PESTICIDE SURFACE WATER QUALITY REPORT

JANUARY 2015 SAMPLING EVENT

Richard J. Pfeuffer
South Florida Water Management District
MSC 4441
3301 Gun Club Road
West Palm Beach, FL 33406

Table of Contents

Summary

As part of the South Florida Water Management District's (SFWMD) quarterly ambient monitoring program, unfiltered surface water grab samples were collected January 26 to January 29, 2015, and analyzed for over 70 pesticides and/or products of their degradation.

The herbicides 2,4-D, ametryn, atrazine, bentazon, diuron, metribuzin, norflurazon, along with the insecticide/degradate imidacloprid and atrazine desethyl, were detected in one or more of these surface water samples. No harmful impacts are expected from the detected pesticides.

The compounds and concentrations found are typical of those expected from an area of intensive historical and contemporary agricultural activity.

Background and Methods

The SFWMD pesticide monitoring network includes stations designated in the Everglades Settlement Agreement, the Lake Okeechobee Protection Act Permit, and the non-Everglades Construction Project (non-ECP) permit. The canals and marshes depicted in **Figure 1** are protected as Florida Administrative Code (F.A.C.) 62-302 Class III (fishable and swimmable) waters, while Lake Okeechobee and a segment of the Caloosahatchee River are protected as a Class I drinking water supply. Arthur R. Marshall Loxahatchee National Wildlife Refuge/Water Conservation Area 1 (WCA-1) and the Everglades National Park are also designated as Outstanding Florida Waters, to which anti-degradation standards apply. Surface water and sediment are sampled quarterly and semiannually or annually, respectively, upstream at each structure identified in the permit or agreement.

Seventy-two pesticides and degradation products were analyzed in samples from 25 of the network 26 sites (**Figure 1**). The analytes, their respective method detection limits (MDLs), and practical quantitation limits (PQLs) are listed in **Table 1**. All the analytical work is performed by the Florida Department of Environmental Protection (FDEP) Central Laboratory in Tallahassee, Florida. Analytical method details can be found at the following location: http://www.dep.state.fl.us/labs/cgi-bin/sop/chemsop.asp.

To evaluate the potential impacts on aquatic life, the observed concentration is compared to the appropriate criterion outlined in F.A.C. 62-302.530. If a pesticide compound is not specifically listed, acute and chronic toxicity criterion are calculated as one-third and one-twentieth, respectively, of the amount lethal to 50% of the test organisms in 96 hours, using the lowest technical grade effective concentration 50 (EC_{50}) or lethal concentration 50 (LC_{50}) reported in the summarized literature for the species significant to the indigenous aquatic community (F.A.C. 62-302.200). Each pesticide's description and possible uses and sites of application described herein are taken from Hartley and Kidd (1987). This summary covers surface water samples collected from January 26 to January 29, 2015.

Results

At least one pesticide was detected in surface water at each of the 25 sites. The non-ECP permit requires sampling at S142 only during discharge or flow events. For this sampling event, no sample was obtained due to the lack of discharge at the time of sample collection. Structure G123 has been decommissioned and FDEP concurred with terminating all monitoring on November 7, 2014. All of these compounds have previously been detected in this monitoring program.

The above findings must be considered with the caveat that pesticide concentrations in surface water and sediment may vary significantly in relation to the timing and magnitude of pesticide application, rainfall events, pumping and other factors, and that this was only one sampling event. The possible acute and chronic toxicity and environmental fate impacts are reported based on the single sampling event and do not take into account previous monitoring data.

Usage and Water Quality Impacts

2,4-D: 2,4-D is a selective systemic herbicide used for the post-emergence control of annual and perennial broad leaf weeds in terrestrial (grassland, established turf, sugarcane, rice, and on non-crop areas) as well as aquatic areas. Environmental fate and toxicity data in **Tables 3 and 4** indicate that 2,4-D (1) has minimum loss from soil by surface adsorption, with a moderate loss by leaching and surface solution; (2) is slightly toxic to mammals and relatively non-toxic to fish; and (3) does not bioaccumulate significantly. The highest 2,4-D residue was detected at S191 (0.025 µg/L) (**Table 2**). Using these criteria, this observed level should not have an acute or chronic effect on fish or aquatic invertebrates.

Ametryn: Ametryn is a selective terrestrial herbicide registered for use on sugarcane, bananas, pineapple, citrus, corn, and non-crop areas. Most algal effects occur at concentrations greater than (>) 10 µg/L (Verschueren, 1983). Environmental fate and toxicity data in **Tables 3 and 4** indicate

that ametryn (1) is moderately lost from soil by leaching, surface adsorption, and in surface solution; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96-hour LC_{50} of 14.1 milligrams per liter (mg/L) for goldfish (Hartley and Kidd, 1987). The ametryn surface water concentrations found in this sampling event ranged from 0.015 to 0.058 µg/L (**Table 2**). Using these criteria, these observed surface water concentrations should not have an acute, detrimental impact on fish or aquatic invertebrates.

Atrazine: Atrazine is a selective systemic herbicide registered for use on pineapple, sugarcane, corn, rangelands, ornamental turf, lawn grasses, and non-crop areas. Environmental fate and toxicity data in **Tables 3 and 4** indicate that atrazine (1) has a large potential for loss from soil by leaching and in surface solution, with moderate loss from surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96-hour LC_{50} of 76 mg/L for carp, 16 mg/L for perch, and 4.3 mg/L for guppies (Hartley and Kidd, 1987). Also, in a flow-through bioassay, the maximum acceptable toxicant concentration (MATC) of atrazine was 90 and 210 µg/L for bluegill and fathead minnow, respectively (Verschueren, 1983). The draft ambient aquatic life water quality criterion identifies a one-hour average concentration that does not exceed 1,500 µg/L more than once every three years on the average (United States Environmental Protection Agency [U.S. EPA], 2003a). The atrazine surface water concentrations found in this sampling event at 18 of the 25 sampling locations, ranged from 0.014 to 0.41 µg/L (**Table 2**). Using these criteria, these observed surface water concentrations should not have an acute or chronic detrimental impact on fish or invertebrates.

Atrazine desethyl (DEA) and atrazine desisopropyl (DIA) are biotic degradation products of atrazine. These degradation products are both persistent and mobile in water; however, DEA is more stable and the dominant initial metabolite. Since DEA and DIA are structurally and toxicologically similar to atrazine, the concentrations of total atrazine residue (atrazine + DEA + DIA) may also be a significant consideration in the surface water environment. The DEA to atrazine ratio (DAR, unitless), on a molar basis, has been suggested as an indicator of nonpoint-source pollution of groundwater (Adams and Thurman, 1991) and as a tracer of groundwater discharge into rivers (Thurman et al., 1992). Goolsby et al. (1997) determined that low DAR values, median <0.1, occur in streams during runoff shortly after application of atrazine. Higher DAR values, median about 0.4, occur later in the year after considerable degradation of atrazine to DEA has occurred in the soil (Goolsby et al. (1997). The low median DAR ratio (e.g. 0.14) at the location where both atrazine and DEA were detected, suggests minimum degradation of atrazine (**Table 5**). However, these general guidelines were developed based on observations in Midwest watersheds in northern temperate climates with different soil and water management regimes as well as higher atrazine water concentrations. Applications to the South Florida environment should be made with caution.

Bentazon: Bentazon is a contact herbicide used for post-emergence control of many annual broad-leaved weeds in beans, peas, rice, and established turf. Environmental fate and toxicity data in **Tables 3 and 4** indicate that bentazon (1) is easily lost from soil by leaching, with moderate loss

from surface solution, and minimum loss by surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. The highest detected concentration of 0.036 µg/L at S31 (**Table 2**), is below any level that would have an acute or chronic detrimental impact on fish or aquatic invertebrates.

Diuron: Diuron is a selective, systemic terrestrial herbicide registered for use on sugarcane, bananas, and citrus. Environmental fate and toxicity data in **Tables 3 and 4** indicate that diuron (1) is easily lost from soil in surface solution, with moderate loss from leaching or surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. Additional fish toxicity data include a 96-hour LC_{50} of 25 mg/L for guppies (Hartley and Kidd, 1987). Crustaceans are affected at lower concentrations with a 48-hour LC_{50} of 1.4 mg/L for water fleas and a 96-hour LC_{50} of 0.7 mg/L for water shrimp (Verschueren, 1983). Most algal effects occur at concentrations > 10 µg/L (Verschueren, 1983). The only surface water concentration of diuron found during this sampling event was 0.0031 µg/L at S140 (**Table 2**). Using these criteria, this concentration should not have an acute, harmful impact on fish, aquatic invertebrates, or algae.

Imidacloprid: Imidacloprid is a systemic insecticide registered for use on a variety of row crops and turf grass applications as well as for flea control. Environmental fate and toxicity data in **Tables 3 and 4** indicate that imidacloprid (1) is soluble in water; (2) is slightly toxic to mammals and relatively non-toxic to fish; and (3) does not bioconcentrate significantly. The highest detected concentration of 0.0052 µg/L at S65E (**Table 2**) is below any level that would have an acute or chronic detrimental impact on fish or aquatic invertebrates.

Metribuzin: Metribuzin is a selective systemic herbicide used on a variety of crops including potatoes, tomatoes, sugarcane, and peas. Environmental fate and toxicity data in **Tables 3 and 4** indicate that metribuzin (1) has a large potential for loss due to leaching, a medium potential for loss in surface solution, and a small potential for loss due to surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioaccumulate significantly. The highest concentration of metribuzin detected was 0.12 µg/L at S6 (**Table 2**). Using these criteria, this surface water concentration should not have an acute impact on fish or aquatic invertebrates.

Norflurazon: Norflurazon is a selective herbicide registered for use on many crops including citrus. Environmental fate and toxicity data in **Tables 3 and 4** indicate that norflurazon (1) is easily lost from soil surface solution and a moderate potential for loss due to leaching and surface adsorption; (2) is relatively non-toxic to mammals and fish; and (3) does not bioconcentrate significantly. The LC_{50} for norflurazon is >200 mg/L for catfish and goldfish (Hartley and Kidd, 1987). The only norflurazon surface water concentration detected (0.034 µg/L at S140) (**Table 2**) is several orders of magnitude below the calculated chronic action level. Using these criteria, these observed concentrations should not have an acute, detrimental impact on fish or aquatic invertebrates.

Quality Assurance Evaluation

No pesticide analytes were detected in the field blanks performed at S191, S177, S31, and S7. The

field blank collected at S8 had an atrazine concentration of 0.0094 µg/L detected. This concentration is very small and passes allowable quality control criteria. All of the 25 collected samples were shipped and all bottles were received.

Figure 1. South Florida Water Management District Pesticide Monitoring Network.

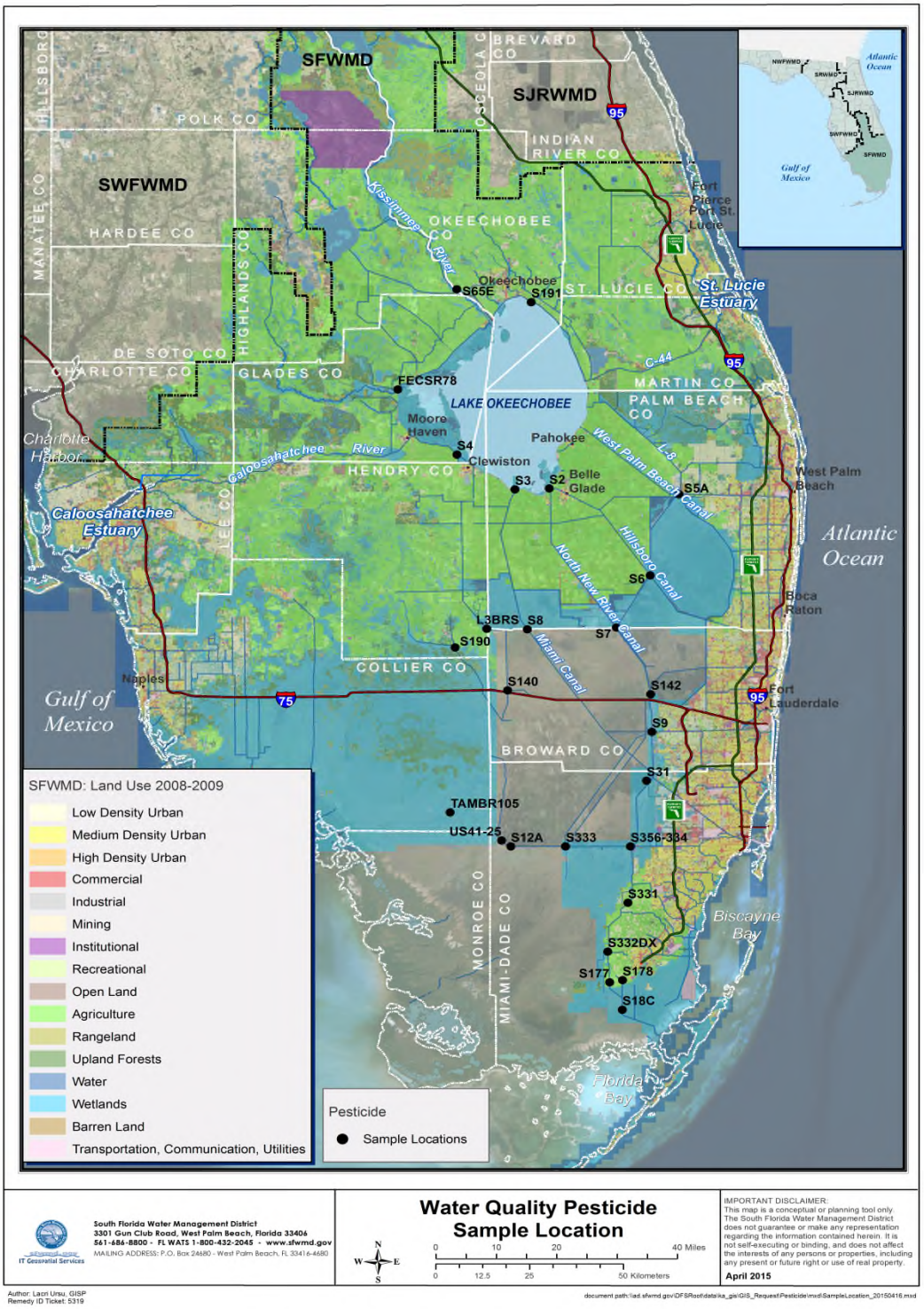

Table 1. Method detection limits (MDLs) and practical quantitation limits (PQLs) for January 2015 sampling event.

Pesticide or metabolite	Water: range of MDLs - PQLs (µg/L)	Pesticide or metabolite	Water: range of MDLs - PQLs (µg/L)
2,4-D	0.002 - 0.01	endrin	0.0037 - 0.016
2,4,5-T	0.002 - 0.01	endrin aldehyde	0.0037 - 0.016
2,4,5-TP (silvex)	0.002 - 0.01	ethion	0.0093 - 0.04
acifluorfen	0.002 - 0.01	ethoprop	0.0047 - 0.02
alachlor	0.056 - 0.24	fenamiphos	0.028 - 0.12
aldrin	0.0019 - 0.008	fonofos	0.0093 - 0.04
ametryn	0.0093 - 0.04	heptachlor	0.0019 - 0.01
atrazine	0.0093 - 0.04	heptachlor epoxide	0.0019 - 0.008
atrazine desethyl	0.0093 - 0.04	hexazinone	0.028 - 0.12
atrazine desisopropyl	0.0093 - 0.04	imidacloprid	0.002 - 0.01
azinphos methyl (guthion)	0.019 - 0.08	linuron	0.004 - 0.02
bentazon	0.002 - 0.01	malathion	0.0093 - 0.04
α-BHC (alpha)	0.0019 - 0.008	metalaxyl	0.037 - 0.16
β-BHC (beta)	0.0019 - 0.008	methoxychlor	0.0093 - 0.04
δ-BHC (delta)	0.0019 - 0.008	metolachlor	0.056 - 0.24
γ-BHC (gamma) (lindane)	0.0019 - 0.008	metribuzin	0.019 - 0.08
bromacil	0.037 - 0.16	mevinphos	0.0093 - 0.04
butylate	0.019 - 0.08	mirex	0.0037 - 0.016
carbophenothion (trithion)	0.0056 - 0.024	naled	0.037 - 0.16
chlordane	0.019 - 0.08	norflurazon	0.028 - 0.12
chlorothalonil	0.0075 - 0.032	parathion ethyl	0.019 - 0.08
chlorpyrifos ethyl	0.0093 - 0.04	parathion methyl	0.0093 - 0.04
chlorpyrifos methyl	0.0093 - 0.04	PCB-1016	0.019 - 0.08
cypermethrin	0.011 - 0.048	PCB-1221	0.019 - 0.08
DDD-P,P'	0.0037 - 0.016	PCB-1232	0.019 - 0.08
DDE-P,P'	0.0037 - 0.016	PCB-1242	0.019 - 0.08
DDT-P,P'	0.0037 - 0.016	PCB-1248	0.019 - 0.08
demeton	0.022 - 0.096	PCB-1254	0.019 - 0.08
diazinon	0.0093 - 0.04	PCB-1260	0.019 - 0.08
dicofol (kelthane)	0.022 - 0.096	permethrin	0.019 - 0.04
dieldrin	0.0019 - 0.008	phorate	0.019 - 0.02
disulfoton	0.0047 - 0.02	prometon	0.019 - 0.08
diuron	0.002 - 0.01	prometryn	0.019 - 0.08
α-endosulfan (alpha)	0.0019 - 0.008	simazine	0.019 - 0.04
β-endosulfan (beta)	0.0019 - 0.016	toxaphene	0.019 - 0.4
endosulfan sulfate	0.0037 - 0.016	trifluralin	0.019 - 0.032

Table 2. Summary of pesticide residues (µg/L) detected above the method detection limit in surface water samples collected by SFWMD in January 2015.

Date	Location	Flow	2,4-D	ametryn	atrazine	atrazine desethyl	bentazon	diuron	imidacloprid	metribuzin	norflurazon	Number of compounds detected at location
1/26/2015	S18C	N	-	-	-	-	0.0046 I	-	-	-	-	1
	S178	N	-	-	-	-	0.0048 I	-	-	-	-	1
	S177	N	-	-	-	-	0.0076 I	-	0.0046 I	-	-	2
	S331	N	-	-	-	-	0.012	-	-	-	-	1
	S332DX	N	-	-	-	-	0.0088 I	-	-	-	-	1
	S4	N	0.0084 I	0.015 I	0.17	0.017 I	0.0084 I	-	-	-	-	5
	S2	N	0.0040 I	-	0.12	0.017 I	0.0074 I	-	-	-	-	4
	S3	N	0.0070 I	-	0.10	0.017 I	0.0080 I	-	-	-	-	4
	S65E	Y	0.0033 I	-	0.025 I	-	0.016	-	0.0052 I	-	-	4
	S191	N	0.025	-	0.021 I	-	-	-	-	-	-	2
	FECSR78	ND	-	-	0.014 I	-	-	-	-	-	-	1
1/27/2015	S31	N	-	-	0.014 I	-	0.036	-	-	-	-	2
	S356-334	N	-	-	-	-	0.0092 I	-	-	-	-	1
	S333	N	0.0076 I	-	0.11	-	0.034	-	-	0.021 I	-	4
	S12A	N	-	-	0.023 I	-	-	-	-	-	-	1
	US41-25	N	-	-	0.015 I	-	-	-	-	-	-	1
	TAMBR105	N	-	-	0.017 I	-	-	-	-	-	-	1
1/28/2015	S140	N	0.0082 I	-	0.057	-	0.0062 I	0.0031 I	0.0041 I	-	0.034 I	6
	S190	N	-	-	0.033 I	-	-	-	-	-	-	1
	L3BRS	Y	0.0042 I	0.021 I	0.15	-	0.014	-	-	-	-	4
	S8	N	-	0.024 I	0.19	-	0.015	-	-	-	-	3
1/29/2015	S6	N	0.010 I	0.058	0.18	0.016 I	0.034	-	-	0.12	-	6
	S7	N	0.0034 I	0.026 I	0.41	0.013 I	0.024	-	-	-	-	5
	S5A	Y	0.0022 I	-	0.16	0.023 I	0.0081 I	-	0.0028 I	-	-	5
	S9	N	0.012	-	-	-	0.031	-	-	-	-	2
Total number of compound detections			12	5	18	6	19	1	4	2	1	68

N = no, Y = yes, R = reverse, ND = not discernable; - = result is below the method detection limit
I = value reported is less than the practical quantitation limit, and greater than or equal to the method detection limit

Table 3. Selected properties of pesticides detected during the January 2015 sampling event.

Common Name	Surface Water Standards F.A.C. 62-302 (µg/L)	Acute Oral LD_{50} For Rats (mg/Kg) (1)	Bioconcentration Factor (2)	Volatility from Water (2)	Soil Conservation Service (SCS) rating (3)			K_{oc} (mL/g) (3, 4)	Soil Half-life (days) (3, 4)	Water Solubility (WS) (mg/L) (3, 4)	U.S. EPA Carcinogenic Potential (5)
					LE	SA	SS				
2,4-D (acid)	(100)	375	13	I	M	S	M	20	10	890	D
ametryn	*	1,110	33	I	M	M	M	300	60	185	D
atrazine	*	3,080	86	I	L	M	L	100	60	33	C
bentazon	*	1,100	19	I	L	S	M	34	20	500	C
diuron	*	3,400	75	I	M	M	L	480	90	42	D
imidacloprid	*	424(6)	18	I	-	-	-	178(6)	520(6)	510(6)	E
metribuzin	*	2,200	11	I	L	S	M	41	30	1,220	D
norflurazon	*	9,400	94	I	M	M	L	700	90	28	-

- = No data available

FDEP F.A.C. 62-302 surface water standards (8/2013) for Class III waters except Class I noted in ( )

Bioconcentration Factor (BCF) calculated as $BCF = 10^{\wedge(2.71 - 0.564 \log WS)}$ (2)

Volatility from water: R = rapid, I = insignificant, S = significant

SCS ratings are pesticide loss due to leaching (LE), surface adsorption (SA) or surface solution (SS) and grouped as large (L), medium (M), small (S), or extra small (XS)

B2 = probable human carcinogen; C = possible human carcinogen; D = not classified; E = evidence of non-carcinogen for humans (5)

(1) Hartley and Kidd (1987)
(2) Lyman, et al. (1990)
(3) Goss and Wauchope (1992)
(4) Montgomery (1993)
(5) U.S. EPA (1996)
(6) U.S. EPA (1994a)

Table 4. Toxicity of pesticides detected during the January 2015 sampling event to freshwater aquatic invertebrates and fishes (µg/L).

	Water Flea *(Daphnia magna)*			Fathead Minnow # *(Pimephales promelas)*			Bluegill *(Lepomis macrochirus)*			Largemouth Bass *(Micropterus salmoides)*			Rainbow Trout # *(Oncorthynchus mykiss)*			Channel Catfish *(Ictgalurus punctatus)*		
Pesticide Common Name	48 hour EC_{50}	Acute Toxicity (*)	Chronic Toxicity (*)	96 hour LC_{50}	Acute Toxicity	Chronic Toxicity	96 hour LC_{50}	Acute Toxicity	Chronic Toxicity	96 hour LC_{50}	Acute Toxicity	Chronic Toxicity	96 hour LC_{50}	Acute Toxicity	Chronic Toxicity	96 hour LC_{50}	Acute Toxicity	Chronic Toxicity
2,4-D	25,000 (3)	8,333	1,250	133,000 (3)	44,333	6,650	180,000 (4)	60,000	9,000	-	-	-	100,000 (1)	33,333	5,000	-	-	-
							900 (48 hr) (2)	-	-				110,000 (3)	36,667	5,500			
ametryn	28,000 (3)	9,333	1,400	16,000 (5)	5,333	800	4,100 (1)	1,367	205	-	-	-	8,800 (1)	2,933	440	-	-	-
													3,600 (5)	1,200	180			
atrazine	6,900 (3)	2,300	345	15,000 (3)	5,000	750	16,000 (1)	5,333	800	-	-	-	8,800 (1)	2,933	440	7,600 (1)	2,533	380
													5,300 (6)	1,767	265			
bentazon	>100,000 (9)	33,333	5,000	-	-	-	>100,000 (9)	33,333	5,000	-	-	-	>100,000 (9)	33,333	5,000	-	-	-
diuron	1,400 (3)	467	70	14,200 (3)	4,733	710	5,900 (1)	1,967	295	-	-	-	5,600 (1)	1,867	280	-	-	-
	1,400 (10)	467	70	14,000 (10)	4,667	700												
imidacloprid	85,200 (8)	28,400	4,260	-	-	-	-	-	-	-	-	-	83,000 (8)	27,667	4,150	-	-	-
metribuzin	4,200 (3)	1,400	210	-	-	-	80,000 (1)	26,667	4,000	-	-	-	64,000 (1)	21,333	3,200	100,000 (3)	33,333	5,000
	4,200 (7)	1,400	210				75,900 (7)	25,300	3,795				76,770 (7)	25,590	3,839			
norflurazon	15,000 (3)	5,000	750	-	-	-	16,300 (3)	5,433	815	-	-	-	8,100 (3)	2,700	405	>200,000 (1)	>67,000	>10,000

- = No data available

(*) F.A.C. 62-302.200, for compounds not specifically listed, acute and chronic toxicity standards are calculated as one-third and one-twentieth, respectively, of the amount lethal to 50% of the test organisms in 96 hours, where the 96 hour LC_{50} is the lowest value which has been determined for a species significant to the indigenous aquatic community.

(#) Species is not indigenous. Information is given for comparison purposes only.

(1) Hartley and Kidd (1987)
(2) Verschueren (1983)
(3) U.S. EPA (1991)
(4) Mayer and Ellersieck (1986)
(5) U.S. EPA (2005)
(6) U.S. EPA (2006)
(7) U.S. EPA (1998)
(8) U.S. EPA (1994a)
(9) U.S. EPA (1994b)
(10) U.S. EPA (2003b)

Table 5. Atrazine Desethyl (DEA)/Atrazine ratio (DAR) data for January 2015 sampling event.

Date	Site	Flow*	atrazine		atrazine desethyl		DAR
			µg/L	moles/L	µg/L	moles/L	
1/26/2015	S4	N	0.17	7.88E-10	0.017	9.06E-11	0.11
1/26/2015	S2	N	0.12	5.56E-10	0.017	9.06E-11	0.16
1/26/2015	S3	N	0.10	4.64E-10	0.017	9.06E-11	0.20
1/29/2015	S6	N	0.18	8.35E-10	0.016	8.53E-11	0.10
1/29/2015	S7	N	0.41	1.90E-09	0.013	6.93E-11	0.04
1/29/2015	S5A	Y	0.16	7.42E-10	0.023	1.23E-10	0.17
				DAR	All sites	Flow only sites	No flow sites
				average	0.13	0.17	0.12
				median	0.14	0.17	0.11
				minimum	0.04	0.17	0.04
				maximum	0.20	0.17	0.20

* N = no; Y = yes; R = reverse

Glossary

Bioconcentration Factor: The ratio of the concentration of a contaminant in an aquatic organism to the concentration in water, after a specified period of exposure via water only. The duration of exposure should be sufficient to achieve a near steady-state condition.

EC_{50}: A concentration necessary for 50 percent of the aquatic species tested to exhibit a toxic effect short of mortality (e.g., swimming on side or upside down, cessation of swimming) within a short (acute) exposure period, usually 24 to 96 hours.

Henry's law constant (H): Relates the concentration of a compound in the gas phase to its concentration in the liquid phase. The constant is calculated from the formula: $H = P_{vp}/S$ where P_{vp} is pressure in atmospheres and S is solubility in moles/meter^3 for a compound.

K_{oc}: The soil/sediment partition or sorption coefficient normalized to the fraction of organic carbon in the soil. This value provides an indication of the chemical's tendency to partition between soil organic carbon and water.

LC_{50}: A concentration which is lethal to 50 percent of the aquatic animals tested within a short (acute) exposure period, usually 24 to 96 hours.

LD_{50}: The dosage which is lethal to 50 percent of the terrestrial animals tested within a short (acute) exposure period, usually 24 to 96 hours.

Method Detection Limits (MDLs): The minimum concentration of an analyte that can be detected with 99 percent confidence of its presence in the sample matrix.

Practical Quantitation Limits (PQLs): The lowest level of quantitation that can be reliably achieved within specified limit of precision and accuracy during routine laboratory operating conditions. The PQLs are further verified by analyzing spike concentrations whose relative standard deviation in 20 fortified water samples is < 15 percent. In general, PQLs are 2 to 5 times larger than the MDLs.

Soil or water half-life: The time required for one-half the concentration of the compound to be lost from the water or soil under the conditions of the test.

References

Adams, C.D. and E.M. Thurman. 1991. *Formation and Transport of Deethylatrazine in the Soil and Vadose Zone*. Journal Environmental Quality, 20: 540-547.

Goolsby, D.A., E.M. Thurman, M.L. Pomes, M.T. Meyer, and W.A. Battaglin. 1997. *Herbicides and Their Metabolites in Rainfall: Origin, Transport, and Deposition Patterns across the Midwestern and Northeastern United States, 1990-1991*. Environmental Science Technology, 31(5): 1325-1333.

Goss, D. and R. Wauchope. (Eds.) 1992. *The SCS/ARS/CES Pesticide Properties Database: II Using It With Soils Data In A Screening Procedure*. Soil Conservation Service. Fort Worth, TX.

Hartley, D. and H. Kidd. (Eds.) 1987. *The Agrochemicals Handbook.* Second Edition, The Royal Society of Chemistry. Nottingham, England.

Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt. 1990. *Handbook of Chemical Property Estimation Methods*. American Chemical Society, Washington, DC.

Mayer, F.L. and M.R. Ellersieck. 1986. *Manual of Acute Toxicity: Interpretation and Database for 410 Chemicals and 66 Species of Freshwater Animals*. United States Fish and Wildlife Service Publication No. 160.

Montgomery, J.H. 1993. *Agrochemicals Desk Reference: Environmental Data*. Lewis Publishers. Chelsea, MI.

Thurman, E.M., D.A. Goolsby, M.T. Meyer, M.S. Mills, M.L. Pomes, and D.W. Kolpin. 1992. *A Reconnaissance Study of Herbicides and Their Metabolites in Surface Water of the Midwestern United States Using Immunoassay and Gas Chromatography/Mass Spectrometry*. Environmental Science Technology, 26(12): 2440-2447.

U.S. EPA 1991. Pesticide Ecological Effects Database. Ecological Effects Branch, Office of Pesticide Programs, Washington, DC.

U.S. EPA 1994a. Pesticide Fact Sheet: Imidacloprid.

U.S. EPA 1994b Reregistration Eligibility Decision (RED) Bentazon, EPA 738-R-94-029 September 1994.

U.S. EPA 1996. *Drinking Water Regulations and Health Advisories*. Office of Water. EPA 822-B-96-002.

U.S. EPA 1998. Reregistration Eligibility Decision (RED) Metribuzin, EPA 738-R-37-006 February 1998.

U.S. EPA 2003a. Ambient Aquatic Life Water Criteria for Atrazine. Revised Draft EPA-822-R-03-023. October 2003.

U.S. EPA 2003b. Reregistration Eligibility Decision (RED) for Diuron, September 30, 2003

U.S. EPA 2005. Reregistration Eligibility Decision (RED) for Ametryn; EPA 738-R-05-006 September 2005.

U.S. EPA 2006. Decisions Document for Atrazine.

Verschueren, K. 1983. *Handbook of Environmental Data on Organic Chemicals*. Second Edition, Van Nostrand Reinhold Co. Inc. New York, NY.