

Appendix 3A. Water-quality benchmarks for pesticide compounds analyzed in NAWQA water samples

[For pesticide compounds in water, benchmarks are for protection of human health and aquatic life. Common synonyms are listed in parentheses in column 1. Cited references are listed in Appendix 3D. Environmental concentration, the measured or calculated concentration statistic that is appropriate for comparison with the benchmark; CRC(10^{-6}), 10^{-6} cancer risk concentration; EC₅₀, 50 percent effect concentration; EFED, Environmental Fate and Effects Division (within EPA's Office of Pesticide Programs); HA-L, lifetime health advisory; IRED, Interim Reregistration Eligibility Decision; IRIS, Integrated Risk Information System database; LC₅₀, 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; USEPA, U.S. Environmental Protection Agency; µg/L, microgram per 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	Chronic aquatic community ⁹	OPP references
Environmental concentration:	Time-weighted annual mean	Each individual sample	4-day moving average	Each individual sample	60-day average	Each individual sample	21-day average	Each individual sample	Each individual sample	60-day average		
Amides												
Alachlor	2	MCL	—	—	900	187	1,600	110	1.64	—	—	USEPA (1998a)
Metolachlor	100	HA-L	—	—	1,950	780	12,550	—	—	—	—	USEPA (1995a)
Napropamide	—	—	—	—	3,200	—	7,150	—	3,400	—	—	USEPA (2005a)
Pronamide (Propyzamide)	50	HA-L	—	—	36,000	—	¹⁰ 2,800	—	760	—	—	USEPA (1994a)
Propachlor	90	HA-L	—	—	85	—	395	—	13.5	—	—	USEPA (1998b)
Propanil	—	—	—	—	1,150	9.1	600	86.0	16	110	—	USEPA (2003a)
Carbamates												
Aldicarb ¹¹	3	MCL (stayed)	—	—	26	0.46	10	1.0	¹⁰ 50,000	—	—	USEPA (2005b)
Aldicarb sulfone ¹¹	2	MCL (stayed)	—	—	21,000	—	140	—	—	—	—	USEPA (2005b)
Aldicarb sulfoxide ¹¹	4	MCL (stayed)	—	—	3,570	—	21.5	—	—	—	—	USEPA (2005b)
Butylate	400	HA-L	—	—	105	¹² 210	5,950	—	—	—	—	USEPA (1993)

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	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	Chronic aquatic community ⁹		
Time-weighted annual mean		Each individual sample	4-day moving average	Each individual sample	60-day average	Each individual sample	21-day average	Each individual sample	Each individual sample	60-day average			
Carbaryl	700	HA-L	—	—	¹³ 125	¹³ 210	2.55	1.5	1,100	—	—	USEPA (2003b, 2004c)	
Carbofuran	40	MCL	—	—	44	5.7	1.115	0.75	—	—	—	USEPA (2005c)	
EPTC	—	—	—	—	7,000	—	3,250	—	1,360	5,600	—	USEPA (1999a)	
Methiocarb	—	—	—	—	218	50	3.5	0.10	—	—	—	USEPA (1994b)	
Methomyl	200	HA-L	—	—	265	57	4.4	¹⁰ 0.4	—	—	—	USEPA (1998c)	
Molinate	—	—	—	—	105	¹² 210	170	¹² 340	220	3,300	—	USEPA (2001a)	
Oxamyl	200	MCL	—	—	2,100	770	90	¹² 180	—	—	—	USEPA (1999b)	
Pebulate	—	—	—	—	3,150	—	3,315	—	230	1,800	—	USEPA (1999c)	
Propham	100	HA-L	—	—	—	—	—	—	—	—	—	—	
Propoxur (Baygon)	3	HA-L	—	—	1,850	—	5.5	—	—	—	—	USEPA (1997a)	
Thiobencarb	—	—	—	—	280	—	50	1.0	17	770	—	USEPA (1997b)	
Triallate	—	—	—	—	600	38	45.5	13	120	—	—	USEPA (2000a)	
Chlorobenzoic acid esters													
Dacthal (DCPA) ¹⁴	70	HA-L	—	—	15,000	—	13,500	—	¹⁰ 11,000	¹⁰ 11,000	—	USEPA (1998d)	

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	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	Chronic aquatic community ⁹		
Time-weighted annual mean		Each individual sample	4-day moving average	Each individual sample	60-day average	Each individual sample	21-day average	Each individual sample	Each individual sample	60-day average			
Chlorophenoxy acids													
2,4-D	70	MCL	—	—	¹⁵ 50,500	¹⁵ 14,200	¹⁵ 12,500	¹⁵ 16,400	¹⁵ 3,880	¹⁵ 299.2	—	USEPA (2004d)	
2,4-DB	—	—	—	—	¹⁵ 1,000	—	¹⁵ 7,500	—	¹⁵ 932	—	—	USEPA (2004e)	
MCPA	4	HA-L	—	—	¹⁵ 380	¹⁵ 12,000	¹⁵ 90	¹⁵ 11,000	¹⁵ 160	¹⁵ 20	—	USEPA (2004f)	
2,4,5-T	70	HA-L	—	—	—	—	—	—	—	—	—	—	
2,4,5-TP (Silvex)	50	MCL	—	—	—	—	—	—	—	—	—	—	
Dinitroanilines													
Benfluralin	—	—	—	—	15.85	1.9	1,090	¹⁶ 15.5	¹⁰ 100	—	—	USEPA (2004g)	
Ethalfuralin	—	—	—	—	16	0.4	30	24	25	—	—	USEPA (1995b)	
Oryzalin	—	—	—	—	1,440	220	700	—	42	15.4	—	USEPA (1994c)	
Pendimethalin	—	—	—	—	69	6.3	140	14.5	5.4	12.5	—	USEPA (1997c)	
Trifluralin	5	HA-L, CRC(10^{-6})	—	—	20.5	1.14	280	2.4	7.52	43.5	—	USEPA (1996a)	
Miscellaneous													
Bentazon	200	HA-L	—	—	¹⁰ 50,000	—	¹⁰ 50,000	—	4,500	5,350	—	USEPA (1994d)	
Norflurazon	—	—	—	—	4,050	770	¹⁰ 7,500	1,000	13	86	—	USEPA (1996b)	

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Environmental concentration:	Time-weighted annual mean		Each individual sample	4-day moving average	Each individual sample	60-day average	Each individual sample	21-day average	Each individual sample	Each individual sample	60-day average	
Miscellaneous acids												
Acifluorfen	1	CRC(10^{-6})	—	—	15,500	¹⁷ 1,500	14,050	—	¹⁰ 265,000	378,000	—	USEPA (2000b)
Dicamba	200	HA-L	—	—	—	—	—	—	—	—	—	—
Picloram	500	MCL	—	—	6,500	550	34,150	11,800	4,900	—	—	USEPA (1995c)
Nitrophenols												
Dinoseb	7	MCL	—	—	—	—	—	—	—	—	—	—
Organochlorines												
Chlorothalonil	1.5	CRC(10^{-6})	—	—	11.5	3	34	39	190	—	—	USEPA (1999d)
<i>p,p'</i> -DDE	¹⁸ 0.1	CRC(10^{-6})	¹⁹ 1.1	^{19,20} 0.001	—	—	—	—	—	—	—	—
Dichlobenil	—	—	—	—	2,465	¹⁷ 330	1,850	560	1,000	30	—	USEPA (1998e)
Dieldrin	0.002	CRC(10^{-6})	0.24	0.056	—	—	—	—	—	—	—	—
<i>alpha</i> -HCH	¹⁸ 0.006	CRC(10^{-6})	—	—	—	—	—	—	—	—	—	—
<i>gamma</i> -HCH (Lindane)	0.2	MCL	0.95	—	0.85	¹² 1.7	0.5	¹² 1	—	—	—	USEPA (2001b)
Triclopyr	—	—	—	—	²¹ 180	^{10,21} 104,000	²¹ 850	²¹ 80,700	²¹ 100	²¹ 880	—	USEPA (1998f)

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Time-weighted annual mean		Each individual sample	4-day moving average	Each individual sample	60-day average	Each individual sample	21-day average	Each individual sample	Each individual sample	60-day average			
Organophosphates													
Azinphos-methyl (Guthion)	—	—	—	0.01	0.18	¹² 0.36	0.08	¹² 0.16	—	—	—	USEPA (2005e)	
Chlorpyrifos	20	HA-L	0.083	0.041	0.9	0.57	0.05	0.04	140	—	—	USEPA (2000c, 2002)	
Diazinon	0.6	HA-L	—	—	45	¹⁷ 0.55	^{13,22} 0.1	¹³ 0.17	3,700	—	—	USEPA (2000d, 2004h)	
Disulfoton	0.3	HA-L	—	—	19.5	¹² 39	1.95	0.037	—	—	—	USEPA (2000e)	
Ethoprop (Ethoprophos)	—	—	—	—	150	24	22	0.8	8,400	—	—	USEPA (1999e)	
Fonofos	10	HA-L	—	—	—	—	—	—	—	—	—	—	
Malathion	100	HA-L	—	0.1	2	¹² 4	0.25	0.06	—	—	—	USEPA (2000f)	
Parathion (Ethyl parathion)	—	—	0.065	0.013	9	¹⁶ 0.19	0.02	0.002	—	—	—	USEPA (1999f)	
Parathion-methyl (Methyl parathion)	2	HA-L	—	—	500	¹⁷ 80	0.07	0.02	5,300	—	—	USEPA (2003c)	

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Time-weighted annual mean		Each individual sample	4-day moving average	Each individual sample	60-day average	Each individual sample	21-day average	Each individual sample	Each individual sample	60-day average			
Phorate	—	—	—	—	0.5	¹² 1	0.30	0.21	1,300	—	—	USEPA (1998g, 1999g)	
Terbufos	0.9	HA-L	—	—	0.385	¹² 0.77	0.1	0.030	—	—	—	USEPA (1999h)	
Phenols													
Bromoxynil	—	—	—	—	11.5	9	5.5	2.5	51	219	—	USEPA (1998h)	
Pyrethroids													
<i>cis</i> -Permethrin ¹⁴	—	—	—	—	²³ 0.395	²³ 0.30	^{13,23} 0.0195	^{13,23} 0.039	—	—	—	USEPA (2005f)	
Sulfite esters													
Propargite	—	—	—	—	¹³ 15.5	¹³ 16	37	9	19.4	75,000	—	USEPA (2000g)	
Triazines													
Atrazine	3	MCL	—	—	2,650	62	360	62	32	18	17.5	USEPA (2003d, 2003e)	
Cyanazine	1	HA-L	—	—	—	—	—	—	—	—	—	—	
Metribuzin	200	HA-L	—	—	21,000	3,000	2,100	1,290	8.7	130	—	USEPA (1998i)	
Prometon	100	HA-L	—	—	—	—	—	—	—	—	—	—	
Simazine	4	MCL	—	—	3,200	960	500	¹² 1,000	36	140	—	USEPA (2005g, 2005h)	

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Uracils												
Bromacil	90	HA-L	—	—	18,000	—	60,500	—	6.8	--	—	USEPA (1996c)
Terbacil	90	HA-L	—	—	23,100	—	31,500	—	11	140	—	USEPA (1998j)
Ureas												
Diuron	10	HA-L	—	—	355	26	80	¹² 160	2.4	--	—	USEPA (2003f)
Fluometuron	90	HA-L	—	—	320	—	110	—	30	220	—	USEPA (2005i)
Linuron	—	—	—	—	1,500	¹⁷ 42	60	¹² 120	67	—	—	USEPA (1995d)
Tebuthiuron	500	HA-L	—	—	53,000	9,300	148,500	21,800	50	135	—	USEPA (1994e)

¹ From USEPA (2004a), unless noted otherwise

² From USEPA (2004b)

³ Benchmark = Toxicity value x LOC. For acute fish, toxicity value is generally the lowest 96-hour LC₅₀ 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, 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, toxicity value is usually the lowest 48- or 96-hour EC₅₀ or LC₅₀ in a standardized test (usually with midge, scud, or daphnids), and the LOC is 0.5.

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Environmental concentration:	Time-weighted annual mean		Each individual sample	4-day moving average	Each individual sample	60-day average	Each individual sample	21-day average	Each individual sample	Each individual sample	60-day average	

⁶ Benchmark = Toxicity value x LOC. For chronic invertebrates, 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, toxicity value is usually a short-term (less than 10 days) EC₅₀ (usually with green algae or diatoms), and the LOC is 1.

⁸ Benchmark = Toxicity value x LOC. For acute vascular plants, toxicity value is usually a short-term (less than 10 days) EC50 (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.

¹⁰ Because the underlying toxicity value is a "greater-than" value (such as >265,000), this benchmark may overestimate toxicity.

¹¹ This MCL is under administrative stay of the effective date. For any combination of 2 or more of these 3 chemicals (aldicarb, aldicarb sulfoxide, and aldicarb sulfone), the summed concentration should not exceed 7 µg/L because of similar mode of action.

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 Although the underlying acute toxicity value is greater than or equal to 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.

¹⁴ This pesticide also can be considered an organochlorine pesticide, because it is an organic compound with one or more chlorine substituents.

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	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	Chronic aquatic community ⁹	OPP references
Environmental concentration:	Time-weighted annual mean		Each individual sample	4-day moving average	Each individual sample	60-day average	Each individual sample	21-day average	Each individual sample	Each individual sample	60-day average	

¹⁵ Original toxicity values are in micrograms of acid equivalents per liter. For 2,4-D and 2,4-DB, the toxicity values selected were the lowest available values for the acid or salt forms. For MCPA, acute toxicity values were the lowest for the acid, salt or ester forms, and chronic toxicity values were the lowest of the acid and salt forms. (Selection was consistent with risk quotients in the cited USEPA references.)

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

¹⁷ Because the underlying toxicity value is a "less-than" value (such as <1,500), this benchmark may underestimate toxicity.

¹⁸ From USEPA (2005d)

¹⁹ Benchmark applies to total DDT, so comparison with measured *p,p'*-DDE concentration may underestimate potential effects.

²⁰ Sporadic contamination by *p,p'*-DDE was measured in 2.9 percent of quality-control (QC) samples (field blanks) collected by NAWQA sampling teams. The median detected *p,p'*-DDE concentration in the QC samples for streams was 0.0014 µg/L, which exceeds the chronic aquatic-life criterion (0.001 µg/L). Of the 26 QC samples in which *p,p'*-DDE was detected, concentrations were greater than 0.002 µg/L in only 5 samples (less than 1 percent of all QC samples). To account for possible incidental contamination of stream-water samples by *p,p'*-DDE, exceedance of the chronic aquatic-life criterion was determined after subtracting 0.002 µg/L from the measured *p,p'*-DDE concentration. Given that *p,p'*-DDE is detected more frequently in stream-water samples (5.5 percent) than in QC samples (2.9 percent), and that the magnitude of contamination in QC samples usually (81 percent of contaminated QC samples) is less than the 0.002 µg/L correction factor, the expected overall effect of this compensation is to underestimate the true frequency of exceedance of the 0.001 µg/L chronic aquatic-life criterion by *p,p'*-DDE. (Also see footnote 19).

²¹ The acute toxicity values were the lowest of the acid, salt or ester forms, and the chronic toxicity values were the lowest of the acid and salt forms of triclopyr. (Selection was consistent with risk quotients in the cited USEPA reference.)

Appendix 3A. Water-quality benchmarks for pesticide compounds analyzed in NAWQA water samples

[For pesticide compounds in water, benchmarks are for protection of human health and aquatic life. Common synonyms are listed in parentheses in column 1. Cited references are listed in Appendix 3D. Environmental concentration, the measured or calculated concentration statistic that is appropriate for comparison with the benchmark; CRC(10^{-6}), 10^{-6} cancer risk concentration; EC₅₀, 50 percent effect concentration; EFED, Environmental Fate and Effects Division (within EPA's Office of Pesticide Programs); HA-L, lifetime health advisory; IRED, Interim Reregistration Eligibility Decision; IRIS, Integrated Risk Information System database; LC₅₀, 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; USEPA, U.S. Environmental Protection Agency; µg/L, microgram per 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	Chronic aquatic community ⁹	OPP references
Environmental concentration:	Time-weighted annual mean		Each individual sample	4-day moving average	Each individual sample	60-day average	Each individual sample	21-day average	Each individual sample	Each individual sample	60-day average	

²² During public comment on draft ambient water-quality criteria that are under development by USEPA, public comment noted an atypical distribution of the acute toxicity data for diazinon. If data from the second most sensitive study were used (USEPA, 2000 risk assessment), rather than the most sensitive study, then the benchmark would change from 0.1 to 0.4 µg/L.

²³ Toxicity values and benchmarks apply to permethrin. Because NAWQA measures only the *cis* isomer of permethrin in water, comparison with benchmarks may underestimate potential toxicity.