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Streamflow, Water Quality, and Constituent Loads and Yields, Scituate Reservoir Drainage Area, Rhode Island, Water Year 2014

Open-File Report 2016–1051

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

Cover. Westconnaug Stream at Plainfield Pike, Rhode Island. Photograph by Joan Whitley.

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SALLY JEWELL, Secretary

U.S. Geological Survey
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U.S. Geological Survey, Reston, Virginia: 2016

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Suggested citation:
Smith, K.P., 2016, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2014: U.S. Geological Survey Open-File Report 2016–1051, 31 p., http://dx.doi.org/10.3133/ofr20161051.

ISSN 2331-1258 (online)

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Conversion Factors

Inch/Pound to International System of Units

Multiply	By	To obtain
	Length	
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
	Mass	
ton, short (2,000 lb)	907.2	kilogram (kg)

Datum

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

Supplemental Information

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

Loads of chemical constituents in water are given either in grams or kilograms (or millions of colony forming units for bacteria) per day or year, and yields are given in grams or kilograms (or millions of colony forming units for bacteria) per day or year per square mile.

Abbreviations

CFU	colony forming units
E. coli	*Escherichia coli*
MOVE.1	Maintenance of Variance Extension type 1
NTU	nephelometric turbidity units
NWIS	National Water Information System
PCU	platinum cobalt units
PWSB	Providence Water Supply Board
RIDEM	Rhode Island Department of Environmental Management
USGS	U.S. Geological Survey
WY	water year

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By Kirk P. Smith

Abstract

Streamflow and concentrations of sodium and chloride estimated from records of specific conductance were used to calculate loads of sodium and chloride during water year (WY) 2014 (October 1, 2013, through September 30, 2014) for tributaries to the Scituate Reservoir, Rhode Island. Streamflow and water-quality data used in the study were collected by the U.S. Geological Survey and the Providence Water Supply Board in the cooperative study. 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 at 37 sampling stations by the Providence Water Supply Board and at 14 continuous-record streamgages by the U.S. Geological Survey during WY 2014 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 WY 2014.

The largest tributary to the reservoir (the Ponaganset River, which was monitored by the U.S. Geological Survey) contributed a mean streamflow of 23 cubic feet per second to the reservoir during WY 2014. For the same time period, annual mean[1] streamflows measured (or estimated) for the other monitoring stations in this study ranged from about 0.35 to about 14 cubic feet per second. Together, tributaries (equipped with instrumentation capable of continuously monitoring specific conductance) transported about 1,200,000 kilograms of sodium and 2,100,000 kilograms of chloride to the Scituate Reservoir during WY 2014; sodium and chloride yields for the tributaries ranged from 7,700 to 45,000 kilograms per year per square mile and from 12,000 to 75,000 kilograms per year per square mile, respectively.

At the stations where water-quality samples were collected by the Providence Water Supply Board, the median of the median chloride concentrations was 24 milligrams per liter, median nitrite concentration was 0.002 milligrams per liter as nitrogen (N), median nitrate concentration was 0.01 milligrams per liter as N, median orthophosphate concentration was 0.07 milligrams per liter as phosphate, and median concentrations of total coliform bacteria and *Escherichia coli* were 320 and 20 colony forming units per 100 milliliters, respectively. The medians of the median daily loads (and yields) of chloride, nitrite, nitrate, orthophosphate, and total coliform and *Escherichia coli* bacteria were 62 kilograms per day (42 kilograms per day per square mile), 19 grams per day (6.1 grams per day per square mile), 79 grams per day (36 grams per day per square mile), 380 grams per day (150 grams per day per square mile), 13,000 million colony forming units per day (8,300 million colony forming units per day per square mile), and 1,000 million colony forming units per day (470 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. It covers 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 for the protection of human health. The Providence Water Supply Board (PWSB), 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. Since 2009,

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

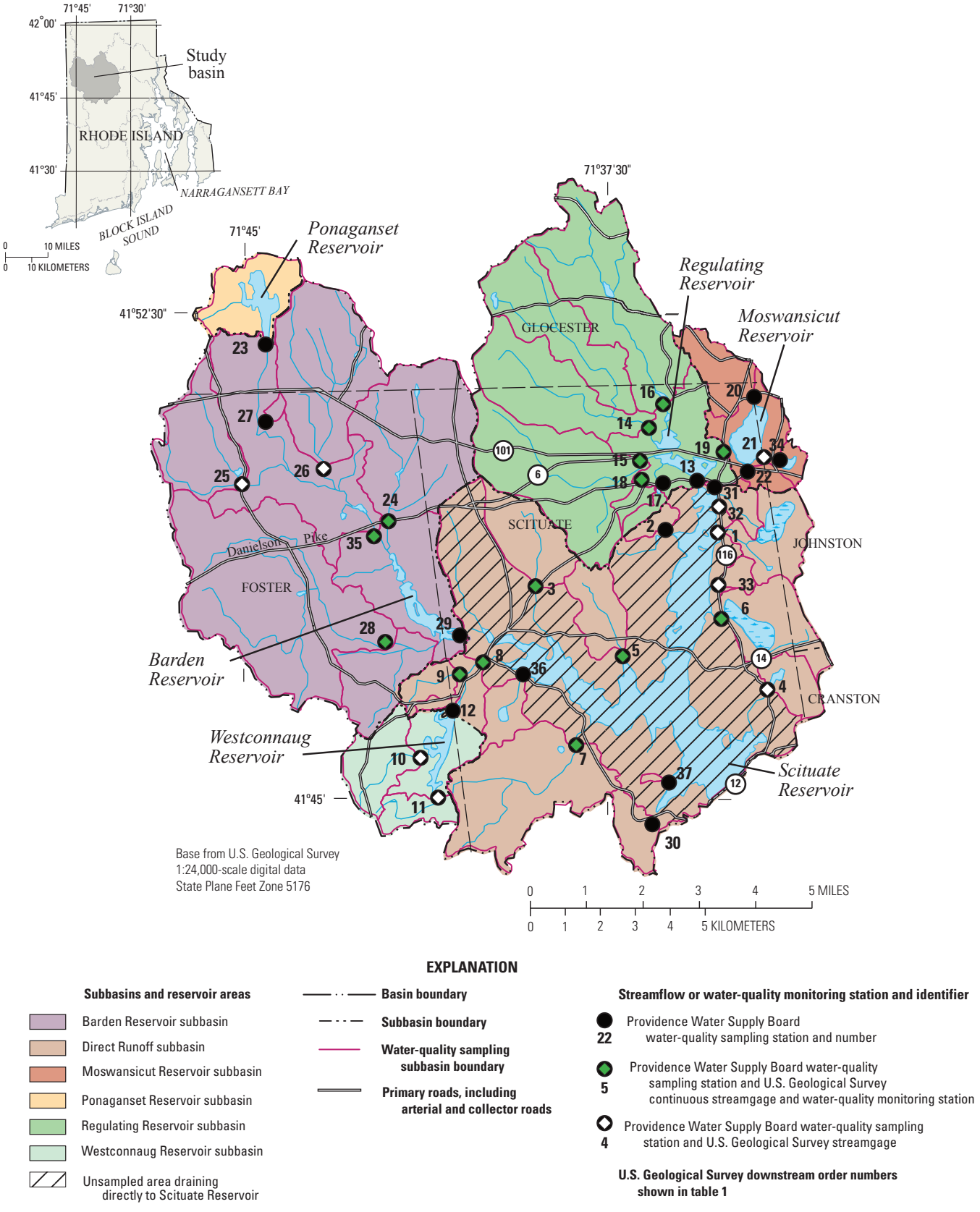

Figure 1. Locations of tributary-reservoir subbasins and stations in the Scituate Reservoir drainage area, Rhode Island, 2014.

streamflow has been continuously measured at 14 streamgages in the drainage area and periodically measured at 9 additional streamgages on tributaries in the drainage area. At the nine partial-record streamgages, daily mean streamflow 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. Equations that relate specific conductance to concentrations of sodium and chloride in streamwater were developed as part of previous USGS/PWSB cooperative studies (Smith, 2015b; Nimiroski and Waldron, 2002). These equations, updated here and used together with measured (or estimated) streamflows, allow for nearly continuous estimation of sodium and chloride loads to the reservoir.

Currently (2014), the PWSB regularly collects water-quality samples from 37 tributaries, either monthly or quarterly. Water-quality results are summarized by station number and constituent or parameter in annual reports published by the PWSB. In addition, the USGS has published reports that have compiled and tabulated streamflow (measured or estimated by the USGS) and water-quality data (collected by the PWSB) (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).

This report presents data on streamflow, water quality, and loads and yields of selected constituents for water year (WY) 2014[2] in the Scituate Reservoir drainage area. These data were collected as parts 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 14 continuous-record and 9 partial-record streamgages in the drainage area. Estimated monthly and annual loads (and yields) of sodium and chloride 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 37 sampling stations (table 1) during WY 2014 also are presented, and these data were used to calculate loads and yields of selected water-quality constituents.

Streamflow Data Collection and Estimation

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

Continuous-record streamgages were operated and maintained by the USGS during WY 2014 in cooperation with RIDEM (USGS streamgage 01115187) and 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 (NWIS Web; U.S. Geological Survey, 2007). Error associated with measured streamflows was generally within about 15 percent (U.S. Geological Survey, unpublished data).

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 or partial records of specific conductance from 14 of the 23 streamgages. Water-quality samples were collected monthly or quarterly at 37 sampling stations in the Scituate Reservoir drainage area by the PWSB during WY 2014 as part of a long-term sampling program (appendix 1). Daily loads of bacteria, chloride, nitrite, nitrate, and orthophosphate were calculated for 23 streamgages where streamflow data were collected by the USGS and water-quality samples were collected by the PWSB. Yields were calculated by dividing load by drainage area.

Data Collected by the U.S. Geological Survey

Water quality was monitored in a periodic water-quality sampling program that included measurements by automatic specific-conductance probes. The USGS collected and

[2]October 1, 2013, through September 30, 2014.

Table 1. Providence Water Supply Board water-quality sampling stations, water-quality samples, and available streamflow and continuous-monitoring streamgages by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, to September 30, 2014.

[Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). USGS, U.S. Geological Survey; mi², square miles; QW, water quality; Na, sodium; Cl, chloride; M, monthly; Q, quarterly; Y, yes; --, none]

PWSB station number	USGS station number	Station name	Drainage area (mi²)	Frequency of QW sample collection	Number of samples collected by Providence Water[1]	Daily estimated Na and Cl loads	Streamflow availability	Specific conductance availability
		Barden Reservoir subbasin						
24	01115190	Dolly Cole Brook	4.90	M	9	Y	Continuous	Continuous
25	01115200	Shippee Brook	2.35	Q	2	N	Estimated	None
26	01115185	Windsor Brook	4.32	Q	3	N	Estimated	None
27	011151845	Unnamed Tributary to Ponaganset River (Unnamed Brook B, Unnamed Brook West of Windsor Brook)	0.10	Q	2	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	8	N	None	None
35	01115187	Ponaganset River	14.0	M	7	Y	Continuous	Continuous
		Direct Runoff subbasin						
1	01115180	Brandy Brook	1.57	M	10	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	8	Y	Continuous	Continuous
4	01115400	Kent Brook (Betty Pond Stream)	0.85	M	9	N	Estimated	None
5	01115184	Spruce Brook	1.22	Q	3	Y	Continuous	Continuous
6	01115183	Quonapaug Brook	1.96	M	10	Y	Continuous	Continuous
7	01115297	Wilbur Hollow Brook	4.32	M	10	Y	Continuous	Continuous
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	5.18	M	7	Y	Continuous	Continuous
9	01115275	Bear Tree Brook	0.62	Q	2	Y	Continuous	Continuous
30	01115350	Unnamed Tributary 4 to Scituate Reservoir (Coventry Brook, Knight Brook)	0.78	Q	2	N	None	None
31	01115177	Toad Pond	0.04	Q	1	N	None	None
32	01115178	Unnamed Tributary 1 to Scituate Reservoir (Pine Swamp Brook)	0.45	Q	2	N	Estimated	None
33	01115182	Unnamed Tributary 3 to Scituate Reservoir (Hall's Estate Brook)	0.28	Q	2	N	Estimated	None
36	--	Outflow from King Pond	0.77	Q	1	N	None	None
37	--	Fire Tower Stream	0.15	Q	1	N	None	None
		Moswansicut Reservoir subbasin						
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	3.25	M	9	Y	Continuous	Continuous
20	01115160	Unnamed Tributary 1 to Moswansicut Reservoir (Blanchard Brook)	1.18	M	9	N	None	None
21	01115165	Unnamed Tributary 2 to Moswansicut Reservoir (Brook from Kimball Reservoir)	0.29	Q	2	N	Estimated	None

Table 1. Providence Water Supply Board water-quality sampling stations, water-quality samples, and available streamflow and continuous-monitoring streamgages by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, to September 30, 2014.—Continued

[Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). USGS, U.S. Geological Survey; mi², square miles; QW, water quality; Na, sodium; Cl, chloride; M, monthly; Q, quarterly; Y, yes; --, none]

PWSB station number	USGS station number	Station name	Drainage area (mi²)	Frequency of QW sample collection	Number of samples collected by Providence Water[1]	Daily estimated Na and Cl loads	Streamflow availability	Specific conductance availability
Moswansicut Reservoir subbasin—Continued								
22	01115167	Moswansicut Reservoir (Moswansicut Stream South)	0.22	M	8	N	None	None
34	01115164	Kimball Stream	0.27	Q	3	N	None	None
Ponaganset Reservoir subbasin								
23	011151843	Ponaganset Reservoir	1.92	M	6	N	None	None
Regulating Reservoir subbasin								
13	01115176	Regulating Reservoir	22.1	M	9	N	None	None
14	01115110	Huntinghouse Brook	6.23	M	6	Y	Continuous	Continuous
15	01115114	Rush Brook	4.70	M	8	Y	Continuous	Continuous
16	01115098	Peeptoad Brook (Harrisdale Brook)	4.96	M	12	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	1	Y	Continuous	Continuous
Westconnaug Reservoir subbasin								
10	01115274	Westconnaug Brook	1.48	M	6	N	Estimated	None
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook south of Westconnaug Reservoir)	0.72	Q	2	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 tributaries in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.

[Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB); USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $ft^3/s/mi^2$, cubic feet per second per square mile]

PWSB station number	USGS station number	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 ($ft^3/s/mi^2$)
		Barden Reservoir subbasin				
24	01115190	Dolly Cole Brook	7.3	8.3	6.3	1.5
25	01115200	Shippee Brook	4.0	14	1.1	1.7
26	01115185	Windsor Brook	6.1	25	1.5	1.4
28	01115265	Barden Reservoir (Hemlock Brook)	14	17	12	1.7
35	01115187	Ponaganset River	23	26	20	1.6
		Direct Runoff subbasin				
1	01115180	Brandy Brook	1.8	3.3	1.0	1.2
3	01115280	Cork Brook	2.3	2.8	1.9	1.3
4	01115400	Kent Brook (Betty Pond Stream)	1.4	6.8	0.30	1.7
5	01115184	Spruce Brook	1.8	2.0	1.6	1.5
6	01115183	Quonapaug Brook	2.8	3.2	2.5	1.4
7	01115297	Wilbur Hollow Brook	6.3	7.0	5.6	1.5
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	8.1	8.8	7.4	1.6
9	01115275	Bear Tree Brook	1.1	1.2	0.98	1.7
32	01115178	Unnamed Tributary 1 to Scituate Reservoir (Pine Swamp Brook)	0.46	0.92	0.23	1.0
33	01115182	Unnamed Tributary 3 to Scituate Reservoir (Hall's Estate Brook)	0.35	0.99	0.13	1.3
		Moswansicut Reservoir subbasin				
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	4.4	4.8	4.0	1.4
21	01115165	Unnamed Tributary 2 to Moswansicut Reservoir (Blanchard Brook)	0.49	1.1	0.22	1.7
		Regulating Reservoir subbasin				
14	01115110	Huntinghouse Brook	9.2	11	7.6	1.5
15	01115115	Rush Brook	7.2	8.4	6.0	1.5
16	01115098	Peeptoad Brook (Harrisdale Brook)	7.5	8.7	6.3	1.5
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	0.37	0.47	0.27	1.3
		Westconnaug Reservoir subbasin				
10	01115274	Westconnaug Brook	1.6	2.9	0.92	1.1
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook South of Westconnaug Reservoir)	0.95	1.6	0.56	1.3

analyzed the specific conductance data. Specific conductance was measured by the USGS at 10- or 15-minute intervals at the 14 continuous-record streamgages (fig. 1). Measurements were made by using an instream probe and standard USGS methods for continuous streamwater-quality monitoring (Wagner and others, 2006).

Concentrations of sodium and chloride were estimated from continuous measurements of specific conductance by using equations that were developed by the USGS to relate specific conductance to concentrations of sodium and chloride (equations 1 and 2). 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[3] along with sodium[4] and chloride[5] concentrations measured in water-quality samples collected by the USGS from tributaries in the Scituate Reservoir drainage area (U.S. Geological Survey, 2001):

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

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

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).

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 at fixed stations on 37 tributaries by the PWSB. Sampling was conducted monthly at 19 stations and quarterly at another 18 stations (table 1) during WY 2014. 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, temperature, acidity, alkalinity, color, turbidity, and concentrations of chloride, nitrite, nitrate, orthophosphate, and bacteria (*Escherichia coli* [*E. coli*] and total coliform). More information on sample-collection, analytical, and quality-control procedures can be found in the Providence Water Supply Board Quality Assurance Program Manual (Providence Water Supply Board Water Quality Laboratory, 2012).

Water-quality samples were collected by the PWSB during a wide range of flow conditions. The daily mean flow-duration curve for Wilbur Hollow Brook at Old Plainfield Pike near Clayville (USGS streamgage 01115297) for WY 2014 is shown in figure 2. The curve represents the percentage of time that each flow was equaled or exceeded at this station. The flows at this station on days when water-quality samples were collected are represented by the plotted points superimposed on the curve. Samples were collected at flow durations ranging from the 1st percentile to the 91st percentile; this range indicates that the water-quality samples collected in WY 2014 represented a wide range of flow conditions during that water year.

Estimating Daily, Monthly, and Annual Loads and Yields

Daily, monthly, and annual sodium and chloride loads in kilograms were estimated for all streamgages for which continuous-streamflow and specific-conductance data were available for WY 2014. Daily flow-weighted concentrations of sodium and chloride were calculated by multiplying instantaneous flows by concurrent concentrations of sodium and chloride (estimated from measurements of specific conductance) for each day and dividing by the total flow for that day. Daily sodium and chloride loads were estimated by multiplying daily flow-weighted concentrations of sodium and chloride 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 2014 (table 4, at 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 (CFU) per liter in single samples by the daily discharge (in liters per

[3]Specific conductance parameter code 90095.

[4]Sodium parameter code 00930.

[5]Chloride parameter code 00940.

Table 3. Regression equation coefficients used to estimate concentrations of chloride and sodium from values of specific conductance for each U.S. Geological Survey monitoring station in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.

[Parameter codes: specific conductance, 90095; chloride, 00940; sodium, 00930. PWSB, Providence Water Supply Board; USGS, U.S. Geological Survey]

PWSB station number	USGS station number	Chloride			Sodium			Samples used in analyses	
		Slope	Intercept	Standard error of regressions (percent)	Slope	Intercept	Standard error of regressions (percent)	Sample data range (month/day/year)	Sample count
24	01115190	1.238	0.0751	2.78	1.205	0.0536	5.47	03/08/2000; 03/29/2005; 01/22/2009 to 07/14/2015	20
28	01115265	1.215	0.0830	3.83	1.076	0.0947	5.37	03/28/2001; 03/30/2005; 01/22/2009 to 07/13/2015	19
35	01115187	1.193	0.0903	4.35	1.120	0.0773	5.91	03/28/2001; 03/29/2005; 01/22/2009 to 07/13/2015	20
3	01115280	1.202	0.0844	3.47	1.029	0.1176	5.47	03/08/2000; 03/30/2005; 01/22/2009 to 07/08/2015	20
5	01115184	1.233	0.0680	4.36	1.070	0.0876	4.41	03/05/2009 to 07/16/2015	17
6	01115183	1.198	0.0755	4.57	1.240	0.0362	6.76	03/08/2000; 03/30/2005; 01/22/2009 to 07/07/2015	24
7	01115297	1.339	0.0427	6.50	1.297	0.0327	9.24	03/28/2001; 03/30/2005; 01/22/2009 to 07/21/2015	20
8	01115276	1.081	0.1462	2.97	1.027	0.1187	4.27	01/22/2009 to 07/08/2015	17
9	01115275	1.053	0.1808	2.91	1.063	0.1019	3.65	03/08/2000; 03/30/2005; 01/22/2009 to 07/10/2015	19
19	01115170	1.304	0.0474	3.18	1.199	0.0483	3.58	03/08/2000; 03/29/2005; 01/22/2009 to 07/16/2015	19
14	01115110	1.070	0.1246	7.37	0.902	0.1533	6.05	03/28/2001; 03/29/2005; 01/22/2009 to 07/07/2015	18
15	01115114	1.183	0.0886	2.81	1.037	0.1143	5.41	01/22/2009 to 07/15/2015	19
16	01115098	1.250	0.0608	6.54	1.046	0.1015	6.54	03/28/2001; 03/29/2005; 01/22/2009 to 07/14/2015	19
18	01115120	1.209	0.0756	2.89	1.078	0.0894	3.48	01/22/2009 to 07/10/2015	12

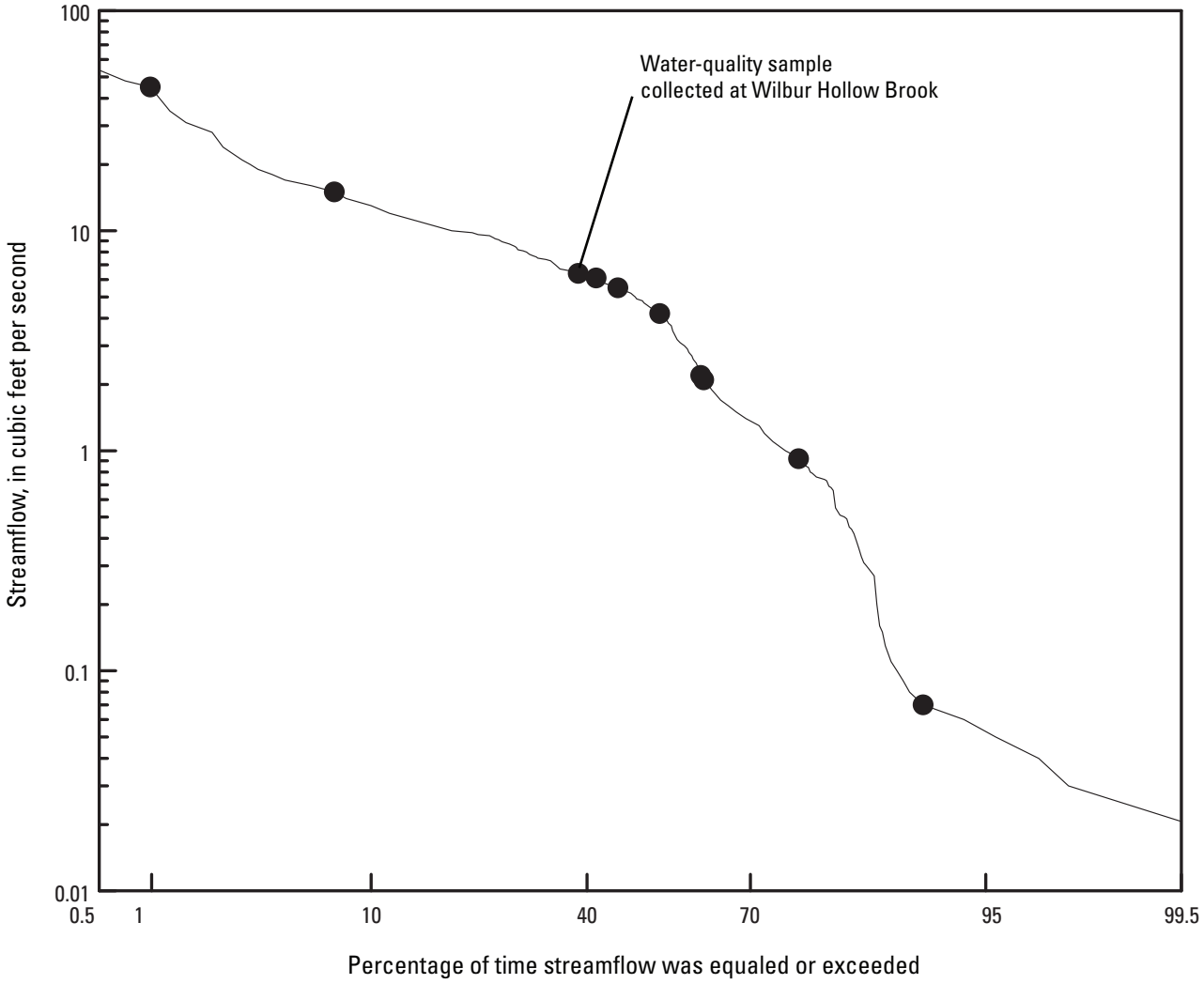

Figure 2. Flow-duration curve and streamflow on the dates (represented by points) when water-quality samples were collected for the U.S. Geological Survey continuous-record streamgage on Wilbur Hollow Brook at Old Plainfield Pike near Clayville (01115297), Rhode Island, water year 2014.

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 grams or kilograms (or millions of CFUs for bacteria) per day and yields in grams or kilograms (or millions of CFUs for bacteria) per day per square mile were calculated for bacteria, chloride, nitrite, nitrate, and orthophosphate. Censored data (or concentrations reported as less than method detection limits) were replaced with concentrations equal to one-half the method detection limit.

Streamflow

Monitoring streamflow is necessary 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, WY 1994–2013) prior to WY 2014 was about 29 cubic feet per second (ft^3/s) (http://waterdata.usgs.gov/nwis). During WY 2014, annual mean streamflow was 23 ft^3/s, and daily mean streamflows for many months were less than the median daily mean streamflows for the period of record (fig. 3). Mean annual streamflow in Peeptoad Brook (PWSB station 16, streamgage 01115098), the other long-term continuous-record streamgage in the Scituate Reservoir drainage area, for its period of record (WY 1994–2013) prior to WY 2014 was about 11 ft^3/s (http://waterdata.usgs.gov/nwis). Annual mean streamflow in Peeptoad Brook during WY 2014 was 7.5 ft^3/s (table 2).

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. 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 to 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 reservoir quality.

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 sodium and chloride loads (estimated from measurements of specific conductance), which include a large number of values, are better summarized in terms of means because a large dataset is more resistant to the effects of outliers. 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 sodium and chloride 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 sodium and chloride coming from tributaries or their drainage basins. It may be best to discuss loads and yields in terms of a range within which the true values lie; however, the most probable values of loads and yields are presented for ease of discussion and presentation. The range within which the true values lie depends on the uncertainties in individual measurements of streamflow and concentration, which are difficult to quantify with available information. The uncertainties associated with estimating streamflow are commonly assumed to affect load and yield calculations more than the errors associated with measuring specific conductance and (or) chemical analysis. The most probable 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.

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

Sodium and chloride 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 sodium and chloride 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.

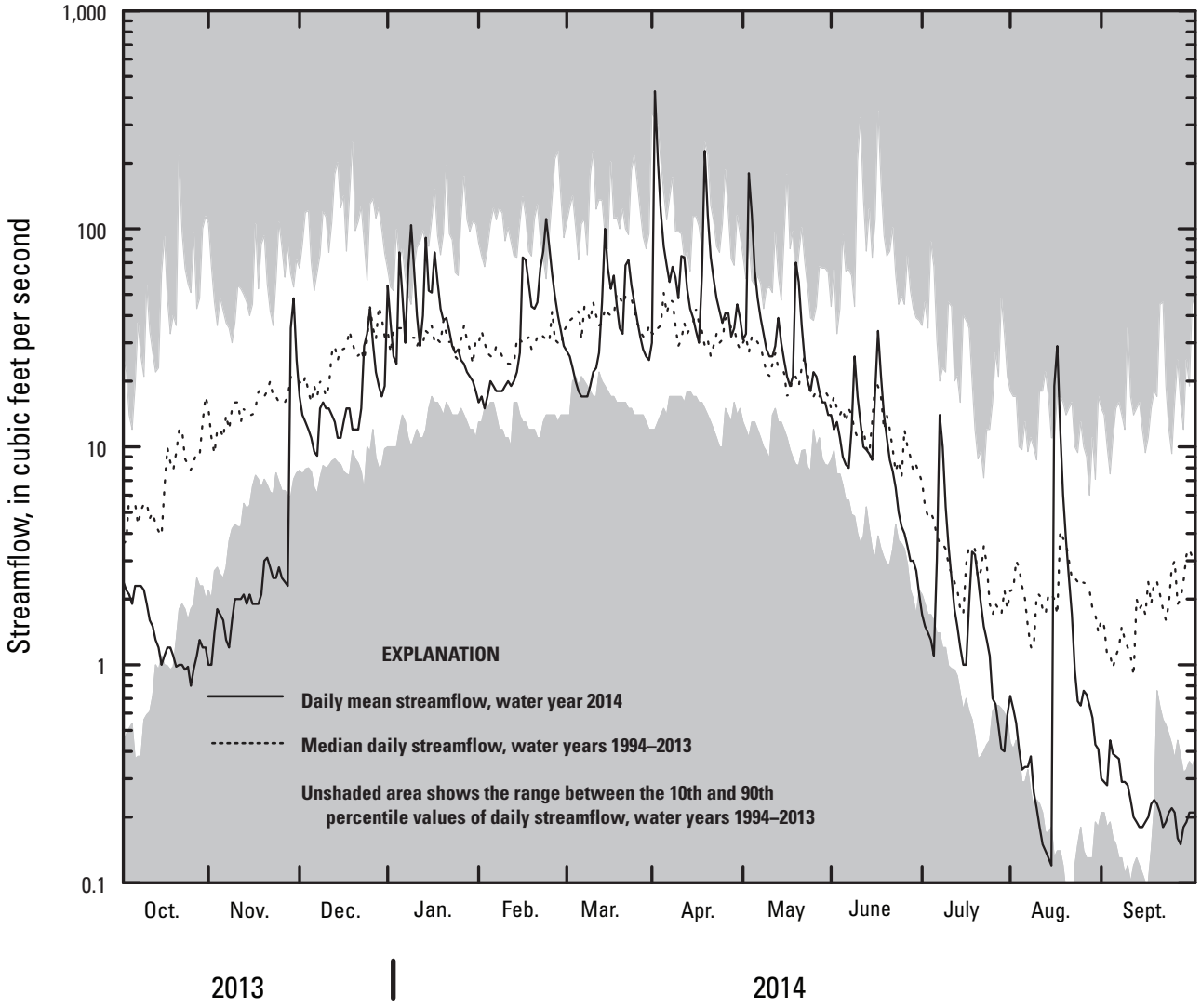

Figure 3. Measured daily mean streamflow for October 1, 2013, through September 30, 2014, and the 10th percentile, median, and 90th percentile values of daily streamflow for October 1, 1994, through September 30, 2013, for the U.S. Geological Survey continuous-record streamgage on the Ponaganset River at South Foster (01115187) in the Scituate Reservoir drainage area, Rhode Island.

Estimated monthly mean[6] sodium concentrations in tributaries of the Scituate Reservoir drainage area ranged from 4.9 to 50.1 milligrams per liter (mg/L), and estimated monthly mean chloride concentrations ranged from 7.5 to 83.9 mg/L (table 5). The highest monthly mean concentrations of sodium and chloride were measured in Bear Tree Brook (PWSB station 9) in September 2013 (50.1 and 83.9 mg/L, respectively; table 5). The highest annual mean[7] concentrations of sodium and chloride also were measured in Bear Tree Brook (29.4 and 49.4 mg/L, respectively; table 6). These high concentrations are the result of residual sodium and chloride leaching from a formerly uncovered salt storage pile to groundwater (Nimiroski and Waldron, 2002) and relatively small surface-water flows.

During WY 2014, the Scituate Reservoir received about 1,200,000 kilograms (kg) (about 1,300 short tons) of sodium and 2,100,000 kg (about 2,300 short tons) of chloride from tributaries that are equipped with instrumentation capable of continuously monitoring specific conductance. The highest sodium and chloride loads in the drainage area during WY 2014 (260,000 and 420,000 kg, respectively) were measured at the Ponaganset River station (PWSB station 35; table 6). Monthly estimated sodium and chloride loads were highest in the months of January, February, March, and April (table 7). During these 4 months, the sum of the monthly sodium and chloride loads at each station accounted for 68 percent of the annual load for the monitored area in the Scituate Reservoir drainage area. The highest annual sodium and chloride yields were 45,000 and 75,000 kilograms per square mile, respectively, measured at Bear Tree Brook (PWSB station 9; table 6). Annual loads of sodium and chloride tended to be less than the median annual loads for WY 2009–13, except at the stations on Westconnaug Brook (PWSB station 8) and Rush Brook (PWSB station 15), which were greater than the median annual loads (fig. 4).

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, specific conductance, and color were routinely measured to characterize water quality in each subbasin (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 12 to 150 platinum cobalt units (PCU); the median for all stations was 39 PCU. Median values of turbidity ranged from 0.27 to 3.3 nephelometric turbidity units (NTU); the median for all stations was 0.61 NTU. Median alkalinity values in tributaries were low, ranging from 2.5 to 17 mg/L as $CaCO_3$; the median for all stations was 6.1 mg/L as $CaCO_3$ (table 8).

Constituent Concentrations and Daily Loads and Yields

Fecal indicator bacteria, chloride, and nutrients such as nitrogen (N) and phosphorus are commonly detected in natural water; at elevated concentrations, these constituents can render water unfit for the intended use. 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 streamwater from precipitation, weathering, or human activities such as waste disposal, use of septic systems, and road deicing. Sources of nutrients in tributary streamwater 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 given in tables 8 and 9.

Bacteria

Median concentrations of total coliform bacteria were above the detection limit (10 colony forming units per 100 milliliters [CFU/100 mL]) at all sites (table 8); median concentrations of *E. coli* were equal to or greater than the detection limit (10 CFU/100 mL) at 31 of the 37 sites. Total coliform bacteria concentrations were greater than *E. coli* concentrations (as expected because total coliform is more inclusive); the medians of median concentrations for all sites in the drainage area were 320 CFU/100 mL for total coliform bacteria and 20 CFU/100 mL for *E. coli*. The median concentration of total coliform bacteria was highest at Kent Brook (PWSB station 4; table 8) at 3,700 CFU/100 mL. The median concentration of *E. coli* was highest at Unnamed Tributary #4 to Scituate Reservoir (PWSB station 30; table 8) at 350 CFU/100 mL.

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

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

Table 5. Monthly mean concentrations of chloride and sodium estimated from continuous measurements of specific conductance in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.

[Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). 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; mg/L, milligrams per liter; --, no flow]

PWSB station number	USGS station number	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	26.8	16.4	25.7	15.7	25.3	15.5	25.0	15.3	29.4	17.9	26.1	15.9
28	01115265	Barden Reservoir (Hemlock Brook)	33.2	19.1	28.1	16.4	25.3	15.0	21.4	12.9	24.2	14.4	15.7	9.76
35	01115187	Ponaganset River	22.2	13.6	21.7	13.3	22.8	13.9	22.4	13.7	24.4	14.8	19.6	12.1
Direct Runoff subbasin														
3	01115280	Cork Brook	45.1	25.5	36.1	21.0	36.9	21.5	33.3	19.7	37.1	21.5	30.2	18.0
5	01115184	Spruce Brook	34.5	19.4	26.8	15.6	24.7	14.5	19.3	11.7	19.9	12.0	16.2	10.0
6	01115183	Quonapaug Brook	48.2	29.0	33.4	19.8	43.0	25.7	34.6	20.5	43.5	26.0	31.0	18.3
7	01115297	Wilbur Hollow Brook	15.1	9.65	11.5	7.38	9.97	6.44	8.61	5.58	9.66	6.25	7.51	4.89
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	29.6	18.4	25	15.7	25.4	15.9	17.9	11.4	18.8	12.0	17.4	11.1
9	01115275	Bear Tree Brook	77.4	46.2	58	34.6	54.6	32.5	47.4	28.2	48.9	29.1	39.9	23.7
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	36.4	21.7	36.4	21.7	37.4	22.3	38.7	23.0	41.2	24.4	38.7	23
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	14.2	8.30	13.7	8.06	15.3	8.83	12.4	7.37	11.7	7.03	9.81	6.05
15	01115114	Regulating Reservoir (Rush Brook)	53.0	31.1	39.4	23.9	45.6	27.2	42.5	25.6	52.7	31.0	32.3	20.0
16	01115098	Peeptoad Brook (Harrisdale Brook)	36.3	21.3	32.5	19.4	37.5	21.9	42.2	24.2	47.5	26.6	38.1	22.2
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	--	--	29.1	18.1	44.3	26.2	61.6	35.3	61.2	35.1	36.8	22.2
Scituate Reservoir drainage area														
		Average	36.3	21.5	29.8	17.9	32.0	19.1	30.5	18.2	33.6	19.9	25.7	15.5

Table 5. Monthly mean concentrations of chloride and sodium estimated from continuous measurements of specific conductance in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.—Continued

[Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). 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; mg/L, milligrams per liter; --, no flow]

PWSB station number	USGS station number	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	24.7	15.1	24.5	15.0	26.9	16.4	28.2	17.2	27.9	17.0	30.7	18.7
28	01115265	Barden Reservoir (Hemlock Brook)	19.2	11.7	19.5	11.9	27.4	16.1	31.0	18.0	28.9	16.8	35.8	20.4
35	01115187	Ponaganset River	19.1	11.8	19.4	11.9	20.8	12.8	22.3	13.6	23.6	14.3	34.9	20.8
Direct Runoff subbasin														
3	01115280	Cork Brook	29.8	17.9	29.0	17.4	33.9	19.9	36.9	21.4	36.8	21.4	46.3	26.0
5	01115184	Spruce Brook	17.6	10.8	18.4	11.3	21.7	13.0	26.1	15.2	28.2	16.2	52.8	28.1
6	01115183	Quonapaug Brook	29.0	17.1	30.1	17.8	34.5	20.5	43.9	26.3	39.2	23.4	73.3	44.7
7	01115297	Wilbur Hollow Brook	7.76	5.05	8.76	5.68	11.1	7.12	15.4	9.79	12.2	7.84	14.4	9.23
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	16.6	10.6	19.4	12.4	22.8	14.3	26.8	16.8	23.1	14.5	29.5	18.4
9	01115275	Bear Tree Brook	39.7	23.6	46.4	27.6	56.6	33.7	67.8	40.5	54.5	32.5	83.9	50.1
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	40.0	23.7	41.7	24.6	42.1	24.8	43.1	25.4	43.9	25.8	46.4	27.2
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	11.1	6.75	11.6	6.97	14.1	8.23	14.9	8.66	15.5	8.94	17.0	9.68
15	01115114	Regulating Reservoir (Rush Brook)	36.9	22.6	35.8	21.9	51.1	30.1	63.6	36.5	49.6	29.3	--	--
16	01115098	Peeptoad Brook (Harrisdale Brook)	37.4	21.8	39.8	23.0	42.9	24.5	45.8	25.9	42.5	24.3	48.5	27.1
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	38.3	23.1	43.8	25.9	62.2	35.6	41.6	24.9	36.1	21.9	--	--
Scituate Reservoir drainage area														
		Average	26.2	15.8	27.7	16.7	33.4	19.8	36.2	21.4	33.0	19.6	42.8	25.0

Table 6. Annual mean chloride and sodium concentrations, loads, and yields by sampling station in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.

[Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). 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. USGS, U.S. Geological Survey; mg/L, milligrams per liter; kg/yr, kilograms per year; kg/yr/mi^2, kilograms per year per square mile; Cl, chloride; Na, sodium]

PWSB station number	USGS station number	Station name	Concentration		Load		Yield	
			Cl (mg/L)	Na (mg/L)	Cl (kg/yr)	Na (kg/yr)	Cl (kg/yr/mi^2)	Na (kg/yr/mi^2)
		Barden Reservoir subbasin						
24	01115190	Dolly Cole Brook	25.9	15.8	170,000	100,000	34,000	21,000
28	01115265	Barden Reservoir (Hemlock Brook)	20.6	12.4	260,000	160,000	30,000	18,000
35	01115187	Ponaganset River	21.0	12.9	420,000	260,000	30,000	19,000
		Direct Runoff subbasin						
3	01115280	Cork Brook	32.3	19.1	67,000	39,000	37,000	22,000
5	01115184	Spruce Brook	19.3	11.7	31,000	19,000	25,000	15,000
6	01115183	Quonapaug Brook	33.9	20.1	85,000	50,000	43,000	26,000
7	01115297	Wilbur Hollow Brook	9.12	5.90	51,000	33,000	12,000	7,700
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	19.7	12.5	140,000	90,000	27,000	17,000
9	01115275	Bear Tree Brook	49.4	29.4	47,000	28,000	75,000	45,000
		Moswansicut Reservoir subbasin						
19	01115170	Moswansicut Reservoir, (Moswansicut Stream North, Moswansicut Pond)	40.0	23.7	160,000	92,000	48,000	28,000
		Regulating Reservoir subbasin						
14	01115110	Huntinghouse Brook	11.6	6.95	95,000	57,000	15,000	9,100
15	01115114	Rush Brook	40.6	24.5	260,000	160,000	55,000	33,000
16	01115098	Peeptoad Brook (Harrisdale Brook)	39.3	22.7	260,000	150,000	53,000	30,000
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	45.4	26.8	15,000	8,900	54,000	32,000
		Scituate Reservoir drainage area						
			Mean		Total		Mean	
			29.2	17.5	2,100,000	1,200,000	33,000	20,000

Table 7. Monthly estimated chloride and sodium loads by sampling station in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.

[Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). USGS, U.S. Geological Survey; Cl, chloride; Na, sodium; kg, kilogram]

PWSB station number	USGS station number	Station name	October		November		December		January		February		March	
			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	1,100	670	4,600	2,800	11,000	6,900	30,000	18,000	28,000	17,000	36,000	22,000
28	01115265	Barden Reservoir (Helmock Brook)	1,500	880	9,800	5,800	22,000	13,000	45,000	27,000	31,000	19,000	44,000	28,000
35	01115187	Ponaganset River	2,400	1,500	9,400	5,700	32,000	20,000	70,000	43,000	67,000	41,000	82,000	50,000
Direct Runoff subbasin														
3	01115280	Cork Brook	400	230	2,300	1,300	5,200	3,000	9,300	5,500	10,000	6,000	14,000	8,400
5	01115184	Spruce Brook	890	500	1,300	770	2,200	1,300	3,500	2,100	3,100	1,900	5,000	3,100
6	01115183	Quonapaug Brook	1,700	1,000	3,200	1,900	6,800	4,100	10,000	6,200	11,000	6,400	15,000	9,100
7	01115297	Wilbur Hollow Brook	1,800	1,100	3,200	2,100	4,900	3,200	6,100	3,900	5,400	3,500	7,700	5,000
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	6,800	4,200	7,000	4,400	6,400	4,000	14,000	9,200	13,000	8,400	19,000	12,000
9	01115275	Bear Tree Brook	2,700	1,600	3,100	1,900	4,100	2,400	4,600	2,700	4,000	2,400	5,400	3,200
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	1,200	690	3,000	1,800	13,000	7,600	18,000	11,000	16,000	9,600	23,000	14,000
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	320	190	2,100	1,200	6,000	3,500	14,000	8,200	14,000	8,600	19,000	12,000
15	01115114	Regulating Reservoir (Rush Brook)	120	73	6,600	4,000	27,000	16,000	40,000	24,000	52,000	30,000	47,000	29,000
16	01115098	Peeptoad Brook (Harrisdale Brook)	1,800	1,100	4,800	2,900	17,000	9,800	25,000	15,000	20,000	11,000	58,000	34,000
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	0	0	310	200	290	170	1,800	1,000	4,100	2,400	2,600	1,600
Scituate Reservoir drainage area														
		Total	23,000	14,000	61,000	37,000	160,000	90,000	290,000	180,000	280,000	170,000	380,000	230,000

Table 7. Monthly estimated chloride and sodium loads by sampling station in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014. —Continued

[Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the Providence Water Supply Board (PWSB). USGS, U.S. Geological Survey; Cl, chloride; Na, sodium; kg, kilogram]

PWSB station number	USGS station number	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	32,000	19,000	18,000	11,000	4,500	2,800	1,500	890	1,300	810	200	120
28	01115265	Barden Reservoir (Hemlock Brook)	52,000	32,000	36,000	22,000	11,000	6,400	3,300	1,900	5,900	3,500	680	390
35	01115187	Ponaganset River	84,000	52,000	52,000	32,000	15,000	9,100	3,800	2,300	4,800	2,900	590	350
Direct Runoff subbasin														
3	01115280	Cork Brook	13,000	7,800	7,900	4,800	2,200	1,300	690	400	1,200	710	16	9.1
5	01115184	Spruce Brook	7,200	4,400	4,900	3,000	1,600	990	630	370	520	300	120	66
6	01115183	Quonapaug Brook	15,000	8,800	12,000	7,100	4,200	2,500	2,500	1,500	2,700	1,600	110	70
7	01115297	Wilbur Hollow Brook	8,500	5,500	7,100	4,600	3,000	1,900	1,600	1,000	1,900	1,200	62	40
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	27,000	17,000	24,000	15,000	10,000	6,600	5,000	3,100	4,900	3,100	3,500	2,200
9	01115275	Bear Tree Brook	7,300	4,300	6,300	3,800	3,400	2,100	2,000	1,200	2,200	1,300	1,600	940
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	40,000	24,000	25,000	15,000	11,000	6,200	2,800	1,600	2,300	1,400	1,100	650
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	21,000	13,000	13,000	7,800	3,600	2,100	910	530	940	540	1.6	0.90
15	01115114	Regulating Reservoir (Rush Brook)	45,000	28,000	24,000	15,000	8,800	5,200	3,000	1,700	4,100	2,400	0.00	0.00
16	01115098	Peeptoad Brook (Harrisdale Brook)	74,000	43,000	42,000	25,000	10,000	5,900	3,300	1,900	3,200	1,900	740	410
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	3,600	2,200	1,800	1,100	240	130	27	16	150	91	0.00	0.00
Scituate Reservoir drainage area														
		Total	430,000	260,000	270,000	167,000	90,000	50,000	30,000	18,000	36,000	22,000	9,000	5,000

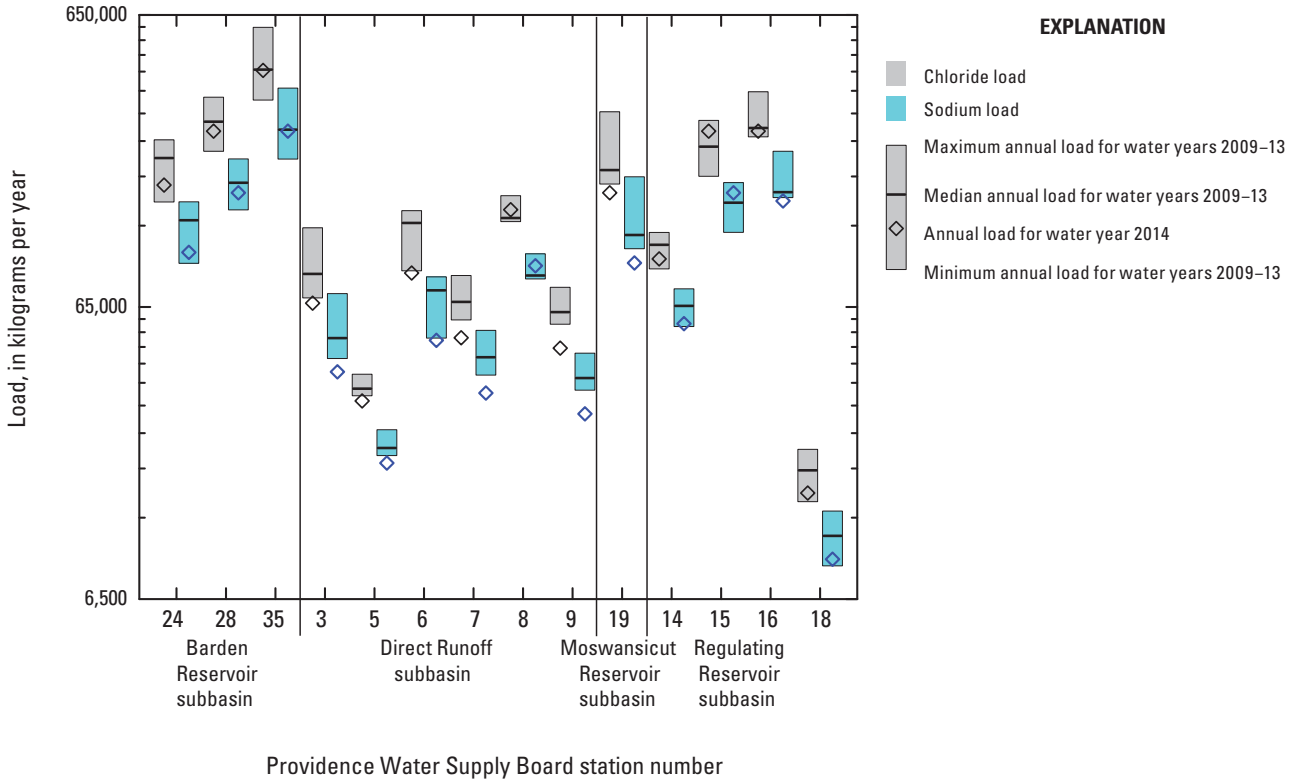

Figure 4. Annual loads of chloride and sodium estimated from continuous measurements of streamflow and specific conductance for water year 2014 and associated minimum, maximum, and median annual loads for water years 2009–13 at 14 Providence Water Supply Board stations in the Scituate Reservoir drainage area, Rhode Island.

Median concentrations of fecal indicator bacteria were lowest at sampling stations Westconnaug Brook (PWSB station 8), Ponaganset Reservoir (PWSB station 23), Outflow from King Pond (PWSB station 36, and Fire Tower Stream (PWSB station 37). Median concentrations of *E. coli* were below detection limits at Shippee Brook (PWSB station 25), Ponaganset River (PWSB station 29), Spruce Brook (PWSB station 5), Westconnaug Brook (PWSB station 8), Fire Tower Stream (PWSB station 37), and Dexter Pond (PWSB station 17). Median daily loads and yields of total coliform bacteria and *E. coli* varied by more than two orders of magnitude; the highest median daily yield of total coliform bacteria (21,000 million colony forming units per day per square mile [$CFU \times 10^6/d/mi^2$]) was at Bear Tree Brook (PWSB station 9; table 9), and the highest median daily yield of *E. coli* (2,100 $CFU \times 10^6/d/mi^2$) was at Wilbur Hollow Brook (PWSB station 7; table 9). Although relatively high for sampling stations in the Scituate Reservoir subbasin, median daily bacteria yields at Bear Tree Brook are low to moderate compared to yields of indicator bacteria in sewage-contaminated streamwater or streamwater 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 850 to 120,000 million colony forming units per day ($CFU \times 10^6/d$), and yields ranged from 2,900 to 21,000 $CFU \times 10^6/d/mi^2$; *E. coli* loads ranged from 34 to 9,300 $CFU \times 10^6/d$, and yields ranged from 120 to 2,100 $CFU \times 10^6/d/mi^2$ (table 9). At many stations, median daily loads for total coliform bacteria were substantially lower than in the previous water year, when the median daily loads of total coliform bacteria ranged from 440 to 200,000 $CFU \times 10^6/d$. Median daily loads of *E. coli* also were less than loads for many stations in the previous water year, when loads of *E. coli* ranged from 100 to 14,000 $CFU \times 10^6/d$ (Smith, 2015a).

Chloride and Sodium

The highest median chloride concentration (94 mg/L) was measured in the Direct Runoff subbasin at Toad Pond (PWSB station 31; 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 yield for monitored areas within the

Table 8. Median values for water-quality data collected at Providence Water Supply Board stations by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.

[Water-quality data are from samples collected and analyzed by the Providence Water Supply Board (PWSB). Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the PWSB. USGS, U.S. Geological Survey; PCU, platinum cobalt units; NTU, nephelometric turbidity units; CFU/100mL, colony forming units per 100 milliliters; *E. coli*, *Escherichia coli*; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; PO_4, phosphate; --, none; <, less than]

PWSB station number	USGS station number	Station name	Properties			Constituents						
			pH (units)	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	6.3	40	0.59	400	40	4.8	24	0.002	0.01	0.05
25	01115200	Shippee Brook	6.0	42	0.47	120	<10	2.9	13	0.002	0.01	0.19
26	01115185	Windsor Brook	6.0	45	0.32	310	10	3.0	19	0.002	<0.01	0.09
27	011151845	Unnamed Tributary to Ponaganset River (Unnamed Brook B, Unnamed Brook West of Windsor Brook)	5.9	13	0.27	140	30	3.5	0.60	0.001	0.01	0.05
28	01115265	Barden Reservoir (Hemlock Brook)	6.2	78	0.61	370	30	4.4	26	0.002	0.01	0.06
29	01115271	Ponaganset River (Barden Stream)	6.4	39	0.57	200	<10	3.7	19	0.002	0.01	0.08
35	01115187	Ponaganset River	6.1	34	0.54	280	20	3.1	20	0.002	0.01	0.04
Direct Runoff subbasin												
1	01115180	Brandy Brook	6.8	53	1.1	650	10	12	7.8	0.003	<0.01	0.07
2	01115181	Unnamed Tributary #2 to Scituate Reservoir (Unnamed Brook North of Bullhead Brook)	6.3	12	0.34	380	15	5.0	68	0.001	0.01	0.05
3	01115280	Cork Brook	6.4	31	0.34	2,400	25	5.0	33	0.001	0.01	0.08
4	01115400	Kent Brook (Betty Pond Stream)	6.6	26	0.60	3,700	50	7.0	1.6	0.001	<0.01	0.02
5	01115184	Spruce Brook	6.6	45	0.76	1,300	<10	7.0	34	0.003	0.01	0.03
6	01115183	Quonapaug Brook	6.3	150	3.3	700	130	17	41	0.006	0.01	0.06
7	01115297	Wilbur Hollow Brook	6.3	63	0.67	600	85	6.0	4.6	0.003	0.01	0.07
8	01115276	Westconnaug Brook (Westconnaug Reservoir)	6.1	18	0.47	60	<10	4.0	11	0.001	0.01	0.09
9	01115275	Bear Tree Brook	6.9	34	0.54	1,300	120	8.0	66	0.002	0.08	0.05
30	01115350	Unnamed Tributary #4 to Scituate Reservoir (Coventry Brook, Knight Brook)	6.2	44	0.33	2,000	350	5.0	24	0.002	0.02	0.12
31	01115177	Toad Pond	6.6	39	0.75	480	30	17	94	0.004	0.01	0.06
32	01115178	Unnamed Tributary #1 to Scituate Reservoir (Pine Swamp Brook)	6.3	54	0.46	260	25	6.0	13	0.002	0.01	0.08
33	01115182	Unnamed Tributary #3 to Scituate Reservoir (Hall's Estate Brook)	6.4	37	0.64	340	15	11	4.3	0.002	<0.01	0.12
36	--	Outflow from King Pond	6.3	24	0.33	70	10	4.0	0.60	0.001	0.01	0.15
37	--	Fire Tower Stream	5.7	23	0.62	80	<10	3.0	0.60	0.002	0.03	0.06

Table 8. Median values for water-quality data collected at Providence Water Supply Board stations by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.—Continued

[Water-quality data are from samples collected and analyzed by the Providence Water Supply Board (PWSB). Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the PWSB. USGS, U.S. Geological Survey; PCU, platinum cobalt units; NTU, nephelometric turbidity units; CFU/100mL, colony forming units per 100 milliliters; *E. coli*, *Escherichia coli*; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; N, nitrogen; PO_4, phosphate; --, none; <, less than]

PWSB station number	USGS station number	Station name	Properties			Constituents						
			pH (units)	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)
Moswansicut Reservoir subbasin												
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	6.9	16	0.81	110	20	9.5	39	0.002	0.01	0.07
20	01115160	Unnamed Tributary #1 to Moswansicut Reservoir (Blanchard Brook)	6.3	90	0.88	1,000	60	7.0	56	0.004	0.01	0.20
21	01115165	Unnamed Tributary #2 to Moswansicut Reservoir (Brook from Kimball Reservoir)	6.7	46	1.8	380	13	13	33	0.004	0.02	0.09
22	01115167	Moswansicut Reservoir (Moswansicut Stream South)	6.5	33	2.0	630	85	12	76	0.009	0.01	0.09
34	01115164	Kimball Stream	6.2	45	0.90	220	20	14	35	0.005	<0.01	0.06
Ponaganset Reservoir subbasin												
23	011151843	Ponaganset Reservoir	6.2	12	0.53	70	10	3.5	15	0.001	0.01	0.03
Regulating Reservoir subbasin												
13	01115176	Regulating Reservoir	6.6	31	0.99	210	30	10	37	0.002	0.01	0.08
14	01115110	Huntinghouse Brook	6.4	33	0.46	320	30	5.3	13	0.002	0.01	0.07
15	01115114	Rush Brook	6.6	50	0.67	280	20	7.4	44	0.003	0.01	0.07
16	01115098	Peeptoad Brook (Harrisdale Brook)	6.6	31	0.89	250	10	12	42	0.002	0.01	0.05
17	01115119	Dexter Pond (Paine Pond)	6.2	75	0.73	780	<10	8.0	44	0.022	<0.01	0.02
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	6.6	80	0.85	420	10	13	14	0.002	0.01	0.09
Westconnaug Reservoir subbasin												
10	01115274	Westconnaug Brook	5.7	24	0.31	140	10	2.5	21	0.002	0.01	0.05
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook South of Westconnaug Reservoir)	5.6	49	0.61	270	13	3.0	0.60	0.002	<0.01	0.14
12	011152745	Unnamed Tributary to Westconnaug Brook (Unnamed Brook north of Westconnaug Reservoir)	6.0	32	0.41	140	20	6.7	45	0.002	<0.01	0.06
Scituate Reservoir drainage area												
		Minimum	5.6	12	0.27	60	<10	2.5	0.60	0.001	<0.01	0.02
		Median	6.3	39	0.61	320	20	6.1	24	0.002	0.01	0.07
		Maximum	6.9	150	3.3	3,700	350	17	94	0.022	0.08	0.20

Table 9. Median daily loads and yields of bacteria, chloride, nitrate, nitrite, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.

[Water-quality data are from samples collected and analyzed by the Providence Water Supply Board (PWSB). USGS, U.S. Geological Survey; CFU×10^6/d; millions of colony forming units per day; CFU×10^6/mi^2; millions of colony forming units per square mile; *E. coli*, *Escherichia coli*; kg/d, kilograms per day; kg/d/mi^2, kilograms per day per square mile; N, nitrogen; g/d, grams per day; g/d/mi^2, grams per day per square mile; PO_4, phosphate]

PWSB station number	USGS station number	Station name	Total coliform bacteria		*E. coli*		Chloride		Nitrite (as N)		Nitrate (as N)		Orthophosphate (as PO_4)	
			(CFUx 10^6/d)	(CFUx 10^6/mi^2)	(CFUx 10^6/d)	(CFUx 10^6/mi^2)	(kg/d)	(kg/d/mi^2)	(g/d)	(g/d/mi^2)	(g/d)	(g/d/mi^2)	(g/d)	(g/d/mi^2)
Barden Reservoir subbasin														
24	01115190	Dolly Cole Brook	39,000	8,000	1,600	330	160	33	14	2.9	61	12	880	180
25	01115200	Shippee Brook	28,000	12,000	1,000	430	290	120	34	14	200	85	4,600	2,000
26	01115185	Windsor Brook	13,000	3,000	1,100	250	24	5.6	22	5.1	17	3.9	1,700	390
28	01115265	Barden Reservoir	62,000	7,100	4,800	550	450	51	40	4.5	200	23	920	110
35	01115187	Ponaganset River	120,000	8,600	7,000	500	1,800	130	86	6.1	860	61	2,600	190
Direct Runoff subbasin														
1	01115180	Brandy Brook	13,000	8,300	410	260	9.0	5.7	6.4	4.0	14	8.8	100	66
3	01115280	Cork Brook	9,000	5,000	850	470	89	49	3.0	1.6	25	14	160	89
4	01115400	Kent Brook	4,300	5,100	270	320	4.7	5.5	2.0	2.4	8.9	10	53	62
5	01115184	Spruce Brook	13,000	11,000	510	420	29	24	4.5	3.7	19	16	120	98
6	01115183	Quonapaug Brook	20,000	10,000	2,000	990	57	29	19	9.7	54	28	260	130
7	01115297	Wilbur Hollow Brook	50,000	11,000	9,300	2,100	19	4.3	23	5.3	140	32	530	120
8	01115276	Westconnaug Brook	15,000	2,900	1,800	350	160	31	34	6.6	370	71	1,200	230
9	01115275	Bear Tree Brook	13,000	21,000	1,200	1,900	120	200	1.3	2.0	38	60	64	100
32	01115178	Unnamed Tributary #1 to Scituate Reservoir (Pine Swamp Brook)	5,600	12,000	720	1,600	34	76	3.5	7.8	18	39	180	390
33	01115182	Unnamed Tributary #3 to Scituate Reservoir (Hall's Estate Brook)	850	3,000	59	210	0.48	1.7	2.2	7.7	14	48	42	150
Moswansicut Reservoir subbasin														
19	01115170	Moswansicut Reservoir (Moswansicut Stream North, Moswansicut Pond)	12,000	3,700	930	290	340	100	25	7.7	160	49	380	120
21	01115165	Unnamed Tributary #2 to Moswansicut Reservoir (Brook from Kimball Reservoir)	4,400	15,000	140	470	40	140	8.9	31	280	960	91	310

Table 9. Median daily loads and yields of bacteria, chloride, nitrate, nitrite, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.—Continued

[Water-quality data are from samples collected and analyzed by the Providence Water Supply Board (PWSB). USGS, U.S. Geological Survey; CFU×10^6/d; millions of colony forming units per day; CFU×10^6/mi^2; millions of colony forming units per square mile; *E. coli*, *Escherichia coli*; kg/d, kilograms per day; kg/d/mi^2, kilograms per day per square mile; N, nitrogen; g/d, grams per day; g/d/mi^2, grams per day per square mile; PO_4, phosphate]

PWSB station number	USGS station number	Station name	Total coliform bacteria		*E. coli*		Chloride		Nitrite (as N)		Nitrate (as N)		Orthophosphate (as PO_4)	
			(CFUx 10^6/d)	(CFUx 10^6/mi^2)	(CFUx 10^6/d)	(CFUx 10^6/mi^2)	(kg/d)	(kg/d/mi^2)	(g/d)	(g/d/mi^2)	(g/d)	(g/d/mi^2)	(g/d)	(g/d/mi^2)
Regulating Reservoir subbasin														
14	01115110	Huntinghouse Brook	65,000	10,000	5,900	940	510	81	83	13	390	63	1,500	230
15	01115114	Regulating Reservoir (Rush Brook)	50,000	11,000	3,500	730	590	120	24	5.1	91	19	1,100	230
16	01115098	Peeptoad Brook (Harrisdale Brook)	19,000	3,800	1,700	340	390	78	23	4.6	93	19	390	79
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	1,400	5,000	34	120	4.9	18	5.9	21.0	200	710	31	110
Westconnaug Reservoir subbasin														
10	01115274	Westconnaug Brook	8,700	5,900	900	600	62	42	12	8.0	53	36	340	230
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook South of Westconnaug Reservoir)	8,300	12,000	360	490	2.0	2.7	28	39	79	110	510	700
Scituate Reservoir drainage area														
		Minimum	850	2,900	34	120	0.48	1.7	1.3	1.6	8.9	3.9	31	62
		Median	13,000	8,300	1,000	470	62	42	19	6.1	79	36	380	150
		Maximum	120,000	21,000	9,300	2,100	1,800	200	86	39	860	960	4,600	2,000

drainage area was 42 kilograms per day per square mile (kg/d/mi^2). Ponaganset River (PWSB station 35) had the largest median daily chloride load (1,800 kilograms per day). The largest median daily chloride yield (200 kg/d/mi^2) was determined for Bear Tree Brook (PWSB station 9). The mean daily yield of chloride and sodium for the drainage areas above the 14 USGS continuous-record streamgages, which represent nearly 66 percent of the Scituate Reservoir drainage area, was 90 and 55 kg/d/mi^2, respectively. The mean daily yields of chloride and sodium for WY 2014 were similar to the annual mean yields for WY 2013 (94 and 57 kg/d/mi^2, respectively; Smith, 2015a).

Nutrients

Median concentrations of nitrite and nitrate (table 8) were 0.002 and 0.01 mg/L as N, respectively. The highest median concentration of nitrite (0.022 mg/L) was measured in a sample collected at Dexter Pond (PWSB station 17). The highest median concentration of nitrate (0.08 mg/L) was 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 0.07 mg/L as phosphate (PO_4). The maximum median concentration of orthophosphate (0.20 mg/L as PO_4) was measured in Unnamed Tributary #1 to Moswansicut Reservoir (PWSB station 20). Median daily nitrite and nitrate loads were largest at Ponaganset River (PWSB station 35; 86 and 860 grams per day [g/d], respectively). The largest median daily phosphate load was determined for Shippee Brook (PWSB station 25; 4,600 g/d). The largest median daily yield for nitrite (39 grams per day per square mile [g/d/mi^2]) was determined for Unnamed Tributary to Westconnaug Reservoir (PWSB station 11). The largest median daily yield for nitrate (960 g/d/mi^2) was determined for Unnamed Tributary #2 to Moswansicut Reservoir (PWSB station 21), and the largest median daily yield for orthophosphate (2,000 g/d/mi^2) was determined for Shippee Brook (PWSB station 25; table 9).

References Cited

Breault, R.F., 2010, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2002: U.S. Geological Survey Open-File Report 2009–1041, 25 p.

Breault, R.F., and Campbell, J.P., 2010a, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2003: U.S. Geological Survey Open-File Report 2010–1043, 24 p.

Breault, R.F., and Campbell, J.P., 2010b, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2004: U.S. Geological Survey Open-File Report 2010–1044, 24 p.

Breault, R.F., and Campbell, J.P., 2010c, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2005: U.S. Geological Survey Open-File Report 2010–1045, 24 p.

Breault, R.F., and Campbell, J.P., 2010d, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2006: U.S. Geological Survey Open-File Report 2010–1046, 25 p.

Breault, R.F., and Smith, K.P., 2010, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2009: U.S. Geological Survey Open-File Report 2010–1275, 24 p.

Breault, R.F., Sorenson, J.R., and Weiskel, P.K., 2002, Streamflow, water quality, and contaminant loads in the lower Charles River watershed, Massachusetts, 1999–2000: U.S. Geological Survey Water-Resources Investigations Report 02–4137, 131 p.

Breault, R.F., Waldron, M.C., Barlow, L.K., and Dickerman, D.C., 2000, Water-quality conditions in relation to drainage basin characteristics in the Scituate Reservoir Basin, Rhode Island, 1982–95: U.S. Geological Survey Water-Resources Investigations Report 00–4086, 46 p.

Helsel, D.R., and Hirsch, R.M., 2002, Statistical methods in water resources: U.S. Geological Survey Techniques of Water-Resources Investigations, book 4, chap. A3, 522 p.

Hirsch, R.M., 1982, A comparison of four streamflow record extension techniques: Water Resources Research, v. 18, no. 4, p. 1081–1088.

Hirsch, R.M., and Gilroy, E.J., 1984, Methods of fitting a straight line to data—Examples in water resources: Water Resources Bulletin, v. 20, no. 5, p. 705–711.

Nimiroski, M.T., DeSimone, L.A., and Waldron, M.C., 2008, Water-quality conditions and constituent loads, 1996–2002, and water-quality trends, 1983–2002, in the Scituate Reservoir drainage area, Rhode Island: U.S. Geological Survey Scientific Investigations Report 2008–5060, 55 p.

Nimiroski, M.T., and Waldron, M.C., 2002, Sources of sodium and chloride in the Scituate Reservoir drainage basin, Rhode Island: U.S. Geological Survey Water-Resources Investigations Report 02–4149, 16 p.

Providence Water Supply Board Water Quality Laboratory, 2012, Quality Assurance Program Manual: Providence Water Supply Board [variously paged].

Ries, K.G., III, and Friesz, P.J., 2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water-Resources Investigations Report 00–4136, 81 p.

Smith, K.P., 2013, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2011: U.S. Geological Survey Open-File Report 2013–1127, 32 p.

Smith, K.P., 2014, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2012: U.S. Geological Survey Open-File Report 2013–1274, 30 p.

Smith, K.P., 2015a, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2013: U.S. Geological Survey Open-File Report 2015–1082, 31 p., accessed June 3, 2015, at http://dx.doi.org/10.3133/ofr20151082.

Smith, K.P., 2015b, Water-quality trends in the Scituate reservoir drainage area, Rhode Island, 1983–2012: U.S. Geological Survey Scientific Investigations Report 2015–5058, 57 p. [Also available at http://dx.doi.org/10.3133/sir20155058.]

Smith, K.P., and Breault, R.F., 2011, Streamflow, water quality, and constituent loads and yields, Scituate Reservoir drainage area, Rhode Island, water year 2010: U.S. Geological Survey Open-File Report 2011–1076, 26 p.

Tasker, G.D., and Driver, N.E., 1988, Nationwide regression models for predicting urban runoff water quality at unmonitored sites: Water Resources Bulletin, v. 24, no. 5, p. 1090–1101.

U.S. Geological Survey, 2001, Water data for the nation: U.S. Geological Survey National Water Information System Web site, accessed November 10, 2010, at http://waterdata.usgs.gov/nwis/.

U.S. Geological Survey, 2007, Water-resources data for the United States, water year 2006: U.S. Geological Survey Water-Data Report WDR–US–2006, accessed November 5, 2009, at http://wdr.water.usgs.gov/.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods, book 1, chap. D3, 8 attachments, accessed April 10, 2006, at http://pubs.water.usgs.gov/tm1d3.

Table 4. Daily loads of bacteria, chloride, nitrate, nitrite, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.

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PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	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	12/06/13	2.9	21,000	1,400	160	14	<35	13,000
			01/15/14	29	240,000	64,000	1,500	140	1,400	12,000
			03/18/14	12	32,000	5,900	760	29	290	880
			04/04/14	13	79,000	<1,600	740	64	320	2,500
			05/02/14	42	410,000	51,000	930	210	1,000	3,100
			06/17/14	2.5	53,000	2,400	160	12	61	310
			07/14/14	0.57	22,000	1,400	33	4.2	14	98
			08/22/14	0.57	39,000	420	35	1.4	14	56
			09/05/14	0.18	23,000	1,300	11	0.88	40	18
25	01115200	Shippee Brook	01/17/14	5.9	8,700	<720	140	14	140	1,000
			04/18/14	11	48,000	<1,300	440	53	260	8,200
26	01115185	Windsor Brook	10/18/13	0.30	4,600	73	18	1.5	<3.7	66
			01/17/14	8.9	13,000	<1,100	420	22	220	1,700
			04/18/14	16	12,0000	16,000	24	80	17	6,400
28	01115265	Barden Reservoir (Hemlock Brook)	10/08/13	0.71	5,400	<87	48	5.2	<21	230
			11/12/13	1.7	2,900	<210	150	8.3	240	250
			12/10/13	9.9	130,000	31,000	510	73	950	1,200
			01/14/14	39	360,000	160,000	1,500	190	340	5,700
			03/11/14	14	38,000	3,400	810	34	640	4,800
			04/15/14	26	250,000	19,000	1,600	32	<160	2,500
			05/13/14	13	89,000	16,000	750	54	<67	640
			06/10/14	5.5	48,000	4,000	350	45	450	270
			07/07/14	4.6	75,000	5,600	380	0.88	44	3,700
			09/09/14	0.18	3,300	<22	12	45	<110	13

Table 4. Daily loads of bacteria, chloride, nitrate, nitrite, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.—Continued

[Water-quality data are from samples collected and analyzed by the Providence Water Supply Board (PWSB). Shaded areas indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the PWSB. USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; PO_4, phosphate; <, less than; --, data not available]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
			Barden Reservoir subbasin—Continued							
35	01115187	Ponaganset River	12/06/13	9.1	53,000	2,200	430	380	3,800	1,100
			01/15/14	78	310,000	95,000	3,100	86	860	21,000
			03/18/14	35	120,000	8,600	1,800	140	1,400	2,600
			04/04/14	57	390,000	<7,000	2,500	570	2,800	5,600
			05/02/14	120	2,300,000	570,000	4,900	7.3	24	8,500
			07/14/14	1.0	13,000	490	61	1.4	64	370
			09/05/14	0.29	61,000	1,400	21	1.8	<4.6	14
			Direct Runoff subbasin							
1	01115180	Brandy Brook	10/01/13	0.38	8,200	<46	1.0	0.82	<4.1	180
			11/05/13	0.33	2,900	160	0.49	8.9	30	65
			12/03/13	1.2	11,000	4,500	40	11.0	<18	680
			01/09/14	1.5	4,300	360	2.2	33	<84	330
			04/01/14	6.8	170,000	<840	120.0	23	77	500
			05/06/14	3.1	15,000	<380	67	17	44	<77
			06/03/14	1.8	100,000	440	49	3.8	10	130
			07/01/14	0.39	32,000	950	10	1.4	<3.4	66
			08/05/14	0.28	15,000	540	7.9	1.1	5.3	20
			09/02/14	0.22	2,200	<26	0.32	0.15	1.5	37
3	01115280	Cork Brook	10/03/13	0.06	440	15	1.2	2.2	22	19
			12/05/13	0.91	4,900	1,100	82	3.7	37	160
			01/02/14	1.5	1,800	370	140	12	120	2,100
			04/03/14	4.8	31,000	1,200	370	230	<390	2,300
			05/01/14	32	2,100,000	230,000	1,700	5.4	27	7,000
			06/16/14	1.1	11,000	1,100	95	0.46	4.6	160
			07/18/14	0.19	6,900	46	3.6	0.29	5.9	19
			08/19/14	0.12	13,000	590	15	0.11	<0.56	18

Table 4. Daily loads of bacteria, chloride, nitrate, nitrite, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.—Continued

[Water-quality data are from samples collected and analyzed by the Providence Water Supply Board (PWSB). Shaded areas indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the PWSB. USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; PO_4, phosphate; <, less than; --, data not available]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
Direct Runoff subbasin—Continued										
4	01115400	Kent Brook	10/01/13	0.05	4,300	230	0.2	2.00	10	19
			12/03/13	0.42	920	<51	4.7	20.0	<98	210
			01/07/14	8.0	14,000	<980	12	1.8	<8.9	390
			03/04/14	0.7	2,500	<89	10	24	<120	53
			04/01/14	9.7	900,000	12,000	12	8.1	41	2,400
			05/06/14	1.7	5,300	410	17	1.2	6.2	81
			06/03/14	0.25	44,000	1,200	2.6	0.11	<0.27	12.0
			07/01/14	0.02	2,000	270	<0.01	<0.01	0.47	<0.54
			09/02/14	<.01	590	9.4	<0.01	2.6	8.6	0.19
5	01115184	Spruce Brook	10/15/13	0.35	11,000	<43	29	21	100	120
			04/28/14	4.2	14,000	<510	190	0.66	2.2	210
			07/31/14	0.09	13,000	660	7.8	4.5	19	6.6
6	01115183	Quonapaug Brook	10/01/13	0.26	22,000	1,300	26	2.7	5.40	260
			11/05/13	0.22	3,600	540	2.4	19	<16	120
			12/03/13	1.3	14,000	1,900	83	30	150	220
			01/07/14	6.1	110,000	19,000	740	100	340	450
			04/01/14	14	150,000	10,000	1,000	47	<59	<340
			05/06/14	4.8	18,000	<590	480	43	54	470
			06/03/14	2.2	32,000	6,500	190	11	<3.3	270
			07/01/14	0.27	15,000	2,000	31	--	--	--
			08/05/14	0.17	16,000	3,700	18	7.9	140	83
			09/02/14	0.12	25,000	590.00	19	4.5	45	68

Table 4. Daily loads of bacteria, chloride, nitrate, nitrite, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.—Continued

[Water-quality data are from samples collected and analyzed by the Providence Water Supply Board (PWSB). Shaded areas indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the PWSB. USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; PO_4, phosphate; <, less than; --, data not available]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
Direct Runoff subbasin—Continued										
7	01115297	Wilbur Hollow Brook	10/03/13	0.92	9,900	450	1.4	32	<53	200
			12/05/13	4.3	58,000	13,000	94	30	150	740
			01/02/14	6.1	19,000	7,500	9.0	13	130.00	2,400
			03/06/14	5.5	12,000	1,300	8.1	73	370	810
			04/03/14	15	170,000	11,000	22	330	1,100	2,900
			05/01/14	45	1,400,000	110,000	1,000	63	160	12,000
			06/16/14	6.4	100,000	19,000	110	15	51	310
			07/18/14	2.1	41,000	3,600	15	16	110.00	260
			08/19/14	2.2	180,000	27,000	33	0.34	21.00	160
			09/04/14	0.07	14,000	340	2.0	16	160.00	5.1
8	01115276	Westconnaug Brook	01/10/14	6.4	<780	<780	140	34	<170	1,100
			02/24/14	14	21,000	<1,700	21	37	370	6,200
			03/21/14	15	15,000	<1,800	480	39	390	1,100
			04/11/14	16	47,000	<2,000	430	42	420	7,400
			05/19/14	17	50,000	<2,100	310	12	120	1,200
			06/20/14	5.1	15,000	<620	160	4.2	370	2,200
			09/12/14	1.7	<210	17,000	160	9.8	49	370
9	01115275	Bear Tree Brook	04/28/14	2.0	16,000	1,500	210	0.83	58	98
			07/30/14	0.17	9,600	830	37	1.7	17	29
32	01115178	Unnamed Tributary 1 to Scituate Reservoir (Pine Swamp Brook)	03/24/14	0.68	5,900	330	22	7.0	35	170
			04/17/14	1.4	5,300	1,100	46	0.00	<0.17	180
33	01115182	Unnamed Tributary 3 to Scituate Reservoir (Hall's Estate Brook)	10/16/13	0.01	190	7.0	0.28	1.1	11	5.9
			04/29/14	0.46	1,500	110	0.7	3.20	16	79

Table 4. Daily loads of bacteria, chloride, nitrate, nitrite, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.—Continued

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PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	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)	10/10/13	0.66	1,800	480	60	29	190	340
			12/12/13	3.9	6,700	2,900	330	25	250	570
			01/09/14	5.2	1,300	<640	470	34	170	380
			02/25/14	6.9	<840	<840	660	32	<160	3,000
			04/10/14	13	19,000	6,400	1,200	37	190	5,100
			05/08/14	7.6	30,000	<930	740	14	71	3,300
			06/12/14	2.9	18,000	1,400	290	2.0	20	140
			07/19/14	0.81	12,000	200	180	8.1	81	140
			08/14/14	3.3	54,000	2,400	340	5.2	31	<81
21	01115165	Unnamed Tributary 2 to Moswansicut Reservoir (Brook from Kimball Reservoir)	01/29/14	0.42	4,000	210	31	3.8	68	130
			05/15/14	0.52	4,700	<64	48	14	490	51
Regulating Reservoir subbasin										
14	01115110	Huntinghouse Brook	12/02/13	2.8	41,000	2,700	92	98	440	750
			01/16/14	20	210,000	20,000	540	88	390	8,300
			03/17/14	18	88,000	13,000	610	78	390	1,300
			04/07/14	16	43,000	3,900	530	160	71	3,500
			05/05/14	16	86,000	7,800	480	7.1	<62	1,600
			06/02/14	2.9	33,000	2,100	4.3	25	680	350
15	01115114	Rush Brook	12/02/13	5.1	57,000	21,000	520	34	140	1,100
			01/16/14	14	72,000	6,800	110	14	270	3,100
			02/03/14	5.8	24,000	<710	650	670	230	990
			03/17/14	11	70,000	5,400	1,100	47	220	1,100
			04/07/14	9.6	100,000	4,700	1,100	420	42	2,300
			05/05/14	9.1	42,000	2,200	910	12	14	1,100
			06/02/14	1.7	12,000	<210	240	4.1	<7.9	250
			07/08/14	0.56	16,000	1,400	77	1.6	<6.2	68

Table 4. Daily loads of bacteria, chloride, nitrate, nitrite, and orthophosphate by tributary reservoir subbasin in the Scituate Reservoir drainage area, Rhode Island, October 1, 2013, through September 30, 2014.—Continued

[Water-quality data are from samples collected and analyzed by the Providence Water Supply Board (PWSB). Shaded areas indicate values that were calculated with concentration data censored at half the detection level. Alternate station names are given in parentheses for stations where different historical names were used for the same sampling location by the PWSB. USGS, U.S. Geological Survey; ft^3/s, cubic feet per second; $CFU \times 10^6/d$; millions of colony forming units per day; *E. coli*, *Escherichia coli*; kg/d, kilograms per day; g/d, grams per day; N, nitrogen; PO_4, phosphate; <, less than; --, data not available]

PWSB station number	USGS station number	Station name	Date	Daily mean streamflow (ft^3/s)	Total coliform bacteria ($CFUx10^6/d$)	*E. coli* ($CFUx10^6/d$)	Chloride (kg/d)	Nitrite (g/d as N)	Nitrate (g/d as N)	Orthophosphate (g/d as PO_4)
			Regulating Reservoir subbasin—Continued							
16	01115098	Peeptoad Brook (Harrisdale Brook)	10/07/13	0.65	4,800	<79	54	1.2	110	95
			11/04/13	0.51	2,100	<62	43	34	730	62
			12/02/13	4.6	57,000	20,000	350	37	95	1,500
			01/16/14	15	140,000	29,000	1,500	19	<210	2,900
			02/03/14	3.9	7,600	<480	420	620	560	860
			03/17/14	17	79,000	4,200	1,800	110	390	420
			04/07/14	23	84,000	<2,800	2,000	940	91	5,100
			05/05/14	16	67,000	7,800	1,700	27	32	1,200
			06/02/14	3.7	15,000	2,700	510	6.4	12	360
			07/08/14	1.3	23,000	<160	140	0.61	16	64
			08/04/14	0.25	3,500	61	25	0.64	3.4	12
			09/17/14	0.13	11,000	640	15	0.68	29	6.4
18	01115120	Unnamed Tributary to Regulating Reservoir (Unnamed Brook A)	05/15/14	0.14	1,400	34	4.9	5.9	200	31
			Westconnaug Reservoir subbasin							
10	01115274	Westconnaug Brook	12/10/13	1.2	8,800	880	63	10	68	410
			01/14/14	4.0	13,000	980	210	14	130	490
			03/11/14	2.8	4,700	<340	4.1	25	91	270
			04/15/14	5.2	8,900	1,300	7.6	14	21	890
			05/13/14	1.9	6,400	910	120	2.1	38	91
			06/10/14	0.86	8,600	<110	61	5.2	<20	63
11	01115273	Unnamed Tributary to Westconnaug Reservoir (Unnamed Brook South of Westconnaug Reservoir)	01/28/14	1.1	8,600	520	1.6	7.6	<38	100
			04/22/14	1.6	8,000	<190	2.3	49	<120	910

Appendix 1. Water-Quality Data Collected by the Providence Water Supply Board at 37 Monitoring Stations in the Scituate Reservoir Drainage Area, Water Year 2014

[Available as a separately downloaded Microsoft Excel file, at http://dx.doi.org/10.3133/ofr20161051.]

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Publishing support by:
The Pembroke Publishing Service Center

ISSN 2331-1258 (online)
http://dx.doi.org/10.3133/ofr20161051