

Prepared in cooperation with the Montgomery Water Works and Sanitary Sewer Board

Occurrence of Selected Pharmaceuticals, Personal-Care Products, Organic Wastewater Compounds, and Pesticides in the Lower Tallapoosa River Watershed near Montgomery, Alabama, 2005

Scientific Investigations Report 2007–5266

Cover photograph. The Tallapoosa River below Tallassee, Alabama.

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Conversion Factors, Horizontal Datum, and Abbreviations and Acronyms

Inch/Pound to SI

Multiply	By	To obtain
	Length	
mile (mi)	1.609	kilometer (km)

SI to Inch/Pound

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
kilometer (km)	0.6214	mile (mi)
	Area	
square kilometer (km ²)	0.3861	square mile (mi ²)
	Flow rate	
cubic meter per second (m ³ /s)	70.07	acre-foot per day (acre-ft/d)
cubic meter per second (m ³ /s)	35.31	cubic foot per second (ft ³ /s)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$^{\circ}\text{F}=(1.8\times^{\circ}\text{C})+32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$^{\circ}\text{C}=(^{\circ}\text{F}-32)/1.8$$

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

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

Abbreviations and Acronyms

AHTN	6-Acetyl-1,1,2,4,4,7-hexamethyltetraline
CIAT	2-Chloro-4-isopropylamino-6-amino-s-triazine
DCPA	Dimethyl tetrachloroterephthalate
DEET	<i>N,N</i> -diethyl- <i>m</i> -toluamide
HHCB	1,3,4,6,7,8-Hexahydro-4,6,6,7,8,8-hexamethylcyclopenta(g)-2-benzopyran
LRL	Laboratory reporting level
LT-MDL	Long-term method-detection level
MDL	Method detection level
NWQL	National Water Quality Laboratory
OGRL	Organic Geochemistry Research Laboratory
OWCs	Organic wastewater compounds

Occurrence of Selected Pharmaceuticals, Personal-Care Products, Organic Wastewater Compounds, and Pesticides in the Lower Tallapoosa River Watershed near Montgomery, Alabama, 2005

By Carolyn J. Oblinger, Amy C. Gill, Ann K. McPherson, Michael T. Meyer, and Edward T. Furlong

Abstract

Synthetic and natural organic compounds derived from agricultural operations, residential development, and treated and untreated sanitary and industrial wastewater discharges can contribute contaminants to surface and ground waters. To determine the occurrence of these compounds in the lower Tallapoosa River watershed, Alabama, new laboratory methods were used that can detect human and veterinary antibiotics; pharmaceuticals; and compounds found in personal-care products, food additives, detergents and their metabolites, plasticizers, and other industrial and household products in the environment. Well-established methods for detecting 47 pesticides and 19 pesticide degradates also were used. In all, 186 different compounds were analyzed by using four analytical methods.

The lower Tallapoosa River serves as the water-supply source for more than 100,000 customers of the Montgomery Water Works and Sanitary Sewer Board. Source-water protection is a high priority for the Board, which is responsible for providing safe drinking water. The U.S. Geological Survey, in cooperation with the Montgomery Water Works and Sanitary Sewer Board, conducted this study to provide baseline data that could be used to assess the effects of agriculture and residential development on the occurrence of selected organic compounds in the lower Tallapoosa River watershed.

Twenty samples were collected at 10 sites on the Tallapoosa River and its tributaries. Ten samples were collected in April 2005 during high base streamflow, and 10 samples were collected in October 2005 when base streamflow was low.

Thirty-two of 186 compounds were detected in the lower Tallapoosa River watershed. Thirteen compounds, including atrazine, 2-chloro-4-isopropylamino-6-amino-s-triazine (CIAT), hexazinone, metalaxyl, metolachlor, prometryn, prometon, simazine, azithromycin, oxytetracycline, sulfamethoxazole, trimethoprim, and tylosin, had measurable concentrations above their laboratory reporting levels. Concentrations were estimated for an additional 19 compounds that were detected below their laboratory reporting levels.

The two most frequently detected compounds were the pesticides atrazine (19 of 20 samples) and simazine (13 of 20 samples). Tylosin, a veterinary antibiotic, was detected in 8 of 20 samples. Other compounds frequently detected at very low concentrations included CIAT and hexazinone (a degradate of atrazine and a pesticide, respectively); camphor (derived from personal-care products or flavorants), *para*-cresol (various uses including solvent, wood preservative, and in household cleaning products), and *N,N*-diethyl-*m*-toluamide (DEET, an insect repellent).

Introduction

Synthetic and natural organic compounds derived from agricultural operations, residential development, and treated and untreated sanitary and industrial wastewater discharges can contribute contaminants to surface and ground waters. Such compounds include pesticides, human and veterinary antibiotics and pharmaceuticals, and some of the degradates of these compounds. Also included are a group of compounds, collectively referred to as organic wastewater compounds (OWCs), that are present in sanitary waste or are disposed in wastewater and include compounds found in personal-care products (for example, fragrances, lotions, soaps, and sun-screen products), food additives, detergents and their metabolites, plastics, and other industrial and household products.

Recent studies in which new laboratory analytical methods were used to detect low concentrations of these compounds have provided information about their occurrence in surface and ground water in the United States (Kolpin and others, 2002; Wilkison and others, 2002; Galloway and others, 2005; Zimmerman, 2005). The greatest concentrations and numbers of detections of antibiotics, pharmaceuticals, and OWCs generally are associated with receiving waters for public sanitary wastewater and industrial wastewater discharges, on-site sanitary wastewater systems, and confined-animal feeding operations.

Pesticides associated with agriculture, lawn care and landscaping, and household use generally are released to the environment directly upon application (Gilliom and others, 2006). Antibiotics and other pharmaceuticals and their degradates can be released to surface and ground waters directly in animal waste, as with veterinary medicines, or indirectly from human waste processed in public sanitary wastewater discharges or in septic system leachates. Until recently, a common recommendation to American households was to dispose of unused pharmaceuticals by flushing them in the toilet. OWCs, such as steroids, compounds found in personal-care products, food additives, insect repellents, and detergents and their metabolites, also are in human waste or wastewater collected by sewage-treatment systems or septic systems before being discharged to surface drainage or ground water.

These compounds can persist in natural systems where they can have long-term effects on stream biota. When the natural system is used as a water supply, human health may be affected (Wilde and others, 2000). One area of concern with respect to health effects is the ability of some of these compounds to disrupt the normal function of the endocrine system of both humans and wildlife, resulting in developmental and reproductive abnormalities. A variety of chemicals have been shown to disrupt the endocrine systems of animals in laboratory studies, and evidence suggests that endocrine systems of certain fish and wildlife have been affected by chemical contaminants (Jobling and others, 1998; Keith, 1998; Lintelmann and others, 2003).

The lower Tallapoosa River watershed supports agriculture and residential development. Agriculture land uses include row crops and livestock production including intense animal-feeding operations. Agriculture land uses potentially contribute contaminants, such as agricultural pesticides, veterinary antibiotics, and feed supplements into surface and ground waters in the watershed. Residential land uses potentially contribute contaminants to streams and ground water through the discharge of OWCs, such as pharmaceuticals, personal-care products, steroids, industrial compounds, and detergents, in wastewater from septic systems and the delivery of pesticides in stormwater runoff. Treated sanitary wastewater effluents from municipalities and industrial wastewater effluents are discharged directly into the lower Tallapoosa River system and may contribute low-level contaminants that are not removed by treatment processes. The water quality of tributaries to the Tallapoosa River is directly influenced by the amount of agricultural activity and residential development within each tributary watershed.

The lower Tallapoosa River is the water-supply source for more than 100,000 customers of the Montgomery Water Works and Sanitary Sewer Board (hereafter referred to as the Board). Source-water protection is a high priority for the Board, which is responsible for providing safe drinking water to citizens in the Montgomery, Alabama, area. The U.S. Geological Survey (USGS), in cooperation with the Board,

designed this study to determine if agricultural and residential development in the lower Tallapoosa River watershed are adversely affecting water resources used to supply Montgomery with drinking water.

This report presents the results of analyses of 20 stream samples collected at 10 sites on the lower Tallapoosa River and its tributaries to determine the occurrence of selected classes of organic compounds in the lower Tallapoosa River watershed. Ten samples were collected in April 2005 when base streamflow was relatively high, although no recent stormwater runoff had occurred, and 10 samples were collected in October 2005 when base streamflow was low. Samples were analyzed for a total of 186 organic compounds by using four different laboratory methods. Included were analyses for pesticides and pesticide degradates, polycyclic aromatic hydrocarbons, fire retardants, byproducts of human and animal metabolism (steroids), compounds contained in personal-care products and detergents, and commonly used prescription and nonprescription pharmaceuticals.

Description of the Study Area

The lower Tallapoosa River watershed in east-central Alabama is the area of the Tallapoosa River basin between Martin Dam and the confluence of the Tallapoosa and Coosa Rivers (fig. 1). The lower Tallapoosa River watershed drains approximately 4,400 square kilometers (km²) and encompasses large portions of Tallapoosa, Lee, Macon, Bullock, Elmore, and Montgomery Counties in Alabama. Yates and Thurlow Dams impound the Tallapoosa River in the upper portion of the lower Tallapoosa River watershed, which has resulted in the formation of two large reservoirs. No additional impoundments are on the Tallapoosa River below Thurlow Dam at Tallassee (CH2M Hill, 2005).

The Montgomery Water Works and Sanitary Sewer Board produces 60 percent of the finished water for the city of Montgomery from water withdrawn from the Tallapoosa River (Montgomery Water Works and Sanitary Sewer Board, 2006). The Board routinely monitors several sites in the lower Tallapoosa River watershed below Thurlow Dam as part of an ongoing source-water protection program. Sampling locations for this study were selected from the Board's established monitoring sites (table 1; fig. 1). Samples were collected near the mouths of seven tributaries—Brensen Branch (BRE) and Harwell Mill (HAR), Chubbehatchee (CHU), Goodwater (GDW), Calebee (CAL), Cubahatchee (CUB), and Line (LIN) Creeks. In addition to these monitoring sites, three locations were sampled on the Tallapoosa River—below Tallassee (TAL-1), below the confluence with Uphapee Creek near Tuskegee (TAL-2), and at the Montgomery Water Works intake (TAL-3, table 1; fig. 1). Goodwater Creek was used as a control site because it is mostly forested and was expected to have relatively few sources of contamination.

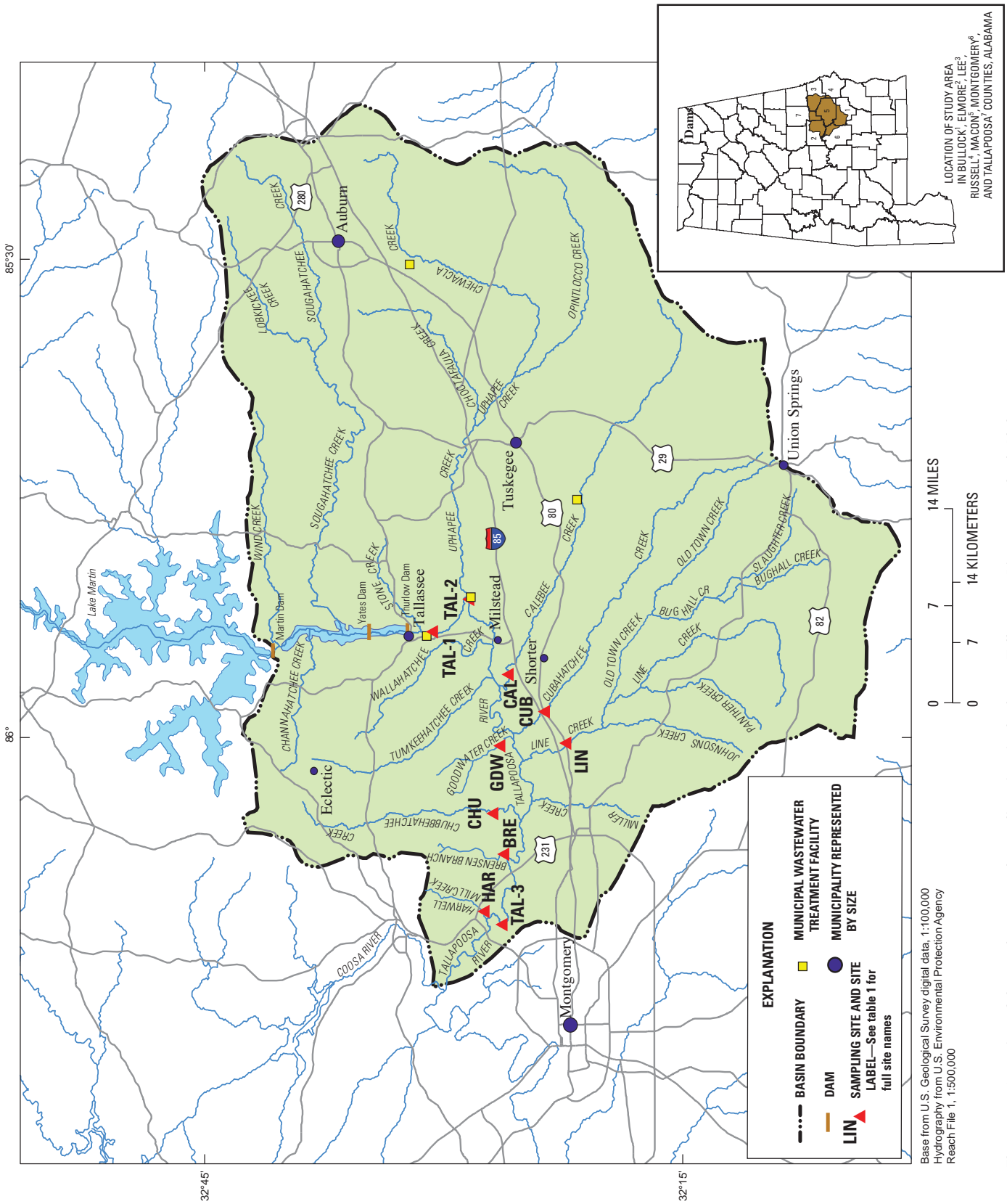


Figure 1. Location of the study area and sampling sites in the lower Tallapoosa River watershed, Alabama, 2005.

4 Occurrence of Pharmaceuticals, Personal-Care Products, OWCs, and Pesticides in the Lower Tallapoosa River

Table 1. Sampled sites in the lower Tallapoosa River watershed, Alabama, 2005.

[USGS, U.S. Geological Survey; km², square kilometers; m³/s, cubic meters per second; —, no data]

Site label (fig. 1)	USGS site number	Site name	Drainage area, in km ²	Sampled discharge, in m ³ /s	
				April 2005	October 2005
TAL-1	02418500	Tallapoosa River below Tallassee, Ala.	8,630	—	—
TAL-2	02419305	Tallapoosa River near Tuskegee, Ala.	9,750	—	—
CAL	02419640	Calebee Creek near Shorter, Ala.	392	2.4	0.45
CUB	02419670	Cubahatchee Creek near Shorter, Ala.	316	1.2	.15
GDW	02419700	Goodwater Creek near Ware, Ala.	29.6	.51	.05
LIN	02419800	Line Creek near Shorter, Ala.	799	6.6	.08
CHU	02419840	Chubbehatchee Creek near Ware, Ala.	160	2.2	.22
BRE	02419865	Brensen Branch near Ware, Ala.	13.4	.26	.08
TAL-3	02419890	Tallapoosa River near Montgomery, Ala.	12,050	259	147
HAR	02419892	Harwell Mill Creek near Montgomery, Ala.	28.5	.51	.16

The climate in the study area is temperate; the mean annual temperature is approximately 18 degrees Celsius (°C; Southeast Regional Climate Center, 2006). Most precipitation occurs as rain. Mean annual rainfall at Milstead (Macon County), which is centrally located in the watershed, was 134.6 centimeters (cm) for 1971–2000. For the same time period, the highest mean monthly rainfall occurred in March (17.04 cm), and the lowest mean monthly rainfall occurred in October (6.71 cm) (Southeast Regional Climate Center, 2006).

Stream samples were collected for this investigation during periods in the spring and fall when little surface rainfall runoff was expected. Base-flow conditions were selected to minimize dilution from rainfall and thereby maximize detection of contaminants in the stream from ground-water or continuous discharge sources. During the 12 days prior to sampling, which began on April 25, 2005, the only significant rainfall was 1.65 cm on April 22 at the Milstead precipitation station (National Climatic Data Center, 2006). An additional 2.13 cm of rainfall was recorded at Milstead on April 26–27, which contributed some runoff to streams sampled on those days. No rainfall was recorded from October 9 through the fall sampling period (October 24–26, 2005).

Sapp and Emplincourt (1975), Kidd (1987, 1989), and Scott and others (1987) provide geologic descriptions and a delineation of the physiographic provinces within the Tallapoosa River watershed. The watershed lies within the Piedmont and Coastal Plain Physiographic Provinces. A small portion of the northern extent of the watershed in Tallapoosa and Lee Counties is within the Southern Piedmont Upland Physiographic District, which is characterized by rolling topography with outcrops of igneous and metamorphic rocks (Copeland, 1968; Kidd, 1989). Most of the watershed is within four physiographic districts (Fall Line Hills, Black Prairie,

Chunnenuggee Hills, and the deltaic Alluvial Plain) of the East Gulf Section of the Coastal Plain Physiographic Province, which is characterized by low-gradient, hilly belts formed by variable erosion of sedimentary rocks of the Mesozoic and Cenozoic eras (Copeland, 1968).

Southward-flowing tributaries to the Tallapoosa River (including Brensen Branch and Harwell Mill, Chubbehatchee, and Goodwater Creeks) from Elmore County and westward-flowing Calebee and Uphapee Creeks in Macon County generally drain sand, gravel, clay, and silt from the Fall Line Hills and Alluvial Plain Districts (Geological Survey of Alabama, 2006). Line Creek and the headwaters of Cubahatchee Creek flow northward to the Tallapoosa through chalk, marl, and clay in the Chunnenuggee Hills and Black Prairie Physiographic Districts before reaching the sandier Alluvial Plain District along the Tallapoosa River.

Land use in the watershed is dominated by forests, pastures, and cultivated crops. Surface mining of sand and gravel is another common land use in the alluvial deposits along the river. Almost 20 percent of the watershed is used for agriculture, including extensive areas of row crops along the Tallapoosa River. Urban land use in the lower Tallapoosa River watershed accounts for only about 3 percent of the entire land area, and almost 50 percent of the urban land use is identified as residential (CH2M Hill, 2005). Below Thurlow Dam, low- to medium-intensity developed areas are concentrated around the municipalities of Tallassee, Tuskegee, and the east side of Montgomery (fig. 1; CH2M Hill, 2005; Multi-Resolution Land Characteristics Consortium, 2006). The drainage area of Goodwater Creek is predominantly mixed forest, and is considered by the Board to be representative of near-background conditions.

Discharge from centralized wastewater-treatment systems and septic systems may contribute wastewater contaminants to streams in the study area. Septic systems commonly are used for sewage treatment and disposal in rural areas, and the effluent may contain contaminants derived from household wastes (Conn and others, 2006). In addition, centralized wastewater systems are designed to remove or limit the discharge of excessive nutrients, but their efficiency in removing many organic compounds is not known.

Several wastewater-treatment system outfalls are located in the study area. Most of these are small facilities, but four major municipal facilities have outfalls in the watershed (fig. 1). The city of Tallapoosa discharges wastewater effluent to the Tallapoosa River downstream from the city. The city of Tuskegee has two effluent discharges, one located on Calebee Creek and one on the Tallapoosa River downstream from the mouth of Uphapee Creek (Alabama Department of Environmental Management, written commun., 2006; U.S. Environmental Protection Agency, 2006a, 2006b). The city of Auburn's H.C. Morgan sewage treatment plant discharges to a tributary of Chewacla Creek.

Discharge from an unidentified pipe was noted on Cubahatchee Creek directly downstream from U.S. Highway 80 during the spring sampling event, but not during the fall sampling event. The location of the pipe did not match location information from the Alabama Department of Environmental Management permitted discharges in the area (Alabama Department of Environmental Management, written commun., 2006), and the source of the discharge is not known.

Methods

Samples were collected according to standard USGS field sample collection procedures (U.S. Geological Survey, variously dated). The two Tallapoosa River main-stem sites at the upstream end of the study area (TAL-1 and TAL-2; fig. 1) were sampled from a boat at a minimum of three locations in the river cross section by using a US DH-95 depth-integrating sampler fitted with a Teflon bottle and nozzle (Wilde and others, 1999; Lane and others, 2003), and samples were composited. The Tallapoosa main-stem site at the downstream end of the study area (TAL-3; fig. 1) was sampled from the catwalk next to the water-supply intake by using a weighted bottle sampler fitted with a baked brown-glass bottle to collect a grab sample. Tributary sites were wadeable and were sampled at a minimum of 10 locations in the stream cross section by using a US DH-81 depth-integrating sampler fitted with a Teflon bottle and nozzle except when stream depth was very low, in which case no nozzle was used and the sample was collected directly into a Teflon bottle. Stream cross-section sub-samples were first composited and then split by using a Teflon cone splitter (Wilde and others, 2004, p. 27).

Samples were processed onsite and prepared for shipment to a laboratory for analysis. Each sample was filtered through a 0.7-micron nominal-pore-size, glass-fiber filter that had been

pretreated by baking at 450 °C and rinsed and preconditioned by filtering 100 milliliters (mL) of sample water through the filter. Samples for analysis of antibiotics were shipped on ice overnight to the USGS Kansas Water Science Center's Organic Geochemistry Research Laboratory (OGRL). The remaining samples were shipped on ice overnight to the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colorado, for analysis.

Special equipment-preparation and sample-processing precautions were taken to prevent contamination of equipment and samples with pharmaceuticals, including antibiotics, personal-care products, and other commonly used substances that could affect sample integrity (Wilde and others, 2004). Thus, on the days of sampling, personnel avoided use of caffeine and insect repellents.

Analytical Methods

Four analytical methods were used to determine concentrations of the compounds of interest (table 2). These four methods were: (1) the OGRL's method for analysis of selected antibiotics (Meyer and others, 2007), (2) a NWQL method for analysis of common-use pesticides and pesticide degradates (Zaugg and others, 1995; Lindley and others, 1996; Sandstrom and others, 2001; Madsen and others, 2003), (3) a NWQL method for analysis of commonly prescribed pharmaceuticals (Cahill and others, 2004), and (4) the NWQL method for analysis of a variety of OWCs associated with human and industrial wastes including personal-care products, food additives, byproducts of metabolism, and pesticides (Zaugg and others, 2002). Ten compounds analyzed by the fourth method also were analyzed by one of the other three methods used. The analytical methods for pharmaceutical and antibiotic compounds were in development at the time of this study. A few compounds determined by these methods produced highly variable results. These results are footnoted where presented herein.

Analytical results from the USGS NWQL were censored to the laboratory reporting level (LRL) determined independently for each compound based on the long-term method-detection level (LT-MDL; Childress and others, 1999; table 2). The LRL is established to minimize the probability of reporting false-positive and false-negative results. The LT-MDL is statistically derived based on long-term, repeated measurements of very low-level known concentrations of each compound and is the lowest concentration that will minimize the probability of a false-positive result (that is, reporting an analyte to be present when it is not). When a compound is detected below the LRL, the concentration is reported as an estimate to indicate the greater uncertainty associated with that measurement compared to concentrations measured above the LRL. Moreover, at very low concentrations that are less than the LRL established by the NWQL, it is much more likely that a compound that is present in a sample will not be detected (a false-negative result).

6 Occurrence of Pharmaceuticals, Personal-Care Products, OWCs, and Pesticides in the Lower Tallapoosa River

Table 2. Reporting levels for compounds analyzed in stream samples collected from the lower Tallapoosa River watershed, Alabama, 2005.

[µg/L, micrograms per liter; **Shaded and bold** compounds were detected in concentrations above the reporting level; **bold** compounds were detected below the reporting level and concentrations were estimated; A, Kansas Organic Geochemistry Research Laboratory method for antibiotics; Ph, National Water Quality Laboratory method for pharmaceuticals; W, National Water Quality Laboratory method for organic wastewater compounds; Pe, National Water Quality Laboratory method for pesticides; AHTN, 6-acetyl-1,1,2,4,4,7-hexamethyltetraline; DEET, *N,N*-diethyl-*m*-toluamide; HHCB, 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethyl-cyclopenta(g)-2-benzopyran; CIAT, 2-chloro-4-isopropylamino-6-amino-s-triazine; DCPA, dimethyl tetrachloroterephthalate]

Compound name	Reporting level ^a (µg/L)	Method	Compound name	Reporting level ^a (µg/L)	Method
Antibiotics and degradates					
Amoxicillin	0.010	A	Sarafloxacin	0.005	A
Ampicillin	0.010	A	Sulfachloropyridazine	0.005	A
Azithromycin^b	0.005	A	Sulfadiazine	0.005	A
Azithromycin ^{b, c}	0.0022	Ph	Sulfadimethoxine	0.005	A
Carbadox	0.005	A	Sulfamerazine	0.005	A
Cefotaxime	0.010	A	Sulfamethazine	0.005	A
Chlorotetracycline	0.010	A	Sulfamethoxazole ^{a, b}	0.005	A
Ciproflaxacin	0.005	A	Sulfamethoxazole^{b, d}	0.0321	Ph
Clinafloxacin	0.005	A		0.024	
Cloxacillin	0.010	A	Sulfathiazole	0.005	A
Doxycycline	0.010	A	Tetracycline	0.010	A
Erythromycin ^b	0.005	A	Alpha apo-oxytetracycline ^c	0.010	A
Erythromycin ^{b, c}	0.0046	Ph	Anhydro-chlorotetracycline ^c	0.010	A
Erythromycin-H ₂ O	0.005	A	Anhydro-tetracycline ^c	0.010	A
Flumequine	0.005	A	Beta apo-oxytetracycline ^c	0.010	A
Lincomycin	0.005	A	Demeclocycline ^c	0.010	A
Lomefloxacin	0.005	A	Epi-anhydro-chlorotetracycline ^c	0.010	A
Minocycline	0.010	A	Epi-anhydro-tetracycline ^c	0.010	A
Norfloxacin	0.005	A	Epi-chlorotetracycline ^c	0.010	A
Ofloxacin	0.005	A	Epi-iso-chlorotetracycline ^c	0.010	A
Ormetoprim	0.005	A	Epi-oxytetracycline ^c	0.010	A
Oxacillin	0.010	A	Epi-tetracycline ^c	0.010	A
Oxolinic Acid	0.005	A	Iso-chlorotetracycline ^c	0.010	A
Oxytetracycline	0.010	A	Trimethoprim^b	0.005	A
Penicillin G	0.010	A	Trimethoprim ^b	0.0063	Ph
Penicillin V	0.010	A		0.020	
Roxithromycin	0.005	A	Tylosin	0.005	A
			Virginiamycin	0.005	A
Detergents and detergent metabolites					
4-Cumylphenol	1	W	4-Octylphenol monoethoxylate	1	W
4- <i>n</i> -Octylphenol	1	W	4-<i>tert</i>-Octylphenol	1	W
4-Nonylphenol diethoxylate	5	W	<i>para</i>-Nonylphenol	5	W
4-Octylphenol diethoxylate	1	W			
Personal-care products including fragrances and flavors					
3-Methyl-1H-indole	1	W	Indole	0.5	W
3- <i>tert</i> -Butyl-4-hydroxyanisole	5	W	Isoborneol	0.5	W
Acetophenone	0.5	W	Isoquinoline	0.5	W
AHTN	0.5	W	Menthol	0.5	W
Benzophenone	0.5	W	Methyl salicylate	0.5	W
Camphor	0.5	W	Phenol	0.5	W
<i>d</i> -Limonene	0.5	W	Triclosan	1.0	W
HHCB	0.5	W	Triethyl citrate	0.5	W

Table 2. Reporting levels for compounds analyzed in stream samples collected from the lower Tallapoosa River watershed, Alabama, 2005.—Continued

[µg/L, micrograms per liter; **Shaded and bold** compounds were detected in concentrations above the reporting level; **bold** compounds were detected below the reporting level and concentrations were estimated; A, Kansas Organic Geochemistry Research Laboratory method for antibiotics; Ph, National Water Quality Laboratory method for pharmaceuticals; W, National Water Quality Laboratory method for organic wastewater compounds; Pe, National Water Quality Laboratory method for pesticides; AHTN, 6-acetyl-1,1,2,4,4,7-hexamethyltetraline; DEET, *N,N*-diethyl-*m*-toluamide; HHCB, 1,3,4,6,7,8-hexahydro-4,6,6,7,8-hexamethyl-cyclopenta(g)-2-benzopyran; CIAT, 2-chloro-4-isopropylamino-6-amino-s-triazine; DCPA, dimethyl tetrachloroterephthalate]

Compound name	Reporting level ^a (µg/L)	Method	Compound name	Reporting level ^a (µg/L)	Method
Industrial compounds and disinfectants					
5-Methyl-1H-benzotriazole	2	W	Tri(2-butoxyethyl) phosphate	0.5	W
9,10-Anthraquinone	0.5	W	Tri(2-chloroethyl) phosphate	0.5	W
Carbazole	0.5	W	Tri(dichloroisopropyl) phosphate	0.5	W
Isophorone	0.5	W	Tributyl phosphate	0.5	W
Isopropylbenzene	0.5	W	Triphenyl phosphate	0.5	W
para-Cresol	1	W	Tetrachloroethylene	0.5	W
Phenanthrene	0.5	W	Tribromomethane	0.5	W
Pyrene	0.5	W			
Polycyclic aromatic hydrocarbons					
1-Methylnaphthalene	0.5	W	Benzo[a]pyrene	0.5	W
2,6-Dimethylnaphthalene	0.5	W	Fluoranthene	0.5	W
2-Methylnaphthalene	0.5	W	Naphthalene	0.5	W
Anthracene	0.5	W			
Insect repellents, pesticides, and degradates					
1,4-Dichlorobenzene	0.5	W	Fenamiphos sulfoxide	0.039	Pe
2,6-Diethylaniline ^c	0.006	Pe	Fipronil	0.016	Pe
2-Chloro-2',6'-diethylacetanilide ^c	0.005	Pe	Desulfinyl fipronil^c	0.012	Pe
2-Ethyl-6-methylaniline ^c	0.004	Pe	Desulfinylfipronil amide ^c	0.029	Pe
3,4-Dichloroaniline^c	0.004	Pe	Fipronil sulfide ^c	0.013	Pe
4-Chloro-2-methylphenol ^c	0.006	Pe	Fipronil sulfone ^c	0.024	Pe
Acetochlor	0.006	Pe	Fonofos	0.003	Pe
Alachlor	0.005	Pe	Hexazinone	0.013	Pe
Atrazine	0.007	Pe	Iprodione	0.538	Pe
CIAT^{c,e}	0.006	Pe	Isofenphos	0.003	Pe
Azinphos-methyl	0.05	Pe	Malathion	0.027	Pe
Azinphos-methyl oxygen analog ^c	0.07	Pe	Malaaxon ^c	0.030	Pe
Benfluralin	0.01	Pe	Metalaxyl	0.5	W
Bromacil	0.5	W	Metalaxyl	0.005	Pe
Carbaryl ^b	1	W	Methodathion	0.006	Pe
Carbaryl ^b	0.041	Pe	Methyl parathion	0.015	Pe
1-Naphthol ^c	0.088	Pe	Methyl paraoxon ^c	0.030	Pe
Chlorpyrifos ^b	0.5	W	Metolachlor ^b	0.5	W
Chlorpyrifos ^b	0.005	Pe	Metolachlor^b	0.006	Pe
Chlorpyrifos oxygen analog ^c	0.056	Pe	Metribuzin	0.006	Pe
<i>cis</i> -Permethrin	0.006	Pe	Myclobutanil	0.008	Pe
Cyfluthrin	0.027	Pe	Pendimethalin	0.022	Pe
Cypermethrin	0.009	Pe	Phorate	0.011	Pe
DCPA	0.003	Pe	Phorate oxygen analog ^c	0.105	Pe
DEET	0.5	W	Phosmet	0.008	Pe

Table 2. Reporting levels for compounds analyzed in stream samples collected from the lower Tallapoosa River watershed, Alabama, 2005.—Continued

[$\mu\text{g/L}$, micrograms per liter; **Shaded and bold** compounds were detected in concentrations above the reporting level; **bold** compounds were detected below the reporting level and concentrations were estimated; A, Kansas Organic Geochemistry Research Laboratory method for antibiotics; Ph, National Water Quality Laboratory method for pharmaceuticals; W, National Water Quality Laboratory method for organic wastewater compounds; Pe, National Water Quality Laboratory method for pesticides; AHTN, 6-acetyl-1,1,2,4,4,7-hexamethyltetraline; DEET, *N,N*-diethyl-*m*-toluamide; HHCB, 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethyl-cyclopenta(g)-2-benzopyran; CIAT, 2-chloro-4-isopropylamino-6-amino-s-triazine; DCPA, dimethyl tetrachloroterephthalate]

Compound name	Reporting level ^a ($\mu\text{g/L}$)	Method	Compound name	Reporting level ^a ($\mu\text{g/L}$)	Method
Insect repellents, pesticides, and degradates—Continued					
Diazinon ^b	0.005	Pe	Phosmet oxygen analog ^c	0.051	Pe
Diazinon ^b	0.5	W	Prometon^b	0.5	W
Diazinon oxygen analog ^c	0.006	Pe	Prometon^b	0.01	Pe
Dichlorvos	0.012	Pe	Prometryn	0.005	Pe
Dicrotophos	0.084	Pe	Propyzamide	0.004	Pe
Dieldrin	0.009	Pe	Simazine	0.005	Pe
Dimethoate	0.006	Pe	Tebuthiuron	0.016	Pe
Ethion	0.004	Pe	Terbufos	0.017	Pe
Ethion monoxon	0.002	Pe	Terbufos oxygen analog sulfone ^c	0.068	Pe
Fenamiphos	0.029	Pe	Terbutylazine	0.010	Pe
Fenamiphos sulfone	0.049	Pe	Trifluralin	0.009	Pe
Pharmaceuticals and degradates					
Acetaminophen	0.0180	Ph	Diphenhydramine ^d	0.0074	Ph
	0.024			0.023	
Caffeine ^b	0.5	W	Fluoxetine ^d	0.0072	Ph
				0.016	
Caffeine ^b	0.008	Ph	Furosemide	MDL	Ph
	0.5				
1,7-dimethylxanthine ^c	0.0722	Ph	Gemfibrozil ^d	0.0064	Ph
	0.021				
Carbamazepine	0.0054	Ph	Ibuprofen ^d	0.0208	Ph
	0.018				
Cimetidine ^d	0.0061	Ph	Metformin ^c	MDL	Ph
Codeine	0.0076	Ph	Miconazole ^c	0.0088	Ph
	0.022				
Cotinine ^b	0.0068	Ph	Ranitidine ^d	0.0064	Ph
	0.028			0.025	
	1.0				
Cotinine ^b	1	W	Salbutamol	0.0115	Ph
				0.014	
Dehydronifedipine ^c	0.0077	Ph	Thiabendazole	0.0054	Ph
	0.022			0.025	
Diltiazem ^d	0.0079	Ph	Warfarin	0.0059	Ph
	0.018			0.019	
Steroids and stanols					
3-beta-Coprostanol	2	W	beta-Stigmastanol	2	W
beta-Sitosterol	2	W	Cholesterol	2	W

^a For some compounds, reporting levels changed depending on when the sample was analyzed.

^b Compound was analyzed using more than one method.

^c Compound is highly variable; concentrations are reported as detections or non-detections.

^d Results are highly variable; concentrations are reported as estimates.

^e Degradation product.

Because of the uncertainty associated with false-negative results at concentrations less than the LRL, only detections that were greater than the reporting level were used to compare the occurrence of compounds among sites in this study. All of the reported results, including estimated results, were used in this study to assess the types of compounds present in the study area and the frequency of occurrence basinwide.

Samples shipped to the OGRL were analyzed for five classes of antibiotics using three online solid-phase extraction methods and liquid chromatography and mass spectrometry or liquid chromatography and mass spectrometry-mass spectrometry (Meyer and others, 2007). The reporting levels for data from this laboratory were set at laboratory-determined method detection levels (MDL; table 2). No estimated concentrations are reported below the MDL.

Quality Control

During each sampling round, a replicate sample, blank sample, and fortified sample were collected to determine the reproducibility of results, whether contamination occurred during any part of the sample collection and analysis process, and the percentage of recovery of target compounds in native water—the target compounds being those compounds analyzed for this study. A total of six quality-control samples were processed and analyzed, including two field blanks, two replicate samples, and two fortified samples. A third replicate sample was analyzed for only a few selected antibiotics.

Blank samples consisted of commercially produced deionized water certified as free of organic compounds. These blank water samples received the same treatment and processing as environmental samples. Blank water was passed through the sampling and sample-processing equipment, collected into the same type of sample bottles used for environmental samples, and shipped to the laboratory in the same coolers.

Replicate samples were produced by collecting a large sample volume and splitting the sample into two or more independent, but theoretically identical samples. Each fortified sample was produced by splitting the sample and adding known concentrations of target compounds to one of the split samples. The percentage of fortified target compound that

was recovered by the analytical method was determined by comparing results from the fortified sample with results from the replicate environmental sample.

With three exceptions, analyses of blank samples produced no detections. Phenol was detected below the LRL in both field blanks (0.13 and 0.12 microgram per liter [$\mu\text{g/L}$]), and benzophenone was detected below the LRL in one field blank (0.01 $\mu\text{g/L}$). The LRL for phenol and benzophenone are each 0.5 $\mu\text{g/L}$. Phenol is a well-known chronic laboratory contaminant because it is used in the laboratory as a solvent. Benzophenone is used in personal-care products and soaps as an agent to prevent ultraviolet light from degrading perfumes. All of the phenol and benzophenone detections in environmental samples were estimated concentrations below the LRL similar to concentrations in blank samples. Thus, all concentrations below the LRL (0.5 $\mu\text{g/L}$) were assumed to be the result of contamination.

One laboratory preparation blank, associated with all of the samples for this study, contained a detectable concentration of diphenhydramine (0.0094 $\mu\text{g/L}$). Because of this, the laboratory recensored diphenhydramine results to a new LRL that was 10 times the concentration in the blank (0.09 $\mu\text{g/L}$). No concentrations for diphenhydramine were greater than this adjusted laboratory reporting level.

Recoveries were calculated for samples fortified, in the field or laboratory, with known concentrations of the target compounds (table 3). The percentage of recovery of fortified compounds indicates the effect of the sample matrix on the performance of the analytical method. Recoveries for the antibiotic method ranged from 20 to 291 percent, and the mean recovery was 104 percent. Recoveries for the pharmaceutical method ranged from 6 to 104 percent, and the mean recovery was 56 percent. Recoveries for the OWC method ranged from 12 percent to 180 percent, and the mean recovery was 91 percent. Recoveries for the pesticide methods ranged from 11 to 149 percent, and the mean recovery was 95 percent.

Differences between results from replicate samples were examined. Of 680 replicate results, all were below the reporting level. Sixteen results were estimated at very low concentrations. All replicate results, when compared, were consistent with one another.

Table 3. Summary of recoveries of fortified compounds for each analytical method used in this study.

[NWQL, National Water Quality Laboratory; OGRL, Organic Geochemistry Research Laboratory]

Laboratory and analytical method	Type of fortified sample	Number of compounds analyzed	Recovery, in percent			
			Minimum	Maximum	Mean	Relative standard deviation
NWQL organic wastewater compounds	Field	114	12	180	91	22
NWQL pesticides	Field	^a 177	11	149	95	29
NWQL pharmaceuticals	Laboratory	13	6	104	56	62
Kansas OGRL antibiotics	Laboratory	39	20	291	104	62

^a Includes some constituents analyzed by two methods.

Results for the 10 compounds that were analyzed by two different methods were compared. Nearly all analytical results were reported below the method's reporting level. Although the reporting level for one method was significantly greater than for the other, the results were consistent. Two results, one each for metolachlor and prometon, were reported above the reporting level using one method and were estimated below the reporting level for the other method. The results at these very low concentrations differed by nearly 75 percent.

Pharmaceuticals, Personal-Care Products, Organic Wastewater Compounds, and Pesticides

Of 186 compounds analyzed, 32 were detected in at least one sample from the lower Tallapoosa River watershed (fig. 2). Of the detected compounds, 13 were measured at concentrations above reporting levels, and 19 only were at concentrations less than the reporting levels but were

estimated (fig. 2; table 4). Detections estimated below the reporting levels are discussed separately from concentrations greater than the reporting level (see "Methods" section).

Atrazine, CIAT¹, hexazinone, metalaxyl, metolachlor, prometryn, prometon, simazine, azithromycin, oxytetracycline, sulfamethoxazole, trimethoprim, and tylosin were measured at concentrations greater than the reporting levels (fig. 2). The first eight of these compounds are pesticides and a pesticide degradate (CIAT); the last five are antibiotics. The lowest reporting levels for these 13 compounds ranged from 0.005 to 0.0321 µg/L (table 2). Every sample collected had between one and six compounds at a concentration above the reporting levels (fig. 3B). Total concentrations of detections above reporting levels ranged from 0.008 to 0.229 µg/L at Chubbetahatchee (CHU, in October) and Cubahatchee (CUB, in April) Creeks, respectively (fig. 3A). Pesticides were more frequently detected above reporting levels than other types of compounds (fig. 2). Concentrations of atrazine equaled or exceeded the reporting level (0.007 µg/L) at every site, and simazine

¹ 2-chloro-4-isopropylamino-6-amino-s-triazine.

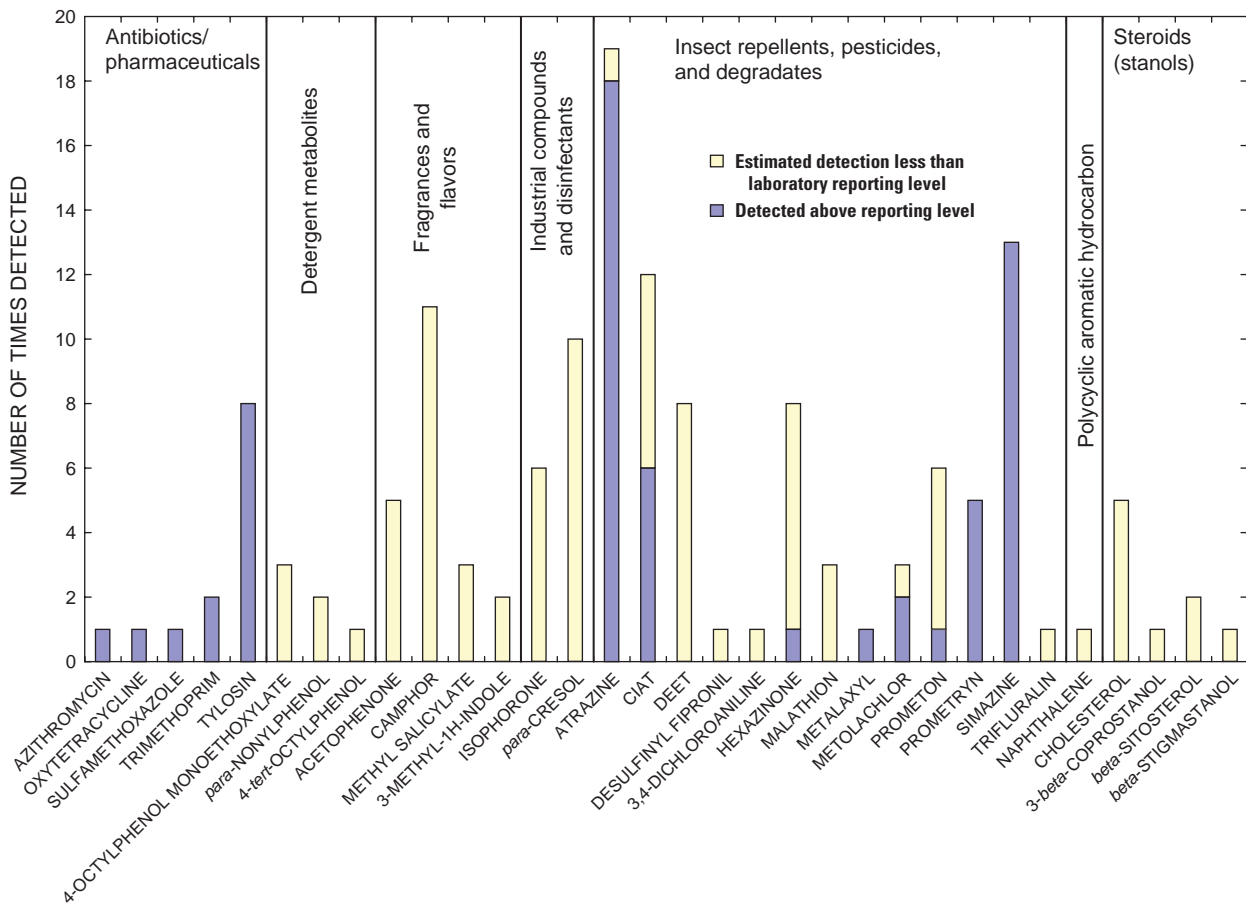


Figure 2. The number of detections of 32 organic compounds at sites in the lower Tallapoosa River watershed, Alabama, April 25–28 and October 24–26, 2005.

Table 4. Compounds detected at measured and estimated concentrations in the lower Tallapoosa River watershed, Alabama, 2005.[DEET, *N,N*-diethyl-*m*-toluamide; compounds in **bold** text only were detected at least once at concentrations above the laboratory reporting level]

Compound	Possible compound uses or sources
Antibiotics/pharmaceuticals	
Azithromycin	Antibiotic (macrolide) used to treat bacterial infections.
Oxytetracycline	Antibiotic (tetracycline) used for infections and to control acne. Also used in fish hatcheries.
Sulfamethoxazole	Antibacterial sulfonamide often used in combination with trimethoprim. Used for urinary tract infections, malaria.
Trimethoprim	Antibiotic used for urinary infections, travelers diarrhea, respiratory and middle ear infections.
Tylosin	Broad-spectrum antibiotic (macrolide) used on cattle, swine, and poultry (veterinary drug).
Detergent metabolites	
4-Octylphenol monoethoxylate ^a	Nonionic detergent metabolite.
<i>para</i> -Nonylphenol ^a	Nonionic detergent metabolite.
4- <i>tert</i> -Octylphenol ^a	Nonionic detergent metabolite.
Fragrances and flavors	
Acetophenone	Fragrance in detergent and tobacco, flavor in beverages.
Camphor	Used for its scent, as a flavor and an odorant, in ointments, as embalming fluid, and for medicinal purposes. Also used in fireworks, as a moth repellent, and as a plasticizer.
Methyl salicylate	Flavoring agent in food, candies, and beverages. It also is used as a perfumery, odorant, an ultraviolet absorber, and as an analgesic. It is a natural product of many species of plants, including wintergreens.
3-Methyl-1H-indole (skatol)	Fragrance in low concentration, stench in feces and coal tar.
Industrial compounds and disinfectants	
Isophorone	Solvent for lacquer, plastic, oil, silicon, resin.
<i>para</i> -Cresol ^b	Several uses including use as a solvent for other chemicals, as a disinfectant and deodorizer, as an ingredient in chemicals that kill pests, and as a wood preservative. Cresol solutions such as Lysol® are used as household cleaners and disinfectants. Found in wood and tobacco smoke, exhaust, coal tar, and creosote (wood preservative).
Insect repellents, pesticides, and degradates	
Atrazine ^b	Triazine herbicide used to control weeds in corn and grain sorghum in the Mobile River Basin.
CIAT	Pesticide degradate of atrazine (2-chloro-4-isopropylamino-6-amino-s-triazine).
DEET	Insect repellent, urban uses, mosquito repellent.
Desulfenyl fipronil	Pesticide degradate of fipronil, a broad-spectrum insecticide. Used on crops and in veterinary products.
3,4-Dichloroaniline ^b	Breakdown product from diuron, linuron, or propanil. Industrial chemical intermediate.
Hexazinone	Herbicide commonly used in silviculture.
Malathion ^b	General-use insecticide of the organophosphate class.
Metalaxyl	Systemic benzenoid fungicide.
Metolachlor ^b	Acetanilide herbicide, indicator of agricultural land use.
Prometon	Nonselective, general-use herbicide (triazine) used in noncrop areas such as roadways, railways, and industrial areas.
Prometryn	Herbicide used on cotton.
Simazine ^b	Triazine herbicide applied on corn, pecans, and peaches.
Trifluralin ^b	Selective, pre-emergent selective herbicide (dinitroaniline) used to control grasses and broadleaf weeds in a large variety of tree fruit, vegetable, and grain crops, including soybeans and alfalfa.
Polycyclic aromatic hydrocarbon	
Naphthalene	Fumigant, moth repellent, major component of gasoline.
Steroids and stanols	
Cholesterol	An animal and plant sterol often used as a fecal indicator; most cholesterol is synthesized internally.
3- <i>beta</i> -Coprostanol	Metabolite of cholesterol that is a mammalian fecal indicator.
<i>beta</i> -Sitosterol	Found in plants, saw palmetto, pumpkin seeds. It is similar to cholesterol, but can actually lower cholesterol.
<i>beta</i> -Stigmastanol	Plant sterol.

^a Known endocrine disrupter.^b Suspected endocrine disrupter.

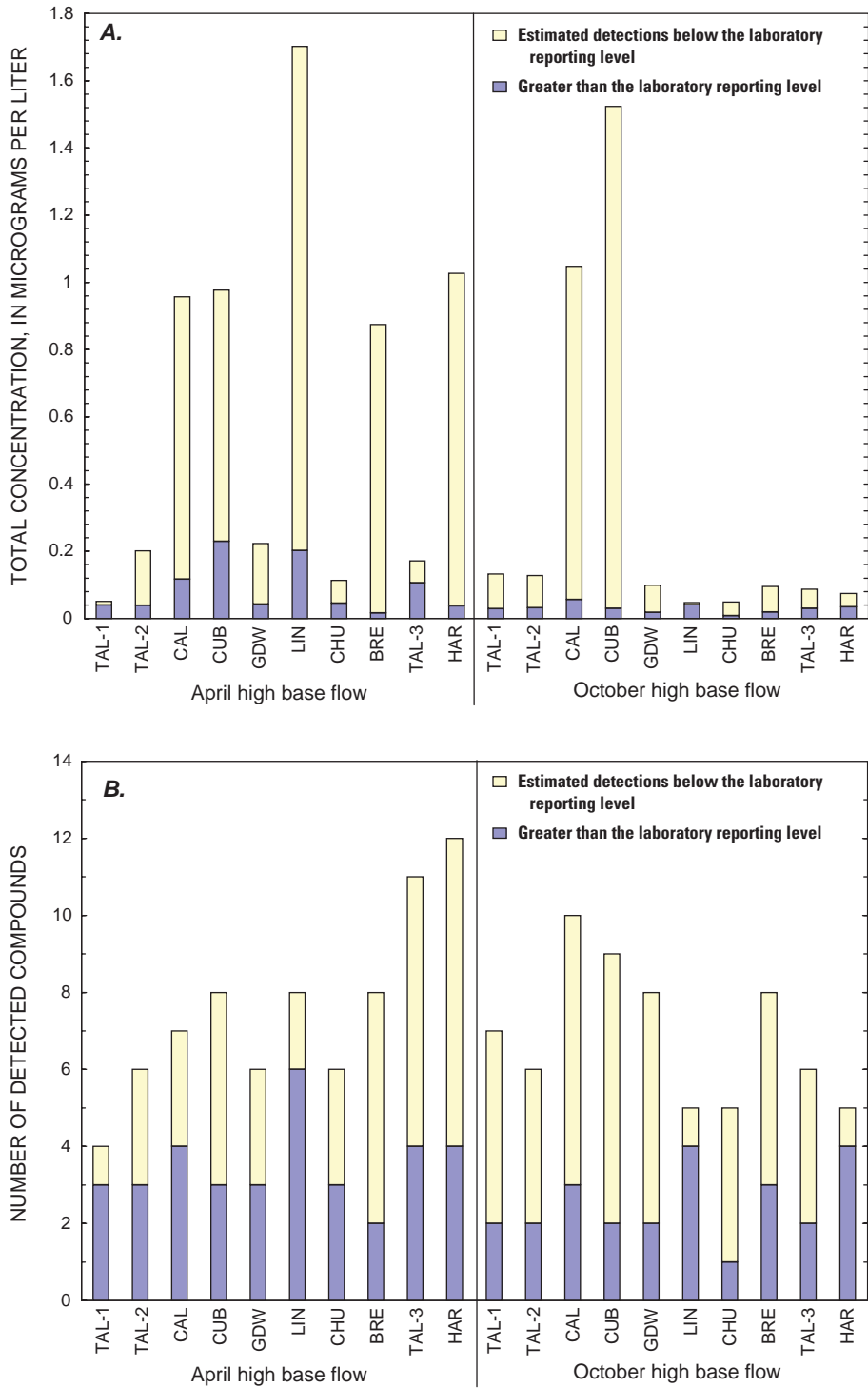


Figure 3. Summary of compounds detected in concentrations greater than the laboratory reporting level and at estimated concentrations summarized by the (A) total concentration in the sample and (B) number of compounds in the sample collected from the lower Tallapoosa River watershed, Alabama, 2005.

exceeded the reporting level (0.005 µg/L) at every site except Calabee (CAL) and Cubahatchee (CUB) Creeks (table 5). This finding is consistent with the results of a national USGS pesticide study, in which atrazine and simazine were among the pesticides most frequently detected along with prometon and metolachlor (Gilliom and others, 2006). Tylosin, a veterinary antibiotic, was found in concentrations equal to or greater than the reporting level (0.005 µg/L) at every site except Brensen Branch (BRE) and Harwell Mill Creek (HAR; table 5). CIAT, a degradate of atrazine, was found in concentrations near the reporting level (0.006 µg/L) at every site except Chubbehatchee (CHU) and Cubahatchee (CUB) Creeks.

Except for Brensen Branch (BRE) and Harwell Mill Creek (HAR), one or two more compounds were detected above reporting levels in April, during a period of high base flow, than in October during a period of low base flow (fig. 3B). The greatest number of compounds detected above the reporting levels and highest concentrations were at Line (LIN), Cubahatchee (CUB), and Calabee (CAL) Creeks and Tallapoosa River near Montgomery (TAL-3; fig. 4).

The greatest total detected concentrations occurred in April at Cubahatchee (CUB), Line (LIN), and Calabee (CAL) Creeks and Tallapoosa River (TAL-3; fig. 4A). Rainfall during April 26–27 may be a contributing factor. Goodwater Creek

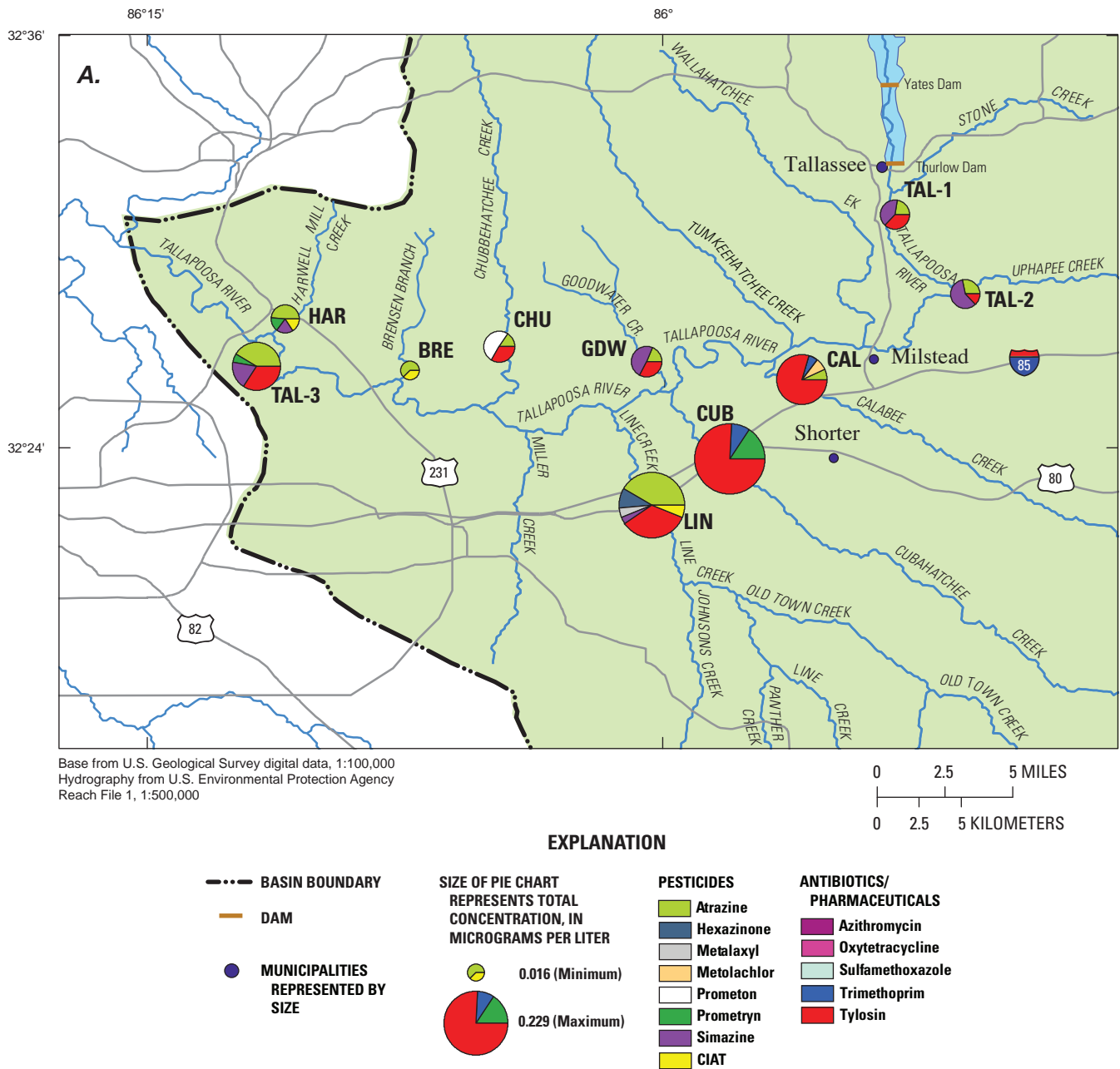
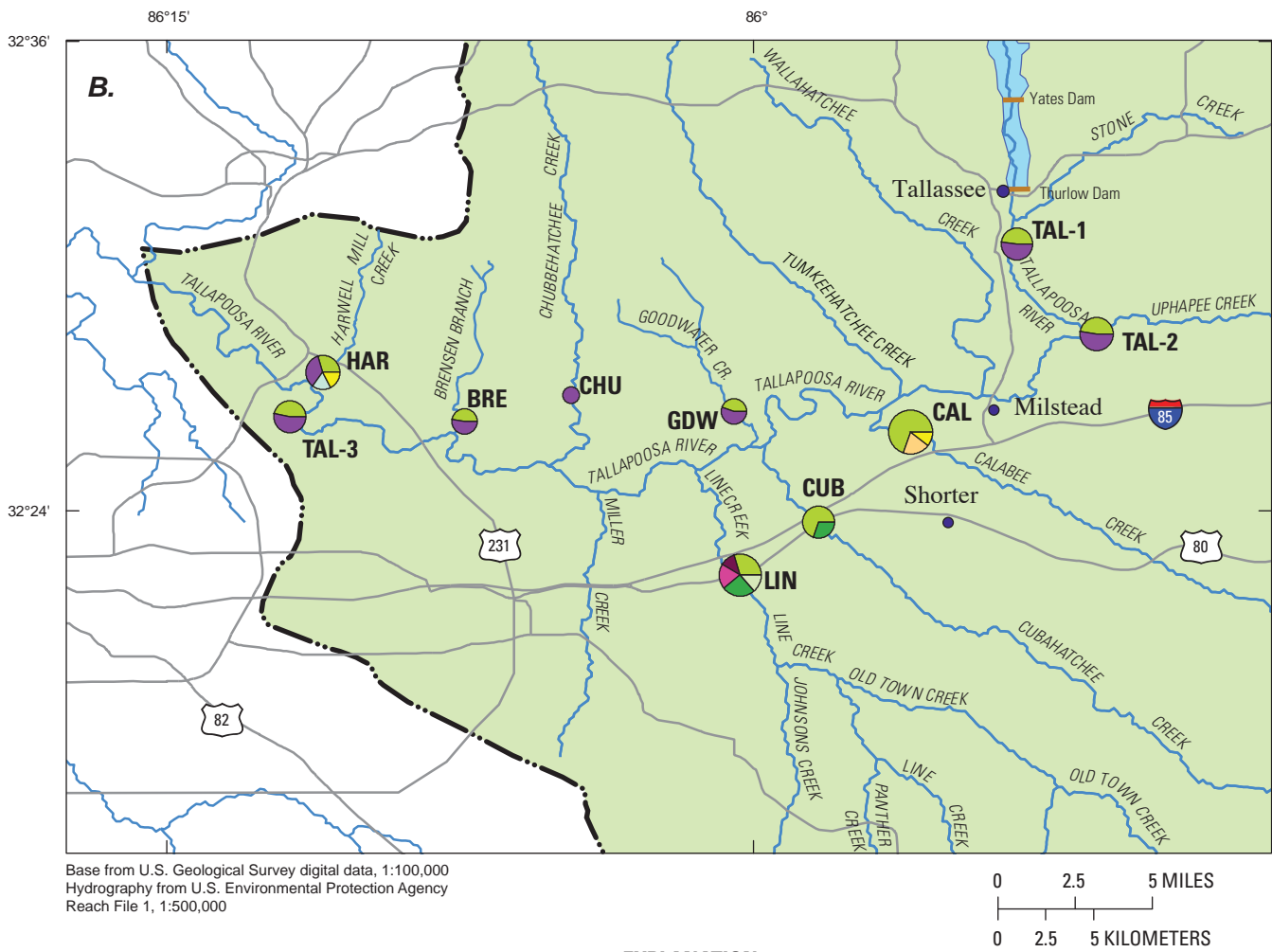


Figure 4. Total concentrations of all compounds detected above and below the laboratory reporting level in samples collected during (A) a high base-flow period in April and (B) a low base-flow period in October in the lower Tallapoosa River watershed, Alabama, 2005.

(GDW, fig. 1) was sampled as a control site because it is mostly forested and was expected to have relatively few sources of contamination; however, concentrations of tylosin, atrazine, and simazine above their reporting levels were reported at this site (table 5).

If a compound was detected at a concentration below its LRL, the NWQL provided an estimate of the concentration. Many of the 19 compounds that were detected only at very low concentrations (table 4) were detected frequently and widely throughout the study area (table 5). The categories of compounds most consistently detected throughout the study area were industrial wastewater compounds and disinfectants,

pesticides, and flavors and fragrances (fig. 5). Camphor, *para*-cresol, and DEET were detected in at least eight samples in very low estimated concentrations (fig. 2). Camphor, used in personal-care products and as a flavor additive, was detected at seven sites (including a replicate sample from site TAL-3); *para*-cresol, used as a wood preservative, a disinfectant, and solvent, was detected at six sites (including a replicate sample from site TAL-2); and the insect repellent DEET was detected at seven sites (table 5). Hexazinone, a triazine herbicide mostly used to control grasses and broadleaf weeds, was detected at six sites; one detection was above the LRL (table 5).



Base from U.S. Geological Survey digital data, 1:100,000
Hydrography from U.S. Environmental Protection Agency
Reach File 1, 1:500,000

Figure 4. Total concentrations of all compounds detected above and below the laboratory reporting level in samples collected during (A) a high base-flow period in April and (B) a low base-flow period in October in the lower Tallapoosa River watershed, Alabama, 2005.—Continued

Table 5. Organic compounds detected in the lower Tallapoosa River watershed, April 25–28 and October 24–26, 2005.

[µg/L, micrograms per liter; CIAT, 2-chloro-4-isopropylamino-6-amino-s-triazine; DEET, *N,N*-diethyl-*m*-toluamide; <, less than; E, estimated below the laboratory reporting level; —, no data]

Compounds detected at a concentration above the reporting level, at least once

Site label (fig. 1 and table 1)	Sample date	Sample time	Atrazine (µg/L)	Azithromycin (µg/L)	CIAT ^a (µg/L)	Hexazinone (µg/L)	Metolachlor (µg/L)	Oxytetracycline (µg/L)	Prometon (µg/L)	Prometryn (µg/L)	Simazine (µg/L)	Sulfamethoxazole (µg/L)
TAL-1	4/27/2005	1045	0.009	< 0.005	< 0.006	< 0.013	< 0.006	< 0.01	< 0.01	< 0.005	0.016	< 0.005
TAL-1	10/26/2005	1030	0.014	< 0.005	E 0.004	E 0.007	< 0.006	< 0.01	E 0.005	< 0.005	0.015	< 0.005
TAL-2	4/27/2005	1145	0.011	< 0.005	< 0.006	E 0.009	< 0.006	< 0.01	< 0.01	< 0.005	0.023	< 0.005
TAL-2	10/26/2005	1125	0.015	< 0.005	E 0.004	E 0.007	< 0.006	< 0.01	E 0.005	< 0.005	0.017	< 0.005
CAL	4/26/2005	1330	0.008	< 0.005	< 0.006	< 0.013	0.009	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005
CAL	10/24/2005	1030	0.039	< 0.005	E 0.006	< 0.013	0.011	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005
CUB	4/26/2005	1015	E 0.006	< 0.005	< 0.006	E 0.012	< 0.006	< 0.01	< 0.01	0.036	< 0.005	< 0.005
CUB	10/24/2005	1450	0.021	< 0.005	< 0.006	< 0.013	< 0.006	< 0.01	< 0.01	0.009	< 0.005	< 0.005
GDW	4/25/2005	1720	0.008	< 0.005	< 0.006	< 0.013	< 0.006	< 0.01	< 0.01	< 0.005	0.021	< 0.005
GDW	10/24/2005	0900	0.008	< 0.005	E 0.005	< 0.013	< 0.006	< 0.01	< 0.01	< 0.005	0.01	< 0.005
LIN	4/28/2005	0920	0.084	< 0.005	0.012a	0.02	< 0.006	< 0.01	< 0.01	< 0.005	0.007	< 0.005
LIN	10/25/2005	1400	0.015	0.006	0.007a	< 0.013	< 0.006	< 0.01	E 0.006	0.013	< 0.008	< 0.005
CHU	4/25/2005	1450	0.007	< 0.005	< 0.006	< 0.013	< 0.006	< 0.01	0.023	< 0.005	< 0.005	< 0.005
CHU	10/24/2005	1135	< 0.007	< 0.005	< 0.006	E 0.004	< 0.006	< 0.01	< 0.01	< 0.005	0.008	< 0.005
BRE	4/25/2005	1210	0.01	< 0.005	E 0.006	< 0.013	< 0.006	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005
BRE	10/24/2005	1240	0.009	< 0.005	E 0.005	< 0.013	< 0.006	< 0.01	< 0.01	< 0.005	0.01	< 0.005
TAL-3	4/28/2005	1315	0.044	< 0.005	E 0.005	E 0.009	E 0.006	< 0.01	E 0.007	0.006	0.02	< 0.005
TAL-3	10/25/2005	0900	0.014	< 0.005	E 0.004	E 0.008	< 0.006	< 0.01	E 0.005	< 0.005	0.016	< 0.005
HAR	4/25/2005	0910	0.018	< 0.005	E 0.006	< 0.013	< 0.006	< 0.01	< 0.01	0.006	0.007	< 0.005
HAR	10/25/2005	1105	0.01	< 0.005	E 0.006	< 0.013	< 0.006	< 0.01	< 0.01	< 0.005	0.012	0.006
Replicates												
TAL-2	4/27/2005	1146	0.012	< 0.005	< 0.006	E 0.009	< 0.006	< 0.01	< 0.01	< 0.005	0.025	< 0.005
TAL-3	10/25/2005	0901	0.014	< 0.005	E 0.004	E 0.007	< 0.006	< 0.01	E 0.005	< 0.005	0.015	< 0.005
LIN	10/25/2005	1401	—	0.006	—	—	—	0.010	—	—	—	< 0.005
Field Blanks												
TAL-1	4/27/2005	0930	< 0.007	< 0.005	< 0.006	< 0.013	< 0.006	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005
TAL-1	10/26/2005	0930	< 0.007	< 0.005	< 0.006	< 0.013	< 0.006	< 0.01	< 0.01	< 0.005	< 0.005	< 0.005

Table 5. Organic compounds detected in the lower Tallapoosa River watershed, April 25–28 and October 24–26, 2005.—Continued

[µg/L, micrograms per liter; CIAT, 2-chloro-4-isopropylamino-6-amino-s-triazine; DEET, *N,N*-diethyl-*m*-toluamide; <, less than; E, estimated below the laboratory reporting level; —, no data]

Site label (fig. 1 and table 1)	Sample date	Sample time	Compounds detected at a concentration above the reporting level, at least once			Compounds only detected at an estimated concentration below the reporting level									
			Trimeth- oprim (µg/L)	Tylosin (µg/L)	Acetophe- none (µg/L)	Camphor (µg/L)	Choles- terol (µg/L)	3- <i>beta</i> - Copros- tanol (µg/L)	DEET (µg/L)	Desulfinyl fipronil (µg/L)	3,4-Dichloro- aniline (µg/L)	Isophorone (µg/L)	Malathion (µg/L)		
TAL-1	4/27/2005	1045	< 0.005	0.015	< 0.5	< 0.5	< 2	< 0.012	< 0.004	< 0.5	< 0.012	< 0.004	< 0.5	E 0.012	
TAL-1	10/26/2005	1030	< 0.005	< 0.005	< 0.5	< 0.5	< 2	E 0.08	< 0.012	< 0.004	E 0.007	< 0.027	< 0.027		
TAL-2	4/27/2005	1145	< 0.005	0.005	E 0.14	< 0.5	< 2	< 0.5	< 0.012	< 0.004	< 0.5	E 0.013	< 0.027		
TAL-2	10/26/2005	1125	< 0.005	< 0.005	< 0.5	< 0.5	< 2	E 0.08	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
CAL	4/26/2005	1330	0.007	0.093	E 0.12	E 0.02	E 0.7	< 0.5	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
CAL	10/24/2005	1030	< 0.005	< 0.005	< 0.5	E 0.006	E 0.5	< 0.006	< 0.012	< 0.004	E 0.005	< 0.027	< 0.027		
CUB	4/26/2005	1015	0.019	0.174	E 0.11	E 0.02	E 0.6	< 0.5	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
CUB	10/24/2005	1450	< 0.005	< 0.005	< 0.5	E 0.008	E 0.7	E 0.2	< 0.012	< 0.004	E 0.006	< 0.027	< 0.027		
GDW	4/25/2005	1720	< 0.005	0.014	E 0.1	E 0.01	< 2	< 0.5	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
GDW	10/24/2005	0900	< 0.005	< 0.005	< 0.5	E 0.02	< 2	< 0.5	< 0.012	< 0.004	E 0.01	< 0.027	< 0.027		
LIN	4/28/2005	0920	< 0.005	0.07	< 0.5	< 0.5	E 0.8	< 2	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
LIN	10/25/2005	1400	< 0.005	< 0.005	< 0.5	< 0.5	< 2	< 0.5	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
CHU	4/25/2005	1450	< 0.005	0.015	< 0.5	E 0.008	< 2	E 0.02	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
CHU	10/24/2005	1135	< 0.005	< 0.005	< 0.5	E 0.01	< 2	< 0.5	< 0.012	< 0.004	E 0.007	< 0.027	< 0.027		
BRE	4/25/2005	1210	< 0.005	< 0.005	E 0.1	E 0.01	< 2	E 0.009	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
BRE	10/24/2005	1240	< 0.005	< 0.005	< 0.5	E 0.01	< 2	E 0.005	< 0.012	< 0.004	E 0.006	< 0.027	< 0.027		
TAL-3	4/28/2005	1315	< 0.005	0.036	< 0.5	< 0.5	< 2	< 0.5	E 0.004	< 0.004	< 0.5	E 0.014	< 0.027		
TAL-3	10/25/2005	0900	< 0.005	< 0.005	< 0.5	< 0.5	< 2	< 0.5	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
HAR	4/25/2005	0910	< 0.005	< 0.005	< 0.5	E 0.01	< 2	E 0.01	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
HAR	10/25/2005	1105	< 0.005	< 0.005	< 0.5	< 0.5	< 2	< 0.5	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027		
Replicates															
TAL-2	4/27/2005	1146	< 0.005	0.009	E 0.12	< 0.5	< 2	< 0.5	< 0.012	< 0.004	< 0.5	E 0.013	< 0.027	< 0.027	
TAL-3	10/25/2005	0901	< 0.005	< 0.005	< 0.5	E 0.006	< 2	< 0.5	E 0.004	E 0.001	E 0.004	< 0.027	< 0.027		
LIN	10/25/2005	1401	< 0.005	< 0.005	< 0.5	—	—	—	—	—	—	—	—	—	
Field Blanks															
TAL-1	4/27/2005	0930	< 0.005	< 0.005	< 0.5	< 0.5	< 2	< 0.5	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027	< 0.027	
TAL-1	10/26/2005	0930	< 0.005	< 0.005	< 0.5	< 0.5	< 2	< 0.5	< 0.012	< 0.004	< 0.5	< 0.027	< 0.027	< 0.027	

Table 5. Organic compounds detected in the lower Tallapoosa River watershed, April 25–28 and October 24–26, 2005.—Continued

Site label (fig. 1 and table 1)	Sample date	Sample time	Compounds only detected at an estimated concentration below the reporting level											
			3-Methyl- 1H-indole (µg/L)	Methyl salicylate (µg/L)	Naphtha- lene (µg/L)	<i>para</i> -Nonyl- phenol (µg/L)	4-Octyl- phenol mono- ethoxyate (µg/L)	4- <i>tert</i> - Octyl- phenol (µg/L)	<i>para</i> -Cresol (µg/L)	<i>beta</i> - Sitosterol (µg/L)	<i>beta</i> -Stig- mastanol (µg/L)	Trifluralin (µg/L)		
TAL-1	4/27/2005	1045	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 1	< 2	< 0.009
TAL-1	10/26/2005	1030	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 1	< 2	< 0.009
TAL-2	4/27/2005	1145	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 1	< 2	< 0.009
TAL-2	10/26/2005	1125	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 1	< 2	< 0.009
CAL	4/26/2005	1330	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 1	< 2	< 0.009
CAL	10/24/2005	1030	< 1	< 0.5	< 0.5	< 5	E 0.07	< 1	< 1	< 1	< 1	E 0.4	< 2	E 0.005
CUB	4/26/2005	1015	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 2	< 2	< 0.009
CUB	10/24/2005	1450	< 1	< 0.5	< 0.5	< 5	E 0.07	< 1	< 1	< 1	< 1	E 0.5	< 2	< 0.009
GDW	4/25/2005	1720	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	E 0.07	< 2	< 2	< 0.009
GDW	10/24/2005	0900	E 0.007	E 0.009	< 0.5	< 5	< 1	< 1	< 1	< 1	E 0.03	< 2	< 2	< 0.009
LIN	4/28/2005	0920	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 2	E 0.7	< 0.009
LIN	10/25/2005	1400	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 2	< 2	< 0.009
CHU	4/25/2005	1450	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	E 0.04	< 2	< 2	< 0.009
CHU	10/24/2005	1135	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	E 0.02	< 2	< 2	< 0.009
BRE	4/25/2005	1210	< 1	< 0.5	< 0.5	E 0.6	E 0.05	< 1	< 1	< 1	E 0.09	< 2	< 2	< 0.009
BRE	10/24/2005	1240	< 1	E 0.01	< 0.5	< 5	< 1	< 1	< 1	< 1	E 0.04	< 2	< 2	< 0.009
TAL-3	4/28/2005	1315	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	E 0.02	< 2	< 2	< 0.009
TAL-3	10/25/2005	0900	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	E 0.04	< 2	< 2	< 0.009
HAR	4/25/2005	0910	E 0.03	E 0.01	E 0.01	E 0.6	< 1	E 0.02	< 1	E 0.02	E 0.3	< 2	< 2	< 0.009
HAR	10/25/2005	1105	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	E 0.04	< 2	< 2	< 0.009
Replicates														
TAL-2	4/27/2005	1146	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	E 0.02	< 2	< 2	< 0.009
TAL-3	10/25/2005	0901	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 2	< 2	< 0.009
LIN	10/25/2005	1401	—	—	—	—	—	—	—	—	—	—	—	—
Field Blanks														
TAL-1	4/27/2005	0930	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 2	< 2	< 0.009
TAL-1	10/26/2005	0930	< 1	< 0.5	< 0.5	< 5	< 1	< 1	< 1	< 1	< 1	< 2	< 2	< 0.009

^a Concentrations greater than the reporting level are considered estimates because this analytical method produces highly variable results.

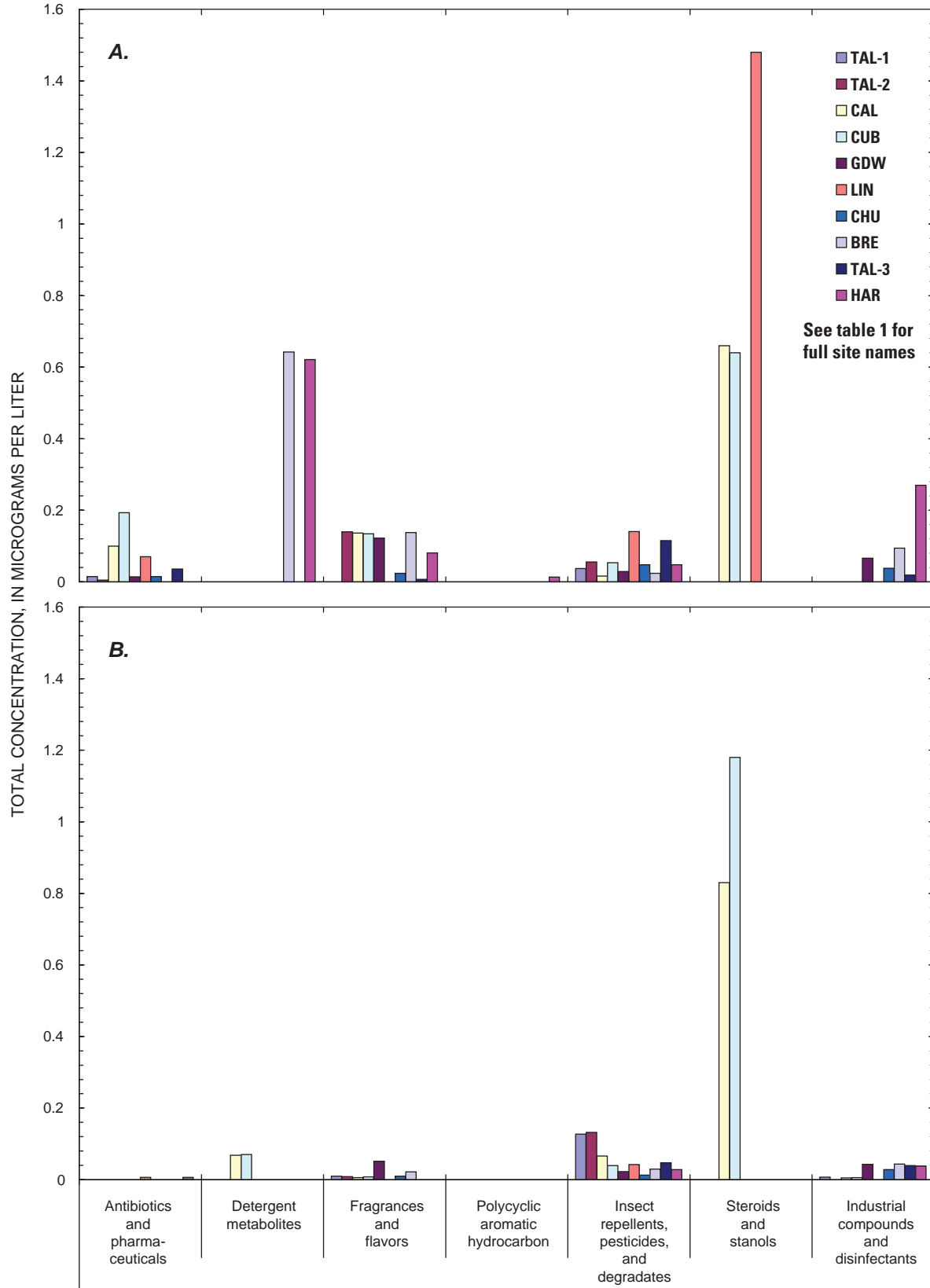


Figure 5. The sum of detected concentrations by type of compound including compounds detected at concentrations above the laboratory reporting level and estimated below the laboratory reporting level from samples collected during (A) a high base-flow period in April and (B) a low base-flow period in October in the lower Tallapoosa River watershed, Alabama, 2005.

Fourteen compounds that are commonly present in raw sewage (Wilkison and others, 2002) were used as indicators of human activity. Three compounds—skatol (3-methyl-1H-indole), 3-*beta*-coprostanol, and cholesterol—are products of metabolism that are found in human and other mammalian feces. Detergents and their metabolites, AHTN (6-acetyl-1,1,2,4,4,7-hexamethyltetraline; musk fragrances), caffeine, triclosan, and DEET are contained in many consumer products and can be delivered to sewage-collection systems through human activities. If not removed during treatment, these compounds can be delivered to streams in sewage effluents. Brensen Branch (BRE) and Cubbahatchee (CUB), Calabee (CAL), and Harwell Mill (HAR) Creeks each had detections of at least three of these compounds (table 6) in at least one sampling period, indicating the effects of human activities. However, these concentrations were estimated below their LRLs; similar low concentrations of these compounds may have been present but undetected at other sites.

The number of compounds detected in the lower Tallapoosa is similar to the number detected in other studies conducted by the USGS in Alabama (table 7; Gill and others, 2005; McPherson and others, 2005). The total concentration of compounds detected in the lower Tallapoosa River watershed was appreciably less than in the other study areas (table 7). In a national USGS study of wastewater-associated compounds, pharmaceuticals, and antibiotics (pesticides were not included), results indicated that detergent metabolites, plasticizers, and steroids contributed nearly 80 percent of the

total concentration of contaminants to the streams sampled (Kolpin and others, 2002). The sites selected for the national study were considered to be most susceptible to human contamination, such as sites below wastewater-treatment discharges. Moreover, samples collected for the two recent Alabama studies (Gill and others, 2005; McPherson and others, 2005) and for the national study (Kolpin and others, 2002) were not filtered as were samples for this study. This may account, in part, for the higher concentrations detected during these other studies.

Laboratory reporting levels were different in the national study—some were greater whereas others were less. However, the results from this study are similar to the national study—that is, steroids and detergent metabolites accounted for a substantial portion of the total concentration of contaminants.

In a study in Iowa (Kolpin and others, 2004), data were gathered on a similar group of compounds, including pesticides, in streams upstream and downstream from urban areas, and results were related to streamflow conditions. More compounds (51) were detected in the Iowa study than in this study. As in this study, a pesticide (in Iowa it was metolachlor) was detected most frequently. Cholesterol, caffeine, and *beta*-sitosterol were detected in more than 50 percent of the Iowa samples—a result not matched in this study. In the Iowa study, the concentrations of these contaminants tended to increase with decreasing streamflow.

Table 6. Concentrations of compounds, which indicate human activity, detected in the lower Tallapoosa River watershed, Alabama, 2005.

[µg/L, micrograms per liter; concentrations in **bold** were reported at concentrations that were estimated below the long-term method-detection level (LT-MDL); <, less than; AHTN, 6-acetyl-1,1,2,4,4,7-hexamethyltetraline; DEET, *N,N*-diethyl-*m*-toluamide; E, estimated]

Site label (fig. 1 and table 1)	Products of metabolism (concentration in µg/L)			Human-use compounds (concentration in µg/L)				Detergents and detergent metabolites (concentration in µg/L)						Number of detections	
	Choles-terol	3- <i>beta</i> -Coprostanol	3-Methyl-1H-indole (skatol)	AHTN	Caffeine	DEET	Triclosan	4-Cumyl-phenol	4-Nonyl-phenol diethoxy-late ^a	4-Octyl-phenol diethoxy-late ^a	4-Octyl-phenol mono-ethoxylate ^a	<i>para</i> -Nonyl-phenol ^a	4- <i>n</i> -Octyl-phenol		4- <i>tert</i> -Octyl-phenol
April high base-flow samples															
TAL-1	<2.0	<2.0	<1.0	<0.5	<0.5	<0.5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	0
TAL-2	<2.0	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	0
CAL	E0.7	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	1
CUB	E0.6	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	1
GDW	<2.0	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	0
LIN	E0.8	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	1
CHU	<2.0	<2.0	<1.0	<5	<5	E0.02	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	1
BRE	<2.0	<2.0	<1.0	<5	<5	E0.009	<1.0	<1.0	<5.0	<1.0	E0.05	<5.0	<1.0	<1.0	3
TAL-3	<2.0	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	0
HAR	<2.0	<2.0	E0.03	<5	<5	E0.01	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	E0.02	4
October low base-flow samples															
TAL-1	<2.0	<2.0	<1.0	<5	<5	E0.08	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	1
TAL-2	<2.0	<2.0	<1.0	<5	<5	E0.08	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	1
CAL	E0.5	<2.0	<1.0	<5	<5	E0.006	<1.0	<1.0	<5.0	<1.0	E0.07	<5.0	<1.0	<1.0	3
CUB	E0.7	E0.2	<1.0	<5	<5	E0.010	<1.0	<1.0	<5.0	<1.0	E0.07	<5.0	<1.0	<1.0	4
GDW	<2.0	<2.0	E0.007	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	1
LIN	<2.0	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	0
CHU	<2.0	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	0
BRE	<2.0	<2.0	<1.0	<5	<5	E0.005	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	1
TAL-3	<2.0	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	0
HAR	<2.0	<2.0	<1.0	<5	<5	<5	<1.0	<1.0	<5.0	<1.0	<1.0	<5.0	<1.0	<1.0	0

^a Results are highly variable.

Table 7. Comparison of pharmaceuticals, personal-care products, organic wastewater compounds, and pesticides detected in samples from three watersheds in Alabama between 2000 and 2005.

[$\mu\text{g/L}$, micrograms per liter; CIAT, 2-chloro-4-isopropylamino-6-amino-s-triazine; NP1EO, nonylphenol monoethoxylate; OP1EO, 4-octylphenol monoethoxylate; DEET, *N,N*-diethyl-*m*-toluamide]

Watershed	Dates sampled	Sum of the concentration of all detected compounds ^a , in $\mu\text{g/L}$		Number of samples	Number of compounds		Compounds most frequently detected
		Study minimum	Study maximum		Analyzed	Detected	
Lower Tallapoosa River	April 25–28 and October 24–26, 2005	0.049	1.70	20	186	32	Atrazine, simazine, tylosin, CIAT, camphor, <i>para</i> -cresol.
J.B. Converse Lake, Mobile County ^{b,c}	August 1999 to August 2002	0	6.32	86	87	29	Metolachlor, atrazine, caffeine, <i>beta</i> -sitosterol, bromacil, metalaxyl, prometon, NP1EO, cholesterol, OP1EO, triclosan.
Threemile Creek, City of Mobile ^{c,d}	March 2000 to September 2003	0.12	56.6	63	48	37	Atrazine, caffeine, <i>tris</i> (2-butoxyethyl) phosphate, cholesterol, diazinon, bromacil, triclosan, fluoranthene, DEET.

^a Includes concentrations estimated below the reporting level.

^b Gill and others, 2005.

^c Samples were unfiltered.

^d McPherson and others, 2005.

Summary

Ten stream sites in the lower Tallapoosa River watershed were sampled April 25–28, 2005, during high base-streamflow conditions and October 24–26, 2005, during low base-streamflow conditions. Concurrent with water-quality sampling, six quality-control samples, including blanks, replicates, and environmental samples fortified with known concentrations of the compounds of interest, were prepared to evaluate the quality of the environmental results. Samples were analyzed for 186 synthetic and natural organic compounds representing a wide variety of uses and origins. Categories of compounds included plant and animal sterols and stanols, fragrances and flavor additives in foods and personal-care products, detergents and their metabolites, polycyclic aromatic hydrocarbons, antibiotics, pharmaceuticals, insect repellents, pesticides, and industrial compounds.

Of 186 compounds for which analyses were conducted, 32 were detected in the study area. Thirteen compounds— atrazine, CIAT, hexazinone, metalaxyl, metolachlor, prometryn, prometon, simazine, azithromycin, oxytetracycline, sulfamethoxazole, trimethoprim, and tylosin—had measurable concentrations above their reporting levels, and 19 compounds were detected only below their reporting levels, in which case the concentrations were estimated. Reporting levels for the 13 compounds detected in concentrations above their reporting levels ranged from 0.005 to 0.0321 $\mu\text{g/L}$.

The most frequently detected compounds were atrazine and simazine, which are two commonly used herbicides, and tylosin, which is a veterinary antibiotic. One or two more compounds were detected in April, during a period of high base

flow, than in October during a period of low base flow, except at Brensen Branch and Harwell Mill Creek. The greatest number of compounds detected above their reporting levels and the highest total concentrations were found at Line, Cubahatchee, and Calebee Creeks and Tallapoosa River near Montgomery. Goodwater Creek was selected as a control site because it is mostly forested and was expected to have relatively few sources of contamination; however, concentrations of tylosin, atrazine, and simazine greater than their reporting levels were detected at this site. Other compounds were detected frequently but mostly below laboratory reporting levels, including hexazinone, camphor, *para*-cresol, and DEET.

Results for skatol (3-methyl-1H-indole), 3-*beta*-coprostanol, cholesterol, seven detergents or their metabolites, AHTN, caffeine, triclosan, and DEET were used as indicators of the effects of human activities on water quality because these compounds are commonly found in raw sewage. None of these compounds were found in concentrations above their reporting levels during this study. At least three of these compounds, however, were detected at very low concentrations at Brensen Branch and at Cubahatchee, Calebee, and Harwell Mill Creeks.

Results for the compounds analyzed for this study were compared with results from similar recent studies in Alabama. The total concentrations in the lower Tallapoosa River watershed were less than total concentrations found in the J.B. Converse Lake watershed in Mobile County (1999–2002) and Threemile Creek watershed in Mobile (2000–2003). Samples in those two studies were not filtered before they were analyzed, which may account, in part, for the higher concentrations found in these studies.

References Cited

- Cahill, J.D., Furlong, E.T., Burkhardt, M.R., Kolpin, D.W., and Anderson, L.G., 2004, Determination of pharmaceutical compounds in surface- and ground-water samples by solid phase extraction and high-performance liquid chromatography-electrospray ionization mass spectrometry: *Journal of Chromatography A*, v. 1041, p. 171–180.
- CH2M Hill, 2005, Tallapoosa River basin management plan: Montgomery, AL, prepared for the Alabama Clean Water Partnership, March 2005, accessed September 29, 2006, at <http://www.cleanwaterpartnership.org/docs/tallapoosa/Sections.pdf>
- 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.
- Conn, K.E., Barber, L.B., Brown, G.K., and Siegrist, R.L., 2006, Occurrence and fate of organic contaminants during onsite wastewater treatment: *Environmental Science and Technology*, v. 40, p. 7358–7366.
- Copeland, C.W., ed., 1968, *Geology of the Alabama Coastal Plain, a guidebook*: Geological Survey of Alabama, Circular 47, 97 p.
- Galloway, J.M., Meyers, M.T., and Green, W.R., 2005, Occurrence of pharmaceuticals and other organic wastewater constituents in selected streams in northern Arkansas, 2004: U.S. Geological Survey Scientific Investigations Report 2005-5140, 24 p.
- Geological Survey of Alabama, 2006, *Geologic map of Alabama, digital version 1.0*: Alabama Geological Survey Special Map 220A [adapted from Szabo, M.W., Osborne, W.E., Copeland, C.W., Jr., and Neathery, T.L., 1988, *Geologic map of Alabama (1:250,000)*: Alabama Geological Survey Special Map 220], accessed November 19, 2007, at <http://portal.gsa.state.al.us/download/Geology1.0/Introduction.pdf>
- Gill, A.C., McPherson, A.K., and Moreland, R.S., 2005, Water quality and simulated effects of urban land-use change in J.B. Converse Lake watershed, Mobile County, Alabama, 1990–2003: U.S. Geological Survey Scientific Investigations Report 2005-5171, 124 p.
- Gilliom, R.J., Barbash, J.E., Crawford, C.G., Hamilton, P.A., Martin, J.D., Nakagake, Naomi, 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.
- Jobling, Susan, Nolan, Monique, Tyler, C.R., Brightly, Geoff, and Sumpter, J.P., 1998, Widespread sexual disruption in wild fish: *Environmental Science and Technology*, v. 32, p. 2498–2506.
- Keith, L.H., 1998, *Environmental endocrine disruptors*: *Pure and Applied Chemistry*, v. 70, no. 12, p. 2319–2326.
- Kidd, R.E., 1987, *Geohydrology and susceptibility of major aquifers to surface contamination in Alabama; Area 9*: U.S. Geological Survey Water-Resources Investigations Report 87-4187, 33 p.
- Kidd, R.E., 1989, *Geohydrology and susceptibility of major aquifers to surface contamination in Alabama; Area 5*: U.S. Geological Survey Water-Resources Investigations Report 88-4083, 28 p.
- Kolpin, D.W., Furlong, E.T., Meyer, M.T., Thurman, E.M., Zaugg, S.D., Barber, L.B., and Buxton, H.T., 2002, *Pharmaceuticals, hormones, and other organic wastewater contaminants in U.S. streams, 1999–2000—A national reconnaissance*: *Environmental Science and Technology*, v. 36, no. 6, p. 1202–1211.
- Kolpin, D.W., Skopec, Mary, Meyer, M.T., Furlong, E.T., and Zaugg, S.D., 2004, *Urban contribution of pharmaceuticals and other organic wastewater contaminants to streams during differing flow conditions*: *Science of the Total Environment*, v. 328, p. 119–130.
- Lane, S.L., Flanagan, Sarah, and Wilde, F.D., 2003, *Selection of equipment for water sampling (ver. 2.0)*: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A2.
- Lindley, C.E., Stewart, J.T., and Sandstrom, M.W., 1996, *Determination of low concentrations of acetochlor in water by automated solid-phase extraction and gas chromatography with mass selective detection*: *The Journal of AOAC International*, v. 79, no. 4, p. 962–966.
- Lintelmann, J., Katayama, A., Kurihara, N., Shore, L., and Wenzel, A., 2003, *Endocrine disruptors in the environment*: *Pure and Applied Chemistry*, v. 75, no. 5, p. 631–681.
- Madsen, J.E., Sandstrom, M.W., and Zaugg, S.D., 2003, *Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—A method supplement for the determination of fipronil and degradates in water by gas chromatography/mass spectrometry*: U.S. Geological Survey Open-File Report 02-462, 11 p. [Method ID: O-1126-02]
- McPherson, A.K., Gill, A.C., and Moreland, R.S., 2005, *Assessment of water quality, benthic invertebrates, and periphyton in the Threemile Creek basin, Mobile, Alabama, 1999–2003*: U.S. Geological Survey Scientific Investigations Report 2004-5302, 166 p.

- Meyer, M.T., Lee, E.A., Ferrell, G.M., Bumgarner, J.E., and Varns, Jerry, 2007, Evaluation of offline tandem and online solid-phase extraction with liquid chromatography/electrospray ionization-mass spectrometry for analysis of antibiotics in ambient water and comparison to an independent method: U.S. Geological Survey Scientific Investigations Report 2007-5021, 28 p.
- Montgomery Water Works and Sanitary Sewer Board, 2006, 2006 Water quality report: Montgomery, AL, 6 p., accessed October 2, 2006, at <http://www.mwsssb.com/ccr2006/2006ccr.pdf>
- Multi-Resolution Land Characteristics Consortium, 2006, National land cover database 2001 (NLCD 2001): U.S. Geological Survey, accessed July 19, 2006, at http://www.mrlc.gov/mrlc2k_nlcd.asp
- National Climatic Data Center, 2006, Record of climatological observations for Milstead, Alabama, accessed October 2, 2006, at <http://www1.ncdc.noaa.gov/pub/orders/510680885565dat.html>
- Sandstrom, M.W., Stoppel, 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. [Method ID: O-2002-01]
- Sapp, D.C., and Emplincourt, Jacques, 1975, Physiographic regions of Alabama: Geological Survey of Alabama Map 168, 1 sheet.
- Scott, J.C., Cobb, R.H., and Castleberry, R.D., 1987, Hydrology and susceptibility of major aquifers to surface contamination in Alabama; Area 8: U.S. Geological Survey Water-Resources Investigations Report 86-4360, 65 p.
- Southeast Regional Climate Center, 2006, National Climatic Data Center 1971–2000 monthly normals for Milstead, Alabama, accessed October 2, 2006, at <http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMAIN.pl?5439>
- U.S. Environmental Protection Agency, 2006a, EnviroMapper for Envirofacts: U.S. Environmental Protection Agency, accessed September 28, 2006, at <http://www.epa.gov/enviro/emef>
- U.S. Environmental Protection Agency, 2006b, Water discharge permits (PCS), overview: U.S. Environmental Protection Agency, accessed October 2, 2006, at <http://www.epa.gov/enviro/html/pcs/index.html>
- 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, accessed October 23, 2007, at <http://pubs.water.usgs.gov/twri9A>
- Wilde, F.D., Britton, L.J., Miller, C.V., and Kolpin, D.W., comps., 2000, Effects of animal feeding operations on water resources and the environment; Proceedings of the technical meeting, Fort Collins, Colorado, August 30–September 1, 1999: U.S. Geological Survey Open-File Report 00-204, 107 p.
- Wilde, F.D., Radtke, D.B., Gibs, Jacob, and Iwatsubo, R.T., eds., 1999, Collection of water samples: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4.
- Wilde, F.D., Radtke, D.B., Gibs, Jacob, and Iwatsubo, R.T., eds., 2004, Processing of water samples (version 2.1): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A5, accessed October 6, 2006, at <http://pubs.water.usgs.gov/twri9A5/>
- Wilkison, D.H., Armstrong, D.J., and Blevins, D.W., 2002, Effects of wastewater and combined sewer overflows on water quality in the Blue River basin, Kansas City, Missouri and Kansas, July 1998–October 2000: U.S. Geological Survey Water-Resources Investigations Report 02-4107, 162 p.
- 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, 60 p. [Method ID: O-1126-95]
- Zaugg, S.D., Smith, S.G., Schroeder, M.P., Barber, L.B., and Burkhardt, M.R., 2002, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of wastewater compounds by polystyrene-divinylbenzene solid-phase extraction and capillary-column gas chromatography/mass spectrometry: U.S. Geological Survey Water-Resources Investigations Report 01-4186, 37 p.
- Zimmerman, M.J., 2005, Occurrence of organic wastewater contaminants, pharmaceuticals, and personal-care products in selected water supplies, Cape Cod, Massachusetts, June 2004: U.S. Geological Survey Open-File Report 2005-1206, 20 p.

