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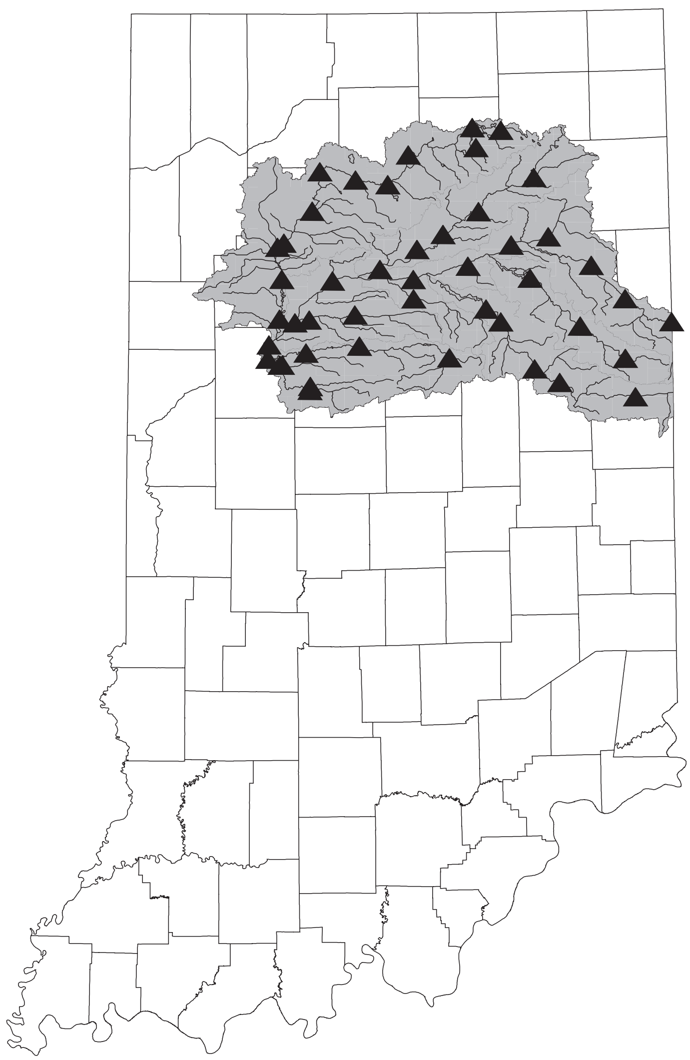
Concentrations of *Escherichia Coli* in Streams in the Upper Wabash River Watershed in Indiana, June–September 1998

Water-Resources Investigations Report 00–4021



Prepared in cooperation with the

Indiana Department of Environmental Management

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

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Concentrations of *Escherichia Coli* in Streams in the Upper Wabash River Watershed in Indiana, June–September 1998

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Abstract

Water samples collected from 46 stream sites in the Upper Wabash River Watershed from June through September 1998 were analyzed for concentrations of the bacteria *Escherichia coli (E. coli)*. Each site was sampled five times in a 30-day period. Twenty-one sites were sampled during June and July, and 25 sites were sampled during August and September. The concentration of *E. coli* in 145 of the 230 samples collected exceeded the Indiana standard of 235 colonies per 100 milliliters for a single sample for waters used for recreation. A five-sample geometric mean also was computed for each site. Concentrations in samples from 43 of the 46 sites exceeded the Indiana bacteriological quality standard of 125 colonies per 100 milliliters for a five-sample geometric mean for waters used for recreation.

Discharge during sample collection generally was greater than the long-term median daily mean discharge. To determine if the greater discharge affected the concentrations of *E. coli*, additional samples were collected at two sites. Statistically significant positive correlations between concentrations of *E. coli* and discharge were determined for these sites, indicating increased concentrations with greater discharge.

Introduction

The Indiana Department of Environmental Management (IDEM) is responsible for monitoring the quality of Indiana's waters. IDEM monitors watersheds on a rotating basis and selected the Upper Wabash River Watershed for monitoring during 1998. As part of this effort, IDEM entered into a cooperative program with the U.S. Geological Survey (USGS) to measure concentrations of the bacteria *Escherichia coli* (*E. coli*) at 46 stream sites in the Upper Wabash River Watershed from June through September 1998.

The presence of *E. coli* in water is direct evidence of the presence of fecal contamination from warm-blooded animals and indicates the possible presence of pathogens (Myers and Sylvester, 1997). *E. coli* is one of the two preferred indicator bacteria used by the U.S. Environmental Protection Agency (USEPA) to determine the suitability of surface waters for recreational use. The water-quality standards for *E. coli* in recreational waters in Indiana require the concentration of *E. coli* to be less than a single-sample standard or less than the geometric mean computed from five samples collected within a 30-day period (Oddi, 1995).

Purpose and Scope

This report documents the concentrations of *E. coli* measured in samples from selected streams in the Upper Wabash River Watershed from June through September 1998. The report describes the relation between concentrations of *E. coli* and streamflow at sites where streamflow records were available and presents the quality-assurance data for the *E. coli* samples. Field measurements of water temperature, pH, dissolved oxygen, specific conductance, and turbidity also are presented.

Description of the Study Area

The part of the Upper Wabash River Watershed that was sampled extends from the Indiana-Ohio state line downstream to include Wildcat Creek near Lafayette, Ind. (fig. 1). The watershed drains 6,918 mi^2 in Indiana and 285 mi^2 in Ohio, for a total of 7,203 mi^2 (Hoggatt, 1975). The predominant land use in the watershed is agricultural (row crop and pasture).

The Upper Wabash River Watershed lies within two distinct physiographic areas (Schneider, 1996)—the Northern Moraine and Lake Region, located north of the Eel River, and the Tipton Till Plain, located predominantly south of the Eel River. The land surface generally is flat to gently undulating, poorly drained, and featureless.

Three principal reservoirs in the basin were built as flood-control structures and have a dual role as recreational water bodies. They are Huntington, Salamonie, and Mississinewa Lakes. Major tributaries to the Wabash River in the study area include the Little, Salamonie, Mississinewa, Eel, and Tippecanoe Rivers, and Pipe, Deer, and Wildcat Creeks.

Selection of Sampling Sites

Sampling-site locations initially were selected by IDEM personnel. Responses from a 1987 poll of local health officials, conservation officers, and sheriff's departments regarding known areas of stream recreational uses were used to provide a core list of potential sampling sites. Additional sites then were added for spatial coverage and (or) positioning of sites at existing USGS streamflow-gaging stations. Site locations were plotted on topographic maps and verified in the field by USGS personnel prior to initiating sample collection during June 1998. Where sampling conditions were unsafe or where site characteristics interfered with the samplers' ability to collect a sample, the site was relocated as close to the initial site as possible. Changes to sampling-site locations were agreed upon by USGS and IDEM personnel.

The 46 sampling sites selected were divided into two groups so that all sites could be sampled five times at equally spaced intervals within a 30-day period. Eight additional samples were collected weekly from July 27 to September 9, 1998, at sites 2 and 15. Figure 2 shows the locations of the sampling sites. Table 1 lists the Group 1 sites (sites 1 through 21) that were sampled during June and July 1998. Table 2 lists the Group 2 sites (sites 22 through 46) that were sampled during August and September 1998.

Methods of Sampling

Water samples were collected during the recreational season in Indiana, defined as April through October. The samples usually were collected by two-person field crews to expedite the sampling process and meet the mandated 6-hour sample-holding-time limit prior to processing the samples. Duties at the sampling sites included completing the field forms, measuring and recording water-surface-elevation data, documenting site characteristics at the time of sampling, measuring and recording field parameters, inspecting the streamflow-gaging station if one were present, and collecting the samples.

Field Measurements

A multi-parameter water-quality measuring meter was used to make field measurements of water temperature, dissolved oxygen, pH, and specific conductance at several locations across the width of the stream. The meter was calibrated daily for dissolved oxygen, pH, and specific conductance before any field measurements were made. Field determinations of turbidity were made by collecting samples of surface water in polyethylene bottles and analyzing the samples with a portable turbidimeter. The measuring range of the portable turbidimeter was checked daily with reference standards. If parameters measured in the field did

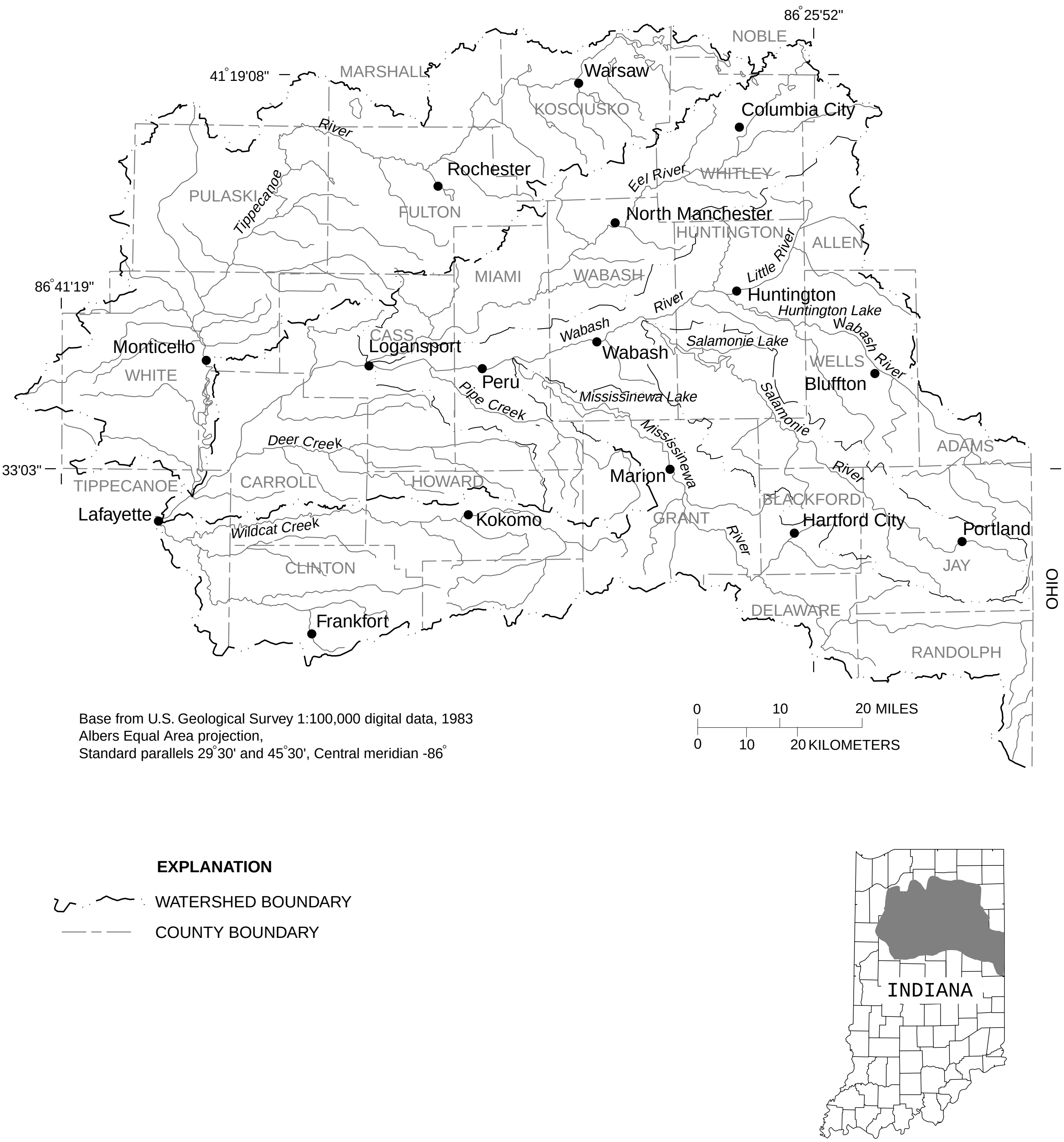


Figure 1. Location and principal streams of the Upper Wabash River Watershed in Indiana.

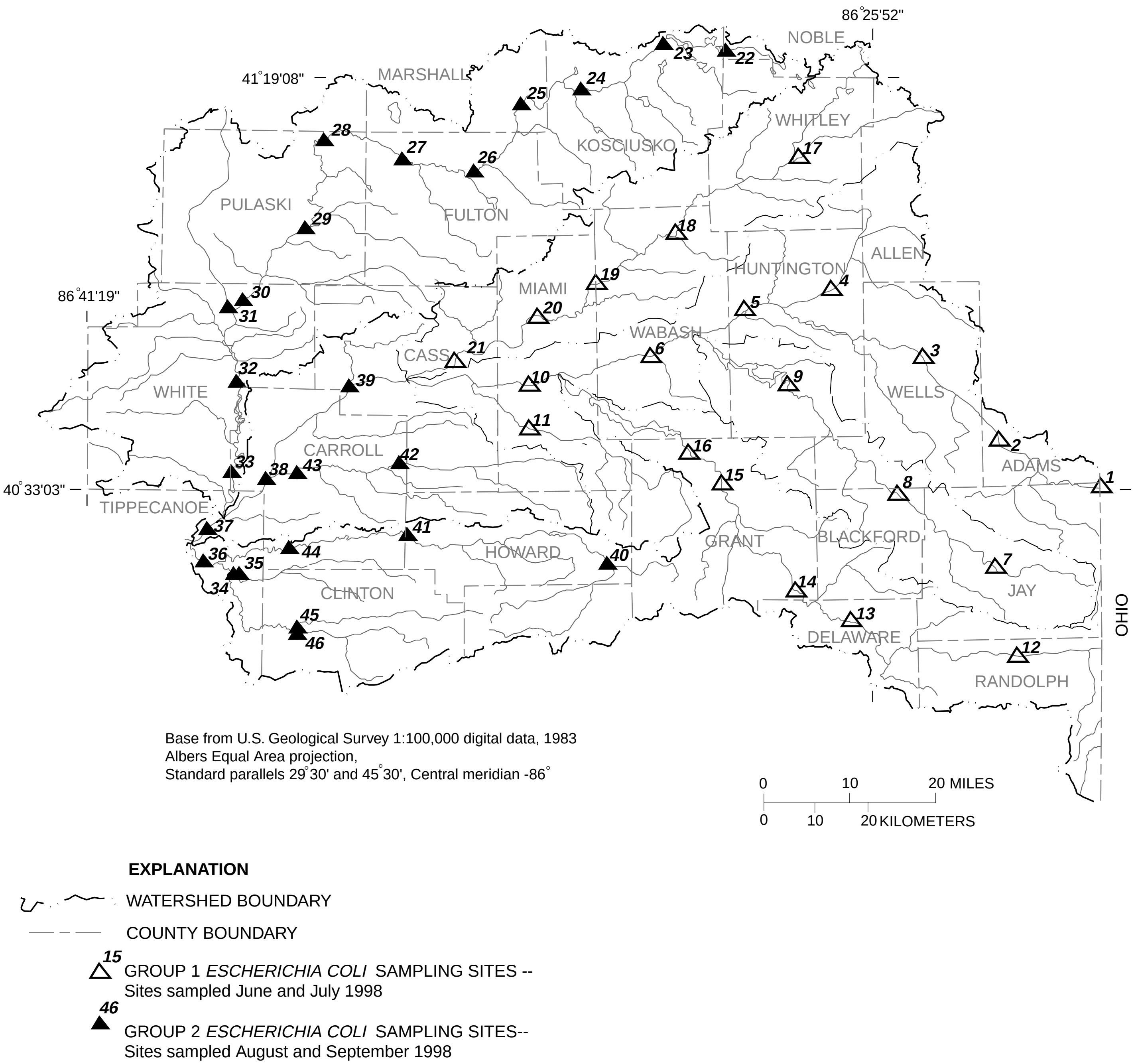


Figure 2. Location of *Escherichia coli* sampling sites within the Upper Wabash River Watershed in Indiana.

Table 1. Sites at which water samples were collected during June and July 1998 (Group 1 sites) for analysis of *Escherichia coli*, Upper Wabash River Watershed in Indiana

[USGS, U.S. Geological Survey; SR, State Road; CR, County Road; E, W, N, and S denote the geographic directions of east, west, north, and south]

Site number	Site location	USGS site identification	Latitude and longitude		County
1	Wabash River at State Line Road	03322500	40°33′50″	84°48′10″	Jay
2	Wabash River at SR 218 at Linn Grove	03322900	40°39′22″	85°01′58″	Adams
3	Wabash River at CR 300N near Bluffton	404709085120001	40°47′09″	85°12′00″	Wells
4	Little River at CR 200E near Huntington	405354085244701	40°53′54″	85°24′47″	Huntington
5	Wabash River at SR 105 near Andrews	405208085360601	40°52′08″	85°36′06″	Huntington
6	Wabash River at Wabash	03325000	40°47′25″	85°49′13″	Wabash
7	Salamonie River at CR 75S near Portland	03324200	40°25′40″	85°02′20″	Jay
8	Salamonie River at SR 18 at Matamoras	403316085154201	40°33′16″	85°15′42″	Blackford
9	Salamonie River at SR 124 near Lancaster	404430085303201	40°44′30″	85°30′32″	Huntington
10	Wabash River at Broadway Street at Peru	404432086054801	40°44’32″	86°05′48″	Miami
11	Pipe Creek at CR 125W near Bunker Hill	03327520	40°40′06″	86°05′44″	Miami
12	Mississinewa River at CR 100W near Ridgeville	03325500	40°16′48″	84°59′33″	Randolph
13	Mississinewa River near Walnut Road near Eaton	402026085221001	40°20′26″	85°22′10″	Delaware
14	Mississinewa River at CR 950E near Matthews	402339085293601	40°23′39″	85°29′36″	Grant
15	Mississinewa River at Highland Avenue at Marion	03326500	40°34′34″	85°39′34″	Grant
16	Mississinewa River at CR 500N at Jalapa	403732085435601	40°37′32″	85°43′56″	Grant
17	Eel River at SR 9 near Columbia City	410733085285201	41°07′33″	85°28′52″	Whitley
18	Eel River at SR 14 at North Manchester	03328000	40°59′55″	85°45′50″	Wabash
19	Eel River at SR 16 near Roann	405448085563901	40°54′48″	85°56′39″	Miami
20	Eel River at Meridian Road near Denver	405125086043301	40°51′25″	86°04′33″	Miami
21	Eel River at Adamsboro Road near Logansport	03328500	40°46′55″	86°15′50″	Cass

Table 2. Sites at which water samples were collected during August and September 1998 (Group 2 sites) for analysis of *Escherichia coli*, Upper Wabash River Watershed in Indiana

[USGS, U.S. Geological Survey; SR, State Road; CR, County Road; E, W, and N denote the geographic directions of east, west, and north]

Site number	Site location	USGS site identification	Latitude	and longitude	County
22	Tippecanoe River at SR 5 at Wilmot	411832085383901	41°18′32″	85°38′39″	Noble
23	Tippecanoe River at Oswego	03330500	41°19′14″	85°47′21″	Kosciusko
24	Tippecanoe River at CR 700W near Atwood	411438085462001	41°14′38″	85°46′20″	Kosciusko
25	Tippecanoe River at SR 331 near Old Tip Town	411308086065401	41°13′08″	86°06′54″	Marshall
26	Tippecanoe River at Old US 31 near Rochester	410620086131301	41°06′20″	86°13′13″	Fulton
27	Tippecanoe River at Leiter’s Ford	410730086225901	41°07′30″	86°22′59″	Fulton
28	Tippecanoe River at CR 200E near Ora	03331500	41°09′26″	86°33′49″	Pulaski
29	Tippecanoe River at SR 119 near Winamac	410023086361001	41°00′23″	86°36′10″	Pulaski
30	Tippecanoe River at Buffalo	03332345	40°53′05″	86°44′49″	White
31	Big Monon Ditch at SR 16 near Buffalo	405208086464401	40°52′08″	86°46′44″	White
32	Tippecanoe River at SR 24 at Monticello	404446086452701	40°44′46″	86°45′27″	White
33	Tippecanoe River at SR 18 near Delphi	03333050	40°35′38″	86°46′12″	Carroll
34	Middle Fork Wildcat Creek at CR 775E	402505086452301	40°25′05″	86°45′23″	Tippecanoe
35	South Fork Wildcat Creek at SR 26 near Lafayette	03334500	40°25′04″	86°46′05″	Tippecanoe
36	Wildcat Creek at CR 2A near Lafayette	03335000	40°26′26″	86°49′45″	Tippecanoe
37	Wabash River at SR 225 near Battleground	402943086492301	40°29′43″	86°49′23″	Tippecanoe
38	Wabash River at CR 200N near Delphi	403448086413401	40°34′48″	86°41′34″	Carroll
39	Wabash River at CR 675W near Georgetown	404420086301001	40°44′20″	86°30′10″	Cass
40	Wildcat Creek at CR 1100E near Jerome	03333450	40°26′29″	85°55′08″	Howard
41	Wildcat Creek at SR 22 near Burlington	402920086221201	40°29′20″	86°22′12″	Howard
42	Deer Creek at SR 29 at Deer Creek	403630086232801	40°36′30″	86°23′28″	Carroll
43	Deer Creek at CR 300N near Delphi	03329700	40°35′25″	86°37′15″	Carroll
44	Wildcat Creek at SR 39 at Owasco	03334000	40°27′50″	86°38′15″	Carroll
45	Kilmore Creek at CR 600W near Hamilton	402009086370001	40°20′09″	86°37′00″	Clinton
46	South Fork Wildcat Creek near Hamilton	03334230	40°19′15″	86°37′06″	Clinton

not appear stable or have reasonable values, the measuring meter was recalibrated at the site and field parameters were remeasured.

Collection of Samples

Water samples for *E. coli* determinations were collected in 300-mL (milliliter) glass bottles with glass stoppers. Prior to use, the bottles were washed with detergent, rinsed three times with hot water and three times with deionized water, and sterilized by autoclaving. To ensure optimum growing conditions for *E. coli,* two solutions were added to each bacteria-sample bottle before the bottle was sterilized. A 10-percent solution of sodium thiosulfate was added to counter the effects of residual chlorine or other halogens used in water-disinfection processes. Residual chlorine and other halogen compounds act as bacterial-growth inhibitors; their effects need to be reduced so that the *E. coli* can be recovered fully on growth medium and produce accurate counts (Bordner and Winter, 1978; American Public Health Association and others, 1992). In addition, a 15-percent solution of ethylenediaminetetraacetic acid (EDTA) was added to neutralize the effects of trace-element concentrations greater than 10 µg/L (micrograms per liter). EDTA, a chelating agent, binds particularly with copper and zinc, making the metals neutral so that they do not adversely affect bacterial growth (Britton and Greeson, 1989, p. 5–6; Bordner and Winter, 1978; American Public Health Association and others, 1992).

In the field, a weighted hand-line sampler, which held the sample bottle, was lowered beneath the surface of the water in the center of flow. Some samples were collected by immersing the bottles by hand when the stream was too shallow for the hand-line sampler. At each site, a sample was a composite of water from one to six well-mixed areas of flow, depending on the width of the stream. The samples were kept chilled until processing.

Processing of Samples

Equipment used to process the samples was washed with detergent prior to field work, rinsed three times with tap water and three times with deionized water, and then sterilized with an 8-watt ultraviolet (UV) lamp with a wave length of 254 nanometers for a minimum of 15 minutes. Processing equipment included a UV sterilization chamber, a multi-port manifold filter stand, stainless-steel filter holders, pumps, sterile disposable pipets, glass graduated cylinders, refrigeration units, and incubators. At least two aluminum-block incubators capable of maintaining temperatures of 35.0°C and 44.5°C were used to provide optimum conditions for bacterial growth.

The *E. coli* substrate medium kit, prepared by the USGS Quality of Water Services Unit (QWSU) in Ocala, Fla., according to USEPA Method 1103.1, (Bordner and others, eds., 1978) was used to prepare the membrane-filter thermotolerant *E. coli* media (mTec) agar. The mTec agar was prepared in the USGS Indiana District laboratory for use in the field. The 2-week holding time for mTec agar, once it was prepared, was monitored in the laboratory and field. Urea/Phenol Red reagent, also included in the kit, was prepared in the field and used to confirm the presence of *E. coli* colonies.

The samples collected for analysis of *E. coli* were processed either in the field in hotel rooms or in the USGS laboratory in Indianapolis. Surfaces on which the samples were processed were cleaned with isopropyl alcohol before the first sample was processed each day, between samples, and after the last sample was processed each day. Sample handlers washed their hands with bactericidal soap before processing the first sample, between samples, and after processing the last sample.

Sample dilutions were made by adding 11 mL of sample water to 99 mL of sterile dilution water for a 1:10 ratio and 1 mL of sample water to another 99 mL of sterile dilution water for a 1:100 dilution. Five to eight different sample volumes, including one to three different dilutions, were filtered for each site to obtain at least one sample volume that represented the ideal colony count of 20 to 80 colonies per filter plate (Myers and Sylvester, 1997).

Sterile, disposable 1- and 10-mL glass pipets were used to measure and deliver concentrated sample volumes to dilution bottles and to measure and deliver dilution volumes to the interior of the funnel filter assembly. For sample dilution volumes less than 10 mL, about 20 mL of sterile saline buffer solution was poured into the funnel before pipetting the sample dilution to evenly distribute the bacteria on the filter. A sterile graduated cylinder was used to transfer sample dilution volumes greater than 10 mL. Samples were shaken vigorously before each sample dilution volume was withdrawn. A three-port manifold with funnels or a single-use stainless-steel filter system was used to support a 0.45-µm (micrometer) filter. The water was pulled through the filter either by a vacuum pump set not to exceed 5 lb/in^2 (pounds per square inch) of pressure or by a hand-vacuum assembly. After filtering each of the sample dilution volumes, 20 to 30 mL of sterile saline buffer solution were used to flush the sides of the funnel to ensure that any bacteria present on the funnel walls were rinsed onto the filter. The graduated cylinders used to measure and deliver sample dilution volumes to the funnel also were rinsed with sterile saline buffer solution, and the rinsate was processed through the filter.

Petri dishes were labeled prior to processing the sample. Concentrated sample and sample dilutions were filtered from smallest to largest. The filters then were placed in petri dishes with the mTec agar and placed inverted in a pre-heated incubator set at 35.0°C for 1.75 to 2 hours, removed, and then placed in a pre-heated incubator set at 44.5°C for 22 to 24 hours. After the second incubation period was completed, the filter was transferred to a filter pad saturated with Urea/Phenol Red reagent. After 15 to 20 minutes at room temperature, only the yellow to yellow-brown *E. coli* colonies were counted. If the filter plate had a colony count in the ideal range, verification of the count was made either by the second crew member or by rotating the filter 90 degrees and the same crew member recounting the colonies. If more than one dilution were within the ideal colony count, the concentration of *E. coli* was computed as the sum of the colony counts for each sample volume, multiplied by 100, and divided by the sum of the dilution volumes. The same calculation was used if none of the dilutions had concentrations of *E. coli* within the ideal colony count, and the result is reported as an estimate. (A "K" before the value indicates that the values are estimated from non-ideal colony counts.) Concentrations of *E. coli* were calculated according to the methods described by Myers and Sylvester (1997) and recorded on the field sheet for each site. Concentrations of *E. coli* are reported in whole numbers for results less than 10, and two significant figures are reported for results greater than or equal to 10 (Myers and Wilde, 1997). After being counted, *E. coli* petri dishes were sterilized with chlorine bleach, placed in sealed plastic bags, and disposed.

Concentrations of *Escherichia Coli*

The Indiana environmental rules establish the bacteriological quality standard for waters for recreational uses (Oddi, 1995, 327 IAC 2-1-6 [d]). These rules are used to evaluate waters for full-body-contact recreational uses, to establish wastewater-treatment requirements, and to establish effluent limits during the recreational season, which is defined as the months of April through October. The standard states that:

> *E. coli* bacteria, using membrane filter (MF) count, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period.

Table 3, at the back of the report, lists field measurements and concentrations of *E. coli* for all 46 sites. The five-sample geometric mean is shown below the last collection date for each site. Figure 3 shows the range of concentrations of *E. coli* for the five samples collected at each site, and figure 4 shows the five-sample geometric-mean concentration computed for each site.

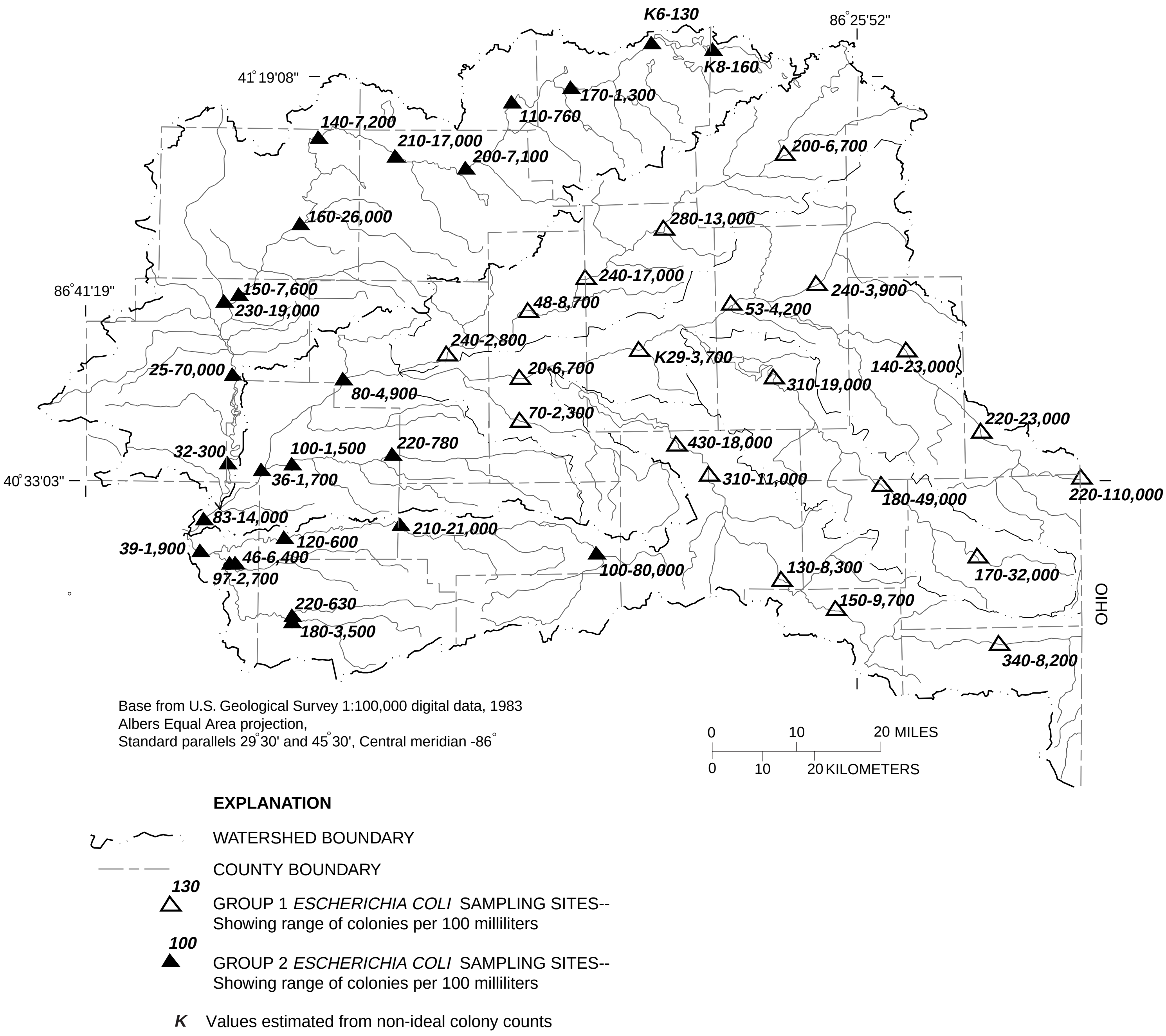


Figure 3. Ranges in concentrations of *Escherichia coli* for each site in the Upper Wabash River Watershed in Indiana, June-September 1998.

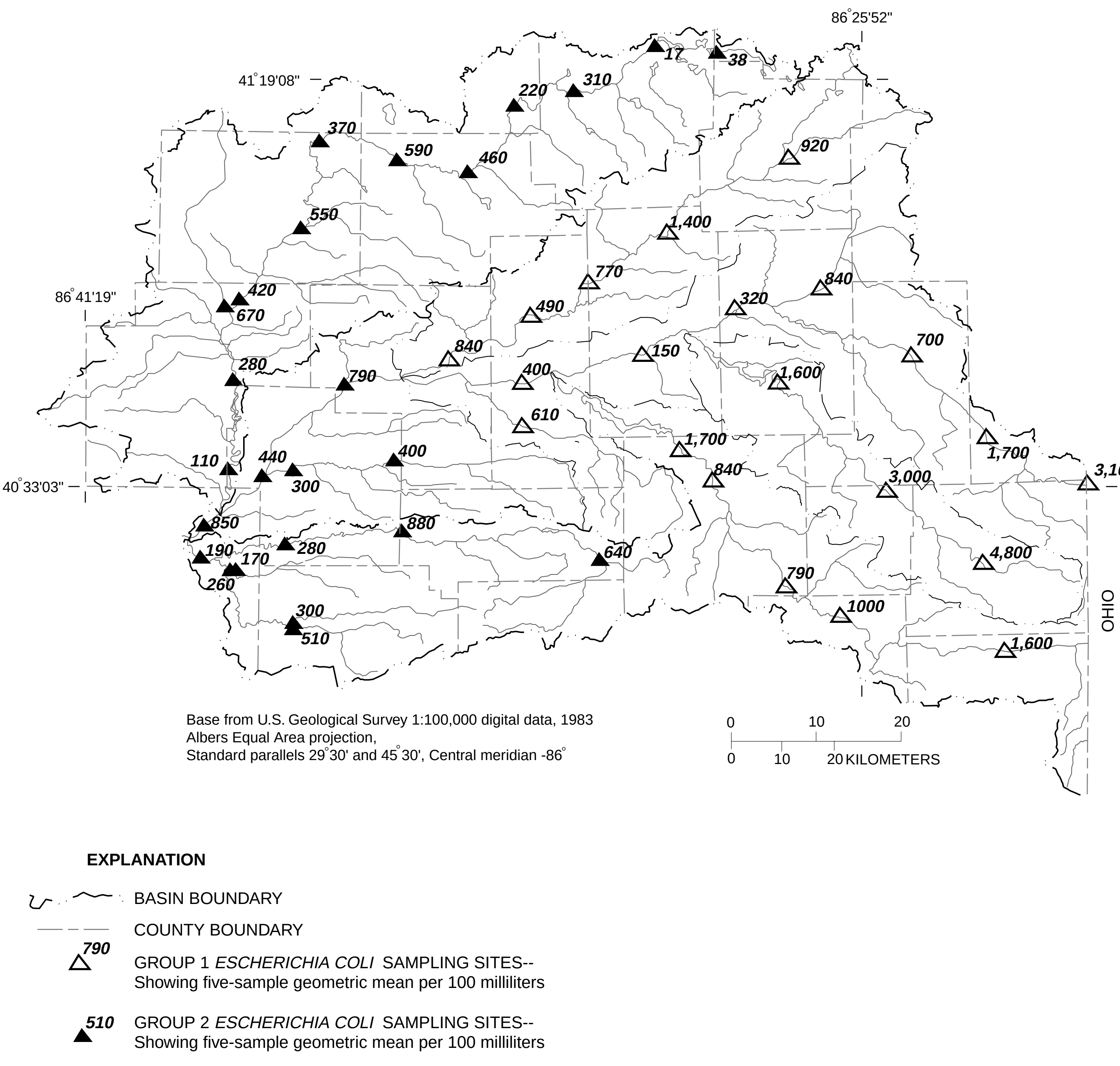


Figure 4. Five-sample geometric mean *Escherichia coli* concentration computed for each site in the Upper Wabash River Watershed in Indiana, June-September 1998.

The five-sample geometric mean of concentrations of *E. coli* for all sites ranged from 17 to 4,800 colonies per 100 mL, and the concentrations in samples from 43 sites exceeded the five-sample geometric-mean standard. Concentrations of *E. coli* at all 46 sites ranged from an estimated 6 to 110,000 colonies per 100 mL, with concentrations in 145 of the 230 samples processed exceeding the single-sample standard. At the three sites where concentrations did not exceed the five-sample geometric-mean standard, only one sample had a concentration that exceeded the single-sample standard.

Figure 5 shows the concentration of *E. coli* at sampling sites in the watershed. Sites are grouped by location along the Wabash, Salamonie, Mississinewa, Eel, and Tippecanoe Rivers, Wildcat Creek, and by other tributaries. Concentrations of *E. coli* at all nine sites along the Wabash River exceeded the standard for the five-sample geometric mean, and concentrations for 28 of the 45 samples processed from those sites exceeded the standard for a single sample. Concentrations of *E. coli* at the Wabash River sites ranged from 20 to 110,000 colonies per 100 mL, and the five-sample geometric mean ranged from 150 to 3,100 colonies per 100 mL.

Thirty-five samples from eight sites on the Salamonie and Mississinewa Rivers had concentrations of *E. coli* that exceeded the single-sample standard. Concentrations of *E. coli* in samples from sites on the Salamonie River ranged from 170 to 49,000 colonies per 100 mL and from 130 to 19,000 colonies per 100 mL in samples from sites on the Mississinewa River. Concentrations at all sites on the Salamonie and Mississinewa Rivers exceeded the standard for the five-sample geometric mean. For the Eel River, 23 samples from five sites had concentrations that exceeded the single-sample standard, and concentrations at all sites exceeded the five-sample geometric-mean standard. Concentrations of *E. coli* in samples from the Eel River ranged from 48 to 17,000 colonies per 100 mL, and the five-sample geometric mean ranged from 490 to 1,400 colonies per 100 mL.

At 8 of the 11 sites on the Tippecanoe River, concentrations of *E. coli* exceeded the standard for the five-sample geometric mean. Concentrations of *E. coli* in samples from the Tippecanoe River sites ranged from an estimated 6 to 70,000 colonies per 100 mL, and the five-sample geometric mean ranged from 17 to 670 colonies per 100 mL. Only sites 22, 23, and 33 had five-sample geometric-mean concentrations that did not exceed the standard. No samples from sites 22 and 23 had concentrations that exceeded the standard for a single sample, and site 33 had one sample that exceeded the standard.

Stream discharges presented in this report were taken from data collected at USGS streamflow-gaging stations located at or near the sampling sites. Figure 6 shows the relation of concentrations of *E. coli* to discharge for sampling sites in the Upper Wabash River Watershed where stage-discharge relations have been developed. During sampling of the Group 1 sites, most of the samples were collected at discharges greater than the long-term median daily mean discharge (Stewart and others, 1999). Seventeen of the 46 sites were at USGS streamflow-gaging stations. Based on records of streamflow from these stations, 62 percent of the samples collected at these sites were collected at discharges above the long-term median daily mean discharge (Stewart and others, 1999). Group 1 sites included nine streamflow-gaging stations, at which 69 percent of the samples were collected at discharges above the long-term median daily mean discharge. Group 2 sites included eight streamflow-gaging stations, at which 55 percent of the samples were collected at discharges above the long-term median daily mean discharge.

Eight additional samples were collected at sites 2 and 15 from July 22 to September 9, 1998, to examine further the effect of variations in flow conditions on the concentrations of *E. coli*. Figure 6 and table 4, at the back of this report, display the results for these two sites. A Kendall's Tau test for significant correlation indicated that at both sites, the correlation between discharge and concentration of *E. coli* was statistically significant. For both sites, the slope was positive, indicating increased concentrations of *E. coli* with greater discharge. The plots for sites 2 and 15 (fig. 6) list the probability of obtaining a correlation coefficient between

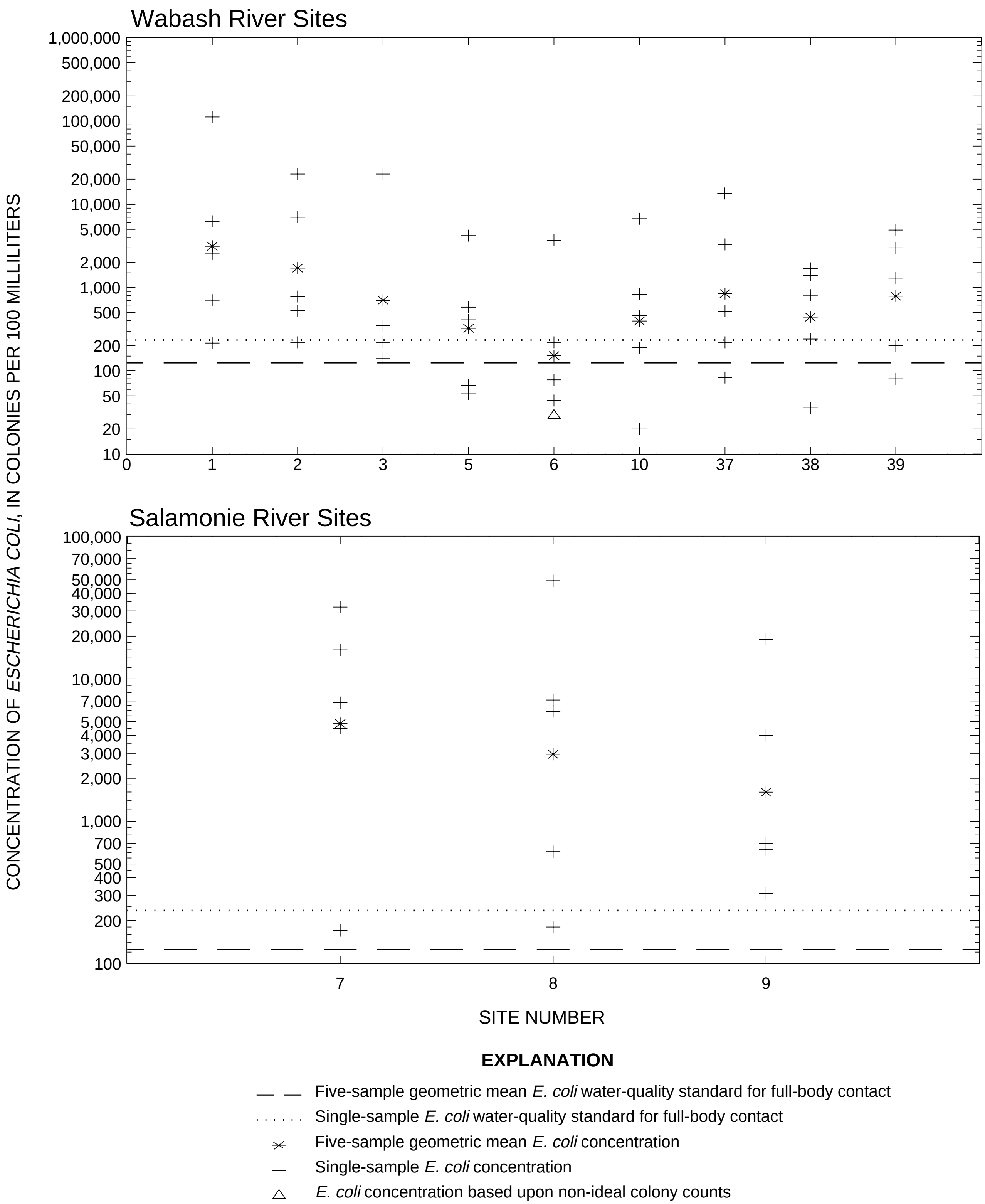


Figure 5. Concentrations of *Escherichia coli* (*E. coli*) and five-sample geometric means for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998.

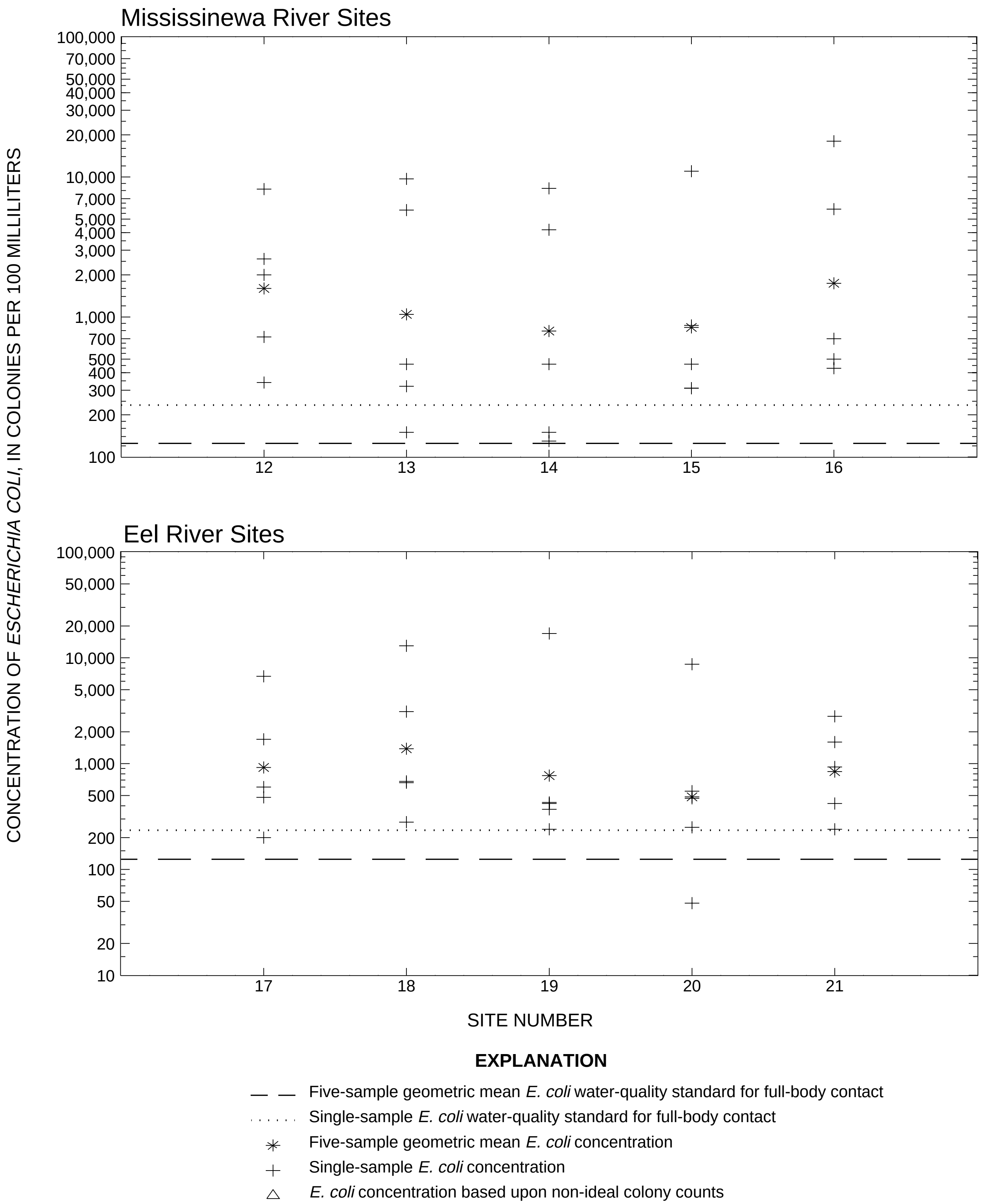
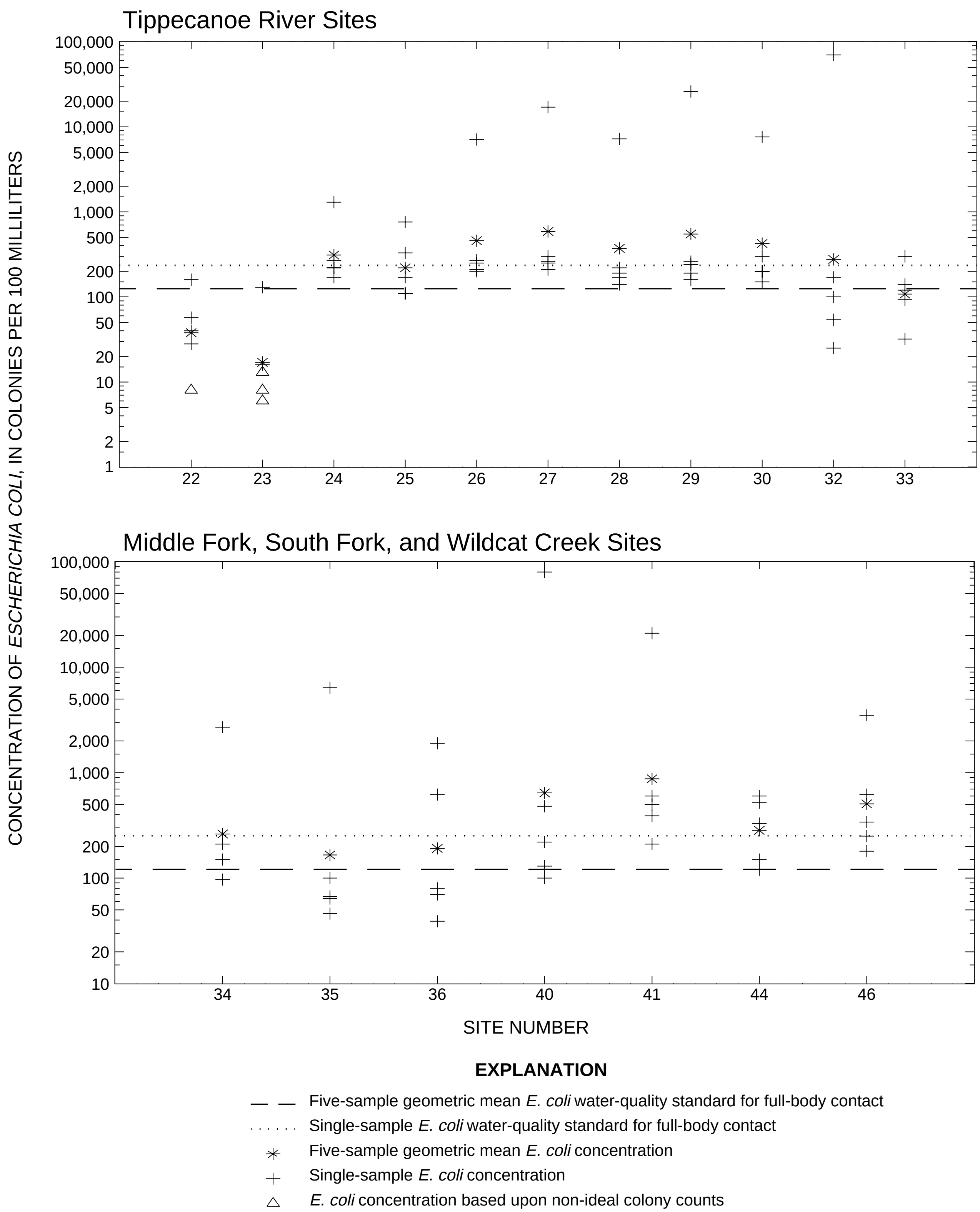


Figure 5. Concentrations of *Escherichia coli* (*E. coli*) and five-sample geometric means for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.



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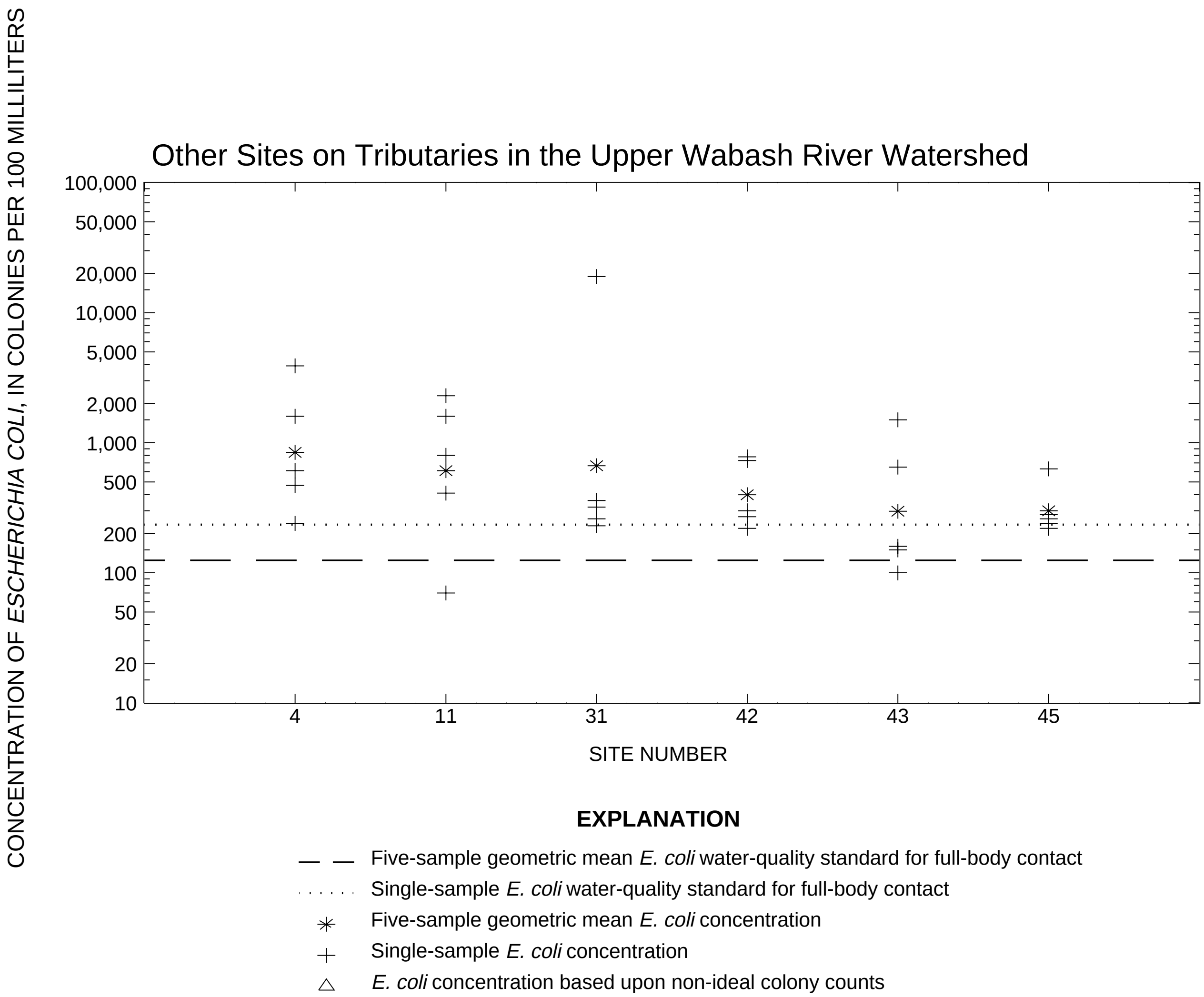

Figure 5. Concentrations of *Escherichia coli* (*E. coli*) and five-sample geometric means for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.

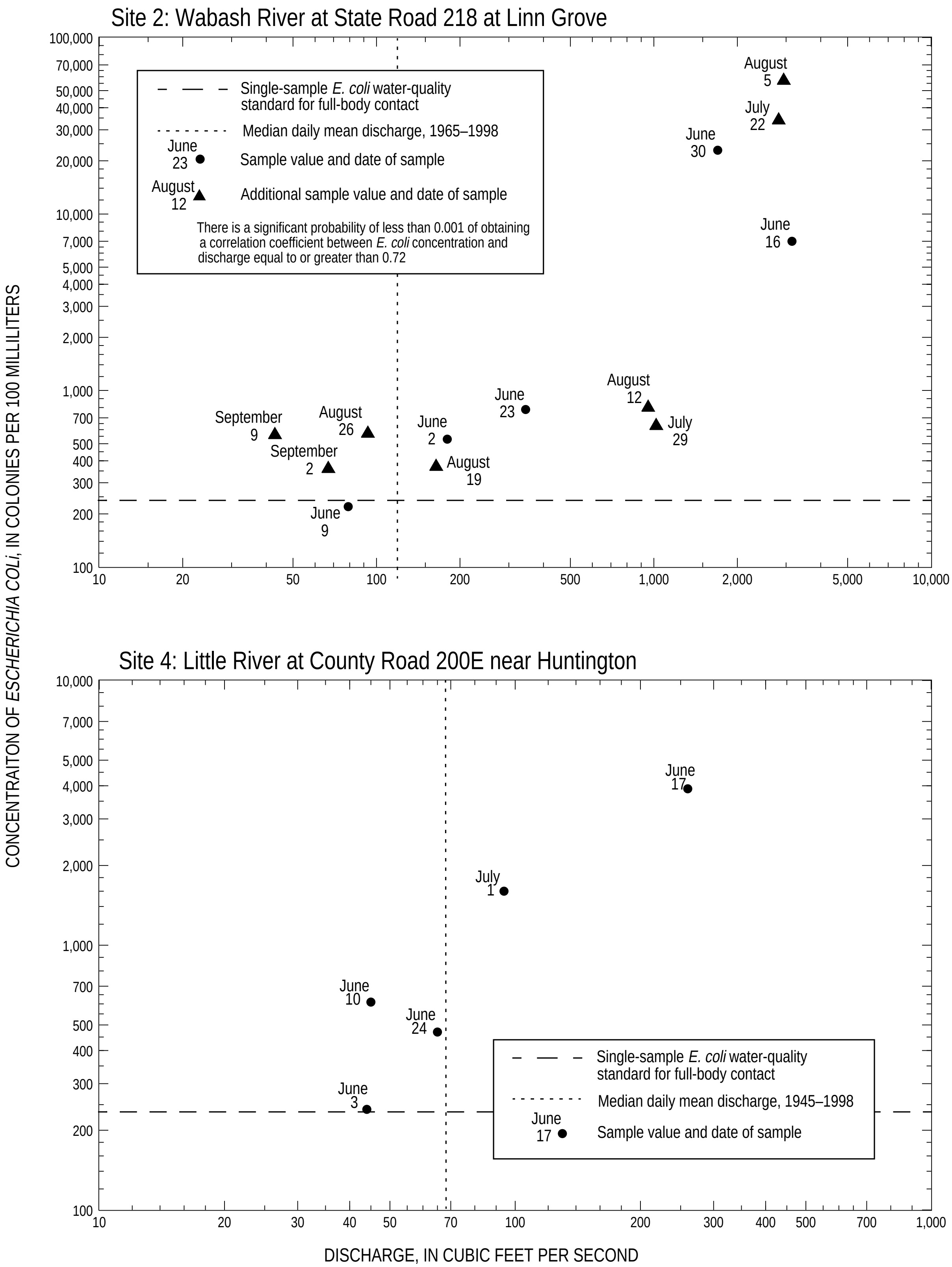

Figure 6. Stream discharge and concentrations of *Escherichia coli* at selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998.

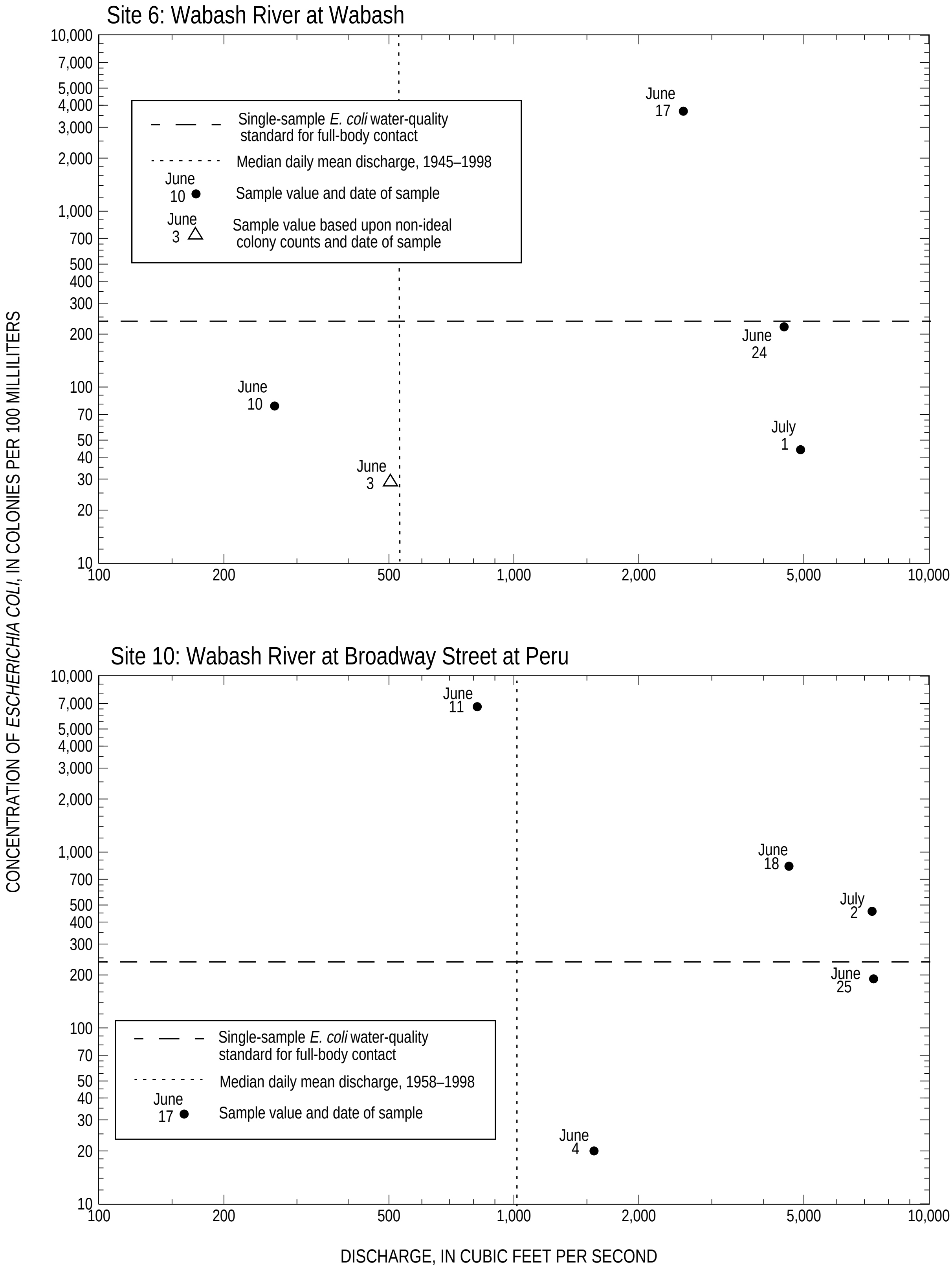

Figure 6. Stream discharge and concentrations of *Escherichia coli* at selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.

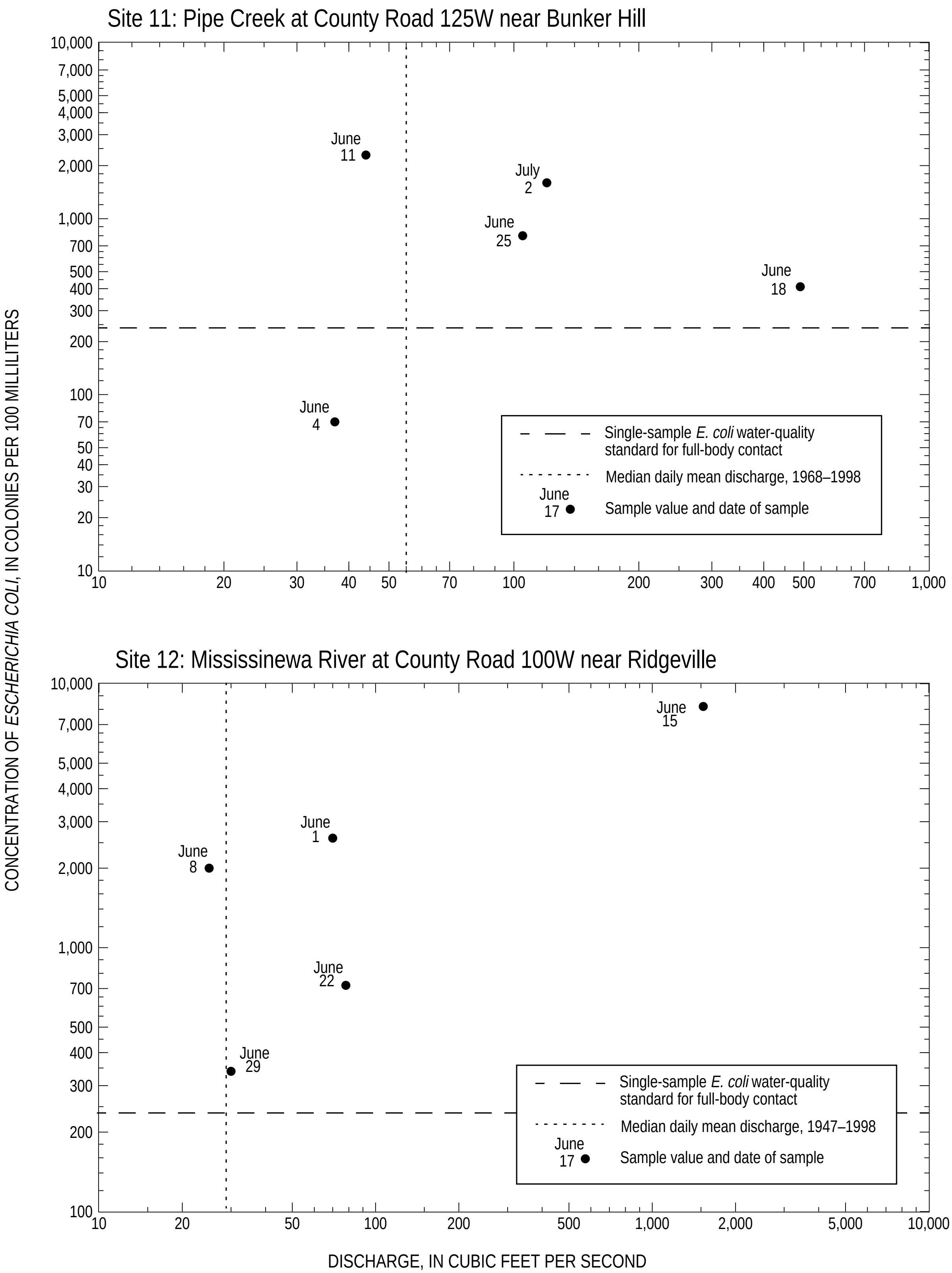

Figure 6. Stream discharge and concentrations of *Escherichia coli* at selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.

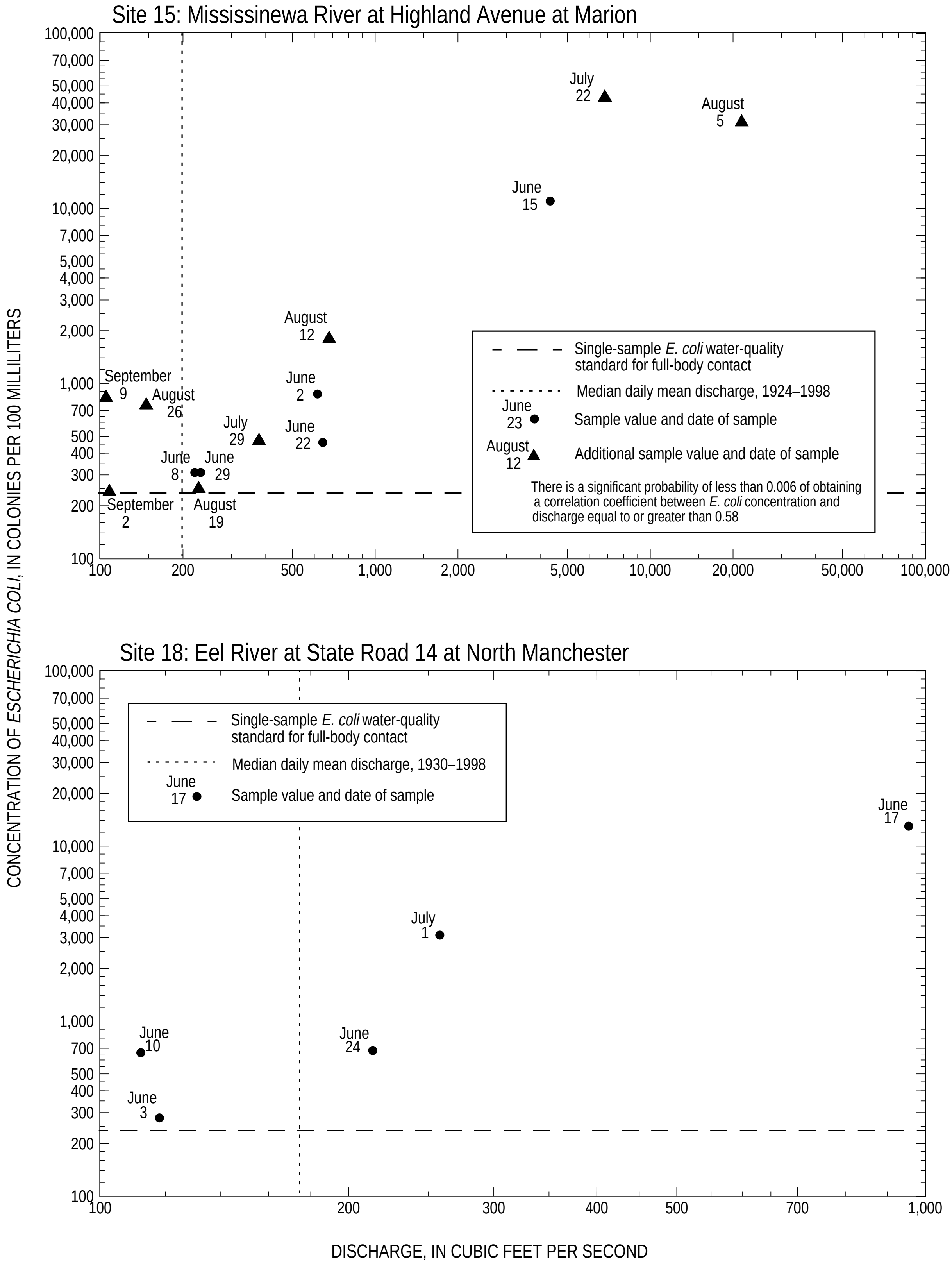

Figure 6. Stream discharge and concentrations of *Escherichia coli* at selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.

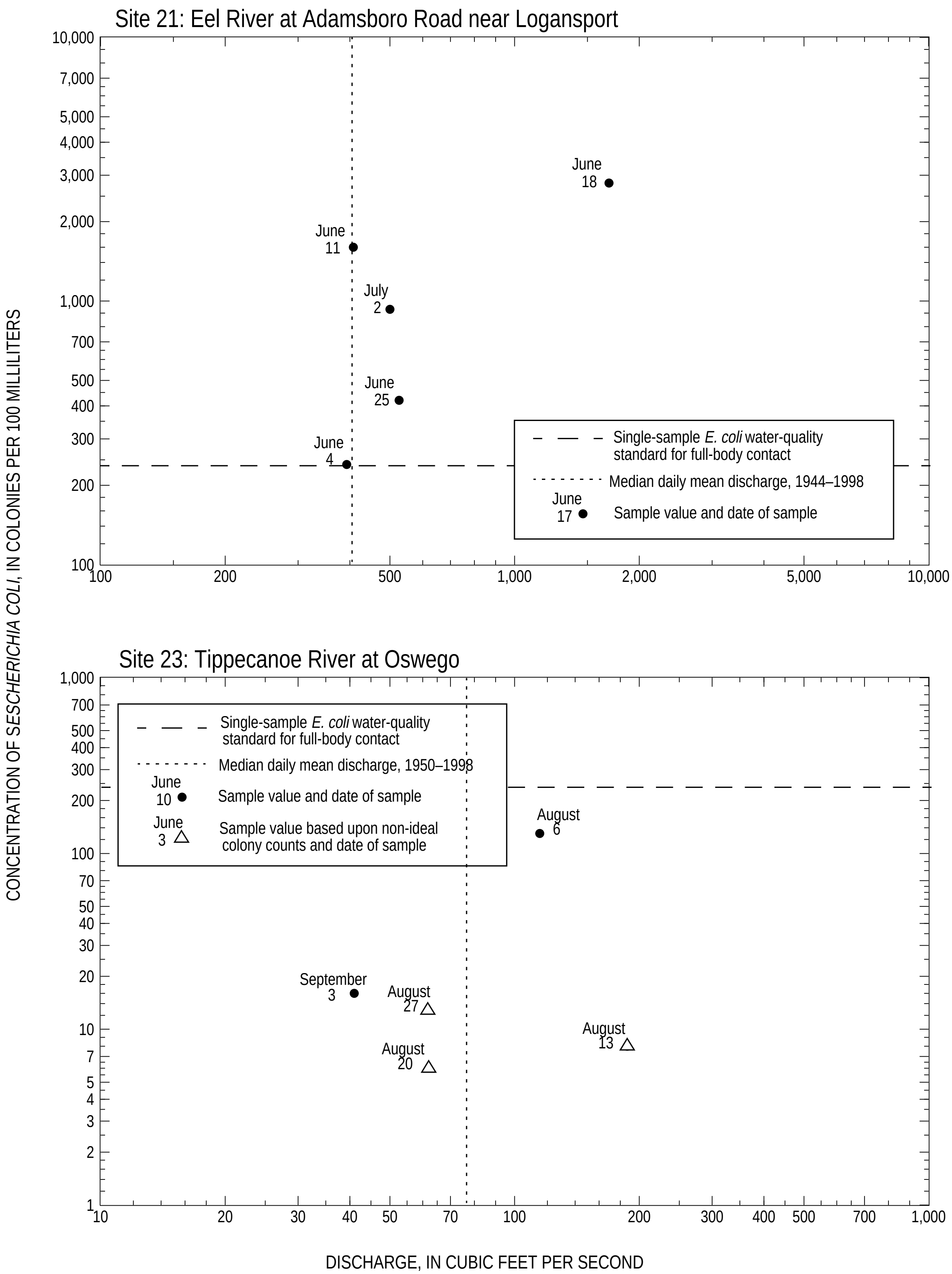

Figure 6. Stream discharge and concentrations of *Escherichia coli* at selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.

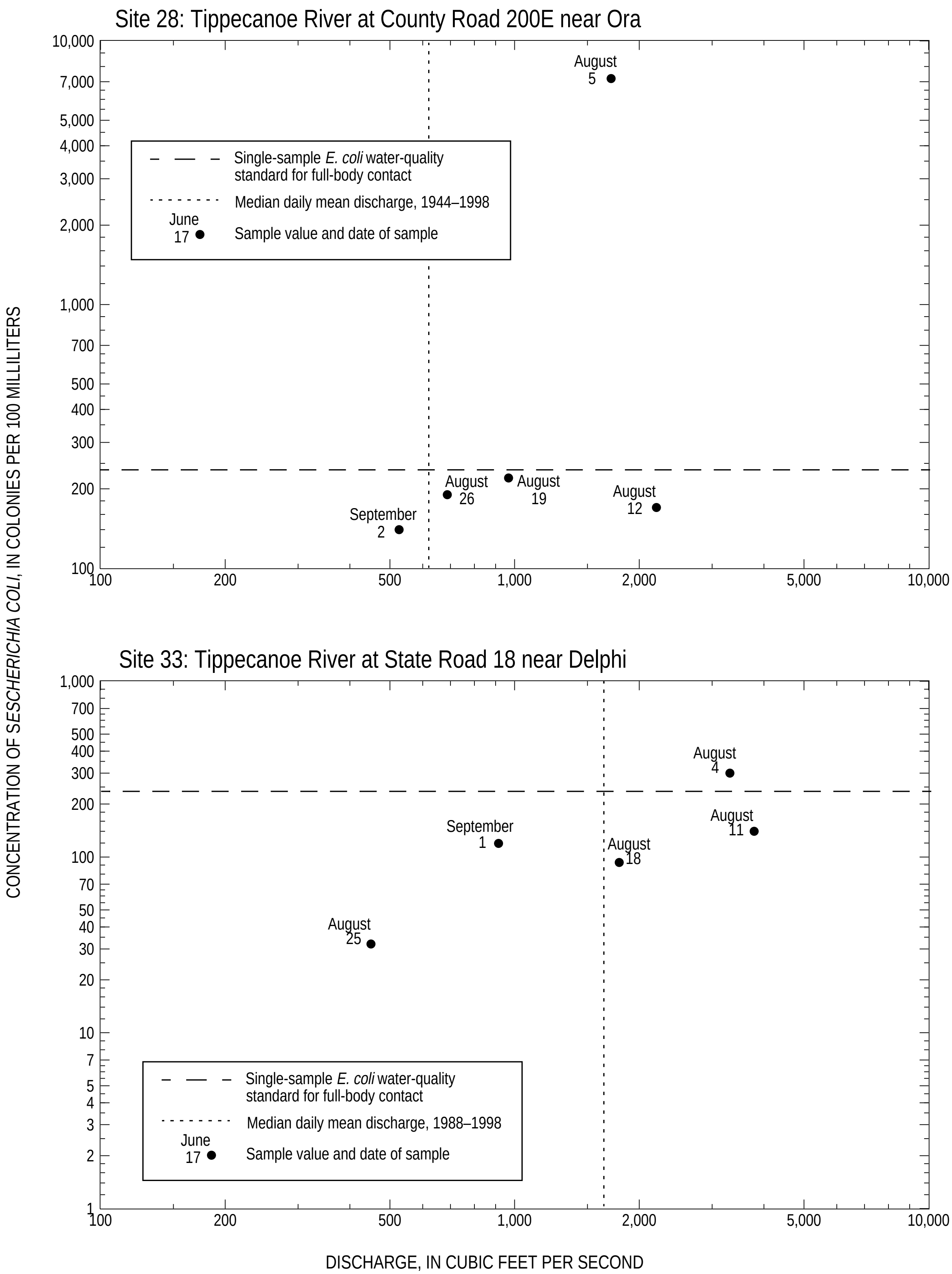

Figure 6. Stream discharge and concentrations of *Escherichia coli* at selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.

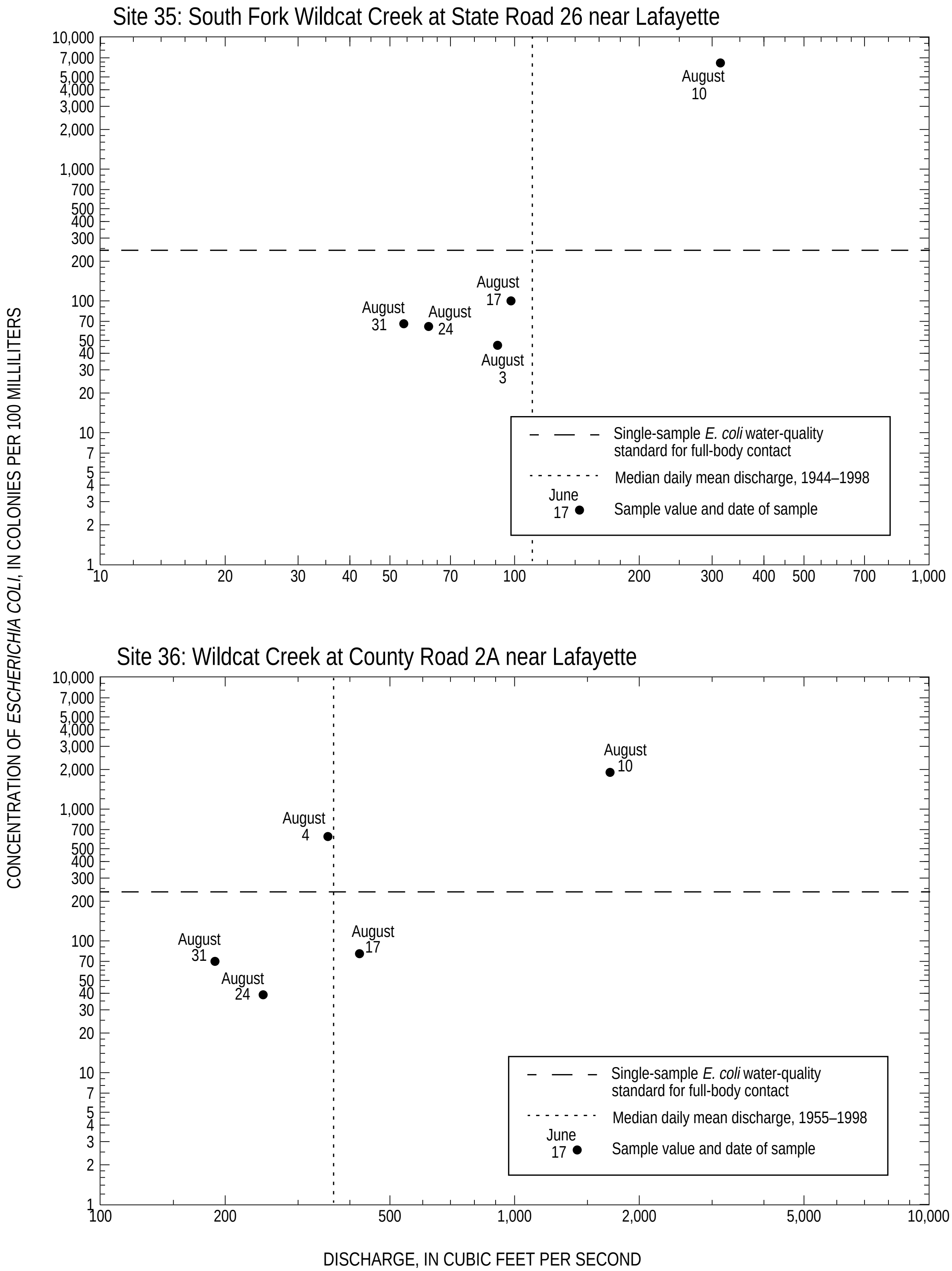

Figure 6. Stream discharge and concentrations of *Escherichia coli* at selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.

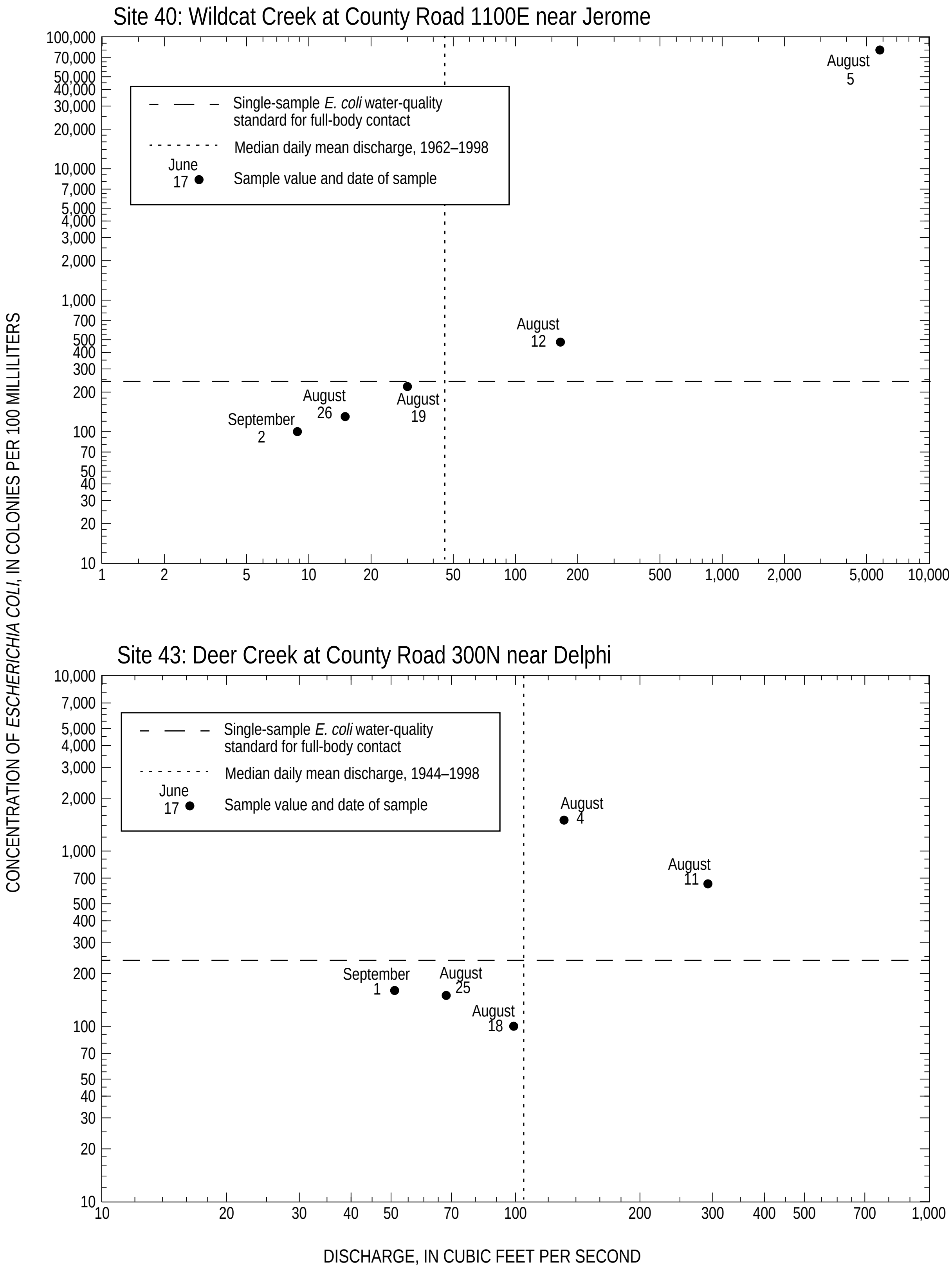

Figure 6. Stream discharge and concentrations of *Escherichia coli* at selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.

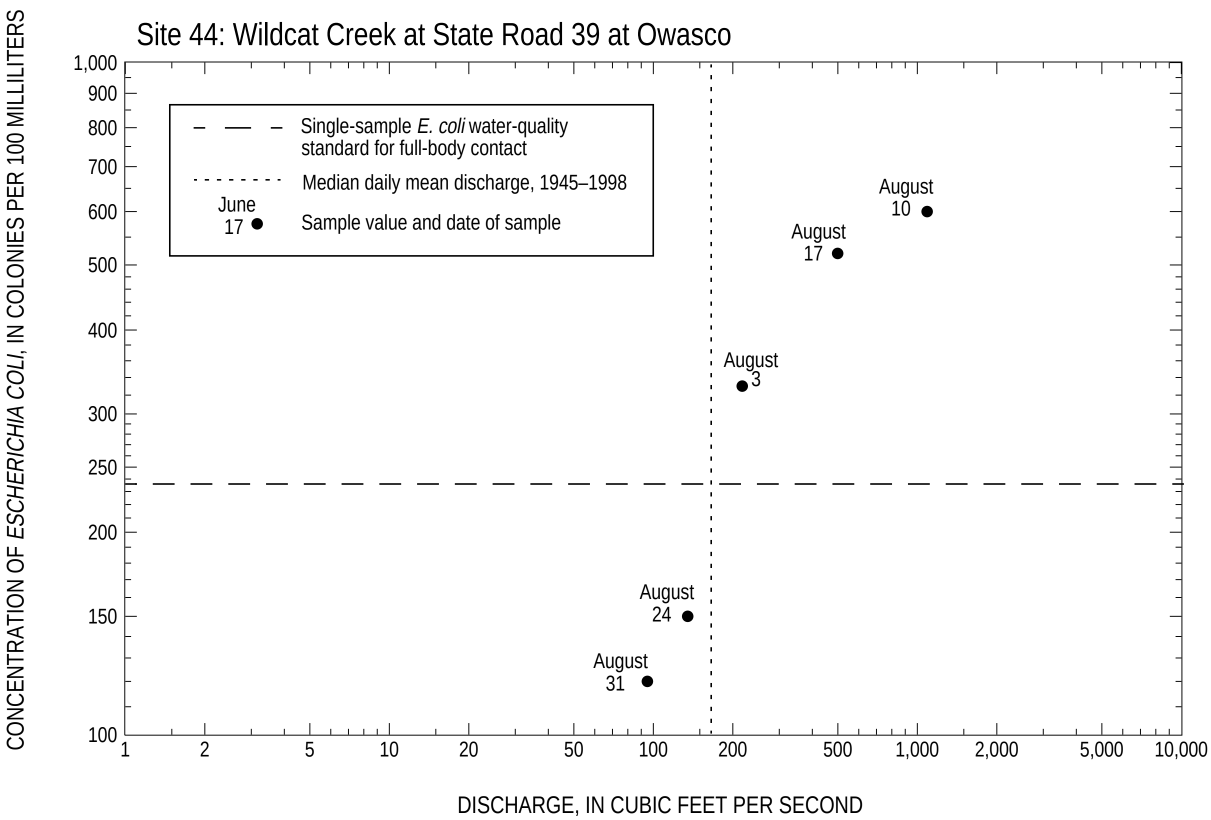

Figure 6. Stream discharge and concentrations of *Escherichia coli* at selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued.

concentrations of *E. coli* and discharge equal to or greater than the computed correlation coefficient.

Quality-Assurance and Quality-Control Procedures

Quality-assurance and quality-control procedures were followed for collection and processing of the samples. These procedures include frequent checking and calibration of equipment as well as collection of additional samples for quality control. Analysis of the quality-control samples provides information not only about the potential for sample contamination during processing but also about the variability of sampling.

The pH buffers and specific-conductance solutions used to calibrate the multi-parameter measuring instrument were quality assured by the QWSU. *E. coli* substrate media kits, membrane filters, sterile saline buffer solution, pre-measured sterile dilution water, petri dishes, and petri dishes with pads also were quality assured by the QWSU. The incubators were checked weekly with an American Society for Testing and Materials (ASTM) certified thermometer to assure that temperature ranges shown on the internal thermometer in the incubator were accurate to ±0.5°C. The incubators were inspected daily to ensure that they were operating properly.

Quality-control samples consisted of 9 field blanks, 226 filter blanks, 42 process blanks, and 44 duplicate samples. Results of the quality-assurance and *E. coli* determinations are presented in tables 5 and 6 at the back of this report.

During the sampling of the Group 1 sites, 20 sequential duplicate samples were collected at selected sites immediately after the environmental *E. coli* samples were collected. This was accomplished by taking an additional sample from the same location at which the environmental sample was collected. The sequential duplicate samples were processed in the same manner as the environmental samples. The comparison between the environmental samples and the sequential duplicate samples provides information on sampling variability because the sequential duplicate samples were not collected from exactly the same water as the environmental samples.

Figure 7 displays the difference between the concentrations of *E. coli* measured in the environmental sample and the sequential duplicate samples and their natural log percent difference. The median difference between the environmental samples and the sequential duplicate samples for the Group 1 sites was -10 colonies per 100 milliliters, with a median natural log difference of -3.8 percent. A Wilcoxon signed-rank test (Helsel and Hirsch, 1992) was used to determine if there were any statistically significant differences between the environmental samples and the sequential duplicates. No statistically significant differences were determined between the environmental samples and the sequential duplicate samples for the Group 1 sites at the 5-percent significance level.

During the sampling of the Group 2 sites in August and September, the sequential-duplicate-sampling method used during sampling of the Group 1 sites was replaced with a sampling method that collected concurrent or simultaneous duplicates. Twenty-one concurrent duplicate samples were collected at selected sites in the same location where the environmental samples were collected. The concurrent duplicates were processed in the same manner as the environmental samples and can be used to evaluate the variability in sampling, sampling equipment, and the natural variability in the samples. Figure 7 displays the differences between the concentrations of *E. coli* measured in the environmental samples and the concurrent duplicate samples and their natural log percent difference. The median difference between the environmental samples and the concurrent duplicate samples for the Group 2 sites was 3 colonies per 100 milliliters, with a median natural log difference of 4.7 percent. A Wilcoxon signed-rank test (Helsel and Hirsch, 1992) was used to determine if there were statistically significant differences between the environmental samples and the concurrent duplicates. No statistically significant differences were determined between the environmental samples and the concurrent duplicate samples for the Group 2 sites at the 5-percent significance level.

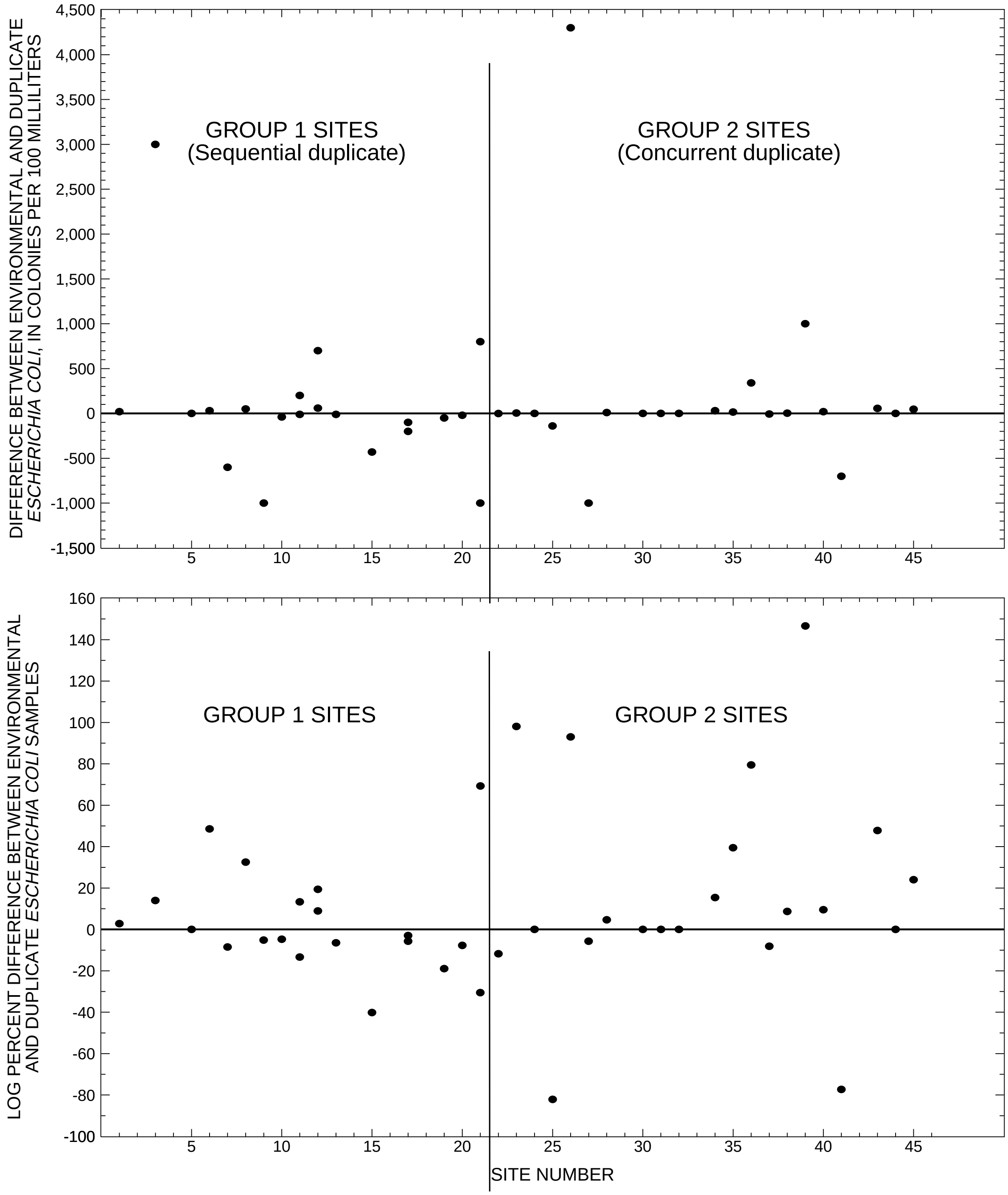

Figure 7. Concentrations of *Escherichia coli* measured in the environmental samples and duplicate samples and their natural log percent difference.

The similarity between the median natural log percent differences determined for the sequential duplicate samples and the concurrent duplicate samples indicates that the waters sampled generally maintained a constant concentration of *E. coli* for at least short periods of time. Collecting the sequential duplicate samples shortly after the environmental samples were collected produced almost the same variability as collecting the concurrent duplicate samples and the environmental samples simultaneously.

Filter Blanks

Filter blanks were processed for 226 of the 230 samples collected. This was accomplished by passing 100 mL of the sterile saline buffer solution through the filter prior to processing any dilutions of the environmental samples. While passing the saline buffer solution through the filter, every attempt was made to have the saline buffer solution come in contact with every surface that the environmental sample might touch; this would help to ensure that the equipment used to process the samples was clean. No *E. coli* colonies were present in any of the filter blanks processed.

Process Blanks

Process blanks were collected following the filtering of all of the dilutions for an environmental sample. Process blanks consisting of 100 mL of the saline buffer solution were filtered after every fourth environmental sample was processed; this was done to determine the adequacy of the equipment rinses following the filtering of each dilution. Eight of the 42 process blanks contained observable concentrations of *E. coli*. The maximum concentration of *E. coli* measured in the process blanks was 5 colonies per 100 mL. All of the process blanks that had observable concentrations of *E. coli* contained less than 1 percent of the concentration of *E. coli* measured in the environmental samples.

Field Blanks

Nine field blanks were processed on randomly selected days during the length of the study. Field blanks consisted of 250 mL of the sterile saline buffer solution that was poured into a sample-collection bottle before the first sample was taken each day. The field blanks were kept chilled and remained with the samples collected at all sites for that day. The field blank then was processed by passing 100 mL of the blank solution through the filter. None of the nine field blanks had observable concentrations of *E. coli*, indicating that there was no contamination resulting from transporting the samples.

Summary

The presence of *E. coli* in water is direct evidence of the presence of fecal contamination from warm-blooded animals and indicates the possible presence of pathogens. *E. coli* is one of the two preferred indicator bacteria used by the USEPA to determine the suitability of surface waters for recreational use. The water-quality standards for *E. coli* in recreational waters in Indiana include a single-sample standard and a geometric mean computed from five samples collected within a 30-day period.

Water samples collected from 46 stream sites in the Upper Wabash River Watershed from June through September 1998 were analyzed for concentrations of *E. coli*. Samples were collected at 21 sites during June and July and at 25 sites during August and September to allow computation of a five-sample geometric mean for each site. The five-sample geometric-mean concentrations ranged from 17 to 4,800 colonies per 100 mL, and concentrations for 43 sites exceeded the five-sample geometric-mean standard of 125 colonies per 100 mL. Of the 230 samples collected, 145 exceeded the single-sample standard of 235 colonies per 100 mL. Concentrations of *E. coli* at all sites ranged from an estimated 6 to 110,000 colonies per 100 mL during the study.

Of the 46 sites, 17 were at USGS streamflow-gaging stations. Based on records from these stations, 62 percent of the samples collected at these sites were collected at discharges above the median daily mean discharge. Statistically significant positive correlations between the concentrations of *E. coli* and discharge were determined for two sites where additional samples were collected, indicating increased concentrations of *E. coli* with greater discharge.

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Supplemental Data

(Tables 3, 4, 5, and 6)

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998

[--, no data; >, greater than; K, values estimated from non-ideal colony counts]

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
1	98-06-02	0933	80.01	--	20.5	8.1	6.6	667	190	2,600
	98-06-09	1010	79.75	--	17.0	8.2	7.8	654	83	220
	98-06-16	0930	85.98	--	20.0	7.8	--	546	250	6,300
	98-06-23	0935	90.67	--	23.5	8.2	6.2	536	84	720
	98-06-30	0935	89.11	--	20.5	7.3	5.6	347	>1,000	110,000
	Five-sample geometric mean									**3,100**
2	98-06-02	1025	4.39	180	21.5	8.2	8.3	681	100	530
	98-06-09	1105	3.91	79	16.0	8.1	8.7	769	74	220
	98-06-16	1035	9.99	3,150	20.5	7.5	--	502	150	7,000
	98-06-23	1035	4.93	345	24.5	8.1	7.6	585	86	780
	98-06-30	1035	7.91	1,700	23.0	7.4	4.0	305	920	23,000
	Five-sample geometric mean									**1,700**
3	98-06-02	1120	77.58	--	22.0	8.3	9.1	688	64	140
	98-06-09	1209	77.33	--	16.5	8.4	9.9	731	62	350
	98-06-16	1120	83.86	--	21.0	7.6	6.8	501	120	700
	98-06-23	1120	77.31	--	25.0	8.2	8.9	571	71	220
	98-06-30	1120	80.82	--	23.0	7.5	4.1	253	>1,000	23,000
	Five-sample geometric mean									**700**
4	98-06-03	1015	1.98	44	18.0	7.9	7.0	840	34	240
	98-06-10	0950	1.99	45	16.0	7.8	7.7	998	29	610
	98-06-17	0845	3.88	260	19.0	7.8	7.1	628	97	3,900
	98-06-24	1035	2.12	65	23.5	7.7	6.7	841	29	470
	98-07-01	1005	2.52	94	21.5	7.8	7.0	700	80	1,600
	Five-sample geometric mean									**840**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
5	98-06-03	0925	72.21	--	19.5	7.9	7.8	662	18	53
	98-06-10	0908	71.87	--	17.5	7.9	8.4	730	20	410
	98-06-17	0800	75.30	--	20.0	7.4	7.4	465	130	4,200
	98-06-24	0945	76.31	--	24.0	7.4	7.4	509	26	67
	98-07-01	0925	73.94	--	25.5	7.7	6.5	532	96	580
	Five-sample geometric mean									**320**
6	98-06-03	1425	3.71	505	18.5	8.4	9.6	545	24	K29
	98-06-10	1445	3.01	265	20.0	8.3	2.5	598	17	78
	98-06-17	1345	6.72	2,560	21.0	7.6	7.1	458	150	3,700
	98-06-24	1756	8.46	4,480	24.0	7.7	8.4	486	31	220
	98-07-01	1505	8.96	4,910	23.0	7.6	8.0	488	49	44
	Five-sample geometric mean									**150**
7	98-06-01	1300	1.92	--	22.0	7.9	6.0	689	280	4,500
	98-06-08	1325	0.76	--	17.5	7.8	7.4	790	83	170
	98-06-15	1010	5.51	--	18.0	7.4	7.0	327	>1,000	16,000
	98-06-22	1023	0.66	--	22.0	7.7	6.4	858	79	6,800
	98-06-29	1025	6.59	--	22.5	7.2	5.4	136	>1,000	32,000
	Five-sample geometric mean									**4,800**
8	98-06-01	1450	81.10	--	20.5	7.7	6.9	542	>1,000	5,900
	98-06-09	0840	81.42	--	16.0	7.8	7.8	729	46	180
	98-06-16	0840	82.64	--	19.0	7.4	6.5	424	290	7,100
	98-06-23	0835	76.69	--	21.5	7.6	6.5	680	57	610
	98-06-30	0845	84.38	--	22.0	7.2	5.3	224	>1,000	49,000
	Five-sample geometric mean									**3,000**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
9	98-06-02	1210	67.15	--	22.5	7.9	7.1	538	250	630
	98-06-09	1302	66.25	--	16.5	8.2	9.2	702	48	310
	98-06-16	1215	74.72	--	19.5	7.6	8.0	255	1,140	19,000
	98-06-23	1244	72.45	--	23.5	7.8	7.2	582	58	700
	98-06-30	1220	70.09	--	25.0	8.0	7.0	740	280	4,000
	Five-sample geometric mean									**1,600**
10	98-06-04	1210	4.00	1,560	18.5	8.2	10.2	519	19	20
	98-06-11	1030	3.12	816	18.5	7.9	8.0	532	24	6,700
	98-06-18	0855	6.54	4,600	21.0	7.6	7.0	472	73	830
	98-06-25	1005	8.31	7,360	22.0	7.6	8.3	420	29	190
	98-07-02	0950	8.30	7,300	23.5	7.7	7.4	446	59	460
	Five-sample geometric mean									**400**
11	98-06-04	1255	2.45	37	16.5	8.2	8.7	704	6	70
	98-06-11	1110	2.59	44	17.0	8.0	7.8	657	18	2,300
	98-06-18	0930	5.21	490	18.5	7.7	7.8	512	94	410
	98-06-25	1100	3.15	105	22.5	7.9	7.9	652	16	800
	98-07-02	1030	3.25	120	19.5	8.0	8.3	572	36	1,600
	Five-sample geometric mean									**610**
12	98-06-01	1155	3.04	70	18.5	8.0	7.4	633	110	2,600
	98-06-08	1425	2.84	25	15.5	8.2	10.0	723	7	2,000
	98-06-15	1055	9.01	1,530	17.5	7.4	6.9	348	570	8,200
	98-06-22	1130	3.40	78	20.5	7.9	7.8	657	31	720
	98-06-29	1120	2.89	30	23.5	8.1	7.7	728	7	340
	Five-sample geometric mean									**1,600**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
13	98-06-01	1550	78.80	--	22.0	7.8	6.4	468	>1,000	5,800
	98-06-08	1550	77.68	--	17.5	8.2	9.2	669	52	150
	98-06-15	1200	81.92	--	18.5	7.6	7.1	344	850	9,700
	98-06-22	1235	78.36	--	22.0	8.0	8.1	613	59	320
	98-06-29	1215	77.45	--	26.5	8.4	9.0	685	18	460
	Five-sample geometric mean									**1,000**
14	98-06-01	1642	70.71	--	21.5	7.7	6.5	405	>1,000	4,200
	98-06-08	1625	68.98	--	17.5	8.1	8.7	672	63	150
	98-06-15	1240	75.74	--	18.5	7.6	7.1	367	520	8,300
	98-06-22	1348	70.19	--	23.0	7.9	7.7	595	64	460
	98-06-29	1255	67.96	--	26.5	8.2	7.9	687	17	130
	Five-sample geometric mean									**790**
15	98-06-02	1420	2.39	617	21.5	7.8	7.2	448	520	870
	98-06-08	1755	1.56	221	17.0	8.1	8.6	692	83	310
	98-06-15	1440	6.50	4,330	19.5	7.6	7.1	381	450	11,000
	98-06-22	1550	2.47	645	22.5	7.8	7.6	545	68	460
	98-06-29	1540	1.58	232	28.5	8.4	11.7	642	29	310
	Five-sample geometric mean									**840**
16	98-06-02	1340	58.99	--	22.5	7.9	7.2	508	330	700
	98-06-09	1400	58.16	--	16.5	8.1	8.9	734	69	500
	98-06-16	1310	65.48	--	19.5	7.7	8.1	317	650	18,000
	98-06-23	1335	64.15	--	23.0	7.8	7.5	606	59	430
	98-06-30	1310	58.68	--	25.5	8.3	8.8	642	68	5,900
	Five-sample geometric mean									**1,700**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
17	98-06-03	1058	77.97	--	16.0	7.8	8.8	840	17	200
	98-06-10	1038	78.05	--	16.0	7.7	8.4	820	9	600
	98-06-17	0925	79.73	--	18.5	7.4	6.3	625	120	6,700
	98-06-24	1118	78.00	--	23.0	7.7	9.8	787	15	480
	98-07-01	1040	78.55	--	21.5	7.6	6.7	616	58	1,700
	Five-sample geometric mean									**920**
18	98-06-03	1205	0.88	118	17.5	8.2	8.4	786	13	280
	98-06-10	1138	0.86	112	16.0	8.0	9.0	761	10	660
	98-06-17	1015	3.72	955	19.0	7.7	7.4	508	230	13,000
	98-06-24	1215	1.18	214	23.5	8.0	8.3	677	17	680
	98-07-01	1130	1.33	258	21.5	7.9	8.1	636	34	3,100
	Five-sample geometric mean									**1,400**
19	98-06-03	1328	75.43	--	18.5	8.2	8.6	739	21	240
	98-06-10	1300	75.40	--	16.0	8.1	8.9	734	14	370
	98-06-17	1100	78.66	--	19.0	7.7	7.3	455	460	17,000
	98-06-24	1352	75.79	--	24.0	8.2	10.0	680	24	430
	98-07-01	1210	75.80	--	22.0	8.2	8.8	708	18	420
	Five-sample geometric mean									**770**
20	98-06-04	1000	76.01	--	17.0	8.3	9.2	725	25	470
	98-06-11	0805	75.90	--	17.5	8.1	8.2	705	20	550
	98-06-17	1140	80.28	--	19.5	7.8	7.0	472	330	8,700
	98-06-25	0825	76.27	--	24.0	8.2	8.1	677	19	250
	98-07-01	1250	76.47	--	23.0	8.3	10.0	677	19	48
	Five-sample geometric mean									**490**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
21	98-06-04	1051	3.47	393	17.5	8.4	10.8	700	29	240
	98-06-11	0910	3.51	408	17.5	8.2	8.4	676	24	1,600
	98-06-18	0800	5.26	1,690	20.0	7.8	7.2	484	230	2,800
	98-06-25	0915	3.75	526	24.5	8.4	9.4	655	22	420
	98-07-02	0850	3.71	500	21.0	8.3	9.0	665	22	930
	Five-sample geometric mean									**840**
22	98-08-06	0910	82.18	--	23.0	7.5	5.6	450	3	160
	98-08-13	0830	82.11	--	24.0	7.4	6.2	454	2	57
	98-08-20	0945	82.38	--	23.0	7.3	5.1	555	1	K8
	98-08-27	0815	82.11	--	23.5	7.3	5.3	481	2	28
	98-09-03	0935	82.30	--	20.5	7.4	5.4	491	2	40
	Five-sample geometric mean									**38**
23	98-08-06	0955	6.09	115	25.5	8.1	7.1	389	3	130
	98-08-13	0900	6.70	187	25.5	8.2	8.1	385	2	K8
	98-08-20	1030	5.54	62	25.5	8.2	8.6	454	2	K6
	98-08-27	0845	5.54	62	26.0	7.9	7.9	379	3	K13
	98-09-03	1025	5.32	41	23.5	7.9	7.2	387	1	16
	Five-sample geometric mean									**17**
24	98-08-06	1045	86.93	--	23.0	7.5	5.2	478	11	1,300
	98-08-13	0950	87.00	--	22.0	7.6	5.4	481	7	170
	98-08-20	1155	85.61	--	21.5	7.6	6.3	641	8	220
	98-08-27	0950	85.50	--	22.0	7.5	5.9	536	9	270
	98-09-03	1140	84.82	--	19.0	7.7	7.5	601	4	220
	Five-sample geometric mean									**310**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
25	98-08-06	1125	86.29	--	22.0	7.5	6.0	396	15	760
	98-08-13	1030	85.63	--	21.5	7.7	6.3	478	5	110
	98-08-20	1245	83.84	--	22.5	7.8	7.0	647	13	170
	98-08-27	1035	83.45	--	22.5	7.8	7.0	562	13	110
	98-09-03	1245	82.89	--	20.0	7.9	8.3	604	8	330
	Five-sample geometric mean									**220**
26	98-08-06	1210	80.90	--	21.5	7.6	6.6	436	24	7,100
	98-08-13	1105	81.32	--	21.5	7.8	6.8	483	9	200
	98-08-19	1330	79.07	--	22.0	8.0	8.0	663	12	270
	98-08-27	1120	78.67	--	22.0	7.8	7.6	581	11	250
	98-09-03	1320	78.33	--	20.0	8.0	8.9	597	7	210
	Five-sample geometric mean									**460**
27	98-08-05	1405	83.33	--	21.5	7.5	6.5	413	37	17,000
	98-08-12	1340	83.49	--	22.5	7.9	7.9	476	14	250
	98-08-20	1520	81.70	--	23.0	8.0	8.0	656	11	300
	98-08-26	1315	81.20	--	23.0	8.0	8.3	580	10	260
	98-09-02	1500	81.03	--	20.5	8.1	8.9	606	7	210
	Five-sample geometric mean									**590**
28	98-08-05	1320	9.36	1,710	21.5	7.6	6.6	440	34	7,200
	98-08-12	1300	10.51	2,200	23.0	7.8	7.5	465	14	170
	98-08-19	1425	7.43	967	23.0	8.0	7.8	652	15	220
	98-08-26	1230	6.59	688	23.0	8.0	7.9	574	11	190
	98-09-02	1415	6.11	526	21.0	8.1	8.6	598	7	140
	Five-sample geometric mean									**370**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
29	98-08-05	1145	81.22	--	21.5	7.7	6.9	473	33	26,000
	98-08-12	1130	81.95	--	23.0	7.8	7.9	455	16	260
	98-08-19	1325	80.12	--	23.0	8.0	8.6	651	12	240
	98-08-26	1140	79.61	--	23.5	8.1	8.5	581	12	190
	98-09-02	1315	79.32	--	21.0	8.1	8.8	598	7	160
	Five-sample geometric mean									**550**
30	98-08-05	1100	81.80	--	21.5	7.5	6.4	361	37	7,600
	98-08-12	1055	75.89	--	22.5	7.9	7.4	563	17	200
	98-08-19	1150	79.06	--	23.0	8.1	8.4	655	12	150
	98-08-26	1050	79.10	--	23.5	8.1	8.3	579	10	300
	98-09-02	1145	78.64	--	20.5	8.1	8.5	598	7	200
	Five-sample geometric mean									**420**
31	98-08-05	1015	77.77	--	21.0	7.1	4.9	254	49	19,000
	98-08-12	1015	76.30	--	21.0	7.7	7.3	576	21	360
	98-08-19	1100	75.68	--	22.5	7.8	7.4	694	12	230
	98-08-26	1005	75.61	--	22.5	7.7	6.6	582	10	320
	98-09-02	1040	75.61	--	19.0	7.8	7.5	606	12	260
	Five-sample geometric mean									**670**
32	98-08-05	0930	55.86	--	22.0	7.7	7.6	384	31	70,000
	98-08-12	0930	55.39	--	23.5	7.8	7.4	488	18	170
	98-08-19	1020	55.36	--	24.5	8.1	9.1	637	13	100
	98-08-26	0925	55.37	--	25.0	7.9	6.8	567	13	54
	98-09-02	1005	55.24	--	23.5	7.8	6.2	578	15	25
	Five-sample geometric mean									**280**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
33	98-08-04	1245	4.63	3,310	22.5	8.1	7.1	447	12	300
	98-08-11	1110	4.96	3,790	24.0	7.8	7.1	420	15	140
	98-08-18	1415	3.45	1,790	26.0	8.1	7.8	487	9	93
	98-08-25	1100	2.18	450	25.0	8.0	7	508	6	32
	98-09-01	1235	2.70	912	24.0	7.9	7.1	525	7	120
	Five-sample geometric mean									**110**
34	98-08-03	1445	79.63	--	24.5	8.4	11.2	659	6	97
	98-08-10	1335	78.29	--	23.0	8.0	8.0	393	390	2,700
	98-08-17	1508	79.67	--	25.0	8.4	10.5	653	6	210
	98-08-24	1355	79.55	--	26.0	8.2	11.2	657	10	150
	98-08-31	1520	79.46	--	24.0	8.2	10.2	678	5	150
	Five-sample geometric mean									**260**
35	98-08-03	1515	2.10	91	25.0	8.4	11.2	676	4	46
	98-08-10	1400	3.16	314	23.5	8.1	7.9	484	120	6,400
	98-08-17	1540	2.15	98	25.5	8.4	9.7	656	7	100
	98-08-24	1430	1.88	62	26.5	8.4	12.5	663	6	64
	98-08-31	1543	1.81	54	25.0	8.3	10.4	685	8	67
	Five-sample geometric mean									**170**
36	98-08-04	1512	3.60	354	24.5	8.3	9.9	636	9	620
	98-08-10	1440	6.19	1,700	24.0	8.0	7.8	436	64	1,900
	98-08-17	1620	3.66	422	25.5	8.5	10.7	607	12	80
	98-08-24	1505	3.27	247	26.5	8.4	11.8	658	7	39
	98-08-31	1610	3.07	189	24.5	8.3	10.9	663	9	70
	Five-sample geometric mean									**190**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
37	98-08-04	1440	70.35	--	24.5	7.9	7.0	380	25	14,000
	98-08-11	1235	72.26	--	23.5	7.7	7.1	350	40	520
	98-08-18	1625	69.75	--	25.0	7.8	7.5	357	18	83
	98-08-25	1235	67.24	--	24.5	7.8	7.7	355	15	3,300
	98-09-01	1515	67.04	--	23.5	7.8	7.6	355	14	220
	Five-sample geometric mean									**850**
38	98-08-04	1325	66.02	--	24.0	7.8	7.2	351	32	1,700
	98-08-11	1150	67.62	--	23.0	7.7	7.4	312	48	810
	98-08-18	1510	65.94	--	24.5	7.8	7.7	318	20	240
	98-08-25	1135	63.70	--	24.0	7.8	7.8	325	18	1,400
	98-09-01	1355	63.60	--	23.0	7.7	7.9	327	14	36
	Five-sample geometric mean									**440**
39	98-08-04	0945	78.03	--	23.5	7.8	7.0	376	42	4,900
	98-08-11	0855	78.65	--	22.5	7.7	7.5	307	39	1,300
	98-08-18	1045	79.05	--	24.0	7.6	7.4	323	17	200
	98-08-25	0845	77.07	--	24.0	7.5	7.4	325	15	3,000
	98-09-01	0955	77.10	--	23.0	7.6	7.3	330	16	80
	Five-sample geometric mean									**790**
40	98-08-05	1310	12.71	5,790	21.0	7.1	6.2	128	73	80,000
	98-08-12	1410	2.69	165	23.0	7.8	7.7	524	11	480
	98-08-19	1440	1.82	30	23.5	8.0	9.2	542	9	220
	98-08-26	1350	1.64	15	23.5	7.9	7.8	594	6	130
	98-09-02	1315	1.54	8.8	21.0	8.0	8.6	614	4	100
	Five-sample geometric mean									**640**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
41	98-08-03	1150	76.37	--	23.5	8.0	8.1	619	9	210
	98-08-10	1045	--	--	23.0	7.8	7.2	469	28	600
	98-08-17	1155	76.84	--	23.5	7.6	6.4	412	73	21,000
	98-08-24	1105	76.17	--	24.5	7.3	7.2	738	7	500
	98-08-31	1125	75.97	--	22.5	7.8	6.8	838	7	390
	Five-sample geometric mean									**880**
42	98-08-04	1030	79.63	--	22.0	8.0	7.8	562	5	270
	98-08-11	0950	80.31	--	21.0	8.0	8.0	592	15	780
	98-08-18	1135	79.46	--	23.5	8.2	9.9	648	3	220
	98-08-25	0930	79.30	--	24.0	7.9	8.1	630	5	730
	98-09-01	1045	79.09	--	20.5	7.8	7.9	657	4	300
	Five-sample geometric mean									**400**
43	98-08-04	1115	2.55	131	22.5	8.2	8.6	636	5	1,500
	98-08-11	1025	3.15	292	22.0	8.1	8.1	563	19	650
	98-08-18	1240	2.40	99	24.5	8.3	10.8	663	4	100
	98-08-25	1010	2.23	68	24.0	8.1	8.9	653	4	150
	98-09-01	1140	2.11	51	20.5	8.1	8.7	691	4	160
	Five-sample geometric mean									**300**
44	98-08-03	1250	1.95	217	23.0	8.1	9.0	627	11	330
	98-08-10	1140	3.59	1,090	23.0	7.9	7.6	447	45	600
	98-08-17	1250	2.62	499	24.0	8.1	8.2	603	21	520
	98-08-24	1210	1.61	135	25.0	8.0	8.4	716	9	150
	98-08-31	1230	1.43	95	22.5	8.0	8.3	720	9	120
	Five-sample geometric mean									**280**

Table 3. Water-quality data for selected sites in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units)	*Escherichia coli* (colonies per 100 milliliters)
45	98-08-03	1340	86.12	--	23.0	8.2	10.1	648	5	260
	98-08-10	1225	87.03	--	22.0	8.1	7.9	536	37	630
	98-08-17	1345	86.35	--	24.5	8.3	9.4	616	10	240
	98-08-24	1255	85.96	--	25.0	8.2	9.3	633	7	280
	98-08-31	1316	85.90	--	22.0	8.1	8.6	633	8	220
	Five-sample geometric mean									**300**
46	98-08-03	1410	82.06	--	23.0	8.4	10.7	854	7	180
	98-08-10	1250	82.56	--	22.5	8.1	7.6	594	34	3,500
	98-08-17	1415	82.05	--	24.5	8.4	9.9	879	16	340
	98-08-24	1320	82.03	--	25.5	8.3	8.7	905	9	250
	98-08-31	1352	81.90	--	23.0	8.2	8.9	968	11	620
	Five-sample geometric mean									**510**

Table 4. Water-quality data for two sites in the Upper Wabash River Watershed in Indiana where additional samples were collected during July–September 1998

[--, no data; >, greater than; K, values estimated from non-ideal colony counts]

Site number	Date	Time	Gage height (feet)	Discharge at time of sample collection (cubic feet per second)	Water temperature (degrees Celsius)	pH (Standard units)	Dissolved oxygen (milligrams per liter)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Turbidity (Nephelometric turbidity units	*Escherichia coli* (colonies per 100 milliliters)
2	98-06-02	1025	4.39	180	21.5	8.2	8.3	681	100	530
	98-06-09	1105	3.91	79	16.2	8.1	8.7	769	74	220
	98-06-16	1035	9.99	3,150	20.3	7.5	--	502	150	7,000
	98-06-23	1035	4.93	345	24.4	8.1	7.6	585	86	780
	98-06-30	1035	7.91	1,700	22.9	7.4	4.0	305	920	23,000
	98-07-22	1015	9.70	2,820	22.0	7.2	5.5	209	570	34,000
	98-07-29	1012	6.63	1,020	24.5	7.3	3.9	375	40	630
	98-08-05	1020	9.83	2,940	21.0	7.1	5.2	159	220	57,000
	98-08-12	1110	6.53	954	24.4	7.4	5.3	387	52	800
	98-08-19	1130	4.32	164	24.3	8.1	8.5	549	75	370
	98-08-26	1110	3.99	93	23.3	7.8	6.0	673	72	570
	98-09-02	1105	3.83	65	21.0	8.0	7.1	699	78	360
	98-09-09	1100	3.66	43	18.3	7.8	5.2	796	53	560
15	98-06-02	1420	2.39	617	21.4	7.8	7.2	448	520	870
	98-06-08	1755	1.56	221	16.9	8.1	8.6	692	83	310
	98-06-15	1440	6.50	4,330	19.3	7.6	7.1	381	450	11,000
	98-06-22	1550	2.47	645	22.6	7.8	7.6	545	68	460
	98-06-29	1540	1.58	232	28.3	8.4	11.7	642	29	310
	98-07-22	1158	8.47	6,840	22.3	7.5	6.7	206	520	43,000
	98-07-29	1149	1.91	378	23.8	7.9	7.9	549	19	470
	98-08-05	1155	15.92	21,500	20.9	7.4	6.8	115	210	31,000
	98-08-12	1230	2.49	680	23.1	7.8	7.7	446	29	1,800
	98-08-19	1305	1.57	228	24.2	8.1	10.0	606	19	250
	98-08-26	1225	1.34	147	24.2	8.1	9.6	708	22	750
	98-09-02	1230	1.22	108	22.2	8.2	10.7	731	21	240
	98-09-09	1210	1.21	105	21.0	8.0	9.4	714	19	K830

Table 5. Quality-assurance data associated with the Group 1 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, June–September 1998
[K, values estimated from non-ideal colony counts; --, no data]

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Sequential duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
1	98-06-02	0933	2,600	0	--	--	--	--
	98-06-09	1010	220	0	--	--	--	--
	98-06-16	0930	6,300	0	0	--	--	--
	98-06-23	0935	720	0	--	--	700	3
	98-06-30	0935	110,000	0	3	--	--	--
2	98-06-02	1025	530	0	--	--	--	--
	98-06-09	1105	220	0	--	--	--	--
	98-06-16	1035	7,000	0	--	--	--	--
	98-06-23	1035	780	0	--	--	--	--
	98-06-30	1035	23,000	0	--	--	--	--
2	98-07-22	1015	34,000	0	5	--	--	--
	98-07-29	1012	630	0	--	--	--	--
	98-08-05	1020	57,000	0	--	--	--	--
	98-08-12	1110	800	0	--	--	--	--
	98-08-19	1130	370	0	0	--	--	--
2	98-08-26	1110	570	0	--	--	340	52
	98-09-02	1105	360	0	0	--	--	--
	98-09-09	1100	560	0	--	--	570	-2
3	98-06-02	1120	140	0	--	--	--	--
	98-06-09	1209	350	0	--	--	--	--
	98-06-16	1120	700	0	--	--	--	--
	98-06-23	1120	220	0	--	--	--	--
	98-06-30	1120	23,000	0	--	--	20,000	14

Table 5. Quality-assurance data associated with the Group 1 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Sequential duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
4	98-06-03	1015	240	0	--	--	--	--
	98-06-10	0950	610	0	--	--	--	--
	98-06-17	0845	3,900	0	--	--	--	--
	98-06-24	1035	470	0	--	--	--	--
	98-07-01	1005	1,600	0	--	--	--	--
5	98-06-03	0925	53	0	--	--	--	--
	98-06-10	0908	410	0	--	--	--	--
	98-06-17	0800	4,200	0	0	--	--	--
	98-06-24	0945	67	0	--	0	67	0
	98-07-01	0925	580	0	--	--	--	--
6	98-06-03	1425	K29	0	--	--	--	--
	98-06-10	1445	78	0	0	--	48	49
	98-06-17	1345	3,700	0	--	--	--	--
	98-06-24	1756	220	0	--	--	--	--
	98-07-01	1505	44	0	--	--	--	--
7	98-06-01	1300	4,500	0	--	--	--	--
	98-06-08	1325	170	0	--	--	--	--
	98-06-15	1010	16,000	--	--	--	--	--
	98-06-22	1023	6,800	0	--	--	7,400	-8
	98-06-29	1025	32,000	0	--	--	--	--
8	98-06-01	1450	5,900	0	--	--	--	--
	98-06-09	0840	180	0	--	--	130	33
	98-06-16	0840	7,100	0	--	--	--	--
	98-06-23	0835	610	0	--	--	--	--
	98-06-30	0845	49,000	0	--	--	--	--

Table 5. Quality-assurance data associated with the Group 1 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Sequential duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
9	98-06-02	1210	630	0	--	--	--	--
	98-06-09	1302	310	0	0	--	--	--
	98-06-16	1215	19,000	0	--	--	20,000	-5
	98-06-23	1244	700	0	0	--	--	--
	98-06-30	1220	4,000	0	--	--	--	--
10	98-06-04	1210	20	0	--	--	--	--
	98-06-11	1030	6,700	0	--	--	--	--
	98-06-18	0855	830	0	2	--	870	-5
	98-06-25	1005	190	0	--	--	--	--
	98-07-02	0950	460	0	--	--	--	--
11	98-06-04	1255	70	0	0	0	80	-13
	98-06-11	1110	2,300	0	--	--	--	--
	98-06-18	0930	410	0	3	--	--	--
	98-06-25	1100	800	0	0	--	--	--
	98-07-02	1030	1,600	0	--	--	1,400	13
12	98-06-01	1155	2,600	0	--	--	--	--
	98-06-08	1425	2,000	0	--	--	--	--
	98-06-15	1055	8,200	0	2	0	7,500	9
	98-06-22	1130	720	0	--	--	--	--
	98-06-29	1120	340	0	0	--	280	19
13	98-06-01	1550	5,800	0	--	--	--	--
	98-06-08	1550	150	0	0	--	160	-6
	98-06-15	1200	9,700	0	--	--	--	--
	98-06-22	1235	320	0	--	--	--	--
	98-06-29	1215	460	0	--	--	--	--

Table 5. Quality-assurance data associated with the Group 1 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Sequential duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
14	98-06-01	1642	4,200	0	--	--	--	--
	98-06-08	1625	150	0	--	--	--	--
	98-06-15	1240	8,300	0	--	--	--	--
	98-06-22	1348	460	--	--	--	--	--
	98-06-29	1255	130	0	--	0	--	--
15	98-06-02	1420	870	0	0	--	1,300	-40
	98-06-08	1755	310	0	--	--	--	--
	98-06-15	1440	11,000	0	--	--	--	--
	98-06-22	1550	460	0	0	--	--	--
	98-06-29	1540	310	0	--	--	--	--
15	98-07-22	1158	43,000	0	--	--	--	--
	98-07-29	1149	470	0	0	--	--	--
	98-08-05	1155	31,000	0	--	--	--	--
	98-08-12	1230	1,800	0	0	--	--	--
	98-08-19	1305	250	0	--	--	--	--
15	98-08-26	1225	750	0	0	--	--	--
	98-09-02	1230	240	0	--	--	240	0
	98-09-09	1210	K830	0	0	--	--	--
16	98-06-02	1340	700	0	--	--	--	--
	98-06-09	1400	500	0	--	--	--	--
	98-06-16	1310	18,000	0	--	--	--	--
	98-06-23	1335	430	0	--	--	--	--
	98-06-30	1310	5,900	0	--	--	--	--

Table 5. Quality-assurance data associated with the Group 1 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, June–September 1998—Continued

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Sequential duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
17	98-06-03	1058	200	0	--	--	--	--
	98-06-10	1038	600	0	--	--	--	--
	98-06-17	0925	6,700	0	--	--	6,900	-3
	98-06-24	1118	480	0	--	--	--	--
	98-07-01	1040	1,700	0	--	--	1,800	-6
18	98-06-03	1205	280	0	--	--	--	--
	98-06-10	1138	660	0	--	--	--	--
	98-06-17	1015	13,000	0	--	--	--	--
	98-06-24	1215	680	0	0	--	--	--
	98-07-01	1130	3,100	0	--	--	--	--
19	98-06-03	1328	240	0	0	--	290	-19
	98-06-10	1300	370	0	--	--	--	--
	98-06-17	1100	17,000	0	--	--	--	--
	98-06-24	1352	430	0	--	--	--	--
	98-07-01	1210	420	0	--	--	--	--
20	98-06-04	1000	470	0	--	--	--	--
	98-06-11	0805	550	0	--	--	--	--
	98-06-17	1140	8,700	0	0	--	--	--
	98-06-25	0825	250	0	--	--	270	-8
	98-07-01	1250	48	0	--	--	--	--
21	98-06-04	1051	240	0	--	--	--	--
	98-06-11	0910	1,600	0	4	0	800	69
	98-06-18	0800	2,800	0	--	--	3,800	-31
	98-06-25	0915	420	0	0	--	--	--
	98-07-02	0850	930	0	--	--	--	--

Table 6. Quality-assurance data associated with the Group 2 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, August–September 1998

[K, values estimated from non-ideal colony counts; --, no data]

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Concurrent duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
22	98-08-06	0910	160	0	--	--	--	--
	98-08-13	0830	57	0	--	--	--	--
	98-08-20	0945	K8	0	--	--	K9	-12
	98-08-27	0815	28	0	--	--	--	--
	98-09-03	0935	40	0	--	--	--	--
23	98-08-06	0955	130	0	--	--	--	--
	98-08-13	0900	K8	0	--	--	K3	98
	98-08-20	1030	K6	0	--	--	--	--
	98-08-27	0845	K13	0	--	--	--	--
	98-09-03	1025	16	0	--	--	--	--
24	98-08-06	1045	1,300	0	--	--	--	--
	98-08-13	0950	170	0	--	--	--	--
	98-08-20	1155	220	0	--	--	--	--
	98-08-27	0950	270	0	--	--	--	--
	98-09-03	1140	220	0	--	--	220	0
25	98-08-06	1125	760	0	--	--	--	--
	98-08-13	1030	110	0	--	--	--	--
	98-08-20	1245	170	0	--	--	--	--
	98-08-27	1035	110	0	--	--	250	-82
	98-09-03	1245	330	0	--	--	--	--
26	98-08-06	1210	7,100	0	--	0	2,800	93
	98-08-13	1105	200	0	--	--	--	--
	98-08-19	1330	270	0	0	--	--	--
	98-08-27	1120	250	0	--	--	--	--
	98-09-03	1320	210	0	--	--	--	--

Table 6. Quality-assurance data associated with the Group 2 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, August–September 1998—Continued

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Concurrent duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
27	98-08-05	1405	17,000	0	--	--	18,000	-6
	98-08-12	1340	250	0	--	--	--	--
	98-08-20	1520	300	0	0	--	--	--
	98-08-26	1315	260	0	--	--	--	--
	98-09-02	1500	210	0	0	--	--	--
28	98-08-05	1320	7,200	0	--	--	--	--
	98-08-12	1300	170	0	--	--	--	--
	98-08-19	1425	220	0	--	0	210	5
	98-08-26	1230	190	0	--	--	--	--
	98-09-02	1415	140	0	--	--	--	--
29	98-08-05	1145	26,000	0	--	--	--	--
	98-08-12	1130	260	0	--	--	--	--
	98-08-19	1325	240	0	--	--	--	--
	98-08-26	1140	190	0	--	--	--	--
	98-09-02	1315	160	0	--	--	--	--
30	98-08-05	1100	7,600	0	--	--	--	--
	98-08-12	1055	200	0	--	--	--	--
	98-08-19	1150	150	0	--	--	--	--
	98-08-26	1050	300	0	--	--	--	--
	98-09-02	1145	200	0	--	--	200	0
31	98-08-05	1015	19,000	0	--	--	--	--
	98-08-12	1015	360	0	--	--	--	--
	98-08-19	1100	230	0	--	--	--	--
	98-08-26	1005	320	0	--	--	320	0
	98-09-02	1040	260	0	--	--	--	--

Table 6. Quality-assurance data associated with the Group 2 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, August–September 1998—Continued

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Concurrent duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
32	98-08-05	0930	70,000	0	--	--	--	--
	98-08-12	0930	170	0	--	0	170	0
	98-08-19	1020	100	0	--	--	--	--
	98-08-26	0925	54	0	0	--	--	--
	98-09-02	1005	25	0	--	--	--	--
33	98-08-04	1245	300	0	--	--	--	--
	98-08-11	1110	140	0	--	--	--	--
	98-08-18	1415	93	0	--	--	--	--
	98-08-25	1100	32	0	--	--	--	--
	98-09-01	1235	120	0	--	--	--	--
34	98-08-03	1445	97	0	--	--	--	--
	98-08-10	1335	2,700	0	--	--	--	--
	98-08-17	1508	210	0	--	--	180	15
	98-08-24	1355	150	0	--	--	--	--
	98-08-31	1520	150	0	--	--	--	--
35	98-08-03	1515	46	0	--	--	31	40
	98-08-10	1400	6,400	0	--	--	--	--
	98-08-17	1540	100	0	--	--	--	--
	98-08-24	1430	64	0	--	--	--	--
	98-08-31	1543	67	0	--	--	--	--
36	98-08-04	1512	620	0	--	--	280	80
	98-08-10	1440	1,900	0	--	--	--	--
	98-08-17	1620	80	0	0	--	--	--
	98-08-24	1505	39	0	--	--	--	--
	98-08-31	1610	70	0	0	--	--	--

Table 6. Quality-assurance data associated with the Group 2 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, August–September 1998—Continued

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Concurrent duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
37	98-08-04	1440	14,000	0	--	--	--	--
	98-08-11	1235	520	0	--	--	--	--
	98-08-18	1625	83	0	0	--	90	-8
	98-08-25	1235	3,300	0	--	--	--	--
	98-09-01	1515	220	0	--	--	--	--
38	98-08-04	1325	1,700	0	--	--	--	--
	98-08-11	1150	810	0	--	--	--	--
	98-08-18	1510	240	0	--	--	--	--
	98-08-25	1135	1,400	0	--	--	--	--
	98-09-01	1355	36	0	0	0	33	9
39	98-08-04	0945	4,900	0	--	--	--	--
	98-08-11	0855	1,300	0	--	--	300	147
	98-08-18	1045	200	0	--	--	--	--
	98-08-25	0845	3,000	0	--	--	--	--
	98-09-01	0955	80	0	--	--	--	--
40	98-08-05	1310	80,000	0	0	--	--	--
	98-08-12	1410	480	0	--	--	--	--
	98-08-19	1440	220	0	--	--	200	10
	98-08-26	1350	130	0	--	--	--	--
	98-09-02	1315	100	0	0	--	--	--
41	98-08-03	1150	210	0	--	--	--	--
	98-08-10	1045	600	0	--	--	1,300	-77
	98-08-17	1155	21,000	0	--	--	--	--
	98-08-24	1105	500	0	2	--	--	--
	98-08-31	1125	390	0	--	--	--	--

Table 6. Quality-assurance data associated with the Group 2 *Escherichia coli* samples collected in the Upper Wabash River Watershed in Indiana, August–September 1998—Continued

Site number	Date	Time	*Escherichia coli* (colonies per 100 milliliters)	Filter blank	Process blank	Field blank	Concurrent duplicate sample for *Escherichia coli* (colonies per 100 milliliters)	Natural log percent difference
42	98-08-04	1030	270	0	--	--	--	--
	98-08-11	0950	780	0	--	--	--	--
	98-08-18	1135	220	0	--	--	--	--
	98-08-25	0930	730	0	0	--	--	--
	98-09-01	1045	300	0	--	--	--	--
43	98-08-04	1115	1,500	0	0	--	--	--
	98-08-11	1025	650	0	1	--	--	--
	98-08-18	1240	100	0	--	--	--	--
	98-08-25	1010	150	0	--	--	93	48
	98-09-01	1140	160	0	--	--	--	--
44	98-08-03	1250	330	0	--	--	--	--
	98-08-10	1140	600	0	--	--	--	--
	98-08-17	1250	520	0	--	--	--	--
	98-08-24	1210	150	0	--	--	150	0
	98-08-31	1230	120	0	--	--	--	-
45	98-08-03	1340	260	0	0	--	--	--
	98-08-10	1225	630	0	--	--	--	--
	98-08-17	1345	240	0	--	--	--	--
	98-08-24	1255	280	0	--	--	--	--
	98-08-31	1316	220	0	--	--	173	24
46	98-08-03	1410	180	0	--	--	--	--
	98-08-10	1250	3,500	0	--	--	--	--
	98-08-17	1415	340	0	--	--	--	--
	98-08-24	1320	250	0	--	--	--	--
	98-08-31	1352	620	0	--	--	--	--