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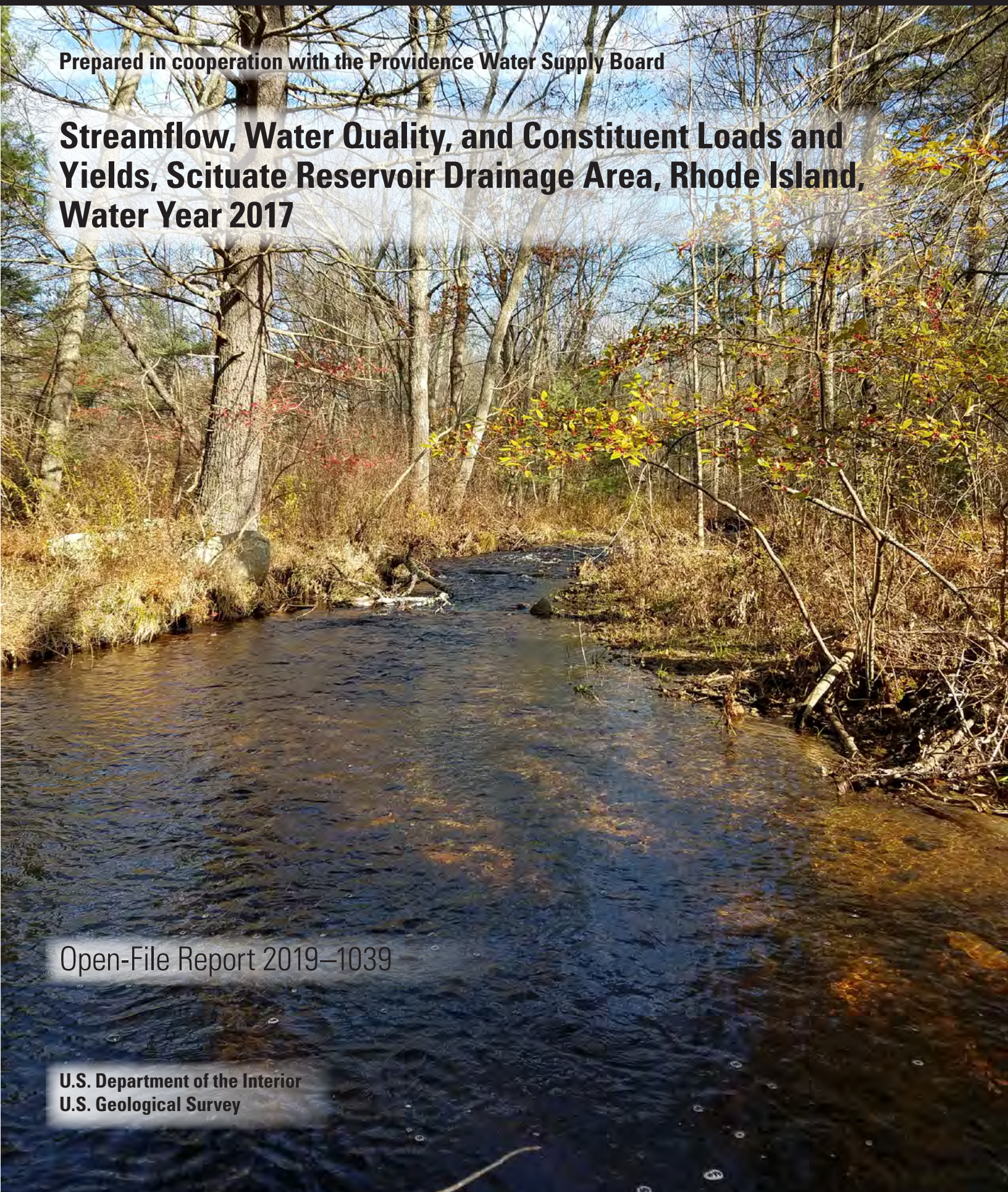

Prepared in cooperation with the Providence Water Supply Board

Streamflow, Water Quality, and Constituent Loads and Yields, Scituate Reservoir Drainage Area, Rhode Island, Water Year 2017

Open-File Report 2019–1039

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

Cover. Photograph of the Dolly Cole Brook in South Foster, Rhode Island, from U.S. Geological Survey streamgage number 01115190 at Old Danielson Pike looking southward. Photograph by Kimberly Campo, U.S. Geological Survey.

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By Kirk P. Smith

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U.S. Department of the Interior
DAVID BERNHARDT, Secretary

U.S. Geological Survey
James F. Reilly II, Director

U.S. Geological Survey, Reston, Virginia: 2019

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
ton, short (2,000 lb)	0.9072	metric ton (t)

Datum

Vertical coordinate information is referenced to North American Vertical Datum of 1988 (NAVD 88).

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

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

Supplemental Information

Concentrations of chemical constituents in water are given in either milligrams per liter (mg/L) or colony forming units per 100 milliliters (CFU/100 mL).

Loads of chemical constituents in water are given in kilograms (kg), and daily loads are given in grams per day (g/d), kilograms per day (kg/d), kilograms per year (kg/yr), metric tons per year (t/yr), or million colony forming units per day (MCFU/d).

Yields are given in grams per day per square mile ($g/d/mi^2$), kilograms per day per square mile ($kg/d/mi^2$), kilograms per year per square mile ($kg/yr/mi^2$), metric tons per year per square mile ($t/yr/mi^2$), or million colony forming units per day per square mile ($MCFU/d/mi^2$).

Abbreviations

E. coli	*Escherichia coli*
MOVE.1	Maintenance of Variance Extension type 1
NWIS	National Water Information System
PWSB	Providence Water Supply Board
RIDEM	Rhode Island Department of Environmental Management
USGS	U.S. Geological Survey
WY	water year

Streamflow, Water Quality, and Constituent Loads and Yields, Scituate Reservoir Drainage Area, Rhode Island, Water Year 2017

By Kirk P. Smith

Abstract

As part of a long-term cooperative program to monitor water quality within the Scituate Reservoir drainage area, the U.S. Geological Survey, in cooperation with the Providence Water Supply Board, collected streamflow and water-quality data at the Scituate Reservoir and tributaries. Streamflow and concentrations of chloride and sodium estimated from records of specific conductance were used to calculate loads of chloride and sodium during water year 2017 (October 1, 2016, through September 30, 2017) for tributaries to the Scituate Reservoir, Rhode Island. Streamflow was measured or estimated by the U.S. Geological Survey following standard methods at 23 streamgages; 14 of these streamgages are equipped with instrumentation capable of continuously monitoring water level, specific conductance, and water temperature. Water-quality samples were collected by the Providence Water Supply Board at 36 sampling stations, which also include the 14 continuous-record streamgages maintained by the U.S. Geological Survey, during water year 2017 as part of a long-term sampling program; all stations are in the Scituate Reservoir drainage area. Water-quality data collected by the Providence Water Supply Board are summarized by using values of central tendency and are used, in combination with measured (or estimated) streamflows, to calculate loads and yields (loads per unit area) of selected water-quality constituents for water year 2017.

The Ponaganset River, which is the largest tributary to the reservoir and was monitored by the U.S. Geological Survey, contributed a mean streamflow of 29 cubic feet per second to the reservoir during water year 2017. For the same period, annual mean streamflows measured (or estimated) for the other monitoring stations in this study ranged from about 0.44 to about 20 cubic feet per second. Together, tributaries equipped with instrumentation capable of continuously monitoring specific conductance transported about 3,100 metric tons of chloride and 1,900 metric tons of sodium to the Scituate Reservoir during water year 2017; chloride yields for the tributaries ranged from 16 to 140 metric tons per square mile, and sodium yields, from 10 to 80 metric tons per square mile.

At the stations where water-quality samples were collected by the Providence Water Supply Board, the medians of the median concentrations were 25.3 milligrams per liter for chloride, 0.002 milligram per liter as nitrogen for nitrite, 0.10 milligram per liter as nitrogen for nitrate, 0.05 milligram per liter as phosphate for orthophosphate, 1,200 colony forming units per 100 milliliters for total coliform bacteria, and 14 colony forming units per 100 milliliters for *Escherichia coli* (*E. coli*). The medians of the median daily loads of chloride, nitrite, nitrate, orthophosphate, total coliform, and *E. coli* bacteria were 230 kilograms per day, 17 grams per day, 860 grams per day, 690 grams per day, 84,000 million colony forming units per day, and 1,200 million colony forming units per day, respectively. The medians of the median yields of chloride, nitrite, nitrate, orthophosphate, total coliform, and *E. coli* bacteria were 87 kilograms per day per square mile, 6.1 grams per day per square mile, 280 grams per day per square mile, 260 grams per day per square mile, 44,000 million colony forming units per day per square mile, and 655 million colony forming units per day per square mile, respectively.

Introduction

The Scituate Reservoir is the primary source of drinking water for more than 60 percent of the population of Rhode Island. The Scituate Reservoir drainage area consists of six subbasins and covers an area of about 94 square miles in parts of the towns of Cranston, Foster, Glocester, Johnston, and Scituate, Rhode Island (fig. 1). Information about the water quality of the reservoir and its tributaries is important for management of the water supply and the protection of human health. The Providence Water Supply Board (PWSB), which is the agency responsible for the management and distribution of the Scituate Reservoir water supply, has been monitoring and assessing water quality in the reservoir and reservoir drainage area for more than 60 years.

Since 1993, the U.S. Geological Survey (USGS) has been cooperating with the PWSB and the Rhode Island Department of Environmental Management (RIDEM) to measure streamflow in tributaries to the Scituate Reservoir. Streamflow has

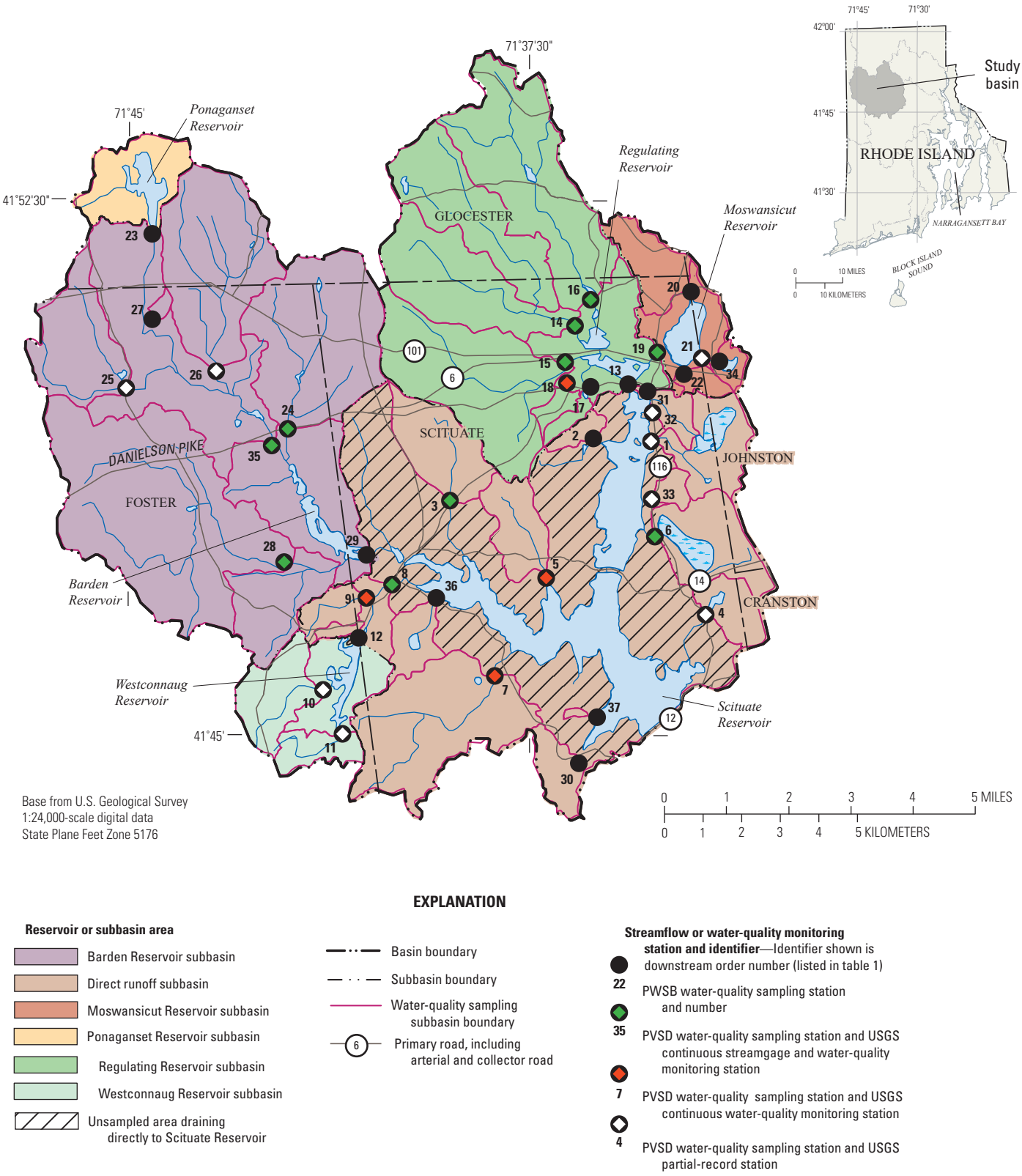

Figure 1. PWSB, Providence Water Supply Board locations of tributary-reservoir subbasins and stations in the Scituate Reservoir drainage area, Rhode Island, in water year 2017.

been continuously measured at 10 streamgages in the drainage area (table 1) since 2009 by the USGS. Streamflow also was continuously measured at four streamgages from 2009 to 2014 and periodically measured at nine additional streamgages on tributaries in the drainage area. At the 13 streamgages without continuous flow data, daily mean[1] streamflow (table 1) has been estimated by using methods developed by the USGS (Hirsch, 1982). The USGS also has been continuously measuring specific conductance at 14 monitoring stations since 2009 (table 1). Equations that relate specific conductance to concentrations of chloride and sodium in stream water were developed as part of previous cooperative studies of the USGS and the PWSB (Nimiroski and Waldron, 2002; Smith, 2015b, 2018a). These equations used together with measured (or estimated) streamflows allow for nearly continuous estimation of chloride and sodium loads to the reservoir.

In 2017, the PWSB regularly, either monthly or quarterly, visited fixed sites on 36 tributaries within the Scituate Reservoir drainage area and collected water-quality samples. Compiled and tabulated streamflow (measured or estimated by the USGS) and water-quality data (collected by the PWSB) have been published in Breault and others (2000), Nimiroski and others (2008), Breault (2010), Breault and Campbell (2010a–d), Breault and Smith (2010), Smith and Breault (2011), Smith (2013, 2014, 2015a, b, 2016, 2018a–d, 2019).

This report presents data on streamflow, water quality, and loads and yields of selected constituents for water year (WY)[2] 2017 in the Scituate Reservoir drainage area. These data were collected as part of studies done by the USGS in cooperation with the PWSB and the RIDEM. A summary of measured and estimated streamflows is presented for the 10 continuous-record and 13 partial-record streamgages in the drainage area. Estimated monthly and annual loads and yields of chloride and sodium are presented for the 14 streamgages at which specific conductance is continuously monitored by the USGS. Summary statistics for water-quality data collected by the PWSB for 36 of the 37 sampling stations (table 1) during WY 2017 also are presented, and these data were used to calculate loads and yields of selected water-quality constituents where flow data were available.

Streamflow Data Collection and Estimation

Streamflow was measured or estimated by the USGS at 23 streamgages (table 1). Measured and estimated streamflows are necessary to estimate water volume and water-quality constituent loads and yields from tributary basins. Stream stage was measured every 10 minutes at most continuous-record streamgages. Streamflow was computed with a stage-discharge relation (known as a rating), which was developed on the basis of periodic manual measurements of streamflow. Daily mean streamflow at a streamgage was calculated by dividing the total volume of water that passed the streamgage each day by 86,400 (the number of seconds in a day). Periodic manual streamflow measurements at partial-record streamgages were used concurrently with continuous-record measurements from streamgages in nearby hydrologically similar drainage areas to estimate a continuous daily record at the partial-record streamgages. Specifically, daily streamflow records for the 13 partial-record sites in the Scituate Reservoir drainage area (table 1) were estimated by using the Maintenance of Variance Extension type 1 (MOVE.1) method, as described by Ries and Friesz (2000) and Smith (2015b); data needed to estimate streamflows at partial-record sites were retrieved from the USGS National Water Information System (NWIS; U.S. Geological Survey, 2018). The upper and lower 90-percent confidence limits for the estimated mean annual streamflows, as described by Tasker and Driver (1988), are listed in table 2. These data indicate that there is a 90-percent chance that the estimated mean annual streamflow is between the upper and lower 90-percent confidence limits.

Continuous-record streamgages were operated and maintained by the USGS during WY 2017 in cooperation with the PWSB (fig. 1; table 1). Streamflow data for these streamgages were collected at 10- or 15-minute intervals (near-real-time streamflow data), were updated at 1-hour intervals on the internet and are available through the NWIS web interface (U.S. Geological Survey, 2018). Error associated with measured streamflows was generally within about 15 percent as noted in the annual water year summary for each USGS streamgage.

Water-Quality Data Collection and Analysis

Water-quality data were collected by the USGS and the PWSB. Concentrations of sodium and chloride were estimated by the USGS from continuous records of specific conductance from 14 of the 23 streamgages. Water-quality samples were collected monthly or quarterly at 36 sampling stations in the Scituate Reservoir drainage area by the PWSB during WY 2017 as part of a long-term sampling program (table 1).

Data Collected by the U.S. Geological Survey

The USGS collected and analyzed continuous-record specific conductance data at 14 streamgages (fig. 1; table 1). Measurements of specific conductance were recorded automatically at 10- or 15-minute intervals at each streamgage. Measurements were made by using an instream probe and standard USGS methods for continuous water-quality monitoring at

[1]The arithmetic mean of the individual daily mean discharges for the year noted or for the designated period.

[2]A water year is the period between October 1 and September 30 and is designated by the year in which it ends.

Table 1. Providence Water Supply Board water-quality sampling stations, water-quality samples, and available streamflow and specific conductance monitoring in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, to September 30, 2017.

[Alternate station names listed in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). Locations of stations are shown in figure 1. no., number; USGS, U.S. Geological Survey; mi^2, square mile; QW, water quality; Na, sodium; Cl, chloride; M, monthly; Q, quarterly; Y, yes; N, no; —, none]

PWSB station no.	USGS station no.	Station name	Drainage area (mi^2)	Frequency of QW sample collection	Samples collected by PWSB (no.)[1]	Daily estimated load for Na and Cl	Streamflow availability	Specific conductance availability
		Barden Reservoir subbasin						
24	01115190	Dolly Cole Brook	4.90	M	12	Y	Continuous	Continuous
25	01115200	Shippee Brook	2.35	Q	4	N	Estimated	None
26	01115185	Windsor Brook	4.32	Q	4	N	Estimated	None
27	011151845	Unnamed tributary to Ponaganset River (unnamed brook B, unnamed brook west of Windsor Brook)	0.10	Q	3	N	None	None
28	01115265	Barden Reservoir (Hemlock Brook)	8.72	M	10	Y	Continuous	Continuous
29	01115271	Ponaganset River (Barden Stream)	33.0	M	12	N	None	None
35	01115187	Ponaganset River	14.0	M	11	Y	Continuous	Continuous
		Direct runoff subbasin						
1	01115180	Brandy Brook	1.57	M	9	N	Estimated	None
2	01115181	Unnamed tributary 2 to Scituate Reservoir (unnamed brook north of Bullhead Brook)	0.15	Q	2	N	None	None
3	01115280	Cork Brook	1.79	M	10	Y	Continuous	Continuous
4	01115400	Kent Brook (Betty Pond Stream)	0.85	M	7	N	Estimated	None
5	01115184	Spruce Brook	1.22	Q	3	Y	Estimated	Continuous
6	01115183	Quonapaug Brook	1.96	M	10	Y	Continuous	Continuous
7	01115297	Wilbur Hollow Brook	4.32	M	12	Y	Estimated	Continuous
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	5.18	M	10	Y	Continuous	Continuous
9	01115275	Bear Tree Brook	0.62	Q	3	Y	Estimated	Continuous
30	01115350	Unnamed tributary 4 to Scituate Reservoir (Coventry Brook, Knight Brook)	0.78	Q	1	N	None	None
31	01115177	Toad Pond	0.04	Q	--	N	None	None
32	01115178	Unnamed tributary 1 to Scituate Reservoir (Pine Swamp Brook)	0.45	Q	3	N	Estimated	None
33	01115182	Unnamed tributary 3 to Scituate Reservoir (Halls Estate Brook)	0.28	Q	4	N	Estimated	None
36	--	Outflow from King Pond	0.77	Q	3	N	None	None
37	--	Fire Tower Stream	0.15	Q	2	N	None	None

Table 1. Providence Water Supply Board water-quality sampling stations, water-quality samples, and available streamflow and specific conductance monitoring in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, to September 30, 2017. —Continued

[Alternate station names listed in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). Locations of stations are shown in figure 1. no., number; USGS, U.S. Geological Survey; mi^2, square mile; QW, water quality; Na, sodium; Cl, chloride; M, monthly; Q, quarterly; Y, yes; N, no; —, none]

PWSB station no.	USGS station no.	Station name	Drainage area (mi^2)	Frequency of QW sample collection	Samples collected by PWSB (no.)[1]	Daily estimated load for Na and Cl	Streamflow availability	Specific conductance availability
		Moswansicut Reservoir subbasin						
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	3.25	M	11	Y	Continuous	Continuous
20	01115160	Unnamed tributary 1 to Moswansicut Reservoir (Blanchard Brook)	1.18	M	6	N	None	None
21	01115165	Unnamed tributary 2 to Moswansicut Reservoir (brook from Kimball Reservoir)	0.29	Q	2	N	Estimated	None
22	01115167	Moswansicut Reservoir (Moswansicut Stream South)	0.22	M	5	N	None	None
34	01115164	Kimball Stream	0.27	Q	3	N	None	None
		Ponaganset Reservoir subbasin						
23	011151843	Ponaganset Reservoir	1.92	M	9	N	None	None
		Regulating Reservoir subbasin						
13	01115176	Regulating Reservoir	22.1	M	9	N	None	None
14	01115110	Huntinghouse Brook	6.23	M	9	Y	Continuous	Continuous
15	01115114	Rush Brook	4.70	M	9	Y	Continuous	Continuous
16	01115098	Peeptoad Brook (Harrisdale Brook)	4.96	M	10	Y	Continuous	Continuous
17	01115119	Dexter Pond (Paine Pond)	0.22	Q	1	N	None	None
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	0.28	Q	2	N	Estimated	Continuous
		Westconnaug Reservoir subbasin						
10	01115274	Westconnaug Brook	1.48	M	8	N	Estimated	None
11	01115273	Unnamed tributary to Westconnaug Reservoir (unnamed brook south of Westconnaug Reservoir)	0.72	Q	4	N	Estimated	None
12	011152745	Unnamed tributary to Westconnaug Brook (unnamed brook north of Westconnaug Reservoir)	0.16	Q	2	N	None	None

[1]Not all samples were analyzed for all water-quality properties or constituents.

Table 2. Measured or estimated annual mean streamflow for tributary streams in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.

[Developed from data presented in U.S. Geological Survey (2018). Alternate station names listed in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). Locations of stations are shown in figure 1. no., number; USGS, U.S. Geological Survey; ft^3/s, cubic foot per second; $ft^3/s/mi^2$, cubic foot per second per square mile]

PWSB station no.	USGS station no.	Station name	Annual mean streamflow (ft^3/s)	Upper 90-percent confidence interval (ft^3/s)	Lower 90-percent confidence interval (ft^3/s)	Annual mean streamflow yield ($ft^3/s/mi^2$)
		Barden Reservoir subbasin				
24	01115190	Dolly Cole Brook	9.3	10	8.5	1.9
25	01115200	Shippee Brook	5.5	20	1.6	2.3
26	01115185	Windsor Brook	8.4	34	2.1	1.9
28	01115265	Barden Reservoir (Hemlock Brook)	20	22	18	2.2
35	01115187	Ponaganset River	29	32	27	2.1
1	01115180	Brandy Brook	2.4	4.3	1.3	1.5
3	01115280	Cork Brook	3.3	3.7	3.0	1.9
4	01115400	Kent Brook (Betty Pond Stream)	1.7	8.1	0.35	2.0
5	01115184	Spruce Brook	2.4	4.6	1.2	1.9
6	01115183	Quonapaug Brook	3.8	4.2	3.5	2.0
7	01115297	Wilbur Hollow Brook	7.9	15	4.1	1.8
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	11	11	9.9	2.1
9	01115275	Bear Tree Brook	1.8	3.1	1.0	2.9
32	01115178	Unnamed tributary 1 to Scituate Reservoir (Pine Swamp Brook)	0.61	1.2	0.30	1.3
33	1115182	Unnamed tributary 3 to Scituate Reservoir (Halls Estate Brook)	0.44	1.2	0.16	1.6
		Moswansicut Reservoir subbasin				
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	5.0	5.4	4.6	1.5
21	01115165	Unnamed tributary 2 to Moswansicut Reservoir (Blanchard Brook)	0.65	1.4	0.29	2.2
		Regulating Reservoir subbasin				
14	01115110	Huntinghouse Brook	12	13	11	1.9
15	01115115	Rush Brook	8.9	9.9	7.8	1.9
16	01115098	Peeptoad Brook (Harrisdale Brook)	11	12	9.9	2.2
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	0.59	2.4	0.14	2.1
		Westconnaug Reservoir subbasin				
10	01115274	Westconnaug Brook	2.2	4.0	1.3	1.5
11	01115273	Unnamed tributary to Westconnaug Reservoir (unnamed brook south of Westconnaug Reservoir)	1.3	2.2	0.75	1.8

streams (Wagner and others, 2006). The specific conductance measurement data are available through the NWIS web interface (U.S. Geological Survey, 2018).

Concentrations of chloride and sodium were estimated from continuous measurements of specific conductance by using equations that were developed by the USGS to relate specific conductance to concentrations of chloride and sodium, as follows:

$$C_{Cl} = SPC^{m} \times b \text{ and} \quad (1)$$

$$C_{Na} = SPC^{m} \times b, \quad (2)$$

where

C_{Cl} is the chloride concentration, in milligrams per liter;

C_{Na} is the sodium concentration, in milligrams per liter;

SPC is the specific conductance, in microsiemens per centimeter;

m is the slope from the MOVE.1 analysis (table 3); and

b is the intercept from the MOVE.1 analysis (table 3).

These regression equations were developed by using the MOVE.1 method (also known as the line of organic correlation; Helsel and Hirsch, 2002) on the basis of concurrent measurements of specific conductance (USGS parameter code 90095) along with chloride (USGS parameter code 00940) and sodium (USGS parameter code 00930) concentrations measured in water-quality samples collected by the USGS from tributaries in the Scituate Reservoir drainage area (U.S. Geological Survey, 2018).

Table 3. Regression equation coefficients used to estimate concentrations of chloride and sodium from values of specific conductance for U.S. Geological Survey streamgage stations in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.

[Developed from data presented in U.S. Geological Survey (2018). Locations of stations are shown in figure 1. USGS parameter codes: specific conductance, 90095; chloride, 00940; sodium, 00930. PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey]

PWSB station no.	USGS station no.	Samples used in analyses		Chloride			Sodium		
		Sample data range (month/day/year)	Sample count	Slope	Intercept	Standard error of regressions (percent)	Slope	Intercept	Standard error of regressions (percent)
24	01115190	3/8/2000; 3/29/2005; 1/22/2009 to 7/6/2017	26	1.2571	0.06894	3.8	1.2244	0.04913	7.3
28	01115265	3/28/2001; 3/30/2005; 1/22/2009 to 7/6/2017	26	1.2270	0.07901	5.5	1.1326	0.07443	9.0
35	01115187	3/28/2001; 3/29/2005; 1/22/2009 to 7/6/2017	26	1.2428	0.07282	6.3	1.1751	0.06094	8.4
3	01115280	3/8/2000; 3/30/2005; 1/22/2009 to 7/19/2017	26	1.2217	0.07704	4.9	1.0722	0.09611	7.8
5	01115184	3/5/2009 to 7/20/2017	23	1.2558	0.06221	6.5	1.0813	0.08318	6.1
6	01115183	3/8/2000; 3/30/2005; 1/22/2009 to 7/20/2017	34	1.1920	0.07872	6.7	1.2291	0.03842	9.2
7	01115297	3/28/2001; 3/30/2005; 1/22/2009 to 7/20/2017	25	1.0552	0.13303	6.3	0.8933	0.16852	8.6
8	01115276	1/22/2009 to 7/19/2017	23	1.1016	0.13513	4.9	1.0463	0.10969	5.9
9	01115275	3/8/2000; 3/30/2005; 1/22/2009 to 7/20/2017	25	1.0600	0.17564	4.2	1.0734	0.09639	5.6
19	01115170	3/8/2000; 3/29/2005; 1/22/2009 to 7/20/2017	29	1.2410	0.06537	4.0	1.1927	0.04976	4.7
14	01115110	3/28/2001; 3/29/2005; 1/22/2009 to 7/19/2017	31	1.2030	0.07202	12	1.0670	0.07766	11
15	01115114	1/22/2009 to 7/20/2017	31	1.1748	0.09355	4.0	1.0885	0.08810	7.5
16	01115098	3/28/2001; 3/29/2005; 1/22/2009 to 7/20/2017	27	1.2748	0.05402	6.9	1.0919	0.08072	9.6
18	01115120	1/22/2009 to 7/19/2017	18	1.2098	0.07604	4.5	1.0879	0.08393	5.1

MOVE.1 was chosen for regression analysis to maintain variance (Hirsch and Gilroy, 1984). Some missing values of specific conductance were estimated. In these cases, values of specific conductance were estimated by proportional distribution between recorded values.

Data Collected by the Providence Water Supply Board

Water-quality samples were collected by the PWSB at 36 of the 37 fixed stations on tributaries draining to the Scituate Reservoir during WY 2017. Sampling visits typically are conducted monthly at 19 stations and quarterly at another 18 stations (table 1). No quarterly water samples were collected at Toad Pond (PWSB station 31) during WY 2017.

Water-quality samples were not collected during specific weather conditions; instead, a strictly periodic water-quality sampling schedule was followed so that water-quality samples would be representative of various weather conditions. However, sometimes samples could not be collected because tributaries at the sampling stations were dry or frozen. When possible, water-quality samples were collected by dipping the sample bottle into the tributary at the center of flow (Richard Blodgett, PWSB, written commun., 2005). Samples were transported on ice to the PWSB water-quality laboratory at the P.J. Holton Water Purification Plant in Scituate. Water-quality properties and constituent concentrations were measured by using unfiltered water samples. These water-quality properties included pH, alkalinity, color, turbidity, and concentrations of chloride, nitrite, nitrate, orthophosphate, and bacteria (*Escherichia coli* [*E. coli*] and total coliform); the data are published in Smith (2019). Analytical methods used for the determination of values or concentrations of pH, color, turbidity, alkalinity, and chloride are documented by Baird and others (2017). Concentrations of nitrite were determined by U.S. Environmental Protection Agency method 353.2 (U.S. Environmental Protection Agency, 1993). Concentrations of nitrate were determined by Standard Method 4500–NO_3 (Holm and others, 2017). Concentrations of orthophosphate were determined by the Hach PhosVer Method (Hach Method 8048; Hach Company, 2000). Standard Method 9223 was used for the determination of concentrations of bacteria (Best and others, 2017).

Water-quality samples were collected by the PWSB during a wide range of flow conditions. The daily mean flow-duration curves for the Dolly Cole Brook at Old Danielson Pike at South Foster (01115190) and Spruce Brook near North Scituate (01115184) USGS streamgages for WY 2017 are shown in figure 2. The curves represent the percentage of time that each flow duration was equaled or exceeded at the respective stations; the flows at each station on days when water-quality samples were collected are represented by the plotted points superimposed on the curves. At Dolly Cole Brook, samples were collected at flow durations ranging from the 1.5 percentile to the 99.5th percentile; this range indicates that the water-quality samples collected in WY 2017 represented a wide range of flow conditions during that water year. Samples at Spruce Brook were collected only on a quarterly schedule, and although no sample was collected during one visit, the quarterly schedule also encompassed a wide range of flow conditions (3.2 percentile to the 92 percentile) at this station during WY 2017 (fig. 2).

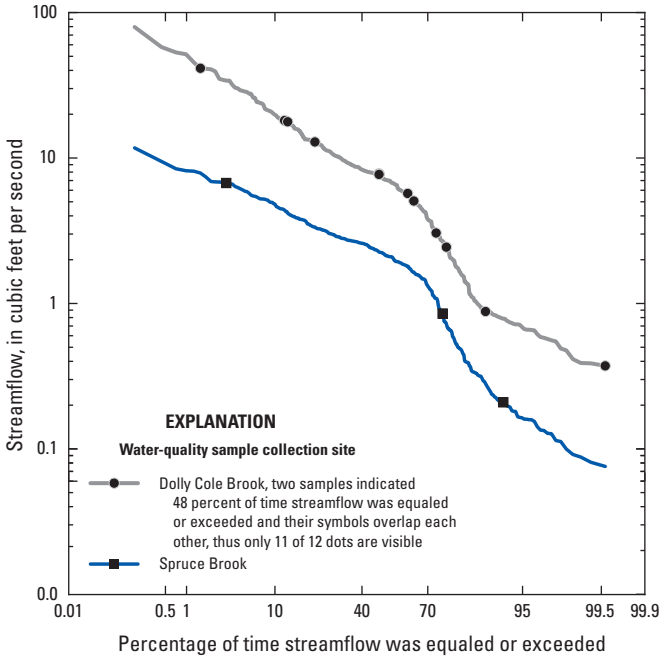

Figure 2. Flow-duration curves and streamflow on the dates (represented by points) when water-quality samples were collected for the U.S. Geological Survey continuous streamgages on Dolly Cole Brook at Old Danielson Pike at South Foster, Rhode Island (01115190) and Spruce Brook near North Scituate, Rhode Island (01115184) for water year 2017. Locations of stations are shown on figure 1.

Estimating Daily, Monthly, and Annual Loads and Yields

Daily, monthly, and annual chloride and sodium loads (in kilograms) were estimated for all streamgages for which continuous-streamflow and specific-conductance data were available for WY 2017. Daily flow-weighted concentrations of chloride and sodium were calculated by multiplying instantaneous flows by concurrent concentrations of chloride and sodium (estimated from measurements of specific conductance) for each day and dividing the sum by the total flow for that day. At the four instrumented monitoring stations, where continuous flow was unavailable (table 1), daily mean concentrations of chloride and sodium were calculated from the daily mean value of specific conductance for each day.

The latter method may result in less accurate concentrations because instantaneous measurements of specific conductance may change (decrease or increase) with surface-water runoff; however, the variability of instantaneous measurements of specific conductance at these streamgages was generally small and daily mean values did not differ substantially from daily flow-weighted values estimated during prior water years when instantaneous flow data were available. Daily loads of chloride and sodium were estimated by multiplying daily concentrations of chloride and sodium (in milligrams per liter) by daily discharge (in liters per day). Daily data were summed to estimate monthly or annual loads.

Daily loads of water-quality constituents (in samples collected by the PWSB) were calculated for all sampling dates during WY 2017 (table 4, in back of report) for which periodic or continuous streamflow data were available (table 1). These loads were calculated by multiplying constituent concentrations (in milligrams or colony forming units per liter) in single samples by the daily discharge (in liters per day) for the day on which each sample was collected. The flows, which in some cases were estimates, were assumed to be representative of the flow at the time of the sample collection. Loads (in million colony forming units per day, kilograms per day, or grams per day) and yields (in million colony forming units per day per square mile, kilograms per day per square mile, or grams per day per square mile) were calculated for bacteria, chloride, nitrite, nitrate, and orthophosphate. Censored data (concentrations reported as less than method detection limits) were replaced with concentrations equal to one-half the method detection limit.

Streamflow

Monitoring streamflow is a necessary step to measure the volume of water and estimate constituent loads to the Scituate Reservoir. The Ponaganset River is the largest monitored tributary to the Scituate Reservoir. Mean annual streamflow at the streamgage on the Ponaganset River (PWSB station 35; USGS streamgage 01115187) for the entire period of its operation (mean of the annual mean streamflows for the period of record, WYs 1994–2016) before WY 2017 was about 28 cubic feet per second (ft^3/s; U.S. Geological Survey, 2018). During WY 2017, the annual mean streamflow of 29 ft^3/s was slightly greater (55th percentile; fig. 3) than the mean of the annual mean streamflows for the period of record. The daily mean streamflow was often below the 10th percentile for the daily mean streamflows for the period of record (fig. 3) for parts of October 2016 and December 2016 through May 2017; otherwise, the daily mean streamflow generally was within the 10th and 90th percentiles for the daily mean streamflows for the period of record. The mean annual streamflow at the Peeptoad Brook streamgage (PWSB station 16, streamgage 01115098), the other long-term continuous-record streamgage in the Scituate Reservoir drainage area, for the period of record (WYs 1994–2016) before WY 2017 was about 10.3 ft^3/s (U.S. Geological Survey, 2018). The annual mean streamflow at the Peeptoad Brook streamgage during WY 2017 also was higher at 11 ft^3/s than the mean annual streamflow for its period of record.

Water Quality and Constituent Loads and Yields

Water-quality conditions in the Scituate Reservoir drainage area are described by summary statistics for water-quality properties, constituent concentrations, and estimated constituent loads and yields. Loads and yields characterize the rates at which masses of constituents are transferred to the reservoir by tributaries. In the case of loads, tributaries with high flows tend to have high loads because the greater volume of water can carry more of the constituent to the reservoir per unit time than tributaries with low flows. Yields represent the constituent load per unit of drainage area and are calculated by dividing the load estimated for a streamgage by the drainage area for the monitoring station. Yields are useful for comparison among streamgages that have different drainage areas because the effects of basin size and therefore total streamflow volume are attenuated. Yields also are useful for examining potential differences among basin properties that may contribute to water quality in the reservoir.

Summary statistics include means and medians. For some purposes, median values are more appropriate because they are less likely to be affected by high or low concentrations (or outliers). Medians are especially important to use for summarizing a relatively limited number of values. In contrast, continuously monitored streamflow and loads of chloride and sodium (estimated from measurements of specific conductance), datasets that include a large number of values, are better summarized in terms of means because large datasets are more resistant to the effects of outliers than small datasets. Mean values also are particularly appropriate for characterizing loads because outlier values, which typically represent large flows, are important to include in estimates of constituent masses delivered to receiving waters.

Uncertainties associated with measuring streamflow and specific conductance and with chloride and sodium sample collection, preservation, and analysis produce uncertainties in load and yield estimates. The load and yield estimates presented in the text and tables are the most likely values for chloride and sodium inputs from tributaries or their drainage basins, based on the available data and analysis methods. It may be best to discuss loads and yields in terms of a range within which the true values lie; however, the most likely values of loads and yields are presented for ease of discussion and presentation. The range within which the true values lies depends on the uncertainties in individual measurements of streamflow and concentration, which are difficult to quantify with the available information. The uncertainties associated

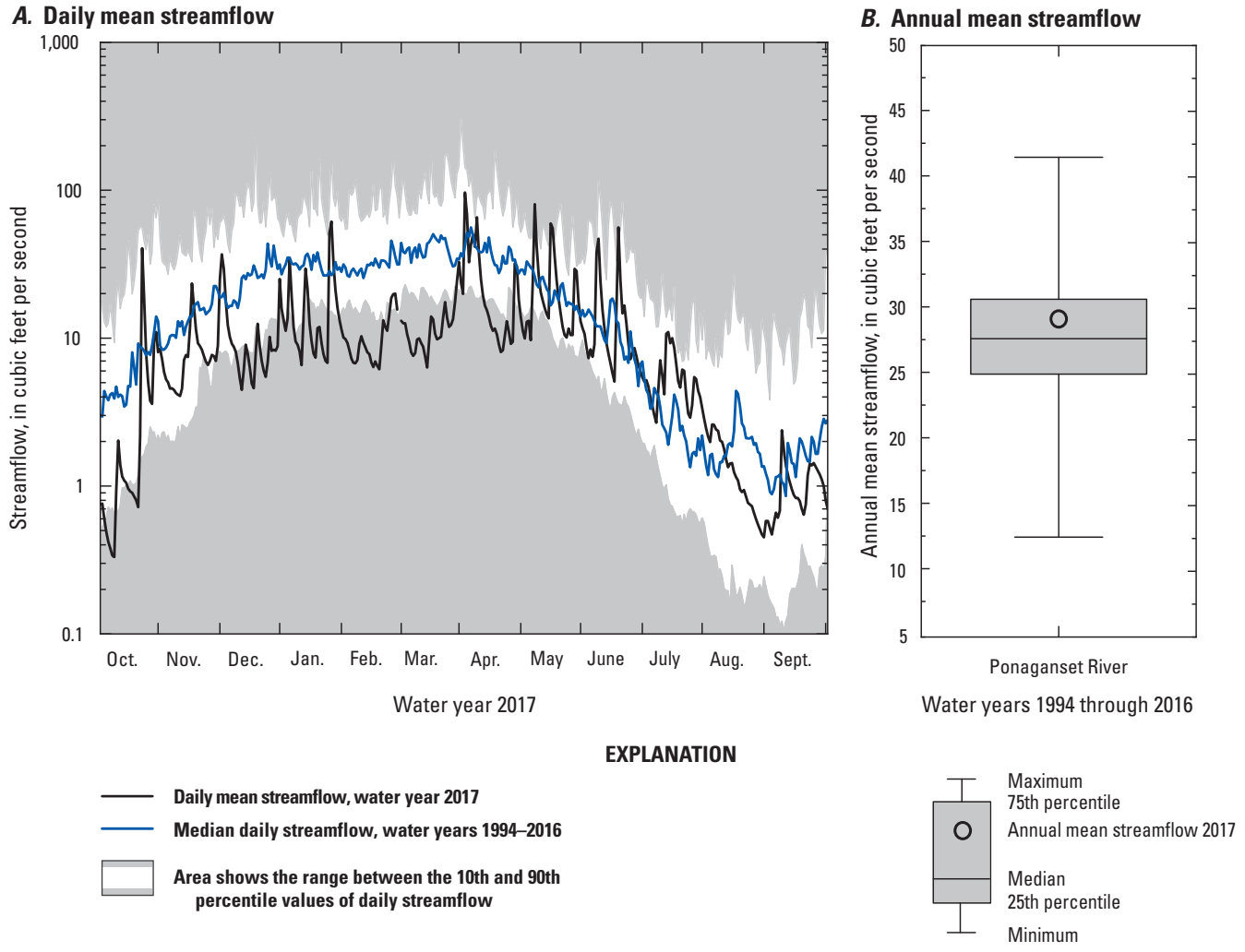

Figure 3. *A*, Measured daily mean streamflow for October 1, 2016, through September 30, 2017, and the 10th percentile, median, and 90th percentile values of daily streamflow for October 1, 1994, through September 30, 2016, for the U.S. Geological Survey continuous-record streamgage on the Ponaganset River at South Foster (01115187) in the Scituate Reservoir drainage area, Rhode Island. *B*, Annual mean streamflow for streamgage 01115187 during water year 2017 and the distribution of annual mean streamflows for water years 1994 through 2016. Location of station is shown on figure 1.

with streamflow are commonly assumed to affect load and yield calculations more than the errors associated with measuring specific conductance and (or) chemical analysis, and the uncertainties associated with estimated streamflow are greater than those associated with measured streamflow. The most likely values of loads and yields presented in the tables and text are sufficient for planning-level analysis of water quality in tributaries and their drainage basins.

Chloride and Sodium Loads and Yields Estimated From Specific-Conductance Monitoring Data

Chloride and sodium are constituents of special concern in the Scituate Reservoir drainage area; they are major constituents of road salt used for deicing, and several major roadways cross the drainage basin. State Routes 12 and 14 cut across the main body of the reservoir, and State Route 116 parallels the eastern limb (fig. 1). Nimiroski and Waldron (2002) indicated that tributaries in basins with State-maintained roads had substantially higher concentrations of chloride and sodium than tributaries in basins with low road density, presumably because of deicing activities. In addition, sodium is a constituent of potential concern for human health; some persons on restricted diets might need to limit intake of sodium.

Estimated monthly mean[3] chloride concentrations in tributaries of the Scituate Reservoir drainage area ranged from 8.9 to 89 milligrams per liter (mg/L) and estimated monthly mean

[3]Monthly mean concentrations were calculated by dividing the total monthly load by the total discharge for the month.

sodium concentrations ranged from 5.9 to 51 mg/L (table 5). The highest monthly mean concentrations of chloride and sodium were estimated to be 89 and 51 mg/L, respectively, at Rush Brook (PWSB station 15) in September 2017. The estimated monthly mean concentrations at most stations were greater during the months of August, September, and October compared with the estimated monthly mean concentrations during the winter months, except at the stations on Dolly Cole Brook (PWSB station 24) and the Moswansicut Reservoir (PWSB station 19), which were greater in March. The highest annual mean[4] concentrations of chloride and sodium were estimated to be 60 and 35 mg/L, respectively, at the Moswansicut Reservoir (table 6). The relatively high annual mean concentrations of chloride and sodium at Bear Tree Brook (53 and 31 mg/L, respectively) are the result of residual chloride and sodium leaching to groundwater from a formerly uncovered salt storage pile (Nimiroski and Waldron, 2002) and comparatively small surface-water flows. Annual mean concentrations of chloride and sodium, ranging from 43 to 52 mg/L and 25 to 30 mg/L, respectively, estimated at the unnamed tributary to the Regulating Reservoir (PWSB station 18), Rush Brook, and Peeptoad Brook (PWSB station 16) also were relatively high (table 6). These stations are in the more developed, northeastern part of the Scituate Reservoir drainage area (fig. 1), which also includes Moswansicut Reservoir.

During WY 2017, the Scituate Reservoir received about 3,100 metric tons (t; about 3,400 short tons) of chloride and 1,900 t (about 2,100 short tons) of sodium from tributaries that are equipped with instrumentation capable of continuously monitoring specific conductance. The highest chloride and sodium loads in the drainage area during WY 2017 were estimated to be 580 and 360 t, respectively, at the Ponaganset River station (PWSB station 35; table 6). Monthly estimated chloride and sodium loads were highest in April (table 7) at all stations. From January through April, the sum of the monthly loads of chloride and sodium at each station accounted for between 47 and 63 percent of the annual load at each station and about 52 percent of the annual load for the monitored area in the Scituate Reservoir drainage area. The highest annual chloride and sodium yields were 140 and 80 metric tons per square mile, respectively, measured at Bear Tree Brook (PWSB station 9; table 6). During WY 2017, estimated annual loads of chloride and sodium at the continuous monitoring stations were greater than the median annual loads for WYs 2009–16 at all stations, and for 9 of the 14 stations, the annual loads were greater than the maximum annual loads for WYs 2009–16 (fig. 4). Estimated annual loads of chloride and sodium for the monitored area in the Scituate Reservoir drainage area during WY 2017 exceeded all prior annual loads since WY 2009 (fig. 5). Loads estimated for WY 2017 represent a 47-percent increase compared with loads estimated for WY 2016 (Smith, 2019).

[4]Annual mean concentrations were calculated by dividing the total annual load by the total discharge for the year.

Physical and Chemical Properties and Daily Loads and Yields Estimated From Data Collected by the Providence Water Supply Board

Physical and Chemical Properties

Physical and chemical properties, including pH, turbidity, alkalinity, and color, were routinely measured to characterize water quality in each of the six subbasins in the Scituate Reservoir drainage area (table 8). Specifically, pH is a measure of the acidity of the water, color can be an indirect measure of the amount of organic carbon dissolved in the water column, turbidity is an indirect measure of suspended particles, and alkalinity is a measure of the acid-neutralizing capacity of water.

The median pH in tributaries in the Scituate Reservoir drainage area ranged from 5.6 to 6.9; the median of the medians for all stations was 6.3. Median values of color ranged from 9.5 to 250 platinum cobalt units; the median for all stations was 50 platinum cobalt units. Median values of turbidity ranged from 0.21 to 1.7 nephelometric turbidity units; the median for all stations was 0.67 nephelometric turbidity units. Median alkalinity values in tributaries were low, ranging from 2.7 to 13 mg/L as calcium carbonate ($CaCO_3$); the median for all stations was 5.5 mg/L as $CaCO_3$ (table 8).

Constituent Concentrations and Daily Loads and Yields

Fecal indicator bacteria, chloride, and nutrients such as nitrogen and phosphorus are commonly detected in natural water; at elevated concentrations, these constituents can cause or contribute to water-quality impairments. Fecal indicator bacteria, which are found in the intestines of warm-blooded animals, may indicate impairment from sewage contamination or from livestock or wildlife that defecate in or near the stream margin. Chloride originates in tributary stream water from precipitation, weathering, or human activities such as waste disposal, use of septic systems, and road deicing. Sources of nutrients in tributary stream water include atmospheric deposition, leaching of naturally occurring organic material, discharge of groundwater that is enriched with nutrients from septic-system leachate, and runoff contaminated with fertilizer or animal waste. The ultimate intended use of water in the tributaries is drinking water, which must meet specific water-quality standards. For this reason, the PWSB and the USGS closely monitor concentrations of these constituents in tributaries. Median concentrations, loads, and yields of water-quality constituents are listed in tables 8 and 9.

Table 5. Monthly mean concentrations of chloride and sodium estimated from continuous measurements of specific conductance in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.

[Developed from data presented in U.S. Geological Survey (2018). Alternate station names given in parenthesis for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations are shown on figure 1. Monthly mean concentrations were calculated by dividing the monthly load by the total discharge for the month. USGS, U.S. Geological Survey; Cl, chloride; Na, sodium; —, no flow]

PWSB station no.	USGS station no.	Station name	October		November		December		January		February		March	
			Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)
Barden Reservoir subbasin														
24	01115190	Dolly Cole Brook	35	21	32	20	34	20	31	19	36	22	40	24
28	01115265	Barden Reservoir (Hemlock Brook)	24	15	23	14	21	13	19	12	24	15	26	15
35	01115187	Ponaganset River	24	15	24	15	23	14	21	13	25	15	25	16
Direct runoff subbasin														
3	01115280	Cork Brook	48	27	43	25	40	23	34	20	40	23	44	25
5	01115184	Spruce Brook	36	20	29	17	24	14	21	13	22	13	24	14
6	01115183	Quonapaug Brook	55	33	50	30	45	26	33	20	40	24	45	27
7	01115297	Wilbur Hollow Brook	11	7.3	10	6.6	9.3	6.2	9.1	6.0	9.5	6.3	10	6.6
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	28	17	23	15	22	14	21	13	23	14	23	15
9	01115275	Bear Tree Brook	57	34	57	33	56	33	50	29	52	31	54	32
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	54	32	59	35	59	35	59	35	62	36	63	37
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	15	8.9	14	8.3	15	8.8	13	7.7	16	9.1	15	9.0
15	01115114	Regulating Reservoir (Rush Brook)	53	31	45	27	42	25	39	23	56	33	60	35
16	01115098	Peeptoad Brook (Harrisdale Brook)	54	30	56	31	49	27	40	23	43	25	46	26
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	56	32	57	32	65	36	48	28	59	33	56	32
Scituate Reservoir drainage area														
		Average	39	23	37	22	36	21	31	19	36	21	38	22

Table 5. Monthly mean concentrations of chloride and sodium estimated from continuous measurements of specific conductance in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[Developed from data presented in U.S. Geological Survey (2018). Alternate station names given in parenthesis for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations are shown on figure 1. Monthly mean concentrations were calculated by dividing the monthly load by the total discharge for the month. USGS, U.S. Geological Survey; Cl, chloride; Na, sodium; —, no flow]

PWSB station no.	USGS station no.	Station name	April		May		June		July		August		September	
			Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)
Barden Reservoir subbasin														
24	01115190	Dolly Cole Brook	34	21	31	19	30	18	33	20	34	20	37	23
28	01115265	Barden Reservoir (Hemock Brook)	21	13	19	12	21	13	21	13	31	18	32	19
35	01115187	Ponaganset River	21	13	21	13	21	13	23	14	27	17	30	18
Direct runoff subbasin														
3	01115280	Cork Brook	34	20	30	18	31	19	38	22	42	24	52	29
5	01115184	Spruce Brook	20	12	20	12	21	13	24	14	34	19	43	23
6	01115183	Quonapaug Brook	33	19	31	18	32	19	35	21	52	31	66	40
7	01115297	Wilbur Hollow Brook	8.9	5.9	9.2	6.1	10	6.3	11	6.8	13	7.9	18	11
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	20	13	20	13	23	14	26	16	33	20	33	20
9	01115275	Bear Tree Brook	47	28	49	29	54	32	61	36	76	45	75	45
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	60	35	60	35	56	33	54	32	56	33	61	36
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	12	7.0	11	6.8	12	7.4	15	8.9	17	10	17	9.6
15	01115114	Regulating Reservoir (Rush Brook)	42	25	39	24	41	25	58	34	76	44	89	51
16	01115098	Peeptoad Brook (Harrisdale Brook)	39	23	38	22	39	23	43	25	48	27	51	28
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	50	29	48	28	43	25	68	38	--	--	79	43
Scituate Reservoir drainage area														
		Average	32	19	30	18	31	18	37	21	41	24	49	28

Table 6. Annual mean chloride and sodium concentrations, loads, and yields for sampling stations in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.

[Developed from data presented in U.S. Geological Survey (2018). Alternate station names given in parenthesis for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations are shown on figure 1. Annual mean concentrations were calculated by dividing the annual load by the total discharge for the year; annual mean yields were calculated by dividing the sum of individual loads by the sum of the drainage area. no., number; USGS, U.S. Geological Survey; Cl, chloride; Na, sodium; mg/L, milligram per liter; t/yr, metric ton per year; t/yr/mi^2, metric ton per year per square mile]

PWSB station no.	USGS station no.	Station name	Concentration		Load		Yield	
			Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)	Cl (mg/L)	Na (mg/L)
		Barden Reservoir subbasin						
24	01115190	Dolly Cole Brook	33	20	280	170	57	34
28	01115265	Barden Reservoir (Hemlock Brook)	22	13	380	230	43	26
35	01115187	Ponaganset River	22	14	580	360	42	25
		Direct runoff subbasin						
3	01115280	Cork Brook	37	22	110	64	61	36
5	01115184	Spruce Brook	23	14	49	29	40	24
6	01115183	Quonapaug Brook	37	22	130	75	65	38
7	01115297	Wilbur Hollow Brook	10	6.3	68	44	16	10
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	22	14	210	130	41	26
9	01115275	Bear Tree Brook	53	31	84	49	140	80
		Moswansicut Reservoir subbasin						
19	01115170	Moswansicut Reservoir, (Moswansicut Stream North, Moswansicut Pond)	60	35	270	160	82	48
		Regulating Reservoir subbasin						
14	01115110	Huntinghouse Brook	13	7.9	140	83	22	13
15	01115114	Rush Brook	46	27	360	220	77	46
16	01115098	Peeptoad Brook (Harrisdale Brook)	43	25	420	240	84	48
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	52	30	27	15	97	55
		Scituate Reservoir drainage area						
			Mean		Total		Mean	
			34	20	3,100	1,900	50	30

Table 7. Monthly estimated chloride and sodium loads for sampling stations in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations are shown on figure 1. USGS, U.S. Geological Survey; Cl, chloride; Na, sodium; t, metric ton; kg, kilogram]

PWSB station no.	USGS station no.	Station name	October		November		December		January		February		March	
			Cl (t)	Na (t)	Cl (t)	Na (t)	Cl (t)	Na (t)	Cl (t)	Na (t)	Cl (t)	Na (t)	Cl (t)	Na (t)
Barden Reservoir subbasin														
24	01115190	Dolly Cole Brook	15	8.9	17	10	27	16	41	25	29	17	30	18
28	01115265	Barden Reservoir (Hemlock Brook)	28	17	24	15	31	19	42	26	36	22	42	25
35	01115187	Ponaganset River	35	21	33	20	51	31	78	48	56	34	66	40
Direct runoff subbasin														
3	01115280	Cork Brook	6.5	3.7	7.5	4.3	10	6.0	16	9.4	12	7.1	16	9.2
5	01115184	Spruce Brook	3.5	1.9	4.6	2.6	4.9	2.9	6.3	3.8	4.9	2.9	5.5	3.2
6	01115183	Quonapaug Brook	6.2	3.7	7.0	4.1	8.0	4.8	15	8.9	16	9.4	18	11
7	01115297	Wilbur Hollow Brook	3.0	1.9	3.2	2.1	3.8	2.5	8.2	5.5	7.9	5.2	8.5	5.5
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	7.2	4.5	12	7.8	18	11	28	17	20	12	21	13
9	01115275	Bear Tree Brook	2.5	1.5	5.1	3.0	7.6	4.5	11	6.3	7.7	4.5	8.1	4.8
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	0.44	0.26	7.5	4.4	19	11	38	22	29	17	30	17
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	6.1	3.6	8.6	5.1	14	8.0	23	14	17	10	16	9.6
15	01115114	Regulating Reservoir (Rush Brook)	15	8.6	18	11	29	18	50	30	44	26	52	30
16	01115098	Peeptoad Brook (Harrisdale Brook)	18	9.9	34	19	39	22	50	29	31	18	45	26
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	0.95	0.54	0.92	0.52	2.2	1.2	4.7	2.7	2.7	1.5	2.4	1.4
Scituate Reservoir drainage area														
		Total	150	87	180	110	260	160	150	87	310	190	360	210

Table 7. Monthly estimated chloride and sodium loads for sampling stations in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations are shown on figure 1. USGS, U.S. Geological Survey; Cl, chloride; Na, sodium; t, metric ton; kg, kilogram]

PWSB station no.	USGS station no.	Station name	April		May		June		July		August		September	
			Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)	Cl (kg)	Na (kg)
Barden Reservoir subbasin														
24	01115190	Dolly Cole Brook	49	30	33	20	18	11	11	6.9	3.9	2.3	2.4	1.4
28	01115265	Barden Reservoir (Hemock Brook)	62	38	53	33	31	19	19	12	4.8	2.8	3.7	2.2
35	01115187	Ponaganset River	93	57	78	48	45	28	34	21	8.6	5.2	4.4	2.6
Direct runoff subbasin														
3	01115280	Cork Brook	17	10	12	7.1	7.4	4.4	3.7	2.2	0.56	0.32	0.55	0.31
5	01115184	Spruce Brook	6.6	3.9	5.4	3.2	3.6	2.2	2.2	1.3	0.77	0.43	0.89	0.48
6	01115183	Quonapaug Brook	21	13	17	10	10	5.9	6.1	3.6	1.1	0.68	0.81	0.49
7	01115297	Wilbur Hollow Brook	11	7.4	10	6.5	6.3	4.2	4.2	2.7	0.82	0.52	0.64	0.38
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	34	22	31	19	18	11	12	7.7	6.2	3.8	5.0	3.1
9	01115275	Bear Tree Brook	13	7.9	12	7.2	7.3	4.3	4.9	2.9	2.4	1.4	2.0	1.2
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	55	32	43	25	32	19	12	6.8	1.4	0.82	0.98	0.57
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	24	15	17	10	10	5.8	3.9	2.3	0.44	0.25	0.38	0.22
15	01115114	Regulating Reservoir (Rush Brook)	63	38	44	27	28	17	15	9.0	1.7	0.96	1.2	0.70
16	01115098	Peeptoad Brook (Harrisdale Brook)	73	42	64	37	40	23	17	10	4.6	2.6	3.8	2.1
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	7.2	4.1	4.2	2.4	1.5	0.87	0.34	0.19	0.0000	0.0000	0.0065	0.0036
Scituate Reservoir drainage area														
		Total	530	320	420	260	260	160	150	88	37	22	27	16

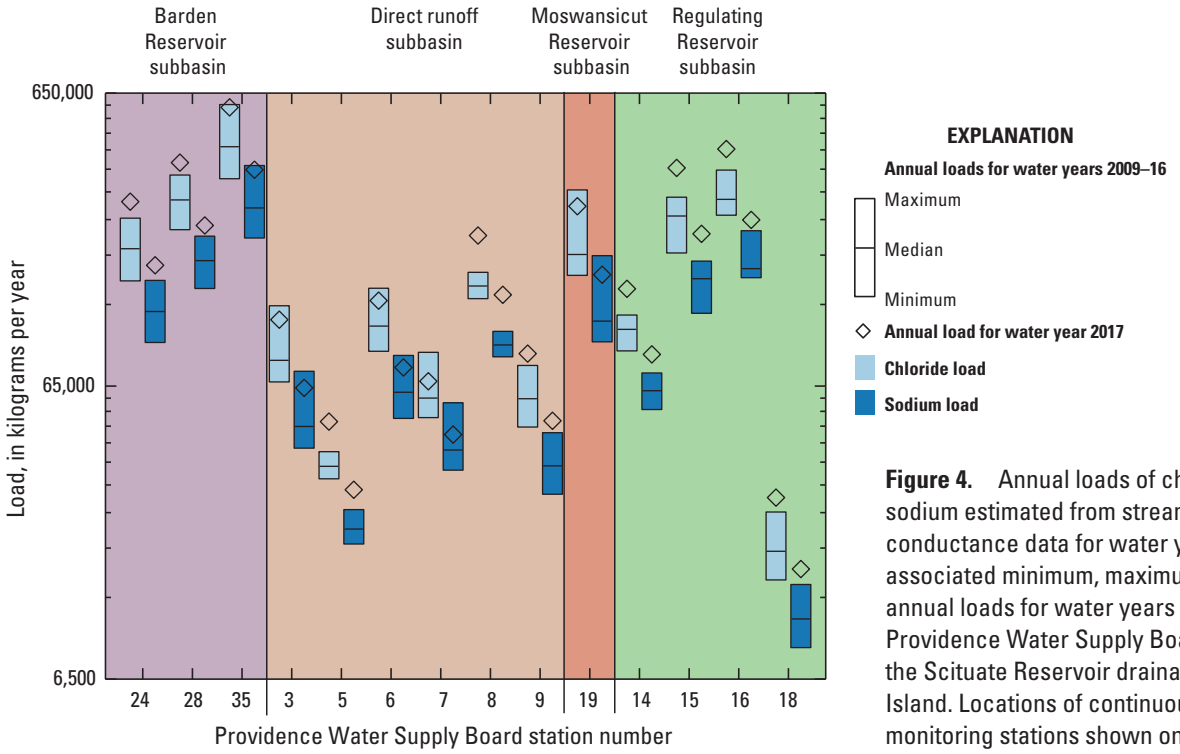

Figure 4. Annual loads of chloride and sodium estimated from streamflow and specific conductance data for water year 2017 and associated minimum, maximum, and median annual loads for water years 2009–16 at 14 Providence Water Supply Board stations in the Scituate Reservoir drainage area, Rhode Island. Locations of continuous water-quality monitoring stations shown on figure 1.

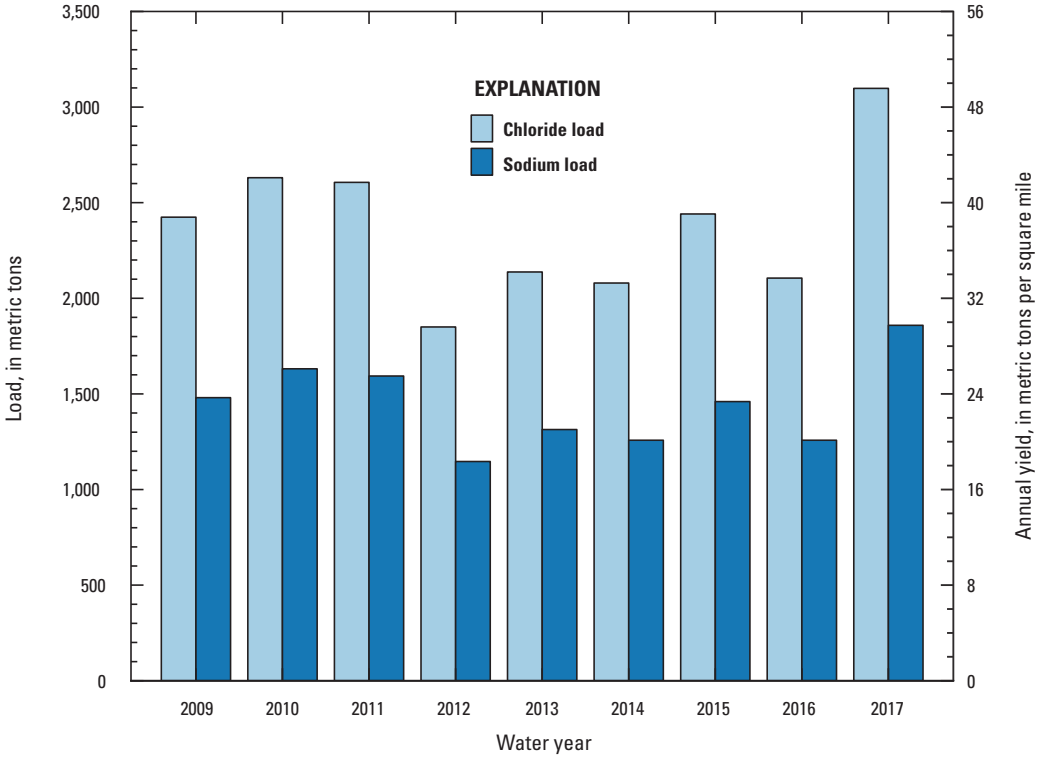

Figure 5. Annual loads and annual yields of chloride and sodium estimated from continuous measurements of flow and specific conductance for water years 2009–17 for the area upstream from 14 Providence Water Supply Board stations in the Scituate Reservoir drainage area, Rhode Island. Locations of continuous water-quality monitoring stations shown on figure 1.

Table 8. Median values for water-quality data collected at Providence Water Supply Board stations in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.

[The data in this table are a subset of the data presented in Smith (2019). Alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations are shown on figure 1. Water-quality data are from samples collected and analyzed by the PWSB. no., number; USGS, U.S. Geological Survey; PCU, platinum-cobalt unit; NTU, nephelometric turbidity unit; CFU/100mL, colony forming unit per 100 milliliters; *E. coli*, *Escherichia coli*; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; N, nitrogen; PO_4, phosphate; <, less than; —, no data]

PWSB station no.	USGS station no.	Station name	Properties			Constituents						
			pH	Color (PCU)	Turbidity (NTU)	Total coliform bacteria (CFU/100mL)	*E. coli* (CFU/100mL)	Alkalinity (mg/L as $CaCO_3$)	Chloride (mg/L)	Nitrite (mg/L as N)	Nitrate (mg/L as N)	Orthophosphate (mg/L as PO_4)
Barden Reservoir subbasin												
24	01115190	Dolly Cole Brook	6.2	39	0.49	1,500	15	4.3	30.4	0.002	0.06	0.04
25	01115200	Shippee Brook	6.2	68	0.57	1,100	21	3.8	13.5	0.002	0.05	0.06
26	01115185	Windsor Brook	6.2	51	0.43	1,400	27	3.8	31.1	0.001	<0.05	0.05
27	011151845	Unnamed tributary to Ponaganset River (unnamed brook B, unnamed brook west of Windsor Brook)	5.6	20	0.24	780	5	3.2	14.8	0.001	0.26	0.05
28	01115265	Barden Reservoir (Hemlock Brook)	6.0	130	0.59	1,300	27	4.2	32.3	0.003	<0.05	0.08
29	01115271	Ponaganset River (Barden Stream)	6.4	62	0.70	560	<10	4.1	24.0	0.002	<0.05	0.05
35	01115187	Ponaganset River	6.2	45	0.52	1,200	20	3.8	24.6	0.002	0.08	0.05
Direct runoff subbasin												
1	01115180	Brandy Brook	6.9	100	1.1	1,200	13	10	13.0	0.003	0.17	0.08
2	01115181	Unnamed tributary 2 to Scituate Reservoir (Unnamed brook north of Bullhead Brook)	6.2	9.5	0.21	590	7	4.1	80.5	0.001	0.34	0.06
3	01115280	Cork Brook	6.3	44	0.42	2,400	12	4.4	39.0	0.001	0.23	0.07
4	01115400	Kent Brook (Betty Pond Stream)	6.5	25	0.67	1,500	<5	6.3	6.60	0.001	<0.05	0.03
5	01115184	Spruce Brook	6.4	55	0.65	1,700	<5	4.7	25.1	0.002	0.23	0.05
6	01115183	Quonapaug Brook	6.4	140	1.0	1,500	100	8.0	37.9	0.003	0.23	0.09
7	01115297	Wilbur Hollow Brook	6.2	110	0.95	1,800	43	6.2	10.2	0.003	<0.05	0.06
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	6.5	18	0.45	200	2	3.5	14.8	0.001	<0.05	0.05
9	01115275	Bear Tree Brook	6.6	45	0.60	1,700	<5	8.1	59.9	0.002	0.59	0.06
30	01115350	Unnamed tributary 4 to Scituate Reservoir (Coventry Brook, Knight Brook)	5.9	45	0.40	780	5	3.5	25.4	0.001	0.08	0.03
31	01115177	Toad Pond	--	--	--	--	--	--	--	--	--	--
32	01115178	Unnamed tributary 1 to Scituate Reservoir (Pine Swamp Brook)	6.5	70	1.7	3,200	16	6.3	14.3	0.003	0.34	0.15

Table 8. Median values for water-quality data collected at Providence Water Supply Board stations in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[The data in this table are a subset of the data presented in Smith (2019). Alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations are shown on figure 1. Water-quality data are from samples collected and analyzed by the PWSB. no., number; USGS, U.S. Geological Survey; PCU, platinum-cobalt unit; NTU, nephelometric turbidity unit; CFU/100mL, colony forming unit per 100 milliliters; *E. coli*, *Escherichia coli*; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; N, nitrogen; PO_4, phosphate; <, less than; —, no data]

PWSB station no.	USGS station no.	Station name	Properties			Constituents						
			pH	Color (PCU)	Turbidity (NTU)	Total coliform bacteria (CFU/100mL)	*E. coli* (CFU/100mL)	Alkalinity (mg/L as $CaCO_3$)	Chloride (mg/L)	Nitrite (mg/L as N)	Nitrate (mg/L as N)	Orthophosphate (mg/L as PO_4)
Direct runoff subbasin—Continued												
33	01115182	Unnamed tributary 3 to Scituate Reservoir (Halls Estate Brook)	6.0	50	0.47	1,900	19	6.3	11.1	0.002	0.11	0.08
36	--	Outflow from King Pond	6.7	26	0.58	1,000	1	4.0	5.10	0.001	0.06	0.05
37	--	Fire Tower Stream	5.9	18	0.21	640	2	2.7	5.75	0.004	<0.05	0.13
Moswansicut Reservoir subbasin												
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	6.8	22	1.0	320	<5	10	58.7	0.002	0.17	0.05
20	01115160	Unnamed tributary 1 to Moswansicut Reservoir (Blanchard Brook)	6.3	250	0.76	1,900	36	7.1	74.1	0.004	0.15	0.08
21	01115165	Unnamed tributary 2 to Moswansicut Reservoir (brook from Kimball Reservoir)	6.7	51	0.90	2,800	52	9.5	39.4	0.003	0.54	0.04
22	01115167	Moswansicut Reservoir (Moswansicut Stream South)	6.6	32	0.86	6,500	120	13	73.6	0.007	0.47	0.05
34	01115164	Kimball Stream	6.6	66	0.85	2,200	36	11	42.4	0.002	0.17	0.04
Ponaganset Reservoir subbasin												
23	011151843	Ponaganset Reservoir	6.1	18	0.51	64	<2	3.0	22	0.001	0.08	0.02
Regulating Reservoir subbasin												
13	01115176	Regulating Reservoir	6.6	45	0.70	150	1	8.8	41.4	0.002	<0.05	0.05
14	01115110	Huntinghouse Brook	6.6	50	0.70	550	13	7.2	17	0.002	0.14	0.09
15	01115114	Rush Brook	6.6	65	0.67	940	40	8.9	65.8	0.002	0.10	0.08
16	01115098	Peeptoad Brook (Harrisdale Brook)	6.5	53	0.81	540	4	8.5	44.1	0.002	0.09	0.07
17	01115119	Dexter Pond (Paine Pond)	6.1	85	0.97	820	14	5.4	23.1	0.006	0.21	0.07
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	6.5	41	0.70	1,700	17	8.9	55.2	0.006	0.34	0.06

Table 8. Median values for water-quality data collected at Providence Water Supply Board stations in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[The data in this table are a subset of the data presented in Smith (2019). Alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations are shown on figure 1. Water-quality data are from samples collected and analyzed by the PWSB. no., number; USGS, U.S. Geological Survey; PCU, platinum-cobalt unit; NTU, nephelometric turbidity unit; CFU/100mL, colony forming unit per 100 milliliters; *E. coli*, *Escherichia coli*; mg/L, milligram per liter; $CaCO_3$, calcium carbonate; N, nitrogen; PO_4, phosphate; <, less than; —, no data]

PWSB station no.	USGS station no.	Station name	Properties			Constituents						
			pH	Color (PCU)	Turbidity (NTU)	Total coliform bacteria (CFU/100mL)	*E. coli* (CFU/100mL)	Alkalinity (mg/L as $CaCO_3$)	Chloride (mg/L)	Nitrite (mg/L as N)	Nitrate (mg/L as N)	Orthophosphate (mg/L as PO_4)
Westconnaug Reservoir subbasin												
10	01115274	Westconnaug Brook	5.7	37	0.31	4,200	<5	2.8	28.0	0.001	<0.05	0.05
11	01115273	Unnamed tributary to Westconnaug Reservoir (unnamed brook south of Westconnaug Reservoir)	5.7	110	0.78	1,600	18	5.7	5.30	0.003	<0.05	0.05
12	011152745	Unnamed Tributary to Westconnaug Brook (unnamed brook north of Westconnaug Reservoir)	6.1	53	0.72	750	14	5.1	23.3	0.001	<0.17	0.04
Scituate Reservoir drainage area												
		Minimum	5.6	9.5	0.21	64	<2	2.7	5.1	0.001	<0.05	0.02
		Median	6.3	50	0.67	1,200	14	5.5	25.3	0.002	0.10	0.05
		Maximum	6.9	250	1.7	6,500	120	13	80.5	0.007	0.59	0.15

Table 9. Median daily loads and yields of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations shown on figure 1. Water-quality data are from samples collected and analyzed by the PWSB. no., number; USGS, U.S. Geological Survey; CFU×10^6/d, million colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilogram per day; kg/d/mi^2, kilogram per day per square mile; N, nitrogen; g/d, gram per day; g/d/mi^2, gram per day per square mile; PO_4, phosphate; g/d, grams per day; <, less than value shown; —, no data]

PWSB station no.	USGS station no.	Station name	Total coliform bacteria		*E. coli*		Chloride		Nitrite (as N)		Nitrate (as N)		Orthophosphate (as PO_4)	
			Load (CFU×10^6/d)	Yield (CFU×10^6/mi^2)	Load (CFU×10^6/d)	Yield (CFU×10^6/mi^2)	Load (kg/d)	Yield (kg/d/mi^2)	Load (g/d)	Yield (g/d/mi^2)	Load (g/d)	Yield (g/d/mi^2)	Load (g/d)	Yield (g/d/mi^2)
Barden Reservoir subbasin														
24	01115190	Dolly Cole Brook	210,000	43,000	1,700	350	480	98	26	5.3	960	200	790	160
25	01115200	Shippee Brook	120,000	52,000	2,100	890	150	62	22	9.1	680	290	650	280
26	01115185	Windsor Brook	260,000	59,000	4,700	1,100	770	180	32	7.4	<590	<140	1,700	390
28	01115265	Barden Reservoir	270,000	31,000	5,300	600	920	100	55	6.3	<1,100	<130	2,200	250
35	01115187	Ponaganset River	610,000	44,000	10,000	710	1,200	86	76	5.4	3,300	240	2,500	180
Direct runoff subbasin														
1	01115180	Brandy Brook	64,000	41,000	1,700	1,100	80	51	14.0	8.9	1,100	700	460	290
3	01115280	Cork Brook	71,000	39,000	700	390	260	150	9.3	5.2	1,900	1,100	760	420
4	01115400	Kent Brook	37,000	44,000	700	820	18	21	2.5	2.9	<63	<74	150	180
5	01115184	Spruce Brook	58,000	48,000	<140	<110	47	39	4.2	3.4	470	390	100	82
6	01115183	Quonapaug Brook	54,000	28,000	5,200	2,600	320	160	20	10	1,800	920	730	370
7	01115297	Wilbur Hollow Brook	300,000	68,000	5,100	1,200	190	43	43	9.8	<760	<170	730	170
8	01115276	Westconnaug Brook	80,000	15,000	<410	<79	460	88	33	6.3	<720	<140	1,600	300
9	01115275	Bear Tree Brook	42,000	68,000	500	810	150	240	2.4	3.9	1,400	2,300	150	240
32	01115178	Unnamed tributary 1 to Scituate Reservoir (Pine Swamp Brook)	49,000	110,000	240	530	22	49	4.4	9.8	420	930	230	510
33	01115182	Unnamed tributary 3 to Scituate Reservoir (Halls Estate Brook)	17,000	61,000	220	790	18	64	2.3	8.2	180	630	140	480

Table 9. Median daily loads and yields of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Alternate station names given in parentheses for stations where different historical names were used for the same sampling location by Providence Water Supply Board (PWSB). Locations of stations shown on figure 1. Water-quality data are from samples collected and analyzed by the PWSB. no., number; USGS, U.S. Geological Survey; CFU×10^6/d, million colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilogram per day; kg/d/mi^2, kilogram per day per square mile; N, nitrogen; g/d, gram per day; g/d/mi^2, gram per day per square mile; PO_4, phosphate; g/d, grams per day; <, less than value shown; —, no data]

PWSB station no.	USGS station no.	Station name	Total coliform bacteria		*E. coli*		Chloride		Nitrite (as N)		Nitrate (as N)		Orthophosphate (as PO_4)	
			Load (CFU×10^6/d)	Yield (CFU×10^6/mi^2)	Load (CFU×10^6/d)	Yield (CFU×10^6/mi^2)	Load (kg/d)	Yield (kg/d/mi^2)	Load (g/d)	Yield (g/d/mi^2)	Load (g/d)	Yield (g/d/mi^2)	Load (g/d)	Yield (g/d/mi^2)
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	5,800	1,800	<230	<71	480	150	14	4.3	1,600	490	470	140
21	01115165	Unnamed tributary 2 to Moswansicut Reservoir (brook from Kimball Reservoir)	88,000	300,000	1,600	5,500	130	430	7.8	27	1,700	5,700	130	440
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	99,000	16,000	2,300	370	280	45	29	4.7	1,600	260	1,600	260
15	01115114	Regulating Reservoir (Rush Brook)	100,000	21,000	5,200	1,100	630	130	27	5.7	460	98	1,100	230
16	01115098	Peeptoad Brook (Harrisdale Brook)	90,000	18,000	280	55	550	110	29	5.8	2,200	440	1,400	280
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	--	--	--	--	--	--	--	--	--	--	--	--
Westconnaug Reservoir subbasin														
10	01115274	Westconnaug Brook	120,000	79,000	320	210	95	64	3.4	2.3	<100	<68	120	78
11	01115273	Unnamed tributary to Westconnaug Reservoir (unnamed brook south of Westconnaug Reservoir)	35,000	49,000	340	470	17	24	7.2	10	<75	<100	160	220
Scituate Reservoir drainage area														
		Minimum	5,800	1,800	<140	55	17	21	2.3	2.3	<63	<68	100	78
		Median	84,000	44,000	1,200	655	230	87	17	6.1	860	280	690	260
		Maximum	610,000	300,000	10,000	5,500	1,200	430	76	27	3,300	5,700	2,500	510

Bacteria

Median concentrations of total coliform bacteria were above the detection limit (1 colony forming unit per 100 milliliters [CFU/100 mL]) at all sites (table 8). Median concentrations of *E. coli* were equal to or greater than a detection limit of 10 CFU/100 mL (highest detection limit of median values) at 21 of the 36 stations; however, uncensored median concentrations of *E. coli* less than 10 CFU/100 mL were available at eight stations. Total coliform bacteria concentrations were greater than *E. coli* concentrations (as expected because total coliform is more inclusive than *E. coli*); the medians of median concentrations for all sites in the drainage area were 1,200 CFU/100 mL for total coliform bacteria and 14 CFU/100 mL for *E. coli* (table 8). Median concentrations of total coliform bacteria and of *E. coli* were highest at the Moswansicut Reservoir (PWSB station 22) at 6,500 and 120 CFU/100 mL, respectively. Median concentrations of fecal indicator bacteria were lowest at the Ponaganset Reservoir (PWSB station 23).

Median daily loads and yields of total coliform bacteria and *E. coli* varied by about two orders of magnitude; the highest median daily yield of total coliform bacteria at 300,000 million colony forming units per day per square mile (MCFU/d/mi^2) and the highest median daily yield of *E. coli* of 5,500 MCFU/d/mi^2 were at unnamed tributary 2 to the Moswansicut Reservoir (PWSB station 21; table 9). Although relatively high for sampling stations in the Scituate Reservoir subbasin, median daily bacteria yields at Moswansicut Reservoir were low to moderate for yields of indicator bacteria in sewage-contaminated stream water or stream water affected by stormwater runoff in an urban environment (Breault and others, 2002). The median daily loads of total coliform bacteria for all subbasins in the Scituate Reservoir drainage area ranged from 5,800 to 610,000 million colony forming units per day (MCFU/d), and yields, from 1,800 to 300,000 million colony forming units per day per square mile (MCFU/d/mi^2); *E. coli* loads ranged from less than 140 to 10,000 MCFU/d, and yields, from 55 to 5,500 MCFU/d/mi^2 (table 9).

Chloride and Sodium

Median chloride concentrations among the PWSB stations ranged from 5.1 to 80.5 mg/L; the highest concentration was measured in the direct runoff subbasin at unnamed tributary 2 to the Scituate Reservoir (PWSB station 2; table 8). The median of median concentrations for all sites in the drainage area was 25.3 mg/L (table 8). Median daily chloride loads and yields estimated from samples collected by the PWSB varied among monitoring stations in the drainage area (table 9); the median daily chloride load and yield for monitored areas within the drainage area was 230 kilograms per day (kg/d) and 87 kilograms per day per square mile (kg/d/mi^2). Ponaganset River (PWSB station 35) had the largest median daily chloride load at 1,200 kilograms per day. The largest median daily chloride yield was determined to be 430 kg/d/mi^2 at unnamed tributary 2 to the Moswansicut Reservoir (PWSB station 21; table 8). The estimated annual mean yields of chloride and sodium for the drainage areas upstream from the 14 USGS continuous-record streamgages, which represent nearly 66 percent of the Scituate Reservoir drainage area, were 50 and 30 metric tons per day per square mile (t/d/mi^2), respectively. These estimated annual mean yields of chloride and sodium for WY 2017 were higher than all prior annual yields since WY 2009 and about 47 percent higher than the estimated annual mean yields of 34 and 20 t/d/mi^2, respectively, for WY 2016 (fig. 5).

Nutrients

Median concentrations of nitrite and nitrate (table 8) were 0.002 and 0.10 mg/L as nitrogen (N), respectively. The highest median concentration of nitrite was 0.007 mg/L as N measured in a sample collected at the Moswansicut Reservoir (PWSB station 22). The highest median concentration of nitrate was 0.59 mg/L as N measured in a sample collected at Bear Tree Brook (PWSB station 9). The median concentration of orthophosphate for the entire study area (table 8) was 0.05 mg/L as phosphate (PO_4). The maximum median concentration of orthophosphate was 0.15 mg/L as PO_4 measured in unnamed tributary 1 to the Scituate Reservoir (PWSB station 32). Median daily nitrite, nitrate, and orthophosphate loads were largest at Ponaganset River (PWSB station 35) at 76, 3,300, and 2,500 grams per day (g/d), respectively (table 9). The largest median daily yields for nitrite and nitrate were 27 and 5,700 grams per day per square mile (g/d/mi^2), respectively, at unnamed tributary 2 to the Moswansicut Reservoir (PWSB station 21). The largest median daily yield for orthophosphate was 510 g/d/mi^2 at Pine Swamp Brook (PWSB station 32; table 9). The medians of median daily loads and yields were 17 g/d and 6.1 g/d/mi^2 for nitrite, 860 g/d and 280 g/d/mi^2 for nitrate, and 690 g/d and 260 g/d/mi^2 for orthophosphate, respectively.

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Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB). Shaded cells indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are listed in parentheses for stations where different historical names were used for the same sampling location by the PWSB. no., number; USGS,U.S. Geological Survey; ft^3/s, cubic foot per second; $CFU \times 10^6/d$; million colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilogram per day; g/d, gram per day; N, nitrogen; PO_4, phosphate; <, less than; —, data not available]

PWSB station no.	USGS station no.	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFU \times 10^6/d$)	*E. coli* ($CFU \times 10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
			Barden Reservoir subbasin							
24	01115190	Dolly Cole Brook	10/7/2016	0.37	14,000	140	36	0.91	54	82
			11/4/2016	5.6	390,000	3,000	340	27	<340	820
			12/2/2016	18	490,000	6,700	1,400	89	<1,100	1,300
			1/20/2017	13	170,000	320	920	95	3,200	<320
			2/3/2017	7.7	160,000	380	600	19	1,900	760
			3/3/2017	7.7	87,000	<190	670	19	1,400	380
			4/7/2017	41	1,100,000	10,000	2,700	100	7,100	4,000
			5/5/2017	18	850,000	2,200	1,100	44	<1,100	1,800
			6/2/2017	5.1	330,000	7,400	360	25	<310	990
			7/7/2017	3.0	180,000	110,000	220	30	820	970
			8/4/2017	2.4	240,000	1,200	200	12	590	120
			9/25/2017	0.88	32,000	430	82	2.1	<54	64
25	01115200	Shippee Brook	10/31/2016	3.5	56,000	2,800	110	17	--	520
			1/13/2017	12	170,000	1,400	290	29	2,700	3,200
			4/21/2017	5.4	210,000	1,300	180	26	680	650
			7/28/2017	0.80	74,000	19,000	27	5.9	<49	--
26	01115185	Windsor Brook	10/28/2016	11	780,000	780,000	1,200	110	<690	2,200
			1/13/2017	18	240,000	870	940	44	3,600	1,700
			4/21/2017	8.1	270,000	8,500	590	20	<490	990
			7/28/2017	1.2	38,000	290	92	2.9	<72	--

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB). Shaded cells indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are listed in parentheses for stations where different historical names were used for the same sampling location by the PWSB. no., number; USGS,U.S. Geological Survey; ft^3/s, cubic foot per second; $CFU \times 10^6/d$; million colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilogram per day; g/d, gram per day; N, nitrogen; PO_4, phosphate; <, less than; —, data not available]

PWSB station no.	USGS station no.	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFU \times 10^6/d$)	*E. coli* ($CFU \times 10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
			Barden Reservoir subbasin—Continued							
28	01115265	Barden Reservoir (Hemlock Brook)	10/12/2016	5.6	300,000	8,000	540	27	<340	1,100
			11/18/2016	23	1,900,000	60,000	2,000	220	<1,400	3,900
			12/15/2016	13	94,000	15,000	1,400	97	2,000	3,200
			2/14/2017	15	45,000	<180	1,200	<18	2,900	1,500
			4/11/2017	23	240,000	2,800	1,800	170	<1,400	2,800
			5/9/2017	30	940,000	7,400	1,500	220	<1,800	5,900
			6/13/2017	8.0	390,000	12,000	460	79	<490	980
			7/11/2017	9.1	1,100,000	2,900	630	22	<560	2,900
			8/8/2017	3.1	100,000	3,100	240	30	810	530
			9/12/2017	1.9	59,000	<460	170	9.1	<110	370
35	01115187	Ponaganset River	10/7/2016	2.0	67,000	1,500	140	4.8	<120	240
			11/4/2016	14	340,000	5,300	1,200	70	<880	1,400
			12/2/2016	50	1,400,000	45,000	2,500	360	6,400	6,100
			1/20/2017	35	320,000	1,700	1,900	430	9,500	<870
			2/3/2017	23	350,000	1,100	1,200	57	8,000	5,700
			3/3/2017	27	460,000	<660	1,600	66	5,400	2,000
			4/7/2017	140	1,500,000	35,000	7,200	690	34,000	14,000
			5/5/2017	53	4,200,000	49,000	4,500	130	<3,300	2,600
			6/2/2017	20	1,300,000	10,000	1,000	100	3,100	4,500
			7/7/2017	10	610,000	82,000	700	76	2,900	2,500
			8/4/2017	9.3	3,900,000	31,000	560	68	2,700	1,800

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB). Shaded cells indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are listed in parentheses for stations where different historical names were used for the same sampling location by the PWSB. no., number; USGS,U.S. Geological Survey; ft^3/s, cubic foot per second; $CFU \times 10^6/d$; million colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilogram per day; g/d, gram per day; N, nitrogen; PO_4, phosphate; <, less than; —, data not available]

PWSB station no.	USGS station no.	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFU \times 10^6/d$)	*E. coli* ($CFU \times 10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
			Direct runoff subbasin							
1	01115180	Brandy Brook	10/4/2016	0.31	8,900	100	13	0.77	260	23
			11/1/2016	1.9	64,000	3,000	72	14	510	460
			12/6/2016	1.6	25,000	77	59	12	650	350
			1/3/2017	2.5	75,000	<30	80	12	1,100	490
			2/7/2017	3.0	37,000	150	96	15	1,600	590
			3/7/2017	2.6	12,000	6,100	46	6.3	3,600	380
			4/4/2017	6.8	120,000	1,700	190	50	1,700	1,000
			5/2/2017	3.7	180,000	22,000	100	27	1,000	3,300
			6/6/2017	4.9	340,000	67,000	120	48	1,300	240
3	01115280	Cork Brook	10/6/2016	0.12	1,600	12	19	<0.15	97	36
			11/3/2016	1.9	230,000	190	240	9.5	450	240
			12/1/2016	8.8	400,000	3,900	710	65	1,600	1,500
			1/5/2017	5.3	68,000	3,400	470	26	2,200	520
			2/2/2017	3.2	30,000	160	280	7.8	3,200	1,200
			3/2/2017	3.7	79,000	<90	380	9.0	2,400	1,300
			4/6/2017	12	64,000	6,000	1,000	<15	6,000	1,800
			5/4/2017	2.3	39,000	1,200	240	5.6	840	<56
			7/7/2017	2.4	140,000	33,000	170	18	2,900	1,000
			8/3/2017	0.41	73,000	<50	43	1.0	410	40
4	01115400	Kent Brook	10/4/2016	0.066	5,000	6.4	1.2	<0.08	<4.0	1.6
			11/1/2016	1.0	37,000	3,500	4.1	2.5	<63	150
			2/7/2017	0.84	10,000	<10	13	2.0	<51	61
			3/7/2017	0.86	340	<21	18	2.1	<52	63
			4/4/2017	8.8	130,000	<1,100	190	21	<540	430
			5/2/2017	1.9	360,000	700	29	4.7	<120	840
			6/6/2017	5.2	590,000	2,600	85	13	<320	1,000

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB). Shaded cells indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are listed in parentheses for stations where different historical names were used for the same sampling location by the PWSB. no., number; USGS,U.S. Geological Survey; ft^3/s, cubic foot per second; $CFU \times 10^6/d$; million colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilogram per day; g/d, gram per day; N, nitrogen; PO_4, phosphate; <, less than; —, data not available]

PWSB station no.	USGS station no.	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFU \times 10^6/d$)	*E. coli* ($CFU \times 10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
			Direct runoff subbasin—Continued							
5	01115184	Spruce Brook	10/18/2016	0.34	14,000	140	36	1.7	230	50
			4/18/2017	2.4	76,000	<150	47	12	1,300	120
			7/21/2017	0.85	58,000	<52	52	4.2	470	100
6	01115183	Quonapaug Brook	10/4/2016	0.20	24,000	1,800	35	<0.25	110	20
			11/1/2016	2.4	130,000	7,100	310	23	1,300	580
			12/6/2016	1.8	19,000	2,000	110	14	1,900	410
			1/3/2017	3.5	38,000	6,900	330	17	4,000	1,300
			2/7/2017	4.5	32,000	23,000	420	22	6,300	1,400
			3/7/2017	3.6	42,000	1,800	220	18	1,700	800
			4/4/2017	14	290,000	3,400	440	100	7,600	2,000
			5/2/2017	6.0	320,000	24,000	550	44	1,700	2,600
			6/6/2017	9.0	5,300,000	710,000	740	110	2,200	660
			8/1/2017	0.54	66,000	1,100	64	5.3	460	80
7	01115297	Wilbur Hollow Brook	10/6/2016	0.44	21,000	700	11	1.1	<27	54
			11/3/2016	3.6	86,000	4,200	82	26	<220	620
			12/1/2016	16	1,900,000	72,000	380	150	<970	3,900
			1/5/2017	11	140,000	3,600	240	170	3,400	2,500
			2/2/2017	11	100,000	540	220	27	5,600	3,500
			3/2/2017	11	240,000	540	300	81	3,200	1,100
			4/6/2017	24	180,000	6,000	190	60	5,200	3,600
			5/4/2017	8.8	350,000	8,200	540	43	<540	430
			6/1/2017	8.5	570,000	6,200	180	42	<520	830
			7/7/2017	6.2	370,000	300,000	170	61	990	610
			8/3/2017	1.8	750,000	3,700	53	13	<110	130
			9/7/2017	2.4	1,100,000	180,000	92	12	<140	580

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB). Shaded cells indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are listed in parentheses for stations where different historical names were used for the same sampling location by the PWSB. no., number; USGS,U.S. Geological Survey; ft^3/s, cubic foot per second; $CFU \times 10^6/d$; million colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilogram per day; g/d, gram per day; N, nitrogen; PO_4, phosphate; <, less than; —, data not available]

PWSB station no.	USGS station no.	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFU \times 10^6/d$)	*E. coli* ($CFU \times 10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
			Direct runoff subbasin—Continued							
8	01115276	Westconnaug Brook	11/18/2016	9.3	46,000	230	1,100	23	<570	910
			12/9/2016	8.8	31,000	430	360	21	<540	1500
			1/13/2017	21	79,000	<260	910	53	<1,300	2,100
			2/24/2017	17	81,000	<210	650	41	<1,000	2,100
			4/14/2017	16	14,000	<390	500	39	<970	1,600
			5/12/2017	15	52,000	<930	560	37	<930	3,000
			6/9/2017	12	80,000	<1,400	410	28	<710	570
			7/14/2017	12	2,000,000	<2,900	370	57	<720	2,000
			8/18/2017	2.3	200,000	<290	76	5.7	<140	110
			9/8/2017	2.7	270,000	<660	87	6.6	<170	530
9	01115275	Bear Tree Brook	10/18/2016	0.35	27,000	34	77	1.7	830	51
			4/18/2017	2.1	52,000	<130	270	10	2,100	150
			7/21/2017	0.99	42,000	970	150	2.4	1,400	190
32	01115178	Unnamed tributary 1 to Scituate Reservoir (Pine Swamp Brook)	1/13/2017	1.2	16,000	230	47	8.5	1,600	650
			4/20/2017	0.62	49,000	240	22	3.0	420	230
			7/20/2017	0.36	86,000	610	11	4.4	300	79
33	01115182	Unnamed tributary 3 to Scituate Reservoir (Halls Estate Brook)	10/26/2016	0.19	9,600	120	6.4	0.46	<11	41
			1/13/2017	1.2	15,000	320	23	2.9	490	230
			4/26/2017	1.3	57,000	11,000	24	6.6	230	230
			7/26/2017	0.35	19,000	85	13	1.7	120	25

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB). Shaded cells indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are listed in parentheses for stations where different historical names were used for the same sampling location by the PWSB. no., number; USGS,U.S. Geological Survey; ft^3/s, cubic foot per second; $CFU \times 10^6/d$; million colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilogram per day; g/d, gram per day; N, nitrogen; PO_4, phosphate; <, less than; —, data not available]

PWSB station no.	USGS station no.	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFU \times 10^6/d$)	*E. coli* ($CFU \times 10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
			Moswansicut Reservoir subbasin							
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	10/13/2016	0.077	2,900	1.9	11	0.38	11	13
			11/2/2016	0.20	4,000	540	28	2.4	63	29
			12/8/2016	3.4	3,400	160	480	8.2	1,600	330
			1/12/2017	9.1	440	<110	1,300	44	4,400	1,300
			3/9/2017	4.8	3,500	230	200	35	3,900	470
			4/13/2017	9.5	5,800	470	1,400	47	6,200	930
			5/11/2017	7.9	53,000	<480	1,200	39	4,500	1,700
			6/8/2017	13	110,000	<1,600	1,900	66	5,400	1,600
			7/13/2017	5.7	650,000	<1,400	810	14	<350	2,400
			8/28/2017	0.22	60,000	<27	33	0.54	<13	11
			9/14/2017	0.16	8,100	<39	23	0.39	<9.6	12
21	01115165	Unnamed tributary 2 to Moswansicut Reservoir (brook from Kimball Reservoir)	1/13/2017	1.3	75,000	710	110	9.3	2,000	93
			4/28/2017	1.3	100,000	2,500	140	6.2	1,300	160
			Regulating Reservoir subbasin							
14	01115110	Huntinghouse Brook	10/3/2016	0.46	4,400	630	15	2.2	160	180
			11/2/2016	6.7	200,000	8,100	280	33	<410	1,600
			12/5/2016	7.4	99,000	2,300	290	36	1,600	1,600
			2/6/2017	8.1	17,000	1,400	340	20	4,000	600
			3/6/2017	6.4	29,000	<160	280	<7.8	2,800	2,300
			4/3/2017	33	310,000	14,000	1,100	80	11,000	2,400
			5/1/2017	11	310,000	2,800	960	56	1,400	1,700
			6/5/2017	6.0	140,000	12,000	240	29	2,000	150
			8/7/2017	0.63	48,000	160	27	3.1	300	140

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

[Developed from data presented in U.S. Geological Survey (2018) and Smith (2019). Water-quality data are from samples collected and analyzed by Providence Water Supply Board (PWSB). Shaded cells indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are listed in parentheses for stations where different historical names were used for the same sampling location by the PWSB. no., number; USGS,U.S. Geological Survey; ft^3/s, cubic foot per second; $CFU \times 10^6/d$; million colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilogram per day; g/d, gram per day; N, nitrogen; PO_4, phosphate; <, less than; —, data not available]

PWSB station no.	USGS station no.	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFU \times 10^6/d$)	*E. coli* ($CFU \times 10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
Regulating Reservoir subbasin—Continued										
15	01115114	Rush Brook	10/3/2016	0.16	18,000	2,500	44	0.38	72	19
			11/2/2016	4.5	100,000	7,900	530	44	<270	1,100
			12/5/2016	5.4	100,000	1,200	630	27	710	1,200
			2/6/2017	5.9	8,000	580	950	14	3,500	1,400
			4/3/2017	20	180,000	5,400	2,400	49	6,800	1,500
			5/1/2017	7.5	280,000	38,000	1,200	37	<460	1,300
			6/5/2017	5.9	140,000	5,800	900	29	1,400	140
			8/7/2017	0.50	170,000	5,200	120	2.4	170	120
			9/11/2017	0.17	9,500	170	36	0.42	30	33
16	01115098	Peeptoad Brook (Harrisdale Brook)	10/3/2016	0.60	8,600	59	76	1.5	<37	15
			11/2/2016	6.0	69,000	290	840	44	<360	870
			12/5/2016	10	110,000	500	1,200	50	2,100	1,700
			2/6/2017	6.8	19,000	170	720	33	5,000	1,700
			3/6/2017	7.6	54,000	<190	370	<9.3	4,600	2,200
			4/3/2017	33	410,000	3,300	3,100	82	15,000	8,200
			5/1/2017	10	400,000	2,500	340	25	2,300	1,500
			6/5/2017	8.9	160,000	4,400	880	87	2,300	1,300
			8/7/2017	2.0	230,000	<250	220	10	<120	150
			9/11/2017	1.1	34,000	<260	120	2.6	<66	180
18	01115120	Unnamed tributary to Regulating Reservoir (unnamed brook A)	1/13/2017	1.9	110,000	370	230	37	2,100	280
			4/28/2017	1.1	29,000	720	170	8.3	600	170

Table 4. Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate in the Scituate Reservoir drainage area, Rhode Island, from October 1, 2016, through September 30, 2017.—Continued

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PWSB station no.	USGS station no.	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFU \times 10^6/d$)	*E. coli* ($CFU \times 10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
			Westconnaug Reservoir subbasin							
10	01115274	Westconnaug Brook	10/12/2016	0.31	37,000	7.6	29	<0.38	<19	46
			11/18/2016	1.4	170,000	140	130	3.4	<86	170
			12/15/2016	0.62	11,000	15	51	1.5	100	110
			4/11/2017	3.9	93,000	<240	270	9.5	<240	470
			5/9/2017	4.1	160,000	<250	220	9.9	<250	300
			6/13/2017	1.0	140,000	490	59	2.5	<61	120
			7/11/2017	2.3	1,300,000	1,100	150	11	<140	110
			8/8/2017	0.28	25,000	680	14	0.70	<17	42
11	01115273	Unnamed tributary to Westconnaug Reservoir (unnamed brook south of Westconnaug Reservoir)	10/25/2016	0.51	26,000	310	6.3	7.5	<31	38
			1/13/2017	2.5	31,000	240	34	6.1	350	360
			4/25/2017	1.5	39,000	360	24	11	<91	150
			7/25/2017	0.94	130,000	1,200	10	6.9	<58	160

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