Portland Water District
Sebago Lake Watershed Monitoring Programs
Tributary Monitoring (1977 – 2016)

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Introduction

Sebago Lake is the primary drinking water supply for nearly 200,000 people in 11 Greater Portland communities. Lake water was first pumped to Portland in 1869, from an intake located in the southernmost part of the lake, referred to as Lower Bay. In 1908, the Portland Water District (PWD) was chartered by the Maine Legislature to provide water and wastewater services to the region. Since its inception, PWD has been actively monitoring and working to protect Sebago Lake.

In 1993, PWD was granted a waiver to the filtration requirements of the federal Safe Drinking Water Act based in part on the purity of the water and the effectiveness of watershed protection efforts. This waiver agreement requires ongoing monitoring of lake water quality. PWD maintains more than 10 monitoring and surveillance programs throughout the watershed and lake. In general, as one moves closer to the intakes, more samples are collected and tested for more parameters.

This report outlines results of the Sebago Lake Tributary Monitoring Program since it began in 1977.

Methods

Ten tributaries to Sebago Lake are sampled at one location each for three parameters: total phosphorus, turbidity, and *Escherichi. coli (E. coli)* bacteria (Figure 1). The tributaries include: 1952 Brook, Panther Run, Crooked River, Songo River, Muddy River, Northwest River, Rich Mill Outlet, Smith Mill, Sticky River, and Standish Brook. The Crooked River monitoring site is also included in the Crooked River Monitoring Program, and results are discussed in the Crooked River report. The other nine tributaries will be discussed here.

Tributary sampling occurred monthly through 2002. In 2003, sampling occurred quarterly in order to target the spring high and fall low flows. Since 2004, total phosphorus has been sampled four times per year, while turbidity and *E. coli* sampling have occurred monthly. A "dipper" is used to lower sterile collection bottles into the water, usually from a bridge over the tributary.

Total phosphorous samples are analyzed using the ascorbic acid method and a spectrophotometer in the Portland Water District's Water Quality Lab. Total phosphorus has been monitored in 1952 Brook since 1995, at Smith Mill since 1997, and at Rich Mill since 1999. Total phosphorus has been monitored in the other six tributaries since 1977.

Turbidity is measured using a turbidimeter. Prior to 1999, turbidity was measured using a benchtop turbidimeter. In 1999, a switch was made to using a Hach Pocket Turbidimeter. In July 2008, a switch was made from using the Hach Pocket Turbidimeter to a benchtop Hach 2100N Turbidimeter, because the Hach Pocket Turbidimeter was not calibrating accurately.

Fecal coliform bacteria samples were analyzed using the membrane filtration technique and incubated on mFC agar at 44.5 degrees Celsius for 24 hours. Fecal coliform was monitored in Smith Mill from 1997-2008 and in 1952 Brook from 1995-2008. Fecal coliform was monitored in the other seven tributaries from 1991-2008. In December 2008, microbiological monitoring changed from fecal coliform to *E.coli*. *E. coli* samples are analyzed using the Colilert method and are incubated at 35 degrees Celsius for 24 hours.

Figure 1: Tributary sampling sites location map for 2016.

Results and Discussion

Total Phosphorus

Phosphorus is one of the major nutrients needed for plant growth. It is generally present in small amounts in temperate lakes and is often the limiting factor for algae growth. As phosphorus increases, the amount of algae also increases. Phosphorus levels are higher in the tributaries, but become diluted once tributary waters enter Sebago Lake. Total phosphorus includes both phosphates attached to sediment and dissolved forms of phosphorus and is measured in parts per billion (ppb) or micrograms per liter (ug/L). A reading of 35 ppb is the action level established by PWD. Sampling events that result in total phosphorus levels above 35 ppb are reviewed and appropriate corrective measures are taken if possible.

In 2016, total phosphorus levels exceeded the 35 ppb action level in three tributaries on 6/29/16 and one tributary on 10/27/16 (Table 1).

Table 1: Total phosphorus (ppb) results for 2016. Results above the action level are indicated by bolded text.

	1952 Brook	**Panther Run**	**Songo River**	**Muddy River**	**Northwest River**	**Rich Mill**	**Smith Mill**	**Sticky River**	**Standish Brook**
4/27/16	23.6	8.6	7.0	9.4	12.8	14.2	11.8	26.2	11.7
6/29/16	31.0	12.0	2.0	14.0	18.0	**36.0**	**50.0**	**40.0**	31.0
8/15/16	Dry	Flowing backwards	14.0	26.3	24.4	26.4	20.9	Flowing backwards	Dry
10/27/16	Dry	15.0	11.8	19.1	24.2	12.8	20.8	**36.7**	9.0

The likely cause of high total phosphorus values at Rich Mill Outlet, Smith Mill, and Sticky River on 6/29/16 was a 0.73 inch rain event on 6/28/16 and a 0.91 inch rain event on 6/29/16.

The cause of the high total phosphorus value in the Sticky River on 10/27/16 is unknown.

Turbidity

Turbidity refers to the amount of suspended particulate matter in the water. Turbidity measurements are performed with a turbidimeter, in which a beam of light is passed through a water sample and the light output is measured 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. 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. Turbidity is measured in NTU (nephelometric 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 the District. Values that exceed 4 NTU are reviewed and appropriate corrective measures taken if possible.

In 2016, 1952 Brook exceeded the action level for turbidity on 6/29/16, and Panther Run exceeded the action level on 9/27/16 (Table 2).

Table 2: Turbidity (ntu) results for 2016. Results above the action level are indicated by bolded text, and resampling results are indicated by italicized text.

	1952 Brook	**Panther Run**	**Songo River**	**Muddy River**	**Northwest River**	**Rich Mill**	**Smith Mill**	**Sticky River**	**Standish Brook**
1/21/16	Frozen	0.6	0.5	0.8	0.4	0.6	0.7	Frozen	0.7
2/23/16	0.7	0.9	1.0	0.7	0.4	0.5	1.0	Flowing backwards	1.5
3/24/16	1.4	0.7	0.5	0.4	0.4	0.5	0.6	Flowing backwards	0.8
4/27/16	2.2	0.6	0.6	0.7	0.6	0.8	0.7	1.1	1.3
5/17/16	2.8	0.6	0.7	0.8	0.7	0.7	0.9	1.2	1.6
6/29/16	**22.2**	2.3	0.7	0.8	0.6	3.0	3.0	2.5	Dry
7/27/16	Dry	1.9	0.6	0.7	0.7	0.9	1.4	2.8	Dry
8/15/16	Dry	Flowing backwards	0.7	0.9	0.5	0.9	1.4	Flowing backwards	Dry
9/27/16	Dry	**10.1**	0.7	0.5	0.4	1.1	1.3	Flowing backwards	Dry
9/30/16		***17.9***							
10/27/16	Dry	0.9	0.9	0.7	0.6	0.8	0.9	1.3	0.6
11/15/16	0.7	1.1	0.9	0.6	0.4	0.9	1.2	0.8	0.6
12/28/16	0.7	3.8	0.8	0.6	0.5	0.6	1.0	0.5	0.8

High turbidity levels in 1952 Brook can most likely be attributed to large amounts of iron bacteria observed in the stream during the May sampling event. High turbidity results due to iron bacteria are not resampled because the presence of iron bacteria is a known cause of elevated turbidity levels in 1952 Brook.

High turbidity levels at Panther Run can most likely be attributed to ducks swimming upstream of the sample point during the 9/27/16 sampling event and at the time of the resample. The turbidity fell below the action level in October.

***Escherichia coli* Bacteria**

In 2008, microbiological monitoring changed from fecal coliform to *E. coli*. *E. coli* bacteria is a type of fecal coliform bacteria found in the gastrointestinal tracts of warm-blooded animals. The presence of *E. coli* in water is a strong indication of recent sewage or animal waste contamination. Sewage may also contain many other types of disease-causing organisms such as Giardia, Cryptosporidium, typhoid, viral and bacterial gastroenteritis, and hepatitis A. Natural occurrences can cause elevated *E. coli* levels. Examples include significant precipitation events that wash pollution from impervious surfaces and areas of development (animal feces, etc.) into the river, and the erosion of soil into the river since a small percentage of fecal bacteria is associated with soil. *E. coli* levels tend to be higher in the tributaries but become diluted when the tributary water enters the lake. The District's action level for *E. coli* is 235 CFU/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 CFU/100mL are reviewed or re-sampled if the cause is unknown.

Four tributaries exceeded the *E. coli* action level on 6/29/16, and three tributaries exceeded the action level on 9/27/16 (Table 3).

Table 3: *E. coli* (MPN/100mL) data for 2016. Results above the action level are indicated by bolded text, and resampling results are indicated by italicized text.

	1952 Brook	**Panther Run**	**Songo River**	**Muddy River**	**Northwest River**	**Rich Mill**	**Smith Mill**	**Sticky River**	**Standish Brook**
1/21/16	Frozen	0	0	2	8	1	3	Frozen	3
2/23/16	0	2	0	9	2	0	1	Flowing backwards	2
3/24/16	0	0	0	3	0	1	1	Flowing backwards	4
4/27/16	1	10	0	10	3	0	4	4	29
5/17/16	0	23	23	8	12	23	130	15	3
6/29/16	**546**	**770**	105	112	16	**1203**	**1203**	1	Dry
7/5/16	Dry	*219*				***261***	*31*		
7/12/16						*5*			
7/27/16	Dry	3	71	3	19	22	88	3	Dry
8/15/16	Dry		40	16	29	19	58	Flowing backwards	Dry
9/27/16	Dry	38	18	12	**236**	**276**	**248**	Flowing backwards	Dry
9/29/16					*39*	*47*	*78*		
10/27/16	Dry	42	23	86	33	13	30	37	41
11/15/16	1	12	3	17	8	22	13	0	4
12/28/16	8	60	3	10	10	25	22	27	45

High *E. coli* levels can most likely be attributed to rain events prior to or on the day of sampling on 6/29/16 and 9/27/16. A 0.73 inch rain event on 6/28/16 and a 0.91 inch rain event on 6/29/16 were the most likely cause of the high *E. coli* results in the 1952 Brook, at Panther Run, Rich Mill Outlet, and Smith Mill on 6/29/16. The *E. coli* level at Panther Run and Smith Mill fell below the action level upon resampling on 7/5/16. The *E. coli* level was still high at Rich Mill Outlet on 7/5/16 but fell below the action level on 7/12/16. 1952 was not able to be resampled on 7/5/16 due to lack of flow that lasted until late fall. The brook fell below the action level during the 11/15/16 sampling event. A 0.24 inch rain event on 9/27/16 the most likely cause of high *E. coli* results in the Northwest River, at Rich Mill Outlet, and at Smith Mill on 9/27/16. Though the rain event was not significant, the dry conditions during 2016 could have led to more pollutants running off into the tributaries during rain events. The *E. coli* levels in all the tributaries fell below the action level upon resampling on 9/29/16.

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, 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.

Total phosphorus levels exceeded the action level in multiple tributaries during two regular sampling events in 2016. The high results were most likely weather related in all tributaries except the Sticky River. The total phosphorus levels in Sticky River remained above the action level during two sampling events. Though the total phosphorus data cannot be statistically trended over time, the total phosphorus results have exceeded the action level more frequently in recent years. In 2016, PWD initiated a more extensive sampling effort to gain a better understanding of total phosphorus in the Sticky River. However, drought conditions throughout the summer season resulted in inadequate water levels for proper sampling. This sampling effort will be continued in 2017 if water levels are adequate. Samples will be collected on a more frequent basis and will be taken at multiple points along the river.

Turbidity levels exceeded the action level in two tributaries in 2016. The turbidity level returned to an acceptable number in the late fall in the 1952 Brook. Iron bacteria in the brook are an annual cause of high turbidity readings in the brook. High turbidity in Panther Run, due to ducks swimming upstream, returned to acceptable levels during the October sampling event.

E. coli levels exceeded the action level in multiple tributaries during two sampling events in 2016. All high levels were most likely caused by rain events. *E. coli* levels fell below the action level upon resampling.

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.