



Sebago Lake Watershed Monitoring Programs

Tributary Monitoring - 2023

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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 2023.

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) or micrograms per liter (µg/L), and a reading 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 2023, a lab error caused all of the April analysis to be invalid. In August, the total phosphorus level was above the 35 ppb action level in Sticky River, and in October the total phosphorus level was above the action level in Smith Mill (Table 1). To determine if these are normal results, the mean (M) and standard deviation (SD) are calculated for each tributaries’ data set. A value that is within two standard deviations of the mean is considered normal, and those outside are outside of the normal range.

Table 1. Total phosphorus (ppb) results for 2023. Results at or above the action level are indicated by bolded text.

	1952 Brook	St. Joe’s Stream	Panther Run	Songo River	Muddy River	Northwest River	Rich Mill	Smith Mill	Sticky River	Standish Brook
4/18/23	Lab Error									
6/12/23	28.6	32.2	17.3	11.2	27.1	11.5	23.0	18.9	31.3	14.7
8/28/23	32.8	35.8	10.8	8.0	11.2	10.6	18.8	19.9	52.6	22.9
10/23/23	33.8	40.8	13.1	9.5	17.3	15.1	31.8	41.6	34.5	27.1

The Sticky River high result of 52.6 ppb in August is outside of the normal range (M=23.7, +2SD = 49.9) for data collected from 1977-2022. The likely cause of the high total phosphorus result for the Sticky River sample in August is a 0.37 inch rain event on 8/27/23.

The Smith Mill high result of 41.6 ppb in October is within the normal range (M=22.0, +2SD=56.9) for data collected from 1997-2022. The likely cause of the high total phosphorus result for the Smith Mill sample in October is the 0.97 inch and 0.88 inch rain events in the days preceding the sampling event.

Due to laboratory staffing changes, samples were not analyzed within the typical span of time that allows us to respond to samples which exceed action levels.

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, which is 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 2023, the turbidity results were above the action level of 4 NTU in 1952 Brook during the June, July, August, September, and October sampling events and in Standish Brook during the July sampling event (see Table 2). To determine if these are normal results, the mean (M) and standard deviation (SD) are calculated for each tributaries' data set. A value that is within two standard deviations of the mean is considered normal, and those outside are outside of the normal range.

Table 2. Turbidity (NTU) results for 2023. Results at or above the action level are in bolded text.

	1952 Brook	St. Joe's Stream	Panther Run	Songo River	Muddy River	Northwest River	Rich Mill	Smith Mill	Sticky River	Standish Brook
1/24/23	0.77	0.50	0.52	0.75	0.38	0.53	0.81	0.66	-	0.77
2/14/23	0.67	0.43	1.02	0.56	0.49	0.51	0.72	0.94	-	1.00
3/29/23	0.63	0.35	0.38	0.48	0.29	0.46	0.44	0.50	0.43	0.60
4/18/23	1.97	0.97	0.75	0.81	0.74	0.63	0.69	0.96	0.84	1.28
5/9/23	2.03	0.43	0.59	0.62	0.57	0.58	0.54	0.55	-	0.82
6/12/23	8.94	0.61	0.95	0.65	0.49	0.48	0.54	0.52	1.06	1.31
7/25/23	25.20	1.54	1.50	0.60	0.78	0.45	0.77	0.61	1.29	5.26
Resample										3.12
8/28/23	15.10	0.75	1.00	0.57	0.51	0.35	0.54	0.78	1.12	3.09
9/26/23	20.60	0.56	0.74	0.63	0.44	0.28	0.52	0.81	1.03	2.81
10/23/23	4.85	0.74	1.00	0.62	0.87	0.68	0.95	1.01	1.51	1.96
11/20/23	3.90	0.49	1.34	1.44	0.81	0.75	1.47	0.77	1.37	2.10
12/19/23	2.00	1.65	1.55	-	2.66	3.76	1.61	2.58	1.86	2.10

The turbidity was high in 1952 Brook throughout the June to October sampling events. The high result on 7/25/23 of 25.20 NTU is the only high result that is outside of the normal range (M=5.5, +2SD=23.2) for data collected from 1995-2022. For each of these sampling events, except for October, it was noted by the sampler that iron bacteria were present in the tributary on each occasion, which is the likely cause of these high turbidity results. The likely cause of the high turbidity result for the sample in October is the 0.97 inch and 0.88 inch rain events in the days preceding the sampling event.

The turbidity was high in Standish Brook during the July sampling event. The high result on 7/25/23 of 5.26 NTU is within the normal range (M=2.1, +2SD=6.6) for data collected from 1977-2022. The cause is unclear as there were no precipitation events prior to sampling. It was noted by the sampler that there was low flow and stagnant pools upstream. The turbidity fell below the action level upon resampling.

In December, Muddy River and Northwest River both had results that were below the action level but were outside of the normal ranges. The Muddy River result of 2.66 NTU is outside of the normal range (M=0.9, +2SD=2.6). The Northwest River result of 3.76 NTU is outside of the normal range (M=0.8, +2SD=2.6). The likely cause of these abnormally high turbidity results is the 2.78 inch and 1.01 inch rain events in the days preceding the 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 2023, the *E. coli* action level was exceeded in Panther Run and Standish Brook during the June sampling, and again in Standish Brook during the July, August, and September sampling (see Table 3). To determine if these are normal results, the mean (M) and standard deviation (SD) are calculated for each tributaries' data set. A value that is within two standard deviations of the mean is considered normal, and those outside are outside of the normal range.

Table 3. *E. coli* (MPN/100mL) results for 2023. Results at or above the action level are in bolded text.

	1952 Brook	St. Joe's Stream	Panther Run	Songo River	Muddy River	Northwest River	Rich Mill	Smith Mill	Sticky River	Standish Brook
1/24/23	0	2	0	1	4	6	1	2	-	1
2/14/23	2	17	2	0	5	4	8	3	-	29
3/29/23	2	15	0	3	13	5	0	4	3	62
4/18/23	3	24	2	24	19	24	11	10	8	157
5/9/23	3	17	13	0	15	9	6	4	-	161
6/12/23	33	2	548	58	43	65	22	73	1	365
Resample										2420
7/25/23	20	11	150	55	55	9	26	28	12	2420
Resample										261
Resample										152
8/28/23	59	4	86	62	27	16	19	64	22	435
Resample										411
9/26/23	19	7	23	20	27	13	15	20	14	313
Resample										201
10/23/23	29	17	55	23	131	80	71	84	57	99
11/20/23	2	0	9	1	10	5	4	10	6	23
12/19/23	48	31	26	-	127	84	33	44	105	152

The *E. coli* level was high in Panther Run during the June sampling event. The Panther Run high result of 548 MPN/100 mL is outside of the normal range (M=107.2, +2SD=535.0) for the data collected from 2009-2022. A June high result in Panther Run has been a common occurrence for several years with the likely cause being waterfowl. We utilized microbial source tracking tools to investigate this further after the June high result. This test indicated that pollution sources could be mammals (not humans), dogs, cows, birds, gulls, and Canada Goose (see Table 4).

The *E. coli* level was high in Standish Brook throughout the June through September sampling events. The June resample high result of 2420 MPN/100 mL and the 7/25/23 result of 2420 MPN/100 mL are outside of the normal range (M=137.8, +2SD=586.6) for the data collected from 2009-2022. After the June high result did not fall below the action level upon resampling, we utilized

microbial source tracking tools to investigate the cause further. This test indicated that pollution sources could be mammals (not humans), dogs, and birds (see Table 4). After the July high results, a field investigation identified two possible sources of contamination. One was a nearby dumpster that was visibly attracting varmints. Outreach to the landowner was conducted and, in September, they replaced this dumpster with one that is varmint proof. Additionally, evidence of beaver activity resulted in the hiring of a trapper to remove beavers from the Standish Brook watershed. Additional efforts are underway to address the water quality in Standish Brook, including additional beaver trapping and redirecting stormwater away from the brook.

Table 4. Microbial source tracking results for 2023.

SampleID	Date	Volume filtered	PCR Markers- Presence (+) or Absence (-)									qPCR (copies/100ml)			E. coli	
			Mam-mal	Human	Dog	Ruminant	Cow	Bird	Gull	Canada Goose	Horse	Mammal	Human	Bird	Total	
Panther Run	6/12/23	300	+	-	+	+	+	+	+	+	+	-	142,575	-	385	548
Standish Brook	6/13/23	300	+	-	+	-	-	+	-	-	-	-	954,687	-	378	> 2420

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 2023, weather and other environmental factors were the most likely causes of exceedances of action levels in some tributaries. Overall, water quality in the tributaries remained high during the sampling events in 2023. However, 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.