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U.S. Department of the Interior
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Abstract

Sulfonylurea (SU), sulfonamide (SA), and imidazolinone (IMI) herbicides are recently developed herbicides that function by inhibiting the action of a key plant enzyme, stopping plant growth, and eventually killing the plant. These compounds generally have low mammalian toxicity, but crop and non-crop plants demonstrate a wide range in sensitivity to SUs, SAs, and IMIs, with over a 10,000-fold difference in observed toxicity levels for some compounds. SUs, SAs, and IMIs are applied either pre- or post-emergence to crops commonly at 1/50th or less of the rate of other herbicides. Little is known about their occurrence, fate, or transport in surface water or ground water in the United States.

To obtain information on the occurrence of SU, SA, and IMI herbicides in the Midwestern United States, 214 water samples were collected from 76 surface-water and 25 ground-water sites in 1998. These samples were analyzed for 16 SU, SA, and IMI herbicides by using high-performance liquid chromatography/mass spectrometry. Samples also were analyzed for 46 pesticides and pesticide degradation products and 13 herbicides and 10 herbicide degradates.

At least 1 of the 16 SUs, SAs, or IMIs was detected at or above the method reporting limit of 0.010 microgram per liter (μg/L) in 83 percent of 133 stream samples. Imazethapyr was detected most frequently (69 percent of samples), followed by flumetsulam (65 percent of samples) and nicosulfuron (53 percent of samples). At least one SU, SA, or IMI herbicide was detected at or above the method reporting limit in 6 of 8 reservoir samples and 5 of 25 ground-water samples. SU, SA, and IMI herbicides occurred less frequently and at a fraction (often 1/50th or less) of the concentrations of other herbicides such as atrazine. Acetochlor, atrazine, cyanazine, and metolachlor were all detected in 95 percent or more of 136 stream samples.

INTRODUCTION

During the last 20 years, low application rate herbicides have been developed that act by inhibiting the action of a key plant enzyme, which stops plant growth and eventually causes plant death. Sulfonylurea (SU), sulfonamide (SA), and imidazolinone (IMI) herbicides are three classes of compounds that share this mode of action (Whitcomb, 1998; Meister, 1999). Crops that can be treated with SU, SA, and IMI herbicides include barley, corn, cotton, durum wheat, rice, canola, peanuts, soybeans, sugar beets, spring wheat, and winter wheat. Some compounds also are approved for use on Conservation Reserve Program acreage and for noncropland weed control.

The amount of cropland in the Midwestern United States treated with SU, SA, and IMI herbicides nearly tripled between 1990 and 1997. The total corn, soybean, and wheat acreages on which nine SUs, one SA, and two IMIs were applied in 11 Midwestern States (Illinois, Indiana, Iowa, Kansas, Kentucky, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin) from 1990 through 1998 are shown in figure 1 (U.S. Department of Agriculture, 1991–99). In 1997, more than 66 million acres were treated with one of the 12 herbicides. For comparison, in the same 11-State area, atrazine, a triazine herbicide, was used on 41 million acres of corn; metolachlor, a chloroacetanilide herbicide, was used on 23 million acres of corn and soybeans; and glyphosate, an amino acid derivative, was used on 16 million acres of corn, soybeans, or wheat. In 1998, only 45 million acres of cropland were treated with one of the 12 low application rate herbicides, while 43 million acres were treated with atrazine, 21 million acres were treated with metolachlor, and 29 million acres were treated with glyphosate (U.S. Department of Agriculture, 1999).

Although applied over comparable areas as triazine or chloroacetanilide herbicides, SU, SA, and IMI herbicides are frequently applied after crops have

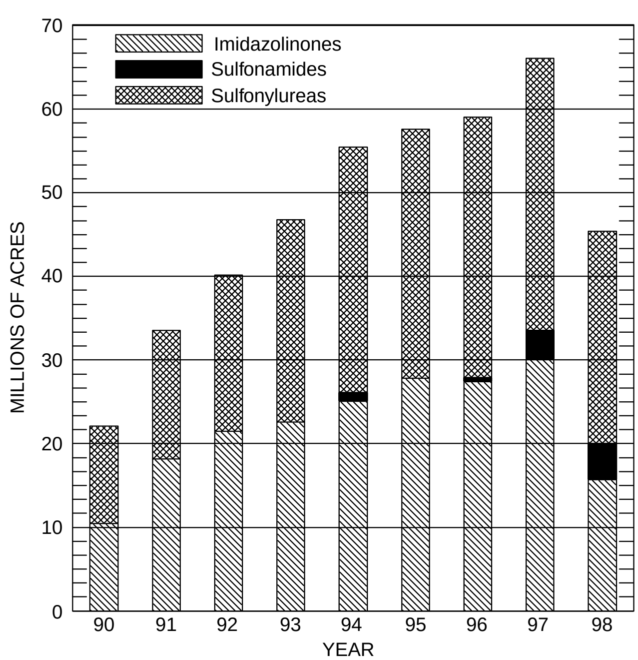


Figure 1. Estimated acres of corn, soybeans, and wheat treated with selected sulfonylurea, sulfonamide, and imidazolinone herbicides, 1998–98, in 11 Midwestern States.

emerged, and at low rates (typically less than 25 grams active ingredient per hectare). These application rates are commonly 1/50th or less of the rates for triazine or chloroacetanilide herbicides (typically more than 1,200 grams per hectare). Hence, the total amount of SU, SA, and IMI herbicides applied annually is small compared to the amount of triazines and chloroacetanilides applied. For example, in 1997 in the 11-State area, an estimated 22,390 tons of atrazine, 23,680 tons of metolachlor, and 5,660 tons of glyphosate were applied to cropland, while the total estimated use of the nine SUs, one SA, and two IMIs was only 1,200 tons (U.S. Department of Agriculture, 1998). In 1998, an estimated 23,770 tons of atrazine, 20,760 tons of metolachlor, and 12,450 tons of glyphosate were applied to cropland, while the estimated use of the nine SUs, one SA, and two IMIs was only 676 tons (U.S. Department of Agriculture, 1999).

Little was known about the occurrence, fate, or transport of SUs, SAs, and IMIs in the hydrologic systems in the United States. To gain a better understanding of the occurrence of these herbicides, a Cooperative Research and Development Agreement (CRADA) between the U.S. Geological Survey (USGS) and DuPont Agricultural Products was initiated in 1997. Battaglin and others (1998b) provided a complete description of this CRADA. The overall objective of the CRADA was to determine if and at what concentrations selected SUs, SAs, and IMIs occur in surface- and ground-water resources of the Midwestern United States. Specific objectives included:

- Developing an analytical method for selected SUs, SAs, and IMIs.
- Conducting a reconnaissance to determine the environmental occurrence of SU, SA, and IMI herbicides in surface water and ground water.
- Determining the frequency of detection and concentration distributions of SU, SA, and IMI herbicides relative to those of selected other herbicides.

These specific hypotheses were tested:

- The frequency of detections and concentrations of SU, SA, and IMI herbicides were significantly less than those of other herbicides that are applied in greater total amounts.
- The frequency of detections and concentrations of SU, SA, and IMI herbicides were greater in post-emergence runoff samples than in pre-emergence runoff samples.
- The frequency of detections and concentrations of SU, SA, and IMI herbicides were greater in streams and reservoirs than in ground water.
- The frequency of detections and concentrations of SU, SA, and IMI herbicides were greater in smaller watersheds that are predominantly agricultural than in larger watersheds that have more diverse land use and land cover.

Purpose and Scope

The purpose of this report is to describe analytical and data-collection methods and quality-assurance procedures and present data on selected SU, SA, and IMI herbicides, other pesticides, nutrients, and streamflow for samples collected in the spring and summer of 1998. These data are only adequate to identify the occurrence of selected SU, SA, IMI, and other pesticides during spring and summer runoff events in Midwestern streams and in ground water in parts of Iowa and Illinois. More data would be needed to estimate annual mean concentrations of detected analytes or to ensure that analytes that were not detected are not present at other times of the year.

Herbicide Properties

The soil half-lives of SUs, SAs, and IMIs generally range from 1 to 25 weeks depending on soil type, soil pH, and temperature. Their water solubilities range from 6 to 40,000 milligrams per liter (mg/L). The water solubilities of SUs are dependent on water pH. SUs degrade by chemical hydrolysis and microbial activity. SUs degrade faster in warm, moist, low pH soils with low organic content (DuPont, 1998). IMIs degrade by microbial activity and photolysis. IMIs degrade faster in warm, moist, low organic soils (Goetz and others, 1990).

SUs, SAs, and IMIs act upon a key plant enzyme (acetolactate synthase) that is not found in mammals or other animals. These herbicides are reported to have very low toxicities in animals (Brown, 1990; Meister, 1999). Terrestrial and aquatic plants demonstrate a wide range in sensitivity to SUs, SAs, and IMIs (Peterson and others, 1994; Whitcomb, 1998) with over a 10,000-fold difference in observed toxicity levels for some compounds. EC50 concentrations are measures of compound toxicity. An EC50 is the concentration in water of a compound that causes a 50-percent reduction in a chosen plant characteristic for which a toxicity endpoint exists. For example, EC50s for algae can be calculated from laboratory tests measuring biomass development in the presence of varying compound concentrations. EC50 values for selected SU, SA, IMI, and other herbicides on five aquatic plants are shown in figure 2 (Fahl and others, 1995; U.S. Environmental Protection Agency, 2000; Sabater and Carrasco, 1997; Fairchild and others, 1997; Wei and others, 1998; C.J. Peter, DuPont Agricultural Products, written commun., 1999). The EC50 values plotted are for green algae (*Selenastrum capricornutum*), duckweed (*Lemna gibba*), blue-green algae (*Anabaena flos-aquae*), freshwater algae (*Scenedesmus costatum*), and freshwater diatom (*Navicula pelliculosa*). In some cases, EC50 values from more than one test on the same plant species are included. EC50 values for several herbicides range over three orders of magnitude. The EC50 data plotted in figure 2 support the hypothesis that an individual concentration of 0.1 µg/L (microgram per liter) in water is an acceptable baseline for non-target aquatic plant toxicity.

SUs, SAs, and IMIs are active at very low concentrations. They can cause reduced yields in some crop rotations, even when only 1 percent or less of the originally applied material remains. Some of these herbicides have demonstrated residual phytotoxicity to rotation crops such as corn, sunflowers, sugar beets, and dry beans (Anderson and Humburg, 1987; Curran and others, 1991). The labels of some of these herbicides restrict the planting of certain rotational crops. Fletcher and others (1993) indicated that spray drift containing SUs at concentrations less than 1 percent

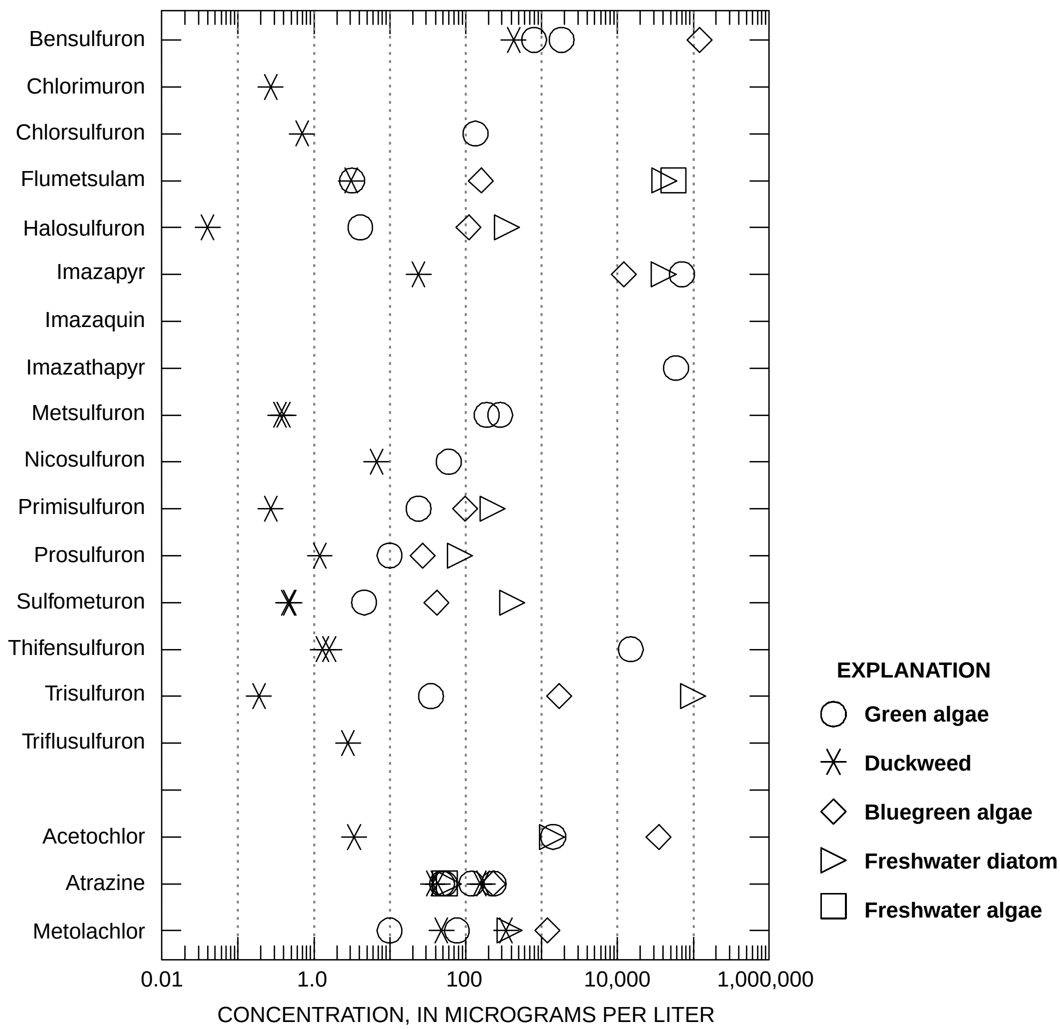


Figure 2. EC50 concentrations in micrograms per liter for selected herbicides on five aquatic plants.

of the recommended application rate may adversely impact fruit tree yields. Felsot and others (1996) suggested that the appearance of chlorotic spots on crops in south-central Washington is a result of exposure to low levels of SU herbicides from precipitation and not from direct spray drift. However, Obrigawitch and others (1998) questioned the validity of Fletcher's findings and the results of other studies (Al-Khatib and others, 1992; Curran and others, 1991) that based their findings on short-term plant-response assessments. Obrigawitch and others (1998) found that a treatment rate of 0.1 gram of the most active SU ingredient per hectare (0.00009 pound per acre) represents a "threshold dose" and would be unlikely to reduce the yields of even the most sensitive non-target plants.

Previous Investigations and Expected Concentrations

Detections of SUs, SAs, and IMIs in water collected from environmental settings have been rare, and the few reported detections have been at nanogram per liter concentrations (Bergstrom, 1990; Michael and Neary, 1993; D'Ascenzo and others, 1998; Okamoto and others, 1998; Steinheimer and others, 2000; Battaglin and others, 2000).

However, several studies indicate that some SU, SA, and IMI herbicides may leach beyond the active root zone and enter ground-water or surface-water systems (Anderson and Humburg, 1987; Bergstrom, 1990; Flury and others, 1995; Veeh and others, 1994). Once in ground water or surface water, some SUs, SAs, and IMIs will tend to persist as the parent compound while others will tend to hydrolyze (Dinelli and others, 1997; Harvey and others, 1985). A study by Afyuni and others (1997) indicated that between 1.1 and 2.3 percent of an applied SU was lost in runoff during a simulated rainfall event 24 hours after herbicide application.

Because of their low application rates and low overall use amounts, SU, SA, and IMI herbicides were expected to occur at below part-per-billion concentrations in most water resources. One also can assume, based upon their chemical characteristics, application rates, and acres treated, that individual SU, SA, and IMI herbicides would be expected to occur in surface or ground water at 1 to 0.1 percent or less of the concentration of the more commonly used triazine herbicides. The USGS measured concentrations of 11 common herbicides and 2 herbicide metabolites in samples from 52 midwestern streams during runoff events that occurred soon after herbicide application in 1989, 1990, 1994, and 1995 (Goolsby and others, 1994; Scribner and others, 1998). Median atrazine concentration for the 4 years of data ranged from 5.5 to 10.9 µg/L; median cyanazine concentrations ranged from 1.3 to 2.7 µg/L; and median metolachlor concentrations ranged from 1.7 to 2.5 µg/L. Maximum concentrations for these three compounds for the 4 years ranged from 10.6 to 108 µg/L. Thus, one could expect to observe SU, SA, and IMI herbicides in midwestern streams during post-application runoff events at concentrations ranging from 0.001 to 0.1 µg/L. Further, one could expect maximum concentrations of SU, SA, and IMI herbicides to range from 0.01 to 1.0 µg/L (Battaglin and others, 1998a). The concentrations of triazine herbicides observed in ground water (Kolpin and others, 1994) are generally one to two orders of magnitude less than those observed in streams during post-application runoff. Hence, one would expect that SU, SA, and IMI concentrations would seldom exceed 0.01 µg/L in ground water.

Acknowledgments

Mariel Rodriguez, C. John Peter, Michael Duffy, and Dayan Goodnough of DuPont Agricultural Products provided information and insights regarding the environmental and analytical chemistry of the herbicides investigated. Samples for this study were collected by USGS employees from Illinois, Indiana, Iowa, Kansas, Kentucky, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin and analyzed by USGS employees at the National Water Quality Laboratory (NWQL) in Lakewood, Colorado, and the USGS Laboratory in Lawrence, Kansas. The authors are grateful for comments by Michael Duffy, DuPont, and reviews by Tom Leiker, Donald Goolsby, and John Flager of the USGS.

METHODS

The study involved collection of more than 200 samples during a 1998 reconnaissance. Samples were collected in the spring and early summer from streams, large rivers, reservoir outflows, and wells, sometimes in conjunction with USGS National Stream Quality Accounting Network (NASQAN) (Hooper and others, 1997) and National Water-Quality Assessment (NAWQA) (Leahy and Thompson, 1994) activities. All reconnaissance samples were analyzed for 16 SU, SA, and IMI herbicides (table 1) using high-performance liquid chromatography coupled with mass spectrometry. This custom analytical method has an estimated method reporting limit (MRL) of 0.010 µg/L for all analytes and is fully described by Furlong and others (2000). All samples also were analyzed for 69 other pesticides or degradates.

Sampling Sites

Samples were collected from 71 sites on free-flowing streams in the Upper Mississippi, Missouri, and Ohio River basins (figs. 3 and 4, table 2). Fifty-two of the surface-water sites have been studied in previous Midcontinent Herbicide Initiative (MHI) investigations (Thurman and others, 1992; Goolsby and others, 1994; Scribner and others,

Table 1. Common names, trade names, and manufacturers for pesticides analyzed for in this study (data from Larson and others, 1997; Meister, 1999)

Common name	Chemical class	Trade names	Primary bulk producer(s)
Sulfonylurea, Sulfonamide, and Imidazolinone Herbicides			
bensulfuron methyl	sulfonylurea	Londax	DuPont
chlorimuron ethyl	sulfonylurea	Classic, Preview	DuPont
chlorsulfuron	sulfonylurea	Glean, Telar, Finesse	DuPont
flumetsulam	sulfonamide	Broadstrike, Preside, Scorpion, Python	Dow AgroSciences
halosulfuron methyl	sulfonylurea	Battalion, Manage, Permit, Sempra	Monsanto, Nissan
imazapyr	imidazolinone	Arsenal, Chopper, Lightning	BASF
imazaquin	imidazolinone	Scepter, Detail, Squadron	BASF
imazethapyr	imidazolinone	Pursuit, Lightning, Contour	BASF
metsulfuron methyl	sulfonylurea	Allie, Ally, Escort, Finesse, Canvas	DuPont
nicosulfuron	sulfonylurea	Accent, Basis Gold, Celebrity+	DuPont
primisulfuron methyl	sulfonylurea	Beacon, Tell, Exceed	Novartis
prosulfuron	sulfonylurea	Peak, Exceed	Novartis
sulfometuron methyl	sulfonylurea	Oust	DuPont
thifensulfuron methyl	sulfonylurea	Pinnacle, Canvas, Basis, Reliance, Harmony	DuPont
triasulfuron	sulfonylurea	Amber, Graminon Forte	Novartis
triflusulfuron methyl	sulfonylurea	Upbeet	DuPont
Other Pesticides and Degradates			
acetochlor	chloroacetamide	Harness, Field Master, Surpass	Monsanto, Zeneca
alachlor	acetanilide	Lasso, Partner, Lariat, Bronco, Freedom	Monsanto, Crystal
2,6-diethylaniline	alachlor degradate		
atrazine	triazine	AAtrex, Gesaprim, Bicep	Novartis
deethylatrazine	atrazine degradate		
azinphos-methyl	organophosphate	Guthion, Gusathion	Bayer
benfluralin (Benefin)	dinitroaniline	Balan	Dow AgroScience
butylate	thiocarbamate	Sutan +	Micro Flo
carbaryl	carbamate	Sevin, Sevimol	Aventis
carbofuran	carbamate	Furadan	FMC
chlorpyrifos	organophosphate	Dursban, Empire	Dow AgroSciences
cyanazine	triazine	Bladex	BASF
dacthal	chlorobenzoic acid	Dacthal	Zeneca
diazinon	organophosphate	Basudin, Knoxout	Novartis, Cleary Chemical
dieldrin	organochlorine	Dieldrex (discontinued, 1991)	Shell
disulfoton	organophosphate	Disyston, Furmin AL	Bayer, Novartis
EPTC	thiocarbamate	Eptam, Eradicane	Zeneca
ethalfluralin	dinitroaniline	Sonalan	Dow AgroScience
ethoprophos	organophosphate	Chipco, Mocap	Aventis
fonofos	organophosphate	fonofos	Zeneca
lindane	organochloride	Sevidol	Aventis
linuron	urea	Lorox, Metolin	DuPont
malathion	organophosphate	Malatox, Malixol	Helb USA, Aventis
metolachlor	chloracetanilide	Dual, Pennant, Derby, Bicep	Novartis
metribuzin	triazine	Contrast, Turbo, Sencor, Lexone, Canopy	Bayer, DuPont
molinate	thiocarbamate	Ordram	Zeneca
napropamide	amide	Devrinol	United Phosphorus
parathion	organophosphate	not registered for use in U.S.	BASF

Table 1. Common names, trade names, and manufacturers for pesticides analyzed for in this study (data from Larson and others, 1997; Meister, 1999)—Continued

Common name	Chemical class	Trade names	Primary bulk producer(s)
		Other Pesticides and Degradates—Continued	
parathion methyl	organophosphate	Bladan, Metacide	Bayer
pebulate	thiocarbamate	Tillam	Zeneca
pendimethalin	dinitroaniline	Accotab, Herbadox, Stomp	BASF, Scotts
phorate	organophosphate	Geomet, Thimet, Granutox	BASF
prometon	triazine	Pramitol	Novartis
propachlor	acetanilide	Ramrod	Monsanto
propanil	amide	Surcopur, Cedar Porpanil	Bayer, Cedar Chemical
propargite	sulfite ester	Comite, Omite, Ornamite	Uniroyal Chemical
propyzamide (also pronamide)	amide	Kerb, Rapier	Rohm and Haas, United Phosphorus
simazine	triazine	Gesatop, Princep, Derby	Novartis
tebuthiuron	urea	Spike	Dow AgroScience
terbacil	urea	Sinbar	DuPont
terbufos	organophosphate	Contraven, Counter	BASF
thiobencarb	thiocarbamate	Bolero, Saturn, Bigturn, Tobosa	Kumiai Chemical, Sanonda, Crystal Inter-America
tri-allate	thiocarbamate	Far-Go, Buckle	Monsanto
trifluralin	dinitroaniline	Treflan, Trilin, Tri-Scept	Dow AgroScience, Griffin
alpha-HCH	organochlorine	degradate of BHC, not sold for use in U.S.	Hooker Chemical
cis-Permethrin	pyrethroid	Ambush, Prelude, Dragon, Permit, Outflank, Astro, Flee, Ancothrin	BASF, FMC, Zeneca, Sanonda, Helb USA
		Other Herbicides and Degradates	
acetochlor	chloroacetamide	Harness, Field Master, Surpass	Monsanto, Zeneca
acetochlor ESA	acetochlor degradate		
acetochlor oxanilic acid	acetochlor degradate		
alachlor	acetanilide	Lasso, Partner, Lariat, Bronco, Freedom	Monsanto, Crystal
alachlor ESA	alachlor degradate		
alachlor oxanilic acid	alachlor degradate		
ametryn	triazine	Evik, Gesapaz, Crisatrina	Monsanto, Crystal
atrazine	triazine	AAtrex, Gesaprim, Bicep	Novartis
deethylatrazine	atrazine degradate		
deisopropylatrazine	atrazine degradate		
hydroxy-atrazine	atrazine degradate		
cyanazine	triazine	Bladex	BASF
cyanazine-amide	cyanazine degradate		
metolachlor	chloracetanilide	Dual, Pennant, Derby, Bicep	Novartis
metolachlor ESA	metolachlor degradate		
metolachlor oxanilic acid	metolachlor degradate		
metribuzin	triazine	Contrast, Turbo, Sencor, Lexone, Canopy	Bayer, DuPont
prometon	triazine	Pramitol	Novartis
prometryn	triazine	Cotton-Pro, Caparol, Gesagard	Novartis, Griffin
propachlor	acetanilide	Ramrod	Monsanto
propazine	triazine	Prozinex	Makhteshim-Agan
simazine	triazine	Gesatop, Princep, Derby	Novartis
terbutryn	triazine	Ternit, Terbutrex	Crystal, Makhteshim-Agan

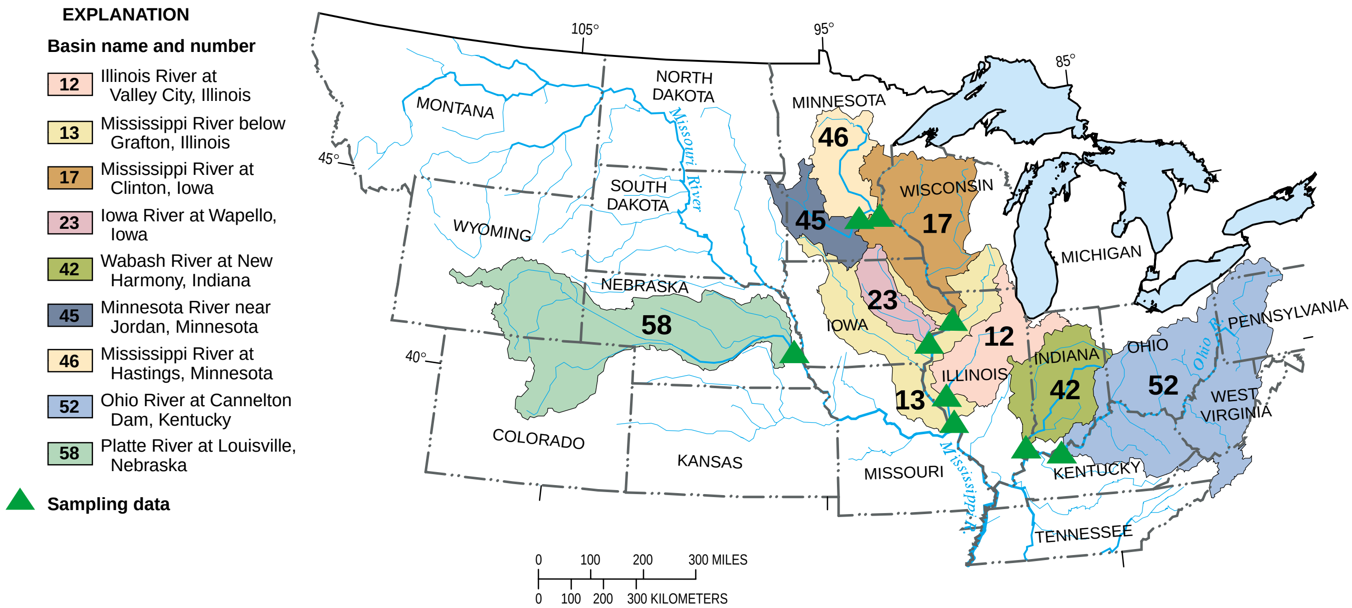


Figure 3. Location and associated basin for the nine stream sites with large drainage areas.

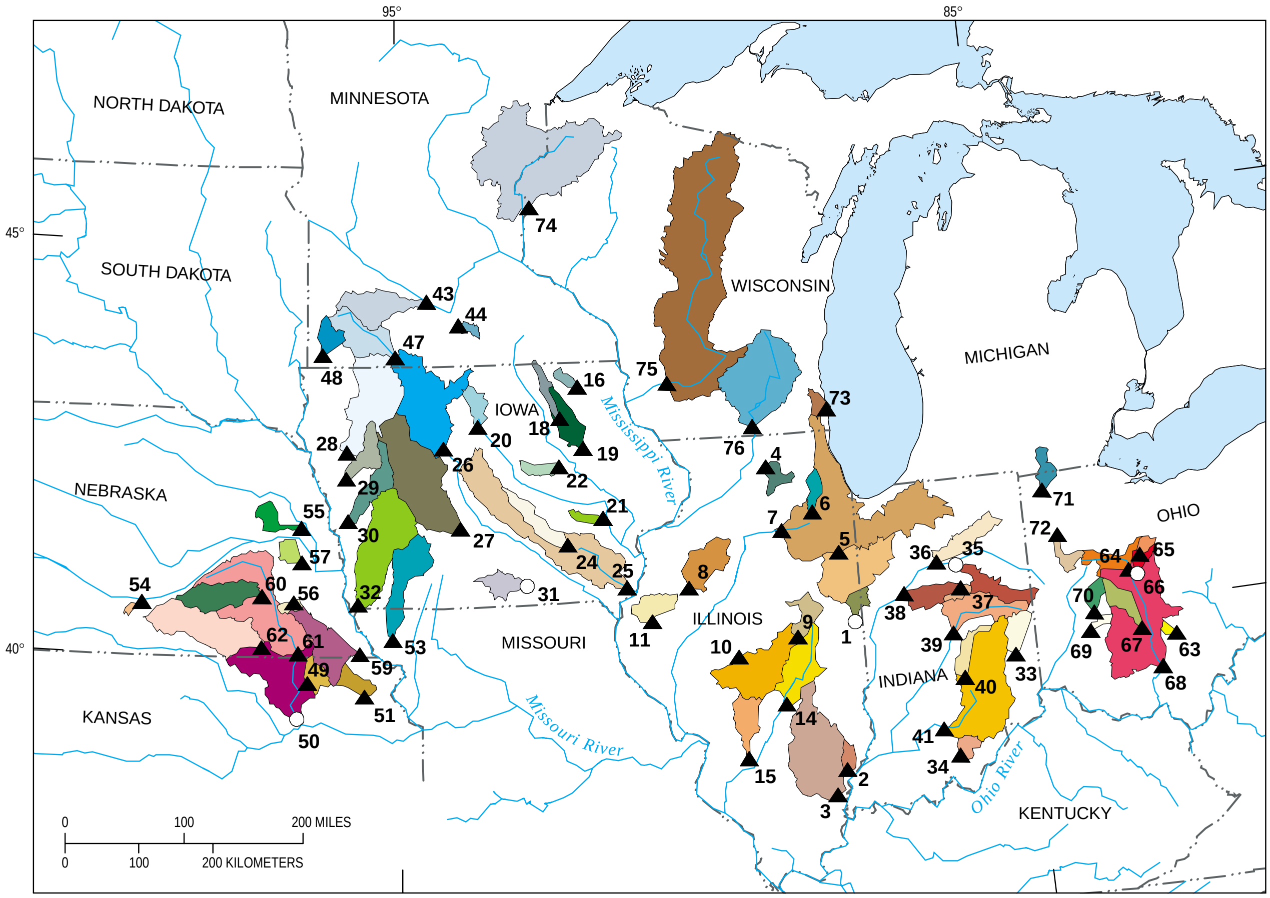
1998). These sites were selected from the set of 150 sites sampled in 1989 using a stratified random method (Scribner and others, 1993). The sampling strategy used was not designed to produce an unbiased estimate of herbicide occurrence in all midwestern streams; rather, the intent was to target higher risk areas while still capturing the variability of the entire population. Samples also were collected at 19 NASQAN or NAWQA sites. Figure 3 shows locations and associated basins for the sites with the nine largest drainage areas. The drainage areas for these sites ranged from 12,499 to 171,300 square miles, and the median drainage area was 37,050 square miles. Figure 4 shows locations and associated basins for the other 62 sites on free-flowing streams. Drainage areas for these sites ranged from 77.7 to 10,400 square miles, and the median drainage area was 655 square miles.

Samples also were collected just downstream from five reservoirs (table 2) at locations that had been sampled in a previous investigation (Coupe and others, 1995; Scribner and others, 1996). The locations and associated basins for these sites area also are shown in figure 4. Drainage areas for these sites ranged from 298 to 9,628 square miles.

Ground-water samples were collected from 25 wells in Iowa and Illinois (fig. 5, table 3). Twenty samples are from a network of municipal wells in Iowa that are part of the Iowa Ground Water Monitoring (IGWM) program (Detroy and others, 1988; Kolpin and others, 1997). Wells from this network have been sampled systematically since 1982. The depths to the top of the well screen for the 20 sampled wells ranged from 6 to 83 meters with 16 of the 20 being less than 20 meters. Five samples are from observation wells in the Lower Illinois NAWQA study unit (Warner and Schmidt, 1994). These five wells were all less than 8 meters deep.

Sampling Schedule and Procedure

Two samples were collected at each surface-water and reservoir site, and one sample was collected at each ground-water site in 1998. The first surface-water samples were collected after pre-emergence herbicides were applied (May or June) and following a precipitation event that produced a significant increase in streamflow. These samples will be referred to as pre-emergence runoff samples. These samples are comparable to the “post-application” samples



EXPLANATION

Sampling site name

1–Vermillion River, Lake Vermillion, IL
2–Bonpas Creek at Browns, IL
3–Little Wabash River at Carmi, IL
4–S. Branch Kishwaukee River, Fairdale, IL
5–Iroquois River near Chebanse, IL
6–Dupage River near Shorewood, IL
7–Illinois River at Marseilles, IL
8–Spoon River at London Mills, IL
9–Sangamon River near Monticello, IL
10–Sangamon River at Riverton, IL
11–LaMoine River at Colmar, IL
14–Kaskaskia River near Cowden, IL
15–Shoal Creek near Breese, IL
16–Turkey River at Spillville, IA
18–Wapsipinicon River near Tripoli, IA
19–Wapsipinicon River at Independence, IA
20–Iowa River near Rowan, IA
21–Old Mans Creek near Iowa City, IA
22–Wolf Creek near Dysart, IA
24–N. Skunk River near Sigourney, IA
25–Skunk River at Augusta, IA
26–Des Moines River at Fort Dodge, IA
27–Raccoon River at Van Meter, IA
28–Little Sioux River, Correctionville, IA
29–Maple River at Mapleton, IA
30–Boyer River at Logan, IA
31–Chariton River below Rathbun Lake, IA
32–Nishnabotna River above Hamburg, IA
33–Whitewater River near Alpine, IN
34–Blue River at Fredericksburg, IN
35–Mississinewa River, Mississinewa Lake, IN
36–Eel River near Logansport, IN
37–Wildcat Creek near Jerome, IN
38–Wildcat Creek near Lafayette, IN
39–White River near Nora, IN
40–Sugar Creek near Edinburgh, IN
41–E. Fork White River near Bedford, IN
43–Cottonwood River near New Ulm, MN
44–Little Cobb River near Beauford, MN
47–Des Moines River at Jackson, MN
48–Rock River at Luverne, MN
49–Black Vermillion River, Frankfort, KS
50–Big Blue River, Tuttle Creek Lake, KS
51–Delaware River near Muscotah, KS
53–Nodaway River near Graham, MO
54–North Dry Creek near Kearney, NE
55–Maple Creek near Nickerson, NE
56–Salt Creek at Roca, NE
57–Wahoo Creek at Ithaca, NE
59–Big Nemaha River, Falls City, NE
60–W. Fork Big Blue River, Dorchester, NE
61–Big Blue River at Barneston, NE
62–Little Blue River near Fairbury, NE
63–Clear Creek near Rockbridge, OH
64–Scioto River near Prospect, OH
65–Olentangy River at Claridon, OH
66–Olentangy River, Delaware Lake, OH
67–Big Darby Creek at Darbyville, OH
68–Scioto River at Higby, OH
69–L. Miami River near Oldtown, OH
70–Mad River at Eagle City, OH
71–Tiffin River at Stryker, OH
72–Auglaize River at Ft. Jennings, OH
73–Root River at Racine, WI
74–St. Croix River, St. Croix Falls, WI
75–Wisconsin River at Muscoda, WI
76–Rock River at Afton, WI

▲ **Stream sampling site**

○ **Reservoir sampling site**

Figure 4. Location and associated basin for the 62 stream and 5 reservoir sites with smaller drainage areas.

Table 2. Surface-water sampling sites

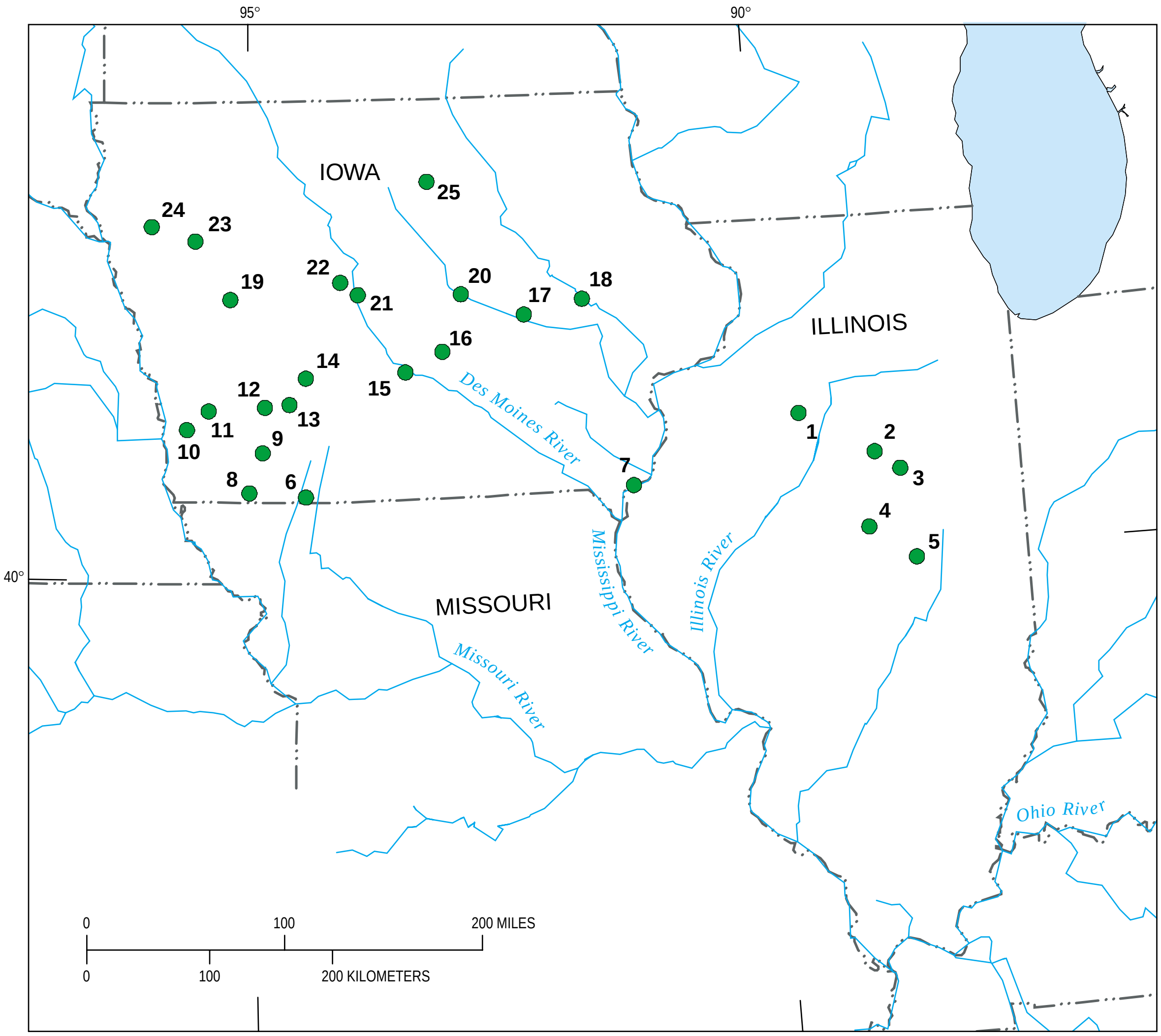
[mi^2, square miles; dd, degrees; mm, minutes; ss, seconds]

Site no. (figs. 3, 4)	Station identification no.	Site name	Site type	Drainage area (mi^2)	Latitude (ddmmss)	Longitude (ddmmss)
		Illinois				
1	03338890	Vermillion River below Lake Vermillion Dam, IL	reservoir	298	400924	873906
2	03378000	Bonpas Creek at Browns, IL	stream	228	382311	875832
3	03381495	Little Wabash River at Carmi, IL	stream	3,088	380532	880922
4	05439500	S. Branch Kishwaukee River near Fairdale, IL	stream	387	420639	885402
5	05526000	Iroquois River near Chebanse, IL	stream	2,091	410032	874927
6	05540500	Dupage River near Shorewood, IL	stream	324	413120	881135
7	05543500	Illinois River at Marseilles, IL	stream	8,259	411937	884303
8	05569500	Spoon River at London Mills, IL	stream	1,072	404232	901653
9	05572000	Sangamon River near Monticello, IL	stream	550	400151	883520
10	05576500	Sangamon River at Riverton, IL	stream	2,618	395034	893252
11	05584500	LaMoine River at Colmar, IL	stream	655	401945	905355
12	05586100	Illinois River at Valley City, IL	stream	26,743	394212	903843
13	05587455	Mississippi River below Grafton, IL	stream	171,300	385805	902542
14	05592100	Kaskaskia River near Cowden, IL	stream	1,330	391350	885033
15	05594000	Shoal Creek near Breese, IL	stream	735	383635	892940
		Iowa				
16	05411600	Turkey River at Spillville, IA	stream	177	431228	915656
17	05420500	Mississippi River at Clinton, IA	stream	85,600	414650	901507
18	05420680	Wapsipinicon River near Tripoli, IA	stream	343	425010	921526
19	05421000	Wapsipinicon River at Independence, IA	stream	1,048	422749	915342
20	05449500	Iowa River near Rowan, IA	stream	429	424536	933723
21	05455100	Old Mans Creek near Iowa City, IA	stream	201	413623	913656
22	05464220	Wolf Creek near Dysart, IA	stream	299	421506	921755
23	05465500	Iowa River at Wapello, IA	stream	12,499	411041	911055
24	05472500	N. Skunk River near Sigourney, IA	stream	730	411803	921216
25	05474000	Skunk River at Augusta, IA	stream	4,303	404513	911640
26	05480500	Des Moines River at Fort Dodge, IA	stream	4,190	423022	941204
27	05484500	Raccoon River at Van Meter, IA	stream	3,441	413202	935659
28	06606600	Little Sioux River at Correctionville, IA	stream	2,500	422820	954749
29	06607200	Maple River at Mapleton, IA	stream	669	420925	954835
30	06609500	Boyer River at Logan, IA	stream	871	413833	954657
31	06903900	Chariton River near below Rathbun Lake Dam, IA	reservoir	549	404922	925322
32	06810000	Nishnabotna River above Hamburg, IA	stream	2,806	403757	953732
		Indiana				
33	03275000	Whitewater River near Alpine, IN	stream	529	393423	850927
34	03302800	Blue River at Fredericksburg, IN	stream	283	382602	861131
35	03327000	Mississinewa River below Mississinewa Lake Dam, IN	reservoir	808	404324	855727
36	03328500	Eel River near Logansport, IN	stream	789	404655	861550
37	03333450	Wildcat Creek near Jerome, IN	stream	146	402629	855508
38	03335000	Wildcat Creek near Lafayette, IN	stream	794	402626	864945
39	03351000	White River near Nora, IN	stream	1,219	395435	860620
40	03362500	Sugar Creek near Edinburgh, IN	stream	474	392139	855951
41	03371500	E. Fork White River near Bedford, IN	stream	3,861	384610	862430
42	03378500	Wabash River at New Harmony, IN	stream	29,234	380755	875625

Table 2. Surface-water sampling sites—Continued

[mi^2, square miles; dd, degrees; mm, minutes; ss, seconds]

Site no. (figs. 3, 4)	Station identification no.	Site name	Site type	Drainage area (mi^2)	Latitude (ddmmss)	Longitude (ddmmss)
		Minnesota				
43	05317000	Cottonwood River near New Ulm, MN	stream	1,300	441729	942624
44	05320270	Little Cobb River near Beauford, MN	stream	130	435948	935430
45	05330000	Minnesota River near Jordan, MN	stream	16,200	444135	933830
46	05331580	Mississippi River near Hastings, MN	stream	37,050	444448	925108
47	05476000	Des Moines River at Jackson, MN	stream	1,250	433710	945910
48	06483000	Rock River at Luverne, MN	stream	425	433915	961203
		Kansas				
49	06885500	Black Vermillion River at Frankfort, KS	stream	410	394103	962615
50	06887000	Big Blue River below Tuttle Creek Lake Dam, KS	reservoir	9,628	391516	963608
51	06890100	Delaware River near Muscotah, KS	stream	431	393117	953157
		Kentucky				
52	03303280	Ohio River at Cannelton Dam, KY	stream	97,000	375358	864220
		Missouri				
53	06817700	Nodaway River near Graham, MO	stream	1,380	401208	950407
		Nebraska				
54	06770195	North Dry Creek near Kearney, NE	stream	77.7	403828	990656
55	06800000	Maple Creek near Nickerson, NE	stream	369	413339	963227
56	06803000	Salt Creek at Roca, NE	stream	167	403929	963955
57	06804000	Wahoo Creek at Ithaca, NE	stream	273	410840	963210
58	06805500	Platte River at Louisville, NE	stream	85,370	410055	960928
59	06815000	Big Nemaha River at Falls City, NE	stream	1,339	400208	953545
60	06880800	W. Fork Big Blue River, Dorchester, NE	stream	1,192	404352	971038
61	06882000	Big Blue River at Barneston, NE	stream	4,447	400240	963512
62	06884000	Little Blue River near Fairbury, NE	stream	2,350	400654	971013
		Ohio				
63	03157000	Clear Creek near Rockbridge, OH	stream	89	393518	823443
64	03219500	Scioto River near Prospect, OH	stream	567	402510	831150
65	03223000	Olentangy River at Claridon, OH	stream	157	403458	825920
66	03225500	Olentangy River below Delaware Lake Dam, OH	reservoir	393	402118	830402
67	03230500	Big Darby Creek at Darbyville, OH	stream	534	394202	830637
68	03234500	Scioto River at Higby, OH	stream	5,131	391244	825150
69	03240000	L. Miami River near Oldtown, OH	stream	129	394454	835553
70	03267900	Mad River at Eagle City, OH	stream	310	395751	834954
71	04185000	Tiffin River at Stryker, OH	stream	410	413016	842547
72	04186500	Auglaize River at Fort Jennings, OH	stream	332	405655	841558
		Wisconsin				
73	04087240	Root River at Racine, WI	stream	190	424505	874925
74	05340500	St. Croix River at St. Croix Falls, WI	stream	6,240	452425	923849
75	05407000	Wisconsin River at Muscoda, WI	stream	10,400	431153	902636
76	05430500	Rock River at Afton, WI	stream	3,340	423633	890414



EXPLANATION

● **Ground-water sampling site**

Illinois
1—LUS1–4
2—LUS1–14
3—LUS1–26
4—LUS2–9
5—LUS2–22

Iowa
6—Blockton 1
7—Fort Madison 4
8—Shambaugh 3
9—Nodaway 4
10—Silver City 3
11—Carson (5), 3
12—Cumberland 1

Iowa
13—Fontanelle 5
14—Menlo 3
15—Carlisle 5
16—Newton 3
17—Belle Plaine 4
18—Cedar Rapids S6
19—Vail 1
20—Marshalltown 8
21—Boone 20
22—Boxholm 2
23—Holstein 3
24—Kingsley 1
25—Sheffield 2

Figure 5. Location of the 25 well sites.

collected in 1989, 1990, 1994, and 1995 from many of the stream sites (Goolsby and others, 1994; Scribner and others, 1998). The second surface-water samples were collected after post-emergence herbicides were applied (June or July), again following a precipitation event that produced runoff and an increase in streamflow. These samples will be referred to as post-emergence runoff samples. Samples collected at current NASQAN stations and the reservoir samples were collected 2–3 weeks after the first surface-water samples were collected from nearby sites. The second NASQAN and reservoir samples were collected 2–3 weeks after the second surface-water samples were collected from nearby sites. Ground-water samples were collected in June, July, or August. The dates of sample collection and discharge on the date of sample collection (for surface-water sites) are given in tables 3 and 4.

Table 3. Ground-water sampling sites and sample type, number, and date of collection

[dd, degrees; mm, minutes; ss, seconds; W1, well sample from round 1; WD, duplicate well sample]

Site no. (fig. 5)	Site name	Depth to top of well screen, in feet	Latitude (ddmmss)	Longitude (ddmmss)	Sample type	Sample no.	Date of sample collection
			Illinois				
1	LUS1–4	15.5	410502	893925	W1	SU–11	05/19/1998
2	LUS1–14	24.0	404603	885635	W1	SU–7	05/18/1998
					WD	SU–10	05/18/1998
3	LUS1–26	8.33	403759	884226	W1	SU–118	06/18/1998
4	LUS2–9	12.50	401327	890252	W1	SU–111	06/15/1998
5	LUS2–22	7.66	395853	883644	W1	SU–121	06/18/1998
			Iowa				
6	Blockton 1	271	403659	942853	W1	SU–184	07/23/1998
7	Fort Madison 4	147	403745	911747	W1	SU–182	07/22/1998
8	Shambaugh 3	30	403906	950150	W1	SU–186	07/24/1998
9	Nodaway 4	36	405632	945344	W1	SU–185	07/23/1998
10	Silver City 3	60	410656	953802	W1	SU–198	07/31/1998
					WD	SU–199	07/31/1998
11	Carson (5), 3	28	411501	952513	W1	SU–200	07/31/1998
12	Cumberland 1	155	411622	945209	W1	SU–188	07/27/1998
13	Fontanelle 5	39	411727	943740	W1	SU–183	07/23/1998
14	Menlo 3	20	412852	942751	W1	SU–193	07/29/1998
15	Carlisle 5	30	413040	932905	W1	SU–187	07/27/1998
16	Newton 13	45	413913	930700	W1	SU–71	06/03/1998
17	Belle Plaine 4	42	415417	921801	W1	SU–70	06/02/1998
18	Cedar Rapids S6	65	420005	914312	W1	SU–211	08/25/1998
					WD	SU–212	08/25/1998
19	Vail 1	32	420336	951156	W1	SU–137	06/23/1998
20	Marshalltown 8	223	420405	925456	W1	SU–72	06/02/1998
21	Boone 20	63	420451	935613	W1	SU–190	07/28/1998
22	Boxholm 2	49	421025	940630	W1	SU–189	07/25/1998
					WD	SU–191	07/25/1998
23	Holstein 3	54	422915	953235	W1	SU–139	06/25/1998
24	Kingsley 1	37	423537	955839	W1	SU–138	06/25/1998
25	Sheffield 2	27	425341	931325	W1	SU–192	07/29/1998

Table 4. Collection dates, sample types, sample numbers, and daily mean discharge for samples from surface-water sites

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample]

Site no. (figs. 3, 4)	Site name	Sample type	Sample no.	Date of sample collection	Daily mean discharge, in cubic feet per second
	Illinois				
1	Vermillion River below Lake Vermillion Dam, IL	R1	SU–98	06/10/1998	494
		RD	SU–103	06/10/1998	494
		R2	SU–177	07/16/1998	162
2	Bonpas Creek at Browns, IL	S1	SU–43	05/23/1998	834
		S2	SU–166	07/07/1998	499
3	Little Wabash River at Carmi, IL	S1	SU–33	05/23/1998	9,340
		S2	SU–175	07/09/1998	4,020
4	S. Branch Kishwaukee River near Fairdale, IL	S1	SU–29	05/20/1998	1,620
		S2	SU–195	07/29/1998	61
5	Iroquois River near Chebanse, IL	S1	SU–99	06/10/1998	1,340
		SD	SU–101	06/10/1998	1,340
		S2	SU–168	07/08/1998	8,490
		SD	SU–170	07/08/1998	8,490
6	Dupage River near Shorewood, IL	S1	SU–100	06/09/1998	284
		SD	SU–102	06/09/1998	284
		S2	SU–194	07/29/1998	166
		SD	SU–196	07/29/1998	166
7	Illinois River at Marseilles, IL	S1	SU–113	06/12/1998	36,800
		S2	SU–176	07/09/1998	21,600
8	Spoon River at London Mills, IL	S1	SU–25	05/20/1998	1,270
		SB	SU–26	05/20/1998	1,270
		S2	SU–160	07/01/1998	1,780
9	Sangamon River near Monticello, IL	S1	SU–35	05/23/1998	836
		S2	SU–201	08/05/1998	268
10	Sangamon River at Riverton, IL	S1	SU–44	05/26/1998	6,800
		S2	SU–174	07/09/1998	4,070
11	LaMoine River at Colmar, IL	S1	SU–27	05/21/1998	939
		S2	SU–142	06/29/1998	2,320
		SD	SU–143	06/29/1998	2,320
12	Illinois River at Valley City, IL	S1	SU–120	06/18/1998	49,700
		S2	SU–207	08/12/1998	21,700
13	Mississippi River below Grafton, IL	S1	SU–60	06/02/1998	172,000
		S2	SU–116	06/15/1998	267,000
14	Kaskaskia River near Cowden, IL	S1	SU–30	05/20/1998	1,400
		S2	SU–169	07/08/1998	2,700
15	Shoal Creek near Breese, IL	S1	SU–32	05/22/1998	768
		SD	SU–34	05/22/1998	768
		S2	SU–167	07/08/1998	761

Table 4. Collection dates, sample types, sample numbers, and daily mean discharge for samples from surface-water sites—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample]

Site no. (figs. 3, 4)	Site name	Sample type	Sample no.	Date of sample collection	Daily mean discharge, in cubic feet per second
	Iowa				
16	Turkey River at Spillville, IA	S1	SU–64	06/02/1998	181
		S2	SU–109	06/12/1998	534
17	Mississippi River at Clinton, IA	S1	SU–55	05/27/1998	56,600
		S2	SU–155	07/01/1998	101,000
18	Wapsipinicon River near Tripoli, IA	S1	SU–54	05/27/1998	595
		SB	SU–125	06/20/1998	1,300
		S2	SU–126	06/20/1998	1,300
19	Wapsipinicon River at Independence, IA	S1	SU–56	05/29/1998	2,570
		S2	SU–110	06/12/1998	4,560
20	Iowa River near Rowan, IA	S1	SU–65	06/02/1998	1,570
		S2	SU–129	06/23/1998	3,770
21	Old Mans Creek near Iowa City, IA	S1	SU–93	06/10/1998	209
		S2	SU–147	06/30/1998	840
22	Wolf Creek near Dysart, IA	S1	SU–87	06/10/1998	1,060
		SD	SU–88	06/10/1998	1,060
		S2	SU–128	06/22/1998	3,630
23	Iowa River at Wapello, IA	S1	SU–53	05/27/1998	13,400
		S2	SU–127	06/19/1998	37,200
		SD	SU–132	06/19/1998	37,200
24	N. Skunk River near Sigourney, IA	S1	SU–21	05/21/1998	1,140
		S2	SU–95	06/10/1998	1,810
25	Skunk River at Augusta, IA	S1	SU–45	05/26/1998	15,600
		S2	SU–122	06/18/1998	14,400
26	Des Moines River at Fort Dodge, IA	S1	SU–8	05/16/1998	7,880
		S2	SU–108	06/12/1998	5,190
		SD	SU–114	06/12/1998	5,190
27	Raccoon River at Van Meter, IA	S1	SU–9	05/17/1998	6,330
		S2	SU–89	06/10/1998	9,160
28	Little Sioux River at Correctionville, IA	S1	SU–42	05/27/1998	1,400
		S2	SU–123	06/18/1998	2,760
29	Maple River at Mapleton, IA	S1	SU–59	05/29/1998	891
		S2	SU–90	06/09/1998	889
		SS	SU–97	06/09/1998	889
30	Boyer River at Logan, IA	S1	SU–31	05/22/1998	1,070
		S2	SU–96	06/09/1998	2,890
31	Chariton River near below Rathbun Lake Dam, IA	R1	SU–69	06/04/1998	868
		R2	SU–148	06/29/1998	812
32	Nishnabotna River above Hamburg, IA	S2	SU–124	06/17/1998	53,700

Table 4. Collection dates, sample types, sample numbers, and daily mean discharge for samples from surface-water sites—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample]

Site no. (figs. 3, 4)	Site name	Sample type	Sample no.	Date of sample collection	Daily mean discharge, in cubic feet per second
	Indiana				
33	Whitewater River near Alpine, IN	S1	SU–47	05/26/1998	727
		S2	SU–162	07/08/1998	652
		SD	SU–213	07/08/1998	652
34	Blue River at Fredericksburg, IN	S1	SU–50	05/27/1998	447
		S2	SU–163	07/08/1998	490
35	Mississinewa River below Mississinewa Lake Dam, IN	R1	SU–83	06/09/1998	210
		R2	SU–164	07/09/1998	1,540
36	Eel River near Logansport, IN	S1	SU–18	05/21/1998	701
		SB	SU–20	05/21/1998	701
		S2	SU–152	06/30/1998	688
37	Wildcat Creek near Jerome, IN	S1	SU–19	05/21/1998	126
		S2	SU–151	06/30/1998	563
38	Wildcat Creek near Lafayette, IN	S1	SU–22	05/20/1998	883
		S2	SU–150	07/01/1998	1,130
39	White River near Nora, IN	S1	SU–51	05/28/1998	1,260
		S2	SU–149	07/01/1998	1,780
40	Sugar Creek near Edinburgh, IN	S1	SU–46	05/26/1998	1,610
		S2	SU–178	07/20/1998	1,490
41	E. Fork White River near Bedford, IN	S1	SU–52	05/28/1998	14,300
		S2	SU–161	07/06/1998	6,050
42	Wabash River at New Harmony, IN	S1	SU–57	05/27/1998	66,000
		SD	SU–58	05/27/1998	66,000
		S2	SU–136	06/23/1998	170,000
	Minnesota				
43	Cottonwood River near New Ulm, MN	S1	SU–49	05/26/1998	525
		S2	SU–180	07/21/1998	673
		SD	SU–181	07/21/1998	673
44	Little Cobb River near Beauford, MN	S1	SU–12	05/18/1998	166
		S2	SU–208	08/17/1998	2.8
45	Minnesota River near Jordan, MN	S1	SU–13	05/19/1998	10,100
		S2	SU–135	06/26/1998	12,000
46	Mississippi River at Hastings, MN	S1	SU–14	05/20/1998	21,600
		SD	SU–15	05/20/1998	21,600
		S2	SU–206	08/11/1998	8,770
47	Des Moines River at Jackson, MN	S1	SU–48	05/26/1998	339
		S2	SU–210	08/24/1998	267
48	Rock River at Luverne, MN	S1	SU–130	06/24/1998	60
		S2	SU–131	06/25/1998	161

Table 4. Collection dates, sample types, sample numbers, and daily mean discharge for samples from surface-water sites—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample]

Site no. (figs. 3, 4)	Site name	Sample type	Sample no.	Date of sample collection	Daily mean discharge, in cubic feet per second
		Kansas			
49	Black Vermillion River at Frankfort, KS	S1	SU–1	05/05/1998	80
		S2	SU–107	06/09/1998	162
50	Big Blue River below Tuttle Creek Lake Dam, KS	R1	SU–74	06/03/1998	3,610
		R2	SU–197	07/29/1998	89
51	Delaware River near Muscotah, KS	S1	SU–2	05/05/1998	111
		S2	SU–105	06/10/1998	100
		SB	SU–106	06/10/1998	100
		Kentucky			
52	Ohio River at Cannelton Dam, KY	S1	SU–75	06/04/1998	78,400
		SD	SU–214	06/04/1998	78,400
		S2	SU–173	07/07/1998	146,000
		Missouri			
53	Nodaway River near Graham, MO	S1	SU–119	06/18/1998	5,030
		S2	SU–209	08/19/1998	282
		Nebraska			
54	North Dry Creek near Kearney, NE	S1	SU–28	05/22/1998	83
		S2	SU–76	06/08/1998	37
55	Maple Creek near Nickerson, NE	S1	SU–37	05/21/1998	208
		SD	SU–38	05/21/1998	208
		S2	SU–79	06/08/1998	705
56	Salt Creek at Roca, NE	S1	SU–6	05/15/1998	470
		S2	SU–94	06/10/1998	148
57	Wahoo Creek at Ithaca, NE	S1	SU–5	05/15/1998	118
		S2	SU–78	06/08/1998	495
58	Platte River at Louisville, NE	S1	SU–39	05/22/1998	22,300
		SD	SU–40	05/22/1998	22,300
		S2	SU–77	06/09/1998	28,900
59	Big Nemaha River at Falls City, NE	S1	SU–41	05/26/1998	333
		S2	SU–80	06/8/1998	438
60	W. Fork Big Blue River, Dorchester, NE	S1	SU–36	05/23/1998	247
		S2	SU–82	06/10/1998	231
61	Big Blue River at Barneston, NE	S1	SU–4	05/15/1998	1,110
		S2	SU–104	06/09/1998	1,170
62	Little Blue River near Fairbury, NE	S1	SU–3	05/12/1998	261
		S2	SU–81	06/08/1998	239
		Ohio			
63	Clear Creek near Rockbridge, OH	S1	SU–86	06/10/1998	36
		S2	SU–145	06/30/1998	84
64	Scioto River near Prospect, OH	S1	SU–63	06/02/1998	128
		S2	SU–141	06/29/1998	1,040

Table 4. Collection dates, sample types, sample numbers, and daily mean discharge for samples from surface-water sites—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample]

Site no. (figs. 3, 4)	Site name	Sample type	Sample no.	Date of sample collection	Daily mean discharge, in cubic feet per second
	Ohio—Continued				
65	Olentangy River at Claridon, OH	S1	SU–85	06/09/1998	13
		S2	SU–157	06/29/1998	3,770
		SB	SU–156	06/29/1998	3,770
66	Olentangy River below Delaware Lake Dam, OH	R1	SU–84	06/09/1998	34
		R2	SU–153	07/01/1998	3,210
		RD	SU–154	07/01/1998	3,210
67	Big Darby Creek at Darbyville, OH	S1	SU–62	06/03/1998	208
		S2	SU–140	06/29/1998	11,400
68	Scioto River at Higby, OH	S1	SU–73	06/04/1998	2,620
		S2	SU–165	07/08/1998	5,030
69	L. Miami River near Oldtown, OH	S1	SU–92	06/10/1998	97
		S2	SU–144	06/30/1998	191
70	Mad River at Eagle City, OH	S1	SU–91	06/10/1998	228
		S2	SU–146	06/30/1998	454
71	Tiffin River at Stryker, OH	S1	SU–66	06/01/1998	98
		SD	SU–67	06/01/1998	98
		S2	SU–172	07/07/1998	40
72	Auglaize River at Fort Jennings, OH	S1	SU–117	06/17/1998	670
		S2	SU–171	07/08/1998	751
	Wisconsin				
73	Root River at Racine, WI	S1	SU–61	06/01/1998	98
		S2	SU–204	08/03/1998	5.3
74	St. Croix River at St. Croix Falls, WI	S1	SU–68	06/03/1998	4,220
		S2	SU–205	08/05/1998	1,690
75	Wisconsin River at Muscoda, WI	S1	SU–133	06/16/1998	12,900
		S2	SU–202	08/07/1998	8,890
		SD	SU–203	08/07/1998	8,890
76	Rock River at Afton, WI	S1	SU–134	06/17/1998	2,140
		S2	SU–179	07/21/1998	1,830

Samples were collected using protocols that are identical to those used for the collection of samples for low levels of other dissolved organic compounds (Shelton, 1994). The equal-width-increment sampling method was used for all stream and reservoir outflow samples except on some large rivers where equal-discharge-increment sampling was used (Edwards and Glysson, 1988). All equipment was precleaned with a Liquinox/tap-water solution, rinsed with tap water, deionized water, and then methanol, and air dried. All samples were filtered through 0.7-µm pore-size heat-cleaned glass-fiber filters using an aluminum-plate filter holder and a ceramic-piston fluid-metering pump with all Teflon tubing into precleaned 1-liter or 125-milliliter amber glass bottles. Samples were immediately chilled and shipped on ice from the field to the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colo., and USGS Organic Geochemistry Research Laboratory (OGRL) in Lawrence, Kansas, within 2 days of collection.

Analytical Methods

Sulfonylurea, Sulfonamide, and Imidazolinone Herbicides

An analytical method was developed by researchers at the NWQL that is an extension and improvement of the high-performance liquid chromatography/mass spectrometry (HPLC/MS) method by Rodriguez and Orescan (1998). Briefly, the method consists of isolation of the analytes of interest from approximately 1 liter of water (precisely measured) using two stacked solid-phase extraction cartridges. After isolation, the cartridges are dried and the analytes eluted using acidified acetone. The analytes are then concentrated and solvent exchanged into 1 mL of 10 percent acetonitrile and 90 percent water. The sample processing procedure is shown schematically in figure 6.

HPLC/MS analysis is performed using a Hewlett Packard 1100 series HPLC, coupled to a Hewlett Packard LC/MSD. Electrospray ionization, operated in the positive ion mode, is used to ionize the analytes. Selected-ion monitoring is used to maximize sensitivity. External standard calibration curves are developed using a minimum of five standards. The linear range of the method is from 0.005 to 0.5 µg/L. Three ions (1 quantitation, 2 confirmation) are monitored for each compound. For confirmed identification of analytes, the relative ion abundances for the detection must be within 20 percent of average response for standards, as well as have the correct relative retention time (within 0.1 minute). Detected analytes that do not meet one criterion are reported as estimates (E on tables 6–10). Details of this analytical methods are provided by Furlong and others (2000).

Concentrations were quantified by comparing the sum of the three integrated ion peaks from an environmental sample to the sum of the integrated ion peaks from a calibration curve. Five-point external calibration curves for concentrations between 0.005 to 0.500 µg/L were produced for the 16 target analytes (Furlong and others, 2000). A substantial fraction of the reported concentrations are flagged with an "E." All concentrations below the estimated reporting limit of 0.010 µg/L or above the upper limit of 1.0 µg/L are flagged with an "E," which indicates the qualitative

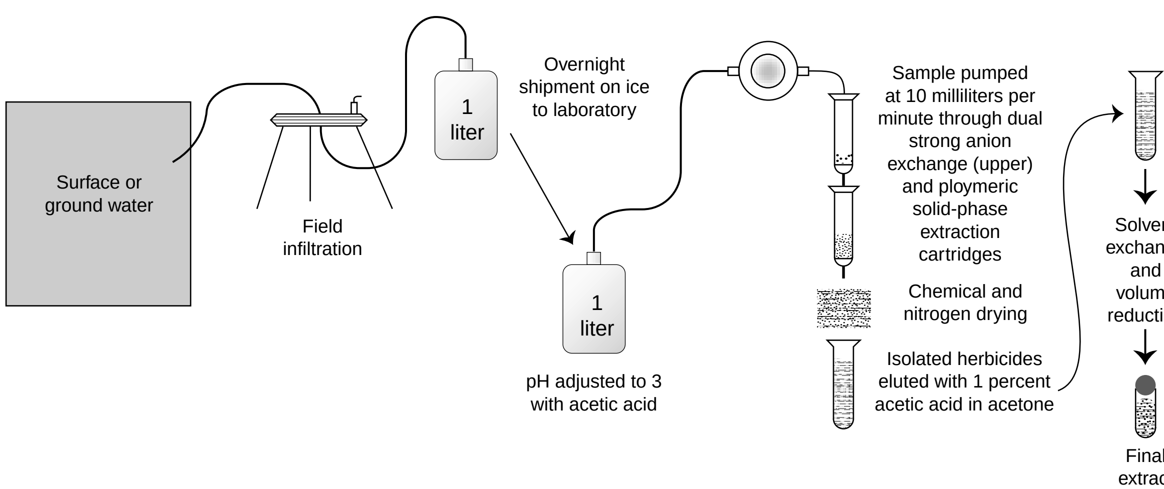


Figure 6. Diagram showing sample preparation steps for analysis of sulfonylurea, sulfonamide, and imidazolinone herbicides.

identification of the compound within a 20-percent acceptance criterion. An “E” qualifier for concentrations within the analytical range of the method indicates that the relative abundance of a secondary or tertiary ion fell outside the 20-percent acceptance criterion, likely due to a co-extracted interference.

Other Pesticides and Degradates

All samples were analyzed for several other classes of pesticides. Samples were analyzed at the NWQL for 46 pesticides and pesticide degradates by capillary-column gas chromatography/mass spectrometry (GC/MS) with selected-ion monitoring using methods described by Zaugg and others (1995). The compounds analyzed are listed under “Other Pesticides and Degradates” in table 1. This analytical method has method detection limits (MDLs) that range from 0.001 to 0.018 μg/L (table 5). The compounds analyzed include selected triazine, acetanilide, and thiocarbamate herbicides and carbamate, organophosphate, and organochloride insecticides. A complete discussion of data reporting procedures, MDLs, MRLs and “E” coded data values is given by Childress and others (1999).

All samples were analyzed at the OGRL for 13 herbicides and 10 herbicide degradates. The 13 herbicides and 3 of the degradates were analyzed by GC/MS with selected-ion monitoring (Zimmerman and Thurman, 1999). The other seven degradates were analyzed by high-performance liquid chromatography (HPLC) with diode-array detection following solid-phase extraction on C_{18} cartridges (Ferrer and others, 1997a, 1997b; Kalkhoff and others, 1998; Hostetler and Thurman, 1999). The analytical method has an MRL of 0.05 μg/L for the 13 herbicides and 3 degradates, and 0.20 μg/L for the other 7 degradates (table 5). The compounds analyzed are listed under “Other Herbicides and Degradates” in tables 1 and 5.

Nutrients, Physical Properties, and Discharge

All samples were analyzed for nutrient concentrations including nitrate plus nitrate, nitrite, ammonia, ammonia plus organic nitrogen, orthophosphate, and total phosphorus. The samples were analyzed by automated colorimetric procedures (Fishman and Friedman, 1989) at the NWQL. Method reporting limits for nutrients are given in table 5. Specific conductance, pH, and water temperature were measured at the time samples were collected. Water discharge normally was measured with current meters. These measurements were used to confirm or adjust a rating for converting stream stage to water discharge. At most sites, estimates of daily mean discharge for the period of sample collection were calculated and are available in the USGS NWIS-W data base (U.S. Geological Survey, 2000). The daily mean discharge estimates at all surface-water sites on the dates of sample collection are given in table 4.

Quality Assurance

Because this study involved application of a new custom analytical method for the SU, SA, and IMI herbicide, a significant effort was put forth to ensure the quality of the results. This included the collection and(or) processing of extra samples in the field and in the laboratory. Also, there are duplicate analyses of some herbicides such as atrazine and metolachlor for nearly every sample (one from NWQL and one from OGRL).

Sample Collection

Quality-assurance (QA) samples were collected at selected sites to provide information on the variability and bias of the measured SU, SA, and IMI concentrations. A total of 26 field QA samples were collected in the field. These samples consist of 21 concurrent duplicates (CD), which are two samples collected as closely as possible in time and space but processed, handled, and analyzed separately; and 5 field blanks (FB), which are blank solutions that are subject to the same aspects of sample collection, field processing, preservation, transportation, and laboratory handling as the environmental samples. Concurrent duplicates were submitted blindly to the USGS NWQL, whereas field blanks were identified as such. Field QA samples were only collected and processed for the SU, SA, and IMI analysis.

Table 5. Method of determination or analysis and reporting limits for physical properties and chemical compounds in water samples

[µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Property or compound	Method of analysis	Reporting limit
Sulfonylurea, sulfonamide, and imidazolinone herbicides		**Method reporting limit (µg/L)**
bensulfuron methyl	high-performance liquid chromatography/ electrospray ionization-mass spectrometry following solid phase extraction	0.010
chlorimuron ethyl	do.	do.
chlorsulfuron	do.	do.
flumetsulam	do.	do.
halosulfuron methyl	do.	do.
imazapyr	do.	do.
imazaquin	do.	do.
imazethapyr	do.	do.
metsulfuron methyl	do.	do.
nicosulfuron	do.	do.
primisulfuron methyl	do.	do.
prosulfuron	do.	do.
sulfometuron methyl	do.	do.
thifensulfuron methyl	do.	do.
triasulfuron	do.	do.
triflusulfuron methyl	do.	do.

Property or compound	Method of analysis	Reporting limit
Other pesticides and degradates		**Method detection limit (µg/L)**
2,6-diethylaniline	gas chromatography/mass spectrometry following solid phase extraction	0.003
acetochlor	do.	.002
alachlor	do.	.002
atrazine	do.	.001
azinphos-methyl	do.	.001
benfluralin	do.	.002
butylate	do.	.002
carbaryl	do.	.003
carbofuran	do.	.003
chlorpyrifos	do.	.004
cyanazine	do.	.004
dacthal	do.	.002
deethylatrazine	do.	.002
diazinon	do.	.002
dieldrin	do.	.001
disulfoton	do.	.017
EPTC	do.	.002
ethalfluralin	do.	.004
ethoprophos	do.	.003
fonofos	do.	.003
lindane	do.	.004
linuron	do.	.002

Table 5. Method of determination or analysis and reporting limits for physical properties and chemical compounds in water samples—Continued

[µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ft^3/s, cubic feet per second].

Property or compound	Method of analysis	Reporting limit
Other pesticides and degradates		Method detection limit (µg/L)
malathion	do.	0.005
metolachlor	do.	.002
metribuzin	do.	.004
molinate	do.	.004
napropamide	do.	.003
parathion	do.	.004
parathion methyl	do.	.006
pebulate	do.	.004
pendimethalin	do.	.004
phorate	do.	.002
prometon	do.	.018
propachlor	do.	.007
propanil	do.	.004
propargite	do.	.013
propyzamide	do.	.003
simazine	do.	.005
tebuthiuron	do.	.010
terbacil	do.	.007
terbufos	do.	.013
thiobencarb	do.	.002
tri-allate	do.	.001
trifluralin	do.	.002
alpha-HCH	do.	.002
cis-permethrin	do.	.005
p,p'-DDE	do.	.006

Property or compound	Method of analysis	Reporting limit
Other pesticides and degradates		Method detection limit (µg/L)
acetochlor	gas chromatography/mass spectrometry following solid phase extraction (GC/MS)	0.05
acetochlor ESA	high-performance liquid chromatography/mass spectrometry following solid phase extraction (HPLC/MS)	.20
acetochlor OA	do.	.20
alachlor	GC/MS	.05
alachlor ESA	HPLC/MS	.20
alachlor OA	do.	.20
ametryn	GC/MS	.05
atrazine	do.	.05
deethylatrazine	do.	.05
deisopropylatrazine	do.	.05
hydroxy-atrazine	HPLC/MS	.20
cyanazine	GC/MS	.05
cyanazine-amide	do.	.05

Table 5. Method of determination or analysis and reporting limits for physical properties and chemical compounds in water samples—Continued

[μg/L, micrograms per liter; μS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; ft^3/s, cubic feet per second]

Property or compound	Method of analysis	Reporting limit
Other pesticides and degradates		**Method detection limit (μg/L)**
metolachlor	do.	0.05
metolachlor ESA	HPLC/MS	.20
metolachlor OA	do.	.20
metribuzin	GC/MS	.05
prometon	do.	.05
prometryn	do.	.05
propachlor	do.	.05
propazine	do.	.05
simazine	do.	.05
tebutryn	do.	.05

Property or compound	Method of analysis	Reporting limit
Nutrients, physical properties, and discharge		**Method reporting limit**
water temperature (degrees Celsius)	thermometer	0.10 degree
specific conductance	conductance meter	1.0 μS/cm
pH	pH meter	.10 units
ammonia as N	colorimetric methods	.02 mg/L
ammonia plus organic N	do.	.10 mg/L
nitrite as N (mg/L)	do.	.01 mg/L
nitrite plus nitrate as N	do.	.05 mg/L
dissolved phosphorus as P	do.	.006 mg/L
orthophosphate as P	do.	.01 mg/L
dissolved organic carbon as C	do.	.33 mg/L
daily mean discharge	current meter or rating curve	.01 ft^3/s

Analytical Methods

Full-scan electrospray ionization mass spectra were collected for each SU, SA, and IMI compound using a Hewlett Packard Series 1100 LC/MSD. Fragmentation conditions were optimized so a minimum of two, and typically three, ions were formed for each analyte. The presence of all three ions and their relative abundances were used to confirm identification. The sum of the three signals was used for maximum detectability and quantitation. Two criteria were used to verify compound detections. The chromatographic retention time for a peak observed in a sample chromatograph was compared to the retention times of the target analytes observed in a standard chromatograph. After this initial criterion was met, identification was confirmed by comparing the relative abundances of the three ions measured in the sample chromatograph to known relative abundances of a user-generated library reference spectrum produced from a pure standard. If the library spectra and the sample spectra did not match within 20 percent, then the presence of the compound was not confirmed. In some instances, qualified identification and concentration estimates were made, reflecting the effect of matrix interference on the ability of the analyst to identify SU, SA, and IMI herbicides at the low end of the concentration range. For example, if an unknown sample peak retention time matched that of one of the target analytes, two of the three ions were present, and the relative abundances of the two ions were within 20 percent of the average response for standards, the detection was flagged with an "E" to indicate it was a qualified identification and concentration estimate. This qualification was required in those cases where the second confirming ion was produced in low (less than 10 percent) relative abundances under normal HPLC/MS conditions.

These criteria are equivalent to those used in an EPA-approved HPLC/MS method (Method 8321A; U.S. Environmental Protection Agency, 1996a), where the relative abundances of two to four ions, at the appropriate retention time, are used to qualitatively identify targeted analytes. Although the ionization technique (thermospray ionization) used in this EPA-approved method differs from that used in this study, the ionization techniques are similar in that simpler spectra are produced than those typically produced by the more common electron-impact ionization-gas chromatography/mass spectrometry (EI-GC/MS), necessitating a minimum of two, rather than three, ions for qualitative identification. Some researchers have successfully used the detection of a single ion, typically a protonated parent molecule, at the appropriate retention time to identify pesticides and other polar contaminants (Ferrer and others, 1997a, 1997b; LaCorte and Barcelo, 1996). This is often the result of the inability of a molecule to be fragmented under electrospray ionization conditions and the desire to improve sensitivity. Tandem mass spectrometry follow-up is typical. In this study, the large number of samples precluded routine reanalysis, so controlled in-source fragmentation was used (Crescenzi and others, 1997; Rodriguez and Orescan, 1998; Vollmer and Wilkes, 1996). In practice, the capillary exit voltage is varied during the chromatographic separation, fragmenting different SU, SA, and IMI herbicides at optimal voltages, producing a minimum of two, and typically three, characteristic fragments for each compound. However, since several of the herbicides studied elute closely to each other, the voltage applied to the capillary exit was a compromise value for several compounds. The net result is that for some compounds, a tertiary ion would be produced at low relative abundance (5 to 10 percent) and occasionally would not be detected in the presence of background ion signal. In these cases, an estimated ("E") flag also was used.

The quality control of the analytical methods used by the USGS NWQL are given in Zaugg and others (1995). The quality control of the analytical methods used by the USGS OGRL for this study are given in Zimmerman and Thurman (1999) and Hostetler and Thurman (1999).

Quality-Assurance Samples for Sulfonylurea, Sulfonamide, and Imidazolinone Herbicides

Samples were analyzed in 27 sets, and instrumental and method QA samples were analyzed with each set. Long-term instrument stability was indicated in analysis of 75 calibration verification samples analyzed over the course of the study. Verification sample concentrations for each compound were set at 0.10 µg/L. The average measured concentration for individual target analytes ranged from 0.093 to 0.101 µg/L. The average standard deviation for the 16 target analytes in 75 calibration verification samples was 0.006 µg/L.

The quality of method performance is indicated by the recovery calculated from the results of 27 set spikes, one analyzed with each set during the study. The recoveries for the 16 target analytes are shown in figure 7. The medians of the recoveries range from 39 to 92 percent, and the average of the medians is 73 percent. The standard deviations of recoveries range from 14 to 26 percent and average 20 percent. Some of this variability is the result of multiple instruments and operators and the use of automated and manual sample preparation. The lowest and most variable recoveries were chlorsulfuron, halosulfuron methyl, prosulfuron, triflusulfuron methyl, and primisulfuron methyl, compounds that were not frequently detected in this study.

Twenty-eight unspiked laboratory duplicate samples were analyzed to estimate method precision at ambient herbicide concentrations and in the presence of interferences. The duplicate samples were made from the second of two 1-liter bottles of water that were collected for SU, SA, and IMI herbicide analysis at each site. Some duplicates were analyzed within a single sample set and others in two separate sets. Differences for each pair are calculated as the concentration in the sample minus

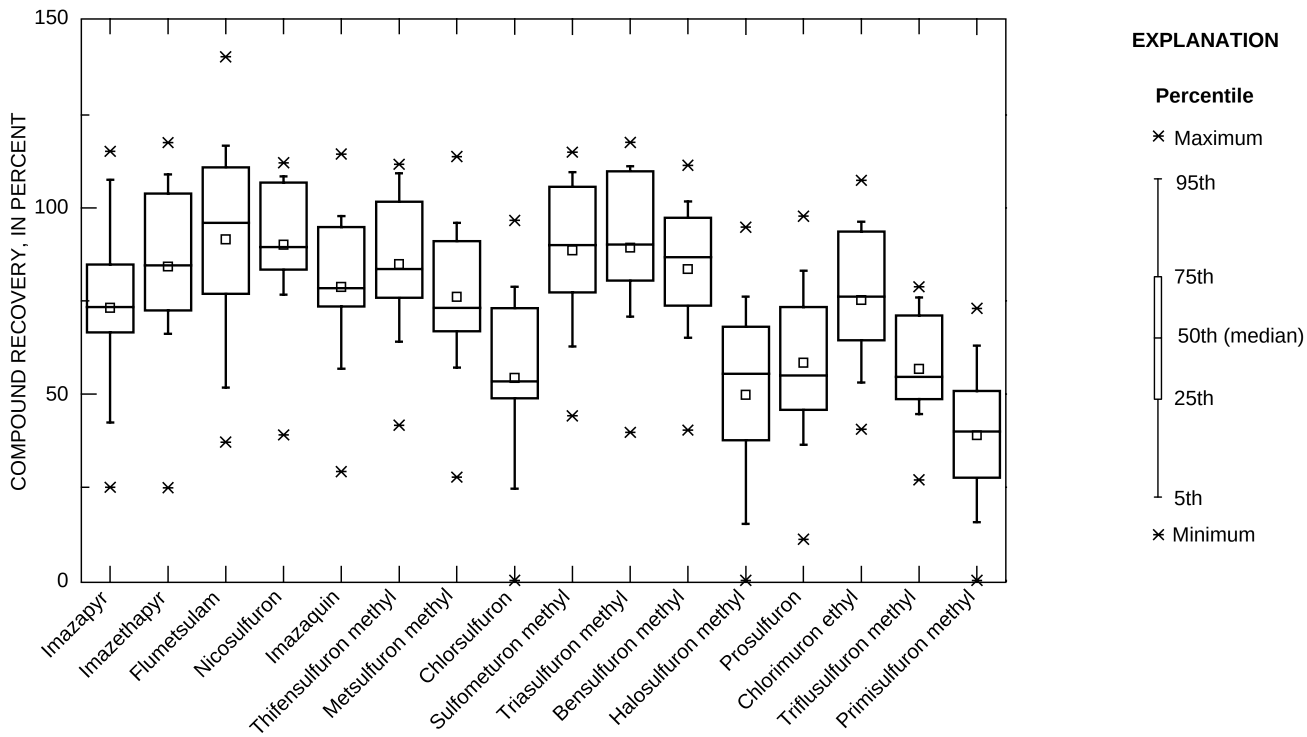


Figure 7. Recoveries of 16 sulfonylurea, sulfonamide, and imidazolinone herbicides from 27 reagent water samples spiked at 0.050 or 0.10 microgram per liter (from Furlong and others, 2000, fig. 3).

the concentration in the duplicate sample. For this analysis, concentrations that are reported as less than the MRL were set to 0.005 µg/L, which allows computation of a difference value when only one of the sample pair has a reported concentration. The number (n) of sample pairs with at least one reported concentration for each herbicide is shown in figure 8. Forty-five of the 112 concentration pairs have only one reported concentration; in 11 of those pairs, the reported concentration is less than the MRL. Most differences are less than 0.050 µg/L, and only a few differences are greater that 0.10 µg/L (fig. 8).

In addition to unspiked duplicates, 28 randomly selected samples were spiked at 0.10 µg/L and analyzed to help determine the magnitude of possible matrix enhancement. The results (fig. 9) indicate that there was apparent matrix enhancement of recovery that varied by compound. This effect was isolated as a matrix effect by spiking sample extracts after processing and observing the same enhancements as when the sample was spiked prior to analysis. The largest enhancements were for metsulfuron methyl, thifensulfuron methyl, and triasulfuron. In most cases, compound recoveries were enhanced by a factor of 1.5 or less (Furlong and others, 2000).

There were no detections above 0.010 µg/L of the 16 SU, SA, and IMI herbicides in the five field blank samples. This suggests that field sample handling and processing were not likely to cause contamination of the samples.

Twenty-one unspiked concurrent field duplicate samples were analyzed to estimate method precision at ambient herbicide concentrations in the presence of sample collection and sample water interferences. Differences for each pair are calculated as the concentrations in the sample minus the concentration in the duplicate sample. Again, concentrations that are reported as less than the MRL are set to 0.005 µg/L. The number of sample pairs with at least one reported concentration is

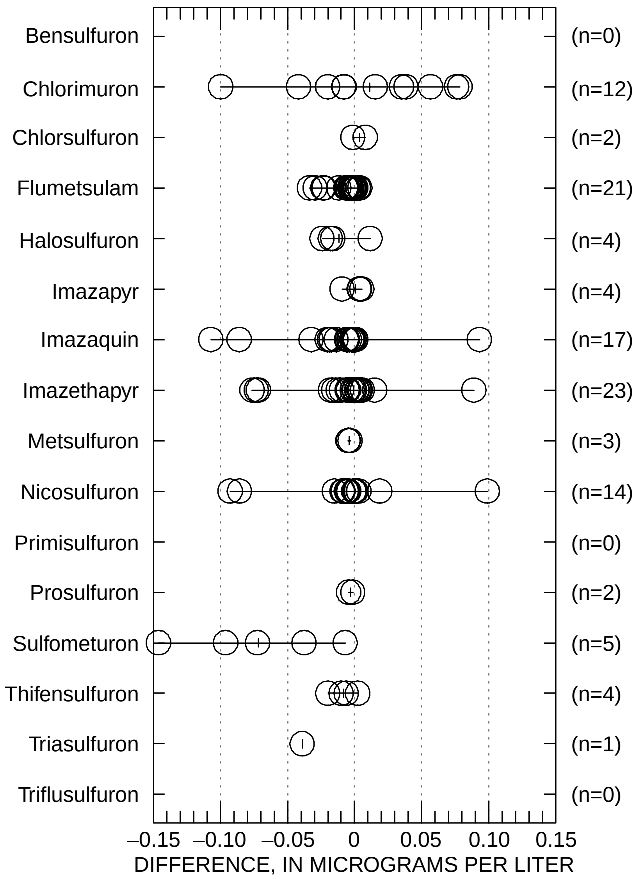


Figure 8. Differences between herbicide concentrations in 28 pairs of unspiked laboratory duplicate natural-water samples (n is number of concentration pairs).

shown in figure 10. Sixteen of the 62 concentration pairs had only one reported concentration; in 8 of those pairs, the one reported concentration was less than the MRL. Most differences were less than 0.020 µg/L (twice the MRL), and only one difference was greater that 0.040 µg/L (fig. 10), which indicates that the reproducibility of analytical results is quite good and that sample-collection procedures did not introduce a large amount of error into the results.

Quality-Assurance Samples for Other Herbicides

Twenty-eight unspiked laboratory duplicate (LD) samples were analyzed by the USGS OGRL to estimate method precision at ambient herbicide concentrations and in the presence of interferences for results from their laboratory. These duplicate samples were made from extra 125-milliliter bottles of water that were collected at each site. These data are not analyzed here, but results from these LD samples and from six concurrent field duplicate samples and one field blank sample are included in the tables of OGRL results (tables 15, 16, 24, and 25).

Duplicate Analysis of Selected Herbicides

Nearly every sample was analyzed for eight herbicides by both the NWQL and the OGRL. This allows for a unique opportunity to compare results from these two laboratories. Percent differences (PD) were calculated for each pair of concentrations as the difference between the values (NWQL – OGRL) divided by the mean of the two values, expressed as a percentage. For this calculation, concentrations reported by the NWQL that are less than 0.05 µg/L, including those that are less than the MDL, are set equal to 0.05 µg/L, the MRL of results from the OGRL, and concentrations reported by the OGRL as less than 0.05 µg/L (not detected) also are set equal to 0.05 µg/L.

Analysis of the PD’s of sample pairs where one or both have a reported concentration greater than or equal to 0.05 µg/L (not an assigned value of 0.05 µg/L) indicate that the concentrations reported by the NWQL for acetochlor, alachlor, atrazine, cyanazine, metolachlor, prometon, and simazine all tend to be higher than those reported by the OGRL (fig. 11). The median of the percent differences for metribuzin were not significantly different from zero. The majority of the percent differences were between –25 and +50 percent. These differences may result from the different methodologies used by the two laboratories. The laboratories use different sample size: 1,000-milliliter nominal for the NWQL and 125 milliliter nominal for the OGRL. Also, the OGRL processes its calibration standards through the sample extraction and isolation procedure, resulting in an inherent processing correction in the calibration curves. The NWQL develops its calibration curves from standards that have not been processed through the extraction and isolation procedure. The NWQL dilutes sample

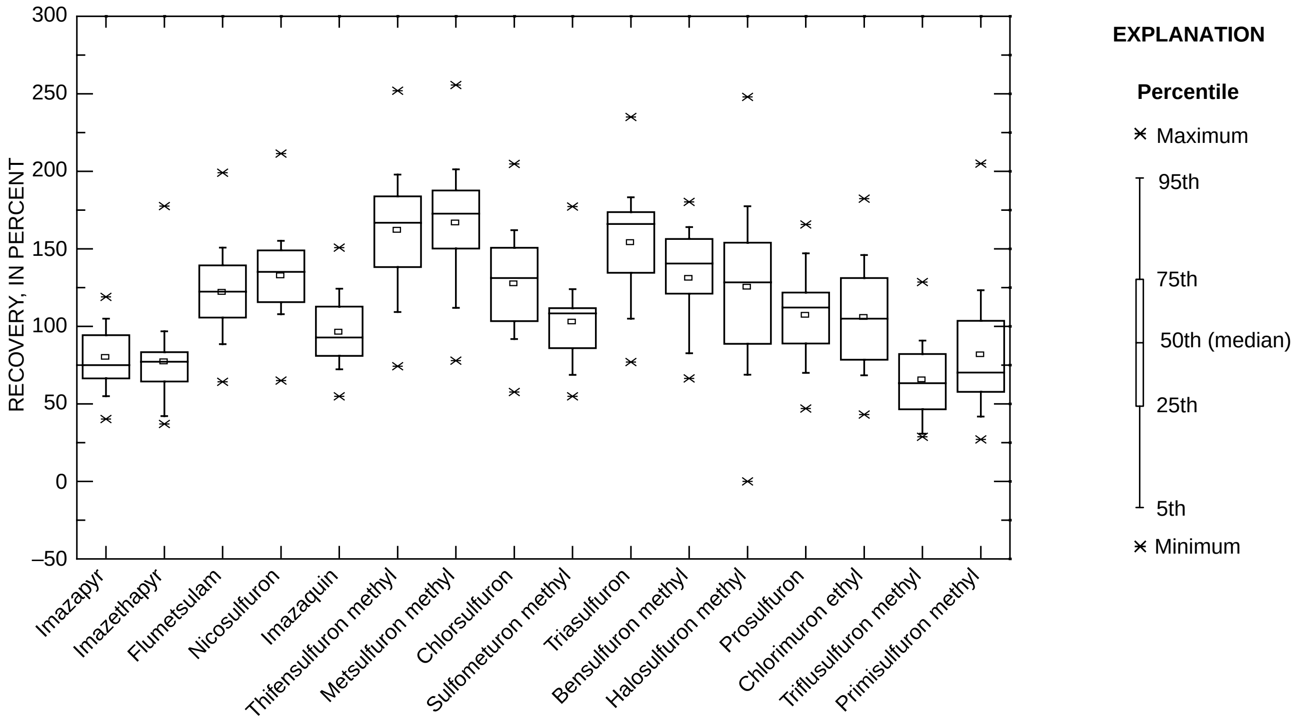


Figure 9. Recoveries of 16 sulfonylurea, sulfonamide, and imidazolinone herbicides from 28 surface- and ground-water samples spiked at 0.10 microgram per liter. The recoveries are corrected for the ambient water herbicide concentration (from Furlong and others, 2000, fig. 5).

extracts for calculating concentrations that are greater than 4 µg/L, which may result in greater analytical error, particularly for concentrations that are greater than 20 µg/L.

Differences for each concentration pair were calculated as the concentration in the NWQL sample minus the concentration in the OGRL sample. The same sample pairs used in the above calculation of PDs are used for this calculation. The number (n) of sample pairs with one or more reported concentrations (equal to or greater than 0.05 µg/L) and differences between laboratory results are shown in figure 12. Fifty percent of the 697 differences are 0.12 µg/L or less, and only 5 percent of the differences are larger than 3.2 µg/L. Paired difference tests were used to determine if the observed differences between herbicide concentrations are statistically significant. Because the distributions of herbicide concentrations are positively skewed, the non-parametric Wilcoxon signed-rank test (Helsel and Hirsch, 1992) was used. The following hypothesis is tested:

Null Hypothesis. Concentrations reported by the NWQL are not significantly different from concentrations reported by the OGRL (median of differences = 0).

Alternate Hypothesis. Concentrations reported by the NWQL are significantly different from concentrations reported by the OGRL (median of differences not equal to 0).

Results indicate that the null hypothesis can be rejected ($p < 0.05$) for acetochlor, atrazine, alachlor, cyanazine, metolachlor, prometon, and simazine. For these seven herbicides, the NWQL concentrations all tended to be larger than the OGRL concentrations. The largest median difference is for metolachlor (0.25 µg/L), followed by atrazine (0.19 µg/L) and acetochlor (0.08 µg/L).

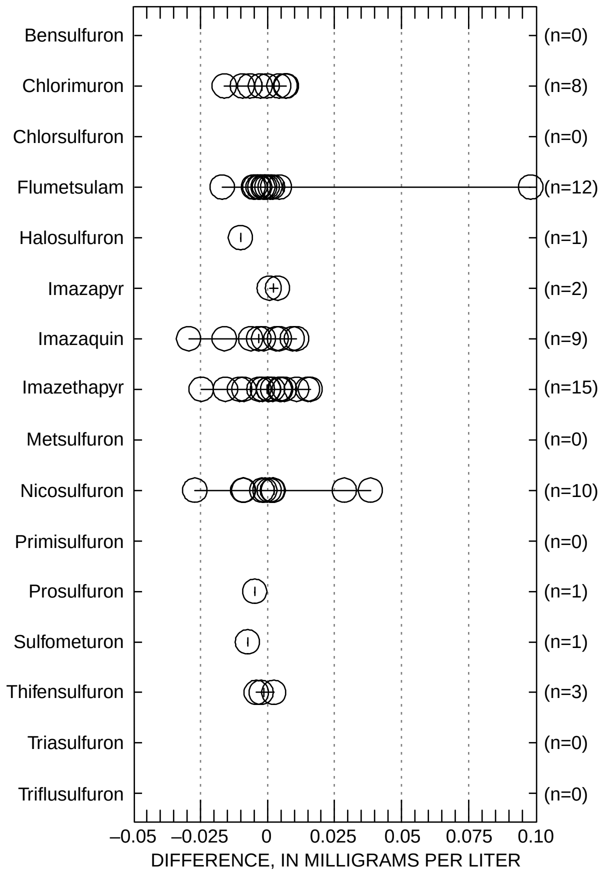


Figure 10. Differences between herbicide concentrations in 21 pairs of unspiked field duplicate natural-water samples (n is the number of concentration pairs).

The number of comparisons that can be made between results from the two laboratories is to some degree limited by the higher MRL of results from the OGRL. For compounds that tend to occur at higher concentrations, the limitation is small. For example, the NWQL reported 158 concentrations in 167 analyses for atrazine at or above the MDL of 0.001 µg/L, whereas the OGRL reported 156 concentrations in 176 analyses at or above the MRL of 0.05 µg/L. The effects of the reporting limit difference is more pronounced for compounds that occur frequently at low concentrations, such as prometon. The NWQL reported 68 concentrations at or above the MDL of 0.018 µg/L in 169 analyses for prometon, whereas the OGRL reported only 12 concentrations in 176 analyses at or above the MRL of 0.05 µg/L.

OCCURRENCE OF SULFONYLUREA, SULFONAMIDE, AND IMIDAZOLINONE HERBICIDES

Streams

Stream sample collection began in May and was completed in August 1998. Results from 133 stream samples are given in table 6. A statistical summary of these results is given in table 7. At least one of the 16 SU, SA, or IMI herbicides was detected in 111 (83 percent) of stream samples. The detection frequencies reported are for samples with concentrations at or above the method reporting limit (MRL), currently 0.010 µg/L. Imazethapyr was the most frequently detected compound. It was detected in 92 or 69 percent of these samples. Flumetsulam was detected in 87 (65 percent) of the samples. Nicosulfuron was detected in 70 (53 percent) of the samples. Imazaquin was detected in 44 (33 percent) of samples and chlorimuron ethyl was detected in 41 (31 percent) of samples. Chlorsulfuron, halosulfuron methyl, imazapyr, prosulfuron, sulfometuron methyl, and thifensulfuron methyl were detected at concentrations at or above the MRL in 7 (5 percent) or fewer of the samples. Bensulfuron methyl, metsulfuron methyl, primisulfuron methyl, triasulfuron, and triflusulfuron methyl were not detected at or above the MRL in any stream sample.

The distributions of concentrations of the target analytes in 133 samples are summarized in figure 13. In some cases, estimated concentrations are reported that are below the MRL. These concentrations are not counted as detections at or above the MRL in table 7 but are used in the calculation of summary statistics (the boxplots themselves and percentile values in table 7). All non-detects are treated as zeros in the calculation of percentile values. The sum of SU, SA, and IMI concentrations exceeded 0.50 µg/L in less than 10 percent of stream samples.

The spatial distribution of concentrations for three compounds, imazethapyr, flumetsulam, and nicosulfuron, are shown in figures 14, 15, and 16, respectively. In these figures, the drainage basins

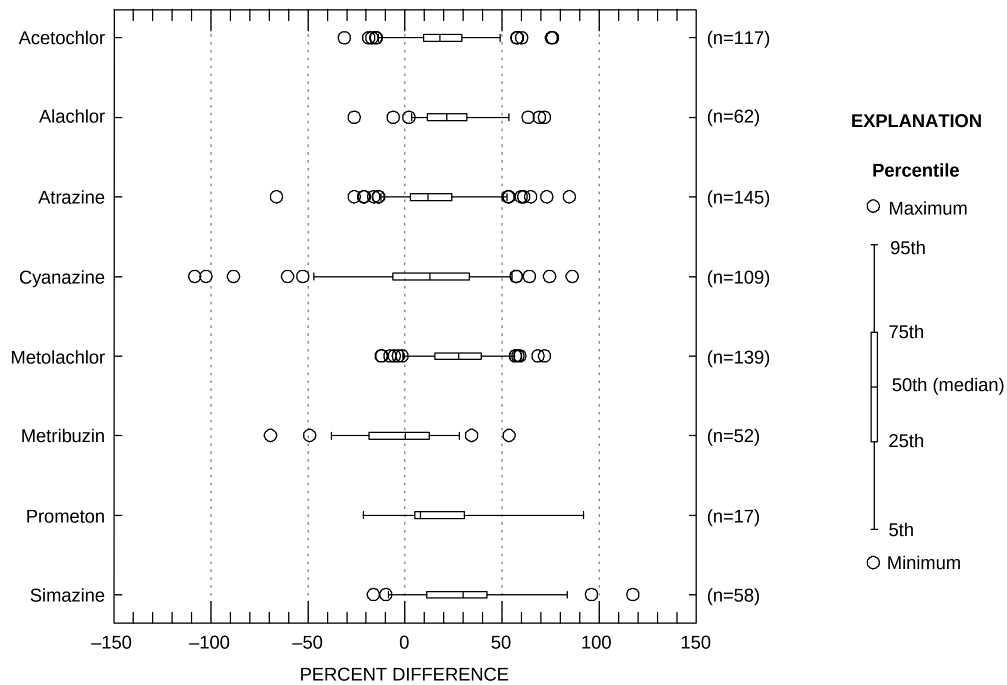


Figure 11. Percent differences between herbicide concentrations reported by the National Water Quality Laboratory and concentrations reported by the Organic Geochemistry Research Laboratory for 177 surface- and ground-water samples (n is the number of concentration pairs).

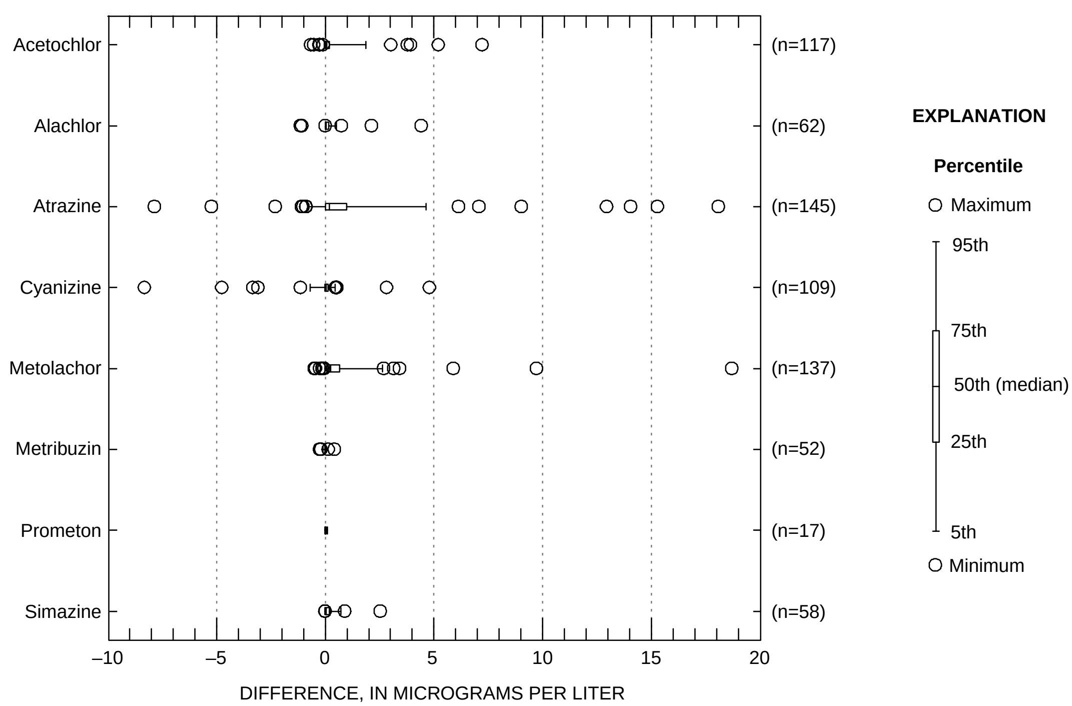


Figure 12. Differences between herbicide concentrations reported by the National Water Quality Laboratory and concentrations reported by the Organic Geochemistry Research Laboratory for 177 surface- and ground-water samples (n is the number of concentration pairs).

Table 6. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in water samples from 71 midwestern streams

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Concentration, in micrograms per liter						
				Sample no.	Bensul-furon methyl	Chlori-muron ethyl	Chlor-sulfuron	Flumet-sulam	Halosul-furon methyl	Imaza-pyr
				Illinois						
1	Vermillion River below Lake Vermillion dam, IL	06/10/98	R1	SU–98	<0.010	<0.010	<0.010	0.054	<0.010	<0.010
		06/10/98	RD	SU–103	Sample not analyzed (duplicate bottle for SU–98)					
		07/16/98	R2	SU–177	Sample not analyzed (both bottles broken)					
2	Bonpas Creek at Browns, IL	05/23/98	S1	SU–43	Sample ruined in laboratory					
		07/07/98	S2	SU–166	<.010	.014	<.010	.020	<.010	<.010
3	Little Wabash River at Carmi, IL	05/23/98	S1	SU–33	<.010	.093	<.010	.074	<.010	<.010
		07/09/98	S2	SU–175	Sample not analyzed (both bottles broken)					
4	S. Branch Kishwaukee River near Fairdale, IL	05/20/98	S1	SU–29	<.010	<.010	<.010	<.010	<.010	<.010
		07/29/98	S2	SU–195	<.010	<.010	<.010	<.010	<.010	<.010
5	Iroquois River near Chebanse, IL	06/10/98	S1	SU–99	<.010	E.005	<.010	E.020	<.010	<.010
		06/10/98	SD	SU–101	Sample not analyzed (duplicate bottle for SU–99)					
		07/08/98	S2	SU–168	<.010	.017	<.010	.065	<.010	<.010
		07/08/98	SD	SU–170	<.010	.024	<.010	.082	E.015	<.010
6	Dupage River near Shorewood, IL	06/09/98	S1	SU–100	<.010	<.010	<.010	<.010	<.010	<.010
		06/09/98	SD	SU–102	Sample not analyzed (duplicate bottle for SU–100)					
		07/29/98	S2	SU–194	<.010	<.010	<.010	<.010	<.010	<.010
		07/29/98	SD	SU–196	<.010	<.010	<.010	<.010	<.010	<.010
7	Illinois River at Marseilles, IL	06/12/98	S1	SU–113	<.010	E.012	<.010	.039	<.010	<.010
		07/09/98	S2	SU–176	Sample not analyzed (both bottles broken)					
8	Spoon River at London Mills, IL	05/20/98	S1	SU–25	<.010	.079	<.010	.030	<.010	<.010
		05/20/98	SB	SU–26	<.010	<.010	<.010	<.010	<.010	<.010
		07/01/98	S2	SU–160	<.010	.026	<.010	.029	<.010	<.010
9	Sangamon River near Monticello, IL	05/23/98	S1	SU–35	<.010	<.010	<.010	<.010	<.010	<.010
		08/05/98	S2	SU–201	<.010	<.010	<.010	.017	<.010	<.010
10	Sangamon River at Riverton, IL	05/26/98	S1	SU–44	<.010	.025	<.010	.067	<.010	<.010
		07/09/98	S2	SU–174	<.010	.012	<.010	.035	E.057	<.010
11	LaMoine River at Colmar, IL	05/21/98	S1	SU–27	<.010	.268	<.010	.058	<.010	<.010
		06/29/98	S2	SU–142	<.010	.032	<.010	.038	<.010	<.010
		06/29/98	SD	SU–143	<.010	.034	<.010	.044	<.010	<.010
12	Illinois River at Valley City, IL	06/18/98	S1	SU–120	<.010	E.019	<.010	.068	<.010	<.010
		08/12/98	S2	SU–207	<.010	<.010	<.010	.013	<.010	<.010

and 5 midwestern reservoirs

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter									
	Imaza-quin	Imaze-thapyr	Metsul-furon methyl	Nicosul-furon	Primi-sulfuron methyl	Prosul-furon	Sulfo-meturon methyl	Thifen-sulfuron methyl	Triasul-furon	Triflu-sulfuron methyl
	Illinois—Continued									
1	<0.010	0.053	<0.010	E0.021	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Sample not analyzed									
	Sample not analyzed									
2	Sample not analyzed									
	.053	.045	<.010	.066	<.010	.018	<.010	<.010	<.010	<.010
3	.133	.031	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	Sample not analyzed									
4	<.010	.016	<.010	E.013	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
5	<.010	.045	<.010	.013	<.010	<.010	<.010	<.010	<.010	<.010
	Sample not analyzed									
	.019	.407	<.010	.052	<.010	<.010	<.010	<.010	<.010	<.010
	E.025	.417	<.010	.079	<.010	E.010	<.010	E.009	<.010	<.010
6	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	Sample not analyzed									
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
7	E.010	.105	<.010	.057	<.010	<.010	.018	<.010	<.010	<.010
	Sample not anlayzed									
8	<.010	.066	<.010	.036	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.015	.097	<.010	.066	<.010	<.010	<.010	<.010	<.010	<.010
9	<.010	.059	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.014	<.010	.013	<.010	<.010	<.010	<.010	<.010	<.010
10	E.007	.099	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.018	.130	<.010	.020	<.010	<.010	<.010	<.010	<.010	<.010
11	.109	.106	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.014	.034	<.010	.095	<.010	<.010	<.010	E.007	<.010	<.010
	.017	.037	<.010	.096	<.010	<.010	<.010	<.010	<.010	<.010
12	<.010	.089	<.010	.054	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.020	<.010	.010	<.010	<.010	<.010	<.010	<.010	<.010

Table 6. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in water samples from 71 midwestern streams

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Concentration, in micrograms per liter						
				Sample no.	Bensulfuron methyl	Chlorimuron ethyl	Chlorsulfuron	Flumetsulam	Halosulfuron methyl	Imazapyr
				Illinois—Continued						
13	Mississippi River below Grafton, IL	06/02/98	S1	SU–60	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
		06/15/98	S2	SU–116	<.010	<.010	<.010	.049	<.010	<.010
14	Kaskaskia River near Cowden, IL	05/20/98	S1	SU–30	<.010	<.010	<.010	<.010	<.010	<.010
		07/08/98	S2	SU–169	<.010	<.010	<.010	.033	<.010	<.010
15	Shoal Creek near Breese, IL	05/22/98	S1	SU–32	<.010	.141	<.010	.070	<.010	<.010
		05/22/98	SD	SU–34	<.010	.135	<.010	.072	<.010	<.010
		07/08/98	S2	SU–167	<.010	.176	<.010	.084	<.010	<.010
				Iowa						
16	Turkey River at Spillville, IA	06/02/98	S1	SU–64	<.010	<.010	<.010	.025	E.008	<.010
		06/12/98	S2	SU–109	<.010	<.010	<.010	.036	E.017	<.010
17	Mississippi River at Clinton, IA	05/27/98	S1	SU–55	<.010	<.010	<.010	<.010	<.010	<.010
		07/01/98	S2	SU–155	<.010	<.010	<.010	.025	<.010	<.010
18	Wapsipinicon River near Tripoli, IA	05/27/98	S1	SU–54	<.010	<.010	<.010	.019	<.010	<.010
		06/20/98	SB	SU–125	<.010	<.010	<.010	<.010	<.010	<.010
		06/20/98	S2	SU–126	<.010	.010	<.010	.060	<.010	<.010
19	Wapsipinicon River at Independence, IA	05/29/98	S1	SU–56	<.010	<.010	<.010	.019	<.010	<.010
		06/12/98	S2	SU–110	<.010	<.010	<.010	.100	E.009	<.010
20	Iowa River near Rowan, IA	06/02/98	S1	SU–65	<.010	<.010	<.010	E.014	<.010	<.010
		06/23/98	S2	SU–129	<.010	<.010	<.010	E.084	<.010	<.010
21	Old Mans Creek near Iowa City, IA	06/10/98	S1	SU–93	<.010	<.010	<.010	E.026	E.013	<.010
		06/30/98	S2	SU–147	<.010	E.008	<.010	.021	<.010	<.010
22	Wolf Creek near Dysart, IA	06/10/98	S1	SU–87	<.010	<.010	<.010	.122	<.010	<.010
		06/10/98	SD	SU–88	<.010	<.010	<.010	E.024	<.010	E.004
		06/22/98	S2	SU–128	<.010	<.010	<.010	E.220	<.010	E.004
23	Iowa River at Wapello, IA	05/27/98	S1	SU–53	<.010	<.010	<.010	E.012	<.010	<.010
		06/19/98	S2	SU–127	<.010	<.010	<.010	E.085	<.010	<.010
		06/19/98	SD	SU–132	<.010	<.010	<.010	.090	<.010	<.010
24	N. Skunk River near Sigourney, IA	05/21/98	S1	SU–21	<.010	<.010	<.010	E.360	<.010	<.010
		06/10/98	S2	SU–95	<.010	<.010	<.010	.187	<.010	<.010
25	Skunk River at Augusta, IA	05/26/98	S1	SU–45	<.010	<.010	<.010	.127	<.010	<.010
		06/18/98	S2	SU–122	<.010	<.010	<.010	.184	<.010	<.010

and 5 midwestern reservoirs—Continued

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter									
	Imaza-quin	Imaze-thapyr	Metsul-furon methyl	Nicosul-furon	Primi-sulfuron methyl	Prosul-furon	Sulfo-meturon methyl	Thifen-sulfuron methyl	Triasul-furon	Triflu-sulfuron methyl
	Illinois—Continued									
13	<0.010	0.027	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	.052	.049	<.010	.028	<.010	<.010	<.010	<.010	<.010	<.010
14	<.010	.059	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.017	.084	<.010	.021	<.010	<.010	<.010	<.010	<.010	<.010
15	<.010	.011	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.034	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.013	.016	<.010	.034	<.010	<.010	<.010	<.010	<.010	<.010
	Iowa—Continued									
16	<.010	.024	<.010	.043	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.061	<.010	.044	<.010	<.010	<.010	<.010	<.010	<.010
17	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.018	<.010	.022	<.010	<.010	<.010	<.010	<.010	<.010
18	<.010	.035	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.369	<.010	.119	<.010	<.010	<.010	E.010	<.010	<.010
19	<.010	<.010	<.010	.021	<.010	<.010	<.010	<.010	<.010	<.010
	E.004	.236	<.010	.096	<.010	<.010	<.010	<.010	<.010	<.010
20	E.003	.018	<.010	E.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.130	<.010	E.110	<.010	<.010	<.010	<.010	<.010	<.010
21	<.010	.019	<.010	.027	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.070	<.010	.132	<.010	<.010	<.010	<.010	<.010	<.010
22	<.010	E.073	<.010	.103	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.058	<.010	.064	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.180	<.010	E.160	<.010	<.010	<.010	<.010	<.010	<.010
23	<.010	E.007	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.063	<.010	E.073	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.079	<.010	.082	<.010	<.010	<.010	<.010	E.005	<.010
24	<.010	E.025	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.183	<.010	.062	<.010	<.010	<.010	<.010	<.010	<.010
25	.010	.060	<.010	E.013	<.010	<.010	<.010	<.010	<.010	<.010
	E.008	.119	<.010	.097	<.010	<.010	<.010	<.010	<.010	<.010

Table 6. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in water samples from 71 midwestern streams

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Concentration, in micrograms per liter						
				Sample no.	Bensulfuron methyl	Chlorimuron ethyl	Chlorsulfuron	Flumetsulam	Halosulfuron methyl	Imazapyr
				Iowa—Continued						
26	Des Moines River at Fort Dodge, IA	05/16/98	S1	SU–8	<0.010	<0.010	<0.010	0.096	<0.010	<0.010
		06/12/98	S2	SU–108	<.010	<.010	<.010	.062	<.010	<.010
		06/12/98	SD	SU–114	<.010	<.010	<.010	.060	<.010	<.010
27	Raccoon River at Van Meter, IA	05/17/98	S1	SU–9	<.010	<.010	<.010	<.010	<.010	<.010
		06/10/98	S2	SU–89	<.010	<.010	<.010	E.015	<.010	<.010
28	Little Sioux River at Correctionville, IA	05/27/98	S1	SU–42	<.010	<.010	<.010	<.010	<.010	<.010
		06/18/98	S2	SU–123	<.010	<.010	<.010	E.011	<.010	<.010
29	Maple River at Mapleton, IA	05/29/98	S1	SU–59	<.010	<.010	<.010	.062	<.010	<.010
		06/09/98	S2	SU–90	<.010	<.010	<.010	<.010	<.010	<.010
		06/09/98	SS	SU–97	Sample ruined in laboratory					
30	Boyer River at Logan, IA	05/22/98	S1	SU–31	<.010	<.010	<.010	<.010	<.010	<.010
		06/09/98	S2	SU–96	<.010	<.010	<.010	<.010	<.010	<.010
31	Chariton River below Rathbun Lake Dam, IA	06/04/98	R1	SU–69	<.010	<.010	<.010	E.006	<.010	<.010
		06/29/98	R2	SU–148	<.010	<.010	<.010	<.010	<.010	<.010
32	Nishnabotna River above Hamburg, IA	06/17/98	S2	SU–124	<.010	E.009	<.010	.032	<.010	<.010
				Indiana						
33	Whitewater River near Alpine, IN	05/26/98	S1	SU–47	<.010	.084	<.010	.020	<.010	<.010
		07/08/98	S2	SU–162	<.010	.037	<.010	.069	<.010	<.010
		07/08/98	SD	SU–213	<.010	.053	<.010	.070	<.010	<.010
34	Blue River at Fredericksburg, IN	05/27/98	S1	SU–50	<.010	<.010	<.010	<.010	<.010	<.010
		07/08/98	S2	SU–163	Sample not analyzed (both bottles broken)					
35	Mississinewa River below Mississinewa Lake Dam, IN	06/09/98	R1	SU–83	<.010	<.010	<.010	.054	<.010	<.010
		07/09/98	R2	SU–164	<.010	.080	<.010	.116	<.010	<.010
36	Eel River near Logansport, IN	05/21/98	S1	SU–18	<.010	E.300	<.010	<.010	<.010	<.010
		05/21/98	SB	SU–20	<.010	<.010	<.010	<.010	<.010	<.010
		06/30/98	S2	SU–152	<.010	.011	<.010	.034	<.010	<.010
37	Wildcat Creek near Jerome, IN	05/21/98	S1	SU–19	<.010	E.050	<.010	E.071	<.010	<.010
		06/30/98	S2	SU–151	<.010	.028	<.010	.169	<.010	<.010
38	Wildcat Creek near Lafayette, IN	05/20/98	S1	SU–22	<.010	<.010	<.010	E.010	<.010	<.010
		07/01/98	S2	SU–150	<.010	.018	<.010	.117	<.010	<.010

and 5 midwestern reservoirs—Continued

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter									
	Imazaquin	Imazethapyr	Metsulfuron methyl	Nicosulfuron	Primisulfuron methyl	Prosulfuron	Sulfometuron methyl	Thifensulfuron methyl	Triasulfuron	Triflusulfuron methyl
					Iowa—Continued					
26	<0.010	0.134	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	<.010	.044	<.010	.015	<.010	<.010	<.010	<.010	<.010	<.010
	E.002	.039	<.010	.012	<.010	<.010	<.010	<.010	<.010	<.010
27	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.063	<.010	E.018	<.010	<.010	<.010	<.010	<.010	<.010
28	<.010	E.011	<.010	E.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.080	<.010	.019	<.010	<.010	<.010	<.010	<.010	<.010
29	<.010	.077	<.010	.266	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.034	<.010	.047	<.010	<.010	<.010	<.010	<.010	<.010
	Sample not analyzed									
30	<.010	.083	<.010	.094	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.033	E.007	.021	<.010	<.010	<.010	<.010	<.010	<.010
31	<.010	<.010	<.010	E.006	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
32	E.007	.105	<.010	.093	<.010	<.010	<.010	<.010	<.010	<.010
					Indiana—Continued					
33	.217	.038	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.018	.073	<.010	.025	<.010	<.010	<.010	<.010	<.010	<.010
	.019	.068	<.010	.033	<.010	<.010	<.010	E.007	<.010	<.010
34	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	Sample not analyzed									
35	.072	.050	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.126	.099	<.010	.043	<.010	<.010	<.010	<.010	<.010	<.010
36	E1.100	E.690	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.021	.061	<.010	.041	<.010	<.010	<.010	<.010	<.010	<.010
37	E.160	E.088	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.034	.046	<.010	.015	<.010	<.010	<.010	<.010	<.010	<.010
38	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.046	.101	<.010	.023	<.010	<.010	<.010	<.010	<.010	<.010

Table 6. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in water samples from 71 midwestern streams

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Concentration, in micrograms per liter						
				Sample no.	Bensul-furon methyl	Chlori-muron ethyl	Chlor-sulfuron	Flumet-sulam	Halosul-furon methyl	Imaza-pyr
				Indiana—Continued						
39	White River near Nora, IN	05/28/98	S1	SU–51	<0.010	0.062	<0.010	0.059	<0.010	<0.010
		07/01/98	S2	SU–149	<.010	.043	<.010	.109	<.010	<.010
40	Sugar Creek near Edinburgh, IN	05/26/98	S1	SU–46	<.010	.070	<.010	<.010	<.010	<.010
		07/20/98	S2	SU–178	Sample not analyzed (both bottles broken)					
41	E. Fork White River near Bedford, IN	05/28/98	S1	SU–52	<.010	.081	<.010	.118	<.010	<.010
		07/6/98	S2	SU–161	<.010	.035	<.010	.025	<.010	<.010
42	Wabash River at New Harmony, IN	05/27/98	S1	SU–57	<.010	.040	<.010	<.010	<.010	<.010
		05/27/98	SD	SU–58	<.010	.033	<.010	<.010	<.010	<.010
		06/23/98	S2	SU–136	<.010	<.010	<.010	.116	<.010	<.010
				Minnesota						
43	Cottonwood River near New Ulm, MN	05/26/98	S1	SU–49	<.010	<.010	<.010	<.010	<.010	<.010
		07/21/98	S2	SU–180	<.010	<.010	<.010	.032	<.010	<.010
		07/21/98	SD	SU–181	<.010	<.010	<.010	E.035	<.010	<.010
44	Little Cobb River near Beauford, MN	05/18/98	S1	SU–12	<.010	<.010	<.010	<.010	<.010	<.010
		08/17/98	S2	SU–208	<.010	<.010	<.010	.016	<.010	<.010
45	Minnesota River near Jordan, MN	05/19/98	S1	SU–13	<.010	<.010	<.010	.013	<.010	<.010
		06/26/98	S2	SU–135	<.010	<.010	<.010	.057	<.010	<.010
46	Mississippi River at Hastings, MN	05/20/98	S1	SU–14	<.010	<.010	<.010	<.010	<.010	<.010
		05/20/98	SD	SU–15	<.010	<.010	<.010	<.010	<.010	<.010
		05/20/98	S2	SU–206	<.010	<.010	<.010	E.009	<.010	<.010
47	Des Moines River at Jackson, MN	05/26/98	S1	SU–48	<.010	<.010	<.010	<.010	<.010	<.010
		08/24/98	S2	SU–210	<.010	<.010	<.010	.345	<.010	<.010
48	Rock River at Luverne, MN	06/24/98	S1	SU–130	<.010	<.010	<.010	E.008	<.010	<.010
		06/25/98	S2	SU–131	<.010	<.010	<.010	.022	<.010	<.010
				Kansas						
49	Black Vermillion River at Frankfort, KS	05/05/98	S1	SU–1	<.010	<.010	<.010	<.010	<.010	<.010
		06/09/98	S2	SU–107	<.010	<.010	<.010	.014	E.011	<.010
50	Big Blue River below Tuttle Creek Lake Dam, KS	06/03/98	R1	SU–74	<.010	<.010	E.023	<.010	<.010	<.010
		07/29/98	R2	SU–197	<.010	E.004	<.010	E.021	<.010	<.010
51	Delaware River near Muscotah, KS	05/05/98	S1	SU–2	<.010	<.010	<.010	<.010	<.010	<.010
		06/10/98	S2	SU–105	<.010	E.007	<.010	<.010	<.010	<.010
		06/10/98	SB	SU–106	<.010	<.010	<.010	<.010	<.010	<.010

and 5 midwestern reservoirs—Continued

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter									
	Imazaquin	Imazethapyr	Metsulfuron methyl	Nicosulfuron	Primisulfuron methyl	Prosulfuron	Sulfometuron methyl	Thifensulfuron methyl	Triasulfuron	Triflusulfuron methyl
Indiana—Continued										
39	0.120	0.027	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	.045	.035	<.010	.017	<.010	<.010	<.010	<.010	<.010	<.010
40	.136	.031	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	Sample not analyzed									
41	.161	.073	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.055	.047	<.010	.026	<.010	.022	<.010	<.010	<.010	<.010
42	.051	.046	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.041	.030	<.010	<.010	<.010	<.010	.012	<.010	<.010	<.010
	<.010	.082	<.010	.045	<.010	<.010	<.010	<.010	E.005	<.010
Minnesota—Continued										
43	<.010	.018	<.010	E.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.026	<.010	.034	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.028	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
44	<.010	.015	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.021	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
45	<.010	.017	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.114	<.010	.059	<.010	<.010	<.010	<.010	<.010	<.010
46	<.010	E.005	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.003	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	.010	<.010	<.010	<.010	<.010	<.010	<.010
47	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.025	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
48	<.010	E.100	<.010	E.006	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.117	<.010	.042	<.010	<.010	<.010	<.010	<.010	<.010
Kansas—Continued										
49	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.774	E.006	<.010	<.010	<.010	E.008	<.010	<.010	<.010	<.010
50	E.011	<.010	<.010	.011	<.010	<.010	<.010	<.010	<.010	<.010
	E.021	E.013	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
51	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.049	.043	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010

Table 6. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in water samples from 71 midwestern streams

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Concentration, in micrograms per liter						
				Sample no.	Bensulfuron methyl	Chlorimuron ethyl	Chlorsulfuron	Flumetsulam	Halosulfuron methyl	Imazapyr
				Kentucky						
52	Ohio River at Cannelton Dam, KY	06/04/98	S1	SU–75	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
		06/04/98	SD	SU–214	<.010	.014	<.010	<.010	<.010	<.010
		07/07/98	S2	SU–173	<.010	<.010	<.010	E.010	<.010	<.010
				Missouri						
53	Nodaway River near Graham, MO	06/18/98	S1	SU–119	<.010	<.010	<.010	.020	<.010	<.010
		08/19/98	S2	SU–209	<.010	<.010	<.010	<.010	<.010	<.010
				Nebraska						
54	North Dry Creek near Kearney, NE	05/22/98	S1	SU–28	<.010	<.010	<.010	.045	<.010	<.010
		06/08/98	S2	SU–76	<.010	<.010	<.010	.035	<.010	E.006
55	Maple Creek near Nickerson, NE	05/21/98	S1	SU–37	<.010	<.010	<.010	.055	<.010	<.010
		05/21/98	SD	SU–38	<.010	<.010	<.010	.051	<.010	<.010
		06/08/98	S2	SU–79	<.010	<.010	<.010	.112	<.010	.016
56	Salt Creek at Roca, NE	05/15/98	S1	SU–6	<.010	<.010	<.010	.019	<.010	<.010
		06/10/98	S2	SU–94	<.010	.054	<.010	<.010	E.013	<.010
57	Wahoo Creek at Ithaca, NE	05/15/98	S1	SU–5	<.010	<.010	<.010	<.010	<.010	<.010
		06/08/98	S2	SU–78	<.010	.010	<.010	.025	<.010	.072
58	Platte River at Louisville, NE	05/22/98	S1	SU–39	<.010	<.010	<.010	<.010	<.010	<.010
		05/22/98	SD	SU–40	<.010	<.010	<.010	<.010	<.010	<.010
		06/09/98	S2	SU–77	<.010	<.010	<.010	<.010	<.010	<.010
59	Big Nemaha River at Falls City, NE	05/26/98	S1	SU–41	<.010	<.010	<.010	<.010	<.010	<.010
		06/08/98	S2	SU–80	<.010	<.010	<.010	.052	<.010	<.010
60	W. Fork Big Blue River, Dorchester, NE	05/23/98	S1	SU–36	<.010	<.010	<.010	.128	<.010	<.010
		06/10/98	S2	SU–82	Sample ruined in laboratory					
61	Big Blue River at Barneston, NE	05/15/98	S1	SU–4	<.010	<.010	<.010	<.010	<.010	<.010
		06/9/98	S2	SU–104	<.010	.036	<.010	.033	.053	.022
62	Little Blue River near Fairbury, NE	05/12/98	S1	SU–3	<.010	<.010	<.010	<.010	<.010	<.010
		06/08/98	S2	SU–81	<.010	.012	<.010	.064	<.010	<.010
				Ohio						
63	Clear Creek near Rockbridge, OH	06/10/98	S1	SU–86	Sample ruined in laboratory					
		06/30/98	S2	SU–145	<.010	.013	<.010	.018	<.010	<.010
64	Scioto River near Prospect, OH	06/02/98	S1	SU–63	<.010	.081	<.010	<.010	<.010	.010
		06/29/98	S2	SU–141	<.010	.044	<.010	.030	<.010	E.018

and 5 midwestern reservoirs—Continued

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter									
	Imaza-quin	Imaze-thapyr	Metsul-furon methyl	Nicosul-furon	Primi-sulfuron methyl	Prosul-furon	Sulfo-meturon methyl	Thifen-sulfuron methyl	Triasul-furon	Triflu-sulfuron methyl
Kentucky—Continued										
52	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.013	<.010	<.010	.012	<.010	<.010	<.010	<.010	<.010	<.010
Missouri—Continued										
53	<.010	.052	<.010	.065	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Nebraska—Continued										
54	<.010	.144	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.028	.078	<.010	.037	<.010	E.011	<.010	<.010	<.010	<.010
55	.071	.051	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	E.061	.040	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.234	.161	<.010	.025	<.010	<.010	<.010	<.010	<.010	<.010
56	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.033	E.022	<.010	E.039	<.010	E.027	<.010	<.010	<.010	<.010
57	<.010	.213	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.028	<.010	.050	<.010	<.010	<.010	<.010	<.010	<.010
58	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	E.021	.030	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	.150	<.010	E.010	<.010	<.010	<.010	<.010
59	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	E.066	.122	<.010	.161	<.010	<.010	<.010	<.010	<.010	<.010
60	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	Sample not analyzed									
61	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.045	.021	<.010	.030	<.010	E.036	.014	<.010	<.010	<.010
62	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.063	<.010	<.010	<.010	<.010	E.009	<.010	<.010	<.010	<.010
Ohio—Continued										
63	Sample not analyzed									
	E.009	<.010	<.010	.017	<.010	E.008	<.010	<.010	<.010	<.010
64	.512	.026	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.266	.314	<.010	.075	<.010	<.010	<.010	<.010	<.010	<.010

Table 6. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in water samples from 71 midwestern streams

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter: Bensul-furon methyl	Chlori-muron ethyl	Chlor-sulfuron	Flumet-sulam	Halosul-furon methyl	Imaza-pyr
				Ohio—Continued						
65	Olentangy River at Claridon, OH	06/09/98	S1	SU–85	<0.010	<0.010	<0.010	<0.010	E0.005	E0.005
		06/29/98	S2	SU–157	<.010	.023	<.010	.013	<.010	<.010
		06/29/98	SB	SU–156	<.010	<.010	<.010	<.010	<.010	<.010
66	Olentangy River below Delaware, Lake Dam, OH	06/09/98	R1	SU–84	Sample ruined in laboratory					
		06/29/98	R2	SU–153	<.010	.048	<.010	.023	<.010	<.010
		07/01/98	RD	SU–154	<.010	.044	<.010	.022	<.010	<.010
67	Big Darby Creek at Darbyville, OH	06/03/98	S1	SU–62	<.010	E.006	<.010	.021	<.010	<.010
		06/29/98	S2	SU–140	<.010	.013	<.010	.048	<.010	<.010
68	Scioto River at Higby, OH	06/04/98	S1	SU–73	<.010	.022	<.010	.014	<.010	<.010
		07/08/98	S2	SU–165	<.010	.041	<.010	.030	<.010	E.004
69	L. Miami River near Oldtown, OH	06/10/98	S1	SU–92	<.010	<.010	<.010	E.007	<.010	<.010
		06/30/98	S2	SU–144	<.010	.015	<.010	.033	<.010	<.010
70	Mad River at Eagle City, OH	06/10/98	S1	SU–91	<.010	<.010	E.013	<.010	<.010	<.010
		06/30/98	S2	SU–146	<.010	.021	<.010	<.010	<.010	<.010
71	Tiffin River at Stryker, OH	06/01/98	S1	SU–66	<.010	E.006	<.010	.020	<.010	<.010
		06/01/98	SD	SU–67	<.010	E.006	<.010	.021	<.010	<.010
		07/07/98	S2	SU–172	Sample not analyzed (both bottles broken)					
72	Auglaize River at Fort Jennings, OH	06/17/98	S1	SU–117	<.010	<.010	<.010	E.290	<.010	<.010
		07/08/98	S2	SU–171	<.010	.067	<.010	.110	E.067	<.010
				Wisconsin						
73	Root River at Racine, WI	06/01/98	S1	SU–61	<.010	<.010	<.010	<.010	<.010	E.008
		08/03/98	S2	SU–204	<.010	<.010	<.010	<.010	<.010	<.010
74	St. Croix River at St. Croix Falls, WI	06/03/98	S1	SU–68	<.010	<.010	<.010	<.010	<.010	<.010
		08/05/98	S2	SU–205	<.010	<.010	<.010	<.010	<.010	<.010
75	Wisconsin River at Muscoda, WI	06/16/98	S1	SU–133	<.010	<.010	<.010	E.009	<.010	<.010
		08/07/98	S2	SU–202	<.010	<.010	<.010	<.010	<.010	<.010
		08/07/98	SD	SU–203	<.010	<.010	<.010	<.010	<.010	<.010
76	Rock River at Afton, WI	06/17/98	S1	SU–134	<.010	<.010	<.010	.020	<.010	<.010
		07/21/98	S2	SU–179	<.010	<.010	<.010	.041	<.010	<.010

and 5 midwestern reservoirs—Continued

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter									
	Imazaquin	Imazethapyr	Metsulfuron methyl	Nicosulfuron	Primisulfuron methyl	Prosulfuron	Sulfometuron methyl	Thifensulfuron methyl	Triasulfuron	Triflusulfuron methyl
					Ohio—Continued					
65	<0.010	E0.014	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	.032	.072	<.010	.049	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
66	Sample not analyzed									
	.103	.158	<.010	.091	<.010	<.010	<.010	<.010	<.010	<.010
	.098	.167	<.010	.089	<.010	<.010	<.010	<.010	<.010	<.010
67	.068	<.010	<.010	E.012	<.010	<.010	<.010	<.010	<.010	<.010
	.025	<.010	<.010	.022	<.010	<.010	<.010	<.010	<.010	<.010
68	.030	<.010	<.010	E.009	<.010	<.010	<.010	<.010	<.010	<.010
	E.084	.083	<.010	.060	<.010	<.010	<.010	<.010	<.010	<.010
69	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	E.008	<.010	<.010	E.008	<.010	<.010	<.010	<.010	<.010	<.010
70	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.007	<.010	.012	<.010	<.010	<.010	<.010	<.010	<.010
71	<.010	E.007	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	E.006	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	Sample not analyzed									
72	E.410	.044	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	.206	.062	<.010	.040	<.010	E.009	<.010	.015	<.010	<.010
					Wisconsin—Continued					
73	<.010	E.024	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
74	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
75	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	E.007	<.010	<.010	<.010	<.010	<.010	<.010
76	<.010	E.008	<.010	E.009	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.020	<.010	.029	<.010	<.010	<.010	<.010	<.010	<.010

Table 7. Statistical summary of sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in 133 water samples from 71 midwestern streams (concentrations in micrograms per liter)

[<, less than; E, estimate]

Herbicide	Method reporting limit (MRL)	Number at or above MRL	25th percentile	Median	75th percentile	95th percentile	Maximum
bensulfuron methyl	0.010	0	<0.010	<0.010	<0.010	<0.010	<0.010
chlorimuron ethyl	.010	41	<.010	<.010	.013	.081	E.300
chlorsulfuron	.010	1	<.010	<.010	<.010	<.010	E.013
flumetsulam	.010	87	<.010	.020	.057	.128	E.360
halosulfuron methyl	.010	7	<.010	<.010	<.010	E.011	E.067
imazapyr	.010	5	<.010	<.010	<.010	E.006	.072
imazaquin	.010	44	<.010	<.010	.021	.217	E1.11
imazethapyr	.010	92	E.005	.028	.073	.183	E.690
metsulfuron methyl	.010	0	<.010	<.010	<.010	<.010	E.007
nicosulfuron	.010	70	<.010	.010	.039	.110	.266
primisulfuron methyl	.010	0	<.010	<.010	<.010	<.010	<.010
prosulfuron	.010	6	<.010	<.010	<.010	E.009	.036
sulfometuron methyl	.010	2	<.010	<.010	<.010	<.010	.018
thifensulfuron methyl	.010	2	<.010	<.010	<.010	<.010	.015
triasulfuron	.010	0	<.010	<.010	<.010	<.010	E.005
triflusulfuron methyl	.010	0	<.010	<.010	<.010	<.010	<.010
Sum of all 16 analytes	.010	111	.027	.128	.237	.560	2.10

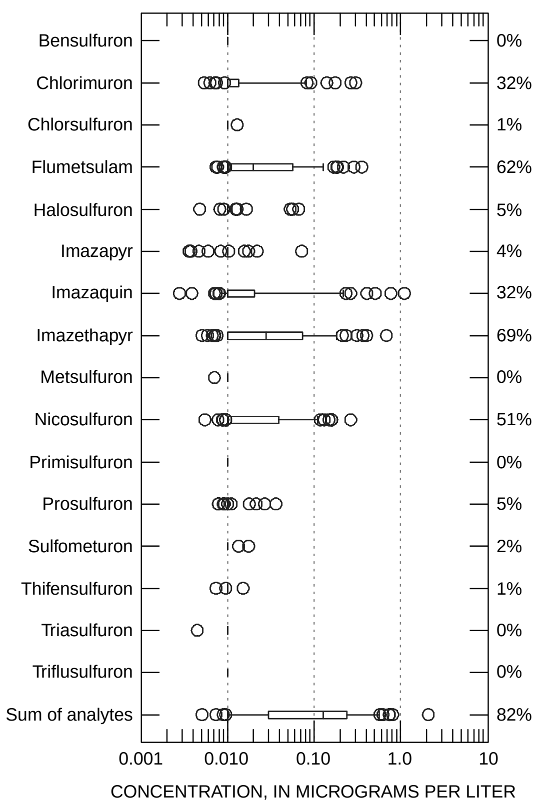


Figure 13. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations and percent detections at or above the method reporting limit of 0.01 microgram per liter in 133 stream samples.

associated with the stream (and reservoir outflow) sampling sites are shaded according to the herbicide concentrations in the associated samples. The difference in concentration between pre- and post-emergence samples is notable for all three of these compounds. In general, the occurrence of imazethapyr at concentrations greater than 0.10 μg/L appears to be more widespread than flumetsulam or nicosulfuron. Nicosulfuron concentrations tend to be lower than flumetsulam or imazethapyr except in the post-emergence samples from the large stream sites (fig. 16*D*). The difference between pre- and post-emergence concentrations for these three compounds is not as distinct as the difference between pre- and post-application concentrations of alachlor, atrazine, or cyanazine observed in previous investigations (Goolsby and others, 1994; Goolsby and Battaglin, 1995). The difference in concentrations between smaller agricultural watersheds and larger watersheds that have more diverse land use also is evident in figures 14, 15, and 16. The concentration of one of these three herbicides exceeds 0.10 μg/L in 43 of 369 values (11.7 percent) in samples from stream or reservoir outflow sites in smaller watersheds but only in 3 of 54 values (5.5 percent) in samples from the nine sites on streams of larger watersheds.

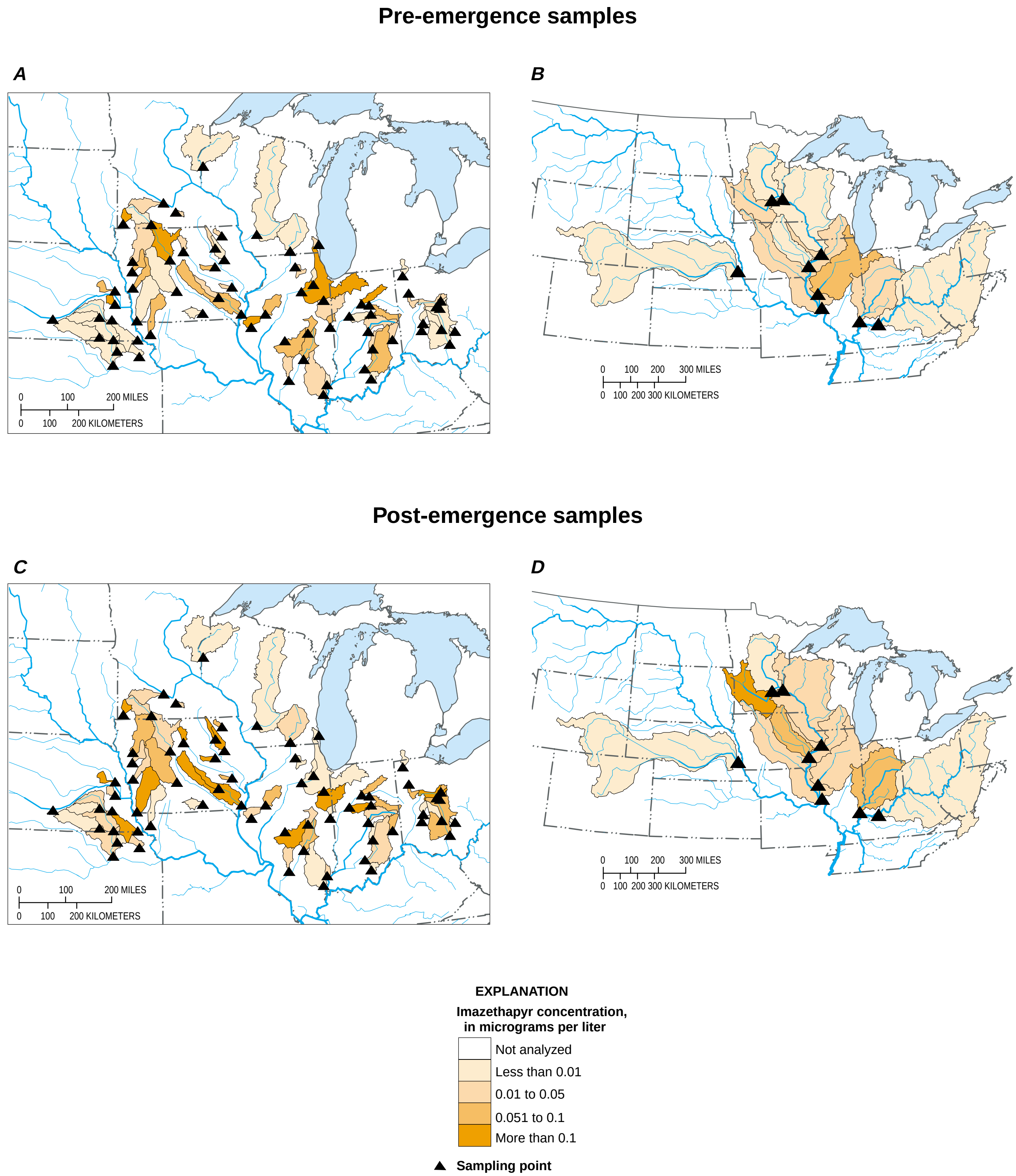


Figure 14. Spatial distributions of imazethapyr concentrations in: (*A*) pre-emergence samples from small stream and reservoir outflow sites, (*B*) pre-emergence samples from large river sites, (*C*) post-emergence samples from small stream and reservoir outflow sites, and (*D*) post-emergence samples from large river sites.

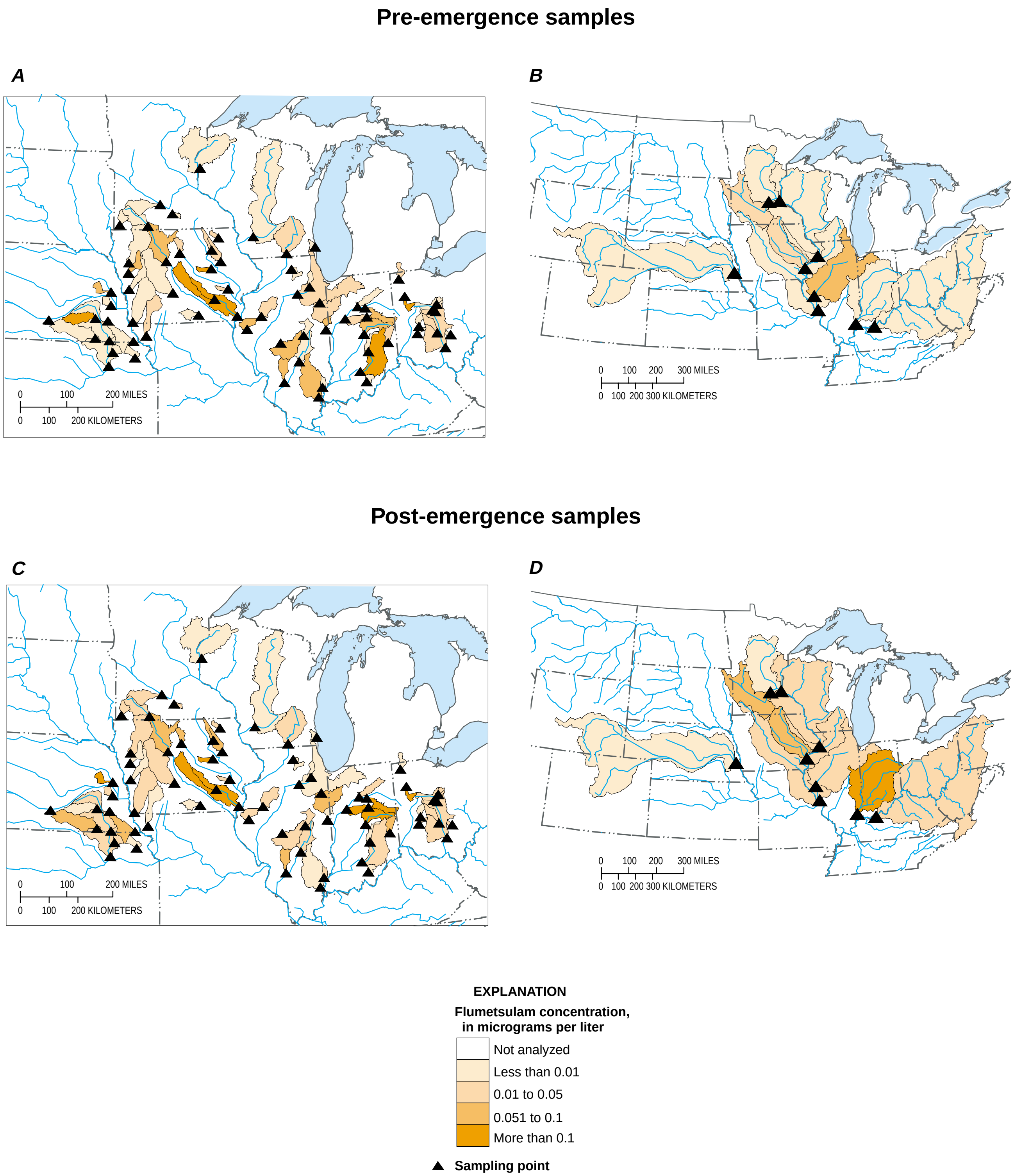


Figure 15. Spatial distributions of flumetsulam concentrations in: (*A*) pre-emergence samples from small stream and reservoir outflow sites, (*B*) pre-emergence samples from large river sites, (*C*) post-emergence samples from small stream and reservoir outflow sites, and (*D*) post-emergence samples from large river sites.

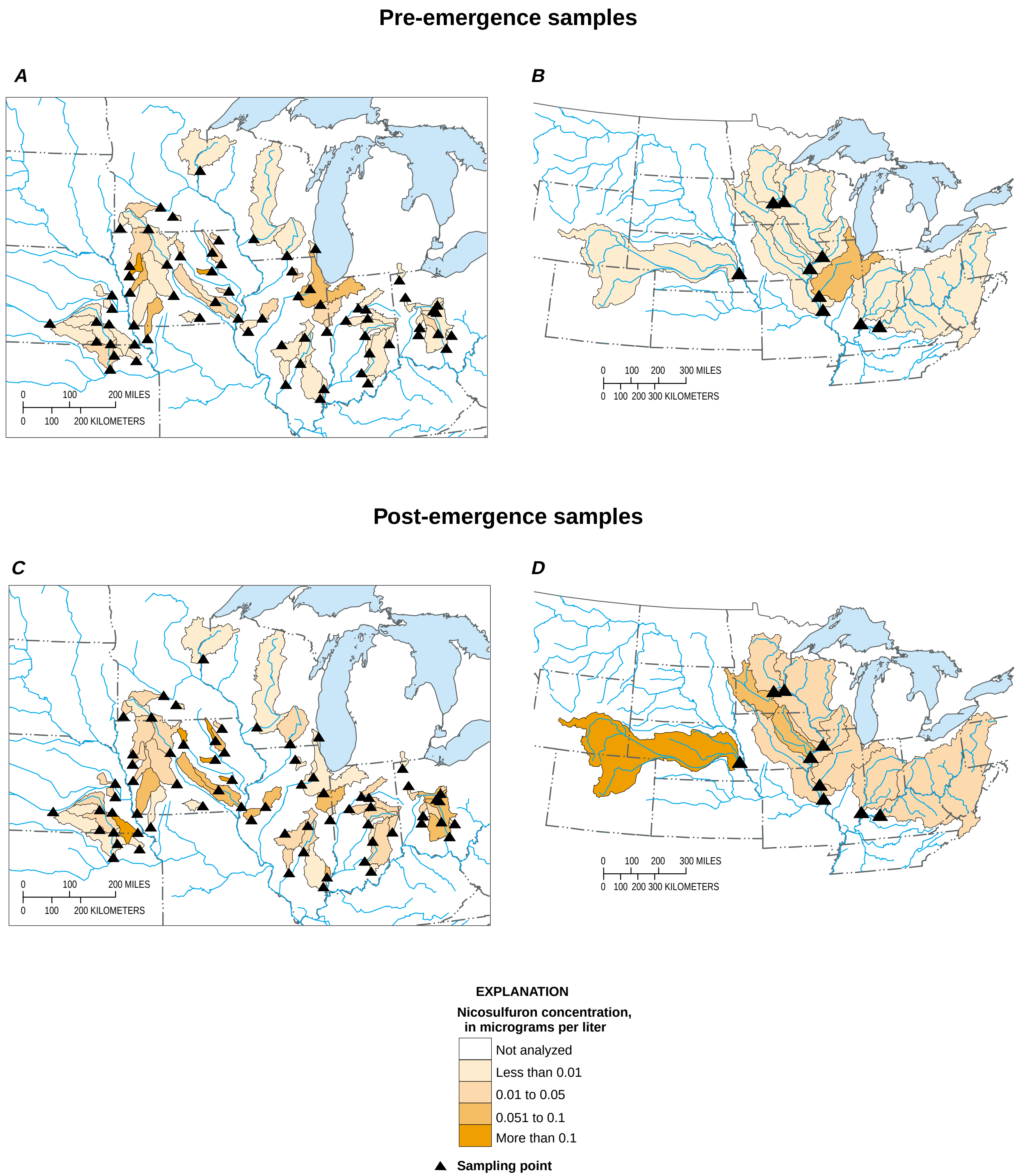


Figure 16. Spatial distributions of nicosulfuron concentrations in: (*A*) pre-emergence samples from small stream and reservoir outflow sites, (*B*) pre-emergence samples from large river sites, (*C*) post-emergence samples from small stream and reservoir outflow sites, and (*D*) post-emergence samples from large river sites.

Reservoir Outflows

Results from eight reservoir outflow samples are given in table 6. A statistical summary of these results is given in table 8. At least one of the 16 SU, SA, or IMI herbicides was detected at or above the MRL in six of eight (75 percent) reservoir outflow samples. Flumetsulam, imazethapyr, and imazaquin were each detected in five samples. Nicosulfuron was detected in four samples. Chlorimuron ethyl was detected in two samples, and chlorsulfuron was detected in one sample. Bensulfuron methyl, halosulfuron methyl, imazapyr, metsulfuron methyl, primisulfuron methyl, prosulfuron, sulfometuron methyl, thifensulfuron methyl, triasulfuron, and triflusulfuron methyl were not detected at or above the MRL.

The distributions of concentrations of the target analytes in eight reservoir outflow samples are summarized in figure 17. In some cases, estimated concentrations are reported that are below the MRL. These concentrations are not counted as detections at or above the MRL in table 8 but are plotted in figure 17 and used to calculate the percentiles shown in table 8. The sum of SU, SA, and IMI concentrations did not exceeded 0.50 µg/L in any of the reservoir outflow samples.

Ground Water

Results from 25 ground-water samples are given in table 9. A statistical summary of these results is given in table 10. At least one of the 16 SU, SA, or IMI herbicides was detected at or above the MRL in 5 of 25 (20 percent) ground-water samples. Imazethapyr was detected in four samples, flumetsulam and imazaquin were each detected in three samples, and nicosulfuron was detected in two samples. Bensulfuron methyl, chlorimuron ethyl, chlorsulfuron, halosulfuron methyl, imazapyr, metsulfuron methyl, primisulfuron methyl, prosulfuron, sulfometuron methyl, thifensulfuron methyl, triasulfuron, and triflusulfuron methyl were not detected at or above the MRL.

Table 8. Statistical summary of sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in eight water samples from the outflow of five midwestern reservoirs (concentrations in micrograms per liter, the 95th percentile is not given as it is the same as the maximum)

[MRL, method reporting limit; <, less than; E, estimate]

Herbicide	Number at or above MRL	25th percentile	Median	75th percentile	Maximum
bensulfuron methyl	0	<0.010	<0.010	<0.010	<0.010
chlorimuron ethyl	2	<.010	<.010	.026	.080
chlorsulfuron	1	<.010	<.010	<.010	E.023
flumetsulam	5	<.010	.022	.054	.116
halosulfuron methyl	0	<.010	<.010	<.010	<.010
imazapyr	0	<.010	<.010	<.010	<.010
imazaquin	5	<.010	.016	.087	.126
imazethapyr	5	<.010	.032	.076	.158
metsulfuron methyl	0	<.010	<.010	<.010	<.010
nicosulfuron	4	<.010	E.009	.032	.091
primisulfuron methyl	0	<.010	<.010	<.010	<.010
prosulfuron	0	<.010	<.010	<.010	<.010
sulfometuron methyl	0	<.010	<.010	<.010	<.010
thifensulfuron methyl	0	<.010	<.010	<.010	<.010
triasulfuron	0	<.010	<.010	<.010	<.010
triflusulfuron methyl	0	<.010	<.010	<.010	<.010
sum of 16 SUs, SAs, and IMIs	6	.029	.094	.299	.464

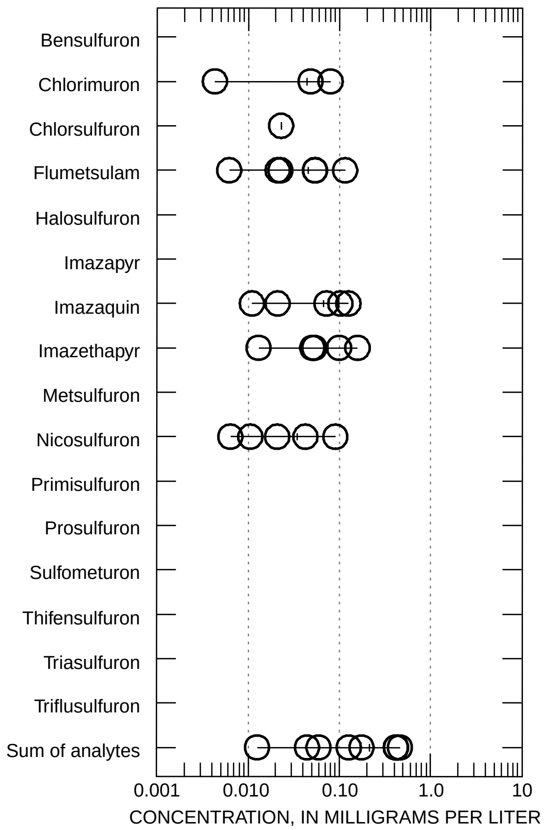


Figure 17. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in eight reservoir outflow samples.

The distributions of concentrations of the target analytes in 25 ground-water samples are summarized in figure 18. In some samples, estimated concentrations are reported that are below the MRL. These concentrations are not counted as detections at or above the MRL in table 10, but are plotted in figure 18 and used to calculate the percentiles shown in table 10. All non-detects are treated as zeros in the calculation of percentiles. The sum of SU, SA, and IMI concentrations exceeded 0.10 µg/L in only one ground-water sample.

OCCURRENCE OF OTHER PESTICIDES

Results of analysis for 46 pesticides or pesticide degradates performed at the NWQL and 13 herbicides and 10 herbicide degradates performed at the OGRL are presented below. Although there is some overlap between these two data sets, the analytical methods used are not identical and, in particular, the MRL for the analyses from the OGRL is generally 10 times higher than the MDLs for analyses from the NWQL. However, the OGRL analyzes for several herbicide metabolites that the NWQL does not quantify.

Streams

The results of analysis by the NWQL for 46 pesticides and pesticide degradates in 134 stream samples are given in tables 11–13. A statistical summary of these results is given in table 14. At least 1 of the 46 compounds was detected at or above the MDL in every sample. Some estimated concentrations are reported that are below the MDL. These concentrations are not counted as detections at or above the MDL in table 14 but are plotted in figures 19 and 20 and used to calculate the percentiles in table 14. All non-detects are treated as zeros in the calculation of percentile values. Acetochlor, atrazine, deethylatrazine, cyanazine, and metolachlor were all detected in 90 percent (121) or more of the stream samples. Alachlor, metribuzin, simazine, and trifluralin were all detected in more than 50 percent (67) of stream samples. Twelve other pesticides or degradates were detected in 5 percent (7) or more of stream samples.

Atrazine had the highest median concentration (3.77 µg/L) in the NWQL results, followed by metolachlor (1.67 µg/L), acetochlor (0.400 µg/L), and cyanazine (0.322 µg/L). The distributions of concentrations of the analytes that were detected more than twice in 134 samples are summarized in figures 19 and 20. The sum of the concentrations of the 46 pesticide and degradates listed in tables 11–14 exceeded 15 µg/L in more than 25 percent of the stream samples.

The results of analysis by the OGRL for 13 herbicides and 10 herbicide degradates in 141 stream samples and 10 reservoir outflow samples are given in tables 15 and 16. A statistical summary of the stream results is given in table 17. One or more of the 13 herbicides was detected at or above the MRL in 140 (99 percent) of the 141 stream samples. One or more of the 10 herbicide degradates was detected in 139 (99 percent) of the samples. Alachlor ESA,

Table 9. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in water samples collected from 25 midwestern wells

[W1, well sample from round 1; WD, duplicate well sample; <, less than; E, estimate]

Site no. (fig. 5)	Site name	Date of collection (month/ day/year)	Sample type	Concentration, in micrograms per liter						
				Sample no.	Bensul- furon	Chlori- muron	Chlor- sulfuron	Flumet- sulam	Halosul- furon	Imaza- pyr
				Illinois						
1	LUS1–4	05/19/98	W1	SU–11	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2	LUS1–14	05/18/98	W1	SU–7	<.010	<.010	<.010	<.010	<.010	<.010
		05/18/98	WD	SU–10	<.010	<.010	<.010	<.010	<.010	<.010
3	LUS1–26	06/18/98	W1	SU–118	<.010	<.010	<.010	<.010	<.010	<.010
4	LUS2–9	06/15/98	W1	SU–111	<.010	<.010	<.010	<.010	<.010	<.010
5	LUS2–22	06/18/98	W1	SU–121	<.010	<.010	<.010	<.010	<.010	<.010
				Iowa						
6	Blockton 1	07/23/98	W1	SU–184	<.010	<.010	<.010	<.010	<.010	<.010
7	Fort Madison 4	07/22/98	W1	SU–182	<.010	<.010	<.010	<.010	<.010	<.010
8	Shambaugh 3	07/24/98	W1	SU–186	<.010	<.010	<.010	<.010	<.010	E.002
9	Nodaway 4	07/23/98	W1	SU–185	<.010	<.010	<.010	<.010	<.010	<.010
10	Silver City 3	07/31/98	W1	SU–198	<.010	<.010	<.010	<.010	<.010	<.010
		07/31/98	WD	SU–199	<.010	<.010	<.010	<.010	<.010	<.010
11	Carson (5), 3	07/31/98	W1	SU–200	<.010	<.010	<.010	<.010	<.010	<.010
12	Cumberland 1	07/27/98	W1	SU–188	<.010	<.010	<.010	<.010	<.010	<.010
13	Fontanelle 5	07/23/98	W1	SU–183	<.010	<.010	<.010	<.010	<.010	<.010
14	Menlo 3	07/29/98	W1	SU–193	<.010	<.010	<.010	.016	<.010	<.010
15	Carlisle 5	07/27/98	W1	SU–187	<.010	<.010	<.010	<.010	<.010	E.005
16	Newton 13	06/03/98	W1	SU–71	<.010	<.010	<.010	<.010	<.010	<.010
17	Belle Plaine 4	06/02/98	W1	SU–70	<.010	<.010	<.010	<.010	<.010	<.010
18	Cedar Rapids S6	08/25/98	W1	SU–211	<.010	<.010	<.010	.023	<.010	<.010
		08/25/98	WD	SU–212	<.010	<.010	<.010	.023	<.010	<.010
19	Vail 1	06/23/98	W1	SU–137	<.010	<.010	<.010	<.010	<.010	<.010
20	Marshalltown 8	06/02/98	W1	SU–72	<.010	<.010	<.010	<.010	<.010	<.010
21	Boone 20	07/28/98	W1	SU–190	<.010	<.010	<.010	.035	<.010	<.010
22	Boxholm 2	07/25/98	W1	SU–189	<.010	<.010	<.010	<.010	<.010	<.010
		07/25/98	WD	SU–191	<.010	<.010	<.010	<.010	<.010	E.001
23	Holstein 3	06/25/98	W1	SU–139	<.010	<.010	E.009	<.010	<.010	<.010
24	Kingsley 1	06/25/98	W1	SU–138	<.010	<.010	<.010	E.007	<.010	<.010
25	Sheffield 2	07/29/98	W1	SU–192	<.010	<.010	<.010	<.010	<.010	<.010

Site no. (fig. 5)	Concentration, in micrograms per liter									
	Imaza-quin	Imaze-thapyr	Metsul-furon	Nicosul-furon	Primisul-furon	Prosul-furon	Sulfo-meturon	Thifensul-furon	Triasul-furon	Triflusul-furon
Illinois—Continued										
1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
2	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
3	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
4	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
5	.024	E.012	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
Iowa—Continued										
6	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
7	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
8	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
9	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
10	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
11	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
12	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
13	<.010	E.002	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
14	E.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
15	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
16	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
17	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
18	<.010	.025	<.010	.016	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	.025	<.010	.015	<.010	<.010	<.010	<.010	<.010	<.010
19	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
20	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
21	E.007	.059	<.010	E.010	<.010	<.010	<.010	<.010	<.010	<.010
22	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
23	.012	.013	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
24	<.010	E.004	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010
25	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010	<.010

Table 10. Statistical summary of sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in 25 water samples from 25 midwestern wells (concentrations in micrograms per liter)

[MRL, method reporting limit; <, less than; E, estimate]

Herbicide	Number at or above MRL	25th percentile	Median	75th percentile	95th percentile	Maximum
bensulfuron methyl	0	<0.010	<0.010	<0.010	<0.010	<0.010
chlorimuron ethyl	0	<.010	<.010	<.010	<.010	<.010
chlorsulfuron	0	<.010	<.010	<.010	<.010	E.009
flumetsulam	3	<.010	<.010	<.010	.023	.035
halosulfuron methyl	0	<.010	<.010	<.010	<.010	<.010
imazapyr	0	<.010	<.010	<.010	E.002	E.005
imazaquin	2	<.010	<.010	<.010	.012	.024
imazethapyr	4	<.010	<.010	<.010	.025	.059
metsulfuron methyl	0	<.010	<.010	<.010	<.010	<.010
nicosulfuron	2	<.010	<.010	<.010	.010	.016
primisulfuron methyl	0	<.010	<.010	<.010	<.010	<.010
prosulfuron	0	<.010	<.010	<.010	<.010	<.010
sulfometuron methyl	0	<.010	<.010	<.010	<.010	<.010
thifensulfuron methyl	0	<.010	<.010	<.010	<.010	<.010
triasulfuron	0	<.010	<.010	<.010	<.010	<.010
triflusulfuron methyl	0	<.010	<.010	<.010	<.010	<.010
Sum of all 16 analytes	5	<.010	<.010	E.005	.064	.110

atrazine, deethylatrazine, metolachlor, and metolachlor ESA were all detected in 127 (90 percent) or more of the samples. Acetochlor, acetochlor ESA, acetochlor OA, deisopropylatrazine, cyanazine, cyanazine-amide, and metolachlor OA were detected in 71 (50 percent) or more of stream samples. Eight other herbicides or degradates were detected in seven (5 percent) or more of stream samples.

Atrazine had the highest median concentration (3.27 µg/L) in the OGRL results, followed by metolachlor ESA (1.55 µg/L), metolachlor (1.15 µg/L), and acetochlor ESA (0.88 µg/L). The median of the sums of the concentrations of the 13 herbicides (5.96 µg/L) was smaller than the median of the sums of the concentrations of the 10 herbicide degradates (7.53 µg/L). The distributions of concentrations of the selected analytes in 141 samples from midwestern streams are summarized in figure 21. The concentrations of several herbicide metabolites such as acetochlor ESA and alachlor ESA tended to be higher than the concentrations of the parent compounds. These findings are consistent with results from several recent studies which found higher concentrations of herbicide metabolites relative to the parent herbicides in streams, tile drains, and ground water (Kolpin and others, 1998; Kalkhoff and others, 1998; Phillips and others, 1999).

Reservoir Outflows

The results of analysis by the NWQL for 46 pesticides and pesticide degradates in 10 samples of reservoir outflow are given in tables 11–13. A statistical summary of these results is given in table 18. At least one of the 46 compounds was detected at or above the MDL in every sample. Acetochlor, alachlor, atrazine, deethylatrazine, cyanazine, metolachlor, metribuzin, and simazine were all detected at or above their MDL in nine (90 percent) or more of the reservoir outflow samples. Prometon was the only other pesticide detected at or above the MDL in more than five (50 percent) of reservoir outflow samples. Five other pesticides or degradates were detected at or above the MDL in two or more samples.

Atrazine had the highest median concentration (2.01 µg/L) in NWQL results, followed by metolachlor (1.36 µg/L), cyanazine (0.325 µg/L), acetochlor (0.294 µg/L), deethylatrazine (0.219 µg/L), and simazine (0.051 μg/L). The sum of the concentrations of the 46 pesticide and degradates listed in tables 11–13 exceeded 10 μg/L in 3 of 10 reservoir outflow samples.

The results of analysis by the OGRL for 13 herbicides and 10 herbicide degradates in 10 reservoir outflow samples are given in tables 15 and 16. A statistical summary of these results is given in table 19. One or more of the 13 herbicides was detected at or above the MRL in every sample. One or more of the 10 herbicide degradates also was detected at or above the MRL in every sample. Acetochlor, alachlor ESA, atrazine, deethylatrazine, deisopropyl-atrazine, hydroxy-atrazine, cyanazine, cyanazine-amide, metolachlor, metolachlor ESA, and metolachlor OA were all detected in 9 (90 percent) or more of the 10 reservoir outflow samples. Acetochlor ESA and acetochlor OA were detected in 6 (60 percent) or more of 10 samples. Five other herbicides or degradates were detected in one (10 percent) or more of reservoir samples.

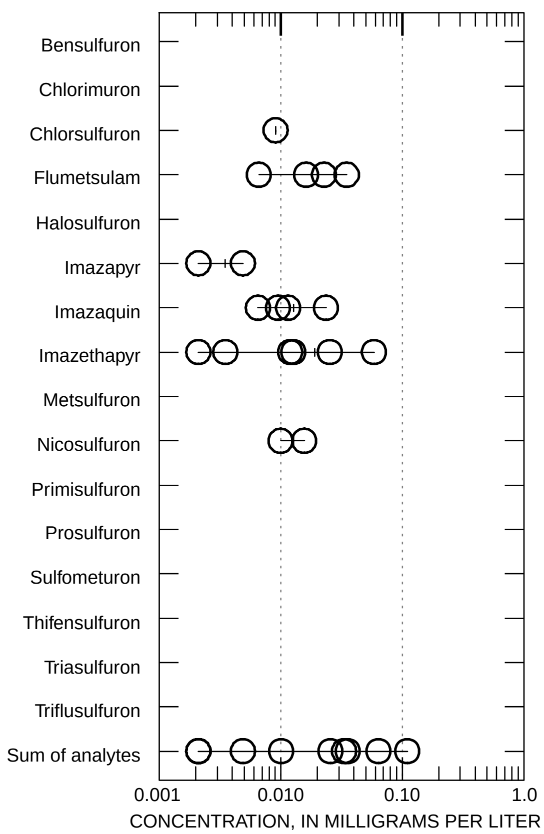


Figure 18. Sulfonylurea, sulfonamide, and imidazolinone herbicide concentrations in 25 ground-water samples.

Atrazine had the highest median concentration (2.15 μg/L) in OGRL results, followed by metolachlor ESA (2.11 μg/L), metolachlor OA (1.17 μg/L), metolachlor (1.06), hydroxy-atrazine (0.68 μg/L), and alachlor ESA (0.63 μg/L). The median of the sum of the concentrations of the 13 herbicides in the 10 reservoir outflow samples (4.33 μg/L) was smaller than the median of the sum of the concentrations of the 10 herbicide degradates (7.58 μg/L) (table 19).

Ground Water

The results of analysis by the NWQL for 46 other pesticides and pesticide degradates in 23 ground-water samples are given in tables 20–22. A statistical summary of these results is given in table 23. At least 1 of the 46 compounds was detected at or above the MDL in 15 of the 23 samples. Atrazine, deethylatrazine, and metolachlor were detected in 13 (57 percent) or more of the samples. 2,6-Diethylaniline, acetochlor, alachlor, butylate, cyanazine, metribuzin, prometon, and simazine were the only other pesticides or degradates that were detected at a concentration at or above their MDL.

Atrazine had the highest median concentration (0.039 μg/L) in NWQL results, followed by deethylatrazine (0.029 μg/L), and metolachlor (0.013 μg/L). The highest concentration for any pesticide or degradate was for metolachlor (0.557 μg/L).

The results of analysis by the OGRL for 13 herbicides and 10 herbicide degradates in 25 ground-water samples are given in tables 24 and 25. A statistical summary of these results is given in table 26. One or more of the 13 herbicides was detected at or above the MRL in seven (28 percent) of the samples. One or more of the 10 herbicide degradates was detected at or above the MRL in 18 (72 percent) of the samples. Metolachlor ESA was detected most frequently (15 of 25 samples), followed by alachlor ESA (8 of 25 samples), and deethylatrazine and metolachlor OA (7 of 25 samples). Atrazine was the most frequently detected parent herbicide (6 of 25 samples). Acetochlor ESA, acetochlor OA, alachlor OA, deisopropylatrazine, cyanazine-amide, and metolachlor were all detected in two or more samples.

Metolachlor ESA had the highest median concentration (0.66 μg/L) in OGRL results and the highest concentration for any herbicide or degradate in a ground-water sample (3.77 μg/L).

Table 11. Pesticide and pesticide degradate (2,6-diethylaniline through fonofos) concentrations in water samples from

[S1, pre-emergence stream sample; S2, post-emergence stream sample; RI, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Concentration, in micrograms per liter							
				Sample no.	2,6-Diethyl-aniline	Aceto-chlor	Ala-chlor	Atra-zine	Azin-phos-methyl	Benflu-ralin	Butyl-ate
				Illinois							
1	Vermillion River below Lake Vermillion Dam, IL	06/10/98	R1	SU–98	<0.0030	0.324	0.009	6.34	<0.0010	<0.0020	<0.0020
		07/16/98	R2	SU–177	<.0030	.0330	<.002	1.52	<.0010	<.0020	<.0150
2	Bonpas Creek at Browns, IL	05/23/98	S1	SU–43	<.0030	15.6	.584	E127	<.0010	<.0020	.0061
		07/07/98	S2	SU–166	<.0030	.103	.016	1.72	<.0010	<.0020	<.0020
3	Little Wabash River at Carmi, IL	05/23/98	S1	SU–33	<.0030	4.33	4.26	E75.4	<.0010	<.0020	.0208
		07/09/98	S2	SU–175	<.0030	.123	.319	7.57	<.0010	<.0020	<.0020
4	S. Branch Kishwaukee River near Fairdale, IL	05/20/98	S1	SU–29	<.0030	17.7	.525	18.5	<.0010	<.0020	<.0020
		07/29/98	S2	SU–195	<.0030	.0140	<.002	.223	<.0010	<.0020	<.0020
5	Iroquois River near Chebanse, IL	06/10/98	S1	SU–99	<.0030	.220	.011	2.22	<.0010	<.0020	<.0020
		07/08/98	S2	SU–168	<.0030	.117	.010	2.87	<.0010	<.0020	<.0020
6	Dupage River near Shorewood, IL	06/09/98	S1	SU–100	<.0030	.0328	.005	.085	<.0010	<.0020	<.0020
		07/29/98	S2	SU–194	<.0030	<.0020	<.002	.029	<.0010	<.0020	<.0020
7	Illinois River at Marseilles, IL	06/12/98	S1	SU–113	<.0030	.934	.048	3.73	<.0010	<.0020	<.0020
		07/09/98	S2	SU–176	<.0030	.197	.017	1.95	<.0010	<.0020	<.0020
8	Spoon River at London Mills, IL	05/20/98	S1	SU–25	<.0030	3.56	.286	E30.0	<.0010	<.0020	<.0020
		07/01/98	S2	SU–160	<.0030	.151	.017	3.07	<.0010	<.0020	<.0020
9	Sangamon River near Monticello, IL	05/23/98	S1	SU–35	<.0030	.622	.021	3.30	<.0010	<.0020	.0372
		08/05/98	S2	SU–201	<.0030	.0180	<.002	.440	<.0010	<.0020	<.0020
10	Sangamon River at Riverton, IL	05/26/98	S1	SU–44	<.0030	1.99	.180	15.1	<.0010	<.0020	E.0014
		07/09/98	S2	SU–174	<.0030	.0901	.025	1.90	<.0010	<.0020	<.0020
11	LaMoine River at Colmar, IL	05/21/98	S1	SU–27	<.0030	11.6	.045	E27.7	<.0010	<.0020	<.0020
		06/29/98	S2	SU–142	<.0030	.263	.028	4.25	<.0010	<.0020	<.0020
12	Illinois River at Valley City, IL	06/18/98	S1	SU–120	<.0030	1.16	.063	8.18	<.0010	<.0020	<.0020
		08/12/98	S2	SU–207	<.0030	.0199	<.002	.326	<.0010	<.0020	<.0020
13	Mississippi River below Grafton, IL	06/02/98	S1	SU–60	<.0030	.879	.029	3.16	<.0010	<.0020	<.0020
		06/15/98	S2	SU–116	<.0030	.901	.069	5.96	<.0010	<.0020	<.0020
14	Kaskaskia River near Cowden, IL	05/20/98	S1	SU–30	<.0030	.478	.027	1.73	<.0010	<.0020	<.0020
		07/08/98	S2	SU–169	<.0030	1.01	.045	4.60	<.0010	<.0020	<.0020
15	Shoal Creek near Breese, IL	05/22/98	S1	SU–32	<.0030	11.4	.405	E34.7	<.0010	<.0020	.270
		07/08/98	S2	SU–167	<.0030	1.14	.015	7.65	<.0010	<.0020	<.0020
				Iowa							
16	Turkey River at Spillville, IA	06/02/98	S1	SU–64	<.0030	.298	.018	4.20	<.0010	<.0020	<.0020
		06/12/98	S2	SU–109	<.0030	1.45	.284	4.39	<.0010	<.0020	<.0020

70 midwestern streams and 5 midwestern reservoirs

SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Carbaryl	Carbo-furan	Chlor-pyrifos	Cyana-zine	Dacthal	Deethyl-atrazine	Diazinon	Dieldrin	Disul-foton	EPTC	Ethal-fluralin	Etho-prophos	Fonofos
Illinois—Continued													
1	<0.0030	E0.0665	E0.0311	0.557	<0.0020	E0.238	E0.004	E0.003	<0.0170	<0.0020	<0.0040	<0.0030	<0.0030
	<.0030	<.0030	<.0200	.188	<.0020	E.287	<.002	<.001	<.0170	<.0200	<.0040	<.0030	<.0030
2	E.0230	<.0030	.0742	1.63	<.0020	E1.10	.005	<.001	<.0170	.0076	<.0040	<.0030	<.0030
	E.0100	<.0030	E.0325	.0159	<.0020	E.431	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
3	<.0030	<.0030	.102	1.98	<.0020	E.597	<.002	<.001	<.0170	E.0027	<.0040	<.0030	<.0030
	<.0030	<.0030	E.0165	.386	E.0011	E.786	.007	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
4	<.0030	<.0030	<.0040	2.41	<.0020	E.235	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	<.0040	<.0020	E.0653	.021	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
5	E.0138	E.0694	E.0160	.473	<.0020	E.143	<.002	E.002	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0089	E.0310	E.0288	.630	<.0020	E.344	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
6	E.106	<.0030	.0054	.0438	<.0020	E.0286	.020	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	<.0040	<.0020	E.0105	.022	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
7	<.0030	E.191	.0323	.827	<.0020	E.184	.029	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0184	<.0030	E.0191	.355	<.0020	E.251	.051	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
8	<.0030	<.0030	.858	E20.0	<.0020	E.377	<.002	.008	<.0170	.0073	<.0040	<.0030	<.0030
	E.195	E.0694	.0157	.409	<.0020	E.234	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
9	<.0030	<.0030	<.0500	.316	<.0020	E.245	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.124	<.0030	<.0040	.0652	<.0020	E.114	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
10	E.0096	E.0061	.0370	.643	E.0011	E.329	.005	.007	<.0170	.0075	<.0040	<.0030	<.0030
	<.0030	<.0030	.0088	.110	<.0020	E.294	.006	.008	<.0170	<.0020	<.0040	<.0030	<.0030
11	<.0030	<.0030	<.300	9.40	<.0020	E.585	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0259	<.0030	<.0400	1.24	<.0020	E.767	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
12	<.0030	E.0872	<.0600	1.70	<.0020	E.828	<.002	<.001	<.0170	E.0018	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.106	<.0020	E.0806	.071	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
13	<.0030	<.0030	<.0040	.284	<.0020	E.0355	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.0244	<.0200	.318	<.0020	E.0824	E.004	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
14	<.0030	<.0030	<.0040	.0290	<.0020	E.0581	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0030	E.0157	.408	<.0020	E.359	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
15	E.0096	<.0030	.366	2.09	<.0020	E.562	.023	<.001	<.0170	.0061	<.0040	<.0030	<.0030
	<.0030	<.0030	E.0201	.326	<.0020	E.640	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
Iowa—Continued													
16	<.0030	E.0707	<.0400	.957	<.0020	E.290	<.002	<.001	<.0170	E.0020	<.0040	<.0030	<.0030
	<.0030	E.653	<.0400	1.56	<.0020	E.461	<.002	<.001	<.0170	E.0030	<.0040	.0454	<.0030

Table 11. Pesticide and pesticide degradate (2,6-diethylaniline through fonofos) concentrations in water samples from

[S1, pre-emergence stream sample; S2, post-emergence stream sample; RI, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Concentration, in micrograms per liter							
				Sample no.	2,6-Diethyl-aniline	Aceto-chlor	Ala-chlor	Atra-zine	Azin-phos-methyl	Benflu-ralin	Butyl-ate
				Iowa—Continued							
17	Mississippi River at Clinton, IA	05/27/98	S1	SU–55	<0.0030	0.252	0.029	0.400	<0.0010	<0.0020	<0.0020
		07/01/98	S2	SU–155	<.0030	.138	.028	.847	<.0010	<.0020	<.0020
18	Wapsipinicon River near Tripoli, IA	05/27/98	S1	SU–54	<.0030	.392	.123	1.47	<.0010	<.0020	<.0020
		06/20/98	S2	SU–126	<.0030	.403	.160	8.56	<.0010	<.0020	<.0020
19	Wapsipinicon River at Independence, IA	05/29/98	S1	SU–56	<.0030	1.71	.480	11.4	<.0010	<.0020	<.0020
		06/12/98	S2	SU–110	<.0030	1.42	.102	11.1	<.0010	<.0020	<.0020
20	Iowa River near Rowan, IA	06/02/98	S1	SU–65	<.0030	.055	.008	.467	<.0010	<.0020	<.0020
		06/23/98	S2	SU–129	<.0030	.921	.064	3.97	<.0010	<.0020	<.0020
21	Old Mans Creek near Iowa City, IA	06/10/98	S1	SU–93	<.0030	.849	.296	4.17	<.0010	<.0020	<.0020
		06/30/98	S2	SU–147	<.0030	.451	.045	4.04	<.0010	<.0020	<.0020
22	Wolf Creek near Dysart, IA	06/10/98	S1	SU–87	<.0030	.744	.023	6.22	<.0010	<.0020	<.0020
		06/22/98	S2	SU–128	<.0030	1.00	.066	4.50	<.0010	<.0020	<.0020
23	Iowa River at Wapello, IA	05/27/98	S1	SU–53	Sample not analyzed (ruined in laboratory)						
		06/19/98	S2	SU–127	<.0030	.417	.050	5.16	<.0010	<.0020	<.0020
24	N. Skunk River near Sigourney, IA	05/21/98	S1	SU–21	<.0030	15.6	.012	E23.4	<.0010	<.0020	<.0020
		06/10/98	S2	SU–95	<.0030	.511	.138	8.00	<.0010	<.0020	<.0020
25	Skunk River at Augusta, IA	05/26/98	S1	SU–45	<.0030	10.6	.120	E48.1	<.0010	<.0020	.0045
		06/18/98	S2	SU–122	<.0030	.983	.079	9.84	<.0010	<.0020	<.0020
26	Des Moines River at Fort Dodge, IA	05/16/98	S1	SU–8	<.0030	16.1	.027	.732	<.0010	<.0020	<.0020
		06/12/98	S2	SU–108	<.0030	.117	<.002	.480	<.0010	<.0020	<.0020
27	Raccoon River at Van Meter, IA	05/17/98	S1	SU–9	<.0030	1.16	.020	2.38	<.0010	<.0020	<.0020
		06/10/98	S2	SU–89	<.0030	.416	.014	3.08	<.0010	<.0020	<.0020
28	Little Sioux River at Correctionville, IA	05/27/98	S1	SU–42	<.0030	.543	.012	1.78	<.0010	<.0020	<.0020
		06/18/98	S2	SU–123	<.0030	.313	.007	1.23	<.0010	<.0020	<.0020
29	Maple River at Mapleton, IA	05/29/98	S1	SU–59	<.0030	3.03	.026	10.0	<.0010	<.0020	<.0020
		06/09/98	S2	SU–90	<.0030	.194	<.002	4.11	<.0010	<.0020	<.0020
30	Boyer River at Logan, IA	05/22/98	S1	SU–31	<.0030	3.26	.458	16.0	<.0010	<.0020	<.0020
		06/09/98	S2	SU–96	<.0030	.714	.017	5.54	<.0010	<.0020	<.0020
31	Chariton River below Rathbun Lake Dam, IA	06/04/98	R1	SU–69	<.0030	.164	.005	1.05	<.0010	<.0020	<.0020
		06/29/98	R2	SU–148	<.0030	.308	.006	1.91	<.0010	<.0020	<.0020
				Indiana							
33	Whitewater River near Alpine, IN	05/26/98	S1	SU–47	E.0016	2.80	1.79	24.2	<.0010	<.0020	.0238
		07/08/98	S2	SU–162	<.0030	.118	.048	1.62	<.0010	<.0020	<.0020

70 midwestern streams and 5 midwestern reservoirs—Continued

SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Carbaryl	Carbo-furan	Chlor-pyrifos	Cyana-zine	Dacthal	Deethyl-atrazine	Diazinon	Dieldrin	Disul-foton	EPTC	Ethal-fluralin	Etho-prophos	Fonofos
						Iowa—Continued							
17	<0.0030	<0.0030	0.0047	0.0707	<0.0020	E0.0276	<0.002	<0.001	<0.0170	E0.0037	<0.0040	<0.0030	<0.0030
	<.0030	E.0248	<.0040	.110	<.0020	E.130	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
18	<.0030	E.0575	<.0080	.180	<.0020	E.162	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.302	.0222	.653	<.0020	E.600	<.002	<.001	<.0170	E.0019	<.0040	<.0030	<.0030
19	<.0030	E1.03	<.0040	.430	<.0020	E.415	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0085	E1.01	E.0194	.681	E.0014	E.754	<.002	<.001	<.0170	<.0020	<.0040	<.0030	E.0022
20	<.0030	E.0119	<.0040	.0109	<.0020	E.0568	<.002	<.001	<.0170	E.0023	<.0040	<.0030	<.0030
	<.0030	E.0894	<.0040	.0988	<.0020	E.283	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
21	<.0030	E.0320	<.0040	.916	<.0020	E.291	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.0392	.0176	.721	<.0020	E.571	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
22	<.0030	E.0865	<.0040	.570	<.0020	E.359	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.0494	<.0040	.874	<.0020	E.415	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
23	Sample not analyzed												
	<.0030	E.0937	E.0261	.788	E.0014	E.514	<.002	E.004	<.0170	<.0020	<.0040	<.0030	<.0030
24	<.0030	<.0030	E.0864	2.51	<.0020	E.297	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0200	E.112	<.0040	2.06	<.0020	E.477	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
25	<.0030	E.0258	<.300	14.0	<.0020	E.539	.005	.006	<.0170	<.0020	<.0040	<.0030	E.0022
	<.0030	E.122	E.0594	1.51	<.0020	E.631	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
26	<.0030	<.0030	.0356	.154	<.0020	E.0339	<.002	<.001	<.0170	.0230	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.0353	<.0020	E.0479	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
27	<.0030	E.0063	<.0040	.442	<.0020	E.0480	<.002	<.001	<.0170	.0759	<.0040	<.0030	<.0030
	<.0030	E.0601	<.0040	.333	<.0020	E.156	<.002	<.001	<.0170	.0045	<.0040	<.0030	<.0030
28	<.0030	<.0030	<.0040	.0416	<.0020	E.0686	.005	<.001	<.0170	.0041	<.0040	<.0030	<.0030
	<.0030	E.0500	<.0040	.0319	<.0020	E.147	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
29	<.0030	<.0030	<.0800	2.24	<.0020	E.228	<.002	<.001	<.0170	E.0032	<.0040	<.0030	.0063
	<.0030	<.0200	<.0040	.310	<.0020	E.135	<.002	<.001	<.0170	.0047	<.0040	<.0030	<.0030
30	<.0030	<.0030	<.0040	8.07	<.0020	E.308	<.002	<.001	<.0170	.0308	<.0040	<.0030	<.0030
	<.0030	E.222	.0341	1.01	<.0020	E.180	.035	<.001	<.0170	.0107	<.0040	<.0030	<.0030
31	<.0030	<.0030	<.0040	.328	<.0020	E.101	<.002	<.001	<.0170	E.0019	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.321	<.0020	E.179	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
						Indiana—Continued							
33	<.0030	E.0387	<.190	6.75	E.0012	E.364	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.415	<.0020	E.216	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030

Table 11. Pesticide and pesticide degradate (2,6-diethylaniline through fonofos) concentrations in water samples from

[S1, pre-emergence stream sample; S2, post-emergence stream sample; RI, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Concentration, in micrograms per liter							
				Sample no.	2,6-Diethyl-aniline	Aceto-chlor	Ala-chlor	Atra-zine	Azin-phos-methyl	Benflu-ralin	Butyl-ate
				Indiana—Continued							
34	Blue River at Fredericksburg, IN	05/27/98	S1	SU–50	<0.0030	0.481	0.049	7.22	<0.0010	<0.0020	<0.0020
		07/08/98	S2	SU–163	<.0030	.0474	.016	1.09	<.0010	<.0020	<.0020
35	Mississinewa River below Mississinewa Lake Dam, IN	06/09/98	R1	SU–83	<.0030	.545	.019	5.70	<.0010	<.0020	<.0020
		07/09/98	R2	SU–164	<.0030	.821	.099	6.90	<.0010	<.0020	<.0020
36	Eel River near Logansport, IN	05/21/98	S1	SU–18	Sample not analyzed (broken bottle)						
		06/30/98	S2	SU–152	<.0030	.245	1.12	3.14	<.0010	<.0020	<.0020
37	Wildcat Creek near Jerome, IN	05/21/98	S1	SU–19	<.0030	1.76	.054	12.3	<.0010	<.0020	<.0020
		06/30/98	S2	SU–151	<.0030	E.312	.306	6.27	<.0010	<.0020	<.0020
38	Wildcat Creek near Lafayette, IN	05/20/98	S1	SU–22	<.0030	1.09	.029	4.56	<.0010	<.0020	<.0020
		07/01/98	S2	SU–150	<.0030	E.198	.038	2.87	<.0010	<.0020	<.0020
39	White River near Nora, IN	05/28/98	S1	SU–51	<.0030	1.56	.039	10.2	<.0010	<.0020	<.0020
		07/01/98	S2	SU–149	<.0030	E.445	.104	5.06	<.0010	<.0020	<.0020
40	Sugar Creek near Edinburgh, IN	05/26/98	S1	SU–46	<.0030	4.16	.148	E28.7	<.0010	<.0020	<.0020
		07/20/98	S2	SU–178	<.0030	.127	.047	.715	<.0010	<.0020	<.0020
41	E. Fork White River near Bedford, IN	05/28/98	S1	SU–52	<.0030	4.44	.913	E27.9	<.0010	<.0020	<.0020
		07/06/98	S2	SU–161	<.0030	.166	.194	1.89	<.0010	<.0020	<.0020
42	Wabash River at New Harmony, IN	05/27/98	S1	SU–57	Sample not analyzed (ruined in laboratory)						
		06/23/98	S2	SU–136	<.0030	1.04	.176	10.4	<.0010	<.0020	<.0020
				Minnesota							
43	Cottonwood River near New Ulm, MN	05/26/98	S1	SU–49	<.0030	.0937	.008	.145	<.0010	<.0020	<.0020
		07/21/98	S2	SU–180	<.0030	.0605	.017	.176	<.0010	<.0020	<.0020
44	Little Cobb River near Beauford, MN	05/18/98	S1	SU–12	<.0030	2.08	.154	.102	<.0010	<.0020	<.0020
		08/17/98	S2	SU–208	<.0030	<.0020	<.002	.062	<.0010	<.0020	<.0020
45	Minnesota River near Jordan, MN	05/19/98	S1	SU–13	<.0030	1.32	.086	.122	<.0010	<.0020	<.0020
		06/26/98	S2	SU–135	<.0030	.320	.112	1.09	<.0010	<.0020	<.0020
46	Mississippi River at Hastings, MN	05/20/98	S1	SU–14	<.0030	.411	.063	.175	<.0010	<.0020	<.0020
		05/20/98	S2	SU–206	<.0030	<.0020	<.002	.088	<.0010	<.0020	<.0020
47	Des Moines River at Jackson, MN	05/26/98	S1	SU–48	<.0030	.530	.012	.536	<.0010	<.0020	<.0020
		08/24/98	S2	SU–210	<.0030	.0494	<.002	.159	<.0010	<.0020	<.0020
48	Rock River at Luverne, MN	06/24/98	S1	SU–130	<.0030	.0455	<.002	.103	<.0010	<.0020	<.0020
		06/25/98	S2	SU–131	<.0030	.0757	<.002	.147	<.0010	<.0020	<.0020
				Kansas							
49	Black Vermillion River at Frankfort, KS	05/05/98	S1	SU–1	<.0030	.0197	.038	.381	<.0010	<.0020	<.0020
		06/09/98	S2	SU–107	<.0030	.0278	1.17	8.71	<.0010	<.0020	<.0020

70 midwestern streams and 5 midwestern reservoirs—Continued

SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Carbaryl	Carbo-furan	Chlor-pyrifos	Cyana-zine	Dacthal	Deethyl-atrazine	Diazinon	Dieldrin	Disul-foton	EPTC	Ethal-fluralin	Etho-prophos	Fonofos
						Indiana—Continued							
34	<0.0030	<0.0030	<0.0100	0.232	<0.0020	E0.325	<0.002	<0.001	<0.0170	<0.0020	<0.0040	<0.0030	<0.0030
	E.0107	<.0030	<.0040	.0384	<.0020	E.277	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
35	<.0030	<.0030	<.0040	2.00	<.0020	E.200	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0282	E.232	<.100	2.90	<.0020	E.729	.012	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
36	Sample not analyzed												
	<.0030	<.0030	<.0040	.288	<.0020	E.398	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
37	<.0030	<.0030	<.0040	14.0	<.0020	E.332	<.002	<.008	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.150	.0136	.879	<.0020	E.608	<.002	E.015	<.0170	<.0020	<.0040	<.0030	<.0030
38	<.0030	<.0030	E.0323	.304	<.0020	E.155	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0060	E.0153	.0065	.376	<.0020	E.419	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
39	<.0030	E.0246	E.0447	1.13	<.0020	E.304	.007	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.0488	<.0040	.578	<.0020	E.652	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
40	E.0060	E.0696	E.0720	2.18	<.0020	E.381	.009	E.003	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0381	<.0030	.0408	<.0500	<.0020	E.140	.022	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
41	<.0030	E.0309	E.0903	2.59	<.0020	E.597	E.004	<.001	<.0170	<.0020	<.0040	<.0030	E.0015
	E.0074	<.0030	<.0100	.130	<.0020	E.296	.006	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
42	Sample not analyzed												
	<.0030	E.157	<.0040	1.78	<.0020	E.875	.012	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
						Minnesota—Continued							
43	<.0030	E.0656	<.0040	.0493	<.0020	E.0166	<.002	<.001	<.0170	.0047	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.0290	<.0020	E.0342	.018	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
44	<.0030	<.0030	<.0040	.0132	<.0020	E.0354	<.002	<.001	<.0170	<.0600	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	<.0040	<.0020	E.0106	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
45	<.0030	<.0030	<.0040	.0277	<.0020	E.0208	<.002	<.001	<.0170	.0160	<.0040	<.0030	<.0030
	<.0030	E.0174	<.0040	.0864	<.0020	E.111	E.002	<.001	<.0170	E.0033	<.0040	<.0030	<.0030
46	<.0030	<.0030	<.0040	.0638	<.0020	E.0185	<.002	<.001	<.0170	.0232	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.0176	<.0020	E.0258	.005	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
47	<.0030	<.0030	<.0040	.0206	<.0020	E.0287	<.002	<.001	<.0170	.0066	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	<.0040	<.0020	E.0636	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
48	<.0030	<.0030	<.0040	<.0040	<.0020	E.0425	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.0260	<.0040	<.0040	<.0020	E.0444	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
						Kansas—Continued							
49	<.0030	<.0030	<.0040	.0060	<.0020	E.0167	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.645	<.0040	E.0176	<.0020	E.405	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030

Table 11. Pesticide and pesticide degradate (2,6-diethylaniline through fonofos) concentrations in water samples from

[S1, pre-emergence stream sample; S2, post-emergence stream sample; RI, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Concentration, in micrograms per liter							
				Sample no.	2,6-Diethyl-aniline	Aceto-chlor	Ala-chlor	Atra-zine	Azin-phos-methyl	Benflu-ralin	Butyl-ate
				Kansas—Continued							
50	Big Blue River below Tuttle Creek Lake Dam, KS	06/03/98	R1	SU–74	<0.0030	0.194	0.388	1.85	<0.0010	<0.0020	<0.0020
		07/29/98	R2	SU–197	<.0030	.279	.815	1.09	<.0010	<.0020	<.0020
51	Delaware River near Muscotah, KS	05/05/98	S1	SU–2	<.0030	.0340	.007	.377	<.0010	<.0020	<.0020
		06/10/98	S2	SU–105	<.0030	.0992	.557	4.12	<.0010	<.0020	<.0020
				Kentucky							
52	Ohio River at Cannelton Dam, KY	06/04/98	S1	SU–75	<.0030	.186	.055	1.49	<.0010	<.0020	<.0020
		07/07/98	S2	SU–173	<.0030	.0506	.014	.696	<.0010	<.0020	<.0020
				Missouri							
53	Nodaway River near Graham, MO	06/18/98	S1	SU–119	Sample not analyzed (ruined in laboratory)						
		08/19/98	S2	SU–209	<.0030	.0047	.005	.254	<.0010	<.0020	<.0020
				Nebraska							
54	North Dry Creek near Kearney, NE	05/22/98	S1	SU–28	<.0030	5.29	.151	7.95	<.0010	<.0020	<.0020
		06/08/98	S2	SU–76	<.0030	.223	.069	8.78	<.0010	<.0020	<.0020
55	Maple Creek near Nickerson, NE	05/21/98	S1	SU–37	<.0030	E25.1	10.9	E30.0	<.0010	<.0020	<.0020
		06/08/98	S2	SU–79	<.0030	2.26	.106	12.6	<.0010	<.0020	<.0020
56	Salt Creek at Roca, NE	05/15/98	S1	SU–6	<.0030	.398	17.2	E224	<.0010	<.0020	<.0020
		06/10/98	S2	SU–94	<.0030	.930	1.84	E37.3	<.0010	<.0020	<.0020
57	Wahoo Creek at Ithaca, NE	05/15/98	S1	SU–5	<.0030	1.58	3.80	E38.1	<.0010	<.0020	<.0020
		06/08/98	S2	SU–78	<.0030	.490	.380	7.73	<.0010	<.0020	<.0020
58	Platte River at Louisville, NE	05/22/98	S1	SU–39	<.0030	3.08	2.70	E25.1	<.0010	<.0020	<.0020
		06/09/98	S2	SU–77	<.0030	.729	.839	8.80	<.0010	<.0020	<.0020
59	Big Nemaha River at Falls City, NE	05/26/98	S1	SU–41	<.0030	.396	.251	4.43	<.0010	<.0020	<.0020
		06/08/98	S2	SU–80	<.0030	1.42	.908	E37.6	<.0010	<.0020	<.0020
60	W. Fork Big Blue River, Dorchester, NE	05/23/98	S1	SU–36	<.0030	3.89	8.58	E46.5	<.0010	<.0020	<.0020
		06/10/98	S2	SU–82	<.0030	1.04	.722	9.54	<.0010	<.0020	<.0020
61	Big Blue River at Barneston, NE	05/15/98	S1	SU–4	<.0030	1.15	2.94	7.06	<.0010	<.0020	<.0020
		06/09/98	S2	SU–104	E.0035	.781	8.19	E24.4	<.0010	<.0020	<.0020
62	Little Blue River near Fairbury, NE	05/12/98	S1	SU–3	Sample not analyzed (broken bottle)						
		06/08/98	S2	SU–81	Sample not analyzed (mislabled bottle)						
				Ohio							
63	Clear Creek near Rockbridge, OH	06/10/98	S1	SU–86	<.0030	.0321	.017	.290	<.0010	<.0020	<.0020
		06/30/98	S2	SU–145	<.0030	.210	.017	1.60	<.0010	<.0020	<.0020
64	Scioto River near Prospect, OH	06/02/98	S1	SU–63	<.0030	.896	.025	4.94	<.0010	E.0039	<.0020
		06/29/98	S2	SU–141	<.0030	.172	.029	4.01	<.0010	<.0020	<.0020
65	Olentangy River at Claridon, OH	06/09/98	S1	SU–85	<.0030	.0437	.009	.897	<.0010	<.0020	<.0020
		06/29/98	S2	SU–157	<.0030	.401	.055	4.32	<.0010	<.0020	<.0020

70 midwestern streams and 5 midwestern reservoirs—Continued

SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Carbaryl	Carbo-furan	Chlor-pyrifos	Cyana-zine	Dacthal	Deethyl-atrazine	Diazinon	Dieldrin	Disul-foton	EPTC	Ethal-fluralin	Etho-prophos	Fonofos
						Kansas—Continued							
50	<0.0030	<0.0030	<0.0040	0.150	<0.0020	E0.0785	<0.002	<0.001	<0.0170	<0.0020	<0.0040	<0.0030	<0.0030
	<.0030	<.0030	<.0040	.0331	<.0020	E.349	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
51	<.0030	<.0030	<.0040	.0291	<.0020	E.0243	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.0520	<.0020	E.170	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
						Kentucky—Continued							
52	E.0202	<.0030	.0122	.280	<.0020	E.0525	.008	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0030	.0050	.0735	<.0020	E.0705	.007	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
						Missouri—Continued							
53	Sample not analyzed												
	<.0030	<.0030	<.0040	.0387	<.0020	E.0557	.008	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
						Nebraska—Continued							
54	<.0030	<.0030	.0089	.127	<.0020	E.578	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0185	<.0030	<.0040	.0685	<.0020	E.692	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
55	<.0030	<.0030	<.0040	3.57	<.0020	E.465	<.002	<.001	<.0170	<.0020	<.0040	<.0030	.0629
	<.0030	E.0156	<.0040	3.67	<.0020	E.441	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
56	<.0030	<.0030	<.0040	.246	<.0020	E.989	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.0587	<.0040	1.80	<.0020	E1.26	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
57	<.0030	<.0030	<.0040	4.42	<.0020	E.318	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0588	E.149	<.0040	1.41	E.0015	E.252	.011	<.001	<.0170	.0148	<.0040	<.0030	<.0030
58	<.0030	E.0111	<.0040	4.67	<.0020	E.610	<.002	<.001	<.0170	E.0036	<.0040	<.0030	<.0030
	<.0030	E.0713	<.0200	1.49	<.0020	E.327	.007	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
59	<.0030	<.0030	<.0040	.592	<.0020	E.102	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0220	<.0040	9.52	<.0020	E.568	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
60	<.0030	<.0030	<.0040	.992	<.0020	E.820	.011	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0200	.0143	.0628	<.0020	E.501	.033	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
61	<.0030	<.0030	.0405	.0337	<.0020	E.101	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	E.0412	<.0400	.427	<.0020	E.734	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
62	Sample not analyzed												
	Sample not analyzed												
						Ohio—Continued							
63	<.0030	<.0030	<.0040	.0247	<.0020	E.0329	.025	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0087	<.0030	.0072	.149	<.0020	E.284	.004	.006	<.0170	<.0020	<.0040	<.0030	<.0030
64	E.117	<.0030	<.0600	1.31	<.0020	E.286	.028	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0304	<.0030	E.0177	.390	E.0011	E.644	.008	.007	<.0170	<.0020	<.0040	<.0030	<.0030
65	<.0030	<.0030	<.0040	.0363	<.0020	E.0773	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0334	<.0030	E.0141	.402	E.0011	E.570	.011	<.001	<.0170	<.0020	<.0040	<.0030	<.0030

Table 11. Pesticide and pesticide degradate (2,6-diethylaniline through fonofos) concentrations in water samples from

[S1, pre-emergence stream sample; S2, post-emergence stream sample; RI, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Concentration, in micrograms per liter							
				Sample no.	2,6-Diethyl-aniline	Aceto-chlor	Ala-chlor	Atra-zine	Azin-phos-methyl	Benflu-ralin	Butyl-ate
				Ohio—Continued							
66	Olentangy River below Delaware, Lake Dam, OH	06/09/98	R1	SU–84	<0.0030	0.257	0.009	2.11	<0.0010	<0.0020	<0.0020
		06/29/98	R2	SU–153	<.0030	.478	.046	5.16	<.0010	<.0020	<.0020
67	Big Darby Creek at Darbyville, OH	06/03/98	S1	SU–62	<.0030	.688	.122	9.18	<.0010	<.0020	<.0020
		06/29/98	S2	SU–140	<.0030	.178	.022	2.55	<.0010	<.0020	<.0020
68	Scioto River at Higby, OH	06/04/98	S1	SU–73	<.0030	1.08	.069	6.97	<.0010	<.0020	<.0020
		07/08/98	S2	SU–165	<.0030	.290	.024	3.80	<.0010	<.0020	<.0020
69	L. Miami River near Oldtown, OH	06/10/98	S1	SU–92	<.0030	.0539	.015	.445	<.0010	<.0020	<.0020
		06/30/98	S2	SU–144	<.0030	.0278	.007	.510	<.0010	<.0020	<.0020
70	Mad River at Eagle City, OH	06/10/98	S1	SU–91	<.0030	<.0020	<.002	.048	<.0010	<.0020	<.0020
		06/30/98	S2	SU–146	<.0030	.0289	.008	.536	<.0010	<.0020	<.0020
71	Tiffin River at Stryker, OH	06/01/98	S1	SU–66	<.0030	.262	.150	1.63	<.0010	<.0020	<.0020
		07/07/98	S2	SU–172	<.0030	.0365	.010	.581	<.0010	<.0020	<.0020
72	Auglaize River at Fort Jennings, OH	06/17/98	S1	SU–117	<.0030	1.45	.188	9.96	<.0010	<.0020	<.0020
		07/08/98	S2	SU–171	<.0030	.297	.030	2.21	<.0010	<.0020	<.0020
				Wisconsin							
73	Root River at Racine, WI	06/01/98	S1	SU–61	<.0030	.193	.040	.351	<.0010	<.0020	<.0020
		08/03/98	S2	SU–204	<.0030	<.0020	<.002	.106	<.0010	<.0020	<.0020
74	St. Croix River at St. Croix Falls, WI	06/03/98	S1	SU–68	<.0030	.0259	.011	.104	<.0010	<.0020	<.0020
		08/05/98	S2	SU–205	<.0030	<.0020	<.002	.013	<.0010	<.0020	<.0020
75	Wisconsin River at Muscoda, WI	06/16/98	S1	SU–133	<.0030	.0479	.027	.264	<.0010	<.0020	<.0020
		08/07/98	S2	SU–202	<.0030	E.0084	.009	.134	<.0010	<.0020	<.0020
76	Rock River at Afton, WI	06/17/98	S1	SU–134	<.0030	.127	.010	.346	<.0010	<.0020	<.0020
		07/21/98	S2	SU–179	<.0030	.0106	<.002	.526	<.0010	<.0020	<.0020

70 midwestern streams and 5 midwestern reservoirs—Continued

SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Carbaryl	Carbo-furan	Chlor-pyrifos	Cyana-zine	Dacthal	Deethyl-atrazine	Diazinon	Dieldrin	Disul-foton	EPTC	Ethal-fluralin	Etho-prophos	Fonofos
Ohio—Continued													
66	<0.0030	<0.0030	<0.0040	0.0678	<0.0020	E0.113	<0.002	<0.001	<0.0170	<0.0020	<0.0040	<0.0030	<0.0030
	E.0085	<.0030	<.0040	.624	<.0020	E.712	<.002	<.001	<.0170	E.0027	<.0040	<.0030	<.0030
67	E.0043	<.0030	<.0700	1.93	<.0020	E.415	.005	E.002	<.0170	<.0020	<.0040	<.0030	<.0030
	E.119	<.0030	.0159	.224	E.0011	E.260	.030	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
68	<.0030	<.0030	<.0040	1.79	<.0020	E.269	.016	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0120	<.0030	.0247	.623	<.0020	E.450	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
69	<.0030	<.0030	<.0040	.0536	<.0020	E.0673	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0067	<.0030	.0045	.0620	<.0020	E.0796	E.004	E.001	<.0170	<.0020	<.0040	<.0030	<.0030
70	<.0030	<.0030	E.0035	<.0040	<.0020	E.0089	.008	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	E.0490	<.0030	E.0037	.0298	<.0020	E.108	.005	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
71	E.0108	<.0030	<.0300	.407	<.0020	E.107	.008	<.001	<.0170	E.0019	<.0040	<.0030	E.0033
	<.0030	<.0030	<.0040	.167	<.0020	E.0820	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
72	<.0030	<.0030	<.0040	1.87	<.0020	E.870	E.004	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0030	.0192	.385	<.0020	E.395	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
Wisconsin—Continued													
73	E.0655	E.0122	<.0080	.167	E.0018	E.109	.016	<.001	<.0170	.0083	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.0213	<.0020	E.0152	.010	<.001	<.0170	.0200	<.0040	<.0030	<.0030
74	<.0030	<.0030	<.0040	.0071	<.0020	E.0172	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	<.0040	<.0020	E.0081	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
75	<.0030	<.0030	<.0040	.0671	<.0020	E.0381	.006	<.001	<.0170	.0047	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.0166	<.0020	E.0364	<.002	<.001	<.0170	<.0020	<.0040	<.0030	<.0030
76	<.0030	<.0030	<.0040	.144	<.0020	E.0624	<.002	<.001	<.0170	.0092	<.0040	<.0030	<.0030
	<.0030	<.0030	<.0040	.349	<.0020	E.101	.011	<.001	<.0170	<.0020	<.0040	<.0030	<.0030

Table 12. Pesticide and pesticide degradate (lindane through terbacil) concentrations in water samples from 70 midwestern

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Lin- dane	Lin- uron	Mala- thion	Metol- achlor	Metri- buzin	Molin- ate	Napro- pamide
				Illinois							
1	Vermillion River below Lake Vermillion Dam, IL	06/10/98	R1	SU–98	<0.004	<0.0020	<0.005	1.33	0.014	<0.0040	<0.0030
		07/16/98	R2	SU–177	<.004	<.0020	<.005	.619	.009	<.0040	<.0030
2	Bonpas Creek at Browns, IL	05/23/98	S1	SU–43	<.004	.0246	<.005	23.8	.198	.0182	<.0030
		07/07/98	S2	SU–166	<.004	<.0020	<.005	1.32	<.015	<.0040	<.0030
3	Little Wabash River at Carmi, IL	05/23/98	S1	SU–33	<.004	.0336	.009	15.0	.344	.0486	<.0030
		07/09/98	S2	SU–175	<.004	.0253	<.005	2.86	1.76	<.0040	<.0030
4	S. Branch Kishwaukee River near Fairdale, IL	05/20/98	S1	SU–29	<.004	<.0020	<.005	13.0	.007	<.0040	<.0030
		07/29/98	S2	SU–195	<.004	<.0020	<.005	.070	<.004	<.0040	<.0030
5	Iroquois River near Chebanse, IL	06/10/98	S1	SU–99	<.004	<.0020	<.005	1.06	.015	<.0040	<.0030
		07/08/98	S2	SU–168	<.004	<.0020	<.005	1.32	.014	<.0040	<.0030
6	Dupage River near Shorewood, IL	06/09/98	S1	SU–100	.004	<.0020	.009	.029	<.004	<.0040	<.0030
		07/29/98	S2	SU–194	<.004	<.0020	<.005	.006	<.004	<.0040	<.0030
7	Illinois River at Marseilles, IL	06/12/98	S1	SU–113	<.004	<.0020	<.005	1.31	.103	<.0040	<.0030
		07/09/98	S2	SU–176	<.004	<.0020	<.005	.796	.016	<.0040	<.0030
8	Spoon River at London Mills, IL	05/20/98	S1	SU–25	<.004	<.0020	<.005	6.81	.274	<.0040	<.0030
		07/01/98	S2	SU–160	<.004	<.0020	<.005	.907	.018	<.0040	<.0030
9	Sangamon River near Monticello, IL	05/23/98	S1	SU–35	<.004	<.0020	<.005	2.57	<.004	<.0040	<.0030
		08/05/98	S2	SU–201	<.004	<.0020	<.005	.147	<.004	<.0040	<.0030
10	Sangamon River at Riverton, IL	05/26/98	S1	SU–44	.005	<.0020	<.005	2.61	.089	<.0040	<.0030
		07/09/98	S2	SU–174	<.004	<.0020	<.005	.553	<.004	<.0040	<.0030
11	LaMoine River at Colmar, IL	05/21/98	S1	SU–27	<.004	<.0020	<.005	1.81	<.600	<.0040	<.0030
		06/29/98	S2	SU–142	<.004	<.0020	<.005	.775	.046	<.0040	<.0030
12	Illinois River at Valley City, IL	06/18/98	S1	SU–120	<.004	<.0020	.009	2.13	.061	<.0040	<.0030
		08/12/98	S2	SU–207	<.004	<.0020	<.005	.112	<.004	<.0040	<.0030
13	Mississippi River below Grafton, IL	06/02/98	S1	SU–60	<.004	<.0020	<.005	1.36	<.004	<.0040	<.0030
		06/15/98	S2	SU–116	<.004	<.0020	<.005	1.75	.021	<.0040	<.0030
14	Kaskaskia River near Cowden, IL	05/20/98	S1	SU–30	<.004	<.0020	<.005	.622	<.004	<.0040	<.0030
		07/08/98	S2	SU–169	<.004	<.0020	.007	1.82	.010	<.0040	<.0030
15	Shoal Creek near Breese, IL	05/22/98	S1	SU–32	<.012	<.0020	<.005	7.30	.190	.0289	<.0030
		07/08/98	S2	SU–167	<.004	.129	<.005	1.98	.162	<.0040	<.0030
				Iowa							
16	Turkey River at Spillville, IA	06/02/98	S1	SU–64	<.004	<.0020	E.004	.139	.018	<.0040	<.0030
		06/12/98	S2	SU–109	<.004	<.0020	<.005	.184	.075	<.0040	<.0030
17	Mississippi River at Clinton, IA	05/27/98	S1	SU–55	<.004	<.0020	<.005	.161	<.004	<.0040	<.0030
		07/01/98	S2	SU–155	<.004	<.0020	<.005	.368	<.004	<.0040	<.0030

streams and 5 midwestern reservoirs

[SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Parathion	Parathion-methyl	Pebu-late	Pendi-methalin	Phorate	Prom-eton	Propa-chlor	Propanil	Propar-gite	Propyz-amide	Sima-zine	Tebu-thiuron	Terbacil
Illinois—Continued													
1	<0.004	<0.0060	<0.0040	0.0140	<0.0020	0.0388	<0.0070	<0.0040	<0.0130	<0.0030	0.0255	<0.0100	<0.0070
	<.004	<.0060	<.0040	.0194	<.0020	.0250	<.0070	<.0040	<.0130	<.0030	.0141	<.0100	<.0070
2	<.004	<.0060	<.0040	.0724	<.0020	.0213	<.0070	<.0040	<.0130	<.0030	E1.10	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0080	<.0070	<.0040	<.0130	<.0030	.0821	<.0100	<.0070
3	<.004	<.0060	<.0040	<.0040	<.0020	.0378	<.0070	<.0040	<.0130	<.0030	7.91	E.0097	<.0070
	<.004	<.0060	<.0040	.0169	<.0020	.0388	<.0070	<.0040	<.0130	<.0030	.370	.0100	<.0070
4	<.004	<.0060	<.0040	.176	<.0020	.0283	<.0070	<.0040	<.0130	<.0030	.0538	.0757	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
5	<.004	<.0060	<.0040	.0106	<.0020	.0320	<.0070	<.0040	<.0130	<.0030	.0111	<.0100	<.0070
	<.004	<.0060	<.0040	.0172	<.0020	E.0102	<.0070	<.0040	<.0130	<.0030	.0159	.0113	<.0070
6	<.004	<.0060	<.0040	.0097	<.0020	E.0160	<.0070	<.0040	<.0130	<.0030	.0088	.0104	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	E.0083	<.0070
7	<.004	<.0060	<.0040	.0398	<.0020	.0400	<.0070	<.0040	<.0130	<.0030	.0293	.0156	<.0070
	<.004	<.0060	<.0040	.0145	<.0020	.0419	<.0070	<.0040	<.0130	<.0030	.0266	.0171	E.0123
8	<.004	<.0060	<.0040	.320	<.0020	E.0051	E.0060	<.0040	<.0130	<.0030	.184	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0169	<.0070	<.0040	<.0130	<.0030	.0223	<.0100	<.0070
9	<.004	<.0060	<.0040	.103	<.0020	E.0107	<.0070	<.0040	<.0130	<.0030	.0212	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0277	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
10	<.004	<.0060	<.0040	.0487	<.0020	.0719	<.0070	<.0040	<.0130	<.0030	.0670	.0231	<.0070
	<.004	<.0060	<.0040	.0178	<.0020	.0420	<.0070	<.0040	<.0130	<.0030	.0224	.0135	<.0070
11	<.004	<.0060	<.0040	.230	<.0020	E.0086	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	.0418	<.0020	E.0074	<.0070	<.0040	<.0130	<.0030	.0205	<.0100	<.0070
12	<.004	<.0060	<.0040	.0370	<.0020	.0283	<.0070	<.0040	<.0130	<.0030	.0631	.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0357	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
13	<.004	<.0060	<.0040	<.0040	<.0020	E.0159	<.0070	<.0040	<.0130	<.0030	.0261	<.0100	<.0070
	<.004	<.0060	<.0040	.0227	<.0020	E.0105	<.0070	<.0040	<.0130	<.0030	.0364	<.0100	<.0070
14	<.004	<.0060	<.0040	<.0040	<.0020	E.0117	<.0070	<.0040	<.0130	<.0030	.169	E.0048	<.0070
	<.004	<.0060	<.0040	.0147	<.0020	.0228	<.0070	<.0040	<.0130	<.0030	.0754	.0117	<.0070
15	<.004	<.0060	<.0040	<.0040	<.0020	E.0114	<.0070	<.0040	<.0130	<.0030	.218	E.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0099	.125	<.0040	<.0130	<.0030	.0550	.0290	<.0070
Iowa—Continued													
16	<.004	<.0060	<.0040	.0084	<.0020	E.0043	<.0070	<.0040	<.0130	<.0030	.0176	<.0100	<.0070
	<.004	<.0060	<.0040	.0111	<.0020	E.0067	<.0070	<.0040	<.0130	<.0030	.0202	<.0100	<.0070
17	<.004	<.0060	<.0040	<.0040	<.0020	E.0049	<.0070	<.0040	<.0130	<.0030	.0126	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	.0162	E.0051	<.0070

Table 12. Pesticide and pesticide degradate (lindane through terbacil) concentrations in water samples from 70 midwestern

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Lin- dane	Lin- uron	Mala- thion	Metol- achlor	Metri- buzin	Molin- ate	Napro- pamide
				Iowa—Continued							
18	Wapsipinicon River near Tripoli, IA	05/27/98	S1	SU–54	<0.004	<0.0020	<0.005	0.938	0.021	<0.0040	<0.0030
		06/20/98	S2	SU–126	<.004	<.0020	<.005	2.46	.029	<.0040	<.0030
19	Wapsipinicon River at Independence, IA	05/29/98	S1	SU–56	<.004	<.0020	<.005	2.18	.015	<.0040	<.0030
		06/12/98	S2	SU–110	<.004	<.0020	<.005	3.86	.037	<.0040	<.0030
20	Iowa River near Rowan, IA	06/02/98	S1	SU–65	<.004	<.0020	<.005	.230	<.004	<.0040	<.0030
		06/23/98	S2	SU–129	<.004	<.0020	<.005	2.31	.026	<.0040	<.0030
21	Old Mans Creek near Iowa City, IA	06/10/98	S1	SU–93	<.004	<.0020	<.005	1.73	.014	<.0040	<.0030
		06/30/98	S2	SU–147	<.004	<.0020	<.005	1.67	.022	<.0040	<.0030
22	Wolf Creek near Dysart, IA	06/10/98	S1	SU–87	<.004	<.0020	<.005	1.99	.154	<.0040	<.0030
		06/22/98	S2	SU–128	<.004	<.0020	<.005	3.11	.059	<.0040	<.0030
23	Iowa River at Wapello, IA	05/27/98	S1	SU–53	Sample not analyzed (ruined in laboratory)						
		06/19/98	S2	SU–127	<.004	<.0020	<.005	1.96	.030	<.0040	<.0030
24	N. Skunk River near Sigourney, IA	05/21/98	S1	SU–21	<.004	<.0020	<.005	2.73	.284	<.0040	<.0030
		06/10/98	S2	SU–95	<.004	<.0020	<.005	3.26	.216	<.0040	<.0030
25	Skunk River at Augusta, IA	05/26/98	S1	SU–45	.005	<.0020	<.005	9.61	.071	<.0040	<.0030
		06/18/98	S2	SU–122	<.004	<.0020	<.005	3.46	.035	<.0040	<.0030
26	Des Moines River at Fort Dodge, IA	05/16/98	S1	SU–8	<.004	<.0020	<.005	5.60	.033	<.0040	<.0030
		06/12/98	S2	SU–108	<.004	<.0020	<.005	.281	.016	<.0040	<.0030
27	Raccoon River at Van Meter, IA	05/17/98	S1	SU–9	.008	<.0020	<.005	3.12	.012	<.0040	<.0030
		06/10/98	S2	SU–89	<.004	<.0020	<.005	1.34	.056	<.0040	<.0030
28	Little Sioux River at Correctionville, IA	05/27/98	S1	SU–42	<.004	<.0020	<.005	.562	<.004	<.0040	<.0030
		06/18/98	S2	SU–123	<.004	<.0020	<.005	.399	<.004	<.0040	<.0030
29	Maple River at Mapleton, IA	05/29/98	S1	SU–59	.005	<.0020	<.005	6.73	.225	<.0040	<.0030
		06/09/98	S2	SU–90	<.004	<.0020	<.005	2.13	.035	<.0040	<.0030
30	Boyer River at Logan, IA	05/22/98	S1	SU–31	<.004	<.0020	<.005	10.3	.071	<.0040	<.0030
		06/09/98	S2	SU–96	<.004	<.0020	<.005	2.38	.079	<.0040	<.0030
31	Chariton River below Rathbun Lake Dam, IA	06/04/98	R1	SU–69	<.004	<.0020	<.005	.196	<.004	<.0040	<.0030
		06/29/98	R2	SU–148	<.004	<.0020	<.005	.461	.007	<.0040	<.0030
				Indiana							
33	Whitewater River near Alpine, IN	05/26/98	S1	SU–47	<.004	<.0020	<.005	2.48	.268	<.0040	<.0030
		07/08/98	S2	SU–162	<.004	<.0020	<.005	.868	.030	<.0040	<.0030
34	Blue River at Fredericksburg, IN	05/27/98	S1	SU–50	<.004	<.0020	<.005	1.38	<.004	<.0040	<.0030
		07/08/98	S2	SU–163	<.004	<.0020	<.005	.187	<.004	<.0040	<.0030

streams and 5 midwestern reservoirs—Continued

[SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Parathion	Parathion-methyl	Pebu-late	Pendi-methalin	Phorate	Prom-eton	Propa-chlor	Propanil	Propar-gite	Propyz-amide	Sima-zine	Tebu-thiuron	Terbacil
Iowa—Continued													
18	<0.004	<0.0060	<0.0040	0.0103	<0.0020	E0.0052	<0.0070	<0.0040	<0.0130	<0.0030	0.0179	<0.0100	<0.0070
	<.004	<.0060	<.0040	.0385	<.0020	.0219	<.0070	<.0040	<.0130	<.0030	.0324	E.0100	<.0070
19	<.004	<.0060	<.0040	.0611	<.0020	E.0064	<.0070	<.0040	<.0130	<.0030	.0341	E.0038	<.0070
	<.004	<.0060	<.0040	.0585	<.0020	E.0103	<.0070	<.0040	<.0130	<.0030	.0342	.0122	<.0070
20	<.004	<.0060	<.0040	<.0040	<.0020	E.0066	<.0070	<.0040	<.0130	<.0030	E.0042	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0126	<.0070	<.0040	<.0130	<.0030	.0158	<.0100	<.0070
21	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	.0136	<.0100	<.0070
	<.004	<.0060	<.0040	.0058	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	.0210	<.0100	<.0070
22	<.004	<.0060	<.0040	.0262	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	.0284	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0442	<.0070	<.0040	<.0130	<.0030	.0285	<.0100	<.0070
23	Sample not analyzed												
	<.004	<.0060	<.0040	.0153	<.0020	E.0117	<.0070	<.0040	<.0130	<.0030	.0282	<.0100	<.0070
24	<.004	<.0060	<.0040	<.0200	<.0020	<.0180	E.0033	<.0040	<.0130	<.0030	.0785	.0127	<.0070
	<.004	<.0060	<.0040	.0200	<.0020	E.0114	<.0070	<.0040	<.0130	<.0030	.0321	E.0054	<.0070
25	<.004	<.0060	<.0040	.0452	<.0020	.0181	.0211	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	.0211	<.0020	E.0096	<.0070	<.0040	<.0130	<.0030	.0283	<.0100	<.0070
26	<.004	<.0060	<.0040	.148	<.0020	E.0114	.175	<.0040	<.0130	<.0030	<.0050	E.0029	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0102	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
27	<.004	<.0060	<.0040	.0309	<.0020	.0873	E.0038	<.0040	<.0130	<.0030	.0098	E.0021	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0296	<.0070	<.0040	<.0130	<.0030	.0137	<.0100	<.0070
28	<.004	<.0060	<.0040	<.0040	<.0020	.0224	<.0070	<.0040	<.0130	<.0030	.0171	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0308	<.0070	<.0040	<.0130	<.0030	.0092	<.0100	<.0070
29	<.004	<.0060	<.0040	.176	<.0020	E.0053	.0139	<.0040	<.0130	<.0030	.0331	<.0100	<.0070
	<.004	<.0060	<.0040	<.0400	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	.0139	<.0100	<.0070
30	<.004	<.0060	<.0040	.187	<.0020	.0375	<.0070	<.0040	<.0130	<.0030	.0808	.0247	<.0070
	<.004	<.0060	<.0040	.0637	<.0020	.0268	E.0021	<.0040	<.0130	<.0030	.0259	.0129	<.0070
31	<.004	<.0060	<.0040	<.0040	<.0020	E.0067	<.0070	<.0040	<.0130	<.0030	.0426	E.0080	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	.0585	E.0089	<.0070
Indiana—Continued													
33	<.004	<.0060	<.0040	.0226	<.0020	.0195	<.0070	<.0040	<.0130	<.0030	.971	E.0071	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0155	<.0070	<.0040	<.0130	<.0030	.138	<.0100	<.0070
34	<.004	<.0060	<.0040	<.0040	<.0020	E.0133	<.0070	<.0040	<.0130	<.0030	2.39	E.0061	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0725	<.0070	<.0040	<.0130	<.0030	.370	<.0100	<.0070

Table 12. Pesticide and pesticide degradate (lindane through terbacil) concentrations in water samples from 70 midwestern

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Lin-dane	Lin-uron	Mala-thion	Metol-achlor	Metri-buzin	Molin-ate	Napro-pamide
	Indiana—Continued										
35	Mississinewa River below Mississinewa Lake Dam, IN	06/09/98	R1	SU–83	<0.004	<0.0020	<0.005	1.38	0.225	<0.0040	<0.0030
		07/09/98	R2	SU–164	<.004	<.0020	<.005	3.08	.188	<.0040	<.0030
36	Eel River near Logansport, IN	05/21/98	S1	SU–18	Sample not analyzed (broken bottle)						
		06/30/98	S2	SU–152	<.004	<.0020	<.005	.727	.012	<.0040	<.0030
37	Wildcat Creek near Jerome, IN	05/21/98	S1	SU–19	<.004	<.0020	<.005	1.67	.204	<.0040	<.0030
		06/30/98	S2	SU–151	<.004	<.0020	<.005	2.80	.104	<.0040	<.0030
38	Wildcat Creek near Lafayette, IN	05/20/98	S1	SU–22	<.004	<.0020	<.005	2.97	.067	<.0040	<.0030
		07/01/98	S2	SU–150	<.004	<.0020	<.005	1.74	.025	<.0040	<.0030
39	White River near Nora, IN	05/28/98	S1	SU–51	<.004	<.0020	<.005	3.84	.099	<.0040	<.0030
		07/01/98	S2	SU–149	<.004	<.0020	<.005	2.62	.056	<.0040	<.0030
40	Sugar Creek near Edinburgh, IN	05/26/98	S1	SU–46	E.003	<.0020	<.005	6.56	.237	<.0040	<.0030
		07/20/98	S2	SU–178	<.004	<.0020	<.005	4.53	.332	<.0040	<.0030
41	E. Fork White River near Bedford, IN	05/28/98	S1	SU–52	<.004	<.0020	<.005	7.34	.148	<.0040	<.0030
		07/06/98	S2	SU–161	<.004	.0277	<.005	.959	.035	<.0040	<.0030
42	Wabash River at New Harmony, IN	05/27/98	S1	SU–57	Sample not analyzed (ruined in laboratory)						
		06/23/98	S2	SU–136	<.004	<.0020	<.005	5.10	.096	<.0040	<.0030
	Minnesota										
43	Cottonwood River near New Ulm, MN	05/26/98	S1	SU–49	<.004	<.0020	<.005	.075	<.004	<.0040	<.0030
		07/21/98	S2	SU–180	<.004	<.0020	<.005	.359	<.004	<.0040	<.0030
44	Little Cobb River near Beauford, MN	05/18/98	S1	SU–12	<.004	<.0020	<.005	.575	<.004	<.0040	<.0030
		08/17/98	S2	SU–208	<.004	<.0020	<.005	.026	<.004	<.0040	<.0030
45	Minnesota River near Jordan, MN	05/19/98	S1	SU–13	<.004	<.0020	<.005	.403	<.004	<.0040	<.0030
		06/26/98	S2	SU–135	<.004	<.0020	<.005	.548	.014	<.0040	<.0030
46	Mississippi River at Hastings, MN	05/20/98	S1	SU–14	<.004	<.0020	<.005	.199	<.004	<.0040	<.0030
		05/20/98	S2	SU–206	<.004	<.0020	<.005	.018	<.004	<.0040	<.0030
47	Des Moines River at Jackson, MN	05/26/98	S1	SU–48	<.004	<.0020	<.005	.104	<.004	<.0040	<.0030
		08/24/98	S2	SU–210	<.004	<.0020	<.005	.189	<.004	<.0040	<.0030
48	Rock River at Luverne, MN	06/24/98	S1	SU–130	<.004	<.0020	<.005	.062	<.004	<.0040	<.0030
		06/25/98	S2	SU–131	<.004	<.0020	<.005	.408	<.004	<.0040	<.0030
	Kansas										
49	Black Vermillion River at Frankfort, KS	05/05/98	S1	SU–1	<.004	<.0020	<.005	.137	<.004	<.0040	<.0030
		06/09/98	S2	SU–107	<.004	<.0020	<.005	10.1	.116	<.0040	<.0030
50	Big Blue River below Tuttle Creek Lake Dam, KS	06/03/98	R1	SU–74	<.004	<.0020	<.005	.830	.026	<.0040	<.0030
		07/29/98	R2	SU–197	<.004	<.0020	<.005	3.17	.026	<.0040	<.0030
51	Delaware River near Muscotah, KS	05/05/98	S1	SU–2	<.004	<.0020	<.005	.191	<.004	<.0040	<.0030
		06/10/98	S2	SU–105	<.004	<.0020	<.005	2.07	.030	<.0040	<.0030

streams and 5 midwestern reservoirs—Continued

[SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Parathion	Parathion-methyl	Pebu-late	Pendi-methalin	Phorate	Prom-eton	Propa-chlor	Propanil	Propar-gite	Propyz-amide	Sima-zine	Tebu-thiuron	Terbacil
						Indiana—Continued							
35	<0.004	<0.0060	<0.0040	<0.0040	<0.0020	0.0324	<0.0070	<0.0040	<0.0130	<0.0030	0.493	0.0146	<0.0070
	<.004	<.0060	<.0040	.0229	<.0020	.0292	<.0070	<.0040	<.0130	<.0030	.358	<.0200	<.0070
36	Sample not analyzed												
	<.004	<.0060	<.0040	<.0040	<.0020	.0143	<.0070	<.0040	<.0130	<.0030	.126	.0045	<.0070
37	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	.0888	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0144	<.0070	<.0040	<.0130	<.0030	.0840	<.0100	<.0070
38	<.004	<.0060	<.0040	<.0150	<.0020	.0275	<.0070	<.0040	<.0130	<.0030	.0291	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0222	<.0070	<.0040	<.0200	<.0030	.0675	E.0088	<.0070
39	<.004	<.0060	<.0040	<.0100	<.0020	.0302	E.0034	<.0040	<.0130	<.0030	.536	E.0061	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0491	<.0070	<.0040	<.0130	<.0030	.196	E.0085	<.0070
40	<.004	<.0060	<.0040	.0129	<.0020	.0261	<.0070	<.0040	<.0130	<.0030	.509	E.0090	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.218	<.0070	<.0040	<.0130	<.0030	.0325	<.0100	<.0070
41	<.004	<.0060	<.0040	<.0200	<.0020	.0297	<.0070	<.0040	<.0130	<.0030	1.17	E.0076	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0203	<.0070	<.0040	<.0130	<.0030	.0610	<.0100	<.0070
42	Sample not analyzed												
	<.004	<.0060	<.0040	.0223	<.0020	.0351	<.0070	<.0040	<.0130	<.0030	.395	.0119	<.0070
						Minnesota—Continued							
43	<.004	<.0060	<.0040	<.0040	<.0020	E.0055	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0522	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
44	<.004	<.0060	<.0400	<.0040	<.0020	<.0180	.173	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0867	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
45	<.004	<.0060	<.0040	<.0040	<.0020	E.0077	.0163	<.0040	<.0130	<.0030	.0083	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0145	<.0070	<.0040	<.0130	<.0030	E.0042	<.0100	<.0070
46	<.004	<.0060	<.0040	<.0040	<.0020	E.0101	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0154	<.0070	<.0040	<.0130	<.0030	.0070	<.0100	<.0070
47	<.004	<.0060	<.0040	<.0040	<.0020	.0365	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0960	<.0030	<.0050	<.0100	<.0070
48	<.004	<.0060	<.0040	<.0040	<.0020	E.0108	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	.0393	<.0020	E.0115	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
						Kansas—Continued							
49	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	.0228	<.0040	<.0130	<.0030	.0225	<.0100	<.0070
50	<.004	<.0060	<.0040	<.0040	<.0020	E.0094	.0170	<.0040	<.0130	<.0030	.0161	E.0061	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0140	.0104	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
51	<.004	<.0060	<.0040	<.0040	<.0020	E.0050	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.346	<.0070	<.0040	<.0130	<.0030	.0568	<.0100	<.0070

Table 12. Pesticide and pesticide degradate (lindane through terbacil) concentrations in water samples from 70 midwestern

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Lin- dane	Lin- uron	Mala- thion	Metol- achlor	Metri- buzin	Molin- ate	Napro- pamide
				Kentucky							
52	Ohio River at Cannelton Dam, KY	06/04/98	S1	SU–75	<0.004	<0.0020	<0.005	0.365	0.016	<0.0040	<0.0030
		07/07/98	S2	SU–173	<.004	<.0020	<.005	.373	<.004	<.0040	<.0030
				Missouri							
53	Nodaway River near Graham, MO	06/18/98	S1	SU–119	Sample not analyzed (ruined in laboratory)						
		08/19/98	S2	SU–209	<.004	<.0020	<.005	.049	<.043	<.0040	<.0030
				Nebraska							
54	North Dry Creek near Kearney, NE	05/22/98	S1	SU–28	E.002	<.0020	<.005	3.23	<.004	<.0040	<.0030
		06/08/98	S2	SU–76	<.004	<.0020	<.005	1.10	<.004	<.0040	<.0030
55	Maple Creek near Nickerson, NE	05/21/98	S1	SU–37	<.004	<.0020	<.005	17.9	.200	<.0040	<.0030
		06/08/98	S2	SU–79	<.004	<.0020	<.005	7.16	.243	<.0040	<.0030
56	Salt Creek at Roca, NE	05/15/98	S1	SU–6	<.004	<.0020	<.005	E143	.329	<.0040	<.0030
		06/10/98	S2	SU–94	.005	<.0020	.008	14.7	.646	<.0040	<.0030
57	Wahoo Creek at Ithaca, NE	05/15/98	S1	SU–5	<.004	<.0020	<.005	17.3	.020	<.0040	<.0030
		06/08/98	S2	SU–78	<.004	<.0020	<.005	1.24	.033	<.0040	<.0030
58	Platte River at Louisville, NE	05/22/98	S1	SU–39	<.004	<.0020	<.005	6.26	.310	<.0040	<.0030
		06/09/98	S2	SU–77	<.004	<.0020	<.005	2.97	.143	<.0040	<.0030
59	Big Nemaha River at Falls City, NE	05/26/98	S1	SU–41	<.004	<.0020	<.005	2.32	.017	<.0040	<.0030
		06/08/98	S2	SU–80	<.004	<.0020	<.005	3.21	.011	<.0040	<.0030
60	W. Fork Big Blue River, Dorchester, NE	05/23/98	S1	SU–36	<.004	<.0020	<.005	17.7	.358	<.0040	<.0030
		06/10/98	S2	SU–82	<.004	<.0020	<.005	3.44	.143	<.0040	<.0030
61	Big Blue River at Barneston, NE	05/15/98	S1	SU–4	.0042	<.0020	<.005	4.05	.256	<.0040	<.0030
		06/09/98	S2	SU–104	<.004	<.0020	<.005	10.2	.242	<.0040	<.0030
62	Little Blue River near Fairbury, NE	05/12/98	S1	SU–3	Sample not analyzed (broken bottle)						
		06/08/98	S2	SU–81	Sample not analyzed (mislabled bottle)						
				Ohio							
63	Clear Creek near Rockbridge, OH	06/10/98	S1	SU–86	.042	<.0020	<.005	.291	<.004	<.0040	<.0030
		06/30/98	S2	SU–145	<.004	.0852	<.005	1.34	.099	<.0040	<.0030
64	Scioto River near Prospect, OH	06/02/98	S1	SU–63	.009	<.0020	<.005	3.71	.223	<.0040	<.0030
		06/29/98	S2	SU–141	<.004	<.0020	<.005	5.75	.105	<.0040	<.0030
65	Olentangy River at Claridon, OH	06/09/98	S1	SU–85	<.004	<.0020	<.005	.831	<.004	<.0040	<.0030
		06/29/98	S2	SU–157	<.004	<.0020	<.005	5.45	.065	<.0040	<.0030
66	Olentangy River below Delaware, Lake Dam, OH	06/09/98	R1	SU–84	<.004	<.0020	<.005	1.65	.048	<.0040	<.0030
		06/29/98	R2	SU–153	<.004	<.0020	<.005	4.36	.087	<.0040	<.0030
67	Big Darby Creek at Darbyville, OH	06/03/98	S1	SU–62	<.004	<.0020	<.005	3.04	.078	<.0040	<.0030
		06/29/98	S2	SU–140	.005	<.0020	<.005	2.89	.018	<.0040	<.0030

streams and 5 midwestern reservoirs—Continued

[SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Parathion	Parathion-methyl	Pebu-late	Pendi-methalin	Phorate	Prom-eton	Propa-chlor	Propanil	Propar-gite	Propyz-amide	Sima-zine	Tebu-thiuron	Terbacil
Kentucky—Continued													
52	<0.004	<0.0060	<0.0040	<0.0040	<0.0020	E0.0160	<0.0070	<0.0040	<0.0130	<0.0030	0.151	E0.0097	<0.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0110	<.0070	<.0040	<.0130	<.0030	.112	<.0100	<.0070
Missouri—Continued													
53	Sample not analyzed												
	<.004	<.0060	<.0040	<.0040	<.0020	E.0051	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
Nebraska—Continued													
54	<.004	<.0060	<.0040	<.0040	<.0020	.166	.0772	<.0040	<.0130	<.0030	.0505	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.159	.0185	<.0040	<.0130	<.0030	.0235	<.0100	<.0070
55	<.004	<.0060	<.0040	.0667	<.0020	.0520	<.0070	<.0040	<.0130	<.0030	.0510	<.0100	<.0070
	<.004	<.0060	<.0040	.0636	<.0020	E.0106	E.0022	<.0040	<.0130	<.0030	.0412	<.0100	<.0070
56	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	.161	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0188	.0642	<.0040	<.0130	<.0030	.188	<.0100	<.0070
57	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	.334	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	.0780	<.0020	.0284	<.0070	<.0040	<.0130	<.0030	.0208	<.0100	<.0070
58	<.004	<.0060	<.0040	.0359	<.0020	.0522	.0402	<.0040	<.0130	<.0030	.221	<.0100	<.0070
	<.004	<.0060	<.0040	.0347	<.0020	.0613	.0149	<.0040	<.0130	<.0030	.0289	E.0038	<.0070
59	<.004	<.0060	<.0040	<.0040	<.0020	.340	.0135	<.0040	<.0130	<.0030	.0768	<.0100	<.0070
	<.004	<.0060	<.0040	.0287	<.0020	E.0076	.557	<.0040	<.0130	<.0030	.0734	E.0042	<.0070
60	<.004	<.0060	<.0040	<.0040	<.0020	.132	.192	<.0040	<.0130	<.0030	.0489	<.0100	<.0070
	<.004	<.0060	<.0040	.0885	<.0020	.0531	.0218	<.0040	<.0130	<.0030	.0367	<.0100	<.0070
61	<.004	.016	<.0040	.0104	<.0020	.0389	.0134	<.0040	<.0130	<.0030	<.0050	E.0035	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0148	.607	<.0040	<.0130	<.0030	.0428	E.0050	<.0070
62	Sample not analyzed												
	Sample not analyzed												
Ohio—Continued													
63	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	.0723	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0217	<.0070	<.0040	<.0130	<.0030	.455	<.0100	<.0070
64	<.004	<.0060	<.0040	.0170	<.0020	.0516	<.0070	<.0040	<.0130	<.0030	2.07	<.0100	<.0070
	<.004	<.0060	<.0040	.0279	<.0020	.0368	<.0070	<.0040	<.0130	<.0030	.784	E.0090	<.0070
65	<.004	<.0060	<.0040	<.0040	<.0020	E.0098	<.0070	<.0040	<.0130	<.0030	.0390	<.0100	<.0070
	<.004	<.0060	<.0040	.0206	<.0020	E.0172	<.0070	<.0040	<.0130	<.0030	.391	<.0100	<.0070
66	<.004	<.0060	<.0040	<.0040	<.0020	.0232	<.0070	<.0040	<.0130	<.0030	.352	<.0100	<.0070
	<.004	<.0060	<.0040	.0121	<.0020	.0286	<.0070	<.0040	<.0130	<.0030	1.03	E.0080	<.0070
67	<.004	<.0060	<.0040	<.0040	<.0020	E.0091	<.0070	<.0040	<.0130	<.0030	.979	<.0100	<.0070
	<.004	<.0060	<.0040	.0163	<.0020	.0224	<.0070	<.0040	<.0130	<.0030	.846	<.0100	<.0070

Table 12. Pesticide and pesticide degradate (lindane through terbacil) concentrations in water samples from 70 midwestern

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Lin-dane	Lin-uron	Mala-thion	Metol-achlor	Metri-buzin	Molin-ate	Napro-pamide
				Ohio—Continued							
68	Scioto River at Higby, OH	06/04/98	S1	SU–73	<0.004	<0.0020	<0.005	2.30	0.107	<0.0040	<0.0030
		07/08/98	S2	SU–165	<.004	<.0020	<.005	2.31	.043	<.0040	<.0030
69	L. Miami River near Oldtown, OH	06/10/98	S1	SU–92	<.004	<.0020	<.005	.177	.007	<.0040	<.0030
		06/30/98	S2	SU–144	<.004	<.0020	<.005	.301	.010	<.0040	<.0030
70	Mad River at Eagle City, OH	06/10/98	S1	SU–91	<.004	<.0020	<.005	.030	<.004	<.0040	<.0030
		06/30/98	S2	SU–146	<.004	<.0020	.008	.875	.020	<.0040	<.0030
71	Tiffin River at Stryker, OH	06/01/98	S1	SU–66	<.004	.0470	<.005	.481	.101	<.0040	<.0030
		07/07/98	S2	SU–172	<.004	<.0020	<.005	.127	.012	<.0040	<.0030
72	Auglaize River at Fort Jennings, OH	06/17/98	S1	SU–117	<.004	<.0020	<.005	6.58	.413	<.0040	<.0030
		07/08/98	S2	SU–171	<.004	<.0020	<.005	2.26	.096	<.0040	<.0030
				Wisconsin							
73	Root River at Racine, WI	06/01/98	S1	SU–61	<.004	<.0020	<.005	.181	<.004	<.0040	<.0030
		08/03/98	S2	SU–204	<.004	<.0020	<.005	.017	<.004	<.0040	<.0030
74	St. Croix River at St. Croix Falls, WI	06/03/98	S1	SU–68	<.004	<.0020	<.005	.016	<.004	<.0040	<.0030
		08/05/98	S2	SU–205	<.004	<.0020	<.005	<.002	<.004	<.0040	<.0030
75	Wisconsin River at Muscoda, WI	06/16/98	S1	SU–133	<.004	<.0020	<.005	.171	<.004	<.0040	<.0030
		08/07/98	S2	SU–202	<.004	<.0020	<.005	.032	<.004	<.0040	<.0030
76	Rock River at Afton, WI	06/17/98	S1	SU–134	<.004	<.0020	<.005	.073	<.004	<.0040	<.0030
		07/21/98	S2	SU–179	<.004	<.0020	<.005	.048	<.004	<.0040	<.0030

streams and 5 midwestern reservoirs—Continued

[SD, stream duplicate sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than; E, estimate]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter												
	Parathion	Parathion-methyl	Pebu-late	Pendi-methalin	Phorate	Prom-eton	Propa-chlor	Propanil	Propar-gite	Propyz-amide	Sima-zine	Tebu-thiuron	Terbacil
						Ohio—Continued							
68	<0.004	<0.0060	<0.0040	<0.0040	<0.0020	0.0375	<0.0070	<0.0040	<0.0130	<0.0030	0.499	E0.0057	<0.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0215	<.0070	<.0040	<.0130	<.0030	.442	E.0095	<.0070
69	<.004	<.0060	<.0040	<.0040	<.0020	E.0048	<.0070	<.0040	<.0130	<.0030	.330	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0078	<.0070	<.0040	<.0130	<.0030	.147	<.0100	<.0070
70	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0062	<.0070	<.0040	<.0130	<.0030	.0632	<.0100	<.0070
71	<.004	<.0060	<.0040	<.0040	<.0020	E.0100	<.0070	<.0040	<.0130	<.0030	.197	E.0068	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0178	<.0070	<.0040	<.0130	<.0030	.0544	.0132	<.0070
72	<.004	<.0060	<.0040	<.0040	<.0020	.0392	<.0070	<.0040	<.0130	<.0030	.682	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0334	<.0070	<.0040	<.0130	<.0030	.144	<.0100	<.0070
						Wisconsin—Continued							
73	<.004	<.0060	<.0040	.0118	<.0020	.0198	<.0070	<.0040	<.0130	<.0030	.0095	.0138	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	.0314	<.0070	<.0040	<.0130	<.0030	<.0050	.0188	<.0070
74	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.0100	<.0070
75	<.004	<.0060	<.0040	<.0040	<.0020	E.0061	<.0070	<.0040	<.0130	<.0030	.0154	<.0100	<.0070
	<.004	<.0060	<.0040	<.0040	<.0020	E.0082	<.0070	<.0040	<.0130	<.0030	.0104	<.0100	<.0070
76	<.004	<.0060	<.0040	<.0040	<.0020	E.0110	<.0070	<.0040	<.0130	<.0030	.0263	E.0061	E.0136
	<.004	<.0060	<.0040	<.0040	<.0020	.0294	<.0070	<.0040	<.0130	<.0030	.0229	<.0100	<.0070

Table 13. Pesticide and pesticide degradate (terbufos through p,p'-DDE) concentrations in water samples from 70 midwestern streams and 5 midwestern reservoirs

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Terbu- fos	Thio- bencarb	Tri- allate	Triflu- ralin	alpha- HCH	cis- permeth- rin	p,p' - DDE
				Illinois							
1	Vermillion River below Lake Vermillion Dam, IL	06/10/98	R1	SU–98	<0.0130	<0.0020	<0.0010	0.0062	<0.0020	<0.0050	<0.0060
		07/16/98	R2	SU–177	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	.0062
2	Bonpas Creek at Browns, IL	05/23/98	S1	SU–43	<.0130	<.0020	<.0010	.0053	<.0020	<.0050	<.0060
		07/07/98	S2	SU–166	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
3	Little Wabash River at Carmi, IL	05/23/98	S1	SU–33	<.0130	.0322	<.0010	.0104	<.0020	<.0050	<.0060
		07/09/98	S2	SU–175	<.0130	<.0020	<.0010	.0070	<.0020	<.0050	<.0060
4	S. Branch Kishwaukee River near Fairdale, IL	05/20/98	S1	SU–29	.0478	<.0020	<.0010	.0054	<.0020	<.0050	<.0060
		07/29/98	S2	SU–195	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
5	Iroquois River near Chebanse, IL	06/10/98	S1	SU–99	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/08/98	S2	SU–168	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
6	Dupage River near Shorewood, IL	06/09/98	S1	SU–100	<.0130	<.0020	<.0010	.0057	<.0020	<.0050	<.0060
		07/29/98	S2	SU–194	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
7	Illinois River at Marseilles, IL	06/12/98	S1	SU–113	<.0130	<.0020	<.0010	.0069	<.0020	<.0050	<.0060
		07/09/98	S2	SU–176	<.0130	<.0020	<.0010	.0062	<.0020	<.0050	<.0060
8	Spoon River at London Mills, IL	05/20/98	S1	SU–25	.0276	<.0020	<.0010	.0328	<.0020	<.0050	<.0060
		07/01/98	S2	SU–160	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
9	Sangamon River near Monticello, IL	05/23/98	S1	SU–35	.0296	<.0020	<.0010	.0157	<.0020	<.0050	<.0060
		08/05/98	S2	SU–201	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
10	Sangamon River at Riverton, IL	05/26/98	S1	SU–44	<.0130	<.0020	<.0010	.0182	<.0020	<.0050	<.0060
		07/09/98	S2	SU–174	<.0130	<.0020	<.0010	.0064	<.0020	<.0050	<.0060
11	LaMoine River at Colmar, IL	05/21/98	S1	SU–27	<.0130	<.0020	<.0010	.0076	<.0020	<.0050	<.0060
		06/29/98	S2	SU–142	<.0130	<.0020	<.0010	.0041	<.0020	<.0050	<.0060
12	Illinois River at Valley City, IL	06/18/98	S1	SU–120	<.0130	<.0020	<.0010	E.0028	<.0020	<.0050	<.0060
		08/12/98	S2	SU–207	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
13	Mississippi River below Grafton, IL	06/02/98	S1	SU–60	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/15/98	S2	SU–116	<.0130	<.0020	<.0010	E.0020	<.0020	<.0050	<.0060

Table 13. Pesticide and pesticide degradate (terbufos through p,p'-DDE) concentrations in water samples from 70 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Terbufos	Thiobencarb	Triallate	Trifluralin	alpha-HCH	cis-permethrin	p,p' -DDE
				Illinois—Continued							
14	Kaskaskia River near Cowden, IL	05/20/98	S1	SU–30	<0.0130	<0.0020	<0.0010	<0.0020	<0.0020	<0.0050	<0.0060
		07/08/98	S2	SU–169	<.0130	<.0020	<.0010	.0064	<.0020	<.0050	<.0060
15	Shoal Creek near Breese, IL	05/22/98	S1	SU–32	<.0130	.0130	<.0010	.0367	<.0020	<.0050	<.0060
		07/08/98	S2	SU–167	<.0130	<.0020	<.0010	.0342	<.0020	<.0050	<.0060
				Iowa							
16	Turkey River at Spillville, IA	06/02/98	S1	SU–64	<.0130	<.0020	<.0010	.0045	<.0020	<.0050	<.0060
		06/12/98	S2	SU–109	<.0130	<.0020	<.0010	.0054	<.0020	<.0050	<.0060
17	Mississippi River at Clinton, IA	05/27/98	S1	SU–55	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/01/98	S2	SU–155	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
18	Wapsipinicon River near Tripoli, IA	05/27/98	S1	SU–54	<.0130	<.0020	<.0010	.0048	<.0020	<.0050	<.0060
		06/20/98	S2	SU–126	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
19	Wapsipinicon River at Independence, IA	05/29/98	S1	SU–56	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/12/98	S2	SU–110	<.0130	<.0020	<.0010	.0081	<.0020	<.0050	<.0060
20	Iowa River near Rowan, IA	06/02/98	S1	SU–65	<.0130	<.0020	<.0010	.0055	<.0020	<.0050	<.0060
		06/23/98	S2	SU–129	<.0130	<.0020	<.0010	.0119	<.0020	<.0050	<.0060
21	Old Mans Creek near Iowa City, IA	06/10/98	S1	SU–93	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/30/98	S2	SU–147	<.0130	<.0020	<.0010	E.0024	<.0020	<.0050	<.0060
22	Wolf Creek near Dysart, IA	06/10/98	S1	SU–87	<.0130	<.0020	<.0010	.0041	<.0020	<.0050	<.0060
		06/22/98	S2	SU–128	<.0130	<.0020	<.0010	.0150	<.0020	<.0050	<.0060
23	Iowa River at Wapello, IA	05/27/98	S1	SU–53	Sample not analyzed (ruined in laboratory)						
		06/19/98	S2	SU–127	<.0130	<.0020	<.0010	.0067	<.0020	<.0050	<.0060
24	N. Skunk River near Sigourney, IA	05/21/98	S1	SU–21	<.0130	<.0020	<.0010	.0045	<.0020	<.0050	<.0060
		06/10/98	S2	SU–95	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
25	Skunk River at Augusta, IA	05/26/98	S1	SU–45	<.0130	<.0020	<.0010	.0062	<.0020	<.0050	<.0060
		06/18/98	S2	SU–122	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060

Table 13. Pesticide and pesticide degradate (terbufos through p,p'-DDE) concentrations in water samples from 70 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Terbufos	Thiobencarb	Triallate	Trifluralin	alpha-HCH	cis-permethrin	p,p' -DDE
				Iowa—Continued							
26	Des Moines River at Fort Dodge, IA	05/16/98	S1	SU–8	<0.0130	<0.0020	<0.0010	0.268	<0.0020	<0.0050	<0.0060
		06/12/98	S2	SU–108	<.0130	<.0020	<.0010	.0047	<.0020	<.0050	E.0028
27	Raccoon River at Van Meter, IA	05/17/98	S1	SU–9	<.0130	<.0020	<.0010	.0856	<.0020	<.0050	<.0060
		06/10/98	S2	SU–89	<.0130	<.0020	<.0010	.0297	<.0020	<.0050	<.0060
28	Little Sioux River at Correctionville, IA	05/27/98	S1	SU–42	<.0130	<.0020	<.0010	E.0031	<.0020	<.0050	<.0060
		06/18/98	S2	SU–123	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
29	Maple River at Mapleton, IA	05/29/98	S1	SU–59	<.0130	<.0020	<.0010	.0514	<.0020	<.0050	<.0060
		06/09/98	S2	SU–90	<.0130	<.0020	<.0010	.0119	<.0020	<.0050	<.0060
30	Boyer River at Logan, IA	05/22/98	S1	SU–31	<.0130	<.0020	<.0010	.0491	<.0020	<.0050	<.0060
		06/09/98	S2	SU–96	<.0130	<.0020	<.0010	.0302	<.0020	<.0050	<.0060
31	Chariton River below Rathbun Lake Dam, IA	06/04/98	R1	SU–69	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/29/98	R2	SU–148	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
				Indiana							
33	Whitewater River near Alpine, IN	05/26/98	S1	SU–47	<.0130	<.0020	<.0010	.0059	<.0020	<.0050	<.0060
		07/08/98	S2	SU–162	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
34	Blue River at Fredericksburg, IN	05/27/98	S1	SU–50	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/08/98	S2	SU–163	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
35	Mississinewa River below Mississinewa Lake Dam, IN	06/09/98	R1	SU–83	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/09/98	R2	SU–164	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
36	Eel River near Logansport, IN	05/21/98	S1	SU–18	Sample not analyzed (broken bottle)						
		06/30/98	S2	SU–152	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
37	Wildcat Creek near Jerome, IN	05/21/98	S1	SU–19	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/30/98	S2	SU–151	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
38	Wildcat Creek near Lafayette, IN	05/20/98	S1	SU–22	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/01/98	S2	SU–150	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060

Table 13. Pesticide and pesticide degradate (terbufos through p,p'-DDE) concentrations in water samples from 70 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Terbufos	Thiobencarb	Triallate	Trifluralin	alpha-HCH	cis-permethrin	p,p'-DDE
				Indiana—Continued							
39	White River near Nora, IN	05/28/98	S1	SU–51	<0.0130	<0.0020	<0.0010	<0.0020	<0.0020	<0.0050	<0.0060
		07/01/98	S2	SU–149	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
40	Sugar Creek near Edinburgh, IN	05/26/98	S1	SU–46	<.0130	<.0020	<.0010	.0047	<.0020	<.0050	<.0060
		07/20/98	S2	SU–178	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
41	E. Fork White River near Bedford, IN	05/28/98	S1	SU–52	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/06/98	S2	SU–161	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
42	Wabash River at New Harmony, IN	05/27/98	S1	SU–57	Sample not analyzed (ruined in laboratory)						
		06/23/98	S2	SU–136	<.0130	<.0020	<.0010	.0070	<.0020	<.0050	<.0060
				Minnesota							
43	Cottonwood River near New Ulm, MN	05/26/98	S1	SU–49	<.0130	<.0020	<.0010	.0050	<.0020	<.0050	<.0060
		07/21/98	S2	SU–180	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
44	Little Cobb River near Beauford, MN	05/18/98	S1	SU–12	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		08/17/98	S2	SU–208	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
45	Minnesota River near Jordan, MN	05/19/98	S1	SU–13	<.0130	<.0020	<.0010	.0051	<.0020	<.0050	<.0060
		06/26/98	S2	SU–135	<.0130	<.0020	<.0010	.0062	<.0020	<.0050	<.0060
46	Mississippi River at Hastings, MN	05/20/98	S1	SU–14	<.0130	<.0020	<.0010	E.0036	<.0020	<.0050	<.0060
		05/20/98	S2	SU–206	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
47	Des Moines River at Jackson, MN	05/26/98	S1	SU–48	<.0130	<.0020	<.0010	.0050	<.0020	<.0050	<.0060
		08/24/98	S2	SU–210	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
48	Rock River at Luverne, MN	06/24/98	S1	SU–130	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/25/98	S2	SU–131	<.0130	<.0020	<.0010	.0080	<.0020	<.0050	<.0060
				Kansas							
49	Black Vermillion River at Frankfort, KS	05/05/98	S1	SU–1	<.0130	<.0020	<.0010	E.0033	<.0020	<.0050	<.0060
		06/09/98	S2	SU–107	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
50	Big Blue River below Tuttle Creek Lake Dam, KS	06/03/98	R1	SU–73	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/29/98	R2	SU–197	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
51	Delaware River near Muscotah, KS	05/05/98	S1	SU–2	<.0130	<.0020	<.0010	E.0031	<.0020	<.0050	<.0060
		06/10/98	S2	SU–105	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060

Table 13. Pesticide and pesticide degradate (terbufos through p,p'-DDE) concentrations in water samples from 70 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Terbufos	Thiobencarb	Triallate	Trifluralin	alpha-HCH	cis-permethrin	p,p'-DDE
				Kentucky							
52	Ohio River at Cannelton Dam, KY	06/04/98	S1	SU–75	<0.0130	<0.0020	<0.0010	<0.0020	<0.0020	<0.0050	<0.0060
		07/07/98	S2	SU–173	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	E.0019
				Missouri							
53	Nodaway River near Graham, MO	06/18/98	S1	SU–119	Sample not analyzed (ruined in laboratory)						
		08/19/98	S2	SU–209	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
				Nebraska							
54	North Dry Creek near Kearney, NE	05/22/98	S1	SU–28	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/08/98	S2	SU–76	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
55	Maple Creek near Nickerson, NE	05/21/98	S1	SU–37	<.0130	<.0020	<.0010	.0188	<.0020	<.0050	<.0060
		06/08/98	S2	SU–79	<.0130	<.0020	<.0010	.0234	<.0020	<.0050	<.0060
56	Salt Creek at Roca, NE	05/15/98	S1	SU–6	<.0130	<.0020	<.0010	E.0034	<.0020	<.0050	<.0060
		06/10/98	S2	SU–94	<.0130	<.0020	<.0010	.0078	<.0020	<.0050	<.0060
57	Wahoo Creek at Ithaca, NE	05/15/98	S1	SU–5	<.0130	<.0020	<.0010	E.0026	<.0020	<.0050	<.0060
		06/08/98	S2	SU–78	<.0130	<.0020	<.0010	.0360	<.0020	<.0050	<.0060
58	Platte River at Louisville, NE	05/22/98	S1	SU–39	<.0130	<.0020	<.0010	.0338	<.0020	<.0050	<.0060
		06/09/98	S2	SU–77	<.0130	<.0020	<.0010	.0300	<.0020	<.0050	<.0060
59	Big Nemaha River at Falls City, NE	05/26/98	S1	SU–41	<.0130	<.0020	<.0010	.0052	<.0020	<.0050	<.0060
		06/08/98	S2	SU–80	<.0130	<.0020	<.0010	.0088	<.0020	<.0050	<.0060
60	W. Fork Big Blue River, Dorchester, NE	05/23/98	S1	SU–36	<.0130	<.0020	<.0010	.0041	<.0020	<.0050	<.0060
		06/10/98	S2	SU–82	<.0130	<.0020	<.0010	.0057	<.0020	<.0050	<.0060
61	Big Blue River at Barneston, NE	05/15/98	S1	SU–4	<.0130	<.0020	<.0010	.0339	<.0020	<.0050	<.0060
		06/09/98	S2	SU–104	<.0130	<.0020	<.0010	.0081	<.0020	<.0050	<.0060
62	Little Blue River near Fairbury, NE	05/12/98	S1	SU–3	Sample not analyzed (bottle broken)						
		06/08/98	S2	SU–81	Sample not analyzed (bottle mislabeled)						
				Ohio							
63	Clear Creek near Rockbridge, OH	06/10/98	S1	SU–86	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/30/98	S2	SU–145	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060

Table 13. Pesticide and pesticide degradate (terbufos through p,p'-DDE) concentrations in water samples from 70 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Terbu- fos	Thio- bencarb	Tri- allate	Triflu- ralin	alpha- HCH	cis- permeth- rin	p,p' - DDE
				Ohio—Continued							
64	Scioto River near Prospect, OH	06/02/98	S1	SU–63	<0.0130	<0.0020	<0.0010	0.0047	<0.0020	<0.0050	E0.0020
		06/29/98	S2	SU–141	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
65	Olentangy River at Claridon, OH	06/09/98	S1	SU–85	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/29/98	S2	SU–157	<.0130	<.0020	<.0010	.0061	<.0020	<.0050	<.0060
66	Olentangy River below Delaware, Lake Dam, OH	06/09/98	R1	SU–84	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/29/98	R2	SU–153	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
67	Big Darby Creek at Darbyville, OH	06/03/98	S1	SU–62	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/29/98	S2	SU–140	<.0130	<.0020	<.0010	.0061	<.0020	<.0050	<.0060
68	Scioto River at Higby, OH	06/04/98	S1	SU–73	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/08/98	S2	SU–165	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
69	L. Miami River near Oldtown, OH	06/10/98	S1	SU–92	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/30/98	S2	SU–144	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
70	Mad River at Eagle City, OH	06/10/98	S1	SU–91	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		06/30/98	S2	SU–146	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
71	Tiffin River at Stryker, OH	06/01/98	S1	SU–66	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/07/98	S2	SU–172	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
72	Auglaize River at Fort Jennings, OH	06/17/98	S1	SU–117	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/08/98	S2	SU–171	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
				Wisconsin							
73	Root River at Racine, WI	06/01/98	S1	SU–61	<.0130	<.0020	<.0010	.0047	<.0020	<.0050	<.0060
		08/03/98	S2	SU–204	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
74	St. Croix River at St. Croix Falls, WI	06/03/98	S1	SU–68	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		08/05/98	S2	SU–205	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
75	Wisconsin River at Muscoda, WI	06/16/98	S1	SU–133	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		08/07/98	S2	SU–202	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
76	Rock River at Afton, WI	06/17/98	S1	SU–134	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
		07/21/98	S2	SU–179	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060

Table 14. Statistical summary of 46 pesticide and pesticide degradate concentrations in 134 water samples from 71 Midwestern streams (concentrations in micrograms per liter)

[<, less than; E, estimate]

Herbicide	Method detection limit (MDL)	Number at or above MDL	25th percentile	Median	75th percentile	95th percentile	Maximum
2,6-diethylaniline	0.003	1	<0.003	<0.003	<0.003	<0.003	0.004
acetochlor	.002	128	.099	.400	1.14	11.40	25.1
alachlor	.002	119	.014	.040	.16	2.94	17.2
atrazine	.001	134	.536	3.77	8.78	37.6	224
azinphos-methyl	.001	0	<.001	<.001	<.001	<.001	<.001
benfluralin	.002	1	<.002	<.002	<.002	<.002	.004
butylate	.002	6	<.002	<.002	<.002	E.001	.270
carbaryl	.003	32	<.003	<.003	<.003	.059	.195
carbofuran	.003	47	<.003	<.003	.031	.191	1.03
chlorpyrifos	.004	44	<.004	<.004	.014	.072	.858
cyanazine	.004	125	.049	.322	1.01	6.75	20.0
dacthal	.002	0	<.002	<.002	<.002	.001	.002
deethylatrazine	.002	134	.067	.256	.446	.820	1.26
diazinon	.002	48	<.002	<.002	.006	.028	.071
dieldrin	.001	12	<.001	<.001	<.001	.006	.015
disulfoton	.017	0	<.017	<.017	<.017	<.017	<.017
EPTC	.002	28	<.002	<.002	<.002	.015	.076
ethalfluralin	.004	0	<.004	<.004	<.004	<.004	<.004
ethoprophos	.003	1	<.003	<.003	<.003	<.003	.045
fonofos	.003	3	<.003	<.003	<.003	<.003	.063
lindane	.004	10	<.004	<.004	<.004	.005	.042
linuron	.002	7	<.002	<.002	<.002	.025	.129
malathion	.005	6	<.005	<.005	<.005	E.004	.009
metolachlor	.002	133	.301	1.67	3.21	14.7	143
metribuzin	.004	88	<.004	.020	.099	.329	1.76
molinate	.004	3	<.004	<.004	<.004	<.004	.049
napropamide	.003	0	<.003	<.003	<.003	<.003	<.003
parathion	.004	0	<.004	<.004	<.004	<.004	<.004
parathion methyl	.006	1	<.006	<.006	<.006	<.006	.016
pebulate	.004	0	<.004	<.004	<.004	<.004	<.004
pendimethalin	.004	51	<.004	<.004	.020	.103	.320
phorate	.002	0	<.002	<.002	<.002	<.002	<.002
prometon	.018	59	E.007	E.015	.031	.087	.346
propachlor	.007	20	<.007	<.007	<.007	.161	.607
propanil	.004	0	<.004	<.004	<.004	<.004	<.004
propargite	.013	0	<.013	<.013	<.013	<.013	<.013
propyzamide	.003	0	<.003	<.003	<.003	<.003	<.003
simazine	.005	105	.009	.029	.086	.971	7.91
tebuthiuron	.010	21	<.010	<.010	E.006	.016	.076
terbacil	.007	2	<.007	<.007	<.007	<.007	.014
terbufos	.013	3	<.013	<.013	<.013	<.013	.048
thiobencarb	.002	2	<.002	<.002	<.002	<.002	.032
tri-allate	.001	0	<.001	<.001	<.001	<.001	<.001
trifluralin	.002	68	<.002	.002	.006	.034	.268
alpha-HCH	.002	0	<.002	<.002	<.002	<.002	<.002
cis-Permethrin	.005	0	<.005	<.005	<.005	<.005	<.005
p,p'-DDE	.006	0	<.006	<.006	<.006	<.006	.003
Sum of 46 pesticides and degradates	.001	134	1.34	7.04	16.0	65.6	385

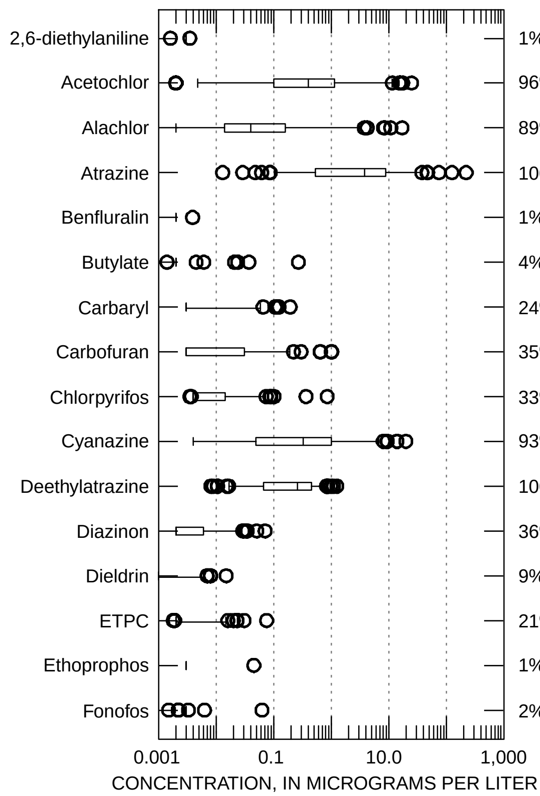


Figure 19. Pesticide and pesticide degradate (2,6-diethylaniline to fonofos) concentrations and percent detections at or above the method detection limit in 134 stream samples.

OCCURRENCE OF NUTRIENTS AND PHYSICAL PROPERTIES

Streams

The results of analyses of 7 nutrients, and measurements of 3 physical properties for 141 stream samples are given in table 27. The discharges on the day of sample collection are given in table 4. A statistical summary of these results is given in table 28. Nitrate was detected at or above the MRL in 136 (98 percent) of 139 samples. Nitrate concentrations were the highest of the nutrients with a median concentration of 4.34 milligrams per liter (mg/L) and more than 10 percent of the samples exceeding the EPA Maximum Contaminant Level (MCL) of 10 mg/L (U.S. Environmental Protection Agency, 1996b). Nitrite was detected at or above the MRL in 132 (96 percent) of 138 samples. However, nitrite concentrations were very low, with a median concentration of only 0.056 mg/L. Ammonia plus organic N was detected in 136 (99 percent) of 137 samples. Organic N concentrations were generally higher than ammonia concentrations. The median organic N concentration was 0.468 mg/L. Ammonia as N was detected at or above the MRL in 123 (89 percent) of 138 samples, with a median concentration of 0.063 mg/L. Dissolved phosphorus and orthophosphate were detected at or above the MRL in 97 percent and 96 percent of samples, respectively. They occurred at similar concentrations; the median dissolved phosphorus concentration was 0.107 mg/L, and the median orthophosphate concentration was 0.084 mg/L. Stream samples tended to be slightly basic; the median pH of the samples was 7.8. Specific conductances were moderate with a median of 500 microsiemens per centimeter at 25 degrees Celsius (µS/cm). Daily mean discharge on the date of sample collection ranged from 3 to 267,000 cubic feet per second (ft^3/s); the median discharge was 1,070 ft^3/s.

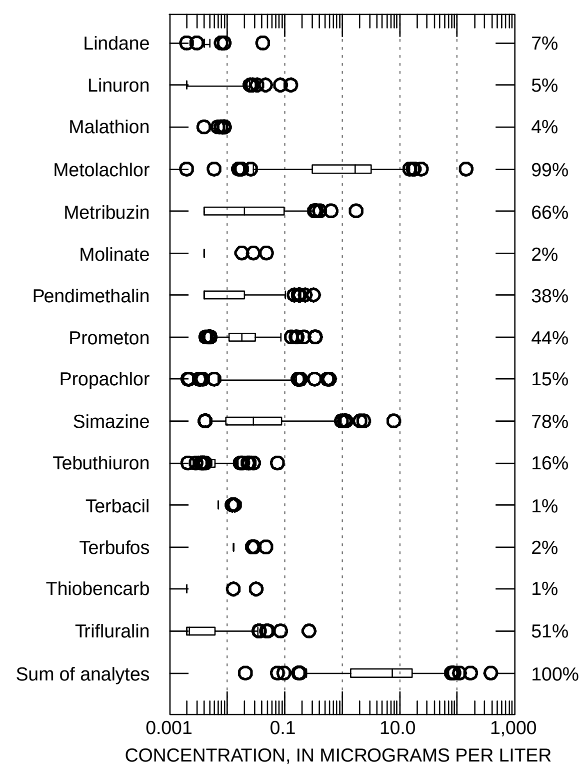


Figure 20. Pesticide and pesticide degradate (lindane to trifluralin) concentrations and percent detections at or above the method detection limit in 134 stream samples.

Table 15. Concentrations of 13 herbicides in water samples from 71 midwestern streams and 5 midwestern reservoirs

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter				
					Aceto-chlor	Ala-chlor	Ame-tryn	Atra-zine	Cyana-zine
			Illinois						
1	Vermillion River below Lake Vermillion Dam, IL	06/10/98	R1	SU–98	0.36	<0.05	<0.05	4.94	0.49
		06/10/98	LD	SU–98	.37	<.05	<.05	5.22	.55
		07/16/98	R2	SU–177	<.05	<.05	<.05	1.37	.15
		07/16/98	LD	SU–177	<.05	<.05	<.05	1.15	.13
2	Bonpas Creek at Browns, IL	05/23/98	S1	SU–43	8.39	.39	<.05	73.34	1.31
		07/07/98	S2	SU–166	.08	<.05	<.05	1.53	<.05
3	Little Wabash River at Carmi, IL	05/23/98	S1	SU–33	3.77	3.80	<.05	51.32	1.95
		07/09/98	S2	SU–175	.08	.30	<.05	6.50	.42
4	S. Branch Kishwaukee River near Fairdale, IL	05/20/98	S1	SU–29	12.50	.37	<.05	13.92	3.01
		07/29/98	S2	SU–195	<.05	<.05	<.05	.22	<.05
5	Iroquois River near Chebanse, IL	06/10/98	S1	SU–99	.22	<.05	<.05	1.90	.44
		07/08/98	S2	SU–168	.09	<.05	<.05	2.71	.54
6	Dupage River near Shorewood, IL	06/09/98	S1	SU–100	.06	<.05	<.05	.09	.45
		07/29/98	S2	SU–194	<.05	<.05	<.05	.05	<.05
7	Illinois River at Marseilles, IL	06/12/98	S1	SU–113	.98	.05	<.05	4.62	.85
		07/09/98	S2	SU–176	.13	<.05	<.05	1.40	.23
8	Spoon River at London Mills, IL	05/20/98	S1	SU–25	4.09	.20	<.05	35.23	67.16
		07/01/98	S2	SU–160	.14	<.05	<.05	2.67	.26
9	Sangamon River near Monticello, IL	05/23/98	S1	SU–35	.54	<.05	<.05	4.07	.22
		05/23/98	LD	SU–35	.57	<.05	<.05	4.16	.23
		08/05/98	S2	SU–201	<.05	<.05	<.05	.43	<.05
10	Sangamon River at Riverton, IL	05/26/98	S1	SU–44	1.46	.13	<.05	8.03	.51
		07/09/98	S2	SU–174	.07	<.05	<.05	1.49	.07
		07/09/98	LD	SU–174	.06	<.05	<.05	1.27	.06
		07/09/98	LD	SU–174	.07	<.05	<.05	1.35	<.05
11	LaMoine River at Colmar, IL	05/21/98	S1	SU–27	9.80	.05	<.05	23.30	10.54
		06/29/98	S2	SU–142	.36	<.05	<.05	4.32	1.40
		06/29/98	LD	SU–142	.35	<.05	<.05	4.22	1.34
12	Illinois River at Valley City, IL	06/18/98	S1	SU–120	.98	.06	<.05	7.08	1.46
		08/12/98	S2	SU–207	<.05	<.05	<.05	.30	.09
13	Mississippi River below Grafton, IL	06/02/98	S1	SU–60	.79	<.05	<.05	3.25	.88
		06/15/98	S2	SU–116	.71	.06	<.05	5.03	.82
		06/15/98	LD	SU–116	.44	<.05	<.05	3.77	.58
		06/15/98	LD	SU–116	.61	.05	<.05	4.03	.63
14	Kaskaskia River near Cowden, IL	05/20/98	S1	SU–30	.33	<.05	<.05	1.76	.10
		05/20/98	LD	SU–30	.36	<.05	<.05	1.73	.08
		07/08/98	S2	SU–169	.77	<.05	<.05	4.66	.21

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter							
	Meto-lachlor	Metri-buzin	Prome-ton	Prome-tryn	Pro-pachlor	Pro-pazine	Sima-zine	Ter-butryn
				Illinois—Continued				
1	0.97	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05
	1.03	<.05	<.05	<.05	<.05	.05	<.05	<.05
	.48	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.41	<.05	<.05	<.05	<.05	<.05	<.05	<.05
2	14.09	.17	<.05	<.05	<.05	.68	14.15	<.05
	.93	<.05	<.05	<.05	<.05	<.05	.08	<.05
3	14.44	.34	<.05	<.05	<.05	.43	5.38	<.05
	1.70	1.34	<.05	<.05	<.05	.07	.22	<.05
4	9.58	<.05	<.05	<.05	<.05	.12	<.05	<.05
	.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
5	.75	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.91	<.05	<.05	<.05	<.05	<.05	<.05	<.05
6	.19	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
7	1.16	.17	<.05	<.05	<.05	.05	<.05	<.05
	.50	<.05	<.05	<.05	<.05	<.05	<.05	<.05
8	4.30	.35	<.05	<.05	<.05	.32	.14	<.05
	.68	<.05	<.05	<.05	<.05	<.05	<.05	<.05
9	2.60	<.05	<.05	<.05	<.05	.05	<.05	<.05
	2.69	<.05	<.05	<.05	<.05	.05	<.05	<.05
	.11	<.05	<.05	<.05	<.05	<.05	<.05	<.05
10	1.69	.09	<.05	<.05	<.05	.08	.06	<.05
	.33	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.28	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.40	<.05	<.05	<.05	<.05	<.05	<.05	<.05
11	1.35	.60	<.05	<.05	<.05	.16	.07	<.05
	.78	.07	<.05	<.05	<.05	.06	<.05	<.05
	.78	.06	<.05	<.05	<.05	.06	<.05	<.05
12	1.63	.06	<.05	<.05	<.05	.08	.06	<.05
	.09	<.05	.06	<.05	<.05	<.05	<.05	<.05
13	1.12	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	1.24	<.05	<.05	<.05	<.05	.06	.06	<.05
	.84	<.05	<.05	<.05	<.05	.06	.06	<.05
	.96	<.05	<.05	<.05	<.05	<.05	<.05	<.05
14	.41	<.05	<.05	<.05	<.05	<.05	.11	<.05
	.43	<.05	<.05	<.05	<.05	<.05	.13	<.05
	1.19	<.05	<.05	<.05	<.05	.06	.07	<.05

Table 15. Concentrations of 13 herbicides in water samples from 71 midwestern streams and 5 midwestern reservoirs

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter				
					Aceto-chlor	Ala-chlor	Ame-tryn	Atra-zine	Cyana-zine
			Illinois—Continued						
15	Shoal Creek near Breese, IL	05/22/98	S1	SU–32	9.52	0.21	<0.05	25.68	1.96
		07/08/98	S2	SU–167	1.10	<.05	<.05	9.95	.21
			Iowa						
16	Turkey River at Spillville, IA	06/02/98	S1	SU–64	.24	<.05	<.05	3.37	.66
		06/12/98	S2	SU–109	1.29	.25	<.05	3.53	1.66
17	Mississippi River at Clinton, IA	05/27/98	S1	SU–55	.25	<.05	<.05	.31	.11
		07/01/98	S2	SU–155	.10	<.05	<.05	.62	.11
18	Wapsipinicon River near Tripoli, IA	05/27/98	S1	SU–54	.33	.08	<.05	1.12	.12
		06/20/98	S2	SU–126	.36	.12	<.05	7.29	.45
19	Wapsipinicon River at Independence, IA	05/29/98	S1	SU–56	1.48	.32	<.05	8.39	.25
		06/12/98	S2	SU–110	1.16	.08	<.05	7.91	.55
20	Iowa River near Rowan, IA	06/02/98	S1	SU–65	.05	<.05	<.05	.39	<.05
		06/23/98	S2	SU–129	.63	<.05	<.05	3.27	.07
21	Old Mans Creek near Iowa City, IA	06/10/98	S1	SU–93	.57	.21	<.05	3.15	.78
		06/22/98	S2	SU–147	.28	<.05	<.05	3.05	.40
22	Wolf Creek near Dysart, IA	06/10/98	S1	SU–87	.64	<.05	<.05	6.02	.69
		06/22/98	S2	SU–128	.68	<.05	<.05	4.34	.54
23	Iowa River at Wapello, IA	05/27/98	S1	SU–53	.43	.05	<.05	1.86	.50
		06/19/98	S2	SU–127	.38	<.05	<.05	3.91	.75
24	N. Skunk River near Sigourney, IA	05/21/98	S1	SU–21	14.50	<.05	<.05	23.64	2.25
		06/10/98	S2	SU–95	.35	.10	<.05	8.26	2.09
25	Skunk River at Augusta, IA	05/26/98	S1	SU–45	7.58	.10	<.05	19.51	9.21
		06/18/98	S2	SU–122	.90	.06	<.05	7.55	1.55
26	Des Moines River at Fort Dodge, IA	05/16/98	S1	SU–8	12.17	<.05	<.05	.53	.13
		06/12/98	S2	SU–108	.11	<.05	<.05	.44	<.05
27	Raccoon River at Van Meter, IA	05/17/98	S1	SU–9	.94	<.05	<.05	2.73	.30
		06/10/98	S2	SU–89	.32	<.05	<.05	3.20	.28
28	Little Sioux River at Correctionville, IA	05/27/98	S1	SU–42	.39	<.05	<.05	1.60	<.05
		06/18/98	S2	SU–123	.23	<.05	<.05	1.19	<.05
29	Maple River at Mapleton, IA	05/29/98	S1	SU–59	2.36	<.05	<.05	8.24	1.78
		06/09/98	S2	SU–90	.19	<.05	<.05	4.31	.25
30	Boyer River at Logan, IA	05/22/98	S1	SU–31	3.93	.41	<.05	14.76	12.82
		06/09/98	S2	SU–96	.64	<.05	<.05	5.23	.99
31	Chariton River below Rathbun Lake Dam, IA	06/04/98	R1	SU–69	.13	<.05	<.05	1.05	.15
		06/29/98	R2	SU–148	.23	<.05	<.05	1.64	.24
32	Nishnabotna River at Hamburg, IA	06/17/98	S2	SU–124	.40	.05	<.05	5.06	.57

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter							
	Meto-lachlor	Metri-buzin	Prome-ton	Prome-tryn	Pro-pachlor	Pro-pazine	Sima-zine	Ter-butryn
				Illinois—Continued				
15	7.55	0.17	<0.05	<0.05	<0.05	<0.05	0.22	<0.05
	1.65	.20	<.05	<.05	.09	.11	.06	<.05
				Iowa—Continued				
16	.10	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.14	.09	<.05	<.05	<.05	<.05	<.05	<.05
17	.12	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.20	<.05	<.05	<.05	<.05	<.05	<.05	<.05
18	.54	<.05	<.05	<.05	<.05	.06	<.05	<.05
	2.03	<.05	<.05	<.05	<.05	.07	<.05	<.05
19	1.82	<.05	<.05	<.05	<.05	.08	<.05	<.05
	2.16	.18	<.05	<.05	<.05	.09	<.05	<.05
20	.15	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	1.61	<.05	<.05	<.05	<.05	<.05	<.05	<.05
21	1.20	<.05	<.05	<.05	<.05	.05	<.05	<.05
	.98	<.05	<.05	<.05	<.05	<.05	<.05	<.05
22	1.84	.15	<.05	<.05	<.05	.06	<.05	<.05
	2.03	.05	<.05	<.05	<.05	.05	<.05	<.05
23	.65	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	1.42	<.05	<.05	<.05	<.05	.05	<.05	<.05
24	2.37	.33	<.05	<.05	<.05	.15	.06	<.05
	2.44	.18	<.05	<.05	<.05	.11	<.05	<.05
25	6.46	.09	<.05	<.05	<.05	.27	.06	<.05
	2.86	<.05	<.05	<.05	<.05	.09	<.05	<.05
26	5.10	.05	<.05	<.05	.28	<.05	<.05	<.05
	.22	<.05	<.05	<.05	<.05	<.05	<.05	<.05
27	2.91	<.05	.06	<.05	<.05	<.05	<.05	<.05
	1.15	<.05	<.05	<.05	<.05	<.05	<.05	<.05
28	.36	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.37	<.05	<.05	<.05	<.05	<.05	<.05	<.05
29	4.50	.23	<.05	<.05	<.05	.08	<.05	<.05
	2.25	.05	<.05	<.05	<.05	.06	<.05	<.05
30	10.45	.10	<.05	<.05	<.05	.16	.08	<.05
	1.95	.11	<.05	<.05	<.05	.07	<.05	<.05
31	.15	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.34	<.05	<.05	<.05	<.05	<.05	<.05	<.05
32	1.16	.10	<.05	<.05	<.05	.06	<.05	<.05

Table 15. Concentrations of 13 herbicides in water samples from 71 midwestern streams and 5 midwestern reservoirs

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter				
					Aceto- chlor	Ala- chlor	Ame- tryn	Atra- zine	Cyana- zine
			Indiana						
33	Whitewater River near Alpine, IN	05/26/98	S1	SU–47	1.70	1.05	<0.05	11.26	3.93
		07/08/98	S2	SU–162	.13	.06	<.05	1.50	.30
34	Blue River at Fredericksburg, IN	05/27/98	S1	SU–50	.40	<.05	<.05	5.89	.19
		07/08/98	S2	SU–163	.05	<.05	<.05	.71	.05
35	Mississinewa River below Mississinewa Lake Dam, IN	06/09/98	R1	SU–83	.45	<.05	<.05	4.27	1.99
		07/09/98	R2	SU–164	.74	.08	<.05	5.63	2.36
36	Eel River near Logansport, IN	05/21/98	S1	SU–18	2.77	.06	<.05	7.23	.49
		06/30/98	S2	SU–152	.22	.86	<.05	2.77	.26
37	Wildcat Creek near Jerome, IN	05/21/98	S1	SU–19	1.31	<.05	<.05	11.95	22.31
		06/30/98	S2	SU–151	.21	.22	<.05	5.21	.77
38	Wildcat Creek near Lafayette, IN	05/20/98	S1	SU–22	.78	<.05	<.05	4.14	.18
		07/01/98	S2	SU–150	.14	<.05	<.05	2.26	.24
39	White River near Nora, IN	05/28/98	S1	SU–51	1.39	<.05	<.05	9.46	1.40
		07/01/98	S2	SU–149	.37	.09	<.05	4.75	.53
		07/01/98	LD	SU–149	.38	.09	–.05	4.86	.58
40	Sugar Creek near Edinburgh, IN	05/26/98	S1	SU–46	3.40	.12	<.05	14.66	1.97
		07/20/98	S2	SU–178	.07	<.05	<.05	.67	<.05
41	E. Fork White River near Bedford, IN	05/28/98	S1	SU–52	4.40	.73	<.05	21.77	3.12
		07/06/98	S2	SU–161	.15	.16	<.05	1.65	.13
42	Wabash River at New Harmony, IN	05/27/98	S1	SU–57	1.98	.14	<.05	9.13	1.22
		05/27/98	SD	SU–58	1.37	<.05	<.05	6.69	.76
		06/23/98	S2	SU–136	.98	.17	<.05	8.36	1.98
			Minnesota						
43	Cottonwood River near New Ulm, MN	05/26/98	S1	SU–49	.09	<.05	<.05	.16	.11
		07/21/98	S2	SU–180	<.05	<.05	<.05	.16	<.05
		07/21/98	SD	SU–181	<.05	<.05	<.05	.16	<.05
44	Little Cobb River near Beauford, MN	05/18/98	S1	SU–12	2.11	.13	<.05	.10	<.05
		08/17/98	S2	SU–208	<.05	<.05	<.05	.07	<.05
45	Minnesota River near Jordan, MN	05/19/98	S1	SU–13	1.19	.07	<.05	.10	<.05
		06/26/98	S2	SU–135	.24	.09	<.05	.90	.10
46	Mississippi River at Hastings, MN	05/20/98	S1	SU–14	.32	.05	<.05	.16	<.05
		05/20/98	SD	SU–15	.38	.06	<.05	.15	.09
		05/20/98	LD	SU–15	.41	.06	<.05	.17	.10
		05/20/98	S2	SU–206	<.05	<.05	<.05	.08	<.05
47	Des Moines River at Jackson, MN	05/26/98	S1	SU–48	.39	<.05	<.05	.38	<.05
		08/24/98	S2	SU–210	<.05	<.05	<.05	.15	<.05

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter							
	Meto-lachlor	Metri-buzin	Prome-ton	Prome-tryn	Pro-pachlor	Pro-pazine	Sima-zine	Ter-butryn
				Indiana—Continued				
33	1.38	0.23	<0.05	<0.05	<0.05	0.09	0.54	<0.05
	.71	.05	<.05	<.05	<.05	<.05	.13	<.05
34	1.05	<.05	<.05	<.05	<.05	.06	1.68	<.05
	.12	<.05	.09	<.05	<.05	<.05	.13	<.05
35	1.15	.22	<.05	<.05	<.05	.05	.31	<.05
	2.48	.20	<.05	<.05	<.05	.07	.19	<.05
36	2.48	.35	<.05	<.05	.05	.06	.10	<.05
	.52	<.05	<.05	<.05	<.05	<.05	.09	<.05
37	1.02	.20	<.05	<.05	<.05	.09	.07	<.05
	2.09	.09	<.05	<.05	.21	.06	.06	<.05
38	2.07	.06	<.05	<.05	<.05	<.05	<.05	<.05
	1.19	<.05	<.05	<.05	<.05	<.05	.05	<.05
39	3.78	.07	<.05	<.05	<.05	.05	.22	<.05
	2.28	.06	.05	<.05	<.05	.05	.15	<.05
	2.35	.06	.06	<.05	<.05	.06	.15	<.05
40	4.00	.33	<.05	<.05	<.05	.15	.37	<.05
	4.07	.32	.16	<.05	<.05	<.05	<.05	<.05
41	4.65	.16	<.05	<.05	<.05	.18	.82	<.05
	.74	<.05	<.05	<.05	<.05	<.05	.06	<.05
42	1.87	.07	<.05	<.05	<.05	.09	.38	<.05
	1.21	.06	<.05	<.05	<.05	.07	.28	<.05
	4.22	.10	<.05	<.05	<.05	.10	.26	<.05
				Minnesota—Continued				
43	.07	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.20	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.20	<.05	<.05	<.05	<.05	<.05	<.05	<.05
44	.55	<.05	<.05	<.05	.14	<.05	<.05	<.05
	<.05	<.05	.09	<.05	<.05	<.05	<.05	<.05
45	.36	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.41	<.05	<.05	<.05	<.05	<.05	<.05	<.05
46	.14	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.17	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.19	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
47	.07	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.13	<.05	<.05	<.05	<.05	<.05	<.05	<.05

Table 15. Concentrations of 13 herbicides in water samples from 71 midwestern streams and 5 midwestern reservoirs

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter				
					Aceto-chlor	Ala-chlor	Ame-tryn	Atra-zine	Cyana-zine
		Minnesota—Continued							
48	Rock River at Luverne, MN	06/24/98	S1	SU–130	<0.05	<0.05	<0.05	0.10	<0.05
		06/25/98	S2	SU–131	.05	<.05	<.05	.13	<.05
		06/25/98	LD	SU–131	.05	<.05	<.05	.14	<.05
		Kansas							
49	Black Vermillion River at Frankfort, KS	05/05/98	S1	SU–1	<.05	.05	<.05	.36	<.05
		06/09/98	S2	SU–107	<.05	1.09	<.05	9.59	<.05
50	Big Blue River below Tuttle Creek Lake Dam, KS	06/03/98	R1	SU–74	.16	.35	<.05	1.99	.10
		07/29/98	R2	SU–197	.27	.65	<.05	.93	<.05
		07/29/98	LD	SU–197	.30	.72	<.05	1.05	<.05
51	Delaware River near Muscotah, KS	05/05/98	S1	SU–2	<.05	<.05	<.05	.22	<.05
		06/10/98	S2	SU–105	.09	.41	<.05	3.94	<.05
		Kentucky							
52	Ohio River at Cannelton Dam, KY	06/04/98	S1	SU–75	.14	<.05	<.05	1.19	.16
		07/07/98	S2	SU–173	.06	<.05	<.05	.58	.09
		Missouri							
53	Nodaway River near Graham, MO	06/18/98	S1	SU–119	.12	<.05	<.05	3.35	.59
		08/19/98	S2	SU–209	<.05	<.05	<.05	.27	<.05
		Nebraska							
54	North Dry Creek near Kearney, NE	05/22/98	S1	SU–28	5.57	.14	<.05	15.80	.20
		05/22/98	LD	SU–28	5.44	.13	<.05	15.80	.20
		06/08/98	S2	SU–76	.18	.05	<.05	7.89	<.05
55	Maple Creek near Nickerson, NE	05/21/98	S1	SU–37	21.32	8.77	.06	27.09	6.66
		06/08/98	S2	SU–79	2.05	.05	<.05	9.30	4.00
56	Salt Creek at Roca, NE	05/15/98	S1	SU–6	.18	18.27	<.05	172.18	.14
		06/10/98	S2	SU–94	.81	1.61	<.05	34.79	2.48
57	Wahoo Creek at Ithaca, NE	05/15/98	S1	SU–5	1.83	4.94	<.05	34.06	5.00
		06/08/98	S2	SU–78	.33	.22	<.05	4.49	.91
58	Platte River at Louisville, NE	05/22/98	S1	SU–39	2.81	2.18	<.05	20.46	8.00
		06/09/98	S2	SU–77	.65	.74	<.05	6.22	1.31
59	Big Nemaha River at Falls City, NE	05/26/98	S1	SU–41	.36	.20	<.05	3.77	.44
		06/08/98	S2	SU–80	1.25	.85	<.05	22.33	9.66
60	W. Fork Big Blue River, Dorchester, NE	05/23/98	S1	SU–36	2.15	4.17	<.05	28.43	.55
		06/10/98	S2	SU–82	.83	.57	<.05	10.63	.08
		06/01/98	LD	SU–82	.85	.57	<.05	11.64	.09
61	Big Blue River at Barneston, NE	05/15/98	S1	SU–4	1.02	2.84	<.05	8.08	<.05
		06/09/98	S2	SU–104	.57	7.90	<.05	25.03	.33
62	Little Blue River near Fairbury, NE	05/12/98	S1	SU–3	.05	.13	<.05	.22	<.05
		06/08/98	S2	SU–81	<.05	<.05	<.05	.98	<.05

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter							
	Meto-lachlor	Metri-buzin	Prome-ton	Prome-tryn	Pro-pachlor	Pro-pazine	Sima-zine	Ter-butryn
				Minnesota—Continued				
48	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
	.24	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.25	<.05	<.05	<.05	<.05	<.05	<.05	<.05
				Kansas—Continued				
49	.11	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	8.80	.17	<.05	<.05	<.05	.10	<.05	<.05
50	.74	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	2.39	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	2.73	<.05	<.05	<.05	<.05	<.05	<.05	<.05
51	.09	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	1.48	<.05	<.05	<.05	<.05	<.05	<.05	<.05
				Kentucky—Continued				
52	.23	<.05	<.05	<.05	<.05	<.05	.11	<.05
	.30	<.05	<.05	<.05	<.05	<.05	.09	<.05
				Missouri—Continued				
53	.93	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
				Nebraska—Continued				
54	3.00	<.05	.14	<.05	.08	.15	.05	<.05
	2.75	<.05	.13	<.05	.07	.14	.05	<.05
	.82	<.05	.12	<.05	<.05	.09	<.05	<.05
55	15.26	.22	<.05	<.05	<.05	.16	.06	<.05
	4.60	.50	<.05	<.05	<.05	<.05	<.05	<.05
56	124.3	.19	<.05	<.05	.06	.60	<.05	<.05
	12.31	.84	<.05	<.05	<.05	.29	<.05	<.05
57	16.03	<.05	<.05	<.05	.31	.36	.08	<.05
	.80	<.05	<.05	<.05	<.05	.05	<.05	<.05
58	6.76	.37	<.05	<.05	<.05	.14	.17	<.05
	2.66	.14	.05	<.05	<.05	.07	<.05	<.05
59	1.49	<.05	.25	<.05	<.05	<.05	.06	<.05
	3.06	<.05	<.05	<.05	.41	<.05	.05	<.05
60	11.81	.31	<.05	<.05	.11	.19	.07	<.05
	3.89	.13	<.05	<.05	<.05	.11	<.05	<.05
	4.29	.15	<.05	<.05	<.05	.12	<.05	<.05
61	3.84	.37	<.05	<.05	<.05	.07	<.05	<.05
	9.51	.23	<.05	<.05	.42	.25	<.05	<.05
62	.13	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.14	<.05	<.05	<.05	<.05	<.05	<.05	<.05

Table 15. Concentrations of 13 herbicides in water samples from 71 midwestern streams and 5 midwestern reservoirs

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample;

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter				
					Aceto- chlor	Ala- chlor	Ame- tryn	Atra- zine	Cyana- zine
			Ohio						
63	Clear Creek near Rockbridge, OH	06/10/98	S1	SU–86	<0.05	<0.05	<0.05	0.21	<0.05
		06/30/98	S2	SU–145	.19	<.05	<.05	1.52	.14
64	Scioto River near Prospect, OH	06/02/98	S1	SU–63	.83	<.05	<.05	4.40	1.17
		06/29/98	S2	SU–141	.20	<.05	<.05	3.76	.43
		06/29/98	LD	SU–141	.19	–.05	–.05	3.82	.40
65	Olentangy River at Claridon, OH	06/09/98	S1	SU–85	<.05	<.05	<.05	.88	<.05
		06/29/98	S2	SU–157	.18	<.05	<.05	4.00	.16
		06/29/98	SB	SU–156	<.05	<.05	<.05	<.05	<.05
66	Olentangy River below Delaware, Lake Dam, OH	06/09/98	R1	SU–84	.20	<.05	<.05	2.30	.10
		06/29/98	R2	SU–153	.53	<.05	<.05	5.33	.60
		07/01/98	RD	SU–154	.41	<.05	<.05	4.20	.43
67	Big Darby Creek at Darbyville, OH	06/03/98	S1	SU–62	.66	.10	<.05	8.07	1.65
		06/03/98	LD	SU–62	.70	.11	<.05	8.53	1.64
		06/29/98	S2	SU–140	.14	<.05	<.05	2.37	.16
68	Scioto River at Higby, OH	06/04/98	S1	SU–73	.90	.05	<.05	5.98	1.58
		07/08/98	S2	SU–165	.22	<.05	<.05	3.30	.45
69	L. Miami River near Oldtown, OH	06/10/98	S1	SU–92	<.05	<.05	<.05	.24	<.05
		06/30/98	S2	SU–144	<.05	<.05	<.05	.43	.10
70	Mad River at Eagle City, OH	06/10/98	S1	SU–91	<.05	<.05	<.05	.06	<.05
		06/30/98	S2	SU–146	<.05	<.05	<.05	.45	<.05
71	Tiffin River at Stryker, OH	06/01/98	S1	SU–66	.24	.13	<.05	1.51	.31
		06/01/98	SD	SU–67	.24	.13	<.05	1.39	.31
		07/07/98	S2	SU–172	<.05	<.05	<.05	.61	.16
		07/07/98	LD	SU–172	<.05	<.05	<.05	.60	.16
72	Auglaize River at Fort Jennings, OH	06/17/98	S1	SU–117	1.28	.14	<.05	7.82	1.84
		07/08/98	S2	SU–171	.19	<.05	<.05	2.07	.38
			Wisconsin						
73	Root River at Racine, WI	06/01/98	S1	SU–61	.14	<.05	<.05	.24	.12
		08/03/98	S2	SU–204	<.05	<.05	<.05	.12	<.05
74	St. Croix River at St. Croix Falls, WI	06/03/98	S1	SU–68	<.05	<.05	<.05	.09	<.05
		08/05/98	S2	SU–205	<.05	<.05	<.05	<.05	<.05
		08/05/98	LD	SU–205	<.05	<.05	<.05	<.05	<.05
75	Wisconsin River at Muscoda, WI	06/16/98	S1	SU–133	.05	<.05	<.05	.28	.08
		08/07/98	S2	SU–202	<.05	<.05	<.05	.12	<.05
76	Rock River at Afton, WI	06/17/98	S1	SU–134	.11	<.05	<.05	.37	.14
		06/17/98	LD	SU–134	.12	<.05	<.05	.38	.15
		07/21/98	S2	SU–179	<.05	<.05	<.05	.47	.25
		07/21/98	LD	SU–179	<.05	<.05	<.05	.49	.21

SD, duplicate stream sample; RD, duplicate reservoir sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Concentration, in micrograms per liter							
	Meto-lachlor	Metri-buzin	Prome-ton	Prome-tryn	Pro-pachlor	Pro-pazine	Sima-zine	Ter-butryn
				Ohio—Continued				
63	0.16	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
	1.09	.12	<.05	<.05	<.05	<.05	.29	<.05
64	2.81	.24	<.05	<.05	<.05	<.05	1.17	<.05
	4.15	.13	<.05	<.05	<.05	.05	.57	<.05
	4.07	.13	<.05	<.05	<.05	.05	.58	<.05
65	.67	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	3.75	<.05	<.05	<.05	<.05	<.05	.17	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
66	1.52	.05	<.05	<.05	<.05	<.05	.24	<.05
	4.06	.10	<.05	<.05	<.05	.06	.67	<.05
	3.26	.08	<.05	<.05	<.05	.05	.53	<.05
67	2.24	.07	<.05	<.05	<.05	.07	.74	<.05
	2.24	.09	<.05	<.05	<.05	.08	.77	<.05
	2.32	<.05	<.05	<.05	<.05	<.05	.61	<.05
68	1.97	.09	<.05	<.05	<.05	.06	.30	<.05
	1.67	<.05	<.05	<.05	<.05	<.05	.21	<.05
69	.10	<.05	<.05	<.05	<.05	<.05	.20	<.05
	.23	<.05	<.05	<.05	<.05	<.05	.11	<.05
70	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.71	<.05	<.05	<.05	<.05	<.05	.05	<.05
71	.41	.09	<.05	<.05	<.05	<.05	.16	<.05
	.40	.08	<.05	<.05	<.05	<.05	.15	<.05
	.10	<.05	<.05	<.05	<.05	<.05	.06	<.05
	.10	<.05	<.05	<.05	<.05	<.05	.06	<.05
72	4.67	.49	<.05	<.05	<.05	.08	.54	<.05
	1.50	.08	<.05	<.05	<.05	<.05	.13	<.05
				Wisconsin—Continued				
73	.11	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
74	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
75	.15	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
76	.07	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	.07	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05

Table 16. Concentrations of 10 herbicide degradates in water samples from 71 midwestern streams and 5 midwestern reservoirs

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; LD, laboratory duplicate sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter									
					Aceto- chlor ESA	Aceto- chlor OA	Ala- chlor ESA	Ala- chlor OA	Cyan- azine- amide	De- ethyl- atrazine	Deiso- prop- ylatra- zine	Hy- droxy- atrazine	Meto- lachlor ESA	Met- ola- chlor OA
					Illinois									
1	Vermillion River below Lake Vermillion Dam, IL	06/10/98	R1	SU–98	1.29	0.62	0.59	<0.20	0.99	0.43	0.44	0.49	4.18	1.15
		06/10/98	LD	SU–98	1.23	.59	.57	<.20	1.06	.43	.42	.45	4.08	1.09
		07/16/98	R2	SU–177	.45	<.20	.66	<.20	.59	.50	.55	.60	3.30	1.31
		07/16/98	LD	SU–177	.60	<.20	<.20	.69	<.20	.47	.51	.74	3.50	1.39
2	Bonpas Creek at Browns, IL	05/23/98	S1	SU–43	1.53	2.25	.50	<.20	<.05	2.67	2.34	.58	1.17	1.12
		07/07/98	S2	SU–166	1.16	.92	.91	<.20	<.05	.77	.42	<.20	2.63	1.86
3	Little Wabash River at Carmi, IL	05/23/98	S1	SU–33	.78	.65	.61	.51	.32	1.36	1.10	.88	.94	.86
		07/09/98	S2	SU–175	.88	.86	1.38	<.20	.48	1.17	.79	1.30	2.84	2.81
4	S. Branch Kishwaukee Rivernear Fairdale, IL	05/20/98	S1	SU–29	2.76	1.10	1.18	<.20	.19	.64	.39	1.26	4.97	2.12
		07/29/98	S2	SU–195	1.45	.39	2.97	<.20	.05	.17	.09	<.20	5.63	.81
5	Iroquois River near Chebanse, IL	06/10/98	S1	SU–99	.90	.55	1.60	<.20	.76	.24	.30	.30	4.56	1.38
		07/08/98	S2	SU–168	1.17	.89	1.02	<.20	1.02	.62	.57	.45	2.86	1.48
6	Dupage River near Shorewood, IL	06/09/98	S1	SU–100	<.20	<.20	<.20	<.20	.05	.10	.09	<.20	<.20	<.20
		07/29/98	S2	SU–194	1.36	<.20	1.17	<.20	<.05	.06	<.05	<.20	.44	.36
7	Illinois River at Marseilles, IL	06/12/98	S1	SU–113	1.70	1.61	1.03	.61	1.05	.51	.37	.74	1.84	1.47
		07/09/98	S2	SU–176	1.60	1.52	1.01	<.20	.72	.37	.35	<.20	2.08	1.08
8	Spoon River at London Mills, IL	05/20/98	S1	SU–25	1.52	1.36	.32	.27	3.98	1.18	1.07	1.72	1.93	.58
		07/01/98	S2	SU–160	.86	.51	.35	<.20	.47	.44	1.07	1.72	1.93	.58
9	Sangamon River near Monticello, IL	05/23/98	S1	SU–35	1.63	.91	.72	<.20	.55	.41	.31	<.20	4.00	1.83
		05/23/98	LD	SU–35	1.63	.98	.71	<.20	.51	.39	.29	<.20	4.06	1.81
		08/05/98	S2	SU–201	1.56	<.20	.58	<.20	.15	.16	.13	.67	3.88	.71
10	Sangamon River at Riverton, IL	05/26/98	S1	SU–44	1.20	.95	.46	<.20	.66	.83	.51	<.20	1.60	1.01
		07/09/98	S2	SU–174	<.20	<.20	<.20	<.20	.22	.46	.29	<.20	<.20	<.20
		07/09/98	LD	SU–174	<.20	<.20	<.20	<.20	.18	.51	.33	<.20	<.20	<.20
		07/09/98	LD	SU–174	<.20	<.20	<.20	<.20	.20	.46	.29	<.20	<.20	<.20
11	LaMoine River at Colmar, IL	05/21/98	S1	SU–27	.75	.55	.20	<.20	1.08	1.02	.67	.57	.75	.29
		06/29/98	S2	SU–142	1.60	1.48	.61	<.20	2.40	1.34	1.38	.67	1.21	.95
		06/29/98	LD	SU–142	1.98	1.85	.56	<.20	2.38	1.26	1.36	.46	1.41	.98
12	Illinois River at Valley City, IL	06/18/98	S1	SU–120	2.25	2.16	.74	<.20	1.74	.98	.63	.66	1.91	1.38
		08/12/98	S2	SU–207	.47	.30	.96	<.20	.12	.14	.10	<.20	1.46	.57

Table 16. Concentrations of 10 herbicide degradates in water samples from 71 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; LD, laboratory duplicate sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter: Acetochlor ESA	Acetochlor OA	Alachlor ESA	Alachlor OA	Cyanazine-amide	Deethylatrazine	Deisopropylatrazine	Hydroxyatrazine	Metolachlor ESA	Metolachlor OA
					Illinois—Continued									
13	Mississippi River below Grafton, IL	06/02/98	S1	SU–60	0.82	0.71	0.64	<0.20	0.69	0.32	0.19	<0.20	2.02	0.73
		06/15/98	S2	SU–116	1.85	1.26	1.02	<.20	.95	.64	.39	<.20	2.58	1.03
14	Kaskaskia River near Cowden, IL	05/20/98	S1	SU–30	1.05	.34	.36	<.20	<.05	.14	.09	.45	2.45	.79
		05/20/98	LD	SU–30	1.01	.34	.35	<.20	<.05	.15	.09	.39	2.39	.84
		07/08/98	S2	SU–169	1.67	1.52	.63	<.20	.21	.66	.35	.52	2.45	1.15
15	Shoal Creek near Breese, IL	05/22/98	S1	SU–32	.77	.75	.41	.33	.46	1.08	.81	1.44	.87	.66
		07/08/98	S2	SU–167	1.48	.80	.83	<.20	.44	1.41	.93	.58	2.59	.95
					Iowa									
16	Turkey River at Spillville, IA	06/02/98	S1	SU–64	1.17	.40	2.14	<.20	.50	.49	.32	<.20	2.06	1.08
		06/12/98	S2	SU–109	5.01	4.27	3.02	.96	1.84	.95	.52	.43	1.64	<.20
17	Mississippi River at Clinton, IA	05/27/98	S1	SU–55	.31	<.20	.42	<.20	<.05	.08	.05	<.20	.73	.29
		07/01/98	S2	SU–155	.65	.43	.66	<.20	.11	.17	.10	.25	.86	.31
18	Wapsipinicon River near Tripoli, IA	05/27/98	S1	SU–54	2.77	1.07	3.15	<.20	.11	.31	.12	<.20	12.44	2.52
		06/20/98	S2	SU–126	2.22	1.27	1.91	.39	.73	.93	.50	<.20	4.22	2.04
19	Wapsipinicon River at Independence, IA	05/29/98	S1	SU–56	1.72	.85	1.41	<.20	.16	.77	.44	<.20	4.43	1.03
		06/12/98	S2	SU–110	3.02	2.39	1.33	<.20	.59	1.20	.56	1.26	3.71	1.49
20	Iowa River near Rowan, IA	06/02/98	S1	SU–65	.76	<.20	1.58	<.20	<.05	.08	.05	<.20	7.04	1.10
		06/23/98	S2	SU–129	1.49	1.34	.88	<.20	.08	.52	.23	<.20	3.19	1.39
21	Old Mans Creek near Iowa City, IA	06/10/98	S1	SU–93	<.20	<.20	<.20	<.20	1.12	.53	.38	<.20	<.20	<.20
		06/30/98	S2	SU–147	2.54	1.76	1.02	<.20	.17	.68	.47	1.16	3.51	1.83
22	Wolf Creek near Dysart, IA	06/10/98	S1	SU–87	1.89	1.58	1.21	<.20	.60	.62	.40	.64	6.29	1.91
		06/22/98	S2	SU–128	1.34	1.05	.63	<.20	.71	.76	.52	<.20	2.42	1.06
23	Iowa River at Wapello, IA	05/27/98	S1	SU–53	.88	.43	1.05	<.20	.29	.23	.14	<.20	3.95	.85
		06/19/98	S2	SU–127	1.67	1.33	.98	<.20	1.05	.80	.46	<.20	2.72	1.16
24	N. Skunk River near Sigourney, IA	05/21/98	S1	SU–21	1.49	.95	.52	<.20	.44	.77	.49	.72	2.94	1.03
		06/10/98	S2	SU–95	1.41	1.25	.91	<.20	2.31	.85	.53	<.20	3.94	1.64
25	Skunk River at Augusta, IA	05/26/98	S1	SU–45	2.69	3.99	.87	<.20	4.51	1.39	.70	.96	2.88	1.61
		06/18/98	S2	SU–122	2.92	2.35	1.00	<.20	2.11	1.18	.64	.88	4.58	2.07
26	Des Moines River at Fort Dodge, IA	05/16/98	S1	SU–8	1.77	<.20	.52	<.20	<.05	.09	.08	<.20	2.08	1.32
		06/12/98	S2	SU–108	1.46	.65	.58	<.20	.06	.09	.09	<.20	4.41	.86

Table 16. Concentrations of 10 herbicide degradates in water samples from 71 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; LD, laboratory duplicate sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter									
					Aceto-chlor ESA	Aceto-chlor OA	Ala-chlor ESA	Ala-chlor OA	Cyan-azine-amide	De-ethyl-atrazine	Deiso-prop-ylatra-zine	Hy-droxy-atrazine	Meto-lachlor ESA	Met-ola-chlor OA
					Iowa—Continued									
27	Raccoon River at Van Meter, IA	05/17/98	S1	SU–9	<0.20	<0.20	0.49	<0.20	0.16	0.13	0.10	<0.20	2.30	1.18
		06/10/98	S2	SU–89	1.50	1.21	.60	<.20	<.05	<.05	<.05	.84	3.44	1.31
28	Little Sioux River at Correctionville, IA	05/27/98	S1	SU–42	.68	.53	.32	<.20	<.05	.10	.08	<.20	1.67	.53
		06/18/98	S2	SU–123	1.19	1.18	.33	<.20	.06	.20	.11	<.20	1.47	.51
29	Maple River at Mapleton, IA	05/29/98	S1	SU–59	.45	.51	.24	<.20	.74	.41	.34	1.48	.85	.67
		06/09/98	S2	SU–90	.34	<.20	.30	<.20	.37	.24	.19	.74	1.43	.39
30	Boyer River at Logan, IA	05/22/98	S1	SU–31	2.13	2.58	.70	<.20	4.97	1.03	.76	2.68	1.67	1.86
		06/09/98	S2	SU–96	.68	.82	.20	<.20	.79	.41	.37	<.20	.76	.53
31	Chariton River below Rathbun Lake Dam, IA	06/04/98	R1	SU–69	<.20	<.20	.26	<.20	.35	.21	.13	.78	.81	.38
		06/29/98	R2	SU–148	.33	.25	.22	<.20	.50	.23	.13	.56	.76	.51
32	Nishnabotna River at Hamburg, IA	06/17/98	S2	SU–124	.95	.99	.26	<.20	.73	.73	.45	.93	1.04	.74
					Indiana									
33	Whitewater River near Alpine, IN	05/26/98	S1	SU–47	1.15	.76	.50	.55	.99	.76	.48	.57	.69	.47
		07/08/98	S2	SU–162	.48	.35	.58	.40	.43	.47	.39	.21	.99	.50
34	Blue River at Fredericksburg, IN	05/27/98	S1	SU–50	.49	.28	.24	<.20	.36	.51	.32	<.20	1.01	.26
		07/08/98	S2	SU–163	<.20	<.20	<.20	<.20	.13	.35	.27	<.20	.59	<.20
35	Mississinewa River below Mississinewa Lake Dam, IN	06/09/98	R1	SU–83	.61	.50	.51	<.20	.88	.81	.33	.67	2.05	.82
		07/09/98	R2	SU–164	1.60	1.58	.70	<.20	2.09	1.39	1.00	.50	2.16	1.50
36	Eel River near Logansport, IN	05/21/98	S1	SU–18	<.20	<.20	.53	<.20	.11	.52	.42	1.21	1.26	1.27
		06/30/98	S2	SU–152	2.21	2.06	1.23	.61	.56	.62	.38	.74	1.36	.96
37	Wildcat Creek near Jerome, IN	05/21/98	S1	SU–19	.99	.65	.53	<.20	1.45	.71	.59	.98	4.80	1.04
		06/30/98	S2	SU–151	1.94	1.14	1.16	.44	1.42	.85	.65	1.01	6.36	2.40
38	Wildcat Creek near Lafayette, IN	05/20/98	S1	SU–22	.85	.46	.44	<.20	.15	.34	.21	.55	3.10	.91
		07/01/98	S2	SU–150	1.64	1.04	.72	<.20	.41	.57	.38	.82	3.67	1.75
39	White River near Nora, IN	05/28/98	S1	SU–51	.97	.80	.62	.22	.43	.53	.38	<.20	3.11	1.26
		07/01/98	S2	SU–149	1.47	1.16	.76	.20	.78	.94	.64	.67	3.45	2.01
		07/01/98	LD	SU–149	1.51	1.23	.76	.22	.96	.93	.64	.55	3.67	2.05
40	Sugar Creek near Edinburgh, IN	05/26/98	S1	SU–46	1.65	1.63	.63	<.20	.88	1.05	.52	<.20	2.57	1.28
		07/20/98	S2	SU–178	.64	.43	.39	<.20	<.05	.30	.14	<.20	1.46	1.03

Table 16. Concentrations of 10 herbicide degradates in water samples from 71 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; LD, laboratory duplicate sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter									
					Aceto-chlor ESA	Aceto-chlor OA	Ala-chlor ESA	Ala-chlor OA	Cyan-azine-amide	De-ethyl-atrazine	Deiso-prop-ylatra-zine	Hy-droxy-atrazine	Meto-lachlor ESA	Met-ola-chlor OA
					Indiana—Continued									
41	E. Fork White River near Bedford, IN	05/28/98	S1	SU–52	1.68	1.89	0.67	0.40	0.90	1.42	.76	1.23	1.50	1.00
		07/06/98	S2	SU–161	.88	.60	.51	<.20	.22	.58	.33	.27	1.17	.82
42	Wabash River at New Harmony, IN	05/27/98	S1	SU–57	.78	.80	.35	<.20	.75	.62	.42	<.20	.86	.65
		05/27/98	SD	SU–58	.60	.70	.29	<.20	.56	.54	.38	<.20	.80	.52
		06/23/98	S2	SU–136	2.31	1.97	1.38	.26	2.22	1.51	.95	<.20	3.25	2.04
					Minnesota									
43	Cottonwood River near New Ulm, MN	05/26/98	S1	SU–49	.40	<.20	.48	<.20	.20	.05	.20	<.20	1.30	.36
		07/21/98	S2	SU–180	.65	.28	.79	<.20	<.05	<.05	.05	<.20	1.58	.46
		07/21/98	SD	SU–181	.63	<.20	.78	<.20	<.05	<.05	<.05	<.20	1.43	.43
44	Little Cobb River near Beauford, MN	05/18/98	S1	SU–12	1.94	<.20	.99	<.20	<.05	.07	<.05	<.20	3.54	.99
		08/17/98	S2	SU–208	1.96	.59	1.99	.24	<.05	<.05	<.05	<.20	4.69	.76
45	Minnesota River near Jordan, MN	05/19/98	S1	SU–13	.95	.65	.70	<.20	<.05	<.05	<.05	<.20	1.78	.62
		06/26/98	S2	SU–135	1.76	1.29	1.45	.43	.17	.19	.96	<.20	2.65	.83
46	Mississippi River at Hastings, MN	05/20/98	S1	SU–14	<.20	<.20	.45	<.20	<.05	<.05	<.05	<.20	.99	.34
		05/20/98	SD	SU–15	<.20	<.20	.46	<.20	<.05	<.05	<.05	<.20	1.02	.32
		05/20/98	LD	SU–15	<.20	<.20	.48	<.20	<.05	<.05	<.05	<.20	1.04	.35
		05/20/98	S2	SU–206	<.20	<.20	.62	<.20	<.05	<.05	<.05	<.20	.53	<.20
47	Des Moines River at Jackson, MN	05/26/98	S1	SU–48	.71	.66	.37	<.20	<.05	.06	.05	<.20	2.00	.49
		08/24/98	S2	SU–210	1.54	1.22	.93	<.20	<.05	.12	.07	<.20	4.97	1.24
48	Rock River at Luverne, MN	06/24/98	S1	SU–130	<.20	<.20	<.20	<.20	<.05	.06	.05	<.20	1.67	<.20
		06/25/98	S2	SU–131	<.20	.50	<.20	<.20	<.05	.08	.05	<.20	1.29	<.20
		06/25/98	LD	SU–131	<.20	.44	<.20	<.20	<.05	.09	.05	<.20	1.29	<.20
					Kansas									
49	Black Vermillion River at Frankfort, KS	05/05/98	S1	SU–1	<.20	<.20	.22	<.20	<.05	.05	<.05	<.20	.35	.21
		06/09/98	S2	SU–107	<.20	<.20	1.17	1.40	<.05	1.56	.42	1.58	1.22	1.34
50	Big Blue River below Tuttle Creek Lake Dam, KS	06/03/98	R1	SU–74	<.20	<.20	.36	<.20	<.05	.15	.08	1.07	.52	.33
		07/29/98	R2	SU–197	.56	.79	1.34	1.95	.06	.73	.43	2.73	.96	1.35
		07/29/98	LD	SU–197	.56	.81	1.42	2.11	.07	.78	.46	3.16	1.03	1.39
51	Delaware River near Muscotah, KS	05/05/98	S1	SU–2	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	.38	<.20
		06/10/98	S2	SU–105	.36	<.20	.37	<.20	<.05	.32	.15	.48	.83	.61
					Kentucky									
52	Ohio River at Cannelton Dam, KY	06/04/98	S1	SU–75	<.20	<.20	<.20	<.20	.08	.10	.06	<.20	<.20	<.20
		07/07/98	S2	SU–173	<.20	<.20	.25	<.20	.10	.14	.11	<.20	<.20	.38

Table 16. Concentrations of 10 herbicide degradates in water samples from 71 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; LD, laboratory duplicate sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter									
					Aceto-chlor ESA	Aceto-chlor OA	Ala-chlor ESA	Ala-chlor OA	Cyan-azine-amide	De-ethyl-atrazine	Deiso-prop-ylatra-zine	Hy-droxy-atrazine	Meto-lachlor ESA	Met-ola-chlor OA
					Missouri									
53	Nodaway River near Graham, MO	06/18/98	S1	SU–119	0.95	0.63	0.38	<0.20	0.93	0.79	0.46	0.88	1.55	0.75
		08/19/98	S2	SU–209	<.20	<.20	.26	<.20	<.05	.12	.09	<.20	.91	<.20
					Nebraska									
54	North Dry Creek near Kearney, NE	05/22/98	S1	SU–28	.65	.59	.28	<.20	<.05	1.62	.77	1.12	.51	.34
		05/22/98	LD	SU–28	.64	.58	.26	<.20	<.05	1.46	.68	1.17	.52	.30
		06/08/98	S2	SU–76	1.28	1.51	.53	<.20	<.05	1.67	.73	.79	.56	.56
55	Maple Creek near Nickerson, NE	05/21/98	S1	SU–37	1.16	1.66	.38	.50	.93	1.29	.70	2.02	.50	.40
		06/08/98	S2	SU–79	1.69	2.62	.47	<.20	<.05	1.10	.80	1.73	.59	.67
56	Salt Creek at Roca, NE	05/15/98	S1	SU–6	<.20	<.20	.59	<.20	<.05	1.74	.97	3.13	1.51	1.01
		06/10/98	S2	SU–94	1.29	2.21	2.81	1.03	1.37	3.66	2.17	4.31	5.17	6.37
57	Wahoo Creek at Ithaca, NE	05/15/98	S1	SU–5	<.20	<.20	.55	.66	.77	.98	.58	4.47	.55	.76
		06/08/98	S2	SU–78	.36	.47	.41	.41	.48	.55	.39	<.20	.34	.41
58	Platte River at Louisville, NE	05/22/98	S1	SU–39	1.19	1.64	.83	1.06	3.03	1.68	1.04	2.75	.92	1.13
		06/09/98	S2	SU–77	1.05	1.48	.72	.61	.78	1.51	.57	2.40	.92	1.10
59	Big Nemaha River at Falls City, NE	05/26/98	S1	SU–41	<.20	<.20	.30	<.20	.18	.24	.14	<.20	.52	.42
		06/08/98	S2	SU–80	.46	.69	.42	.42	<.05	<.05	<.05	1.59	.58	.43
60	W. Fork Big Blue River, Dorchester, NE	05/23/98	S1	SU–36	<.20	<.20	.58	<.20	.17	1.45	.86	2.59	.59	.42
		06/10/98	S2	SU–82	.69	1.06	.69	.67	<.05	2.16	.64	4.43	.58	.72
		06/01/98	LD	SU–82	.70	1.06	.67	.66	<.05	2.28	.65	4.20	.55	.77
61	Big Blue River at Barneston, NE	05/15/98	S1	SU–4	<.20	<.20	.26	<.20	<.05	.31	.15	1.13	.38	.21
		06/09/98	S2	SU–104	.61	1.23	2.74	4.30	<.05	<.05	<.05	2.23	1.58	1.82
62	Little Blue River near Fairbury, NE	05/12/98	S1	SU–3	<.20	<.20	<.20	<.20	<.05	.07	<.05	<.20	<.20	<.20
		06/08/98	S2	SU–81	<.20	<.20	.52	.69	<.05	.19	.10	<.20	.40	.34
					Ohio									
63	Clear Creek near Rockbridge, OH	06/10/98	S1	SU–86	.50	<.20	<.20	<.20	<.05	.05	<.05	<.20	.91	.28
		06/30/98	S2	SU–145	4.17	3.87	.81	<.20	.47	.51	.36	.52	3.66	2.28
64	Scioto River near Prospect, OH	06/02/98	S1	SU–63	2.35	.49	4.52	<.20	.66	.53	.45	<.20	2.44	3.18
		06/29/98	S2	SU–141	1.54	1.08	2.13	.21	.76	1.08	.88	.84	5.08	3.30
		06/29/98	LD	SU–141	1.50	1.02	2.06	.33	.67	1.09	.88	.72	4.94	3.19
65	Olentangy River at Claridon, OH	06/09/98	S1	SU–85	<.20	<.20	.60	<.20	<.05	.14	.09	.31	1.92	.58
		06/29/98	S2	SU–157	1.92	2.00	1.22	<.20	.22	.71	.54	.78	2.87	2.12
		06/29/98	SB	SU–156	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20

Table 16. Concentrations of 10 herbicide degradates in water samples from 71 midwestern streams and 5 midwestern reservoirs—Continued

[S1, pre-emergence stream sample; S2, post-emergence stream sample; R1, first reservoir outflow sample; R2, second reservoir outflow sample; SD, duplicate stream sample; RD, duplicate reservoir sample; LD, laboratory duplicate sample; SB, blank stream sample; SS, spiked stream sample; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter									
					Aceto-chlor ESA	Aceto-chlor OA	Ala-chlor ESA	Ala-chlor OA	Cyan-azine-amide	De-ethyl-atrazine	Deiso-prop-ylatra-zine	Hy-droxy-atrazine	Meto-lachlor ESA	Met-ola-chlor OA
					Ohio—Continued									
66	Olentangy River below Delaware Lake Dam, OH	06/09/98	R1	SU–84	0.58	<0.20	0.75	<0.20	0.05	0.55	0.19	0.68	3.20	1.19
		06/29/98	R2	SU–153	2.91	3.22	1.28	<.20	.80	1.29	.98	1.32	5.31	4.83
		07/01/98	RD	SU–154	2.44	2.87	1.11	.25	.65	1.01	.76	1.14	4.71	4.25
67	Big Darby Creek at Darbyville, OH	06/03/98	S1	SU–62	1.78	1.01	.64	<.20	.81	.79	.52	<.20	3.04	1.37
		06/03/98	LD	SU–62	1.66	1.07	.66	<.20	.67	.83	.58	<.20	2.99	1.23
		06/29/98	S2	SU–140	.36	.45	.34	<.20	.13	.46	.41	.49	.75	.68
68	Scioto River at Higby, OH	06/04/98	S1	SU–73	.57	.49	.41	<.20	.67	.41	.33	.45	1.55	.59
		07/08/98	S2	SU–165	1.09	1.05	.99	<.20	.49	.64	.48	.51	2.52	1.61
69	L. Miami River near Oldtown, OH	06/10/98	S1	SU–92	.24	<.20	.31	<.20	<.05	.07	.08	<.20	1.13	.28
		06/30/98	S2	SU–144	.78	.33	.51	<.20	.21	.16	.14	<.20	1.73	.58
70	Mad River at Eagle City, OH	06/10/98	S1	SU–91	<.20	<.20	.31	<.20	<.05	<.05	<.05	<.20	.63	<.20
		06/30/98	S2	SU–146	.44	.22	.44	<.20	<.05	.16	.09	<.20	1.25	.50
71	Tiffin River at Stryker, OH	06/01/98	S1	SU–66	<.20	<.20	.62	<.20	.08	.20	.17	<.20	1.07	.47
		06/01/98	SD	SU–67	<.20	<.20	.60	<.20	.08	.17	.15	<.20	1.21	.53
		07/07/98	S2	SU–172	.32	<.20	.54	<.20	.16	.15	.12	<.20	.66	.33
		07/07/98	LD	SU–172	.30	<.20	.62	<.20	.17	.15	.11	<.20	.66	.24
72	Auglaize River at Fort Jennings, OH	06/17/98	S1	SU–117	4.03	4.17	2.15	<.20	1.53	1.68	1.05	.89	6.23	3.83
		07/08/98	S2	SU–171	1.91	1.86	2.01	<.20	.57	.65	.51	.68	5.03	3.45
					Wisconsin									
73	Root River at Racine, WI	06/01/98	S1	SU–61	<.20	<.20	<.20	.38	.22	.18	.16	<.20	.69	.30
		08/03/98	S2	SU–204	<.20	<.20	.37	<.20	<.05	.05	<.05	<.20	1.35	<.20
74	St. Croix River at St. Croix Falls, WI	06/03/98	S1	SU–68	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
		08/05/98	S2	SU–205	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
		08/05/98	LD	SU–205	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
75	Wisconsin River at Muscoda, WI	06/16/98	S1	SU–133	<.20	<.20	.29	<.20	<.05	.07	<.05	<.20	<.20	<.20
		08/07/98	S2	SU–202	.26	<.20	.56	<.20	<.05	.07	<.05	<.20	.56	.21
76	Rock River at Afton, WI	06/17/98	S1	SU–134	.60	<.20	.85	<.20	.09	.13	.09	<.20	.93	.41
		06/17/98	LD	SU–134	.58	<.20	.82	<.20	.10	.14	.09	<.20	.86	.38
		07/21/98	S2	SU–179	.84	.71	1.23	.22	.12	.18	.07	<.20	.78	.44
		07/21/98	LD	SU–179	.76	.74	1.20	.25	.12	.19	.10	<.20	.76	.42

Table 17. Statistical summary of 23 herbicide and herbicide degradate concentrations in 141 water samples from 71 midwestern streams (concentrations in micrograms per liter)

[<, less than]

Herbicide	Method reporting limit (MRL)	Number at or above MRL	25th percentile	Median	75th percentile	95th percentile	Maximum
acetochlor	0.05	115	0.08	0.32	0.98	7.58	21.3
acetochlor ESA	.20	109	.32	.88	1.60	2.69	5.01
acetochlor OA	.20	96	<.20	.60	1.21	2.35	4.27
alachlor	.05	62	<.05	<.05	.13	2.18	18.3
alachlor ESA	.20	127	.36	.58	.99	2.14	4.52
alachlor OA	.20	30	<.20	<.20	<.20	.66	4.30
ametryn	.05	1	<.05	<.05	<.05	<.05	.06
atrazine	.05	140	.47	3.27	7.91	27.1	172
deethylatrazine	.05	131	.14	.49	.85	1.68	3.66
deisopropylatrazine	.05	125	.09	.36	.54	.97	2.34
hydroxy-atrazine	.20	67	<.20	<.20	.79	2.40	4.47
cyanazine	.05	104	<.05	.25	.88	6.66	67.2
cyanazine-amide	.05	99	<.05	.21	.73	2.22	4.99
metolachlor	.05	132	.20	1.15	2.48	10.5	124
metolachlor ESA	.20	131	.76	1.55	2.87	5.08	12.4
metolachlor OA	.20	123	.39	.76	1.28	2.40	6.37
metribuzin	.05	56	<.05	<.05	.10	.35	1.34
prometon	.05	11	<.05	<.05	<.05	.06	.35
prometryn	.05	0	<.05	<.05	<.05	<.05	<.05
propachlor	.05	11	<.05	<.05	<.05	.09	.42
propazine	.05	61	<.05	<.05	.07	.25	.68
simazine	.05	58	<.05	<.05	.08	.57	14.2
terbutryn	.05	0	<.05	<.05	<.05	<.05	<.05
Sum of 13 herbicides	.05	140	1.12	5.96	13.4	47.8	316
Sum of 10 degradates	.05	139	3.47	7.53	10.93	17.7	30.4

Reservoir Outflows

The results of analyses of 7 nutrients and measurements of 3 physical properties for 10 reservoir outflow samples are given in table 27. The discharges on the day of sample collection are given in table 4. A statistical summary of these results is given in table 29. Nitrate was detected at or above the MRL in all 10 samples. Nitrate concentrations were the highest of the nutrients with a median concentration of 1.83 mg/L, and one sample exceeded the EPA MCL of 10 mg/L. Nitrite was detected at or above the MRL in 9 of 10 samples. Nitrite concentrations were very low, with a median concentration of only 0.040 mg/L. Ammonia was detected in 7 of 10 samples, and ammonia plus organic N was detected in 9 of 10 samples. Organic N concentrations were generally higher, with a median concentrations of 0.389 mg/L compared to 0.061 mg/L for ammonia. Dissolved phosphorus and orthophosphate were each detected at or above the MRL in 8 of 10 samples. They occurred at similar concentrations; the median dissolved phosphorus concentration was 0.063 mg/L, and the median orthophosphate concentration was 0.059 mg/L. Reservoir outflow samples tended to be slightly basic, although less so than the stream samples. The median pH of the reservoir outflow samples was 7.4. Specific conductances (median value of 409 µS/cm) were lower in reservoir outflows than in streams. Daily mean discharge on the date of sample collection ranged from 34 to 3,610 ft^3/s; the median discharge was 653 ft^3/s.

Ground Water

The results of analyses of 7 nutrients and measurements of 3 physical properties for 25 ground-water samples are given in table 30. A statistical summary of these results is given in table 31. Nitrate plus nitrite was detected at or above the MRL in 18 (72 percent) of 25 samples. Nitrate concentrations were the highest of the nutrients with a median concentration of 1.33 mg/L and three samples exceeded the EPA MCL of 10 mg/L. Nitrite was detected at or above the MRL in only 7 (33 percent) of 21 samples, and concentrations were very low. Ammonia was detected at or above the MRL in 18 (72 percent) of 25 samples, and ammonia plus organic N was detected in 13 (52 percent) of 25 samples. Unlike in streams and reservoir outflow, ammonia concentrations were generally higher than organic N concentrations in ground-water samples (table 31). Dissolved phosphorus was detected at or above the MRL in 14 (67 percent) of 21 samples and orthophosphate was detected in 22 (88 percent) of 25 samples. Orthophosphate tended to occur at a higher concentrations with the median value of 0.077 mg/L for orthophosphate compared to 0.036 mg/L for dissolved phosphorus. Ground-water samples tended to be slightly basic; the median pH of the samples was 7.19. Specific conductances were higher than for streams or reservoir outflows, with a median value of 675 µS/cm.

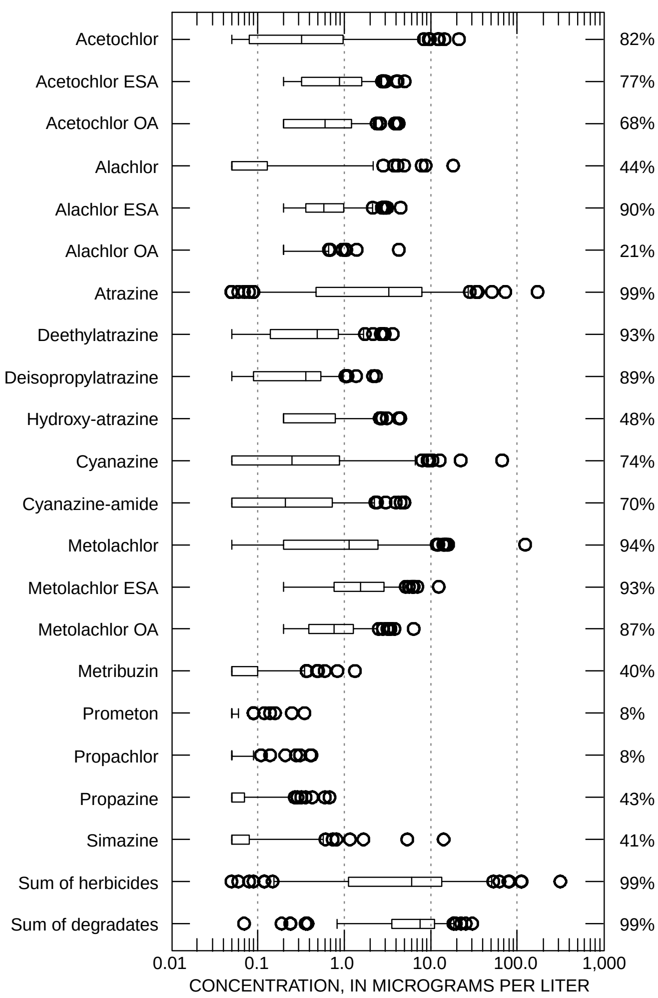


Figure 21. Herbicide and herbicide degradate concentrations and percent detections at or above the method reporting limit in 141 midwestern stream samples.

HERBICIDES IN PRE-EMERGENCE AND POST-EMERGENCE STREAM AND RESERVOIR OUTFLOW SAMPLES

Because they are more frequently applied after crops have emerged, the frequency of detections and concentrations of SU, SA, and IMI herbicides was expected to be greater in post-emergence stream runoff and reservoir outflow samples than in pre-emergence samples. The opposite was expected for herbicides such as acetochlor, atrazine, and metolachlor that are more often applied prior to crop emergence, and would be expected to occur at higher concentrations in the pre-emergence sample. A summary of discharge and herbicide concentration in pre- and post-emergence stream runoff and reservoir outflow samples is given for flumetsulam, imazethapyr, nicosulfuron, acetochlor, atrazine, and metolachlor in table 32. Flumetsulam, imazethapyr, and nicosulfuron were all more frequently detected in post-emergence samples than in pre-emergence samples. There is little difference in detection frequencies for acetochlor, atrazine, and metolachlor between pre- and post-emergence samples (table 32).

Paired difference tests were used to determine if the observed differences between pre- and post-emergence herbicide concentrations are statistically significant. Because the distributions of herbicide concentrations are positively skewed, the nonparametric Wilcoxon signed-rank test was used (Helsel and Hirsch, 1992). The following hypothesis was tested.

Table 18. Statistical summary of 46 pesticide and pesticide degradate concentrations in 10 water samples from five Midwestern reservoir outflows (concentrations in micrograms per liter, the 95th percentile is not given as it is the same as the maximum)

[<, less than; E, estimated]

Herbicide	Method reporting limit (MRL)	Number at or above MRL	25th percentile	Median	75th percentile	Maximum
2,6-diethylaniline	0.003	0	<0.003	<0.003	<0.003	<0.003
acetochlor	.002	10	.194	.294	.478	.821
alachlor	.002	9	.006	.014	.099	.815
atrazine	.001	10	1.52	2.01	5.70	6.90
azinphos-methyl	.001	0	<.001	<.001	<.001	<.001
benfluralin	.002	0	<.002	<.002	<.002	<.002
butylate	.002	0	<.002	<.002	<.002	<.002
carbaryl	.003	2	<.003	<.003	<.003	.028
carbofuran	.003	2	<.003	<.003	<.003	.232
chlorpyrifos	.004	1	<.004	<.004	<.004	.031
cyanazine	.004	10	.150	.325	.624	2.90
dacthal	.002	0	<.002	<.002	<.002	<.002
deethylatrazine	.002	10	.133	.219	.349	.729
diazinon	.002	2	<.002	<.002	<.002	.012
dieldrin	.001	1	<.001	<.001	<.001	.003
disulfoton	.017	0	<.017	<.017	<.017	<.017
EPTC	.002	1	<.002	<.002	<.002	.0027
ethalfluralin	.004	0	<.004	<.004	<.004	<.004
ethoprophos	.003	0	<.003	<.003	<.003	<.003
fonofos	.003	0	<.003	<.003	<.003	<.003
lindane	.004	0	<.004	<.004	<.004	<.004
linuron	.002	0	<.002	<.002	<.002	<.002
malathion	.005	0	<.005	<.005	<.005	<.005
metolachlor	.002	10	.619	1.36	3.08	4.36
metribuzin	.004	9	.009	.026	.087	.225
molinate	.004	0	<.004	<.004	<.004	<.004
napropamide	.003	0	<.003	<.003	<.003	<.003
parathion	.004	0	<.004	<.004	<.004	<.004
parathion methyl	.006	0	<.006	<.006	<.006	<.006
pebulate	.004	0	<.004	<.004	<.004	<.004
pendimethalin	.004	4	<.004	<.004	.014	.023
phorate	.002	0	<.002	<.002	<.002	<.002
prometon	.018	6	E.0094	.024	.029	.039
propachlor	.007	2	<.007	<.007	<.007	.017
propanil	.004	0	<.004	<.004	<.004	<.004
propargite	.013	0	<.013	<.013	<.013	<.013
propyzamide	.003	0	<.003	<.003	<.003	<.003
simazine	.005	9	.016	.051	.358	1.03
tebuthiuron	.010	1	<.005	E.0031	.008	.015
terbacil	.007	0	<.007	<.007	<.007	<.007
terbufos	.013	0	<.013	<.013	<.013	<.013
thiobencarb	.002	0	<.002	<.002	<.002	<.002
tri-allate	.001	0	<.001	<.001	<.001	<.001
trifluralin	.002	1	<.002	<.002	<.002	.0062
alpha-HCH	.002	0	<.002	<.002	<.002	<.002
cis-permethrin	.005	0	<.005	<.005	<.005	<.005
p,p'-DDE	.006	1	<.006	<.006	<.006	.0062
Sum of 46 pesticides and degradates	.001	10	3.08	4.98	10.4	14.7

Table 19. Statistical summary of 13 herbicide and 10 herbicide degradate concentrations in 10 water samples from five midwestern reservoir outflows (concentration in micrograms per liter, the 95th percentile is not given as it is the same as the maximum)

[<, less than]

Herbicide	Method reporting limit (MRL)	Number at or above MRL	25th percentile	Median	75th percentile	Maximum
acetochlor	0.05	9	0.16	0.25	0.45	0.74
acetochlor ESA	.20	8	.33	.57	1.29	2.91
acetochlor OA	.20	6	<.20	.38	.79	3.22
alachlor	.05	3	<.05	<.05	.08	.65
alachlor ESA	.20	10	.36	.63	.75	1.34
alachlor OA	.20	1	<.20	<.20	<.20	1.95
ametryn	.05	0	<.05	<.05	<.05	<.05
atrazine	.05	10	1.37	2.15	4.94	5.63
deethylatrazine	.05	10	.23	.53	.81	1.39
deisopropylatrazine	.05	10	.13	.38	.55	1.00
hydroxy-atrazine	.20	10	.56	.68	1.07	2.73
cyanazine	.05	9	.10	.20	.60	2.36
cyanazine-amide	.05	9	.06	.55	.88	2.09
metolachlor	.05	10	.48	1.06	2.39	4.06
metolachlor ESA	.20	10	.81	2.11	3.30	5.31
metolachlor OA	.20	10	.51	1.17	1.35	4.83
metribuzin	.05	4	<.05	<.05	.10	.22
prometon	.05	0	<.05	<.05	<.05	<.05
prometryn	.05	0	<.05	<.05	<.05	<.05
propachlor	.05	0	<.05	<.05	<.05	<.05
propazine	.05	4	<.05	<.05	.06	.07
simazine	.05	4	<.05	<.05	.24	.67
terbutryn	.05	0	<.05	<.05	<.05	<.05
Sum of 13 herbicides	.05	10	2.45	4.33	8.44	11.8
Sum of 10 degradates	.05	10	3.49	7.58	10.9	21.94

Null Hypothesis. Concentrations/streamflows in pre-emergence samples are not significantly different from values in post-emergence samples (median of differences = 0).

Alternate Hypothesis. Concentrations/streamflows in pre-emergence samples are significantly different from values in post-emergence samples (median of differences not equal to 0).

Differences were calculated as the post-emergence value minus pre-emergence value, so a significant test result with a positive signed rank would mean that the post-emergence values are larger than the pre-emergence values, while a negative signed rank would mean the opposite. The expected relations are observed for flumetsulam, imazethapyr, and nicosulfuron. Concentrations of these herbicides are all significantly larger in the post-emergence samples than in pre-emergence samples (table 33). The median of the paired differences is largest for nicosulfuron (0.031 µg/L). The expected relations also are observed for acetochlor, atrazine, and metolachlor. Concentration of these herbicides are all significantly larger in the pre-emergence samples than in post-emergence samples (table 33). The median of the paired differences is largest for atrazine (–0.66 µg/L). Some of the differences in concentration could be a result of differences in streamflow. Results of the paired-difference test on streamflow indicate that post-emergence streamflows were larger than pre-emergence flows, but that the difference is not statistically significant at the $p = 0.05$ level.

Table 20. Pesticide and pesticide degradate (2,6 diethylaniline through fonofos) concentrations in water samples

[W1, well sample from round 1; WD, duplicate well sample; <, less than; E, estimate]

Site no. (fig. 5)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					2,6-diethyl-aniline	Aceto-chlor	Ala-chlor	Atra-zine	Azin-phos-methyl	Benflu-ralin	Butyl-ate
					Illinois						
1	LUS1–4	05/19/98	W1	SU–11	<0.0030	<0.0020	<0.0020	<0.0010	<0.0010	<0.0020	<0.0020
2	LUS1–14	05/18/98	W1	SU–7	Sample not analyzed (broken bottle)						
3	LUS1–26	06/18/98	W1	SU–118	<.0030	<.0020	<.0020	E.0034	<.0010	<.0020	<.0020
4	LUS2–9	06/15/98	W1	SU–111	<.0030	<.0020	<.0020	.010	<.0010	<.0020	<.0020
5	LUS2–22	06/18/98	W1	SU–121	<.0030	<.0020	<.0020	.032	<.0010	<.0020	<.0020
					Iowa						
6	Blockton 1	07/23/98	W1	SU–184	<.0030	<.0020	<.0020	<.0010	<.0010	<.0020	<.0020
7	Fort Madison 4	07/22/98	W1	SU–182	.0894	<.0020	<.0020	<.0010	<.0010	<.0020	.0042
8	Shambaugh 3	07/24/98	W1	SU–186	<.0030	<.0020	<.0020	<.0010	<.0010	<.0020	<.0020
9	Nodaway 4	07/23/98	W1	SU–185	<.0030	<.0020	<.0020	<.0010	<.0010	<.0020	<.0020
10	Silver City 3	07/31/98	W1	SU–198	<.0030	<.0020	<.0020	<.0010	<.0010	<.0020	<.0020
11	Carson (5), 3	07/31/98	W1	SU–200	<.0030	<.0020	<.0020	.014	<.0010	<.0020	<.0020
12	Cumberland 1	07/27/98	W1	SU–188	<.0030	<.0020	<.0020	<.0010	<.0010	<.0020	<.0020
13	Fontanelle 5	07/23/98	W1	SU–183	<.0030	<.0020	<.0020	.036	<.0010	<.0020	<.0020
14	Menlo 3	07/29/98	W1	SU–193	<.0030	<.0020	<.0020	.091	<.0010	<.0020	<.0020
15	Carlisle 5	07/27/98	W1	SU–187	<.0030	<.0020	<.0020	.015	<.0010	<.0020	<.0020
16	Newton 13	06/03/98	W1	SU–71	<.0030	<.0020	<.0020	.039	<.0010	<.0020	<.0020
17	Belle Plaine 4	06/02/98	W1	SU–70	Sample not analyzed (broken bottle)						
18	Cedar Rapids S6	08/25/98	W1	SU–211	<.0030	<.0020	<.0020	.410	<.0010	<.0020	<.0020
19	Vail 1	06/23/98	W1	SU–137	<.0030	<.0020	<.0020	.004	<.0010	<.0020	<.0020
20	Marshalltown 8	06/02/98	W1	SU–72	.0045	<.0020	<.0020	<.0010	<.0010	<.0020	<.0020
21	Boone 20	07/28/98	W1	SU–190	<.0030	E.0039	<.0020	.179	<.0010	<.0020	<.0020
22	Boxholm 2	07/25/98	W1	SU–189	<.0030	<.0020	<.0020	<.0010	<.0010	<.0020	<.0020
23	Holstein 3	06/25/98	W1	SU–139	<.0030	<.0020	.016	.123	<.0010	<.0020	<.0020
24	Kingsley 1	06/25/98	W1	SU–138	<.0030	<.0020	<.0020	.011	<.0010	<.0020	<.0020
25	Sheffield 2	07/29/98	W1	SU–192	<.0030	<.0020	<.0020	.221	<.0010	<.0020	<.0020

collected in 1998 from 23 midwestern wells

Site no. (fig. 5)	Concentration, in micrograms per liter												
	Car-baryl	Carbo-furan	Chlor-pyrifos	Cyana-zine	Dac-thal	Deethyl-atrazine	Diaz-inon	Dield-rin	Disul-foton	EPTC	Ethal-fluralin	Etho-prophos	Fono-fos
Illinois—Continued													
1	<0.0030	<0.0030	<0.0040	<0.0040	<0.0020	<0.0020	<0.002	<0.0010	<0.0170	<0.0020	<0.0040	<0.0030	<0.0030
2	Sample not analyzed												
3	<.0030	<.0030	<.0040	<.0040	<.0020	<.0020	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
4	<.0030	<.0030	<.0040	<.0040	<.0020	E.0243	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
5	<.0030	<.0030	<.0040	<.0040	<.0020	E.0283	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
Iowa—Continued													
6	<.0030	<.0030	<.0040	<.0040	<.0020	<.0020	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
7	<.0030	<.0030	<.0040	<.0040	<.0020	<.0020	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
8	<.0030	<.0030	<.0040	<.0040	<.0020	<.0020	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
9	<.0030	<.0030	<.0040	<.0040	<.0020	<.0020	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
10	<.0030	<.0030	<.0040	<.0040	<.0020	<.0020	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
11	<.0030	<.0030	<.0040	<.0040	<.0020	E.0094	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
12	<.0030	<.0030	<.0040	<.0040	<.0020	<.0020	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
13	<.0030	<.0030	<.0040	<.0040	<.0020	E.0071	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
14	<.0030	<.0030	<.0040	<.0040	<.0020	E.0740	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
15	<.0030	<.0030	<.0040	<.0040	<.0020	E.0068	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
16	<.0030	<.0030	<.0040	<.0040	<.0020	.0808	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
17	Sample not analyzed												
18	<.0030	<.0030	<.0040	<.0040	<.0020	E.103	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
19	<.0030	<.0030	<.0040	<.0040	<.0020	E.0065	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
20	<.0030	<.0030	<.0040	<.0040	<.0020	<.0020	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
21	<.0030	<.0030	<.0040	<.0040	<.0020	E.0287	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
22	<.0030	<.0030	<.0040	<.0040	<.0020	<.0020	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
23	<.0030	<.0030	<.0040	.0074	<.0020	E.0423	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
24	<.0030	<.0030	<.0040	<.0040	<.0020	.0188	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030
25	<.0030	<.0030	<.0040	<.0040	<.0020	E.237	<.0020	<.0010	<.0170	<.0020	<.0040	<.0030	<.0030

Table 21. Pesticide and pesticide degradate (lindane through terbacil) concentrations in water samples from 23 midwestern wells

[W1, well sample from round 1; WD, duplicate well sample; <, less than; E, estimate]

Site no. (fig. 5)	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Lindane	Linuron	Malathion	Metolachlor	Metribuzin	Molinate	Napropamide
					Illinois						
1	LUS1–4	05/19/98	W1	SU–11	<0.0040	<0.0020	<0.0050	<0.0020	<0.0040	<0.0040	<0.0030
2	LUS1–14	05/18/98	W1	SU–7	Sample not analyzed (broken bottle)						
3	LUS1–26	06/18/98	W1	SU–118	<.0040	<.0020	<.0050	E.0024	<.0040	<.0040	<.0030
4	LUS2–9	06/15/98	W1	SU–111	<.0040	<.0020	<.0050	.005	<.0040	<.0040	<.0030
5	LUS2–22	06/18/98	W1	SU–121	<.0040	<.0020	<.0050	.364	<.0040	<.0040	<.0030
					Iowa						
6	Blockton 1	07/23/98	W1	SU–184	<.0040	<.0020	<.0050	<.0020	<.0040	<.0040	<.0030
7	Fort Madison 4	07/22/98	W1	SU–182	<.0040	<.0020	<.0050	<.0020	<.0040	<.0040	<.0030
8	Shambaugh 3	07/24/98	W1	SU–186	<.0040	<.0020	<.0050	<.0020	<.0040	<.0040	<.0030
9	Nodaway 4	07/23/98	W1	SU–185	<.0040	<.0020	<.0050	<.0020	<.0040	<.0040	<.0030
10	Silver City 3	07/31/98	W1	SU–198	<.0040	<.0020	<.0050	<.0020	<.0040	<.0040	<.0030
11	Carson (5), 3	07/31/98	W1	SU–200	<.0040	<.0020	<.0050	.007	<.0040	<.0040	<.0030
12	Cumberland 1	07/27/98	W1	SU–188	<.0040	<.0020	<.0050	<.0020	<.0040	<.0040	<.0030
13	Fontanelle 5	07/23/98	W1	SU–183	<.0040	<.0020	<.0050	.013	<.0040	<.0040	<.0030
14	Menlo 3	07/29/98	W1	SU–193	<.0040	<.0020	<.0050	.002	<.0040	<.0040	<.0030
15	Carlisle 5	07/27/98	W1	SU–187	<.0040	<.0020	<.0050	.006	<.0040	<.0040	<.0030
16	Newton 13	06/03/98	W1	SU–71	<.0040	<.0020	<.0050	.035	<.0040	<.0040	<.0030
17	Belle Plaine 4	06/02/98	W1	SU–70	Sample not analyzed (broken bottle)						
18	Cedar Rapids S6	08/25/98	W1	SU–211	<.0040	<.0020	<.0050	.100	<.0040	<.0040	<.0030
19	Vail 1	06/23/98	W1	SU–137	<.0040	<.0020	<.0050	E.002	<.0040	<.0040	<.0030
20	Marshalltown 8	06/02/98	W1	SU–72	<.0040	<.0020	<.0050	<.0020	<.0040	<.0040	<.0030
21	Boone 20	07/28/98	W1	SU–190	<.0040	<.0020	<.0050	.190	<.0040	<.0040	<.0030
22	Boxholm 2	07/25/98	W1	SU–189	<.0040	<.0020	<.0050	<.0020	<.0040	<.0040	<.0030
23	Holstein 3	06/25/98	W1	SU–139	<.0040	<.0020	<.0050	.557	<.0040	<.0040	<.0030
24	Kingsley 1	06/25/98	W1	SU–138	<.0040	<.0020	<.0050	.003	.006	<.0040	<.0030
25	Sheffield 2	07/29/98	W1	SU–192	<.0040	<.0020	<.0050	<.0020	<.0040	<.0040	<.0030

Site no. (fig. 5)	Concentration, in micrograms per liter												
	Para-thion	Para-thion-methyl	Pebu-late	Pendi-metha-lin	Phor-ate	Prome-ton	Propa-chlor	Prop-anil	Prop-argite	Prop-yzamide	Sima-zine	Tebu-thiuron	Terba-cil
						Illinois—Continued							
1	<0.0040	<0.0060	<0.0040	<0.0040	<0.0020	<0.0180	<0.0070	<0.0040	<0.0130	<0.0030	<0.0050	<0.010	<0.0070
2	Sample not analyzed												
3	<.0040	<.0060	<.0040	<.0040	<.0020	<.0108	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
4	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
5	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
						Iowa—Continued							
6	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
7	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
8	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
9	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
10	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
11	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
12	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
13	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
14	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
15	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
16	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
17	Sample not analyzed												
18	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	.0051	<.010	<.0070
19	<.0040	<.0060	<.0040	<.0040	<.0020	.0414	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
20	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
21	<.0040	<.0060	<.0040	<.0040	<.0020	E.0079	<.0070	<.0040	<.0130	<.0030	E.0032	<.010	<.0070
22	<.0040	<.0060	<.0040	<.0040	<.0020	<.0180	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
23	<.0040	<.0060	<.0040	<.0040	<.0020	E.0112	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
24	<.0040	<.0060	<.0040	<.0040	<.0020	.0222	<.0070	<.0040	<.0130	<.0030	<.0050	<.010	<.0070
25	<.0040	<.0060	<.0040	<.0040	<.0020	.146	<.0070	<.0040	<.0130	<.0030	E.0031	<.010	<.0070

Table 22. Pesticide and pesticide degradate (terbufos through p,p'-DDE) concentrations in water samples from 23 midwestern wells

[W1, well sample from round 1; WD, duplicate well sample; <, less than]

Site no. (fig. 5)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter						
					Terb- ufos	Thio- bencarb	Tri- allate	Triflur- alin	alpha- HCH	cis- per- methrin	p,p' - DDE
					Illinois						
1	LUS1–4	05/19/98	W1	SU–11	<0.0130	<0.0020	<0.0010	<0.0020	<0.0020	<0.0050	<0.0060
2	LUS1–14	05/18/98	W1	SU–7	Sample not analyzed (broken bottle)						
3	LUS1–26	06/18/98	W1	SU–118	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
4	LUS2–9	06/15/98	W1	SU–111	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
5	LUS2–22	06/18/98	W1	SU–121	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
					Iowa						
6	Blockton 1	07/23/98	W1	SU–184	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
7	Fort Madison 4	07/22/98	W1	SU–182	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
8	Shambaugh 3	07/24/98	W1	SU–186	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
9	Nodaway 4	07/23/98	W1	SU–185	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
10	Silver City 3	07/31/98	W1	SU–198	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
11	Carson (5), 3	07/31/98	W1	SU–200	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
12	Cumberland 1	07/27/98	W1	SU–188	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
13	Fontanelle 5	07/23/98	W1	SU–183	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
14	Menlo 3	07/29/98	W1	SU–193	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
15	Carlisle 5	07/27/98	W1	SU–187	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
16	Newton 13	06/03/98	W1	SU–71	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
17	Belle Plaine 4	06/02/98	W1	SU–70	Sample not analyzed (broken bottle)						
18	Cedar Rapids S6	08/25/98	W1	SU–211	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
19	Vail 1	06/23/98	W1	SU–137	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
20	Marshalltown 8	06/02/98	W1	SU–72	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
21	Boone 20	07/28/98	W1	SU–190	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
22	Boxholm 2	07/25/98	W1	SU–189	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
23	Holstein 3	06/25/98	W1	SU–139	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
24	Kingsley 1	06/25/98	W1	SU–138	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060
25	Sheffield 2	07/29/98	W1	SU–192	<.0130	<.0020	<.0010	<.0020	<.0020	<.0050	<.0060

Table 23. Statistical summary of 46 pesticide and pesticide degradate concentrations in 23 water samples from 23 midwestern wells (concentrations in micrograms per liter)

[<, less than; E, estimate]

Herbicide	Method reporting limit	Number above MRL	25th percentile	Median	75th percentile	95th percentile	Maximum
2,6-diethylaniline	0.003	2	<0.003	<0.003	<0.003	0.0045	0.089
acetochlor	.002	1	<.002	<.002	<.002	<.002	E.004
alachlor	.002	1	<.002	<.002	<.002	<.002	.016
atrazine	.001	14	<.001	.010	.039	.221	.410
azinphos-methyl	.001	0	<.001	<.001	<.001	<.001	<.001
benfluralin	.002	0	<.002	<.002	<.002	<.002	<.002
butylate	.002	1	<.002	<.002	<.002	<.002	.004
carbaryl	.003	0	<.003	<.003	<.003	<.003	<.003
carbofuran	.003	0	<.003	<.003	<.003	<.003	<.003
chlorpyrifos	.004	0	<.004	<.004	<.004	<.004	<.004
cyanazine	.004	1	<.004	<.004	<.004	<.004	.0074
dacthal	.002	0	<.002	<.002	<.002	<.002	<.002
deethylatrazine	.002	13	<.002	.0068	.029	.103	E.237
diazinon	.002	0	<.002	<.002	<.002	<.002	<.002
dieldrin	.001	0	<.001	<.001	<.001	<.001	<.001
disulfoton	.017	0	<.017	<.017	<.017	<.017	<.017
EPTC	.002	0	<.002	<.002	<.002	<.002	<.002
ethalfluralin	.004	0	<.004	<.004	<.004	<.004	<.004
ethoprophos	.003	0	<.003	<.003	<.003	<.003	<.003
fonofos	.003	0	<.003	<.003	<.003	<.003	<.003
lindane	.004	0	<.004	<.004	<.004	<.004	<.004
linuron	.002	0	<.002	<.002	<.002	<.002	<.002
malathion	.005	0	<.005	<.005	<.005	<.005	<.005
metolachlor	.002	13	<.002	.002	.013	.364	.557
metribuzin	.004	1	<.004	<.004	<.004	<.004	.006
molinate	.004	0	<.004	<.004	<.004	<.004	<.004
napropamide	.003	0	<.003	<.003	<.003	<.003	<.003
parathion	.004	0	<.004	<.004	<.004	<.004	<.004
parathion methyl	.006	0	<.006	<.006	<.006	<.006	<.006
pebulate	.004	0	<.004	<.004	<.004	<.004	<.004
pendimethalin	.004	0	<.004	<.004	<.004	<.004	<.004
phorate	.002	0	<.002	<.002	<.002	<.002	<.002
prometon	.018	3	<.018	<.018	<.018	.041	.146
propachlor	.007	0	<.007	<.007	<.007	<.007	<.007
propanil	.004	0	<.004	<.004	<.004	<.004	<.004
propargite	.013	0	<.013	<.013	<.013	<.013	<.013
propyzamide	.003	0	<.003	<.003	<.003	<.003	<.003
simazine	.005	1	<.005	<.005	<.005	E.0032	.0051
tebuthiuron	.010	0	<.010	<.010	<.010	<.010	<.010
terbacil	.007	0	<.007	<.007	<.007	<.007	<.007
terbufos	.013	0	<.013	<.013	<.013	<.013	<.013
thiobencarb	.002	0	<.002	<.002	<.002	<.002	<.002
tri-allate	.001	0	<.001	<.001	<.001	<.001	<.001
trifluralin	.002	0	<.002	<.002	<.002	<.002	<.002
alpha-HCH	.002	0	<.002	<.002	<.002	<.002	<.002
cis-permethrin	.005	0	<.005	<.005	<.005	<.005	<.005
p,p'-DDE	.006	0	<.006	<.006	<.006	<.006	<.006
Sum of 46 pesticides and degradates	.001	15	<.001	.021	.093	.515	.715

Table 24. Concentrations of 13 herbicides in water samples from 25 midwestern wells

[W1, well sample from round 1; WD, duplicate well sample; LD, laboratory duplicate sample; <, less than]

Site no. (fig. 5)	Site name	Date of collection (month/ day/year)	Sample type	Sample no.	Concentration, in micrograms per liter				
					Aceto- chlor	Ala- chlor	Ame- tryn	Atra- zine	Cyan- azine
				Illinois					
1	LUS1–4	05/19/98	W1	SU–11	<0.05	<0.05	<0.05	<0.05	<0.05
2	LUS1–14	05/18/98	W1	SU–7	<.05	<.05	<.05	<.05	<.05
		05/18/98	WD	SU–10	<.05	<.05	<.05	<.05	<.05
		05/18/98	LD	SU–10	<.05	<.05	<.05	<.05	<.05
3	LUS1–26	06/18/98	W1	SU–118	<.05	<.05	<.05	<.05	<.05
		06/18/98	LD	SU–118	<.05	<.05	<.05	<.05	<.05
4	LUS2–9	06/15/98	W1	SU–111	<.05	<.05	<.05	<.05	<.05
5	LUS2–22	06/18/98	W1	SU–121	<.05	<.05	<.05	<.05	<.05
				Iowa					
6	Blockton 1	07/23/98	W1	SU–184	<.05	<.05	<.05	<.05	<.05
7	Fort Madison 4	07/22/98	W1	SU–182	<.05	<.05	<.05	<.05	<.05
8	Shambaugh 3	07/24/98	W1	SU–186	<.05	<.05	<.05	<.05	<.05
		07/24/98	LD	SU–186	<.05	<.05	<.05	<.05	<.05
9	Nodaway 4	07/23/98	W1	SU–185	<.05	<.05	<.05	<.05	<.05
10	Silver City 3	07/31/98	W1	SU–198	<.05	<.05	<.05	<.05	<.05
11	Carson (5), 3	07/31/98	W1	SU–200	<.05	<.05	<.05	<.05	<.05
12	Cumberland 1	07/27/98	W1	SU–188	<.05	<.05	<.05	<.05	<.05
		07/27/98	LD	SU–188	<.05	<.05	<.05	<.05	<.05
13	Fontanelle 5	07/23/98	W1	SU–183	<.05	<.05	<.05	<.05	<.05
14	Menlo 3	07/29/98	W1	SU–193	<.05	<.05	<.05	.08	<.05
		07/29/98	LD	SU–193	<.05	<.05	<.05	.08	<.05
15	Carlisle 5	07/27/98	W1	SU–187	<.05	<.05	<.05	<.05	<.05
16	Newton 13	06/03/98	W1	SU–71	<.05	<.05	<.05	<.05	<.05
17	Belle Plaine 4	06/02/98	W1	SU–70	<.05	<.05	<.05	.20	<.05
18	Cedar Rapids S6	08/25/98	W1	SU–211	<.05	<.05	<.05	.40	<.05
19	Vail 1	06/23/98	W1	SU–137	<.05	<.05	<.05	<.05	<.05
20	Marshalltown 8	06/02/98	W1	SU–72	<.05	<.05	<.05	<.05	<.05
		06/02/98	LD	SU–72	<.05	<.05	<.05	<.05	<.05
21	Boone 20	07/28/98	W1	SU–190	<.05	<.05	<.05	.18	<.05
22	Boxholm 2	07/25/98	W1	SU–189	<.05	<.05	<.05	<.05	<.05
23	Holstein 3	06/25/98	W1	SU–139	<.05	<.05	<.05	.09	<.05
24	Kingsley 1	06/25/98	W1	SU–138	<.05	<.05	<.05	<.05	<.05
25	Sheffield 2	07/29/98	W1	SU–192	<.05	<.05	<.05	.22	<.05

Site no. (fig. 5)	Concentration, in micrograms per liter							
	Metola-chlor	Metri-buzin	Prome-ton	Prome-tryn	Propa-chlor	Propa-zine	Sima-zine	Terbu-tryn
				Illinois—Continued				
1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
3	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
4	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
5	.41	<.05	<.05	<.05	<.05	<.05	<.05	<.05
				Iowa—Continued				
6	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
7	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
8	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
9	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
10	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
11	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
12	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
13	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
14	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
15	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
16	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
17	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
18	.07	<.05	<.05	<.05	<.05	<.05	<.05	<.05
19	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
20	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
21	.16	<.05	<.05	<.05	<.05	<.05	<.05	<.05
22	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
23	.43	<.05	<.05	<.05	<.05	<.05	<.05	<.05
24	<.05	<.05	<.05	<.05	<.05	<.05	<.05	<.05
25	<.05	<.05	.16	<.05	<.05	<.05	<.05	<.05

Table 25. Concentrations of 10 herbicide degradates in water samples from 25 midwestern wells

[W1, well sample from round 1; WD, duplicate well sample, LD, laboratory duplicate sample; <, less than]

Site no.	Site name	Date of collection (month/day/year)	Sample type	Sample no.	Concentration, in micrograms per liter: Aceto-chlor ESA	Aceto-chlor OA	Ala-chlor ESA	Ala-chlor OA	Cyan-azine-amide	Deethyl-atra-zine	Deiso-prop-ylatra-zine	Hy-droxy-atra-zine	Meto-lachlor ESA	Metola-chlor OA
					Illinois									
1	LUS1–4	05/19/98	W1	SU–11	<0.20	<0.20	<0.20	<0.20	<0.05	<0.05	<0.05	<0.20	<0.20	<0.20
2	LUS1–14	05/18/98	W1	SU–7	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
		05/18/98	WD	SU–10	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
		05/18/98	LD	SU–10	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
3	LUS1–26	06/18/98	W1	SU–118	3.47	1.43	.44	<.20	<.05	<.05	<.05	<.20	3.05	1.13
		06/18/98	LD	SU–118	3.08	1.23	.35	<.20	<.05	<.05	<.05	<.20	2.78	.99
4	LUS2–9	06/15/98	W1	SU–111	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	1.37	<.20
5	LUS2–22	06/18/98	W1	SU–121	<.20	<.20	<.20	<.20	<.05	.05	<.05	<.20	<.20	<.20
					Iowa									
6	Blockton 1	07/23/98	W1	SU–184	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
7	Fort Madison 4	07/22/98	W1	SU–182	<.20	<.20	1.93	.72	<.05	<.05	<.05	<.20	1.17	.45
8	Shambaugh 3	07/24/98	W1	SU–186	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
		07/24/98	LD	SU–186	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
9	Nodaway 4	07/23/98	W1	SU–185	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
10	Silver City 3	07/31/98	W1	SU–198	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	.37	<.20
11	Carson (5), 3	07/31/98	W1	SU–200	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	.60	<.20
12	Cumberland 1	07/27/98	W1	SU–188	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
		07/27/98	LD	SU–188	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
13	Fontanelle 5	07/23/98	W1	SU–183	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	1.62	.53
14	Menlo 3	07/29/98	W1	SU–193	<.20	<.20	2.25	<.20	.14	.15	.39	<.20	.75	<.20
		07/29/98	LD	SU–193	<.20	<.20	2.54	<.20	.13	.14	.37	<.20	.84	<.20
15	Carlisle 5	07/27/98	W1	SU–187	<.20	<.20	2.99	<.20	<.05	<.05	<.05	<.20	.75	<.20
16	Newton 13	06/03/98	W1	SU–71	<.20	<.20	<.20	<.20	<.05	.08	.05	<.20	1.05	<.20
17	Belle Plaine 4	06/02/98	W1	SU–70	<.20	<.20	3.26	1.23	<.05	<.05	<.05	<.20	1.84	1.29
18	Cedar Rapids S6	08/25/98	W1	SU–211	<.20	<.20	<.20	<.20	<.05	.14	.06	<.20	<.20	<.20
19	Vail 1	06/23/98	W1	SU–137	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	<.20	<.20
20	Marshalltown 8	06/02/98	W1	SU–72	<.20	<.20	1.07	<.20	<.05	<.05	<.05	<.20	1.87	.70
		06/02/98	LD	SU–72	<.20	<.20	1.09	<.20	<.05	<.05	<.05	<.20	1.82	.78
21	Boone 20	07/28/98	W1	SU–190	1.54	.39	.64	<.20	<.05	.05	<.05	<.20	3.77	.87
22	Boxholm 2	07/25/98	W1	SU–189	<.20	<.20	.72	2.00	<.05	<.05	<.05	<.20	<.20	<.20
23	Holstein 3	06/25/98	W1	SU–139	<.20	<.20	<.20	<.20	.06	.06	<.05	<.20	1.06	.61
24	Kingsley 1	06/25/98	W1	SU–138	<.20	<.20	<.20	<.20	<.05	<.05	<.05	<.20	.66	<.20
25	Sheffield 2	07/29/98	W1	SU–192	<.20	<.20	<.20	<.20	<.05	.39	.85	<.20	1.16	<.20

Table 26. Statistical summary of 13 herbicide and 10 herbicide degradate concentrations in 25 water samples from 25 midwestern wells (concentrations in micrograms per liter)

[<, less than]

Herbicide	Method reporting limit (MRL)	Number at or above MRL	25th percentile	Median	75th percentile	95th percentile	Maximum
acetochlor	0.05	0	<0.05	<0.05	<0.05	<0.05	<0.05
acetochlor ESA	.20	2	<.20	<.20	<.20	1.54	3.47
acetochlor OA	.20	2	<.20	<.20	<.20	.39	1.43
alachlor	.05	0	<.05	<.05	<.05	<.05	<.05
alachlor ESA	.20	8	<.20	<.20	.64	2.99	3.26
alachlor OA	.20	3	<.20	<.20	<.20	1.23	2.00
ametryn	.05	0	<.05	<.05	<.05	<.05	<.05
atrazine	.05	6	<.05	<.05	<.05	.22	.40
deethylatrazine	.05	7	<.05	<.05	.05	.15	.39
deisopropylatrazine	.05	4	<.05	<.05	<.05	.39	.85
hydroxy-atrazine	.20	0	<.20	<.20	<.20	<.20	<.20
cyanazine	.05	0	<.05	<.05	<.05	<.05	<.05
cyanazine-amide	.05	2	<.05	<.05	<.05	.06	.14
metolachlor	.05	4	<.05	<.05	<.05	.41	.43
metolachlor ESA	.20	15	<.20	.66	1.17	3.05	3.77
metolachlor OA	.20	7	<.20	<.20	.45	1.13	1.29
metribuzin	.05	0	<.05	<.05	<.05	<.05	<.05
prometon	.05	1	<.05	<.05	<.05	<.05	.16
prometryn	.05	0	<.05	<.05	<.05	<.05	<.05
propachlor	.05	0	<.05	<.05	<.05	<.05	<.05
propazine	.05	0	<.05	<.05	<.05	<.05	<.05
simazine	.05	0	<.05	<.05	<.05	<.05	<.05
terbutryn	.05	0	<.05	<.05	<.05	<.05	<.05
Sum of 13 herbicides	.05	7	<.05	<.05	.08	.47	.52
Sum of 10 degradates	.05	18	<.05	1.18	3.64	7.62	9.52

SULFONYLUREA, SULFONAMIDE, AND IMIDAZOLINONE HERBICIDES RELATIVE TO ATRAZINE AND METOLACHLOR

Because they have similar chemical properties, much lower application rates, and a shorter history of use, SU, SA, and IMI herbicides were expected to occur at fraction (1/100th or less) of the concentrations of other herbicides such as atrazine (Battaglin and others, 1998a). In figures 22 and 23, the concentrations in streams and reservoir outflows of imazethapyr, flumetsulam, and nicosulfuron, the three most frequently detected SU, SA, or IMI herbicides, are plotted in relation to the concentrations of atrazine and metolachlor, the two most frequently detected other herbicides in results from the NWQL. On figures 22 and 23, the circles are pre-emergence samples and the triangles are post-emergence samples. The lines crossing these plots show the 1:10, 1:100, and 1:1,000 ratios of concentration. The data plotted in figure 22 indicate that in about one-half of the samples, imazethapyr, flumetsulam, and nicosulfuron occur at 1/100th or less the concentration of atrazine. The ratios of metolachlor concentration to imazethapyr, flumetsulam, and nicosulfuron concentrations (fig. 23) are, in general, smaller than the ratios of these compounds to atrazine.

Table 27. Concentrations of nutrients and field data for water samples from 71 midwestern streams and outflow from 5 midwestern reservoirs

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, not analyzed; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample no.	Water temper-ature (°C)	Specific cond-uctance (µS/cm)	pH (stand-ard units)	Concentration, in milligrams per liter: Am-monia as nitro-gen	Nitrite as nitro-gen	Am-monia and organic nitro-gen	Nitrite plus nitrate as nitro-gen	Phos-phorus (dis-solved)	Ortho-phos-phate as phos-phorus	Dis-solved organic carbon
	Illinois												
1	Vermillion River below Lake Vermillion Dam, IL	06/10/98	SU–98	19.5	602	7.4	<0.02	0.042	0.389	11.06	0.084	0.079	--
		07/16/98	SU–177	25.5	422	7.8	.076	.06	.465	6.26	.063	.062	--
2	Bonpas Creek at Browns, IL	05/23/98	SU–43	20.5	178	6.4	.552	.081	1.392	2.05	.234	.024	--
		07/07/98	SU–166	24.2	120	6.82	.028	.038	.533	1.36	.089	.084	--
3	Little Wabash River at Carmi, IL	05/23/98	SU–33	20.0	177	6.4	.664	.069	1.285	1.06	.291	.269	--
		07/09/98	SU–175	27.2	340	7.06	.088	.081	.734	1.66	.055	.051	--
4	S. Branch Kishwaukee River near Fairdale, IL	05/20/98	SU–29	17.8	514	8.05	.509	.107	1.553	10.80	.151	.076	--
		07/29/98	SU–195	23.4	835	8.0	<.02	.022	.338	4.34	.253	.211	--
5	Iroquois River near Chebanse, IL	06/10/98	SU–99	17.8	645	7.5	<.02	.038	.509	9.91	.057	.044	--
		07/08/98	SU–168	23.0	366	7.8	.054	.035	.545	6.49	.127	.125	--
6	Dupage River near Shorewood, IL	06/09/98	SU–100	16.3	1,085	--	<.02	.029	.537	6.10	.957	.993	--
		07/29/98	SU–194	26.0	1,045	8.52	<.02	<.01	.464	.82	1.097	<.01	--
7	Illinois River at Marseilles, IL	06/12/98	SU–113	21.2	580	7.63	.15	.095	.601	5.16	.293	.309	--
		07/09/98	SU–176	27.4	521	7.7	.041	.043	.55	5.34	.269	.242	--
8	Spoon River at London Mills, IL	05/20/98	SU–25	18.9	541	7.64	.035	.08	.575	8.16	.086	.037	--
		07/01/98	SU–160	22.5	578	7.89	.048	.05	.489	9.31	.099	.074	--
9	Sangamon River near Monticello, IL	05/23/98	SU–35	16.3	436	7.54	.123	.051	.562	9.21	.097	.096	4.1
		08/05/98	SU–201	23.0	486	7.8	.047	.013	.309	2.52	.081	.074	2.9
10	Sangamon River at Riverton, IL	05/26/98	SU–44	21.0	484	7.58	.052	.122	.554	8.08	.151	.025	--
		07/09/98	SU–174	25.7	479	7.56	.197	.055	.471	6.21	.180	.167	--
11	LaMoine River at Colmar, IL	05/21/98	SU–27	20.0	376	7.58	.21	.102	.869	5.46	.099	.105	4.7
		06/29/98	SU–142	24.3	251	7.44	.088	.063	.687	4.14	.132	.116	6.4
12	Illinois River at Valley City, IL	06/18/98	SU–120	22.8	491	7.53	<.02	.088	.505	6.76	.157	.148	4.3
		08/12/98	SU–207	28.4	630	7.66	.089	.056	.351	2.89	.313	.316	4.5
13	Mississippi River below Grafton, IL	06/02/98	SU–60	23.3	522	7.92	.053	.197	.389	4.85	.118	.117	4.8
		06/15/98	SU–116	21.8	495	8.13	.029	.098	.475	5.47	.167	.14	4.3
14	Kaskaskia River near Cowden, IL	05/20/98	SU–30	17.5	505	7.9	.082	.123	.393	8.44	.034	.036	17.5
		07/08/98	SU–169	23.2	418	7.65	.061	.101	.542	6.09	.071	.075	23.2
15	Shoal Creek near Breese, IL	05/22/98	SU–32	20.0	301	7.1	.767	.137	1.547	2.28	.582	.601	--
		07/08/98	SU–167	25.2	233	7.08	.295	.068	1.096	1.92	.392	.351	--
	Iowa												
16	Turkey River at Spillville, IA	06/02/98	SU–64	25.5	515	7.8	.110	.068	.360	10.21	.031	.048	--
		06/12/98	SU–109	15.8	482	7.43	.163	.067	.830	13.06	.164	.157	--

Table 27. Concentrations of nutrients and field data for water samples from 71 midwestern streams and outflow from 5 midwestern reservoirs—Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, not analyzed; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample no.	Water temperature (°C)	Specific conductance (µS/cm)	pH (standard units)	Concentration, in milligrams per liter						
							Ammonia as nitrogen	Nitrite as nitrogen	Ammonia and organic nitrogen	Nitrite plus nitrate as nitrogen	Phosphorus (dissolved)	Orthophosphate as phosphorus	Dissolved organic carbon
	Iowa—Continued												
17	Mississippi River at Clinton, IA	05/27/98	SU–55	20.5	461	7.6	0.033	0.063	0.593	1.17	0.026	0.065	6.5
		07/01/98	SU–155	25.7	440	7.4	<.02	.146	.468	2.80	.132	.141	5.0
18	Wapsipinicon River near Tripoli, IA	05/27/98	SU–54	17.9	457	7.63	.081	.105	.593	14.46	.03	.014	2.7
		06/20/98	SU–126	18.7	275	7.29	<.02	.072	.559	8.12	.092	.075	5.5
19	Wapsipinicon River at Independence, IA	05/29/98	SU–56	20.5	406	7.5	.120	.087	.602	11.30	.093	.065	--
		06/12/98	SU–110	19.0	272	7.26	.135	.05	.606	6.98	.167	.164	--
20	Iowa River near Rowan, IA	06/02/98	SU–65	15.1	683	8.09	.063	.077	.536	11.80	.071	.069	3.7
		06/23/98	SU–129	21.1	412	7.47	.022	.141	.867	9.71	.206	.169	5.4
21	Old Mans Creek near Iowa City, IA	06/10/98	SU–93	14.6	494	7.6	.102	.09	.475	11.99	.146	.120	3.4
		06/30/98	SU–147	19.7	363	7.2	.048	.10	.719	7.78	.102	.030	6.1
22	Wolf Creek near Dysart, IA	06/10/98	SU–87	15.6	458	7.67	.073	.048	.429	14.10	.146	.131	3.0
		06/22/98	SU–128	21.1	284	7.43	.038	.048	.426	7.34	.193	.186	3.8
23	Iowa River at Wapello, IA	05/27/98	SU–53	20.2	500	8.42	.061	.047	.294	8.05	.049	.012	3.2
		06/19/98	SU–127	19.8	489	7.66	.087	.062	.518	9.74	.152	.137	3.4
24	N. Skunk River near Sigourney, IA	05/21/98	SU–21	19.0	391	7.3	.092	.096	.651	7.74	.107	.057	--
		06/10/98	SU–95	15.2	405	7.74	.109	.076	.662	8.98	.078	.096	--
25	Skunk River at Augusta, IA	05/26/98	SU–45	17.0	327	7.26	.15	.113	.840	7.91	.134	.044	18.
		06/18/98	SU–122	20.4	385	7.55	.047	.071	.508	8.34	.136	.146	4.8
26	Des Moines River at Fort Dodge, IA	05/16/98	SU–8	17.0	437	7.7	--	--	--	8.52	--	--	--
		06/12/98	SU–108	18.5	711	8.2	<.02	.025	.401	13.85	.085	.056	--
27	Raccoon River at Van Meter, IA	05/17/98	SU–9	20.5	598	7.7	.112	.08	.542	11.95	.109	.106	--
		06/10/98	SU–89	16.0	522	8.1	.062	.04	.405	11.15	.113	.067	--
28	Little Sioux River at Correctionville, IA	05/27/98	SU–42	18.5	642	8.1	.053	.048	.362	8.45	.075	.059	--
		06/18/98	SU–123	22.0	678	8.0	.028	.043	.434	12.25	.100	.101	--
29	Maple River at Mapleton, IA	05/29/98	SU–59	21.5	514	7.7	.444	.109	1.078	8.80	.141	.152	--
		06/09/98	SU–90	14.0	574	8.2	.164	.042	.723	8.10	.154	.151	--
30	Boyer River at Logan, IA	05/22/98	SU–31	15.5	471	7.6	.425	.097	.923	4.92	.186	.523	--
		06/09/98	SU–96	14.0	384	7.7	.183	.041	.555	3.95	.128	.111	--
31	Chariton River below Rathbun Lake Dam, IA	06/04/98	SU–69	18.0	240	7.0	.073	.025	.451	.63	.015	.023	--
		06/29/98	SU–148	20.8	234	7.28	.029	<.01	.377	.80	.021	.016	--
32	Nishnabotna River above Hamburg, IA	06/04/98	SU–124	19.5	172	7.3	.07	.033	<.10	2.69	.056	.066	--

Table 27. Concentrations of nutrients and field data for water samples from 71 midwestern streams and outflow from 5 midwestern reservoirs—Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, not analyzed; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/day/year)	Sample no.	Water temperature (°C)	Specific conductance (µS/cm)	pH (standard units)	Concentration, in milligrams per liter: Ammonia as nitrogen	Nitrite as nitrogen	Ammonia and organic nitrogen	Nitrite plus nitrate as nitrogen	Phosphorus (dissolved)	Orthophosphate as phosphorus	Dissolved organic carbon
	Indiana												
33	Whitewater River near Alpine, IN	05/26/98	SU–47	16.2	592	8.11	0.055	0.060	0.463	5.89	0.030	0.029	--
		07/08/98	SU–162	23.5	428	7.94	.039	.024	.300	2.74	.058	.051	--
34	Blue River at Fredericksburg, IN	05/27/98	SU–50	17.4	342	7.73	<.02	.023	.182	3.35	.073	.045	--
		07/08/98	SU–163	21.6	289	7.45	.04	.024	.472	1.97	.115	.118	--
35	Mississinewa River below Mississinewa Lake Dam, IN	06/09/98	SU–83	18.7	444	8.10	.049	.013	<.10	.07	<.01	<.01	--
		07/09/98	SU–164	23.3	340	7.38	.104	.197	.630	4.49	.141	.106	--
36	Eel River near Logansport, IN	05/21/98	SU–18	20.8	550	7.91	Sample not analyzed						--
		06/30/98	SU–152	24.1	968	8.34	<.02	.045	.489	4.24	.050	.050	--
37	Wildcat Creek near Jerome, IN	05/21/98	SU–19	17.9	524	7.79	.273	.119	--	11.88	--	.057	--
		06/30/98	SU–151	21.5	474	7.60	.029	.075	.579	10.05	.049	.027	--
38	Wildcat Creek near Lafayette, IN	05/20/98	SU–22	21.4	651	8.28	.050	.035	.438	7.76	.172	.015	--
		07/01/98	SU–150	22.5	509	8.03	.036	.031	.498	6.40	.128	.132	--
39	White River near Nora, IN	05/28/98	SU–51	20.7	624.	8.04	.022	.055	.333	5.50	.076	.117	--
		07/01/98	SU–149	24.7	607	7.97	<.02	.032	.517	5.32	.121	.118	--
40	Sugar Creek near Edinburgh, IN	05/26/98	SU–46	17.6	521	7.95	.046	.075	.595	7.55	.072	.030	--
		07/20/98	SU–178	23.2	242	7.57	.125	.040	.617	1.22	.118	.102	--
41	E. Fork White River near Bedford, IN	05/28/98	SU–52	21.4	373	7.66	.027	.084	.572	4.03	.083	.085	--
		07/06/98	SU–161	25.3	371	7.67	.072	.046	.425	2.57	.053	.057	--
42	Wabash River at New Harmony, IN	05/27/98	SU–57	20.5	370	7.60	.087	.114	.429	3.55	.076	.066	4.2
		06/23/98	SU–136	26.0	332	7.60	.021	.089	.474	4.47	.106	.119	4.4
	Minnesota												
43	Cottonwood River near New Ulm, MN	05/26/98	SU–49	21.3	1,086	8.25	.058	.036	.533	9.43	<.01	<.01	--
		07/21/98	SU–180	24.9	752	8.12	.024	.034	.438	3.68	.046	.04	--
44	Little Cobb River near Beauford, MN	05/18/98	SU–12	19.5	655	7.94	.068	.127	.893	16.19	.103	.103	6.6
		08/17/98	SU–208	25.8	549	7.97	.037	<.01	.886	<.05	.092	.084	8.5
45	Minnesota River near Jordan, MN	05/19/98	SU–13	21.0	824	8.14	.046	.042	.537	9.64	.051	.040	5.3
		06/26/98	SU–135	23.5	746	8.07	.024	.044	.771	10.47	.125	.129	5.4
46	Mississippi River at Hastings, MN	05/20/98	SU–14	21.2	632	8.05	.128	.065	.983	3.33	.075	.065	7.2
		05/20/98	SU–206	24.9	570	8.08	.066	.041	.641	1.03	.127	.127	8.0
47	Des Moines River at Jackson, MN	05/26/98	SU–48	17.6	728	8.63	.053	.042	.561	3.47	<.01	<.01	--
		08/24/98	SU–210	26.3	636	8.59	.085	.013	.733	<.05	.046	.042	--
48	Rock River at Luverne, MN	06/24/98	SU–130	24.2	697	8.23	.037	.041	.359	2.98	.023	.027	--
		06/25/98	SU–131	21.1	530	8.03	.236	.055	.732	2.78	.227	.137	--

Table 27. Concentrations of nutrients and field data for water samples from 71 midwestern streams and outflow from 5 midwestern reservoirs—Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, not analyzed; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample no.	Water temper-ature (°C)	Specific cond-uctance (µS/cm)	pH (stand-ard units)	Concentration, in milligrams per liter: Am-monia as nitro-gen	Nitrite as nitro-gen	Am-monia and organic nitro-gen	Nitrite plus nitrate as nitro-gen	Phos-phorus (dis-solved)	Ortho-phos-phate as phos-phorus	Dis-solved organic carbon
							Kansas						
49	Black Vermillion River at Frankfort, KS	05/05/98	SU–1	17.6	652	7.87	0.041	0.024	0.359	0.88	0.064	0.072	--
		06/09/98	SU–107	17.3	504	7.84	.171	.092	.727	3.21	.147	.089	--
50	Big Blue River below Tuttle Creek Lake Dam, KS	06/03/98	SU–73	22.6	515	8.26	<.02	.037	.422	1.52	.140	.163	--
		07/29/98	SU–197	27.6	395	8.26	<.02	.015	.341	.92	.084	.088	--
51	Delaware River near Muscotah, KS	05/05/98	SU–2	22.2	579	8.32	.022	.019	.308	.80	.051	.042	--
		06/10/98	SU–105	21.8	571	8.17	.045	.072	.431	1.93	.141	.086	--
							Kentucky						
52	Ohio River at Cannelton Dam, KY	06/04/98	SU–75	23.4	335	7.3	.049	.058	.221	1.30	.053	.044	2.6
		07/07/98	SU–173	24.4	231	7.0	.041	<.01	.248	1.07	.026	.023	4.0
							Missouri						
53	Nodaway River near Graham, MO	06/18/98	SU–119	20.5	240	7.7	Sample not analyzed						
		08/19/98	SU–209	30.5	309	9.2	.063	<.01	.269	<.05	.022	.031	--
							Nebraska						
54	North Dry Creek near Kearney, NE	05/22/98	SU–28	16.5	1,040	8.0	.763	.220	2.042	5.37	.627	.567	9.1
		06/08/98	SU–76	15.5	1,040	7.9	.231	.223	.910	7.57	.539	.503	6.1
55	Maple Creek near Nickerson, NE	05/21/98	SU–37	21.0	657	7.93	.402	.403	1.347	5.52	.261	.24	--
		06/08/98	SU–79	14.0	405	7.74	.609	.144	1.630	4.46	.178	.15	--
56	Salt Creek at Roca, NE	05/15/98	SU–6	19.0	452	7.75	.770	.083	1.963	4.98	.168	.141	--
		06/10/98	SU–94	18.5	383	7.69	.251	.075	.848	4.87	.136	.108	--
57	Wahoo Creek at Ithaca, NE	05/15/98	SU–5	19.0	420	7.10	.624	.078	1.326	3.19	.125	.056	--
		06/08/98	SU–78	15.0	534	7.78	.303	.079	.646	3.48	.170	.153	--
58	Platte River at Louisville, NE	05/22/98	SU–39	19.0	464	7.44	.555	.075	1.101	2.05	.042	.060	6.1
		06/09/98	SU–77	15.5	440	7.92	.200	.061	.665	2.61	.129	.144	4.9
59	Big Nemaha River at Falls City, NE	05/26/98	SU–41	21.0	620	--	<.02	.029	.302	2.05	.224	.224	--
		06/08/98	SU–80	17.0	555	7.88	.491	.121	1.201	4.89	.204	.159	--
60	W. Fork Big Blue River, Dorchester, NE	05/23/98	SU–36	19.0	417	7.22	.292	.172	1.008	4.20	.556	.541	--
		06/10/98	SU–82	17.5	460	7.56	.164	.083	.619	3.88	.37	.37	--
61	Big Blue River at Barneston, NE	05/15/98	SU–4	22.0	592	8.26	.056	.029	.387	.64	.161	.145	--
		06/09/98	SU–104	18.5	543	7.90	.168	.078	.741	4.41	.369	.370	--
62	Little Blue River near Fairbury, NE	05/12/98	SU–3	21.5	464	8.32	.042	<.01	.247	.63	.192	.190	--
		06/08/98	SU–81	16.0	438	7.64	.151	.041	.428	1.60	.241	.254	--
							Ohio						
63	Clear Creek near Rockbridge, OH	06/10/98	SU–86	18.6	395	8.3	.038	.019	.182	1.35	.057	.026	--
		06/30/98	SU–145	21.1	420	7.8	<.02	.036	.446	5.30	.044	.040	--

Table 27. Concentrations of nutrients and field data for water samples from 71 midwestern streams and outflow from 5 midwestern reservoirs—Continued

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; --, not analyzed; <, less than]

Site no. (figs. 3, 4)	Site name	Date of collection (month/ day/year)	Sample no.	Water temper- ature (°C)	Specific cond- uctance (µS/cm)	pH (stand- ard units)	Concentration, in milligrams per liter: Am- monia as nitro- gen	Nitrite as nitro- gen	Am- monia and organic nitro- gen	Nitrite plus nitrate as nitro- gen	Phos- phorus (dis- solved)	Ortho- phos- phate as phos- phorus	Dis- solved organic carbon
						Ohio—Continued							
64	Scioto River near Prospect, OH	06/02/98	SU–63	21.6	797	7.7	0.682	0.192	1.309	4.82	0.392	0.374	--
		06/29/98	SU–141	23.0	392	7.2	.197	.107	1.043	7.87	.273	.166	--
65	Olentangy River at Claridon, OH	06/09/98	SU–85	15.9	730	7.7	.062	.026	.373	1.23	.017	.046	--
		06/29/98	SU–157	21.0	187	7.4	.101	.070	.791	3.76	.081	.068	--
66	Olentangy River below Delaware, Lake Dam, OH	06/09/98	SU–84	19.8	442	7.4	.307	.120	.727	2.30	<.01	<.01	--
		06/29/98	SU–153	23.8	266	7.1	.219	.102	.873	4.89	.062	.055	--
67	Big Darby Creek at Darbyville, OH	06/03/98	SU–62	20.4	750	8.2	.124	.067	.446	8.44	.122	.130	--
		06/29/98	SU–140	21.8	106	7.4	.106	.027	.526	1.37	.161	.091	--
68	Scioto River at Higby, OH	06/04/98	SU–73	20.8	574	8.3	.037	.038	.341	3.19	.069	.060	--
		07/08/98	SU–165	24.0	490	8.0	.065	.029	.420	4.14	.068	.076	--
69	L. Miami River near Oldtown, OH	06/10/98	SU–92	15.5	685	8.0	.028	.016	.168	4.36	<.01	.018	--
		06/30/98	SU–144	20.8	679	8.3	<.02	.016	.211	4.77	.035	.037	--
70	Mad River at Eagle City, OH	06/10/98	SU–91	14.4	727	8.1	.063	.038	.147	4.147	.041	.023	--
		06/30/98	SU–146	17.9	664	8.0	<.02	.022	.267	4.098	.025	.018	--
71	Tiffin River at Stryker, OH	06/01/98	SU–66	21.0	623	8.0	.135	.069	.573	1.89	.049	.048	--
		07/07/98	SU–172	22.5	631	7.9	.064	.024	.418	1.12	.064	.067	-
72	Auglaize River at Fort Jennings, OH	06/17/98	SU–117	20.0	597	7.9	.053	.093	.786	10.43	.111	.120	--
		07/08/98	SU–171	23.0	534	7.8	.063	.021	.686	6.00	.126	.129	--
73	Root River at Racine, WI	06/01/98	SU–61	19.0	747	7.8	.096	.075	.814	2.27	.051	.015	--
		08/03/98	SU–204	23.5	753	8.0	.121	.013	.647	.11	.124	.117	--
						Wisconsin							
74	St. Croix River at St. Croix Falls, WI	06/03/98	SU–68	17.6	171	7.7	.060	.022	.336	.12	.034	.018	5.8
		08/05/98	SU–205	22.5	191	7.9	.060	<.01	.439	.09	<.01	<.01	--
75	Wisconsin River at Muscoda, WI	06/16/98	SU–133	20.5	237	8.4	.051	.010	.371	.18	.037	<.01	--
		08/07/98	SU–202	21.5	298	7.6	.055	.015	.594	.56	.030	.051	--
76	Rock River at Afton, WI	06/17/98	SU–134	22.0	639	8.4	.047	.014	.706	.87	.062	.043	--
		07/21/98	SU–179	27.0	549	8.6	.028	.025	.840	.69	.032	.035	--

Table 28. Statistical summary of nutrient, field, and discharge data in water samples from 71 midwestern streams

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; N, nitrogen; P, phosphorus, C, carbon; ft³/s, cubic feet per second]

Parameter	Method reporting limit (MRL)	Number of samples analyzed	Number at or above MRL	25th percentile	Median	75th percentile	95th percentile	Maximum
Water temperature (°C)	0.10	141	141	17.9	20.8	22.8	26.0	30.5
Specific conductance (µS/cm)	1.0	141	141	391	500	624	824	1,086
pH (standard units)	.10	139	139	7.58	7.80	8.04	8.4	9.2
Ammonia as N (mg/L)	.02	138	123	.038	.063	.135	.609	.770
Ammonia plus organic N (mg/L)	.10	137	136	.425	.542	.732	1.35	2.04
Organic N (mg/L)[1]	.10	137	136	.336	.468	.575	.846	1.28
Nitrite as N (mg/L)	.01	138	132	.032	.056	.084	.146	.403
Nitrite plus nitrate as N (mg/L)	.05	139	136	2.05	4.47	8.08	12.0	16.2
Nitrate as N (mg/L)[2]	.05	139	136	.198	4.34	7.96	11.87	16.1
Dissolved phosphorus as P (mg/L)	.006	137	133	.056	.107	.161	.392	1.10
Orthophosphate as P (mg/L)	.01	138	133	.044	.084	.141	.374	.993
Dissolved organic carbon as C (mg/L)	.33	37	37	4.0	4.8	6.1	9.1	18.0
Daily mean discharge (ft³/s)	.01	141	141	268	1,070	5,030	56,600	267,000

[1]Calculated as ammonia plus organic N concentration minus ammonia concentration with non-detects set equal to zero.
[2]Calculated as nitrite plus nitrate concentration minus nitrite concentration with non-detects and missing values set equal to zero.

Table 29. Statistical summary of nutrient, field, and discharge data in water samples from five midwestern reservoir outflows (the 95th percentile is not given as it is the same as the maximum)

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; N, nitrogen; P, phosphorus, C, carbon; ft³/s, cubic feet per second; ND, no data; <, less than]

Parameter	Method reporting limit (MRL)	Number of samples analyzed	Number at or above MRL	25th percentile	Median	75th percentile	Maximum
Water temperature (°C)	0.10	10	10	19.5	21.7	23.8	27.6
Specific conductance (µS/cm)	1.0	10	10	266	409	444	602
pH (standard units)	.10	10	10	7.28	7.40	8.10	8.26
Ammonia as N (mg/L)	.02	10	7	<.02	.061	.104	.307
Ammonia plus organic N (mg/L)	.10	10	9	.377	.437	.630	.873
Organic N (mg/L)[1]	.10	10	9	.348	.389	.422	.654
Nitrite as N (mg/L)	.01	10	9	.015	.040	.102	.197
Nitrite plus nitrate as N (mg/L)	.05	10	10	.80	1.91	4.89	11.1
Nitrate as N (mg/L)[2]	.05	10	10	.80	1.83	4.79	11.0
Dissolved phosphorus as P (mg/L)	.006	10	8	.015	.063	.084	.141
Orthophosphate as P (mg/L)	.01	10	8	.016	.059	.088	.163
Dissolved organic carbon as C (mg/L)	.33	0	ND	ND	ND	ND	ND
Daily mean discharge (ft³/s)	.01	10	10	162	653	1,540	3,610

[1]Calculated as ammonia plus organic N concentration minus ammonia concentration with non-detects set equal to zero.
[2]Calculated as nitrite plus nitrate concentration minus nitrite concentration with non-detects set equal to zero.

Table 30. Concentrations of nutrients and field data for water samples from 25 midwestern wells

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; ND, no data; <, less than]

Site no. (fig. 5)	Site name	Date of collection (month/day/year)	Sample no.	Water temperature (°C)	Specific conductance (µS/cm)	pH (standard units)	Concentration, in milligrams per liter: Ammonia as nitrogen	Nitrite as nitrogen	Ammonia and organic nitrogen	Nitrite plus nitrate as nitrogen	Phosphorus (dissolved)	Orthophosphate as phosphorus	Dissolved organic carbon
							Illinois						
1	LUS1–4	05/19/98	SU–11	31.5	675	7.1	0.582	0.017	0.709	0.06	0.013	0.031	1.2
2	LUS1–14	05/18/98	SU–7	19.5	660	7.33	1.39	<.01	1.349	<.05	.024	.077	1.7
3	LUS1–26	06/18/98	SU–118	30.0	647	7.34	.056	.047	<.1	17.38	<.01	.015	.7
4	LUS2–9	06/15/98	SU–111	19.5	561	7.2	.032	<.01	<.1	7.77	.017	<.01	.6
5	LUS2–22	06/18/98	SU–121	21.8	786	7.05	.062	<.01	<.1	26.02	<.01	.018	.7
							Iowa						
6	Blockton 1	07/23/98	SU–184	13.5	1,770	7.87	2.7	ND	3.5	<.1	ND	.400	ND
7	Fort Madison 4	07/22/98	SU–182	21.4	511	6.94	5.05	<.01	5.90	.05	.239	.317	ND
8	Shambaugh 3	07/24/98	SU–186	11.0	473	6.53	<.1	ND	.2	<.1	ND	.300	ND
9	Nodaway 4	07/23/98	SU–185	11.5	577	6.91	<.1	ND	.2	1.10	ND	<.1	ND
10	Silver City 3	07/31/98	SU–198	11.5	982	7.37	.261	<.01	.281	<.05	<.01	.015	ND
11	Carson (5), 3	07/31/98	SU–200	11.0	742	7.19	.060	<.01	<.1	1.33	<.01	.011	ND
12	Cumberland 1	07/27/98	SU–188	13.5	350	7.03	<.02	<.01	<.1	.08	<.01	.012	ND
13	Fontanelle 5	07/23/98	SU–183	11.5	675	7.05	.600	ND	.8	<.1	ND	.500	ND
14	Menlo 3	07/29/98	SU–193	10.5	490	7.34	.02	<.01	<.1	5.49	.164	.175	ND
15	Carlisle 5	07/27/98	SU–187	12.0	600	7.36	<.02	<.01	<.1	.78	<.01	.015	ND
16	Newton 13	06/03/98	SU–71	10.4	692	7.06	<.02	.017	<.1	7.90	.103	.109	ND
17	Belle Plaine 4	06/02/98	SU–70	11.2	624	11.1	.340	1.081	.494	5.15	.036	.340	ND
18	Cedar Rapids S6	08/25/98	SU–211	17.1	514	7.14	.212	.047	.291	3.09	.049	.062	ND
19	Vail 1	06/23/98	SU–137	12.5	899	7.0	.020	<.01	<.1	6.45	.112	.121	ND
20	Marshalltown 8	06/02/98	SU–72	10.7	737	7.28	1.323	<.01	1.507	<.05	.047	.077	ND
21	Boone 20	07/28/98	SU–190	11.5	761	7.33	<.02	.031	.16	5.30	.078	.100	ND
22	Boxholm 2	07/25/98	SU–189	11.0	1,067	7.35	1.621	<.01	1.672	<.05	.151	.025	ND
23	Holstein 3	06/25/98	SU–139	10.5	735	7.07	.025	.012	<.1	7.20	.074	.082	ND
24	Kingsley 1	06/25/98	SU–138	10.0	884	7.02	.024	<.01	<.1	9.44	.128	.135	ND
25	Sheffield 2	07/29/98	SU–192	12.0	583	7.44	<.02	<.01	<.1	11.56	<.01	<.023	ND

Table 31. Statistical summary of nutrient and field data in water samples from 25 midwestern wells

[°C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; N, nitrogen; P, phosphorus, C, carbon; ft^3/s, cubic feet per second; <, less than]

Parameter	Method reporting limit (MRL)	Number of samples analyzed	Number at or above MRL	25th percentile	Median	75th percentile	95th percentile	Maximum
Water temperature (°C)	0.10	25	25	11.0	11.5	17.1	30.0	31.5
Specific conductance (µS/cm)	1.0	25	25	577	675	761	1,067	1,770
pH (standard units)	.10	25	25	7.05	7.19	7.34	7.87	11.1
Ammonia as N (mg/L)	.02	25	18	<.02	.056	.582	2.70	5.05
Ammonia plus organic N (mg/L)	.10	25	13	<.10	.160	.709	3.50	5.90
Organic N (mg/L)[1]	.10	25	13	<.10	<.10	0.16	.80	.85
Nitrite as N (mg/L)	.01	21	7	<.01	<.01	.017	.047	1.08
Nitrite plus nitrate as N (mg/L)	.05	25	18	<.05	1.33	7.20	17.4	26.0
Nitrate as N (mg/L)[2]	.05	25	18	.05	1.33	7.19	17.3	26.0
Dissolved phosphorus as P (mg/L)	.006	21	14	<.006	.036	.103	.164	.239
Orthophosphate as P (mg/L)	.01	25	22	.015	.077	.135	.40	.50
Dissolved organic carbon as C (mg/L)	.33	5	5	.7	.7	1.2	1.7	1.7

[1]Calculated as ammonia plus organic N concentration minus ammonia concentration with non-detects set equal to zero.
[2]Calculated as nitrite plus nitrate concentration minus nitrite concentration with non-detects and missing values set equal to zero.

Table 32. Statistical summary of selected herbicide concentrations and discharge in pre-emergence and post-emergence water samples from midwestern streams and reservoir outflows (concentration in µg/L)

[<, less than]

Herbicide	Number of samples	Number above MRL	25th percentile	Median	75th percentile	95th percentile	Maximum
flumetsulam pre-emergence	72	37	<0.010	0.011	0.049	0.127	0.358
flumetsulam post-emergence	69	55	.013	.032	.062	.169	.220
imazethapyr pre-emergence	72	44	<.010	.019	.056	.134	.689
imazethapyr post-emergence	69	53	.014	.045	.097	.236	.407
nicosulfuron pre-emergence	72	19	<.010	<.010	.010	.065	.266
nicosulfuron post-emergence	69	55	.012	.028	.059	.132	.161
acetochlor pre-emergence	70	69	.22	.80	2.80	15.6	25.1
acetochlor post-emergence	74	69	.05	.20	.49	1.42	2.26
atrazine pre-emergence	70	70	.54	.32	15.1	48.1	224
atrazine post-emergence	74	74	.70	2.97	5.96	12.6	37.6
metolachlor pre-emergence	70	70	.29	1.70	4.05	17.7	143
metolachlor post-emergence	74	73	.37	1.33	2.89	7.16	14.7
			Discharge, in cubic feet per second				
pre-emergence	75	75	210	883	4,220	56,600	172,000
post-emergence	76	76	360	1,235	4,795	101,000	267,000

Table 33. Median of differences between post-emergence and pre-emergence concentrations of selected herbicides and Wilcoxon signed-rank test results (differences in micrograms per liter)

[<, less than]

Herbicide	Number of pairs	Median of paired differences between post- and pre-emergence concentrations	Wilcoxon signed-rank test results		
			Rank	p value	Accept alternate hypothesis?
flumetsulam	65	0.016	442	<0.001	yes
imazethapyr	65	.017	334	.005	yes
nicosulfuron	65	.023	598	<.001	yes
acetochlor	70	–.42	–870	<.001	yes
atrazine	70	–.66	–573	.001	yes
metolachlor	70	–.14	–360	.032	yes
		Discharge, in cubic feet per second			
discharge	75	82	341	.07	no

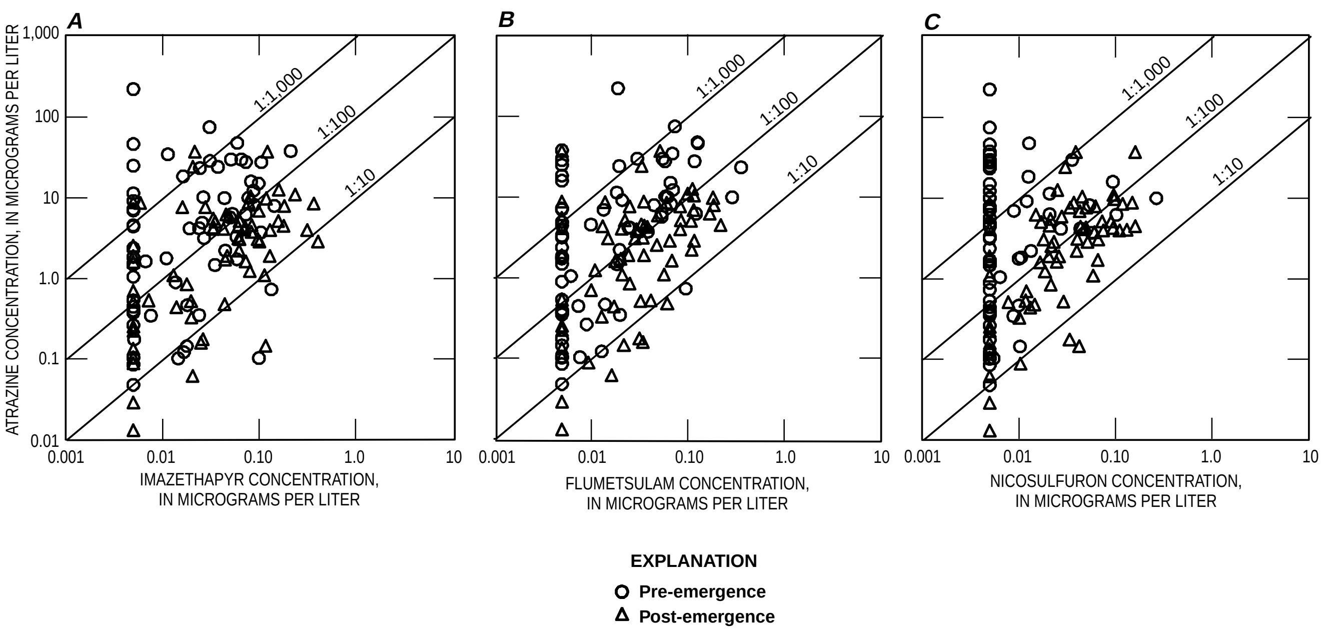


Figure 22. Concentrations of atrazine in samples collected from midwestern streams and reservoir outflows in relation to: (*A*) imazethapyr, (*B*) flumetsulam, and (*C*) nicosulfuron.

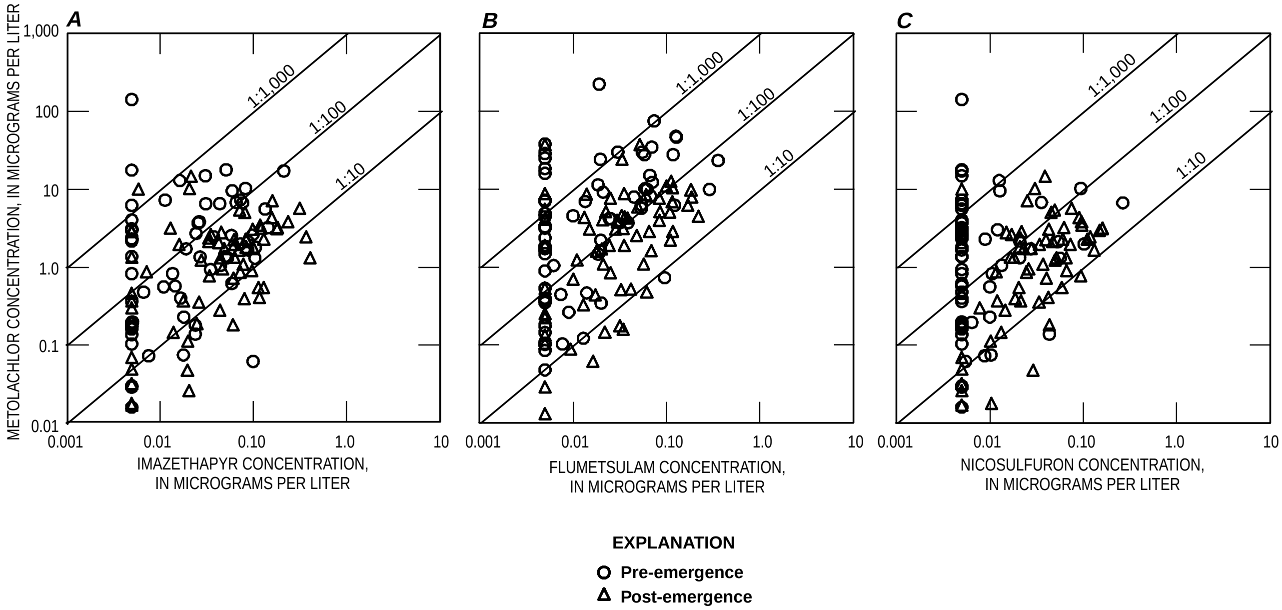


Figure 23. Concentrations of metolachlor in samples collected from midwestern streams and reservoir outflows in relation to: (*A*) imazethapyr, (*B*) flumetsulam, and (*C*) nicosulfuron.

SU, SA, and IMI herbicide concentrations were expected to be smaller relative to atrazine and metolachlor concentrations in the pre-emergence samples than the post-emergence samples because the majority of atrazine and metolachlor is applied before crops emerge, and the majority of the SU, SA, and IMI herbicides are applied after crops emerge. In 68 pre-emergence stream and reservoir outflow samples, the median imazethapyr, flumetsulam, and nicosulfuron to atrazine concentration ratios were 1:157, 1:173, and 1:315, respectively. In 68 post-emergence stream and reservoir outflow samples, the median imazethapyr, flumetsulam, and nicosulfuron to atrazine concentration ratios were 1:50, 1:75, and 1:68, respectively. In all cases, the medians of the ratios of these three compounds to metolachlor concentrations were less than the medians of ratios to atrazine concentration. This was expected as the median atrazine to metolachlor ratios was 2.6:1 for pre-emergence samples and 2.4:1 for post-emergence samples. The distributions of imazethapyr, flumetsulam, and nicosulfuron to atrazine and metolachlor ratios from pre- and post-emergence stream and reservoir outflow samples are shown in figure 24.

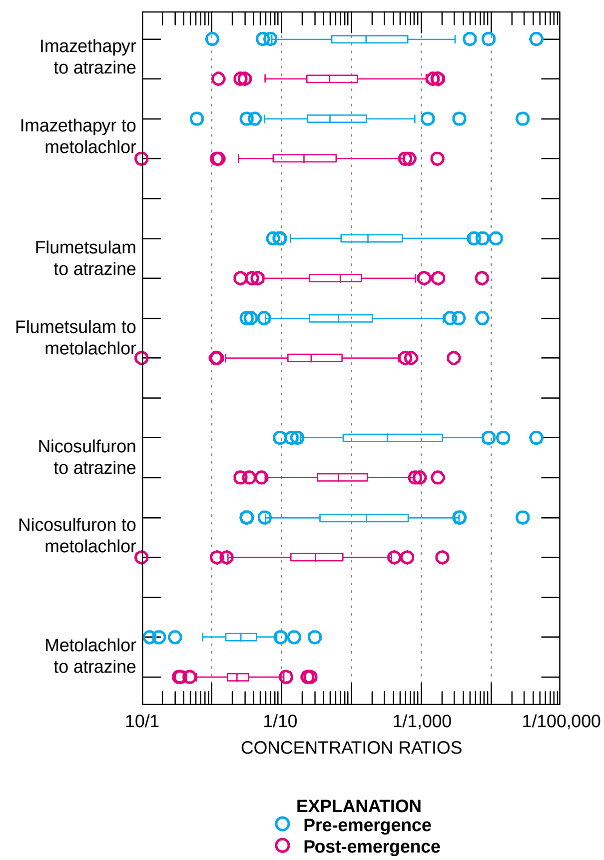


Figure 24. Ratios of imazethapyr, flumetsulam, and nicosulfuron concentrations to atrazine and metolachlor concentrations in pre- and post-emergence stream and reservoir outflow samples.

CONCLUSIONS

Sulfonylurea (SU), sulfonamide (SA), and imidazolinone (IMI) herbicides were detected in samples of both surface water and ground water from across the Midwestern United States. The frequency of detection and concentrations of SU, SA, and IMI herbicides were generally larger in streams and reservoir outflows than in ground-water samples. At least 1 of the 16 SUs, SAs or IMIs was detected at or above the method reporting limit (MRL) of 0.01 μg/L in 111 of 133 stream samples, 6 of 8 reservoir samples, and 5 of 25 ground-water samples. In stream and reservoir samples, the frequency of detection and concentrations of SU, SA, and IMI herbicides were larger in post-emergence samples than in pre-emergence samples. SU, SA, and IMI herbicides were detected less frequently and at substantially lower concentrations than other herbicides like atrazine and metolachlor that are applied in greater total amounts.

The observed ranges and maximum concentrations of SU, SA, and IMI herbicides in samples collected from midwestern streams during post-application runoff events in 1998 were very close to what was expected. The majority of SU, SA, and IMI detections were at concentrations less than 0.1 μg/L. These concentrations are not likely to be toxic to non-target aquatic plants or humans, but they do add to the overall burden of pesticides carried by midwestern streams. The maximum concentrations of SU, SA, and IMI herbicide in samples collected from midwestern ground water in 1998 were slightly higher than expected.

Several other pesticides, particularly triazine and chloroacetanilide herbicides, occurred more frequently and at higher concentrations than did the SU, SA, and IMI herbicides. In streams and reservoir outflows, the SU, SA, and IMI herbicides generally occurred 1/50th or less of the concentrations of atrazine and metolachlor. The ratios of imazethapyr, flumetsulam, and nicosulfuron concentrations to atrazine and metolachlor concentrations were larger in pre-emergence samples (when atrazine and metolachlor concentrations tended to be higher) than in post-emergence samples.

The results and interpretations presented here are limited by the quantity of samples that have been analyzed for SU, SA, and IMI herbicides. The data that are available are lacking, mostly due to the low frequency of sample collection and resulting limited temporal distribution of results. More frequent sampling at selected sites is required to determine if herbicides are present at other times of the year and to determine annual mean concentrations and fluxes of SU, SA, and IMI herbicides in midwestern streams.

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