

# Quality of Surface Water in New Jersey, Water Years 2009 and 2010

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## Introduction

The U.S. Geological Survey (USGS), in cooperation with Federal, State, and local agencies, collects a large amount of data pertaining to the water resources of New Jersey each water year (WY—October 1 to September 30). These data are stored and maintained in the National Water Information System database (NWIS) and constitute a valuable source of reliable, impartial, and timely information for developing an improved understanding of the water resources of the State. To make this information readily available, the data were published annually from WY 1961 to WY 2005 in the report series, titled “Water Resources Data-New Jersey.” Additionally, data from WY 2002 through WY 2005 are available in electronic form as PDF files of individual, or groups of, stations. Data from WY 2006 through WY 2010 are available as individual electronic Site Data Sheets. Both forms of current and archival electronic data can be accessed through the World Wide Web at <http://wdr.water.usgs.gov>. The water-quality volumes of the WY 2009 and WY 2010 annual data reports consist of analytical results of multiple samples from 178 surface-water stations and single samples from 43 streambed-sediment and 61 groundwater stations and can also be accessed through the USGS-NJ Water Science Center at <http://nj.usgs.gov/adr/adr2009/WDR-NJ-09-3> and <http://nj.usgs.gov/adr/adr2010/WDR-NJ-10-3/>. These volumes include a detailed cross-referenced index of stations.

Data on the physical characteristics of some streams are available in near real-time. Continuous records of water temperature, specific conductance, pH, dissolved oxygen (DO) concentration, DO in percent of saturation, or turbidity were collected at stations 01382210, Pequannock River at Oak Ridge; 01388000, Ramapo River at Pompton Lakes NJ, downstream of dam; 01389005, Passaic River below Pompton River at Two Bridges NJ; 01400500, Raritan River at Manville; 01408029, Manasquan River at Allenwood; 01463500, Delaware River at Trenton NJ; and 01467029, Delaware River diversion at Delran. Not all constituents are measured at each station. These data are not summarized in this report but are available in near real time at <http://waterdata.usgs.gov/nj/nwis/current/?type=quality>. These records consist of near real-time hourly values for the most recent 120-day period. Daily values (maximum, minimum, and mean) for the period of record can be found on the NWIS Web at <http://nwis.waterdata.usgs.gov/nj/nwis>.

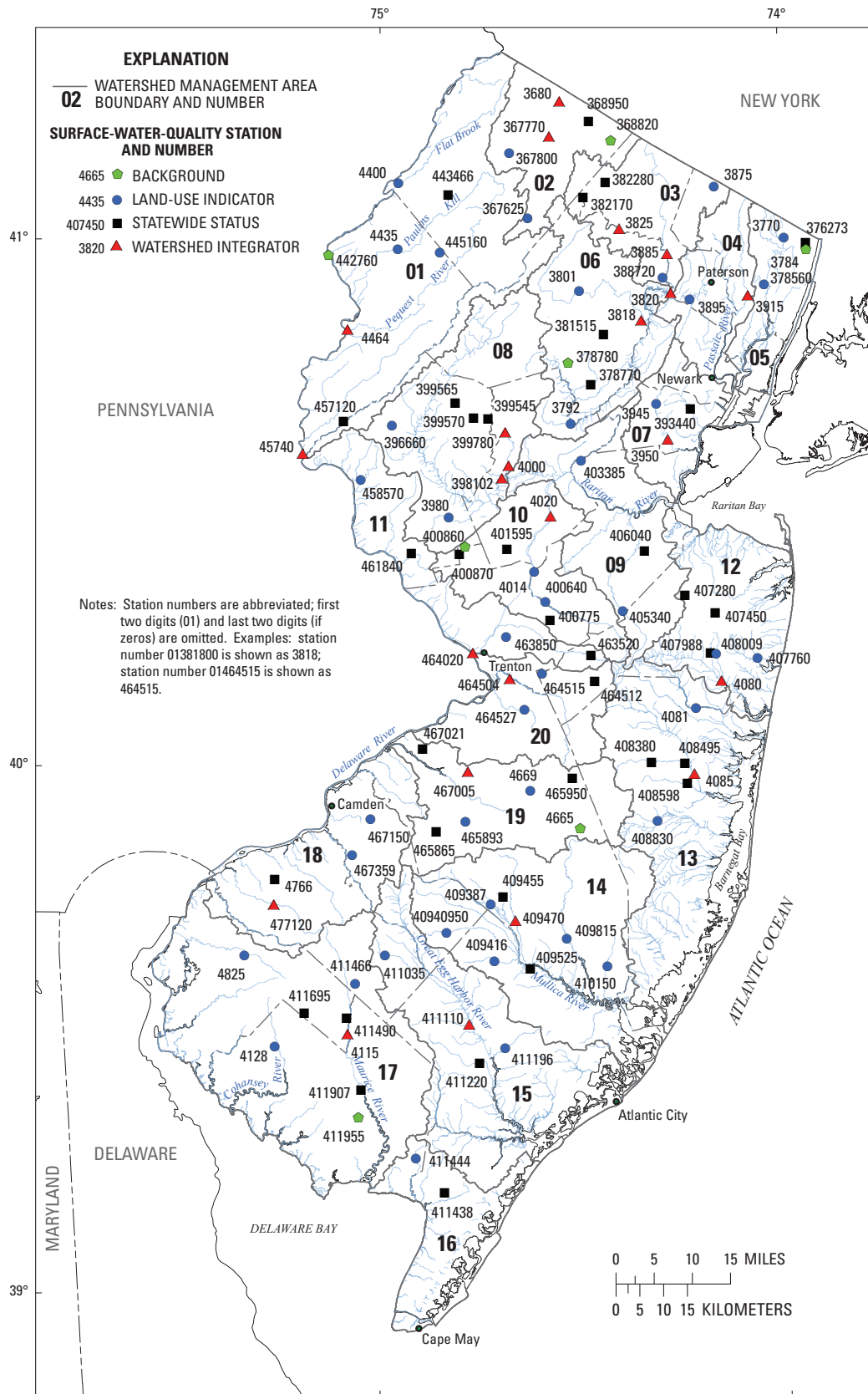
In WY 2009, studies were conducted during base-flow conditions to measure the 24-hour variability of continuously monitored DO concentration, DO in percent of saturation, specific conductance, water temperature, and pH at two Ambient Surface-Water-Quality Monitoring Network (ASWQMN)

stations and eight special-study sites, and in WY 2010, at two network stations. The sites monitored during 2009 were 01397000, South Branch Raritan River at Stanton; 01398110, Holland Brook at South Branch; 01399520, Herzog Brook near Pottersville; 0140000, North Branch Raritan River near Raritan; 01403075, East Branch Middle Brook at Green Valley Road, at Warrenville; 01404100, Raritan River near South Bound Brook; 01405003, Lawrence Brook at River Avenue, at Milltown; 01408100, North Branch Metedeconk River at Lakewood; 01443500, Paulins Kill at Blairstown, 01446400, Pequest River at Belvidere, and 01461900, Alexauken Creek near Lambertville. The sites monitored during WY 2010 were 01408100, North Branch Metedeconk River at Lakewood and 01443500, Paulins Kill at Blairstown. Site selection was based on previous occurrence of DO super-saturation (greater than 120 percent of saturation), DO under-saturation (less than 60 percent of saturation), or exceedance of New Jersey surface-water-quality standards. In-situ multiparameter water-quality monitors measured the occurrence and magnitude of diurnal variations not observed when instantaneous samples were collected during sampling visits (generally between the hours of 8 a.m. and 2 p.m.). The monitors were deployed for 1 or 2 periods during July to September with each period lasting 5 to 7 days. The data are not summarized in this report but can be accessed in tabular form at [http://nj.usgs.gov/qw/diurnal\\_do/](http://nj.usgs.gov/qw/diurnal_do/) and in graphical form in the annual data reports.

The purpose of this report is to summarize selected ambient surface-water-quality data collected cooperatively by the USGS and New Jersey Department of Environmental Protection (NJDEP) during WY 2009 and WY 2010. Data on the physical characteristics and (or) water-quality constituents in samples collected at 113 surface-water and 43 streambed-sediment stations are presented in figures and tables.

## Ambient Surface-Water-Quality Monitoring Network

The USGS and NJDEP operate the cooperative Ambient Surface-Water-Quality Monitoring Network (ASWQMN)—a collection of monitoring stations on streams throughout New Jersey. Constituent concentration data from the ASWQMN are used to determine statewide water-quality status and trends, define the water quality of streams near the downstream end of each NJDEP Watershed Management Area (WMA), define background water quality in each of the four physiographic provinces of New Jersey, and define water quality in streams that drain targeted land-use areas. The ASWQMN consists of as many as 115 stations located throughout the 20 WMAs (fig. 1). Seven background stations are located on reaches of streams that remain relatively unaffected by human activity;



**Figure 1.** Location and type of stations in the Ambient Surface-Water-Quality Monitoring Network, water years 2009 and 2010.

data from these stations are used to develop a water-quality database consisting of baseline measurements. Twenty-three Watershed Integrator (Integrator) stations are located near the farthest downstream point, not affected by tide, in one of the large drainage basins in each WMA, except WMAs 5, 9, and 16 because of the effects of tides, lack of suitable sites, and limited basin size, respectively. The Integrator stations provide water-quality data for large drainage areas that integrate the effects of different types of land use on, and point and nonpoint contributions of constituents to, the water quality of streams within each WMA. Land Use Indicator (LUI) stations are used to monitor the effects of the dominant land use in each WMA and provide data on nonpoint source loading of contaminants to streams. Of the 43 LUI stations, 15 are designated undeveloped; 9, agriculture; 13, urban; and 6, mixed. Statewide status (Status) stations were chosen randomly to obtain a statistical basis that can be used to estimate values of water-quality indicators statewide. Status stations were selected on a bi-annual basis and were sampled during two consecutive years. Forty-two Status stations were chosen randomly in WY 2009, and 41 were chosen in WY 2010. Status stations were sited at six existing Integrator or LUI stations in WY 2009 and five stations in WY 2010. Additionally, four stations on the Delaware River main stem were dropped in 2010. The total number of stations sampled was reduced to 113 in WY 2009 and 109 in WY 2010. Data from four additional stations on the Delaware River, the border between New Jersey and Pennsylvania, are not summarized in this report. The results obtained from samples collected in water 2009 are available in the 2009 annual data report at <http://wdr.water.usgs.gov>.

### Laboratory Reporting Conventions

The analyzing laboratories use two different methods and reporting conventions to establish the minimum concentration above which a quantitative measurement can be made. These reporting conventions are the minimum reporting level (MRL) and the laboratory reporting level (LRL). The MRL, used infrequently with certain methods, is defined by the National Water Quality Laboratory (NWQL) as the smallest concentration of a substance that can be reliably measured using a given analytical method. The LRL, used frequently with most methods, generally is equal to twice the yearly determined long-term method detection level (LT-MDL). The LT-MDL is a detection level derived by determining the standard deviation of a minimum of 24 method detection limit spike-sample measurements over an extended period of time. The LT-MDL controls false positive error; the probability of falsely reporting a concentration at or greater than the LT-MDL for a sample that did not contain an analyte is predicted to be less than or equal to 1 percent. The LRL controls false negative error; the probability of falsely reporting a non-detection for a sample that contained an analyte at a concentration equal to or greater than the LRL is predicted to be less than or equal to 1 percent. Analytes detected at concentrations between the LT-MDL and the LRL, and that pass identification criteria, are “estimated” (noted with a remark code of E). The value of the LRL is reported with a “less than” (<) remark code for samples in which the analyte is not detected.

### Data Analysis Methods

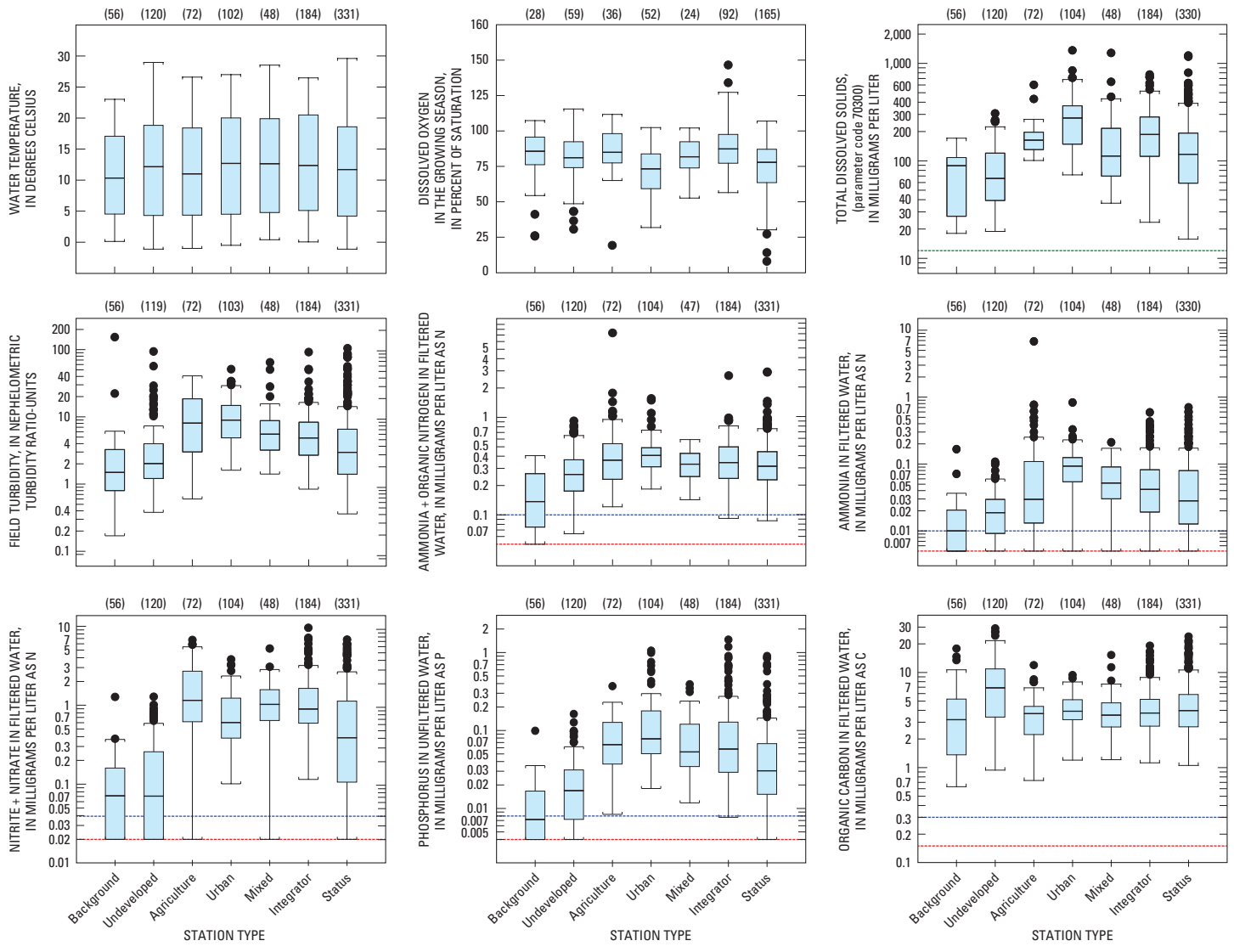
The distribution of selected constituent data is graphically displayed using side-by-side box plots. The plots show

the median [midpoint of the data (50th percentile)—the center line of the box], the variation [interquartile range (25th to 75th percentiles)—the box height], the skewness (quartile skew—the relative size of the box halves), the spread (upper and lower adjacent values—vertical lines or whiskers), and the presence or absence of unusual values or outliers (individual points). If the median equals the 25th and 75th percentiles, the box is represented by a line. For box plots in this report, values reported to be less than the LRL or MRL are included in each distribution as a value equal to the LT-MDL or one-half the MRL, respectively; values reported as “E”—estimated to be greater than the LT-MDL but less than the LRL—also are included. The following constituents had multiple LRLs during the 2-year period: arsenic, beryllium, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, Carbaryl, Chloromethylphenol, Dacthal, Dichloroaniline, Metalaxyl, Metribuzin, Naphthol, Simazine, Tebuthiuron, and Trifluralin. For these, values reported as less than the lower LRL or estimated between the lower LT-MDL and LRL were corrected to the higher of the two LT-MDLs. For scatter distributions of detected values in this report, values reported as less than the LRL are considered to be not detected and are excluded; values that were reported as estimates below the LRL are included.

### Distribution and Concentration of Selected Constituents from Stations in the ASWQMN

Physical characteristics and concentrations of filtered and unfiltered nutrients, filtered organic carbon, and total dissolved solids (TDS; parameter code 70300, residue upon evaporation) were determined in water samples from 110 stations in the ASWQMN. Samples were collected at each station four times each WY during November to December, February to March, May to June, and August to September. Data are presented in boxplots in figure 2. Water temperatures over the 2 years ranged from a minimum of -1.1 °C to a maximum of 29.6 °C; both were measured at Status stations. The low for temperature was also measured at an undeveloped land-use indicator station (fig. 2). DO in percent of saturation, in the growing season, ranged from 8.0 to 147 percent; the low was measured at a Status station, and the high was measured at a Watershed Integrator station. Field-determined turbidity ranged from 0.17 nephelometric turbidity ratio units (NTRU) to 154 NTRU; both were measured at background stations. TDS concentrations ranged from 16 milligrams per liter (mg/L) in a sample collected at a Status station to 1,360 mg/L at an urban-LUI station. Ammonia-plus-organic nitrogen concentrations in filtered water ranged from 0.05 mg/L at a background station to 7.4 mg/L at an agriculture-LUI station. Ammonia as nitrogen (N) concentrations in filtered water ranged from 0.005 mg/L at a Status station to 6.81 mg/L at an agriculture-LUI station. Nitrite-plus-nitrate as nitrogen concentrations in unfiltered water ranged from 0.02 mg/L at several station types to 9.56 mg/L at a Watershed Integrator station. Phosphorus concentrations in filtered water ranged from 0.004 mg/L at several station types to 1.46 mg/L at a Watershed Integrator station.

The median water temperatures measured during WY 2009 and WY 2010 were similar for all station types, ranging from 10.3 to 12.7 °C. Samples from urban-LUI stations had the lowest median DO in the growing season (73.2 percent); the highest median turbidity (9.0 NTRU); and the highest median



**EXPLANATION**

- (56) Number of observation
- Outlier data values less than or equal to 3 and more than 1.5 times the interquartile range outside the quartile
- Data value less than or equal to 1.5 times the interquartile range outside the quartile
  - 75th percentile
  - Median
  - 25th percentile
- Minimum reporting level
- Laboratory reporting level
- Long-term method detection level

**Figure 2.** Distribution of selected physical characteristics and concentrations of nutrients in samples from 113 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2009 and 2010. [“Less than” values are shown as equal to the long-term method detection level (or one-half the laboratory reporting level).]

concentrations of TDS (275 mg/L), ammonia-plus-organic nitrogen (0.41 mg/L), ammonia as nitrogen (0.09 mg/L), and phosphorus (0.08 mg/L). Agriculture-LUI stations had the highest median concentration of nitrite-plus-nitrate as N (1.15 mg/L). In contrast, samples from background and undeveloped-LUI stations had the lowest median levels of turbidity (1.5 and 2.0 NTRU, respectively) and the lowest median concentrations of TDS (89.2 and 66.0 mg/L), ammonia as N (0.01 and 0.02 mg/L), ammonia-plus-organic nitrogen (0.14 and 0.26 mg/L), nitrite-plus-nitrate as N (0.02 mg/L), and phosphorus (0.007 and 0.017 mg/L).

Dissolved organic carbon (DOC) is a heterogeneous mixture of many organic materials, mostly high molecular-weight organic acids, which are the product of biodegradation of organic matter. Organic matter can originate from anthropogenic or natural sources. For example, urban-LUI stations would have DOC associated with human activities, and undeveloped-LUI and background stations would have naturally occurring DOC. Concentrations of DOC during WY 2009 and WY 2010 ranged from 0.6 mg/L at a background station to 29.1 mg/L at an undeveloped-LUI station. The highest median concentrations of DOC were found in samples from undeveloped-LUI and Status stations (6.9 and 4.0 mg/L, respectively).

#### Distribution and Concentration of Recoverable Trace Elements from Selected Stations in the ASWQMN

Samples for the determination of recoverable trace elements in unfiltered water were collected during February to March and August to September of 2009 and 2010 at 7 background stations, as well as 42 Status stations, in 2009 and 41 Status stations in 2010. Concentrations ranged as follows: arsenic, 0.10 to 3.9 micrograms per liter ( $\mu\text{g/L}$ ); barium, 7.2 to 254  $\mu\text{g/L}$ ; beryllium, 0.02 to 2.99  $\mu\text{g/L}$ ; boron, 7 to 337  $\mu\text{g/L}$ ; cadmium, 0.03 to 1.16  $\mu\text{g/L}$ ; chromium, 0.21 to 5.6  $\mu\text{g/L}$ ; copper, 2.0 to 12.6  $\mu\text{g/L}$ ; iron, 7 to 8,740  $\mu\text{g/L}$ ; lead, 0.05 to 10.7  $\mu\text{g/L}$ ; manganese, 0.57 to 486  $\mu\text{g/L}$ ; mercury, 0.005 to 0.128  $\mu\text{g/L}$ ; nickel, 0.16 to 10.7  $\mu\text{g/L}$ ; selenium, 0.06 to 2.2  $\mu\text{g/L}$ ; silver, 0.03 to 2.33  $\mu\text{g/L}$ ; and zinc, 1.0 to 72.8  $\mu\text{g/L}$ . The median concentration of each trace element, in general, was lower in samples from background stations than in samples from Status stations (fig. 3). Measurable concentrations (greater than the LRL) of all constituents, except mercury, were present in at least 1 of the 28 samples from background stations. Median concentrations of arsenic, barium, iron, manganese, and selenium, determined in samples collected at background stations, were less than the 25th percentile concentration of samples from Status stations.

#### Distribution, Concentration, and Detection Frequency of Pesticides from Selected Stations in the ASWQMN

Samples for the determination of moderate-use pesticides and selected degradates in filtered water (USGS method number O-2002-01) were collected during May and June of 2009 and 2010 at 7 background and 42 Status stations. Thirty-one of 87 compounds analyzed were detected in at least one sample. Fifteen of those 31 compounds had only very low (estimated) concentrations, whereas 16 compounds had concentrations greater than their respective LRLs (fig. 4). All 31 compounds were detected in samples from one or more Status stations. The

herbicides atrazine, chloro-triazine, dichloroaniline, metolachlor, and prometon were the only compounds detected at background stations; concentrations generally were near or less than 0.01  $\mu\text{g/L}$ . Atrazine, metolachlor, and chloro-triazine were the most frequently detected compounds in 84, 78, and 76 percent of all samples, respectively. Median concentrations generally were near 0.01  $\mu\text{g/L}$ . Concentrations of atrazine ranged from 0.004 to 0.286  $\mu\text{g/L}$ , concentrations of metolachlor ranged from 0.004 to 0.139  $\mu\text{g/L}$ , and concentrations of chloro-triazine ranged from 0.004 to 0.074  $\mu\text{g/L}$ . A generally high detection of carbaryl was estimated at 0.188  $\mu\text{g/L}$  in one sample from a Status station.

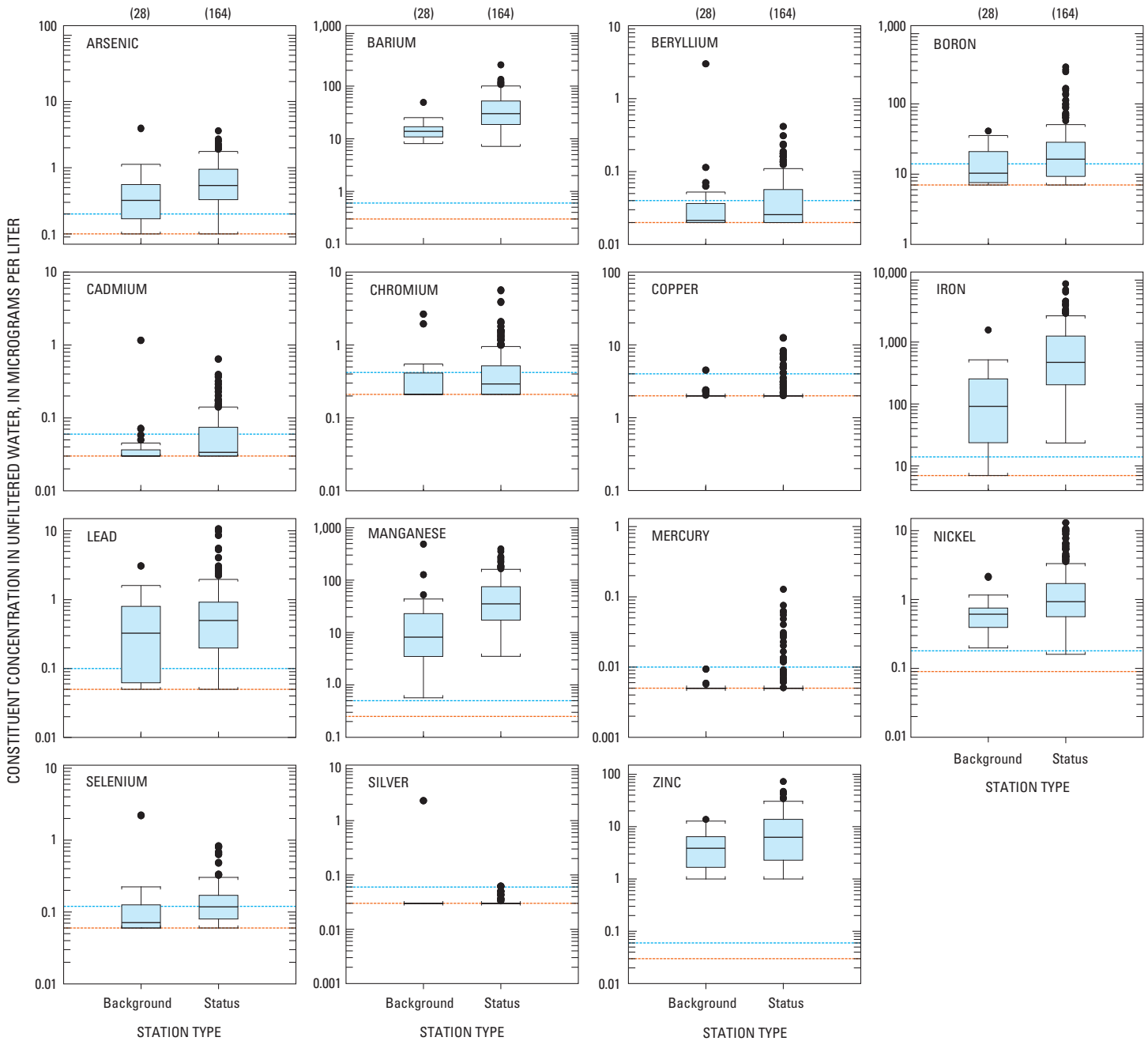
#### Distribution and Concentration of Nutrients and Recoverable Trace Elements in Streambed Sediment from Selected Stations in the ASWQMN

Samples for the determination of selected constituent concentrations in streambed sediment were collected at 23 of the Status stations in WY 2009 and 22 in WY 2010. In the event Status stations were determined to be unsuitable for the collection of streambed sediments, other types of stations were substituted. Samples for the determination of nutrients and trace elements in streambed sediment were collected under low-flow conditions during August and September of 2009 and 2010 at a combined total of 2 undeveloped-LUI, 7 Integrator, and 36 Status stations. Total carbon was present in all streambed-sediment samples, and concentrations ranged from 0.4 grams per kilogram (g/kg) to 140 g/kg (fig. 5). The highest concentrations of total carbon occurred at Status stations. Phosphorus concentrations ranged from 3.25 milligrams per kilogram (mg/kg) to 1,800 mg/kg, and both concentrations occurred at Integrator stations. Median concentrations did not vary appreciably by station type.

Measurable concentrations of several trace elements—arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, and zinc—were found in all samples of streambed sediment (fig. 6). Concentrations ranged as follows: arsenic, from 0.25 to 47.0 milligrams per kilogram (mg/kg), both at Status stations; cadmium, from 0.01 mg/kg at a Status station to 2.14 mg/kg at an Integrator station; chromium, 1.24 mg/kg at a Status station to 70.1 mg/kg at an Integrator station; cobalt 0.05 to 78.6 mg/kg, both at Status stations; iron, 346 mg/kg at a Status station to 57,460 mg/kg at an Integrator station; lead, 2.29 to 120 mg/kg, both at Status stations; manganese, 2.13 mg/kg to 1,850 mg/kg, both at Status stations; nickel, 0.24 to 134 mg/kg, both at Status stations; and zinc, 3.33 to 222 mg/kg, both at Status stations. Concentrations less than the MRLs of cobalt, copper, mercury, and selenium were reported in 1, 8, 30, and 17 samples, respectively. Measurable concentrations did not vary appreciably by station type.

#### Distribution, Concentration, and Detection Frequency of Organic Compounds in Streambed Sediment from Selected Stations in the ASWQMN

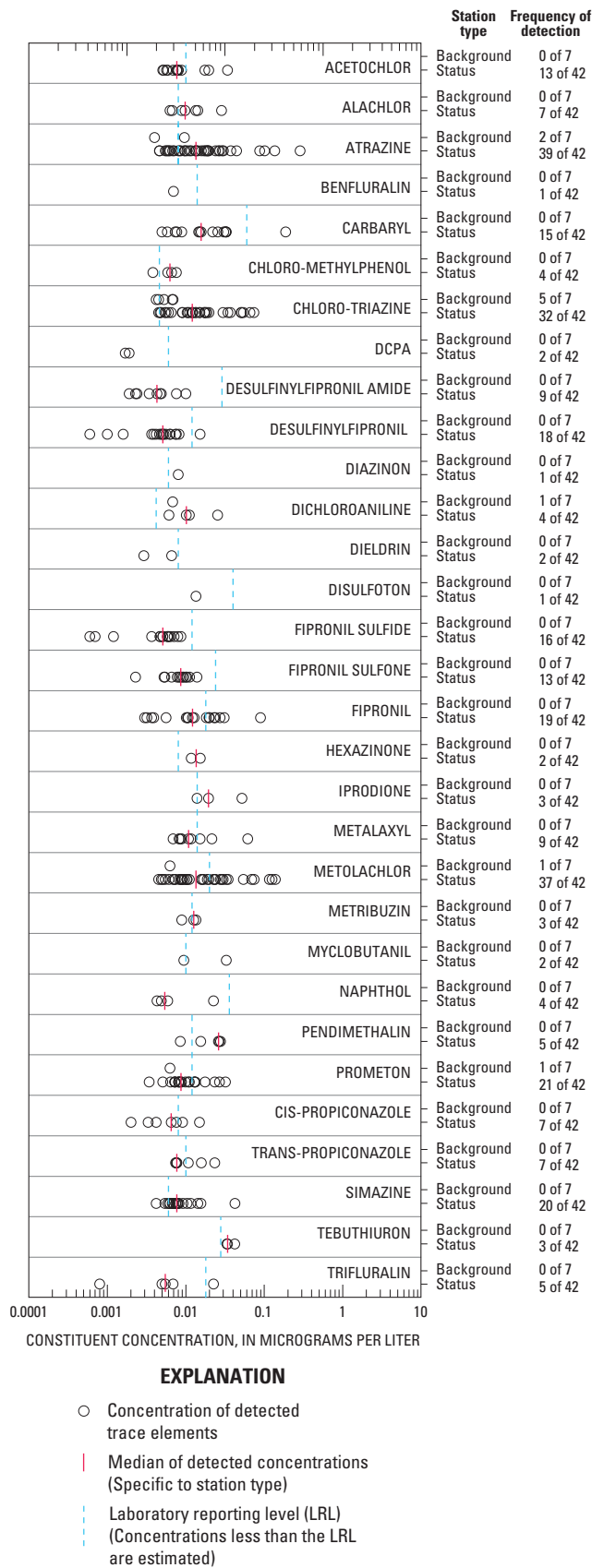
Samples for the determination of polycyclic aromatic hydrocarbon (PAH) and total polychlorinated biphenyl (PCB) concentrations in bed sediment were collected at the same times and station types noted in the preceding section. Of the 29 PAH compounds analyzed using USGS method number



**EXPLANATION**

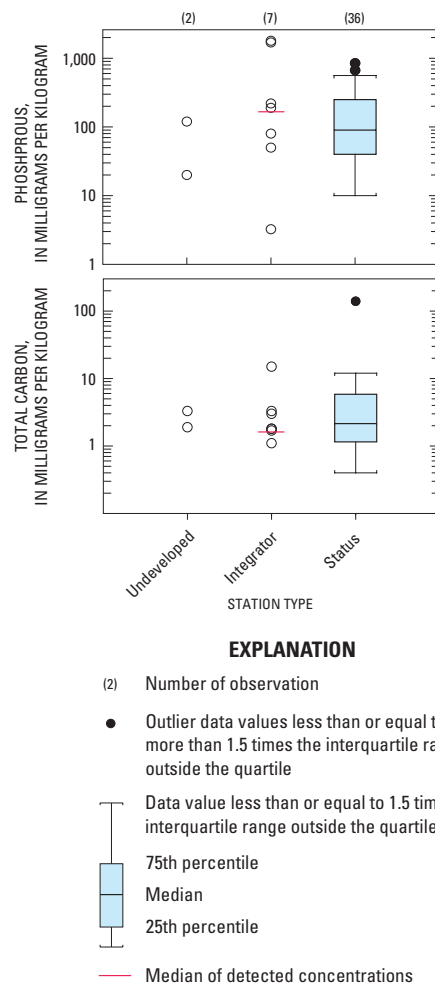
- (28) Number of observation
- Outlier data values less than or equal to 3 and more than 1.5 times the interquartile range outside the quartile
- Data value less than or equal to 1.5 times the interquartile range outside the quartile
- 75th percentile
- Median
- 25th percentile
- Laboratory reporting level
- Long-term method detection level

**Figure 3.** Distribution of concentrations of trace elements in unfiltered samples from 49 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2009 and 2010. [“Less than” values are shown as equal to the long-term method detection level (or one-half the laboratory reporting level).]

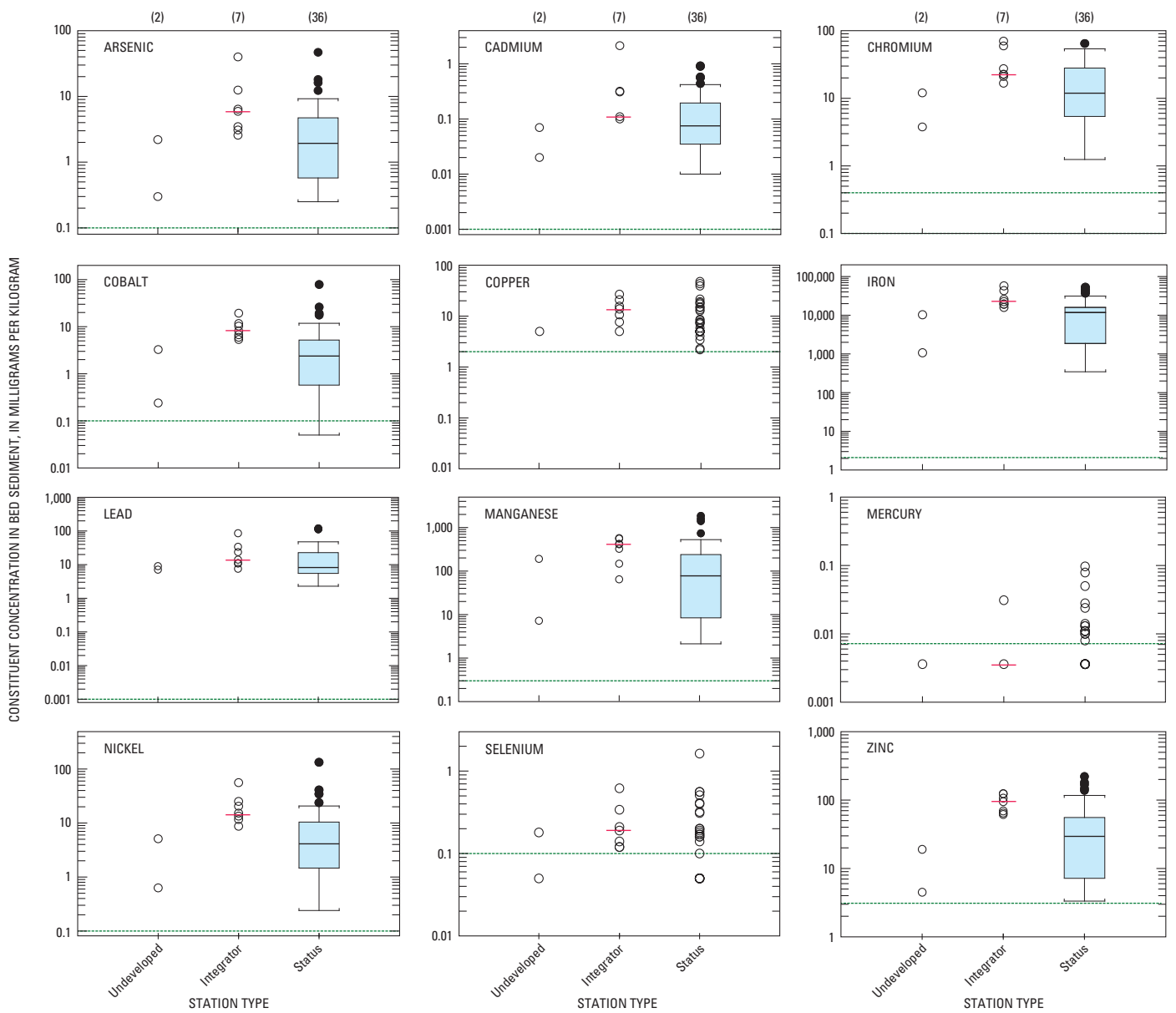


**Figure 4.** Concentration and detection frequency of selected pesticides detected in filtered samples from 49 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2009 and 2010. [Concentrations less than the long-term method detection level are considered “not detected” and are excluded. Concentrations less than the laboratory reporting level are estimated.]

O-5505-03 and total PCBs analyzed using USGS method number O-5504-03, only those that were detected and have a State of New Jersey surface-water-quality standard—15 compounds—are discussed here. Bed-sediment samples from undeveloped-LUI stations had the fewest detections and lowest concentrations; samples from Status stations had the highest concentrations (fig. 7). One compound, isophorone, was detected only once (table 1).



**Figure 5.** Concentrations of selected nutrients in streambed-sediment samples from 43 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2009 and 2010.

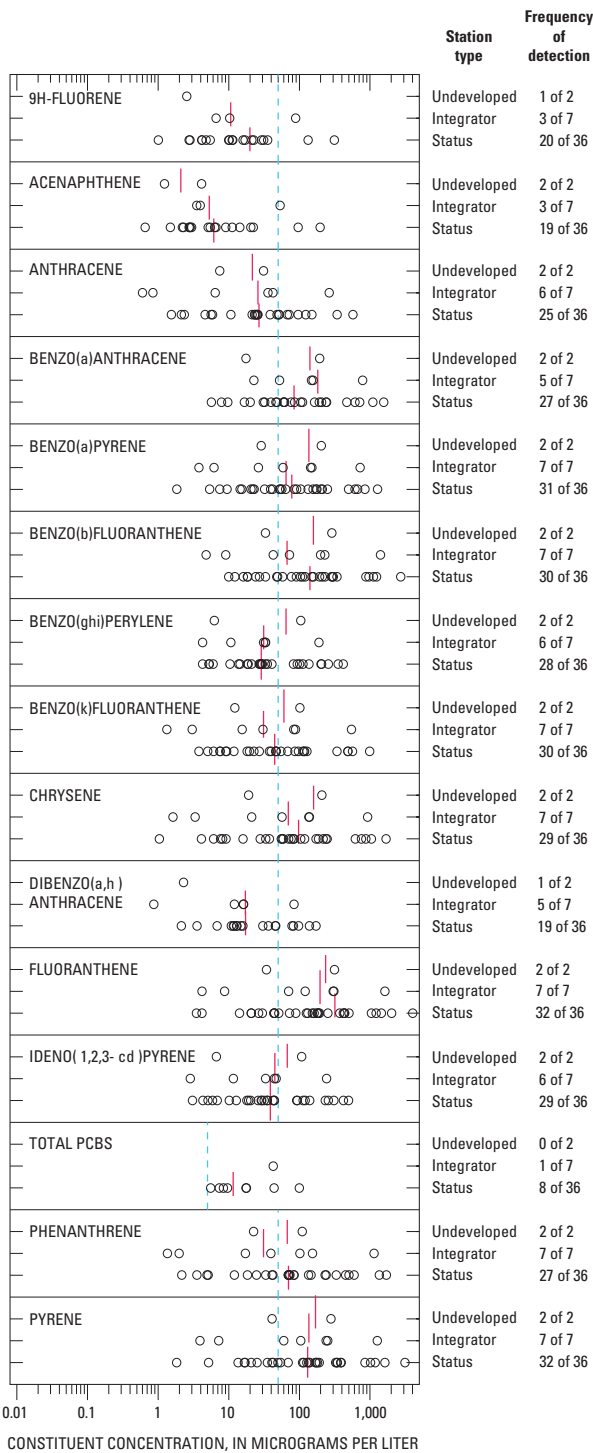


### EXPLANATION

- (2) Number of observation
- Outlier data values less than or equal to 3 and more than 1.5 times the interquartile range outside the quartile
- Data value less than or equal to 1.5 times the interquartile range outside the quartile
- 75th percentile
- Median
- 25th percentile
- Minimum reporting level
- Median of detected concentrations

**Figure 6.** Concentrations of trace elements in streambed-sediment samples from 43 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2009 and 2010. [“Less than” values are shown as one-half the minimum reporting level.]





**EXPLANATION**

- Concentration of detected pesticides
- | Median of detected concentrations (Specific to station type)
- Laboratory reporting level (LRL) (Concentrations less than the LRL are estimated)

**Table 1.** Concentration of a polycyclic aromatic hydrocarbon detected only once in streambed-sediment samples from 43 stations in the Ambient Surface-Water-Quality Monitoring Network, water years 2009 and 2010.

Constituent	Concentration (micrograms per kilogram)	Station type
Isophorone	6.73	Statewide Status

**Figure 7.** Concentration and detection frequency of selected polycyclic aromatic hydrocarbons detected in streambed-sediment samples from 43 stations in the Ambient Surface-Water-Quality Monitoring Network, in relation to station type, water years 2009 and 2010. [Concentrations less than the long-term method detection level are considered “not detected” and are excluded. Concentrations less than the laboratory reporting level are estimated.]



Station 01398000, Neshanic River at Reaville, New Jersey. (File photograph, U.S. Geological Survey, West Trenton, New Jersey)

**For additional information, write to:**  
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New Jersey Water Science Center  
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West Trenton, NJ 08628

or visit our Web site at:  
<http://nj.usgs.gov/>