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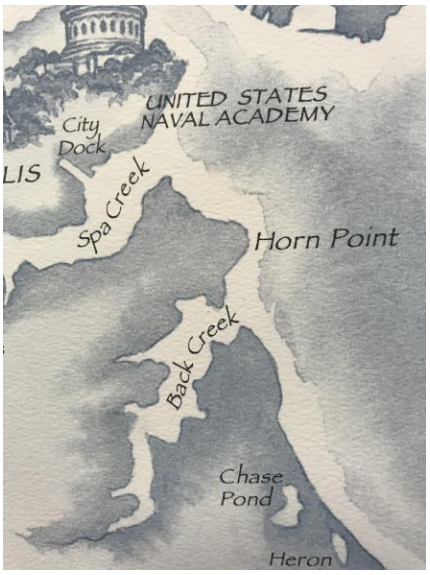
Water Quality Analysis
Back Creek

Water Column Dissolved Oxygen, Bottom Dissolved Oxygen, and Clarity Analysis

By Emi McGeady, Field Investigator
Severn River Association



aerial photo: marinas.com

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Executive Summary: This analysis focuses on dissolved oxygen levels and clarity, two important metrics of water quality, in Back Creek. Back Creek is a creek located on the Severn River in Annapolis, between the Eastport, Bembe Beach, and Annapolis Roads communities. The areas studied include SRA's water quality monitoring stations* titled Back Creek #1, Back Creek #2, and Back Creek #3, located on the map below.

Water quality conditions in Back Creek ranged from moderate to good for the majority of monitoring in 2020. Dissolved oxygen (D.O.) levels only fell into dead zone conditions (under 2.0 mg/L) in June and August, apart from one day in September at Back Creek #3, for an average of 15% of the time. Dissolved oxygen was typically lower at Back Creek #3, whereas towards the mouth of the creek at stations #1 and #2, D.O. was typically moderate to good, lending to good fishing and crabbing conditions.

Clarity had a similar story as it was typically worse at Back Creek #3 than the other stations. Clarity at all stations began high in June, averaging above 1.2 m. Clarity then dropped in the summer due likely to stormwater runoff and algal blooms, and then rose above 1.0m again in October.

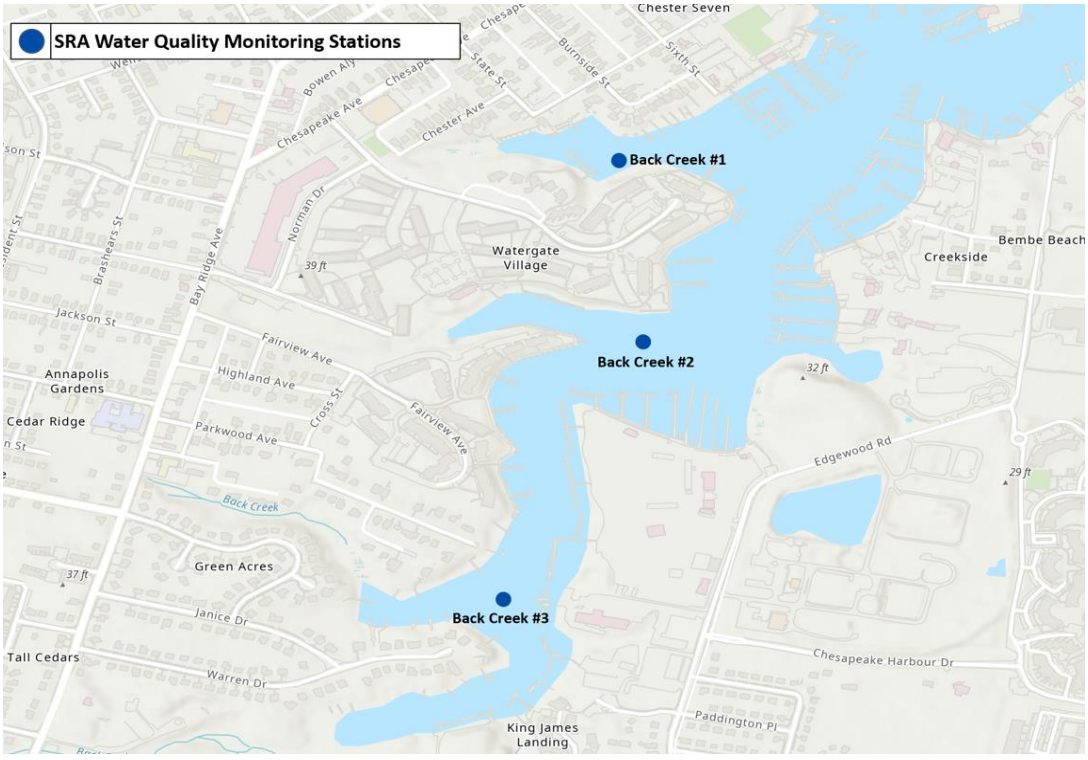

Figure 1. Back Creek water quality monitoring stations locations.

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Dissolved Oxygen by Depth Profile

River life, including oysters, fish, and crabs prefer dissolved oxygen levels above 5.0 mg/L (depicted by green lines on the graphs below). Oxygen levels below 2.0 mg/L are insufficient for river life survival and are therefore designated as dead zone conditions (depicted by the red lines on the graphs below).

In the 2020 monitoring season, dissolved oxygen measurements were taken biweekly from June 10 to November 4 at each Back Creek station. A YSI probe was lowered to the deepest depth where the first measurement was taken. The probe was then raised through the water column, taking measurements at every subsequent half meter. Bars above the red line indicate depths where moderate to good oxygen levels were measured, and bars that fall below the red line indicate depths exhibiting dead zone conditions.

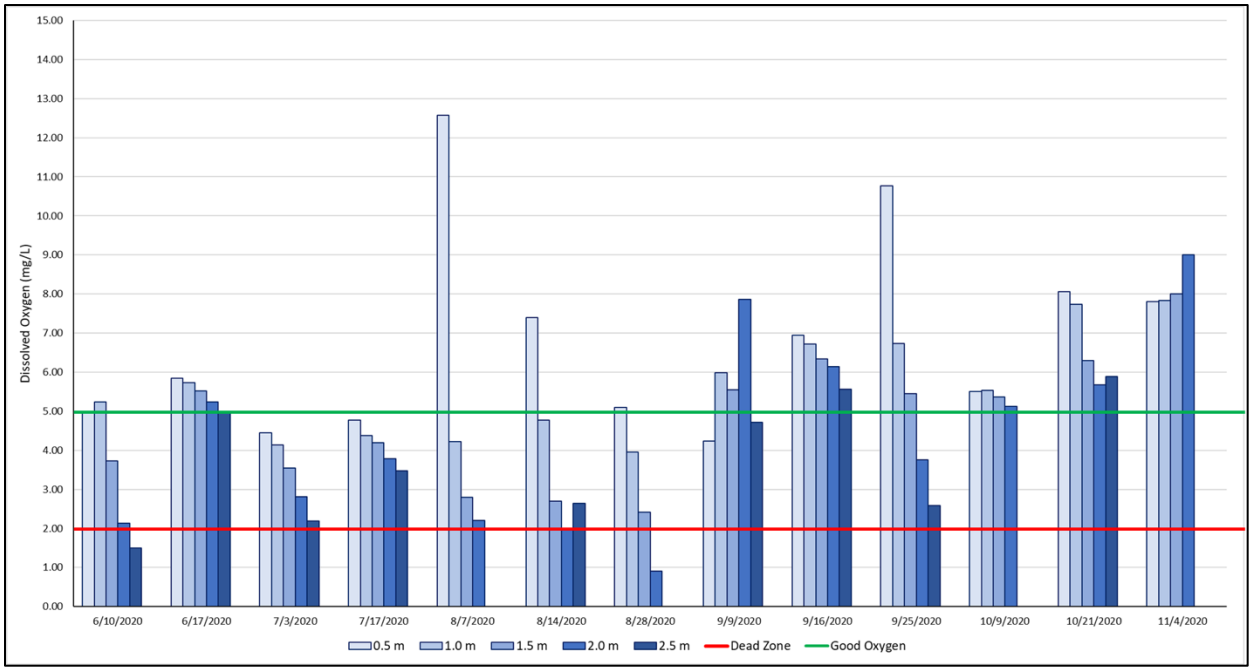

Figure 2. Dissolved oxygen levels through the water column at Back Creek #1.

Dead zone conditions rarely occurred at Back Creek #1 during monitoring. On June 10 and August 28, dissolved oxygen at 2.5 meters fell below 2.0 mg/L, measuring at 1.50 mg/L and 0.91 mg/L respectively. Otherwise, oxygen levels typically ranged from 2.0 mg/L – 5.0 mg/L (moderate conditions) in the summer months of June, July, and August.

In the fall, the majority of depths had good oxygen conditions (D.O. > 5.0 mg/L), indicating that river life could be found through the entire water column. Dissolved oxygen was typically greatest through the water column in the fall with the exception of the greatest dissolved oxygen measurement, 12.57 mg/L, measured on August 7 in the surface water (0.5 m).

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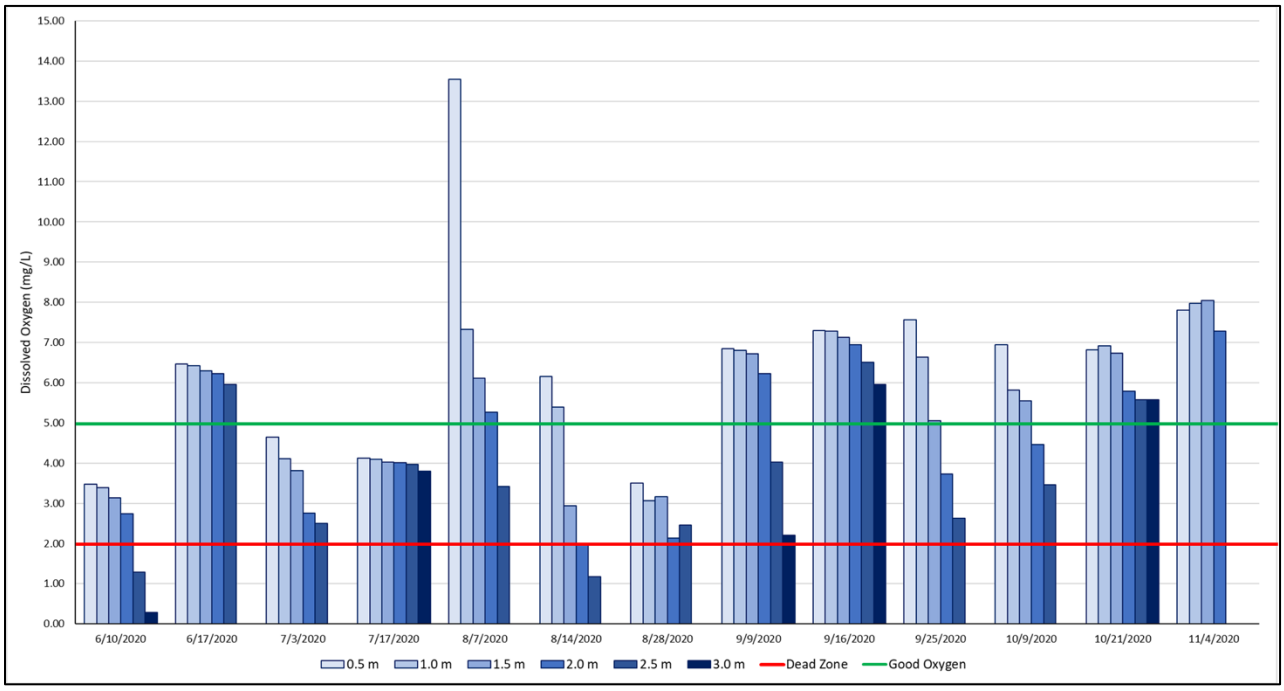

Figure 3. Dissolved oxygen levels through the water column at Back Creek #2 in 2020.

Similar to dissolved oxygen levels at Back Creek #1 (figure 2), dead zone conditions only occurred on two days of monitoring at Back Creek #2. However, the dead zone was taller on both days at Back Creek #2. On June 10, dead zone was found from 2.5-2.0 meters, measuring at 0.29 mg/L and 1.29 mg/L respectively. On August 14 the dead zone was also found from 2.5-2.0 meters, measuring at 1.18 mg/L and 1.97 mg/L respectively.

Dissolved oxygen levels were in the moderate to good range on all other monitoring days. With the exception of four days where dissolved oxygen at all water depths measured above 5.0 mg/L (6/17, 9/16, 10/21, and 11/4), dissolved oxygen was typically in moderate levels in deeper depths and rose above 5.0 mg/L in shallower depths.

An example of this is seen on September 9 where dissolved oxygen on the bottom was 2.20 mg/L, then rose to 4.02 mg/L at 2.5 meters. Dissolved oxygen then rose above 5.0 mg/L at 2.0 meters and continued to increase as depth decreased to 0.5 meters.

Additionally similar to levels at Back Creek #1, dissolved oxygen was typically greatest through the water column in the fall, with the exception of the greatest dissolved oxygen measurement, 13.55 mg/L, measured on August 7 in the surface water (0.5 m).

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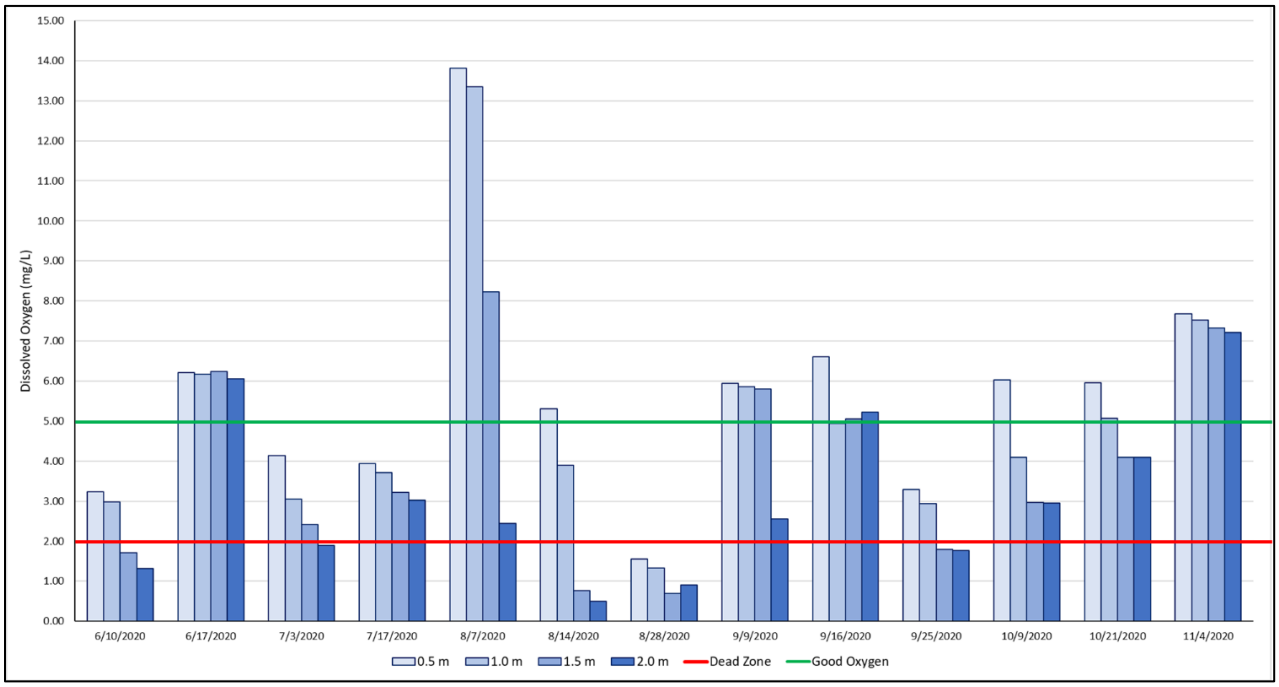

Figure 4. Dissolved oxygen levels through the water column at Back Creek #3 in 2020. Dead zone conditions occurred more frequently during monitoring at Back Creek #3, and at shallower depths, than other monitoring stations. For example dead zone conditions occurred from 2.0-1.5 meters on June 10, August 14, August 28, and September 25. Additionally, dead zone occurred at 2.0 m on July 3. The worse dead zone, measured through the entire water column, occurred on August 28. Here dissolved oxygen levels ranged from 0.7 mg/L to 1.56 mg/L.

Dissolved oxygen was in the moderate to good range on all other monitoring days but did not measure above 5.0 mg/L nearly as much as in Back Creek #1 or #2. With the exception of two days where dissolved oxygen at all water depths measured above 5.0 mg/L (6/17 and 11/4), dissolved oxygen was typically in moderate levels (2.0-5.0 mg/L) for most water depths.

The greatest dissolved oxygen levels were seen on August 7, similar to Back Creek #1 and #2. Unlike other stations however, dissolved oxygen from 1.5-0.5 meters reached levels not seen in the fall months when oxygen was typically better. For example, on August 7 from 1.5-0.5 meters oxygen ranged from 8.23-13.81 mg/L, whereas oxygen in November peaked only at 7.68 mg/L.

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Bottom Dissolved Oxygen Comparison at all Back Creek Stations

Measuring dissolved oxygen on the bottom of the river is important for understanding conditions for sedentary creatures that cannot move through the water column and escape dead zone conditions.

Additionally, during summer months water is stratified by temperature and warmer surface water on top of deeper water prevents mixing of the water column. Therefore, water at bottom depths typically holds the lowest oxygen in the water column, and thus gives us the worst extent of conditions, and serves as a good comparison point amongst the three monitoring stations.

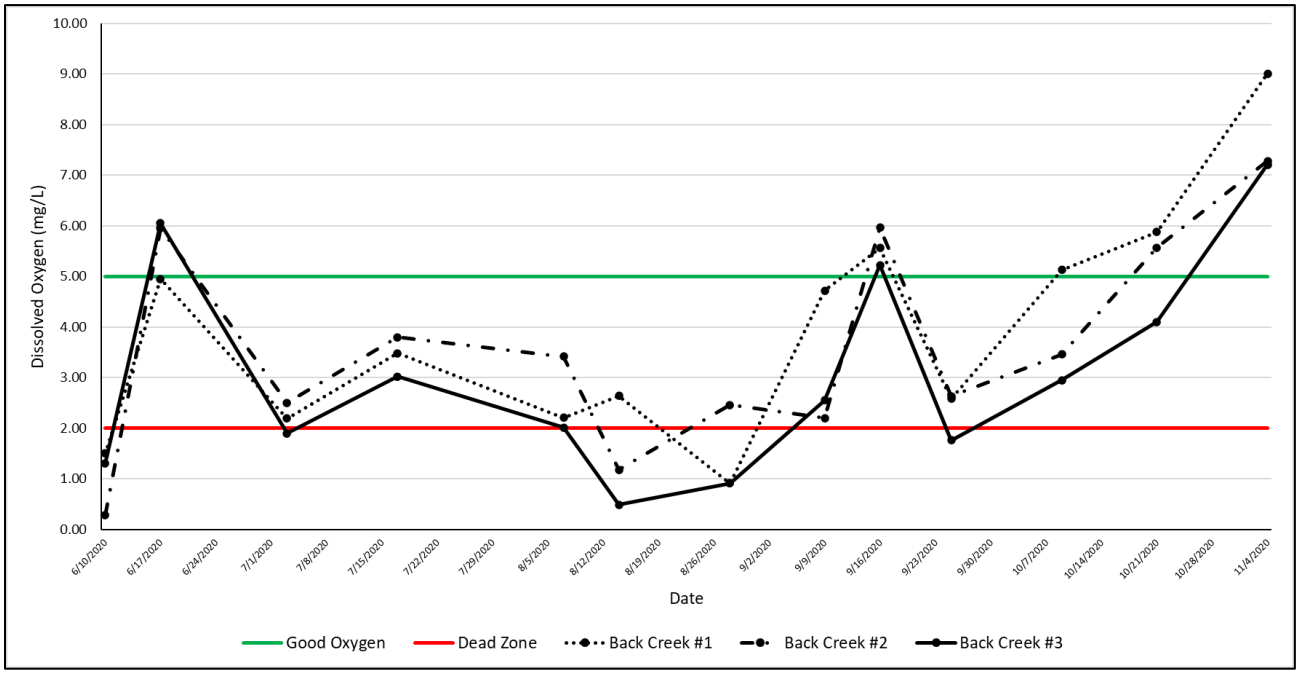

Figure 5. Bottom dissolved oxygen measured at Back Creek monitoring stations in 2020.

Dead zone conditions (D.O. < 2.0 mg/L) occurred in all Back Creek stations on June 10, with the worst conditions occurring at Back Creek #2. Dead zones were also evident at Back Creek stations once in July (Back Creek #3), and more frequently in August.

Oxygen rebounded in September for all stations, with the exception of dead zone at Back Creek #1 on September 25. Bottom dissolved oxygen remained in moderate levels (2-5 mg/L) for all monitoring stations into October and began increasing above the good oxygen level (5.0 mg/L) in late October and early November.

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Water Clarity

Water clarity is a measure of how far we can see down into the water column. Higher clarity is indicative of less suspended sediment, algal blooms, and other pollutants that cloud the water. Tracking clarity allows us to understand water quality conditions better, and aid in determining sites suitbale for submerged aquatic vegetation (SAV) growth, that require sunlight to penetrate deeply into the water column.

Clarity was measured biweekly from June 10 to November 4. A Secchi disk was lowered into the water from the shady side of the boat until the pattern of the disk was no longer visible. The disk was then raised towards the surface of the water until barely visible. This depth was recorded for each station on each monitoring day and displayed below.

Due to COVID-19 restrictions, our water quality monitoring of Back Creek did not start until after an intense algal bloom in April and May. Though we do not have data on this algal bloom, clarity during the bloom was reduced to about 13 cm, and Back Creek was a red-orange hue. This color was indicative of microscopic algae, *Prorocentrum minimum*, that causes the mahogany tide. Though we saw clarity rebound by June (figure 7), it is important to note as these algal blooms decrease light reaching submerged aquatic vegetation and contribute to fish kills when blooms die and decay.

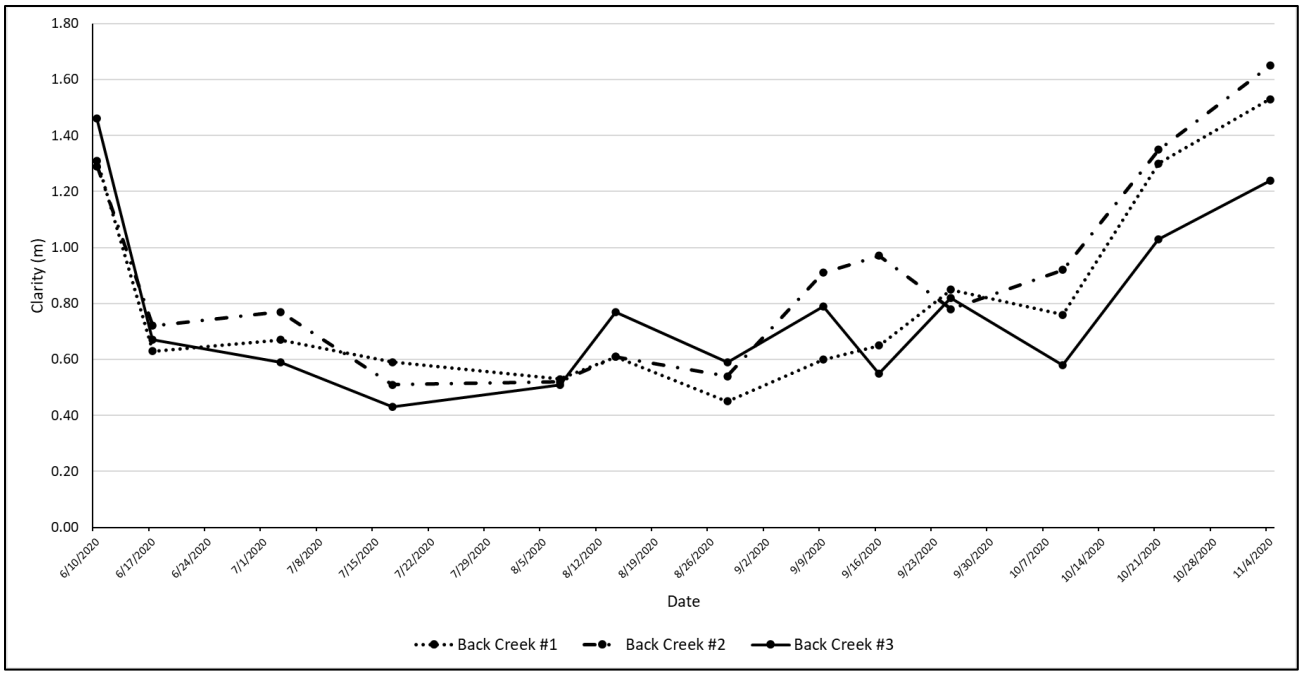

Figure 7. Water clarity at Back Creek stations.

Clarity started high on June 10 with readings above 1.2 meters at all monitoring stations. Clarity then fell to ranges of 0.4-0.8 meters for the rest of the summer. In the summer, the worst clarity was typically observed at Back Creek #3, with exceptions on August 14 and 28. Clarity

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fluctuated more greatly between stations in September, seen in the greater spread between lines above from August 28 to September 25.

Clarity began steadily increasing for all stations in the fall. Back Creek #3 again typically displayed lower clarity than the other two stations. This is especially seen on November 4 when clarity peaked at Back Creek #1 and #2 at 1.53 and 1.65 meters respectively, and clarity only reached 1.24 meters at Back Creek #1.