

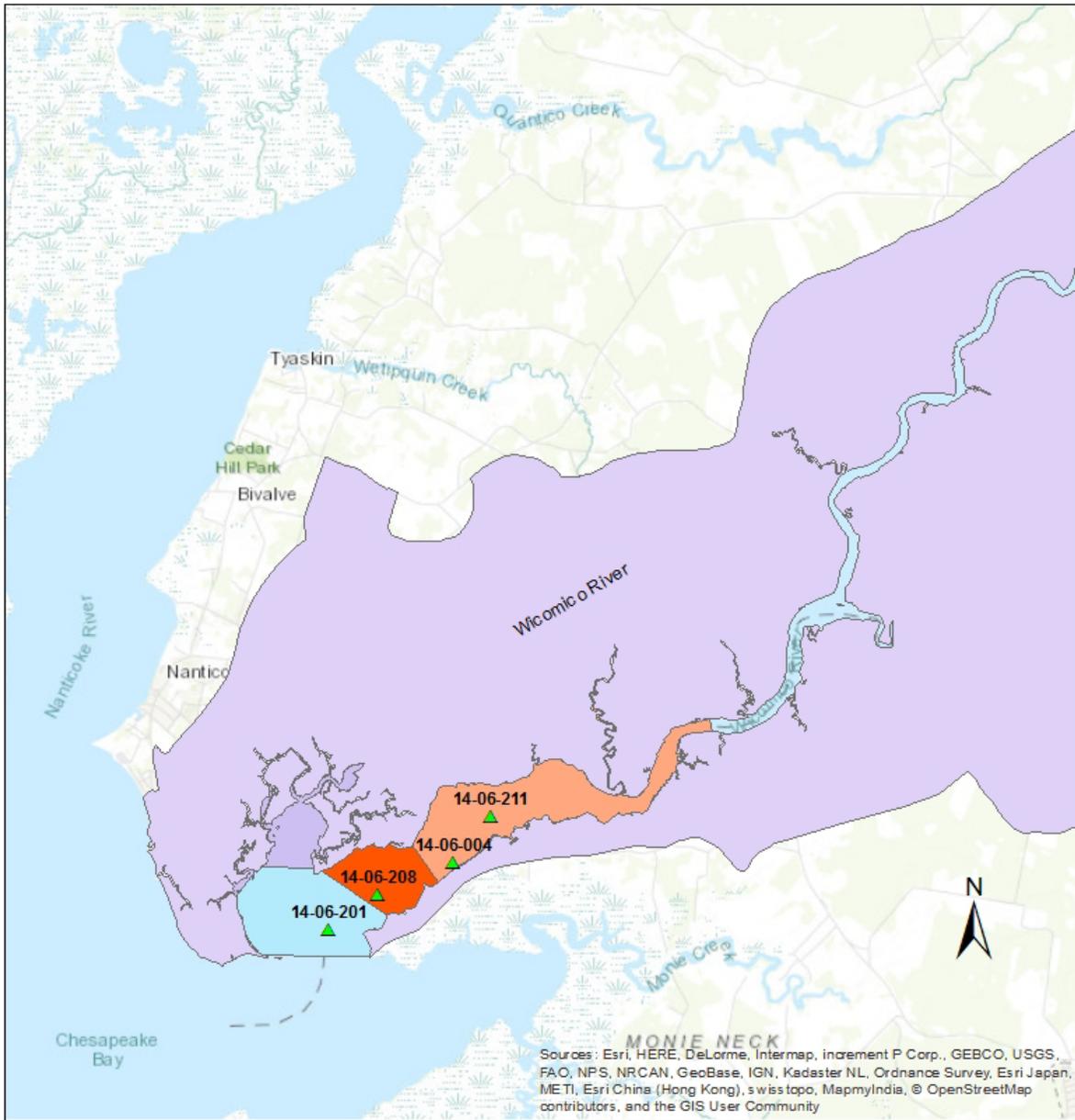
Appendix F: Extended Restricted Shellfish Harvesting Area in Lower Wicomico River Mainstem

Background

On June 18, 2008, the U.S. Environmental Protection Agency (USEPA) approved the “Total Maximum Daily Loads of Fecal Coliform for the Restricted Shellfish Harvesting Area in the Lower Wicomico River Basin in Wicomico and Somerset Counties, Maryland” developed by the Maryland Department of the Environment (MDE). In 2010, subsequent to the approval of the TMDL by USEPA, a shellfish harvesting area directly downstream of the impairment addressed in the 2008 TMDL was listed as impaired on the Integrated Report (IR). The assessment unit listing code for this area in Maryland’s 2010 Integrated Report is MD-WICMH-WICOMICO_RIVER_2.

Despite not being explicitly assessed within the 2008 TMDL due to the absence of an impairment, the 2010 listing was entirely covered by the 2008 modeling. The watershed for the 2010 listing was fully defined within the drainage to the 2008 TMDL segment; watershed loads, water quality, and hydrodynamics of this reach were explicitly simulated in the HEM-3D model for the TMDL. Within the TMDL, median reductions of 55.23% and 90th-percentile reductions of 59.20% were applied evenly to all of the subwatersheds draining directly to both the original impairment and to the 2010 impairment. Based on the spatial compatibility of the 2010 listing within the 2008 TMDL framework, it is expected that any reductions to meet the 2008 TMDL would result in a similar water quality response for the 2010-listed shellfish harvesting area. This addendum will demonstrate that these TMDL reductions would result in the attainment of water quality standards in that segment, and that the TMDL framework is fully protective of the mainstem section of the Wicomico River that was listed in 2010.

With the approval of this addendum by the USEPA, the shellfish harvesting area covered by the 2008 TMDL will be extended to cover the assessment unit MD-WICMH-Wicomico_River-2. Figure F-1 depicts the location of the 2008 TMDL and the area added to that TMDL covered by this addendum.



Shellfish Water Listing Category	
	2-Meets Water Quality Criterion
	4a-Impaired, 2008 Segment
	5-Impaired, 2010 Listing
	Wicomico Station
	Wicomico TMDL Drainage Area

0 0.5 1 2 Miles



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Figure F-1: Restricted Shellfish Harvesting Area in the Lower Wicomico River Mainstem

Water Quality Assessment

Maryland’s listing methodology for shellfish harvesting waters states, “In order to demonstrate support of the shellfish harvesting designated use, the measured level of fecal coliform in water, expressed as MPN/100 ml (most probable number of colony forming units per 100 milliliters), must have a median of less than 14 and a 90th-percentile of less than 49, calculated from a minimum of 30 samples taken over a three year period” (MDE 2017).

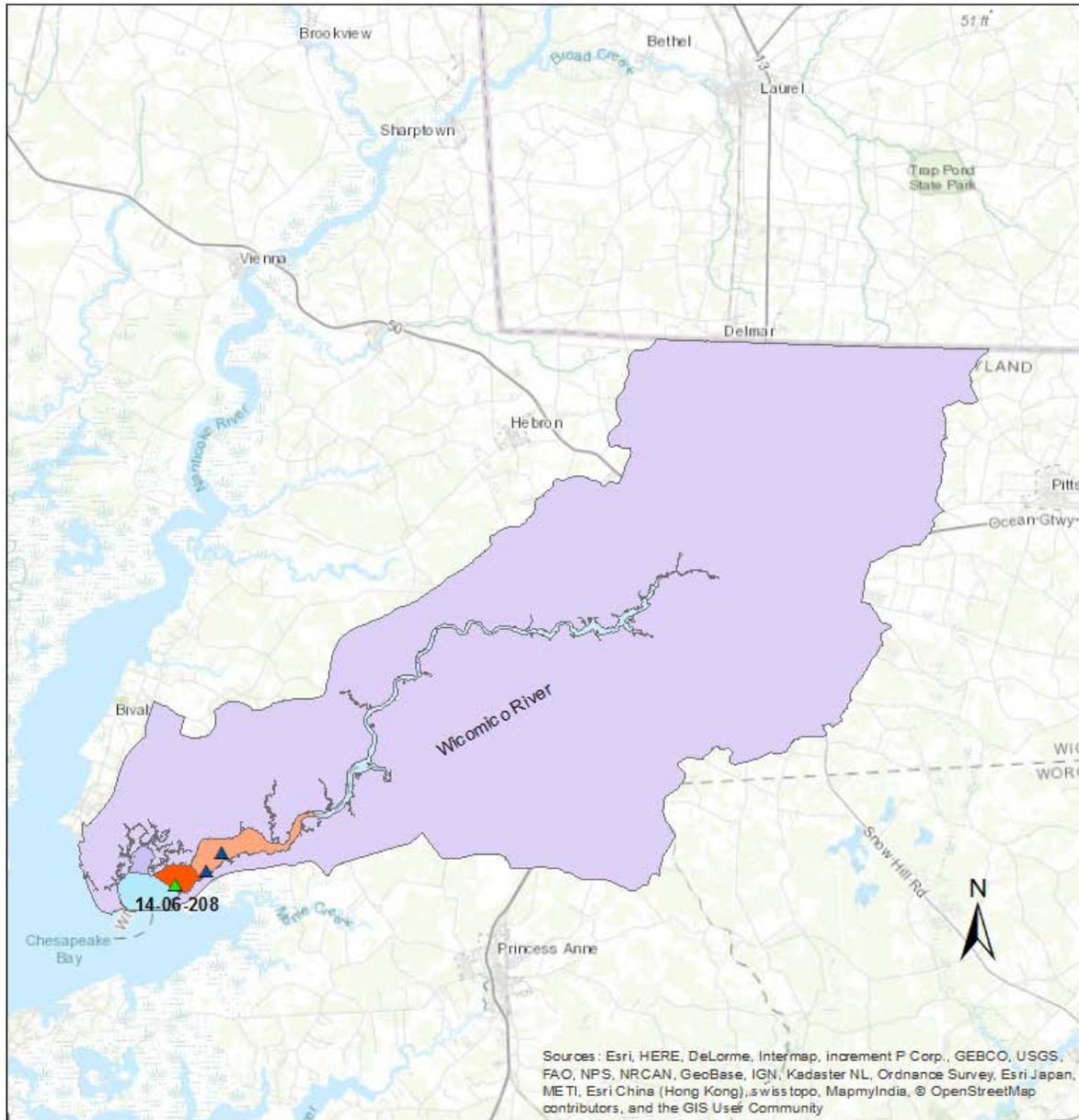
The 2010 listing is based on the fecal coliform data at Station 14-06-208. A data assessment based on 30 samples collected from September 12, 2013 to January 12, 2017 is shown in Table F-1. The median fecal coliform concentration value at this station meets the criterion, but the 90th-percentile fecal coliform concentration value exceeds the criterion.

Table F-1: Water Quality Assessment of Fecal Coliform at Station 14-06-208

Based on the most recent 30 samples – 9/12/2013 to 1/12/2017		
Station	Median (MPN/100ml)	90th percentile (MPN/100ml)
14-06-208	9.1	62.2
Criterion	14	49

Watershed

The watershed covered by the 2008 TMDL for fecal coliform in the Lower Wicomico River, shown in Figure F-2, is coincident with the watershed that drains to Station 14-06-208. This station is located directly downstream of the restricted shellfish harvesting area addressed by the TMDL, so any implementation actions for the 2008 TMDL would provide a benefit there as well.



Shellfish Water Listing Category

- 2-Meets Water Quality Criterion
- 4a-Impaired, 2008 Segment
- 5-Impaired, 2010 Listing
- Station listed as impaired in 2010
- Stations addressed in 2008 TMDL
- Wicomico TMDL Drainage Area



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Figure F-2: The Watershed Covered by the 2008 TMDL for Fecal Coliform in the Lower Wicomico River

In order to understand the spatial patterns of fecal coliform concentrations within the river, data from three other mainstem stations were analyzed, dating from April 2000 to January 2017. From upstream to downstream the Stations are 14-06-211 and 14-06-004, located in the shellfish harvesting area addressed by the original TMDL, and 14-06-201, located downstream of the extended restricted area, closest to the mainstem of the Chesapeake Bay. The locations of these stations are shown in Figure F-1.

Data Analysis

Figure F-3 shows a box plot of the fecal coliform concentrations at these four stations, for data collected over the last 17 years. The plot shows maximum, 90th-percentile, median and 25th-percentile fecal coliform concentrations decreasing with proximity to the mainstem of the Chesapeake Bay.

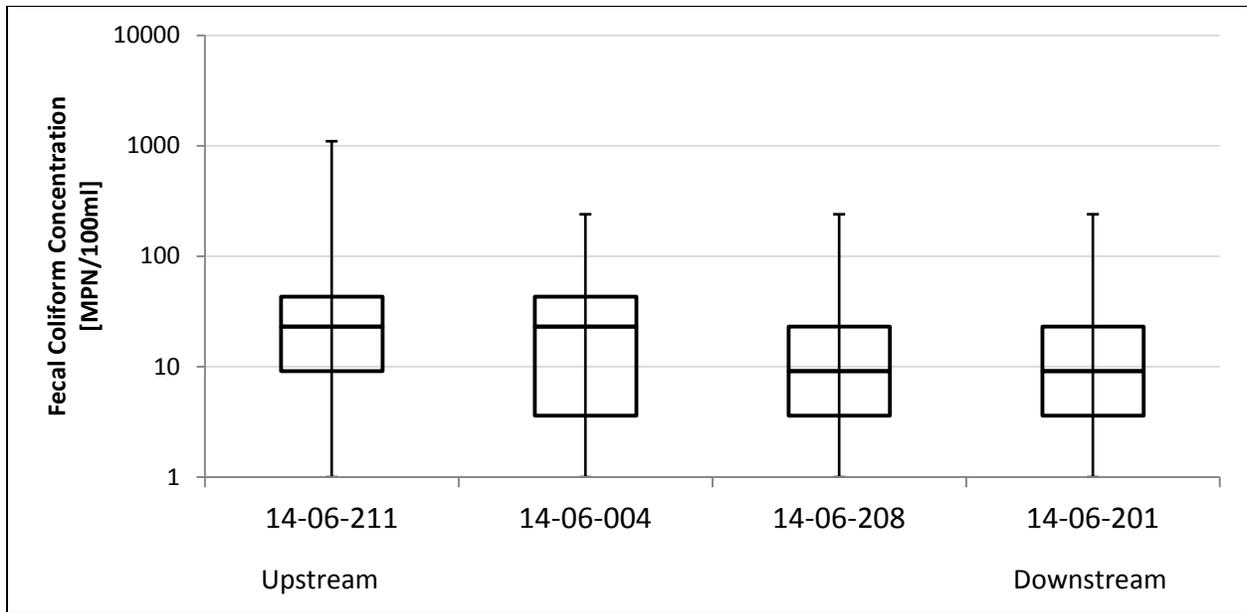


Figure F-3: Box and Whisker Plot of Fecal Coliform Concentration

This result was supported statistically through paired sample t-tests, of each consecutive upstream-downstream station combination. The paired sample t-test is based on pairing the results of two samples taken on the same date from adjacent monitoring stations to determine whether the fecal coliform concentrations from the two stations are significantly different from each other. These tests showed statistically-significant decreases in fecal concentration between the consecutive stations moving downstream.

Table F-2: Comparison of upstream-downstream fecal coliform counts (MPN/100 mL)

t-Test: Paired Two Sample for Means	Test 1		Test 2		Test 3	
Stations	14-06-211	14-06-004	14-06-004	14-06-208	14-06-208	14-06-201
Mean	47	29	30	20	20	16
Variance	9,135	1,579	1,777	843	848	617
Observations	187	187	188	188	187	187
Pearson Correlation	0.3796		0.4352		0.6957	
Hypothesized Mean Difference	0		0		0	
df	186		187		186	
t Stat	2.8236		3.4447		2.2101	
P(T<=t) one-tail	2.63E-03		3.53E-04		1.42E-02	
t Critical one-tail	1.6531		1.6530		1.6531	

The decreasing pattern is also visually represented in temporal plots of fecal coliform sample results. Figure F-4 shows the rolling 30-sample median fecal coliform concentrations at all four stations and Figure F-5 shows the rolling 30-sample 90th percentile fecal coliform concentrations. The stations all show a clear decreasing pattern from upstream to downstream.

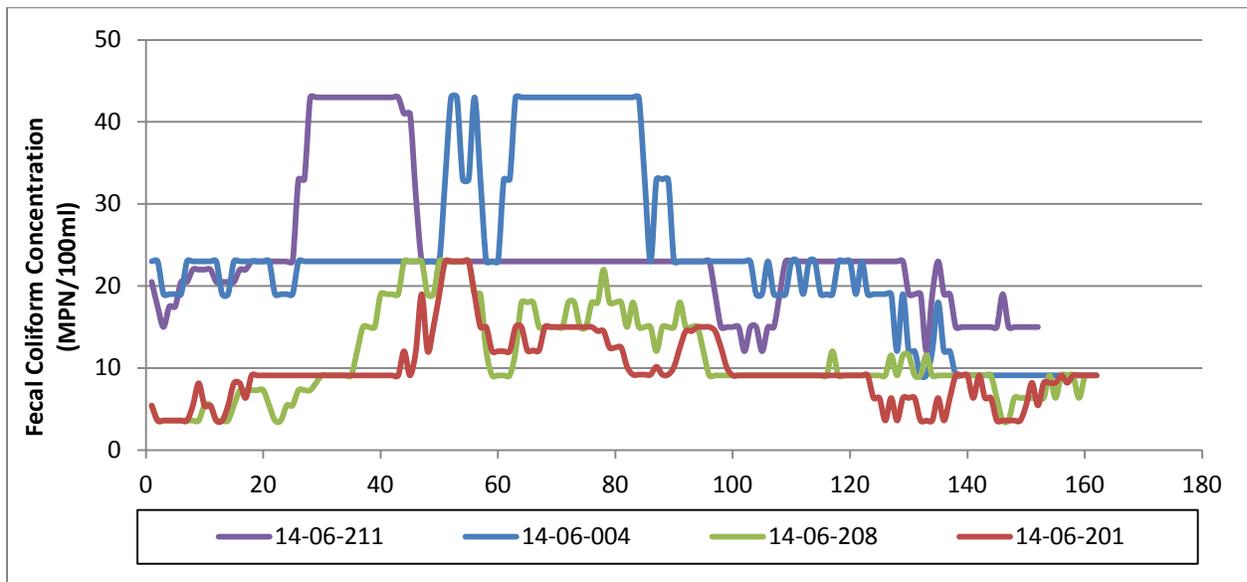


Figure F-4: Rolling 30-sample median Fecal Coliform Concentration

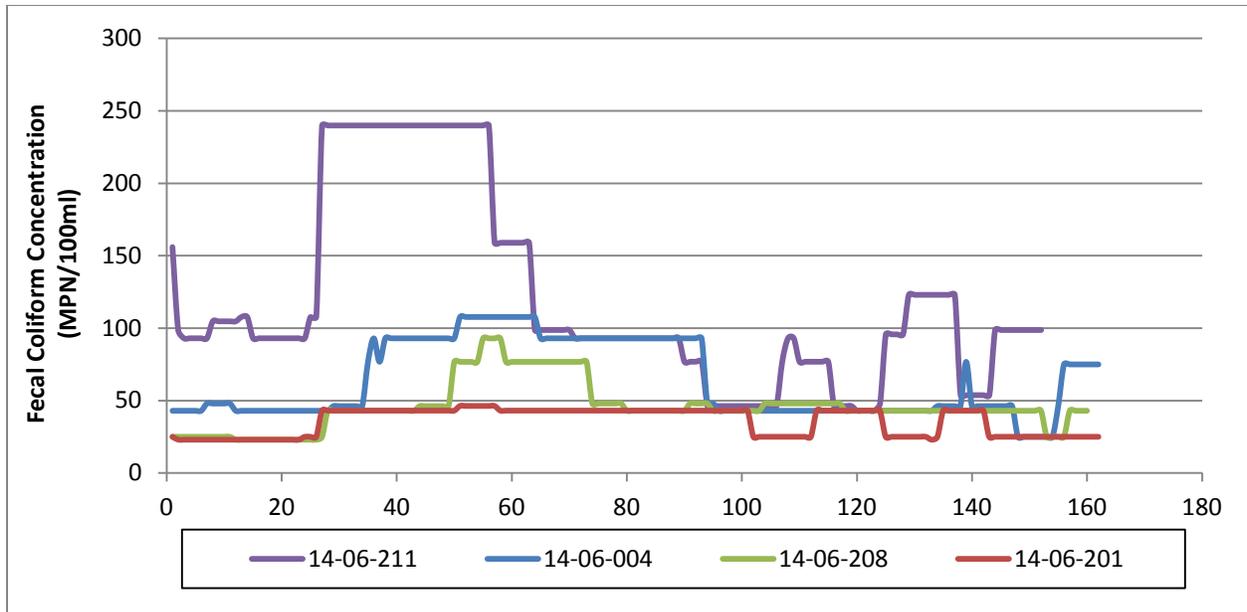


Figure F-5: Rolling 30-sample 90th percentile Fecal Coliform Concentration

Conclusion

The results of this analysis support the inclusion of the 2010 listing in the Lower Wicomico River mainstem, MD-WICMH-Wicomico_River-2, in the TMDL for fecal coliform in the Lower Wicomico River mainstem. First, the drainage area to the 2010 listing is identical to the drainage area described in the 2008 TMDL, meaning that any implementation for the TMDL will benefit the area in the 2010 listing as well. Second, since fecal coliform concentrations are consistently lower in the area listed in 2010, the attainment of water quality criteria in areas covered by the 2008 TMDL will result in fecal coliform levels at Station 14-06-208 that are below the criteria.

References:

- Maryland Department of the Environment (MDE). 2008. *Total Maximum Daily Loads of Fecal Coliform for the Restricted Shellfish Harvesting Area in the Lower Wicomico River Basin in Wicomico and Somerset Counties, Maryland*.
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