USGS
science for a changing world

Prepared in cooperation with the Missouri Department of Natural Resources

Quality of Surface Water in Missouri, Water Year 2014

Data Series 971

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

Cover photographs. A. Hydrographer collecting a surface-water quality sample by wading. B. Hydrologic technician collecting a surface-water quality sample from a boat using a motorized crane. C. Hydrologic technician checking streamgaging equipment during a flood event. D. pH measurement in a mobile water-quality lab.

Quality of Surface Water in Missouri, Water Year 2014

By Miya N. Barr

Prepared in cooperation with the Missouri Department of Natural Resources

Data Series 971

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

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment—visit http://www.usgs.gov or call 1–888–ASK–USGS.

For an overview of USGS information products, including maps, imagery, and publications, visit http://www.usgs.gov/pubprod/.

Suggested citation:
Barr, M.N., 2015, Quality of surface water in Missouri, water year 2014: U.S. Geological Survey Data Series 971, 22 p., http://dx.doi.org/10.3133/ds971.

ISSN 2327-638X (online)

Contents

Figures

Tables

Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

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

°F=(1.8×°C)+32

Datum

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

Supplemental Information

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Density of bacteria is given in colonies per 100 milliliters (col/100 mL) of water.

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

Water year in U.S. Geological Survey reports is the 12-month period October 1 through September 30. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months; thus, the year ending September 30, 2014, is called “water year 2014”.

Abbreviations

AWQMN	Ambient Water Quality Monitoring Network
CIAT	2-chloro-4-isopropylamino-6-amino-s-triazine
CWA	Clean Water Act
DO	dissolved oxygen
LT–MDL	long-term method detection level
MDL	method detection level
MDNR	Missouri Department of Natural Resources
MRL	minimum reporting level
NASQAN	National Stream Quality Assessment Network
NWIS	National Water Information System
NWISWeb	National Water Information System Web Interface
NWQL	National Water Quality Laboratory
TMDL	total maximum daily load
USGS	U.S. Geological Survey

Quality of Surface Water in Missouri, Water Year 2014

By Miya N. Barr

Abstract

The U.S. Geological Survey, in cooperation with the Missouri Department of Natural Resources, designed and operates a series of monitoring stations on streams and springs throughout Missouri known as the Ambient Water-Quality Monitoring Network. During the 2014 water year (October 1, 2013, through September 30, 2014), data were collected at 74 stations—72 Ambient Water-Quality Monitoring Network stations and 2 U.S. Geological Survey National Stream Quality Assessment Network stations. Dissolved oxygen, specific conductance, water temperature, suspended solids, suspended sediment, *Escherichia coli* bacteria, fecal coliform bacteria, dissolved nitrate plus nitrite as nitrogen, total phosphorus, dissolved and total recoverable lead and zinc, and select pesticide compound summaries are presented for 71 of these stations. The stations primarily have been classified into groups corresponding to the physiography of the State, primary land use, or unique station types. In addition, a summary of hydrologic conditions in the State including peak discharges, monthly mean discharges, and 7-day low flow is presented.

Introduction

The Missouri Department of Natural Resources (MDNR) is responsible for the implementation of the Federal Clean Water Act (CWA) in Missouri. Section 305(b) of the CWA requires that each State develop a water-quality monitoring program and periodically report the status of its water quality (U.S. Environmental Protection Agency, 1997). Water-quality status is described in terms of the suitability of the water for various uses, such as drinking, fishing, swimming, and support of aquatic life; these uses formally are defined as "designated uses" in State and Federal Regulations. Section 303(d) of the CWA requires certain waters that do not meet applicable water-quality standards for the designated uses be identified and total maximum daily loads (TMDLs) be determined for these waters (U.S. Environmental Protection Agency, 1997). Total maximum daily loads establish the maximum amount of an impairing substance that a waterbody can assimilate and still meet the water-quality standards. A TMDL addresses a single pollutant for each waterbody.

Missouri has an area of about 69,000 square miles (mi^2) and an estimated population of 6 million people (U.S. Census Bureau, 2015). Within Missouri, there are 24,491 miles (mi) of classified streams that support a variety of uses including wildlife, recreation, agriculture, industry, transportation, and public utilities. An estimated 11,029 mi of streams are adversely affected (impaired) by various physical changes or chemical contaminants to the point that criteria for at least one of the designated uses no longer can be met (Missouri Department of Natural Resources, 2014a). The impairment of about 6,283 mi of assessed streams has been documented by data that meet the requirements of the 303(d) listing methodology of Missouri. Also, there are about 4,746 mi of classified, unassessed streams suspected of nonsupport for which some data have been collected, but the data are not of sufficient quality or quantity to officially rate the stream as impaired. Several of the unassessed streams suspected of nonsupport have been affected or modified by nonpoint or unknown sources (Missouri Department of Natural Resources, 2014a).

The U.S. Geological Survey (USGS), in cooperation with the MDNR, collects surface-water quality data pertaining to Missouri's water resources each water year (October 1 through September 30). These data, stored and maintained in the USGS National Water Information System (NWIS) database, are collected as part of the Missouri Ambient Water-Quality Monitoring Network (AWQMN) and constitute a source of reliable, impartial, and timely information for developing an enhanced understanding of the State's water resources. To make this information readily available, these data were published annually in the Water-Data Report series from water years 1964 through 2005 (U.S. Geological Survey, 1964–2005). Published data for the 2006 through 2010 water years can be accessed at http://wdr.water.usgs.gov (U.S. Geological Survey, 2006–2010). Beginning in the 2011 water year, discrete water-quality data are no longer published annually, but can be accessed on the National Water Information System Web Interface (NWISWeb) at http://nwis.waterdata.usgs.gov/mo/nwis/qwdata.

The USGS, in cooperation with the U.S. Army Corps of Engineers, collects suspended-sediment concentration data and various particle-size distribution information on the Missouri and Mississippi Rivers. These data assist with sediment transport and navigable channel assessments along the larger rivers. Sediment samples are collected at seven USGS streamflow-gaging stations within Missouri, but only four stations were used for this report because these also are MDNR-USGS cooperative stations within the AWQMN where additional water-quality data are collected. The suspended-sediment concentration data in this report is provided for comparison to the State's total suspended solids criteria.

The purpose of this report is to summarize surface-water quality data collected by the MDNR-USGS cooperative AWQMN for water year 2014. The annual summary of select constituents provides MDNR with current information to assess the quality of surface water within the State and ensure the objectives of the AWQMN are being met. This report is one in a series of annual summaries (Otero-Benitez and Davis, 2009a, 2009b; Barr, 2010, 2011, 2012, 2013; Barr and Schneider, 2014). Data on the physical characteristics and water-quality constituents in samples collected at 71 surface-water stations are presented in figures and tables. These 71 stations primarily were classified into groups corresponding to the physiography of the State, primary land use, or unique station types.

The Ambient Water-Quality Monitoring Network

The USGS, in cooperation with the MDNR, designed and operates the cooperative AWQMN, which is a series of monitoring stations on streams and springs throughout Missouri. Constituent concentration data from the AWQMN have been used to determine statewide water-quality status and long-term trends for a 15-year period (Barr and Davis, 2010) to meet information needs of State agencies involved in water-quality planning and management. The data collected also provide support for the design, implementation, and evaluation of preventive and remediation programs.

The objectives of the AWQMN are to obtain data on the quality and quantity of surface water within the State; provide a historical database of water-quality information that can be used by the State planning and management agencies to make informed decisions about anthropogenic effects (such as agriculture, mining, and urban) on the State's surface waters; and provide for consistent methodology in data collection, laboratory analysis, and data reporting.

The MDNR and the USGS established a fixed-station AWQMN in 1964 with 18 stations, 5 of which are still currently (2015) being sampled. The number of stations within the AWQMN has varied since its inception because of the State's needs. During the 2014 water year, the program consisted of 72 stations. In addition to the AWQMN stations, water samples are collected by the USGS at two USGS National Stream Quality Assessment Network (NASQAN; a national water-quality sampling network operated by the USGS, see http://cida.usgs.gov/quality/rivers/home) stations. From these 74 stations, 71 are included in this report (table 1). Three stations from the AWQMN did not fit in the classes defined for this report and were not included. The three excluded stations were Cuivre River near Troy (05514500) and Lamine River near Pilot Grove (06907300), both located in the Ozark Plateaus border, and Lake Taneycomo at Branson (07053700). Sampling frequency (table 1) is determined by a number of factors, including drainage basin size, potential effects from anthropogenic activities (such as agriculture, mining, and urban), history of chemical change, need for annual data, and cost. Each of the streams in the AWQMN is classified for one or more designated uses. For specific information on the designated uses applicable to the streams sampled in the AWQMN, refer to Missouri Department of Natural Resources (2014a; 2014b).

The unique eight-digit number used by the USGS to identify each surface-water station is assigned when a station first is established. The complete eight-digit number for each station includes a two-digit prefix that designates the primary river system (05 is the Upper Mississippi River, 06 is the Missouri River, and 07 is the Lower Mississippi River) plus a six-digit downstream-order number; for example, the station number 05587455 indicates the station is located on the Upper Mississippi River (05), and the remaining six digits (587455) locate the station in downstream order. In this system, the station numbers increase downstream along the main stem. A station on a tributary that enters between two main stem stations is assigned a station number between them.

Methods used for collecting and processing representative water-quality samples are presented in detail in the USGS "National Field Manual for the Collection of Water-Quality Data" (U.S. Geological Survey, variously dated). Onsite measurements of dissolved oxygen (DO), specific conductance, and water temperature were collected at each station according to procedures described in Wilde (variously dated). Samples were collected, analyzed for indicator bacteria (*Escherichia coli* [*E. coli*] and fecal coliform), and processed using the membrane filtration procedure described in Myers and others (2014). Methods used by the USGS for collecting and processing representative samples for nutrients, primary chemical constituents, trace elements, suspended solids, suspended sediment, and pesticide analysis are presented in detail in U.S. Geological Survey (2006), Guy (1969), and Wilde and others (2004). All chemical analyses were done by the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colorado, according to procedures described in Patton and Kryskalla (2011), Patton and Truitt (1992), Garabarino, Kanagy, and Cree (2006), Fishman (1993), Sandstrom and others (2001), and Zaugg and others (1995). Suspended-sediment concentrations were computed according to procedures described in Guy (1969).

Laboratory Reporting Conventions

The NWQL uses method reporting conventions (Childress and others, 1999) to establish the minimum concentration for which more than a qualitative measurement can be made.

Table 1. U.S. Geological Survey station number, name, drainage area, sampling frequency, and class of 71 selected stations in Missouri, water year 2014.

[Water year 2014 is defined as October 1, 2013, through September 30, 2014. mi^2, square mile; DTPL, Dissected Till Plains; ag, agriculture; BRMIG, Big River—Mississippi River below Grafton, Illinois; wi, watershed indicator; BRMOSJ, Big River—Missouri River at St. Joseph, Missouri; BRMOS, Big River—Missouri River at Sibley, Missouri; MINING, mining; OSPL, Osage Plains; OZPLSP, Ozark Plateaus—Springfield Plateau; ag/fo, agriculture and forest; OZPLSA, Ozark Plains—Salem Plateau; fo/ag, forest and agriculture; —, not applicable; SPRING, springs; BRMOH, Big River—Missouri River at Hermann, Missouri; URBAN, urban; BRMIT, Big River—Mississippi River at Thebes, Illinois; MIALPL, Mississippi Alluvial Plain]

U.S. Geological Survey station number (figs. 1 and 3)	Station name	Contributing drainage area (mi^2)	Water year 2014 sampling frequency	U.S. Geological Survey station class (table 2)
05495000	Fox River at Wayland	400	6	DTPL ag
05496000	Wyaconda River above Canton	393	6	DTPL ag
05497150	North Fabius River near Ewing	471	6	DTPL ag
05500000	South Fabius River near Taylor	620	12	DTPL ag
05587455 [a]	Mississippi River below Grafton, Illinois	171,300	12	BRMIG
06817700	Nodaway River near Graham	1,520	6	DTPL wi ag
06818000 [a]	Missouri River at St. Joseph	426,500	12	BRMOSJ
06821190	Platte River at Sharps Station	2,380	6	DTPL wi ag
06894100	Missouri River at Sibley	426,500	12	BRMOS
06896187	Middle Fork Grand River near Grant City	82.4	6	DTPL ag
06898100	Thompson River at Mount Moriah	891	8	DTPL ag
06898800	Weldon River near Princeton	452	7	DTPL ag
06899580	No Creek near Dunlap	34.0	10	DTPL ag
06899950	Medicine Creek near Harris	192	12	DTPL ag
06900100	Little Medicine Creek near Harris	66.5	12	DTPL ag
06900900	Locust Creek near Unionville	77.5	11	DTPL ag
06902000	Grand River near Sumner	6,880	12	DTPL wi ag
06905500	Chariton River near Prairie Hill	1,870	6	DTPL wi ag
06905725	Mussel Fork near Mystic	24.0	9	DTPL ag
06906300	East Fork Little Chariton River near Huntsville	220	6	MINING
06918070	Osage River above Schell City	5,410	6	OSPL wi ag
06918600	Little Sac River near Walnut Grove	119	12	OZPLSP ag/fo
06919500	Cedar Creek near Pleasant View	420	12	OZPLSP ag/fo
06921070	Pomme de Terre River near Polk	276	9	OZPLSA fo/ag
06921590	South Grand River at Archie	356	6	OSPL ag
06921720	Big Creek near Blairstown	414	8	OSPL ag
06923700	Niangua River at Bennett Spring	441	6	OZPLSA fo/ag
06926510	Osage River below St. Thomas	14,580	6	OZPLSA wi fo/ag
06927850	Osage Fork of the Gasconade River near Lebanon	43.6	6	OZPLSA fo/ag
06928440	Roubidoux Spring at Waynesville	—	6	SPRING
06930450	Big Piney River at Devil's Elbow	746	9	OZPLSA fo/ag
06930800	Gasconade River above Jerome	2,570	12	OZPLSA wi fo/ag
06934500 [a,b]	Missouri River at Hermann	522,500	14	BRMOH
07014000	Huzzah Creek near Steelville	259	6	OZPLSA fo/ag
07014200	Courtois Creek at Berryman	173	6	OZPLSA fo/ag
07014500	Meramec River near Sullivan	1,475	12	OZPLSA wi fo/ag
07016400	Bourbeuse River above Union	808	9	OZPLSA fo/ag
07018100	Big River near Richwoods	735	10	MINING

Table 1. U.S. Geological Survey station number, name, drainage area, sampling frequency, and class of 71 selected stations in Missouri, water year 2014.—Continued

[Water year 2014 is defined as October 1, 2013, through September 30, 2014. mi^2, square mile; DTPL, Dissected Till Plains; ag, agriculture; BRMIG, Big River—Mississippi River below Grafton, Illinois; wi, watershed indicator; BRMOSJ, Big River—Missouri River at St. Joseph, Missouri; BRMOS, Big River—Missouri River at Sibley, Missouri; MINING, mining; OSPL, Osage Plains; OZPLSP, Ozark Plateaus—Springfield Plateau; ag/fo, agriculture and forest; OZPLSA, Ozark Plains—Salem Plateau; fo/ag, forest and agriculture; —, not applicable; SPRING, springs; BRMOH, Big River—Missouri River at Hermann, Missouri; URBAN, urban; BRMIT, Big River—Mississippi River at Thebes, Illinois; MIALPL, Mississippi Alluvial Plain]

U.S. Geological Survey station number (figs. 1 and 3)	Station name	Contributing drainage area (mi^2)	Water year 2014 sampling frequency	U.S. Geological Survey station class (table 2)
07019280	Meramec River at Paulina Hills	3,920	11	URBAN wi
07020550	South Fork Saline Creek near Perryville	55.3	6	OZPLSA fo/ag
07021020	Castor River at Greenbriar	423	6	OZPLSA fo/ag
07022000 [a,b]	Mississippi River at Thebes, Illinois	713,200	14	BRMIT
07036100	St. Francis River near Saco	664	9	OZPLSA fo/ag
07037300	Big Creek at Sam A. Baker State Park	189	6	OZPLSA fo/ag
07042450	St. Johns Ditch at Henderson Mound	313	7	MIALPL
07046250	Little River Ditches near Rives	1,620	12	MIALPL
07050150	Roaring River Spring at Cassville	—	6	OZPLSP ag/fo
07052152	Wilson Creek near Brookline	51	12	URBAN
07052250	James River near Boaz	462	6	URBAN
07052345	Finley Creek below Riverdale	261	12	OZPLSP ag/fo
07052500	James River at Galena	987	12	URBAN
07052820	Flat Creek below Jenkins	274	12	OZPLSP ag/fo
07053900	Swan Creek near Swan	148	6	OZPLSA fo/ag
07057500	North Fork River near Tecumseh	561	6	OZPLSA fo/ag
07057750	Bryant Creek below Evans	214	6	OZPLSA fo/ag
07061600	Black River below Annapolis	493	8	OZPLSA fo/ag
07066110	Jacks Fork above Two River	425	12	OZPLSA fo/ag
07067500	Big Spring near Van Buren	—	4	SPRING
07068000	Current River at Doniphan	2,040	12	OZPLSA wi fo/ag
07068510	Little Black River below Fairdealing	194	6	OZPLSA fo/ag
07071000	Greer Spring at Greer	—	3	SPRING
07071500	Eleven Point River near Bardley	793	6	OZPLSA fo/ag
07185764	Spring River above Carthage	425	12	OZPLSP ag/fo
07186480	Center Creek near Smithfield	303	9	MINING
07186600	Turkey Creek near Joplin	41.8	9	URBAN
07187000	Shoal Creek above Joplin	427	12	OZPLSP ag/fo
07188653	Big Sugar Creek near Powell	141	12	OZPLSP ag/fo
07188838	Little Sugar Creek near Pineville	195	12	OZPLSP ag/fo
07188885	Indian Creek near Lanagan	239	12	OZPLSP ag/fo
07189000	Elk River near Tiff City	872	12	OZPLSP ag/fo
07189100	Buffalo Creek at Tiff City	60.8	12	OZPLSP ag/fo

[a]Additional water temperature and suspended-sediment samples collected in cooperation with the U.S. Army Corps of Engineers.

[b]Stations 06934500 and 07022000 are not part of the Ambient Water-Quality Monitoring Network, but were used in the report. Stations 06934500 and 07022000 are funded by the U.S. Geological Survey National Stream Quality Account Network.

These reporting conventions are the minimum reporting level (MRL), the method detection level (MDL) and the laboratory reporting level (LRL). The MRL is defined by the NWQL as the smallest measured concentration of a substance that can be measured reliably using a given analytical method. The MDL is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the concentration is greater than zero. A long-term method detection level (LT–MDL) is a detection level obtained by determining the standard deviation of 24 or more MDL spiked-sample measurements for an extended period of time. The LRL is computed as twice the LT–MDL. Pesticide data in this report that are not reported as less than (<) the LRL and are graphically displayed below the LRL are estimated values (Childress and others, 1999).

Data Analysis Methods

The distribution of select constituent data was graphically displayed using side-by-side boxplots (box and whiskers distributions; Helsel and Hirsch, 2002). The plots show the center of the data (median, the center line of the boxplot), the variation (interquartile range [25th to 75th percentiles] or the height of the box), the skewness (quartile skew, which is the relative size of the box halves), the spread (upper and lower adjacent values are the vertical lines or whiskers), and the presence or absence of unusual values or outliers (upper and lower detached and outside values). If the median equals the 25th and 75th percentiles, the boxplot is represented by a single horizontal line. Boxplots with censored data (suspended solids, dissolved nitrate plus nitrite as nitrogen, total phosphorus, and dissolved and total recoverable lead and zinc) were modified by making the lower limit of the box equal to the MRL or LT–MDL. For pesticide concentration distributions, censored concentrations (reported as less than the LRL) were included in each distribution as a concentration value equal to the LRL. For some samples, pesticide concentrations are reported as estimated values (Childress and others, 1999), which are included in the distribution as a concentration that is plotted below the LRL and above the LT–MDL.

Station Classification for Data Analysis

The stations primarily were classified in groups corresponding to the physiography of the State (fig. 1), primary land use (fig. 2), or unique station types. The physiography-based groups include the Dissected Till Plains (DTPL) in the north, the Osage Plains (OSPL) in the west, the Mississippi Alluvial Plain (MIALPL) in the southeast, and between them the Ozark Plateaus. The Ozark Plateaus (Fenneman, 1938) were further subdivided into two distinct groups based on physiographic location—the Salem Plateau (OZPLSA) and the Springfield Plateau (OZPLSP). Primary land use considered for station classification included agriculture, forest, urban, and mining, but mining is not shown at the scale of the map (fig. 2). Station classes specifically designated by land-use groups include mining (MINING) and urban (URBAN) stations, whereas station classes designated with unique station types refer to springs (SPRING) and the stations located on the Mississippi River (BRMIG and BRMIT) and the Missouri River (BRMOSJ, BRMOS and BRMOH), also referred to in this report as the "Big River stations."

Some additional variability caused by differences in drainage area and land use was observed within physiographic regions; therefore, contributing drainage area (table 1) and land-use indicators were used to develop a complete set of classes. The land-use indicator provides a subclassification for stations in similar regions with different land uses (fig. 1; table 2). The land-use indicators include watershed indicator stations (wi), which are the most downstream stations in a large watershed and are defined for the purposes of this report as a drainage area greater than 1,000 mi^2, and the secondary land-use indicators, forest (fo) and agriculture (ag). Unlike data from secondary land-use indicator sites, observations and analyses from watershed indicator stations can be interpreted as being representative of the general condition of the watershed rather than affected by a specific land use. In some instances, both agriculture and forest land uses were present; therefore, the convention was to mention them in predominant order. An agriculture and forest (ag/fo) indicator, for example, implies that the dominant land use of the watershed is agriculture, although a substantial part of the land use is forest.

Hydrologic Conditions

Surface-water streamflow varies seasonally in Missouri and tends to reflect precipitation patterns. During the 2014 water year, the average annual precipitation of the conterminous United States was about 0.82 inches (in.) above the 20th century average at 30.76 in. (National Oceanic and Atmospheric Administration, 2014a). Precipitation in Missouri during the 2014 water year ranked less than normal with 37.72 in. of total precipitation, whereas the long-term State precipitation average was 40.84 in. (National Oceanic and Atmospheric Administration, 2014b).

The selection of streamflow-gaging stations (hereinafter referred to as "streamgages") used to describe the variation in hydrologic conditions was based on their geographical distribution across the State and their long period of record. This summary of statewide hydrologic condition data is a legacy of information that was previously provided in the annual Water-Data Reports (U.S. Geological Survey, 1964–2005). Stations used for the hydrologic summary are identified in figure 3.

Six streamgages across the State were selected to determine the 2014 water year monthly mean streamflow and the long-term median of monthly mean streamflow (fig. 4). Monthly mean streamflow is the arithmetic mean of daily

Figure 1. Location and class of selected stations and physiographic regions of Missouri, water year 2014.

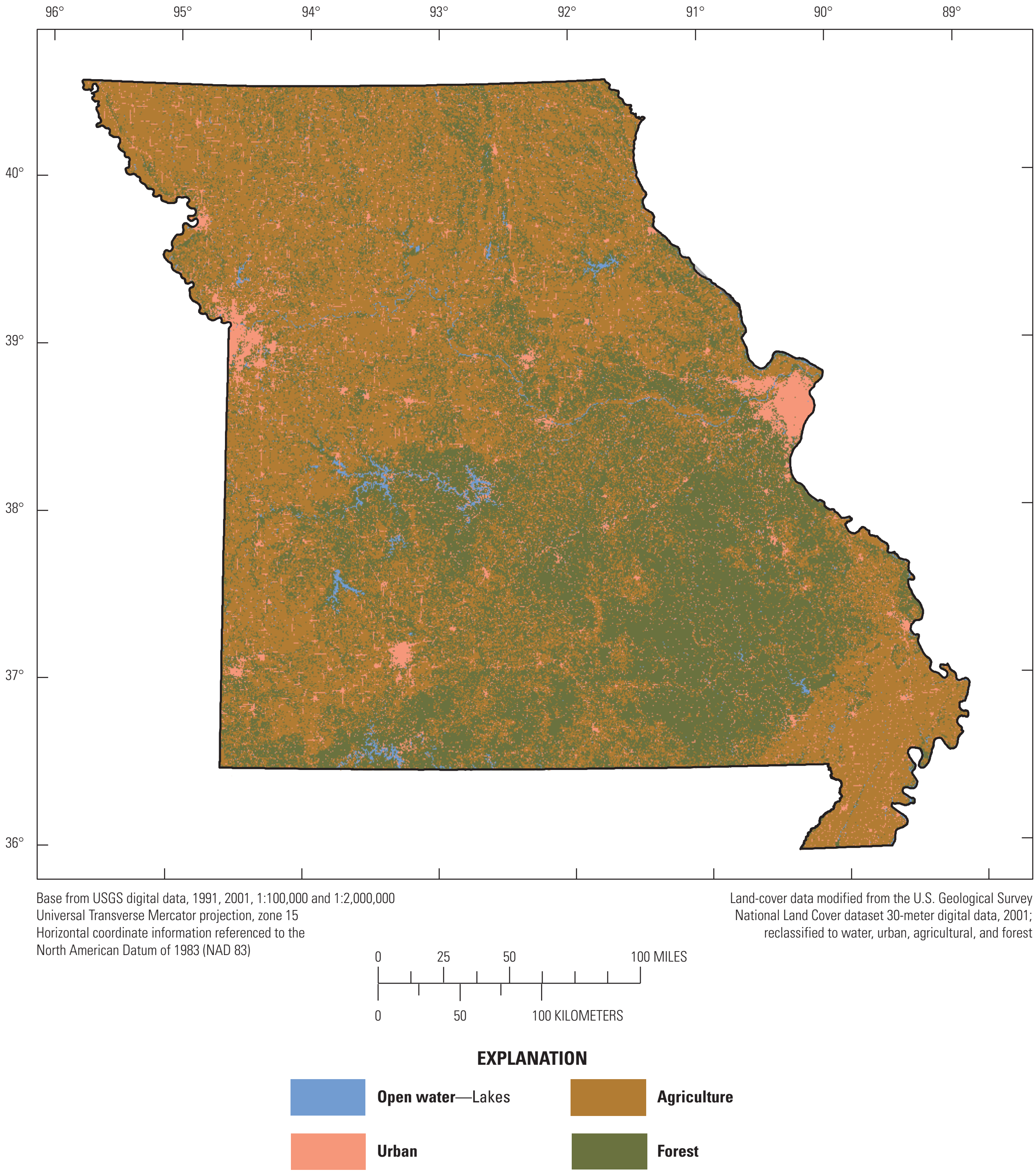

Figure 2. Primary land use in Missouri.

Table 2. Station classification system.

[Classification system is based on physiography of the State, primary and secondary land use, unique station type, and watershed size, as well as a station's representativeness to the general condition of the watershed. See "Station Classification for Data Analysis" section for full explanation of station classes.]

U.S. Geological Survey station class (fig. 1)	Description	Number of stations
BRMIG	Big River—Mississippi River below Grafton, Illinois	1
BRMIT	Big River—Mississippi River at Thebes, Illinois	1
BRMOSJ	Big River—Missouri River at St. Joseph, Missouri	1
BRMOS	Big River—Missouri River at Sibley, Missouri	1
BRMOH	Big River—Missouri River at Hermann, Missouri	1
MIALPL	Mississippi Alluvial Plain	2 [a]
OZPLSA fo/ag	Ozark Plateaus—Salem Plateau forest and agriculture	18
OZPLSA wi fo/ag	Ozark Plateaus—Salem Plateau watershed indicator, forest and agriculture	4
OZPLSP ag/fo	Ozark Plateaus—Springfield Plateau agriculture and forest	12
DTPL ag	Dissected Till Plains agriculture	12
DTPL wi ag	Dissected Till Plains watershed indicator, agriculture	4
OSPL ag	Osage Plains agriculture	2
OSPL wi ag	Osage Plains watershed indicator, agriculture	1
SPRING	Springs	3
MINING	Mining	3
URBAN	Urban	4
URBAN wi	Urban watershed indicator	1

[a]One station in this class, Little River Ditches near Rives, Missouri (07046250), has a drainage area greater than 1,000 square miles but is not considered a watershed indicator station because the manmade canals and ditches within its drainage area are not hydrologically connected.

streamflow for a given month. For comparison to the 2014 water year, a historical monthly median was attained from the median of all monthly mean streamflows for the available period of record. Of these six streamgages, three (05495000, 06921590, and 07052500) are part of the AWQMN and the remaining three (06897500, 06933500, and 07067000) streamgages only record streamflow and are not part of the AWQMN (table 1; figs. 3, 4). Monthly mean streamflows for the 2014 water year were lower than the long-term medians for the northern streamgages (05495000, 06897500, and 06921590) from October 2013 through January 2014. From June 2014 through September 2014 the northern streamgages had higher mean streamflows than long-term medians. The monthly mean streamflows for the three southern streamgages (06933500, 07052500, and 07067000) were higher than the long-term medians from October 2013 through January 2014. The largest differences in monthly mean streamflow and long-term median streamflows were noted at 05495000 and 06897500 during September 2014 (fig. 4).

Peak streamflow for the 2014 water year and select periods of record are presented for nine streamgages (table 3). The peak streamflow values presented in table 3 were less than the peak streamflow for the period of record at all stations. The 7-day low flow for the period of record and the 2014 water year and the minimum daily mean flow for the period of record are presented for selected stations in table 4. The 7-day low flow and minimum daily mean flows recorded during the 2014 water year did not exceed historical records for the stations.

Distribution, Concentration, and Detection Frequency of Select Constituents

The analyses presented in this report include the following constituents: DO, specific conductance, water temperature, suspended solids, suspended sediment, *E. coli* bacteria, fecal coliform bacteria, dissolved nitrate plus nitrite as nitrogen (hereinafter referred to as "nitrate plus nitrite"), total phosphorus, and dissolved and total recoverable lead and zinc. Boxplots of these constituents are presented for the different station classes (figs. 5–7). In addition, pesticide data were analyzed from seven stations from six classes. Three Big River stations (05587455, 06934500, and 07022000) had pesticide analyses as part of the NASQAN program, which began using a new method of pesticide analyses during the 2013 water year (Sandstrom and Wilde, 2014). Many constituents available

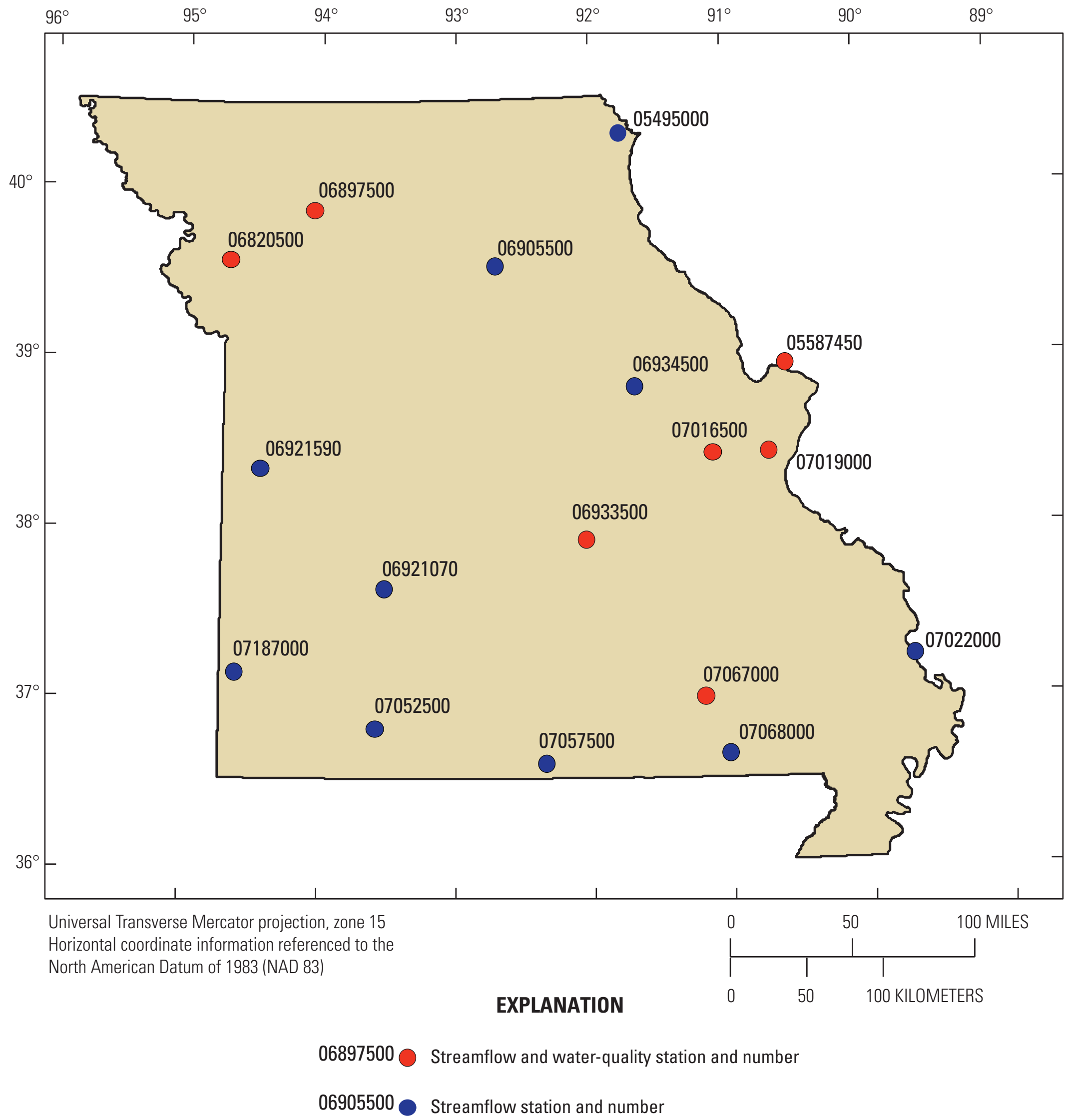

Figure 3. Location of selected streamflow-gaging stations used for summary of hydrologic conditions within Missouri, water year 2014.

using the new method were similar to the constituents available with traditional pesticide sampling methods used for the AWQMN stations (06918070, 07042450, 07046250, 07052250), but because of the different method, some have different LRLs (fig. 8). Of the 85 pesticide constituents analyzed during water year 2014, 15 had concentrations larger than their LRL and are presented in this report: 2-chloro-4-isopropylamino-6-amino-*s*-triazine (CIAT; a degradation product of atrazine), acetochlor, alachlor, atrazine, fipronil, hexazinone, metolachlor, metribuzin, prometon, prometryn, propanil, simazine, tebuconazole, tebuthiuron, and terbuthylazine (fig. 8). Missouri water-quality standards are not shown on the graphs because these standards are not applicable to all streams in the AWQMN. For specific information on Missouri water-quality standards, refer to Missouri Department of Natural Resources (2014b).

Distribution of Physical Properties, Suspended-Solids Concentration, Suspended-Sediment Concentration, and Indicator Bacteria Density

The physical properties analyzed for this report were DO, specific conductance, and water temperature. The median DO, in percent saturation, ranged from 79 to 119 percent (fig. 5). Samples from OSPL wi ag stations had the lowest median DO percent saturation values, whereas samples from URBAN stations had the highest median DO (fig. 5). Median specific conductance values varied substantially among the station classes (fig. 5), ranging from 297 microsiemens per centimeter at 25 degrees Celsius (mS/cm at 25 °C) at the MIALPL stations to 802 mS/cm at 25 °C at the BRMOSJ station. Median water temperature ranged from 11.5 to 20.2 degrees Celsius;

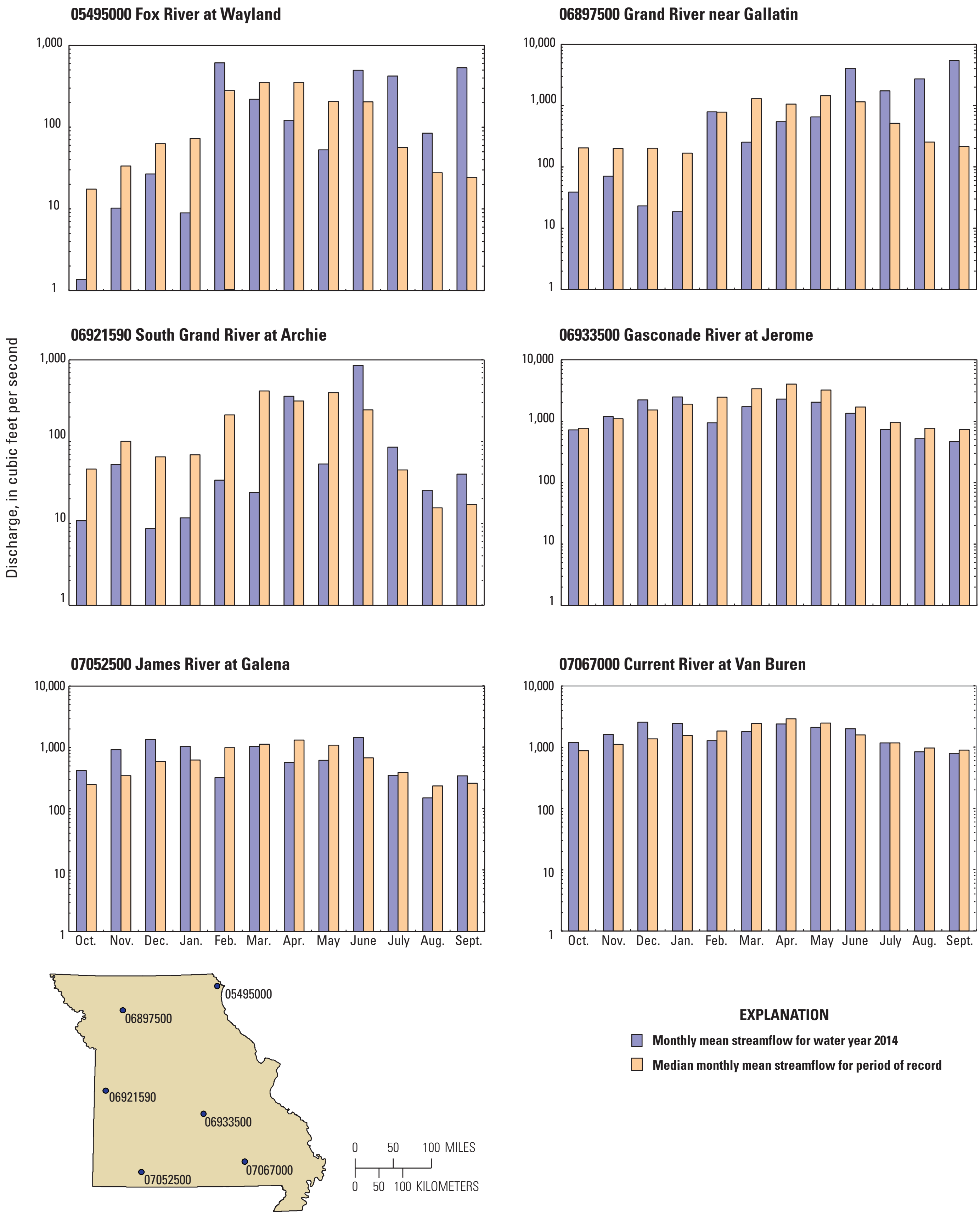

Figure 4. Monthly mean streamflow for water year 2014 and long-term median of monthly mean streamflow at six representative streamgages.

Table 3. Peak streamflow for the 2014 water year and select periods of record for selected streamgages.

[Water year 2014 is defined as October 1, 2013, through September 30, 2014. ft³/s, cubic foot per second]

U.S. Geological Survey station number[a]	Station name (period of record used for statistical summaries in water years)	2014 water year		Long-term period of record	
		Peak streamflow (ft³/s)	Date	Peak streamflow (ft³/s)	Date
05495000	Fox River at Wayland, Mo. (1922–2014)	8,070	February 21	26,400	April 22, 1973
05587450	Mississippi River at Grafton, Ill. (1987–2014)	376,000	July 11	598,000	August 1, 1993
06905500	Chariton River near Prairie Hill, Mo. (1929–2014)	34,100	September 11	38,400	July 27, 2008
06933500	Gasconade River at Jerome, Mo. (1903–2014)	9,150	December 24	138,000	August 7, 2013
06934500	Missouri River at Hermann, Mo. (1958–2014)	193,000	June 11	750,000	July 31, 1993
07019000	Meramec River near Eureka, Mo. (1904–2014)	29,500	April 5	145,000	December 6, 1982
07022000	Mississippi River at Thebes, Ill. (1933–2014)	539,000	July 14	996,000	August 7, 1993
07057500	North Fork River near Tecumseh, Mo. (1945–2014)	3,110	December 22	133,000	November 19, 1985
07068000	Current River at Doniphan, Mo. (1921–2014)	22,200	April 28	122,000	December 3, 1982

[a]Stations 05587450, 06933500, and 07019000 are streamflow-gaging stations only and not part of the Ambient Water-Quality Monitoring Network.

Table 4. Seven-day low flow for water year 2014, period of record 7-day low flow, and period of record minimum daily mean streamflow for selected streamgages in Missouri.

[Water year 2014 is defined as October 1, 2013, through September 30, 2014. ft³/s, cubic foot per second]

U.S. Geological Survey station number[a]	Station name (period of record in water years)	7-day low flow (ft³/s)		Minimum daily mean streamflow for period of record (ft³/s)	
		2014 water year	Period of record	Streamflow	Date
05495000	Fox River at Wayland (1922–2014)	0.32	0	0	September 10, 1930
06820500	Platte River near Agency (1933–2014)	17.3	0	0	July 19, 1934
06921070	Pomme de Terre river near Polk (1969–2014)	3.0	0.21	0.17	August 13, 2012
07016500	Bourbeuse River near Union (1921–2014)	25.6	13	12	October 10, 1956
07067000	Current River at Van Buren (1912–2014)	756	479	476	October 8, 1956
07187000	Shoal Creek above Joplin (1942–2014)	49	16	15	September 7, 1954

[a]Stations 06820500, 07016500, and 07067000 are streamflow-gaging stations only and not part of the Ambient Water-Quality Monitoring Network.

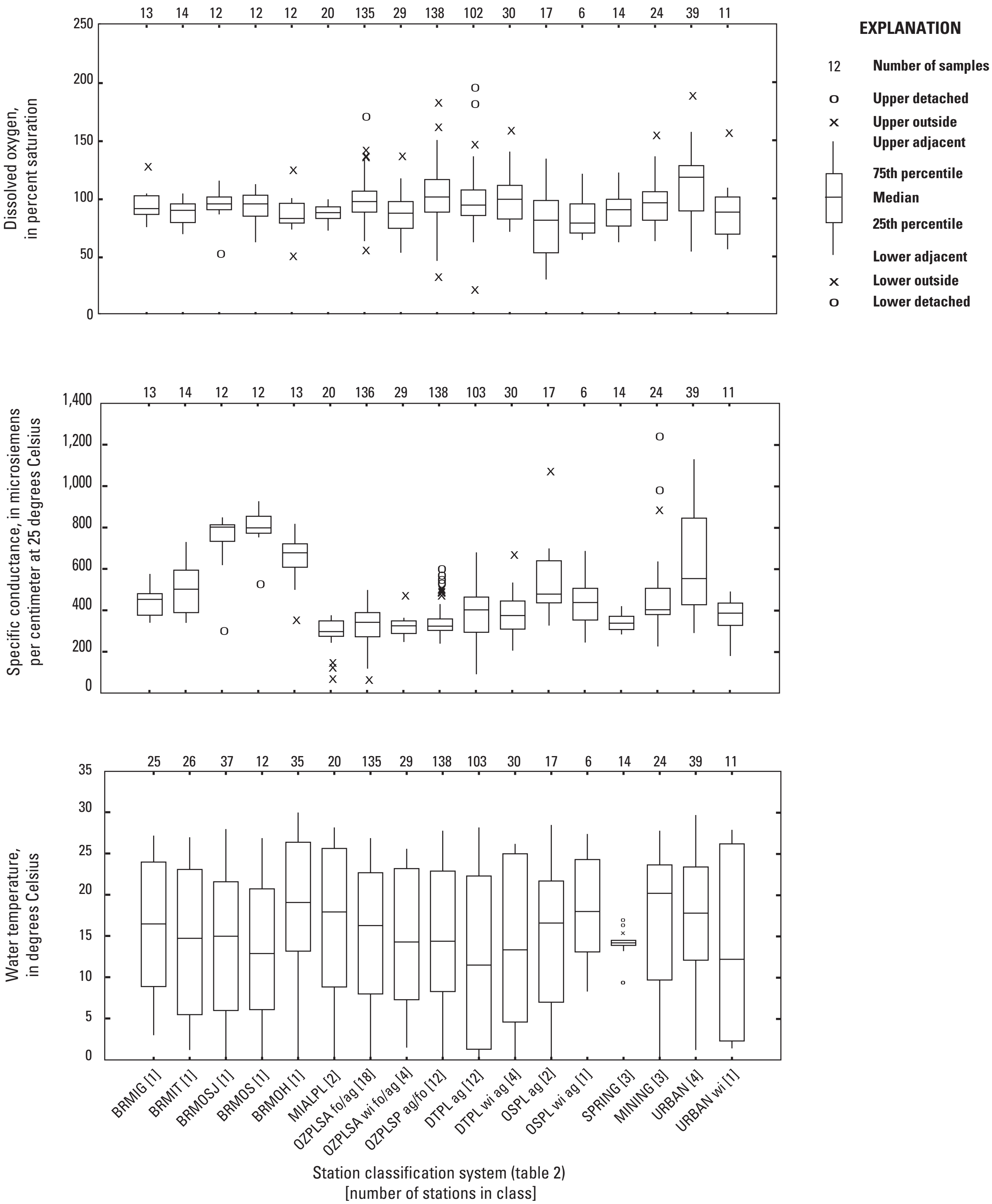

Figure 5. Distribution of physical properties, suspended-solids concentrations, suspended-sediment concentrations, and indicator bacteria densities in samples from 71 stations, water year 2014.

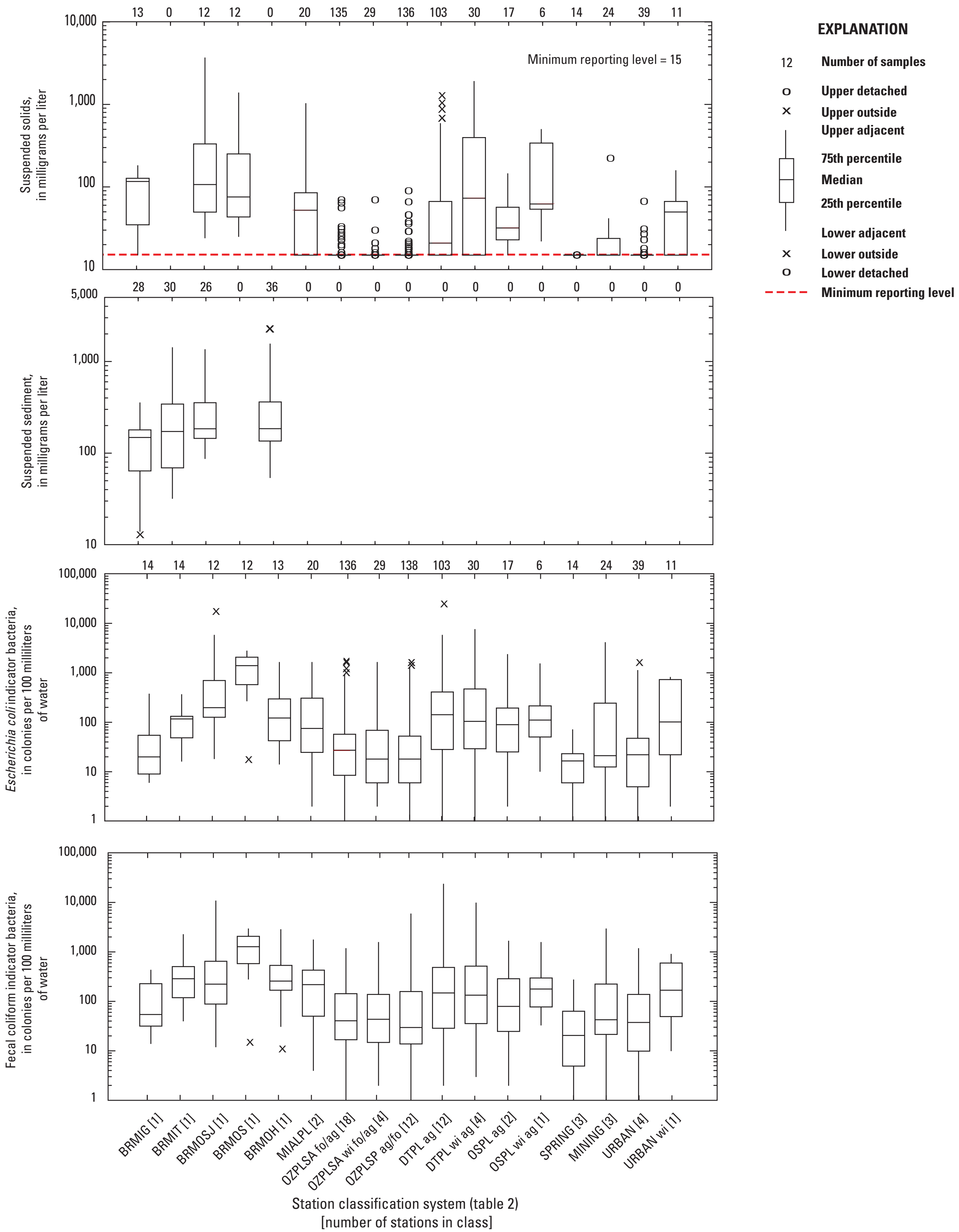

Figure 5. Distribution of physical properties, suspended-solids concentrations, suspended-sediment concentrations, and indicator bacteria densities in samples from 71 stations, water year 2014.

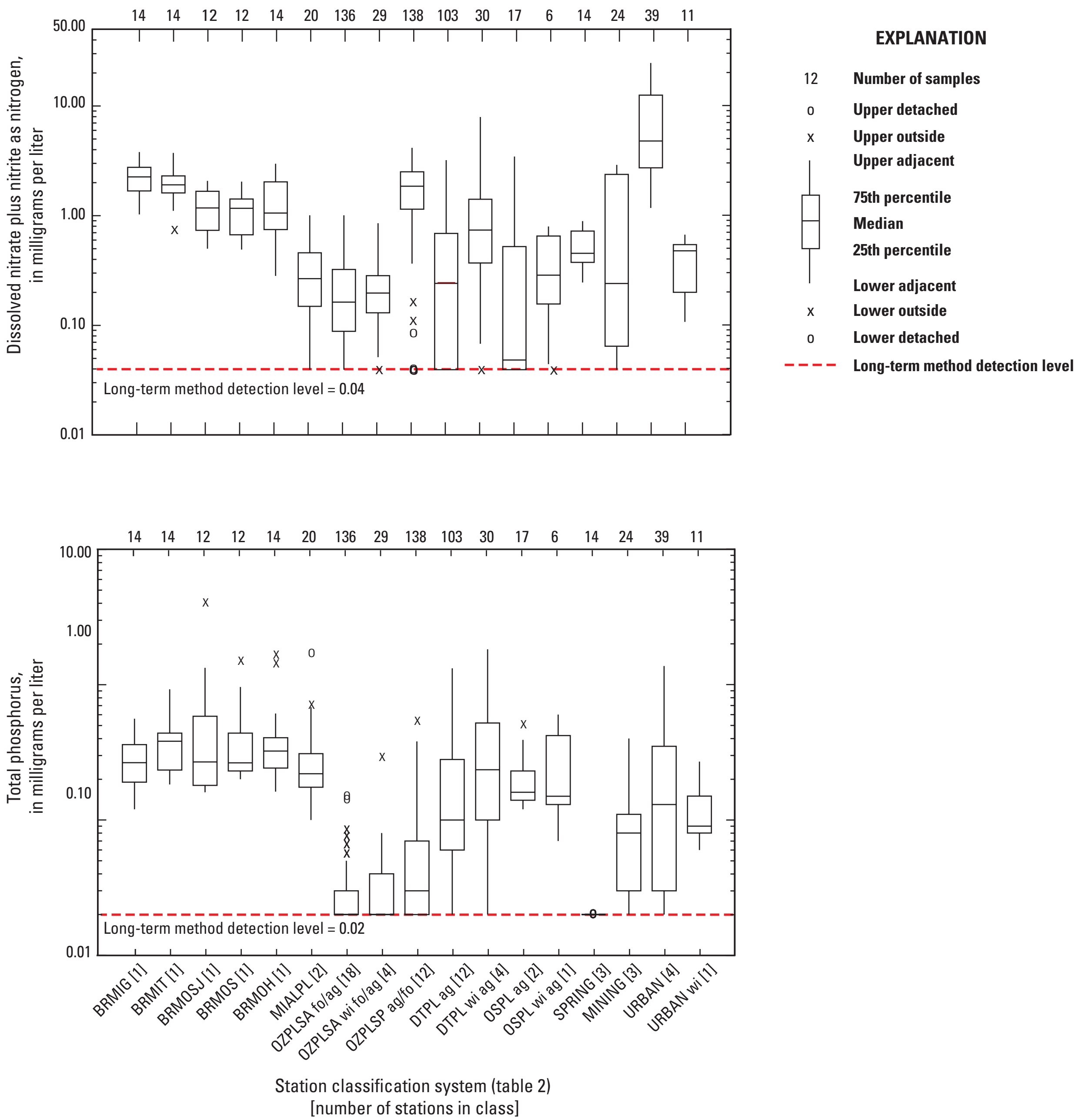

Figure 6. Distribution of dissolved nitrate plus nitrite as nitrogen and total phosphorus concentrations in samples from 71 stations, water year 2014.

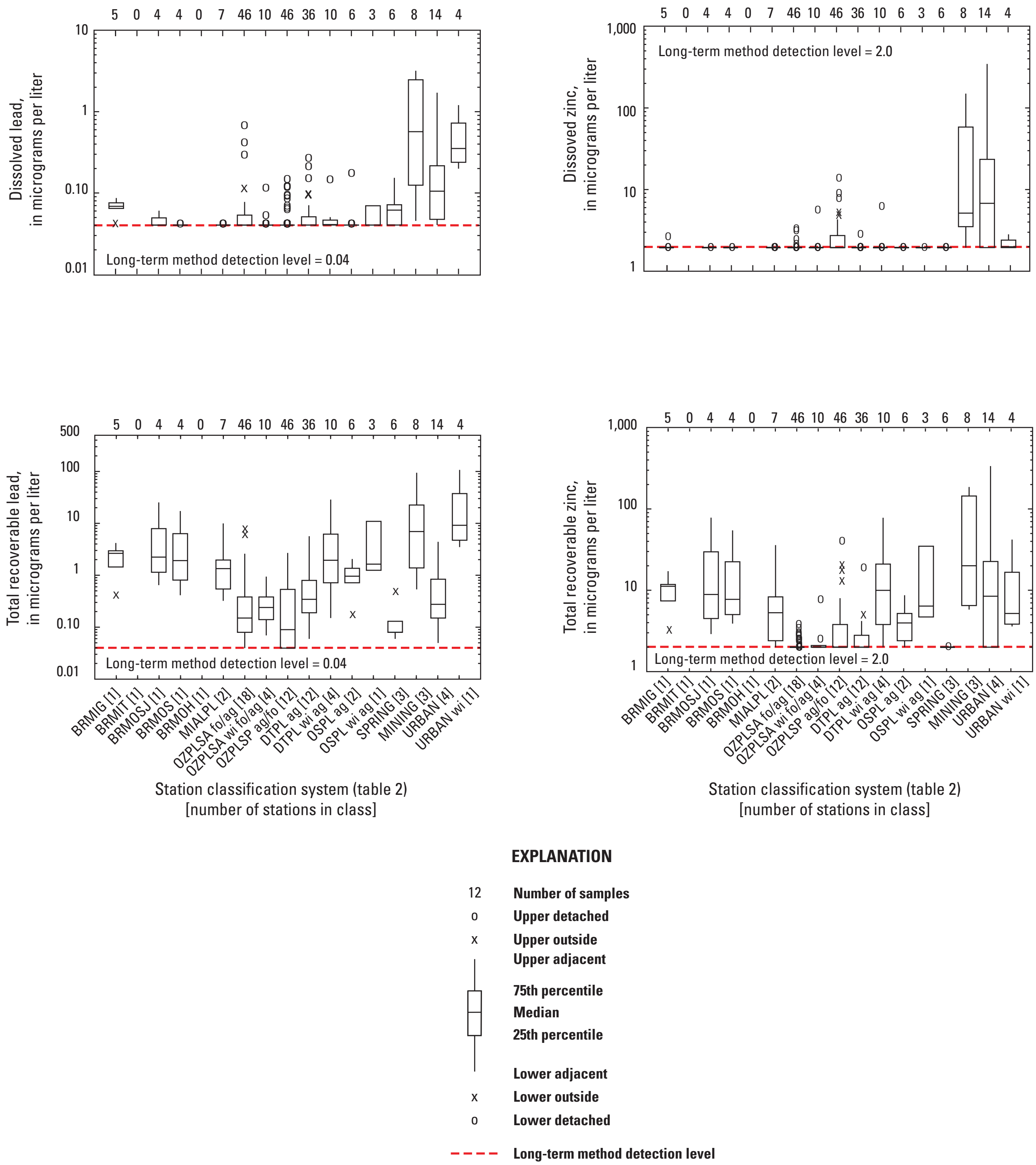

Figure 7. Distribution of dissolved and total recoverable lead and zinc concentrations from 71 stations, water year 2014.

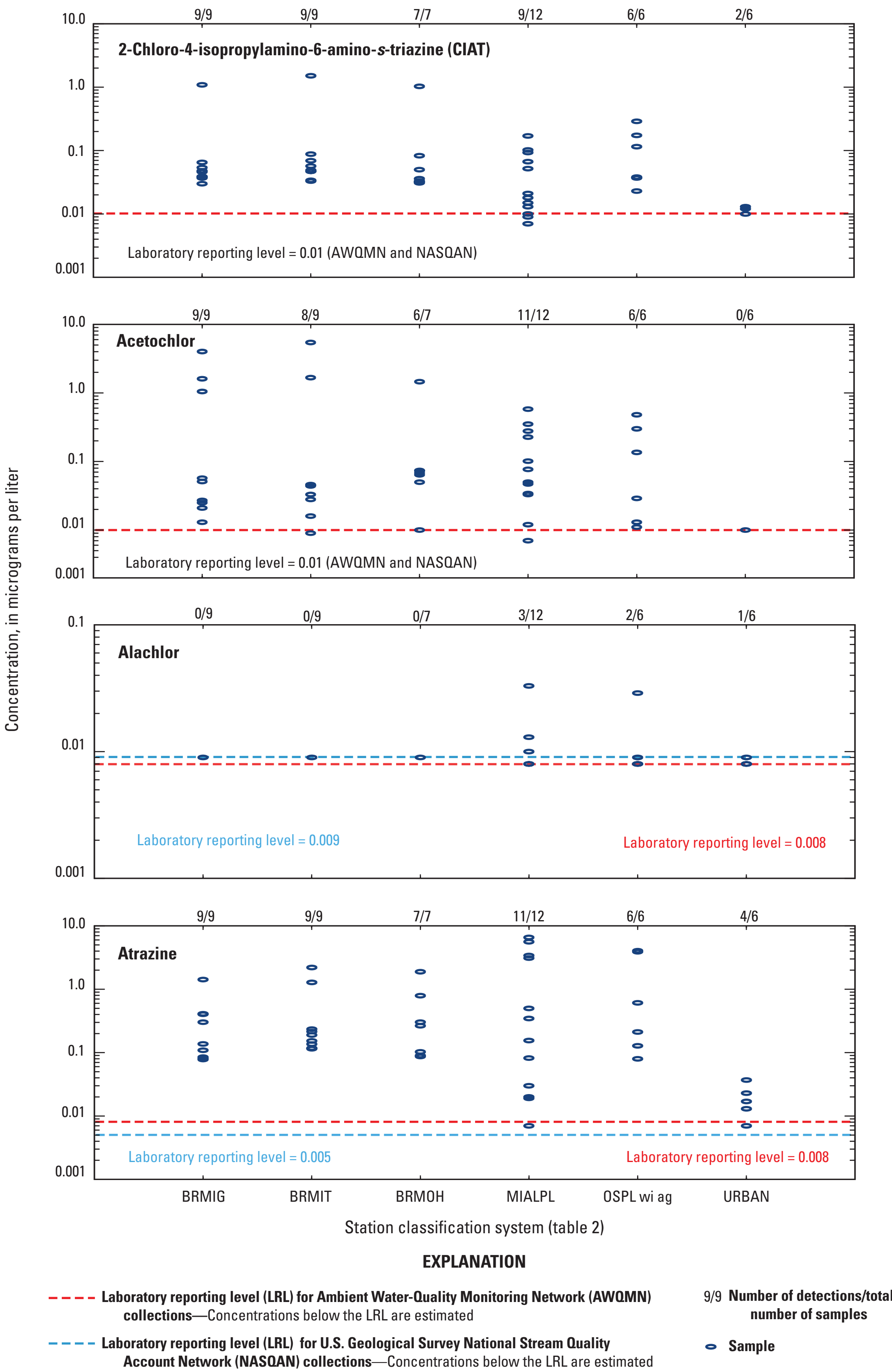

Figure 8. Detection of select pesticides from selected stations, water year 2014.

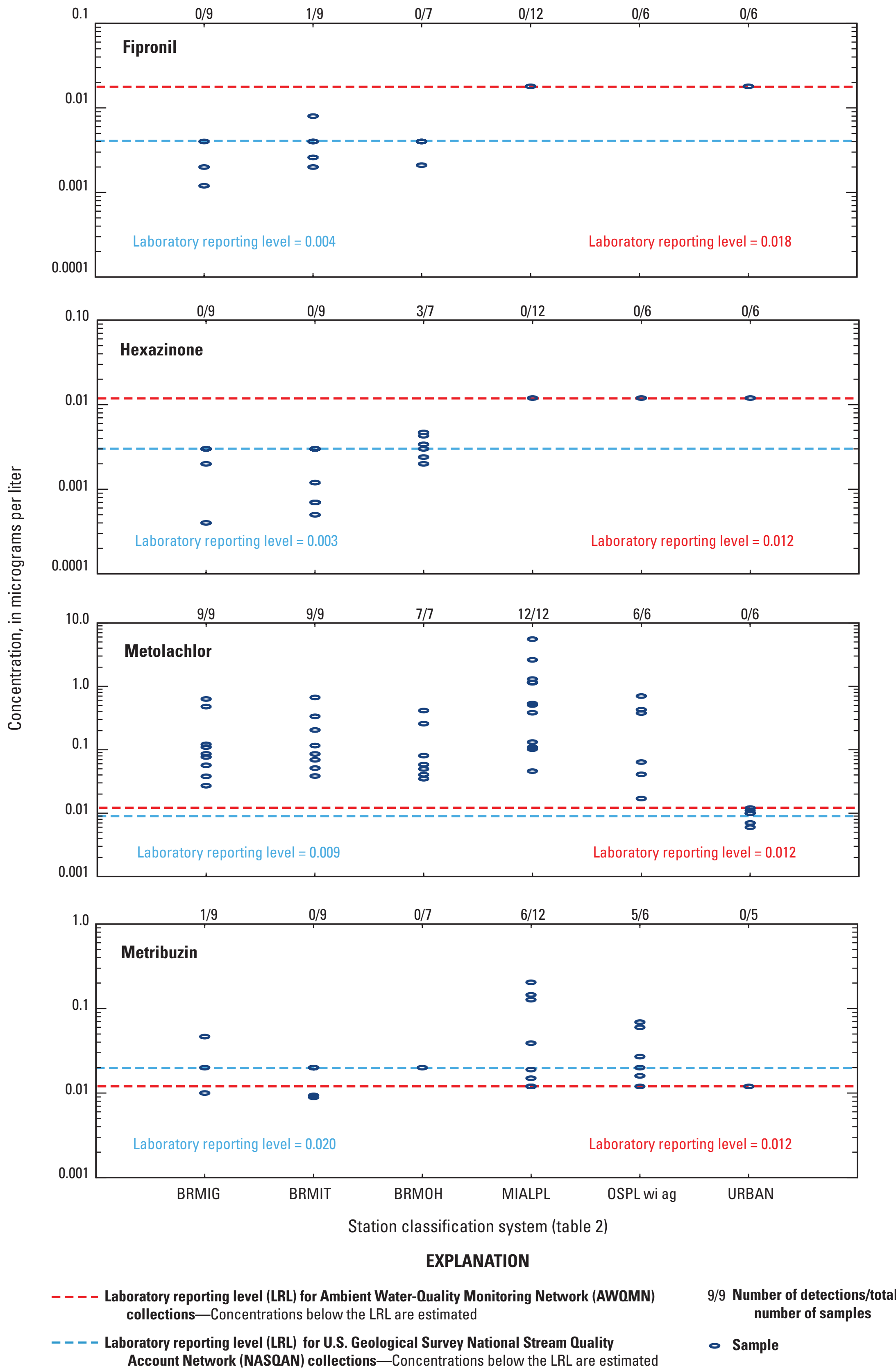

Figure 8. Detection of select pesticides from selected stations, water year 2014.—Continued

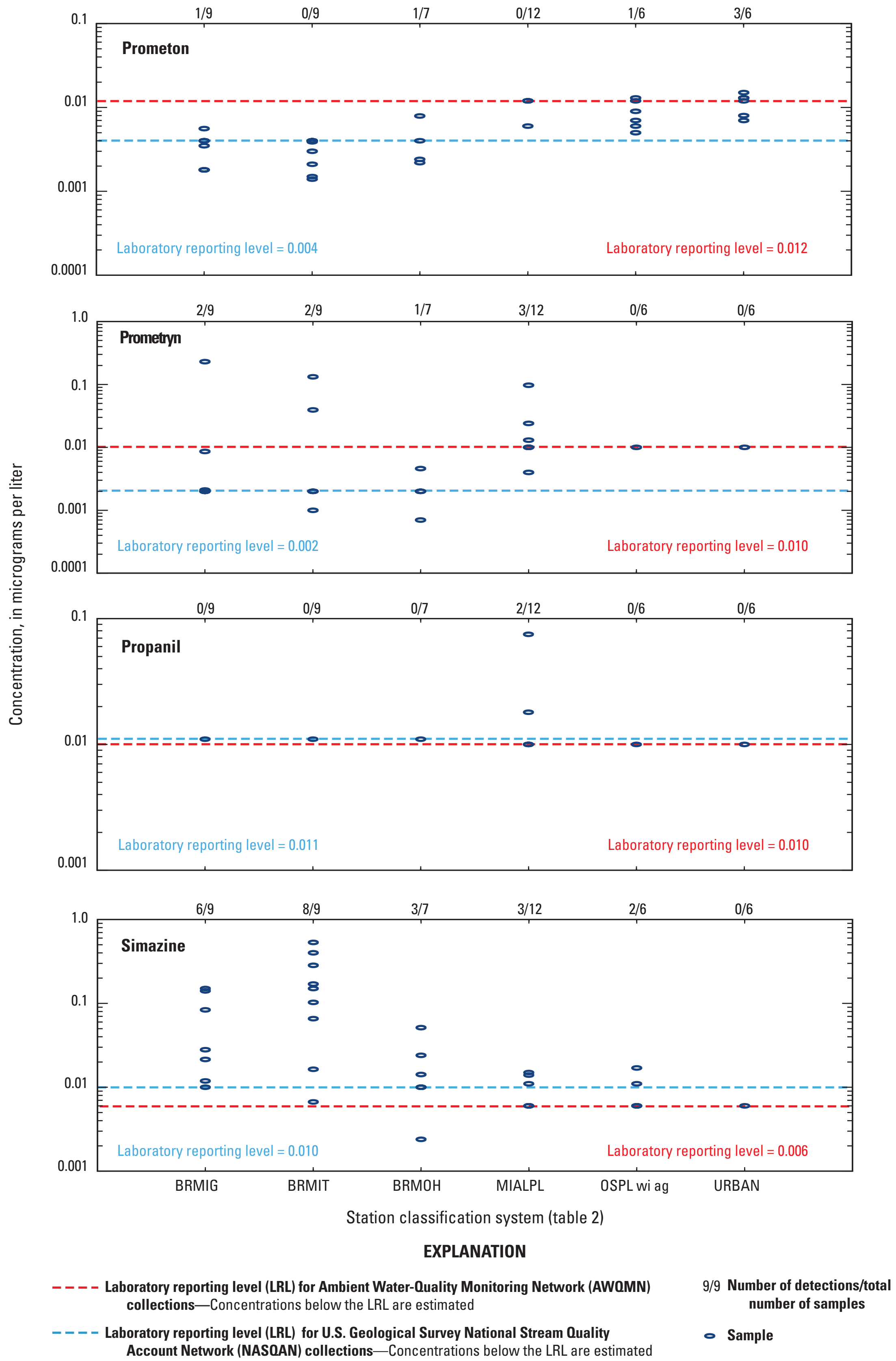

Figure 8. Detection of select pesticides from selected stations, water year 2014.—Continued

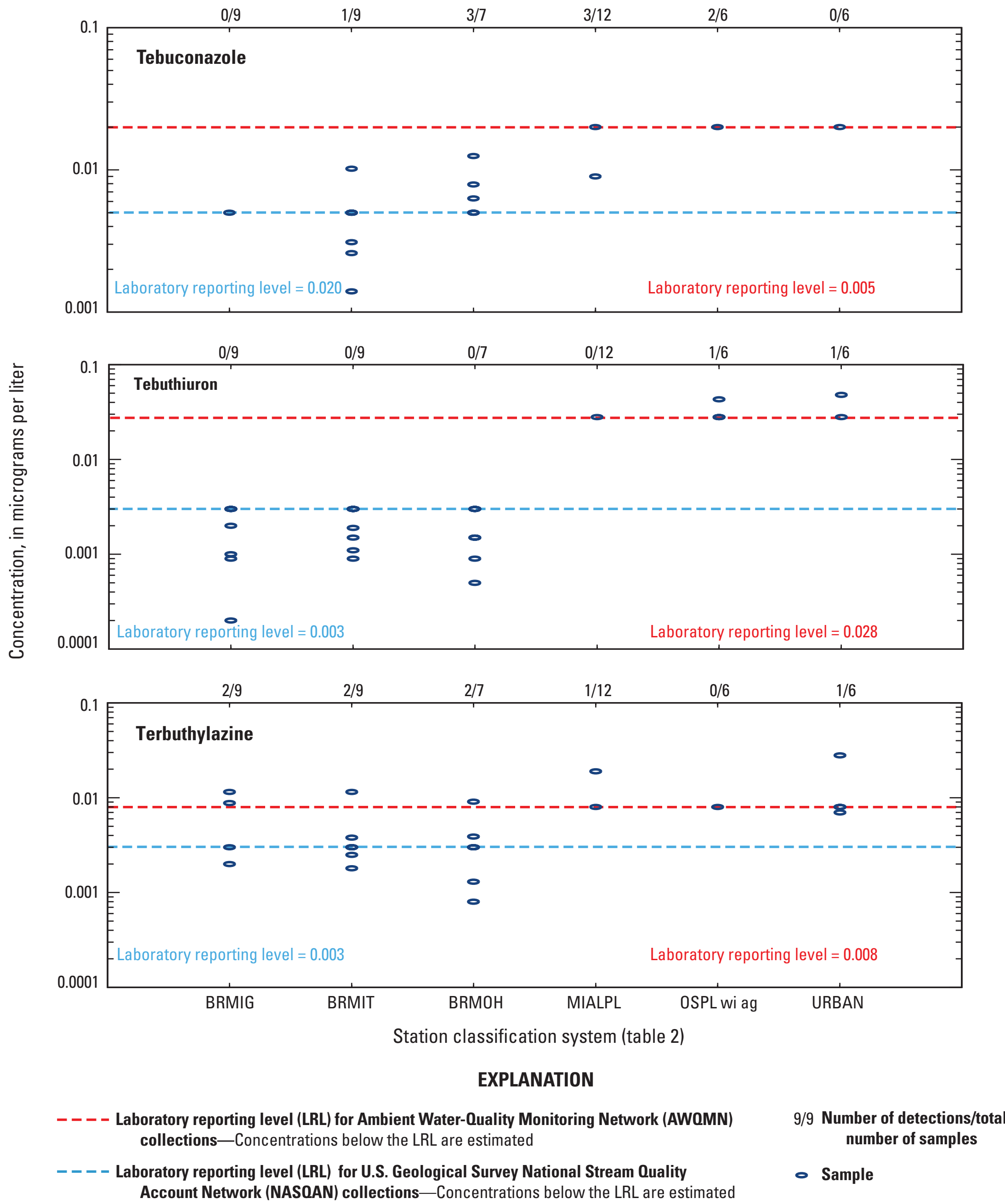

Figure 8. Detection of select pesticides from selected stations, water year 2014.—Continued

the smallest median temperature was measured at the DTPL ag stations and the largest was measured at MINING stations (fig. 5). The range in water temperature at the SPRING stations was much smaller than at any other station class.

Suspended solids and suspended sediment are measures of the solid material suspended in the water column. These two measures are not considered directly comparable because of differences in collection and analytical techniques. Suspended-solids concentrations were determined at all stations except BRMIT and BRMOH. Median suspended-solids concentrations varied considerably between all station classes, ranging from 15 to 117 milligrams per liter (mg/L; fig 5). Samples collected at the OZPL (SA fo/ag, SA wi fo/ag, and SP ag/fo), SPRING, MINING, and URBAN stations had median concentrations less than the MRL. The BRMIG station had the largest median suspended-solids concentrations. Suspended-sediment concentrations were determined only at four Big River stations (fig. 5). The suspended-sediment data used in this report consist of composited cross-sectional concentrations and average cross-sectional concentrations computed from five depth-integrated samples within the cross section (Edwards and Glysson, 1999). Additional suspended-sediment concentrations from individual depth-integrated samples within cross-sections are available on NWISWeb (http://nwis.waterdata.usgs.gov/mo/nwis/qwdata). Median suspended-sediment concentrations ranged from 142 mg/L at BRMIG to 189 mg/L at BRMOH (fig. 5).

Median *E. coli* densities ranged from 16 to 1,350 colonies per 100 milliliters of water, and fecal coliform bacteria densities ranged from 21 to 1,300 colonies per 100 milliliters of water (fig. 5). The smallest median densities were in samples collected at SPRING stations, whereas the largest median densities were in samples collected at BRMOS (fig. 5). Median *E. coli* and fecal coliform bacteria densities varied considerably between all station classes.

Distribution of Dissolved Nitrate plus Nitrite and Total Phosphorus Concentrations

Samples were collected at all stations for the analysis of nutrients, including dissolved nitrate plus nitrite and total phosphorus. Median dissolved nitrate plus nitrite and total phosphorus concentrations varied considerably between all station classes (fig. 6), ranging from 0.049 to 4.85 mg/L for nitrate plus nitrite and 0.02 to 0.38 mg/L for total phosphorus. The smallest median dissolved nitrate plus nitrite concentrations were detected at OSPL ag stations, and the largest concentrations were detected in samples collected at URBAN stations (fig. 6). The smallest median total phosphorus concentrations were detected at the OZPLSA (fo/ag and wi fo/ag) and SPRING stations, all of which had median values equal to the LT–MDL, and the largest median concentration was at the BRMIT station (fig. 6).

Distribution of Dissolved and Total Recoverable Lead and Zinc Concentrations

Samples were collected for the analysis of dissolved and total recoverable trace elements, including lead and zinc. No dissolved or total recoverable lead and zinc samples were collected at the BRMIT and BRMOH stations. Median concentration ranges were 0.04 to 0.56 micrograms per liter (µg/L) of dissolved lead, 0.08 to 9.48 µg/L of total recoverable lead, 2.0 to 9.0 µg/L of dissolved zinc, and 2.0 to 21.6 µg/L of total recoverable zinc (fig. 7).

The smallest median concentrations of dissolved lead were detected at the LT–MDL in samples collected at all classes except BRMIG, SPRING, MINING, URBAN, and URBAN wi stations; MINING had the highest median concentration (fig. 7). Median dissolved zinc concentrations were detected at the LT–MDL for all classes except MINING, URBAN, and URBAN wi; URBAN had the highest median concentration. The largest median concentrations of total recoverable lead were detected at the URBAN wi station, and the largest median concentrations of total recoverable zinc were detected at MINING stations.

Concentration and Detection Frequency of Select Pesticides from Selected Stations

Samples for the analysis of dissolved pesticides were collected at eight stations in the AWQMN, including three of the five Big River stations (BRMIG, BRMIT, and BRMOH), both stations in the MIALPL, one DTPL ag station, one OSPL wi ag station, and one URBAN station. Data from 16 compounds detected at concentrations greater than the LRL at 1 or more stations are presented graphically in this report (fig. 8). The most frequently detected pesticides were CIAT, acetochlor, atrazine, metolachlor, metribuzin, prometryn, and simazine. The concentrations for all pesticide compounds analyzed for all stations were less than 1.00 µg/L except CIAT, acetochlor, atrazine and metolachlor. The CIAT concentrations ranged from 0.007 to 1.51 µg/L, acetochlor concentrations ranged from 0.007 to 5.45 µg/L, atrazine concentrations ranged from 0.007 to 6.58 µg/L, and metolachlor concentrations ranged from 0.006 to 5.55 µg/L. Of the 16 pesticide compounds with concentrations greater than the LRL, 6 had the largest concentrations at the MIALPL stations (fig. 8).

References Cited

Barr, M.N., 2010, Quality of surface water in Missouri, water year 2009: U.S. Geological Survey Open-File Report 2010–1233, 22 p., accessed July 2015 at http://pubs.usgs.gov/of/2010/1233/.

Barr, M.N., 2011, Quality of surface water in Missouri, water year 2010: U.S. Geological Survey Data Series 636, 21 p., accessed July 2015 at http://pubs.usgs.gov/ds/636/.

Barr, M.N., 2013, Quality of surface water in Missouri, water year 2011: U.S. Geological Survey Data Series 734, 22 p., accessed July 2015 at http://pubs.usgs.gov/ds/734/.

Barr, M.N., 2014, Quality of surface water in Missouri, water year 2012: U.S. Geological Survey Data Series 818, 24 p., accessed July 2015 at http://dx.doi.org/10.3133/ds818.

Barr, M.N., and Davis, J.V., 2010, Surface-water quality conditions and long-term trends at selected sites within the ambient water-quality monitoring network in Missouri, water years 1993–2008: U.S. Geological Survey Scientific Investigations Report 2010–5078, 42 p. [Also available at http://pubs.usgs.gov/sir/2010/5078/.]

Barr, M.N., and Schneider, R.E., 2014, Quality of surface water in Missouri, water year 2013: U.S. Geological Survey Data Series 886, 21 p., accessed August 2015 at http://pubs.usgs.gov/ds/0886/.

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. [Also available at http://water.usgs.gov/owq/OFR_99-193/index.html.]

Edwards, T.K., and Glysson, G.D., 1999, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. C2, accessed August 2015 at http://pubs.usgs.gov/twri/twri3-c2/.

Fenneman, N.M., 1938, Physiography of eastern United States: New York, McGraw-Hill Book Co., Inc., 689 p.

Fishman, M.J., ed., 1993, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of inorganic and organic constituents in water and fluvial sediments: U.S. Geological Survey Open-File Report 93–125, 217 p. [Also available at http://pubs.er.usgs.gov/publication/ofr93125.]

Garbarino, J.R., Kanagy, L.K., and Cree, M.E., 2006, Determination of elements in natural-water, biota, sediment and soil samples using collision/reaction cell inductively coupled plasma-mass spectrometry: U.S. Geological Survey Techniques and Methods, book 5, chap. B1, 88 p. [Also available at http://pubs.usgs.gov/tm/2006/tm5b1/.]

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. C1, accessed July 2015 at http://pubs.usgs.gov/twri/twri5c1/.

Helsel, D.R., and Hirsch, R.M., 2002, Statistical methods in water resources: U.S. Geological Survey Techniques of Water-Resources Investigations, book 4, chap. A3, accessed July 2015 at http://pubs.usgs.gov/twri/twri4a3/.

Missouri Department of Natural Resources, 2014a, Missouri integrated water quality report and section 303(d) list, 2014: Jefferson City, Mo., Missouri Department of Natural Resources, Water Protection Program, accessed August 2015 at http://dnr.mo.gov/env/wpp/waterquality/303d/303d.htm.

Missouri Department of Natural Resources, 2014b, Water quality, chap. 7 *of* Rules of Department of Natural Resources—Division 20—Clean Water Commission: Jefferson City, Mo., Missouri Department of Natural Resources, Clean Water Commission, 151 p., accessed August 2015 at http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7a.pdf.

Myers, D.N., Stoeckel, D.M., Bushon, R.N., Francy, D.S., and Brady, A.M.G., 2014, Fecal indicator bacteria (ver. 2.1): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7, sec. 7.1, accessed May 2015 at http://pubs.water.usgs.gov/twri9A/.

National Oceanic and Atmospheric Administration, 2014a, State of the climate—National overview—Annual 2014: National Oceanic and Atmospheric Administration, National Centers for Environmental Information, accessed May 2015 at http://www.ncdc.noaa.gov/sotc/national/201413.

National Oceanic Atmospheric Administration, 2014b, Climate at a glance—Missouri climate summary: National Oceanic Atmospheric Administration, National Climatic Data Center database, accessed May 2015 at http://www.ncdc.noaa.gov/cag/.

Otero-Benitez, William, and Davis, J.V., 2009a, Quality of surface water in Missouri, water year 2007: U.S. Geological Survey Open-File Report 2009–1096, 19 p., accessed May 2015 at http://pubs.usgs.gov/of/2009/1096/.

Otero-Benitez, William, and Davis, J.V., 2009b, Quality of surface water in Missouri, water year 2008; U.S. Geological Survey Open-File Report 2009–1214, 18 p., accessed May 2015 at http://pubs.usgs.gov/of/2009/1214/.

Patton, C.J., and Truitt, E.P., 1992, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—Determination of total phosphorus by a Kjeldahl digestion method and an automated colorimetric finish that includes dialysis: U.S. Geological Survey Open-File Report 92–146, 39 p. [Also available at http://pubs.er.usgs.gov/publication/ofr92146.]

Patton, C.J., and Kryskalla, J.R., 2011, Colorimetric determination of nitrate plus nitrite in water by enzymatic reduction, automated discrete analyzer methods: U.S. Geological Survey Techniques and Methods, book 5, chap. B8, 48 p. [Also available at http://pubs.usgs.gov/tm/05b08/.]

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. [Also available at http://nwql.usgs.gov/pubs/WRIR/WRIR-01-4098.pdf.]

Sandstrom, M.W., and Wilde, F.D., 2014, Syringe-filter procedure for processing samples for analysis of organic compounds by DAI LC–MS/MS: U.S. Geological Survey Techniques of Water Resources Investigations, book 9, chap. A5 sec. 2.2.B, accessed August 2015 at http://pubs.water.usgs.gov/twri9A5/.

U.S. Census Bureau, 2015, U.S. population estimates: accessed May 2015 at http://www.census.gov/.

U.S. Environmental Protection Agency, 1997, Guidelines for preparation of the comprehensive state water quality assessments (305(b) reports) and electronic updates (1997): Washington, D.C., Office of Water, EPA–841–B97–002A, [variously paged], accessed May 2015 at http://www.epa.gov/owow/monitoring/guidelines.html.

U.S. Geological Survey, 1964–2005, Water resources data—Missouri: U.S. Geological Survey, [variously paged].

U.S. Geological Survey, 2006, Collection of water samples (ver. 2.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4, accessed May 2015 at http://pubs.water.usgs.gov/twri9A4.

U.S. Geological Survey, 2006–2010, Water resources data for the United States: Annual Water-Data Report, accessed May 2015 at http://wdr.water.usgs.gov/.

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 May 2015 at http://pubs.water.usgs.gov/twri9A.

Wilde, F.D., ed.,variously dated, Field measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, accessed May 2015 at http://pubs.water.usgs.gov/twri9A6/.

Wilde, F.D., Radtke, D.B., Gibs, Jacob, and Iwatsubo, R.T., eds., 2004, with updates through 2009, Processing of water samples (ver. 2.2): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A5, accessed May 2015 at http://pubs.water.usgs.gov/twri9A5/.

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. [Also available at http://pubs.usgs.gov/of/1995/0181/report.pdf.]

Publishing support provided by:
Rolla Publishing Service Center

For more information concerning this publication, contact:
Director, USGS Missouri Water Science Center
1400 Independence Road
Rolla, MO 65401
(573) 308–3667

Or visit the Missouri Water Science Center Web site at:
http://mo.water.usgs.gov

Barr—**Quality of Surface Water in Missouri, Water Year 2014**—Data Series 971

ISSN 2327-638X (online)
http://dx.doi.org/10.3133/ds971