# 2021 Masonville Cove – Patapsco River Shallow Water Monitoring Data Report

# February 2023

# 2021 Masonville Cove – Patapsco River Shallow Water Monitoring Data Report

Prepared by:
Brian Smith, Diana Domotor, T. Mark Trice and Bruce Michael
Maryland Department of Natural Resources
Tawes Building, D-2
580 Taylor Avenue
Annapolis, MD 21401

Website Address:
dnr.maryland.gov

Toll Free in Maryland:
877-620-8DNR, ext.: 8630
Out of state call: 410-260-8630
TTY users call via the MD Relay: 711 (within MD)
Out of state call: 800-735-2258

# TABLE OF CONTENTS

## LIST OF TABLES



## LIST OF FIGURES

## Executive summary

Masonville Cove, a small inlet of the upper tidal Patapsco River, figures in local Baltimore lore as a natural respite from the rigors of early 20th-century city life. However, as the Patapsco River was heavily impacted by pollution from centuries of being a center of commerce and population, so too was Masonville Cove. In 2007, the Maryland Port Administration received a permit to build a dredged material containment facility at the Masonville Marine Terminal, adjacent to Masonville Cove. As part of the mitigation agreement for this project, the Maryland Department of Natural Resources (DNR) deployed a continuous water quality monitor in the summer of 2009, ahead of the construction of the dredged material containment facility. Since 2009, DNR has continued to deploy a monitor during most of the year, although it has been removed in the winter in some years due to icing conditions. In continuation of this project, a water quality monitor was deployed off the Masonville Cove pier during the entirety of 2021.

Results from 2021 indicate continuing poor habitat conditions in Masonville Cove. Dissolved oxygen concentrations degraded for the third straight year and were among the worst conditions observed since monitoring began in Masonville Cove. These results coincided with continued increases in algal concentrations and frequent blooms. And, although 2021 was drier than normal, water clarity degraded as compared to the prior year. Together, these results indicate that excessive runoff and associated nutrients continue to impair aquatic grass growth within Masonville Cove and are fueling algal blooms and degrading dissolved oxygen levels within the water.

All 2021 continuous monitoring data, as well as data from previous years, are available on the DNR "Eyes on the Bay" website (https://eyesonthebay.dnr.maryland.gov/contmon/ContMon.cfm). Data from grab samples are available through the Chesapeake Bay Program's Data Hub (https://www.chesapeakebay.net/what/data). The most recent seven days of water quality data can also be viewed on the "Eyes on the Bay" Masonville Cove webpage (https://eyesonthebay.dnr.maryland.gov/contmon/masonville.cfm). Data collected from the current station location between 2013 and 2021 at the time of each instrument replacement (pigments, suspended solids, Secchi disk depth, and ambient water quality data) are also available for download via the following link: https://data.chesapeakebay.net/api.CSV/WaterQuality/WaterQuality/3-27-2013/2-20-2023/0/4/2/Station/1930/21,31,55,60,63,65,71,73,74,76,77,78,82,83,85,88,94,104,105,116,121,123. Data collected at the previous station location between 2009 and 2012 are available for download at: https://data.chesapeakebay.net/api.CSV/WaterQuality/WaterQuality/6-3-2009/12-31-2012/0/4/2/Station/1929/21,31,55,60,63,65,71,73,74,76,77,78,82,83,85,88,94,104,105,116,121,123.

## Introduction

In 2007, the Maryland Port Administration (MPA) submitted plans to the United States Army Corps of Engineers (USACE) to construct a Dredged Material Containment Facility (DMCF) in the vicinity of the Masonville Marine Terminal (Figure 1). The terminal, located on the upper Patapsco River in Baltimore, is a major port for the automotive industry. The design for the DMCF uses sand and clay dikes to contain material dredged from the navigation channels in Baltimore Harbor. The same year, an environmental impact study submitted to USACE suggested mitigation for the project. Mitigation was deemed necessary as the DMCF was to fill 130 acres of tidal open water, cover 10 acres of upland habitat and disturb 1 acre of vegetated wetland and 0.38 acres of submerged aquatic vegetation (SAV).

In 2021, as a continuation of the mitigation plan implemented in 2009, the Resource Assessment Service of the Maryland Department of Natural Resources (DNR) monitored water quality in Masonville Cove adjacent to the DMCF site. DNR deployed a continuous water quality monitor that collected data every 15 minutes on a suite of water quality parameters, including dissolved oxygen, salinity, temperature, turbidity, pH, and chlorophyll. Data from this monitor were telemetered to the DNR website, "Eyes on the Bay" (eyesonthebay.net), and displayed in near real-time. DNR personnel visited the station every two to four weeks to replace the meters and to collect water samples for analyses of total suspended solids, chlorophyll *a* and pheophytin concentrations. The continuous monitoring site at Masonville Cove was one of four continuous monitoring stations located in the upper Patapsco in 2021. The other sites were deployed adjacent to the National Aquarium in the Baltimore Harbor and in the Middle Branch of the Patapsco River.

### Description of continuous monitoring

In 2021, a data collection device known as a sonde was attached to a piling on the Masonville Cove pier (39.2447°, -76.5972°) with its instrumentation deployed 1 meter below the water surface (see Figure 1 for station location). This location is approximately one-tenth of a mile west of the deployment location used before 2013 (Figure 1). The location change was made so that DNR field personnel would be able to access the site during the winter months, which allows the monitor to be deployed year-round. Prior to 2013, the site was only accessible by boat, so the monitor needed to be removed during the winter months when icing at the boat ramp precluded access. The data sonde deployed in Masonville Cove was a YSI™ 6600 V2 (Yellow Springs Instruments, Yellow Springs, Ohio), which housed several water quality sensors (Figure 2). The water quality indicator data collected by each sensor are explained in greater detail in the following section. The sonde collected a reading from each sensor simultaneously every 15 minutes for the duration of its deployment. These readings were stored in the sonde's data memory and sent, by attached cellular telemetry equipment, to DNR headquarters in Annapolis. There, the data were posted on DNR's "Eyes on the Bay" website (eyesonthebay.net) for easy public access. This website enables the public to access near real-time water quality data for numerous locations throughout Maryland. The data are called "near real-time" because there is a lag of approximately 30 minutes to one hour between the time that the sonde collects the data and the time that the data are posted on the website. A page specific to Masonville Cove on the "Eyes on the Bay" website also displays charts and data from the most recent seven days. This page can be found at: eyesonthebay.dnr.maryland.gov/contmon/masonville.cfm.

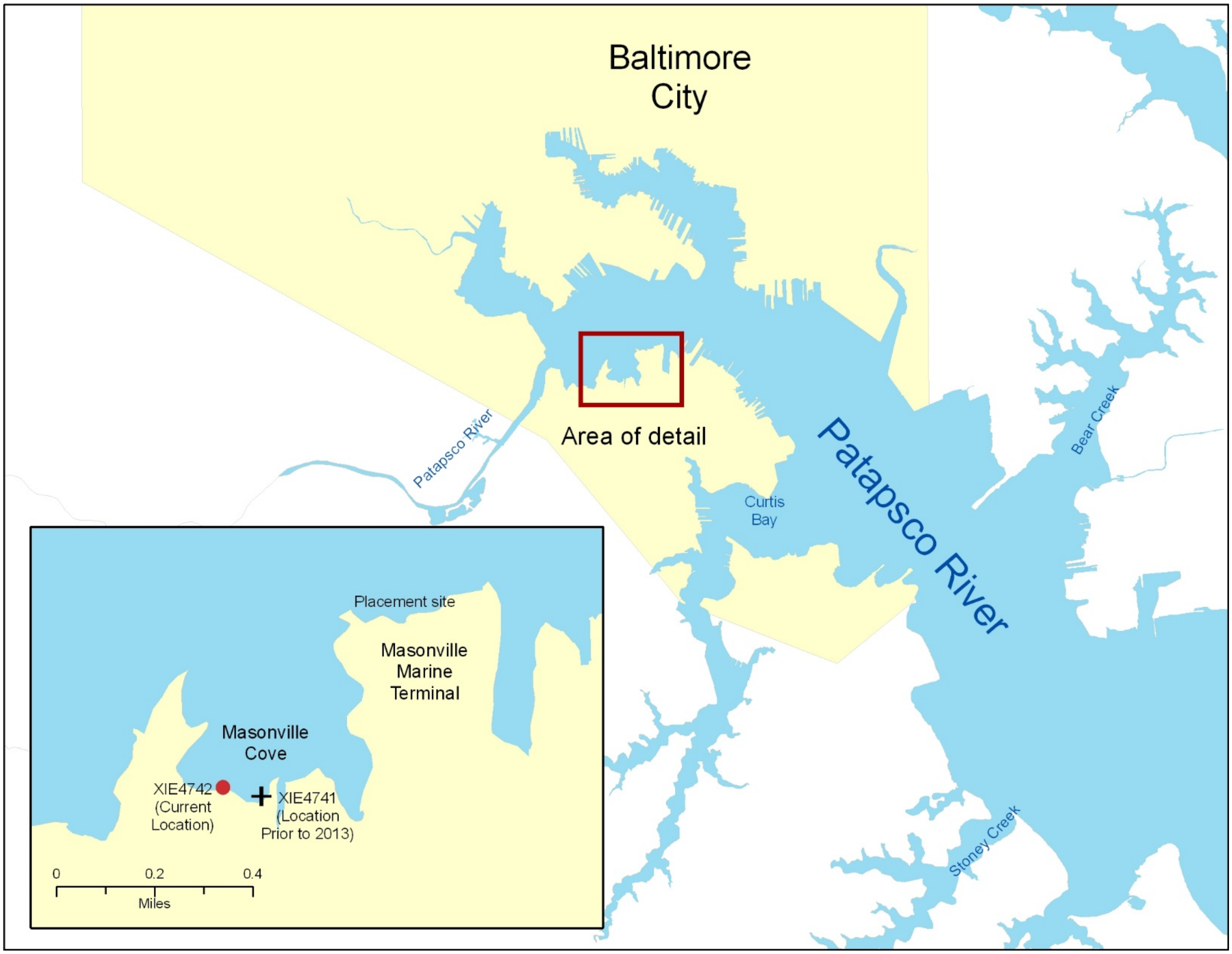


**Figure 1. Map of the Patapsco River and Masonville Cove. The inset shows the 2021 continuous monitor location within the cove, the location of the monitor prior to 2013, and the approximate site for dredged material placement.**

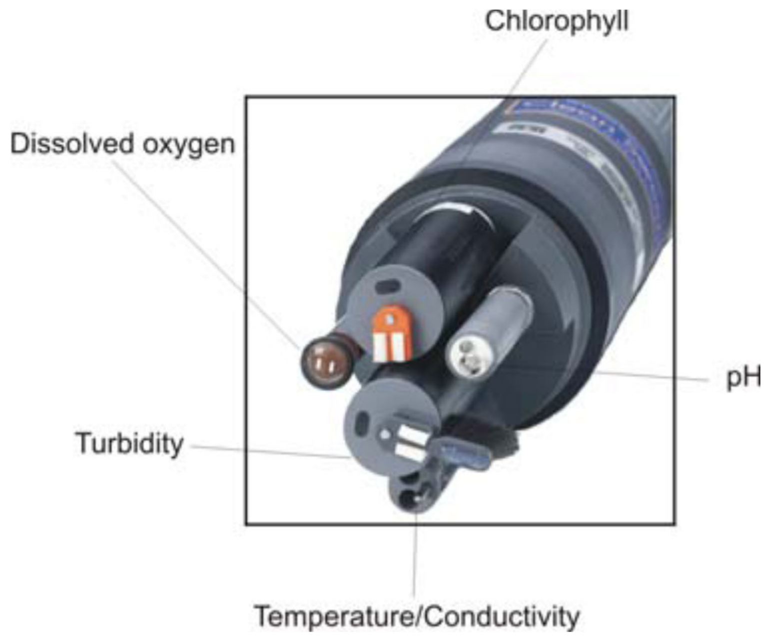


**Figure 2. YSI 6600 continuous monitoring sonde showing individual sensors. Image courtesy of YSI, Inc.**

### Continuous monitoring parameters

The continuous monitor at Masonville Cove, like all continuous monitors in the DNR Shallow Water Monitoring Program, collect data on six water quality parameters:

1. Dissolved oxygen (DO): Fish and other aquatic life require DO to survive. Maryland state water quality criteria require a minimum DO concentration of 5 milligrams per liter (mg/L) (COMAR 1995). This threshold is necessary for the survival of many fish and shellfish species, including blue crabs (*Callinectes sapidus*) and striped bass (*Morone saxitilis*).
2. Salinity: Salinity, or salt concentration, is calculated automatically by the continuous monitoring sonde from conductivity and temperature readings. Salinity in the Patapsco River comes from the Chesapeake Bay. Therefore, areas closer to the Bay have higher salinities, except perhaps during large freshwater releases from the Conowingo Dam on the Susquehanna River. During periods of low precipitation and river flow, salinity increases as salty water intrudes further up the river. During wetter periods, salinity decreases. Salinity also cycles in relation to tides, increasing during flood tides and decreasing during ebb tides. Salinity levels are important to aquatic organisms, as some organisms are adapted to live only in brackish or salt water, while others require fresh water.
3. Water temperature: Water temperature is another variable affecting the suitability of waterways for aquatic organisms. Many aquatic organisms can tolerate gradual temperature changes associated with changing seasons, but sudden changes can cause stress. Higher water temperatures cause more dissolved oxygen to come out of solution and enter the air, decreasing the amount available to fish and other aquatic organisms.
4. pH: The acidity of water is indicated by pH. A neutral pH is 7; lower values indicate more acidity, while higher numbers indicate more alkaline conditions. pH is affected by salinity (higher salinities tend to buffer pH in the 7-8 range) and algal blooms (large algal blooms can raise the pH of water over 8 in low salinity).

5. Turbidity: Turbidity is a measure of water clarity. Events that stir up sediment or cause runoff, such as storms, will increase turbidity. Dense algal blooms will also cause increased turbidity. Relatively clear water (low turbidity) is required for the growth and survival of SAV.
6. Chlorophyll: Chlorophyll concentration is a surrogate measure of the density of algae in the water. Chlorophyll is the main photopigment responsible for photosynthesis, the process by which sunlight is converted into food energy. Chlorophyll concentrations are calculated from fluorescence values collected by the sensors. One downside to this method is that certain species of phytoplankton, such as cyanobacteria or blue-green algae, fluoresce outside the detection range of the chlorophyll fluorescence sensor.

**Calibration of continuous monitors and collection of laboratory water samples**

Pigments and suspended solids data were obtained by DNR staff during deployment and replacement of continuous monitoring data sondes. Discrete whole water samples were collected to measure chlorophyll *a*, pheophytin and total suspended solids. Data sondes were removed and replaced with freshly calibrated instruments on a biweekly basis between April and October and once a month between November and March. At the time of each instrument replacement, Secchi disk depth was recorded for use in water clarity determination, and water column profiles were taken. During profiles, an instrument was lowered into the water and collected readings for depth, water temperature, pH, dissolved oxygen, and salinity.

**Masonville Cove continuous monitor deployment**

In 2021, a continuous monitor at Masonville Cove was deployed for the entire year. Data sondes collected 27,561 data records and 18 calibration samples were collected and analyzed in 2021. Generally, calibration samples are collected when sondes are changed out every two weeks between April and October and every four weeks between November and March. However, DNR field personnel were unable to service the station between June 3rd and July 15th. During this time, the United States Fish and Wildlife Service enforced a no entry policy into areas surrounding the monitoring site due to a pair of nesting eagles.

A malfunction to the deployed water quality monitoring sonde precluded data collection between January 1st and January 5th, March 2nd and March 27th, March 28th and April 6th, and November 2nd and December 9th. Additional gaps in the data are where questionable data were removed for quality assurance purposes. Automated telemetry generally operated when deployed, but there were times when telemetry did not work properly, which led to gaps in near real-time web presentation of the data. Telemetry issues did not, however, impede the sonde from collecting data.

## 2021 Precipitation and Discharge Events

Precipitation increases runoff into waterways, which can lead to a higher input of nutrients that fuel algal blooms, decrease water clarity, and suppress SAV growth. Although beyond the scope of sampling for this report, precipitation has also been tied to increased loads of contaminants from urban and industrial centers in and around Baltimore (Leffler and Greer 2001).

Annual precipitation for 2021 at Baltimore Washington International (BWI) Thurgood Marshall Airport was 4.21 inches below the 30-year average (Figure 3). Total precipitation was below monthly averages in eight of the twelve months with December being the driest month of the year (Figure 3). Over half of the total annual precipitation in 2021 fell in the four wettest months (February, August, September, and October), with September being the wettest month of the year as total monthly rainfall was 36% above the long-term average. September rain totals were fueled by the remnants of Tropical Storm Ida, which impacted the region September 1st and dropped over 4 inches of rain. October was the second wettest month of 2021 as heavy rains on October 29th dropped over 3 inches on the region.

Daily mean discharge at the United States Geological Survey (USGS) gaging station in the Gwynns Falls reflected the pattern of precipitation seen in 2021 (Figure 4). Gage data show numerous spikes throughout 2021, which are indicative of the precipitation events that affected the region during the year. The largest flow of the year occurred on October 29th, in association with the aforementioned heavy rains that day. This flow event was more than 700 cubic feet per second (cfs) greater than the daily median measured over 57 years, reflecting very high discharge levels into the Patapsco River and the Chesapeake Bay. Extremely high flows more than 300 cfs greater than the daily median were also measured following heavy rains on March 24th, May 29th, June 3rd, and June 11th. Flows in November and December, the two driest months of 2021, were generally below the daily median.

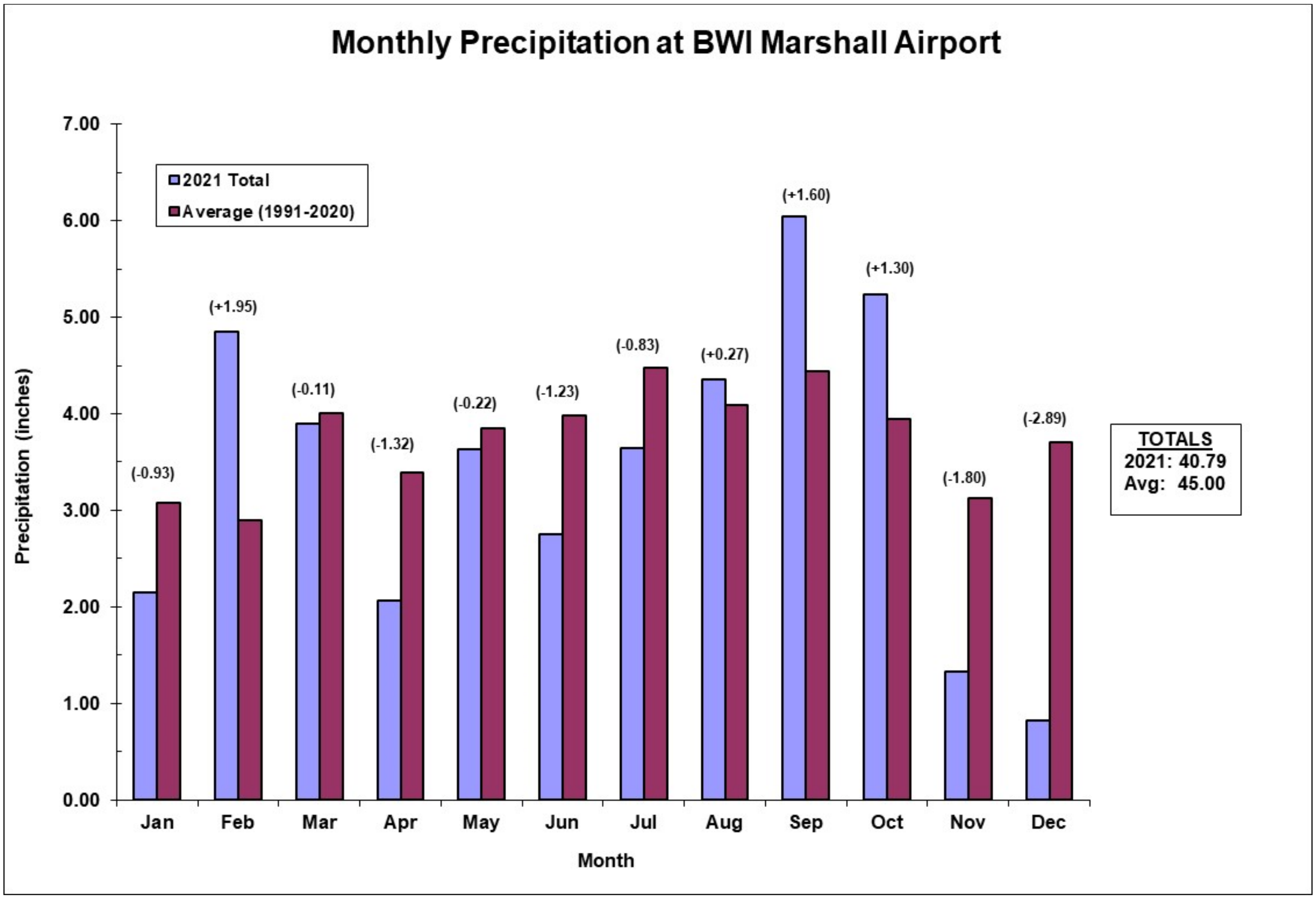


**Figure 3. Total 2021 monthly precipitation at BWI Thurgood Marshall Airport compared to 30-year averages. Data source: National Weather Service (weather.gov/media/lwx/climate/bwiprecip.pdf).**

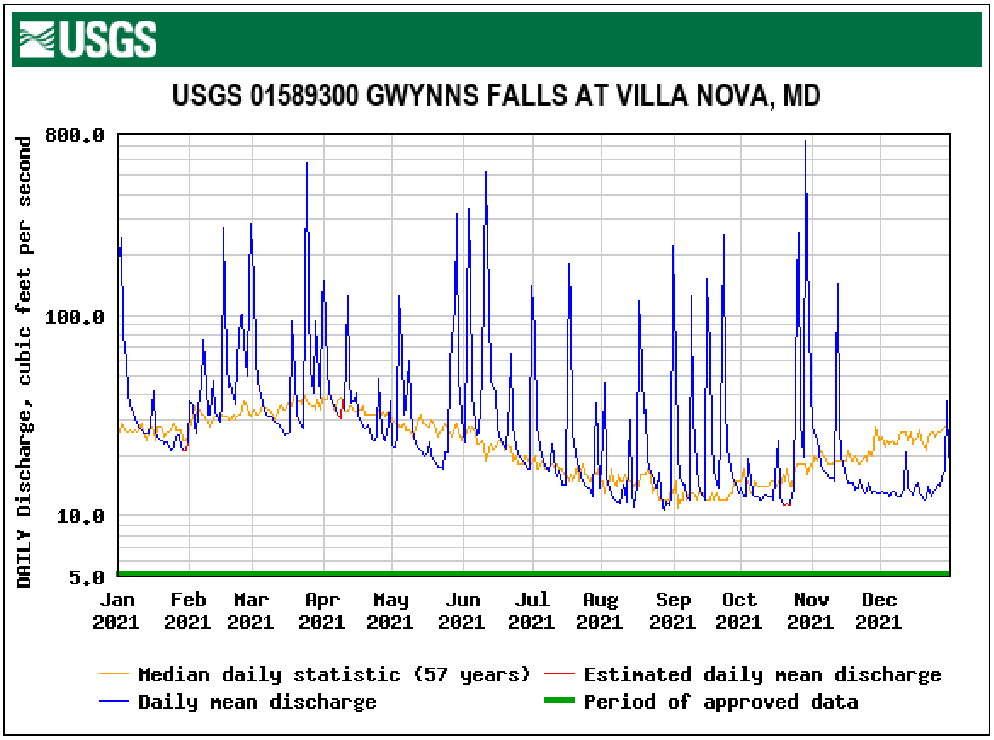


**Figure 4. 2021 daily discharge in cubic feet per second measured at a USGS gaging station northwest of Masonville Cove. Graph courtesy of the United States Geological Survey (https://waterdata.usgs.gov/nwis/dv/?site_no=01589300).**

## 2021 Continuous Monitoring Data

### Water temperature

Water temperature at Masonville Cove rose predictably during the first seven months of 2021 as air temperatures increased (Figure 5). Water temperatures peaked at 31.5°C (~89º F) in mid-August and generally remained between 25-30°C (77-86º F) through late August. Heavy rains associated with the remnants of Tropical Storm Ida on September 1st led to an almost 5°C (8º F) drop, which precipitated a decline in water temperature, as air temperatures cooled, through the rest of the year. Variability in the plot in Figure 5 was most likely a result of diel variation in temperature (warming temperatures during the day and cooling temperatures during the night).

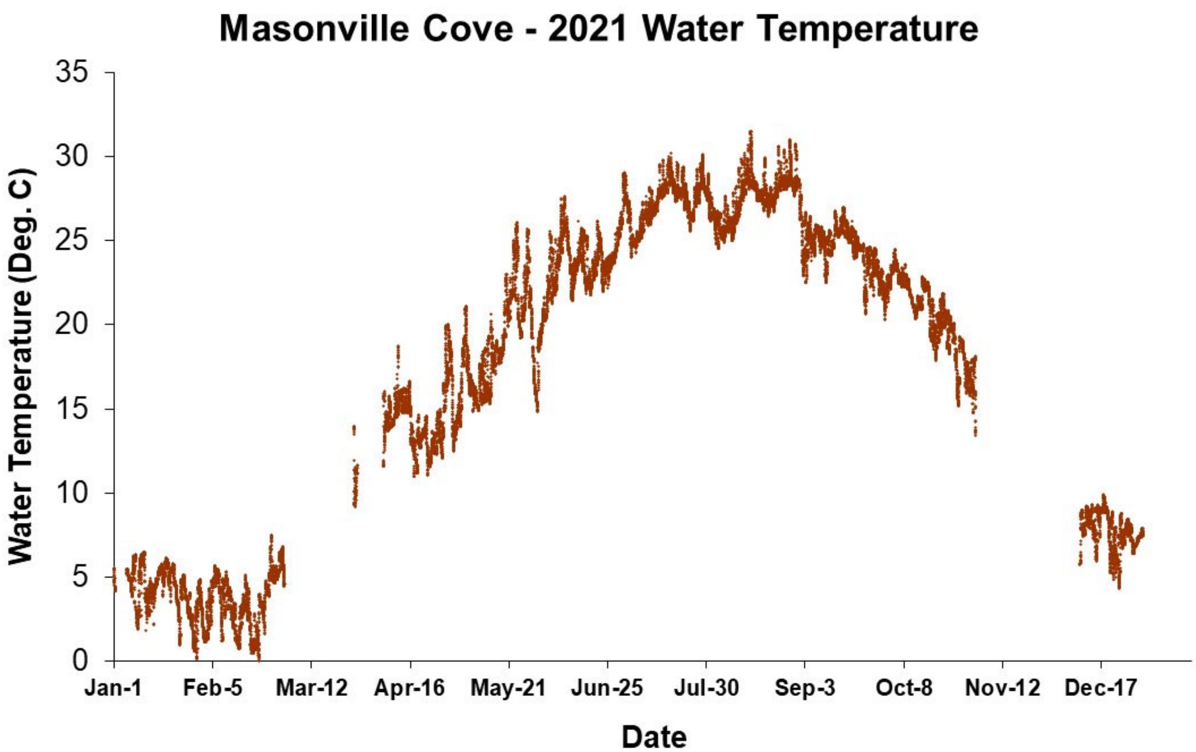


**Figure 5. Water temperature at Masonville Cove Continuous Monitor during 2021.**

## Salinity

Salinity tends to vary with precipitation and streamflow. The general annual trend in salinity that has been observed at Masonville Cove since monitoring began in 2009 is higher values in late winter and early spring, a drop in readings during the wetter summer months, and a rise in values again in the late fall and early winter. The overall pattern in 2021 (Figure 6) began with higher salinities in January before a drop in readings during a wetter than normal February (Figure 3) and early March. The lowest concentration of 2021 (0.65 parts per thousand – ppt) was recorded on March 1st. Concentrations then rose during a dry April (Figure 3) before dropping to near 0 ppt again following heavy rains in late May and mid-June. Salinity ranged between 4 and 8 ppt for much of the rest of the summer, before dropping to near 0 ppt in early September, following the remnants of Tropical Storm Ida impacting the region, and again in late September and October following heavy rains. Salinity then rose to over 11 ppt in December during the driest month of 2021 (Figure 3).

Salinity readings in Masonville Cove often quickly dropped to near 0 ppt following a rain event, before quickly rebounding to prior levels. This 'flashiness' pattern is often observed in urban environments and reflects how quickly flow in a river or stream increases and decreases during a storm. Flashy patterns are common in urbanized areas because stormwater runoff reaches the waterways much more quickly than rural areas due to a higher amount of impervious surfaces.

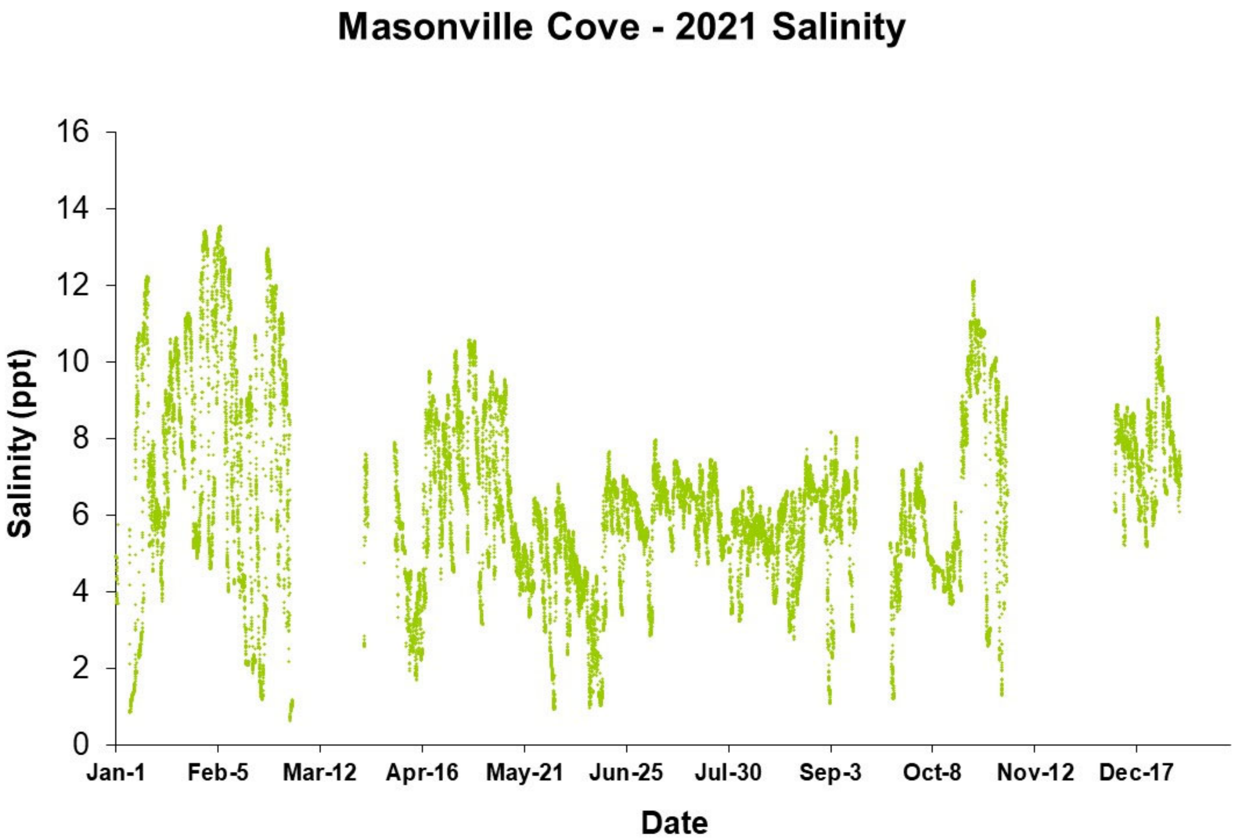


**Figure 6. Salinity levels at Masonville Cove Continuous Monitor during 2021.**

## Dissolved oxygen

Dissolved oxygen (DO) values remained high through winter and early spring before the deployed water quality monitoring sondes malfunctioned, which precluded data collection for the majority of the time between March 2nd and April 6th (Figure 7). In early spring, DO levels continued to remain relatively high until mid-May, when DO concentration peaked to its highest levels (25.4 mg/L; 293% saturation) in 2021, which coincided with the presence of a severe algal bloom (Figure 8) within Masonville Cove. Oxygen concentrations can become super-saturated (greater than 100% saturation) and peak during the day when algal cells are photosynthesizing and producing large amounts of oxygen.

Throughout the year, algal blooms coincided with super-saturated DO concentrations in early June (15.8 mg/L; 204% saturation), mid-July (16.4 mg/L; 222% saturation), late August (14.5 mg/L; 200% saturation), and late December (16.1 mg/L; 144% saturation). During algal blooms, DO can also drop to very low levels at night when photosynthesis ceases and oxygen is consumed through cellular respiration. This pattern was observed throughout the late spring through early fall as DO exhibited large swings in concentrations, with a substantial number of low readings (< 5 mg/L). Prolonged periods of low DO concentrations can stress and be detrimental to the survival of juvenile fish and other aquatic animals (U.S. Environmental Protection Agency, 2003).

Decreases in DO concentrations can also coincide with the death and decomposition of large algal blooms. The decomposition process can consume significant amounts of oxygen in the water and can lead to conditions harmful to aquatic organisms. Large drops in chlorophyll levels (Figure 8), indicative of the dieback of algal blooms, coincided with large drops in DO concentrations to extremely low levels in late May (1.3 mg/L), mid-June (0.67 mg/L), late July (0.44 mg/L), late August (0.97 mg/L), and mid-September (0.23 mg/L). Oxygen readings then increased again in early winter as water temperature cooled since cooler waters can hold more dissolved oxygen than warmer waters.

As part of the 1987 Chesapeake Bay Agreement, the signatories agreed "to provide for the restoration and protection of living resources, their habitats and ecological relationships." Further, the Chesapeake Executive Council (CEC) committed to "develop and adopt guidelines for the protection of water quality and habitat conditions necessary to support the living resources found in the Chesapeake Bay system, and to use these guidelines in the implementation of water quality and habitat protection programs." Because prolonged periods of low DO concentrations can stress and be detrimental to the survival of juvenile fish and other aquatic animals (U.S. Environmental Protection Agency, 2003), a document was produced by the Chesapeake Bay Program outlining dissolved oxygen thresholds for various living resources (Jordan et al. 1992). The State of Maryland adopted these dissolved oxygen thresholds as standards in 1995 (COMAR 1995). For shallow water habitats, the DO criteria are a 30-day average of 5 mg/L and an instantaneous minimum of 3.2 mg/L.

Table 1 shows the percentage of time the Masonville Cove DO data fell below these criteria values in June through September, which is generally the time of year that DO values are the lowest due to warmer waters. In 2021, DO failure rates were the second highest since monitoring began in Masonville Cove in 2009 (Table 1). Concentrations were below 5 mg/L 42% of the time and below 3.2 mg/L for 22% of readings. Both of these failure rates were markedly higher than the average annual failure rate over the prior 12 years of monitoring (33.9% for 5 mg/L; 15.3% for 3.2 mg/L). These degraded oxygen conditions in Masonville Cove may be related to the high algal concentrations recorded in 2021 (Table 2).

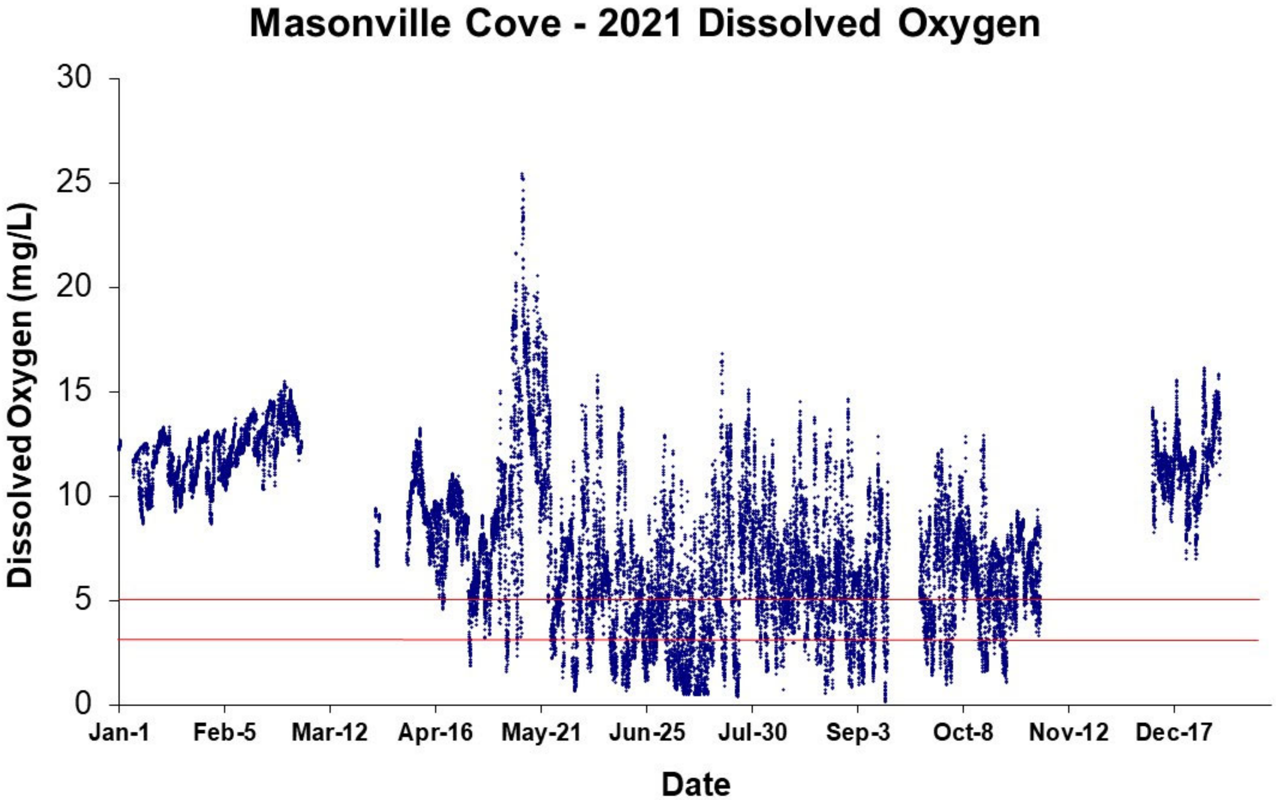


**Figure 7. Dissolved oxygen levels at Masonville Cove Continuous Monitor during 2021. (***Red lines indicate 5 mg/L and 3.2 mg/L criteria.)*

**Table 1. Dissolved oxygen criteria failure at Masonville Cove Continuous Monitor from June through September, 2009 to 2021.**

| Dissolved Oxygen | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | **2021** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Less than 5 mg/L | 27.3% | 36.0% | 28.1% | 37.0% | 37.8% | 33.7% | 39.2% | 48.1% | 38.3% | 18.2% | 23.7% | 39.0% | **42.2%** |
| Less than 3.2 mg/L | 9.4% | 16.4% | 10.0% | 15.5% | 17.2% | 12.6% | 20.8% | 28.5% | 19.7% | 5.7% | 7.7% | 20.0% | **22.1%** |

## Chlorophyll

Chlorophyll concentrations tend to vary with and are an indicator of algal (phytoplankton) levels. Readings above 15 micrograms per liter (µg/L) represent algal blooms that can negatively affect living resources. Chlorophyll concentrations greater than 50 µg/L represent significant algal blooms and concentrations above 100 µg/L represent severe blooms. At Masonville Cove, measured chlorophyll values indicate that significant or severe algal blooms occurred in eight of the twelve months in 2021 (Figure 8).

Chlorophyll sonde data indicate significant bloom conditions within Masonville Cove starting in late February (Figure 8). Concentrations dropped to below 10 µg/L by early March, before sonde malfunctions precluded data collection for much of March into early April. When data collection resumed, chlorophyll readings indicate numerous significant to severe algal blooms occurred in Masonville Cove through the summer and into the fall. The longest and most intense blooms occurred over several days in May with chlorophyll concentrations of 500 µg/L, the maximum measurable value of the chlorophyll probes. Chlorophyll readings then indicate multiple significant to severe blooms in June, July, and August. During these three months, chlorophyll concentrations peaked at 185 µg/L on August 31$^{st}$, which coincided with elevated microcystin levels within the Masonville Dredged Material Containment Facility. A sample collected by Maryland Environmental Service on August 23rd verified total microcystin levels within the Dredged Material Containment Facility to be 37.5 parts per billion (ppb), which is over four times greater than the EPA recommended no contact threshold of 8 ppb. Chlorophyll concentrations dropped in early September as the remnants of Tropical Storm Ida dropped over 4 inches of rain on the region and flushed algae from Masonville Cove. Chlorophyll concentrations again increased to bloom levels later in September, October, and December. No water quality sonde readings were collected between November 2$^{nd}$ and December 9$^{th}$ due to sonde malfunctions.

As stated previously, chlorophyll readings greater than 15 µg/L and 50 µg/L indicate blooms with potential ecosystem effects and significant blooms, respectively. Table 2 lists the percentage of data readings that exceed these thresholds for Masonville Cove during the portion of the 2021 deployment that coincided with SAV growing season (March – October). Algal blooms during this period may impede the ability of SAV to grow and reproduce. In 2021, chlorophyll exceedance rates were the third highest recorded in Masonville and the highest since 2013. Chlorophyll levels exceeded the 15 µg/L threshold during 51.2% of readings and exceeded the 50 µg/L threshold during 10.1% of readings, both of which were higher than the average annual rates over the prior years of monitoring (41.9% for 15 µg/L; 5.5% for 50 µg/L). 2021 was also the third year in a row that chlorophyll exceedance rates increased from the prior year.

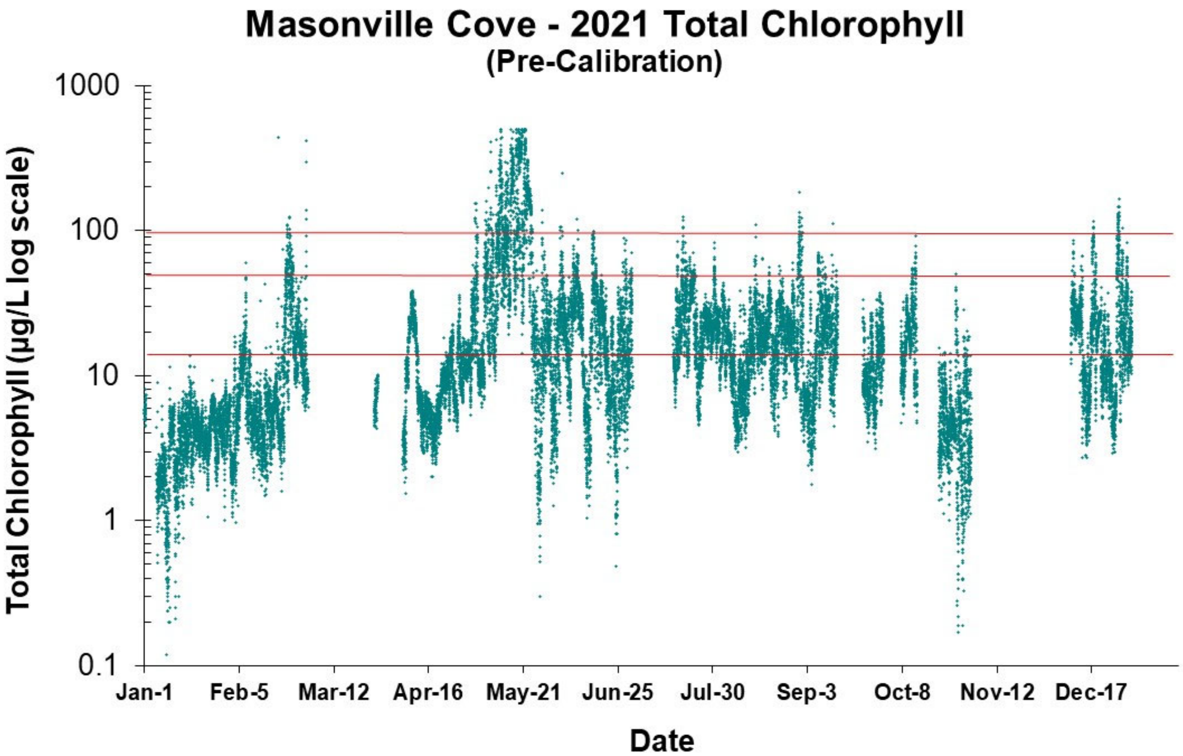


**Figure 8. Total chlorophyll levels at Masonville Cove Continuous Monitor during 2021.** *(Red lines indicate thresholds above which levels may have harmful effects on aquatic ecosystems—15 mg/L—are considered significant blooms—50 mg/L—or are considered severe blooms—100 mg/L.)*

**Table 2. Chlorophyll threshold failure at Masonville Cove Continuous Monitor during June through November, 2009, March through October, 2010 to 2019 and 2021, and the month of March as well as June through October, 2020.**

| Chlorophyll | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020* | **2021** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greater than 15 µg/L | 37.4% | 59.0% | 38.8% | 55.6% | 52.1% | 36.2% | 43.1% | 40.1% | 46.4% | 23.3% | 27.6% | 43.2% | **51.2%** |
| Greater than 50 µg/L | 3.3% | 6.6% | 0.9% | 14.5% | 10.5% | 5.2% | 8.9% | 4.0% | 5.5% | 1.5% | 1.0% | 4.5% | **10.1%** |

*Months of data collected limited in 2020 due to COVID-19 pandemic.

## pH

pH readings tend to fluctuate between 7 and 9 in most Chesapeake Bay tidal waters, with spikes above 9 indicating potential algal blooms. High pH in the absence of high chlorophyll also can indicate that a blue-green algal bloom may have occurred (the chlorophyll sensors on the continuous monitors deployed at Masonville Cove are not designed to detect the wavelengths emitted by cyanobacteria). At Masonville Cove in 2021, pH values exceeded 9 during significant to severe algal blooms in May, June, July, August, and October (Figure 9). The highest pH readings of the year (9.7) occurred during the prolonged and intense algal blooms in May (Figure 8).

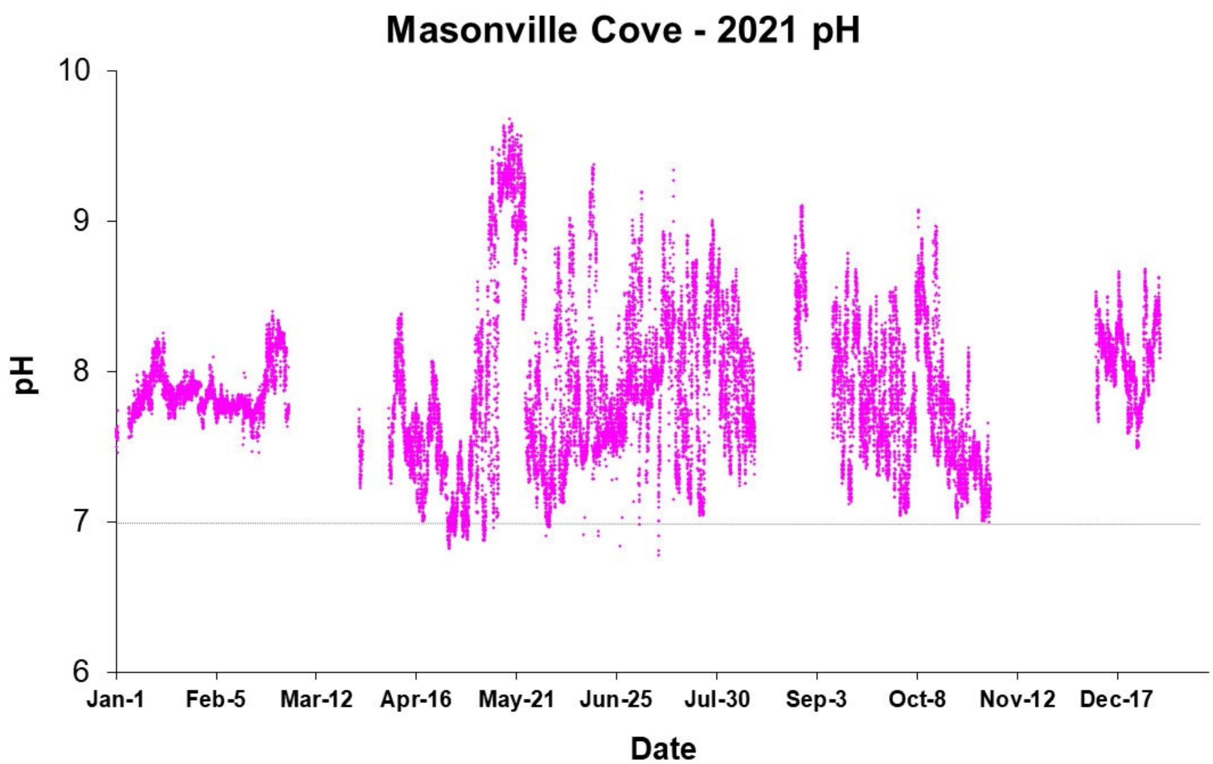


**Figure 9. pH levels at Masonville Cove Continuous Monitor during 2021.** *(Line indicates neutral pH.)*

**Turbidity**

Turbidity is quantified by measuring how much light is reflected from suspended particles in the water and is used to determine water clarity. Lower turbidity values indicate less reflection and, therefore, clearer water, while values above 7 Nephelometric Turbidity Units (NTU) are generally thought to be detrimental to SAV growth based on the effects of elevated turbidity in other systems (M. Trice, MD DNR, personal communication). Heavy rains and associated discharge events can lead to runoff that bring high concentrations of particles and sediment into waterways, leading to increased turbidity levels. Algal blooms can also cloud the water and increase turbidity measurements.

During the year, turbidity levels spiked extremely high to more than 100 NTU during a few readings in February and June, and for an extended period in September and early October (Figure 10). Readings also spiked at other times during the year, generally following precipitation events, but the majority (60%) of turbidity values throughout the year were at or below 7 NTU (mean value: 15.8 NTU; median value: 5.9 NTU).

In winter, turbidity measurements spiked to 68 NTU in late January and to 300 NTU in late February following a rain event. Sonde malfunctions precluded data collection for much of March. When data collection resumed in early April, turbidity readings generally ranged below 15 NTU during the drier than normal month (Figure 3) before spiking to 50 NTU following rains at the end of the month. Readings next spiked following rains in mid- (82 NTU) and late June (269 NTU).

September was the wettest year in 2021 (Figure 3), which coincided with the highest turbidity measurements of the year. Readings spiked to 51 NTU on September 2$^{nd}$, following the remnants of Tropical Storm Ida impacting the region. Readings then climbed above 50 NTU on September 23$^{rd}$ and continued to climb over the next week before reaching a maximum of 384 NTU on September 30$^{th}$. Readings then quickly dropped before approaching 40 NTU following heavy rains at the end of October. No water quality sonde readings were collected between November 2$^{nd}$ and December 9$^{th}$ due to sonde malfunctions. When data collection resumed, turbidity readings generally ranged below 7 NTU during the driest period of the year (Figure 3).

Turbidity measurements above 7 NTU, as stated previously, are considered a threshold for detrimental effects on SAV. During the 2021 growing season, turbidity readings exceeded the 7 NTU threshold during 49.5% of readings (Table 3). Although this annual exceedance rate was slightly lower than the average rate over the prior 12 years of monitoring (50.2%) and was the fourth lowest annual rate since monitoring began in Masonville Cove, the rate represented an increase of 15% from the prior year. Thus, preliminary conclusions are that water clarity conditions declined in Masonville Cove during the drier than normal year (Figure 3) of 2021.

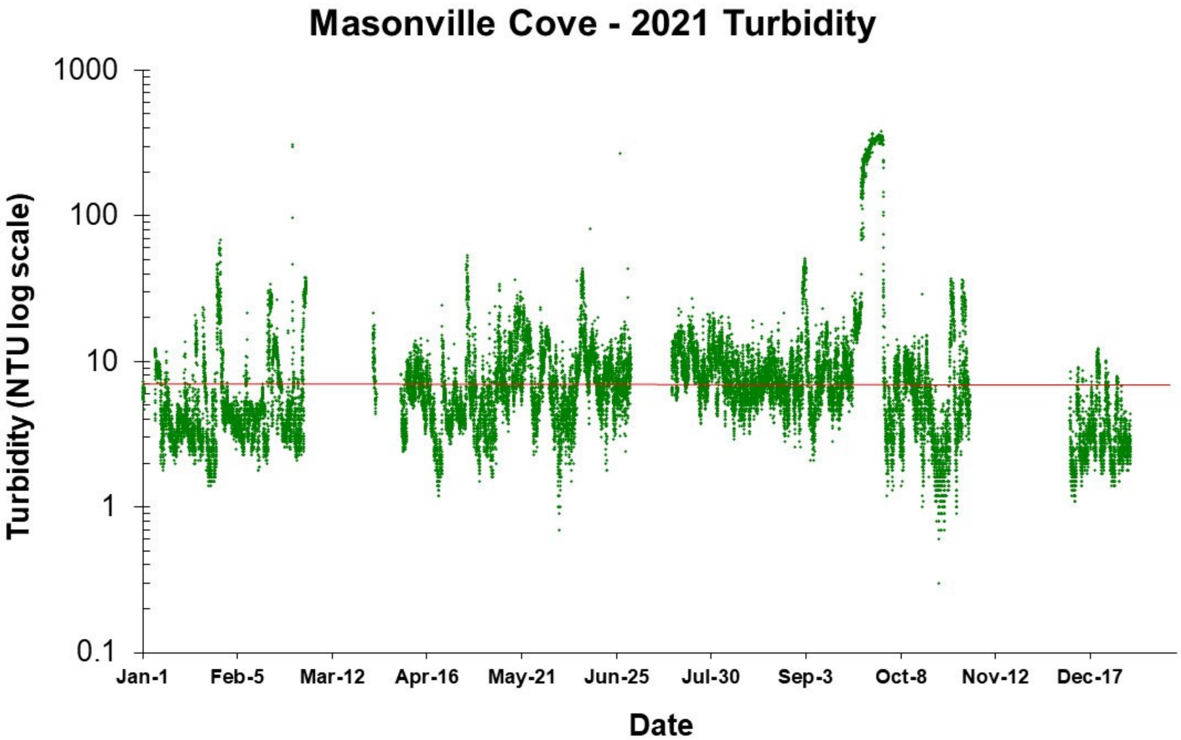


**Figure 10. Turbidity levels at Masonville Cove Continuous Monitor during 2021.** *(Red line indicates threshold above which levels are considered detrimental to bay grass growth.)*

**Table 3. Turbidity threshold failure at Masonville Cove Continuous Monitor during June through December, 2009, March through October, 2010 to 2019 and 2021, and the month of March as well as June through October, 2020.**

| Turbidity | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020* | **2021** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greater than 7 NTU | 54.6% | 60.1% | 51.6% | 35.0% | 53.9% | 52.9% | 53.8% | 34.9% | 60.9% | 53.8% | 56.9% | 34.3% | **49.5%** |

*Months of data collected limited in 2020 due to COVID-19 pandemic.

## Submerged Aquatic Vegetation (SAV) in the Patapsco River

SAV, or underwater grasses, are an important component of estuarine ecosystems. SAV provides habitat for juvenile fish and shellfish, supplies food for waterfowl, filters and oxygenates the water, and helps stabilize bottom sediments. Since 1984, SAV within the Chesapeake Bay and associated tributaries has been assessed annually (with the exception of 1988) by the Virginia Institute of Marine Science (VIMS). Figure 11 shows the total area and density of SAV within the Patapsco beginning in 1994 (the first year SAV was found in the river) through 2021.

The total area of SAV within the Patapsco River in 2021 was 164 acres, all of which was located in tributaries of the river while SAV was absent within Masonville Cove and the mainstem of the Patapsco. Poor water clarity and lack of viable seed banks may explain the lack of SAV coverage within Masonville Cove. However, total acreage observed in 2021 was the most coverage found in the segment since the mid-2000s when a population explosion and range expansion of dark false mussels (*Mytilopsis leucophaeata*) increased water clarity and allowed SAV coverage to significantly expand (L. Karrh, MD DNR, personal communication). In 2021, the total area of SAV within the Patapsco River system increased 14% from the prior year, and over 4,650% since 2016 when only 3.5 acres were found. The total area of SAV within the Patapsco River system currently stands at 42% of the total restoration goal of 389 acres.

The increase in SAV coverage seen in the Patapsco River system since 2016 is in contrast to the recent trends found throughout the Chesapeake Bay watershed. Reductions of SAV beds have been recorded in many tributaries over the past few years. Bay-wide, SAV coverage declined 40% between 2017 and 2020, but increased by almost 8% in 2021 from the prior year. Approximately 68,000 acres were observed bay-wide in 2021, which is 37% of the restoration goal of almost 185,000 acres.

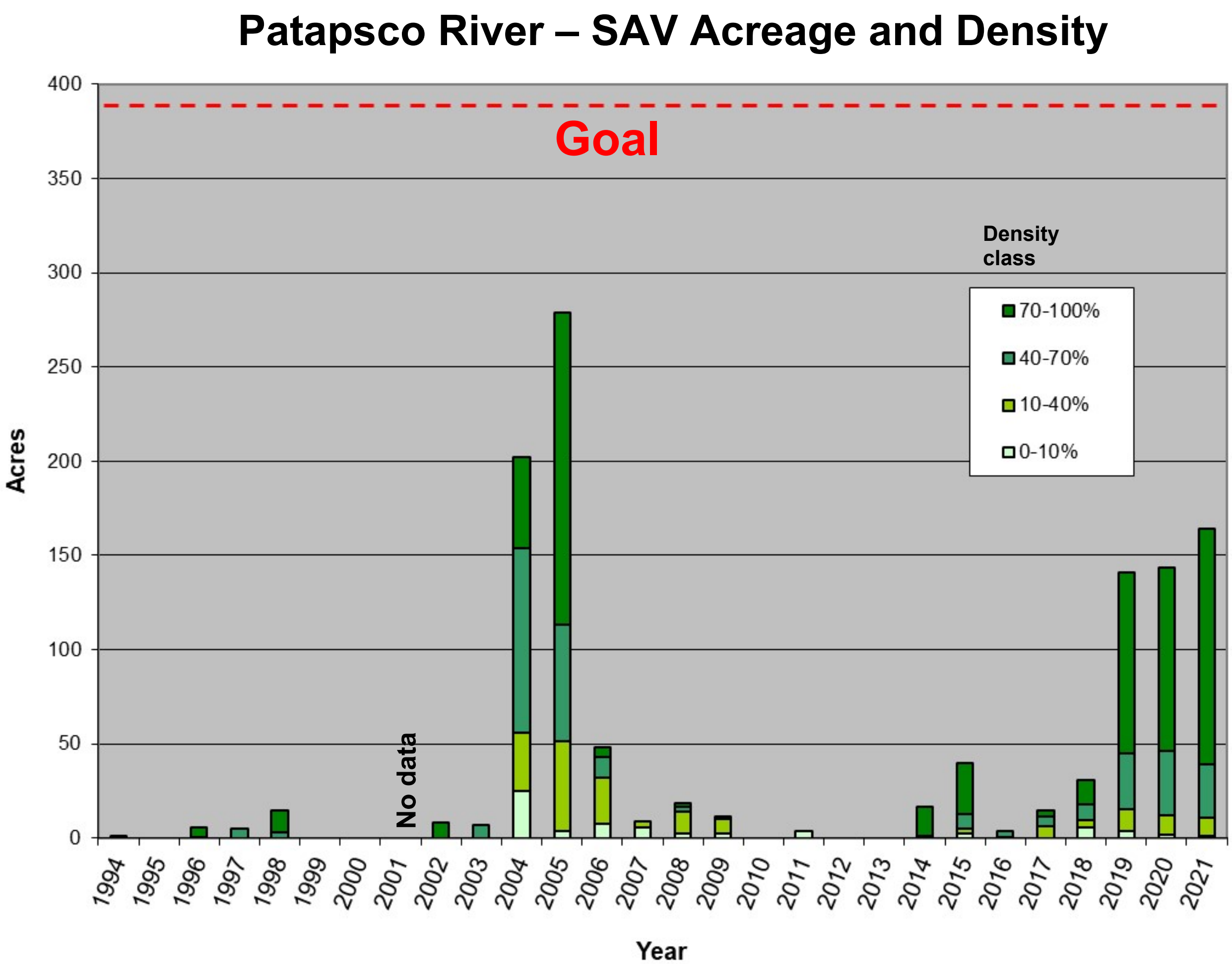


**Figure 11. Total area and density of SAV in the Patapsco River between 1994 and 2021. (*Restoration goal is 389 acres)***

## Pigments, Suspended Solids and Secchi Depths

Bi-weekly grab samples of water were taken at the Masonville Cove station when the YSI meters were exchanged during continuous monitoring service visits. Samples collected from November through February were collected monthly instead of bi-weekly (Table 4). Secchi depth, a measure of water clarity, was also recorded at the Masonville Cove station each time a grab sample was collected.

Samples collected during continuous monitoring service visits were analyzed for pigments and suspended solids. The water samples were processed in the field using vacuum filtration, and the resulting particulate samples were delivered to the laboratory for analysis. All analyses were performed by the University of Maryland's Chesapeake Biological Laboratory (CBL) Nutrient Analytical Services Laboratory (NASL). For details on methods, procedures, analysis, and detection limits, refer to the Quality Assurance Project Plan (QAPP) for the Shallow Water Monitoring Program. This document can be found at: https://eyesonthebay.dnr.maryland.gov/eyesonthebay/documents/SWM_QAPP_2021_2022_Draft_v6.pdf. Results of the laboratory analyses are presented graphically in Appendix A (Figures A-1 through A-3). Secchi depth measurements are presented in Figure A-4. The suspended sediments, pigments, and Secchi depth data values are also documented in Table A-1 of Appendix A.

**Table 4. Deployment and calibration record for Masonville Cove continuous monitor in 2021.**

| Scheduled calibration date | Samples collected | Comment |
|---|---|---|
| January 5th, 2021 | Yes | Telemetry data reestablished following a malfunction in December |
| February 4th, 2021 | Yes | |
| March 2nd, 2021 | Yes | |
| April 6th, 2021 | Yes | Telemetry data reestablished following a malfunction in March |
| April 21st, 2021 | Yes | |
| May 5th, 2021 | Yes | |
| May 19th, 2021 | Yes | |
| June 3rd, 2021 | Yes | Service visits suspended following enforced no entry policy due to eagle nesting site |
| July 15th, 2021 | Yes | Regular service visits resumed |
| July 28th, 2021 | Yes | |
| August 12th, 2021 | Yes | |
| August 26th, 2021 | Yes | |
| September 8th, 2021 | Yes | |
| September 23rd, 2021 | Yes | |
| October 7th, 2021 | Yes | |
| October 21st, 2021 | Yes | |
| November 2nd, 2021 | Yes | |
| December 9th, 2021 | Yes | Telemetry data reestablished following a malfunction in December |

### Pigments

Chlorophyll concentrations at Masonville Cove were below 10 µg/L from January through April 2021 (Figure A-1). In the months that followed, chlorophyll values increased but generally remained below 50 µg/L throughout the year. Two exceptions were a small peak of 63 µg/L chlorophyll in early September, and a much larger peak of 351 µg/L chlorophyll in mid-May. The September peak was greater than the 50 µg/L chlorophyll threshold, which may indicate a significant algal bloom. The May peak was greater than the 100 µg/L threshold indicative of a severe algal bloom. The September peak in chlorophyll may have been fueled in part by the remnants of Tropical Storm Ida which passed through the region on September 1$^{st}$, 2021. The heavy rains and runoff associated with TS Ida may have increased nutrient inputs to the waterbody and contributed to algal growth.

Pheophytin values in 2021 showed a general pattern of lower values in the winter and spring, with more elevated concentrations in the summer and fall (Figure A-2). January-March and November-December pheophytin concentrations were all less than 5 µg/L. Pheophytin concentrations between April and early August fluctuated between approximate values of 1 µg/L and 25 µg/L. The largest pheophytin values were observed on April 21$^{st}$ (24 µg/L) and July 15$^{th}$ (15 µg/L). From late August through early October, pheophytin concentrations were around 10 µg/L.

**Suspended solids**

In 2021, suspended solids concentrations ranged between 5-50 mg/L at Masonville Cove (Figure A-3). Suspended solids concentrations greater than 20 mg/L were observed in March, May, and September. The peak suspended solids value on May 19$^{th}$ (50 mg/L) coincided with peak measurements of chlorophyll, suggesting that algal cells contributed to the high suspended solids on this date. Higher values of suspended solids on March 2$^{nd}$ and September 23$^{rd}$ (27 mg/L and 24 mg/L, respectively), were likely impacted by rainfall events. Approximately one inch of rain was recorded at the Baltimore-Washington International Airport on February 28$^{th}$ and on September 22$^{nd}$ – 23$^{rd}$, just a few days prior to sample collection.

**Secchi depths**

Secchi depth is a measurement of water clarity and shows an inverse relationship to suspended solids concentration. As suspended solids in the water increase, water clarity decreases, and Secchi depth measurements decline. The lowest Secchi depth value at Masonville Cove in 2021 (0.2 m) was recorded on March 2$^{nd}$ and May 19$^{th}$, dates when peak values of total suspended solids were observed (Figure A-4). The highest Secchi depth value in 2021 (1.5 m) occurred on October 21$^{st}$. The October 21$^{st}$ sample date followed a four-week period with little to no rainfall, and laboratory results showed low concentrations of pigments and suspended solids in the water; all of which resulted in greater water clarity on this date.

## Ambient Water Quality

Ambient water quality data (salinity, dissolved oxygen, water temperature, and pH) were collected concurrently with the grab samples. The data values are presented graphically in Figures A-5 to A-8 in Appendix A. These water quality parameters are measured as a profile, with readings recorded at 0.5 meter depth intervals through the water column. In the graphs, the individual readings within a profile are represented by separate data points. The solid line on each graph intersects the mean value for the parameter on each sampling date. All data values for dissolved oxygen, pH, salinity, and water temperature are provided in Table A-2 of Appendix A.

### Salinity

The measured daily mean salinity at Masonville Cove in 2021 averaged 6.2 ppt for the year (Figure A-5). The highest salinities were observed in February (February 4$^{th}$, 10.6 ppt) and late October (October 21$^{st}$, 10.3 ppt) on sampling dates that followed several weeks with little or no precipitation. The lowest daily mean salinity (3.0 ppt) occurred on March 2$^{nd}$. Some stratification of the water column was evident in the salinity readings for January-March. During these months, surface and bottom water salinities differed by as much as 3.5-6.5 ppt.

### Dissolved oxygen

Dissolved oxygen concentrations greater than 5mg/L are considered necessary to support a healthy marine ecosystem. Daily mean values of dissolved oxygen at Masonville Cove were always greater than 5 mg/L during 2021 sampling (Figure A-6). However, individual dissolved oxygen readings below this threshold did occur, especially in bottom waters during the months of June-September. Conversely, high dissolved oxygen concentrations were also observed at Masonville Cove in 2021. Daily mean dissolved oxygen values greater than 13 mg/L occurred on July 28$^{th}$, December 9$^{th}$, and May 19$^{th}$. The May 19$^{th}$ profile included an individual reading of 18.1 mg/L dissolved oxygen in the surface waters, which was the highest dissolved oxygen concentration recorded in 2021. Laboratory analysis of water samples collected on May 19$^{th}$ at Masonville Cove showed high concentrations of chlorophyll, suggesting a severe algal bloom. During bloom conditions, dissolved oxygen concentrations can reach high levels due to algal photosynthesis.

### Water temperature and pH

Water temperatures varied seasonally at Masonville Cove (Figure A-7). Water temperatures ranging from 2.3 °C to 5.8 °C were measured from January through March 2021. As the weather warmed, water temperatures gradually rose to a peak value of 30.2 °C on July 28$^{th}$, and then declined steadily to around 6 °C on December 9$^{th}$.

The pattern of pH values at Masonville Cove in 2021 closely matched the pattern of dissolved oxygen concentrations (Figure A-8). Daily mean pH values greater than 8.5 occurred on May 19$^{th}$, July 28$^{th}$, October 7$^{th}$, and December 9$^{th}$, mimicking peaks in dissolved oxygen on those dates. Throughout the rest of the year, daily mean pH values generally ranged from 7.5 to 8.0.

## Conclusion

Shallow water monitoring was conducted in Masonville Cove in the upper Patapsco River during 2021. Continuous monitoring data provide a critical function for assessing the health of Maryland's tidal waters in areas historically lacking water quality information. Shallow water data provide information about the effects of nutrient pollution and weather events on Masonville Cove and the Patapsco River as a whole. In 2021, algal and dissolved oxygen conditions were degraded as compared to prior years. Samples collected within the Masonville Dredged Material Containment Facility during algal blooms in August indicated elevated and unhealthy levels of microcystin. Finally, although 2021 was drier than normal, water clarity conditions in Masonville declined and no submerged aquatic vegetation was found in the Cove. Thus, habitat conditions in Masonville Cove remain poor for living resources in the upper Patapsco River.

Shallow water monitoring information is not only used for characterizing the health of shallow water habitats, but it is also useful for: 1) assessing the Chesapeake Bay water quality criteria for dissolved oxygen, water clarity, and chlorophyll in shallow water habitats; 2) determining attainment or nonattainment of shallow water habitats for their designated uses; 3) assessing SAV habitats and identifying potential SAV restoration sites; 4) providing information to better understand ecosystem processes and the impact of extreme events (e.g. hurricanes, high flows, sanitary sewer overflows) in shallow water and open water environments; 5) providing data for calibrating the Bay Eutrophication and Watershed Model; and 6) assessing mitigation efforts in relation to the dredged material containment facility at the Masonville Marine Terminal.

## References

COMAR (Code of Maryland Regulations). 1995. Code of Maryland Regulations: 26.08.02.03 – Water Quality Criteria Specific to Designated Uses. Maryland Department of the Environment. Baltimore, Maryland.

Jordan, S., C. Stegner, M. Olson, R. Batiuk and K. Mountford. 1992. Chesapeake Bay dissolved oxygen goal for restoration of living resources habitats. Chesapeake Bay Program, Reevaluation Report #7c. CBP/TRS88/93. Annapolis, Maryland.

Leffler, M. and J. Greer. 2001. Taking on toxics in Baltimore Harbor. Maryland Marine Notes 19(2). https://www.mdsg.umd.edu/sites/default/files/files/MN19_2.PDF

# Appendix A

**Results of laboratory and ambient water quality analyses for:**
**Masonville Cove Pier (Station XIE4742)**

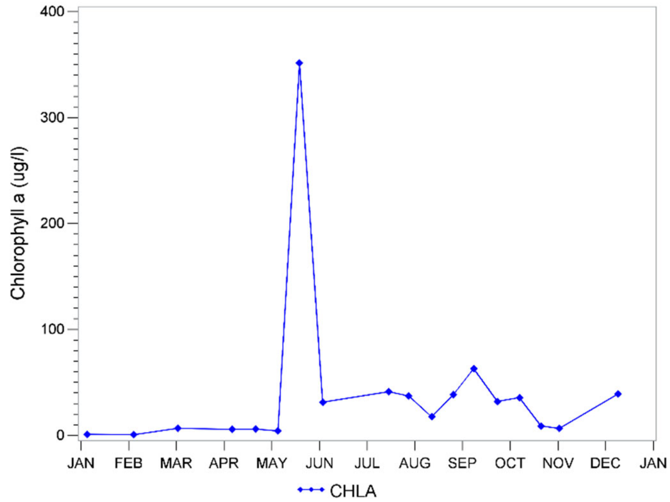


**Figure A-1. Chlorophyll *a* concentrations at Masonville Cove in 2021.**

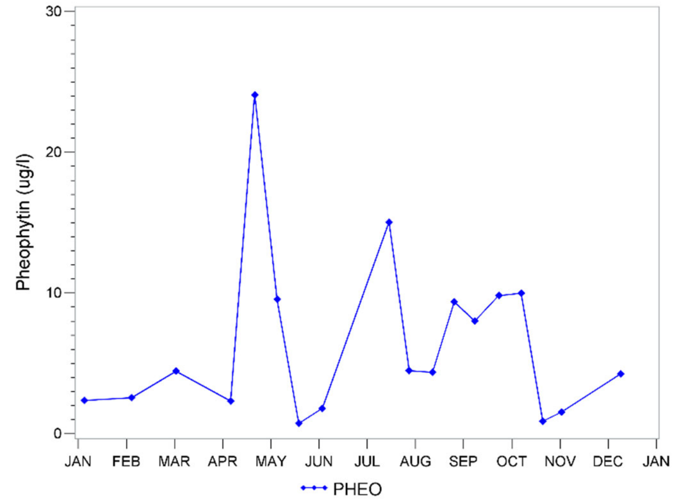


**Figure A-2. Pheophytin concentrations at Masonville Cove in 2021.**

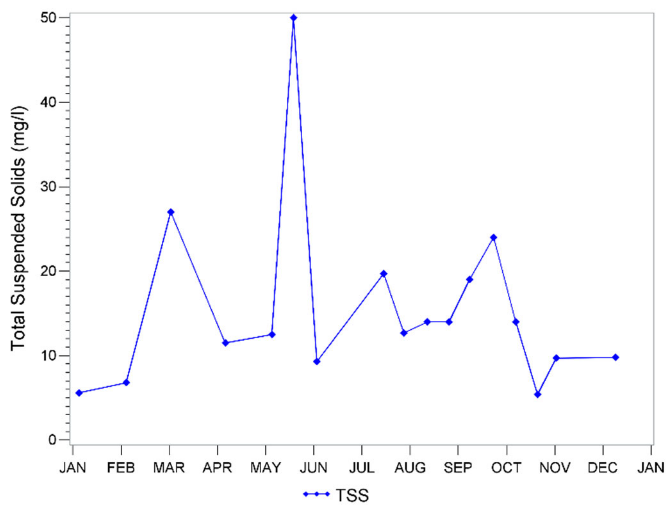


**Figure A-3. Total suspended solids concentrations at Masonville Cove in 2021.**

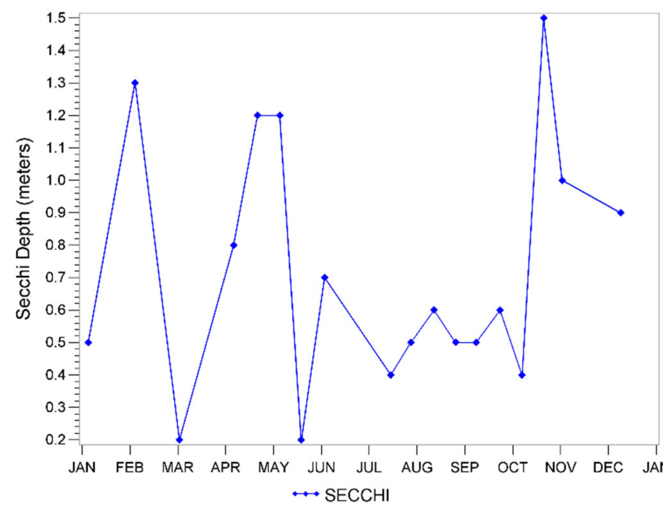


**Figure A-4. Secchi depth at Masonville Cove in 2021.**

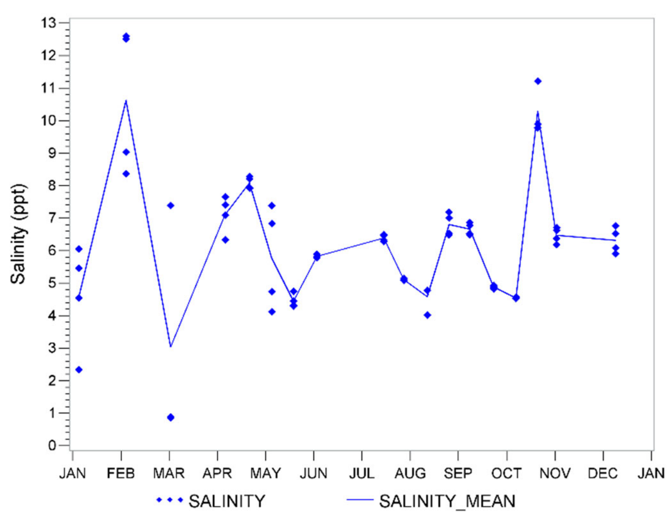


**Figure A-5. Salinity concentrations at Masonville Cove in 2021.**

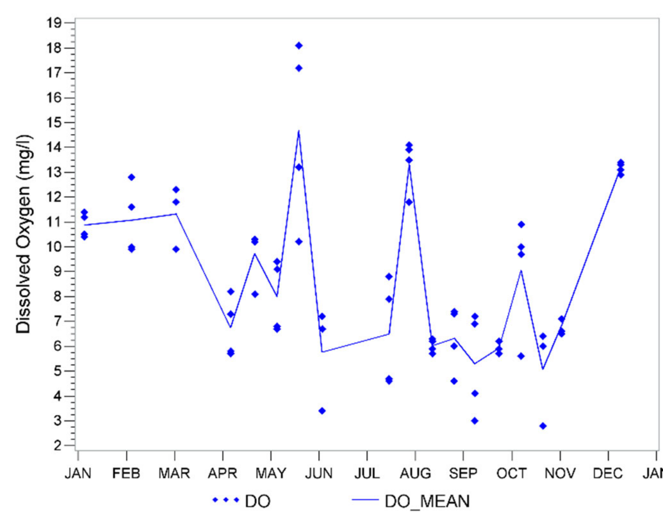


**Figure A-6. Dissolved oxygen concentrations at Masonville Cove in 2021.**

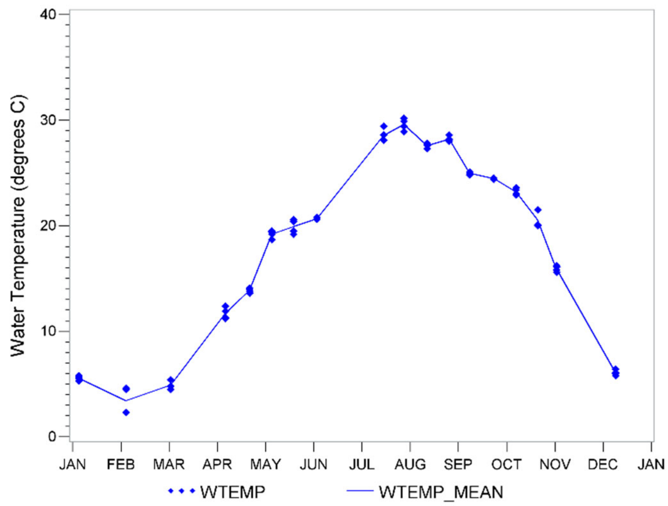


**Figure A-7. Water temperature at Masonville Cove in 2021.**

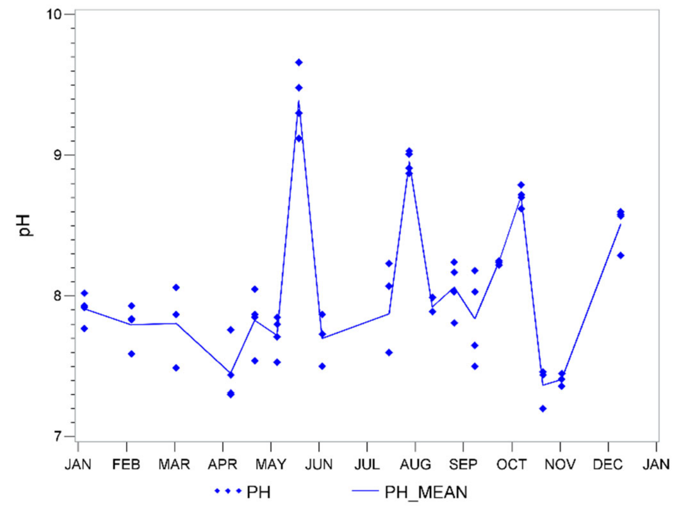


**Figure A-8. Values of pH at Masonville Cove in 2021.**

*Graphs with multiple y-values on a single point on the x-axis represent values measured at different depths in the water column. In such cases, lines intersect the mean value.*

**Table A-1. Discrete Continuous Monitoring Data for Chlorophyll-a, Pheophytin, Total Suspended Solids, and Secchi Disk Depth for Masonville Cove (XIE4742) in 2021.**

| Date | Sample Depth (m) | Chlorophyll-a (ug/L) | Pheophytin (ug/L) | Total Suspended Solids (mg/L) | Secchi Depth (m) |
|---|---|---|---|---|---|
| 01/05/21 | 1 | 1.068 | 2.371 | 5.6[1] | 0.5 |
| 02/04/21 | 1 | < 0.62 | 2.563 | 6.8 | 1.3 |
| 03/02/21 | 1 | 6.764 | 4.450 | 27.0 | 0.2 |
| 04/06/21 | 1 | 5.874 | 2.350 | 11.5 | 0.8 |
| 04/21/21 | 1 | 5.981 | 24.073 | no data[2] | 1.2 |
| 05/05/21 | 1 | 4.272 | 9.559 | 12.5 | 1.2 |
| 05/19/21 | 1 | 351.372 | < 0.74 | 50.0 | 0.2 |
| 06/03/21 | 1 | 31.328 | 1.816 | 9.3 | 0.7 |
| 06/17/21 | no sample taken[3] | | | | |
| 07/01/21 | no sample taken[3] | | | | |
| 07/15/21 | 1 | 41.296 | 15.023 | 19.7 | 0.4 |
| 07/28/21 | 1 | 37.380 | 4.486 | 12.7 | 0.5 |
| 08/12/21 | 1 | 17.800 | 4.379 | 14.0 | 0.6 |
| 08/26/21 | 1 | 38.448 | 9.398 | 14.0 | 0.5 |
| 09/08/21 | 1 | 63.012 | 8.010 | 19.0 | 0.5 |
| 09/23/21 | 1 | 32.040 | 9.826 | 24.0 | 0.6 |
| 10/07/21 | 1 | 35.600 | 10.004 | 14.0 | 0.4 |
| 10/21/21 | 1 | 8.971 | 0.897 | 5.4 | 1.5 |
| 11/02/21 | 1 | 6.675 | 1.549 | 9.7[1] | 1.0 |
| 12/09/21 | 1 | 39.089 | 4.272 | 9.8 | 0.9 |

1) Poor replication between pads, mean reported.

2) Sample results rejected due to quality control criteria.

3) Due to a pair of nesting eagles, the U.S. Fish and Wildlife service enforced a no entry policy for the area surrounding the Masonville Cove monitoring site. The station was inaccessible on this date.

**Table A-2. Ambient Water Quality Data for Dissolved Oxygen, pH, Salinity, and Water Temperature for Masonville Cove (XIE4742) in 2021 (continued on next page).**

| Date | Sample Depth (m) | Dissolved Oxygen (mg/L) | pH | Salinity (ppt) | Water Temperature (°C) |
|---|---|---|---|---|---|
| 01/05/21 | 0.5 | 11.2 | 8.02 | 2.34 | 5.5 |
| 01/05/21 | 1.0 | 11.4 | 7.77 | 4.55 | 5.3 |
| 01/05/21 | 1.5 | 10.4 | 7.93 | 5.46 | 5.6 |
| 01/05/21 | 2.2 | 10.5 | 7.92 | 6.05 | 5.8 |
| 02/04/21 | 0.5 | 11.6 | 7.93 | 8.37 | 2.3 |
| 02/04/21 | 1.0 | 12.8 | 7.59 | 9.03 | 2.3 |
| 02/04/21 | 1.5 | 9.9 | 7.83 | 12.51 | 4.5 |
| 02/04/21 | 2.1 | 10.0 | 7.84 | 12.60 | 4.6 |
| 03/02/21 | 0.5 | 11.8 | 7.87 | 0.86 | 4.8 |
| 03/02/21 | 1.0 | 12.3 | 8.06 | 0.88 | 4.5 |
| 03/02/21 | 1.7 | 9.9 | 7.49 | 7.39 | 5.4 |
| 04/06/21 | 0.5 | 8.2 | 7.44 | 6.33 | 12.4 |
| 04/06/21 | 1.0 | 7.3 | 7.76 | 7.10 | 11.9 |
| 04/06/21 | 1.5 | 5.7 | 7.31 | 7.40 | 11.3 |
| 04/06/21 | 2.1 | 5.8 | 7.30 | 7.66 | 11.2 |
| 04/21/21 | 0.5 | 10.3 | 7.87 | 7.92 | 14.1 |
| 04/21/21 | 1.0 | 10.3 | 8.05 | 8.21 | 14.0 |
| 04/21/21 | 1.5 | 10.2 | 7.85 | 7.94 | 13.8 |
| 04/21/21 | 2.0 | 8.1 | 7.54 | 8.28 | 13.6 |
| 05/05/21 | 0.5 | 9.4 | 7.80 | 4.12 | 19.5 |
| 05/05/21 | 1.0 | 9.1 | 7.85 | 4.74 | 19.4 |
| 05/05/21 | 1.5 | 6.7 | 7.71 | 6.83 | 19.2 |
| 05/05/21 | 2.0 | 6.8 | 7.53 | 7.39 | 18.7 |
| 05/19/21 | 0.5 | 18.1 | 9.66 | 4.30 | 20.6 |
| 05/19/21 | 1.0 | 17.2 | 9.48 | 4.45 | 20.4 |
| 05/19/21 | 1.5 | 13.2 | 9.30 | 4.32 | 19.5 |
| 05/19/21 | 2.1 | 10.2 | 9.12 | 4.75 | 19.2 |
| 06/03/21 | 0.5 | 6.7 | 7.87 | 5.78 | 20.8 |
| 06/03/21 | 1.0 | 7.2 | 7.73 | 5.81 | 20.6 |
| 06/03/21 | 2.0 | 3.4 | 7.50 | 5.89 | 20.6 |
| 07/15/21 | 0.5 | 8.8 | 8.23 | 6.29 | 29.4 |
| 07/15/21 | 1.0 | 7.9 | 8.07 | 6.32 | 28.6 |
| 07/15/21 | 1.5 | 4.7 | 7.60 | 6.46 | 28.1 |
| 07/15/21 | 1.9 | 4.6 | 7.60 | 6.49 | 28.1 |
| 07/28/21 | 0.5 | 14.1 | 9.03 | 5.10 | 29.9 |
| 07/28/21 | 1.0 | 13.5 | 8.91 | 5.14 | 30.2 |
| 07/28/21 | 1.5 | 13.9 | 9.01 | 5.08 | 29.4 |
| 07/28/21 | 1.8 | 11.8 | 8.87 | 5.11 | 28.9 |

**Table A-2 (continued). Ambient Water Quality Data for Dissolved Oxygen, pH, Salinity, and Water Temperature for Masonville Cove (XIE4742) in 2021.**

| Date | Sample Depth (m) | Dissolved Oxygen (mg/L) | pH | Salinity (ppt) | Water Temperature (°C) |
|---|---|---|---|---|---|
| 08/12/21 | 0.5 | 5.9 | 7.89 | 4.78 | 27.6 |
| 08/12/21 | 1.0 | 6.3 | no data | 4.02 | 27.3 |
| 08/12/21 | 1.5 | 6.2 | 7.99 | 4.78 | 27.8 |
| 08/12/21 | 1.8 | 5.7 | 7.89 | 4.78 | 27.7 |
| 08/26/21 | 0.5 | 7.4 | 8.17 | 6.49 | 28.6 |
| 08/26/21 | 1.0 | 7.3 | 8.24 | 6.53 | 28.2 |
| 08/26/21 | 1.5 | 6.0 | 8.03 | 7.01 | 28.1 |
| 08/26/21 | 1.9 | 4.6 | 7.81 | 7.19 | 28.0 |
| 09/08/21 | 0.5 | 7.2 | 8.18 | 6.49 | 25.0 |
| 09/08/21 | 1.0 | 6.9 | 8.03 | 6.52 | 24.8 |
| 09/08/21 | 1.5 | 4.1 | 7.65 | 6.78 | 25.0 |
| 09/08/21 | 2.0 | 3.0 | 7.50 | 6.87 | 25.1 |
| 09/23/21 | 0.5 | 5.9 | 8.25 | 4.82 | 24.5 |
| 09/23/21 | 1.0 | 6.2 | 8.24 | 4.86 | 24.4 |
| 09/23/21 | 1.5 | 5.9 | 8.25 | 4.88 | 24.5 |
| 09/23/21 | 2.0 | 5.9 | 8.25 | 4.92 | 24.5 |
| 09/23/21 | 2.4 | 5.7 | 8.22 | 4.93 | 24.5 |
| 10/07/21 | 0.5 | 10.9 | 8.79 | 4.54 | 23.6 |
| 10/07/21 | 1.0 | 5.6 | 8.62 | 4.53 | 23.4 |
| 10/07/21 | 1.5 | 10.0 | 8.72 | 4.54 | 23.0 |
| 10/07/21 | 1.8 | 9.7 | 8.70 | 4.57 | 22.9 |
| 10/21/21 | 0.5 | 6.0 | 7.46 | 9.90 | 20.1 |
| 10/21/21 | 1.0 | 6.4 | 7.44 | 9.78 | 20.0 |
| 10/21/21 | 1.5 | 2.8 | 7.20 | 11.22 | 21.5 |
| 11/02/21 | 0.5 | 7.1 | 7.45 | 6.18 | 15.6 |
| 11/02/21 | 1.0 | 7.1 | 7.36 | 6.37 | 15.8 |
| 11/02/21 | 1.5 | 6.6 | 7.41 | 6.63 | 16.1 |
| 11/02/21 | 1.9 | 6.5 | 7.41 | 6.71 | 16.2 |
| 12/09/21 | 0.5 | 13.4 | 8.58 | 6.08 | 6.0 |
| 12/09/21 | 1.0 | 12.9 | 8.29 | 5.91 | 5.8 |
| 12/09/21 | 1.5 | 13.3 | 8.60 | 6.53 | 6.1 |
| 12/09/21 | 1.8 | 13.1 | 8.57 | 6.76 | 6.4 |