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# 2014 Masonville Cove – Patapsco River Shallow Water Monitoring Data Report

## 20 April 2015

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# 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 twentieth 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) first 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 prior 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 2014.

Water quality conditions in Masonville Cove during 2014, as in the rest of the Chesapeake Bay watershed, were influenced by meteorological events. Heavy rains in April, as well as a major storm and several associated sanitary sewer overflows in mid-August, led to massive discharge events that affected salinity and turbidity. Nutrients in the August storm runoff may also have been a factor in the formation of algae blooms in Masonville Cove in late August and early September. However, both chlorophyll levels and dissolved oxygen readings showed improving trends for the second straight year. Colder than normal temperatures throughout 2014 may have played a role in suppressing algal growth and improving dissolved oxygen levels. All 2014 continuous monitoring data, as well as data from previous years, are available on the DNR "Eyes on the Bay" website (www.eyesonthebay.net). Data from grab samples are available through the Chesapeake Bay Program's Data Hub (www.chesapeakebay.net/data).

## 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 ten acres of upland habitat, and disturb one acre of vegetated wetland and 0.38 acres of submerged aquatic vegetation (SAV).

In 2014, as 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" (www.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 phaeophytin concentrations. The continuous monitoring site at Masonville Cove was the only continuous monitoring station located in the upper Patapsco in 2014.

### Description of continuous monitoring

For the entirety of 2014, 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 one 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 prior to 2013 (Figure 1). The location change was made so that DNR field personnel would be able to access the site during winter months, which now 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, OH), 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 (www.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" since 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.

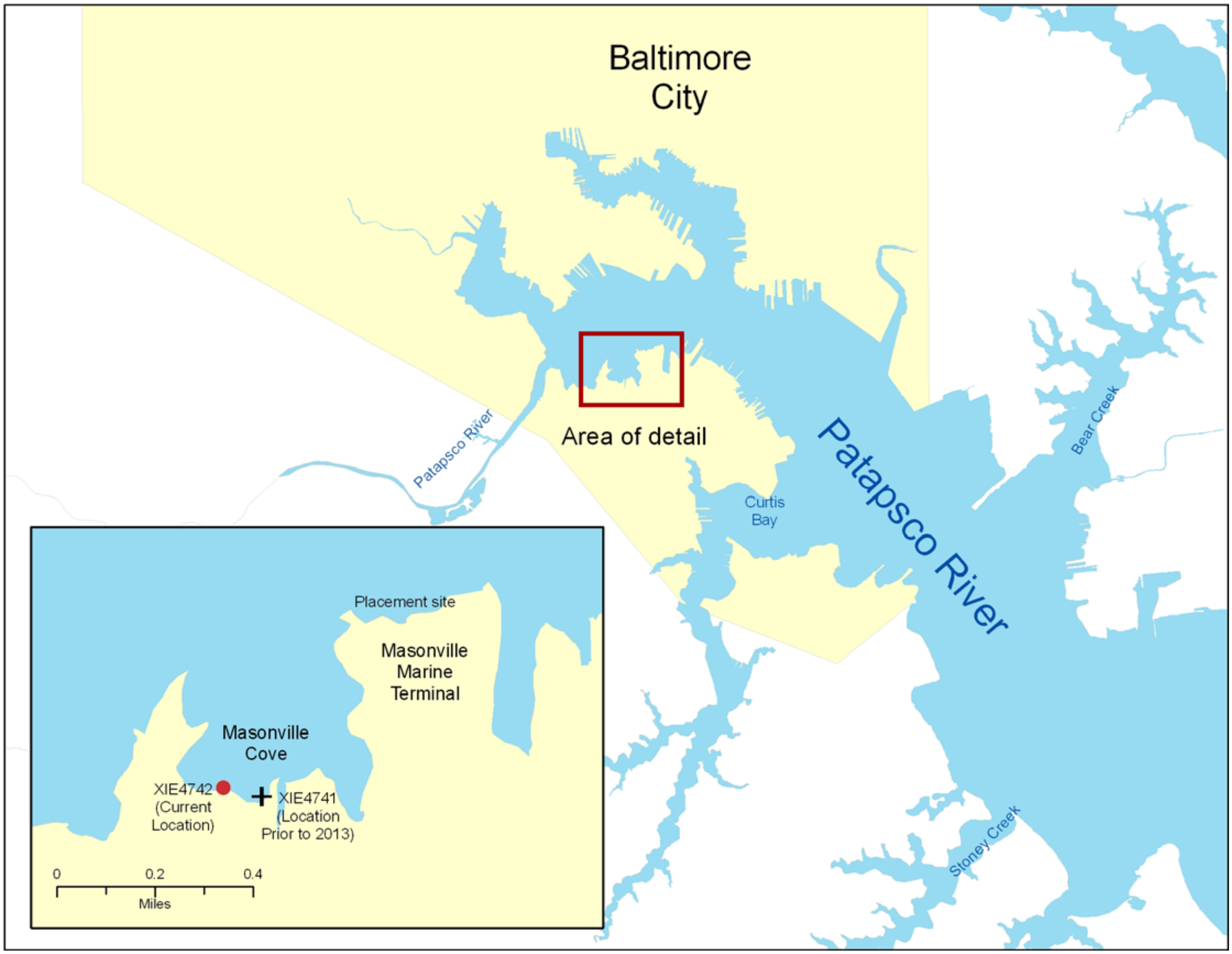



**Figure 1. Map of the Patapsco River and Masonville Cove. The inset shows the 2014 continuous monitor location within the cove, the location of the monitor prior to 2013, and the approximate site for dredged material placement.**

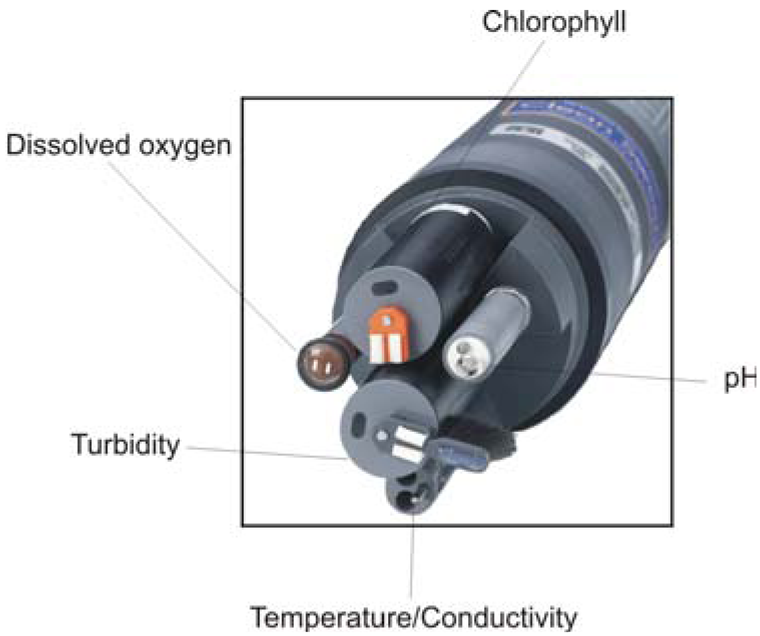



**Figure 2. YSI 6600 continuous monitoring sonde showing individual sensors. Image courtesy of YSI, Inc.**

### Continuous monitoring parameters

The continuous monitor at Masonville Cove, like all continuous monitors in the DNR Shallow Water Monitoring Program, collected 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, 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 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 higher 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 algae blooms (large algae blooms can raise the pH over 8 in low salinity waters).

5. Turbidity: Turbidity is a measure of water clarity. Events that stir up sediment or cause runoff, such as storms, will increase turbidity. Dense algae blooms will also cause higher turbidities. Relatively clear water (low turbidity) is required for growth and survival of submerged aquatic vegetation (SAV).
6. Chlorophyll: Chlorophyll concentration is a surrogate measure of the amount 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 of continuous monitoring data sondes. Discrete whole water samples were collected to measure chlorophyll *a*, phaeophytin, 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.

### Masonville Cove continuous monitor deployment

In 2014, the continuous monitor at Masonville Cove was deployed the entire year, the first time this has occurred since monitoring began in 2009. Data sondes collected 33,804 data records and twenty calibration samples were collected and analyzed in 2014. Automated telemetry generally operated throughout the deployment of the sonde, 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. The water quality monitor did not, however, collect data between March 27th and April 9th due to a sonde malfunction. Water quality data were also not collected between May 28th and June 3rd and between June 12th and June 19th due to sonde power failures. Additional gaps seen in the data are where questionable data were removed for quality assurance purposes.

## 2014 Precipitation and Discharge Events

Precipitation increases runoff into waterways, which can lead to a higher discharge 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 at Baltimore Washington International (BWI) Thurgood Marshall Airport was almost 11-inches greater than the 20-year average (Figure 3), making 2014 the 12th wettest year on record in Baltimore. Eight of the twelve months in 2014 were above average for precipitation and over 16-inches of rain fell in the two wettest months of April and August. The largest single event of 2014 occurred on August 12th as over 10-inches of rain fell in some areas of Central Maryland.

Daily mean discharge at the USGS gaging station in the Gwynns Falls reflected the pattern of precipitation seen in 2014 (Figure 4). Gage data show numerous spikes throughout 2014, which are indicative of the many precipitation events that affected the region during the wetter than normal year. The largest spike, associated with heavy rains in late April, was 100-times greater than the 49-year mean, reflecting very high discharge levels into the Patapsco River and Chesapeake Bay. Lowest flows occurred during March and September, and generally reflected the 49-year mean.

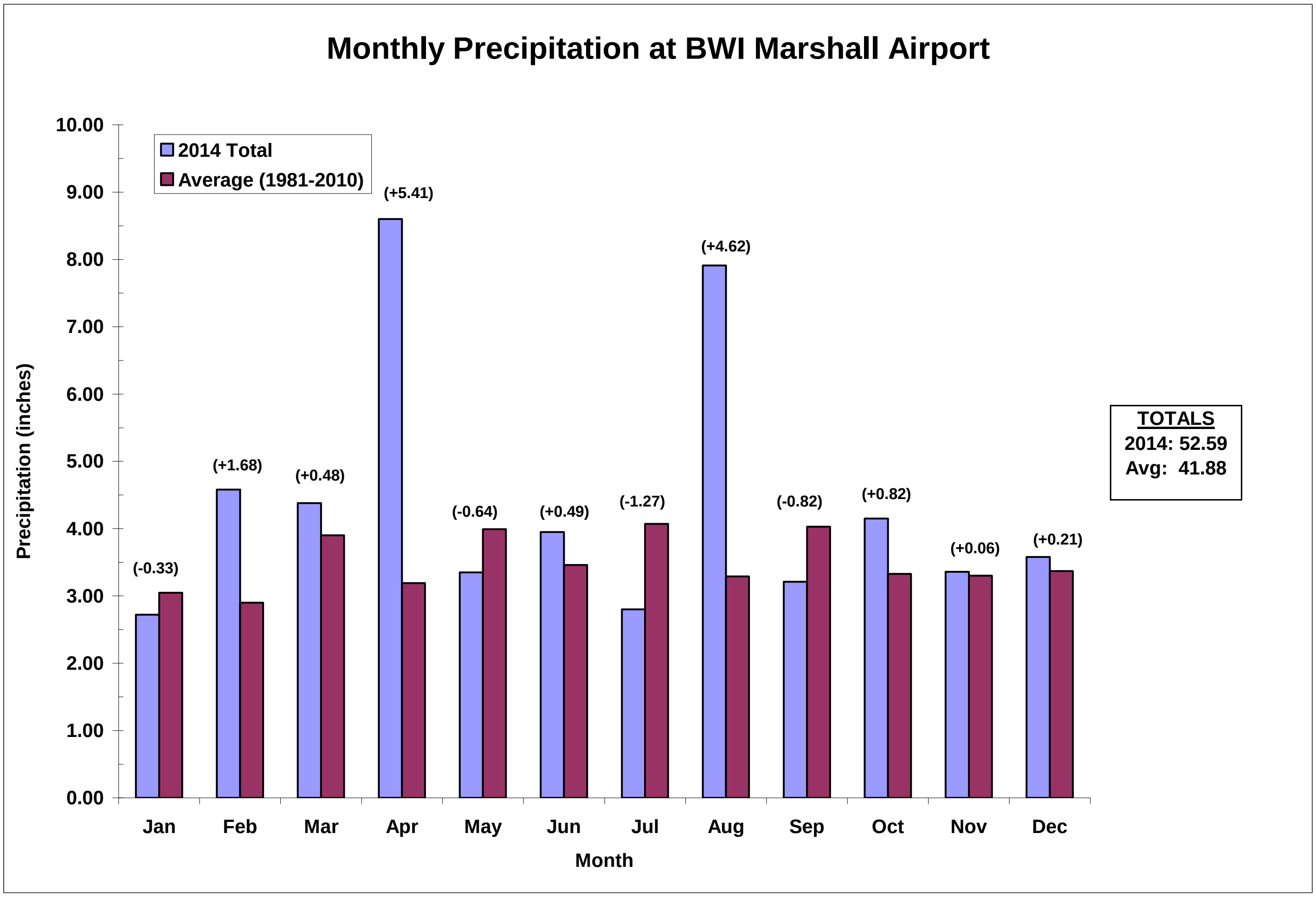



**Figure 3. Total monthly precipitation at BWI Thurgood Marshall Airport compared to 20-year averages for 2014. Data source: National Oceanographic and Atmospheric Administration (http://www.ncdc.noaa.gov/cdo-web/datasets/GHCNDMS/stations/GHCND:USW00093721/detail).**

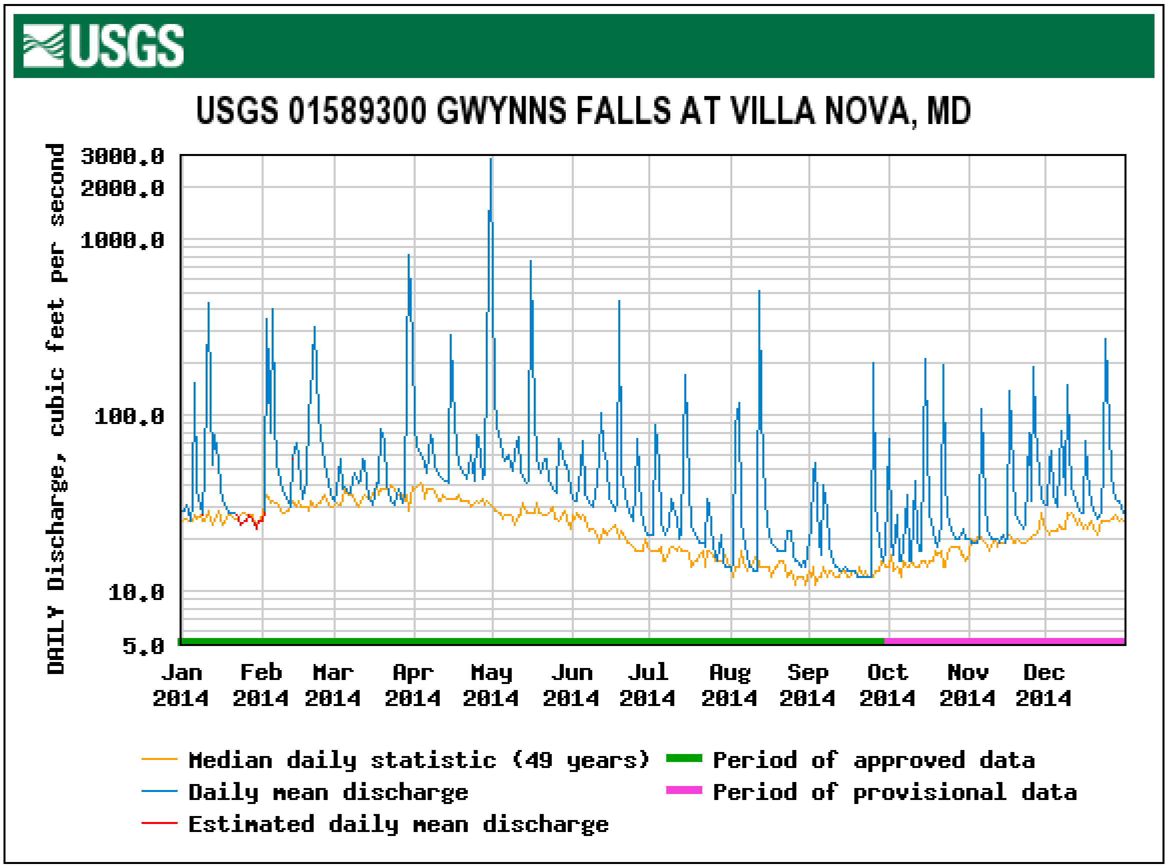



**Figure 4. Daily discharge in cubic feet per second measured at a USGS gaging station west of Masonville Cove. The y-axis is in logarithmic scale. Graph courtesy of the United States Geological Survey (http://waterdata.usgs.gov/nwis/dv/?site_no=01589300).**

## 2014 Continuous Monitoring Data

### Water Temperature

Water temperature at Masonville Cove rose predictably as air temperatures increased during the summer months (Figure 5). Water temperature peaked at approximately 30°C (86° F) on July 15th, declined slightly during a cooler than normal late-July and early-August, before peaking again at approximately 29°C (84° F) on September 6th. Water temperature then gradually declined through the rest of the year. Variability in the plots in Figure 5 was most likely a result of diel variation in temperature (warming temperatures during the day and cooling temperatures during the night).

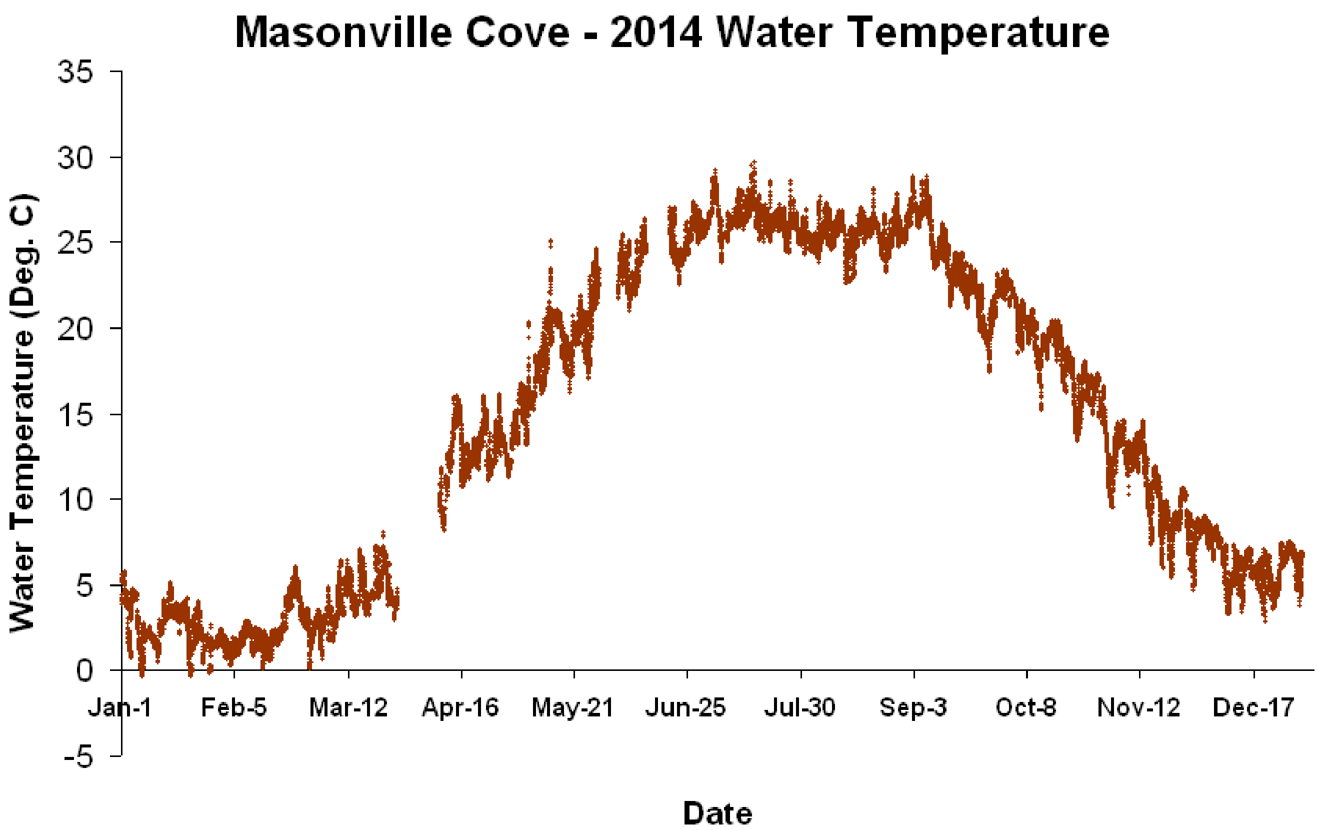



**Figure 5. Water temperature at Masonville Cove Continuous Monitor during 2014.**

## Salinity

Salinity tends to vary with precipitation and stream flow. The overall salinity trend in 2014 (Figure 6) began with steady or increasing salinities in late winter and early spring, coinciding with a slightly wetter than average first three months of the year (Figure 3). Salinity values then dropped precipitously in late spring as almost 9-inches of rain fell during April. In particular, salinity levels dropped from approximately 7 parts per thousand (ppt) to the lowest levels of the year at less than 1 ppt as heavy rains and associated discharge event affected Central Maryland on April 29$^{th}$ and 30$^{th}$. Beginning in late-May, salinity levels rose for much of the rest of the year, punctuated by periodic dips associated with precipitation and discharge events, to the highest levels of the year in mid to late-December.

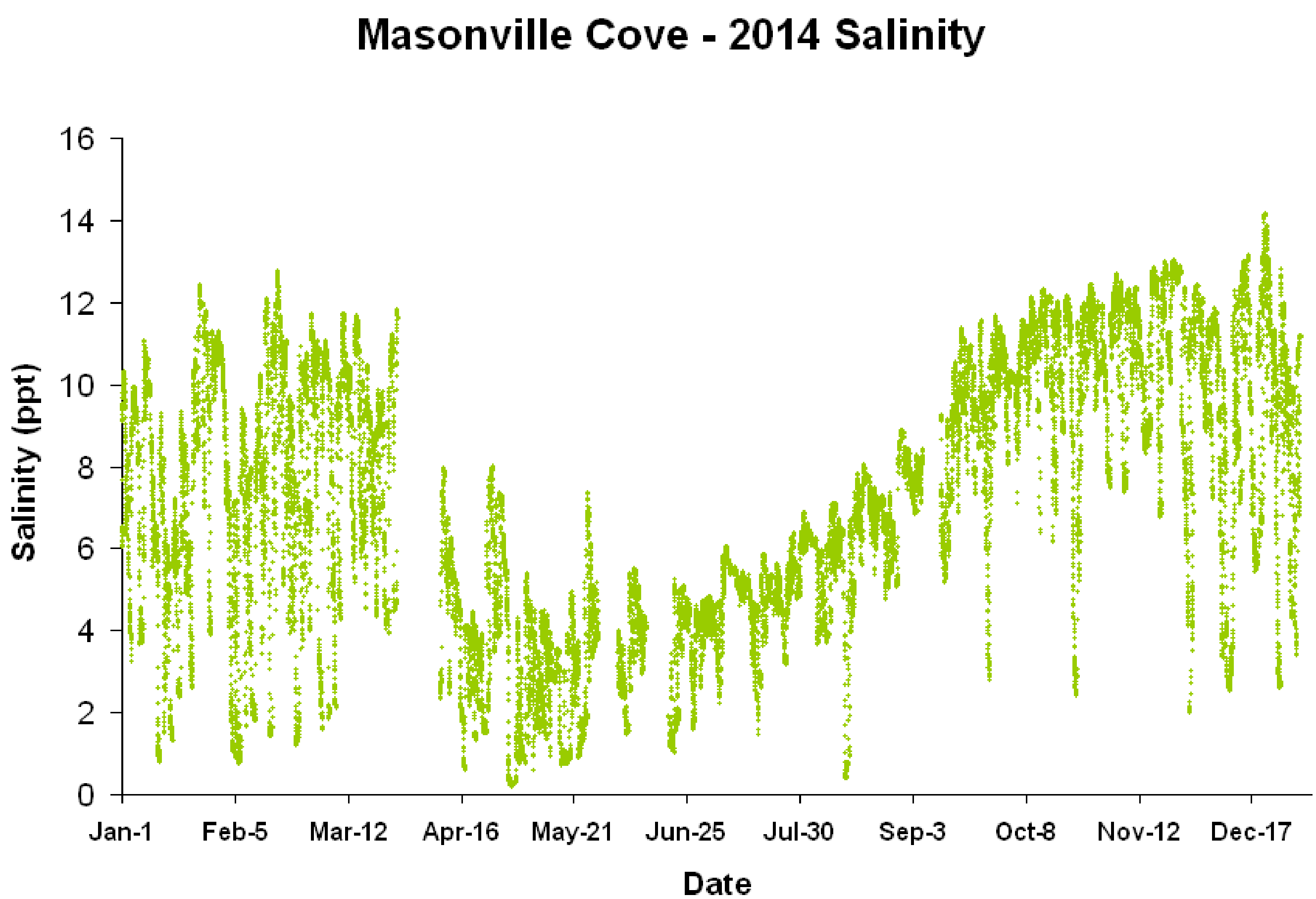



**Figure 6. Salinity levels at Masonville Cove Continuous Monitor during 2014.**

## Dissolved Oxygen

Dissolved oxygen (DO) values remained steady through the early spring of 2014, showed a general downward trend throughout the late spring and summer, before gradually increasing again in the fall (Figure 7). The summer decrease and fall increase were expected since warmer water carries less dissolved oxygen, while cooler water can hold more. DO also generally fluctuated on a daily (diel) basis, possibly due to photosynthetic activity and tidal influence.

A large number of DO readings between mid-June and mid-October were below 5 milligrams per liter (mg/L). Prolonged periods of low DO concentrations can stress and be detrimental to the survival of juvenile fish and other aquatic animals (US EPA, 2003). The lowest DO reading of 2014 was 0.29 mg/L on August 8$^{th}$.

Decreases in chlorophyll levels signal the death and decomposition of algal blooms and are often accompanied by a drop in dissolved oxygen levels. The decomposition process can consume significant amounts of dissolved oxygen in the water and can lead to conditions harmful to aquatic organisms. For example, decreases in dissolved oxygen levels to extremely low concentrations at the Masonville Cove water quality monitor coincided with drops in chlorophyll levels (Figure 8) on April 25th (2.91 mg/L), May 25th (1.88 mg/L), and September 17th (0.64 mg/L).

As part of the goal 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." 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 between April and September, which is generally the time of year that DO values are the lowest due to warmer waters. 2014 DO failure rates decreased for the second straight year and the 3.2 mg/L failure rate was the lowest since 2011. The 3.2 mg/L failure rate was also slightly below the 6-year average failure rate (10.2%) in Masonville Cove, while the 5 mg/L failure rate was approximately equal to the 6-year average (24%). Colder than normal temperatures throughout the year may have played a role in these reduced DO failure rates. Cooler water can hold more DO and 2014 was the 13th coldest year on record, and the coldest since 2003, in Baltimore.

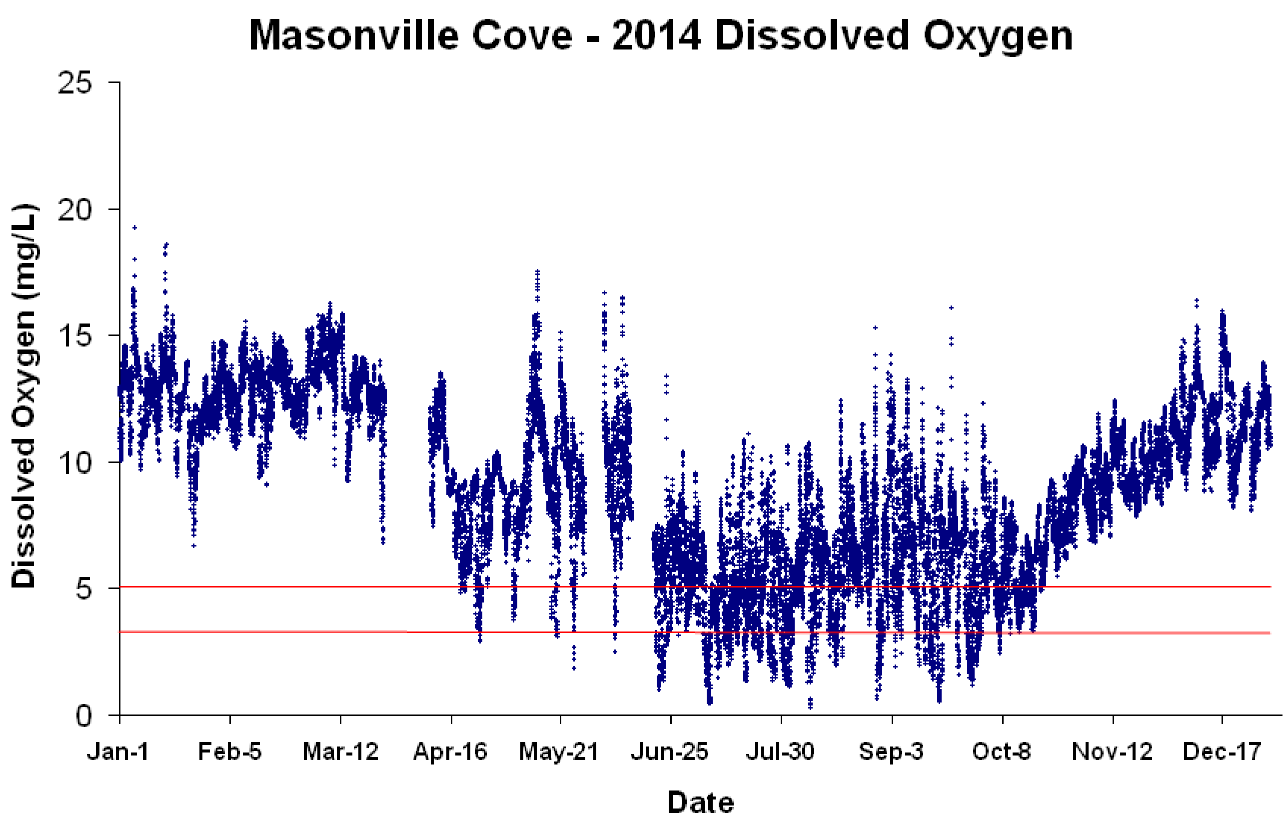



**Figure 7. Dissolved oxygen levels at Masonville Cove Continuous Monitor during 2014. (***Red lines indicate 5 mg/L and 3.2 mg/L criteria.)*

**Table 1. Dissolved oxygen criteria failure at Masonville Cove Continuous Monitor during June through November, 2009, March through October, 2010, and April through September, 2011 to 2014.**

| Continuous Monitor | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| **Surface** | | | | | | |
| Dissolved Oxygen less than 5 mg/L | 28.29% | 20.02% | 14.32% | 30.59% | 26.01% | **24.88%** |
| Dissolved Oxygen less than 3.2 mg/L | 9.89% | 8.61% | 8.17% | 14.20% | 11.73% | **8.81%** |

## Chlorophyll

Chlorophyll values tend to vary with, and are an indicator of, algal (phytoplankton) levels. Spikes 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, chlorophyll values indicated bloom conditions for much of the first three months of 2014 (Figure 8), including a potentially severe algal bloom in late March. Numerous chlorophyll readings were above 100 µg/L between March 23$^{rd}$ and March 29$^{th}$, with the highest value of the year (263.8 µg/L) occurring on March 25$^{th}$. Chlorophyll levels then dropped in April as heavy rains during the month flushed algae out of Masonville Cove. Chlorophyll values then rebounded to bloom conditions for much of the rest of the summer, including significant to severe levels during the first half of September. Chlorophyll levels then declined and remained low during much of October and early November, before increasing to bloom conditions for the rest of the year.

No potentially harmful algal blooms were documented in Masonville Cove in 2014. Information on all potential toxic algal blooms throughout Maryland's waterways can be found at DNR's Harmful Algal Bloom website (http://mddnr.chesapeakebay.net/eyesonthebay/habs.cfm).

As stated previously, chlorophyll readings of 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 violated these thresholds for Masonville Cove during the portion of the 2014 deployment that coincided with SAV growing season (March – October). Algal blooms during this period may impede the ability of SAV to grow and reproduce. Chlorophyll levels exceeded the 15 µg/L threshold during approximately 36% of the readings in 2014 (Table 2), which was the lowest failure rate since DNR began monitoring Masonville Cove in 2009. Chlorophyll levels exceeded the 50 µg/L during approximately 5% of the readings (Table 2), which was the lowest failure rate since 2011, and both failure rates were below the 6-year average failure rates (15 µg/L: 46.5%; 50 µg/L: 7.2%). It's possible that the colder than normal temperatures during 2014 may have suppressed algal growth and reduced threshold failure rates.

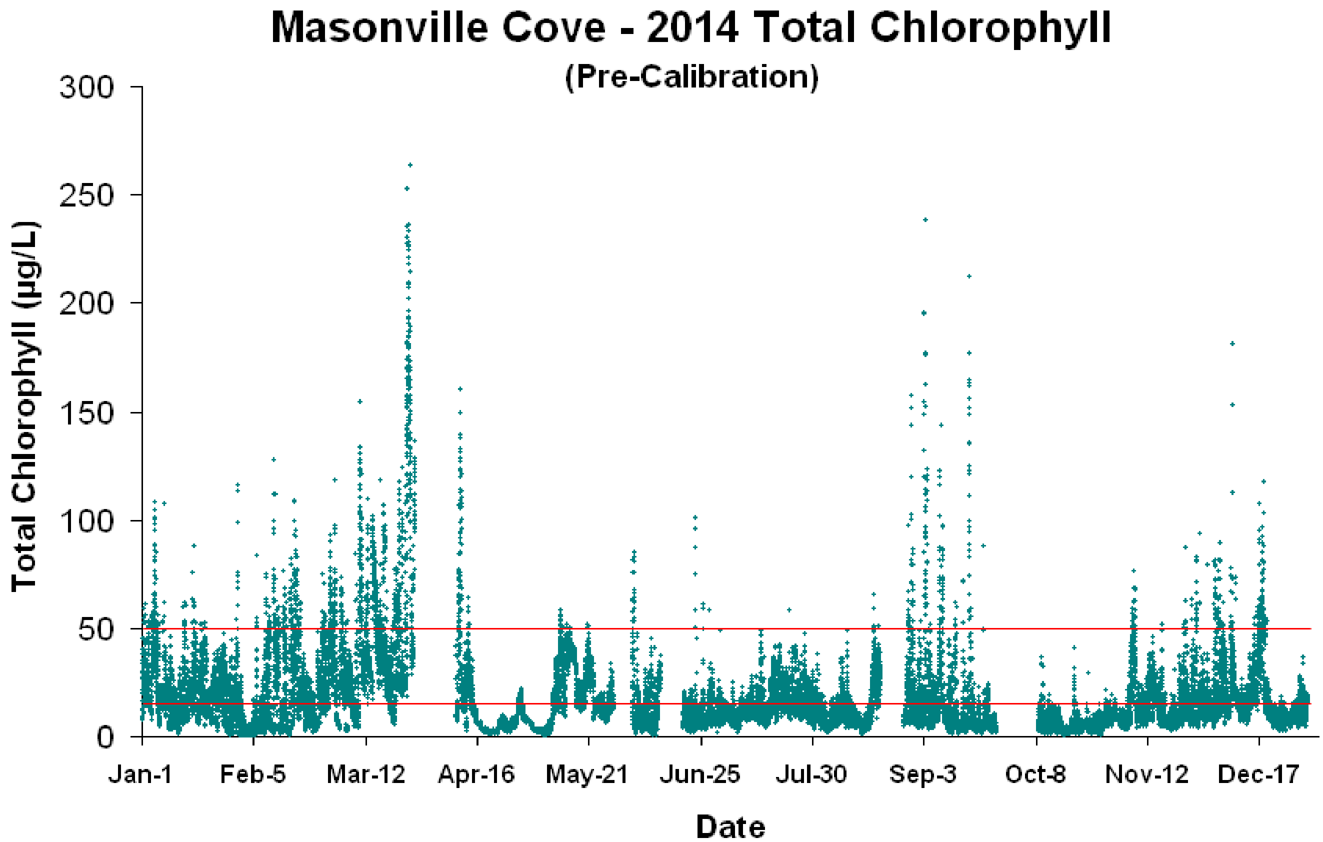



**Figure 8. Total chlorophyll levels at Masonville Cove Continuous Monitor during 2014.** *(Red lines indicate thresholds above which levels may have harmful effects on aquatic ecosystems---15mg/L-- or are considered significant blooms—50mg/L.)*

**Table 2. Chlorophyll threshold failure at Masonville Cove Continuous Monitor during June through November, 2009, and March through October, 2010 to 2014.**

| Continuous Monitor | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| **Surface** | | | | | | |
| Readings greater than 15 µg/L | 37.37% | 58.99% | 38.78% | 55.63% | 52.12% | **36.24%** |
| Readings greater than 50 µg/L | 3.28% | 6.58% | 0.87% | 14.52% | 10.50% | **5.24%** |

**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 can also give some indication that a blue-green algal bloom may have occurred (the chlorophyll sensors on the continuous monitors deployed at Masonville Cove were not designed to detect the wavelengths emitted by cyanobacteria). At Masonville Cove in 2014, pH peaked at 10.36 on January 5th (Figure 9), which coincided with chlorophyll values exceeding 100 µg/L (Figure 8). pH values remained above 9 through March, and exceeded 9.5 during a potentially severe algal bloom in late March, before the dilution effect from heavy rains in April reduced pH levels to 8 and below. pH values generally remained between 7 and 9 for the remainder of the year.

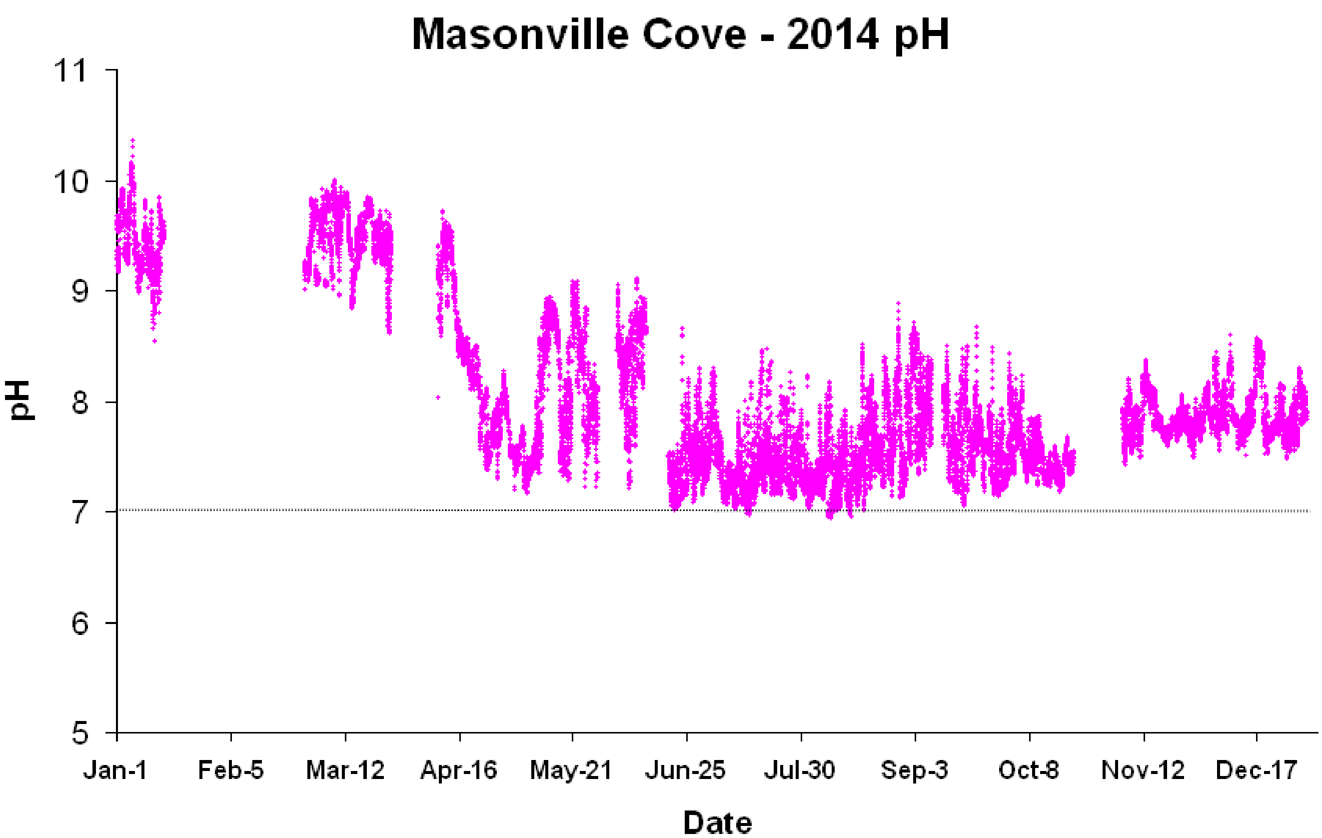



**Figure 9. pH levels at Masonville Cove Continuous Monitor during 2014.** *(Line indicates neutral pH.)*

## 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). During the year, there were only a couple time periods when turbidity levels spiked to above

100 NTU, and both of these occurred during and in the aftermath of heavy precipitation and discharge events. However values were generally high throughout the year (Figure 10). Masonville Cove turbidity levels were greater than 7 NTU for approximately 43% of all readings collected in 2014 (median value: 6.1 NTU).

Turbidity levels spiked from approximately 3 NTU on April 28th to almost 115 NTU on May 1st following heavy rains and associated discharge event that affected Central Maryland on April 29th and 30th. Levels then remained below 100 NTU until mid-August. A major storm impacted the Baltimore-Metropolitan region on August 12th, which led to a massive discharge event and several sanitary sewer overflows into the Patapsco River and associated tributaries (see further details below). Turbidity increased more than 50-fold during this time as readings went from approximately 5 NTU on August 11th to 265.1 NTU on August 13th.

Algal blooms can also negatively impact water clarity. Turbidity peaked at 42.2 NTU during the late-March algal bloom, and 29.3 NTU during the September bloom.

As stated previously, turbidity concentrations above 7 NTU are considered a threshold for detrimental effects on SAV. The water quality monitor at Masonville Cove was above this threshold for over half of the readings (Table 3) during the 2014 SAV growing season (March through October), which was similar to the 5-year average of 51.4%.

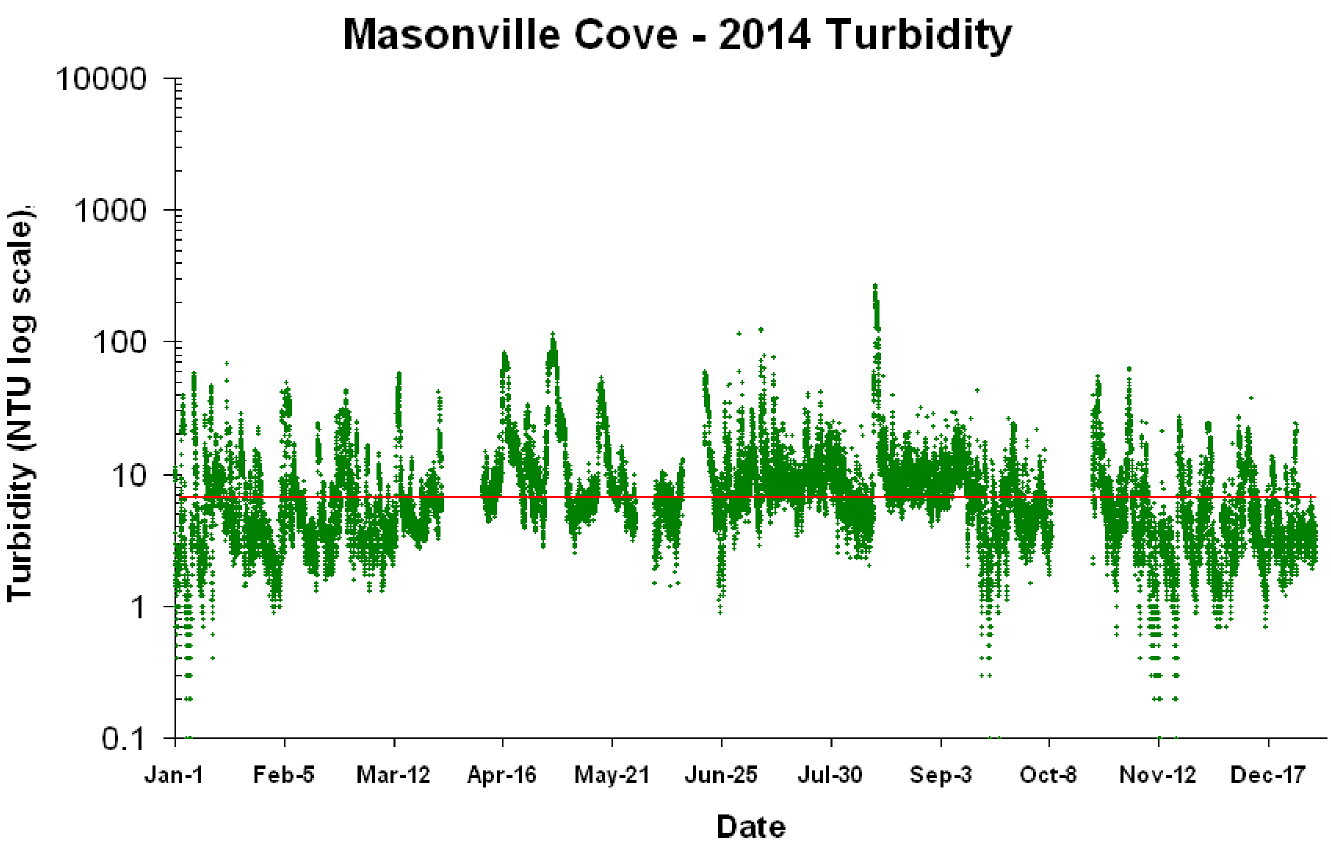



**Figure 10. Turbidity levels at Masonville Cove Continuous Monitor during 2014.** *(Red line indicates threshold above which levels are considered detrimental to bay grass growth.)*

**Table 3. Turbidity threshold failure at Masonville Cove Continuous Monitor during June through December, 2009, and March through October, 2010 to 2014.**

| Continuous Monitor | 2009 | 2010 | 2011 | 2012 | 2013 | **2014** |
|---|---|---|---|---|---|---|
| **Surface** | | | | | | |
| Readings greater than 7 NTU | 54.58% | 60.09% | 51.58% | 35.0% | 53.91% | **52.92%** |

## Heavy Rain and Massive Sewage Overflows Impact Baltimore Region and the Patapsco River

On August 12th, 2014, a major storm impacted the Baltimore-Metropolitan area as over 6-inches of rain fell at BWI Marshall Airport, with some areas in the region receiving up to 10-inches (Figure 11). Due to heavy rains overwhelming sanitary lines, three major sanitary sewer overflows (Figure 12) impacting the Patapsco River and associated tributaries were reported by the Baltimore City Department of Public Works on August 15th. The largest of these spills occurred at the Patapsco Wastewater Treatment Plant in Fairfield and dumped approximately three million gallons of untreated, diluted wastewater into the Patapsco River. A second sewage overflow occurred less than a half mile away and spilled approximately 170,300 gallons into the river. The last of these spills occurred at 1901 Falls Road and discharged 23,050 gallons into the Jones Falls. On August 22nd, the Department of Public Works reported that an additional nine million gallons of untreated, diluted sewage was spilled at three additional locations: Eager Street at Durham Street, the 1700 block of E. Chase Street, and the 2100 Block of Wicomico Street. Full details of these overflows can be found through the Baltimore City Department of Public Works website (http://publicworks.baltimorecity.gov/).

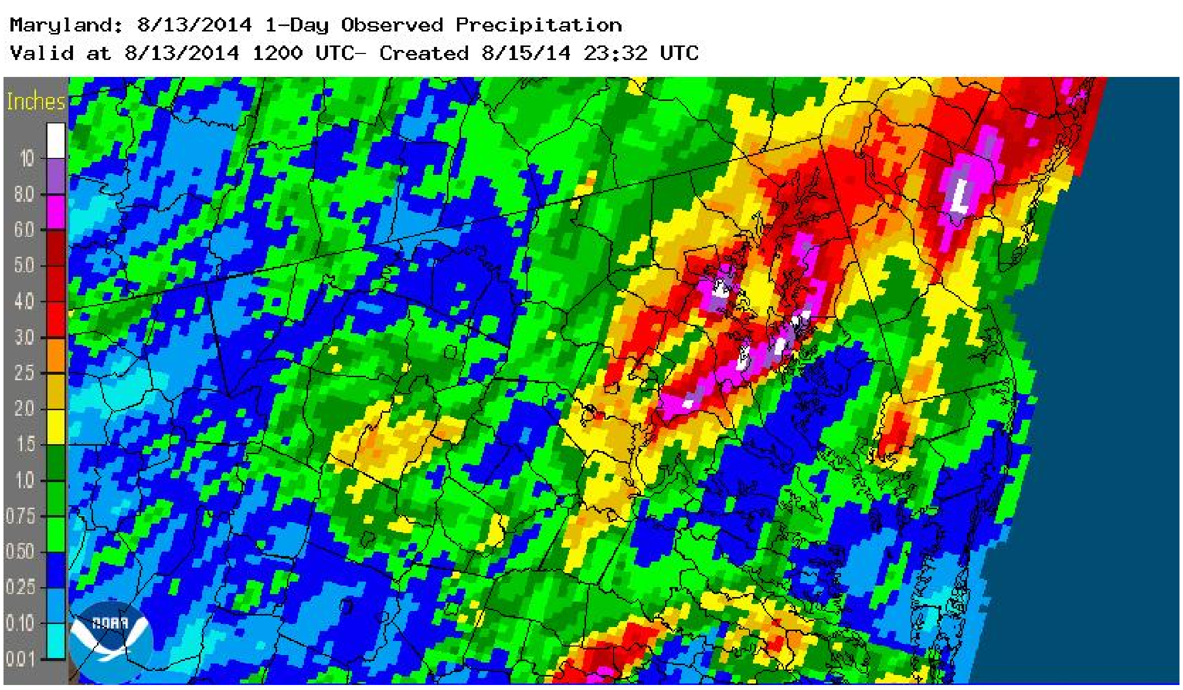
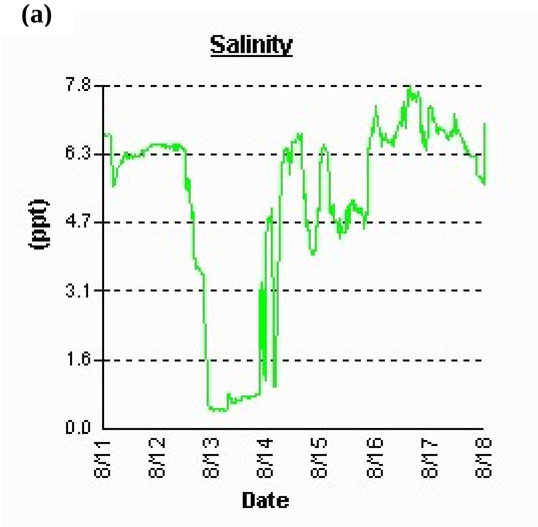



**Figure 11. National Weather Service map of 1-day observed precipitation on August 12th in Maryland. (http://water.weather.gov/precip/index.php)**


**Figure 12. Map of the Patapsco River showing the location of six reported sanitary sewer overflows on August 12th, and Maryland DNR's Continuous Monitor at Masonville Cove.**

Direct effects from two of the sanitary sewer overflows on August 12th that occurred at the Patapsco Wastewater Treatment Plant and a nearby pumping station are probably not evident in the Masonville water quality data because they occurred downstream of the cove. The Jones Falls, however, empties into the Patapsco River near the Baltimore Inner Harbor, upstream from Masonville Cove. Gwynns Falls, which was impacted by the spill on Wicomico Street, empties into the middle branch of the Patapsco, which is also upstream of the cove. The Patapsco River then flows past the communities of Curtis Bay, Dundalk, and Orchard Beach, before reaching the Chesapeake Bay at Fort Smallwood Park. Therefore, discharge from the Jones Falls and Gwynns Falls spills, as well as storm runoff from the land, may have impacted Masonville Cove.

Data collected from Masonville Cove show an influx of freshwater on the afternoon of August 12th as salinity levels dropped from almost 6.5 parts per thousand (ppt) to less than 0.5 ppt in twelve hours (Figure 13a). During this same time period, turbidity readings increased 50-fold (Figure 13b), and a Secchi disk reading taken by DNR field personnel on August 13th measured underwater visibility at less than 0.1m. These high turbidity levels and low Secchi reading indicate water discharged into the river brought high concentrations of particles and sediment that clouded the water.



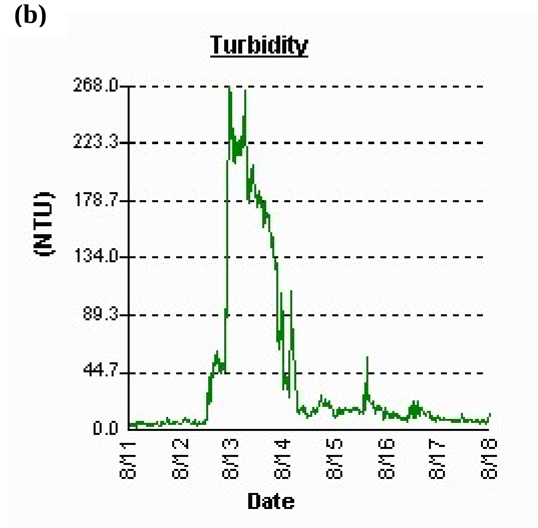




**Figure 13. Salinity (a) and turbidity (b) levels recorded between August 11th and August 18th, 2014 at Masonville Cove.**

Excessive nutrients, particularly nitrogen and phosphorus, also flow into waterways with storm runoff and sewer overflows and have the potential to fuel algal blooms. And as Figure 14 indicates, chlorophyll levels at Masonville Cove increased and repeatedly spiked in the weeks following the storm.

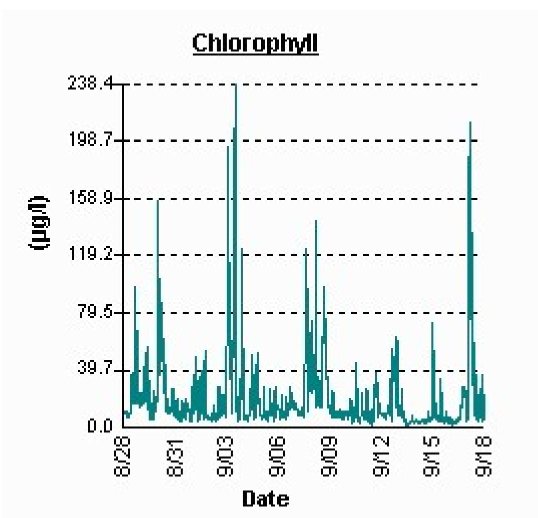



**Figure 14. Chlorophyll levels recorded between August 28th and September 18th, 2014 at Masonville Cove.**

## Late Spring Fish Kill in Upper Patapsco

A fish kill was reported in the Baltimore Harbor and upper Patapsco River on April 28th. Dissolved oxygen (DO) readings at Masonville Cove during this time indicate low DO levels may not have been responsible for the fish kill.

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

SAV, or underwater grasses, are an important component of estuarine ecosystems. They provide habitat for juvenile fish and shellfish, supply food for waterfowl, oxygenate the water, and help 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 15 shows total area and density of SAV within the Patapsco beginning in 1994 (the first year SAV was found in the river) through 2013. As of the publication date of this document, 2014 SAV data had not yet been released by the Chesapeake Bay Program.

Total area of SAV within the Patapsco River remains well below the restoration goal of 389 acres. 2005 was the single best year with 72% of the restoration goal achieved, including SAV beds within Masonville Cove. 2004 and 2005 were generally very good years for SAV throughout the Chesapeake Bay region and the increases in coverage have been attributed to an accompanying population explosion and range expansion of dark false mussels (*Mytilopsis leucophaeata*). These filter feeders may have increased water clarity and allowed SAV coverage to significantly expand (L. Karrh, MD DNR, personal communication). In 2006, the mussels died back, SAV beds disappeared in Masonville Cove, and total area of SAV within the Patapsco decreased 83%. In 2010, there was no SAV in the entire Patapsco River. As of 2013, there continued to be no SAV within Masonville Cove, as well as no SAV within the entire Patapsco River.

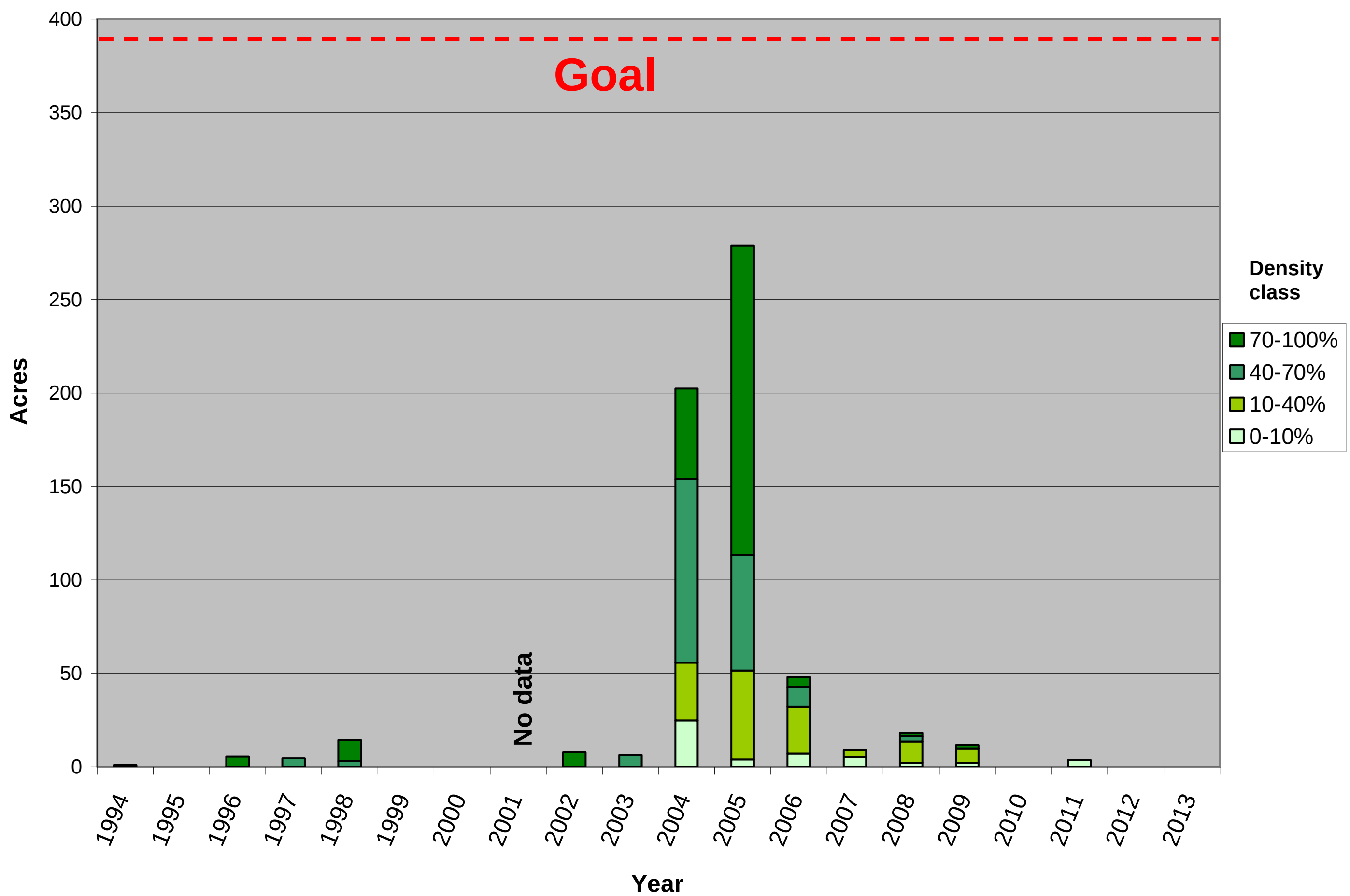



**Figure 15. Total area and density of SAV in the Patapsco River between 1994 and 2013. As of the publication date of this document, 2014 SAV data had not yet been released by the Chesapeake Bay Program. (*Restoration goal is 389 acres)***

## Pigments, Suspended Solids, and Secchi Data

Bi-weekly grab samples of water were taken at the Masonville Cove station when the YSI meters were exchanged during Continuous Monitoring cruises. Samples collected during November through March 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.

For the grab samples, the water was processed in the field using vacuum filtration, and the resulting particulate samples were delivered to the laboratory for analysis. Samples collected during Continuous Monitoring service visits were analyzed for pigments and suspended solids. 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 http://mddnr.chesapeakebay.net/eyesonthebay/documents/SWM_QAPP_2014_2015_Draft_v3.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 are also presented in Table A-1 of Appendix A.

Ambient water quality data (dissolved oxygen, pH, salinity, and water temperature) 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 0.5m depth intervals at the station. In the graphs, the data range for each profile is represented by a vertical bar for each sample date. The vertical bars are connected by a line that intersects each bar at the mean value for the station on that date. All data values for dissolved oxygen, pH, salinity, and water temperature are provided in Table A-2 of Appendix A.

**Table 4. Deployment and calibration record for Masonville Cove continuous monitor 2014.**

| Scheduled calibration date | Samples collected | Comment |
|---|---|---|
| January 9, 2014 | No | Ice precluded collection of samples and swapping of sonde. |
| January 15, 2014 | Yes | |
| February 12, 2014 | No | Ice precluded collection of samples and swapping of sonde. |
| February 27, 2014 | Yes | |
| March 26, 2014 | Yes | |
| April 9, 2014 | Yes | |
| April 22, 2014 | Yes | |
| May 6, 2014 | Yes | |
| May 20, 2014 | Yes | |
| June 3, 2014 | Yes | |
| June 19, 2014 | Yes | |
| July 2, 2014 | Yes | |
| July 15, 2014 | Yes | |
| July 31, 2014 | Yes | |
| August 13, 2014 | Yes | |
| August 27, 2014 | Yes | |
| September 11, 2014 | Yes | |
| September 25, 2014 | Yes | |
| October 8, 2014 | Yes | No profile conducted. |
| October 21, 2014 | Yes | |
| November 5, 2014 | Yes | |
| December 2, 2014 | Yes | |

Chlorophyll concentrations at Masonville Cove generally remained below 40 µg/l throughout 2014 (Figure A-1). The exception was a peak value of 83 µg/l on August 27$^{th}$. A corresponding peak in phaeophytin values (18 µg/l) was also observed on this date (Figure A-2). These peak chlorophyll and phaeophytin levels, measured in the grab samples, are consistent with higher values of chlorophyll recorded by the continuous monitoring data sonde at Masonville Cove in late August and early September (Figure 8). However, it should be noted that these laboratory results also included an error code, “Volume filtered not recorded (assumed)”. This error is assigned by the laboratory when the sample volume that was filtered in the field is in question. Since the reported concentrations are calculated based on the volume of water that was filtered, the chlorophyll and phaeophytin results are considered to be suspect values.

On August 12, 2014, the Baltimore region experienced an extremely heavy rainfall event as over six inches of rainfall were measured at BWI Marshall Airport (Figure 11). Field personnel visited the Masonville

Cove site on the following day, and the data results for total suspended solids (Figure A-3), Secchi depth (Figure A-4), and salinity (Figure A-6) reflect the effects of the storm on water quality. Due to turbid water conditions and a large amount of freshwater input, the concentration of total suspended solids on August 13th was 123 mg/l, Secchi depth was less than 0.1 m, and salinity was 0.4 ppt at the surface.

Dissolved oxygen (Figure A-5), pH (Figure A-7), and water temperature (Figure A-8) at Masonville Cove showed expected seasonal variability in 2014. Dissolved oxygen concentrations declined through the spring months and exhibited values below 5 mg/l in the bottom waters from June through September. Measured pH values at the site ranged from 7 to 9 in 2014, with the lowest values occurring during late spring and late summer. Beginning in April, water temperatures rose steadily, peaked at around 29 degrees C in July, and then gradually decreased through December.

## Conclusion

Shallow water monitoring was conducted in Masonville Cove in the upper Patapsco River during 2014. 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 2014, heavy rains in April and August led to sanitary sewer overflows and massive discharge events that affected salinity and turbidity. Algal bloom conditions occurred during the first three months of the year, and again for much of the summer, including significant to severe blooms during the first half of September. However, both chlorophyll and dissolved oxygen levels improved for the second straight year, possibly due in part to the colder than normal temperatures that occurred throughout 2014. Finally, as of 2013, no submerged aquatic vegetation was found in the entire Patapsco River. Therefore, conditions remain relatively 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 Chesapeake Bay water quality criteria for dissolved oxygen, water clarity and chlorophyll in shallow water habitats; 2) determining attainment or non-attainment 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). http://www.mdsg.umd.edu/MarineNotes/Mar-Apr01/

# Appendix A

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

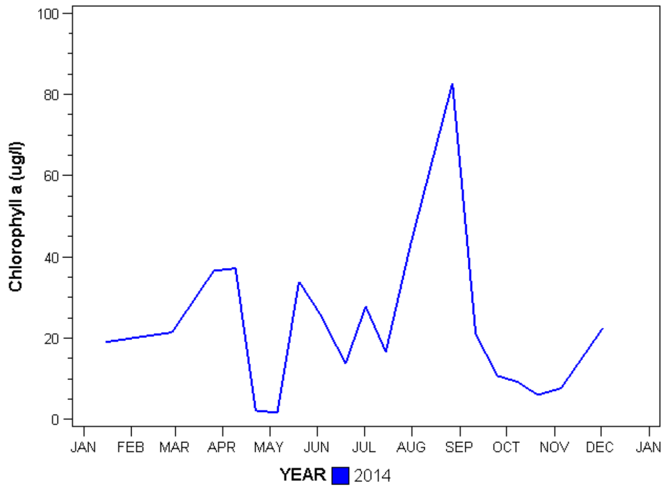



**Figure A-1. Chlorophyll *a* concentrations at Masonville Cove in 2014.**

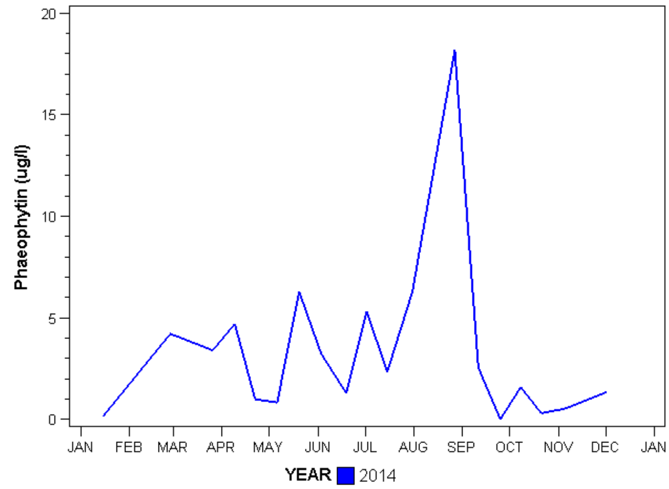



**Figure A-2. Phaeophytin concentrations at Masonville Cove in 2014.**

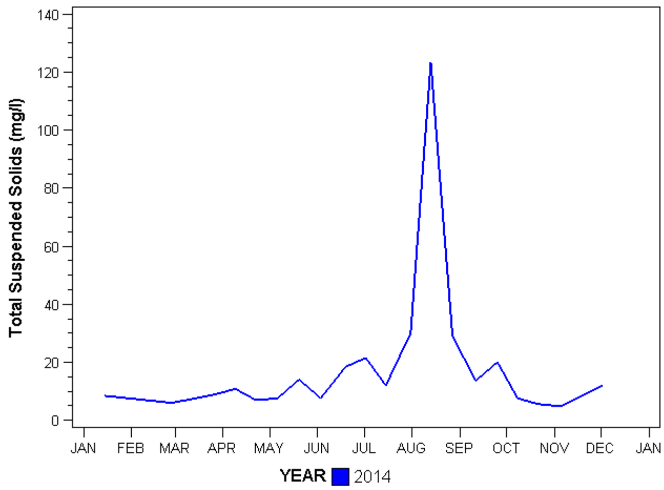



**Figure A-3. Total suspended solids concentrations at Masonville Cove in 2014.**

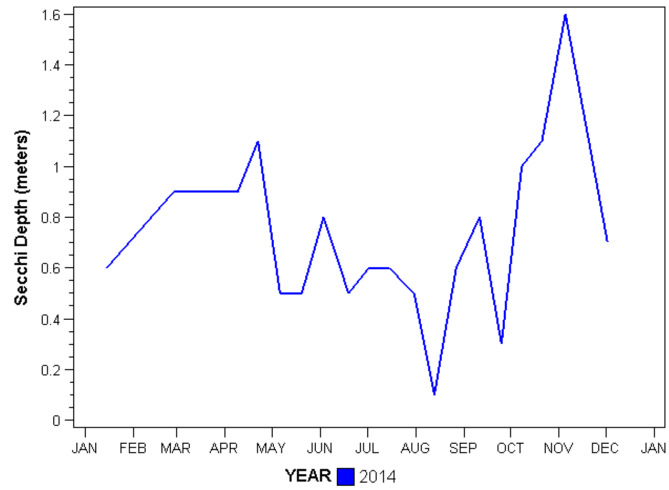



**Figure A-4. Secchi depth at Masonville Cove in 2014.**

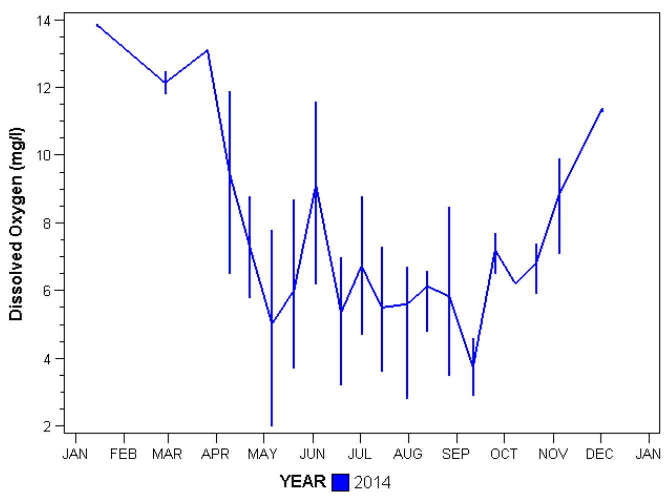



**Figure A-5. Dissolved oxygen concentrations at Masonville Cove in 2014.**

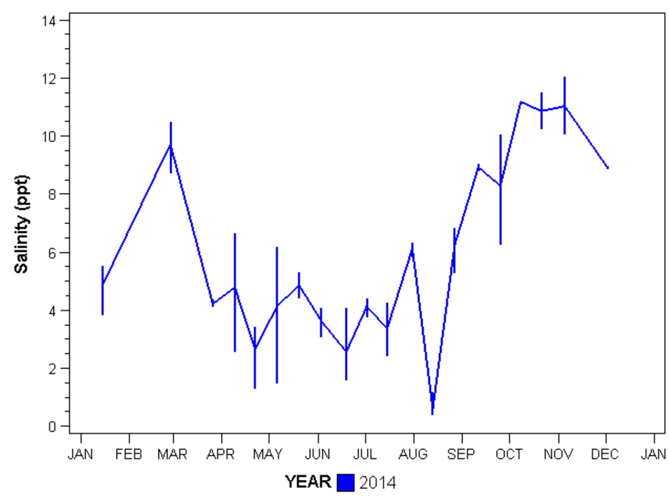



**Figure A-6. Salinity concentrations at Masonville Cove in 2014.**

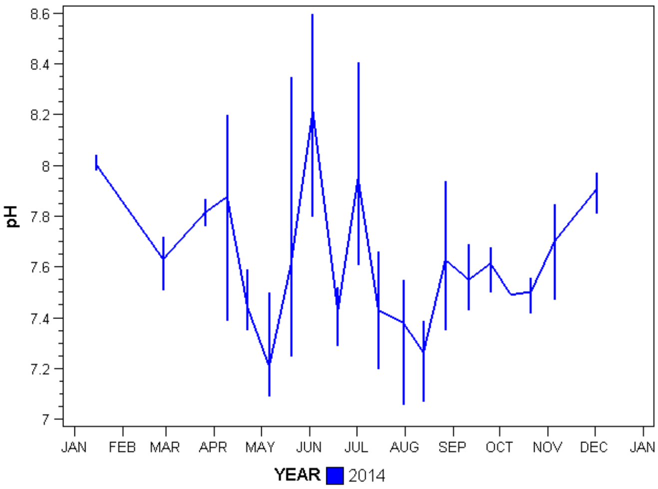



**Figure A-7. Values of pH at Masonville Cove in 2014.**

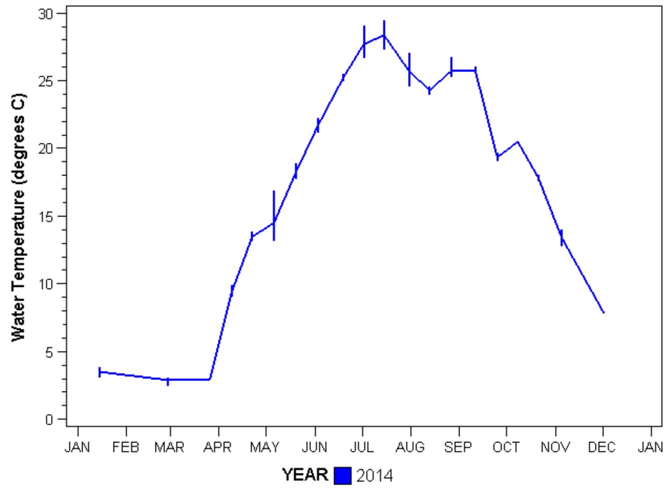



**Figure A-8. Water temperature at Masonville Cove in 2014.**

*Vertical bars within a graph represent the data range for each profile, with readings recorded at 0.5m depth intervals, and are intersected at the mean value.*

**Table A-1. Discrete Continuous Monitoring Data for Chlorophyll-a, Phaeophytin, Total Suspended Solids, and Secchi Disk Depth for Masonville Cove (XIE4742) in 2014.**

| Date | Sample Depth (m) | Chlorophyll-a (ug/L) | Phaeophytin (ug/L) | Total Suspended Solids (mg/L) | Secchi Depth (m) |
|---|---|---|---|---|---|
| 01/15/14 | 1 | 19.010 | 0.128 | 8.4 | 0.6 |
| 02/27/14 | 1 | 21.360 | 4.208 | 6.0 | 0.9 |
| 03/26/14 | 1 | 36.526 | 3.396 | 8.8 | 0.9 |
| 04/09/14 | 1 | 37.166 | 4.699 | 10.8 | 0.9 |
| 04/22/14 | 1 | 2.136 | 0.979 | 7.0 | 1.1 |
| 05/06/14 | 1 | 1.602 | 0.828 | 7.5 | 0.5 |
| 05/20/14 | 1 | 33.909 | 6.275 | 14.0 | 0.5 |
| 06/03/14 | 1 | 25.632 | 3.225 | 7.6 | 0.8 |
| 06/19/14 | 1 | 13.670 | 1.282 | 18.4 | 0.5 |
| 07/02/14 | 1 | 27.768 | 5.313 | 21.5 | 0.6 |
| 07/15/14 | 1 | 16.554 | 2.323 | 12.0 | 0.6 |
| 07/31/14 | 1 | 43.076 | 6.266 | 30.0 | 0.5 |
| 08/13/14 | 1 | no data (1) | no data (1) | 123.3 | < 0.1 |
| 08/27/14 | 1 | 82.770 (2) | 18.156 (2) | 29.0 (2) | 0.6 |
| 09/11/14 | 1 | 20.933 | 2.542 | 13.6 | 0.8 |
| 09/25/14 | 1 | 10.680 | 0.000 | 20.0 | 0.3 |
| 10/08/14 | 1 | 9.185 | 1.581 | 7.6 | 1.0 |
| 10/21/14 | 1 | 5.981 | 0.299 | 5.6 | 1.1 |
| 11/05/14 | 1 | 7.609 | 0.521 | 4.8 | 1.6 |
| 12/02/14 | 1 | 22.428 | 1.346 | 12.0 | 0.7 |

(1) Missing data value has an associated error code: "Sample results rejected due to quality control criteria".
(2) Data value has an associated error code: "Volume filtered not recorded (assumed)".

**Table A-2. Ambient Water Quality Data for Dissolved Oxygen (D.O.), pH, Salinity, and Water Temperature for Masonville Cove (XIE4742) in 2014 (continued on next page).**

| Date | Sample Depth (m) | D.O. (mg/L) | pH | Salinity (ppt) | Water Temperature ($^oC$) |
|---|---|---|---|---|---|
| 01/15/14 | 0.5 | 13.9 | 8.04 | 3.85 | 3.9 |
| 01/15/14 | 1.0 | 13.8 | 7.98 | 5.26 | 3.5 |
| 01/15/14 | 1.7 | 13.8 | 7.99 | 5.54 | 3.1 |
| 02/27/14 | 0.5 | 12.5 | 7.66 | 8.74 | 2.5 |
| 02/27/14 | 1.0 | 11.8 | 7.72 | 9.91 | 3.1 |
| 02/27/14 | 1.6 | 12.1 | 7.51 | 10.50 | 3.1 |
| 03/26/14 | 0.5 | 13.1 | 7.76 | 4.13 | 2.9 |
| 03/26/14 | 1.0 | no data (1) | no data (1) | 4.38 | 3.0 |
| 03/26/14 | 1.6 | 13.1 | 7.87 | 4.15 | 2.9 |
| 04/09/14 | 0.5 | 11.9 | 8.20 | 2.57 | 9.2 |
| 04/09/14 | 1.0 | 10.0 | 8.04 | 5.15 | 9.9 |
| 04/09/14 | 1.7 | 6.5 | 7.39 | 6.64 | 9.1 |
| 04/22/14 | 0.5 | 8.8 | 7.59 | 1.31 | 13.9 |
| 04/22/14 | 1.0 | 7.9 | 7.46 | 2.70 | 13.6 |
| 04/22/14 | 1.5 | 5.8 | 7.35 | 3.16 | 13.2 |
| 04/22/14 | 1.8 | 6.6 | 7.37 | 3.44 | 13.2 |
| 05/06/14 | 0.5 | 7.8 | 7.50 | 1.47 | 16.9 |
| 05/06/14 | 1.0 | 6.0 | 7.14 | 2.48 | 15.5 |
| 05/06/14 | 1.5 | 4.7 | 7.16 | 5.09 | 13.6 |
| 05/06/14 | 2.0 | 4.6 | 7.15 | 5.51 | 13.4 |
| 05/06/14 | 2.3 | 2.0 | 7.09 | 6.20 | 13.2 |
| 05/20/14 | 0.5 | 8.7 | 8.35 | 4.41 | 18.9 |
| 05/20/14 | 1.0 | 7.6 | 7.58 | 4.60 | 18.6 |
| 05/20/14 | 1.5 | 3.7 | 7.25 | 5.09 | 17.9 |
| 05/20/14 | 2.0 | 4.0 | 7.26 | 5.31 | 17.8 |
| 06/03/14 | 0.5 | 11.0 | 8.60 | 3.09 | 22.3 |
| 06/03/14 | 1.0 | 11.6 | 8.46 | 3.23 | 22.1 |
| 06/03/14 | 1.5 | 8.9 | 8.20 | 3.81 | 21.7 |
| 06/03/14 | 2.0 | 7.9 | 8.01 | 3.94 | 21.3 |
| 06/03/14 | 2.3 | 6.2 | 7.80 | 4.09 | 21.2 |
| 06/19/14 | 0.5 | 6.6 | 7.52 | 1.60 | 25.5 |
| 06/19/14 | 1.0 | 7.0 | 7.51 | 1.66 | 25.4 |
| 06/19/14 | 1.5 | 4.6 | 7.38 | 2.89 | 25.0 |
| 06/19/14 | 2.0 | 3.2 | 7.29 | 4.10 | 25.0 |

(1) Missing data value has an associated error code: "Instrument failure".

**Table A-2 (continued). Ambient Water Quality Data for Dissolved Oxygen (D.O.), pH, Salinity, and Water Temperature for Masonville Cove (XIE4742) in 2014.**

| Date | Sample Depth (m) | D.O. (mg/L) | pH | Salinity (ppt) | Water Temperature ($^{o}C$) |
|---|---|---|---|---|---|
| 07/02/14 | 0.5 | 8.8 | 8.41 | 3.76 | 29.1 |
| 07/02/14 | 1.0 | 8.3 | 8.10 | 3.94 | 28.2 |
| 07/02/14 | 1.5 | 5.1 | 7.68 | 4.38 | 26.8 |
| 07/02/14 | 2.1 | 4.7 | 7.61 | 4.42 | 26.7 |
| 07/15/14 | 0.5 | 7.3 | 7.56 | 2.43 | 29.5 |
| 07/15/14 | 1.0 | 7.3 | 7.66 | 2.63 | 29.3 |
| 07/15/14 | 1.5 | 3.8 | 7.20 | 4.15 | 27.3 |
| 07/15/14 | 2.0 | 3.6 | 7.30 | 4.27 | 27.3 |
| 07/31/14 | 0.5 | 6.4 | 7.46 | 6.14 | 27.1 |
| 07/31/14 | 1.0 | 6.7 | 7.55 | 5.82 | 25.7 |
| 07/31/14 | 1.5 | 6.5 | 7.45 | 6.20 | 25.3 |
| 07/31/14 | 2.1 | 2.8 | 7.06 | 6.34 | 24.6 |
| 08/13/14 | 0.5 | 6.6 | 7.30 | 0.39 | 24.6 |
| 08/13/14 | 1.0 | 6.6 | 7.07 | 0.41 | 24.5 |
| 08/13/14 | 1.5 | 6.5 | 7.39 | 0.41 | 24.0 |
| 08/13/14 | 2.1 | 4.8 | 7.29 | 1.20 | 24.1 |
| 08/27/14 | 0.5 | 8.5 | 7.94 | 5.30 | 26.8 |
| 08/27/14 | 1.0 | 6.5 | 7.78 | 6.30 | 25.4 |
| 08/27/14 | 1.5 | 4.8 | 7.44 | 6.57 | 25.3 |
| 08/27/14 | 2.0 | 3.5 | 7.35 | 6.85 | 25.5 |
| 09/11/14 | 0.5 | 4.6 | 7.67 | 8.78 | 26.1 |
| 09/11/14 | 1.0 | 4.6 | 7.69 | 9.04 | 25.8 |
| 09/11/14 | 1.5 | 3.6 | 7.51 | 8.83 | 25.7 |
| 09/11/14 | 2.0 | 3.0 | 7.45 | 8.98 | 25.5 |
| 09/11/14 | 2.3 | 2.9 | 7.43 | 9.02 | 25.6 |
| 09/25/14 | 0.5 | 7.4 | 7.68 | 6.27 | 19.1 |
| 09/25/14 | 1.0 | 7.7 | 7.66 | 8.51 | 19.2 |
| 09/25/14 | 1.7 | 6.5 | 7.50 | 10.07 | 19.7 |
| 10/08/14 | 1.0 | 6.2 | 7.49 | 11.18 | 20.5 |
| 10/21/14 | 0.5 | 6.8 | 7.55 | 10.26 | 17.6 |
| 10/21/14 | 1.0 | 7.4 | 7.42 | 10.62 | 17.8 |
| 10/21/14 | 1.5 | 7.1 | 7.56 | 11.05 | 17.9 |
| 10/21/14 | 1.9 | 5.9 | 7.48 | 11.51 | 18.1 |
| 11/05/14 | 0.5 | 9.6 | 7.78 | 10.06 | 12.8 |
| 11/05/14 | 1.0 | 9.9 | 7.85 | 10.96 | 13.4 |
| 11/05/14 | 1.7 | 7.1 | 7.47 | 12.07 | 14.0 |
| 12/02/14 | 0.5 | 11.4 | 7.97 | 8.89 | 7.8 |
| 12/02/14 | 1.0 | 11.3 | 7.81 | 8.89 | 7.8 |
| 12/02/14 | 1.6 | 11.4 | 7.94 | 9.00 | 7.8 |