USGS
science for a changing world

Prepared in cooperation with the Alabama Department of Agriculture and Industries

Occurrence of Pesticides in Groundwater Underlying Areas of High-Density Row-Crop Production in Alabama, 2009–2013

Scientific Investigations Report 2015–5014

U.S. Department of the Interior
U.S. Geological Survey

Occurrence of Pesticides in Groundwater Underlying Areas of High-Density Row-Crop Production in Alabama, 2009–2013

By Heather L. Welch

Prepared in cooperation with the Alabama Department of Agriculture and Industries

Scientific Investigations Report 2015–5014

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
SALLY JEWELL, Secretary

U.S. Geological Survey
Suzette M. Kimball, Acting Director

U.S. Geological Survey, Reston, Virginia: 2015

Suggested citation:
Welch, H.L., 2015, Occurrence of pesticides in groundwater underlying areas of high-density row-crop production in Alabama, 2009–2013: U.S. Geological Survey Scientific Investigations Report 2015–5014, 35 p., *http://dx.doi.org/10.3133/sir20155014.*

ISSN 2328-0328 (online)

Contents

Figures

Tables

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)
acre	0.004047	square kilometer (km^2)
	Volume	
million gallons (Mgal)	3,785	cubic meter (m^3)
	Flow rate	
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

SI to Inch/Pound

Multiply	By	To obtain
	Mass	
kilogram (kg)	2.205	pound, avoirdupois (lb)

Altitude, as used in this report, refers to distance above the vertical datum.

Concentrations of chemical constituents in water are given in micrograms per liter (µg/L).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29).

Abbreviations and Acronyms

HAL	lifetime health advisory level
MCL	maximum contaminant level
MRL	method reporting limit
NAWQA	National Water-Quality Assessment Program
NWQL	National Water Quality Laboratory
USGS	U.S. Geological Survey

Occurrence of Pesticides in Groundwater Underlying Areas of High-Density Row-Crop Production in Alabama, 2009–2013

By Heather L. Welch

Abstract

The U.S. Geological Survey, in cooperation with the Alabama Department of Agriculture and Industries, sampled a network of 15 wells for up to 167 pesticides and pesticide degradates from 2009 through 2013 in three areas of high-density row-crop agriculture in Alabama. Eighteen herbicides, 2 fungicides, and 9 degradates were detected in water from the sampled wells. The highest concentration of a detected pesticide was 4.49 micrograms per liter of bentazon in Baldwin County, Alabama, which was well below the lifetime health advisory level of 200 micrograms per liter. None of the measured pesticide concentrations exceeded a human-health benchmark. Insecticides were not detected.

Relatively flat land and permeable soils prevalent in each of the three areas facilitate the transport of pesticides through the unsaturated zone into the underlying aquifers. Pesticides and the degradate, deethylatrazine, were more frequently detected in groundwater from wells located in northern Alabama than in southeastern Alabama and Baldwin County, Alabama. Greater amounts of pesticide usage and shallow well depths in northern Alabama likely explain the detection of pesticides in that area. Pesticides were detected in two of the shallowest sampled wells in southeastern Alabama, and the detected pesticides have been extensively used on the crops grown in this area. Total pesticide use among the three areas was lowest in Baldwin County; however, fungicides were detected more often in Baldwin County, which is indicative of peanut crops planted in that area.

Concentrations of metolachlor and atrazine have substantially decreased in the northern Alabama wells since 2000. A decline in use of metolachlor and atrazine from a high in the late-1990s and a high in 2004, respectively, in northern Alabama could account for the lower concentrations. Fluometuron use has also declined since 1998, but the relation between time and concentrations differed in the five northern Alabama wells. Fluometuron concentrations in three of the five wells have been decreasing over time, while concentrations in the remaining two wells have been increasing.

Introduction

Agriculture is an important part of the economy for the State of Alabama. In 2012, approximately 3.9 million acres of crops were harvested, and $5.6 billion in agricultural products were sold in the State (U.S. Department of Agriculture, 2012). Agricultural pesticides, including insecticides, herbicides, and fungicides, improve crop production by limiting losses to pests such as insects, weeds, and fungi. More than 4 million acres in Alabama were treated with pesticides during 2012 (U.S. Department of Agriculture, 2012).

Groundwater is an important source of drinking water throughout much of Alabama. In 2005, about 277 million gallons per day (Mgal/d) was withdrawn for public water supply and about 39 Mgal/d was withdrawn for domestic supply (Kenny and others, 2009). The potential for activities related to agriculture at the land surface to adversely affect water quality of drinking-water aquifers can be evaluated in part by characterizing the quality of shallow groundwater that may move downward to underlying aquifers used for public supply. In other areas of the United States, pesticides have been commonly detected in shallow groundwater underlying agricultural and urban land use (Gilliom and others, 2006). The widespread use of pesticides to support agriculture makes responsible management of agricultural pesticide use in the State of Alabama a priority, and monitoring the occurrence of pesticides in groundwater is an important first step in management activities.

The U.S. Geological Survey (USGS), in cooperation with the Alabama Department of Agriculture and Industries, sampled a network of 15 wells for up to 167 pesticides and pesticide degradates from 2009 through 2013 in three areas of intense row-crop agriculture in Alabama. The results of this investigation will provide further scientific data and information on the occurrence, fate, and transport of contaminants in the water resources of the Nation and aid in the evaluation of the vulnerability of water supplies to contamination (Bright and others, 2013; U.S. Geological Survey, 2014).

The three areas selected for this study are underlain by productive aquifers, have high-density row crops, and are located in northern Alabama (Limestone, Madison, and Colbert Counties), southeastern Alabama (Houston, Henry, and Geneva Counties), and Baldwin County in southwestern Alabama (fig. 1). The purpose of this report is to describe the occurrence of pesticides in groundwater samples from wells in these three areas from 2009 through 2013. Occurrence is related to well depth, hydrogeology, and use in each of the three agricultural areas where possible. For temporal comparison, fluometuron, metolachlor, and atrazine concentrations are examined for the five northern Alabama wells from 2000 through 2013.

Hydrogeology

Wells located in northern Alabama were completed in regolith overlying carbonate bedrock that makes up the Mississippian carbonate aquifer (table 1; Kingsbury, 2003). The regolith is a layer of residual material derived in place from the weathering of the carbonate bedrock and is a mixture of clay, silt, and clay-sized chert with some chert gravel and chert interbeds (Kingsbury, 2003). Material in the regolith is poorly consolidated, and the aquifer is under water-table conditions (Kingsbury, 2003).

Wells located in southeastern Alabama were screened in either the Lisbon or the Ocala Limestone aquifer (table 1). The Lisbon aquifer is composed of glauconitic sand, calcareous clay, and thin beds of siltstone and calcareous sandstone overlain by massive sand, sandy clay, and sandy limestone (Scott and Cobb, 1988). The Ocala Limestone aquifer is a basal bed of fossiliferous glauconitic sand overlain by calcareous clay overlain by soft coquinoidal limestone (Scott and Cobb, 1988).

Wells located in Baldwin County were screened in the Miocene aquifer (table 1). The Miocene aquifer is composed of interbedded gravel, sand, silt, and clay and is confined to semi-confined by interbedded clay units (Robinson and others, 1996). Soils overlying the aquifer are highly permeable, which allows for rapid infiltration of water (Mooty, 1988).

Table 1. Characteristics of wells sampled in areas of high-density row-crop production in Alabama, 2009–2013.

[Land-surface datum (LSD) is a datum plane that is approximately at land surface at each well. The altitude of the LSD is described in feet above the National Geodetic Vertical Datum of 1929. USGS, U.S. Geological Survey; M, monitor; D, domestic; I, irrigation; U, unused]

Well number (fig. 1)	USGS station number	County	Well depth (feet below LSD)	Use of well	Aquifer name	Crop type[a]
Northern Alabama						
1	345822086254001	Madison	50	M	Mississippian carbonate	Corn[b], soybeans, cotton
2	345112086313401	Madison	35	M		Corn[b], soybeans, cotton
3	344124086531401	Limestone	24	M		Soybeans[c], cotton, corn
4	344348086493401	Limestone	53	M		Soybeans[c], cotton, corn
5	344131087335201	Colbert	53	M		Soybeans, corn
Southeastern Alabama						
6	312143085230301[d]	Henry	105	D	Lisbon	Peanuts
7	312118085193001[e]	Henry	245	I	Lisbon	Peanuts
8	311928085191101	Henry	231	D	Lisbon	Peanuts
9	311048085403201	Geneva	310	D	Lisbon	Peanuts, cotton
10	310453085383001	Geneva	140	D	Ocala Limestone	Peanuts, cotton
11	310153085225901	Houston	95	D	Ocala Limestone	Cotton[f], peanuts
Baldwin County						
12	303432087485501	Baldwin	110	D	Miocene	Peanuts[g], Soybeans, Corn
13	303252087500801	Baldwin	140	I		
14	303231087525801	Baldwin	130	I		
15	302434087462601	Baldwin	65	U		
16	302438087325801	Baldwin	45	D		

[a]Main crops produced in each county from *http://www.nass.usda.gov/Statistics_by_State/Alabama/Publications/County_Estimates/index.asp* accessed on September 9, 2014.

[b]Top corn-producing county in Alabama.

[c]Top soybean-producing county in Alabama.

[d]Sampled from 2009 through 2011.

[e]Replaced well number 6 beginning with the 2012 sample.

[f]Top cotton-producing county in Alabama.

[g]Top peanut-producing county in Alabama.

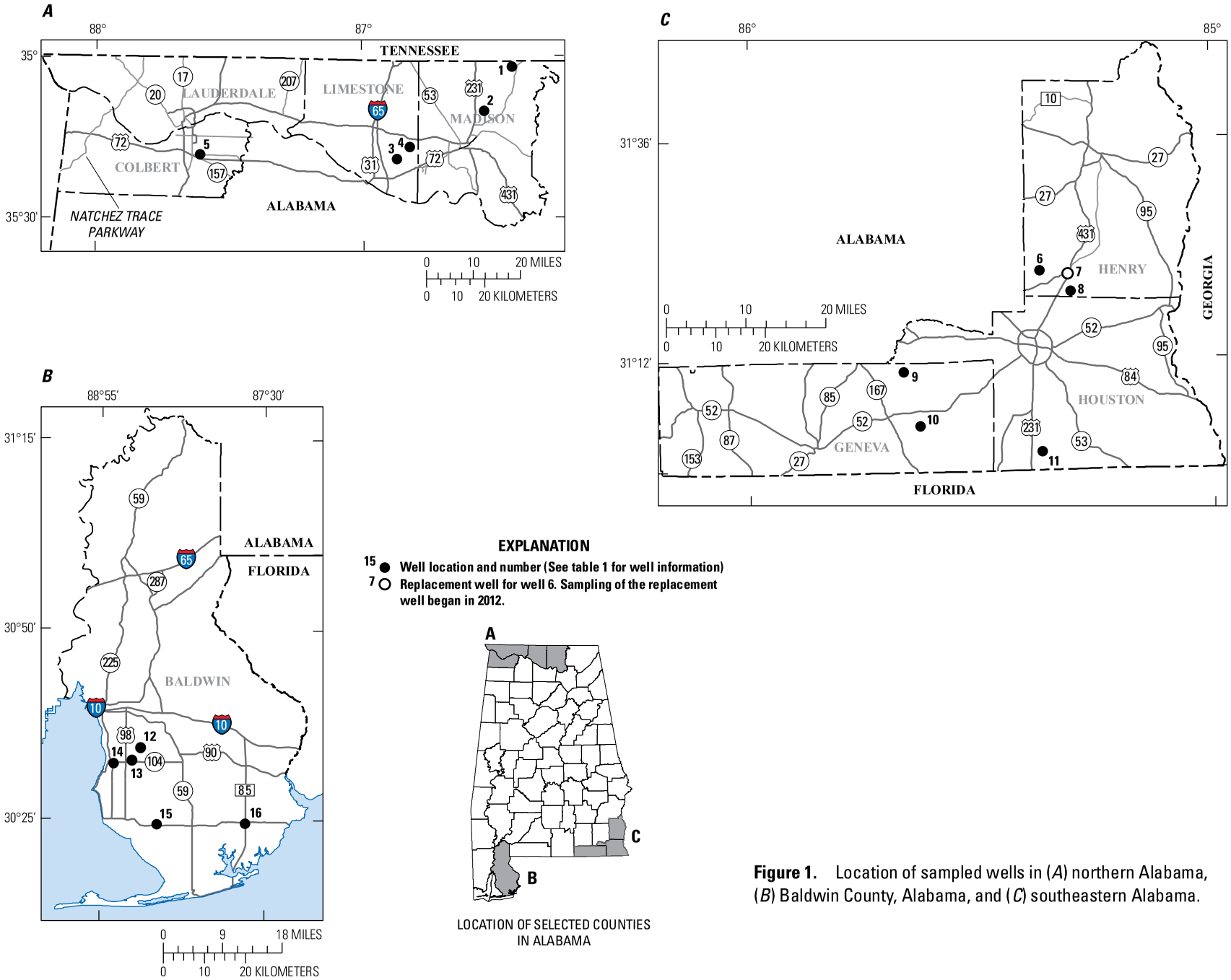

Figure 1. Location of sampled wells in (*A*) northern Alabama, (*B*) Baldwin County, Alabama, and (*C*) southeastern Alabama.

Methods

Five wells in each of the three agricultural areas were sampled during this study once annually from 2009 through 2013 (fig. 1; table 1). During the course of the study, well number 6 in southeastern Alabama was decommissioned; therefore, to maintain the 15-well network, a replacement well (well number 7) was selected for sampling beginning in 2012. The wells were selected based upon several factors, including proximity to row crops, well depth, accessibility, and the existence of comparable pesticide data from previous studies. Domestic water-supply or irrigation wells were sampled in southeastern Alabama and Baldwin County. Site selection and well installation for the monitoring wells located in northern Alabama are outlined in Kingsbury (2003). The wells in northern Alabama were installed for the USGS National Water-Quality Assessment (NAWQA) Program, have been sampled by NAWQA since 2000, and are periodically resampled as a part of that Program. Selected NAWQA data from these wells are presented in addition to the annual samples collected as part of this study. Well depths ranged from 24 to 310 feet (ft), with a median depth of 100 ft.

Sampling procedures, field methods, and equipment decontamination were consistent with standard USGS procedures set forth in the USGS National Field Manual (U.S. Geological Survey, variously dated). Wells were purged of at least three casing volumes of water and (or) until field measurements of temperature, pH, specific conductance, and dissolved oxygen were stable for three consecutive readings at 5-minute intervals prior to sample collection.

Samples from all wells were submitted to the USGS National Water Quality Laboratory (NWQL), in Denver, Colorado, and analyzed for up to 167 pesticides and pesticide degradates by using either capillary-column gas chromatography/mass spectrometry with selected-ion monitoring (Sandstrom and others, 2001) or high-performance liquid chromatography/mass spectrometry (Zaugg and others, 1995; Furlong and others, 2001). Samples were filtered through 0.7-micron glass-fiber filters and shipped on ice overnight to the NWQL. Once at the laboratory, samples were extracted onto solid-phase extraction columns prior to analysis.

In 2012, as part of additional NAWQA sampling, acetamide herbicide degradates were analyzed in samples from five wells located in northern Alabama. Samples were filtered through 0.7-micron glass-fiber filters and shipped on ice overnight to the USGS Organic Geochemistry Research Laboratory in Lawrence, Kansas. Once at the laboratory, samples were extracted onto solid-phase extraction columns prior to analysis as outlined in Lee and Strahan (2003).

Some concentrations of pesticides were estimated by the two laboratories. Possible reasons for estimating concentrations are as follows: (1) the concentration was greater than or equal to the long-term method reporting level (MRL) but less than the laboratory reporting limit; (2) the concentration was greater than or equal to the long-term MRL but less than the lowest calibration standard; (3) the result was extrapolated above the calibration curve; (4) data quantification was not performed according to method-specific criteria; (5) performance of the analyte did not meet acceptable method-specific criteria; (6) deviation from the standard operating procedure was required; (7) some moderate losses occurred in sample preparation but were not quantifiable; and (8) moderate matrix interference conditions occurred (Childress and others, 1999). Estimated concentrations were treated as detections in this study unless the value was lower than the MRL for that constituent. All detected values lower than an established MRL were "censored" and reported as less than (<) the MRL. In addition, during the period of sample collection, MRLs for some of the analytical methods changed. In this report, detection frequencies of each pesticide were calculated with a common MRL (table 2).

Quality-control data were collected at selected sites during the study period from 2009 through 2013 and included eight field equipment blanks to measure contamination, replicate samples to estimate variability, and field-spike samples to measure recovery of analytes. Analyzed pesticides were not detected in the field equipment blanks. Three field-spikes of pesticide compounds were conducted during the study period. Recoveries in the spiked samples ranged from 89 to 110 percent, indicating no substantial loss of pesticides during transport to the NWQL, no matrix effects, and adequate extraction procedures.

Variability in the sample dataset was quantified by collecting 11 replicates during the study period (appendix 1). The relative percent difference for pesticides ranged from 0 to 5.4 percent, with a median of 0.86 percent. The relative percent difference is computed as

$$[|A-B|/(A+B)]/2\times100, \quad (1)$$

where

A represents the environmental sample concentration and

B represents the replicate sample concentration.

In two pairs of samples, a pesticide was detected in the replicate sample but not in the environmental sample. Analysis of the quality-control dataset included all detected values, including those below the MRL.

Table 2. Summary statistics for pesticides detected in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2009–2013.

[The method reporting level (MRL) was equal to the minimum concentration for each pesticide. Human-health benchmarks are from appendix 3A in Gilliom and others (2006). USGS, U.S. Geological Survey; µg/L, micrograms per liter; <, less than; MCL, maximum contaminant level; HAL, lifetime health advisory level; —, no benchmark available]

Pesticide	USGS parameter code	Number of samples	Detection frequency (percent)	MRL, in µg/L	Human-health benchmark, in µg/L, and type of benchmark	Maximum, in µg/L	Median, in µg/L
			Herbicides				
Alachlor	46342	75	7	<0.008	2; MCL	0.064	<0.008
Atrazine	39632	79	43	<0.008	3; MCL	0.378	0.008
Bentazon	38711	65	6	<0.06	200; HAL	4.49	<0.06
DCPA	82682	75	1	<0.0076	70; HAL	0.0152	<0.0076
Dinoseb	49301	65	8	<0.06	7; MCL	1.06	<0.06
Diuron	49300	65	5	<0.08	10; HAL	0.29	0.04
Fluometuron	38811	65	45	<0.04	90; HAL	2.71	0.04
Glyphosate	62722	5	20	<0.02	—	0.02	<0.02
Metolachlor	39415	75	23	<0.02	100; HAL	4.30	<0.02
Metribuzin	82630	75	1	<0.016	200; HAL	0.023	<0.016
Molinate	82671	75	1	<0.008	—	0.0223	<0.008
Norflurazon	49293	65	25	<0.04	—	1.49	0.04
Prometon	04037	75	5	<0.018	100; HAL	0.027	<0.018
Prometryn	04036	75	3	<0.010	—	0.027	<0.010
Simazine	04035	75	7	<0.011	4; MCL	0.353	<0.011
Tebuthiuron	82670	79	4	<0.06	500; HAL	0.123	<0.06
Terbuthylazine	04022	75	1	<0.008	—	0.021	<0.008
Thiobencarb	82681	75	1	<0.016	—	0.029	<0.016
			Fungicides				
cis-Propiconazole	79846	75	1	<0.008	—	0.010	<0.008
Metalaxyl[a]	50359	65	6	<0.06	—	0.10	<0.06
Metalaxyl	61596	75	8	<0.014	—	0.134	<0.014
			Degradates				
2-Chloro-4-isopropylamino-6-amino-s-triazine (deethylatrazine)	04040	79	38	<0.014	—	0.598	0.014
2-[(2-Ethyl-6-methylphenyl) amino]-2-oxoethanesulfonic acid (acetochlor ESA)	62850	5	40	<0.02	—	0.04	<0.02
3,4-Dichloroaniline	61625	75	4	<0.006	—	0.0212	<0.006
Alachlor oxanilic acid (alachlor OXA)	61031	5	40	<0.02	—	0.05	<0.02
Alachlor sulfonic acid (alachlor ESA)	50009	5	20	<0.02	—	0.13	<0.02
Disulfoton sulfone	61640	75	1	<0.014	—	0.022	0.014
Metolachlor oxanilic acid (metolachlor OXA)	61044	5	60	<0.02	—	0.09	0.02
Metolachlor sulfonic acid (metolachlor ESA)	61043	5	60	<0.02	—	0.23	0.14
sec-Alachlor sulfonic acid	62849	5	20	<0.02	—	0.02	<0.02

[a]Metalaxyl was analyzed using two different methods as noted by separate parameter codes.

Pesticides Detected in the Sampled Wells

Twenty-nine pesticides—18 herbicides, 2 fungicides, and 9 degradates—were detected in water from 12 of the groundwater wells sampled during this study (table 2). A list of pesticides not detected in any groundwater samples collected during the study period can be found in table 3. Results for water-quality analysis of the sampled wells can be found in appendix 2. No pesticides were detected in groundwater from wells 7 through 9 or well 11, all in southeastern Alabama (fig. 1; appendix 2). Fluometuron, atrazine, norflurazon, and metolachlor were the most frequently detected herbicides during the 5-year study period. Fungicides were detected in about 8 percent or less of the samples, and insecticides were not detected (tables 2 and 3). The highest concentration measured for any pesticide was a detection of 4.49 micrograms per liter (µg/L) of bentazon at well 15 in Baldwin County (table 2; appendix 2). None of the measured concentrations in any well exceeded a human-health benchmark (table 2).

Intensity of use and chemical and physical properties of a pesticide are two of the important factors that influence occurrence in groundwater. Glyphosate, atrazine, and metolachlor were the most widely used pesticides in the study area (fig. 2; Stone, 2013); atrazine and metolachlor have been frequently detected in groundwater across the United States (Gilliom and others, 2006). Atrazine is generally more prevalent than metolachlor in groundwater because atrazine is more persistent with a half-life of 146 days compared to 26 days for metolachlor (Gilliom and others, 2006). Norflurazon and fluometuron are two herbicides that are used to control weeds in cotton, which is a relatively prevalent row crop in the study area. In addition to the amount of use (fig. 2), the frequency of detection is likely related to the fact that norflurazon and fluometuron are both mobile and persistent, which allows for leaching into groundwater long after they have been applied. The half-life of norflurazon in soils ranges from 38 to 731 days, and the half-life of fluometuron in water is 110 to 144 weeks (Cornell University, 2008).

Degradates are often more prevalent in groundwater than their parent compounds and can be just as harmful as or more persistent than the parent compound (Bergin and Nordmark, 2012). Three degradates were detected in the annual samples, but only deethylatrazine was detected in more than 5 percent of samples. Deethylatrazine was detected almost as frequently and at similar concentrations as its parent compound, atrazine (table 2).

Effect of Well Depth and Pesticide Use on Pesticide Detections

Frequency of detection and the types of pesticides detected can be related to local hydrogeology and the pesticides used on the specific crops grown in each area. Each of the three agricultural areas are located on relatively flat land, which contributes to less runoff from fields and greater infiltration of pesticides through the permeable soils and unsaturated zones underlying each area. However, well depths in the areas differed greatly. The median depths were 50 ft in northern Alabama, 185.5 ft in southeastern Alabama, and 110 ft in Baldwin County.

Northern Alabama

Twelve herbicides, 1 fungicide, and 3 degradates were detected in water from wells located in northern Alabama (table 4). The number of pesticides and degradates detected was greater and detection frequencies were higher in water

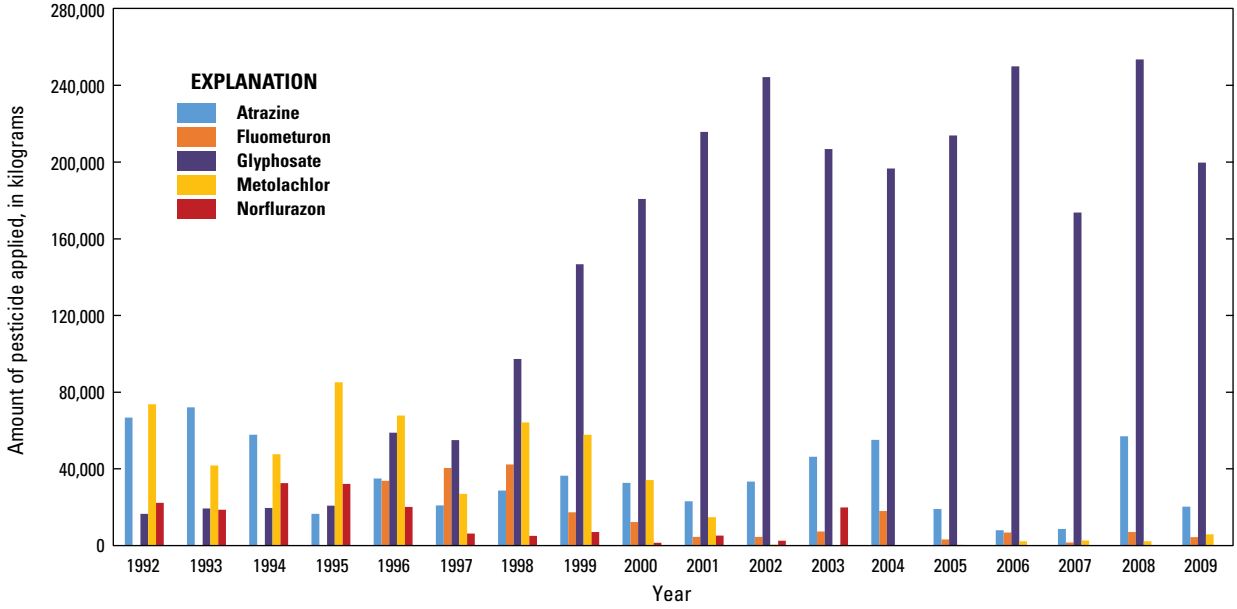

Figure 2. Total amounts of atrazine, fluometuron, glyphosate, metolachlor, and norflurazon applied in Baldwin, Colbert, Geneva, Henry, Houston, Limestone, and Madison Counties in Alabama, 1992–2009.

from wells located in northern Alabama than in water from wells located in southeastern Alabama and Baldwin County (table 4). Atrazine and fluometuron were detected in 100 percent of the collected samples, and the degradate, deethylatrazine, was detected in 97 percent of the collected samples in northern Alabama. The highest concentration of any pesticide detected in northern Alabama was 2.71 µg/L of fluometuron, which was below the lifetime health advisory level (HAL) of 90 µg/L (tables 2 and 4).

Shallower well depths and greater amounts of pesticides applied to crops likely influence the frequency of detection and variety of pesticides that were detected in groundwater of northern Alabama when compared to southeastern Alabama and Baldwin County. Atrazine, fluometuron, and norflurazon use was higher in northern Alabama compared to the use in southeastern Alabama and Baldwin County from 1992 through 2009 (Stone, 2013; figs. 3*A*, *B*, and *D*). Use of these pesticides was warranted by the main crops in the area—corn, soybeans, and to a lesser extent, cotton (table 1). The frequency of detection and variety of pesticides detected suggest that pesticides are transported readily into shallow groundwater in regolith overlying the Mississippian carbonate aquifer.

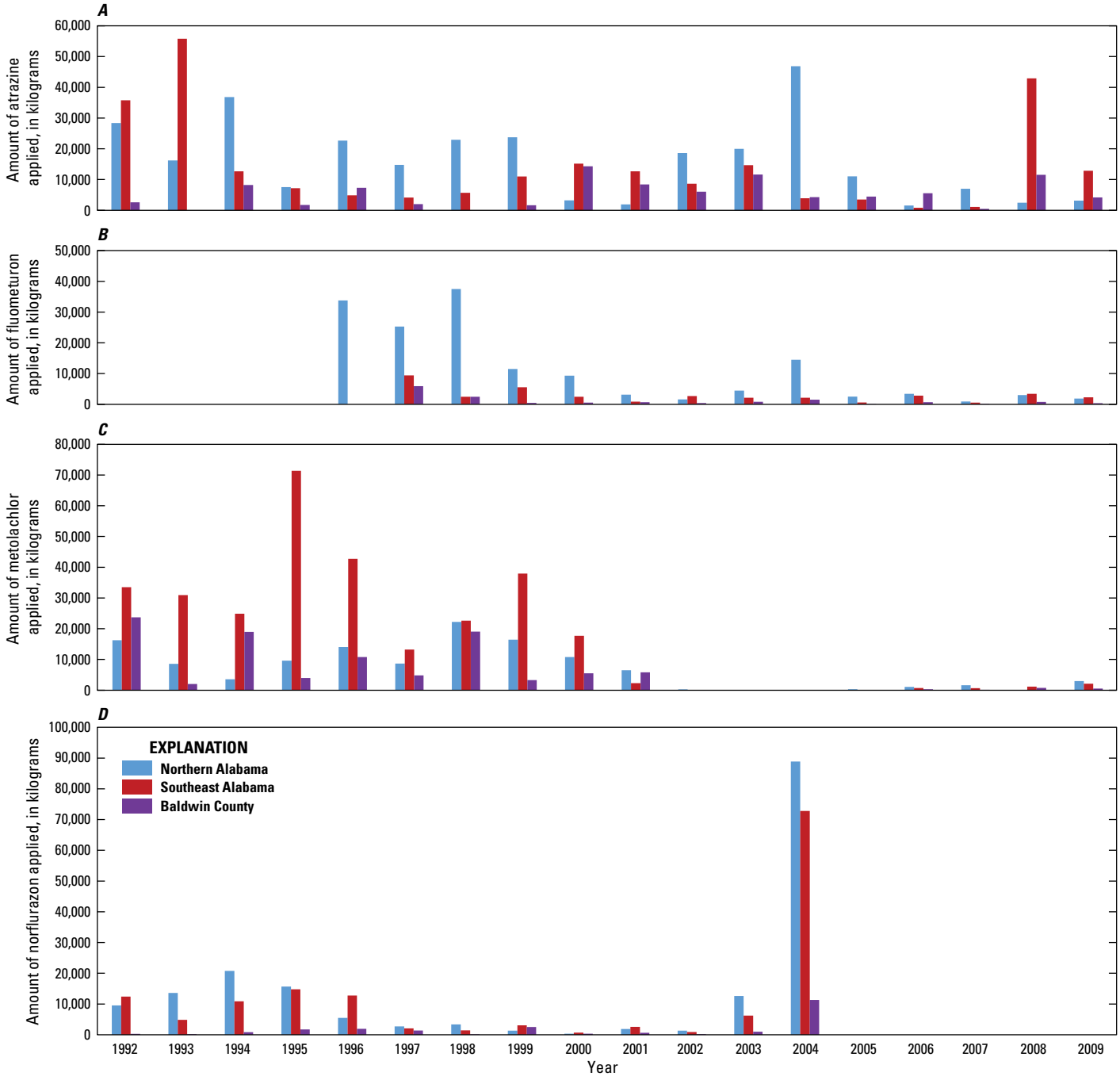

Figure 3. Total amounts of (*A*) atrazine, (*B*) fluometuron, (*C*) metolachlor, and (*D*) norflurazon applied in each of three high-density row-crop areas in Alabama, 1992–2009.

Southeastern Alabama

Six herbicides and one pesticide degradate were the only compounds detected in water from wells in southeastern Alabama (table 4), where cotton and peanuts are the predominant crops. The highest concentration of a pesticide was 1.49 µg/L of norflurazon, which is an herbicide applied to cotton. Dinoseb, an herbicide used on peanuts, was the most frequently detected pesticide. All the detected pesticides were in water from two of the shallow wells in southeastern Alabama—wells 6 and 10 (appendix 2). Two pesticides, atrazine and tebuthiuron, and the degradate, deethylatrazine, were detected in water from well 6 (appendix 2). Alachlor, dinoseb, fluometuron, and norflurazon were detected in water from well 10. Although use of metolachlor from 1992 through 2009 was higher in southeastern Alabama (fig. 3*C*; Stone, 2013) than in northern Alabama and Baldwin County, metolachlor was not detected in water from any of the wells in southeastern Alabama (table 4). The lack of metolachlor detection in the wells could be related to greater well depths in southeastern Alabama.

Baldwin County, Alabama

Four herbicides and two fungicides were detected in water from wells located in Baldwin County (table 4). While metolachlor was the most frequently detected pesticide, the highest concentration of any pesticide at any location was 4.49 µg/L of bentazon from well 15 in Baldwin County (appendix 2). This concentration was below the HAL of 200 µg/L for bentazon. The detection of fungicides is not surprising because they are applied annually to peanuts, and Baldwin County is the top peanut-producing county in Alabama (table 1). From 1992 through 2009, the use of select pesticides in Baldwin County (fig. 3) was generally less than 20,000 kilograms per year, which is less than use in northern Alabama and southeastern Alabama (Stone, 2013). Metolachlor was used more than the other three herbicides, which could explain its detection in shallow groundwater underlying Baldwin County.

Table 3. Pesticides not detected in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2009–2013.

[USGS, U.S. Geological Survey]

USGS parameter code	Pesticide	USGS parameter code	Pesticide	USGS parameter code	Pesticide
		Herbicides			
39732	2,4-D	38442	Dicamba	49294	Neburon
38746	2,4-DB	49302	Dichlorprop	50364	Nicosulfuron
50470	2,4-D methyl ester	61588	Dimethenamid	49292	Oryzalin
66496	2,4-D plus 2,4-D methyl ester	04033	Diphenamid	61600	Oxyfluorfen
49260	Acetochlor	82668	EPTC	82683	Pendimethalin
49315	Acifluorfen	49297	Fenuron	49291	Picloram
82673	Benfluralin	62481	Flufenacet	04024	Propachlor
61693	Bensulfuron-methyl	61694	Flumetsulam	82679	Propanil
04029	Bromacil	62721	Glufosinate	49236	Propham
49311	Bromoxynil	04025	Hexazinone	82676	Propyzamide
04028	Butylate	50356	Imazaquin	38548	Siduron
61188	Chloramben methyl ester	50407	Imazethapyr	50337	Sulfometuron-methyl
50306	Chlorimuron-ethyl	38478	Linuron	04032	Terbacil
49305	Clopyralid	38482	MCPA	61610	Tribufos
04041	Cyanazine	38487	MCPB	49235	Triclopyr
04031	Cycloate	61697	Metsulfuron-methyl	82661	Trifluralin

Table 3. Pesticides not detected in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2009–2013.—Continued

[USGS, U.S. Geological Survey]

USGS parameter code	Pesticide	USGS parameter code	Pesticide	USGS parameter code	Pesticide
			Insecticides		
49312	Aldicarb	38454	Dicrotophos	39532	Malathion
34362	alpha-Endosulfan	39381	Dieldrin	61598	Methidathion
82686	Azinphos-methyl	82662	Dimethoate	38501	Methiocarb
50299	Bendiocarb	82677	Disulfoton	49296	Methomyl
49310; 82680	Carbaryl	82346	Ethion	82667	Methyl parathion
49309; 82674	Carbofuran	82672	Ethoprop	38866	Oxamyl
38933	Chloropyrifos	61591	Fenamiphos	82664	Phorate
82687	*cis*-Permethrin	62166	Fipronil	61601	Phosmet
61585	Cyfluthrin	04095	Fonofos	82685	Propargite
61586	Cypermethrin	61695	Imidacloprid	38538	Propoxur
39572	Diazinon	61594	Isofenphos	61606	Tefluthrin
38775	Dichlorvos	61595	lambda-Cyhalothrin	82675	Terbufos
			Fungicides		
50300	Benomyl	61599	Myclobutanil	62852	Tebuconazole
61593	Iprodione	50471	Propiconazole	79847	*trans*-Propiconazole
			Degradates		
49295	1-Napthol	61635	Azinphos-methyl oxygen analog	62168	Fipronil sulfone
82660	2,6-Diethylaniline	61636	Chlorpyrifos oxygen analog	62483	Flufenacet oxanilic acid
61618; 63781	2-Chloro-2',6'-diethylacetanilide	49304	DCPA, monoacid	61952	Flufenacet sulfonic acid
04038	2-Chloro-6-ethylamino-4-amino-s-triazine (deisopropylatrazine)	63778	Dechloroacetochlor	63784	Hydroxyacetochlor
63782	2-Chloro-N-(2-ethyl-6-methylphenyl) acetamide	63780	Dechlorometolachlor	63783	Hydroxyalachlor
61633	4-Chloro-2-methylphenol	63777	Dechloroalachlor	64045	Hydroxydimethenamid
50355	2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine (hydroxyatrazine)	63779	Dechlorodimethenamid	63785	Hydroxymetolachlor
61627	3,5-Dichloroaniline	62170	Desulfinylfipronil	61652	Malaoxon
61620	2-Ethyl-6-methylaniline	62169	Desulfinylfipronil amide	61664	Methyl paraoxon
49308	3-Hydroxy carbofuran	61638	Diazoxon	61692	N-(4-Chlorophenyl)-N'-methylurea
61030	Acetochlor oxanilic acid	62482	Dimethenamid oxanilic acid	61666	Phorate oxyen analog
62847	Acetochlor sulfinylacetic acid	61951	Dimethenamid sulfonic acid	61668	Phosmet oxygen analog
61029	Acetochlor sulfonic acid	61590	Endosulfan sulfate	62766	Propachlor sulfonic acid
62848	Alachlor sulfinylacetic acid	61644	Ethion monoxon	61674	Terbufos oxygen analog sulfone
49313	Aldicarb sulfone	61645	Fenamiphos sulfone		
49314	Aldicarb sulfoxide	61646	Fenamiphos sulfoxide		
62649	Aminomethylphosphonic acid	62167	Fipronil sulfide		

Table 4. Summary statistics for pesticides detected in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2009–2013, by agricultural region.

[All concentrations are in micrograms per liter. USGS, U.S. Geological Survey; N, number; --, not detected; <, less than]

Pesticide	USGS parameter name	Northern Alabama					Southeastern Alabama				
		N	Detection frequency (percent)	Minimum	Maximum	Median	N	Detection frequency (percent)	Minimum	Maximum	Median
Herbicides											
Alachlor	46342	--	--	--	--	--	25	20	<0.008	0.064	<0.008
Atrazine	39632	29	100	0.01	0.378	0.057	25	20	<0.008	0.025	<0.008
Bentazon	38711	--	--	--	--	--	--	--	--	--	--
DCPA	82682	25	4	<0.0076	0.0152	<0.0076	--	--	--	--	--
Dinoseb	49301	--	--	--	--	--	20	25	<0.06	1.06	<0.06
Diuron	49300	25	12	<0.08	0.29	<0.08	--	--	--	--	--
Fluometuron	38811	25	100	0.09	2.71	0.24	20	20	<0.04	0.11	<0.04
Metolachlor	39415	25	44	<0.02	0.307	<0.02	--	--	--	--	--
Metribuzin	82630	--	--	--	--	--	--	--	--	--	--
Molinate	82671	25	4	<0.008	0.0223	<0.008	--	--	--	--	--
Norflurazon	49293	25	48	<0.04	0.93	<0.04	20	20	<0.04	1.49	<0.04
Prometon	04037	25	16	<0.018	0.027	<0.018	--	--	--	--	--
Prometryn	04036	25	8	<0.010	0.027	<0.010	--	--	--	--	--
Simazine	04035	25	16	<0.011	0.014	<0.011	--	--	--	--	--
Tebuthiuron	82670	--	--	--	--	--	25	12	<0.06	0.123	<0.06
Terbuthylazine	04022	25	4	<0.008	0.021	<0.008	--	--	--	--	--
Thiobencarb	82681	25	4	<0.016	0.029	<0.016	--	--	--	--	--
Fungicides											
cis-Propiconazole	79846	--	--	--	--	--	--	--	--	--	--
Metalaxyl	50359	--	--	--	--	--	--	--	--	--	--
Metalaxyl	61596	25	4	<0.014	0.015	<0.014	--	--	--	--	--
Degradates											
2-Chloro-4-isopropylamino-6-amino-s-trazine (deethylatrazine)	04040	29	97	<0.014	0.598	0.054	25	8.3	<0.014	0.032	<0.014
3,4-Dichloroaniline	61625	25	12	<0.006	0.0212	<0.006	--	--	--	--	--
Disulfoton sulfone	61640	25	4	<0.014	0.022	<0.014	--	--	--	--	--

Table 4. Summary statistics for pesticides detected in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2009–2013, by agricultural region.—Continued

[All concentrations are in micrograms per liter. USGS, U.S. Geological Survey; N, number; --, not detected; <, less than]

Pesticide	USGS parameter name	Baldwin County				
		N	Detection frequency (percent)	Minimum	Maximum	Median
Herbicides						
Alachlor	46342	--	--	--	--	--
Atrazine	39632	--	--	--	--	--
Bentazon	38711	20	20	<0.06	4.49	<0.06
DCPA	82682	--	--	--	--	--
Dinoseb	49301	--	--	--	--	--
Diuron	49300	--	--	--	--	--
Fluometuron	38811	--	--	--	--	--
Metolachlor	39415	25	24	<0.02	4.30	<0.02
Metribuzin	82630	25	4	<0.016	0.023	<0.016
Molinate	82671	--	--	--	--	--
Norflurazon	49293	--	--	--	--	--
Prometon	04037	--	--	--	--	--
Prometryn	04036	--	--	--	--	--
Simazine	04035	25	4	<0.011	0.353	<0.011
Tebuthiuron	82670	--	--	--	--	--
Terbuthylazine	04022	--	--	--	--	--
Thiobencarb	82681	--	--	--	--	--
Fungicides						
cis-propiconazole	79846	25	4	<0.008	0.010	<0.008
Metalaxyl	50359	20	20	<0.06	0.10	<0.06
Metalaxyl	61596	25	20	<0.014	0.134	<0.014
Degradates						
2-Chloro-4-isopropylamino-6-amino-s-trazine (deethylatrazine)	04040	--	--	--	--	--
3,4-Dichloroaniline	61625	--	--	--	--	--
Disulfoton sulfone	61640	--	--	--	--	--

Pesticide Concentrations and Detections in Northern Alabama Since 2000—Fluometuron, Metolachlor, and Atrazine

Metolachlor and atrazine concentrations have decreased substantially in the northern Alabama wells since 2000 when they were first installed and sampled as part of the NAWQA Program (fig. 4). A decline in use of metolachlor and atrazine in this area from the late-1990s for metolachlor and 2004 for atrazine could account for lower concentrations (Stone, 2013). Concentrations of fluometuron have generally declined since 2000 in the northern Alabama wells; however, concentrations of fluometuron have increased in wells 2 and 3 (appendix 2). Fluometuron use in northern Alabama has declined from a high in 1998 likely because of an increase in use of glyphosate on resistant crops. More than 63 percent of the total glyphosate application in the counties in the study area has been on agricultural lands in the northern Alabama counties (Stone, 2013).

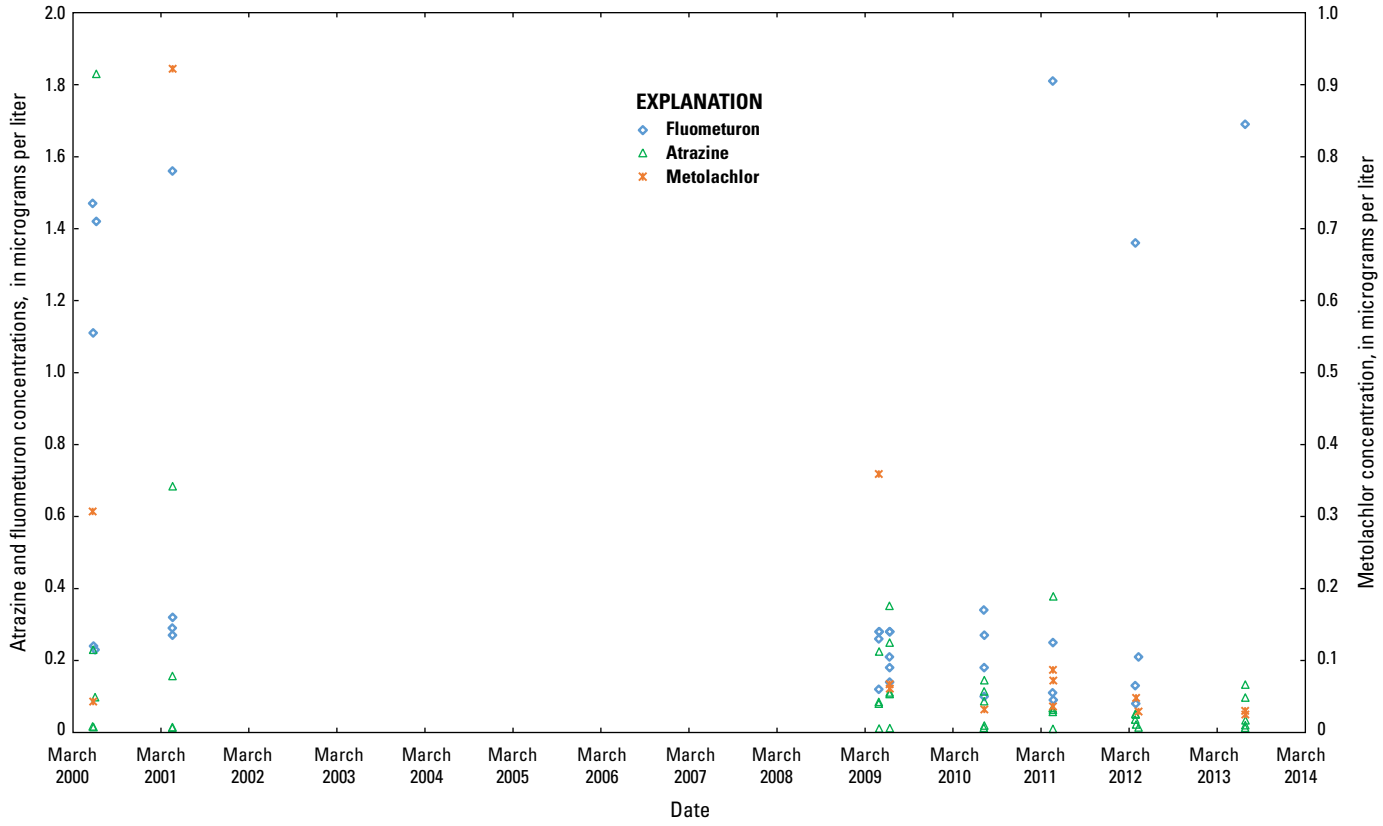

Figure 4. Fluometuron, metolachlor, and atrazine concentrations detected in samples from wells in high-density row-crop areas in northern Alabama, 2000–2013.

Summary and Conclusions

Each year a large amount of pesticides are applied to land in the United States for the control of weeds, insects, and other pests, and agriculture accounts for the majority of the total pesticide usage across the United States. Pesticides have the potential to affect water quality by infiltrating into shallow groundwater, which could influence water quality in deeper underlying aquifers used as drinking-water sources and water quality in nearby streams.

During 2009–2013, the U.S. Geological Survey, in cooperation with the Alabama Department of Agriculture and Industries, sampled a network of 15 wells for a total of 167 pesticides and pesticide degradates in three areas of intense high-density row-crop agriculture in Alabama. Eighteen herbicides, 2 fungicides, and 9 degradates were detected in water from the sampled wells. The highest concentration of a detected pesticide was 4.49 micrograms per liter of bentazon in Baldwin County, Alabama; this concentration was well below the lifetime health advisory level of 200 micrograms per liter. None of the measured pesticide concentrations exceeded a human-health benchmark. Insecticides were not detected.

Detection of pesticides and degradates in water from wells located in the study area reflected the influence of local land use, well depth, and pesticide use in each area. Pesticide use was greater in northern Alabama and well depths were shallower when compared to those in southeastern Alabama and Baldwin County; well depths likely influenced the higher detection frequencies and the greater number of pesticides detected in the shallow monitoring wells in northern Alabama. Common pesticides detected during this study, such as atrazine and metolachlor, are among the most frequently detected pesticides in surface water throughout the United States, and could have an adverse effect on aquatic life.

Use of metolachlor, atrazine, and to a lesser extent, fluometuron, has decreased in northern Alabama with time. Results from this study indicate that concentrations of these three herbicides have also generally decreased in northern Alabama wells since they were first sampled in 2000. Even though concentrations are decreasing, however, all three herbicides are still frequently detected in groundwater in northern Alabama. Thus, long-term monitoring of the groundwater resources underlying these three areas of Alabama is important because some pesticides have the potential to affect water quality years into the future.

References

Bergin, R., and Nordmark, C., 2012, Study GW 09: Ground water protection list monitoring for metolachlor and alachlor: California Environmental Protection Agency Department of Pesticide Regulation Report GW 09B, 38 p.

Bright, P.R., Buxton, H.T., Balistrieri, L.S., Barber, L.B., Chapelle, F.H., Cross, P.C., Krabbenhoft, D.P., Plumlee, G.S., Sleeman, J.M., Tillitt, D.E., Toccalino, P.L., and Winton, J.R., 2013, U.S. Geological Survey environmental health science strategy—Providing environmental health science for a changing world: U.S. Geological Survey Circular 1383-E, 43 p.

Childress, C.J.O., Foreman, W.T., Connor, B.F., and Maloney, T.J., 1999, New reporting procedures based on long-term method detection levels and some considerations for interpretations of water-quality data provided by the U.S. Geological Survey National Water Quality Laboratory: U.S. Geological Survey Open-File Report 99-193, 19 p.

Cornell University, 2008, Pesticide Management Education Program, accessed October 27, 2014, at *http://pmep.cce.cornell.edu/*.

Furlong, E.T., Anderson, B.D., Werner, S.L., Soliven, P.P., Coffey, L.J., and Burkhardt, M.R., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of pesticides in water by graphitized carbon-based solid-phase extraction and high-performance liquid chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4134, 73 p.

Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagaki, N., Nowell, L.H., Scott, J.C., Stackelberg, P.E., Thelin, G.P., and Wolock, D.M., 2006, The quality of our Nation's waters—Pesticides in the Nation's streams and ground water, 1992-2001: U.S. Geological Survey Circular 1291, 172 p.

Kenny, J.F., Barber, N.L., Hutson, S.S., Linsey, K.S., Lovelace, J.K., and Maupin, M.A., 2009, Estimated use of water in the United States in 2005: U.S. Geological Survey Circular 1344, 52 p.

Kingsbury, J.A., 2003, Shallow groundwater quality in agricultural areas of northern Alabama and middle Tennessee, 2000–2001: U.S. Geological Survey Water-Resources Investigations Report 03-4181, 38 p.

Lee, E.A., and Strahan, A.P., 2003, Mathods of analysis by the U.S. Geological Survey Organic Geochemistry Research Group—Determination of acetamide herbicides and their degradation products in water using online solid-phase extraction and liquid-chromatography/mass spectrometry: U.S. Geological Survey Open-File Report 03-173, 17 p.

Mooty, W.S., 1988, Geohydrology and susceptibility of major aquifers to surface contamination in Alabama; area 13: U.S. Geological Survey Water-Resources Investigations Report 88-4080, 29 p.

Robinson, J.L., Moreland, R.S., and Clark, A.E., 1996, Groundwater resources data for Baldwin County, Alabama: U.S. Geological Survey Open-File Report 96-487, 63 p.

Sandstrom, M.W., Stroppel, M.E., Foreman, W.T., and Schroeder, M.P., 2001, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of moderate-use pesticides and selected degradates in water by C-18 solid-phase extraction and gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4098, 70 p.

Scott, J.C., and Cobb, R.H., 1988, Geohydrology and susceptibility of major aquifers to surface contamination in Alabama; Area 12: U.S. Geological Survey Water-Resources Investigations Report 88-4078, 51 p.

Stone, W.W., 2013, Estimated annual agricultural pesticide use for counties of the conterminous United States, 1992–2009: U.S. Geological Survey Data Series 752, 1-p. pamphlet, 14 tables.

Thelin, G.P., and Stone, W.W., 2013, Estimation of annual agricultural pesticide use for counties of the conterminous United States, 1992–2009: U.S. Geological Survey Scientific Investigations Report 2013-5009, 54 p.

U.S. Department of Agriculture, 2012, National census of agriculture, accessed September 22, 2014, at *http://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=ALABAMA*.

U.S. Geological Survey, 2014, Drinking water exposure to chemical and pathogenic contaminants, accessed November 20, 2014, at *http://health.usgs.gov/dw_contaminants/*.

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A9. [Also available online at *http://pubs.water.usgs.gov/twri9A*.]

Zaugg, S.D., Sandstrom, M.W., Smith, S.G., and Fehlberg, K.M., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of pesticides in water by C-18 solid-phase extraction and capillary-column gas chromatography/mass spectrometry with selected-ion monitoring: U.S. Geological Survey Open-File Report 95-181, 49 p.

Appendixes

Appendix 1. Relative percent difference between environmental and replicate samples collected at selected wells located in areas of high-density row-crop production in Alabama, 2009–2013.

[µg/L, micrograms per liter; <, less than; NC, not calculated; --, not detected]

Pesticide	Environmental concentration, in µg/L	Replicate concentration, in µg/L	Relative percent difference
2-Chloro-4-isopropylamino-6-amino-s-triazine (deethylatrazine)	<0.014	<0.014	--
	0.007	0.0068	0.72
	0.0064	0.0059	2.03
	0.0058	0.006	0.85
	0.0053	0.0051	0.96
	0.0048	0.0046	1.06
	<0.006	<0.006	--
	0.0324	0.0302	1.76
	0.0267	0.029	2.06
	0.0271	0.0246	2.42
	0.0983	0.0924	1.55
2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine (hydroxyatrazine)	<0.06	<0.06	--
	<0.06	<0.06	--
	<0.06	<0.06	--
	<0.06	<0.06	--
	<0.06	<0.06	--
	<0.06	<0.06	--
	<0.06	<0.06	--
	0.0162	0.0165	0.46
	0.0201	0.0177	3.17
	0.0176	0.017	0.87
3,4-Dichloroaniline	<0.0042	<0.0055	--
	<0.0042	<0.0042	--
	<0.006	<0.006	--
	<0.006	<0.006	--
	<0.004	<0.004	--
	<0.006	<0.006	--
	<0.006	<0.006	--
	<0.0042	<0.0042	--
	<0.006	0.0014	NC
	0.0022	0.0022	0.00
Aldicarb sulfoxide	<0.06	<0.06	--
	<0.06	<0.06	--
	<0.08	<0.08	--
	<0.08	<0.08	--
	<0.08	<0.08	--
	<0.08	<0.08	--
	<0.06	<0.06	--
	<0.08	<0.08	--
	0.0118	0.0116	0.43
	<0.06	<0.06	--
Atrazine	<0.007	<0.007	--
	<0.008	<0.008	--
	<0.008	<0.008	--
	<0.008	<0.008	--
	0.0058	0.006	0.85
	<0.008	<0.008	--
	<0.008	<0.008	--
	0.0211	0.0177	4.38
	0.0135	0.0139	0.73
	0.0631	0.0656	0.97
	0.114	0.11	0.89
Diuron	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	0.0216	0.0193	2.81
Fluometuron	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	0.2112	0.2085	0.32
	0.2912	0.281	0.89
	0.2582	0.2466	1.15
Imazethapyr	<0.06	<0.06	--
	<0.06	<0.06	--
	0.0025	0.0028	2.83
	0.0151	0.0164	2.06
	<0.08	<0.08	--
	<0.08	<0.08	--
	<0.06	<0.06	--
	<0.08	<0.08	--
	<0.06	<0.06	--
	<0.06	<0.06	--

Appendix 1. Relative percent difference between environmental and replicate samples collected at selected wells located in areas of high-density row-crop production in Alabama, 2009–2013. —Continued

[µg/L, micrograms per liter; <, less than; NC, not calculated; --, not detected]

Pesticide	Environmental concentration, in µg/L	Replicate concentration, in µg/L	Relative percent difference
Imadacloprid	<0.06	<0.06	--
	<0.06	<0.06	--
	<0.08	<0.08	--
	<0.08	<0.08	--
	<0.08	<0.08	--
	<0.08	<0.08	--
	<0.06	<0.06	--
	<0.08	0.0304	NC
	0.0114	0.0112	0.44
	0.0337	0.0326	0.83
Metalaxyl (50359)	0.1047	0.1061	0.33
	0.0717	0.0712	0.17
	0.0899	0.087	0.82
	0.0814	0.0806	0.25
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	0.007	0.0072	0.70
Metalaxyl (61596)	0.134	0.108	5.37
	0.0709	0.0687	0.79
	0.0822	0.0767	1.73
	0.0959	0.092	1.04
	<0.0069	<0.0069	--
	<0.014	<0.014	--
	<0.014	<0.014	--
	<0.014	<0.014	--
	0.0025	0.0023	2.08
	0.0107	0.0107	0.00
Metolachlor	4.3	5.26	5.02
	3.2	3.18	0.16
	3.69	4.12	2.75
	3.5	3.52	0.14
	<0.014	<0.014	--
	<0.012	<0.012	--
	<0.02	<0.02	--
	0.007	0.0072	0.70
	0.011	0.0112	0.45
	0.0185	0.0178	0.96
Norflurazon	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	<0.04	<0.04	--
	0.0427	0.0429	0.12
	0.9273	0.909	0.50
	0.0268	0.0262	0.57
Prometryn	<0.006	<0.006	--
	<0.006	<0.006	--
	<0.01	<0.01	--
	<0.01	<0.01	--
	<0.0059	<0.0059	--
	<0.01	<0.01	--
	<0.01	<0.01	--
	<0.006	<0.006	--
	<0.01	<0.01	--
	0.0059	0.006	0.42
Tebuthiuron	<0.028	<0.028	--
	<0.028	<0.028	--
	<0.028	<0.028	--
	<0.028	<0.028	--
	<0.02	<0.02	--
	<0.028	<0.028	--
	<0.028	<0.028	--
	0.109	0.0925	4.09
	<0.028	<0.028	--
	<0.06	<0.06	--
	<0.028	<0.028	--

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	Date	p00010 Temperature, water,°C	p00020 Temperature, air,°C	p00025 Barometric pressure, mm of Hg	p00095 Specific conductance, µS/cm at 25°C	p00300 Dissolved oxygen, mg/L	p00400 pH, field, standard units	p00403 pH, lab, standard units	p00405 Carbon dioxide, mg/L	p00419 Acid neutralizing capacity, mg/L as $CaCO_3$
1	345822086254001	6/6/2000	18.5	20	758	66	7.9	4.6	5.2	194	NA
	345822086254001	4/19/2001	16	13	748	67	7.7	4.9	5.2	185	NA
	345822086254001	4/27/2009	18.4	28.5	746	71	8.3	4.7	6.4	126	NA
	345822086254001	6/11/2009	17.4	NA	NA	74	8.1	4.9	NA	61	2
	345822086254001	7/8/2010	18.4	28.5	750	105	7.6	4.9	NA	65	2
	345822086254001	4/18/2011	18.4	25.8	738	66	7.3	5	E 5.2	49	NA
	345822086254001	3/28/2012	16.7	NA	742	66	5.2	5	E 5.3	56	NA
	345822086254001	6/26/2013	18.1	NA	746	67	7.5	4.9	NA	94	NA
2	345112086313401	6/1/2000	23	30	760	248	6.7	7.1	6.9	15	NA
	345112086313401	4/18/2001	16.5	18	750	215	7.2	6.8	7.3	28	NA
	345112086313401	4/27/2009	E 20.3	27.3	750	223	7.3	6.8	6.9	29	NA
	345112086313401	6/11/2009	18.8	NA	752	223	8.5	7.1	NA	16	104
	345112086313401	7/8/2010	17.7	28.5	750	291	8.4	7	NA	21	107
	345112086313401	4/19/2011	18	19.4	715	196	6.4	6.8	7.1	26	NA
	345112086313401	3/27/2012	19.3	NA	745	212	5.2	6.8	7.4	27	NA
	345112086313401	6/26/2013	18	NA	NA	210	8.1	6.8	NA	20	64
3	344124086531401	5/24/2000	23.1	30	754	258	6.4	6.6	7.2	57	NA
	344124086531401	6/11/2009	20.9	NA	NA	146	7.7	6.6	NA	25	50
	344124086531401	7/9/2010	29.4	29.6	754	246	6.1	6.7	NA	35	86
	344124086531401	4/21/2011	15	14.5	749	108	6.2	6.2	NA	46	NA
	344124086531401	3/26/2012	19.2	NA	748	150	4.2	6.2	6.9	69	NA
	344124086531401	6/27/2013	21.5	NA	750	154	8.1	6.5	NA	NA	NA
4	344348086493401	5/25/2000	20	28	755	295	6.4	6.7	7.3	53	NA
	344348086493401	4/17/2001	15.5	9	751	220	7.9	6.9	7.1	23	NA
	344348086493401	4/28/2009	18.3	NA	NA	274	7.1	6.9	7.4	27	NA
	344348086493401	6/10/2009	17.5	NA	NA	210	7.7	7	NA	18	91
	344348086493401	7/9/2010	18.1	29.6	754	247	7.7	6.6	NA	47	88
	344348086493401	4/20/2011	16.6	21.3	746	206	7.5	7	7.1	17	NA
	344348086493401	3/30/2012	16.4	NA	742	273	6.7	6.8	7.3	32	NA
	344348086493401	6/26/2013	17.5	NA	NA	254	7.1	6.8	NA	26	83
5	344131087335201	5/22/2000	20.5	26	760	259	4.7	7.6	7.1	5.9	NA
	344131087335201	4/18/2001	16	9	760	263	4.9	7.4	7.4	8.9	NA
	344131087335201	4/28/2009	18.7	28	NA	291	5.3	7.3	7.7	12	NA
	344131087335201	6/12/2009	19.9	NA	NA	262	5.5	7.2	NA	15	121
	344131087335201	7/7/2010	18.8	27.7	760	292	5	7.3	NA	11	123
	344131087335201	4/20/2011	17.4	NA	750	293	4.7	7.6	7.7	6.4	NA
	344131087335201	4/9/2012	18.1	22	750	286	3.4	7.3	7.7	12	NA
	344131087335201	6/25/2013	19	NA	756	284	5.1	7.4	NA	7.7	98
6	312143085230301	6/10/2009	21.2	NA	760	154	8	4.3	NA	NA	NA
	312143085230301	6/29/2010	21.5	NA	NA	172	7.9	4.3	NA	203	2
	312143085230301	9/20/2011	21.1	24.5	NA	203	8.4	4.2	NA	NA	NA
7	312118085193001	9/26/2012	22.6	NA	771	232	4.3	7.6	NA	5.4	NA
	312118085193001	6/20/2013	22.6	NA	775	226	4.5	7.6	NA	549	114

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	Date	p00010 Temperature, water,°C	p00020 Temperature, air,°C	p00025 Barometric pressure, mm of Hg	p00095 Specific conductance, µS/cm at 25°C	p00300 Dissolved oxygen, mg/L	p00400 pH, field, standard units	p00403 pH, lab, standard units	p00405 Carbon dioxide, mg/L	p00419 Acid neutralizing capacity, mg/L as $CaCO_3$
	311928085191101	6/10/2009	21.8	NA	760	235	2.7	7.9	NA	NA	NA
	311928085191101	6/29/2010	22.4	NA	NA	246	3.6	7.9	NA	NA	NA
8	311928085191101	9/20/2011	22.4	27	NA	226	3.5	7.8	NA	3.4	NA
	311928085191101	9/20/2012	22.1	NA	NA	238	4.2	7.6	NA	4.9	NA
	311928085191101	6/20/2013	23.1	NA	775	235	3.9	7.8	NA	3.3	106
	311048085403201	6/11/2009	22	NA	757	201	4.2	7.2	NA	NA	NA
	311048085403201	6/30/2010	25.1	NA	NA	199	3.9	7.1	NA	12	79
9	311048085403201	9/21/2011	22.8	31	NA	197	4.9	7.3	NA	9.4	NA
	311048085403201	9/21/2012	21.7	NA	764	338	4.4	7	NA	16	NA
	311048085403201	6/19/2013	22.4	NA	770	192	NA	7.2	NA	9.1	80
	310453085383001	6/11/2009	21.6	NA	757	100	9	4.5	NA	NA	NA
	310453085383001	7/1/2010	21.5	NA	NA	128	9.1	4.5	NA	26	0
10	310453085383001	9/21/2011	22	25	NA	101	9.2	4.7	NA	51	NA
	310453085383001	9/20/2012	22.4	NA	NA	106	9.1	4.7	NA	NA	NA
	310453085383001	6/19/2013	24.5	NA	770	117	8	4.5	NA	NA	NA
	310153085225901	6/12/2009	21.8	NA	750	206	7	7.8	NA	NA	NA
	310153085225901	6/30/2010	21.9	NA	NA	226	7.3	7.8	NA	2.9	85
11	310153085225901	9/21/2011	24.1	23	NA	177	7.2	7.8	NA	2.5	NA
	310153085225901	9/19/2012	22.4	NA	NA	209	7.8	7.5	NA	5.8	NA
	310153085225901	6/18/2013	25.6	NA	771	183	NA	7.6	NA	4.1	83
	303432087485501	6/16/2009	21.9	35	760	170	9	4.2	NA	NA	NA
	303432087485501	6/23/2010	22.6	33	NA	207	8.7	4.2	NA	572	2
12	303432087485501	9/1/2011	21.7	27	NA	180	9	4.2	NA	NA	NA
	303432087485501	9/13/2012	22.2	NA	771	180	8.4	4.1	NA	NA	NA
	303432087485501	6/11/2013	23.8	NA	759	142	8.4	4.2	NA	NA	NA
	303252087500801	6/16/2009	21.3	NA	760	138	8.8	4.7	NA	NA	NA
	303252087500801	6/24/2010	21.2	NA	NA	162	8.2	4.5	NA	113	0
13	303252087500801	9/1/2011	20.8	28	NA	134	8.6	4.6	NA	NA	NA
	303252087500801	9/12/2012	21	NA	774	143	9.1	4.5	NA	NA	NA
	303252087500801	6/13/2013	20.8	NA	775	147	8.7	4.6	NA	NA	NA
	303231087525801	6/17/2009	22	NA	760	27	8.5	5.7	NA	NA	NA
	303231087525801	6/23/2010	26.7	NA	NA	60	5.4	5.1	NA	33	2
14	303231087525801	9/2/2011	21.6	NA	NA	27	8.6	5.7	NA	14	NA
	303231087525801	9/13/2012	20.4	NA	771	E 39	NA	5.3	NA	43	NA
	303231087525801	6/13/2013	21.8	NA	775	28	8.8	5.7	NA	NA	NA
	302434087462601	6/17/2009	21	NA	760	132	8.7	4.4	NA	NA	NA
	302434087462601	6/23/2010	22.1	NA	NA	152	7.3	4.4	NA	303	2
15	302434087462601	9/1/2011	21.4	26	NA	120	8.4	4.4	NA	NA	NA
	302434087462601	9/12/2012	21.6	NA	774	116	8.7	4.1	NA	NA	NA
	302434087462601	6/11/2013	21.9	NA	759	122	8.4	4.4	NA	NA	NA
	302438087325801	6/17/2009	22.5	NA	760	164	9.1	4.3	NA	NA	NA
	302438087325801	6/22/2010	22.8	NA	NA	180	8.4	4.3	NA	211	0
16	302438087325801	9/2/2011	21.9	NA	NA	165	9.1	4.3	NA	NA	NA
	302438087325801	9/12/2012	22.8	NA	774	169	9.6	4.1	NA	NA	NA
	302438087325801	6/12/2013	25.3	NA	778	168	8.8	4.3	NA	NA	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p00453 Bicarbonate, mg/L	p00618 Nitrate, mg/L as N	p00631 Nitrate plus nitrite, mg/L as N	p00660 Orthophosphate, mg/L as P	p00666 Phosphorus, mg/L as P	p00671 Orthophosphate, mg/L as P	p00681 Organic carbon, mg/L	p00915 Calcium, mg/L	p00925 Magnesium, mg/L
1	345822086254001	5	5	5	< 0.055	< 0.006	< 0.02	0.3	5.14	1.72
	345822086254001	9	4.76	4.76	< 0.055	< 0.006	< 0.02	0.27	5.16	1.76
	345822086254001	4	4.76	4.76	E 0.017	NA	< 0.02	NA	5.41	1.84
	345822086254001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345822086254001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345822086254001	3	NA	4.52	NA	NA	NA	NA	5.13	1.8
	345822086254001	3	4.44	4.44	0.013	NA	0.004	< 0.23	5.12	1.8
	345822086254001	5	NA	NA	NA	NA	NA	NA	NA	NA
2	345112086313401	117	3.27	3.27	0.107	0.042	0.04	E 0.3	27.5	12.4
	345112086313401	111	3.21	3.21	0.101	0.036	0.03	0.27	25	10.8
	345112086313401	109	3.78	3.78	0.12	NA	0.039		27.9	11.9
	345112086313401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345112086313401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345112086313401	101	NA	3.85	NA	NA	NA	NA	23.6	10.7
	345112086313401	102	3.78	3.78	0.135	NA	0.044	< 0.23	24.6	11
	345112086313401	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	344124086531401	141	3.37	3.37	< 0.055	< 0.006	< 0.02	0.7	43.1	3.65
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344124086531401	44	NA	NA	NA	NA	NA	NA	NA	NA
	344124086531401	60	4.32	4.32	0.034	NA	0.011	0.3	24.3	1.94
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	344348086493401	165	2.72	2.72	0.043	0.014	< 0.02	0.3	47.3	5.6
	344348086493401	113	3.1	3.1	E 0.028	0.014	< 0.02	0.36	35.3	4.51
	344348086493401	137	3.36	3.36	0.067	NA	0.022	NA	47.2	5.68
	344348086493401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344348086493401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344348086493401	104	4.13	4.13	0.06	NA	0.02	NA	34.9	4.61
	344348086493401	138	3.87	3.88	0.069	NA	0.022	< 0.23	47	5.7
	344348086493401	101	NA	NA	NA	NA	NA	NA	NA	NA
5	344131087335201	144	3.67	3.67	0.046	0.017	0.02	< 0.23	46.1	1.67
	344131087335201	138	4.46	4.46	0.055	0.019	0.02	0.36	49.8	1.71
	344131087335201	154	4.09	4.09	0.061	NA	0.02	NA	59.2	1.93
	344131087335201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344131087335201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344131087335201	158	4.97	4.97	0.065	NA	0.021		58.9	2
	344131087335201	160	4.33	4.33	0.063	NA	0.02	< 0.23	55.4	1.95
	344131087335201	119	NA	NA	NA	NA	NA	NA	NA	NA
6	312143085230301	NA	NA	NA	NA	NA	NA	NA	NA	NA
	312143085230301	NA	NA	NA	NA	NA	NA	NA	NA	NA
	312143085230301	NA	NA	NA	NA	NA	NA	NA	NA	NA
7	312118085193001	133	NA	NA	NA	NA	NA	NA	NA	NA
	312118085193001	NA	NA	NA	NA	NA	NA	NA	NA	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p00453 Bicarbonate, mg/L	p00618 Nitrate, mg/L as N	p00631 Nitrate plus nitrite, mg/L as N	p00660 Orthophosphate, mg/L as P	p00666 Phosphorus, mg/L as P	p00671 Orthophosphate, mg/L as P	p00681 Organic carbon, mg/L	p00915 Calcium, mg/L	p00925 Magnesium, mg/L
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	311928085191101	135	NA	NA	NA	NA	NA	NA	NA	NA
	311928085191101	132	NA	NA	NA	NA	NA	NA	NA	NA
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	311048085403201	108	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	103	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	310453085383001	1	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	310153085225901	106	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	110	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
13	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA
14	303231087525801	4	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	5	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
15	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA
16	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p00930 Sodium, mg/L	p00935 Potassium, mg/L	p00940 Chloride, mg/L	p00945 Sulfate, mg/L	p00955 Silica, mg/L	p01005 Barium	p01010 Beryllium	p01020 Boron	p01025 Cadmium
1	345822086254001	1.92	0.94	4.3	0.38	7.73	NA	NA	NA	NA
	345822086254001	1.72	1.1	4.44	0.31	7.8	NA	NA	NA	NA
	345822086254001	1.74	1.26	4.71	0.45	8.18	33.1	0.095	E 3	0.171
	345822086254001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345822086254001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345822086254001	1.62	1.07	4.5	0.39	8.4	24.2	0.094	3	0.163
	345822086254001	1.71	1.09	4.74	0.42	8.63	27.6	0.08	3	0.168
	345822086254001	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	345112086313401	1.13	0.5	5.74	0.51	7.97	NA	NA	NA	NA
	345112086313401	1.45	0.45	5.06	0.5	8.06	NA	NA	NA	NA
	345112086313401	1.28	0.61	4.75	0.22	8.91	9.21	E 0.020	E 3	0.149
	345112086313401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345112086313401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345112086313401	1.45	0.62	5.12	0.18	8.99	9.34	0.05	3	0.176
	345112086313401	1.24	0.53	5.47	0.41	9.14	9.01	0.025	3	0.183
	345112086313401	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	344124086531401	1.41	0.82	1.96	3.43	6.54	NA	NA	NA	NA
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344124086531401	1.29	0.87	2.43	1	8.18	22.2	< 0.006	5	< 0.016
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	344348086493401	1.66	0.96	2.89	1.19	8.21	NA	NA	NA	NA
	344348086493401	1.61	0.73	2.73	0.91	8.05	NA	NA	NA	NA
	344348086493401	2.25	1.12	3.02	0.53	8.32	14.1	< 0.020	E 2	0.05
	344348086493401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344348086493401	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344348086493401	1.66	0.73	3.18	0.4	9.12	9.87	< 0.006	3	0.027
	344348086493401	1.71	0.9	3.79	0.59	9.09	14.3	< 0.006	< 3	0.032
	344348086493401	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	344131087335201	1.72	0.54	2.97	1.89	8.66	NA	NA	NA	NA
	344131087335201	1.67	0.54	3.28	0.94	8.95	NA	NA	NA	NA
	344131087335201	1.6	0.41	2.6	0.55	9.81	26.4	< 0.020	E 3	0.035
	344131087335201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344131087335201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344131087335201	1.75	0.35	3.08	0.64	9.99	23.1	< 0.006	4	0.031
	344131087335201	1.62	0.33	2.64	0.61	10.1	25.9	< 0.006	4	0.034
	344131087335201	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	312143085230301	NA	NA	NA	NA	NA	NA	NA	NA	NA
	312143085230301	NA	NA	NA	NA	NA	NA	NA	NA	NA
	312143085230301	NA	NA	NA	NA	NA	NA	NA	NA	NA
7	312118085193001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	312118085193001	NA	NA	NA	NA	NA	NA	NA	NA	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p00930 Sodium, mg/L	p00935 Potassium, mg/L	p00940 Chloride, mg/L	p00945 Sulfate, mg/L	p00955 Silica, mg/L	p01005 Barium	p01010 Beryllium	p01020 Boron	p01025 Cadmium
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
13	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA
14	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
15	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA
16	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p01030 Chromium	p01035 Cobalt	p01040 Copper	p01046 Iron	p01049 Lead	p01056 Manganese	p01060 Molybdenum	p01065 Nickel	p01080 Strontium	p01085 Vanadium
1	345822086254001	NA	NA	NA	< 10.0	NA	44	NA	NA	NA	NA
	345822086254001	NA	NA	NA	< 10.0	NA	39.8	NA	NA	NA	NA
	345822086254001	0.59	0.233	E 0.83	< 10.0	0.166	23.3	E 0.014	3	26.8	E 0.11
	345822086254001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345822086254001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345822086254001	0.64	0.588	0.56	< 10.0	0.819	20.7	0.015	2.8	22.6	< 0.08
	345822086254001	0.5	0.489	30.5	< 10.0	3.43	20.8	< 0.014	2.5	24.4	< 0.08
	345822086254001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	345112086313401	NA	NA	NA	< 10.0	NA	108	NA	NA	NA	NA
	345112086313401	NA	NA	NA	< 10.0	NA	< 3.20	NA	NA	NA	NA
	345112086313401	0.46	0.077	< 1.0	< 10.0	E 0.043	< 3.20	0.228	2.9	21	E 0.12
	345112086313401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345112086313401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	345112086313401	0.7	0.215	0.5	22.7	0.13	< 3.20	0.206	3.8	19.4	0.26
	345112086313401	0.32	0.024	2.5	< 10.0	1.29	< 3.20	0.117	1.9	20.9	0.14
	345112086313401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	344124086531401	NA	NA	NA	< 10.0	NA	< 2.20	NA	NA	NA	NA
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344124086531401	1.1	0.039	< 0.80	< 10.0	0.139	< 3.20	0.065	0.64	29.1	0.18
	344124086531401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4	344348086493401	NA	NA	NA	< 10.0	NA	< 3.20	NA	NA	NA	NA
	344348086493401	NA	NA	NA	< 10.0	NA	< 3.20	NA	NA	NA	NA
	344348086493401	1.8	0.118	< 1.0	< 10.0	0.078	< 3.20	0.485	2.4	61.5	0.38
	344348086493401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344348086493401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344348086493401	1.2	0.084	< 0.50	11.5	0.142	< 3.20	0.24	1.1	49.8	0.36
	344348086493401	1.4	0.029	< 0.80	< 10.0	0.054	< 3.20	0.367	0.82	63.5	0.35
	344348086493401	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5	344131087335201	NA	NA	NA	< 10.0	NA	< 3.20	NA	NA	NA	NA
	344131087335201	NA	NA	NA	< 10.0	NA	< 3.20	NA	NA	NA	NA
	344131087335201	1.7	0.105	< 1.0	< 10.0	0.069	< 3.20	0.098	0.96	79.3	0.56
	344131087335201	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344131087335201	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	344131087335201	1.7	0.055	< 0.50	< 10.0	0.057	< 3.20	0.097	0.49	75.6	0.55
	344131087335201	1.8	0.036	< 0.80	< 10.0	0.113	< 3.20	0.101	0.52	77.2	0.54
	344131087335201	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	312143085230301	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	312143085230301	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	312143085230301	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7	312118085193001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	312118085193001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p01030 Chromium	p01035 Cobalt	p01040 Copper	p01046 Iron	p01049 Lead	p01056 Manganese	p01060 Molybdenum	p01065 Nickel	p01080 Strontium	p01085 Vanadium
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311928085191101	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
9	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	311048085403201	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310453085383001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	310153085225901	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303432087485501	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
13	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303252087500801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	303231087525801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
15	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302434087462601	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
16	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	302438087325801	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p01090 Zinc	p01106 Aluminum	p01130 Lithium	p04022 Terbuthylazine	p04035 Simazine	p04036 Prometryn	p04037 Prometon	p04040 2-Chloro-4-isopropylamino-6-amino-s-triazine (deethylatrazine)	p22703 Uranium (natural)
1	345822086254001	NA	NA	NA	NA	< 0.011	NA	< 0.018	E 0.235	NA
	345822086254001	NA	NA	NA	NA	< 0.011	NA	< 0.018	E 0.124	NA
	345822086254001	10.8	15.6	1.28	< 0.008	< 0.011	0.01	< 0.018	E 0.054	0.02
	345822086254001	NA	NA	NA	NA	NA	NA	NA	E 0.04	NA
	345822086254001	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.098	NA
	345822086254001	8.8	14.2	1.4	< 0.008	< 0.011	< 0.010	< 0.018	0.03	0.017
	345822086254001	32	14.9	1.29	< 0.008	< 0.011	< 0.010	< 0.018	E 0.047	0.017
	345822086254001	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.033	NA
2	345112086313401	NA	NA	NA	NA	< 0.011	NA	< 0.018	E 0.038	NA
	345112086313401	NA	NA	NA	NA	< 0.011	NA	< 0.018	E 0.051	NA
	345112086313401	7.1	< 4.0	1.7	< 0.008	< 0.011	< 0.010	< 0.018	E 0.124	0.035
	345112086313401	NA	NA	NA	NA	NA	NA	NA	0.1	NA
	345112086313401	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.169	NA
	345112086313401	8.6	40.6	1.94	< 0.008	< 0.011	< 0.010	< 0.018	0.07	0.021
	345112086313401	9.7	< 4.0	1.65	< 0.008	< 0.011	< 0.010	< 0.018	E 0.119	0.03
	345112086313401	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.063	NA
3	344124086531401	NA	NA	NA	NA	0.021	NA	0.174	E 0.221	NA
	344124086531401	NA	NA	NA	< 0.008	0.013	< 0.010	0.018	E 0.213	NA
	344124086531401	NA	NA	NA	< 0.008	0.014	< 0.010	0.021	E 0.206	NA
	344124086531401	NA	NA	NA	< 0.008	0.012	< 0.010	< 0.018	E 0.236	NA
	344124086531401	< 1.4	16.9	< 1.00	< 0.008	< 0.011	< 0.010	0.02	E 0.156	0.125
	344124086531401	NA	NA	NA	< 0.008	0.012	< 0.010	0.027	E 0.120	NA
4	344348086493401	NA	NA	NA	NA	< 0.011	NA	< 0.018	< 0.014	NA
	344348086493401	NA	NA	NA	NA	< 0.011	NA	< 0.018	< 0.014	NA
	344348086493401	E 1.9	< 4.0	< 1.00	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	0.253
	344348086493401	NA	NA	NA	NA	NA	NA	NA	E 0.02	NA
	344348086493401	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.027	NA
	344348086493401	< 1.4	16.4	< 1.00	< 0.008	< 0.011	< 0.010	< 0.018	0.03	0.063
	344348086493401	1.6	4.6	< 1.00	< 0.008	< 0.011	< 0.010	< 0.018	E 0.044	0.197
	344348086493401	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.028	NA
5	344131087335201	NA	NA	NA	NA	< 0.011	NA	< 0.018	E 0.030	NA
	344131087335201	NA	NA	NA	NA	< 0.011	NA	< 0.018	E 0.024	NA
	344131087335201	< 1.4	< 4.0	< 1.00	0.021	< 0.011	0.027	< 0.018	E 0.598	0.494
	344131087335201	NA	NA	NA	NA	NA	NA	NA	E 0.04	NA
	344131087335201	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.051	NA
	344131087335201	< 1.4	< 4.0	< 1.00	< 0.008	< 0.011	< 0.010	< 0.018	0.04	0.432
	344131087335201	< 1.4	< 4.0	< 1.00	< 0.008	< 0.011	< 0.010	< 0.018	E 0.059	0.471
	344131087335201	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.027	NA
6	312143085230301	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.018	NA
	312143085230301	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	312143085230301	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	E 0.032	NA
7	312118085193001	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	312118085193001	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p01090 Zinc	p01106 Aluminum	p01130 Lithium	p04022 Terbuthylazine	p04035 Simazine	p04036 Prometryn	p04037 Prometon	p04040 2-Chloro-4-isopropylamino-6-amino-s-triazine (deethylatrazine)	p22703 Uranium (natural)
	311928085191101	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	311928085191101	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
8	311928085191101	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	311928085191101	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	311928085191101	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	311048085403201	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	311048085403201	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
9	311048085403201	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	311048085403201	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	311048085403201	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	310453085383001	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	310453085383001	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
10	310453085383001	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	310453085383001	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	310453085383001	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	310153085225901	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	310153085225901	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
11	310153085225901	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	310153085225901	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	310153085225901	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303432087485501	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303432087485501	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
12	303432087485501	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303432087485501	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303432087485501	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303252087500801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303252087500801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
13	303252087500801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303252087500801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303252087500801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303231087525801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303231087525801	NA	NA	NA	< 0.008	0.353	< 0.010	< 0.018	< 0.014	NA
14	303231087525801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303231087525801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	303231087525801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	302434087462601	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	302434087462601	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
15	302434087462601	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	302434087462601	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	302434087462601	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	302438087325801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	302438087325801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
16	302438087325801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	302438087325801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA
	302438087325801	NA	NA	NA	< 0.008	< 0.011	< 0.010	< 0.018	< 0.014	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p38711 Bentazon	p38811 Fluometuron	p39086 Alkalinity, mg/L as $CaCO_3$	p39415 Metolachlor	p39632 Atrazine	p46342 Alachlor	p49293 Norflurazon	p49300 Diuron	p49301 Dinoseb
1	345822086254001	< 0.06	E 1.69	4	0.922	1.83	< 0.008	E 0.05	< 0.08	< 0.06
	345822086254001	< 0.06	E 1.42	8	0.359	0.684	< 0.008	E 0.07	< 0.08	< 0.06
	345822086254001	NA	NA	3	< 0.02	0.085	< 0.008	NA	NA	NA
	345822086254001	< 0.06	0.32	NA	NA	0.111	NA	< 0.04	< 0.08	< 0.06
	345822086254001	< 0.06	0.26	NA	< 0.02	0.114	< 0.008	< 0.04	< 0.08	< 0.06
	345822086254001	< 0.06	0.18	2	< 0.02	0.068	< 0.008	< 0.04	< 0.08	< 0.06
	345822086254001	< 0.06	0.18	3	< 0.02	0.05	< 0.008	< 0.04	< 0.08	< 0.06
	345822086254001	< 0.06	0.11	3	< 0.02	0.133	< 0.008	< 0.04	0.08	< 0.06
2	345112086313401	< 0.06	0.08	96	< 0.02	0.098	< 0.008	< 0.04	< 0.08	< 0.06
	345112086313401	< 0.06	0.09	91	< 0.02	0.157	< 0.008	E 0.04	< 0.08	< 0.06
	345112086313401	NA	NA	89	< 0.02	0.08	< 0.008	NA	NA	NA
	345112086313401	< 0.06	0.23	NA	NA	0.107	NA	< 0.04	< 0.08	< 0.06
	345112086313401	< 0.06	0.27	NA	< 0.02	0.087	< 0.008	0.05	< 0.08	< 0.06
	345112086313401	< 0.06	0.12	83	< 0.02	0.057	< 0.008	< 0.04	< 0.08	< 0.06
	345112086313401	< 0.06	0.14	84	< 0.02	0.052	< 0.008	< 0.04	< 0.08	< 0.06
	345112086313401	< 0.06	0.1	NA	< 0.02	0.097	< 0.008	< 0.04	< 0.08	< 0.06
3	344124086531401	< 0.06	E 1.11	115	0.043	0.23	< 0.008	E 0.07	0.14	< 0.06
	344124086531401	< 0.06	0.28	NA	0.067	0.25	< 0.008	< 0.04	< 0.08	< 0.06
	344124086531401	< 0.06	0.27	NA	0.032	0.145	< 0.008	< 0.04	< 0.08	< 0.06
	344124086531401	< 0.06	0.09	36	0.072	0.378	< 0.008	0.01	< 0.08	< 0.06
	344124086531401	< 0.06	0.13	49	< 0.02	0.036	< 0.008	< 0.04	0.16	< 0.06
	344124086531401	< 0.06	E 2.71	NA	0.307	0.034	< 0.008	< 0.04	0.29	< 0.06
4	344348086493401	< 0.06	E 1.81	136	< 0.02	0.015	< 0.008	0.63	< 0.08	< 0.06
	344348086493401	< 0.06	E 1.36	92	< 0.02	0.013	< 0.008	0.76	< 0.08	< 0.06
	344348086493401	NA	NA	113	< 0.02	0.011	< 0.008	NA	NA	NA
	344348086493401	< 0.06	0.5	NA	NA	0.352	NA	0.82	< 0.08	< 0.06
	344348086493401	< 0.06	0.24	NA	0.036	0.019	< 0.008	0.77	< 0.08	< 0.06
	344348086493401	< 0.06	0.29	85	0.048	0.063	< 0.008	0.93	< 0.08	< 0.06
	344348086493401	< 0.06	0.28	113	0.025	0.022	< 0.008	0.74	< 0.08	< 0.06
	344348086493401	< 0.06	0.21	NA	0.032	0.02	< 0.008	0.84	< 0.08	< 0.06
5	344131087335201	< 0.06	E 1.47	118	< 0.02	0.017	< 0.008	0.12	< 0.08	< 0.06
	344131087335201	< 0.06	E 1.56	113	< 0.02	0.015	< 0.008	0.13	< 0.08	< 0.06
	344131087335201	NA	NA	126	0.061	0.225	< 0.008	NA	NA	NA
	344131087335201	< 0.06	0.28	NA	NA	E 0.012	NA	E 0.04	< 0.08	< 0.06
	344131087335201	< 0.06	0.28	NA	< 0.02	0.013	< 0.008	0.04	< 0.08	< 0.06
	344131087335201	< 0.06	0.34	130	0.087	0.01	< 0.008	0.06	< 0.08	< 0.06
	344131087335201	< 0.06	0.25	131	0.029	0.014	< 0.008	0.05	< 0.08	< 0.06
	344131087335201	< 0.06	0.21	NA	< 0.02	0.013	< 0.008	0.04	< 0.08	< 0.06
6	312143085230301	NA	NA	NA	< 0.02	0.025	< 0.008	NA	NA	NA
	312143085230301	< 0.06	< 0.04	NA	< 0.02	0.01	< 0.008	< 0.04	< 0.08	< 0.06
	312143085230301	< 0.06	< 0.04	NA	< 0.02	0.021	< 0.008	< 0.04	< 0.08	0.08
7	312118085193001	< 0.06	< 0.04	110	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	312118085193001	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p38711 Bentazon	p38811 Fluometuron	p39086 Alkalinity, mg/L as $CaCO_3$	p39415 Metolachlor	p39632 Atrazine	p46342 Alachlor	p49293 Norflurazon	p49300 Diuron	p49301 Dinoseb
	311928085191101	NA	NA	NA	< 0.02	< 0.008	< 0.008	NA	NA	NA
	311928085191101	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
8	311928085191101	< 0.06	< 0.04	111	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	311928085191101	< 0.06	< 0.04	109	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	311928085191101	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	311048085403201	NA	NA	NA	< 0.02	< 0.008	< 0.008	NA	NA	NA
	311048085403201	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
9	311048085403201	< 0.06	< 0.04	89	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	311048085403201	< 0.06	< 0.04	84	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	311048085403201	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	310453085383001	NA	NA	NA	< 0.02	< 0.008	0.064	NA	NA	NA
	310453085383001	< 0.06	E 0.04	NA	< 0.02	E 0.009	E 0.053	0.19	< 0.08	0.7
10	310453085383001	< 0.06	0.04	1	< 0.02	< 0.008	0.062	0.2	< 0.08	0.52
	310453085383001	< 0.06	0.07	NA	< 0.02	< 0.008	0.052	0.24	< 0.08	0.35
	310453085383001	< 0.06	0.11	NA	< 0.02	< 0.008	0.05	E 1.49	< 0.08	E 1.06
	310153085225901	NA	NA	NA	< 0.02	< 0.008	< 0.008	NA	NA	NA
	310153085225901	< 0.06	< 0.04	NA	< 0.02	0.008	< 0.008	< 0.04	< 0.08	< 0.06
11	310153085225901	< 0.06	< 0.04	87	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	310153085225901	< 0.06	< 0.04	90	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	310153085225901	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	303432087485501	NA	NA	NA	0.068	< 0.008	< 0.008	NA	NA	NA
	303432087485501	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
12	303432087485501	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	303432087485501	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	303432087485501	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	303252087500801	NA	NA	NA	< 0.02	< 0.008	< 0.008	NA	NA	NA
	303252087500801	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
13	303252087500801	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	303252087500801	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	303252087500801	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	303231087525801	NA	NA	NA	< 0.02	< 0.008	< 0.008	NA	NA	NA
	303231087525801	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
14	303231087525801	< 0.06	< 0.04	3	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	303231087525801	< 0.06	< 0.04	4	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	303231087525801	< 0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	302434087462601	NA	NA	NA	< 0.02	< 0.008	< 0.008	NA	NA	NA
	302434087462601	0.06	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
15	302434087462601	E 4.49	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	302434087462601	0.65	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	302434087462601	0.36	< 0.04	NA	< 0.02	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	302438087325801	NA	NA	NA	4.08	< 0.008	< 0.008	NA	NA	NA
	302438087325801	< 0.06	< 0.04	NA	E 4.30	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
16	302438087325801	< 0.06	< 0.04	NA	E 3.20	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	302438087325801	< 0.06	< 0.04	NA	E 3.69	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06
	302438087325801	< 0.06	< 0.04	NA	E 3.50	< 0.008	< 0.008	< 0.04	< 0.08	< 0.06

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p49313 Aldicarb sulfone	p50009 Alachlor sulfonic acid (alachlor ESA)	p50355 2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine (hydroxyatrazine)	p50359 Metalaxyl	p61031 Alachlor oxanilic acid (alachlor OXA)	p61043 Metolachlor sulfonic acid (metolachlor ESA)	p61044 Metolachlor oxanilic acid (metolachlor OXA)	p61596 Metalaxyl	p61625 3,4-Dichloro-aniline
1	345822086254001	M	NA	E 0.1	< 0.06	NA	NA	NA	NA	NA
	345822086254001	M	NA	E 0.1	< 0.06	NA	NA	NA	NA	NA
	345822086254001	NA	NA	NA	NA	NA	NA	NA	E 0.015	< 0.006
	345822086254001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	NA	NA
	345822086254001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	345822086254001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	345822086254001	< 0.2	0.13	< 0.06	< 0.06	0.05	0.14	0.02	< 0.014	< 0.006
	345822086254001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
2	345112086313401	M	NA	M	< 0.06	NA	NA	NA	NA	NA
	345112086313401	< 0.2	NA	M	< 0.06	NA	NA	NA	NA	NA
	345112086313401	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	345112086313401	M	NA	< 0.06	< 0.06	NA	NA	NA	NA	NA
	345112086313401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	345112086313401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	345112086313401	< 0.2	< 0.02	< 0.06	< 0.06	< 0.02	< 0.02	< 0.02	< 0.014	< 0.006
	345112086313401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
3	344124086531401	< 0.2	NA	M	< 0.06	NA	NA	NA	NA	NA
	344124086531401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	344124086531401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	344124086531401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	344124086531401	< 0.2	< 0.02	< 0.06	< 0.06	0.16	0.03	0.03	< 0.014	E 0.0103
	344124086531401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	E 0.0212
4	344348086493401	E 0.2	NA	M	< 0.06	NA	NA	NA	NA	NA
	344348086493401	< 0.2	NA	M	< 0.06	NA	NA	NA	NA	NA
	344348086493401	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	344348086493401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	NA	NA
	344348086493401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	344348086493401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	344348086493401	< 0.2	< 0.02	< 0.06	< 0.06	< 0.02	< 0.02	< 0.02	< 0.014	< 0.006
	344348086493401	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
5	344131087335201	< 0.2	NA	M	< 0.06	NA	NA	NA	NA	NA
	344131087335201	M	NA	M	< 0.06	NA	NA	NA	NA	NA
	344131087335201	NA	NA	NA	NA	NA	NA	NA	< 0.014	E 0.0138
	344131087335201	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	NA	NA
	344131087335201	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	344131087335201	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	344131087335201	< 0.2	< 0.02	< 0.06	< 0.06	< 0.02	0.23	0.09	< 0.014	< 0.006
	344131087335201	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
6	312143085230301	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	312143085230301	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	312143085230301	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
7	312118085193001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	312118085193001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p49313 Aldicarb sulfone	p50009 Alachlor sulfonic acid (alachlor ESA)	p50355 2-Hydroxy-4-isopropylamino-6-ethylamino-s-triazine (hydroxyatrazine)	p50359 Metalaxyl	p61031 Alachlor oxanilic acid (alachlor OXA)	p61043 Metolachlor sulfonic acid (metolachlor ESA)	p61044 Metolachlor oxanilic acid (metolachlor OXA)	p61596 Metalaxyl	p61625 3,4-Dichloro-aniline
	311928085191101	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	311928085191101	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
8	311928085191101	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	311928085191101	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	311928085191101	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	311048085403201	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	311048085403201	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
9	311048085403201	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	311048085403201	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	311048085403201	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	310453085383001	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	310453085383001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
10	310453085383001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	310453085383001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	310453085383001	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	310153085225901	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	310153085225901	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
11	310153085225901	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	310153085225901	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	310153085225901	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	303432087485501	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	303432087485501	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
12	303432087485501	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	303432087485501	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	303432087485501	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	303252087500801	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	303252087500801	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
13	303252087500801	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	303252087500801	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	303252087500801	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	303231087525801	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	303231087525801	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
14	303231087525801	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	303231087525801	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	303231087525801	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	302434087462601	NA	NA	NA	NA	NA	NA	NA	< 0.014	< 0.006
	302434087462601	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
15	302434087462601	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	302434087462601	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	302434087462601	< 0.2	NA	< 0.06	< 0.06	NA	NA	NA	< 0.014	< 0.006
	302438087325801	NA	NA	NA	NA	NA	NA	NA	0.03	< 0.006
	302438087325801	< 0.2	NA	< 0.06	0.1	NA	NA	NA	0.134	< 0.006
16	302438087325801	< 0.2	NA	< 0.06	0.07	NA	NA	NA	0.071	< 0.006
	302438087325801	< 0.2	NA	< 0.06	0.09	NA	NA	NA	0.082	< 0.006
	302438087325801	< 0.2	NA	< 0.06	0.08	NA	NA	NA	0.096	< 0.006

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p61640 Disulfoton sulfone	p62722 Glyphosate	p62849 *sec*-Alachlor sulfonic acid	p62850 2-[(2-Ethyl-6-methylphenyl)amino]-2-oxoethanesulfonic acid	p62971 Dissolved oxygen, lab, mg/L	p63676 Turbidity, NTRU	p70300 Dissolved solids dried at 180 °C, mg/L
1	345822086254001	NA	NA	NA	NA	NA	NA	61
	345822086254001	NA	NA	NA	NA	NA	NA	58
	345822086254001	< 0.014	NA	NA	NA	NA	8.2	57
	345822086254001	NA	NA	NA	NA	NA	NA	NA
	345822086254001	< 0.014	NA	NA	NA	NA	7.4	NA
	345822086254001	< 0.014	NA	NA	NA	NA	1.6	56
	345822086254001	< 0.014	< 0.02	0.02	< 0.02	4.1	1	47
	345822086254001	< 0.010	NA	NA	NA	NA	12	NA
2	345112086313401	NA	NA	NA	NA	NA	NA	140
	345112086313401	NA	NA	NA	NA	NA	NA	110
	345112086313401	< 0.014	NA	NA	NA	NA	100	125
	345112086313401	NA	NA	NA	NA	NA	NA	NA
	345112086313401	< 0.014	NA	NA	NA	NA	11	NA
	345112086313401	< 0.014	NA	NA	NA	NA	60	115
	345112086313401	< 0.014	< 0.02	< 0.02	< 0.02	0.9	0.5	116
	345112086313401	< 0.014	NA	NA	NA	NA	10	NA
3	344124086531401	NA	NA	NA	NA	NA	NA	150
	344124086531401	< 0.014	NA	NA	NA	NA	NA	NA
	344124086531401	< 0.014	NA	NA	NA	NA	3.9	NA
	344124086531401	< 0.014	NA	NA	NA	NA	NA	NA
	344124086531401	< 0.014	< 0.02	< 0.02	0.04	0.2	2.4	101
	344124086531401	< 0.014	NA	NA	NA	NA	NA	NA
4	344348086493401	NA	NA	NA	NA	NA	NA	170
	344348086493401	NA	NA	NA	NA	NA	NA	131
	344348086493401	< 0.014	NA	NA	NA	NA	14	149
	344348086493401	NA	NA	NA	NA	NA	NA	NA
	344348086493401	< 0.014	NA	NA	NA	NA	6.4	NA
	344348086493401	< 0.014	NA	NA	NA	NA	2.5	115
	344348086493401	< 0.014	< 0.02	< 0.02	< 0.02	5.5	1.4	160
	344348086493401	< 0.014	NA	NA	NA	NA	3.9	NA
5	344131087335201	NA	NA	NA	NA	NA	NA	162
	344131087335201	NA	NA	NA	NA	NA	NA	179
	344131087335201	0.022	NA	NA	NA	NA	1.3	175
	344131087335201	NA	NA	NA	NA	NA	NA	NA
	344131087335201	< 0.014	NA	NA	NA	NA	7.8	NA
	344131087335201	< 0.014	NA	NA	NA	NA	2.2	186
	344131087335201	< 0.014	0.02	< 0.02	0.03	0.2	0.3	174
	344131087335201	< 0.014	NA	NA	NA	NA	0.5	NA
6	312143085230301	< 0.014	NA	NA	NA	NA	NA	NA
	312143085230301	< 0.014	NA	NA	NA	NA	1.1	NA
	312143085230301	< 0.014	NA	NA	NA	NA	NA	NA
7	312118085193001	< 0.014	NA	NA	NA	NA	NA	NA
	312118085193001	< 0.014	NA	NA	NA	NA	1.4	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p61640 Disulfoton sulfone	p62722 Glyphosate	p62849 *sec*-Alachlor sulfonic acid	p62850 2-[(2-Ethyl-6-methylphenyl)amino]-2-oxoethanesulfonic acid	p62971 Dissolved oxygen, lab, mg/L	p63676 Turbidity, NTRU	p70300 Dissolved solids dried at 180 °C, mg/L
	311928085191101	< 0.014	NA	NA	NA	NA	NA	NA
	311928085191101	< 0.014	NA	NA	NA	NA	2	NA
8	311928085191101	< 0.014	NA	NA	NA	NA	NA	NA
	311928085191101	< 0.014	NA	NA	NA	NA	0.4	NA
	311928085191101	< 0.014	NA	NA	NA	NA	0.4	NA
	311048085403201	< 0.014	NA	NA	NA	NA	NA	NA
	311048085403201	< 0.014	NA	NA	NA	NA	1.2	NA
9	311048085403201	< 0.014	NA	NA	NA	NA	NA	NA
	311048085403201	< 0.014	NA	NA	NA	NA	0.6	NA
	311048085403201	< 0.014	NA	NA	NA	NA	0.9	NA
	310453085383001	< 0.014	NA	NA	NA	NA	NA	NA
	310453085383001	< 0.014	NA	NA	NA	NA	1.2	NA
10	310453085383001	< 0.014	NA	NA	NA	NA	NA	NA
	310453085383001	< 0.014	NA	NA	NA	NA	0.4	NA
	310453085383001	< 0.014	NA	NA	NA	NA	0.2	NA
	310153085225901	< 0.014	NA	NA	NA	NA	NA	NA
	310153085225901	< 0.014	NA	NA	NA	NA	1.7	NA
11	310153085225901	< 0.014	NA	NA	NA	NA	NA	NA
	310153085225901	< 0.014	NA	NA	NA	NA	0.5	NA
	310153085225901	< 0.014	NA	NA	NA	NA	0.3	NA
	303432087485501	< 0.014	NA	NA	NA	NA	NA	NA
	303432087485501	< 0.014	NA	NA	NA	NA	0.6	NA
12	303432087485501	< 0.014	NA	NA	NA	NA	NA	NA
	303432087485501	< 0.014	NA	NA	NA	NA	0.2	NA
	303432087485501	< 0.014	NA	NA	NA	NA	0.6	NA
	303252087500801	< 0.014	NA	NA	NA	NA	NA	NA
	303252087500801	< 0.014	NA	NA	NA	NA	0.9	NA
13	303252087500801	< 0.014	NA	NA	NA	NA	NA	NA
	303252087500801	< 0.014	NA	NA	NA	NA	0.2	NA
	303252087500801	< 0.014	NA	NA	NA	NA	2.6	NA
	303231087525801	< 0.014	NA	NA	NA	NA	NA	NA
	303231087525801	< 0.014	NA	NA	NA	NA	NA	NA
14	303231087525801	< 0.014	NA	NA	NA	NA	NA	NA
	303231087525801	< 0.014	NA	NA	NA	NA	14	NA
	303231087525801	< 0.014	NA	NA	NA	NA	5.2	NA
	302434087462601	< 0.014	NA	NA	NA	NA	NA	NA
	302434087462601	< 0.014	NA	NA	NA	NA	0.8	NA
15	302434087462601	< 0.014	NA	NA	NA	NA	NA	NA
	302434087462601	< 0.014	NA	NA	NA	NA	0.6	NA
	302434087462601	< 0.014	NA	NA	NA	NA	0.8	NA
	302438087325801	< 0.014	NA	NA	NA	NA	NA	NA
	302438087325801	< 0.014	NA	NA	NA	NA	NA	NA
16	302438087325801	< 0.014	NA	NA	NA	NA	NA	NA
	302438087325801	< 0.014	NA	NA	NA	NA	0.2	NA
	302438087325801	< 0.014	NA	NA	NA	NA	0.6	NA

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p79846	p82630	p82670	p82671	p82681	p82682	p82683
		cis-Propiconazole	Metribuzin	Tebuthiuron	Molinate	Thiobencarb	DCPA	Pendimethalin
1	345822086254001	NA	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345822086254001	NA	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	E 0.014
	345822086254001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345822086254001	NA	NA	< 0.060	NA	NA	NA	NA
	345822086254001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345822086254001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345822086254001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345822086254001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
2	345112086313401	NA	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345112086313401	NA	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345112086313401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345112086313401	NA	NA	NA	NA	NA	NA	NA
	345112086313401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345112086313401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345112086313401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	345112086313401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
3	344124086531401	NA	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344124086531401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344124086531401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344124086531401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344124086531401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344124086531401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
4	344348086493401	NA	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344348086493401	NA	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344348086493401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344348086493401	NA	NA	< 0.060	NA	NA	NA	NA
	344348086493401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344348086493401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344348086493401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344348086493401	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
5	344131087335201	NA	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344131087335201	NA	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344131087335201	< 0.008	< 0.016	< 0.060	0.022	0.029	0.015	< 0.012
	344131087335201	NA	NA	< 0.060	NA	NA	NA	NA
	344131087335201	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344131087335201	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344131087335201	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	344131087335201	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
6	312143085230301	< 0.008	< 0.016	0.123	< 0.008	< 0.016	< 0.0076	< 0.012
	312143085230301	< 0.008	< 0.016	0.078	< 0.008	< 0.016	< 0.0076	< 0.012
	312143085230301	< 0.008	< 0.016	E 0.109	< 0.008	< 0.016	< 0.0076	< 0.012
7	312118085193001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	312118085193001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012

Appendix 2. Concentrations of detected compounds in groundwater samples from wells located in areas of high-density row-crop production in Alabama, 2000–2013.—Continued

[pxxxxxx, National Water Information System parameter code; °C, degrees Celsius; mm, millimeters; Hg, mercury; µS/cm, microsiemens per centimeter at 25 °C; NTRU, Nephelometric turbidity ratio units; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; P, phosphorus; <, value is less than the minimum reporting level; E, estimated value; NA, not collected; A, average; M, presence of constituent is verified, but not quantified; NA, not collected. All concentrations in micrograms per liter (µg/L) unless otherwise noted]

Well number (fig. 1)	USGS station number	p79846	p82630	p82670	p82671	p82681	p82682	p82683
		cis-Propiconazole	Metribuzin	Tebuthiuron	Molinate	Thiobencarb	DCPA	Pendimethalin
	311928085191101	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	311928085191101	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
8	311928085191101	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	311928085191101	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	311928085191101	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	311048085403201	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	311048085403201	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
9	311048085403201	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	311048085403201	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	311048085403201	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	310453085383001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	310453085383001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
10	310453085383001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	310453085383001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	310453085383001	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	310153085225901	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	310153085225901	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
11	310153085225901	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	310153085225901	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	310153085225901	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303432087485501	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303432087485501	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
12	303432087485501	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303432087485501	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303432087485501	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303252087500801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303252087500801	E 0.010	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
13	303252087500801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303252087500801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303252087500801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303231087525801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303231087525801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
14	303231087525801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303231087525801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	303231087525801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	302434087462601	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	302434087462601	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
15	302434087462601	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	302434087462601	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	302434087462601	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	302438087325801	< 0.008	0.023	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	302438087325801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
16	302438087325801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	302438087325801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012
	302438087325801	< 0.008	< 0.016	< 0.060	< 0.008	< 0.016	< 0.0076	< 0.012

For more information regarding this publication, contact
Athena Clark
USGS Lower Mississippi-Gulf Water Science Center
75 TechnaCenter Drive
Montgomery, AL 36117
telephone: 334–395–4120
http://al.water.usgs.gov

ISSN 2328-0328 (online)
http://dx.doi.org/10.3133/sir20155014