# Appendix 3— Water-quality benchmarks for pesticide compounds that exceeded one or more benchmarks in NAWQA samples.

**Table A.** Water-quality benchmarks for pesticide compounds that exceeded one or more benchmarks in NAWQA water samples.

[For pesticide compounds in water, benchmarks are for protection of human health and aquatic life. This table includes only those pesticide compounds that exceeded one or more benchmarks in NAWQA water samples; for these compounds, all benchmark values that were compared with concentrations in water are listed here. The complete set of benchmarks used for all pesticide compounds analyzed by NAWQA is available at *http://ca.water.usgs.gov/pnsp/pubs/circ1291/*. Common synonyms are listed in parentheses in column 1. OPP references are listed by number at the end of Appendix 3. Environmental concentration, the measured or calculated concentration statistic that is appropriate for comparison with the benchmark; CRC($10^{-6}$), $10^{-6}$ cancer risk concentration; $EC_{50}$, 50 percent effect concentration; EFED, Environmental Fate and Effects Division; USEPA, U.S. Environmental Protection Agency; HA-L, lifetime health advisory; IRED, Interim Reregistration Eligibility Decision; IRIS, Integrated Risk Information System database; $LC_{50}$, 50 percent lethal concentration; LOC, level of concern; MCL, maximum contaminant level; NOAEC, no-observed-adverse-effects concentration; OPP, Office of Pesticide Programs; RED, Reregistration Eligibility Decision; µg/L, microgram sper liter; >, greater than; <, less than; —, no benchmark available.]

| Pesticide compound (synonym) | Human-health benchmarks (µg/L) | | Aquatic-life benchmarks (µg/L) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Derived from USEPA drinking-water standards and guidelines (Office of Water) | | Derived from USEPA ambient water-quality criteria for aquatic life (Office of Water) | | Derived from USEPA Reregistration Eligibility Decisions and ecological risk assessments (Office of Pesticide Programs) | | | | | | | |
| | Value [1] | Type | Acute [2] | Chronic [2] | Acute fish [3] | Chronic fish [4] | Acute invertebrates [5] | Chronic invertebrates [6] | Acute nonvascular plants [7] | Acute vascular plants [8] | Aquatic community effects [9] | OPP references |
| **Environmental concentration (µg/L):** | **Time-weighted annual mean** | | **Each individual sample** | **4-day moving average** | **Each individual sample** | **60-day moving average** | **Each individual sample** | **21-day moving average** | **Each individual sample** | **Each individual sample** | **60-day moving average** | |
| **Amides** | | | | | | | | | | | | |
| Alachlor | 2 | MCL | — | — | 900 | 187 | 1,600 | 110 | 1.64 | — | — | (3) |
| **Carbamates** | | | | | | | | | | | | |
| Carbaryl | 700 | HA-L | — | — | [10] 125 | [10] 210 | 2.55 | 1.5 | 1,100 | — | — | (4, 5) |
| Carbofuran | 40 | MCL | — | — | 44 | 5.7 | 1.115 | 0.75 | — | — | — | (6) |
| Methomyl | 200 | HA-L | — | — | 265 | 57 | 4.4 | [11] 0.4 | — | — | — | (7) |
| Molinate | — | — | — | — | 105 | [12] 210 | 170 | [12] 340 | 220 | 3,300 | — | (8) |
| Thiobencarb | — | — | — | — | 280 | — | 50 | 1.0 | 17 | 770 | — | (9) |
| **Nitrophenols** | | | | | | | | | | | | |
| Dinoseb | 7 | MCL | — | — | — | — | — | — | — | — | — | — |
| **Organochlorines** | | | | | | | | | | | | |
| *p,p'*-DDE | [13] 0.1 | CRC($10^{-6}$) | [14] 1.1 | [14] 0.001 | — | — | — | — | — | — | — | — |
| Dieldrin | 0.002 | CRC($10^{-6}$) | 0.24 | 0.056 | — | — | — | — | — | — | — | — |
| *gamma*-HCH (Lindane) | 0.2 | MCL | 0.95 | — | 0.85 | [12] 1.7 | 0.5 | [12] 1 | — | — | — | (11) |

**Table A.** Water-quality benchmarks for pesticide compounds that exceeded one or more benchmarks in NAWQA water samples.—Continued

[For pesticide compounds in water, benchmarks are for protection of human health and aquatic life. This table includes only those pesticide compounds that exceeded one or more benchmarks in NAWQA water samples; for these compounds, all benchmark values that were compared with concentrations in water are listed here. The complete set of benchmarks used for all pesticide compounds analyzed by NAWQA is available at *http://ca.water.usgs.gov/pnsp/pubs/circ1291/*. Common synonyms are listed in parentheses in column 1. OPP references are listed by number at the end of Appendix 3. Environmental concentration, the measured or calculated concentration statistic that is appropriate for comparison with the benchmark; CRC($10^{-6}$), $10^{-6}$ cancer risk concentration; $EC_{50}$, 50 percent effect concentration; EFED, Environmental Fate and Effects Division; USEPA, U.S. Environmental Protection Agency; HA-L, lifetime health advisory; IRED, Interim Reregistration Eligibility Decision; IRIS, Integrated Risk Information System database; $LC_{50}$, 50 percent lethal concentration; LOC, level of concern; MCL, maximum contaminant level; NOAEC, no-observed-adverse-effects concentration; OPP, Office of Pesticide Programs; RED, Reregistration Eligibility Decision; µg/L, microgram sper liter; >, greater than; <, less than; —, no benchmark available.]

| Pesticide compound (synonym) | Human-health benchmarks (µg/L) | | Aquatic-life benchmarks (µg/L) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Derived from USEPA drinking-water standards and guidelines (Office of Water) | | Derived from USEPA ambient water-quality criteria for aquatic life (Office of Water) | | Derived from USEPA Reregistration Eligibility Decisions and ecological risk assessments (Office of Pesticide Programs) | | | | | | | |
| | Value [1] | Type | Acute [2] | Chronic [2] | Acute fish [3] | Chronic fish [4] | Acute invertebrates [5] | Chronic invertebrates [6] | Acute nonvascular plants [7] | Acute vascular plants [8] | Aquatic community effects [9] | OPP references |
| Environmental concentration (µg/L): | Time-weighted annual mean | | Each individual sample | 4-day moving average | Each individual sample | 60-day moving average | Each individual sample | 21-day moving average | Each individual sample | Each individual sample | 60-day moving average | |
| **Organophosphates** | | | | | | | | | | | | |
| Azinphos-methyl (Guthion) | — | — | — | 0.01 | 0.18 | [12] 0.36 | 0.08 | [12] 0.16 | — | — | — | (12) |
| Chlorpyrifos | 20 | HA-L | 0.083 | 0.041 | 0.9 | 0.57 | 0.05 | 0.04 | 140 | — | — | (13, 14) |
| Diazinon | 0.6 | HA-L | — | — | 45 | [15] 0.55 | [10] 0.1 | [10] 0.17 | 3,700 | — | — | (15, 16) |
| Disulfoton | 0.3 | HA-L | — | — | 19.5 | [12] 39 | 1.95 | 0.037 | — | — | — | (17) |
| Malathion | 100 | HA-L | — | 0.1 | 2 | [12] 4 | 0.25 | 0.06 | — | — | — | (18) |
| Parathion (Ethyl parathion) | — | — | 0.065 | 0.013 | 9 | [16] 0.19 | 0.02 | 0.002 | — | — | — | (19) |
| Parathion-methyl (Methyl parathion) | 2 | HA-L | — | — | 500 | [15] 80 | 0.07 | 0.02 | 5,300 | — | — | (20) |
| Phorate | — | — | — | — | 0.5 | [12] 1 | 0.30 | 0.21 | 1,300 | — | — | (21, 22) |
| Terbufos | 0.9 | HA-L | — | — | 0.385 | [12] 0.77 | 0.1 | 0.030 | — | — | — | (23) |
| **Sulfite esters** | | | | | | | | | | | | |
| Propargite | — | — | — | — | [10] 15.5 | [10] 16 | 37 | 9 | 19.4 | 75,000 | — | (24) |
| **Triazines** | | | | | | | | | | | | |
| Atrazine | 3 | MCL | — | — | 2,650 | 62 | 360 | 62 | 32 | 18 | 17.5 | (25, 26) |
| Cyanazine | 1 | HA-L | — | — | — | — | — | — | — | — | — | — |
| **Ureas** | | | | | | | | | | | | |
| Diuron | 10 | HA-L | — | — | 355 | 26 | 80 | [12] 160 | 2.4 | — | — | (27) |

[1] From reference 1, unless noted otherwise.

[2] From reference 2.

[3] Benchmark = Toxicity value x LOC. For acute fish, the toxicity value is generally the lowest 96-hour $LC_{50}$ in a standardized test (usually with rainbow trout, fathead minnow, or bluegill), and the LOC is 0.5.

[4] Benchmark = Toxicity value x LOC. For chronic fish, the toxicity value is usually the lowest NOEAC from a life-cycle or early life-stage test (usually with rainbow trout or fathead minnow), and the LOC is 1.

[5] Benchmark = Toxicity value x LOC. For acute invertebrate, the toxicity value is usually the lowest 48- or 96-hour $EC_{50}$ or $LC_{50}$ in a standardized test (usually with midge, scud, or daphnids), and the LOC is 0.5.

[6] Benchmark = Toxicity value x LOC. For chronic invertebrates, the toxicity value is usually the lowest NOAEC from a life-cycle test with invertebrates (usually with midge, scud, or daphnids), and the LOC is 1.

[7] Benchmark = Toxicity value x LOC. For acute nonvascular plants, the toxicity value is usually a short-term (less than 10 days) $EC_{50}$ (usually with green algae or diatoms), and the LOC is 1.

[8] Benchmark = Toxicity value x LOC. For acute vascular plants, the toxicity value is usually a short-term (less than 10 days) $EC_{50}$ (usually with duckweed) and the LOC is 1.

[9] Exceedance of this benchmark concentration, as an average for any 60-day period, could cause community-level effects on aquatic plants (based on changes in plant community diversity as predicted by the Comprehensive Aquatic Systems Model), and indirect effects on fish and aquatic invertebrates from disturbance of the aquatic plant community (from reference 26).

[10] Although the underlying acute toxicity value is greater than the chronic toxicity value, the acute benchmark is lower than the chronic benchmark because acute and chronic toxicity values were multiplied by LOC values of 0.5 and 1, respectively.

[11] Because the underlying toxicity value is a "greater-than" value (such as >265,000), this benchmark may overestimate toxicity.

[12] The chronic benchmark is based on the acute toxicity value (which was lower than the lowest available chronic toxicity value) and, therefore, may underestimate chronic toxicity.

[13] From reference 10.

[14] Benchmark applies to total DDT, so comparison with measured *p,p'*-DDE concentration may underestimate potential effects. To account for potential contamination of some stream-water samples by *p,p'*-DDE, which may have resulted from sample collection and analysis procedures, exceedance of the chronic aquatic-life criterion was determined after subtracting 0.002 ug/L from the measured concentration of *p,p'*-DDE. The expected overall effect of this compensation is to underestimate the true frequency of exceedance of the 0.001 ug/L chronic aquatic-life criterion for *p,p'*-DDE (Details are provided at *http://ca.water.usgs.gov/pnsp/pubs/circ1291/.*)

[15] Because the underlying toxicity value is a "less-than" value (such as <1,500), this benchmark may underestimate toxicity.

[16] This benchmark has greater uncertainty than usual because of methods used or conditions in the underlying toxicity study.

**Table B.** Water-quality benchmarks for pesticide compounds that exceeded one or more benchmarks in NAWQA bed sediment or whole-fish samples.

[For pesticide compounds in bed sediment and whole-fish tissue, benchmarks are for protection of aquatic life and fish-eating wildlife, respectively. This table includes only those pesticide compounds that exceeded one or more benchmarks in NAWQA sediment or fish samples; for these compounds, all benchmark values that were compared with concentrations in sediment or fish are listed here. The complete set of benchmarks used for all pesticide compounds analyzed by NAWQA is available at *http://ca.water.usgs.gov/pnsp/pubs/circ1291/*. Common synomyms are listed in parentheses in column 1. The cited references are listed by number at the end of Appendix 3. $Benchmark_{High}$, highest value in the range of wildlife benchmarks available for a given pesticide compound or group; $Benchmark_{Low}$, lowest value in the range of wildlife benchmarks available for a given pesticide or group; $C_f$, concentration in food; Eisler-PC, proposed criterion from Contaminant Hazard Review series by R. Eisler and colleagues; ESB, equilibrium partitioning sediment benchmark; FFC, fish flesh criterion; NOAEL-ECF, no-observed-adverse-effects level equivalent concentration in food; TEC, threshold effect concentration; TRG, tissue residue guideline; USEPA, U.S. Environmental Protection Agency; µg/g, micrograms per gram; µg/kg dw, micrograms per kilogram dry weight; µg/kg ww, micrograms per kilogram wet weight; —, no benchmark available.]

| Pesticide compound (synonym) | Bed-sediment benchmarks for protection of benthic aquatic organisms | | Whole-fish benchmarks for protection of fish-eating wildlife | | | |
|---|---|---|---|---|---|---|
| | Consensus-based threshold effect concentration (TEC) (µg/kg dw) [1] | USEPA equilibrium partitioning sediment benchmark (ESB) (µg/g of sediment organic carbon) [1] | $Benchmark_{Low}$ value (µg/kg ww) [2] | Type of $Benchmark_{Low}$ | $Benchmark_{High}$ value (µg/kg ww) [2] | Type of $Benchmark_{High}$ |
| Organochlorines | | | | | | |
| Total Chlordane [3] | 3.24 | — | 300 | Eisler-PC | 4,200 | NOAEL-ECF |
| *o,p′*-DDD + *p,p′*-DDD [4] | 4.88 | — | see ([5]) | — | see ([5]) | — |
| *o,p′*-DDE + *p,p′*-DDE [4] | 3.16 | — | see ([5]) | — | see ([5]) | — |
| *o,p′*-DDT + *p,p′*-DDT [4] | 4.16 | — | see ([5]) | — | see ([5]) | — |
| Total DDT [5] | 5.28 | — | 6 | NOAEL-ECF | 200 | New York FFC |
| Dieldrin | 1.90 | 12 | 81 | NOAEL-ECF | [6] 120 | New York FFC |
| Endosulfan I (*alpha*-Endosulfan | — | 0.29 | — | — | — | — |
| Endrin | 2.22 | 5.4 | 20 | NOAEL-ECF | 25 | New York FFC |
| *gamma*-HCH (Lindane) | 2.37 | 0.37 | 3,950 | NOAEL-ECF | 3,950 | NOAEL-ECF |
| Heptachlor epoxide | 2.47 | — | see ([7]) | — | see ([7]) | — |
| Total Heptachlor [7] | — | — | 200 | New York FFC | 529 | NOAEL-ECF |
| Total Methoxychlor [8] | — | 1.9 | 16,300 | NOAEL-ECF | 16,300 | NOAEL-ECF |
| Toxaphene | — | 10 | 6.3 | Canadian TRG | 32,500 | NOAEL-ECF |

[1] TECs are from reference 28. ESBs are from references 29–31.

[2] $Benchmark_{Low}$ and $Benchmark_{High}$ refer to the range of benchmark values from the following four sources: Oak Ridge NOAEL-equivalent concentrations in food (the lowest $C_f$ value for piscivorous wildlife species from reference 32); New York fish flesh criteria—noncancer (reference 33); Canadian tissue residue guidelines (references 34–35); proposed criteria from the U.S. Fish and Wildlife Service's report series, Contaminant Hazard Reviews (references 36–37).

[3] Sum of the concentrations of *cis*- and *trans*-chlordane, *cis*- and *trans*-nonachlor, and oxychlordane.

[4] Benchmark applies to the sum of these two compounds.

[5] Sum of the concentrations of *o,p′* and *p,p′* isomers of DDD, DDE, and DDT.

[6] The benchmark is for total dieldrin (sum of the concentrations of aldrin plus dieldrin). However, this benchmark is considered applicable to dieldrin concentration data because only one fish sample contained any aldrin (10 µg/kg), and in that sample both aldrin and dieldrin (43 µg/kg) were well below all benchmarks.

[7] Sum of the concentrations of heptachlor and heptachlor epoxide.

[8] Sum of the concentrations of *o,p′* and *p,p′* isomers of methoxychlor.

## References—Appendix 3


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## Water: Human-Health Benchmarks

### 1. Pesticide compounds without human-health benchmarks:

The following pesticide compounds measured by NAWQA in stream water and ground water had no human-health benchmarks (names in parentheses are synonyms):

Acetochlor
Azinphos-methyl (Guthion)
Benfluralin
Bromoxynil
Chloramben methyl ester
Clopyralid
Dacthal mono-acid
2,4-DB
Deethylatrazine
Dichlobenil
Dichlorprop
2,6-Diethylaniline
DNOC
EPTC
Ethalfluralin
Ethoprop (Ethoprophos)
Fenuron
3-Hydroxycarbofuran
Linuron
MCPB
Methiocarb
Molinate
Napropamide
Neburon
Norflurazon
Oryzalin
Parathion (Ethyl parathion)
Pebulate
Pendimethalin
*cis*-Permethrin
Phorate
Propanil
Propargite
Thiobencarb
Triallate
Triclopyr

### 2. Pesticide compounds with human-health benchmarks, but no exceedances:

The following pesticide compounds measured in water had human-health benchmarks available, but these benchmarks were never exceeded (names in parentheses are synonyms):

Acifluorfen
Alachlor
Aldicarb
Aldicarb sulfone
Aldicarb sulfoxide
Bentazon
Bromacil
Butylate
Carbaryl
Carbofuran
Chlorothalonil
Chlorpyrifos
2,4-D
Dacthal (DCPA)
*p,p'*-DDE
Dicamba
Disulfoton
Diuron
Fluometuron
Fonofos
*alpha*-HCH
Malathion
MCPA
Methomyl
Metolachlor
Metribuzin
Oxamyl
Parathion-methyl (Methyl parathion)
Picloram
Prometon
Pronamide (Propyzamide)
Propachlor
Propham
Propoxur (Baygon)
Simazine
2,4,5-T
Tebuthiuron
Terbacil
Terbufos
2,4,5-TP (Silvex)
Trifluralin

## Water: Aquatic-Life Benchmarks

### 1. Pesticide compounds without aquatic-life benchmarks:

The following pesticide compounds measured by NAWQA in stream water had no aquatic-life benchmarks (names in parentheses are synonyms):

Acetochlor
Chloramben methyl ester
Clopyralid
Cyanazine
Dacthal mono-acid
Deethylatrazine
Dicamba
Dichlorprop
2,6-Diethylaniline
Dinoseb
DNOC
Fenuron
Fonofos
*alpha*-HCH
3-Hydroxycarbofuran
MCPB
Neburon
Prometon
Propham
2,4,5-T
2,4,5-TP (Silvex)

### 2. Pesticide compounds with aquatic-life benchmarks, but no exceedances:

The following pesticide compounds measured in stream water had aquatic-life benchmarks available, but these benchmarks were never exceeded (names in parentheses are synonyms):

Acifluorfen
Aldicarb
Aldicarb sulfone
Aldicarb sulfoxide
Benfluralin
Bentazon
Bromacil
Bromoxynil
Butylate
Chlorothalonil
2,4-D
Dacthal (DCPA)
2,4-DB
Dichlobenil
EPTC
Ethalfluralin
Ethoprop (Ethoprophos)
Fluometuron
*gamma*-HCH (Lindane)
Linuron
MCPA
Methiocarb
Metolachlor
Metribuzin
Napropamide
Norflurazon
Oryzalin
Oxamyl
Pebulate
Pendimethalin
*cis*-Permethrin
Picloram
Pronamide (Propyzamide)
Propachlor
Propanil
Propoxur (Baygon)
Simazine
Tebuthiuron
Terbacil
Triallate
Trifluralin
Triclopyr

## Bed Sediment: Aquatic-Life Benchmarks

### 1. Pesticide compounds without aquatic-life benchmarks:

The following pesticide compounds measured by NAWQA in bed sediment had no aquatic-life benchmarks:

Aldrin
Chloroneb
Dacthal (DCPA)
*alpha*-HCH
*beta*-HCH
Heptachlor
Hexachlorobenzene
Isodrin
Mirex
Pentachloroanisole
*cis*-Permethrin
*trans*-Permethrin

Note: Several additional compounds measured, such as *cis*-chlordane and *p,p'*-DDE, did not have benchmarks themselves, but were part of pesticide groups (total chlordane and total DDT, respectively) that did have sediment benchmarks.

### 2. Pesticide compounds with aquatic-life benchmarks, but no exceedances:

All pesticide compounds or groups with benchmarks in sediment exceeded those benchmarks in one or more samples.

## Whole Fish Tissue: Wildlife Benchmarks

### 1. Pesticide compounds without wildlife benchmarks:

The following pesticide compounds measured by NAWQA in whole fish had no benchmarks for fish-eating wildlife:

Dacthal (DCPA)
Pentachloroanisole

Note: Several additional compounds measured, such as *cis*-chlordane and *p,p'*-DDE, did not have benchmarks themselves, but were part of pesticide groups (total chlordane and total DDT, respectively) that did have wildlife benchmarks.

### 2. Pesticide compounds with wildlife benchmarks, but no exceedances:

The following pesticide compounds or groups measured in whole fish had wildlife benchmarks available, but these benchmarks were never exceeded (names in parentheses are synonyms):

*beta*-HCH
*gamma*-HCH (Lindane)
Total HCH
Heptachlor
Hexachlorobenzene
Total Methoxychlor
Mirex