

Portland Water District
Sebago Lake Watershed Monitoring Programs
Crooked River Monitoring (1977 to 2018)
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Introduction

Sebago Lake is the primary drinking water supply for 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 was chartered by the Maine Legislature to provide water and wastewater services to the region. Since its inception, the District has been actively monitoring and working to protect Sebago Lake.

In 1993, the District 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. The District 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.

The Crooked River originates at the southern end of Songo Pond in Bethel and meanders southward for approximately 38 miles to its junction with the Songo River near the State Park in Naples, Maine. The two rivers then wind two more miles to their outlet in the northernmost part of Sebago Lake. The District has monitored the Crooked River for over 30 years. Since the Crooked contributes nearly 40% of the surface inflow to the lake, it is the most important tributary we monitor.

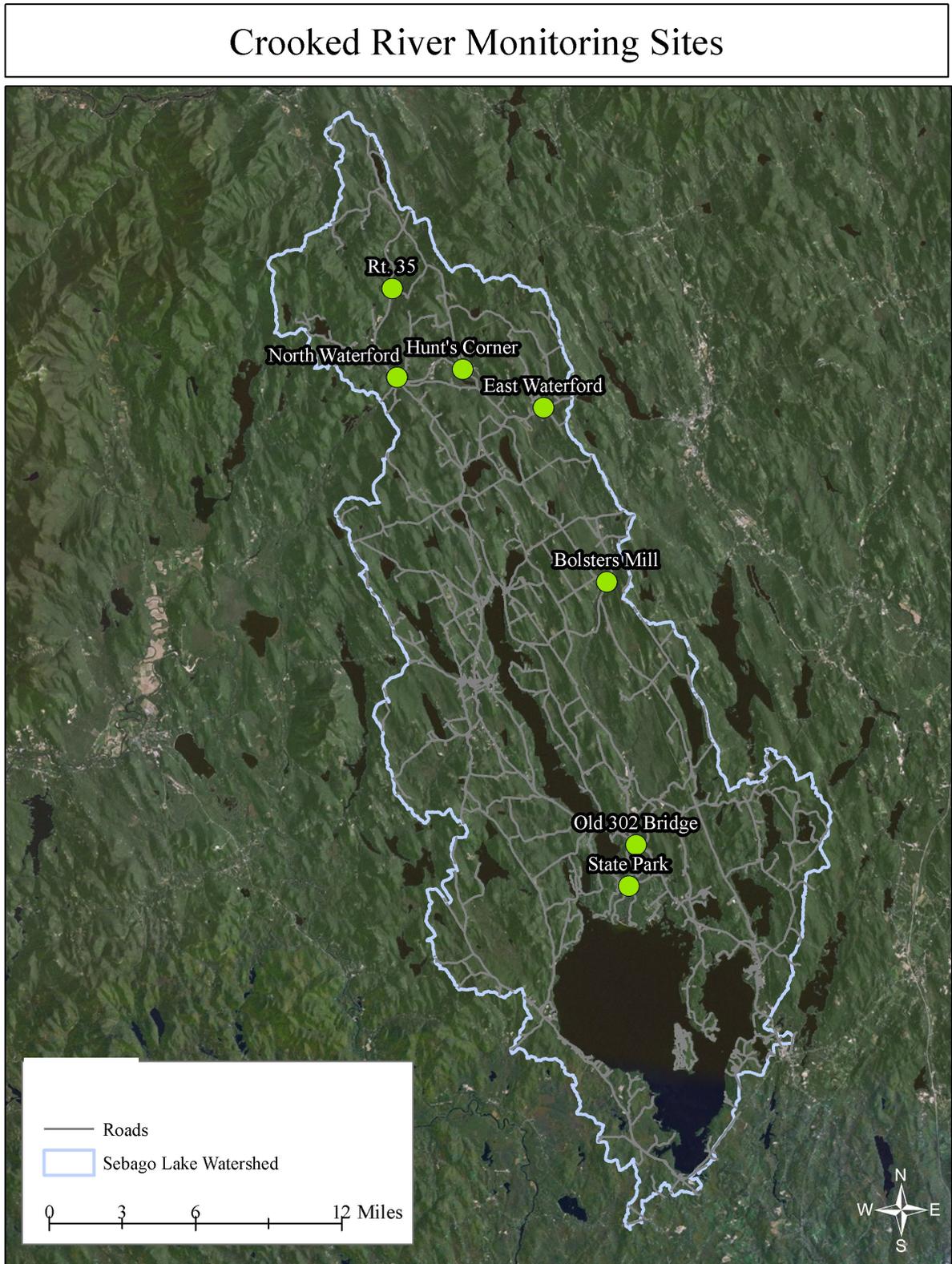
Methods

The Crooked River is monitored four times a year from the Sebago Lake State Park in Naples to a bridge on Rt. 35 in Albany for the following analytes: turbidity, total phosphorus, and *E. coli* bacteria. A total of seven sites are monitored as part of the program. These sites listed from North to South are as follows: Route 35, North Waterford, Hunt's Corner, East Waterford, Bolster's Mills, Old 302 Bridge, and State Park (see Figure 1). Of these sites, the southern-most sampling point (State Park) has been monitored for the longest period of time, and at the highest frequency. This is due in part to the fact that this site is also included in the Tributary Monitoring Program (see the 2018 Tributary Monitoring Report). For the purposes of this report, data from the State Park site will be used to characterize the Crooked River's overall contribution to Sebago Lake. All data collected from this site are presented.

Sampling is performed using a "dipper" to lower acid-washed total phosphorus collection flasks and sterilized bacteria collection bottles into the water, usually from a bridge over the river. Total phosphorous samples are analyzed using the ascorbic acid method and a spectrophotometer in the District's water quality laboratory. *E. coli* samples are analyzed using the Colilert method and are incubated at 35 degrees Celsius for 24 hours. Turbidity is measured using a benchtop Hach 2100N Turbidimeter.

Data presented in this report pertain to data collected at the State Park sample site as a measure of the overall contribution of total phosphorus, *E. coli* bacteria, and turbidity from the Crooked River to Sebago Lake. Data from all seven sample sites for 2018 are included in the appendix of this report.

Figure 1.



Results and Discussion

Total Phosphorus

Phosphorus is one of the major nutrients needed for plant growth. It is generally present in relatively small amounts in temperate lakes. Phosphorous is often the limiting nutrient for algal growth in the system, meaning that as phosphorus increases, the amount of algae also increases. Phosphorus levels are generally higher in flowing tributaries than in a lake. When tributary water enters a lake, phosphorus becomes diluted and sediments with phosphorus attached settle out on the lake bottom. Total phosphorus includes phosphates attached to sediment as well as dissolved forms of phosphorus and is measured in parts per billion (ppb). A reading of 35 ppb is the action level established by the District. Sampling events that result in total phosphorus levels above 35 ppb are reviewed and appropriate corrective measures are taken if possible.

Total phosphorus has been monitored at the State Park sampling site since 1977, at Bolster's Mills, East Waterford, Hunt's Corner, North Waterford, and Route 35 since 1993, and at the Old 302 Bridge site since 1995.

Total phosphorus concentrations did not exceed the action level at the State Park or any other site in 2018. All samples were under the action level, with the highest reading on the river of 18.3 ppb being taken at Hunt's Corner on 8/7/18. During the time period of 1977 to 2018, total phosphorus levels at the State Park ranged from 5 ppb to 126 ppb. In 2018, State Park total phosphorus levels ranged from 11 ppb to 18 ppb (Table 1). This range in the data can often be attributed to the presence or absence of precipitation events that cause erosion of river banks and runoff from developed areas to enter the river.

Table 1. 2018 Total phosphorus (ppb) results for the State Park site on the Crooked River, Naples, ME. No total phosphorus samples exceeded the action level in 2018.

4/24/2018	Lab error - no data
6/18/2018	Lab error - no data
6/26/2018	17.8
8/7/2018	11.5
8/13/2018	11.6
10/16/2018	11.1
10/30/2018	12.3

***Escherichia coli* Bacteria**

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 also 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 MPN/100 mL in accordance with 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.

E. coli levels did not exceed the action level at the State Park in 2018. During the time period of 2009-2018 *E. coli* levels ranged from 2 MPN/100 mL to 613 MPN/100 mL at the State Park. In 2018, *E. coli* levels ranged from 3 MPN/100 mL to 99 MPN/100 mL at the State Park (Table 2). The Route 35 site exceeded the action level for *E. coli* on two occasions, 6/18/18 and 10/30/18. Both times, the site was re-sampled and the results were below the action level of 235 MPN/100mL. The cause of the elevated results may have been beavers immediately upstream of the sample site (a new beaver dam has been built across the river), or the 0.73 inches of rain that fell in the 24 hours before sampling on 10/30/18. The North Waterford site exceeded the action level on 8/7/18 and when it was re-sampled on 8/9/18. North Waterford was re-sampled a second time on 8/13/18 and was below the action level. The Hunt's Corner site was above the action level on 8/7/18 and two more times when it was re-sampled. A canoe and two kayaks passed by the sample site just before the sample was taken on 8/7/18, but since this site was re-sampled twice and the results remained above the action limit, an investigation along the river was performed on foot, upstream of the sample site. The riverbank is wooded in this location and the investigation revealed no obvious sources of *E. coli*.

Table 2. 2018 *E. coli* (MPN/100 mL) results for the State Park site on the Crooked River, Naples, ME. No *E. coli* samples from the State Park exceeded the action level in 2018.

1/29/2018	Frozen
2/12/2018	Frozen
3/27/2018	6
4/24/2018	8
5/23/2018	52
6/18/2018	44
6/26/2018	96
7/10/2018	99
8/7/2018	96
8/13/2018	93
9/25/2018	48
10/16/2018	26
10/30/2018	38
11/19/2018	14
12/12/2018	Frozen

Turbidity

Turbidity refers to the amount of suspended particulate matter in the water. Turbidity measurements are performed through the use of 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. 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 rivers and lakes. Particulates also provide attachment sites for heavy metals such as cadmium, mercury and lead, and 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 4.0 NTU or greater is the action level determined by the District’s Environmental Services Department. Values of 4.0 NTU or higher are reviewed, the site is resampled, and appropriate corrective measures are taken if possible.

In 2018 turbidity values ranged from 0.5 to 1.3 NTU at the State Park site (Table 3). There were no turbidity readings above the action level at any site on the Crooked River in 2018. Even the highest reading taken all year (1.8 NTU at Hunt’s Corner on 10/30/18) was well below the action level.

Table 3. 2018 Turbidity (NTU) results for the State Park site on the Crooked River, Naples, ME. No turbidity samples from the State Park exceeded the action level in 2018.

1/29/2018	Frozen
2/12/2018	Frozen
3/27/2018	0.6
4/24/2018	1.2
5/23/2018	1.0
6/18/2018	1.1
6/26/2018	0.7
7/10/2018	0.8
8/7/2018	1.2
8/13/2018	1.3
9/25/2018	1.2
10/16/2018	1.1
10/30/2018	1.1
11/19/2018	0.7
12/12/218	Frozen

Conclusion:

This sampling program provides a “snapshot” determination of the health of the Crooked River. Samples that exceed established action levels are re-sampled and investigated if necessary. Because sampling occurs four times a year, 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.

The total phosphorus levels in 2018 remained within the historical range, with no readings above the 35 ppb action level.

E. coli bacteria levels obtained at the State Park in 2018 remained consistent with historical fecal coliform bacteria and *E. coli* data, with no readings above the 235 MPN/100 mL action level. Two sites much farther up in the watershed repeatedly had results slightly over the action limit. The hotter than usual summer weather may have played a role in promoting the growth of *E. coli*. In addition, the Hunt’s Corner site is just downstream of where Papoose Pond (with a large campground and swimming beach) outlets into the river, and beaver activity was noted just upstream of the Rte. 35 site. If *E. coli* levels are above the action level in 2019, potential causes will be investigated further.

Turbidity levels in the Crooked River in 2018 also remained well within the historical range. No turbidity readings exceeded the action level in 2018.

Overall, the Crooked River appears to have generally stable water quality. Continued monitoring of the river is necessary as the Crooked River contributes more surface inflow to Sebago Lake than any other tributary and a reduction in water quality in the Crooked River could reduce water quality in the lake.

Appendix: Crooked River Data 2018

Sample Date	Site	Turbidity (NTU)	Total Phosphours (ppb)	<i>E. coli</i> (MPN/100mL)	Re-sample date	<i>E. coli</i> Re-sample	Re-sample date	<i>E. coli</i> Re-sample
1/29/2018	State Park	Frozen		Frozen				
2/12/2018	State Park	Frozen		Frozen				
3/27/2018	State Park	0.6		6				
4/24/2018	State Park	1.2	Lab Error	8				
4/24/2018	Old 302 Bridge	1.2	Lab Error	15				
4/24/2018	Bolster's Mill	0.7	Lab Error	2				
4/24/2018	E. Waterford	0.8	Lab Error	6				
4/24/2018	Hunt's Corner	0.6	Lab Error	10				
4/24/2018	N. Waterford	0.6	Lab Error	5				
4/24/2018	Rte. 35	0.6	Lab Error	5				
5/23/2018	State Park	1.0		52				
6/18/2018	State Park	1.1	Lab Error	44				
6/18/2018	Old 302 Bridge	0.8	Lab Error	80				
6/18/2018	Bolster's Mill	1.3	Lab Error	32				
6/18/2018	E. Waterford	1.2	Lab Error	138				
6/18/2018	Hunt's Corner	1.2	Lab Error	137				
6/18/2018	N. Waterford	1.7	Lab Error	162				
6/18/2018	Rte. 35	1.3	Lab Error	345	6/20/2018	225		
6/26/2018	State Park	0.7	17.8	96				
7/10/2018	State Park	0.8		99				
8/7/2018	State Park	1.2	11.5	96				
8/7/2018	Old 302 Bridge	1.0	14.5	122				
8/7/2018	Bolster's Mill	1.5	18.0	79				
8/7/2018	E. Waterford	1.2	18.3	225				
8/7/2018	Hunt's Corner	1.2	13.5	261	8/9/2018	328	8/13/2018	326
8/7/2018	N. Waterford	1.2	13.4	248	8/9/2018	365	8/13/2018	228
8/7/2018	Rte. 35	1.2	18.1	131				
8/13/2018	State Park	1.3	11.6	93				
9/25/2018	State Park	1.2		48				
10/16/2018	State Park	1.1	12.3	26				
10/30/2018	State Park	1.1	11.1	38				
10/30/2018	Old 302 Bridge	1.1	11.5	64				
10/30/2018	Bolster's Mill	1.0	10.2	36				
10/30/2018	E. Waterford	1.3	11.8	63				
10/30/2018	Hunt's Corner	1.8	15.4	71				
10/30/2018	N. Waterford	0.9	9.8	67				
10/30/2018	Rte. 35	0.8	9.9	261	11/1/2018	27		
11/19/2018	State Park	0.7		14				
12/12/2018	State Park	Frozen		Frozen				