). All are established by EPA's Office of Water. A related set of guidelines is called EPA fish-tissue concentrations. This terminology is from EPA Region IV in Atlanta, Georgia (U.S. Environmental Protection Agency, 1993a). EPA fish tissue concentrations are an intermediate calculation in the derivation of EPA ambient water-quality criteria for human health. They were derived in individual ambient water-quality criteria documents by EPA's Office of Water (U.S. Environmental Protection Agency, 1980a-k; 1984a), and they were subsequently updated on the basis of revised toxicity or carcinogenicity information, compiled, and distributed by EPA Region IV (U.S. Environmental Protection Agency, 1993a).

This report also lists U.S. Environmental Protection Agency (1993e) recommended screening values for pesticides in fish and shellfish tissue. EPA defined screening values as concentrations of target analytes in fish and shellfish tissues that are of public health concern and that are used as standards against which levels of contamination in similar tissue collected from the ambient environment can be compared. These values were published recently in volume 1 of an EPA document that provides nonregulatory, technical guidance to the States on methods for sampling and analyzing contaminants in fish and shellfish tissue "that will promote consistency in the data States use to determine the need for fish consumption advisories" (U.S. Environmental Protection Agency, 1993e). This guidance document includes risk-based procedures for calculating screening values for target analytes as well as numeric screening values for various analytes, including a number of pesticides. Although EPA recommended screening values do not constitute regulatory requirements, they may be used by the States in issuing fish consumption advisories.

In two areas related to pesticide contamination of environmental samples, EPA is developing new guidelines: sediment-quality criteria and wildlife criteria. Sediment-quality criteria have been proposed for two pesticides and three polycyclic aromatic hydrocarbons (PAHs) (U.S. Environmental Protection Agency, 1994). In addition, two documents containing preliminary sediment-quality criteria values for additional pesticides were available at one time from EPA (U.S. Environmental Protection Agency, 1988d; 1990a). The values therein are likely to be replaced by revised values as additional sediment-quality criteria are proposed by EPA in the future. Nonetheless, these preliminary values provide an indication of what contaminant concentrations may be of concern and are useful on an interim basis, and so they are included in this report. Draft national wildlife criteria are not yet available from EPA, and are not included in this report.

Also within the scope of this report are guidelines developed by the National Academy of Sciences (NAS), either alone or jointly with the National Academy of Engineering. These guidelines were obtained from the primary source references, a 9-volume series by NAS on drinking water and health (National Research Council, 1977; 1980a,b; 1982; 1983; 1986; 1987a,b; 1989) and a single volume by NAS/NAE containing maximum recommended concentrations of contaminants in water and tissues for protection of aquatic life and wildlife (National Academy of Sciences and National Academy of Engineering, 1973). Although much of the information in the latter report is dated, it is useful in assessing the effects of pesticides on aquatic organisms and wildlife when EPA aquatic-life criteria are not available.

APPROACH

Current (1993) values for pesticide standards and guidelines were extracted from various sources and compiled in tables 3-6 (at back of report). More recent (January 1994) values are included for two sets of guidelines because these were published subsequently: EPA recommended screening values for pesticides in fish and shellfish tissue and EPA proposed sediment-quality criteria for protection of benthic organisms (U.S. Environmental Protection Agency, 1993e,f,g; 1994). All original source documents were obtained, and standard and guideline values were verified. Three previous compilations were particularly useful in identifying original source documents: U.S. Environmental Protection Agency (1991b; 1993a), and the IRIS data base (U.S. Environmental Protection Agency, 1993b). In addition, relevant Federal Register notices and other publications were identified by reviewing various newsletters and consulting

EPA's Safe Drinking Water Hotline, EPA's Hazardous Waste (Resources Conservation and Recovery Act (RCRA) - Superfund) Hotline, as well as representatives from various source agencies and offices: EPA's Office of Pesticides Programs, Office of Water, Office of Solid Waste, Office of Research and Development, and EPA Laboratories in Cincinnati, Ohio and Duluth, Minnesota; FDA's Office of Regulatory Affairs, and Center for Food Safety and Applied Nutrition; U.S. Fish and Wildlife Service; U.S. Geological Survey; and National Academy of Sciences.

A number of discrepancies were found between values from different references. All discrepancies were investigated and explained to the extent possible. Discrepancies were resolved readily for enforceable standards by consulting primary source documents: EPA primary drinking-water regulations from the Code of Federal Regulations, Volume 40, Part 141, and appropriate Federal Register notices publishing changes therein (U.S. Environmental Protection Agency, 1991a,c; 1992d); EPA tolerances from the Code of Federal Regulations, Volume 40, Part 180; and FDA action levels from FDA's Compliance Policy Guide 7141.01, Attachment B (Food and Drug Administration, 1989). Only current values for these standards were included in the tables in this report.

Discrepancies involving guidelines among different references were more difficult to resolve, especially when a primary source document was contradicted by a more recent compilation. Some discrepancies in subsequent publications represented an update or correction, and other discrepancies, an error. All multiple values for the same guideline were included in tables 3-6; each is attributed to the appropriate reference(s). An explanation for the discrepancy is included, to the extent possible, in the status code for that guideline or as a footnote in the table. Discrepancies were particularly common for the following guidelines:

1. EPA drinking-water health advisories. These are updated frequently. The most recent version can be difficult to identify because health advisories do not undergo APA public notice and comment procedures. The most recent values are reported in EPA's periodic summary of drinking-water regulations and health advisories (U.S. Environmental Protection Agency, 1993c); however, the values therein can be difficult to verify because this periodic compilation does not include references or information on the technical basis for current values. The values in U.S. Environmental Protection Agency (1993c) do not always correspond with the most recent health-advisory document. Sometimes the rationale for recent changes is available in the IRIS data base (U.S. Environmental Protection Agency, 1993b); however, no published rationale is available for a number of revised values in U.S. Environmental Protection Agency (1993c). When health advisory values reported in an earlier reference are clearly superseded by more recent values, they have been identified as superseded in table 3, section 2; where there is some ambiguity, this too is indicated.

2. EPA ambient water-quality criteria for the protection of human health. Discrepancies occur primarily because there are two sets of human-health criteria: published criteria issued by EPA as Section 304(a) (CWA) guidance to the States, which have undergone APA public notice and comment procedures (U.S. Environmental Protection Agency, 1980a-k; 1984a), and recalculated values based on updated human-health data from the IRIS data base (as of September 1990). Both sets of values are included in table 3, section 4, along with references and the technical basis for the recalculated criteria values. When it may be appropriate to use one set of values over the other is discussed in the section entitled "U.S. Environmental Protection Agency Ambient Water-Quality Criteria for the Protection of Human Health."

NATIONAL STANDARDS AND GUIDELINES FOR PESTICIDES IN WATER, BED SEDIMENT AND AQUATIC ORGANISMS

Each type of national standard or guideline in this report is specific for one sampling medium (water, bed sediment, or fish and shellfish tissue) and is aimed at protection of one or more beneficial uses of water (drinking water, fish and shellfish consumption, aquatic organisms, and (or) wildlife). These characteristics can be used to identify standards and guidelines that are appropriate for comparison with measured pesticide concentrations in environmental samples from a given hydrologic system:

1. Sampling medium. Review of standards and guidelines can be restricted to the applicable sampling medium: Water (table 3), bed sediment (table 4), or fish and shellfish tissue (table 5).

2. Beneficial uses. Pesticide concentrations in samples from the given hydrologic system need to be compared with standards and guidelines for all beneficial uses that apply to that hydrologic system.

Standards and guidelines appropriate for each beneficial use are summarized by sampling medium in figure 2. Two general principles apply within each sampling medium and beneficial use grouping: (1) It is appropriate to compare pesticide concentrations in samples with both standards and guidelines for a given target analyte (if both exist) because standards and guidelines often differ in their technical bases and in the implications and consequences of finding measured concentrations in exceedance of standard or guideline values. (2) Guidelines from the National Academy of Sciences are useful primarily when EPA guidelines for the same sampling medium and beneficial use are not available for a given target analyte. Details are provided for individual standards and guidelines in the various sections entitled "Use in Evaluation of Environmental Data."

The standards and guidelines in this report are organized to facilitate comparison with measured concentrations in environmental samples. Preceding the standards and guidelines, certain general information on each pesticide is provided: Chemical Abstract Services registry number, priority pollutant status, and EPA carcinogenicity classification (table 3, section 1). Standards and guidelines in this report are divided into groups by sampling medium, as follows: WATER (table 3, sections 1 through 5), which is subdivided into DRINKING WATER (sections 1 through 3) and AMBIENT SURFACE WATER (sections 4 and 5); BED SEDIMENT (table 4); FISH AND SHELLFISH TISSUE (table 5, sections 1 through 3), which is subdivided into EDIBLE FISH AND SHELLFISH TISSUE (sections 1 and 2) and WHOLE FISH TISSUE (section 3). For convenience, the Chemical Abstracts Services registry number and priority pollutant status are repeated in table 4 and in table 5, section 1.

Each type of standard or guideline within the scope of this report is defined below in the same order that values are presented in tables 3-5. For each category of standard or guideline, the entry is divided into three parts: (1) Definitions, including mathematical derivation and underlying assumptions; (2) discussion focusing on how the standard or guideline can be used to interpret environmental data; and (3) primary and secondary source references. All definitions are keyed to these tables and to specific columns within them.

Because different guideline values sometimes are reported in different source references, tables 3-5 may list more than one value for a given guideline for a specific pesticide. To determine which value is most appropriate, check (1) for a status code, (2) for an explanation in footnotes, and (3) the date and (for EPA guidelines) the issuing EPA office of the source reference. Superseded values are noted as such in a footnote or with an appropriate status code.

Chemical name. In general, pesticides are listed alphabetically by common name, with alternative names provided in parentheses. Exceptions are pesticides for which standards or guidelines are listed under a trade name in the original references; in these cases, the compound is listed in tables 3-5 by the trade name, with the common name in parentheses.

Chemical Abstracts Services (CAS) Registry Number. This identifying number is provided at the beginning of table 3, section 1; table 4; and table 5, section 1, to aid in identifying compounds that may be known by multiple names.

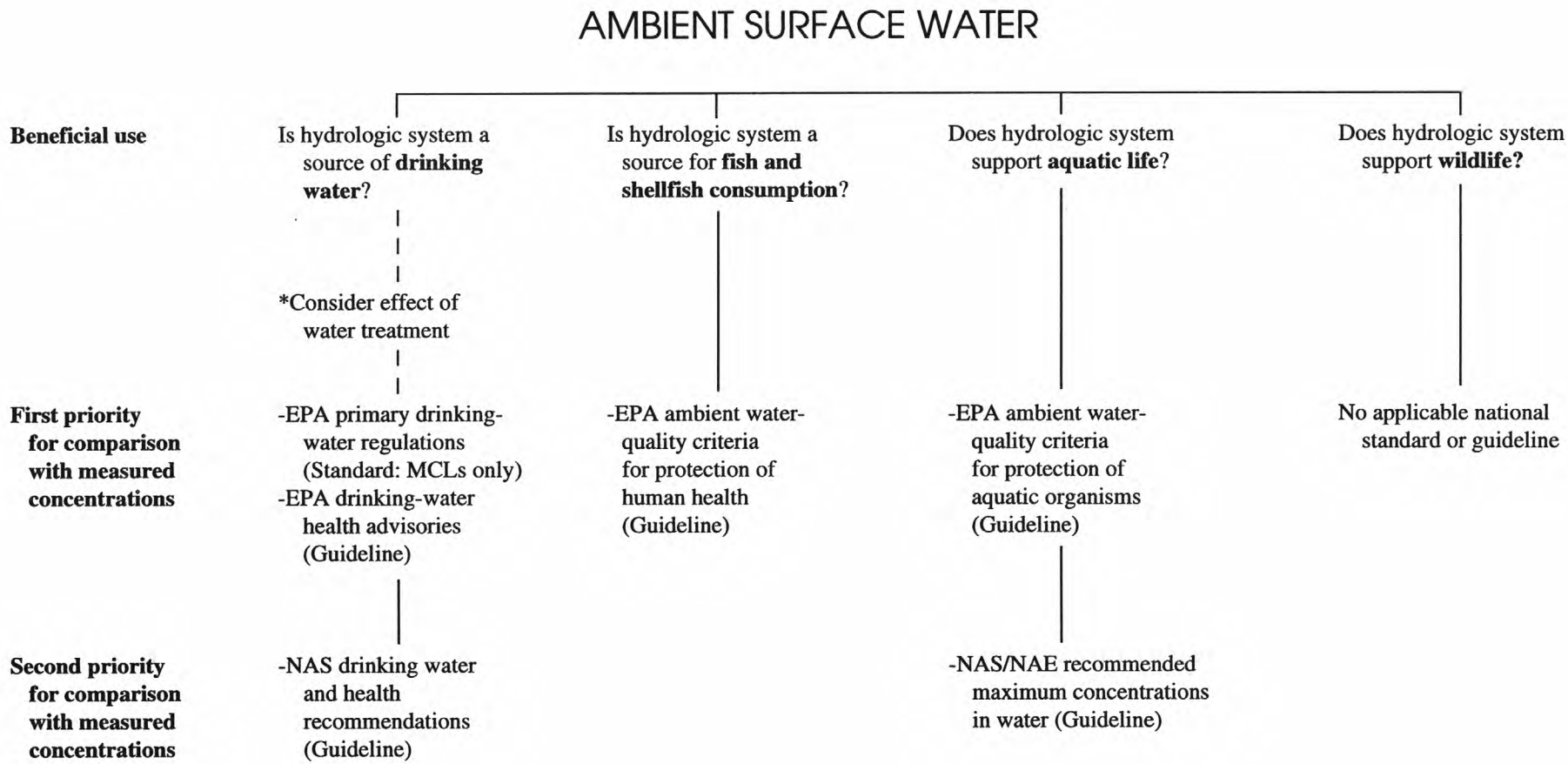
Priority pollutant status. Priority pollutant status is provided in table 3, section 1; table 4; and table 5, section 1. As required by Section 307 of the Federal Water Pollution Control Act (FWPCA), EPA designated a list of priority toxic pollutants. At present, there are 126 priority toxic pollutants. The list is published as Appendix A to Code of Federal Regulations, volume 40, Part 423. Priority pollutant status indicates that State standards exist.

DRINKING WATER AND GROUND WATER

Beneficial use	Is hydrologic system a source of **drinking water**?	Is hydrologic system a source for **fish and shellfish consumption**?	Does hydrologic system support **aquatic life**?	Does hydrologic system support **wildlife?**
First priority for comparison with measured concentrations	-EPA primary drinking-water regulations (Standard: MCLs only) -EPA drinking-water health advisories (Guideline)	No applicable national standard or guideline	No applicable national standard or guideline	No applicable national standard or guideline
Second priority for comparison with measured concentrations (Use if no first priority standards or guidelines are available.)	-NAS drinking water and health recommendations (Guideline)			

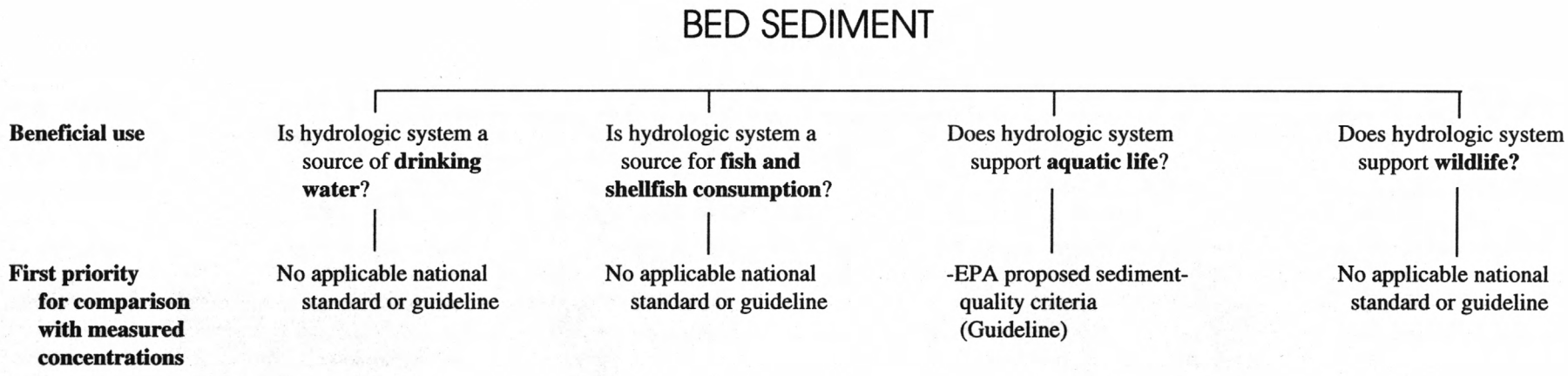
(*A*)

Figure 2. How to select appropriate national standards and guidelines for comparison with measured pesticide concentrations based on the beneficial uses of the hydrologic system, by sampling medium. (*A*), Drinking water and ground water; (*B*), ambient surface water; (*C*), bed sediment; (*D*), edible fish and shellfish tissue; and (*E*), whole fish tissue. ¦, Listed standards and guidelines may not be directly applicable to sampling medium, so comparison should consider factor denoted by asterisk (*). Regulatory status is given in parentheses. **Acronyms**: EPA, U.S. Environmental Protection Agency; FDA, Food and Drug Administration; MCL, maximum contaminant level; NAS, National Academy of Sciences; NAS/NAE, National Academy of Sciences and National Academy of Engineering. (**Note**: Data should be compared with all first priority standards and guidelines applicable to the hydrologic system. Second priority guidelines should be used when first priority standards and guidelines do not exist for a given pesticide.



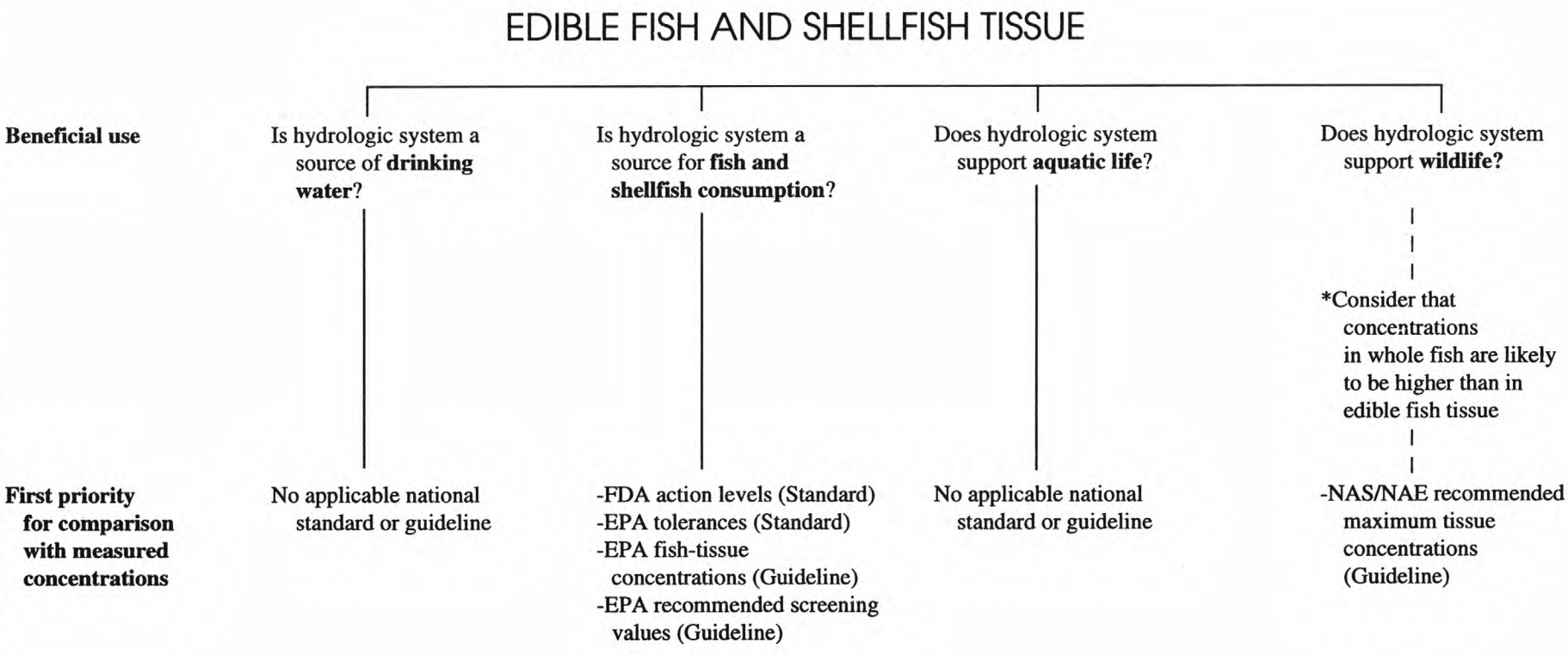
(*B*)

Figure 2. *Continued.*



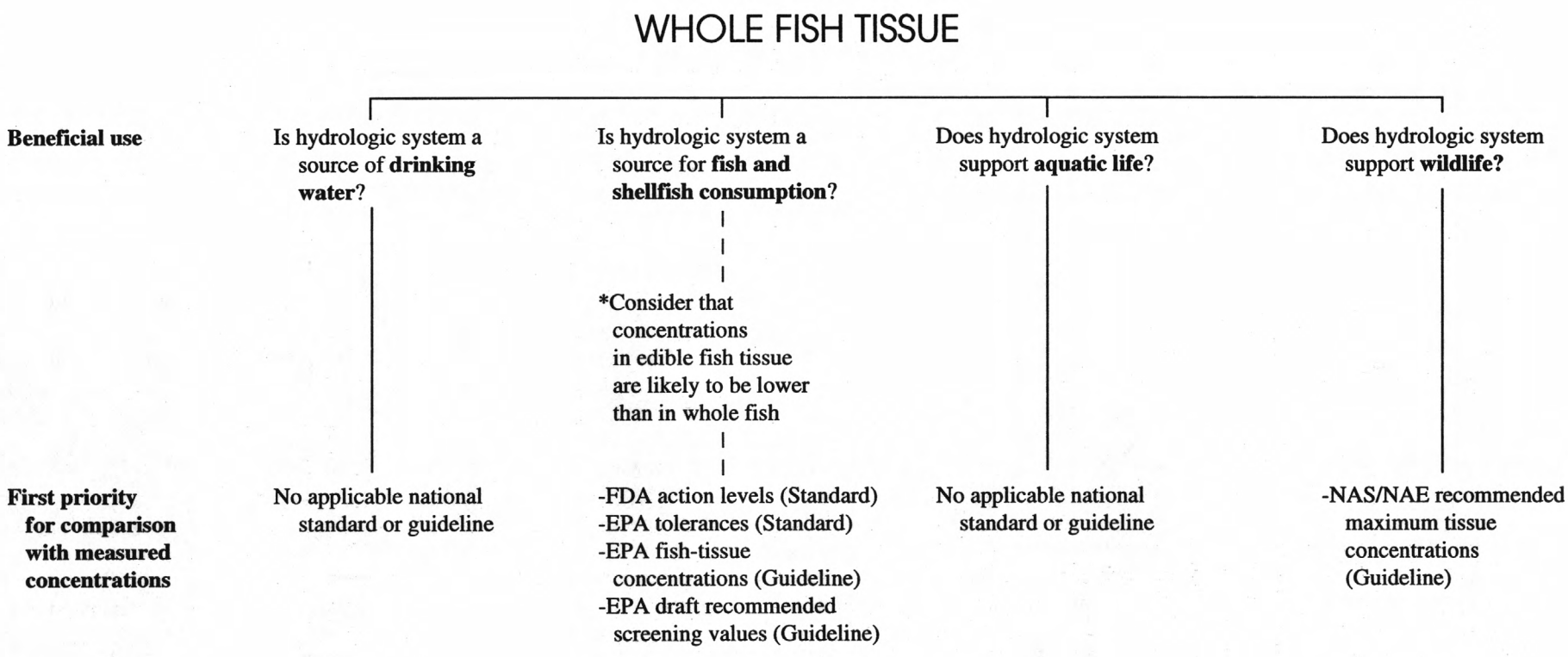
(C)

Figure 2. *Continued.*



(*D*)

Figure 2. *Continued.*



(*E*)

Figure 2. *Continued.*

EPA Carcinogenicity Classification. EPA's carcinogenicity classification is provided in table 3, section 1, columns A and B. This includes classification into one of five cancer groups (column A) and, for known or probable carcinogens, the cancer potency factor (or q_1^* value, in column B). EPA's approach to categorizing chemicals by their carcinogenic potential (U.S. Environmental Protection Agency, 1986b; 1988e) is summarized as follows:

Group A: Human carcinogen—compounds for which there is sufficient evidence in epidemiologic studies to support causal association between exposure and cancer.

Group B: Probable human carcinogen—compounds for which there is limited evidence in epidemiologic studies (Group B1) or sufficient evidence from animal studies (Group B2) to support causal association between exposure and cancer.

Group C: Possible human carcinogen—compounds for which there is limited or equivocal evidence from animal studies and inadequate or no data in humans to support causal association between exposure and cancer.

Group D: Not classified—compounds for which there is inadequate or no human or animal evidence of carcinogenicity.

Group E: No evidence of carcinogenicity for humans—compounds for which there is no evidence of carcinogenicity in at least two adequate animal tests in different species or in adequate epidemiological and animal studies.

Other factors such as genotoxicity, structure-activity relations, and incidence of benign compared to malignant tumors also may influence classification. The EPA carcinogenicity classification (cancer group) for each pesticide (if available) is shown in table 3, section 1, column A.

For known (Group A) or probable (Group B) human carcinogens, EPA uses a linearized multistage model to estimate a cancer potency factor for humans, q_1^* (also called carcinogenic potency, unit cancer risk, or oral slope factor), with the 95-percent upper-confidence limit providing a low-dose estimate of cancer risk. The q_1^* value (table 3, section 1, column B) is expressed in units of $[(\text{milligram of contaminant per kilogram body weight}) \text{ per day}]^{-1}$. The linearized multistage model is one of several mathematical models that can be used in carcinogen risk assessment; others include the one-hit, Weibull, logit, and probit models. Because the mechanism of cancer is not well understood, there is no evidence to indicate that one model can predict risk more accurately than another (U.S. Environmental Protection Agency, 1989b). The linearized multistage model tends to be conservative (over-protective) (U.S. Environmental Protection Agency, 1989b). This model fits linear dose-response curves to low doses (National Research Council, 1986) and is consistent with a zero-threshold model of carcinogenesis (in other words, exposure to even a small amount of a carcinogen produces a finite excess cancer risk) (U.S. Environmental Protection Agency, 1989b).

The q_1^* value generally is based on dose-response data from lifetime-exposure studies in animals. When several carcinogenicity studies for a single compound are adequate for quantitative risk estimation, EPA generally estimates cancer potency for each data set, then takes the geometric mean of the potency estimates as the cancer potency for that compound for the general population (the q_1^*). The q_1^* value then is used to estimate the upper-bound excess cancer risk associated with lifelong exposure to that carcinogen in drinking water (also called risk specific dose; table 3, section 2, column L), both water and aquatic organisms (table 3, section 4, column P), or aquatic organisms only (table 3, section 4, column Q).

Use in evaluation of environmental data. Carcinogenicity classification information is not intended for direct comparison with environmental data. It consists of technical information that may be useful in interpreting potential human-health effects at measured environmental levels.

Primary and secondary references. Primary sources for carcinogenicity information are the drinking-water health-advisory documents for individual pesticides (for example, U.S. Environmental Protection Agency, 1988f; 1990c; 1992e-g). Secondary sources that include the rationale for the carcinogenicity classification are various compilations of drinking-water health advisories (U.S. Environmental Protection Agency, 1987a,b; 1988a-c; 1989a,b) and IRIS (U.S. Environmental Protection Agency, 1993b). Secondary sources without the technical basis for the classification include U.S. Environmental Protection Agency (1992c; 1993c).

WATER

There are so many standards and guidelines applicable to water measurements that table 3 was divided into five sections: Standards and guidelines in sections 1 through 4 are for protection of human health; of these, sections 1 through 3 apply to drinking water and section 4 applies to ambient surface water. Guidelines in table 3, section 5, are for protection of aquatic organisms and apply to ambient surface water.

It is appropriate to compare environmental concentrations in water with applicable standards and guidelines in all five parts of table 3, depending on the source and beneficial uses of the water sampled (fig. 2). For pesticide data in ground water, measured concentrations can be compared with EPA primary drinking-water regulations (table 3, section 1, columns C and D), EPA drinking-water health advisories (table 3, section 2, columns E through L), and NAS drinking-water and health recommendations (table 3, section 3, columns M through O). Surface freshwater data can be compared with these same standards and guidelines if it is used as a drinking-water source, although it should be noted that these standards and guidelines apply to finished drinking water (potable water delivered to the consumer, which sometimes has been treated). Water-treatment processes, such as filtration, may reduce concentrations of some pesticides, especially those associated with particulates. In addition, surface-water data can be compared to the guidelines for ambient surface water, namely, EPA water-quality criteria for the protection of human health (table 3, section 4, columns P and Q) and those for the protection of freshwater aquatic organisms (table 3, section 5, columns S and T), as well as NAS/NAE recommended maximum concentrations in water for protection of freshwater aquatic life (table 3, section 5, column W). Marine data can be compared with EPA water-quality criteria for the protection of saltwater aquatic organisms (table 3, section 5, columns U and V), and NAS/NAE recommended maximum concentrations in water for protection of marine aquatic life (table 3, section 5, column X).

DRINKING WATER

U.S. Environmental Protection Agency Primary Drinking-Water Regulations

Primary drinking-water regulations are established by EPA's Office of Ground Water and Drinking Water, within the Office of Water, for contaminants that may adversely affect human health and are known or anticipated to exist in public water systems. The Safe Drinking Water Act requires that EPA publish a maximum contaminant level goal (MCLG, a nonenforceable health goal) for such a contaminant. At the same time EPA publishes an MCLG, the agency also must promulgate either a maximum contaminant level (MCL) or a required treatment technique. Primary drinking-water regulations undergo APA public notice and comment procedures before promulgation in a final rule.

Maximum contaminant level (MCL).--The MCL, expressed in milligrams of contaminant per liter (table 3, section 1, column C), is the maximum permissible level of a contaminant in water that is delivered to any user of a public water system. This is an enforceable standard, established on the basis of health effects, organoleptic effects, treatment feasibility, cost of treatment, and analytical detection, and is set as close to the MCLG as is feasible. As required by the Safe Drinking Water Act, the MCL is promulgated together with the MCLG.

Proposed maximum contaminant level (proposed MCL).--The proposed MCL (expressed in milligrams of contaminant per liter) is the maximum permissible level of a contaminant in water that is delivered to any user of a public water system. This level is set as close to the proposed MCLG as is practical. A proposed MCL has not yet been through the APA public notice and comment procedures. When an MCL or treatment technique has not been promulgated, a proposed MCL may be used for guidance.

Maximum contaminant level goal (MCLG).--The MCLG, expressed in milligrams of contaminant per liter (table 3, section 1, column D), is a nonenforceable concentration of a drinking-water contaminant that is protective of adverse human-health effects and allows an adequate margin of safety. This MCLG is set at zero for known or probable human carcinogens. An MCLG must be promulgated simultaneously with an MCL or treatment technique. For noncarcinogens, the MCLG is equivalent to the lifetime health advisory (when both values are final).

Proposed maximum contaminant level goal (proposed MCLG).--The proposed MCLG (expressed in milligrams of contaminant per liter) is a nonenforceable concentration of a drinking-water contaminant that is protective of adverse human-health effects and allows an adequate margin of safety. The proposed MCLG is set at zero for known or probable human carcinogens, and must be proposed simultaneously with a proposed MCL or treatment technique. As with the proposed MCL, a proposed MCLG has not been through the APA public notice and comment procedures.

Required treatment technique.--Requirements for drinking water treatment can be established in lieu of an MCL for a given contaminant when it is not economically or technically feasible to establish a quantifiable level of that contaminant for compliance purposes. Treatment techniques have not been established in lieu of MCLs for any pesticides within the scope of this report.

Use in evaluation of environmental data.--Of EPA's primary drinking-water regulations, the MCLs are the only enforceable standards (table 3, section 1, column C). The regulatory consequences of exceeding the MCL for a given compound are beyond the scope of this report. Sampling and analytical requirements for determining compliance with the MCL (when its status is final) depend on the water system, the compound, and the frequency of violation (Code of Federal Regulations, v. 40, subpart C). Scientifically, measured concentrations greater than MCLGs (table 3, section 1, column D) may indicate potential adverse health effects over a lifetime exposure. Comparison with various health advisories, determined for adults and children and for various exposure periods, may help in interpreting potential effects associated with consumption of drinking water containing the measured pesticide residues.

Primary and secondary references.--The primary source for EPA primary drinking-water regulations for pesticides is the Code of Federal Regulations, volume 40, Parts 141.61 (MCLs) and 141.50 (MCLGs). In addition, both proposed and final primary drinking-water regulations are published in the Federal Register (for example, U.S. Environmental Protection Agency, 1989c; 1991a,c; 1992d). Each regulation is supported by a drinking-water criteria document containing detailed technical information on which the regulation was based (for example, U.S. Environmental Protection Agency, 1990b). Secondary sources for primary drinking-water regulations include EPA's periodic summary of drinking-water regulations and health advisories (U.S. Environmental Protection Agency, 1993c) and EPA's IRIS data base (U.S. Environmental Protection Agency, 1993b).

U.S. Environmental Protection Agency Secondary Drinking-Water Regulations

Secondary drinking-water regulations are nonenforceable guidelines based on esthetics. They are issued by EPA's Office of Ground Water and Drinking Water within the Office of Water.

Secondary maximum contaminant levels (SMCLs).--SMCLs (expressed in milligrams of contaminant per liter) are established for contaminants that can adversely affect the odor or appearance of water and result in the discontinuation of its use. There are no final SMCLs for any pesticides (December 1993).

Proposed secondary maximum contaminant levels (proposed SMCLs).--Proposed SMCLs (expressed in milligrams of contaminant per liter) are nonenforceable guidelines that have not been through the APA public notice and comment process. Like the SMCLs, the proposed SMCLs are based on esthetics, for contaminants that can adversely affect the odor or appearance of water and result in the discontinuation of its use. Proposed SMCLs are provided in footnotes appended to the chemical name in table 3, section 1, where applicable.

Use in evaluation of environmental data.--SMCLs are nonenforceable guidelines. However, measured concentrations that are greater than SMCLs or proposed SMCLs may indicate potential taste and odor problems.

Primary and secondary references.--In general, the primary source reference for secondary drinking-water regulations is the Code of Federal Regulations, volume 40, Part 143.3. However, no final SMCLs for pesticides exist at this time (December 1993). Secondary drinking-water regulations for one pesticide were proposed (pentachlorophenol, U.S. Environmental Protection Agency, 1989c) and subsequently deferred (U.S. Environmental Protection Agency, 1993b).

U.S. Environmental Protection Agency Health Advisories

Drinking-water health advisories (table 3, section 2, columns E through L) are issued by EPA's Office of Science and Technology within the Office of Water. They are nonregulatory levels of contaminants in drinking water that may be used for guidance in the absence of regulatory limits. They consist of estimates of concentrations that would result in no known or anticipated health effects (or for carcinogens, a specified cancer risk), determined for a child or for an adult for various exposure periods. They are calculated from the no-observed-adverse-effect level (NOAEL) or the lowest-observed-adverse-effect level (LOAEL) in suitable toxicity or carcinogenicity tests, making assumptions about body weight and drinking-water consumption, and incorporating uncertainty factors.

The uncertainty factor selected for each pesticide depends on the quality and quantity of data available. With slight modification, EPA's Office of Water has followed the recommendations of the National Academy of Sciences (National Research Council, 1977; 1980a) regarding selection of uncertainty factors. Uncertainty factors usually range from 10 to 10,000, depending on the type and quality of available data (assessed using scientific judgment). An uncertainty factor of 10 generally is used when chronic or subchronic human-exposure data identifying a NOAEL are available and are supported by chronic or subchronic toxicity data in other animal species. An uncertainty factor of 100 generally is used when chronic toxicity data identifying a NOAEL are available for one or more animal species (and human data are not available), or when chronic or subchronic toxicity data identifying a LOAEL in humans are available. An uncertainty factor of 1,000 generally is used either when limited or incomplete chronic toxicity data are available, or when chronic data that identify a LOAEL but not a NOAEL for one or more animal species are available, or when chronic or subchronic toxicity data identifying a LOAEL in humans are available. An uncertainty factor of 10,000 may be used when a subchronic toxicity identifying a LOAEL but not a NOAEL is used (U.S. Environmental Protection Agency, 1989b).

The underlying principles, based on National Academy of Sciences recommendations, are to apply a factor of 10 for each of the following, where applicable: variation in population, interspecies differences (if the toxicity data used are from animal tests), or the lack of a NOAEL in human or animal tests (if the basis for the health advisory is a LOAEL). For lifetime health advisories based on NOAELs in animal tests, an additional factor of 10 may be added (making a total uncertainty factor of 1,000) for sensitive individuals or less-than-lifetime exposure (U.S. Environmental Protection Agency, 1988e). Additional uncertainty factors ranging from 1 to 10 may be incorporated for deficiencies in the data base, quality of the data, or severity of the effect (U.S. Environmental Protection Agency, 1988e).

Health advisories for a child include 1-day, 10-day, and longer-term health-advisory values. Health advisories for an adult include longer-term health advisory, the reference dose (RfD), drinking water equivalent level (DWEL), and lifetime health-advisory values. For known or probable human carcinogens,

concentrations associated with excess cancer risk levels of 10^{-4}, 10^{-5}, and 10^{-6} are calculated in lieu of lifetime health-advisory levels. Ideally, each drinking-water health advisory is based on data from studies involving oral administration of the contaminant for an appropriate duration of exposure (specified as part of the following definitions).

One-day health advisory (child).--The 1-day health advisory, expressed in milligrams of contaminant per liter (table 3, section 2, column E), is calculated for a 10-kg child based on data describing noncarcinogenic endpoints of toxicity, and is intended to protect a child exposed for 1 day. The preferred study duration is from 1 to 5 successive daily doses. The 1-day health advisory assumes 10-kg body weight and consumption of 1 liter per day (L/d) of drinking water. If suitable toxicity tests are not available, the 10-day or longer-term child health advisory may be used as a conservative estimate of the 1-day health advisory (U.S. Environmental Protection Agency, 1988e).

Ten-day health advisory (child).--The 10-day health advisory, expressed in milligrams of contaminant per liter (table 3, section 2, column F), is calculated for a 10-kg child based on data describing noncarcinogenic endpoints of toxicity, and is intended to protect a child exposed for less than 1 month. The preferred study duration is from 7 to 30 successive daily doses. The 10-day health advisory assumes 10-kg body weight and consumption of 1 L/d of drinking water. If suitable toxicity tests are not available, the longer-term child health advisory may be used as a conservative estimate of the 10-day health advisory (U.S. Environmental Protection Agency, 1988e).

Longer-term health advisory (child and adult).--Separate longer-term health advisories, expressed in milligrams of contaminant per liter, are calculated for a 10-kg child (table 3, section 2, column G) and a 70-kg adult (table 3, section 2, column H), based on data describing noncarcinogenic endpoints of toxicity. They are intended to represent about 7 years, or 10 percent of an individual's lifetime. The preferred study duration is 10 percent of the animal's lifetime (about 90 days for rats or mice). The child health advisory assumes consumption of 1 L/d of drinking water and the adult health advisory assumes consumption of 2 L/d of drinking water. If suitable toxicity tests are not available, the DWEL may be used as a conservative estimate of the longer-term adult health advisory, and the DWEL, adjusted for a 10-kg child, as a conservative estimate of the longer-term child health advisory (U.S. Environmental Protection Agency, 1988e).

Reference dose (RfD).--The RfD (table 3, section 2, column I) is an estimate (with an uncertainty of perhaps one order of magnitude) of the daily exposure that is likely to be without appreciable risk of deleterious health effects in the human population (including sensitive subgroups) over an individual's lifetime (70 years). The RfD, expressed in milligrams of contaminant per kilogram of body weight per day (mg/kg)/d) is used to calculate the lifetime health advisory. The RfD was formerly called the acceptable daily intake (ADI). The RfD is calculated from the NOAEL in chronic tests (2 years for rats or mice), divided by an uncertainty factor. If subchronic tests are used, an additional uncertainty factor of 10 is added (U.S. Environmental Protection Agency, 1988e).

Drinking-water equivalent level (DWEL).--The DWEL, expressed in milligrams of contaminant per liter, (table 3, section 2, column J) is an intermediate calculation in the derivation of the lifetime health advisory. The DWEL is the highest lifetime-exposure level in drinking water, assuming 100 percent exposure from that medium, at which adverse noncarcinogenic health effects would not be expected to occur. The DWEL is calculated as follows, assuming 70-kg body weight and consumption of 2 L/d of drinking water (U.S. Environmental Protection Agency, 1988e):

$$\text{DWEL (mg/L)} = \frac{(\text{RfD}) \times (70\text{-kg body wt})}{(2\text{ L water/d})}, \qquad (1)$$

where RfD is the reference dose, in (mg/kg body weight)/d.

Lifetime health advisory.--The lifetime health advisory (table 3, section 2, column K) is established for that part of an individual's lifetime exposure that is attributed to drinking water and is considered protective of noncarcinogenic adverse health effects over a lifetime exposure (70 years). The lifetime

health advisory, expressed in milligrams of contaminant per liter, is calculated from the DWEL, which is based on RfD and assumes a body weight of 70 kg and consumption of 2 L/d of drinking water. The relative source contribution (RSC) from drinking water is assumed to be 20 percent (80 percent of exposure is assumed to come from other sources). The lifetime health advisory is calculated as follows (U.S. Environmental Protection Agency, 1988e):

$$\text{Lifetime health advisory (mg/L)} = \text{DWEL} \times (0.20), \tag{2}$$

where DWEL is the drinking-water equivalent level, in mg/L.

For human carcinogens (Group A) or probable human carcinogens (Group B), a lifetime health advisory is not recommended; instead, a risk-specific dose (RSD) is calculated. For Group C compounds (possible human carcinogens), EPA's Office of Water calculates a lifetime health advisory, but uses an additional uncertainty factor of 10 for potential carcinogenicity.

$$\text{Lifetime health advisory (mg/L)} = \frac{\text{DWEL} \times (0.20)}{10}, \tag{3}$$

where DWEL is the drinking-water equivalent level, in mg/L.

For noncarcinogens, the lifetime health advisory (table 3, section 2, column K) and the maximum contaminant level goal (MCLG) (table 3, section 1, column D) are the same when both values are final. For carcinogens, the MCLG is set at zero.

Risk specific dose (RSD).--RSD values must be associated with a specified cancer risk level, usually 10^{-4}, 10^{-5}, 10^{-6}, or 10^{-7}. The RSD is the concentration in milligrams of contaminant per liter that is associated with the specified cancer risk level, under certain exposure conditions: consumption of 2 L/d of drinking water by a 70-kg body weight individual over a lifetime (70 years). The RSD refers to the excess cancer risk attributed to consumption of drinking water only. RSD values associated with a cancer risk of 10^{-6} are provided in table 3, section 2, column L. RSD values are calculated from the q_1^* value (table 3, section 1, column B), which is the cancer potency estimate for that compound as derived from dose-response (carcinogenicity) data using a linearized multistage model. This model is conservative, so the resulting cancer risk is an upper-limit estimate (U.S. Environmental Protection Agency, 1989b). The RSD is calculated as follows:

$$\text{RSD (mg/L)} = \frac{(70\text{-kg body wt}) \times (\text{risk level})}{(2\text{ L water/d}) \times (q_1^*)}, \tag{4}$$

where q_1^* is the cancer potency factor, in $[(\text{mg/kg body weight})/\text{d}]^{-1}$.

So, the RSD at 10^{-6} cancer risk (in mg/L) =

$$\frac{(70\text{-kg body wt}) \times (10^{-6})}{(2\text{ L water/d}) \times (q_1^*)}, \tag{5}$$

where q_1^* is the cancer potency factor, in $[(\text{mg/kg body weight})/\text{d}]^{-1}$.

This RSD value at 10^{-6} cancer risk level is the concentration of a potential carcinogen (having a cancer potency factor, q^{1*}) in drinking water that is estimated to result in an excess cancer risk of one in a million, assuming consumption of 2 L/d of water contaminated at this (RSD) concentration by a 70-kg body weight individual over a lifetime (70 years).

Use in evaluation of environmental data.--Health advisories indicate concentrations above which the health of a child or an adult may be adversely affected when the child or adult is exposed for various periods. Two general principles hold: (1) The longer the exposure period, the lower the health advisory, and (2) a child tends to be affected at lower concentrations than an adult for a comparable exposure

Table 2. Guidance on use of health-advisory values for risk assessment

[Table adapted from U.S. Environmental Protection Agency, 1988e; for some compounds, risk levels as high as 10^{-4} may be considered protective of public health (U.S. Environmental Protection Agency, 1988e). >, greater than; <, less than]

Contaminant concentration in drinking water (C[water])	Recommended response
C[water] > 1-day child health advisory	Immediate action needed; reduce exposure immediately.
1-day child health advisory > C[water] > 10-day child health advisory	Reduce exposure within about 10 days.
10-day child health advisory > C[water] > Longer-term child or adult health advisory	Conduct site-specific assessment; reduce exposures accordingly.
Longer-term child or adult health advisory > C[water] > Lifetime health advisory or 10^{-6} cancer risk	No immediate risk to public health; develop and implement strategy to reduce contaminant level if desired by risk-management agency.
C[water] < Lifetime health advisory or 10^{-6} excess cancer risk level	Protective of public health.

period. For example, if a contaminant concentration exceeds the lifetime adult health advisory, but does not exceed the longer-term adult or any of the child health advisory levels, then adverse health effects may occur over a lifetime's exposure to this level of contamination in drinking water, but shorter-term exposure is unlikely to adversely affect health. However, if a contaminant concentration exceeds the longer-term adult or any of the child health advisory levels, consumption of this drinking water over the prescribed period by an adult or a child, as appropriate, may adversely affect health.

For carcinogens in drinking water, EPA considers risk levels of 10^{-6} (and for some compounds, risk levels as high as 10^{-4}) to be protective of public health, provided these levels also are protective of noncancer adverse effects (U.S. Environmental Protection Agency, 1988e; table 2). EPA reviews individual State policies on cancer risk levels as part of its water-quality standards oversight function under the Clean Water Act; EPA's policy is to accept cancer risk policies from the States in the range of 10^{-6} to 10^{-4} (U.S. Environmental Protection Agency, 1992a).

Primary and secondary references.--Primary source references for health advisories are individual health advisory documents prepared by U.S. Environmental Protection Agency (such as, 1988f; 1990c; 1992e-g). These documents are updated by EPA when necessary. Secondary sources for health advisory information include several EPA compilations (U.S. Environmental Protection Agency, 1987a,b; 1988a-c; 1989a,b), each of which contains out-of-date information. The most recent health advisory values are reported in EPA's periodic summary of drinking-water regulations and health advisories (U.S. Environmental Protection Agency, 1993c) and IRIS (U.S. Environmental Protection Agency, 1993b). However, these secondary sources do not contain the rationale or technical basis for the health advisories. If accurate and current health advisories are essential, users probably will need to verify current values by checking that the basis for these values has not changed. IRIS (U.S. Environmental Protection Agency, 1993b) is useful in this regard. IRIS contains the RfD and q_1* for most compounds, including the technical bases for these values and the dates these values were entered or last revised. Also, for most chemicals, IRIS lists the name and phone number of the lead scientist responsible for the health advisories for a given chemical. Users also can call EPA's Safe Drinking Water Hotline (800/426-4791) for assistance.

National Academy of Sciences Drinking Water and Health Recommendations

The National Academy of Sciences recommendations for pesticides in drinking water (table 3, section 3, columns M through O) were published in four volumes of a nine-volume series on drinking water and health (National Research Council, 1977; 1980b; 1983; 1986). The other volumes in this series include information on compounds other than pesticides as well as emerging issues in risk assessment, such as risk assessment of mixtures (National Research Council, 1980a; 1982; 1987a,b; 1989).

Acceptable daily intake (ADI).--The ADI (table 3, section 3, column M) is the maximum dose producing no observed adverse (noncarcinogenic) effect divided by an uncertainty factor. The uncertainty factor ranges from 10 to 1,000 depending on the quantity and quality of available data (assessed using scientific judgement): A factor of 10 is used where chronic human-exposure data are available and supported by chronic oral-toxicity data in other species. A factor of 100 is used where chronic oral-toxicity data are available in some animal species. A factor of 1,000 is used with limited chronic-toxicity data. The ADI is equivalent to a reference dose and is expressed in units of milligrams contaminant per kilogram body weight per day.

Suggested no-adverse-response level (SNARL).--The SNARL, expressed in milligrams of contaminant per liter, is the highest exposure level in drinking water where adverse (noncarcinogenic) health effects would not be expected to occur. The SNARL is calculated from the acceptable daily intake; it assumes consumption of 2 L/d of drinking water by a 70-kg adult, and that 20 percent of total daily contaminant intake is from drinking water. Unless noted otherwise, the SNARL values given in this report (table 3, section 3, column N) are for chronic exposure (a 70 year lifetime). For some compounds, NAS calculated 24-hour or 70-day SNARL values. National Academy of Sciences' SNARL is comparable to EPA's lifetime health advisory; they are derived from the acceptable daily intake and reference dose, respectively (which are equivalent) using the same exposure assumptions.

Lifetime cancer risk (per microgram per liter).--The lifetime cancer risk per microgram per liter (table 3, section 3, column O) is the excess cancer risk associated with consuming 1 liter (L) of drinking water containing 1 microgram (µg) contaminant per liter every day for 70 years. National Academy Sciences' lifetime cancer risk (per microgram per liter) is not directly comparable to EPA's risk specific dose; the NAS lifetime cancer risk (per microgram per liter) assumes consumption of 1 L/d of drinking water and is expressed as a risk level (unitless) corresponding to a contaminant concentration of 1 µg/L. The EPA's risk specific dose assumes consumption of 2 L/d of drinking water and is expressed as the contaminant concentration corresponding to a risk level of 10^{-6}.

Use in evaluation of environmental data.--Contaminant concentrations in drinking water can be compared with the SNARL (table 3, section 3, column N) for noncarcinogens or with the lifetime cancer risk (table 3, section 3, column O) for carcinogens. These comparisons may be important only for those pesticides for which no EPA standards or guidelines exist. For a few compounds, however, NAS recommendations provide more information on the type of health effect expected (such as nitrofen), or the effect of formulation or contaminants (such as pentachlorophenol), than the EPA standards and guidelines.

Primary references.--The primary sources for NAS drinking-water and health recommendations for pesticides are National Research Council (1977; 1980b; 1983; 1986).

AMBIENT SURFACE WATER

U.S. Environmental Protection Agency Ambient Water-Quality Criteria for the Protection of Human Health

There are two types of EPA ambient water-quality criteria: those for the protection of human health (table 3, section 4, columns P and Q), and those for the protection of aquatic organisms (table 3, section 5, columns S through V). All EPA ambient water-quality criteria are nonenforceable guidelines that may

provide the basis for State standards. Ambient water-quality criteria were issued by EPA for pollutants designated as toxic under the CWA, in accordance with EPA's mandate under Section 304(a) of that Act.

Water-quality criteria for the protection of human health, commonly called human-health criteria, consist of ambient concentrations that, for noncarcinogens, prevent adverse health effects in humans, and for suspected or proven carcinogens, represent various levels of incremental cancer risk. Human-health criteria are expressed in milligrams of contaminant per liter. There are two types of human-health criteria: those for ingestion of water and aquatic organisms (table 3, section 4, column P), and those for ingestion of aquatic organisms only (table 3, section 4, column Q). Both types are based on the same technical information and derived using the same procedures (described in the next paragraph). The technical basis for the human-health criteria consists of a health-based number (a dose that corresponds to a specific health endpoint) and a bioconcentration factor (table 3, section 4, column R).

The procedure used to calculate human-health criteria is as follows:

1. A total daily intake for humans is estimated that establishes either a NOAEL (for noncarcinogens) or a defined level of risk for nonthreshold effects (for carcinogens). This health-based number is provided in table 3, section 4, column R. For noncarcinogens, the daily intake value is the RfD. For carcinogens, the daily intake value is derived from the q_1* (cancer potency factor), calculated using the linearized multistage model. Because carcinogenicity is a zero-threshold response in this model, the daily intake value used is associated with a specified cancer risk, rather than a NOAEL. EPA generally provides risk specific dose values for several risk levels ranging from 10^{-4} to 10^{-7}. The human-health criteria shown in table 3, section 4 (columns P and Q) are for 10^{-6} risk level. Values for other cancer risk levels can be obtained by appropriately adjusting the values shown in table 3, section 4, columns P and Q; for example, to obtain the criterion for a 10^{-5} risk level, multiply the criterion by 10.

2. Assumptions are made about the contribution of contaminated water and the consumption of contaminated fish or shellfish to the total daily intake of the chemical. The assumptions made (specified below) are different for the two types of criteria, those for ingestion of water and aquatic organisms, and those for ingestion of aquatic organisms only.

3. For both carcinogens and noncarcinogens, ambient concentrations in surface water are calculated by applying a weighted-average bioconcentration factor to the pollutant residue in aquatic organisms. A bioconcentration factor (BCF) is the ratio between the concentration of the chemical in an organism's tissues to the concentration in the surrounding water. The BCF value used by EPA in developing water-quality criteria for a given chemical was calculated based on the premise that the steady-state BCF for a lipid-soluble compound is proportional to the percent lipids as follows: (a) Available BCF values were compiled from both field and laboratory studies for which percent lipid content (of the tissues analyzed) data were available. (b) The lipid content of the test organism was used to normalize each BCF value to 1 percent lipid, so that BCF data from different tissues and species could be integrated. (c) The geometric mean of the normalized BCF values was calculated and then adjusted by a factor of 3 to correspond to the average percentage of lipids in freshwater and estuarine fish and shellfish consumed in the United States (based on a diet survey, U.S. Environmental Protection Agency, 1980l). The BCF adjusted to 3 percent lipids is called the weighted-average BCF. (d) If a measured BCF value was not available, a weighted-average BCF value was estimated from the octanol-water partition coefficient. The BCF (at equilibrium) has been shown to follow a straight-line relation with octanol-water partition coefficient, which is the ratio of the equilibrium concentration of a chemical between *n*-octanol and water (Neely and others, 1974).

BCF values used in calculating human-health criteria are provided in table 3, section 4, column R. These BCF values apply to fish with 3 percent lipid content (on average); other BCF values may be more appropriate in some regions of the country. Our understanding of bioaccumulation processes has advanced considerably since EPA issued its human-health water-quality criteria documents (U.S. Environmental Protection Agency, 1980a-k; 1984a). Bioconcentration refers to the uptake of a chemical by aquatic

organisms exposed to a contaminant only from the surrounding water, whereas bioaccumulation refers to uptake from all sources, such as diet or bottom sediment in addition to the water column. Current EPA policy is to distinguish between field-based bioaccumulation factor (BAF) values, where organisms are exposed through water, food, and other sources of the chemical, and BCF values measured in the laboratory, where organisms are exposed to the chemical in the surrounding water only (U.S. Environmental Protection Agency, 1993k). However, both the published human-health criteria (U.S. Environmental Protection Agency, 1980a-k; 1984a) and the recalculated (updated) values (U.S. Environmental Protection Agency, 1991b; 1992a; 1993a) are based on the original BCF values from the 1980 water-quality criteria documents.

Ingestion of water and aquatic organisms.--This criterion (table 3, section 4, column P) assumes exposure from consumption of both (a) water containing a specified concentration of a toxic pollutant and (b) aquatic organisms that are assumed to have bioaccumulated pollutants from the water in which they live. All calculations also assume consumption of 2 L of drinking water and 6.5 g of freshwater and estuarine fish or shellfish per day by a 70-kg adult, and that 100 percent of exposure to this contaminant is from consumption of water and fish or shellfish. Calculations are shown below for noncarcinogens (equations 6 and 7) and potential carcinogens (equations 8 and 9).

For a noncarcinogen, the ambient concentration in water, or C[water], is calculated as follows:

$$\text{C[water] (mg/L)} = \frac{\text{(RfD)} \times \text{(70-kg body wt)}}{[\text{(0.0065 kg fish/d)} \times \text{(BCF)}] + \text{(2 L/d)}}, \tag{6}$$

where RfD is the reference dose, in (mg/kg body weight)/d, and BCF is the bioconcentration factor, in L/kg fish.

For a noncarcinogen, the corresponding (edible) fish tissue concentration, or C[fish], can be calculated as follows:

$$\text{C[fish] (mg/kg fish)} = \text{(BCF)} \times \text{(C[water])}, \tag{7}$$

where BCF is the bioconcentration factor, in L/kg fish, and C[water] is the ambient concentration of the chemical in water, in mg/L.

For a carcinogen, the ambient concentration in water, or C[water], is calculated as follows:

$$\text{C[water](mg/L)} = \frac{\text{(risk level, such as } 10^{-6})\text{(70-kg body wt)}}{(q_1^*) \times \left\{[(0.0065 \ \frac{\text{kg fish}}{\text{d}}) \times \text{(BCF)}] + \frac{2 \text{ L}}{\text{d}}\right\}}, \tag{8}$$

where q_1^* is the cancer potency factor, in $[\text{(mg/kg body weight)/d}]^{-1}$, and BCF is the bioconcentration factor, in L/kg fish.

For a carcinogen, the (edible) fish tissue concentration, or C[fish], can be calculated as follows:

$$\text{C[fish] (mg/kg fish)} = \text{(BCF)} \times \text{(C[water])}, \tag{9}$$

where BCF is the bioconcentration factor, in L/kg fish, and C[water] is the ambient concentration of the chemical in water, in mg/L.

Ingestion of aquatic organisms only.--This criterion (table 3, section 4, column Q) assumes that 100 percent of exposure is from consumption of aquatic organisms that are assumed to have bioconcentrated pollutants from the water in which they live. All calculations also assume a 70-kg body weight and an

average daily consumption of 6.5 g of freshwater and estuarine fish and shellfish. Calculations are shown below for noncarcinogens (equations 10 and 11) and for potential carcinogens (equations 12 and 13).

For a noncarcinogen, the fish tissue concentration, or C[fish], can be calculated as follows:

$$C[fish]\,(mg/kg\ fish) = \frac{(RfD) \times (70\text{-kg body wt})}{(0.0065\ kg\ fish/d)}, \tag{10}$$

where RfD is the reference dose, in (mg/kg body weight)/d.

For a noncarcinogen, the corresponding ambient water concentration, or C[water], is:

$$C[water]\ (mg/L) = \frac{(C[fish]}{(BCF)}, \tag{11}$$

where C[fish] is the fish tissue concentration, in mg/kg fish, and BCF is the bioconcentration factor, in L/kg fish.

For a carcinogen, the (edible) fish tissue concentration, or C[fish] is:

$$C[fish]\,(mg/kg\ fish) = \frac{(70\text{-kg body wt}) \times (\text{risk level, such as } 10^{-6})}{(q_1^*) \times (0.0065\ kg\ fish/d)}, \tag{12}$$

where q_1^* is the cancer potency factor, in $[(mg/kg\ body\ weight)/d]^{-1}$.

For a carcinogen, the corresponding ambient water concentration, or C[water], is:

$$C[water]\ (mg/L) = \frac{(C[fish])}{(BCF)}, \tag{13}$$

where C[fish] is the fish tissue concentration, in mg/kg fish, and BCF is the bioconcentration factor, in L/kg fish.

Use in evaluation of environmental data.--Contaminant concentrations in ambient surface water can be compared to criteria for consumption of water and aquatic organisms (table 3, section 4, column P) and to those for consumption of aquatic organisms only (table 3, section 4, column Q). For noncarcinogens, concentrations exceeding these values may result in adverse health effects. For carcinogens, concentrations exceeding these values may result in an incremental cancer risk greater than 10^{-6} over a 70-year lifetime. Criteria for other specific risk levels can be determined using equation 8 and combining equations 12 and 13. Incremental cancer risks associated with a specific concentration of pollutant in water also can be estimated using these equations by solving for the risk level. As previously noted, EPA's policy in reviewing State water-quality standards for carcinogens is to accept cancer risk levels in the range of 10^{-4} to 10^{-6} (U.S. Environmental Protection Agency, 1992a). In this reference, EPA further states that States could reasonably adopt a risk level of 10^{-5} for many carcinogens and a more stringent risk level of 10^{-6} for carcinogens with substantially higher bioconcentration factors.

As previously noted, EPA has issued two sets of human-health criteria values for some compounds: published criteria issued as EPA's Section 304(a) guidance to the States, which have undergone APA public notice and comment procedures (U.S. Environmental Protection Agency, 1980a-k; 1984a), and recalculated values (U.S. Environmental Protection Agency, 1991b; 1992a; 1993a), based on updated human health data from the IRIS data base (as of September, 1990). Both sets of values are included in table 3, section 4, along with references and the technical basis for recalculated criteria values. Whether to compare measured pesticide concentrations with published values or with recalculated values depends on the objectives of the comparison. For human-health risk assessment, it may be more appropriate to use the recalculated human-health criteria values, which are based on better technical information (updated

from human health data). For enforcement or compliance purposes, it is important to ascertain the numerical values for applicable State standards. Some State may base their standards on EPA's published criteria and others on EPA's recalculated criteria values. The recalculated human-health criteria were promulgated in the Toxics Rule (U.S. Environmental Protection Agency, 1992a), which applies only to those 14 States and Territories without criteria previously approved by EPA. The remaining States, which were determined by EPA to fully comply with Section 303(2)(B) of the Clean Water Act, are not affected by the Toxics Rule. A State (other than the 14 States and Territories affected by the Toxics Rule) that has set standards based on EPA's published criteria would be in compliance with the CWA. Nonetheless, the recalculated human-health criteria values in the Toxics Rule have been interpreted by some (U.S. Environmental Protection Agency, 1993a) as updated guidance under Section 304(a) of the CWA.

Existing EPA ambient water-quality criteria for pesticides do not specify whether they apply to concentrations in filtered water or in whole water. From the regulatory standpoint, ambient water-quality criteria probably should be compared with whole-water concentrations. EPA regulations include guidelines that establish test procedures for the analysis of pollutants (Code of Federal Regulations, v. 40, Part 136). Except where alternative test methods are approved, these procedures must be used whenever waste constituents are required to be measured for National Pollutant Discharge Elimination System (NPDES) permits or reports required to be submitted under NPDES permits, or other requests for effluent data under State programs, or for State certifications (Code of Federal Regulations, v. 40, Part 136.1). The methods approved for pesticides are listed in the Code of Federal Regulations, v. 40, Part 136.3 (table 1D). The details of those methods are provided in the Code of Federal Regulations, v. 40, Part 136, Appendix A, and in references cited therein. The methods approved for pesticides do not call for filtration, but for collection of a grab sample following "conventional sampling practices," citing American Society for Testing and Materials (ASTM) D3370. This ASTM method specifies that samples normally are collected without separation of particulate matter (American Society for Testing and Materials, 1989).

From a scientific standpoint, the answer is more complex. Human-health criteria were derived on the basis of the total concentration of contaminant in water. As described previously, dose-response information from animal studies (expressed in milligrams contaminant per kilogram body weight per day) is combined with exposure assumptions (daily consumption rates of fish and shellfish) to obtain the concentration of the contaminant in fish or shellfish tissue that corresponds to a NOAEL or (for carcinogens) a specified cancer risk. The resulting fish tissue concentration then is converted to a contraction in water by applying a bioconcentration factor that relates the concentration in water to the concentration in aquatic organisms living in the water (and accumulating contaminant from the water). Use of the bioconcentration factor introduces questions about the form and bioavailability of the chemical contaminant in the water. For highly lipophilic chemicals (with a high octanol-water partition coefficient), a substantial percentage of the total chemical concentration may be associated with particulate and dissolved organic matter in water, which may reduce its bioavailability. Thus, the bioavailability of a chemical may vary with the organic-carbon content of the water. For nonionic organic chemicals with low octanol-water partition coefficients, there will not be much difference between total, dissolved, and bioavailable concentrations (Charles Stephan, U.S. Environmental Protection Agency, Environmental Research Laboratory, oral commun., 1993). For compounds with high octanol-water partition coefficients, such as the organochlorine pesticides, application of a bioconcentration factor to a given site may be improved by adjusting for the difference in bioavailability between the site water and the water(s) on which the predicted bioconcentration factor was based (U.S. Environmental Protection Agency, 1993k). However, it is important to note that the bioconcentration factors used to derive existing human-health criteria for most organic chemicals have not been updated since they were published in 1980, and for some compounds, the BCF values were based on a limited amount of information. For organic chemicals, including pesticides, these BCF values were derived based on the total concentration of chemical in water. Moreover, the tests in which BCF values were measured generally did not distinguish between dissolved and particulate-associated chemical, or even report the amount of dissolved and particulate organic-carbon content of the test water. In future, it may be more appropriate to derive bioaccumulation factors in terms of "freely dissolved" chemical (U.S. Environmental Protection Agency, 1993k). However, at present, existing human-health criteria are based on BCF values that do not consider bioavailability but are based on total contaminant concentration in water. In its proposed water-quality guidance for the Great Lakes system, U.S. Environmental Protection Agency (1993k) cautioned that any compromise analytical

measurement not err on the side of underprotection when measurements are made on a surface water. For lipophilic chemicals, comparison of ambient human-health criteria with concentrations in whole water would be more conservative (over-protective) than comparison with concentrations in filtered water.

For lipophilic chemicals, if data on residues in fish and shellfish tissues are available for a given site, it may be better to emphasize comparison of tissue data with guidelines for fish and shellfish tissue (such as "U.S. Environmental Protection Agency Fish Tissue Concentrations" or "U.S. Environmental Protection Agency Recommended Screening Values") rather than comparison of water-column data with ambient human-health criteria. Relying on guidelines for tissue data eliminates the necessity of converting from fish-tissue concentrations to water-column concentrations using bioconcentration factors.

Primary and secondary references.--Primary sources for published human-health criteria are individual water-quality documents (U.S. Environmental Protection Agency, 1980a-k; 1984a). Criteria and the basis for them are summarized in the "Gold Book" (U.S. Environmental Protection Agency, 1986a) and in Federal Register notices announcing the availability of water-quality criteria documents (for example, U.S. Environmental Protection Agency, 1980m; 1984b). The primary source for recalculated (updated) human-health criteria is the Toxics Rule (U.S. Environmental Protection Agency, 1992a), although this rule applies only to 14 States and Territories. Secondary sources for human-health criteria include IRIS (U.S. Environmental Protection Agency, 1993b) for published values, U.S. Environmental Protection Agency (1993a) for recalculated values, and U.S. Environmental Protection Agency (1991b) for both published and recalculated values.

U.S. Environmental Protection Agency Ambient Water-Quality Criteria for the Protection of Aquatic Organisms

EPA water-quality criteria for the protection of aquatic organisms and their uses, commonly called aquatic-life criteria (table 3, section 5, columns S through V), are national numerical criteria designed to prevent unacceptable long-term and short-term effects on (1) commercially, recreationally, and otherwise important species, (2) fish and benthic invertebrates in rivers and streams; and (3) fish, benthic invertebrates and zooplankton in lakes, reservoirs, estuaries, and oceans. Concentrations at or below these criteria should not result in unacceptable effects on aquatic organisms and their uses during a short-term exposure (for acute criteria) or chronic exposure (for chronic criteria). For most compounds, criteria are provided for both freshwater and saltwater organisms. As in EPA's human-health criteria, EPA's aquatic-life criteria are nonenforceable guidelines that may provide the basis for State standards.

In 1985, EPA changed the procedures used to establish aquatic-life criteria so that there are two different types of acute and chronic criteria. Acute and chronic criteria issued before 1985 (under the 1980 guidelines) are the final acute value (FAV), which is instantaneous, and the final chronic value (FCV), a 24-hour average. Acute and chronic criteria issued under the 1985 guidelines (Stephan and others, 1985) are the criterion maximum concentration (CMC), a 1-hour average, and the criterion continuous concentration (CCC), a 4-day average. Both the 1980 and 1985 guidelines for establishing aquatic-life criteria were published by the U.S. Environmental Protection Agency (1986a). All EPA aquatic-life criteria are expressed in milligrams of contaminant per liter.

The mathematical derivation of the aquatic-life criteria is complex. Data requirements for establishing aquatic-life criteria are extensive. Acceptable tests must be available for at least one species of aquatic animal in at least eight families. A summary of the procedures used to calculate various criteria is provided below. However, many significant details (such as what constitutes an acceptable test and which families of test organisms must be represented) have been omitted. Anyone wishing to fully understand or to use the procedures described should consult the 1985 guidelines (U.S. Environmental Protection Agency, 1986a).

Freshwater acute criteria.--As previously noted, there are two different types of acute criteria. An acute criterion issued under the 1980 guidelines (final acute value) is instantaneous, whereas an acute criterion issued under the 1985 guidelines (criterion maximum concentration) is a 1-hour average. As an

approximation, dividing the final acute value by 2 yields a criterion maximum concentration. Freshwater acute criteria are provided in table 3, section 5, column S. Unless otherwise noted in a footnote, the values provided in column S are criterion maximum concentration values.

Final acute value (FAV).--The FAV is an instantaneous value that is based on acute-toxicity data for various fish and invertebrate species. By considering the number and relative sensitivities of the tested species, the FAV is designed to protect most, but not necessarily all, of the tested and untested species. The FAV is an estimate of the concentration of a chemical that is lower than acute-toxicity values for 95 percent of the genera for which acceptable acute-toxicity tests have been conducted on the chemical. The FAV applies to those compounds for which criteria were issued under 1980 guidelines (U.S. Environmental Protection Agency, 1986a). Derivation of the FAV is summarized as follows:

A species mean acute value (SMAV) is calculated from the acceptable acute-toxicity tests available; this is the geometric mean of all flow-through tests where concentrations of test chemical were measured. Then, the genus mean acute value (GMAV) is calculated as the geometric mean of SMAVs available for the genus. The GMAVs are assigned a rank (R) from the lowest value (R=1) to the highest value (R=n). A cumulative probability (P) is calculated for each GMAV as follows: $P = (R/n+1)$. The four GMAV values with the cumulative probabilities closest to 0.05 are selected. From these four GMAVs and their P values, the final acute value is calculated as follows:

$$s^2 = \frac{\sum((1nGMAV)^2) - ((\sum(1nGMAV))^2/4)}{\sum(P) - ((\sum\sqrt{P})^2/4)}, \tag{14}$$

$$A = s\sqrt{0.05} + (\sum(1nGMAV) - s(\sum\sqrt{P}))/4, \tag{15}$$

$$FAV = e^A, \tag{16}$$

where s^2 is the sample variance, A is an intermediate variable calculated from GMAV and associated P values, and FAV is the final acute value.

Criterion maximum concentration (CMC).--The CMC is the highest concentration of a pollutant that freshwater aquatic organisms can be exposed to for a short period (1-hour average) without deleterious effects and is intended to protect 95 percent of a diverse group of genera. If the 1-hour average concentration of the pollutant does not exceed the CMC more than once every 3 years, freshwater aquatic organisms and their uses should not be unacceptably affected (except possibly where a locally important species is very sensitive). Three years is EPA's best scientific judgment of the time aquatic ecosystems should be allowed between excursions above the CMC. Excursions are defined as extreme values in the distribution of ambient concentrations and the result of usual variation (in flows, for example), rather than high concentrations caused by spills or other similar major events (U.S. Environmental Protection Agency, 1986a). The frequency of allowed excursions above the CMC is based on the ability of aquatic ecosystems to recover afterwards, which depends in part on the magnitude and duration of the excursions. EPA estimates that most aquatic ecosystems can recover from most excursions within 3 years. The CMC applies to those compounds for which criteria were issued under EPA's 1985 guidelines (U.S. Environmental Protection Agency, 1986a).

The CMC is calculated as follows:

$$CMC = (FAV)/2, \tag{17}$$

where FAV is the final acute value.

Freshwater chronic criteria.--As previously noted, there are two different types of chronic criteria. A chronic criterion issued under the 1980 guidelines (final chronic value) is interpreted as a 24-hour average,

whereas a chronic criterion issued under the 1985 guidelines (criterion continuous concentration) is a 4-day average. As an approximation, however, the final chronic value can be used directly as a criterion continuous concentration. Freshwater chronic criteria are provided in table 3, section 5, column T. Unless otherwise noted in a footnote, the values provided in column T are criterion continuous concentration values.

Final chronic value (FCV).--The FCV is derived from chronic toxicity data, either directly (if chronic data are available for a specified number and array of species) or indirectly (by calculation of an acute-chronic ratio). The FCV is an estimate of the concentration of a chemical that is lower than chronic-toxicity values for 95 percent of the genera with which acceptable chronic-toxicity tests have been conducted on the chemical. The FCV applies to those compounds for which criteria were issued under EPA's 1980 guidelines (U.S. Environmental Protection Agency, 1986a). Derivation of the FCV is summarized below.

The species mean chronic value (SMCV), genus mean chronic value (GMCV), and FCV are calculated the same way as the corresponding acute values previously described, if chronic test values are available for species in eight families. Alternatively, an acute-chronic ratio is calculated for each chronic value for which at least one corresponding acute value is available. Four ways of calculating the acute-chronic ratio, depending on the data available, are specified in the 1980 guidelines (U.S. Environmental Protection Agency, 1986a). Then the FCV is calculated from the acute-chronic ratio as follows:

$$\text{FCV} = (\text{FAV}) \,/\, (\text{acute-chronic ratio}), \tag{18}$$

where FAV is the final acute value.

To derive the freshwater chronic criterion under EPA's 1980 guidelines (U.S. Environmental Protection Agency, 1986a), two additional parameters were calculated (when data were available): the final plant value and the final residue value. The final plant value is the lowest result from a toxicity test with an important aquatic-plant species in which the endpoint was biologically important and test-material concentrations were measured. The final residue value protects both the marketability of fish and wildlife that consume aquatic organisms; it is defined as the lowest of the residue values obtained by dividing maximum permissible tissue concentrations (that for humans is the FDA action level, and that for wildlife, is based on wildlife feeding studies) by appropriate bioconcentration factors. For most compounds, the maximum permissible tissue concentrations used were FDA action levels. Then the chronic criterion is set equal to the lowest of the FCV, final plant value, and final residue value.

Criterion continuous concentration (CCC).--The CCC is the highest concentration of a pollutant that freshwater aquatic organisms can be exposed to for an extended period of time (4 days) without deleterious effects. If the 4-day average concentration of the pollutant does not exceed the CCC more than once every 3 years, freshwater aquatic organisms and their uses should not be unacceptably affected (except possibly where a locally important species is very sensitive). Three years is EPA's best scientific judgment of the time aquatic ecosystems should be allowed between excursions above the CCC. The CCC applies to those compounds for which criteria were issued under EPA's 1985 guidelines (U.S. Environmental Protection Agency, 1986a).

To derive the CCC, three parameters first must be calculated: the final chronic value (FCV), the final plant value, and the final residue value (all previously described). The CCC is equal to the lowest of the final chronic value, the final plant value, and the final residue value, unless other data (for example, cumulative or delayed toxicity) indicate that a lower value should be used.

Saltwater acute criteria.--As for the freshwater acute criteria, there are two different types of saltwater acute criteria: the final acute value issued under EPA's 1980 guidelines and the criterion maximum concentration, issued under EPA's 1985 guidelines (both published by the U.S. Environmental Protection Agency, 1986a). The final acute value and criterion maximum concentration for saltwater are defined and

derived as for freshwater except that conclusions apply to marine aquatic organisms. Saltwater acute-criteria values are provided in table 3, section 5, column U. Unless otherwise noted in a footnote, the values provided in column U are criterion maximum concentration values.

Saltwater chronic criteria.--As for the freshwater chronic criteria, there are two different types of saltwater chronic criteria: the final chronic value issued under the 1980 guidelines and the criterion continuous concentration issued under the 1985 guidelines (both published by the U.S. Environmental Protection Agency, 1986a). The final chronic value and criterion continuous concentration for saltwater are defined and derived as for freshwater except that conclusions apply to marine aquatic organisms. Saltwater chronic-criteria values are provided in table 3, section 5, column V. Unless otherwise noted in a footnote, the values provided in column V are criterion continuous concentration values.

Use in evaluation of environmental data.--Contaminant concentrations in ambient surface water (rivers, lakes, streams) can be compared with both freshwater acute criteria (table 3, section 5, column S) and freshwater chronic criteria (table 3, section 5, column T). Concentrations in estuarine or ocean samples would be compared with corresponding saltwater criteria (table 3, section 5, columns U and V). Concentrations exceeding these values may result in unacceptable adverse effects on aquatic organisms exposed for the prescribed period. These criteria are not necessarily protective of all locally important organisms or species.

Many water-quality studies may not meet the exposure conditions specified by EPA's 1985 guidelines for establishing aquatic-life criteria (U.S. Environmental Protection Agency, 1986a). As stated in these guidelines, unacceptable adverse effects may occur if the 1-hour average contaminant concentration exceeds the acute criterion (criterion maximum concentration, or CMC), or if the 4-day average concentration exceeds the chronic criterion (criterion continuous concentration, or CCC), more than once every 3 years. Many water-quality studies measure concentrations at one point in time, rather than 1-hour or 4-day average concentrations. Moreover, these definitions imply that exceeding the criteria only once in 3 years is acceptable, because the ecosystem should have time to recover. Therefore, documenting exceedance of criteria would require repeated measurements of 1-hour and 4-day average concentrations to be collected in a 3-year period; this is impractical for most water-quality studies.

However, a single measurement of a given pesticide in ambient surface water can be compared with aquatic-life criteria, as long as any conclusions are qualified. For example, if a measured pesticide concentration exceeds the final acute value (FAV, which is instantaneous), then deleterious effects on aquatic organisms may be occurring in that system. If the measured pesticide concentration exceeds the CMC (a 1-hour average which equals one-half of the FAV), then deleterious effects on aquatic life may occur if this concentration is maintained (on average) for 1 hour and if this excursion is repeated within 3 years. Finally, if a measured pesticide concentration exceeds the CCC (4-day average), then deleterious effects on aquatic organisms may occur if this concentration is maintained (on average) for 4 days and if this excursion is repeated within 3 years. It may be useful to consider seasonal patterns in pesticide use and occurrence in evaluating whether a repeated excursion within 3 years is probable.

Pesticide concentrations less than the aquatic-life criteria values do not necessarily indicate that adverse effects are not taking place in any given aquatic ecosystem for two reasons: (1) Aquatic-life criteria are based on toxicity tests with a limited number of test organisms, and (2) the criteria values were established to protect 95 percent of the genera tested. The species tested to develop criteria for a pesticide may not be representative of the organisms present in any given aquatic ecosystem. Especially if locally important or sensitive species are present, it may be useful to obtain supplementary information on toxicity to those species (see "Other Sources of Information").

An important question is whether EPA aquatic-life criteria should be compared with contaminant concentrations in filtered water or in whole water. Whereas existing criteria for metals do distinguish between dissolved and total concentrations, this is not true for pesticides. An EPA workgroup is currently revising EPA's 1985 guidelines (as issued by the U.S. Environmental Protection Agency, 1986a) for deriving water-quality criteria for the protection of aquatic organisms (Stephan and others, 1985), and the issue of bioavailability for organic compounds is under discussion. The trend is toward explicitly con-

sidering the percent of total concentration that is bioavailable (Charles Stephan, U.S. Environmental Protection Agency, Environmental Research Laboratory, oral commun., 1993).

From the regulatory standpoint, ambient aquatic-life criteria for organic compounds probably should be compared with whole-water concentrations. The rationale for this conclusion is provided previously in the section "U.S. Environmental Protection Agency Ambient Water-Quality Criteria for the Protection of Human Health."

From a scientific standpoint, the answer is complex. The concepts of bioaccumulation and bioavailability have advanced considerably since most of the existing water-quality criteria were published in 1980. Existing criteria for pesticides were based on total concentrations of contaminant in water, rather than on the bioavailable fraction; at that time, no attempt was made to make such a distinction (Charles Stephan, U.S. Environmental Protection Agency, Environmental Research Laboratory, oral commun., 1993). For nonionic organic compounds with low high octanol-water partition coefficients, there will not be much difference between total, dissolved, and bioavailable concentrations (Charles Stephan, U.S. Environmental Protection Agency, Environmental Research Laboratory, oral commun., 1993). For compounds with high octanol-water partition coefficient, such as the organochlorine pesticides, use of ambient aquatic-life criteria to interpret water-column data is less straight-forward. Because existing criteria were not derived using dissolved or bioavailable concentrations, it is inappropriate to apply them to dissolved concentrations without considering the percent of total concentration that is bioavailable in the toxicity tests used to derive the criteria (Charles Stephan, U.S. Environmental Protection Agency, Environmental Research Laboratory, oral commun., 1993). However, given the absence of criteria based on bioavailable contaminant levels, it may be useful to compare existing aquatic-life criteria values with concentrations of a lipophilic contaminant in both filtered and whole water, if both types of measurements are available. For consideration of aquatic organisms, it is important to consider whether existing chronic aquatic-life criteria were based on the FDA action level or on the fish tissue concentration that is protective of wildlife, rather than on chronic aquatic toxicity. For a few pesticides, the chronic aquatic-life criterion was based on the FDA action level or a wildlife feeding study; these cases are noted in table 3, section 5, in footnotes to the chronic aquatic-life criteria (columns T and V). In EPA's proposed water-quality guidance to the Great Lakes system, EPA proposed separate water-quality criteria for the protection of human health, aquatic toxicity, and wildlife (U.S. Environmental Protection Agency, 1993k).

Primary and secondary references.--Primary sources for aquatic-life criteria are individual water-quality documents (U.S. Environmental Protection Agency, 1980a-i; 1984a; 1986c-f). Criteria and the basis for them are summarized in the "Gold Book" (U.S. Environmental Protection Agency, 1986a) and in Federal Register notices announcing the availability of water-quality criteria documents (U.S. Environmental Protection Agency, 1980m; 1984b; 1986g; 1990d). Secondary sources include IRIS (U.S. Environmental Protection Agency, 1993b) and U.S. Environmental Protection Agency (1991b; 1993a). The original aquatic-life criteria for pentachlorophenol and toxaphene (U.S. Environmental Protection Agency, 1980j,k) were superseded by revised criteria in subsequent publications (U.S. Environmental Protection Agency, 1986e,f).

National Academy of Sciences and National Academy of Engineering Recommended Maximum Concentrations in Water

Recommendations were made for the protection of both freshwater and marine aquatic life (table 3, section 5, columns W and X, respectively) by separate NAS/NAE committees. The NAS/NAE report containing these criteria was financed and approved for publication by EPA. EPA considered that the criteria were "an important contribution to the scientific literature, but not as the Agency's sole criteria for standards-setting purposes. Neither is it necessarily a reflection of the Agency's views and policies" (EPA Review Notice in National Academy of Sciences and National Academy of Engineering, 1973). Moreover, these recommendations have not been subject to APA public notice and comment procedures for EPA criteria. Therefore, although they sometimes are called aquatic-life criteria, they are not EPA criteria as defined in Section 304(a) of the Clean Water Act (discussed previously in the section "Scope of Review". Because the NAS/NAE aquatic-life recommendations were published in 1973, they tend to

be out-of-date. This is especially true of the marine values, considered preliminary even at the time because so few data were available. However, the NAS/NAE guidelines for protection of aquatic life may be useful for compounds that do not have EPA aquatic-life criteria.

Freshwater aquatic-life recommendations.--For a number of pesticides, the National Academy of Sciences and National Academy of Engineering (1973) listed recommended maximum concentrations in water, sampled at any time and any place, for the protection of freshwater aquatic life (table 3, section 5, column W). These guidelines, expressed in milligrams of contaminant per liter, were derived by multiplying acute toxicity values by an appropriate factor. Generally, the 96-hour median lethal concentration (LC_{50}) for the most sensitive species tested was multiplied by an application factor of 0.01, except where an experimentally-derived application factor was indicated. For compounds that persist and accumulate in aquatic organisms (for example, the organochlorine pesticides), these guidelines were not considered protective of predators, because knowledge was not considered sufficient at the time to predict or estimate safe concentrations of these compounds in the water column of hydrologic systems. Instead, NAS/NAE made preliminary recommendations for specific maximum tissue concentrations as a guideline for protection of predators (see "Fish and Shellfish Tissue").

Marine aquatic-life recommendations.--NAS/NAE recommendations to protect marine aquatic life are provided in table 3, section 5, column X. These guidelines are expressed in milligrams of contaminant per liter. Recommended values were derived by multiplying the acute-toxicity value (usually a 96-hour LC_{50}) for the most sensitive species tested from National Academy of Sciences and National Academy of Engineering (1973) by an application factor of 0.01, as recommended in that reference. The National Academy of Sciences and National Academy of Engineering (1973) recommended that marine life, with the exception of fish-eating wildlife, should be protected where the maximum concentration does not exceed these values. Levels that will protect fish-eating wildlife against the effects of compounds that are trophically accumulated from prey species were recommended separately by NAS/NAE (see "Fish and Shellfish Tissue").

Use in evaluation of environmental data.--Contaminant concentrations in ambient stream water can be compared with NAS/NAE freshwater criteria (table 3, section 5, column W). Concentrations in estuarine or ocean samples would be compared with corresponding marine criteria (table 3, section 5, column X). Because the NAS/NAE aquatic-life criteria tend to be out-of-date, they should be considered only for those pesticides that do not have EPA aquatic-life criteria.

Primary reference.--The primary reference for NAS/NAE aquatic-life criteria is National Academy of Sciences and National Academy of Engineering (1973).

BED SEDIMENT

U.S. ENVIRONMENTAL PROTECTION AGENCY SEDIMENT-QUALITY CRITERIA FOR THE PROTECTION OF BENTHIC ORGANISMS

EPA is developing sediment-quality criteria (SQC) for some pollutants designated as toxic under the Clean Water Act, in accordance with its mandate under Section 304(a) of that Act. Preliminary SQC values for pesticides are provided in table 4, columns Y through BB. When these criteria are promulgated in a final rule, they will comprise EPA's recommendation of the concentrations of a substance in sediment that will not unacceptably affect benthic organisms. Development of SQC is related to an ongoing EPA effort to develop a national strategy for dealing with contaminated sediments (U.S. Environmental Protection Agency, 1992h).

Preliminary EPA documents addressing sediment contamination include a draft document on EPA's national sediment strategy (U.S. Environmental Protection Agency, 1992h), as well as proposed sediment-quality criteria documents for five compounds, of which two are pesticides (U.S. Environmental Protection Agency, 1993f,g) and three are polynuclear aromatic hydrocarbons (U.S. Environmental Protection Agency, 1993h-j). Proposed sediment-quality criteria for the five compounds were published in the Federal Register (U.S. Environmental Protection Agency, 1994) following both Science Advisory Board review (U.S. Environmental Protection Agency, 1992i) and internal review at EPA. Earlier documents containing

interim (U.S. Environmental Protection Agency, 1988d) and tentative (U.S. Environmental Protection Agency, 1990a) sediment-quality criteria for additional pesticides were available from EPA at one time. Although interim and tentative criteria were based on incomplete data, they represent the only sediment-quality criteria available for some compounds, so they are included in this report. SQC documents for these compounds probably will be developed by EPA in the future.

The following summary of the technical basis for EPA's sediment-quality criteria is extracted from the comprehensive review by Di Toro and others (1991). Two technical issues had to be resolved to develop numeric sediment-quality criteria that would apply to different types of sediments: (1) the varying bioavailability of chemicals in sediments, and (2) the choice of an appropriate biological-effects concentration. First, in toxicity tests using the same chemical and test organism but different sediments, there was no relation between toxicity and the chemical concentration in sediment on a dry weight basis. However, if the chemical concentration in sediment was expressed on an organic-carbon basis (or, except for highly hydrophobic compounds, if the chemical concentration in porewater was used), then biological effects took place at similar concentrations (within a factor of 2) for the different sediments. Second, the biological-effects concentration in sediments (expressed on a porewater basis) was essentially equal to the biological-effects concentration determined in toxicity tests with water-only exposures. Data on mortality, growth rate, and bioaccumulation demonstrated this correlation.

These observations can be explained using an equilibrium-partitioning model. "Equilibrium partitioning" refers to the assumption that the porewater and sediment organic-carbon are in equilibrium and that the chemical concentrations in these phases are related by a partition coefficient (K_{oc}). As stated by Di Toro and others (1991), "In each of these phases, the fugacity or chemical activity of the chemical is the same at equilibrium. As a consequence, it is assumed that the organism receives an equivalent exposure from a water-only exposure or from any equilibrated phase; either from pore water by respiration; from sediment carbon via ingestion; or from a mixture of the routes. Thus, the pathway of exposure is not significant. The biological effect is produced by the chemical activity of the single phase or the equilibrated system."

The SQC in table 4 were developed using this equilibrium-partitioning model. SQC are based on (1) chemical concentrations in sediment organic-carbon, and (2) chronic toxicity to aquatic organisms (chronic aquatic-life criteria). Porewater concentration is not used because for highly hydrophobic chemicals, chemical activity is better represented by free (dissolved) chemical concentration than by total concentration of the chemical in porewater (which includes both dissolved chemical and chemical complexed to dissolved organic-carbon, of which only the former is bioavailable) (Di Toro and others, 1991). Because SQC are based on biologically-available chemicals, they are applicable across a range of sediments of different types.

SQC values in table 4 are derived as follows: Chronic water-quality criteria for water-column species are used to determine acceptable porewater concentrations, and then the K_{oc} is applied to estimate the corresponding contaminant concentration in sediment organic-carbon at equilibrium. Sediment-quality criteria expressed on an organic-carbon basis (SQC_{oc}) are calculated as follows:

$$SQC_{oc} = (K_{oc}) \times (FCV), \tag{19}$$

where K_{oc} is the sediment organic-carbon/porewater partition coefficient for a chemical, and FCV is the final chronic value for that chemical. Both K_{oc} and SQC_{oc} are expressed on a sediment organic-carbon basis and are intended to be independent of sediment type for nonionic chemicals. SQC_{oc} is expressed in milligrams of contaminant per kilogram sediment organic-carbon.

FCVs used to derive SQC for the pesticides dieldrin and endrin in EPA's proposed sediment-quality criteria documents (U.S. Environmental Protection Agency, 1993f,g) were revised from the values published in 1980 (U.S. Environmental Protection Agency, 1980a,g). The revised FCVs are more appropriate to use in deriving SQC than the 1980 published FCVs for two reasons: (1) Revised FCVs included more recent toxicity information, and (2) revised FCVs were based on chronic aquatic toxicity only, whereas the water-quality criteria published in 1980 for dieldrin and endrin were based on marketability of fish

(FDA action level). As discussed previously, published chronic water-quality criteria values are the lowest of the FCV, the final plant value (which is a measure of toxicity to aquatic plants), and the final residue value (which protects both the marketability of fish and wildlife that consume aquatic organisms). In the case of both dieldrin and endrin, the final residue value based on FDA's action level was lower than the FCV so the 1980 chronic aquatic-life criteria (U.S. Environmental Protection Agency, 1980a,g) were based on the final residue values.

Because the equilibrium assumptions of the equilibrium-partitioning model are only approximately true, uncertainty is inherent in predictions from the model (Di Toro and others, 1991). In a recent review of EPA's methodology for developing SQC for nonionic organic compounds, EPA's Science Advisory Board (U.S. Environmental Protection Agency, 1992i) affirmed that the equilibrium-partitioning approach was scientifically sound and would be appropriate for regulatory use, if the uncertainty associated with the method was incorporated.

Use in evaluation of environmental data.--A measured pesticide concentration in bed sediment must be normalized for organic-carbon content before it can be compared to EPA's SQC. A measured pesticide concentration in sediment on a dry weight basis (milligrams of pesticide per kilogram of sediment, dry weight) can be converted to an organic-carbon basis by multiplying by the fraction of organic carbon in the sediment (kilograms organic-carbon per kilograms total sediment, dry weight). The resulting pesticide concentration will be in units of milligrams of pesticide per kilogram sediment organic-carbon, as are EPA's SQC. All tentative and interim sediment criteria values from EPA must be considered preliminary. For a given pesticide, proposed criteria (U.S. Environmental Protection Agency, 1993f,g) supersede tentative criteria (U.S. Environmental Protection Agency, 1990a), which supersede interim criteria (U.S. Environmental Protection Agency, 1988d).

As discussed in the proposed SQC documents (U.S. Environmental Protection Agency, 1993f,g), comparisons of ambient sediment concentrations (normalized for organic carbon) with SQC can be interpreted as follows: Except possibly where a locally important species is very sensitive or where sediment organic-carbon is less than 0.2 percent, benthic organisms should be acceptably protected in freshwater sediments containing contaminant concentrations that are less than or equal to the freshwater criterion (table 4, column Y). In sediment with less than 0.2 percent organic carbon, particle size and sorption to nonorganic mineral fractions influence partitioning to a greater degree (Di Toro and others, 1991). The upper-95-percent confidence limit (table 4, column Z) should be interpreted as a concentration above which effects on benthic species should be expected and the lower-95-percent confidence limit (table 4, column Z) as a concentration below which impacts on benthic species should be unlikely (U.S. Environmental Protection Agency, 1993f,g). For contaminant concentrations in marine or estuarine sediments, the saltwater criteria (table 4, column AA) and 95-percent confidence limits (table 4, column BB) would apply. In its review of draft proposed SQC documents, the Science Advisory Board (U.S. Environmental Protection Agency, 1992i) recommended that for sediments with contaminant levels outside the boundaries of uncertainty, the SQC could be used to support regulatory decisions; for levels within the bounds of uncertainty, confirmatory tests would be required.

Primary references.--Primary sources for sediment-quality criteria for pesticides are U.S. Environmental Protection Agency (1988d; 1990a; 1993f,g). Proposed criteria for dieldrin, endrin, and three polycyclic aromatic hydrocarbons also were summarized in U.S. Environmental Protection Agency (1994).

U.S. ENVIRONMENTAL PROTECTION AGENCY/U.S. ARMY CORPS OF ENGINEERS TIERED-TESTING PROCEDURE FOR DETERMINING THE SUITABILITY OF DREDGED MATERIAL FOR OCEAN DISPOSAL

A document entitled "Evaluation of Dredged Material Proposed for Ocean Disposal, Testing Manual" was prepared jointly by the EPA and U.S. Army Corps of Engineers (COE) (U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, 1991). Known as the "Green Book," this manual contains technical guidance for determining the suitability of dredged material for ocean disposal through chemical, physical, and biological evaluations. This approach emphasizes potential biological effects rather than chemical presence of the possible contaminants; thus, there are no numerical criteria or

threshold levels above which the sediment is considered contaminated or unsuitable for ocean dumping, so guideline values are not included in table 4.

The "Green Book" describes a tiered-testing procedure for evaluating compliance with the limiting permissible concentration (LPC), defined by EPA's ocean dumping regulations (Code of Federal Regulations, Volume 40, Part 227.27). The suitability of dredged sediment for ocean dumping entails evaluation of potential effects on water column and benthic organisms. The LPC applicable to water-column effects is the concentration of any dissolved dredged-material constituent that, after making allowances for mixing, will not exceed applicable marine water-quality criteria. If water-quality criteria have not been established for all contaminants of concern in the dredged material, or if synergistic effects are suspected, bioassays are performed. The LPC then becomes one-hundredth of the acutely toxic concentration of dredged material in the water column after the initial 4-hour mixing period. Regarding potential effects on the benthic environment, chemical analyses of contaminants are considered necessary to determine the presence and concentrations of contaminants of concern. However, chemical analysis is not considered adequate to directly evaluate the biological effects of any contaminants because the potential effects depend on their bioavailability. Instead, bioassays are done to determine the biological availability and potential effects of contaminants associated with dredged material. This EPA/COE tiered-testing procedure is an alternative approach to assessing sediment quality than the sediment-quality criteria based on the equilibrium-partitioning method being developed by EPA's Office of Water.

FISH AND SHELLFISH TISSUE

Standards and guidelines in table 5, sections 1 and 2, apply to edible fish and shellfish tissue concentrations and are aimed at protection of human health: Section 1 contains applicable standards and section 2 applicable guidelines. Table 5, section 3, contains guidelines that apply to whole-fish tissue and are aimed at protection of fish-eating wildlife.

Contaminant distribution in biological tissues is dependent on many factors, such as the species, size, age, and fat content of the organism(s) sampled, and the type of tissue or organ analyzed. Hydrophobic, persistent pesticides that accumulate in biological tissues are associated with high lipid portions of the fish (for example, skin and liver), although this is contaminant- and species-dependent to some extent. Most standards and guidelines for pesticides in fish and shellfish tissue apply to edible portions of fish and shellfish, rather than to whole fish. This distinction is important because concentrations of hydrophobic pesticides are expected to be higher in whole fish than in fish muscle tissue, which is relatively low in fat (Niimi and Oliver, 1989). In general, standards and guidelines aimed at protection of human health apply to contaminant concentrations in the edible portion of fish or shellfish only. The only national guidelines that apply to whole fish tissue are the preliminary recommendations made by NAS/NAE in 1972 (National Academy of Sciences and National Academy of Engineering, 1973), and are aimed at the protection of fish-eating wildlife.

Contaminant-residue data in whole fish cannot be compared directly with standards and guidelines for edible fish and shellfish tissue. However, such standards and guidelines may be useful in determining whether additional sampling and analysis of edible game-fish tissue is warranted.

EDIBLE FISH AND SHELLFISH TISSUE

The standards and guidelines in table 5, sections 1 and 2, respectively, can be applied directly to contaminant concentrations in edible fish or shellfish tissue. For a given pesticide, either EPA tolerances or FDA action levels may exist, but not both (depending on whether it is currently registered for use). EPA tolerances in fish and shellfish are established to regulate the maximum amount of a pesticide that results from the registered use of that pesticide in water. FDA action levels in fish and shellfish exist for pesticides that are no longer registered for use but that may be present as unavoidable residues in food or feed because of their persistence in the environment.

Food and Drug Administration Action Levels

Food and Drug Administration action levels, expressed in milligrams of contaminant per kilogram of fish or shellfish, are provided in table 5, section 1, column CC. An FDA action level is an enforceable regula-tory limit for unavoidable pesticide residues in or on a food. FDA action levels exist only for pesticides without EPA tolerances, but that may be unavoidable residues in fish or shellfish because these pesticides are environmentally persistent. Such pesticides include a number of organochlorine insecticides that are no longer registered for use in the United States.

Action levels are listed in FDA's Compliance Policy Guide (CPG) 7141.01, Attachment B (Food and Drug Administration, 1989). When residues are at or above this action level, FDA can, at the agency's discretion, take legal action to remove the adulterated food from the market. It is legally nonbinding in that FDA's enforcement action is discretionary. The Food and Drug Administration (1990) published a policy statement explaining its use of action levels to regulate residues of pesticides in food or feed. The Federal Food, Drug and Cosmetic Act (FFDCA) provides that, in the absence of an EPA tolerance, any amount of a pesticide residue in a food or feed is unsafe and therefore renders the food or feed adulterated. However, FDA recognized that food or feed may contain residues of certain pesticides for which no tolerances existed (because the pesticides had been canceled by EPA), but that persist in the environment (for example, organochlorine insecticides). FDA found that in such cases, the level of pesticide was frequently so low that it was not of any regulatory or public health significance, and that pursuing enforcement action would provide little or no benefit to the public and would not be the most prudent way to expend agency resources. FDA therefore adopted the concept of action levels to define amounts of a particular contaminant that FDA regarded as rendering a food or feed adulterated. These action levels represent an exercise of FDA's discretion (1) under Section 306 of the FFDCA to refrain from initiating enforcement action in cases involving minor violations, and (2) to decide when and how to enforce the FFDCA. However, action levels provide guidance only on how FDA may exercise its enforcement discretion. FDA may decide that an enforcement action is not warranted even though the level of residue in a food or feed exceeds the applicable action level, or it may decide that an action is warranted against a food or feed that contains a level of pesticide residue that is lower than the applicable action level.

An action level is established by FDA based on EPA's recommendation. The action levels recommended by EPA were derived primarily from FDA's monitoring data, which provided an indication of the extent to which residues of a particular pesticide cannot be avoided by good agricultural or current good manufacturing practice. These recommended action levels also considered existing analytical detection levels (Food and Drug Administration, 1990).

As discussed in a draft EPA document (U.S. Environmental Protection Agency, 1992j), the development of FDA action levels entails consideration of both health risks posed to consumers (based on national average consumption rates) and the economic costs of banning a foodstuff from a specific source. This draft EPA document is the precursor to EPA's four-volume series entitled, "Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories," of which only the first volume is published in final form at this time (U.S. Environmental Protection Agency, 1993e). Subsequent volumes will address risk assessment, risk management, and risk communication. EPA is reevaluating action levels for several organochlorine insecticides in fish and shellfish (John Wessel, Food and Drug Administration, Office of Regulatory Affairs, oral commun., 1992; Tina Levine, U.S. Environmental Protection Agency, Office of Pesticide Programs, oral commun., 1992).

Use in evaluation of environmental data.--Although FDA action levels are called "guidance" by FDA, they are legally enforceable. If these levels (table 5, section 1, column CC) are exceeded, FDA can, but is not required to, take action to remove the contaminated fish or shellfish from interstate commerce (Food and Drug Administration, 1990).

Because the technical basis for FDA action levels is not publicly available, and action levels are not based exclusively on health considerations, it is difficult to use them in estimating potential health effects associated with consumption of fish or shellfish containing pesticide residues. Based on FDA's policy

statement (Food and Drug Administration, 1990), pesticide residues exceeding FDA action levels would be considered adulterated and, presumably, may comprise some risk to public health. FDA action levels are much higher than health-based EPA guidelines for pesticide-residue levels in edible fish or shellfish (see "U.S. Environmental Protection Agency Fish Tissue Concentrations" and "U.S. Environmental Protection Agency Recommended Screening Values"). Interpretation of pesticide-residue concentrations in fish tissues that are greater than these health-based EPA guidelines (table 5, section 2, columns EE and GG), but less than FDA action levels, is not straight-forward. FDA's policy statement on action levels for pesticide residues in food or feed implies that levels of pesticides less than the action levels frequently are of little or no regulatory or public-health significance. John Wessel, Food and Drug Administration, Office of Regulatory Affairs (oral commun., 1992), stated that FDA would consider food contaminated below the action level to be safe for consumption, at least under the exposure conditions expected for the general public.

However, because FDA action levels consider factors other than health concerns (such as economic costs and analytical detection levels), it is not necessarily appropriate to infer that adverse health effects will not take place when measured pesticide residues in edible fish or shellfish tissues fall below these limits. In fact, EPA specifically recommended in its draft guidance document to the States (U.S. Environmental Protection Agency, 1992j) that FDA "health protection criteria" (including action levels) NOT be used to develop State fish and shellfish consumption advisories because: (1) FDA action levels consider health risks posed to consumers and the economic costs of banning a foodstuff from a specific source, while the recommended EPA risk-assessment procedure considers only health risks (Reinert and others, 1991); (2) FDA health-protection criteria were developed on a national basis, and were not intended to protect local consumers of fish and shellfish, such as subsistence or sport fishermen who often consume more of a particular fish than the national average, or susceptible subpopulations, such as children or pregnant women (U.S. Environmental Protection Agency, 1992j); and (3) FDA action levels do not provide the same correlation between risk level and dose (consumption rate) as does the EPA risk-assessment approach (U.S. Environmental Protection Agency, 1992j).

Therefore, comparison of measured pesticide residues in fish or shellfish with FDA action levels indicates the likelihood that FDA would take enforcement action against this fish or shellfish if it were in interstate commerce. For use in health-risk calculations, however, it is better to use guidelines that are based on health considerations alone and for which the underlying assumptions are known (such as EPA fish-tissue concentrations or EPA recommended screening values).

Primary and secondary references.--The primary source for FDA action levels is the Compliance Policy Guide, Attachment B (Food and Drug Administration, 1989). Two secondary sources, Food and Drug Administration (1990; 1992) both contain errors. Specifically, both sources omit action levels in shellfish for all pesticides except one (chlordecone). Food and Drug Administration (1990) also lists an incorrect action level for heptachlor and heptachlor epoxide in fish.

U.S. Environmental Protection Agency Tolerances

The FFDCA authorizes EPA to set tolerances (provided in table 5, section 1, column DD) for pesticides in raw agricultural commodities. EPA tolerances, expressed in milligrams of contaminant per kilogram of fish or shellfish, are enforceable standards. Under the FFDCA, a tolerance or tolerance exemption is required when EPA grants registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) for the use of a pesticide in food or feed production in the United States. Under the FFDCA, FDA is responsible for the enforcement of pesticide tolerances established by EPA.

Tolerance.--This is the maximum amount of a pesticide residue that can be legally present in or on a raw agricultural commodity (Section 408 of the FFDCA).

Temporary tolerance.--EPA may establish a temporary tolerance to permit the experimental use of a nonregistered pesticide (Section 408(j) of the FFDCA). A temporary tolerance is issued for a period of time designed to allow the orderly marketing of raw-agricultural commodities produced while testing a

pesticide chemical under an experimental permit issued under authority of FIFRA; certain conditions apply.

Use in evaluation of environmental data.--EPA tolerances exist only for selected applications of currently registered pesticides. As previously noted, FDA has the responsibility for enforcing pesticide tolerances established by EPA. A concentration greater than these values (table 5, section 1, column DD) indicates that the food is adulterated and subject to FDA action. FDA can invoke various sanctions to remove the product from interstate commerce, such as seizure or injunction. Because the technical or health bases for EPA tolerances are not publicly available, it is not necessarily appropriate to infer that adverse health effects will not occur when measured residues in edible fish or shellfish tissues are less than these limits.

Primary reference.--The primary source for EPA tolerances is the Code of Federal Regulations, V. 40, Part 180.

U.S. Environmental Protection Agency Fish-Tissue Concentrations

EPA fish tissue concentrations (table 5, section 2, column EE) apply to freshwater and estuarine edible fish and shellfish tissue. They represent an intermediate calculation in the derivation of water-quality criteria for the protection of human health (table 3, section 4, columns P and Q) by EPA's Office of Water and are expressed in milligrams of contaminant per kilogram of fish. As are the water-quality criteria, EPA's fish-tissue concentrations are guidelines, not Federal standards. Unlike the water-quality criteria that are based on these values, EPA fish-tissue concentrations were not published in the Federal Register. They were compiled and reported, and the terminology "EPA fish-tissue concentrations" introduced, by EPA Region IV (U.S. Environmental Protection Agency, 1993a). The fish-tissue concentration values reported in this reference were updated based on revised RfD and q_1* information from IRIS (presented in table 5, section 2, column FF), so they correspond to recalculated human-health criteria values (U.S. Environmental Protection Agency, 1991b; 1992a; 1993a), rather than the published values (U.S. Environmental Protection Agency, 1980a-k; 1984a; 1991b).

EPA fish-tissue concentrations are calculated as follows: A total daily intake for humans is estimated, which establishes either a NOAEL (for noncarcinogens) or a defined level of risk for zero-threshold effects (for carcinogens). This total daily intake value, together with a set of exposure assumptions, is used to calculate the maximum concentration in fish and shellfish that would result in no adverse health effects. These exposure assumptions (specified below), are the same as those used to derive water-quality criteria for the protection of human health.

For noncarcinogens, the total daily intake is the RfD (in milligrams per kilogram body weight per day). Assuming (1) a body weight of 70 kg, (2) consumption of 6.5 g fish or shellfish per day, and (3) that 100 percent of exposure to this contaminant is from consumption of fish and shellfish, the maximum concentration in fish and shellfish that would result in no adverse health effects, or C[fish], is calculated as follows:

$$\text{C[fish] (mg/kg fish)} = \frac{(\text{RfD}) \times (70\text{-kg body wt})}{(0.0065 \text{ kg fish/d})}, \qquad (20)$$

where RfD is the reference dose, in (mg/kg body weight)/d. Note that equation 20 is identical to equation 10, which is an intermediate step in calculating human-health criteria for ingestion of aquatic organisms only.

The calculations for carcinogens are similar, except that the daily intake value used is derived from the q_1*, or cancer potency factor, and it is associated with a cancer risk of 10^{-6} (see equation 12).

Use in evaluation of environmental data.--EPA fish-tissue concentrations (table 5, section 2, column EE) are designed to protect human health under certain conditions of exposure, namely, daily ingestion

by a 70-kg adult of 6.5 g of freshwater and estuarine fish or shellfish for a lifetime of 70 years. These guidelines indicate the concentrations in fish tissue that are expected to result, for noncarcinogens, in no adverse health effects and for carcinogens, in an incremental cancer risk of 10^{-6}. Exceedance of these values indicates, for noncarcinogens, that adverse effects on human health may result, assuming the exposure conditions previously listed; for carcinogens, it indicates that the excess cancer risk may exceed 1 in 10^6. Fish-tissue concentrations corresponding to other cancer risk levels can be obtained by multiplying the value given in table 5, section 2, column EE, by an appropriate factor. For example, for values corresponding to a cancer risk level of 10^{-5}, multiply the fish-tissue concentration value given in the table by 10.

EPA fish-tissue concentrations may be used to make conservative estimates of potential adverse health effects or potential cancer risk from comparison of these guidelines with measured concentrations in edible fish or shellfish tissue. However, the risk-estimation procedures used by EPA are intentionally conservative and may overestimate risk. Also, the exposure assumptions underlying these guidelines need to be carefully considered when using them to interpret environmental data.

Primary reference.--The primary source for EPA fish-tissue concentrations is U.S. Environmental Protection Agency (1993a). Although these guidelines represent an intermediate calculation in the derivation of water-quality criteria for human health, fish-tissue concentrations were not reported in the original water-quality criteria documents for individual pesticides (U.S. Environmental Protection Agency, 1980a-k; 1984a). As previously noted, fish-tissue concentration values in U.S. Environmental Protection Agency (1993a) correspond to the recalculated (updated) water-quality criteria for human health (U.S. Environmental Protection Agency, 1991b; 1992a; 1993a).

U.S. Environmental Protection Agency Recommended Screening Values

EPA recommended screening values (table 5, section 2, column GG) consist of concentrations of contaminants in edible fish or shellfish tissue that are associated with a specified cancer risk or without appreciable health risk (other than cancer). These guidelines are expressed in milligrams of contaminant per kilogram of fish or shellfish. Recommended screening values (SVs) are contained in volume 1 of EPA's document series providing guidance to States on methods for monitoring contaminants in fish or shellfish tissue and on assessing health risks from exposure to environmental pollutants through consumption of chemically contaminated seafood (U.S. Environmental Protection Agency, 1993e). This guidance is intended for use by the States in assessing the need for and in issuing fish-consumption advisories. It does not constitute a regulatory requirement and States may choose to use procedures and assumptions other than those recommended by EPA. U.S. Environmental Protection Agency (1993e) recommends a risk-based method for developing screening values that is based on a dose-response variable and certain assumptions regarding exposure. The dose-response variable is the effective ingested dose of a chemical associated with a specified level of health risk, as estimated from dose-response studies.

For noncarcinogens, the dose-response variable is the reference dose, which defines a NOAEL. EPA recommends that the following equation be used to calculate SVs for noncarcinogens (SV_{nc}):

$$SV_{nc}(\text{mg/kg fish}) = \frac{(RfD) \times (BW) \times (RSC)}{(CR)}, \qquad (21)$$

where

RfD is the reference dose, in (mg/kg body weight)/d,
BW is the mean body weight of the general population or the subpopulation of concern, in kg,
RSC is the relative source contribution, which is the (unitless) fraction of total daily exposure contributed by the consumption of fish and shellfish, and
CR is the mean daily consumption rate of the fish and shellfish by the general population or subpopulation of concern averaged for a 70-year lifespan, in kg fish/d.

EPA recommended using the following values for these parameters to represent the general U.S. population of adults: BW = 70 kg, CR = 0.0065 kg of freshwater and estuarine fish and shellfish per day, and (in the absence of actual monitoring data for a compound in drinking water and other dietary sources), RSC = 0.80 (or 80 percent). By using these parameter values, equation 21 reduces to:

$$SV_{nc}\ (\text{mg/kg fish}) = \frac{(\text{RfD}) \times (70\text{-kg body wt}) \times (0.80)}{(0.0065\ \text{kg fish/d})}. \qquad (22)$$

For carcinogens, the dose-response variable is the cancer potency factor (oral slope factor), which generally is an upper-bound risk estimate. EPA recommends using the q_1*, the upper-95-percent-bound oral slope factor based on the linearized multistage model. As previously noted, the linearized multistage model fits linear dose-response curves to low dosage (see EPA Carcinogenicity Classification, above). The model is conservative in that there is no NOAEL for carcinogens; exposure to even a very small amount of a substance theoretically produces a finite increased risk of cancer ((U.S. Environmental Protection Agency, 1989b). Therefore, the screening value is calculated that denotes a specific risk level, an assigned level of maximum acceptable individual-lifetime risk. EPA recommends using the following equation to calculate screening values for carcinogens (SV_c):

$$SV_c\ (\text{mg/kg fish}) = \frac{(\text{RL}) \times (\text{BW})}{(q_1^*) \times (\text{CR})}, \qquad (23)$$

where

RL is the assigned risk level (unitless),
BW is the mean body weight of the population or subpopulation of concern, in kg,
q_1* is the cancer potency factor, in $[(\text{mg/kg body weight})/\text{d}]^{-1}$, and
CR is the mean daily consumption rate of fish and shellfish, in kg fish/d.

EPA recommended using the following values for these parameters for pesticides in fish or shellfish to represent the general U.S. adult population: RL = 10^{-5} (or a risk level not to exceed one excess case of cancer per 100,000 individuals exposed for a 70-year lifetime), BW = 70 kg, and CR = 0.0065 kg fish/d (for consumption of freshwater and estuarine fish and shellfish). By using these parameter values, equation 23 reduces to:

$$SV_c\ (\text{mg/kg fish}) = \frac{(10^{-5}) \times (70\ \text{kg body wt})}{(q_1^*) \times (0.0065\ \text{kg fish/d})}. \qquad (24)$$

U.S. Environmental Protection Agency (1993e) specified that other values for body weight (BW) and consumption rate (CR) be used to protect susceptible subpopulations. For example, EPA recommended mean body weight values of 65 kg for adult females, and 12 to 61 kg for children, depending on age. Other recommended values for consumption rates of freshwater, marine, or estuarine fish and shellfish are 30 g/d for the 50th percentile of recreational fishermen (to represent sport fishermen), and 140 g/d for the 90th percentile of recreational fishermen (to represent subsistence fishermen). EPA emphasized the need for States to accurately characterize the subpopulation of interest to establish adequately protective SVs.

Although recommending that a risk level of 10^{-5} be used to calculate SVs for the general adult population, U.S. Environmental Protection Agency (1993e) specified that States may choose to use an appropriate risk level typically ranging from 10^{-4} to 10^{-7}. U.S. Environmental Protection Agency (1993e) noted that selection of an appropriate risk level is a risk management decision to be made by the State.

Use in evaluation of environmental data.--These guidelines (table 5, section 2, column GG) are intended to protect human health under certain conditions of exposure. These conditions are identical to those assumed in deriving EPA fish-tissue concentrations, namely, daily ingestion by a 70-kg adult of 6.5 g of freshwater and estuarine fish for a lifetime of about 70 years. The health basis for EPA recommended

screening values (RfD or q_1* value) is identical to that for EPA fish-tissue concentrations, so is provided in table 5, section 2, column FF. Despite these similarities, EPA recommended screening values are less than EPA fish-tissue concentrations by 20 percent for noncarcinogens, and they are higher by a factor of 10 for carcinogens. The discrepancy for noncarcinogens is because of differences in exposure assumptions (relative source contribution). EPA recommended screening values assume that only 80 percent of exposure comes from ingestion of contaminated fish and shellfish, whereas EPA fish tissue concentrations assume that 100 percent of exposure is from contaminated fish and shellfish. The discrepancy for carcinogens is because these guidelines are calculated for different cancer risk levels: 10^{-5} for EPA's recommended screening values and 10^{-6} for EPA fish-tissue concentrations. Screening values for sensitive subpopulations can be calculated using equations 21 and 23 above (from U.S. Environmental Protection Agency, 1993e) and making appropriate exposure assumptions (body weight and fish consumption rate).

As noted previously, EPA's guidance document on setting fish advisories (U.S. Environmental Protection Agency, 1993e) recommends an "acceptable" level of cancer risk (10^{-5}, or 1 in 100,000), although individual States may choose to use another appropriate risk level when setting fish-consumption advisories. "Acceptable" levels of cancer risk were discussed previously (see "U.S. Environmental Protection Agency Health Advisories" and "U.S. Environmental Protection Agency Ambient Water-Quality Criteria for the Protection of Human Health"). U.S. Environmental Protection Agency (1992a) also indicated that States could reasonably adopt a risk level of 10^{-5} for many carcinogens and a more stringent risk level of 10^{-6} for carcinogens with substantially higher bioconcentration factors.

Primary reference.--The primary source for EPA recommended screening values is U.S. Environmental Protection Agency (1993e). This is volume 1 of EPA's four-volume series, "Guidance for Assessing Chemical Contaminant Data for use in Fish Advisories. Volumes 2-4 of this series, not yet published (as of January 1994) will address risk assessment, risk management and risk communication (U.S. Environmental Protection Agency, 1993e). However, preliminary discussion of these issues can be found in a draft EPA document (U.S. Environmental Protection Agency, 1992d) that is the precursor to EPA's final four-volume series.

WHOLE FISH TISSUE

National Academy of Sciences and National Academy of Engineering (1973) recommended maximum-tissue concentrations for protection of fish-eating wildlife are the only set of guidelines for fish-tissue that can be directly applied to contaminant concentrations in whole fish (table 5, section 3, columns HH and II); no standards exist for whole fish tissue. A preliminary comparison of contaminant concentrations in whole fish with various guidelines for edible fish and shellfish tissue (table 5, sections 1 and 2) may be useful; however, conclusions that can be drawn from this comparison are limited.

National Academy of Sciences and National Academy of Engineering Recommended Maximum Tissue Concentrations

The National Academy of Sciences and National Academy of Engineering (1973) recommended maximum tissue concentrations for the protection of fish-eating wildlife, expressed in milligrams of contaminant per kilogram of fish, are provided in table 5, section 3, columns HH and II. Because certain organochlorine pesticides persist and accumulate in aquatic organisms, the NAS/NAE recommended maximum concentrations in water (table 3, section 5, columns W and X) were not considered to be protective of predators (National Academy of Sciences and National Academy of Engineering, 1973). Because of trophic accumulation, birds and mammals that occupy the higher trophic levels in the food web may acquire body burdens that are lethal or that have significant sublethal effects on reproductive capacity, even though the concentration in water remains very low. Therefore, National Academy of Sciences and National Academy of Engineering (1973) recommended two sets of specific maximum-tissue concentrations as guidelines for water-quality control: one for protection of wildlife dependent on freshwater ecosystems and another for marine wildlife. Marine wildlife is defined as those species of birds, mammals, and reptiles that inhabit estuaries or coastal and marine waters for at least a part of their lifespan.

The specific guideline values recommended by NAS/NAE are based on experimental studies showing induction by DDT and metabolites of eggshell thinning in birds of several families and on studies of eggshell thinning in wild bird populations. More conservative guideline values for other organochlorines were set by analogy to DDT and metabolites. Recommended values for some compounds (aldrin, dieldrin, endrin, and heptachlor epoxide) are lower than those for DDT and metabolites, based on their greater toxicity to wildlife. NAS/NAE acknowledged that pooled collections (composites) of fish would be necessary to mitigate the effect of individual variation in residue concentrations. Pooled collections of 25 or more fish were recommended for marine guidelines; freshwater guidelines did not specify any compositing requirement. Recommendations for freshwater and marine wildlife were made by two separate panels of NAS/NAE representatives.

Use in evaluation of environmental data.--Even when originally published, National Academy of Sciences and National Academy of Engineering (1973) recommended maximum tissue concentrations were considered preliminary values; they are now over 20 years old. These guidelines are included in this report only because subsequent Federal guidelines are not available. Concentrations in freshwater fish tissue that exceed these values (table 5, section 3, column HH) indicate that adverse effects may occur to fish-eating wildlife dependent on freshwater ecosystems. Exceedance of corresponding marine criteria (table 5, section 3, column II) by residues in marine or estuarine fish tissues indicates that adverse effects may occur to fish-eating wildlife that spend a part of their lifecycle in estuarine, coastal, or marine areas.

Primary reference.--National Academy of Sciences and National Academy of Engineering (1973) is the primary source for recommended maximum tissue concentrations.

Preliminary Comparison with Standards and Guidelines Applicable to Edible Fish Tissue

Although the following standards and guidelines apply to edible fish and shellfish tissue, some limited information can be gained by comparing measured concentrations of pesticides in whole fish tissue to FDA action levels (table 5, section 1, column CC), EPA tolerances (table 5, section 1, column DD), EPA fish-tissue concentrations (table 5, section 2, column EE), and EPA recommended screening values (table 5, section 2, column GG). Definitions of these standards and guidelines were given previously (see "Edible Fish and Shellfish Tissue").

Use in evaluation of environmental data.--Residues of hydrophobic organic contaminants, including organochlorine pesticides, are expected to be higher in whole fish than in edible fish tissue (muscle or fillets), which has a lower-fat content than does the whole fish (Niimi and Oliver, 1989). Limited conclusions are possible from preliminary comparison of whole fish data with a given standard or guideline for a contaminant in edible fish and shellfish tissue: If measured concentrations in whole fish are less than a standard or guideline value for that contaminant edible fish and shellfish tissue, then it is reasonable to conclude that edible fish and shellfish tissue residues are likely to be below the applicable standard or guideline. However, if measured contaminant concentrations in whole fish exceed a standard or guideline for that contaminant in edible fish and shellfish tissue, this indicates only that additional sampling and analysis of fish fillets may be warranted. Hydrophobic organic contaminants are not distributed uniformly among extractable fish lipids (Schneider, 1982) and different extraction methods yield significantly different lipid concentrations (Randall and others, 1991). Therefore, percentage of extractable lipid should not be used to estimate the concentration of organic contaminants in edible fish and shellfish tissues based on residue analyses of the whole fish (Schmitt and others, 1990).

OTHER SOURCES OF INFORMATION

In addition to national standards and guidelines, many other sources of information may be useful in interpreting water-quality data from the standpoint of implications for human health or toxicity to aquatic life or wildlife.

APPLICABLE STATE STANDARDS AND GUIDELINES

Many Federal guidelines may form the basis of enforceable State standards or criteria. Moreover, some States may have adopted more stringent standards or criteria than those of EPA. In addition, some States may have criteria in areas where there is a paucity of national information, such as wildlife criteria (for example, Wisconsin and Minnesota) and fish-tissue residues for protection of piscivorous birds and mammals (for example, New York).

U.S. ENVIRONMENTAL PROTECTION AGENCY PROPOSED WATER-QUALITY GUIDANCE FOR THE GREAT LAKES SYSTEM

On April 16, 1993, the U.S. Environmental Protection Agency (1993k) proposed water-quality criteria for 28 substances. These included human-health criteria for eight pesticides, aquatic-life criteria for five pesticides, and a wildlife criterion for one pesticide. Human-health and wildlife criteria also were proposed for 2,3,7,8-TCDD. All proposed Great Lakes criteria are expressed as whole-water concentrations. These criteria were derived using updated methodology, such as the use of bioaccumulation factors (which reflect uptake by all exposure routes) rather than bioconcentration factors (which reflect uptake from the surrounding water only) and regionally appropriate exposure assumptions (for example, fish-consumption rates of sport and subsistence fishermen). Users are encouraged to consult U.S. Environmental Protection Agency (1993k) for details. These proposed criteria are summarized in table 6.

CANADIAN WATER-QUALITY AND AQUATIC SEDIMENT-QUALITY GUIDELINES

Canadian Council of Resource and Environment Ministers (1991) published numeric guidelines for freshwater aquatic life and summaries for individual chemicals of the aquatic-toxicity information used to derive them. These Canadian guidelines are analogous to EPA aquatic-life criteria.

The Ontario Ministry of the Environment and Energy published guidelines for the protection and management of aquatic sediment quality in Ontario (Persaud and others, 1993). Guidelines are provided for 16 organochlorine insecticides, as well as polychlorinated biphenyls (PCBs), PAHs, metals, and nutrients. The guidelines establish three levels of effect: (1) No Effect Level, the level at which the chemical in the sediment does not affect fish or sediment-dwelling organisms and does not transfer through the food chain; (2) Lowest Effect Level, a level of contamination that has no effect on the majority of sediment-dwelling organisms; and (3) Severe Effect Level, a level of contamination that is likely to affect the health of sediment-dwelling organisms and at which the sediment is considered heavily polluted. The guidelines provide the basis for sediment-quality evaluations made in Ontario, including Ministry programs that deal with the problem of contaminated sediments. If the Lowest Effect Level is exceeded, further testing and a management plan may be required. If the Severe Effect Level is exceeded, a management plan may be required; this plan may include controlling the source of contamination or removing the sediment.

WORLD HEALTH ORGANIZATION GUIDELINES FOR DRINKING-WATER QUALITY

The World Health Organization (WHO) is an agency of the United Nations that specializes in public health and international matters related to health. The WHO issued guidelines for use by countries as the basis for the development of standards that, when implemented, will ensure the safety of drinking-water supplies. These guidelines are not prescribed international standards but are intended to be used in a risk-benefit approach that also considers "...prevailing environmental, social, economic, and cultural conditions..." (World Health Organization, 1984). World Health Organization (1984) guidelines include numeric guideline values for pesticides and other organic contaminants and review the toxicological, epidemiological, and clinical evidence used to derive the guideline values.

PUBLISHED COMPILATIONS OF TOXICITY DATA

Ronald Eisler and others from the Fish and Wildlife Service, Patuxent Wildlife Research Center, authored a series of 25 synoptic reviews on the hazards of individual pesticides and trace elements to fish, wildlife, and invertebrates. Each review contains information on the properties, environmental chemistry, and use of the subject compound, as well as an excellent review of available information (as of the time the individual report was published) on its toxicology and environmental effects. Synoptic reviews are available for the following pesticides and other organic compounds: mirex, carbofuran, toxaphene, PCBs, dioxins, diazinon, PAHs, chlorpyrifos, pentachlorophenol, atrazine, chlordane, paraquat, fenvalerate, and diflubenzuron (Eisler, 1985a,b; 1986a-c; 1987; 1989a,b; 1990a,b; 1992a,b; Eisler and Jacknow, 1985; Odenkirchen and Eisler, 1988).

Mayer and Ellersieck (1986) compiled acute-toxicity data developed since 1965 by the Columbia National Fisheries Research Laboratory, U.S. Fish and Wildlife Service. Data were analyzed to make taxonomic comparisons and evaluate the effects of factors such as pH, temperature, and test design on toxicity. This publication includes acute-toxicity levels, with related experimental parameters and formulation information for individual chemicals, including pesticides.

Long and Morgan (1991) evaluated alternative approaches to establishing effects-based sediment criteria and compared sediment data from the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends Program with chemical concentrations measured or predicted by the different methods to be associated with biological effects. Although the National Status and Trends program covers estuarine and near-coastal areas, Long and Morgan (1991) merged results of both freshwater and saltwater studies to determine biological effects concentrations for individual contaminants. The contaminants addressed in this report include pesticides, trace metals, PCBs, and PAHs, and includes a summary of sediment-toxicity data available for each contaminant.

AQUIRE (AQUATIC INFORMATION RETRIEVAL) DATA BASE

This on-line data base was developed by a research group associated with EPA's Environmental Research Laboratory in Duluth, Minnesota. This data base contains information on acute and chronic toxicity, bioaccumulation, and sublethal effects of chemical substances on aquatic organisms; data are included on freshwater and saltwater species, but not on aquatic birds, mammals, or bacteria. The information in AQUIRE was extracted from independently compiled data files and from the literature published since 1970. This data base is available from Chemical Information Systems (1-800-CIS-USER).

SUMMARY

National standards and guidelines for pesticides can be useful tools in water-quality assessment for evaluating potential human health or ecological effects of measured pesticide residues in water, bed sediment, or aquatic organisms. However, valid use of a given standard or guideline requires an understanding of its technical basis and underlying assumptions.

Each type of standard or guideline is specific for one sampling medium (water, bed sediment, fish and shellfish tissue) and is aimed at protection of one or more beneficial uses of the hydrologic system (drinking water, fish and shellfish consumption, aquatic organisms, and wildlife). These characteristics can be used to identify which standards and guidelines are appropriate for comparison with measured pesticide concentrations in environmental samples from a given hydrologic system. A review of standards and guidelines can be restricted to the applicable sampling medium. Then, the beneficial uses of the hydrologic system need to be identified and the measured pesticide concentrations compared with standards and guidelines for all beneficial uses that apply to that system. Several key factors that must be considered when applying this general process to water-quality assessment are summarized below.

SAMPLING MEDIUM

Two precautions need to be considered regarding sampling media:

1. Standards and guidelines for water distinguish between finished drinking water (potable water, often treated) and ambient surface water. If standards and guidelines for drinking water (U.S. Environmental Protection Agency (EPA) primary drinking-water regulations and drinking-water health advisories) are applied to measured pesticide concentrations in ambient water samples, the effects of water treatment (such as filtration) need to be considered.

2. Standards and guidelines for fish and shellfish tissue distinguish between edible fish and shellfish tissue and whole fish tissue. Comparison of pesticide concentrations in whole fish tissue with standards or guidelines for edible fish and shellfish tissue is appropriate only as a screening procedure to determine whether additional sampling and analysis for contaminants in edible fish fillets are warranted.

STANDARDS AND GUIDELINES

For some sampling media (water, fish and shellfish tissue), both standards and guidelines may exist for a given pesticide. Standards and guidelines may differ in their technical bases and in the implications or consequences of finding measured concentrations in exceedance of the standard or guideline value. Therefore, comparison of measured pesticide concentrations with both standards and guidelines is useful because each provides different information about the hydrologic system. When pesticide concentrations in environmental samples exceed applicable enforceable standards, this may have legal or regulatory significance. It is not necessarily appropriate, however, to infer that adverse human-health effects will not occur where measured pesticide concentrations do not exceed the applicable standards; standards may consider other factors in addition to health effects.

The only standard for water is the maximum contaminant level (MCL) in drinking water, which is established based on health effects, organoleptic effects, treatment feasibility, cost of treatment, and analytical detection. Health-effects guidelines for water are the maximum contaminant level goal (MCLG) and drinking water health advisory values; these are based on health effects alone. Except for potential carcinogens, the MCL for a given pesticide is equivalent to the MCLG. The MCLG for noncarcinogens also is equivalent to the lifetime health advisory value, which is the lowest (most protective, because it assumes lifetime exposure) of the health advisory values. For noncarcinogens, therefore, the standard for a given pesticide (the MCL) will be equivalent to (or lower than) strictly health-based guideline values from EPA (MCLG and health advisory values). It is reasonable to rely on the MCL as a measure of both regulatory significance and potential health effects. For potential carcinogens, EPA uses a zero-threshold model of carcinogenesis (in other words, exposure to even a small amount of a carcinogen produces a finite excess cancer risk). This model is intentionally conservative. The MCL values for potentially carcinogenic pesticides are based on the practical quantitation level, which reflects the level that can be measured by laboratories under normal operating conditions under specified limits of accuracy and precision. For potential carcinogens, therefore, it is reasonable to compare measured concentrations of a pesticide with both the MCL and the risk specific dose, a guideline value that provides a conservative (overprotective) estimate of the pesticide concentration in water that, over a lifetime exposure may result in specified cancer risk. National Academy of Sciences (NAS) drinking water and health recommendations may provide additional information (such as concentrations associated with teratogenic effects) or they may be useful for pesticides for which there are no EPA drinking water regulations or health advisories.

For fish and shellfish tissue, both standards (Food and Drug Administration (FDA) action levels) and various guidelines (EPA recommended screening values or EPA fish-tissue concentrations) exist for a number of organochlorine insecticides. FDA action levels for unavoidable pesticide residues in edible fish and shellfish are derived from FDA's monitoring data (which indicate the extent to which residues cannot be avoided by good agricultural and manufacturing practices); they also consider analytical detection limits. To assess potential human-health effects associated with pesticide concentrations in edible fish and

shellfish, it may be more appropriate to use guidelines that were based solely on health effects: namely, EPA recommended screening values or EPA fish tissue concentrations.

TECHNICAL BASIS

The technical (health or toxicity) basis of applicable guidelines is important to understand. Most human-health guidelines for noncarcinogens are based on results of short-term toxicity tests with animals, and the results are extrapolated to longer-term exposures of humans using an uncertainty factor. The uncertainty factor used depends on the quantity and quality of the data available for a given pesticide. Because health assessment for carcinogens is based on a zero-threshold model of carcinogenesis, guideline values for carcinogens are associated with a specified excess cancer risk; because the model used is conservative (overprotective), guideline values are upper-bound estimates of excess cancer risk. If health assessments are desired for different cancer risk levels than those used in deriving the guideline values in this report (either 10^{-5} or 10^{-6}), adjusted guideline values can be obtained using the equations in the text. What constitutes an "acceptable" level of cancer risk may vary somewhat for different pesticides and different regulatory agencies; this is a risk management issue, rather than a technical one. EPA's policy in reviewing State water-quality standards has been to accept cancer risk levels in the range of 10^{-4} and 10^{-6}. EPA considers it reasonable to adopt a risk level of 10^{-5} for many carcinogens, and a more stringent risk level of 10^{-6} for carcinogens with substantially higher bioconcentration factors.

Aquatic-life criteria from both EPA and National Academy of Sciences/National Academy of Engineering (NAS/NAE) are based for the most part on single-species toxicity tests involving exposure to a single test chemical. EPA's 1985 guidelines for establishing water-quality criteria for protection of aquatic organisms specify that a diverse group of genera must be tested before criteria can be established; the criteria are set to protect 95 percent of the species tested. EPA's aquatic-life criteria provide a consistent framework for assessing the potential aquatic toxicity of chemicals among different hydrologic systems. However, EPA's aquatic-life criteria do not reflect the potential for synergistic (or antagonistic) effects of exposure to multiple chemicals, nor do they necessarily protect locally important or sensitive species in a given hydro-logic system. In general, NAS/NAE criteria are based on a more limited array of toxicity tests than are EPA aquatic-life criteria; this is particularly true for saltwater (marine) criteria.

EXPOSURE ASSUMPTIONS

Once guidelines that apply to samples from a given sampling medium and hydrologic system have been identified, the exposure assumptions underlying each guideline need to be considered. For human-health guidelines, assumptions are made regarding the following characteristics: body weight (male or female, adult or child), exposure duration, consumption rates for drinking water and fish and shellfish, and relative source contribution (what percentage of the total exposure to the pesticide of concern is due to consumption of the water or fish and shellfish being assessed). Most human-health guideline values in this report were calculated for the general U.S. population over a lifetime (70-year) exposure, unless noted otherwise; for example, certain drinking-water health advisories are for children and shorter-term exposures. If desired, guideline values in this report can be adjusted to represent alternative exposure assumptions (for example, higher fish consumption rates for sport or subsistence fishermen) using the equations in the text.

EPA's water-quality criteria for protection of aquatic organisms were derived for certain exposure conditions. Documenting exceedance of EPA's aquatic-life criteria established under EPA's 1985 guidelines would require measurement of 1-hour and 4-day average concentrations (for acute and chronic criteria, respectively) to be collected at least twice within a 3-year period. This is impractical for many water-quality studies. Therefore, it is appropriate to qualify conclusions drawn from comparison of any single measurement of a pesticide concentration in surface water with EPA's aquatic-life criteria. For example, if a measured pesticide concentration exceeds the chronic criteria (CCC, or criterion continuous concentration), it is reasonable to conclude that deleterious effects on aquatic organisms may result if this excursion is repeated within 3 years. EPA aquatic-life criteria assume that excursions above the criteria

are extreme values in the distribution of ambient concentrations and the result of usual variations (for example, in flows) rather than high concentrations caused by spills or other major events.

MULTIPLE APPLICABLE GUIDELINES

For some sampling media, multiple guidelines aimed at protection of the same beneficial use may exist for a given pesticide. Two examples occur frequently:

1. Both EPA ambient water-quality criteria for protection of aquatic life and NAS/NAE maximum recommended concentrations in water are guidelines for ambient surface water and are aimed at protection of aquatic organisms. In general, the more recent EPA criteria (published in 1980-1986) are based on more up-to-date toxicity information than the NAS/NAE recommendations (published in 1973). However, NAS/NAE recommendations for aquatic life may be useful for those pesticides for which no EPA criteria are available.

2. For many pesticides, two types of guidelines apply to fish and shellfish tissue for human consumption: EPA fish-tissue concentrations and EPA recommended screening values. Except for one pesticide (endosulfan, as noted in the appropriate table), these guidelines are based on the same health-effects information. Discrepancies between these two types of guidelines are because of differences in exposure assumptions for noncarcinogens (relative source contribution) and differences in cancer risk levels for carcinogens. EPA recommended screening values are especially useful because the detailed methodology used to derive them (including exposure assumptions) has been published in final form.

Measured pesticide concentrations in ground water can be compared with EPA primary drinking-water regulations, EPA health advisories, and NAS drinking-water and health recommendations.

For ambient surface water, pesticide residues in freshwater can be compared with these same standards and guidelines, if the water body is used as a drinking-water source. However, these standards and guidelines apply to finished drinking water, which may or may not be accurately represented by measurements of ambient conditions, depending on the water treatment methods used. In many hydrologic systems, measured pesticide concentrations in freshwater may more appropriately be compared to guidelines for ambient surface water, namely, EPA water-quality criteria for the protection of human health (if fish and shellfish from the water body are consumed) and freshwater aquatic organisms, and NAS/NAE maximum recommended concentrations in water for protection of freshwater aquatic life. Marine data can be compared with EPA water-quality criteria for the protection of saltwater aquatic organisms, and NAS/NAE maximum recommended concentrations in water for protection of marine aquatic life. These NAS/NAE recommendations are useful when EPA criteria are not available.

Pesticide concentrations in bed sediment can be compared with EPA proposed sediment-quality criteria for the protection of benthic organisms. Because proposed criteria are available for only two pesticides at this time, it may be useful to compare measured pesticide concentrations in bed sediment with preliminary (tentative or interim) sediment-quality criteria. However, given the preliminary nature of these criteria, such comparisons need to be made with caution and qualified appropriately.

Pesticide residues in edible fish and shellfish tissue can be compared with FDA action levels or EPA tolerances, if either exists. Clearly, there may be legal or regulatory consequences if measured residues exceed these standards. However, these standards are not based on health considerations alone, and documentation of their technical basis is not publicly available. Therefore, to evaluate potential adverse health effects due to consumption of pesticide-contaminated fish or shellfish, it is appropriate to compare measured residues with EPA recommended screening values or EPA fish-tissue concentrations. Careful attention should be paid to the exposure assumptions and (for carcinogens), acceptable risk levels underlying these guidelines. Guideline values can be adjusted, if desired, to represent alternative exposure assumptions (for example, higher fish consumption rates associated with sport or subsistence fishing) or alternative cancer risk levels.

Whole fish-tissue data can be compared with NAS/NAE recommendations for protection of fish-eating wildlife, although the latter are preliminary values. Comparison of whole fish-tissue data with standards or guidelines for edible fish and shellfish tissue (such as FDA action levels) is appropriate only as a screening procedure to determine whether additional sampling and analysis for contaminants in fish fillets is warranted.

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TABLES

Table 3. Compilation of national standards and guidelines for pesticides in water

[**CAS No.**: Chemical Abstracts Services registry number. (This number is provided for ease of identifying compounds that may be known by multiple names.)
PP: priority pollutant status (EPA, 1992a; 1993a), N, no; Y, yes.
Carcinogenicity classification: EPA classification into one of five cancer groups. A, human carcinogen; B, probable human carcinogen, based on epidemiological studies (B1) or animal studies (B2); C, possible human carcinogen; D, not classified; E, no evidence of carcinogenicity; U, under review. Quantitative measure of carcinogenic potency (q_1*) is determined for A, B, and some C carcinogens.
Primary drinking water regulations: EPA regulations for contaminants that may adversely affect human health and that may occur in public water systems. Consists of regulatory limit (MCL) and health-based goal (MCLG).
Status code: B, values for which the only published rationale is in the IRIS data base; D, draft; E, existing guidelines published with technical rationale; F, published in final rule, applicable to all States; I, insufficient data to establish criteria; L, listed for regulation; N, not confirmed and no published rationale available; P, published in proposed rule; R, revised to reflect updated health or toxicity information; S, superseded because of more recent health or toxicity information; T, tentative; X, published in final Toxics Rule (EPA, 1992a), which promulgates these values as water-quality standards for 14 States and Territories only; Y, regulation is stayed, so values are not in effect.
Health advisories: EPA guidelines indicating contaminant concentrations in drinking water that would result in no adverse human health effects, determined for a child or an adult for various exposure periods. Assumes consumption of 1 L/d drinking water by 10-kg child or 2 L/d drinking water by 70-kg adult. Child: 1-day, 10-day, longer-term (7 year) exposure. Adult: Longer-term (7 year) and lifetime (70 year) exposure. RfD (reference dose) indicates acceptable daily intake (ADI). DWEL (drinking water equivalent level) indicates contaminant concentration in drinking water that corresponds to the RfD, assuming 100 percent of exposure is from drinking water. Lifetime advisory assumes 20 percent of exposure is from drinking water. For A or B carcinogens, RSD (risk specific dose) is the contaminant concentration in drinking water that corresponds to a specified cancer risk, assuming 100 percent of exposure is from drinking water and is calculated in lieu of lifetime advisory.
NAS drinking water and health recommendations: NAS guidelines for contaminants in drinking water. Consists of ADI, SNARL (suggested-no-adverse-response level) and lifetime cancer risk. SNARL indicates the contaminant concentration in drinking water that would result in the ADI. Assumes 70-kg body weight, consumption of 2 L/d drinking water over a 70-year lifetime, and that 20 percent of exposure is from drinking water. Lifetime cancer risk is the risk associated with consuming 1 L/d drinking water containing 1 µg contaminant per liter for 70 years.
EPA ambient water-quality criteria, human health: EPA guidelines indicating contaminant concentrations in ambient water that are expected to prevent adverse human health effects or (for carcinogens) result in a 10^{-6} cancer risk, under two sets of exposure conditions: consumption of water and aquatic organisms and consumption of organisms only. Assumes consumption of 2 L/d drinking water and (or) 6.5 g of freshwater and estuarine fish or shellfish. Technical basis consists of health-based number (q_1* for A or B carcinogens, RfD for noncarcinogens) and bioconcentration factor (BCF, which is the ratio between the chemical concentration in fish or shellfish tissue to that in the surrounding water, normalized to 3 percent lipids, in units of L/kg fish). Technical basis is provided only for the most recent set of criteria.
EPA ambient water-quality criteria, aquatic organisms: EPA guidelines indicating contaminant concentrations in ambient water that are not expected to result in unacceptable ambient effects on aquatic organisms and their uses during short-term (acute) or long-term (chronic) exposure. Provided for freshwater and saltwater organisms.
NAS/NAE recommended maximum concentrations in water: NAS/NAE guidelines indicating contaminant concentrations in ambient water that are expected to protect aquatic life. Provided for freshwater and marine organisms. Preliminary values only. Freshwater value was reported in NAS/NAE (1973). Marine value was calculated by applying an application factor of 100 to the LC_{50} (median lethal concentration) value for the most sensitive species listed in NAS/NAE (1973), as recommended in NAS/NAE (1973). For a compound that trophically accumulates in foodwebs, this criterion will not protect fish-eating wildlife.
References: Boldface indicates that cited reference contains the technical basis for the corresponding standard or guideline.
Numerical values for all standards and guidelines are reported as in cited references, except that some references may contain rounded values.
Acronyms: EPA, U.S. Environmental Protection Agency; FDA, Food and Drug Administration; NAS, National Academy of Sciences; NAS/NAE, National Academy of Sciences and National Academy of Engineering; NRC, National Research Council. ADI, acceptable daily intake, in (mg/kg)/d; BCF, bioconcentration factor normalized to 3 percent lipids, in L/kg fish; CCC, criterion continuous concentration, in mg/L; CMC, criterion maximum concentration, in mg/L; DWEL, drinking water equivalent level, in mg/L; FAV, final acute value, in mg/L; FCV, final chronic value; IRIS, Integrated Risk Information System (EPA, 1993b); LC_{50}, median lethal concentration, in mg/L; LOAEL, lowest-observed-adverse-effect level; MCL, maximum contaminant level, in mg/L; MCLG, maximum contaminant level goal, in mg/L; NOAEL, no-observed-adverse-effect level; RfD, reference dose, in (mg/kg)/d; RSD, risk specific dose, in mg/L; q_1*, cancer potency factor, also called oral slope factor, in $[(mg/kg)/d]^{-1}$; SMCL, secondary maximum contaminant level, in mg/L; SNARL, suggested-no-adverse-response level, in mg/L; UF, uncertainty factor.
Abbreviations: 24-h, 24-hour exposure; 7-d, 7-day exposure. g, gram; kg, kilogram; L, liter; L/d, liter per day; L/kg-fish, liter per kilogram of fish; mg/L, milligram per liter; (mg/kg)/d, milligram per kilogram body weight per day; nsg, no standard or guideline reported for this compound in the cited reference(s); µg, microgram; µg/L, microgram per liter. --, no data; >, greater than; <, less than]

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification			(C) EPA Primary drinking water regulations (mg/L)			
			Cancer group	(B) q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
Acifluorfen	50594-66-6	N	B2	0.0355	EPA ([1]**1988a**; [1]**1989b**, [1]1992c; 1993c,d)	nsg	0	T	EPA (1993c)
Alachlor	15972-60-8	N	B2	[2]0.083	EPA ([1]**1988b,[1]f**; 1993c,d)	[3]0.002	0	F	([4]) EPA (1991a; 1993b,c)
			B2	[2]0.080	EPA ([1]1992c)				
			B2	[2]0.060	EPA ([1]**1987a**)				
			U		EPA (1993b)				
Aldicarb	116-06-3	N	D	nsg	EPA (**1988b**; 1991c; **1993b**,c)	[3]0.003	0.001	Y[5]	([4]) EPA (1991c; 1993b,c)
			E[6]	nsg	EPA (**1987a**)				
Aldicarb sulfone	1646-88-4	N	D	nsg	EPA (1991c; 1993c)	[3 7]0.002	0.001	Y[5]	([4]) EPA (1991c; 1993b,c)
Aldicarb sulfoxide	1646-87-3	N	D	nsg	EPA (1991c; 1993c)	[3]0.004	0.001	Y[5]	([4]) EPA (1991c; 1993c)
Aldrin	309-00-2	Y	B2	17	EPA ([1]**1992e**; [1]**1993b**,c)	nsg	nsg	--	--
			C	nsg	EPA (1993d)				
Allethrin	584-79-2	N	nsg	nsg	--	nsg	nsg	--	--
Ametryn (ametryne)	834-12-8	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Aminotriazole (amitrole)	61-82-5	N	B2	1.1	EPA ([1]1992c; 1993d)	nsg	nsg	--	--
Atrazine	1912-24-9	N	C	0.22	EPA (**1988a**; **1989b**; [1]1992c; 1993c,d)	0.003	0.003	F	([4]) EPA (1991a; 1993b,c)
			U		EPA (1993b)				

Footnotes:

[1]This reference contains cancer potency (q_1*) value.

[2]q_1* value in EPA (1987a) is superseded by that in EPA (1988b,f). Discrepancy between q_1* value in EPA (1988b,f) vs. EPA (1992c) is because EPA's Office of Water (EPA, 1988b,f) uses a 70-kg adult, and the Office of Pesticide Programs (EPA, 1992c) a 60-kg adult, as a surrogate in deriving the q_1* value.

[3]EPA has set the maximum contaminant level (MCL) to the practical quantitation level, which reflects the level that can be measured by laboratories under normal operating conditions with specified limits of precision and accuracy.

[4]Code of Federal Regulations, v. 40, Parts 141.50(a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for MCLs.

[5]Regulation is stayed (Federal Register, v. 57, no. 102, pp. 22178-22179, May 27, 1992). These values are not in effect.

[6]Superseded classification.

[7]The MCL for aldicarb sulfone is incorrectly listed as 0.003 mg/L in the Code of Federal Regulations (1992), v. 40, Part 141.61(c) and in the table on p. 30280 in EPA (1991c). The correct value of 0.002 mg/L is given in the text in EPA (1991c) and in EPA (1993b,c).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water--*Continued*

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification		(B)	(C) EPA Primary drinking water regulations (mg/L)			(D)
			Cancer group	q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
Baygon (propoxur)	114-26-1	N	B2[1]	0.0079	EPA ([2]1992c)	nsg	nsg	--	--
			C[1]		EPA (**1988a**; **1989b**; 1993c)				
			B2/C		EPA (1993d)				
			U		EPA (1988a; 1989b; 1993b)				
Benfluralin (benefin)	1861-40-1	N	nsg	nsg	--	nsg	nsg	--	--
Benomyl	17804-35-2	N	C	nsg	EPA (1992c)	nsg	nsg	--	--
			U		EPA (1993b)				
Bentazon (bentazone)	25057-89-0	N	E[3]	nsg	EPA (1992c; 1993d)	nsg	0.02	T	EPA (1993c)
			D[3]	nsg	EPA (**1988a**; **1989b**; 1993c)				
α-BHC (α-HCH, α-benzene hexachloride, α-hexachlorocyclohexane)	319-84-6	Y	B2	6.3	EPA ([2]1992b; [2]**1993b**)	nsg	nsg	--	--
β-BHC (β-HCH, β-benzene hexachloride, β-hexachlorocyclohexane)	319-85-7	Y	C	1.8	EPA ([2]**1993b**)	nsg	nsg	--	--
γ-BHC (γ-HCH, lindane, γ-benzene hexachloride, γ-hexachlorocyclohexane)	58-89-9	Y	B2/C	1.3	EPA (1992c; 1993d,[2]e)	0.0002	0.0002	F	([4]) EPA (1991a; 1993b,c)
			C		EPA (**1987a**; **1988b**; 1993c)				
			U	1.3	EPA ([2]1992b; 1993b)				
δ-BHC, (δ-HCH, δ-benzene hexachloride, δ-hexachlorocyclohexane)	319-86-8	Y	D	nsg	EPA (**1993b**)	nsg	nsg	--	--
BHC, technical mixture (HCH, benzene hexachloride, hexachlorocyclohexane)	608-73-1	Y	nsg	nsg	--	nsg	nsg	--	--
Bromacil	314-40-9	N	C[5]	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	L	EPA (1993c)

Footnotes:

[1]Applying the criteria in EPA's guidelines for carcinogen risk assessment (EPA, 1986b), this compound may be classified in group C (EPA, 1988a; 1989b). EPA's Office of Pesticide Programs has classified this compound in group B2 (EPA, 1987c; 1992c). Resolution is pending (EPA, 1988a; 1989b).

[2]This reference contains cancer potency (q_1*) value.

[3]Discrepancy is between EPA's Office of Water (EPA, 1988a; 1989b; 1993c) and Office of Pesticide Programs (EPA, 1992c; 1993d).

[4]Code of Federal Regulations, v. 40, Parts 141.50(a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for maximum contaminant levels (MCLs).

[5]Classification is deferred (EPA, 1992c). Existing data are inadequate for classification.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water--*Continued*

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification	(B)		(C)	(D)		
						EPA Primary drinking water regulations (mg/L)			
			Cancer group	q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
Butachlor	23184-66-9	N	nsg	nsg	--	nsg	nsg	--	--
Butylate	2008-41-5	N	D[1]	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
			E[1]		EPA (1992c; 1993d)				
Captan	133-06-2	N	B2	0.0036	EPA ([2]1992c; 1993d)	nsg	nsg	--	--
			U		EPA (1993b)				
Carbaryl	63-25-2	N	D[1]	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
			C[1]		EPA (1993d)				
Carbofuran	1563-66-2	N	E	nsg	EPA (**1987a**; **1988b**; 1993c)	0.04	0.04	F	([3]) EPA (1991a; 1993b,c)
Carboxin	5234-68-5	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Chloramben (Amiben)	133-90-4	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
			U		EPA (1993b,d)				
Chlordane	57-74-9	Y	B2	1.3	EPA ([2]**1987a**; [2]**1988b**; [2]1992b,[2]c; [2]**1993b**,c,d,[2]e)	[4]0.002	0	F	([3]) EPA (1991a; [5]1992b; 1993b,c)
Chlordecone (Kepone)	143-50-0	N	nsg	nsg	--	nsg	nsg	--	--
Chlorfenac (fenac)	85-34-7	N	nsg	nsg	--	nsg	nsg	--	--
Chlorothalonil	1897-45-6	N	B2	[6]0.011	EPA ([2]1992c; 1993c,d)	nsg	nsg	--	--
			B2	[6]0.024	EPA ([2]**1988a**; [2]**1989b**)				
			U		EPA (1993b)				
Chlorpyrifos (Dursban)	2921-88-2	N	D[1]	nsg	EPA (**1992f**; 1993c)	nsg	nsg	--	--
			E[1]		EPA (1993d)				
Coumaphos	56-72-4	N	nsg	nsg	--	nsg	nsg	--	--
Crotoxyphos (Ciodrin)	7700-17-6	N	nsg	nsg	--	nsg	nsg	--	--
Cyanazine	21725-46-2	N	C	0.84	EPA ([2]1992c; 1993c,d)	nsg	0.001	T	EPA (1993c)
			D[7]	nsg	EPA (**1988a**; **1989b**)				

Footnotes:

[1]Discrepancy is between EPA's Office of Water (EPA, 1988a; 1989b; 1992f; 1993c) and Office of Pesticide Programs (EPA, 1992c; 1993d).

[2]This reference contains cancer potency (q_1*) value.

[3]Code of Federal Regulations, v. 40, Parts 141.50(a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for maximum contaminant levels (MCLs).

[4]EPA has set the MCL equal to the practical quantitation level, which reflects the level that can be measured by laboratories under normal operating conditions with specified limits of precision and accuracy.

[5]This reference incorrectly lists the status of these values as proposed; they were promulgated in a final rule on 1/30/91 (EPA, 1991a).

[6]Discrepancy in q_1* values is between EPA's Office of Water (1988a; 1989b) and Office of Pesticide Programs (EPA, 1992c).

[7]D is probably superseded by C classification, which is reported in the most recent publications from both EPA's Office of Water (EPA, 1993c) and Office of Pesticide Programs (EPA, 1992c; 1993d).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water--*Continued*

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification	(B)		(C)	(D)		
						EPA Primary drinking water regulations (mg/L)			
			Cancer group	q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
2,4-D	94-75-7	N	D	nsg	EPA (**1987a**; **1988b**; 1992c; 1993c,d)	0.07	0.07	F	([1]) EPA (1991a; 1993b,c)
Dacthal (DCPA, chlorthal-dimethyl	1861-32-1	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	L	EPA (1993c)
Dalapon	75-99-0	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	0.2	0.2	F	([1]) EPA (1992d; [2]1993b,c)
2,4-DB	94-82-6	N	nsg	nsg	--	nsg	nsg	--	--
ρ,ρ′-DDD (ρ,ρ′-TDE)	72-54-8	Y	B2	[3]0.34	EPA ([4]1992c)	nsg	nsg	--	--
			B2	[3]0.24	EPA ([4]**1993b**,[4]e)				
ρ,ρ′-DDE	72-55-9	Y	B2	0.34	EPA ([4]1992b,[4]c; [4]**1993b**,[4]e)	nsg	nsg	--	--
ρ,ρ′-DDT	50-29-3	Y	B2	0.34	EPA ([4]1992c; [4]**1993b**,[4]e)	nsg	nsg	--	--
Demeton	8065-48-3	N	nsg	nsg	--	nsg	nsg	--	--
Diallate	2303-16-4	N	nsg	nsg	--	nsg	nsg	--	--
Diazinon	333-41-5	N	E	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
1,2-dibromo-3-chloropropane (DBCP)[5]	96-12-8	N	B2	1.4	EPA ([4]**1987a**; [4]**1988b**; [4]1992c; 1993c,d)	[6]0.0002	0	F	([1]) (EPA 1991a; 1993c)
			U		EPA (1993b)				
Dicamba	1918-00-9	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	L	EPA (1993b,c)
Dichlobenil	1194-65-6	N	C	nsg	EPA (1992c; 1993d)	nsg	nsg	--	--
Dichlone	117-80-6	N	nsg	nsg	--	nsg	nsg	--	--
1,3-dichloropropene (DCP; 1,3-dichloropropylene; Telone II)	542-75-6	Y	B2	0.175	EPA ([4]**1988a**; [4]**1989b**; [4]1992c; **1993b**,c,d)	nsg	0	T	EPA (1993c)
Dichlorvos (DDVP)	62-73-7	N	C	0.20	EPA ([4]1992c; 1993d)	nsg	nsg	--	--
			B2	0.29	EPA ([4]**1993b**)				

Footnotes:

[1]Code of Federal Regulations, v. 40, Parts 141.50(a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for maximum contaminant levels (MCLs).

[2]IRIS (5/93) incorrectly lists the status of these values as proposed. They were promulgated in a final rule (EPA, 1992d) and went into effect on 1/17/94.

[3]Cancer potency (q_1*) from EPA (1992c) is for the sum of DDD, DDE, and DDT. IRIS (EPA, 1993b) provides the rationale for the q_1* of 0.24, which is the value for DDD alone.

[4]This reference contains cancer potency (q_1*) value.

[5]Organoleptic effect thresholds (perception thresholds for taste and odor) for this compound = 0.01 mg/L (EPA, 1987a).

[6]EPA has set the MCL equal to the practical quantitation level, which reflects the level that can be measured by laboratories under normal operating conditions with specified limits of precision and accuracy.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water--*Continued*

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification		(B)	(C) EPA Primary drinking water regulations (mg/L)			(D)
			Cancer group	q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
Dieldrin[1]	60-57-1	Y	B2	16	EPA ([2]**1988a**; [2]**1989b**; [2]1992b,[2]c; [2]**1993b**,c,d,[2]e)	nsg	nsg	--	--
Dimethoate	60-51-5	N	C	nsg	EPA (1992c; 1993d)	nsg	nsg	--	--
			U		EPA (1993b)				
Dimethrin	70-38-2	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Dinoseb (2-sec-butyl-4, 6-dinitrophenol)	88-85-7	N	C[3]	nsg	EPA (1992c; 1993d)	0.007	0.007	F	([4]) EPA (1992d; [5]1993b,c)
			D[3]	nsg	EPA (**1988a**; **1989b**; 1993b,c)				
Dioxathion	78-34-2	N	nsg	nsg	--	nsg	nsg	--	--
Diphenamid	957-51-7	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Diquat	2764-72-9	N	D	nsg	EPA (1993c)	0.02	0.02	F	([4]) EPA (1992d; [5]1993b,c)
			U		EPA (1993b)				
Disulfoton	298-04-4	N	E	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Diuron	330-54-1	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Endosulfan	115-29-7	Y	E	nsg	EPA (1992c; 1993d)	nsg	nsg	--	--
α-endosulfan (endosulfan I)	959-98-8	Y	nsg	nsg	--	nsg	nsg	--	--
β-endosulfan (endosulfan II)	33213-65-9	Y	nsg	nsg	--	nsg	nsg	--	--
Endosulfan sulfate	1031-07-8	Y	nsg	nsg	--	nsg	nsg	--	--
Endothall (endothal)	145-73-3	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	0.1	0.1	F	([4]) EPA (1992d; [5]1993b,c)
			U		EPA (1993b)				

Footnotes:

[1]Organoleptic effect threshold (perception threshold for odor) for this compound = 0.04 mg/L (EPA, 1993b).

[2]This reference contains cancer potency (q_1*) value.

[3]Incomplete data (EPA, 1992c; 1993d). Discrepancy is between EPA's Office of Water (EPA, 1988a; 1989b; 1993c) and Office of Pesticide Programs (EPA, 1992c; 1993d).

[4]Code of Federal Regulations, v. 40, Parts 141.50(a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for maximum contaminant levels (MCLs).

[5]This reference incorrectly lists the status of these values as proposed; they were promulgated in a final rule (EPA, 1992d) and went into effect on 1/17/94.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water--*Continued*

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification		(B)	(C) EPA Primary drinking water regulations (mg/L)			(D)
			Cancer group	q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
Endrin	72-20-8	Y	D	nsg	EPA (1992b; **1993b**,c)	0.002	0.002	F	([1 2]) EPA (1992d; [3]1993b,c)
			E	nsg	EPA (**1987a**; **1988b**)				
Endrin aldehyde	7421-93-4	Y	nsg	nsg	--	nsg	nsg	--	--
EPN	2104-64-5	N	nsg	nsg	--	nsg	nsg	--	--
EPTC	759-94-4	N	nsg	nsg	--	nsg	nsg	--	--
Ethion	563-12-2	N	nsg	nsg	--	nsg	nsg	--	--
Ethylene dibromide (EDB)	106-93-4	N	B2	67	EPA (**1987a**; **1988b**; [4]1992c; 1993c)	[5]5×10^{-5}	0	F	([2]) EPA (1991a; 1993b,c)
			B2	85	EPA ([4]**1993b**)				
Ethylene thiourea (ETU)	96-45-7	N	B2	0.11[6]	EPA ([4]1992c; 1993c,d)	nsg	nsg	L	EPA (1993c)
			B2	0.1428[6]	EPA ([4]**1988a**; [4]**1989b**)				
			U		EPA (1993b)				
Famphur	52-85-7	N	nsg	nsg	--	nsg	nsg	--	--
Fenamiphos	22224-92-6	N	D[6]	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
			E[6]		EPA (1993d)				
Fenthion	55-38-9	N	nsg	nsg	--	nsg	nsg	--	--
Fenuron	101-42-8	N	nsg	nsg	--	nsg	nsg	--	--
Ferbam	14484-64-1	N	nsg	nsg	--	nsg	nsg	--	--
Fluometuron	2164-17-2	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Fluridone	59756-60-4	N	E	nsg	EPA (1992c; 1993d)	nsg	nsg	--	--
			U		EPA (1993b)				
Folpet	133-07-3	N	B2	0.0035	EPA ([4]1992c; [4]**1993b**,d)	nsg	nsg	--	--
Fonofos	944-22-9	N	D[6]	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
			E[6]		EPA (1993d)				
Glyphosate	1071-83-6	N	E[6]	nsg	EPA (1992c)	0.7	0.7	F	([2]) EPA (1992d; [3]1993b,c)
			D[6]	nsg	EPA (**1988a**; **1989b**; **1993b**,c)				

Footnotes:

[1]EPA (1992b) reports an incorrect value for the maximum contaminant level (MCL).

[2]Code of Federal Regulations, v. 40, Parts 141.50(a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for MCLs.

[3]This reference incorrectly lists the status of these values as proposed.

[4]This reference contains cancer potency (q_1*) value.

[5]EPA has set the MCL equal to the practical quantitation level, which reflects the level that can be measured by laboratories under normal operating conditions with specified limits of precision and accuracy.

[6]Discrepancy is between EPA's Office of Water (EPA, 1988a; 1989b; 1993c) and Office of Pesticide Programs (EPA, 1992c; 1993d).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water--*Continued*

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification	(B)		(C)	(D)		
						EPA Primary drinking water regulations (mg/L)			
			Cancer group	q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
Guthion (azinphos-methyl)	86-50-0	N	D	nsg	EPA (1992c)	nsg	nsg	--	--
			E		EPA (1993d)				
Heptachlor	76-44-8	Y	B2	4.5	EPA ([1]**1987a**; [1]**1988b**; [1]1992b,[1]c; [1]**1993b**,c,d)	[2]0.0004	0	F	([3]) EPA (1991a; [4]1992b; 1993b,c)
Heptachlor epoxide	1024-57-3	Y	B2	9.1	EPA ([1]**1987a**; [1]**1988b**; [1]1992b; [1]**1993b**,c)	[2]0.0002	0	F	([3]) EPA (1991a; [4]1992b; 1993b,c)
Hexachlorobenzene	118-74-1	Y	B2	1.7	EPA (**1987b**; **1988c**; [1]1992b,[1]c; 1993c,d)	[2]0.001	0	F	([3 5]) EPA (1992d; [4]1993b,c)
			B2	1.6	EPA ([1]**1993b**,[1]e)				
Hexazinone	51235-04-2	N	C[6]	nsg	EPA (1992c; 1993d)	nsg	nsg	--	--
			D[6]	nsg	EPA (**1988a**; **1989b**; 1993c)				
Linuron	330-55-2	N	C	nsg	EPA (1992c; 1993b,d)	nsg	nsg	--	--
Malathion	121-75-5	N	D	nsg	EPA (1992c,**g**; 1993c,d)	nsg	nsg	--	--
Maleic hydrazide	123-33-1	N	D	nsg	EPA (**1988a**; **1989b**; 1992c)	nsg	nsg	--	--
			E		EPA (1993c)				
			U		EPA (1993b)				
Maneb	12427-38-2	N	B2[7]	([7])	EPA (1992c)	nsg	nsg	--	--
MCPA	94-74-6	N	D	nsg	EPA (**1988a**; **1989b**)	nsg	nsg	--	--
			E	nsg	EPA (1993c)				
Methomyl	16752-77-5	N	E	nsg	EPA (**1988a**; **1989b**)	nsg	nsg	L	EPA (1993b,c)
			D	nsg	EPA (1993c)				
			U		EPA (1993b)				
Methoxychlor	72-43-5	N	D	nsg	EPA (**1987a**; **1988b**; 1992c; **1993b**,c)	0.04	0.04	F	([3 8]) EPA (1991a; 1993b,c)

Footnotes:

[1]This reference contains cancer potency (q_1*) value.

[2]EPA has set the maximum contaminant level (MCL) equal to the practical quantitation level, which reflects the level that can be measured by laboratories under normal operating conditions with specified limits of precision and accuracy.

[3]Code of Federal Regulations, v. 40, Parts 141.50(a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for MCLs.

[4]This reference incorrectly lists the status of these values as proposed.

[5]EPA (1992b) incorrectly states that no MCL has been established at present.

[6]Discrepancy is between EPA's Office of Water (EPA, 1988a; 1989b; 1993c) and Office of Pesticide Programs (EPA, 1992c; 1993d).

[7]This compound is an ethylenebis(dithiocarbamate) pesticide, which degrades to ETU, a B2 carcinogen. Documentation is being prepared to support use of q_1* of ETU for this compound (EPA, 1992c).

[8]EPA (1992b) lists incorrect values for MCL and MCLG.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water--*Continued*

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification	(B)		(C)	(D)		
						EPA Primary drinking water regulations (mg/L)			
			Cancer group	q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
Methyl parathion	298-00-0	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Metolachlor	51218-45-2	N	C	0.0020	EPA (**1988a**; **1989b**; [1]1992c; **1993b**,c,d)	nsg	nsg	L	EPA (1993b,c)
Metribuzin	21087-64-9	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	L	EPA (1993b,c)
			U		EPA (1993b)				
Mevinphos (Phosdrin)	26718-65-0	N	nsg	nsg	--	nsg	nsg	--	--
Mirex	2385-85-5	N	U	1.8	EPA ([1]1992b,c; 1993b)	nsg	nsg	--	--
Molinate	2212-67-1	N	C	nsg	EPA (1992c; 1993d)	nsg	nsg	--	--
Monuron	150-68-5	N	nsg	nsg	--	nsg	nsg	--	--
Nabam	142-59-6	N	nsg	nsg	--	nsg	nsg	--	--
Naled	300-76-5	N	nsg	nsg	--	nsg	nsg	--	--
Nitralin	4726-14-1	N	nsg	nsg	--	nsg	nsg	--	--
Nitrofen	1836-75-5	N	B2[2]	nsg	EPA (1992c)	nsg	nsg	--	--
Oxamyl (Vydate)	23135-22-0	N	E	nsg	EPA (**1987a**; **1988b**; 1993c)	0.2	0.2	F	([3]) EPA (1992d; [4]1993b,c)
Oxydemeton-methyl	301-12-2	N	nsg	nsg	--	nsg	nsg	--	--
Paraquat	4685-14-7	N	E	nsg	EPA (**1988a**; **1989b**; 1992c; 1993c,d)	nsg	nsg	--	--
			C	nsg	EPA (**1993b**)				
Parathion	56-38-2	N	C	nsg	EPA (1992c; **1993b**,d)	nsg	nsg	--	--
Pentachlorophenol[5]	87-86-5	Y	B2	0.12	EPA (1991c, 1992c; [1]**1993b**,c,d)	[6]0.001	0	F	([3 7]) EPA (1991c; **1993b**,c)
			D[8]	nsg	EPA (**1987a**; **1988b**; 1992b)				
Permethrin	52645-53-1	N	C	0.018	EPA ([1]1992c; 1993d)	nsg	nsg	--	--

Footnotes:

[1]This reference contains cancer potency (q_1*) value.

[2]Probable classification. This compound was canceled before EPA's carcinogenicity guidelines (EPA, 1986b) were developed (EPA, 1992c).

[3]Code of Federal Regulations, v. 40, Parts 141.50(a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for maximum contaminant levels (MCLs).

[4]This reference incorrectly lists the status of these values as proposed; they were promulgated in a final rule (EPA, 1992d).

[5]Secondary drinking water regulations (secondary maximum contaminant level (SMCL) = 0.03 mg/L) were proposed for this compound (EPA, 1989c) and subsequently deferred (EPA, 1993b). Organoleptic effect thresholds are 0.03 mg/L (taste threshold) and 1.6 mg/L (odor threshold) (EPA, 1987a; 1993b).

[6]EPA has set the MCL equal to the practical quantitation level, which reflects the level that can be measured by laboratories under normal operating conditions with specified limits of precision and accuracy.

[7]Proposed values reported in EPA (1992b) are incorrect.

[8]Superseded classification.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water--*Continued*

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification		(B)	(C) EPA Primary drinking water regulations (mg/L)			(D)
			Cancer group	q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
Phorate	298-02-2	N	D	nsg	EPA (1992c)	nsg	nsg	--	--
			E		EPA (1993d)				
Phosphamidon	13171-21-6	N	C	nsg	EPA (1992c; 1993d)	nsg	nsg	--	--
Picloram	1918-02-1	N	D	nsg	EPA (**1988a**; **1989b**; 1992c; 1993c)	0.5	0.5	F	([1]) EPA (1992d; [2]1993b,c)
			E		EPA (1993d)				
			U		EPA (1993b)				
Prometon	1610-18-0	N	D	nsg	EPA (**1988a**; **1989b**; 1992c; 1993c,d)	nsg	nsg	L	EPA (1993c)
Prometryn	7287-19-6	N	nsg	nsg	--	nsg	nsg	--	--
Pronamide (propyzamide)	23950-58-5	N	C		EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
			B2/C	0.016	EPA ([3]1992c)				
			B2	nsg	EPA (1993d)				
			U		EPA (1993b)				
Propachlor	1918-16-7	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Propanil	709-98-8	N	nsg	nsg	--	nsg	nsg	--	--
Propazine	139-40-2	N	C	nsg	EPA (**1988a**; **1989b**; 1992c; 1993c,d)	nsg	nsg	--	--
			U		EPA (1993b)				
Propham	122-42-9	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Pyrethrins (pyrethrum)	8003-34-7	N	nsg	nsg	--	nsg	nsg	--	--
Rotenone	83-79-4	N	E	nsg	EPA (1992c; 1993d)	nsg	nsg	--	--
			U		EPA (1993b)				
Simazine	122-34-9	N	C	0.12	EPA (**1988a**; **1989b**; [3]1992c; 1993c,d)	0.004	0.004	F	([1 4]) EPA (1992d; 1993c)
			U		EPA (1993b)				
Sulfallate	95-06-7	N	nsg	nsg	--	nsg	nsg	--	--
2,4,5-T	93-76-5	N	D[5]	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	L	EPA (1993c)

Footnotes:

[1]Code of Federal Regulations, v. 40, Parts 141.50 (a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for maximum contaminant levels (MCLs).

[2]This reference incorrectly lists the status of these values as proposed; they were promulgated in a final rule (EPA, 1992d).

[3]This reference contains cancer potency (q_1*) value.

[4]Proposed values in IRIS (EPA, 1993b) are incorrect (superseded).

[5]EPA's Cancer Assessment Group classified the chlorophenoxyacetic acids and chlorophenols containing 2,3,7,8-TCDD (such as 2,4,5-T) in Cancer Group 2A. A q_1* was estimated only for 2,3,7,8-TCDD itself (EPA, 1987a; 1988a; 1989b), which (by itself) is in cancer group B2 (EPA, 1987b; 1992b; 1993c).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 1: Protection of human health--Drinking water--*Continued*

Chemical name	CAS No.	PP	(A) EPA carcinogencity classification		(B)	(C) EPA Primary drinking water regulations (mg/L)			(D)
			Cancer group	q_1* [(mg/kg)/d]$^{-1}$	References	MCL	MCLG	Status	References
2,3,7,8-TCDD (dioxin)	1746-01-6	Y	B2	156,000	EPA ([1]**1987b**; [1]**1989a**; [1]1992b; 1993c)	3×10^{-8}	0	F	([2]) EPA (1992d; 1993c)
Tebuthiuron	34014-18-1	N	D	nsg	EPA (**1988a**; **1989b**; 1992c; 1993c,d)	nsg	nsg	--	--
TEPP	107-49-3	N	nsg	nsg	--	nsg	nsg	--	--
Terbacil	5902-51-2	N	E	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Terbufos	13071-79-9	N	D	nsg	EPA (**1988a**; **1989b**; 1993c)	nsg	nsg	--	--
Thiobencarb	28249-77-6	N	nsg	nsg	--	nsg	nsg	--	--
Thiram	137-26-8	N	U		EPA (1993b)	nsg	nsg	--	--
Toxaphene (camphechlor)	8001-35-2	Y	B2	1.1	EPA (**1987a**; [1]**1988b**; [1]**1993b**,c,d,[1]e)	[3]0.003	0	F	([2]) EPA (1991a; 1993b,c)
2,4,5-TP (silvex, fenoprop)	93-72-1	N	D	nsg	EPA (**1987a**; **1988b**; 1993b,c)	0.05	0.05	F	([2]) EPA (1991a; 1993b,c)
Triallate	2303-17-5	N	C	nsg	EPA (1992c; 1993d)	nsg	nsg	--	--
Trichlorfon	52-68-6	N	nsg	nsg	--	nsg	nsg	--	--
Trifluralin (Treflan)	1582-09-8	N	C	0.0077	EPA ([1]**1988a**; [1]**1989b**; [1]**1990c**; [1]1992b,[1]c; [1]**1993b**,c,d)	nsg	nsg	L	EPA (1993c)
Zectran (mexacarbate)	315-18-4	N	nsg	nsg	--	nsg	nsg	--	--
Zineb[4]	12122-67-7	N	U[4]		EPA (1993b)	nsg	nsg	--	--
Ziram	137-30-4	N	nsg	nsg	--	nsg	nsg	--	--

Footnotes:

[1]This reference contains cancer potency (q_1*) value.

[2]Code of Federal Regulations, v. 40, Parts 141.50 (a,b) for maximum contaminant level goals (MCLGs) and 141.61(c) for maximum contaminant levels (MCLs).

[3]EPA has set the MCL equal to the practical quantitation level, which reflects the level that can be measured by laboratories under normal operating conditions with specified limits of precision and accuracy.

[4]This compound is an ethylenebis(dithiocarbamate) pesticide, which degrades to ETU, a B2 carcinogen (EPA, 1992c).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Acifluorfen	2	2	0.1	0.4	0.013	0.4	nsg	0.001	E	EPA (**1988a**; **1989b**; [1]**1993b**,c,[2]d)
Alachlor	0.1	0.1	0.1	([3])	0.01	0.35	nsg	nr	S	EPA (**1987a**)
	0.1	0.1	([3])	([3])	0.01	0.35	nsg	[4]0.00044	E,R	EPA (**1988b,f**; [1]**1993b**,c,[2]d)
Aldicarb	[5]0.01	[5]0.01	[5]0.01	[5]0.04	[5]0.00125	[5]0.04	[5]0.009	nsg	S[6]	EPA (**1987a**; **1988b**)
	[5]0.001	[5]0.001	[5]0.001	[5]0.001	[5]0.0002	[5]0.007	[5]0.001	nsg	B,S[6]	EPA ([7]1993b)
	([8])	([8])	([8])	([8])	[9]0.001	[9]0.035	[9]0.007	nsg	R[6]	EPA (1993c,[2]d)
Aldicarb sulfone	0.06	0.06	0.06	0.21	0.006	0.21	0.042	nsg	S[6]	EPA (**1987a**; **1988b**)
	([8])	([8])	([8])	([8])	[9]0.001	[9]0.035	[9]0.007	nsg	R[6]	EPA (1993c,[2]d)
Aldicarb sulfoxide	[5]0.01	[5]0.01	[5]0.01	[5]0.04	[5]0.00125	[5]0.04	[5]0.009	nsg	S[6]	EPA (**1987a**; 1988b)
	([8])	([8])	([8])	([8])	[9]0.001	[9]0.035	[9]0.007	nsg	R[6]	EPA (1993c)
Aldrin	0.0003	0.0003	0.0003	([10])	3×10^{-5}	0.001	nsg	2×10^{-6}	E	EPA (**1992e**; [11]**1993b**)
	0.0003	0.0003	0.0003	[12]0.0003	3×10^{-5}	0.001	nsg	2×10^{-6}	D,R	EPA (1993c)
Allethrin	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Ametryn (ametryne)	9	9	0.9	3	0.009	0.3	0.06	nsg	E	EPA (**1988a**; **1989b**; [7]**1993b**,c,[2]d)
Aminotriazole (amitrole)	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--

Footnotes:

[1]IRIS (EPA, 1993b) contains technical basis for the reference dose (RfD) only. This reference does not report the risk specific dose (RSD).

[2]This reference contains the RfD only.

[3]Health advisories for exposure over the longer term are not recommended due to the carcinogenic risk of this compound.

[4]Carcinogenicity assessment is pending (EPA, 1993b).

[5]Values are for aldicarb, aldicarb sulfoxide, or a mixture of the aldicarb sulfoxide and sulfone metabolites.

[6]EPA revised the RfD twice, so the health advisories (EPA, 1987; 1988b; 1993b) are superseded. Values in EPA (1993c) are the most up-to-date, except that no published rationale is available yet.

[7]IRIS (EPA, 1993b) contains technical basis for the RfD only.

[8]A revised value for this health advisory is not yet available.

[9]Value applies to the sum of aldicarb and its sulfone and sulfoxide metabolites (Amal Mahfouz, U.S. Environmental Protection Agency, personal commun., 1993).

[10]Original health-advisory document stated that suitable data were not available to determine this health advisory, and did not estimate one.

[11]IRIS (EPA, 1993b) contains the RfD and RSD only, including the technical basis for both values.

[12]Standard procedure for estimating this health advisory in the absence of suitable data is to use the drinking water equivalent level (DWEL). However, the revised value for the longer-term adult health advisory in EPA (1993c) is equivalent to the DWEL adjusted for a 10-kg child. It is unclear why the more conservative estimation procedure was used in this case.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Atrazine	0.1	0.1	0.05	0.2	[1]0.005	0.2	0.003	([2])	S	EPA (**1988a**; **1989b**)
	0.1	0.1	0.05	0.2	0.035	[3]0.2	[3]0.003	([2])	R	EPA (1993c,[4]d)
Baygon (propoxur)	0.04	0.04	0.04	0.1	0.004	0.1	0.003	([2])	E	EPA (**1988a**; **1989b**; [5]**1993b**,c,[4]d)
Benfluralin (benefin)	nsg	nsg	nsg	nsg	0.3	nsg	nsg	nsg	B	EPA (**1993b**,d)
Benomyl	nsg	nsg	nsg	nsg	0.05	nsg	nsg	([2])	B	EPA (**1993b**,d)
Bentazon (bentazone)	0.3	0.3	0.3	0.9	[6]0.0025	0.09	0.02	nsg	E	EPA (**1988a**; **1989b**; [5]**1993b**,c,[4]d)
α-BHC (α-HCH,	nsg	nsg	nsg	nsg	nsg	nsg	nsg	6×10^{-6}	B	EPA (**1993b**)
α-benzene hexachloride,	0.05[7]	0.05[7]	0.05[7]	0.02[7]	nsg	nsg	nsg	nsg	N	EPA ([7]1992b)
α-hexachlorocyclohexane)										
β-BHC (β-HCH,	nsg	nsg	nsg	nsg	nsg	nsg	nsg	2×10^{-5}	B	EPA (**1993b**)
β-benzene hexachloride,										
β-hexachlorocyclohexane)										
γ-BHC (γ-HCH, lindane,	1.2	1.2	0.033	0.12	0.0003	0.01	0.002	2.65×10^{-5}	S[8]	EPA (**1987a**)
γ-benzene hexachloride,	1.2	1.2	0.033	0.12	0.0003	0.01	0.0002	2.65×10^{-5}	E,R[8]	EPA (**1988b**)
γ-hexachlorocyclohexane)	1.2	1.2	0.033	0.12	0.0003	0.01	0.0002	([9])	E,R[8]	EPA ([10]1992b; [5]**1993b**,c,[4]d)
δ-BHC, (δ-HCH,	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
δ-benzene hexachloride,										
δ-hexachlorocyclohexane)										

Footnotes:

[1]This reference dose (RfD) value was withdrawn (EPA, 1993b).

[2]Carcinogenicity assessment is pending (EPA, 1993b).

[3]This value is under review (EPA, 1993c). It has not been revised to correspond with the revised RfD.

[4]This reference contains the RfD only.

[5]IRIS (EPA, 1993b) contains technical basis for the RfD only.

[6]Oral RfD assessment is under review (EPA, 1993b).

[7]Original source for these values is not reported in EPA (1992b). No health-advisory values for this compound are reported in recent references (EPA, 1993b,c).

[8]Revised lifetime advisory value is correct; it reflects reclassification of this compound to Group C. It is standard practice for EPA's Office of Water to use an uncertainty factor of 10 to derive the lifetime advisory for Group C compounds, in addition to the uncertainty factor used in determining the RfD, to account for potential carcinogenicity. EPA (1988b) also reports a risk specific dose (RSD) because a unit cancer potency (q_1*) value was determined for this compound.

[9]Carcinogenicity assessment is pending (EPA, 1992b; 1993b,e).

[10]EPA (1992b) reported an incorrect value for the longer-term adult health advisory, and no value for the drinking water equivalent level (DWEL).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
BHC, technical mixture (HCH, benzene hexachloride, hexachlorocyclohexane)	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Bromacil	5	5	3	9	0.13	5	0.09	nsg	E	EPA (**1988a**; **1989b**; 1993c)
Butachlor	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Butylate	2	2	1	([1])	0.1	4	0.7	nsg	S	EPA (**1988a**)
	2	2	1	4	0.05	1.8	0.35	nsg	E,R	EPA (**1989b**; [2]**1993b**,c,[3]d)
Captan	nsg	nsg	nsg	nsg	0.13	nsg	nsg	([4])	B	EPA (**1993b**,d)
Carbaryl	1	1	1	([1])	0.1	4	0.7	nsg	E	EPA (**1988a**; **1989b**)
	1	1	1	[5]1	0.1	4	0.7	nsg	R	EPA ([2]**1993b**,c,[3]d)
Carbofuran	0.05	0.05	0.05	0.18	0.005	0.18	0.036	nsg	E	EPA (**1987a**; **1988b**; [6]**1993b**,c,[3]d)
Carboxin	1	1	1	4	0.1	4	0.7	nsg	E	EPA (**1988a**; **1989b**; [2]**1993b**,c,[3]d)
Chloramben (Amiben)	3	3	0.2	0.5	0.015	0.5	0.1	([4])	E	EPA (**1988a**; **1989b**; [2]**1993b**,c,[3]d)

Footnotes:

[1]Original health-advisory document stated that suitable data were not available to determine this health advisory, and did not estimate one.

[2]IRIS (EPA, 1993b) contains the reference dose (RfD) only, including the technical basis.

[3]This reference contains the RfD only.

[4]Carcinogenicity assessment is pending (EPA, 1993b).

[5]Standard procedure for estimating this health advisory in the absence of suitable data is to use the drinking water equivalent level (DWEL). However, the revised value for the longer-term adult health advisory in EPA (1993c) is equivalent to the DWEL adjusted for a 10-kg child. It is unclear why the more conservative estimation procedure was used in this case.

[6]IRIS (EPA, 1993b) contains technical basis for the RfD only, and reports an incorrect value for the DWEL.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Chlordane	0.06	0.06	[1]5×10^{-5}	([2])	5×10^{-5}	0.002	nsg	2.7×10^{-5}	S[3]	EPA (**1987a**)
	0.06	0.06	[4]0.0005	([2])	5×10^{-5}	0.002	nsg	2.7×10^{-5}	R,S[3]	EPA (**1988b**)
	0.06	0.06	[4]0.0005	[4]0.002	6×10^{-5}	0.002	nsg	3×10^{-5}	R,B[3]	EPA ([5]1992b; [6]**1993b**)
	0.06	0.06	([7])	([7])	6×10^{-5}	0.002	nsg	3×10^{-5}	R[3]	EPA (1993c,[8]d)
Chlordecone (Kepone)	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Chlorfenac (fenac)	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Chlorothalonil	0.2	0.2	0.2	0.5	0.015	0.5	nsg	[9]0.0015	E	EPA (**1988a**; **1989b**; [10]**1993b**,c,[8]d)
Chlorpyrifos (Dursban)	0.03	0.03	0.03	0.1	0.003	0.1	0.02	nsg	E	EPA ([11]1992b,**f**; [12]**1993b**,[13]c,[8]d)
Coumaphos	nsg	nsg	nsg	nsg	([14])	nsg	nsg	nsg	--	--
Crotoxyphos (Ciodrin)	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--

Footnotes:

[1]Longer-term child health-advisory values in EPA (1987a) was incorrectly estimated from the drinking water equivalent level (DWEL).

[2]This health-advisory document stated that suitable data were not available to determine this health advisory, and did not estimate one.

[3]Values in EPA (1987a; 1988b) are superseded. Revised values from EPA (1992b; 1993b,c,d) are identical, except that longer-term values are not listed in EPA (1993c).

[4]This value was estimated using the standard procedure, which is to use the DWEL adjusted for a 10-kg child as an estimate of the longer-term health advisory for a child, and the DWEL as an estimate of the longer-term adult health advisory.

[5]EPA (1992b) did not include any value for the DWEL.

[6]EPA (1993b) contains technical basis for the reference dose (RfD) and risk specific dose (RSD) only.

[7]No value is listed in EPA (1993c) for this health advisory. It is unclear why this health advisory was not estimated from the DWEL, using the standard procedure (described in footnote 4).

[8]This reference contains RfD only.

[9]Carcinogenicity assessment is pending (EPA, 1993b).

[10]IRIS (EPA, 1993b) contains the technical basis for the RfD only and does not report the RSD.

[11]EPA (1992b) contains RfD only and incorrectly states that no health advisory values have been established yet.

[12]IRIS (EPA, 1993b) contains RfD only, including the technical basis.

[13]EPA (1993c) lists the status of these values as draft.

[14]Oral RfD assessment is pending (EPA, 1993b,d).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Cyanazine	0.1	0.1	0.02	0.07	[1]0.002	0.07	0.01	nsg	S[2]	EPA (**1988a**; **1989b**)
	0.1	0.1	0.02	0.07	[1]0.002	0.07	[2]0.001	nsg	R[2]	EPA (1993c,[3]d)
2,4-D	1.1	0.30	([4])	([4])	0.01	0.35	0.070	nsg	S	EPA (**1987a**)
	1.1	0.3	0.1	([4])	0.01	0.35	0.070	nsg	S	EPA (**1988b**)
	1	0.3	[5]0.1	[5]0.4	0.01	0.4	0.07	nsg	R	EPA ([6]**1993b**,c,[3]d)
Dacthal (DCPA, chlorthal-dimethyl)	80	80	5	20	0.5	20	4	nsg	E	EPA (**1988a**; **1989b**; [6]**1993b**,c,[3]d)
Dalapon	4	4	0.3	0.9	0.03	0.9	0.2	nsg	S	EPA (**1988a**)
	3	3	0.3	0.9	0.026	0.9	0.2	nsg	E,R	EPA (**1989b**; [7]**1993b**,c,[3]d)
2,4-DB	nsg	nsg	nsg	nsg	0.008	nsg	nsg	nsg	B	EPA (**1993b**,d)
p,p'-DDD (*p,p'*-TDE)	nsg	nsg	nsg	nsg	nsg	nsg	nsg	0.0001	B	EPA (**1993b**)
p,p'-DDE	nsg	nsg	nsg	nsg	nsg	nsg	nsg	0.0001	B	EPA (**1993b**)
p,p'-DDT	nsg	nsg	nsg	nsg	0.0005	nsg	nsg	0.0001	B	EPA (**1993b**,[3]d)
Demeton	nsg	nsg	nsg	nsg	4×10^{-5}	nsg	nsg	nsg	B	EPA (**1993b**,d)
Diallate	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Diazinon	0.02	0.02	0.005	0.02	[8]9×10^{-5}	0.003	0.0006	nsg	E	EPA (**1988a**; **1989b**; 1993c)

Footnotes:

[1]Oral reference dose (RfD) was withdrawn. Assessment is under review (EPA, 1993b).

[2]Revised health advisories (EPA, 1993c) supersede those in EPA (1988a; 1989b). The revised lifetime health advisory reflects reclassification of this compound to Group C. It is standard practice for EPA's Office of Water to use an uncertainty factor of 10 to derive the lifetime health advisory for Group C compounds, in addition to the uncertainty factor used in determining the RfD, to account for potential carcinogenicity.

[3]This reference contains RfD only.

[4]This health-advisory document stated that suitable data were not available to determine this health advisory, and did not estimate one.

[5]This revised value in EPA (1993c) probably was estimated using standard procedure, which is to use the drinking water equivalent level (DWEL) for a longer-term health advisory for an adult and the DWEL adjusted for a 10-kg child as the longer-term health advisory for a child.

[6]IRIS (EPA, 1993b) contains RfD only, including the technical basis.

[7]IRIS (EPA, 1993b) contains technical basis for RfD only.

[8]Oral RfD assessment is pending (EPA, 1993b).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
1,2-dibromo-3-chloropropane (DBCP)[1]	0.2	0.050	([2])	([2])	nsg	([2])	nsg	[3]2.5×10^{-5}	E	EPA (**1987a**; **1988b**; 1993c)
Dicamba	0.3	0.3	0.3	1	0.03	1	0.2	nsg	E	EPA (**1988a**; **1989b**; [4]**1993b**,c,[5]d)
Dichlobenil	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Dichlone	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
1,3-dichloropropene (DCP; 1,3-dichloropropylene; Telone II)	0.03	0.03	0.03	0.1	0.0003	0.01	nsg	0.0002	E	EPA (**1988a**; **1989b**; [6]**1993b**,c,[5]d)
Dichlorvos (DDVP)	nsg	nsg	nsg	nsg	([7])	nsg	nsg	0.0001	B	EPA (**1993b**)
	nsg	nsg	nsg	nsg	[8]0.0005	nsg	nsg	nsg	R	EPA (1993d)
Dieldrin	0.0005	0.0005	0.0005	([9])	5×10^{-5}	0.002	nsg	2.19×10^{-6}	S	EPA (**1988a**; **1989b**)
	0.0005	0.0005	0.0005	[10]0.002	5×10^{-5}	0.002	nsg	2×10^{-6}	B,R	EPA ([11]1992b; [12]**1993b**,c,[5]d)
Dimethoate	nsg	nsg	nsg	nsg	0.0002	nsg	nsg	([3])	B	EPA (**1993b**)
Dimethrin	10	10	10	40	[13]0.3	10	2	nsg	E	EPA (**1988a**; **1989b**; 1993c)

Footnotes:

[1]Organoleptic effect threshold (taste and odor thresholds) for this compound is 0.01 mg/L (EPA, 1987a; 1988b).

[2]Health advisories for exposure over the longer term are not recommended due to the carcinogenic risk of this compound.

[3]Carcinogenicity assessment is pending (EPA, 1993b).

[4]IRIS (EPA, 1993b) contains reference dose (RfD) only, including the technical basis.

[5]This reference contains RfD only.

[6]IRIS (EPA, 1993b) contains technical basis for RfD only. This reference does not report any values for cancer potency factor (q_1*) or risk specific dose (RSD).

[7]Oral RfD was withdrawn; assessment is pending (EPA, 1993b).

[8]There is no published rationale available for the revised value, which is not yet in IRIS.

[9]Original health-advisory document stated that suitable data were not available to determine this health advisory, and did not estimate one.

[10]This revised value was estimated using standard procedure, which is to use the drinking water equivalent level (DWEL) as an estimate of the longer-term health advisory for an adult and the DWEL adjusted for a 10-kg child as an estimate of the longer-term health advisory for a child.

[11]DWEL and RSD values are not reported in EPA (1992b).

[12]IRIS (EPA, 1993b) contains technical basis for RfD and RSD only.

[13]Oral RfD assessment is pending (EPA, 1993b).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Dinoseb (2-sec-butyl-4, 6-dinitrophenol)	0.3	0.3	0.01	0.04	0.001	0.04	0.007	nsg	E	EPA (**1988a**; **1989b**; [1]**1993b**,c,[2]d)
Dioxathion	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Diphenamid	0.3	0.3	0.3	([3])	0.03	1	0.2	nsg	S	EPA (**1988a**; **1989b**)
	0.3	0.3	0.3	[4]1	0.03	1	0.2	nsg	R	EPA ([5]**1993b**,c,[2]d)
Diquat	nsg	nsg	nsg	nsg	0.0022	0.08	0.02	([6])	B	EPA ([1]**1993b**,c,[2]d)
Disulfoton	0.01	0.01	0.003	0.009	4×10^{-5}	0.001	0.0003	nsg	E	EPA (**1988a**; **1989b**; [1]**1993b**,c,[2]d)
Diuron	1	1	0.3	0.9	0.002	0.07	0.01	nsg	E	EPA (**1988a**; **1989b**; [5]**1993b**,c,[2]d)
Endosulfan	nsg	nsg	nsg	nsg	([7])	nsg	nsg	nsg	--	--
α-endosulfan (endosulfan I)	nsg	nsg	nsg	nsg	([7])	nsg	nsg	nsg	--	--
β-endosulfan (endosulfan II)	nsg	nsg	nsg	nsg	([7])	nsg	nsg	nsg	--	--
Endosulfan sulfate	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Endothall (endothal)	0.8	0.8	0.2	([3])	0.02	0.7	0.1	nsg	S	EPA (**1988a**; **1989b**)
	0.8	0.8	0.2	[8]0.2	0.02	0.7	0.1	nsg	R[8]	EPA (1993c)
	0.8	0.8	0.2	[8]0.7	0.02	0.7	0.14	([6])	R[8]	EPA ([5]**1993b**,[2]d)

Footnotes:

[1]IRIS (EPA, 1993b) contains reference dose (RfD) only, including its technical basis.

[2]This reference contains RfD only.

[3]Original health-advisory document stated that suitable data were not available to determine this health advisory, and did not estimate one.

[4]This revised value was estimated using standard procedure, which is to use the drinking water equivalent level (DWEL) as an estimate of the longer-term health advisory for an adult and the DWEL adjusted for a 10-kg child as an estimate of the longer-term health advisory for a child.

[5]IRIS (EPA, 1993b) contains technical basis for RfD only.

[6]Carcinogencity assessment is pending (EPA, 1993b).

[7]Oral RfD was withdrawn; assessment is pending (EPA, 1993b).

[8]It is unclear which revised adult longer-term advisory (EPA, 1993b or 1993c) is correct. The revised value in EPA (1993b) was estimated using the standard procedure, which is to use the DWEL in the absence of suitable data. The revised value in EPA (1993c) is equivalent to the DWEL adjusted for a 10-kg child; it is unclear why the more conservative estimation procedure was used in this case.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Endrin	0.02	0.005	0.0045	0.016	4.5×10^{-5}	0.0016	0.00032	nsg	S[1]	EPA (**1987a**; **1988b**)
	0.02	[2]0.02	[3]0.003	[3]0.01	0.0003	0.01	0.002	nsg	R[1]	EPA ([4]1992b; [5]**1993b**,c,[6]d)
Endrin aldehyde	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
EPN	nsg	nsg	nsg	nsg	1×10^{-5}	nsg	nsg	nsg	B	EPA (**1993b**,d)
EPTC	nsg	nsg	nsg	nsg	0.025	nsg	nsg	nsg	B	EPA (**1993b**,d)
Ethion	nsg	nsg	nsg	nsg	0.0005	nsg	nsg	nsg	B	EPA (**1993b**,d)
Ethylene dibromide (EDB)	0.008	0.008	([7])	([7])	nsg	([7])	nsg	5×10^{-7}	S	EPA (**1987a**)
	0.008	0.008	([7])	([7])	nsg	([7])	nsg	4×10^{-7}	B,R	EPA (**1988b**; [8]**1993b**,c)
Ethylene thiourea (ETU)	0.3	0.3	0.1	0.4	3×10^{-5}	0.001	nsg	0.00024	S[9]	EPA (**1988a**; **1989b**)
	0.3	0.3	0.1	0.4	8×10^{-5}	0.003	nsg	[2 10]0.0003	R[9]	EPA ([5]**1993b**,c,[6]d)
Famphur	nsg	nsg	nsg	nsg	([11])	nsg	nsg	nsg	--	--

Footnotes:

[1]Revised values in EPA (1992b; 1993b,c,d) probably are correct (except, see footnote 2). IRIS (EPA, 1993b) contains the rationale for the revised reference dose (RfD), and also confirms the drinking water equivalent level (DWEL) and lifetime health advisory values in EPA (1992b; 1993c).

[2]No published rationale is available for this revised value.

[3]This revised value in EPA (1993c) probably was estimated using standard procedure, which is to use the DWEL for a longer-term health advisory for an adult and the DWEL adjusted for a 10-kg child as the longer-term health advisory for a child.

[4]This reference does not report the DWEL.

[5]IRIS (EPA, 1993b) contains the RfD only, including its technical basis.

[6]This reference contains the RfD only.

[7]Health advisories for exposure over the longer term are not recommended due to the carcinogenic risk of this compound.

[8]IRIS (EPA, 1993b) contains technical basis for the risk specific dose (RSD) only.

[9]Values in EPA (1993c) probably are correct. However, no published rationale is available for the revised RSD.

[10]Carcinogencity assessment is pending (EPA, 1993b).

[11]Oral RfD assessment is pending (EPA, 1993b).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Fenamiphos	0.009	0.009	0.005	0.02	0.00025	0.009	0.002	nsg	--	EPA (**1988a**; **1989b**; [1]**1993b**,c,[2]d)
Fenthion	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Fenuron	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Ferbam	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Fluometuron	2	2	2	5	0.013	[3]0.5	0.09	nsg	S[3]	EPA (**1988a**; **1989b**)
	2	2	2	5	0.013	[3]0.4	0.09	nsg	R[3]	EPA ([1]**1993b**,c,[2]d)
Fluridone	nsg	nsg	nsg	nsg	0.08	nsg	nsg	([4])	B	EPA (**1993b**,d)
Folpet	nsg	nsg	nsg	nsg	0.1	nsg	nsg	0.01	B	EPA (**1993b**)
Fonofos	0.02	0.02	0.02	0.07	0.002	0.07	0.01	nsg	E	EPA (**1988a**; **1989b**; [5]**1993b**,c,[2]d)
Glyphosate	20	20	1	4	0.1	4	0.7	nsg	E	EPA (**1988a**; **1989b**; [1]**1993b**)
	20	20	1	[6]1	0.1	4	0.7	nsg	R	EPA (1993c,[2]d)
Guthion (azinphos-methyl)	nsg	nsg	nsg	nsg	([7])	nsg	nsg	nsg	--	--

Footnotes:

[1]IRIS (EPA, 1993b) contains the technical basis for the reference dose (RfD) only.

[2]This reference contains RfD only.

[3]The revised drinking water equivalent level (DWEL) value probably is correct. In EPA (1988a; 1989b), the rounded RfD was used to calculate the DWEL and lifetime health advisory. The revised DWEL and lifetime health-advisory values apparently were calculated from the RfD before rounding.

[4]Carcinogencity assessment is pending (EPA, 1993b).

[5]IRIS (EPA, 1993b) contains the RfD only, including its technical basis.

[6]Standard procedure for estimating this health advisory in the absence of suitable data is to use the DWEL; however, the revised value for the longer-term adult health advisory in EPA (1993c) is equivalent to the DWEL adjusted for a 10-kg child. It is unclear why the more conservative estimation procedure was used.

[7]Oral RfD assessment is pending (EPA, 1993b).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Heptachlor	0.01	0.01	[1]0.0015	([2])	0.0005	0.0175	nsg	[1]7.6×10^{-5}	S^1	EPA (**1987a**)
	0.01	0.01	0.005	([2])	0.0005	0.0175	nsg	7.6×10^{-6}	R^3	EPA (**1988b**)
	0.01	0.01	[4]0.005	[3]0.0175	0.0005	0.0175	nsg	8×10^{-6}	B,R^3	EPA ([5]1992b; [6]**1993b**)
	0.01	0.01	[4]0.005	[3]0.005	0.0005	0.02	nsg	8×10^{-6}	R^3	EPA (1993c,[7]d)
Heptachlor epoxide	([2])	([2])	([2])	([2])	1.3×10^{-5}	0.0004	nsg	[8]3.8×10^{-5}	S^8	EPA (**1987a**)
	([2])	([2])	([2])	([2])	1.3×10^{-5}	0.00044	nsg	[8]3.8×10^{-6}	R^9	EPA (**1988b**; **1990b**)
	([2])	([2])	[4]0.00013	[9]0.00044	1.3×10^{-5}	0.00044	nsg	[8]4×10^{-6}	B,R^9	EPA ([10]1992b; [6]**1993b**)
	[11]0.01	([2])	[4]0.0001	[9]0.0001	1.3×10^{-5}	0.0004	nsg	[8]4×10^{-6}	R^9	EPA (1993c,[7]d)

Footnotes:

[1]Values in EPA (1987a) are superseded; the longer-term child health advisory and the risk specific dose (RSD) values in this reference are incorrect.

[2]Health-advisory document stated that suitable data were not available to determine this health advisory, and did not estimate one.

[3]Revised values from all sources are equivalent except for longer-term adult health advisory. In EPA (1993b), this health advisory is estimated using the standard procedure, which is to use the drinking water equivalent level (DWEL). The revised value in EPA (1993c) was estimated from the DWEL adjusted for a 10-kg child. It is unclear why this more conservative procedure was used in this case. No estimate was made in EPA (1988b).

[4]This revised value was estimated using the standard procedure, which is to use the DWEL adjusted for a 10-kg child as an estimate of the longer-term health advisory for a child.

[5]This reference reports all health advisory values except the DWEL and RSD.

[6]IRIS (EPA, 1993b) contains technical basis for the reference dose (RfD) and RSD values only.

[7]This reference contains the RfD only.

[8]Original health-advisory values in EPA (1987a) are superseded; the RSD in this reference is incorrect.

[9]Revised values in EPA (1993c) probably are correct because they are more recent, although no published rationale is available for the two changes: (1) Only EPA (1993c) contains an estimate for the 1-day child health advisory; and (2) The revised longer-term adult health advisory value in EPA (1993b) was estimated using the standard procedure, which is to use the DWEL, whereas the value in EPA (1993c) is equivalent to the DWEL adjusted for a 10-kg child. It is unclear why this more conservative estimation procedure was used in the latter case.

[10]In this reference, the longer-term adult health advisory is incorrectly rounded and no DWEL or RSD values are reported.

[11]No published rationale is available for this value.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E) EPA drinking water health advisories: 10-kg child (mg/L) 1-day	10-day	Longer-term	(H) 70-kg adult Longer-term (mg/L)	(I) RfD [(mg/kg)/d]	(J) DWEL (mg/L)	(K) Lifetime (mg/L)	(L) RSD at 10^{-6} risk level (mg/L)	Status	References
Hexachlorobenzene	0.05	0.05	0.05	0.175	0.0008	0.028	nsg	2×10^{-5}	E	EPA (**1987b**; [1]1992b; [2]**1993b**,c,[3]d)
	0.05	0.05	0.05	0.175	[4]8×10^{-5}	0.028	nsg	2×10^{-5}	S[4]	EPA (**1988c**)
Hexazinone	3	3	3	9	0.033	1	0.2	nsg	E	EPA (**1988a**; **1989b**; [5]**1993b**,c,[3]d)
Linuron	nsg	nsg	nsg	nsg	0.002	nsg	nsg	nsg	B	EPA (**1993b**,d)
Malathion	0.2	0.2	0.2	[6]0.7	0.02	[6]0.7	[6]0.1	nsg	S[6]	EPA (**1992g**)
	0.2	0.2	0.2	[6]0.8	0.02	[6]0.8	[6]0.2	nsg	R[6]	EPA ([5]**1993b**,c,[3]d)
Maleic hydrazide	10	10	5	18	0.5	18	4	([7])	E	EPA (**1988a**; **1989b**; [5]**1993b**,c,[3]d)
Maneb[8]	nsg	nsg	nsg	nsg	0.005	nsg	nsg	([8])	B	EPA (**1993b**,d)
MCPA	0.1	0.1	0.1	0.4	[9]0.0005	0.02	0.004	nsg	S[9]	EPA (**1988a**; [5]**1993b**,[3]d)
	0.1	0.1	0.1	0.4	[9]0.0015	0.05	0.01	nsg	E,R[9]	EPA (**1989b**; 1993c)

Footnotes:

[1]This reference does not report drinking water equivalent level (DWEL) or risk specific dose (RSD) values.

[2]IRIS (EPA, 1993b) contains reference dose (RfD) and RSD only, including the technical basis for these values.

[3]This reference contains RfD only.

[4]RfD value in EPA (1988c) is incorrect.

[5]IRIS (EPA, 1993b) contains RfD only, including its technical basis.

[6]Revised values probably are correct. In EPA (1992g), the rounded RfD was used to calculate the DWEL and lifetime health advisory. The revised DWEL and lifetime health-advisory values in EPA (1993c) apparently were calculated from the RfD before rounding.

[7]Carcinogencity assessment is pending (EPA, 1993b).

[8]This compound is an ethylenebis(dithiocarbamate) pesticide, which degrades to ETU, a B2 carcinogen (EPA, 1992c). This same reference recommends using the carcinogenic potency of ETU, which would result in an RSD of 0.0003 mg/L (10^{-6} risk level).

[9]Revised values in EPA (1989b; 1993c) probably supersede those in EPA (1988a; 1993b,d), because the former were published more recently. In the original health-advisory document (EPA, 1988a), an additional uncertainty factor (UF) of 3 was used to calculate the RfD (making a total UF of 300), to account for the incomplete database on chronic toxicity. In EPA (1989b), this additional UF was omitted (making an UF of 100), although the same studies were used to calculate the RfD. No explanation for the change in UF is published. The revised value (based on UF = 100) was listed in EPA (1993c), but IRIS (EPA, 1993b) contains the originally published value (based on UF = 300) and the rationale for it. EPA (1993d) reports that the RfD used by EPA's Office of Pesticide Programs is 0.0015 (mg/kg)/d and the RfD value used by EPA is 0.0005 (mg/kg)/d. Both EPA (1989b; 1993c) are issued by EPA's Office of Water.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Methomyl	0.3	0.3	0.3	[1]0.9	0.025	0.9	0.2	([2])	E[1]	EPA (**1988a; 1989b**; [3]**1993b**)
	0.3	0.3	0.3	[1]0.3	0.025	0.9	0.2	nsg	R[1]	EPA (1993c,[4]d)
Methoxychlor	6.4	2.0	0.5	([5])	0.05	1.7	0.34	nsg	S[6]	EPA (**1987a, 1988b**)
	6	2	0.5	[7]2	0.005	2	0.4	nsg	R,S[6]	EPA ([8]1992b,[3]**1993b**)
	[9]0.05	[9]0.05	[9]0.05	[9]0.2	0.005	0.2	0.04	nsg	R[6]	EPA (1993c)
Methyl parathion	0.3	0.3	0.03	0.1	0.00025	0.009	0.002	nsg	E	EPA (**1988a; 1989b**; [3]**1993b**,c,[4]d)
Metolachlor	2	2	2	5	0.15	5	0.1	nsg	E	EPA (**1988a; 1989b**; [3]**1993b**,c,[4]d)
Metribuzin	5	5	0.3	0.9	0.025	0.9	0.2	([2])	E	EPA (**1988a; 1989b**; [3]**1993b**,c,[4]d)
Mevinphos (Phosdrin)	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Mirex	nsg	nsg	nsg	nsg	0.0002	nsg	nsg	([2])	B	EPA (**1993b**,d)([10])
Molinate	nsg	nsg	nsg	nsg	0.002	nsg	nsg	nsg	B	EPA (**1993b**,d)
Monuron	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Nabam	nsg	nsg	nsg	nsg	([11])	nsg	nsg	nsg	--	--
Naled	nsg	nsg	nsg	nsg	0.002	nsg	nsg	nsg	B	EPA (**1993b**,d)

Footnotes:

[1]The original value for the longer-term adult health advisory (EPA, 1988a; 1989b) was estimated using standard procedure, which is to use the drinking water equivalent level (DWEL) in the absence of suitable data. However, the revised value in EPA (1993c) is equivalent to the DWEL adjusted for a 10-kg child. It is unclear why the more conservative estimation procedure was used in this case.

[2]Carcinogencity assessment is pending (EPA, 1993b).

[3]IRIS (1993b) contains technical basis for the reference dose (RfD) only.

[4]This reference contains the RfD only.

[5]Original health-advisory document stated that suitable data were not available to determine this health advisory, and did not estimate one.

[6]Revised values in EPA (1993c) are correct. Revised DWEL and lifetime health-advisory values in this reference correspond to the revised RfD; the technical basis is given in IRIS (EPA 1993b). Except for the RfD, other health advisories in IRIS have not been updated yet. (Also see footnote 9.)

[7]This revised value was estimated using standard procedure, which is to use the DWEL as an estimate of the longer-term health advisory for an adult.

[8]This reference does not report RfD or DWEL values.

[9]No published rationale is available for this revised value. However, longer-term values probably were estimated using standard procedure (given in footnote 7). One-day and 10-day values are identical to the longer-term child value, and may have been estimated from it. This is a common estimation procedure.

[10]RfD value reported in EPA (1992b) is incorrect.

[11]Oral RfD assessment is pending (EPA, 1993b).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Nitralin	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Nitrofen	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Oxamyl (Vydate)	0.175	0.175	0.175	0.175	0.025	0.875	0.175	nsg	S	EPA (**1987a**; **1988b**; [1]**1993b**)
	0.2	0.2	0.2	[2]0.9	0.025	0.9	0.2	nsg	R	EPA (1993c,[3]d)
Oxydemeton-methyl	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Paraquat	0.1	0.1	0.05	0.2	0.0045	0.2	0.03	nsg	E	EPA (**1988a**; **1989b**; [1]**1993b**,c,[3]d)
Parathion	nsg	nsg	nsg	nsg	([4])	nsg	nsg	nsg	--	--
Pentachlorophenol	1	0.3	0.3	1.05	0.03	1.05	[5]0.22	nsg	S[5]	EPA (**1987a**; **1988b**; [6]1992b)
	1	0.3	0.3	1.05	0.03	1.05	[5]0.2	0.0003	B,S[5]	EPA ([7]**1993b**)
	1	0.3	0.3	1	0.03	1	nsg	0.0003	R[5]	EPA (1993c,[3]d)
Permethrin	nsg	nsg	nsg	nsg	0.05	nsg	nsg	([8])	B	EPA (**1993b**,d)
Phorate	nsg	nsg	nsg	nsg	([4])	nsg	nsg	nsg	--	--
Phosphamidon	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Picloram	20	20	0.7	2	0.07	2	0.5	([8])	E	EPA (**1988a**; **1989b**; [1]**1993b**,c,[3]d)
Prometon	0.2	0.2	0.2	0.5	[9]0.015	[9]0.5	[9]0.1	--	E	EPA (**1988a**; **1989b**; [10]**1993b**,c,[3]d)

Footnotes:

[1]IRIS (EPA, 1993b) contains technical basis for reference dose (RfD) only.

[2]The revised longer-term adult health-advisory value in EPA (1993c) probably was estimated using standard procedure, which is to use the drinking water equivalent level (DWEL).

[3]This reference contains RfD only.

[4]Oral RfD assessment is pending (EPA, 1993b).

[5]The correct health-advisory values are reported in EPA (1993c). Lifetime health advisory reported in EPA (1987a; 1988b; 1992b; 1993b) is superseded. This compound was originally classified in cancer group D, and a lifetime health advisory was calculated based on the RfD (EPA, 1987a). Based on new data, this compound was reclassified in group B2 (EPA, 1991a). Therefore a lifetime health advisory is not recommended and instead risk specific dose (RSD) values are determined. IRIS (EPA, 1993b) incorrectly reported the superseded lifetime health advisory, as well as the correct RSD value.

[6]This reference does not report a DWEL value.

[7]IRIS (EPA, 1993b) contains technical basis for RfD and RSD only. These values are up-to-date; the lifetime advisory value in IRIS is superseded (see footnote 5).

[8]Carcinogenicity assessment is pending (EPA, 1993b).

[9]Assessment is under review (EPA, 1993c).

[10]IRIS (EPA, 1993b) contains RfD only, including the technical basis.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Prometryn	nsg	nsg	nsg	nsg	0.004	nsg	nsg	nsg	B	EPA (**1993b**,d)
Pronamide (propyzamide)	0.8	0.8	0.8	3	0.075	2.6	0.05	([1])	E	EPA (**1988a**; **1989b**; [2]**1993b**,c,[3]d)
Propachlor	0.5	0.5	0.1	0.5	0.013	0.5	0.09	--	E	EPA (**1988a**; **1989b**; [2]**1993b**,c,[3]d)
Propanil	nsg	nsg	nsg	nsg	0.005	nsg	nsg	nsg	B	EPA (**1993b**,d)
Propazine	1	1	0.5	2	0.02	0.7	0.01	([1])	E	EPA (**1988a**; **1989b**; [2]**1993b**,c,[3]d)
Propham	5	5	5	20	0.02	0.6	0.1	nsg	E	EPA (**1988a**; **1989b**; [2]**1993b**,c,[3]d)
Pyrethrins (pyrethrum)	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Rotenone	nsg	nsg	nsg	nsg	0.004	nsg	nsg	([1])	B	EPA (**1993b**,d)
Simazine	0.5	0.5	0.05	0.2	0.005	0.2	0.004	nsg	E[4],S	EPA (**1988a**; **1989b**)
	nr	nr	nr	nr	([5])	[4]0.06	[4]0.001	([1])	B,S[4]	EPA (1993b)
	[6]0.07	[6]0.07	[6]0.07	[6]0.07	0.005	0.2	0.004	nsg	R[4]	EPA (1993c,[3]d)
Sulfallate	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
2,4,5-T	0.8	0.8	0.3	1	0.01	0.35	0.07	nsg	E	EPA (**1988a**; **1989b**; [2]**1993b**)
	0.8	0.8	[6]0.8	1	0.01	0.35	0.07	nsg	R	EPA (1993c,[3]d)
2,3,7,8-TCDD (dioxin)	1×10^{-6}	1×10^{-7}	1×10^{-8}	3.5×10^{-8}	1×10^{-9}	3.5×10^{-8}	nsg	2.2×10^{-10}	E	EPA (**1987b**; **1989a**; [7]1992b; 1993c)
Tebuthiuron	3	3	0.7	2	0.07	2	0.5	nsg	E	EPA (**1988a**; **1989b**; [8]**1993b**,c,[3]d)

Footnotes:

[1]Carcinogenicity assessment is pending (EPA, 1993b).

[2]IRIS (EPA, 1993c) contains technical basis for reference dose (RfD) only.

[3]This reference contains RfD only.

[4]Health-advisory values in EPA (1993c) probably are correct (see footnote 6). Drinking water equivalent level (DWEL) and lifetime health-advisory values in IRIS (EPA, 1993b) are incorrect; these are superseded values from the proposed rule for the maximum contaminant level (MCL) and maximum contaminant level goal (MCLG) for simazine, which were changed when additional data on reproductive effects became available (EPA, 1992d). DWEL and lifetime health-advisory values in EPA (1988a; 1989b; 1993c) are correct. The technical basis for these values is in EPA (1992d), which is the final rule promulgating the MCL and MCLG for simazine.

[5]Oral RfD was withdrawn: assessment is pending (EPA, 1993b).

[6]No published rationale is available for this value.

[7]This reference does not report DWEL or risk specific dose (RSD) values.

[8]IRIS (EPA, 1993b) contains RfD only, including the technical basis.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
TEPP	nsg	nsg	nsg	nsg	([1])	nsg	nsg	nsg	--	--
Terbacil	0.3	0.3	0.3	0.9	0.013	0.4	0.09	nsg	E	EPA (**1988a**; **1989b**; [2]**1993b**,c,[3]d)
Terbufos	0.005	0.005	0.001	0.005	[1]0.00013	0.005	0.0009	nsg	E	EPA (**1988a**; **1989b**;1993c)
Thiobencarb	nsg	nsg	nsg	nsg	0.01	nsg	nsg	nsg	B	EPA (**1993b**,d)
Thiram	nsg	nsg	nsg	nsg	0.005	nsg	nsg	([4])	B	EPA (**1993b**,d)
Toxaphene (camphechlor)	0.5	0.04	([5])	([5])	nsg	([5])	([5])	3.1×10^{-5}	E[6]	EPA (**1987a**; **1988b**)
	0.5	0.04	nsg	nsg	[7]0.1	[7]0.0035	nsg	3×10^{-5}	R[6]	EPA ([8]**1993b**,c)
2,4,5-TP (silvex, fenoprop)	0.2	0.2	0.07	([5])	0.0075	0.26	0.052	nsg	E	EPA (**1987a**; **1988b**)
	0.2	0.2	0.07	[9]0.3	0.0075	0.3	0.05	nsg	R	EPA ([2]**1993b**,c,[3]d)
Triallate	nsg	nsg	nsg	nsg	0.013	nsg	nsg	nsg	B	EPA (**1993b**,d)

Footnotes:

[1]Oral reference dose (RfD) assessment is pending (EPA, 1993b).

[2]IRIS (EPA, 1993b) contains RfD only, including the technical basis.

[3]This reference contains RfD only.

[4]Carcinogenicity assessment is pending (EPA, 1993b).

[5]Original health-advisory document stated that suitable data were not available to determine this health advisory, and did not estimate one.

[6]Revised values in EPA (1993c) are identical to original values in EPA (1987a; 1988b), except that additional health advisories are reported in EPA (1993c). (See footnote 7.)

[7]No published rationale is available for this revised value.

[8]IRIS (EPA, 1993b) contains the risk specific dose (RSD) only, including the technical basis.

[9]This revised longer-term adult health advisory probably was estimated using standard procedure, which is to use the drinking water equivalent level (DWEL).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 2: Protection of human health--Drinking water--*Continued*

Chemical name	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	Status	References
	EPA drinking water health advisories									
	10-kg child (mg/L)			70-kg adult						
	1-day	10-day	Longer-term	Longer-term (mg/L)	RfD [(mg/kg)/d]	DWEL (mg/L)	Lifetime (mg/L)	RSD at 10^{-6} risk level (mg/L)		
Trichlorfon	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Trifluralin (Treflan)	0.03	0.03	0.03	0.1	0.003	0.1	0.002	0.005	S[1]	EPA (**1988a**; **1989b**)
	0.03	0.03	0.03	0.03	0.0075	nr	0.002	nsg	S[1]	EPA (1992b)
	0.08	0.08	0.08	[2]0.3	0.0075	0.3	0.005	0.005	R[1]	EPA (**1990c**; [3]**1993b**,[4]c,[5]d)
Zectran (mexacarbate)	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--
Zineb[6]	nsg	nsg	nsg	nsg	0.05	nsg	nsg	([6 7])	B	EPA (**1993b**,d)
Ziram	nsg	nsg	nsg	nsg	nsg	nsg	nsg	nsg	--	--

Footnotes:

[1]Revised values in EPA (1990c) supersede values in EPA (1988a; 1989b; 1992b). EPA (1992b) reports the (correct) revised reference dose (RfD), but the other health-advisory values are out-of-date. This compound has both a lifetime health advisory and a risk specific dose (RSD) because it is classified in Cancer Group C (possible human carcinogen), but sufficient data were also available for EPA's Cancer Assessment Group to calculate a cancer potency factor (q_1*) and RSD. It is the standard practice of EPA's Office of Water to calculate a lifetime health advisory for Group C compounds, using an additional uncertainty factor of 10 to account for potential carcinogenicity.

[2]This revised longer-term adult health advisory was estimated using the standard procedure, which is to use the drinking water equivalent level (DWEL).

[3]IRIS (EPA, 1993b) contains the RfD and RSD only, including the technical basis for these values.

[4]This reference does not report a RSD value.

[5]This reference contains RfD only.

[6]This compound is an ethylenebis(dithiocarbamate) pesticide, which degrades to ETU, a B2 carcinogen (EPA, 1992c).

[7]Carcinogenicity assessment is pending (EPA, 1993b).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 3: Protection of human health--Drinking water

Chemical name	(M)	(N)	(O)	
	NAS drinking water and health recommendations			
	ADI [(mg/kg)/d]	SNARL (mg/L)	Lifetime cancer risk per µg/L	References
Acifluorfen	nsg	nsg	nsg	--
Alachlor	0.1	0.7000	nsg	National Research Council (**1977**)
Aldicarb	0.001	[1]0.007	nsg	National Research Council (**1977**)
Aldicarb sulfone	nsg	nsg	nsg	--
Aldicarb sulfoxide	nsg	nsg	nsg	--
Aldrin	nsg	nsg	nsg	--
Allethrin	nsg	nsg	nsg	--
Ametryn (ametryne)	nsg	nsg	nsg	--
Aminotriazole (amitrole)	nsg	nsg	nsg	--
Atrazine	0.0215	0.15	nsg	National Research Council (**1977**)
Baygon (propoxur)	nsg	nsg	nsg	--
Benfluralin (benefin)	0.1	0.7000	nsg	National Research Council (**1977**)
Benomyl	nsg	nsg	nsg	--
Bentazon (bentazone)	nsg	nsg	nsg	--
α-BHC (α-HCH, α-benzene hexachloride, α-hexachlorocyclohexane)	nsg	nsg	1.5×10^{-6}	National Research Council (**1977**)
β-BHC (β-HCH, β-benzene hexachloride, β-hexachlorocyclohexane)	nsg	nsg	4.2×10^{-6}	National Research Council (**1977**)
γ-BHC (γ-HCH, lindane, γ-benzene hexachloride, γ-hexachlorocyclohexane)	nsg	nsg	9.3×10^{-6}	National Research Council (**1977**)
δ-BHC, (δ-HCH, δ-benzene hexachloride, δ-hexachlorocyclohexane)	nsg	nsg	nsg	--
BHC, technical mixture (HCH, benzene hexachloride, hexachlorocyclohexane)	nsg	24-h:3.5 7-d:0.5	nsg	National Research Council (**1980b**)
Bromacil	0.0125	0.0875	nsg	National Research Council (**1977**)
Butachlor	0.01	0.0700	nsg	National Research Council (**1977**)
Butylate	nsg	nsg	nsg	--
Captan	0.05	0.35	nsg	National Research Council (**1977**)
Carbaryl	0.082	0.574	nsg	National Research Council (**1977**)
Carbofuran	nsg	nsg	nsg	--
Carboxin	nsg	nsg	nsg	--

Footnotes:

[1]Additional suggested-no-adverse-response level (SNARL) values, where the adverse response consists of 20 percent cholinesterase inhibition, are: adult, 0.0007 mg/L; child, 0.0002 mg/L (National Research Council, 1986).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 3: Protection of human health--Drinking water--*Continued*

Chemical name	(M)	(N)	(O)	
	NAS drinking water and health recommendations			
	ADI [(mg/kg)/d]	SNARL (mg/L)	Lifetime cancer risk per µg/L	References
Chloramben (Amiben)	0.25	1.7500	nsg	National Research Council (**1977**)
Chlordane	nsg	nsg	1.8×10^{-5}	National Research Council (**1977**)
Chlordecone (Kepone)	nsg	nsg	4.4×10^{-5}	National Research Council (**1977**)
Chlorfenac (fenac)	nsg	nsg	nsg	--
Chlorothalonil	nsg	nsg	nsg	--
Chlorpyrifos (Dursban)	nsg	nsg	nsg	--
Coumaphos	nsg	nsg	nsg	--
Crotoxyphos (Ciodrin)	nsg	nsg	nsg	--
Cyanazine	nsg	nsg	nsg	--
2,4-D	0.0125	0.0875	nsg	National Research Council (**1977**)
Dacthal (DCPA, chlorthal-dimethyl)	nsg	nsg	nsg	--
Dalapon	nsg	nsg	nsg	--
2,4-DB	nsg	nsg	nsg	--
p,p'-DDD (*p,p'*-TDE)	nsg	nsg	nsg	--
p,p'-DDE	nsg	nsg	nsg	--
p,p'-DDT	nsg	nsg	1.2×10^{-5}	National Research Council (**1977**)
Demeton	nsg	nsg	nsg	--
Diallate	nsg	nsg	nsg	--
Diazinon	0.002	0.0140	nsg	National Research Council (**1977**)
1,2-dibromo-3-chloropropane (DBCP)	nsg	nsg	9.9×10^{-6}	National Research Council (**1986**)
Dicamba	0.00125	0.00875	nsg	National Research Council (**1977**)
Dichlobenil	nsg	nsg	nsg	--
Dichlone	nsg	nsg	nsg	--
1,3-dichloropropene (DCP; 1,3-dichloropropylene; Telone II)	nsg	nsg	1.1×10^{-6}	National Research Council (**1986**)
Dichlorvos (DDVP)	nsg	nsg	nsg	--
Dieldrin	nsg	nsg	2.6×10^{-4}	National Research Council (**1977**)
Dimethoate	nsg	nsg	nsg	--
Dimethrin	nsg	nsg	nsg	--
Dinoseb (2-sec-butyl-4, 6-dinitrophenol)	nsg	0.039	nsg	National Research Council (**1983**)
Dioxathion	nsg	nsg	nsg	--
Diphenamid	nsg	nsg	nsg	--
Diquat	nsg	nsg	nsg	--

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 3: Protection of human health--Drinking water--*Continued*

Chemical name	(M) NAS drinking water and health recommendations	(N)	(O)	
	ADI [(mg/kg)/d]	SNARL (mg/L)	Lifetime cancer risk per µg/L	References
Disulfoton	0.0001	0.0007	nsg	National Research Council (**1977**)
Diuron	nsg	nsg	nsg	--
Endosulfan	nsg	nsg	nsg	--
α-endosulfan (endosulfan I)	nsg	nsg	nsg	--
β-endosulfan (endosulfan II)	nsg	nsg	nsg	--
Endosulfan sulfate	nsg	nsg	nsg	--
Endothall (endothal)	nsg	nsg	nsg	--
Endrin	nsg	nsg	nsg	--
Endrin aldehyde	nsg	nsg	nsg	--
EPN	nsg	nsg	nsg	--
EPTC	nsg	nsg	nsg	--
Ethion	nsg	nsg	nsg	--
Ethylene dibromide (EDB)	nsg	nsg	9.1×10^{-6}	National Research Council (**1980b**)
Ethylene thiourea (ETU)	nsg	nsg	2.2×10^{-6}	National Research Council (**1977**)
Famphur	nsg	nsg	nsg	--
Fenamiphos	nsg	nsg	nsg	--
Fenthion	nsg	nsg	nsg	--
Fenuron	nsg	nsg	nsg	--
Ferbam	0.0125	0.0875	nsg	National Research Council (**1977**)
Fluometuron	nsg	nsg	nsg	--
Fluridone	nsg	nsg	nsg	--
Folpet	0.16	1.12	nsg	National Research Council (**1977**)
Fonofos	nsg	nsg	nsg	--
Glyphosate	nsg	nsg	nsg	--
Guthion (azinphos-methyl)	0.0125	0.0875	nsg	National Research Council (**1977**)
Heptachlor	nsg	nsg	4.2×10^{-5}	National Research Council (**1977**)
Heptachlor epoxide	nsg	nsg	nsg	--
Hexachlorobenzene	0.001	0.007	nsg	National Research Council (**1977**)
	nsg	7d:0.03	2.9×10^{-5}	National Research Council (**1980b**)
	nsg	nsg	1.85×10^{-6}	National Research Council (**1983**)
Hexazinone	nsg	nsg	nsg	--
Linuron	nsg	nsg	nsg	--
Malathion	0.02	0.14	nsg	National Research Council (**1977**)
Maleic hydrazide	nsg	nsg	nsg	--

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 3: Protection of human health--Drinking water--*Continued*

Chemical name	(M)	(N)	(O)	
	NAS drinking water and health recommendations			
	ADI [(mg/kg)/d]	SNARL (mg/L)	Lifetime cancer risk per µg/L	References
Maneb	0.005	0.035	nsg	National Research Council (**1977**)
MCPA	0.00125	0.00875	nsg	National Research Council (**1977**)
Methomyl	nsg	0.175	nsg	National Research Council (**1983**)
Methoxychlor	0.1	0.7000	nsg	National Research Council (**1977**)
Methyl parathion	0.0043	0.03	nsg	National Research Council (**1977**)
Metolachlor	nsg	nsg	nsg	--
Metribuzin	nsg	nsg	nsg	--
Mevinphos (Phosdrin)	nsg	nsg	nsg	--
Mirex	nsg	nsg	nsg	--
Molinate	nsg	nsg	nsg	--
Monuron	nsg	nsg	nsg	--
Nabam	nsg	nsg	nsg	--
Naled	nsg	nsg	nsg	--
Nitralin	0.1	0.7000	nsg	National Research Council (**1977**)
Nitrofen	nsg	[1]0.0011	5.6×10^{-5}	National Research Council (**1986**)
Oxamyl (Vydate)	nsg	nsg	nsg	--
Oxydemeton-methyl	nsg	nsg	nsg	--
Paraquat	0.0085	0.0595	nsg	National Research Council (**1977**)
Parathion	0.0043	0.03	nsg	National Research Council (**1977**)
Pentachlorophenol	0.003	[2]0.021	nsg	National Research Council (**1977**)
	nsg	[2]child:0.006	nsg	National Research Council (**1986**)
Permethrin	nsg	nsg	nsg	--
Phorate	0.0001	0.0007	nsg	National Research Council (**1977**)
Phosphamidon	nsg	nsg	nsg	--
Picloram	nsg	1.05	nsg	National Research Council (**1983**)
Prometon	nsg	nsg	nsg	--
Prometryn	nsg	nsg	nsg	--
Pronamide (propyzamide)	nsg	nsg	nsg	--
Propachlor	0.1	0.7000	nsg	National Research Council (**1977**)

Footnotes:

[1]Suggested-no-adverse-response level (SNARL) is based on teratogenicity. Upper 95-percent confidence estimate of lifetime risk for teratogenesis per µg/L of contaminant concentration is 7.1×10^{-6} (National Research Council, 1986).

[2]Values shown are for pure pentachlorophenol. For technical mixture, the SNARL (adult) is 0.007 mg/L (National Research Council, 1986).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 3: Protection of human health--Drinking water--*Continued*

Chemical name	(M)	(N)	(O)	
	NAS drinking water and health recommendations			
	ADI [(mg/kg)/d]	SNARL (mg/L)	Lifetime cancer risk per µg/L	References
Propanil	0.02	0.1400	nsg	National Research Council (**1977**)
Propazine	0.0464	0.325	nsg	National Research Council (**1977**)
Propham	nsg	nsg	nsg	--
Pyrethrin (pyrethrum)	nsg	nsg	nsg	--
Rotenone	nsg	0.014	nsg	National Research Council (**1983**)
Simazine	0.215	1.505	nsg	National Research Council (**1977**)
Sulfallate	nsg	nsg	1.6×10^{-6}	National Research Council (**1986**)
2,4,5-T	0.1	0.7	nsg	National Research Council (**1977**)
2,3,7,8-TCDD (dioxin)	1×10^{-7}	7×10^{-7}	nsg	National Research Council (**1977**)
Tebuthiuron	nsg	nsg	nsg	--
TEPP	nsg	nsg	nsg	--
Terbacil	nsg	nsg	nsg	--
Terbufos	nsg	nsg	nsg	--
Thiobencarb	nsg	nsg	nsg	--
Thiram	0.005	0.035	nsg	National Research Council (**1977**)
Toxaphene (camphechlor)	0.00125	0.00875	nsg	National Research Council (**1977**)
2,4,5-TP (silvex, fenoprop)	0.00075	0.00525	nsg	National Research Council (**1977**)
Triallate	nsg	nsg	nsg	--
Trichlorfon	nsg	0.088 child:0.026	nsg	National Research Council (**1986**)
Trifluralin (Treflan)	0.1	0.7000	nsg	National Research Council (**1977**)
Zectran (mexacarbate)	nsg	nsg	nsg	--
Zineb	0.005	0.035	nsg	National Research Council (**1977**)
Ziram	0.0125	0.0875	nsg	National Research Council (**1977**)

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 4: Protection of human health--Ambient surface water

Chemical name	(P)	(Q)			(R)	
	EPA ambient water-quality criteria, human health					
	Ingestion of (mg/L) (for carcinogens, values denote 10^{-6} excess cancer risk level)				Technical basis for most recent set of criteria	
	Water and aquatic organisms	Aquatic organisms only	Status	Reference	q_1* [(mg/kg)/d]$^{-1}$ or RfD [(mg/kg)/d] and BCF (3 percent lipids, L/kg fish)	Reference
Acifluorfen	nsg	nsg	--	--	--	--
Alachlor	nsg	nsg	--	--	--	--
Aldicarb	nsg	nsg	--	--	--	--
Aldicarb sulfone	nsg	nsg	--	--	--	--
Aldicarb sulfoxide	nsg	nsg	--	--	--	--
Aldrin	[1] [2]1.3×10^{-7}	[1] [2]1.4×10^{-7}	R,X	EPA (1991b; 1992a; 1993a)	q_1* = [2]17	EPA (**1993a,b**)
	[1] [2]7.4×10^{-8}	[1] [2]7.9×10^{-8}	F	EPA (**1980a**,m; 1986a; 1991b; 1993b)	BCF = [2]28	EPA (**1980a**)
Allethrin	nsg	nsg	--	--	--	--
Ametryn (ametryne)	nsg	nsg	--	--	--	--
Aminotriazole (amitrole)	nsg	nsg	--	--	--	--
Atrazine	nsg	nsg	--	--	--	--
Baygon (propoxur)	nsg	nsg	--	--	--	--
Benfluralin (benefin)	nsg	nsg	--	--	--	--
Benomyl	nsg	nsg	--	--	--	--
Bentazon (bentazone)	nsg	nsg	--	--	--	--
α-BHC (α-HCH, α-benzene hexachloride, α-hexachlorocyclohexane)	[1]3.9×10^{-6}	[1]1.3×10^{-5}	R,X	EPA (1991b; 1992a; 1993a)	q_1* = 6.3	EPA (1992b; **1993a,b**)
	[1]9.2×10^{-6}	[1]3.10×10^{-5}	F	EPA (**1980i**,m; 1986a; 1991b; [3]1992b; 1993b)	BCF = 130	EPA (**1980i**; 1992b; 1993a)
β-BHC (β-HCH, β-benzene hexachloride, β-hexachlorocyclohexane)	[1]1.4×10^{-5}	[1]4.6×10^{-5}	R,X	EPA (1991b; 1992a; 1993a)	q_1* = 1.8	EPA (**1993a,b**)
	[1]1.63×10^{-5}	[1]5.47×10^{-5}	F	EPA (**1980i**,m; 1986a; 1991b; 1993b)	BCF = 130	EPA (**1980i**; 1993a)

Footnotes:

[1]Criteria are based on carcinogenicity (10^{-6} risk). For a risk level of 10^{-5}, move the decimal point in the matrix one place to the right.

[2]Aldrin is converted to dieldrin in fish, so criteria also consider risk resulting from intake of dieldrin in fish owing to the presence of aldrin in water, as well as risk from intake of aldrin itself in fish or water. Therefore, criteria for aldrin also depend on the cancer potency (q_1* = 17 [(mg/kg)/d]$^{-1}$) and bioconcentration factor (BCF = 4,670 L/kg fish) for dieldrin. The intake of dieldrin resulting from aldrin in the water is estimated by assuming that, in the absence of conversion of dieldrin, aldrin would bioconcentrate 4,670 times (as dieldrin does), and that since aldrin accumulates 28 times, the remainder of the expected aldrin residues are being stored as dieldrin (4,670 - 28 = 4,642) (EPA, 1980a). BCF for aldrin is reported as 4,670 in EPA (1993a).

[3]This reference contains only the value for consumption of aquatic organisms.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 4: Protection of human health--Ambient surface water--*Continued*

Chemical name	(P)	(Q)		(R)		
	EPA ambient water-quality criteria, human health					
	Ingestion of (mg/L) (for carcinogens, values denote 10^{-6} excess cancer risk level)				Technical basis for most recent set of criteria	
	Water and aquatic organisms	Aquatic organisms only	Status	Reference	q_1* [(mg/kg)/d]$^{-1}$ or RfD [(mg/kg)/d] and BCF (3 percent lipids, L/kg fish)	Reference
γ-BHC (γ-HCH, lindane, γ-benzene hexachloride, γ-hexachlorocyclohexane)	[1]1.86×10^{-5}	[1]6.25×10^{-5}	F,X	EPA (**1980i**,m; 1986a; 1991b; 1992a,[2]b; 1993a,b)	q_1* = [3]1.326 BCF = 130	EPA (**1980i**; 1992b; 1993e) EPA (**1980i**; 1993a)
δ-BHC, (δ-HCH, δ-benzene hexachloride, δ-hexachlorocyclohexane)	nsg	nsg	--	--	--	--
BHC, technical mixture (BHC, benzene hexachloride, hexachlorocyclohexane)	[1]1.23×10^{-5}	[1]4.14×10^{-5}	F	EPA (**1980i**,m; 1986a; 1991b)	q_1* = 2.0 BCF = 130	EPA (**1980i**) EPA (**1980i**)
Bromacil	nsg	nsg	--	--	--	--
Butachlor	nsg	nsg	--	--	--	--
Butylate	nsg	nsg	--	--	--	--
Captan	nsg	nsg	--	--	--	--
Carbaryl	nsg	nsg	--	--	--	--
Carbofuran	nsg	nsg	--	--	--	--
Carboxin	nsg	nsg	--	--	--	--
Chloramben (Amiben)	nsg	nsg	--	--	--	--
Chlordane	[1]5.7×10^{-7} [1]4.6×10^{-7}	[1]5.9×10^{-7} [1]4.8×10^{-7}	R,X F	EPA ([4]1991b; 1992a; 1993a) EPA (**1980b**,m; 1986a; 1991b; [2]1992b; 1993b)	q_1* = 1.3 BCF = 14,100	EPA (1992b; **1993a,b**) EPA (**1980b**; 1992b; 1993a)
Chlordecone (Kepone)	nsg	nsg	--	--	--	--
Chlorfenac (fenac)	nsg	nsg	--	--	--	--
Chlorothalonil	nsg	nsg	--	--	--	--
Chlorpyrifos (Dursban)	nsg	nsg	--	--	--	--
Coumaphos	nsg	nsg	--	--	--	--
Crotoxyphos (Ciodrin)	nsg	nsg	--	--	--	--

Footnotes:

[1]Criteria are based on carcinogenicity (10^{-6} risk). For a risk level of 10^{-5}, move the decimal point in the matrix one place to the right.

[2]This reference contains only the value for consumption of aquatic organisms.

[3]Carcinogenicity assessment is pending (EPA, 1993b).

[4]The criterion for consumption of water and organisms is reported as 5.8×10^{-7} mg/L in this reference; the difference is probably due to rounding error.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 4: Protection of human health--Ambient surface water--*Continued*

Chemical name	(P) EPA ambient water-quality criteria, human health: Ingestion of (mg/L) (for carcinogens, values denote 10^{-6} excess cancer risk level)				(R) EPA ambient water-quality criteria, human health: Technical basis for most recent set of criteria	
	Water and aquatic organisms	Aquatic organisms only	Status	Reference	q_1* [(mg/kg)/d]$^{-1}$ or RfD [(mg/kg)/d] and BCF (3 percent lipids, L/kg fish)	Reference
Cyanazine	nsg	nsg	--	--	--	--
2,4-D	[1]0.1	nsg	F	EPA (1976; 1986a; 1991b)([2])	RfD = ([1]) BCF = nsg	--
Dacthal (DCPA, chlorthal-dimethyl)	nsg	nsg	--	--	--	--
Dalapon	nsg	nsg	--	--	--	--
2,4-DB	nsg	nsg	--	--	--	--
p,p'-DDD (*p,p'*-TDE)	[3]8.3×10^{-7}	[3]8.4×10^{-7}	X	EPA ([4]1991b; 1992a; 1993a)	q_1* = 0.24 BCF = 53,600	EPA (**1993a,b**) EPA (**1980d**; 1993a)
p,p'-DDE	[3]5.9×10^{-7} nsg	[3]5.9×10^{-7} [5]2.4×10^{-8}	R,X F	EPA (1991b; 1992a; 1993a) EPA (1992b)	q_1* = 0.34 BCF = 53,600	EPA (1992b; **1993a,b**) EPA (**1980d**; 1992b; 1993a)
p,p'-DDT	[3]5.9×10^{-7} [3]2.4×10^{-8}	[3]5.9×10^{-7} [3]2.4×10^{-8}	R,X F	EPA (1991b; 1992a; 1993a) EPA (**1980d**,m; 1986a; 1991b; [6]1992b; 1993b)	q_1* = 0.34 BCF = 53,600	EPA (**1993a,b**,e) EPA (**1980d**; 1993a)
Demeton	nsg	nsg	--	--	--	--
Diallate	nsg	nsg	--	--	--	--
Diazinon	nsg	nsg	--	--	--	--
1,2-dibromo-3-chloropropane (DBCP)	nsg	nsg	--	--	--	--
Dicamba	nsg	nsg	--	--	--	--
Dichlobenil	nsg	nsg	--	--	--	--
Dichlone	nsg	nsg	--	--	--	--

Footnotes:

[1]This criterion predates use of the reference dose (RfD) terminology. The value listed is based on the no-observed-adverse-effect level (NOAEL) from a long-term dog study, which was adjusted using a safety factor of 500 and assuming that 20 percent of exposure is from drinking water (EPA, 1976). The current RfD for this compound is shown in Table 3, Section 2, Column I.

[2]Criterion is reported incorrectly in IRIS database (EPA, 1993b).

[3]Criteria are based on carcinogenicity (10^{-6} risk). For a risk level of 10^{-5}, move the decimal point in the matrix one place to the right.

[4]The criterion for consumption of organisms is reported as 8.3×10^{-7} mg/L in this reference; the difference is probably due to rounding error.

[5]Criterion reported is for combined (DDE and DDT) cancer risk.

[6]This reference reports only the criterion for consumption of aquatic organisms.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 4: Protection of human health--Ambient surface water--*Continued*

Chemical name	(P)	(Q)		(R) EPA ambient water-quality criteria, human health		
	Ingestion of (mg/L) (for carcinogens, values denote 10^{-6} excess cancer risk level)				Technical basis for most recent set of criteria	
	Water and aquatic organisms	Aquatic organisms only	Status	Reference	q_1* [(mg/kg)/d]$^{-1}$ or RfD [(mg/kg)/d] and BCF (3 percent lipids, L/kg fish)	Reference
1,3-dichloropropene (DCP; 1,3-dichloropropylene; Telone II)	[1]0.01 0.087	[1]1.7 14.1	R,X F	EPA (1991b; 1992a; 1993a) EPA (**1980e**,m; 1986a; 1991b; [2]1993b)	RfD = 0.0003 BCF = 1.91	EPA (**1993a,b**) EPA (**1980e**; 1993a)
Dichlorvos (DDVP)	nsg	nsg	--	--	--	--
Dieldrin	[3]1.4×10^{-7} [3]7.1×10^{-8}	[3]1.4×10^{-7} [3]7.6×10^{-8}	R,X F	EPA (1991b; 1992a; 1993a) EPA (**1980a**,m; 1986a; [4]1991b; 1993b)([5])	q_1* = 16 BCF = 4,670	EPA (1992b; **1993a,b**) EPA (**1980a**; 1992b; 1993a)
Dimethoate	nsg	nsg	--	--	--	--
Dimethrin	nsg	nsg	--	--	--	--
Dinoseb (2-sec-butyl-4, 6-dinitrophenol)	nsg	nsg	--	--	--	--
Dioxathion	nsg	nsg	--	--	--	--
Diphenamid	nsg	nsg	--	--	--	--
Diquat	nsg	nsg	--	--	--	--
Disulfoton	nsg	nsg	--	--	--	--
Diuron	nsg	nsg	--	--	--	--

Footnotes:

[1]This revised criterion is based on the reference dose (RfD), although this compound is a B2 carcinogen (EPA, 1992c; 1993b,c,d). The standard procedure for a B2 carcinogen is to base human-health criteria on cancer potency (q_1*). When human-health criteria originally were determined, this compound had not been adequately tested for carcinogenicity, so human-health criteria were based on a toxicity (noncarcinogenic) endpoint and an uncertainty factor of 1,000 (EPA, 1980e). (This is the standard procedure used by EPA's Office of Water for Group C compounds.) IRIS (EPA, 1993b) lists this compound as a B2 carcinogen, but does not report a cancer potency (oral slope) factor (q_1*). When human-health criteria were recalculated using current information in IRIS, the revised RfD was used (EPA, 1993a). This is inconsistent with the drinking-water health advisory for this compound issued by the same office (Office of Science and Technology in EPA's Office of Water), which reports an oral q_1* value of 0.175 [(mg/kg)/d]$^{-1}$ and cancer risk estimates based on this q_1* value (EPA, 1988a; 1989b).

[2]Value for aquatic organisms only is incorrectly reported in IRIS database (EPA, 1993b).

[3]Criteria are based on carcinogenicity (10^{-6} risk). For a risk level of 10^{-5}, move the decimal point in the matrix one place to the right.

[4]In this reference, the value reported for consumption of organisms is incorrect.

[5]EPA (1992b) reports only the criterion for consumption of organisms and the value reported is incorrect.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 4: Protection of human health--Ambient surface water--*Continued*

Chemical name	(P) EPA ambient water-quality criteria, human health: Ingestion of (mg/L) (for carcinogens, values denote 10^{-6} excess cancer risk level)				(Q) Technical basis for most recent set of criteria	
	Water and aquatic organisms	Aquatic organisms only	Status	Reference	q_1* [(mg/kg)/d]$^{-1}$ or RfD [(mg/kg)/d] and BCF (3 percent lipids, L/kg fish)	Reference
Endosulfan	[1]0.074	[1]0.159	F[1]	EPA (**1980f**,m; 1986a; 1991b; 1993b)	RfD = 0.004 BCF = 270	EPA (1980f) EPA (**1980f**)
α-endosulfan (endosulfan I)	0.074	0.159	R[1]	EPA (1993a)	RfD = 0.004	EPA (1980f)
	0.00093	0.0020	S,X[1]	EPA (1991b; 1992a)	BCF = 270	EPA (1993a)
β-endosulfan (endosulfan II)	0.074	0.159	R[1]	EPA (1993a)	RfD = 0.004	EPA (1980f)
	0.00093	0.0020	S,X[1]	EPA (1991b; 1992a)	BCF = 270	EPA (1993a)
Endosulfan sulfate	0.074	0.159	R[1]	EPA (1993a)	RfD = 0.004	EPA (1980f)
	0.00093	0.0020	S,X[1]	EPA (1991b; 1992a)	BCF = 270	EPA (1993a)
Endothall (endothal)	nsg	nsg	--	--	--	--
Endrin	0.00076	0.00081	R,X	EPA (1991b; 1992a; 1993a)	RfD = 0.0003	EPA (1992b; **1993a,b**)
	[2]0.001	nsg	F	EPA (**1980g**,m; 1986a; 1991b; 1992b; 1993b)	BCF = 3,970	EPA (**1980g**)
Endrin aldehyde	0.00076	0.00081	X	EPA (1991b; 1992a; 1993a)	RfD = 0.0003 BCF = 3,970	EPA (1993a) EPA(1993a)
EPN	nsg	nsg	--	--	--	--
EPTC	nsg	nsg	--	--	--	--
Ethion	nsg	nsg	--	--	--	--
Ethylene dibromide (EDB)	nsg	nsg	--	--	--	--
Ethylene thiourea (ETU)	nsg	nsg	--	--	--	--
Famphur	nsg	nsg	--	--	--	--

Footnotes:

[1]In lieu of updating the original published criteria for endosulfan, EPA (1992a) promulgated criteria for individual stereoisomers, α- and β-endosulfan, as well as the metabolite endosulfan sulfate. Updated criteria in EPA (1991b; 1992a) were based on a revised reference dose (RfD) from IRIS as of September 1990 (EPA, 1991b). However, EPA withdrew the RfD value from IRIS in December 1992 (EPA, 1993b). Therefore, EPA (1993a) reported the criteria originally published for endosulfan (EPA, 1980f) as the criteria for α- and β-endosulfan and endosulfan sulfate.

[2]Criterion was set equal to the drinking water standard at the time, 0.001 mg/L (EPA, 1980g,m).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 4: Protection of human health--Ambient surface water--*Continued*

Chemical name	(P)	(Q)			(R)	
	EPA ambient water-quality criteria, human health					
	Ingestion of (mg/L) (for carcinogens, values denote 10^{-6} excess cancer risk level)				Technical basis for most recent set of criteria	
	Water and aquatic organisms	Aquatic organisms only	Status	Reference	q_1* [(mg/kg)/d]$^{-1}$ or RfD [(mg/kg)/d] and BCF (3 percent lipids, L/kg fish)	Reference
Fenamiphos	nsg	nsg	--	--	--	--
Fenthion	nsg	nsg	--	--	--	--
Fenuron	nsg	nsg	--	--	--	--
Ferbam	nsg	nsg	--	--	--	--
Fluometuron	nsg	nsg	--	--	--	--
Fluridone	nsg	nsg	--	--	--	--
Folpet	nsg	nsg	--	--	--	--
Fonofos	nsg	nsg	--	--	--	--
Glyphosate	nsg	nsg	--	--	--	--
Guthion (azinphos-methyl)	nsg	nsg	--	--	--	--
Heptachlor	[1]2.1×10^{-7}	[1]2.1×10^{-7}	R,X	EPA (1991b; 1992a; 1993a)	q_1* = 4.5	EPA (1992b; **1993a,b**)
	[1]2.8×10^{-7}	[1]2.9×10^{-7}	F	EPA (**1980h**,m; 1986a; 1991b; [2]1992b; 1993b)	BCF = 11,200	EPA(**1980h**; 1992b; 1993a)
Heptachlor epoxide	[1]1.0×10^{-7}	[1]1.1×10^{-7}	R,X	EPA (1991b; 1992a; 1993a)	q_1* = 9.1	EPA (1992b; **1993a,b,e**)
	[1 3]2.8×10^{-7}	[1 3]2.9×10^{-7}	F	EPA ([2]1992b; 1993b)	BCF = 11,200	EPA (1993a)
Hexachlorobenzene	[1]7.5×10^{-7}	[1]7.7×10^{-7}	R,X	EPA (1992a; 1993a)	q_1* = 1.6	EPA (**1993a,b,e**)
	[1]7.2×10^{-7}	[1]7.4×10^{-7}	F	EPA (**1980c**,m; 1986a; 1991b; 1993b)	BCF = 8,690	EPA (**1980c**; 1992b; 1993a)
Hexazinone	nsg	nsg	--	--	--	--
Linuron	nsg	nsg	--	--	--	--
Malathion	nsg	nsg	--	--	--	--
Maleic hydrazide	nsg	nsg	--	--	--	--
Maneb	nsg	nsg	--	--	--	--

Footnotes:

[1]Criteria are based on carcinogenicity (10^{-6} risk). For a risk level of 10^{-5}, move the decimal point in the matrix one place to the right.

[2]This reference reports only the criterion for consumption of aquatic organisms.

[3]Criterion is taken from the 1980 criterion for heptachlor. EPA's Office of Water has not developed criteria for heptachlor epoxide (EPA, 1993b).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 4: Protection of human health--Ambient surface water--*Continued*

Chemical name	(P)	(Q)			(R)	
	EPA ambient water-quality criteria, human health					
	Ingestion of (mg/L) (for carcinogens, values denote 10^{-6} excess cancer risk level)				Technical basis for most recent set of criteria	
	Water and aquatic organisms	Aquatic organisms only	Status	Reference	q_1* [(mg/kg)/d]$^{-1}$ or RfD [(mg/kg)/d] and BCF (3 percent lipids, L/kg fish)	Reference
MCPA	nsg	nsg	--	--	--	--
Methomyl	nsg	nsg	--	--	--	--
Methoxychlor	[1]0.1	nsg	F	EPA (1976; 1986a; 1991b; 1992b; [2]1993a,[2]b)	RfD = ([1]) BCF = ([3])	--
Methyl parathion	nsg	nsg	--	--	--	--
Metolachlor	nsg	nsg	--	--	--	--
Metribuzin	nsg	nsg	--	--	--	--
Mevinphos (Phosdrin)	nsg	nsg	--	--	--	--
Mirex	nsg	nsg	--	--	--	--
Molinate	nsg	nsg	--	--	--	--
Monuron	nsg	nsg	--	--	--	--
Nabam	nsg	nsg	--	--	--	--
Naled	nsg	nsg	--	--	--	--
Nitralin	nsg	nsg	--	--	--	--
Nitrofen	nsg	nsg	--	--	--	--
Oxamyl (Vydate)	nsg	nsg	--	--	--	--
Oxydemeton-methyl	nsg	nsg	--	--	--	--
Paraquat	nsg	nsg	--	--	--	--
Parathion	nsg	nsg	--	--	--	--

Footnotes:

[1]This criterion predates use of the reference dose (RfD) terminology. The value listed is based on the minimal- or no-effect level for humans, adjusted using a safety factor of 100 and assuming that 20 percent of exposure is from drinking water (EPA, 1976). The current RfD for this compound is shown in Table 3, Section 2, Column I.

[2]This reference incorrectly states that this criterion is the same as the drinking water standard (maximum contaminant level, MCL). The current MCL for this compound is 0.04 mg/L.

[3]Although a bioconcentration factor (BCF) was not used to derive the criterion shown, EPA (1992b) lists a BCF of 8,300 [(mg/kg)/d]$^{-1}$ for this compound.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 4: Protection of human health--Ambient surface water--*Continued*

Chemical name	(P)	(Q)			(R)	
	EPA ambient water-quality criteria, human health					
	Ingestion of (mg/L) (for carcinogens, values denote 10^{-6} excess cancer risk level)				Technical basis for most recent set of criteria	
	Water and aquatic organisms	Aquatic organisms only	Status	Reference	q_1* [(mg/kg)/d]$^{-1}$ or RfD [(mg/kg)/d] and BCF (3 percent lipids, L/kg fish)	Reference
Pentachlorophenol	[1]0.00028 [3]1.01	[1]0.0082 --	R,X F,S[3]	EPA (1992a; 1993a) ([2]) EPA (**1980j**,m; 1986a; 1991b; 1992b; 1993b)	q_1* = 0.12 BCF = 11	EPA (**1993a,b**) EPA (**1980j**; 1993a)
Permethrin	nsg	nsg	--	--	--	--
Phorate	nsg	nsg	--	--	--	--
Phosphamidon	nsg	nsg	--	--	--	--
Picloram	nsg	nsg	--	--	--	--
Prometon	nsg	nsg	--	--	--	--
Prometryn	nsg	nsg	--	--	--	--
Pronamide (propyzamide)	nsg	nsg	--	--	--	--
Propachlor	nsg	nsg	--	--	--	--
Propanil	nsg	nsg	--	--	--	--
Propazine	nsg	nsg	--	--	--	--
Propham	nsg	nsg	--	--	--	--
Pyrethrin (pyrethrum)	nsg	nsg	--	--	--	--
Rotenone	nsg	nsg	--	--	--	--
Simazine	nsg	nsg	--	--	--	--
Sulfallate	nsg	nsg	--	--	--	--
2,4,5-T	nsg	nsg	--	--	--	--
2,3,7,8-TCDD (dioxin)	[1 4]1.3x10^{-11}	[1 4]1.4x10^{-11}	F	EPA (**1984a**,b; 1986a; 1991b; 1992a,[5]c; 1993a)	q_1* = 156,000 BCF = [4]5,000	EPA (**1984a**; 1993a,e) EPA (**1984a**; 1992b; 1993a)

Footnotes:

[1]Criteria are based on carcinogenicity (10^{-6} risk). For a risk level of 10^{-5}, move the decimal point in the matrix one place to the right.

[2]Recalculated values in EPA (1991b) are incorrect. They were calculated based on the revised reference dose (RfD), rather than the cancer potency (q_1*, which is the standard procedure for a B2 carcinogen).

[3]The original criterion was based on toxicity data because pentachlorophenol was classified in Cancer Group D at that time (EPA, 1980j). This compound was subsequently reclassified as a B2 carcinogen, so the cancer potency (q_1*) value was used as the basis for revised criteria (EPA, 1993a).

[4]Criteria are based on EPA's best estimate of the bioconcentration factor (BCF) at that time. If the BCF is actually >5,000, then criteria will underestimate human exposure (EPA, 1984a).

[5]This reference reports only the criterion for consumption of aquatic organisms.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 4: Protection of human health--Ambient surface water--*Continued*

Chemical name	(P)	(Q)	(R)			
	EPA ambient water-quality criteria, human health					
	Ingestion of (mg/L) (for carcinogens, values denote 10^{-6} excess cancer risk level)				Technical basis for most recent set of criteria	
	Water and aquatic organisms	Aquatic organisms only	Status	Reference	q_1* [(mg/kg)/d]$^{-1}$ or RfD [(mg/kg)/d] and BCF (3 percent lipids, L/kg fish)	Reference
Tebuthiuron	nsg	nsg	--	--	--	--
TEPP	nsg	nsg	--	--	--	--
Terbacil	nsg	nsg	--	--	--	--
Terbufos	nsg	nsg	--	--	--	--
Thiobencarb	nsg	nsg	--	--	--	--
Thiram	nsg	nsg	--	--	--	--
Toxaphene (camphechlor)	[1]7.3×10^{-7}	[1]7.5×10^{-7}	R,X	EPA (1991b; 1992a; 1993a)	q_1* = 1.1	EPA (**1993a,b**)
	[1]7.1×10^{-7}	[1]7.3×10^{-7}	F	EPA (**1980k**,m; 1986a; 1991b)	BCF = 13,100	EPA (**1980k**; 1993a)
2,4,5-TP (silvex, fenoprop)	[2]0.01	nsg	F	EPA (1976; 1986a; 1991b; [3]1993b)	RfD = ([2])	--
	[4]0.05	nsg	R	EPA (1993a)	--	--
Trichlorfon	nsg	nsg	--	--	--	--
Trifluralin (Treflan)	nsg	nsg	--	--	--	--
Zectran (mexacarbate)	nsg	nsg	--	--	--	--
Zineb	nsg	nsg	--	--	--	--
Ziram	nsg	nsg	--	--	--	--

Footnotes:

[1]Criteria are based on carcinogenicity (10^{-6} risk). For a risk level of 10^{-5}, move the decimal point in the matrix one place to the right.

[2]This criterion predates use of the reference dose (RfD) terminology. The value listed is based on the no-observed-adverse-effect level (NOAEL) from a long-term dog study, which was adjusted using a safety factor of 500 and assuming that 20 percent of exposure is from drinking water (EPA, 1976). The current RfD for this compound is shown in Table 3, Section 2, Column I.

[3]IRIS (1993b) incorrectly states that this criterion is equivalent to the drinking water standard. The current maximum contaminant level (MCL) for this compound is 0.05 mg/L.

[4]Revised criterion is equivalent to the current MCL (EPA, 1993a).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 5: Protection of aquatic organisms--Ambient surface water

Chemical name	(S) EPA ambient water-quality criteria, aquatic organisms (mg/L)						(W) (X) NAS/NAE recommended maximum concentrations in water for protection of aquatic life (mg/L)		
	Freshwater		Saltwater		Status	References	Freshwater	Marine	References
	Acute	Chronic	Acute	Chronic					
Acifluorfen	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Alachlor	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Aldicarb	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Aldicarb sulfone	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Aldicarb sulfoxide	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Aldrin	[1]0.003	nsg	[1]0.0013	nsg	F	EPA (**1980a**,m; 1986a; 1991b; 1992a; 1993a,b)	1×10^{-5}	7.4×10^{-6}	NAS/NAE (**1973**)
Allethrin	nsg	nsg	nsg	nsg	--	--	2×10^{-6}	nsg	NAS/NAE (**1973**)
Ametryn (ametryne)	nsg	nsg	nsg	nsg	--	--	nsg	0.0001	NAS/NAE (**1973**)
Aminotriazole (amitrole)	nsg	nsg	nsg	nsg	--	--	0.3000	nsg	NAS/NAE (**1973**)
Atrazine	nsg	nsg	nsg	nsg	--	--	nsg	0.001	NAS/NAE (**1973**)
Baygon (propoxur)	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Benfluralin (benefin)	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Benomyl	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Bentazon (bentazone)	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
α-BHC (α-HCH, α-benzene hexachloride, α-hexachlorocyclohexane)	[2 3]0.1	nsg	[2 3]0.00034	nsg	I	EPA (1992b; 1993b)	nsg	nsg	--
β-BHC (β-HCH, β-benzene hexachloride, β-hexachlorocyclohexane)	[2 3]0.1	nsg	[2 3]0.00034	nsg	I	EPA (1993b)	nsg	nsg	--
γ-BHC (γ-HCH, lindane, γ-benzene hexachloride, γ-hexachlorocyclohexane)	[1]0.0020	$[1]8.0\times10^{-5}$	[1]0.00016	nsg	F	EPA (**1980i**,m; 1986a; 1991b; 1992a,b; 1993a,b)	2×10^{-5}	5×10^{-5}	NAS/NAE (**1973**)

Footnotes:

[1]Criteria were issued in 1980 utilizing EPA's 1980 Guidelines for criteria development (EPA, 1986a). Acute and chronic values shown are final acute values (FAVs) and final chronic values (FCVs), respectively. FAVs are intended to be interpreted as instantaneous maximum values, and FCVs as 24-hour average values. However, as an approximation, dividing the FAV in Column S or U by 2 yields a criterion maximum concentration (CMC). The FCV in Columns T and V can be used directly as approximating a criterion continuous concentration (CCC). EPA has not updated these criteria pursuant to the 1985 Guidelines.

[2]Value shown is not a criterion, but rather the lowest-observed-adverse-effect level (LOAEL). There were insufficient data to establish a criterion.

[3]Value shown is for a mixture of BHC isomers, published in 1980 (EPA, 1980i).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 5: Protection of aquatic organisms--Ambient surface water--*Continued*

Chemical name	(S) EPA ambient water-quality criteria, aquatic organisms (mg/L)		(T) EPA ambient water-quality criteria, aquatic organisms (mg/L)		(U) Status	(V) References	(W) NAS/NAE recommended maximum concentrations in water for protection of aquatic life (mg/L)		(X) References
	Freshwater		Saltwater				Freshwater	Marine	
	Acute	Chronic	Acute	Chronic					
δ-BHC, (δ-HCH, δ-benzene hexachloride, δ-hexachlorocyclohexane)	[1,2]0.1	nsg	[1,2]0.00034	nsg	I	EPA (1993b)	nsg	nsg	--
BHC, technical mixture (HCH, benzene hexachloride, hexachlorocyclohexane)	[1,2]0.1	nsg	[1,2]0.00034	nsg	I	EPA (**1980i**,m; 1986a)	nsg	2.8×10^{-5}	NAS/NAE (**1973**)
Bromacil	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Butachlor	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Butylate	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Captan	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Carbaryl	nsg	nsg	nsg	nsg	--	--	2×10^{-5}	6×10^{-5}	NAS/NAE (**1973**)
Carbofuran	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Carboxin	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Chloramben (amiben)	nsg	nsg	nsg	nsg	--	--	nsg	0.025	NAS/NAE (**1973**)
Chlordane	[3]0.0024	[3,4]4.3×10^{-6}	[3]9×10^{-5}	[3,4]4.0×10^{-6}	F	EPA (**1980b**,m; 1986a; 1991b; 1992a,b; 1993a,b)	4×10^{-5}	0.00018	NAS/NAE (**1973**)
Chlordecone (kepone)	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Chlorfenac (fenac)	nsg	nsg	nsg	nsg	--	--	[5]0.041	nsg	NAS/NAE (**1973**)
Chlorothalonil	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Chlorpyrifos (Dursban)	8.3×10^{-5}	4.1×10^{-5}	1.1×10^{-5}	5.6×10^{-6}	F	EPA (**1986a,c,g**; 1991b; [6]1992b; 1993a,b)	1×10^{-6}	1×10^{-7}	NAS/NAE (**1973**)
Coumaphos	nsg	nsg	nsg	nsg	--	--	1×10^{-6}	0.0011	NAS/NAE (**1973**)

Footnotes:

[1]Value shown is not a criterion, but rather the lowest-observed-adverse-effect level (LOAEL). There were insufficient data to establish a criterion.

[2]Value shown is for a mixture of BHC isomers, published in 1980 (EPA, 1980i).

[3]Criteria were issued in 1980 utilizing EPA's 1980 Guidelines for criteria development (EPA, 1986a). Acute and chronic values shown are final acute values (FAVs) and final chronic values (FCVs), respectively. FAVs are intended to be interpreted as instantaneous maximum values, and FCVs as 24-hour average values. However, as an approximation, dividing the FAV in Column S or U by 2 yields a criterion maximum concentration (CMC). The FCV in Columns T and V can be used directly as approximating a criterion continuous concentration (CCC). EPA has not updated these criteria pursuant to the 1985 Guidelines.

[4]Criterion based on marketability of fish (FDA action level).

[5]Freshwater value shown (as active ingredient) was calculated from criterion for chlorfenac sodium salt in NAS/NAE (1973).

[6]In this reference, the value listed for the acute saltwater criterion is incorrect.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 5: Protection of aquatic organisms--Ambient surface water--*Continued*

Chemical name	(S) EPA ambient water-quality criteria, aquatic organisms (mg/L)						(W) NAS/NAE recommended maximum concentrations in water for protection of aquatic life (mg/L)		
	Freshwater		Saltwater		Status	References	Freshwater	Marine	References
	Acute	Chronic	Acute	Chronic					
Crotoxyphos (ciodrin)	nsg	nsg	nsg	nsg	--	--	0.0001	nsg	NAS/NAE (**1973**)
Cyanazine	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
2,4-D	nsg	nsg	nsg	nsg	--	--	[1]0.003	[1]0.0074	NAS/NAE (**1973**)
Dacthal (DCPA, chlorthal-dimethyl	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Dalapon	nsg	nsg	nsg	nsg	--	--	0.1100	nsg	NAS/NAE (**1973**)
2,4-DB	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
p,p'-DDD (*p,p'*-TDE)	[2]0.0006	nsg	[2]0.0036	nsg	I	EPA (**1980d**,m; 1986a; 1991b)	6×10^{-6}	2.5×10^{-5}	NAS/NAE (**1973**)
p,p'-DDE	[2]1.05	nsg	[2]0.014	nsg	I	EPA (**1980d**,m; 1986a; 1991b; 1993b)	nsg	nsg	--
p,p'-DDT	[3 4]0.0011	[3 4 5]1.0×10^{-6}	[3 4]0.00013	[3 4 5]1.0×10^{-6}	F	EPA (**1980d**,m; 1986a; 1991b; 1992a,b; 1993a,b)	2×10^{-6}	1.2×10^{-6}	NAS/NAE (**1973**)
Demeton	nsg	0.0001	nsg	0.0001	F	EPA (**1976**; 1986a; 1991b; 1993a,b)	nsg	nsg	--
Diallate	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Diazinon	nsg	nsg	nsg	nsg	--	--	9×10^{-6}	nsg	NAS/NAE (**1973**)
1,2-dibromo-3-chloropropane (DBCP)	nsg	nsg	nsg	nsg	--	--	nsg	0.0078	NAS/NAE (**1973**)
Dicamba	nsg	nsg	nsg	nsg	--	--	0.2	nsg	NAS/NAE (**1973**)
Dichlobenil	nsg	nsg	nsg	nsg	--	--	0.0370	nsg	NAS/NAE (**1973**)
Dichlone	nsg	nsg	nsg	nsg	--	--	0.0002	nsg	NAS/NAE (**1973**)

Footnotes:

[1]Criteria shown are expressed as mg/L active ingredient. Freshwater value shown was calculated from criterion for butoxyethyl ester of 2,4-D in NAS/NAE (1973).

[2]Value shown is not a criterion, but rather the lowest-observed-adverse-effect level (LOAEL). There were insufficient data to establish a criterion.

[3]Criteria were issued in 1980 utilizing EPA's 1980 Guidelines for criteria development (EPA, 1986a). Acute and chronic values shown are final acute values (FAVs) and final chronic values (FCVs), respectively. FAVs are intended to be interpreted as instantaneous maximum values, and FCVs as 24-hour average values. However, as an approximation, dividing the FAV in Column S or U by 2 yields a criterion maximum concentration (CMC). The FCV in Columns T and V can be used directly as approximating a criterion continuous concentration (CCC). EPA has not updated these criteria pursuant to the 1985 Guidelines.

[4]Criteria apply to DDT and its metabolites (EPA, 1980d,m).

[5]Criterion is final residue value based on wildlife feeding study.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 5: Protection of aquatic organisms--Ambient surface water--*Continued*

Chemical name	(S) EPA ambient water-quality criteria, aquatic organisms (mg/L)						(W) (X) NAS/NAE recommended maximum concentrations in water for protection of aquatic life (mg/L)		
	Freshwater		Saltwater		Status	References	Freshwater	Marine	References
	Acute	Chronic	Acute	Chronic					
1,3-dichloropropene (DCP; 1,3-dichloropropylene; Telone II)	[1,2]6.06	[1,2]0.244	[1,2]0.79	nsg	I	EPA (**1980e**,m; 1986a; 1991b; [3]1993b)	nsg	nsg	--
Dichlorvos (DDVP)	nsg	nsg	nsg	nsg	--	--	1×10^{-6}	4×10^{-5}	NAS/NAE (**1973**)
Dieldrin	[4]0.0025	[4,5]1.9×10^{-6}	[4]0.00071	[4,5]1.9×10^{-6}	F	EPA (**1980a**,m; 1986a; 1991b; 1992a,b; 1993a,[3]b)	5×10^{-6}	9×10^{-6}	NAS/NAE (**1973**)
	[6]0.0003595	[6]6.51×10^{-5}	[6]0.0006594	[6]0.0001194	R,P	EPA (**1993f**)			
Dimethoate	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Dimethrin	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Dinoseb (2-sec-butyl-4, 6-dinitrophenol)	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Dioxathion	nsg	nsg	nsg	nsg	--	--	9×10^{-5}	6×10^{-5}	NAS/NAE (**1973**)
Diphenamid	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Diquat	nsg	nsg	nsg	nsg	--	--	0.0005	0.15	NAS/NAE (**1973**)
Disulfoton	nsg	nsg	nsg	nsg	--	--	5×10^{-5}	nsg	NAS/NAE (**1973**)
Diuron	nsg	nsg	nsg	nsg	--	--	0.0016	2×10^{-7}	NAS/NAE (**1973**)

Footnotes:

[1]Value shown is not a criterion, but rather the lowest-observed-adverse-effect level (LOAEL). There were insufficient data to establish a criterion.

[2]Value shown is for dichloropropenes as a class (CAS No. 26952-23-8, from EPA (1991b)).

[3]The freshwater acute value is incorrectly reported in IRIS (EPA, 1993b).

[4]Criteria were issued in 1980 utilizing EPA's 1980 Guidelines for criteria development (EPA, 1986a). Acute and chronic values shown are final acute values (FAVs) and final chronic values (FCVs), respectively. FAVs are intended to be interpreted as instantaneous maximum values, and FCVs as 24-hour average values. However, as an approximation, dividing the FAV in Column S or U by 2 yields a criterion maximum concentration (CMC). The FCV in Columns T and V can be used directly as approximating a criterion continuous concentration (CCC). EPA has not updated these criteria pursuant to the 1985 Guidelines.

[5]Criterion is based on marketability of fish (FDA action level).

[6]Revised values shown are FAVs and FCVs derived using new aquatic-toxicity data, as reported in EPA's proposed sediment-quality criteria document for this compound (EPA, 1993f). Using the 1985 Guidelines, the CMC would be one-half of the FAV, and the CCC would be equivalent to the FCV.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 5: Protection of aquatic organisms--Ambient surface water--*Continued*

Chemical name	(S) EPA ambient water-quality criteria, aquatic organisms (mg/L)						(W) (X) NAS/NAE recommended maximum concentrations in water for protection of aquatic life (mg/L)		
	Freshwater		Saltwater		Status	References	Freshwater	Marine	References
	Acute	Chronic	Acute	Chronic					
Endosulfan	[1]0.00022	[1]5.6×10^{-5}	[1]3.4×10^{-5}	[1]8.7×10^{-6}	F	EPA (**1980f**,m; 1986a; 1991b; 1993b)	3×10^{-6}	3.4×10^{-5}	NAS/NAE (**1973**)
α-endosulfan (endosulfan I)	[1]0.00022	[1]5.6×10^{-5}	[1]3.4×10^{-5}	[1]8.7×10^{-6}	F	EPA (1991b; 1992a; 1993a)	nsg	nsg	--
β-endosulfan (endosulfan II)	[1]0.00022	[1]5.6×10^{-5}	[1]3.4×10^{-5}	[1]8.7×10^{-6}	F	EPA (1991b; 1992a; 1993a)	nsg	nsg	--
Endosulfan sulfate	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Endothall (endothal)	nsg	nsg	nsg	nsg	--	--	nsg	0.125	NAS/NAE (**1973**)
Endrin	[1]0.00018	[1 2]2.3×10^{-6}	[1]3.7×10^{-5}	[1 2]2.3×10^{-6}	F	EPA (**1980g**,m; 1986a; 1991b; 1992a,[3]b; 1993a,b)	2×10^{-6}	5×10^{-7}	NAS/NAE (**1973**)
	[4]0.00019	[4]6.1×10^{-5}	[4]3.3×10^{-5}	[4]1.1×10^{-5}	R,P	EPA (**1993g**)			
Endrin aldehyde	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
EPN	nsg	nsg	nsg	nsg	--	--	6×10^{-5}	nsg	NAS/NAE (**1973**)
EPTC	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Ethion	nsg	nsg	nsg	nsg	--	--	2×10^{-5}	nsg	NAS/NAE (**1973**)
Ethylene dibromide (EDB)	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Ethylene thiourea (ETU)	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Famphur	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Fenamiphos	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Fenthion	nsg	nsg	nsg	nsg	--	--	6×10^{-6}	3.0×10^{-5}	NAS/NAE (**1973**)
Fenuron	nsg	nsg	nsg	nsg	--	--	nsg	0.0029	NAS/NAE (**1973**)
Ferbam	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--

Footnotes:

[1]Criteria were issued in 1980 utilizing EPA's 1980 Guidelines for criteria development (EPA, 1986a). Acute and chronic values shown are final acute values (FAVs) and final chronic values (FCVs), respectively. FAVs are intended to be interpreted as instantaneous maximum values, and FCVs as 24-hour average values. However, as an approximation, dividing the FAV in Column S or U by 2 yields a criterion maximum concentration (CMC). The FCV in Columns T and V can be used directly as approximating a criterion continuous concentration (CCC). EPA has not updated these criteria pursuant to the 1985 Guidelines.

[2]Criterion is based on marketability of fish (FDA action level).

[3]In this reference, the freshwater chronic and saltwater acute criteria reported are incorrect; values are reversed.

[4]Revised values shown are FAVs and FCVs that were derived using new aquatic-toxicity data, as reported in EPA's proposed sediment-quality-criteria document for this compound (EPA, 1993g). Using the 1985 Guidelines, the CMC would be one-half of the FAV, and the CCC would be equivalent to the FCV.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 5: Protection of aquatic organisms--Ambient surface water--*Continued*

Chemical name	(S) EPA ambient water-quality criteria, aquatic organisms (mg/L)		(T) EPA ambient water-quality criteria, aquatic organisms (mg/L)		(U) Status	(V) References	(W) NAS/NAE recommended maximum concentrations in water for protection of aquatic life (mg/L)		(X) References
	Freshwater		Saltwater				Freshwater	Marine	
	Acute	Chronic	Acute	Chronic					
Fluometuron	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Fluridone	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Folpet	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Fonofos	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Glyphosate	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Guthion (azinphos-methyl)	nsg	1×10^{-5}	nsg	1×10^{-5}	F	EPA (**1976**; 1986a; 1991b; 1993a)	1×10^{-6}	4.8×10^{-5}	NAS/NAE (**1973**)
Heptachlor	[1]0.00052	[1,2]3.8×10^{-6}	[1]5.3×10^{-5}	[1,2]3.6×10^{-6}	F	EPA (**1980h**,m; 1986a; 1991b; 1992a,b; 1993a,b)	1×10^{-5}	[3]8×10^{-6}	NAS/NAE (**1973**)
Heptachlor epoxide	[1]0.00052	[1,2]3.8×10^{-6}	[1]5.3×10^{-5}	[1,2]3.6×10^{-6}	F	EPA (1991b; 1992a,b; 1993a,b)	nsg	[3]8×10^{-6}	NAS/NAE (**1973**)
Hexachlorobenzene	[4,5]0.250	nsg	[4,5]0.16	[4,5]0.129	I	EPA (**1980c**,m)	nsg	nsg	--
	0.006	0.00368	nsg	nsg	P	EPA (**1990d**; 1991b; 1993b)			
Hexazinone	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Linuron	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Malathion	nsg	0.0001	nsg	0.0001	F	EPA (**1976**; 1986a; 1991b; 1993a,b)	8×10^{-6}	0.00027	NAS/NAE (**1973**)
Maleic hydrazide	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Maneb	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
MCPA	nsg	nsg	nsg	nsg	--	--	nsg	0.156	NAS/NAE (**1973**)
Methomyl	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--

Footnotes:

[1]Criteria were issued in 1980 utilizing EPA's 1980 Guidelines for criteria development (EPA, 1986a). Acute and chronic values shown are final acute values (FAVs) and final chronic values (FCVs), respectively. FAVs are intended to be interpreted as instantaneous maximum values, and FCVs as 24-hour average values. However, as an approximation, dividing the FAV in Column S or U by 2 yields a criterion maximum concentration (CMC). The FCV in Columns T and V can be used directly as approximating a criterion continuous concentration (CCC). EPA has not updated these criteria pursuant to the 1985 Guidelines.

[2]Criterion is based on marketability of fish (FDA action level).

[3]Marine criterion is for heptachlor and heptachlor epoxide.

[4]Value shown is not a criterion, but rather the lowest-observed-adverse-effect level (LOAEL). There were insufficient data to establish a criterion.

[5]LOAEL values shown are for the chlorinated benzenes as a class (EPA, 1980c,m). When the proposed criteria for hexachlorobenzene (EPA, 1990d) are promulgated in a final rule, they will supersede these LOAEL values.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 5: Protection of aquatic organisms--Ambient surface water--*Continued*

Chemical name	(S) EPA ambient water-quality criteria, aquatic organisms (mg/L)						(W) (X) NAS/NAE recommended maximum concentrations in water for protection of aquatic life (mg/L)		
	Freshwater		Saltwater		Status	References	Freshwater	Marine	References
	Acute	Chronic	Acute	Chronic					
Methoxychlor	nsg	3×10^{-5}	nsg	3×10^{-5}	F	EPA (**1976**; 1986a; 1991b; 1992b; 1993a,[1]b)	5×10^{-6}	4.4×10^{-6}	NAS/NAE (**1973**)
Methyl parathion	nsg	nsg	nsg	nsg	--	--	nsg	2×10^{-5}	NAS/NAE (**1973**)
Metolachlor	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Metribuzin	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Mevinphos (phosdrin)	nsg	nsg	nsg	nsg	--	--	2×10^{-6}	0.00011	NAS/NAE (**1973**)
Mirex	nsg	1×10^{-6}	nsg	1×10^{-6}	F	EPA (**1976**; 1986a; 1991b; 1992b; 1993a,[2]b)	nsg	1.0×10^{-5}	NAS/NAE (**1973**)
Molinate	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Monuron	nsg	nsg	nsg	nsg	--	--	nsg	0.0002	NAS/NAE (**1973**)
Nabam	nsg	nsg	nsg	nsg	--	--	nsg	0.001	NAS/NAE (**1973**)
Naled	nsg	nsg	nsg	nsg	--	--	4×10^{-6}	nsg	NAS/NAE (**1973**)
Nitralin	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Nitrofen	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Oxamyl (vydate)	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Oxydemeton-methyl	nsg	nsg	nsg	nsg	--	--	0.0004	nsg	NAS/NAE (**1973**)
Paraquat	nsg	nsg	nsg	nsg	--	--	nsg	0.05	NAS/NAE (**1973**)
Parathion	6.5×10^{-5}	1.3×10^{-5}	nsg	nsg	F	EPA (**1986a,d**,g; 1991b; 1993a,b)	4×10^{-7}.	0.0001	NAS/NAE (**1973**)
Pentachlorophenol	[3]0.020	[3]0.013	0.013	0.0079	F	EPA (**1986a,e**,g; 1991b; 1992a; 1993a,[4]b)([5])	nsg	nsg	--
Permethrin	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Phorate	nsg	nsg	nsg	nsg	--	--	nsg	5×10^{-5}	NAS/NAE (**1973**)

Footnotes:

[1]The saltwater chronic value reported in IRIS (EPA, 1993b) is incorrect.

[2]In IRIS (EPA, 1993b), chronic values were incorrectly reported as acute criteria (at any time).

[3]Freshwater aquatic-life criteria for this compound are pH-dependent. Values shown are for a pH of 7.8. Criteria are calculated as follows: Criteria maximum concentration (acute value, in µg/L)=exp[1.005(pH)-4.830]; criterion continuous concentration (chronic value, in µg/L)=exp[1.005(pH)-5.290].

[4]The acute freshwater value for pH 7.8 is reported incorrectly in IRIS (EPA, 1993b).

[5]All criteria reported in EPA (1992b) are incorrect; acute and chronic values are reversed, and the error in IRIS (see footnote 4) is repeated.

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 5: Protection of aquatic organisms--Ambient surface water--*Continued*

Chemical name	(S) EPA ambient water-quality criteria, aquatic organisms (mg/L)						(W) (X) NAS/NAE recommended maximum concentrations in water for protection of aquatic life (mg/L)		
	Freshwater		Saltwater		Status	References	Freshwater	Marine	References
	Acute	Chronic	Acute	Chronic					
Phosphamidon	nsg	nsg	nsg	nsg	--	--	3×10^{-5}	nsg	NAS/NAE (1973)
Picloram	nsg	nsg	nsg	nsg	--	--	nsg	0.5	NAS/NAE (1973)
Prometon	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Prometryn	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Pronamide (propyzamide)	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Propachlor	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Propanil	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Propazine	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Propham	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Pyrethrins (pyrethrum)	nsg	nsg	nsg	nsg	--	--	1×10^{-5}	nsg	NAS/NAE (1973)
Rotenone	nsg	nsg	nsg	nsg	--	--	0.0100	nsg	NAS/NAE (1973)
Simazine	nsg	nsg	nsg	nsg	--	--	0.0100	0.005	NAS/NAE (1973)
Sulfallate	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
2,4,5-T	nsg	nsg	nsg	nsg	--	--	nsg	[1]0.5	NAS/NAE (1973)
2,3,7,8-TCDD (dioxin)	[2 3]$<1\times10^{-5}$	[2 3]$<1\times10^{-8}$	nsg	nsg	I	EPA (1986a; 1991b)	nsg	nsg	--
Tebuthiuron	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
TEPP	nsg	nsg	nsg	nsg	--	--	0.0004	nsg	NAS/NAE (1973)
Terbacil	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Terbufos	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Thiobencarb	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Thiram	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--

Footnotes:

[1]Value is expressed in mg/L active ingredient (acid).

[2]Value shown is not a criterion, but rather the lowest-observed-adverse-effect level (LOAEL). There were insufficient data to establish a criterion.

[3]LOAEL values are not computed in the water-quality document for this compound (EPA, 1984a). Conclusions therein are: (1) There are insufficient data to determine criteria; (2) however, available data indicate that acute values for several freshwater species are >0.0010 mg/L; (3) the chronic value for rainbow trout is $<1\times10^{-6}$ mg/L; and (4) chronic values for several other species are $<1\times10^{-5}$ mg/L. The LOAEL values in EPA (1991b) probably were calculated by applying an uncertainty factor of 100 to these values. Because exposure of some species of fishes for <6 days resulted in substantial mortality several weeks later, derivation of aquatic-life criteria for this compound may require special consideration (EPA, 1984a,b). Concentrations greater than 1×10^{-8} mg/L should result in concentrations in edible fish and shellfish tissue that exceed FDA's health advisory (EPA, 1984a,b).

Table 3. Compilation of national standards and guidelines for pesticides in water--*Continued*

Section 5: Protection of aquatic organisms--Ambient surface water--*Continued*

Chemical name	(S) (T) (U) (V) EPA ambient water-quality criteria, aquatic organisms (mg/L)						(W) (X) NAS/NAE recommended maximum concentrations in water for protection of aquatic life (mg/L)		
	Freshwater		Saltwater		Status	References	Freshwater	Marine	References
	Acute	Chronic	Acute	Chronic					
Toxaphene	0.00073	[1 2 3]2×10^{-7}	0.00021	[2 3]2×10^{-7}	F	EPA (**1986a,f**,g; 1991b; 1992a; 1993a,b)	1×10^{-5}	7.8×10^{-5}	NAS/NAE (**1973**)
2,4,5-TP (silvex, fenoprop)	nsg	nsg	nsg	nsg	--	--	[4]0.0014	[4]0.0071	NAS/NAE (**1973**)
Triallate	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Trichlorfon	nsg	nsg	nsg	nsg	--	--	2×10^{-6}	0.01	NAS/NAE (**1973**)
Trifluralin	nsg	nsg	nsg	nsg	--	--	nsg	0.025	NAS/NAE (**1973**)
Zectran (mexacarbate)	nsg	nsg	nsg	nsg	--	--	0.0001	nsg	NAS/NAE (**1973**)
Zineb	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--
Ziram	nsg	nsg	nsg	nsg	--	--	nsg	nsg	--

Footnotes:

[1]Criterion may not protect channel catfish (EPA, 1986f,g).

[2]If the concentration exceeds the freshwater chronic or saltwater chronic value, then edible portions of consumed species should be analyzed to determine whether the concentration of toxaphene exceeds FDA's action level of 5 mg/L (EPA, 1986f,g).

[3]Criterion is based on marketability of fish (FDA action level).

[4]Value is expressed in mg/L active ingredient (acid). Freshwater value shown was calculated from criterion for 2-butoxy-1-methylethyl ester (polyethylene glycol butyl ether ester) of 2,4,5-TP reported in NAS/NAE (1973).

Table 4. Compilation of national guidelines for pesticides in bed sediment

Protection of benthic organisms

[**CAS No.**: Chemical Abstracts Services Registry Number. (This number is provided for ease of identifying compounds that may be known by multiple names.)
PP: priority pollutant status (EPA, 1992a; 1993a), N, no; Y, yes.
Freshwater and **Saltwater**: SQC, sediment-quality criterion, contaminant concentration in sediment (expressed in mg/kg-sediment-OC) that will not unacceptably affect benthic organisms, derived from final chronic value (contaminant concentration in water that will not result in unacceptable effects on aquatic organisms in the water column during 24-hour exposure), unless noted otherwise; 95 percent CL, 95-percent confidence limits.
Status codes: I, interim; P, proposed; R, revised from previous value; S, superseded by more recent value; T, tentative.
References: Boldface indicates that cited reference contains the technical basis for the corresponding draft guidelines.
Acronyms: EPA, U.S. Environmental Protection Agency; FDA, U.S. Food and Drug Administration. CL, confidence limits; SQC, sediment-quality criterion.
Abbreviations: mg/kg-sediment-OC, milligram per kilogram of sediment organic-carbon; nsg, no standard or guideline reported for this compound in the cited reference(s)]

Chemical name	CAS No.	PP	(Y) EPA draft sediment-quality criteria (mg/kg-sediment-OC)		(Z) EPA draft sediment-quality criteria (mg/kg-sediment-OC)		Status	References
			Freshwater		Saltwater			
			SQC	95-percent CL	SQC	95-percent CL		
γ-BHC (γ-HCH, lindane, γ-benzene hexachloride, γ-hexachlorocyclohexane)	58-89-9	Y	0.157	0.0394-0.636	nsg	nsg	I,S	EPA (1988d)
			0.430	0.0697-2.65	nsg	nsg	R,T	EPA (1990a)
Chlordane	57-74-9	Y	0.309	0.0355-2.76	0.0116	0.00134-0.104	T	EPA (1990a)
Chlorpyrifos (Dursban)	2921-88-2	N	3.22	0.831-12.7	0.440	0.114-1.73	I,S	EPA (1988d)
			1.75	0.271-11.6	0.239	0.0370-1.58	R,T	EPA (1990a)
p,p'-DDT	50-29-3	Y	[1]0.828	[1]0.183-3.80	[1]0.828	[1]0.183-3.80	I	EPA (1988d)
Dieldrin	60-57-1	Y	11	5.2-24	20	9.5-44	P	EPA (**1993f**; [2]1994)
Endosulfan	115-29-7	Y	0.330	0.0345-3.08	0.0512	0.00536-0.478	T	EPA (1990a)
Endrin	72-20-8	Y	4.2	2.0-9.1	0.76	0.35-1.6	P	EPA (**1993g**; [2]1994)
Heptachlor	76-44-8	Y	[1]0.110	[1]0.0148-0.840	[1]0.104	[1]0.0140-0.796	I	EPA (1988d)
Methyl parathion	298-00-0	N	0.0407	0.00692-0.245	0.0310	0.00526-0.187	T	EPA (1990a)
Parathion	56-38-2	N	0.0810	0.0160-0.416	nsg	nsg	I	EPA (1988d)
Toxaphene	8001-35-2	Y	0.0647	0.00726-0.551	0.349	0.039-2.97	T	EPA (1990a)

[1]Derived from final residue value (contaminant concentration in water that will protect wildlife that consume aquatic organisms and that will not result in tissue concentrations that exceed FDA action levels), rather than from final chronic value.
[2]This reference does not include 95-percent confidence limits.

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue

[**CAS No.**: Chemical Abstracts Services Registry Number. (This number is provided for ease of identifying compounds that may be known by multiple names.)
PP: Priority pollutant status (EPA, 1992a; 1993a), N,no; Y, yes.
Action level: FDA regulatory limit for contaminant residue in edible fish or shellfish for use in interstate commerce, in mg/kg-fish.
Status code: F, final.
Tolerance: EPA regulatory limit for contaminant residue in edible fish or shellfish, in mg/kg-fish.
References: Boldface indicates that cited reference contains the technical basis for the corresponding standards or guidelines.
Fish tissue concentration (FTC): EPA guideline indicating the contaminant concentration in edible fish and shellfish tissue associated with 10^{-6} cancer risk or without appreciable noncancer health risk. Assumes 70-kg body weight, consumption of 6.5 g/d of freshwater and estuarine fish or shellfish over a 70-year lifetime, and (for noncarcinogens) that fish and shellfish comprise 100 percent of exposure. Discrepancies between FTCs and screening values (SVs) occur because of different exposure assumptions and different cancer-risk levels.
FTC (mg/kg-fish): Applies to freshwater or estuarine fish and shellfish, edible portion only, wet weight.
Health basis for FTC: Based on either reference dose (RfD), for noncarcinogens, or cancer potency (q_1*), for carcinogens.
Screening value (SV): EPA guideline indicating the contaminant concentration in edible fish and shellfish tissue associated with 10^{-5} cancer risk or without appreciable noncancer health risk. Assumes 70-kg body weight, consumption of 6.5 g/d of freshwater and estuarine fish or shellfish over a 70-year lifetime, and (for noncarcinogens) that fish and shellfish comprise 80 percent of exposure. SVs have same health basis (RfD or q_1* value) as EPA FTCs, unless noted otherwise.
SV (mg/kg-fish): Screening value applies to freshwater or estuarine fish and shellfish, edible portion only, wet weight.
Recommended maximum tissue concentration: NAS/NAE guideline indicating the contaminant concentration in whole fish above which adverse effects on fish-eating wildlife may occur. Freshwater value applies to whole fish (wet weight); marine value applies to homogenate of 25 or more fish (wet weight) of any species consumed by fish-eating wildlife, within the size range consumed by fish-eating wildlife.
Acronyms: EPA, U.S. Environmental Protection Agency; FDA, Food and Drug Administration; NAS/NAE, National Academy of Sciences and National Academy of Engineering. FTC, fish tissue concentration, in mg/kg-fish; q_1*, cancer potency, also called oral slope factor, in $[(mg/kg)/d]^{-1}$; RfD, reference dose in (mg/kg)/d; SV, screening value, in mg/kg-fish.
Abbreviations: g/d, gram per day; kg, kilogram; mg/kg-fish, milligram per kilogram of fish or shellfish; (mg/kg)/d, milligram per kilogram of body weight per day; ng/kg-fish, nanogram per kilogram of fish or shellfish; nsg, no standard or guideline reported for this compound in this type of tissue; >, greater than; <, less than; --, no data]

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue--*Continued*

Section 1: Protection of human health--Edible fish and shellfish tissue

Chemical name	CAS No.	PP	(CC) FDA action levels				(DD) EPA tolerances			
			Type of tissue	Action level (mg/kg-fish)	Status	References	Type of tissue	Tolerance (mg/kg-fish)	Status	References
Aldrin	309-00-2	Y	Fish[1], shellfish	[2]0.3 [2]0.3	F F	FDA (1989; [3]1990; [3]1992)	--	nsg	--	--
α-BHC (α-HCH, α-benzene hexachloride, α-hexachlorocyclohexane)	319-84-6	Y	--	nsg	--	--	--	nsg	--	--
β-BHC (β-HCH, β-benzene hexachloride, α-hexachlorocyclohexane)	319-85-7	Y	--	nsg	--	--	--	nsg	--	--
γ-BHC (γ-HCH, lindane, γ-benzene hexachloride, γ-hexachlorocyclohexane)	58-89-9	Y	--	nsg	--	--	--	nsg	--	--
BHC, technical mixture (BHC, benzene hexachloride, hexachlorocyclohexane)	319-86-8	Y	--	nsg	--	--	--	nsg	--	--
Chlordane	57-74-9	Y	Fish[1], shellfish	[4]0.3 [4]0.3	F F	FDA (1989; [3]1990; [3]1992); EPA ([3]1992b)	--	nsg	--	--
Chlordecone (Kepone)	143-50-0	N	Fish[1], shellfish, crabmeat[5]	0.3 0.3 0.4	F F F	FDA (1989; [3]1990; 1992)	--	nsg	--	--

Footnotes:

[1]Edible portion; all action levels for fish also apply to shellfish (FDA, 1989).

[2]Action level applies to aldrin and dieldrin individually or in combination. In adding amounts of aldrin and dieldrin, do not count aldrin or dieldrin found at <0.1 mg/kg-fish.

[3]This reference does not specify that the action level also applies to shellfish.

[4]Action level applies to residues of chlordane, including *cis*- and *trans*-chlordane, *cis*- and *trans*-nonachlor, oxychlordane, α-, β-, and γ-chlordene and chlordene. Levels of individual components must be quantitated at 0.02 mg/kg-fish or above to be added into the total chlordane value. If the gas liquid chromotography pattern of the residue matches that of technical chlordane, quantitate against a technical chlordane standard. If the residue consists of identifiable individual components (listed above), quantitate individual components against their respective standards. Do not include levels of heptachlor epoxide in the summation.

[5]Edible portion.

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue--*Continued*

Section 1: Protection of human health--Edible fish and shellfish tissue--*Continued*

Chemical name	CAS No.	PP	(CC) FDA action levels				(DD) EPA tolerances			
			Type of tissue	Action level (mg/kg-fish)	Status	References	Type of tissue	Tolerance (mg/kg-fish)	Status	References
2,4-D	94-75-7	N	--	nsg	--	--	Fish[1]	1.0	F	([2])
							Shellfish[1]	1.0	F	([2])
							Fish[3]	1.0	F	([4])
p,p'-DDD (*p,p'*-TDE)	72-54-8	Y	Fish[5],	[6]5	F	FDA (1989; [7]1990;	--	nsg	--	--
			shellfish	[6]5	F	[7]1992); EPA ([7]1992b)				
p,p'-DDE	72-55-9	Y	Fish[5],	[6]5	F	FDA (1989; [7]1990;	--	nsg	--	--
			shellfish	[6]5	F	[7]1992); EPA ([7]1992b)				
p,p'-DDT	50-29-3	Y	Fish[5],	[6]5	F	FDA (1989; [7]1990;	--	nsg	--	--
			shellfish	[6]5	F	[7]1992); EPA ([7]1992b)				
Dibromochloropropane (DBCP)	96-12-8	N	--	nsg	--	--	--	nsg	--	--
1,3-dichloropropene (DCP, 1,3-dichloropropylene, Telone II)	542-75-6	Y	--	nsg	--	--	--	nsg	--	--
Dieldrin	60-57-1	Y	Fish[5],	[8]0.3	F	FDA (1989; [7]1990;	--	nsg	--	--
			shellfish	[8]0.3	F	[7]1992); EPA ([7]1992b)				
Dimethoate	60-51-5	N	--	nsg	--	--	--	nsg	--	--
Dinoseb (2-sec-butyl-4,6-dinitrophenol)	88-85-7	N	--	nsg	--	--	--	nsg	--	--

Footnotes:

[1]Tolerance applies to use of dimethylamine salt for water hyacinth control in slow-moving or quiescent water bodies by Federal, State, or local public agencies.

[2]Code of Federal Regulations, v. 40, Part 180.142(f).

[3]Tolerance applies to use of dimethylamine salt or its butoxyethanol ester for Eurasian watermilfoil control in Tennessee Valley Authority programs.

[4]Code of Federal Regulations, v. 40, Part 180.142(i).

[5]Edible portion; all action levels for fish also apply to shellfish (FDA, 1989).

[6]Action level applies to residues of DDT, DDE, or DDD, individually or in combination. In adding amounts of DDT, DDE, and DDD, do not count any of the three detected at <0.2 mg/kg-fish.

[7]This reference does not specify that the action level also applies to shellfish.

[8]Action level applies to aldrin and dieldrin individually or in combination. In adding amounts of aldrin and dieldrin, do not count aldrin or dieldrin detected at <0.1 mg/kg-fish.

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue--*Continued*

Section 1: Protection of human health--Edible fish and shellfish tissue--*Continued*

Chemical name	CAS No.	PP	(CC) FDA action levels				(DD) EPA tolerances			
			Type of tissue	Action level (mg/kg-fish)	Status	References	Type of tissue	Tolerance (mg/kg-fish)	Status	References
Diquat	2764-72-9	N	--	nsg	--	--	Fish[1],	[2]0.1	F	([3])
						--	shellfish[1]	[2]0.1	F	([3])
Disulfoton	298-04-4	N	--	nsg	--	--	--	nsg	--	--
Endosulfan	115-29-7	Y	--	nsg	--	--	--	nsg	--	--
α-endosulfan (endosulfan I)	959-98-8	Y	--	nsg	--	--	--	nsg	--	--
β-endosulfan (endosulfan II)	33213-65-9	Y	--	nsg	--	--	--	nsg	--	--
Endrin	72-20-8	Y	Fish[4],	0.3	F	FDA (1989; [5]1990;	--	nsg	--	--
			shellfish	0.3	F	[5]1992); EPA ([5]1992b)				
Endrin aldehyde	7421-93-4	Y	--	nsg	--	--	--	nsg	--	--
Ethylene dibromide (EDB)	106-93-4	N	--	nsg	--	--	--	nsg	--	--
Famphur	52-85-7	N	--	nsg	--	--	--	nsg	--	--
Fluridone	59756-60-4	N	--	nsg	--	--	Fish[6],	[7]0.5	F	([8])
							crayfish[6]	[7]0.5	F	([8])
Glyphosate	1071-83-6	N	--	nsg	--	--	Fish[9],	[10]0.25	F	([11])
							shellfish[9]	[10]3.0	F	([11])

Footnotes:

[1]Tolerance applies to use of dibromide salt to slow-moving or quiescent water bodies in programs of Federal or State public agencies, or to ponds, lakes, and drainage ditches with little or no outflow of water and which are totally under the control of the user.

[2]Calculated as the cation.

[3]Code of Federal Regulations, v. 40, Part 180.226(b).

[4]Edible portion; all action levels for fish also apply to shellfish (FDA, 1989).

[5]This reference does not specify that the action level also applies to shellfish.

[6]Applications are unspecified.

[7]For the combined residues (free and bound) of fluridone.

[8]Code of Federal Regulations, v. 40, Part 180.42(a).

[9]Of glyphosate isopropylamine salt and glyphosate monoammonium salt for herbicidal and plant growth regulator purposes and (or) the sodium sesqui salt for growth regulator purposes.

[10]For the combined residues of glyphosate and its metabolite, aminomethyl-phosphonic acid.

[11]Code of Federal Regulations, v. 40, Part 180.364(b).

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue--*Continued*

Section 1: Protection of human health--Edible fish and shellfish tissue--*Continued*

Chemical name	CAS No.	PP	(CC) FDA action levels				(DD) EPA tolerances			
			Type of tissue	Action level (mg/kg-fish)	Status	References	Type of tissue	Tolerance (mg/kg-fish)	Status	References
Heptachlor	76-44-8	Y	Fish[1],	[2]0.3	F	FDA (1989; [3]1992)([4])	--	nsg	--	--
			shellfish	[2]0.3	F					
Heptachlor epoxide	1024-57-3	Y	Fish[1],	[2]0.3	F	FDA (1989; [3]1992)([4])	--	nsg	--	--
			shellfish	[2]0.3	F					
Hexachlorobenzene	118-74-1	Y	--	nsg	--	--	--	nsg	--	--
Methoxychlor	72-43-5	N	--	nsg	--	--	--	nsg	--	--
Methyl parathion	298-00-0	N	--	nsg	--	--	--	nsg	--	--
Mirex	2385-85-5	N	Fish[1],	0.1	F	FDA (1989; [3]1990;	--	nsg	--	--
			shellfish	0.1	F	[3]1992; EPA ([3]1992b)				
Parathion	56-38-2	N	--	nsg	--	--	--	nsg	--	--
Pentachlorophenol	87-86-5	Y	--	nsg	--	--	--	nsg	--	--
Phorate	298-02-2	N	--	nsg	--	--	--	nsg	--	--
Pronamide (propyzamide)	23950-58-5	N	--	nsg	--	--	--	nsg	--	--
Simazine	122-34-9	N	--	nsg	--	--	Fish[5]	[6]12	F	([7])
2,4,5-T	93-76-5	N	--	nsg	--	--	--	nsg	--	--
2,3,7,8-TCDD (dioxin)	1746-01-6	Y	--	([8])	--	--	--	nsg	--	--
Toxaphene	8001-35-2	Y	Fish[1],	5.0	F	FDA (1989; [3]1990; [3]1992)	--	nsg	--	--
			shellfish	5.0	F					
2,4,5-TP (silvex, fenoprop)	93-72-1	N	--	nsg	--	--	--	nsg	--	--

Footnotes:

[1]Edible portion; all action levels in fish also apply to shellfish (FDA, 1989).

[2]Action level applies to heptachlor and heptachlor epoxide individually or in combination. Do not count heptachlor or heptachlor epoxide detected at <0.1 mg/kg-fish.

[3]This reference does not specify that the action level also applies to shellfish (FDA, 1989).

[4]Action level for fish reported in FDA (1990) and EPA (1992b) is incorrect (Sonia Delgado, Food and Drug Administration, Center for Food Safety and Applied Nutrition, personal commun., 1992; John Wessel, Food and Drug Administration, Office of Regulatory Affairs, personal commun., 1992). These references also do not report an action level for this compound in shellfish.

[5]Applications are unspecified.

[6]For the combined residues of simazine and its metabolites, 2-amino-4-chloro-6-ethylamino-*s*-triazine and 2,4-diamino-6-chloro-*s*-triazine.

[7]Code of Federal Regulations, v. 40, Part 180.213(a).

[8]FDA issued an advisory opinion on the public health significance of TCDD contamination levels in Great Lakes fish (FDA, 1981). For average contamination levels: <25 ng/kg-fish, little cause for concern; 25-50 ng/kg-fish, sport fisherman who consume fish from these areas only a few times per year should limit consumption to 1 meal per week, and local residents who consume these fish over the entire year, to 1-2 meals per month; >50 ng/kg-fish, the State should consider limiting the taking of fish from these areas. This is a guideline, not a formal action level, although it was reported in EPA (1992b) as an FDA health advisory for fish.

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue--*Continued*

Section 2: Protection of human health--Edible fish and shellfish tissue

Chemical name	(EE) EPA fish tissue concentrations (for carcinogens, values denote 10^{-6} excess cancer risk level)			(GG) EPA recommended screening values (for carcinogens, values denote 10^{-5} excess cancer risk level)	
	FTC (mg/kg-fish)	Health basis for FTC (RfD or q_1*)	References	SV (mg/kg-fish)	References
Aldrin	[1]0.000654	q_1* = 17	EPA (**1993a**)	nsg	--
α-BHC (α-HCH, α-benzene hexachloride, α-hexachlorocyclohexane)	[1]0.0017	q_1* = 6.3	EPA (**1993a**)	nsg	--
β-BHC (β-HCH, β-benzene hexachloride, α-hexachlorocyclohexane)	[1]0.006	q_1* = 1.8	EPA (**1993a**)	nsg	--
γ-BHC (γ-HCH, lindane, γ-benzene hexachloride, γ-hexachlorocyclohexane)	[1]0.0081	q_1* = [2]1.3	EPA (1993a)	[3]0.08	EPA (**1993e**)
BHC, technical mixture (BHC, benzene hexachloride, hexachlorocyclohexane)	nsg	--	--	nsg	--
Chlordane	[1]0.0083	q_1* = 1.3	EPA (**1993a**)	[3]0.08	EPA (**1993e**)
Chlordecone (Kepone)	nsg	--	--	nsg	--
2,4-D	nsg	--	--	nsg	--
p,p'-DDD (*p,p'*-TDE)	[1]0.0449	q_1* = 0.24	EPA (**1993a**)	[3 4]0.3	EPA (**1993e**)
p,p'-DDE	[1]0.0316	q_1* = 0.34	EPA (**1993a**)	[3 4]0.3	EPA (**1993e**)
p,p'-DDT	[1]0.0316	q_1* = 0.34	EPA (**1993a**)	[3 4]0.3	EPA (**1993e**)
1,2-dibromo-3-chloropropane (DBCP)	nsg	--	--	nsg	--

Footnotes:

[1]Based on carcinogenicity at 10^{-6} risk level.

[2]No carcinogenic potency (q_1*) value is reported in EPA (1993a). However, the fish tissue concentration (FTC) value in EPA (1993a) corresponds to a q_1* value of 1.3 $[(mg/kg)/d]^{-1}$, which was reported in EPA (1980i; 1992b; 1993e).

[3]Based on carcinogenicity at 10^{-5} risk level.

[4]Applies to total residues of *p,p'*- and *o,p'* -isomers of DDT, DDE, and DDD. Screening value (SV) is based on the q_1* value for DDE and DDT (0.34 $[(mg/kg)/d]^{-1}$.

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue--*Continued*

Section 2: Protection of human health--Edible fish and shellfish tissue--*Continued*

Chemical name	(EE) EPA fish tissue concentrations (for carcinogens, values denote 10^{-6} excess cancer risk level)			(GG) EPA recommended screening values (for carcinogens, values denote 10^{-5} excess cancer risk level)	
	FTC (mg/kg-fish)	Health basis for FTC (RfD or q_1*)	References	SV (mg/kg-fish)	References
1,3-dichloropropene (DCP; 1,3-dichloropropylene, Telone II)	[1]3.23	RfD = 0.0003	EPA (**1993a**)	nsg	--
Dieldrin	[2]0.00067	q_1* = 16	EPA (**1993a**)	[3]0.007	EPA (**1993e**)
Dimethoate	nsg	--	--	nsg	--
Dinoseb (2-sec-butyl-4,6-dinitrophenol)	nsg	--	--	nsg	--
Diquat	nsg	--	--	nsg	--
Disulfoton	nsg	--	--	nsg	--
Endosulfan	nsg	--	--	[45]20	EPA (**1993e**)
α-endosulfan (endosulfan I)	42.93	RfD = [56]0.004	EPA (**1993a**)	[45]20	EPA (**1993e**)
β-endosulfan (endosulfan II)	42.93	RfD = [56]0.004	EPA (**1993a**)	[45]20	EPA (**1993e**)
Endrin	3.23	RfD = 0.0003	EPA (**1993a**)	3	EPA (**1993e**)
Endrin aldehyde	3.23	RfD = 0.0003	EPA (**1993a**)	nsg	--
Ethylene dibromide (EDB)	nsg	--	--	nsg	--
Famphur	nsg	--	--	nsg	--
Fluridone	nsg	--	--	nsg	--
Glyphosate	nsg	--	--	nsg	--
Heptachlor	[2]0.0024	q_1* = 4.5	EPA (**1993a**)	nsg	--
Heptachlor epoxide	[2]0.0012	q_1* = 9.1	EPA (**1993a**)	[3]0.01	EPA (**1993e**)

Footnotes:

[1]The fish tissue concentration (FTC) value reported is based on the reference dose (RfD), although this compound is a B2 carcinogen (EPA, 1993b). Standard procedure for a B2 carcinogen is to base human-health criteria (and the associated fish tissue concentrations) on cancer potency (q_1*). IRIS (EPA, 1993b) lists this compound as a B2 carcinogen, but does not report an oral q_1* value. When human-health criteria were recalculated using current information in IRIS, the revised RfD was used (EPA, 1993a). This is inconsistent with the drinking-water health advisory for this compound issued by the same office (Office of Science and Technology in EPA's Office of Water), which reports an oral q_1* value of 0.175 $[(mg/kg)/d]^{-1}$ and cancer risk estimates based on this q_1* value (EPA, 1988a; 1989b).

[2]Based on carcinogenicity at 10^{-6} risk level.

[3]Based on carcinogenicity at 10^{-5} risk level.

[4]Applies to the sum of α- and β-isomers. The technical basis for this screening value is RfD of 1.5×10^{-3} (mg/kg)/d, which is cited in EPA (1993e) as being from a 1993 "Reference Dose List" from EPA's Office of Pesticide Programs. This RfD value was listed in EPA (1993l), which was superseded by EPA (1993d).

[5]The RfD for endosulfan was withdrawn in 1992 and a revised assessment is pending (EPA, 1993b).

[6]This RfD value is from EPA (1980f).

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue--*Continued*

Section 2: Protection of human health--Edible fish and shellfish tissue--*Continued*

Chemical name	(EE) EPA fish tissue concentrations (for carcinogens, values denote 10^{-6} excess cancer risk level)			(GG) EPA recommended screening values (for carcinogens, values denote 10^{-5} excess cancer risk level)	
	FTC (mg/kg-fish)	Health basis for FTC (RfD or q_1*)	References	SV (mg/kg-fish)	References
Hexachlorobenzene	[1]0.00673	q_1* = [2]1.6	EPA (**1993a**)	[2 3]0.07	EPA (**1993e**)
Methoxychlor	nsg	--	--	nsg	--
Methyl parathion	nsg	--	--	nsg	--
Mirex	nsg	--	--	[4]2	EPA (**1993e**)
Parathion	nsg	--	--	nsg	--
Pentachlorophenol	[1]0.09	q_1* = 0.12	EPA (**1993a**)	nsg	--
Phorate	nsg	--	--	nsg	--
Pronamide (propyzamide)	nsg	--	--	nsg	--
Simazine	nsg	--	--	nsg	--
2,4,5-T	nsg	--	--	nsg	--
2,3,7,8-TCDD (dioxin)	[1]7×10^{-8}	q_1* = 156,000	EPA (**1993a**)	[3]7×10^{-7}	EPA (**1993e**)
Toxaphene (camphechlor)	[1]0.0098	q_1* = 1.1	EPA (**1993a**)	[3]0.1	EPA (**1993e**)
2,4,5-TP (silvex, fenoprop)	nsg	--	--	nsg	--

Footnotes:

[1]Based on carcinogenicity at 10^{-6} risk level.

[2]Fish tissue concentration (FTC) and screening value (SV) are based on the updated cancer potency (q_1*) of 1.6 $[(mg/kg)/d]^{-1}$, which is reported in EPA (1992a; 1993a). The q_1* value used to derive the published human-health criteria in EPA (1980c) is 1.688 $[(mg/kg)/d]^{-1}$.

[3]Based on carcinogenicity at 10^{-5} risk level.

[4]The SV is based on a reference dose (RfD) of 2×10^{-4} (mg/kg)/d (EPA, 1993e).

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue

Section 3: Protection of fish-eating wildlife--Whole fish tissue

Chemical name	(HH) (II) NAS/NAE recommended maximum tissue concentrations (mg/kg-fish)		
	Freshwater	Marine	References
Aldrin	[1]0.1	[2]0.005	NAS/NAE (1973)
α-BHC (α-HCH, α-benzene hexachloride, α-hexachlorocyclohexane)	nsg	nsg	--
β-BHC (β-HCH, β-benzene hexachloride, β-hexachlorocyclohexane)	nsg	nsg	--
γ-BHC (γ-HCH, lindane, γ-benzene hexachloride, γ-hexachlorocyclohexane)	[1]0.1	0.05	NAS/NAE (1973)
BHC, technical mixture (HCH, benzene hexachloride, hexachlorocyclohexane)	[1]0.1	nsg	NAS/NAE (1973)
Chlordane	[1]0.1	0.05	NAS/NAE (1973)
Chlordecone	nsg	nsg	--
2,4-D	nsg	nsg	--
p,p'-DDD (*p,p'*-TDE)	[3]1.0	[4]0.05	NAS/NAE (1973)
p,p'-DDE	[3]1.0	[4]0.05	NAS/NAE (1973)
p,p'-DDT	[3]1.0	[4]0.05	NAS/NAE (1973)
1,2-dibromo-3-chloropropane (DBCP)	nsg	nsg	--
1,3-dichloropropene (DCP; 1,3-dichloropropylene; Telone II)	nsg	nsg	--
Dieldrin	[1]0.1	[2]0.005	NAS/NAE (1973)
Dimethoate	nsg	nsg	--
Dinoseb (2-sec-butyl-4,6-dinitrophenol)	nsg	nsg	--
Diquat	nsg	nsg	--
Disulfoton	nsg	nsg	--
Endosulfan	[1]0.1	0.05	NAS/NAE (1973)
α-endosulfan (endosulfan I)	nsg	nsg	NAS/NAE (1973)
β-endosulfan (endosulfan II)	nsg	nsg	NAS/NAE (1973)
Endrin	[1]0.1	[2]0.005	NAS/NAE (1973)
Endrin aldehyde	nsg	nsg	--
Ethylene dibromide (EDB)	nsg	nsg	--
Famphur	nsg	nsg	--

Footnotes:

[1]Applies to total residues for aldrin, BHC, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, lindane, and toxaphene, either singly or in combination.

[2]Applies to the sum of the concentrations of aldrin, dieldrin, endrin, and heptachlor epoxide.

[3]Applies to total DDT residues, including DDE and DDD.

[4]Applies to total residues of *p,p'*- and *o,p'*-isomers of DDT, DDE, and DDD.

Table 5. Compilation of national standards and guidelines for pesticides in fish and shellfish tissue

Section 3: Protection of fish-eating wildlife--Whole fish tissue--*Continued*

Chemical name	(HH) (II) NAS/NAE recommended maximum tissue concentrations (mg/kg-fish)		
	Freshwater	Marine	References
Fluridone	nsg	nsg	--
Glyphosate	nsg	nsg	--
Heptachlor	[1]0.1	nsg	NAS/NAE (1973)
Heptachlor epoxide	[1]0.1	[2]0.005	NAS/NAE (1973)
Hexachlorobenzene	nsg	0.05	NAS/NAE (1973)
Methoxychlor	nsg	0.05	NAS/NAE (1973)
Methyl parathion	nsg	nsg	--
Mirex	nsg	0.05	NAS/NAE (1973)
Parathion	nsg	nsg	--
Pentachlorophenol	nsg	nsg	--
Phorate	nsg	nsg	--
Pronamide (propyzamide)	nsg	nsg	--
Simazine	nsg	nsg	--
2,4,5-T	nsg	nsg	--
2,3,7,8-TCDD (dioxin)	nsg	nsg	--
Toxaphene (camphechlor)	[1]0.1	0.05	NAS/NAE (1973)
2,4,5-TP (silvex, fenoprop)	nsg	nsg	--

Footnotes:

[1]Applies to total residues for aldrin, BHC, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, lindane, and toxaphene, either singly or in combination.

[2]Applies to the sum of the concentrations of aldrin, dieldrin, endrin, and heptachlor epoxide.

Table 6. U.S. Environmental Protection Agency proposed water-quality criteria for the Great Lakes system

[All criteria are from EPA's proposed guidance to Great Lakes States and Tribes in EPA (1993k). Units are provided as in the original reference.
Human-health criteria: Contaminant concentrations (in ng/L) that are protective of human health. Determined for noncarcinogenic (toxic) effects (human noncancer values) and carcinogenic effects (human cancer values) for two different exposure assumptions: Drinking, exposure is from recreational activities, consumption of drinking water and fish; nondrinking, exposure is from recreational activities and consumption of fish only. Assumes 70-kg body weight, consumption of 2-liters drinking water and 15 grams of fish per day and incidental consumption of 0.1-liter water through recreational exposure over a 70-year lifetime, and that 80 percent of exposure is from surface-water pathways (water and fish). For carcinogens, criteria are derived for 10^{-5} cancer risk.
Aquatic-life criteria: Contaminant concentrations (in µg/L) that are protective of aquatic life. Determined for short-term (acute, or CMC) and long-term (chronic, or CCC) exposures. Criteria do not necessarily protect marketability of fish or wildlife that consume fish.
Wildlife criteria: Contaminant concentrations (in pg/L) that are protective of wildlife that consume Great Lakes fish.
Acronyms: CCC, criterion continuous concentration. CMC, criterion maximum concentration. EPA, U.S. Environmental Protection Agency.
Abbreviations: kg, kilogram; ng/L, nanogram per liter; pg/L, picogram per liter; µg/L, microgram per liter. nsg, no standard or guideline reported for this compound]

Chemical name	Human-health criteria (ng/L)				Aquatic-life criteria (µg/L)		Wildlife criteria (pg/L)
	Human noncancer value		Human cancer value (values denote 10^{-5} excess cancer risk level)		CMC (acute)	CCC (chronic)	
	Drinking	Nondrinking	Drinking	Nondrinking			
γ-BHC (γ-HCH, lindane, γ-benzene hexachloride, γ-hexachlorocyclohexane)	700	800	nsg	nsg	0.95	nsg	nsg
Chlordane	9	9	0.2	0.2	nsg	nsg	nsg
p,p'-DDT	1.0	1.0	0.07	0.07	nsg	nsg	[1]0.87
Dieldrin	7	7	0.1	0.1	0.24	0.056	nsg
Endrin	nsg	nsg	nsg	nsg	0.09	0.037	nsg
Heptachlor	300	300	0.5	0.5	nsg	nsg	nsg
Hexachlorobenzene	10	10	0.1	0.1	nsg	nsg	nsg
Parathion	nsg	nsg	nsg	nsg	0.065	0.013	nsg
Pentachlorophenol	2×10^{-5}	2×10^{-5}	500	600	[2]5.3	[2]3.3	nsg
2,3,7,8-TCDD (dioxin)	1×10^{-4}	1×10^{-4}	1×10^{-5}	1×10^{-5}	nsg	nsg	0.0096
Toxaphene	6	6	0.02	0.02	nsg	nsg	nsg

[1]Applies to DDT and metabolites.
[2]Criterion is pH-dependent; value given is for pH 6.5.

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