Sebago Lake Watershed Monitoring Programs
Tributary Monitoring - 2024

Carina Brown

Introduction

Sebago Lake is the primary drinking water supply for the greater Portland area. The Portland Water District (PWD) treats and delivers drinking water to over 200,000 people in 11 communities. PWD has a waiver from the filtration requirements of the federal Safe Drinking Water Act. There are many criteria for obtaining and keeping the waiver, but one of the largest factors is the continued excellent water quality of Sebago Lake and PWD's watershed protection efforts. This waiver agreement requires ongoing monitoring of lake water quality.

PWD monitors Sebago Lake and the rivers and streams that drain to it through more than 10 monitoring and surveillance programs. In general, more samples are collected and tested for more parameters the closer one moves to the intake pipes, located in Lower Bay.

The water quality of Sebago Lake is influenced by many factors, one of which is the condition of the watershed. A watershed is the land area that drains to a water body. In the case of Sebago Lake, the watershed includes part or all of 24 towns from Standish to Bethel. The majority of the watershed is forested, and because forests act as a natural filter, the water quality of the lake is excellent.

The tributary monitoring program was created to be an indicator of conditions in the watershed. If water pollution problems exist on the land that drains to the lake, one would expect to see water quality declines in the tributaries first.

This report covers the Tributary Monitoring Program which includes 11 tributaries that drain to Sebago Lake. The Tributary Monitoring Program began in 1977 with the purpose of monitoring the health of the watershed.

Methods

Eleven tributaries to Sebago Lake are sampled at one location each for three parameters: total phosphorus, turbidity, and *Escherichia coli (E. coli)* bacteria (Figure 1). The tributaries include: 1952 Brook, Panther Run, Crooked River (site name: State Park), Songo River, Muddy River, Northwest River, Rich Mill, Smith Mill, Sticky River, Standish Brook, and an un-named stream near St. Joseph's College (site name: St. Joe's). The State Park site is located on the Crooked River and is also part of the Crooked River Monitoring Program. Results for that site are discussed in PWD's Crooked River monitoring report. The other ten tributaries will be discussed here.

Tributary sampling occurs monthly with a hand grab or by using a "dipper" that lowers sample bottles into the water, usually from a bridge over the tributary. *E. coli* and turbidity samples are collected monthly in sterile sample bottles. Total phosphorus samples are collected four times per year (April, June, August, and October) in acid-washed glass flasks. In instances where the tributary is frozen, there is not enough flow to collect a sample, flow does not go to the lake, or the site is unsafe, a sample will not be collected.

Total phosphorous samples are analyzed using the ascorbic acid method and a spectrophotometer in the Portland Water District's Water Quality Lab. Turbidity is analyzed using a laboratory benchtop Hach TU5200 Turbidimeter. *E. coli* samples are analyzed using the IDEXX Colilert method and are incubated at 35 degrees Celsius for 24 hours.

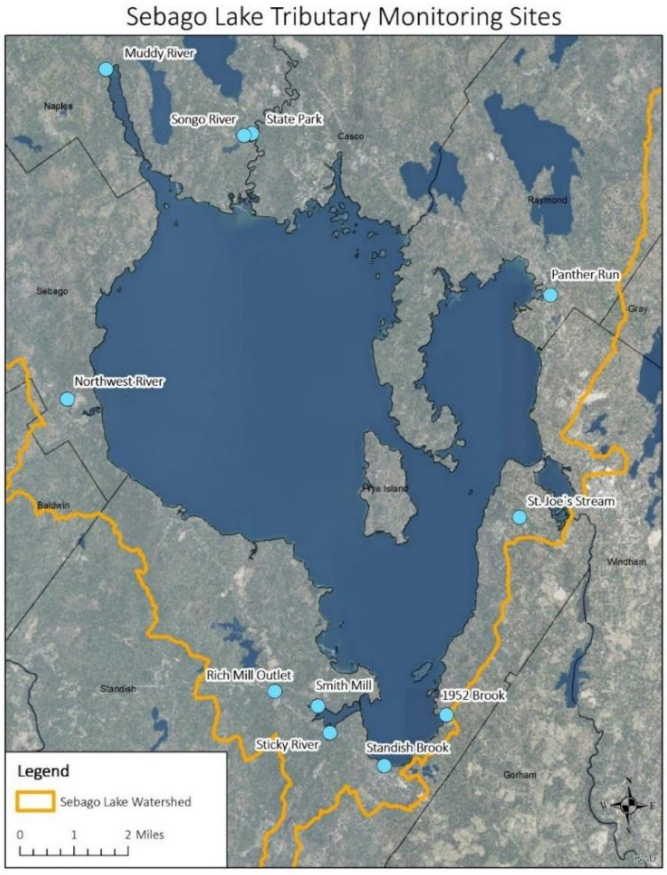

Figure 1: Tributary sampling sites location map for 2024.

Results and Discussion

Total Phosphorus

PWD measures phosphorus in the tributaries because it is an important nutrient for plant growth. In lakes, the amount of phosphorus in the water often limits the growth of algae. Increases in phosphorus levels can lead to more algae growth and declines in water quality of a lake. Phosphorus levels tend to be higher in the tributaries but become diluted once the tributary waters reach Sebago Lake.

There are many forms of phosphorus in the environment. PWD measures total phosphorus, which includes both phosphates attached to sediment and dissolved forms of phosphorus. It is measured in parts per billion (ppb). A result of 35 ppb is the action level established by PWD. For St. Joe's Stream, the action level is 60 ppb based on past data indicating that the typical range of total phosphorus is higher in this tributary. Sampling events that result in total phosphorus levels at or above these action levels are reviewed and appropriate corrective measures are taken, if possible.

In 2024, two sampling events produced total phosphorus results that were above the PWD established action levels (Table 1). To determine if these are normal results, the mean (M) and standard deviation (SD) are calculated for each tributaries' historical data set. A value that is within two standard deviations of the mean is considered normal, and those beyond are outside of the normal range.

Table 1. Total phosphorus (ppb) results for 2024. Results at or above the action level (35 ppb or 60 ppb) are in bold text and those exceeding the action level which are outside of the normal range are in red text.

	1952 Brook	St. Joe's Stream	Panther Run	Songo River	Muddy River	Northwest River	Rich Mill	Smith Mill	Sticky River	Standish Brook
4/22/24	25.3	15.9	9.7	9.8	11.9	10.0	15.1	14.5	22.4	
6/3/24	31.8	39.1	33.9	33.6	17.5	16.1	26.9	32.3		28.8
8/19/24		50.4	11.9	9.0	13.1	15.0	27.4	24.3		26.9
10/9/24		30.3		8.2	14.5	11.8	26.3	**36.1**	**36.0**	25.2

The Smith Mill high result of 36.1 ppb in October is within the normal range (M=22.1, +2SD=56.8) for data collected from 1997-2023. The likely cause of the high total phosphorus result for the Smith Mill sample in October is the 0.49-inch rain event two days preceding the sampling event.

The Sticky River high result of 36.0 ppb in October is within the normal range (M=23.9, +2SD = 50.3) for data collected from 1977-2023. The likely cause of the high total phosphorus result for the Sticky River sample in October is the 0.49-inch rain event two days preceding the sampling event.

Turbidity

Turbidity is the amount of suspended particulate matter in the water. In streams, the three major types of suspended particulates that contribute to turbidity are algae, detritus (dead organic material), and silt (inorganic or mineral suspended sediment). High turbidity decreases light penetration and facilitates eutrophication of lakes. Particulates also provide attachment sites for heavy metals such as cadmium, mercury and lead, many toxic organic contaminants such as PCBs, and many pesticides.

PWD measures turbidity using a turbidimeter, an instrument that passes a beam of light through a water sample and measures the light output on the other side. The greater the amount of suspended particulate matter in the water, the more the light beam is refracted and blocked, and the higher the turbidity reading. Turbidity is measured in NTU (nephelometric turbidity units). Generally, readings below 1 NTU indicate water that appears "clear" to the naked eye. Readings greater than 4 NTU indicate water that would appear cloudy or murky.

A reading of 4 NTU or greater is the action level established by PWD. Values that exceed 4 NTU are reviewed and appropriate corrective measures taken, if possible.

In 2024, five sampling events and one resampling event produced turbidity results that were above the PWD established action level (Table 2). To determine if these are normal results, the mean (M)

and standard deviation (SD) are calculated for each tributaries' historical data set. A value that is within two standard deviations of the mean is considered normal, and those beyond are outside of the normal range.

Table 2. Turbidity (NTU) results for 2024. Results at or above the action level (4 NTU) are in bold text and those and those exceeding the action level which are outside of the normal range are in red text.

	1952 Brook	St. Joe's Stream	Panther Run	Songo River	Muddy River	Northwest River	Rich Mill	Smith Mill	Sticky River	Standish Brook
1/22/24	1.03	0.69	1.06	0.64		0.41	1.75	0.62		0.84
2/26/24	2.1	0.8	1.3	1.3	0.8	1.4	0.9	0.8	2.1	1.8
3/11/24	0.9	0.8	0.9	0.7	0.7	0.7	0.7	1	0.9	1.3
4/22/24	3.4	0.8	0.81	0.79	0.81	0.66	0.63	0.72	0.78	
5/28/24	**5.57**	1.43	1.36	0.88	1.33	0.72	0.8	1.31	1.2	2.55
6/3/24	**20.3**	1.83	1.81	0.95	0.86	0.58	0.93	1.25		3.08
7/8/24	**42.0**	0.42	1.76	0.68	0.69	0.49	0.6	1.29		
8/19/24		0.65	0.93	0.51	0.47	0.4	0.67	0.86		**8.61**
9/23/24			2.32	0.64	0.45	0.28	0.94	2.8		
10/9/24		1.11		0.84	0.78	0.5	0.92	2.16	2.01	**5.18**
11/12/24			1.7	1.65	0.51	0.31	0.8	0.75		
12/16/24	1.1	0.58	**5.57**	2.53	1.01	0.83	2.08	1.57	1.06	0.91
Resample			**8.15**							

The turbidity was high in 1952 Brook in the May, June, and July sampling events. The May and June results are within the normal range (M=5.6, +2SD=23.2), while the July result is outside of the normal range for data collected from 1995-2023. For all sampling events, it was noted by the sampler that iron bacteria were present in the tributary, which is the likely cause of these high turbidity results.

The turbidity was high in Panther Run during the December sampling event. The initial high result is within the normal range (M=1.7, +2SD=6.8) and the resampled high result is outside the normal range for data collected from 1977-2023. For both sampling events, it was noted by the sampler that numerous waterfowl were present. A field investigation upstream also indicated that numerous waterfowl and low water levels likely contributed to these high results.

The turbidity was high in Standish Brook during the August and October sampling events. The high result in August is outside the normal range (M=2.1, +2SD=6.5) and the high result in October is within the normal range for data collected from 1977-2023. These results may be attributed to light precipitation events during and preceding the August sampling event and a large 0.49-inch rain event in days prior to the October sampling event.

Escherichia coli Bacteria

E. coli is a type of fecal coliform bacteria that is found in the guts of warm-blooded animals and is used by water utilities as an indicator of possible contamination and pathogens in the water. *E. coli* is used as an indicator organism because it has been shown to be a reliable indicator of contamination, and it is not practical to test every sample for all the pathogens that could be present in water.

E. coli levels tend to be higher in the tributaries than the lake, but the levels become diluted once the tributary water enters the lake. Natural occurrences can cause elevated *E. coli* levels. Examples include significant precipitation events that wash pollution (i.e., animal feces) and eroded soils into the tributaries. A small percentage of fecal bacteria is associated with soil.

PWD's action level for *E. coli* is 235 Most Probable Number (MPN) per 100mL in accordance with the recommended level for beach closure under the Maine Healthy Beaches Program. Sampling events that result in *E. coli* levels above 235 MPN/100mL are reviewed or re-sampled if the cause is unknown.

In 2024, ten sampling events and two resampling events produced *E. coli* results that were above the PWD established action level (Table 3). To determine if these are normal results, the mean (M) and standard deviation (SD) are calculated for each tributaries' historical data set. A value that is within two standard deviations of the mean is considered normal, and those beyond are outside of the normal range.

Table 3. *E. coli (MPN/100mL)* results for 2024. Results at or above the action level (235 MPN/100 mL) are in bold text and those exceeding the action level which are outside of the normal range are in red text.

	1952 Brook	St. Joe's Stream	Panther Run	Songo River	Muddy River	Northwest River	Rich Mill	Smith Mill	Sticky River	Standish Brook
1/22/24	0	26	8	0		4	8	3		20
2/26/24	0	11	18	0	20	4	5	5	0	31
3/11/24	2	6	1	0	9	3	5	3	4	**1733**
Resample										11
4/22/24	0	79	0	0	10	2	65	81	5	
5/28/24	**488**	138	167	120	**1120**	219	179	**488**	19	**2420**
6/3/24	5	23	**980**	133	16	24	58	61		**1733**
Resample			68							**2420**
7/8/24	**1414**	4	222	70	49	19	125	**299**		
Resample	157							219		
8/19/24		18	31	42	22	29	147	155		**1203**
9/23/24			26	28	2	26	44	112		
10/9/24		91		23	26	199	39	214	31	**365**
11/12/24			26	15	0	16	228	30		
12/16/24	115	11	53	7	194	131	31	31	38	**488**
Resample										**488**

The *E. coli* level was high in 1952 Brook during the May and July sampling events. The May result is within the normal range (M=122.7, +2SD=918), while the July result is outside of the normal range for data collected from 2009-2023. In response to the May high result, we treated the June 3rd sampling event as the resample, and this result fell below the action level. The high *E. coli* levels in May is likely due to the 0.61-inch rain event during sampling and a 0.55-inch rain event the day prior. We resampled after the July high result and bacteria levels fell below the action level, but the likely cause is unknown.

The *E. coli* level was high in Panther Run during the June sampling event. The initial high result is outside the normal range (M=105.2, +2SD=526) for data collected from 2009-2023, and the resample result fell below the action level. A June high result in Panther Run has been a common occurrence for several years with the likely cause being waterfowl, but no waterfowl were observed during this sampling event. We confirmed with upstream dam managers that there are no unique June operations that could be influencing this annual phenomenon.

The *E. coli* level was high in Muddy River during the May sampling event. The result is outside the normal range (M=39, 2SD=199) for data collected from 2009-2023. In response to the high result, we treated the June 3rd sampling event as the resample, and this result showed that bacteria levels

fell below the action level. The likely cause of the high *E. coli* result is the 0.61-inch rain event the day of sampling and 0.55 inches of rain the day before the sampling event.

The *E. coli* level was high in Smith Mill during the May and July sampling events. The May and July results are within the normal range (M=98.6, +2SD=568) for data collected from 2009-2023. In response to the May high result, we treated the June 3rd sampling event as the resample, and this result fell below the action level. The high *E. coli* levels in May is likely due to the 0.61-inch rain event during sampling and a 0.55-inch rain event the day prior. We resampled after the July high result and bacteria levels fell below the action level, but the cause is unknown.

The *E. coli* level was high in Standish Brook during each sampling event when a sample could be collected, with the exception of the January and February sampling events. The March, May, June, and August high results are outside of the normal range (M=175.3, +2SD=865.2), while the October and December results are within the normal range for the data collected from 2009-2023. Responses to these high results included resampling, field investigations, using microbial source tracking, and securing standing permission from Inland Fisheries & Wildlife to remove beavers around the Lower Bay sampling sites.

Conclusion

This sampling program provides a "snapshot" determination of the health of the major tributaries to Sebago Lake. Samples that exceed established action limits are investigated and re-sampled if necessary. Because sampling occurs on a monthly basis under various weather conditions, it is difficult to determine a continuous water quality trend from the data. Rather, this program reflects the variability of water quality in response to both environmental and human factors.

In 2024, weather and other environmental factors were the most likely causes of exceedances of action levels in some tributaries. The number of *E. coli* action level exceedances was outside the normal range, and is likely due to repeated high levels in Standish Brook. PWD is working with Maine DOT to remove a culvert frequently dammed by beavers and restoring the stream channel. Overall, water quality in the tributaries remained high during the sampling events in 2024. Continued monitoring of the tributaries is necessary. The tributaries empty directly into Sebago Lake, and reductions in water quality in these streams could affect the health of the lake.