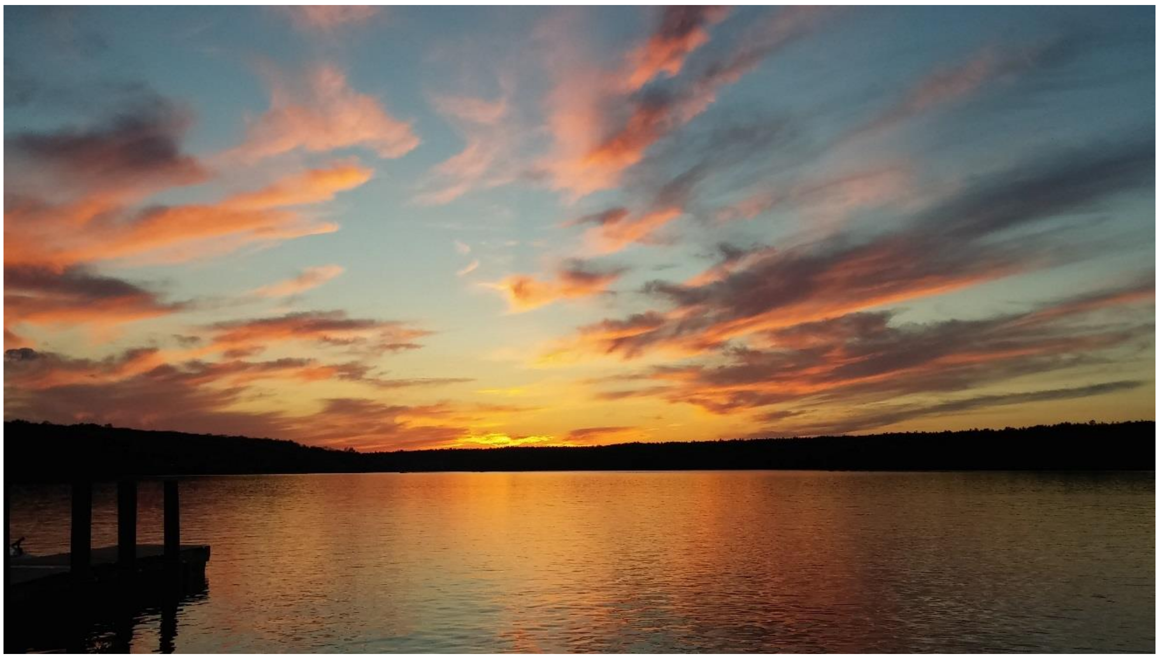
Final 2016 Delisting Document

Waterbody Impairments Removed from the Impaired Waters Lists



State of Rhode Island
Department of Environmental Management
Office of Water Resources

March 2018

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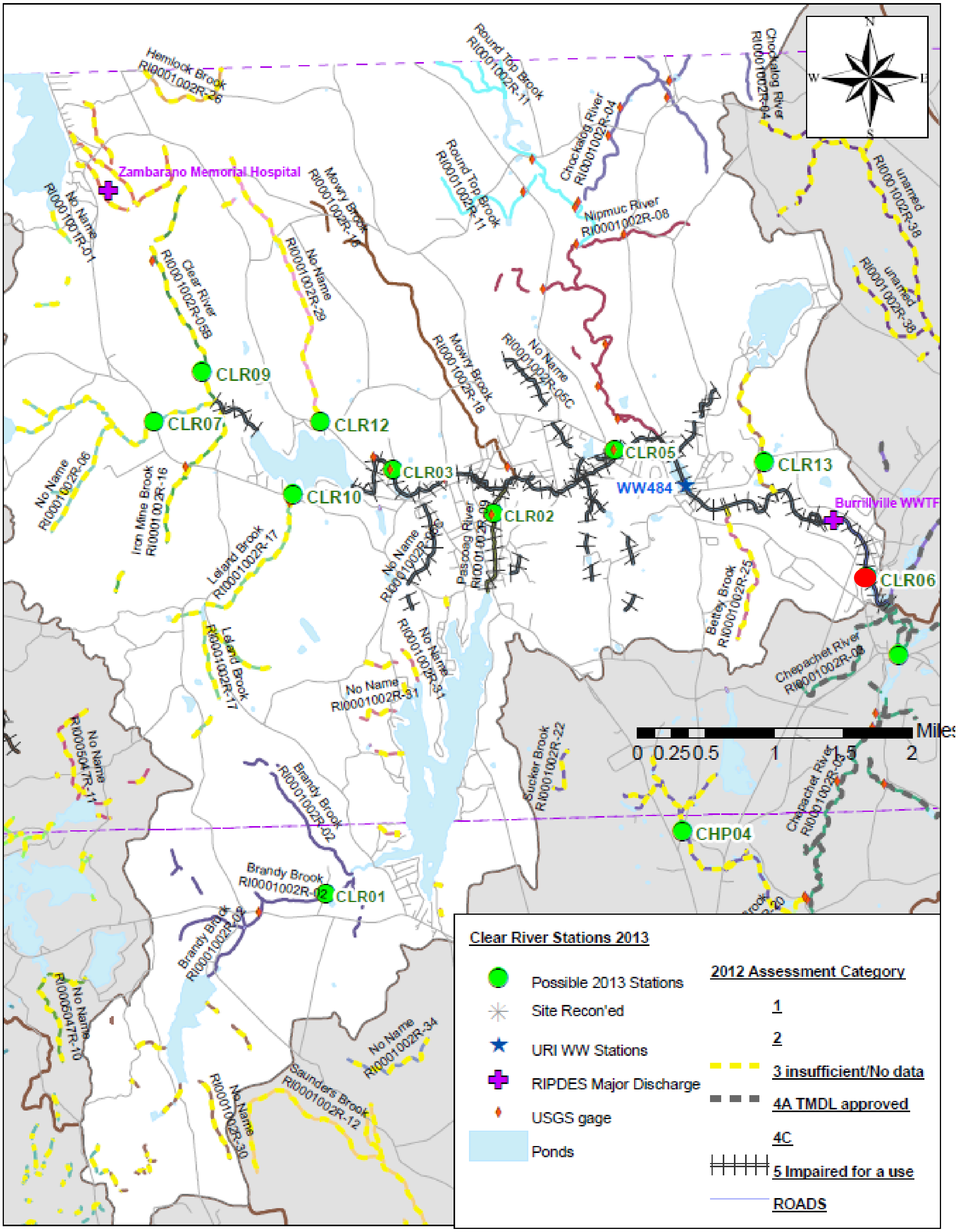
1. Clear River (RI0001002R-05D)

Clear River from the Burrillville WWTF discharge point to the confluence with the Chepachet River. Glocester, Burrillville

Benthic-Macroinvertebrate Bioassessments – This segment of the Clear River is listed on RI's 2014 303(d) List of Impaired Waters as not supporting aquatic life designated use due to benthic-macroinvertebrate bioassessments. This impairment was first listed on RI's 1994 303(d) list based on coarse (family level) macroinvertebrate data collected using a time kick method in 1991-1992 by Roger Williams University. Sampling was conducted using this same methodology at a station (RWU14) by the Victory Highway bridge on seven occasions between 1991 and 2001. RIDEM efforts over the last ten years to refine its biological monitoring and assessment program have resulted in a modification in the way that macroinvertebrate data is used and how the cause benthic macroinvertebrate bioassessments is applied in the assessment of Aquatic Life Use. RIDEM's current biological monitoring and assessment program uses macroinvertebrate data identified to genus, at a minimum, and to species, when possible. Family level identification may miss changes within the community or inaccurately identify problems. Furthermore, RIDEM's current biological monitoring and assessment program has also refined where it is appropriate to use a timed kick of riffle habitat. More details are listed on pg. 66. This river segment is non-wadeable, and the use of a timed kick of riffle habitat and the resulting data is not appropriate. Therefore, the benthic macroinvertebrate bioassessment cause is not appropriate and will be delisted. Rhode Island has not yet developed a biological indicator for non-wadeable rivers. We will continue to use water chemistry data as a means to assess non-wadeable streams, until a suitable biological indicator is developed. The 2016 303d list continues to identify this river segment as having Aquatic Life Use impairment causes of dissolved cadmium, dissolved copper, dissolved lead, and non-native aquatic plants.



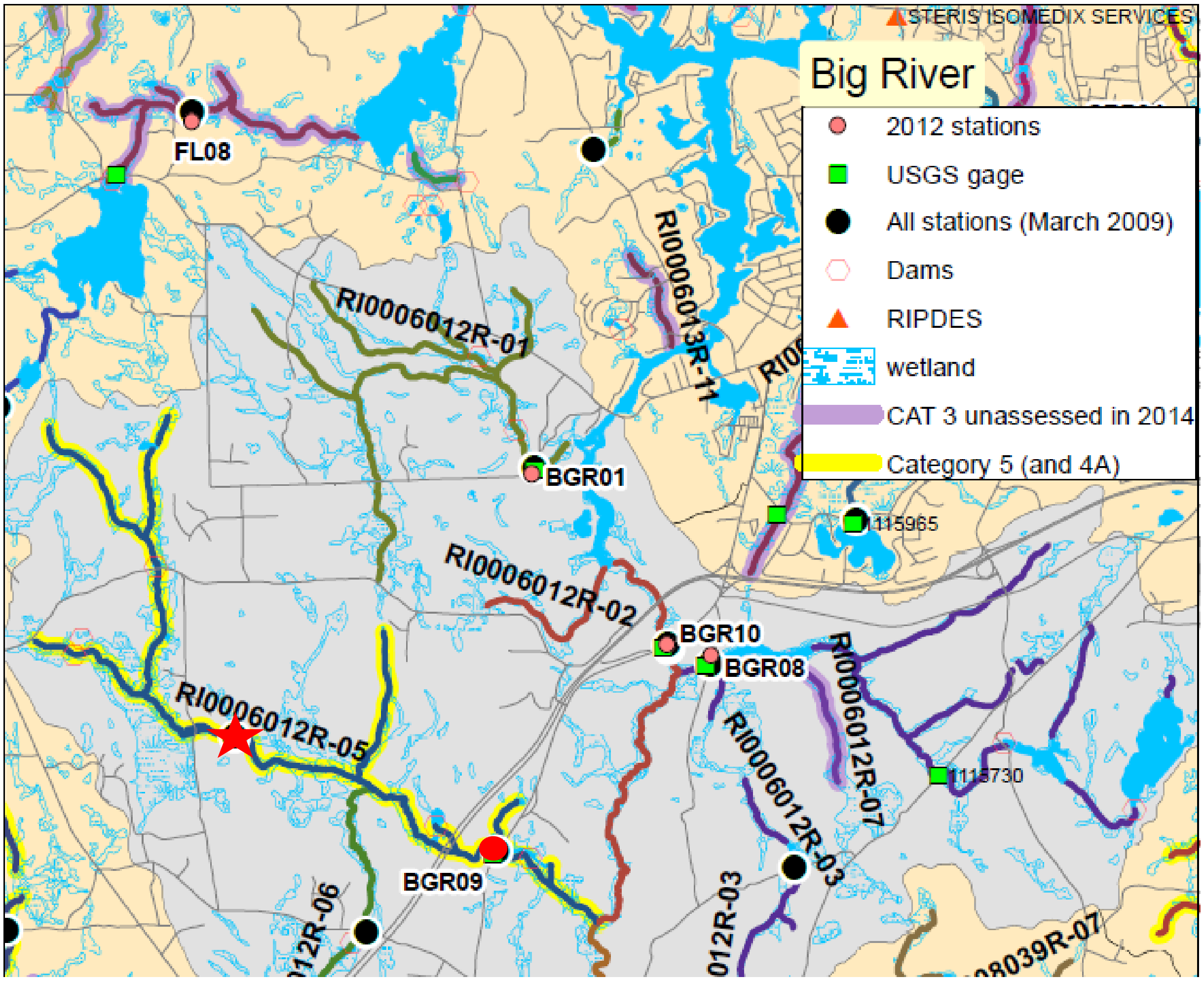
Hemlock Brook RI0001002R-26
Round Top Brook RI0001002R-11
Chockalog River RI0001002R-04
Zambarano Memorial Hospital
No Name RI0001001R-01
Mowry Brook RI0001002R-18
Nipmuc River RI0001002R-08
unnamed RI0001002R-38
Clear River RI0001002R-05B
No Name RI0001002R-29
No Name RI0001002R-05C
CLR09
CLR07
CLR12
CLR03
CLR05
CLR13
CLR10
CLR02
WW484
Burrillville WWTF
CLR06
No Name RI0001002R-06
Iron Mine Brook RI0001002R-16
Leland Brook RI0001002R-17
Pascoag River
Betty Brook RI0001002R-25
Chepachet River RI0001002R-03
No Name RI0001002R-31
Sucker Brook RI0001002R-22
Miles
0 0.25 0.5 1 1.5 2
CHP04
No Name RI0005047R-11
Brandy Brook RI0001002R-02
CLR01
No Name RI0005047R-10
No Name RI0001002R-34
Saunders Brook RI0001002R-12
No Name RI0001002R-30
N
E
S
W
Clear River Stations 2013
Possible 2013 Stations
Site Recon'ed
URI WW Stations
RIPDES Major Discharge
USGS gage
Ponds
2012 Assessment Category
1
2
3 insufficient/No data
4A TMDL approved
4C
5 Impaired for a use
ROADS

2. Nooseneck River & Tribs (RI0006012R-05)

Nooseneck River and tributaries. West Greenwich

Enterococcus – Enterococcus was originally listed as an impairment in 2010. EPA approved the TMDL for this waterbody on September 22, 2011 as part of the Statewide Bacteria TMDL. The same data were used for listing the waterbody on the 303(d) List and calculating the required TMDL reductions. Identified sources included: agriculture, wildlife, pet waste, stormwater, and onsite/septic systems. The ten enterococci samples collected at stations BGR03 (red star on map below) and BGR09 (red circle on map below) between October 2006 and August 2007 were predominately collected under dry weather conditions (eight of ten samples) and had a geometric mean value of 93.14 colonies per 100 mL. Recent Enterococcus data collected by RIDEM's ambient river monitoring program indicates that the primary and secondary contact uses are being met with the attainment of the Enterococcus geometric mean criteria of 54 colonies/100 ml. The original listing of this waterbody was based on two stations, BGR03 and BGR09; however, the BGR03 station was discontinued in favor of keeping a single, most downstream station to capture the full influence of all sources. Furthermore, BGR03 had poor flow, and the access to BGR03 is no longer available. The dirt road used to access has been blocked and is developed to a driveway. Stormwater is identified as a potential source of bacteria, however no specific stormwater concerns were identified. Given that the Nooseneck River watershed has an impervious cover of 3.7%, consistent with the Statewide Bacteria TMDL findings, wet weather impacts from urban stormwater are unexpected. Absent other known wet weather sources of bacteria, given the predominately undeveloped condition of this watershed (82%), wet weather impairments are unexpected. DEM is not aware of any actions that may have led to the improved water quality conditions.

Station ID	Location	05/21/12	07/31/12	08/22/12	09/25/12	10/25/12	Geometric Mean
BGR09	Nooseneck Hill Rd.	12.0	84.0	461.0	29.0	12.0	43.83
Station ID	**Location**	**05/12/16**	**06/15/16**	**07/13/16**	**08/16/16**	**09/13/16**	**Geometric Mean**
BGR09	Nooseneck Hill Rd.	5.2	90.6	329	114	24.1	53.19



3. <u>Boyd Brook (RI0006013R-01)</u>

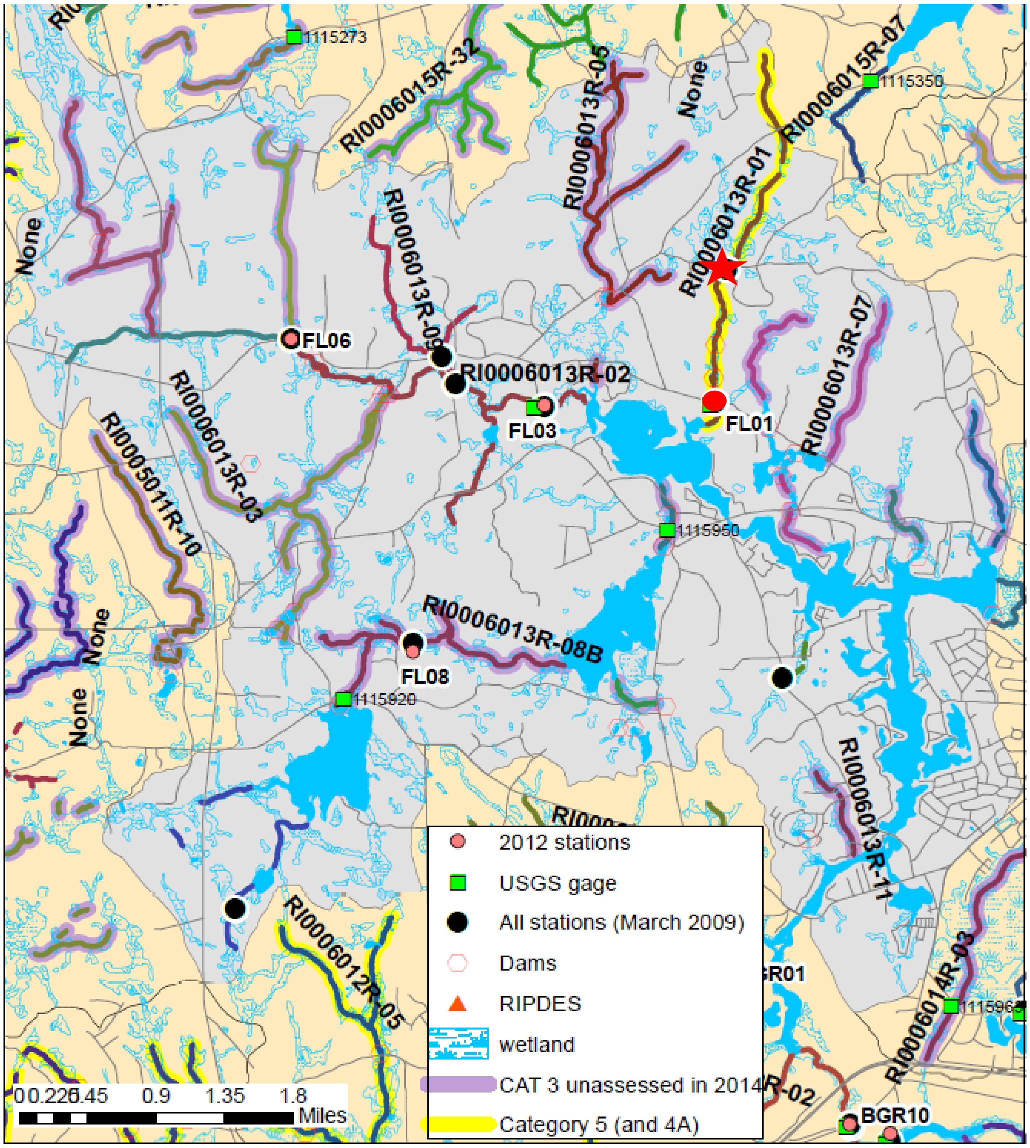
Boyd Brook. Scituate, Coventry

<u>Enterococcus</u> – Enterococcus was originally listed as an impairment in 2010. EPA approved the TMDL for this waterbody on September 22, 2011 as part of the Statewide Bacteria TMDL. The same data were used for listing the waterbody on the 303(d) List and calculating the required TMDL reductions. Identified sources included: agriculture, wildlife, pet waste, stormwater, and onsite/septic systems. The ten enterococci samples collected at stations FL01 (red circle on map below) and FL02 (red star on map below) between October 2006 and August 2007 had a geometric mean value of 57.7 colonies per 100 mL. The original listing of this waterbody was based on two stations, FL01 and FL02; however, the FL02 station was not used in the 2010 macroinvertebrate assessment due to ponding (documented in picture from 8/22/2006 below), and, therefore, should not have been used in the bacteria assessment. The geometric mean of the October 2006 and August 2007 data at FL01 was 35.23 colonies per 100 mL suggesting this waterbody was incorrectly listed. The station at FL02 was documented to have continued ponding issues in 2016 making this station not representative of the waterbody, and this station will not

be utilized by RIDEM's ambient river monitoring program in the future due to poor flow conditions. Recent Enterococcus data collected by RIDEM's ambient river monitoring program at FL01 indicates that the primary and secondary contact uses continue to be met with the attainment of the Enterococcus geometric mean criteria of 54 colonies/100 ml. Given that the Boyd Brook watershed has an impervious cover of 4.5%, consistent with the Statewide Bacteria TMDL findings, wet weather impacts from urban stormwater are unexpected. The majority of the watershed is undeveloped (80%, see the Statewide Bacteria TMDL: http://www.dem.ri.gov/programs/benviron/water/quality/swbpdf/boyd.pdf), which will protect water quality. DEM is not aware of any actions that may have led to the improved water quality conditions.

Station ID	Location	10/09/06	06/12/07	06/26/07	07/09/07	08/09/07	Geometric Mean
FL01	Town Farm Rd.	4	78	23	42	180	35.2
Station ID	**Location**	**05/21/12**	**07/31/12**	**08/22/12**	**09/25/12**	**10/25/12**	**Geometric Mean**
FL01	Town Farm Rd.	18.9	365	102	34.1	13.4	50.3
Station ID	**Location**	**05/12/16**	**06/15/16**	**07/13/16**	**08/16/16**	**09/13/16**	**Geometric Mean**
FL01	Town Farm Rd.	1	43.2	122	387	192	52.31

Boyd Brook at FL02 8/22/2006



4. Pawtuxet River South Branch (RI0006014R-04B)

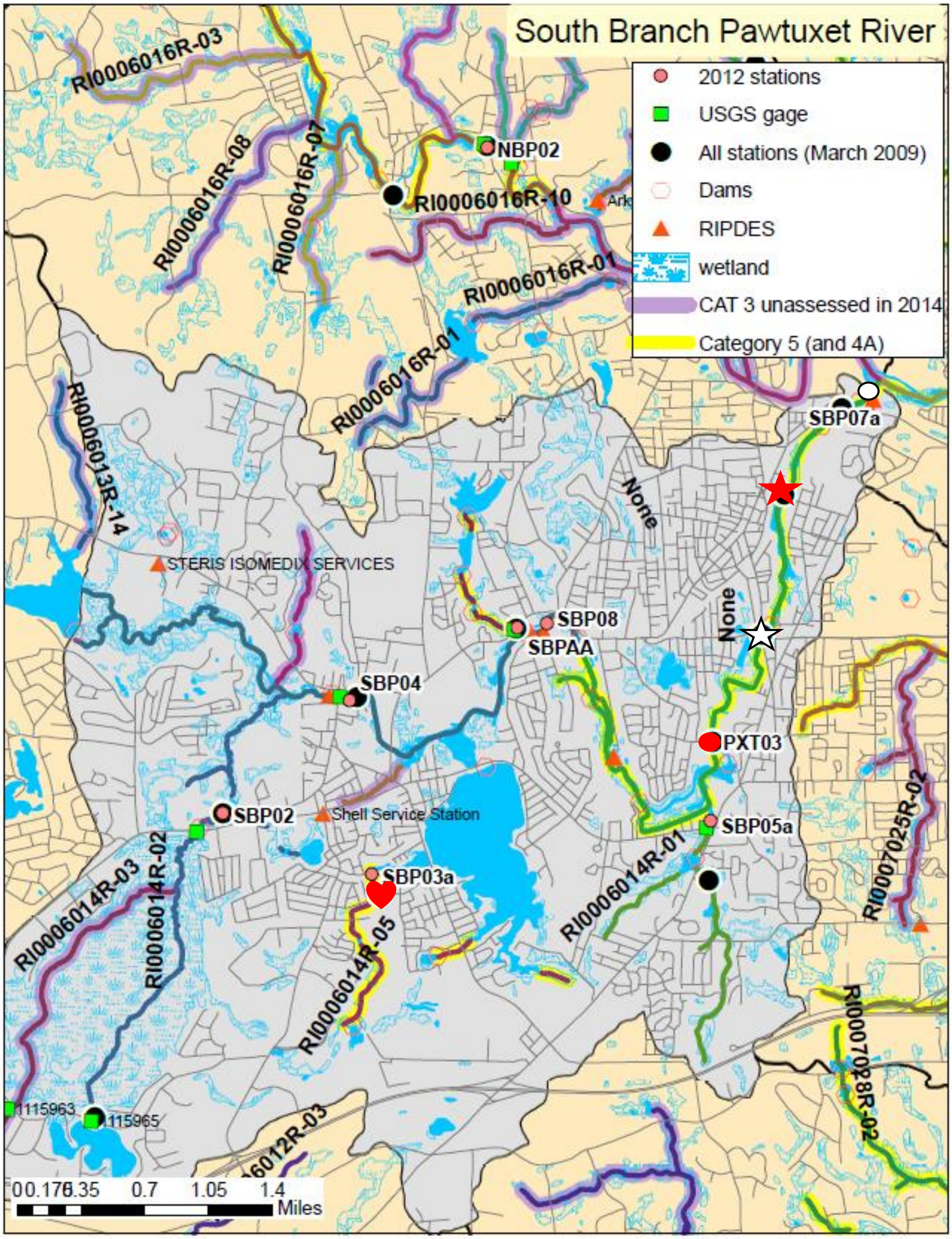
Pawtuxet River South Branch from the Quidnick Dye Mill dam to its confluence with the North Branch of the Pawtuxet River. Coventry, West Warwick, Warwick

Enterococcus – Enterococcus was originally listed as an impairment in 2010. EPA approved the TMDL for this waterbody on September 22, 2011 as part of the Statewide Bacteria TMDL. The same data were used for listing the waterbody on the 303(d) List and calculating the required TMDL listings. Identified sources included: wildlife, pet waste, stormwater, onsite/septic systems, and RIPDES-industrial. The enterococci samples collected at stations PXT03 (Pulaski St.-red circle on map below), PXT04 (Factory St.-red star on map below), SBP06 (Main St.-white star on map below), and SBP07 (Providence St.-white circle on map below) between October 2006 and August

2008 had a geometric mean value of 105.00 colonies per 100 mL with individual geometric means of 265.59, 264.63, 85.17, and 25.0 colonies per 100mL, respectively. Recent Enterococcus data collected in 2012 and 2016 by RIDEM's ambient river monitoring program at PXT03 and SBP07a indicates that the primary and secondary contact uses are now being met with the attainment of the Enterococcus geometric mean criteria of 54 colonies/100 ml. Due to a number of factors, including access to the river, backwater from the dam, and safety, the station at SBP07 was relocated to just downstream of the dam to SBP07a. This station is more representative of the conditions of the river. Stations PXT04 and SBP06 were not sampled in 2012 or 2016, because these sites are bracketed by PXT03 and SBP07a with no tributaries or RIPDES permits that would not be captured with sampling at PXT03 and SBP07a. Furthermore, SBP06 is just upstream of a dam making it non-representative of the conditions of a flowing waterbody. PXT04 is also a poor site, being just below the dam causing backwater flow, which is also non-representative of the conditions of a flowing waterbody.

The improvement in this segment's water quality apparent from the observed declines in bacteria concentrations from 2006-2008 to 2016, especially at the Pulaski Street station (PXT03) may be associated with ongoing sewering in the Town of Coventry in 2008 in the Sandy Bottom and Main Street area and in 2011-2012 along Tiogue Avenue and Arnold Road. The Town of Coventry has a mandatory sewer tie-in requirement.

Station ID	**Location**	**06/20/12**	**08/14/12**	**09/13/12**	**10/22/12**		**Geometric Mean**
PXT03	Pulaski St.	31	47	19	66		36.77
Station ID	**Location**	**06/19/12**	**08/14/12**	**09/12/12**	**10/18/12**		**Geometric Mean**
SBP07a	Providence St.	45	99	36	30		46.83
Station ID	**Location**	**05/23/16**	**06/28/16**	**07/25/16**	**08/29/16**	**10/17/16**	**Geometric Mean**
PXT03	Pulaski St.	29.5	186	86.6	26.2	10.8	42.24
Station ID	**Location**	**05/19/16**	**06/27/16**	**07/21/16**	**08/25/16**	**10/13/16**	**Geometric Mean**
SBP07a	Providence St.	24.9	35.5	24.1	12.0	7.4	18.00



South Branch Pawtuxet River
2012 stations
USGS gage
All stations (March 2009)
Dams
RIPDES
wetland
CAT 3 unassessed in 2014
Category 5 (and 4A)
RI0006016R-03
RI0006016R-08
RI0006016R-07
NBP02
RI0006016R-10
RI0006016R-01
RI0006016R-01
RI0006013R-14
STERIS ISOMEDIX SERVICES
None
None
SBP07a
SBP08
SBPAA
SBP04
PXT03
SBP02
Shell Service Station
SBP05a
SBP03a
RI0006014R-01
RI0006014R-03
RI0006014R-02
RI0006014R-05
RI0007025R-02
RI0007028R-02
115963
115965
6012R-03
Miles

5. <u>Cedar Swamp Brook & Tribs (RI0006018R-01)</u>

Cedar Swamp Brook and tributaries. Johnston

<u>Total Iron</u> – Total iron was originally listed as an impairment in 2000. This waterbody does not have a completed TMDL; however, a site remediation project is being carried out in accordance with RIDEM Office of Waste Management oversight. Samples are collected quarterly by a contractor to the Rhode Island Resource Recovery Corporation for the Central Landfill, which were the basis of the impairment in 2000. Recent data collected by the contractor indicates that the water quality standard of 1000µg/L is being met.

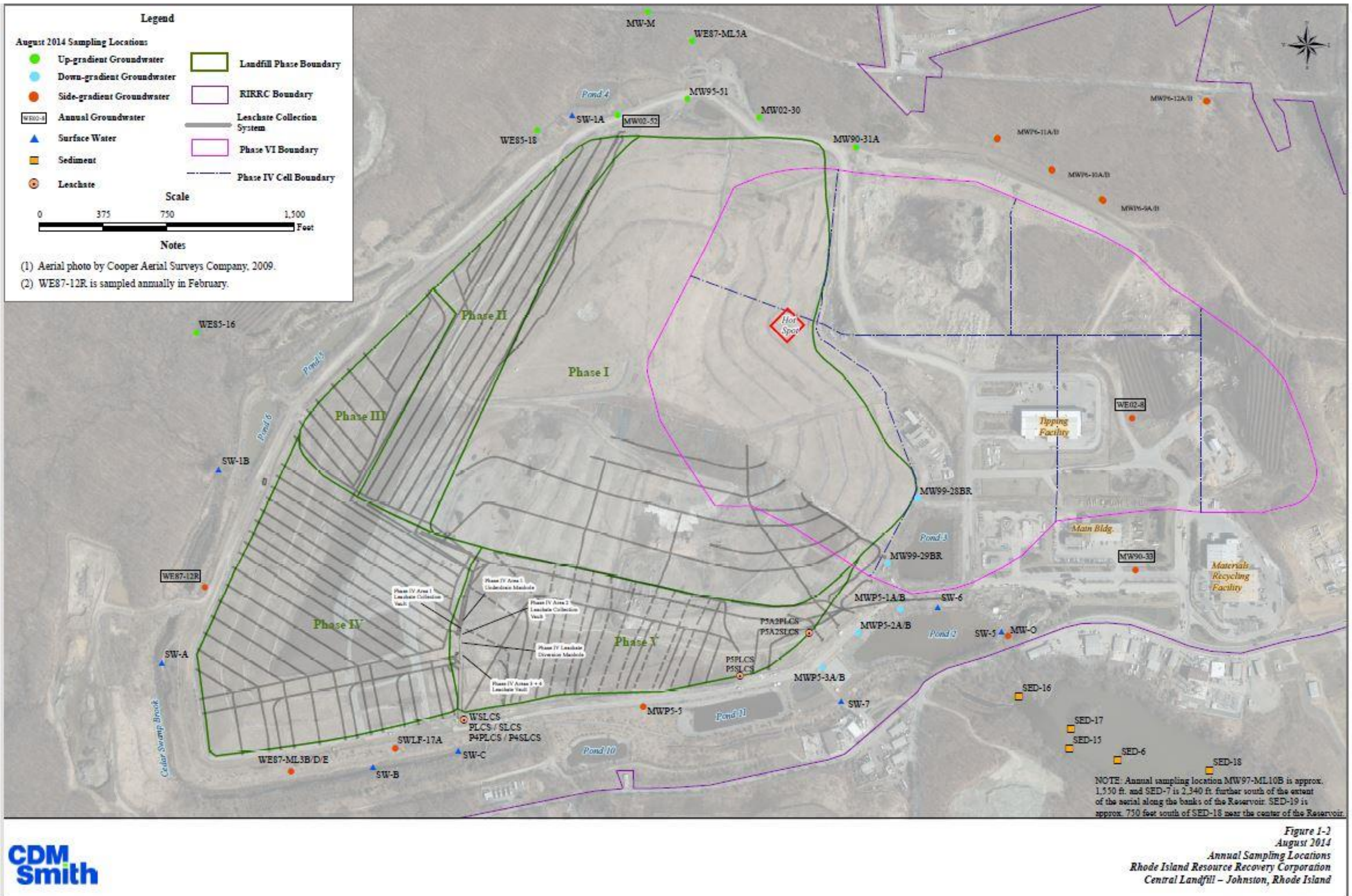
This stream flows next to the Central Landfill in Johnston, RI, the largest sanitary landfill in the State. Cedar Swamp Brook is the main surface flow from the area of the landfill feeding Upper and Lower Simmonsville Reservoirs. By January 1982, initial sampling of wells near Cedar Swamp Brook showed contamination along the southern border of the Central Landfill. Following the indication of well contamination, sampling of Cedar Swamp Brook surface water was recommended. This early sampling of Cedar Swamp Brook found lower concentrations of contaminants than the wells; however, the highest contaminants were iron and ammonia, both indicative of refuse leachate. In the Record of Decision (ROD) September 2002, it was noted that the groundwater contours indicated that Cedar Swamp Brook acts as a discharge/drainage area for groundwater coming from the Central Landfill and from the north flank of Lawton Hill. Furthermore, to a lesser degree than groundwater, Cedar Swamp Brook can also be affected by runoff and uncontrolled dust and litter from the Central Landfill.

The Central Landfill has been the subject of many remediation actions taken by both RIDEM and the U.S. Environmental Protection Agency, under various state and federal laws, beginning in 1979. The Central Landfill has also gone through several phases of construction and expansion and closure of operations, with the Phase 6 landfill currently being constructed. During the construction of both Phases 4 and 5, Cedar Swamp Brook was relocated and restored (initially during the construction of Phase 4 and again during the construction of Phase 5). As part of Phase 4, the southern/downstream reach of Cedar Swamp Brook was initially relocated beginning in the summer of 2002 and open for flow in May 2003. During Phase 5 construction, which began in 2004, Cedar Swamp Brook was again relocated and the path of the previously relocated Cedar Swamp Brook was filled with stone to create an underdrain that discharged to Sedimentation Pond 2; however, RIDEM, through the RIPDES permit program, determined that the discharge from this underdrain must be captured and treated to remove ammonia and iron. The RIPDES permit, issued in 2007, included water quality-based limits for iron that were developed to ensure that water quality criteria are met and that Cedar Swamp Brook is not impaired. The system to capture and treat ammonia and iron began construction in 2013 and, as of 2017, the treatment system has been meeting its iron limits.

A combination of the permanent relocation of the stream and the installation of the treatment system, along with other operational improvements at Central Landfill (e.g. improved erosion controls) have led to the improvement of water quality in Cedar

Swamp Brook. Data collected from various locations along the re-routed stream path are found to be in compliance with the State's water quality standard for iron, as shown in the table below. The current stream path location and sampling sites are shown in the figure below. Site SW-1B is located on Cedar Swamp Brook at the outlet from a waterbody known as the "swimming hole", and the other four sampling locations are downstream locations along the new route of Cedar Swamp Brook (SW-A, SW-B, SW-C, and SW-7). All sampling locations are shown as blue triangles.

Station ID	8/2012	11/2012	2/2013	5/2013	8/2013	2/2014	5/2014	8/2014	11/2014	2/2015	5/2015	8/2015	11/2015	2/2016	5/2016
SW-1B	510	147	710	170	290	96	99	570	120	53	150	340	180	200	80
SW-A	460	258	200	310	470	320	210	1000	450	100	300	600	230	490	250
SW-B	500	408	270	340	580	320	220	840	560	250	330	570	470	550	310
SW-C	570	383	270	320	580	340	260	960	490	270	320	780	480	510	270
SW-7	160	222	300	510	400	400	280	520	200	200	310	120	150	490	260



Site map of Central Landfill including relocated Cedar Swamp Brook and sampling stations.

6. Tiogue Lake (RI0006014L-02)

Tiogue Lake. Coventry

Mercury in Fish Tissue – Mercury in fish tissue was originally listed as an impairment in 2006. EPA approved the TMDL for this waterbody on December 12, 2007 as part of the Northeast Regional Mercury TMDL. Identified sources included: wastewater discharges and atmospheric deposition. Mercury reductions required by the TMDL's Waste Load Allocation were to be accomplished through mercury minimization plans and the continuation of region-wide mercury reduction efforts. In Rhode Island, the Mercury Reduction and Education Act required the phase-out of mercury added products, labeling, collection plans, and bans on certain products among other actions. Recent mercury in fish tissue data collected by the U.S. EPA's Atlantic Ecology Division indicates that the fish consumption use is being met with the attainment of the mercury in fish tissue less than 0.30ppm in less than 10% of fish samples.

Site Collection	Date	Species Code	Total Hg ng/g (wet weight)	Exceeds Criterion?	Number of Samples	% of Samples Exceeding Criterion
Tiogue Lake	9/9/2013	LMB	104	no	9	0
Tiogue Lake	9/9/2013	LMB	78	no		
Tiogue Lake	9/9/2013	LMB	90	no		
Tiogue Lake	9/9/2013	LMB	40	no		
Tiogue Lake	9/9/2013	LMB	140	no		
Tiogue Lake	9/9/2013	WP	61	no		
Tiogue Lake	9/9/2013	WP	61	no		
Tiogue Lake	9/9/2013	WP	64	no		
Tiogue Lake	9/9/2013	YP	31	no		
Tiogue Lake	9/28/2008	BC	61	no	16	0
Tiogue Lake	9/28/2008	BG	28	no		
Tiogue Lake	9/28/2008	LMB	119	no		
Tiogue Lake	9/28/2008	PS	18	no		
Tiogue Lake	9/28/2008	PS	34	no		
Tiogue Lake	9/28/2008	PS	19	no		
Tiogue Lake	9/28/2008	WP	91	no		
Tiogue Lake	9/28/2008	WP	76	no		
Tiogue Lake	9/28/2008	WP	76	no		
Tiogue Lake	9/28/2008	WP	29	no		
Tiogue Lake	9/28/2008	WP	28	no		
Tiogue Lake	9/28/2008	WS	33	no		
Tiogue Lake	9/28/2008	WS	28	no		
Tiogue Lake	9/28/2008	WS	25	no		
Tiogue Lake	9/28/2008	WS	48	no		
Tiogue Lake	9/28/2008	YP	54	no		

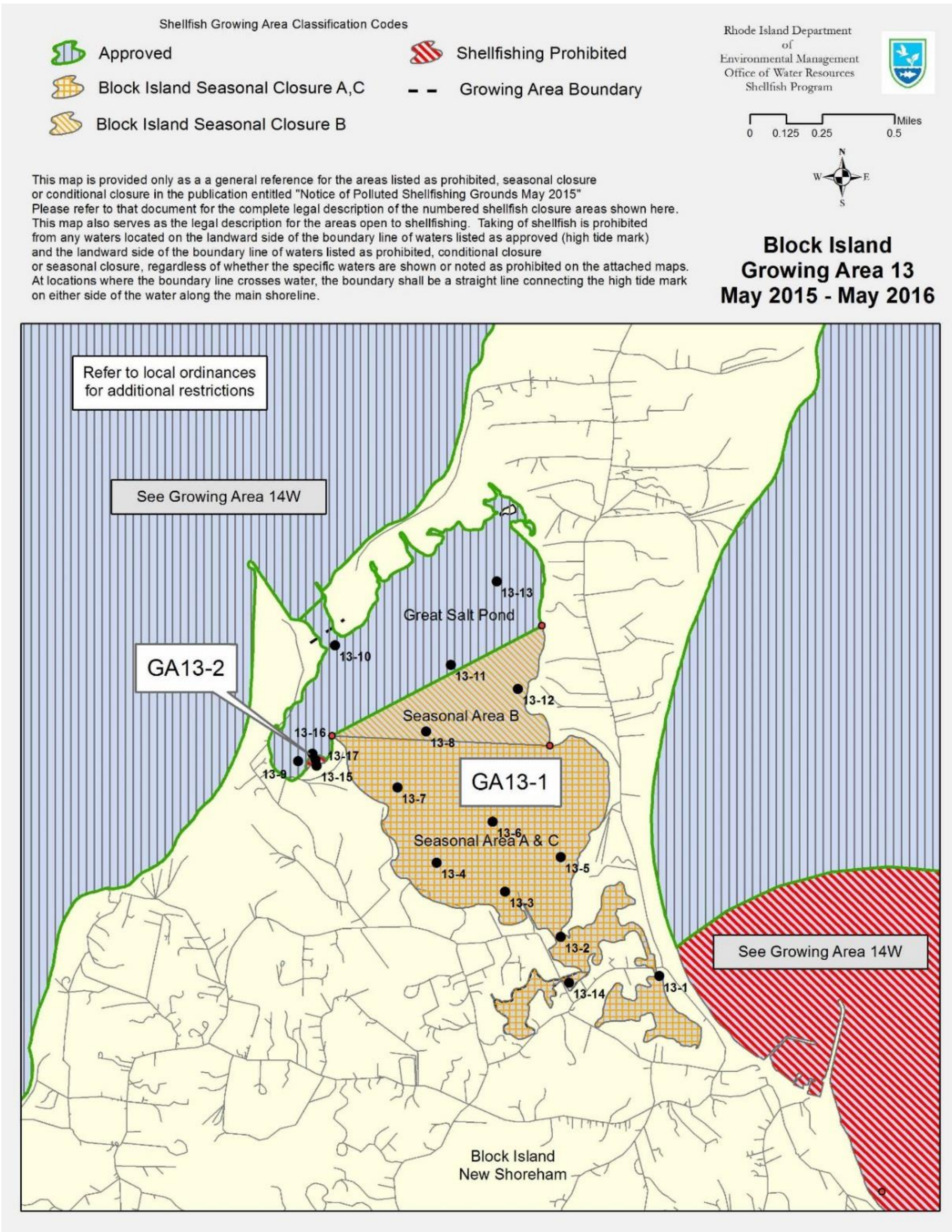
Tiogue Lake	10/10/2007	LMB	145	no	24	0
Tiogue Lake	10/10/2007	LMB	64	no		
Tiogue Lake	10/10/2007	LMB	173	no		
Tiogue Lake	10/10/2007	LMB	60	no		
Tiogue Lake	10/10/2007	BC	87	no		
Tiogue Lake	10/10/2007	BC	59	no		
Tiogue Lake	10/10/2007	BC	22	no		
Tiogue Lake	10/10/2007	YP	43	no		
Tiogue Lake	10/10/2007	YP	35	no		
Tiogue Lake	10/10/2007	YP	33	no		
Tiogue Lake	10/10/2007	YP	30	no		
Tiogue Lake	10/10/2007	YP	26	no		
Tiogue Lake	10/10/2007	PS	10	no		
Tiogue Lake	10/10/2007	PS	10	no		
Tiogue Lake	10/10/2007	PS	8	no		
Tiogue Lake	10/10/2007	BG	54	no		
Tiogue Lake	10/10/2007	BG	51	no		
Tiogue Lake	10/10/2007	BG	29	no		
Tiogue Lake	10/10/2007	WP	117	no		
Tiogue Lake	10/10/2007	WP	25	no		
Tiogue Lake	10/10/2007	WP	24	no		
Tiogue Lake	10/10/2007	WP	27	no		
Tiogue Lake	10/10/2007	WP	18	no		
Tiogue Lake	10/10/2007	WP	23	no		

7. Great Salt Pond, Trim’s Pond and Harbor Pond (RI0010046E-01C)

Great Salt Pond, Trim’s Pond and Harbor Pond. New Shoreham

Fecal coliform – The majority of Great Salt Pond including Trim’s Pond and Harbor Pond are conditionally approved for shellfishing on a seasonal basis (see Shellfish Growing Area Classification Map below). They are closed to shellfishing from sunrise on the last Saturday in June through sunrise on the Tuesday immediately following Columbus Day, due to concerns that marina activities may adversely impact the sanitary quality of the waters. Though shellfishing use is prohibited seasonally, water quality must meet the applicable fecal coliform criteria for SA-classified waters year-round for the most recent 30 samples (geomean of 14; 90th percentile of < 49 to 31, dependent on number of samples analyzed using Mtec or MPN method) to be considered in support of the shellfishing use. Samples are collected monthly at all stations (shown on map below) by the Block Island Harbor Master.

Fecal coliform was originally listed as an impairment for Trims Pond and Harbor Pond (located in inner Great Salt Pond) in 2006, due to exceedance of the variability criteria when data from both open and closed months were evaluated. A TMDL has not been developed for this waterbody. Recent fecal coliform data collected by RIDEM's Shellfish Program indicates that the shellfishing use is being met year-round with the attainment of the geometric mean and variability requirements of the U.S. Food and Drug Administration National Shellfish Sanitation Program (NSSP). Stations 13-2, 13-1, and 13-14, shown on the Shellfish Growing Area Classification map below, are used to assess water quality of Trims Pond and Harbor Pond. All other stations in other portions of the Great Salt Pond have continuously met the shellfishing use criteria year-round.



Block Island Trim's Pond (stations 13-1, 13-2, 13-14) fecal coliform results for 2010 to 2016. Statistics calculated as though these were "Approved Waters" with NSSP shellfishing criteria of geometric mean <14 and 90th percentile of <49 to 31 (dependent on number of MPN and Mtec samples) calculated from most recent 30 samples; both 'open' and 'closed' season data included in statistics. Bold = violation of NSSP criteria.

Year	GeoMean	% exceed Variability	GeoMean	% exceed Variability	GeoMean	% exceed Variability	MPN-Mtec variability criteria
	Station 13-1		Station 13-2		Station 13-14		
2010	8.7	**53.4**	7.7	44.1	11.9	**87.8**	49
2011	10	**80.2**	7.1	44.7	11.3	**111.9**	49
2012	9.6	**106**	6.6	39.7	9.6	**82.4**	44
2013	8.5	**60.2**	5.2	22.1	7.5	33.4	37
2014	5.7	30.9	4.2	15.2	5.9	18.3	31
2015	4.8	19	4	17.2	5.5	18.5	31
2016	4.8	20.1	4.6	19.1	5.2	20	31

Exceedances are shown in **bold**

8. Moswansicut Stream (RI0006015R-16)

Moswansicut Stream. Scituate

Escherichia coli (E. coli) – Moswansicut Stream was first listed as impaired for *E. coli* on the 2000 303(d) List. Rhode Island has not adopted water quality criteria for *E. coli*, but the USEPA's *E. coli* criteria of 126 col/100ml can be used to assess *E. coli* data in cases where there are no fecal coliform or enterococci data available. EPA approved the TMDL for this waterbody on September 22, 2011 as part of the Statewide Bacteria TMDL.

The 2000 303(d) listing and the TMDL used monthly *E. coli* data collected by the Providence Water Supply Board. The TMDL included calculated annual geometric means from 2003 to 2009 with a partial year geometric mean calculated for 2010. Annual geometric means ranged from 64 to 199 colonies/100 mL (col/100 mL). Land use within the watershed is predominately undeveloped (57%), commercial, residential, and transportation land uses make up 41% with the remaining percentage attributed to agricultural uses (2%). Identified sources included: developed area stormwater, onsite/septic systems, and animal waste from waterfowl, wildlife, and domestic animals. Given that the Moswansicut watershed has an impervious cover of 20.4%, consistent with the Statewide Bacteria TMDL findings, it is expected that urbanized stormwater may have contributed to the impairment. Homes in the watershed use onsite wastewater disposal systems (OWTS) and the area is regulated under the Stormwater Phase II program.

E. coli data collected monthly in Moswansicut Stream from 2010 – 2015 (at Station 22 on the map below) under both wet and dry weather conditions by the Providence Water Supply Board indicate that the primary and secondary contact uses are being met with the attainment of the USEPA *E. coli* geometric mean criteria of 124 col/100 mL. In the last few years, the Providence Water Supply Board has worked to discourage geese from this sub-watershed. They have a contract with USDA regarding goose management and have stopped mowing grass near the top of the dam upstream of the sampling location. RIDEM is not aware of other management actions that may have been taken that may have also contributed to the observed water quality improvements.

Annual *E.coli* Geometric Mean (col/100 mL)

Location	2010	2011	2012	2013	2014	2015
Number of Samples	10	9	11	9	8	6[1]
Old Danielson Pike	102	70	43	90	61	63

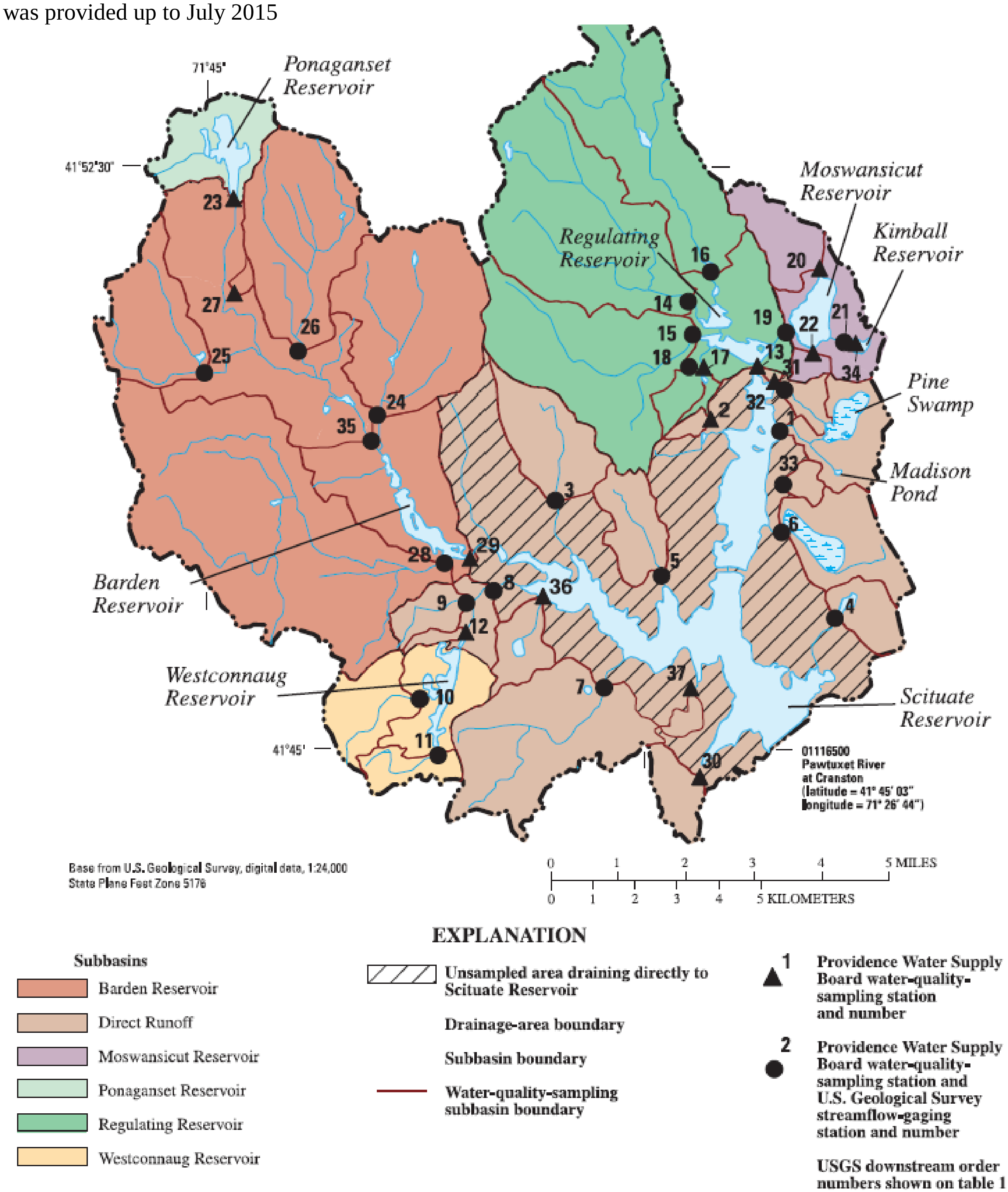
[1]Data was provided up to July 2015

Wet and Dry Weather *E.coli* Number of Samples

Weather	2010	2011	2012	2013	2014	2015[2]
Dry	8	7	8	7	4	4
Wet	2[1]	2	3	2	4	2

[1]Includes flooding event in March 2010, 8.81” of rain in 96hrs. preceding April 1, 2010 sample.

[2]Data was provided up to July 2015



9. Greenwich Cove (RI0007025E-05A)

Greenwich Cove south of Long Point. East Greenwich/Warwick

Fecal coliform – Fecal coliform was originally listed as an impairment for this segment of Greenwich Cove in 2004 when fecal coliform was the indicator to evaluate primary and secondary contact use. Currently, as noted in the Consolidated Assessment and Listing

Methodology (CALM), enterococci are the primary bacteria indicator for assessing recreational/swimming use attainment. During the transition to the enterococci indicator, the water quality standards have maintained fecal coliform criteria for use in evaluating recreational/swimming use when adequate enterococci data are not available.

EPA approved the RIDEM's Bacteria TMDL for Greenwich Cove on February 16, 2006 as part of the Greenwich Bay watershed Bacteria TMDL. Though Greenwich Cove itself is not approved for shellfishing, Greenwich Bay is an important shellfish harvesting resource for the State of Rhode Island. The Bay and its coves are known to experience elevated bacteria levels under wet weather conditions and as a result, the Bay is conditionally approved for shellfish harvesting. It is closed under wet weather conditions defined as within seven days of 0.5 inches of rain. The approved 2006 TMDL calculated wet and dry weather statistics on the data with Greenwich Cove having both wet and dry weather violations.

Currently, RIDEM Shellfish Program collects year-round monthly fecal coliform samples when Greenwich Bay is open to shellfish harvesting (i.e. dry weather conditions), while Watershed Watch volunteers collect seasonal (May through October) monthly enterococci samples. The Watershed Watch sampling dates are determined at the beginning of each sampling season, which means that either wet or dry weather conditions could be captured. RIDEM evaluated both RIDEM Shellfishing and Watershed Watch datasets as part of this assessment to ensure compliance with all relevant criteria. However, since ample enterococci data are available and the Watershed Watch dataset contains samples collected under both wet and dry weather conditions, RIDEM's recreational use assessment is predominately based on the enterococci data.

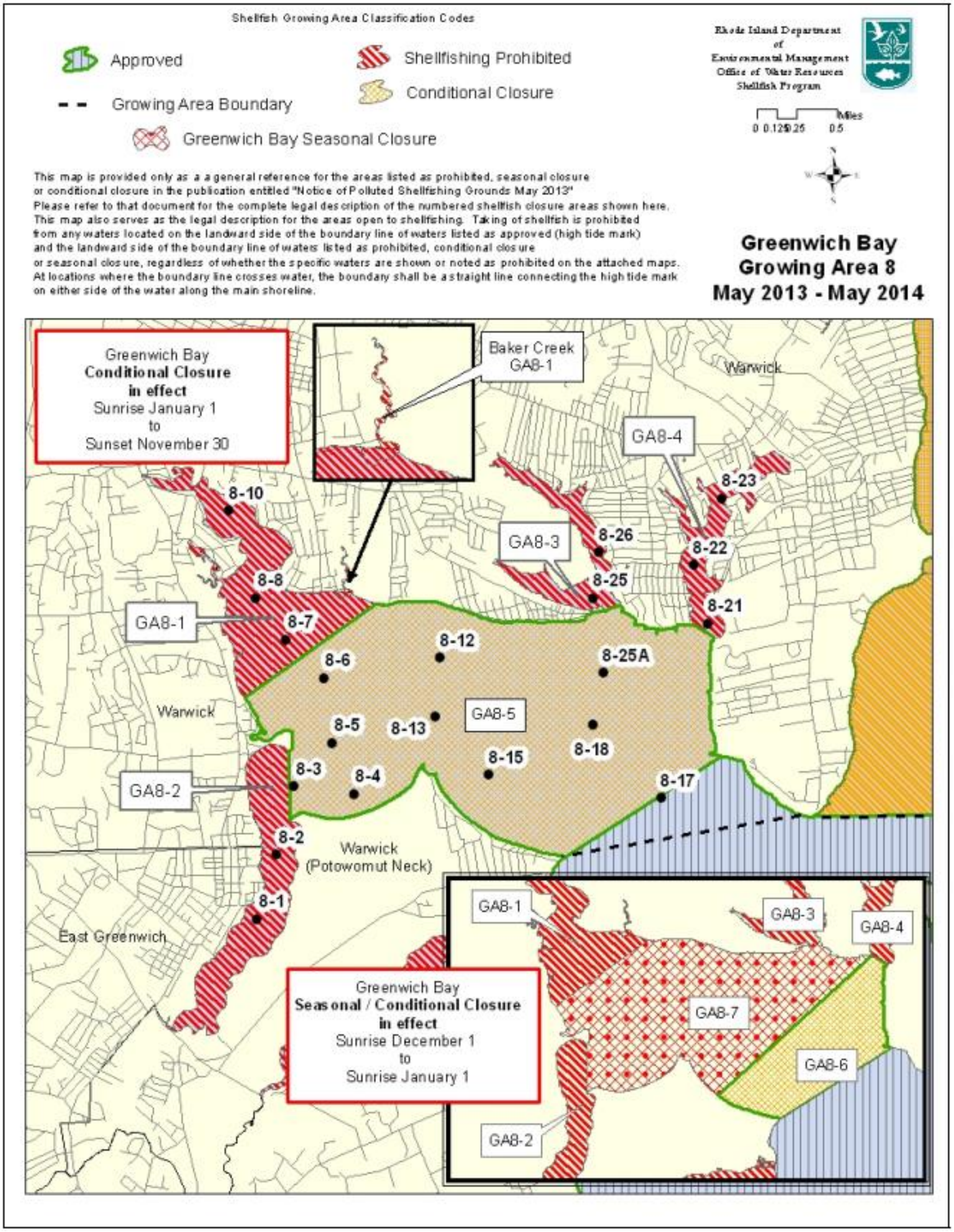
The Shellfish Program fecal coliform data (see Shellfish Growing Area Classification map below for sampling station locations) is presented below for comparison to the recreational fecal coliform criteria. Both portions of the criteria are met; geometric mean of 200 MPN/100 ml is met and not more than 10% of the total samples exceed 400 MPN/100 ml.

RIDEM Shellfishing Dry Weather Fecal coliform Geometric Means

	2013		2014		2015	
	Geomean	%>Critical (31/49)	Geomean	%>Critical (31)	Geomean	%>Critical (31)
Site 8-1	3.5	0.00	3.5	0.00	5.7	7.7
Site 8-2	5.5	6.67	7.7	6.67	5.7	13.33

RIDEM Shellfishing Dry Weather Fecal coliform Number of Samples

Station	2013	2014	2015
Site 8-1	15	14	13
Site 8-2	15	15	15



Enterococci data collected monthly from May through October at the East Greenwich Town Dock (WW325-red star on the map below) in Greenwich Cove by Watershed

Watch volunteers from 2012 – 2016 indicate that the primary and secondary contact uses are being met with the attainment of the enterococci geometric mean criterion of 35 colonies/100 ml. (NOTE: the other station WW324 in Greenwich Cove Segment 5A on the map is not an active site.)

Combined Wet and Dry Weather Enterococci Geometric Means (2012-2016)

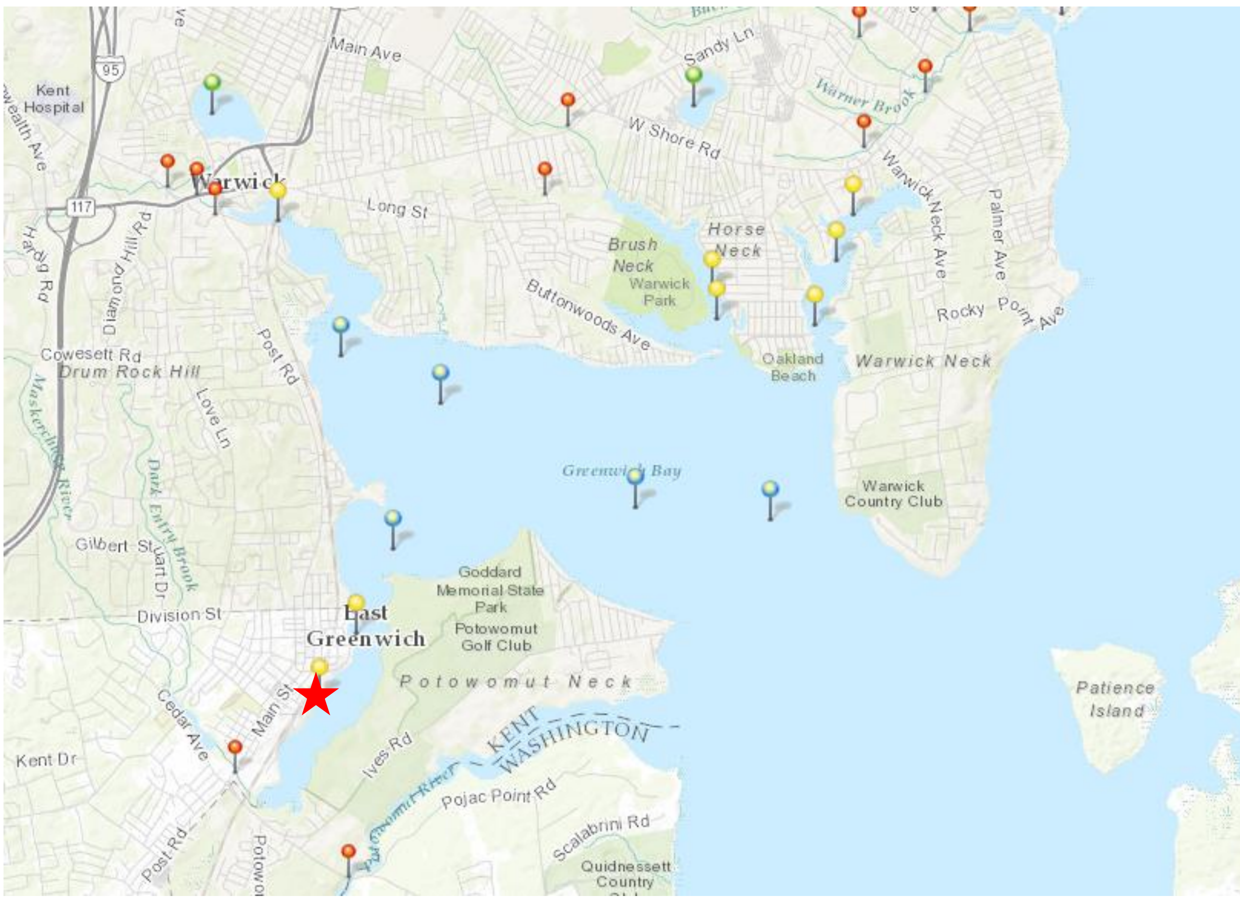
	2012	2013	2014	2015	2016
Number of Samples	6	6	6	6	6
WW325 – EG Town Dock	27.9	13.6	22.2	14.2	9.9

RIDEM also calculated separate wet weather and dry weather geometric means for the most recent Watershed Watch collected data (2012-2016). For each sampling date, RIDEM used the same criteria that was used for the 2006 TMDL to categorize wet versus dry weather samples. RIDEM determined whether the adjacent shellfish grounds were open or closed due to rainfall received (i.e. seven day closure following a 0.5 inch or greater rain event in twenty-four hours). RIDEM also included the nearest rainfall for the closed dates. At least seventeen of the last thirty samples collected were collected when the Greenwich Bay shellfish grounds were closed and experiencing wet weather conditions. Thirteen samples were collected under dry weather conditions. Two samples were collected when the timing of the rainfall, sampling, opening/closing of shellfish grounds are not known for certain. Best professional judgement in both these cases would indicate that the Shellfish Grounds were closed and that these samples were collected under wet weather conditions. It should be noted that the inclusion of these two samples with the wet weather samples had a less than 0.5 MPN/100 mL effect on the geometric mean.

Wet and Dry Weather Enterococci Geometric Means (2012-2016)

Station	WET	DRY
Number of Samples	19	11
WW325 – EG Town Dock	17.7	14.3

Improvements in water quality conditions in Greenwich Cove can be attributed to several actions in the watershed. In 2012, the Town of East Greenwich installed 23 infiltrating catch basins in its Hill and Harbor District, which is located within the Greenwich Cove watershed. Funding was provided by the EPA Section 319 program and from the Rhode Island Bay and Watershed Restoration Fund. Infiltrating catch basins reduce the amount of stormwater entering the stormwater drainage system by allowing the first flush of stormwater to infiltrate into the surrounding soils, rather than continuing into the municipal stormwater system. The Town of East Greenwich annually cleans catch basins throughout town, while frequently sweeping Main Street. Also, in 2012, East Greenwich replaced a sewer main along Water Street, which runs along Greenwich Cove. While there was no evidence that the sewer main was exfiltrating sewage, it was known to be impacted by infiltration.



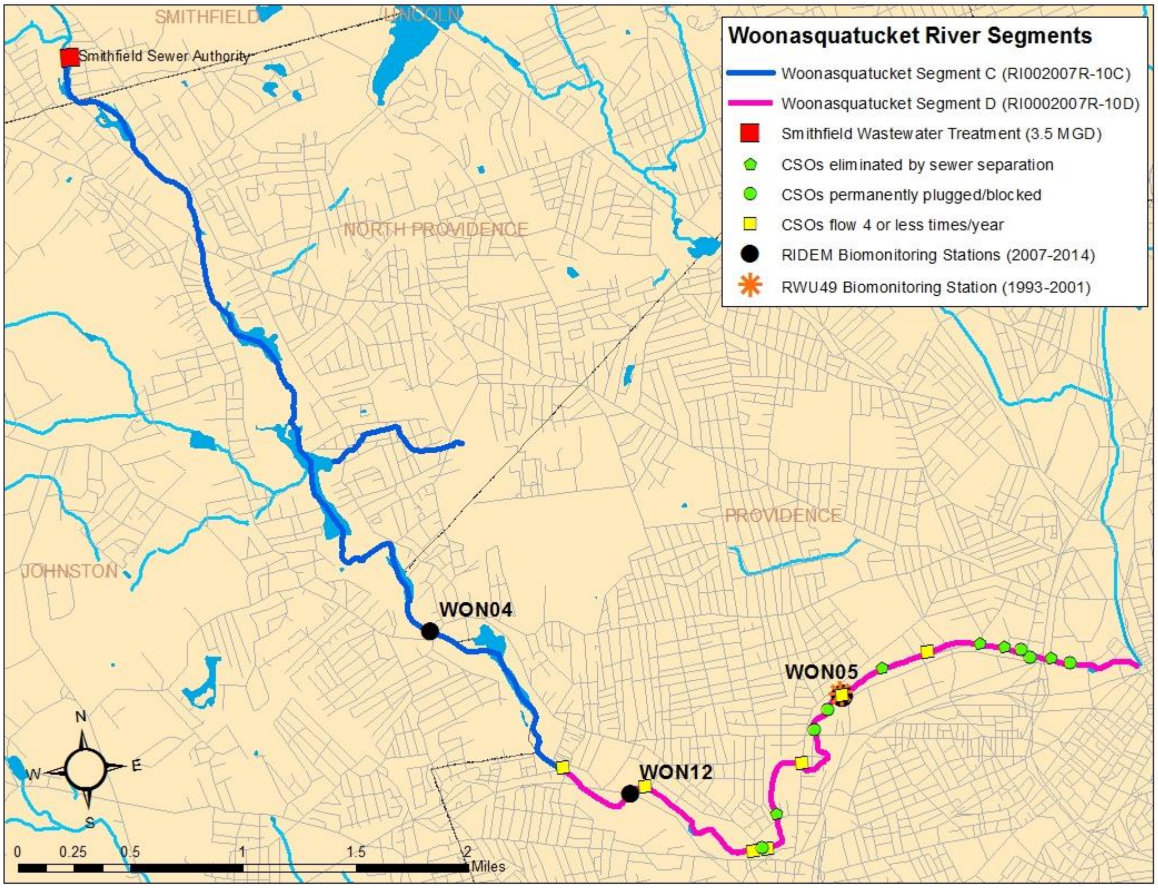
In accordance with US Food and Drug Administration requirements, the RIDEM Shellfish Program conducts periodic shoreline surveys in this area. The last comprehensive shoreline survey, conducted in 2005, identified two storm drains with elevated bacteria levels discharging into this segment of Greenwich Cove. Following the 2005 survey, the DEM Office of Compliance and Inspection conducted an illicit discharge detection study into the two storm drain networks. The actions conducted to identify bacteria sources to the storm drain networks included sampling the upgradient catch basins and manholes multiple times. Also, many onsite wastewater treatment systems (OWTS) were inspected, and East Greenwich and Warwick each hired contractors to video their storm drain networks.

Several failing OWTS systems were found in the drainage areas to these outfalls. At a one marina, a cesspool was removed when it was able to connect to the Warwick sewer line in 2011 with funding assistance from the Bay and Watershed Restoration Fund. The marina had to pump its cesspool 3-4 times per week while waiting for permission to connect to the sewer line which required constructing under an active railway. A senior living facility located on Division Street in Warwick also connected to an adjacent sewer line after the Office of Compliance and Inspection found its onsite wastewater treatment system to be failing. Other remediation efforts included connecting a mill property close to the water to the adjacent sewer line and correcting a grey water direct discharge to the storm drain.

10. Woonasquatucket River (RI0002007R-10C)

Woonasquatucket River and tributaries from Smithfield WWTF discharge point at Esmond Mill Drive to the CSO outfall at Glenbridge Avenue in Providence. Smithfield, North Providence, Providence, Johnston

Benthic-Macroinvertebrate Bioassessments – This segment of the Woonasquatucket River is listed on RI's 2014 303(d) List of Impaired Waters as not supporting aquatic life use due to benthic-macroinvertebrate bioassessments. This impairment was first listed on RI's 2010 303(d) list based on macroinvertebrate data, summarized below, collected in 2007 & 2008 in accordance with a Quality Assurance Program Plan, under the Rhode Island Department of Environmental Management's Wadeable Stream Biomonitoring Program. Sampling was conducted at a station (WON04) by the Greenville/Manton Street Bridge in Providence. This waterbody segment runs from Esmond Mill Drive, Smithfield to the CSO outfall at Glenbridge Avenue in Providence, and the station is in the downstream region of the segment (see map below).



More recent sampling, also conducted in accordance with a Quality Assurance Program Plan, under the Rhode Island Department of Environmental Management's Wadeable Stream Biomonitoring Program, show the macroinvertebrate data, summarized below, indicating the bioassessment is now Fully Supporting according to the Index Score (% reference station score). Sampling was conducted at the same location at the Greenville/Manton Street Bridge (WON04) in 2009 and 2014. The biomonitoring stations are located in the Narragansett-Bristol Lowland ecoregion using the reference site approach to complete the bioassessment as detailed in the Consolidated Assessment and Listing Methodology (CALM). Most recent data show macroinvertebrates are now Fully Supporting the Aquatic Life Use as noted by the Index Scores.

Improvements in the Woonasquatucket River Segment C may be attributed to upgrades to the Smithfield Wastewater Treatment Plant, as well as improvements in stormwater treatment at Metals Recycling, LLC. Upgrades to the Smithfield Wastewater Treatment facility located at the beginning of Segment 10C were completed in July 2006 (to meet seasonal nutrient limits for ammonia, total nitrogen and phosphorus), May 2014 (to meet seasonal phosphorus limits), and August 2014 (to meet zinc limits). Metals Recycling, LLC, a significant metals shredding/recycling facility located in Johnston, operates under a RIPDES Multi-Sector General Permit for its stormwater system that also discharges into segment 10C. They made improvements to their stormwater treatment system in 2005 and more significant improvements in 2012 specifically targeting reductions to BOD, COD, metals, and PCBs (2015 RIPDES Permit # RI0023485). Together these upgrades have helped improve water quality in the Woonasquatucket River over time and likely have contributed to the observed improvements in the river's macroinvertebrate communities.

Sample Date	Station Name	Index Score Required for Fully Supporting	Calculated Lowland Index Score	Bioassessment Determination
8 – 23 – 2007	WON04	$\geq$54 %	29 %	Not Supporting
8 – 22 – 2008	WON04	$\geq$54 %	54 %	**Fully Supporting**
8 – 13 – 2009	WON04	$\geq$54 %	67 %	**Fully Supporting**
9 – 05 – 2014	WON04	$\geq$54 %	56 %	**Fully Supporting**

11. Woonasquatucket River (RI0002007R-10D)

Woonasquatucket River from the CSO outfall at Glenbridge Avenue to the confluence with the Moshassuck River. Providence

Benthic-Macroinvertebrate Bioassessments – This segment of the Woonasquatucket River is listed on RI's 2014 303(d) List of Impaired Waters as not supporting aquatic life designated use due to benthic-macroinvertebrate bioassessments. This impairment was first listed on RI's 1994 303(d) list based on coarse (family level) macroinvertebrate data, summarized below, collected in 1991 by Roger Williams University. Sampling was conducted at a station (RWU49) by the Eagle Street Bridge in Providence on seven occasions 1991 – 2001 (see above map-Same station as WON05).

More recent sampling, conducted in accordance with a Quality Assurance Program Plan, under the Rhode Island Department of Environmental Management's Wadeable Stream Biomonitoring Program, show more detailed macroinvertebrate data (to species when possible), summarized below, indicating the bioassessment is now Fully Supporting according to the Index Score (% reference station score). Sampling was conducted at the same location at the Eagle Street Bridge (WON05) in 2007, 2008, and 2014, as well as at another location (WON12) on that river segment, (approximately 1.8 miles upstream from WON05 at Merino Park) in 2014. The biomonitoring stations are located in the Narragansett-Bristol Lowland ecoregion using the reference site approach to complete the bioassessment as detailed in the Consolidated Assessment and Listing Methodology (CALM). Most recent data show macroinvertebrates are now Fully Supporting the Aquatic Life Use as noted by the Index Scores.

Completion of water pollution abatement projects in the Woonasquatucket Watershed have contributed to improved water quality of the river and to the observed improvements in Segment 10D's macroinvertebrate communities. This segment of the Woonasquatucket River benefits from improved water quality conditions in the upstream segment resulting from upgrades at the Smithfield Wastewater Treatment Plant and Metals Recycling, LLC. Stormwater Treatment Facility that discharge upstream in Segment C of the river (as detailed above). More directly, water quality in this reach of the river will benefit from the Narragansett Bay Commission's (NBC) combined sewer overflow (CSO) abatement project. In June 2001, NBC embarked on construction of a three-phase Combined Sewer Overflow (CSO) abatement program, targeted to limit CSO overflows from up to a three-month storm (1.64 inches of rain in six hours) to 4 or less times per year. Phase I, completed in 2008, included a deep rock tunnel that captures combined stormwater and sewage overflows within the city of Providence (1.1 billion gallons annually) and transports the flow for treatment to the NBC's Field's Point Wastewater Treatment Facility. Phase II facilities, constructed 2011-2015, consists of, in part, an interceptor located along the Woonasquatucket River to convey combined stormwater and sewage flows to the Main Spine Tunnel constructed as part of Phase I. Additionally, in Phase II, a sewer separation project has helped reduce the discharge from 14 combined sewer overflows in the Woonasquatucket River (7 permanently blocked, 7 now only discharge in higher rainfall events 4 or less times per year). One of the CSOs is upstream of sampling station WON12 and 11 of the 14 CSOs are upstream of the WON05 sampling station). These projects will further support protection of water quality for healthy macroinvertebrate communities.

Sample Date	Station Name	Index Score Required for Fully Supporting	Calculated Lowland Index Score	Bioassessment Determination
8 – 01 – 1991	RWU49	≥54 %	19 %	Not Supporting
8 – 01 – 1995	RWU49	≥ 54 %	25 %	Not Supporting
8 – 01 – 1996	RWU49	≥54 %	6 %	Not Supporting
8 – 01 – 1997	RWU49	≥54 %	25 %	Not Supporting
8 – 01 – 1999	RWU49	≥54 %	13 %	Not Supporting
8 – 01 – 2000	RWU49	≥54 %	38 %	Not Supporting
8 – 01 – 2001	RWU49	≥54 %	25 %	Not Supporting
8 – 23 – 2007	WON05	≥54 %	33 %	Not Supporting
8 – 22 – 2008	WON05	≥54 %	58 %	**Fully Supporting**
9 – 04 – 2014	WON05	≥54 %	58 %	**Fully Supporting**
9 – 05 – 2014	WON12	≥54 %	83 %	**Fully Supporting**

12. Dundery Brook & Tribs (RI0010048R-02C*)

Dundery Brook from 1 mile downstream of Meetinghouse Lane to Briggs Marsh Pond. Little Compton

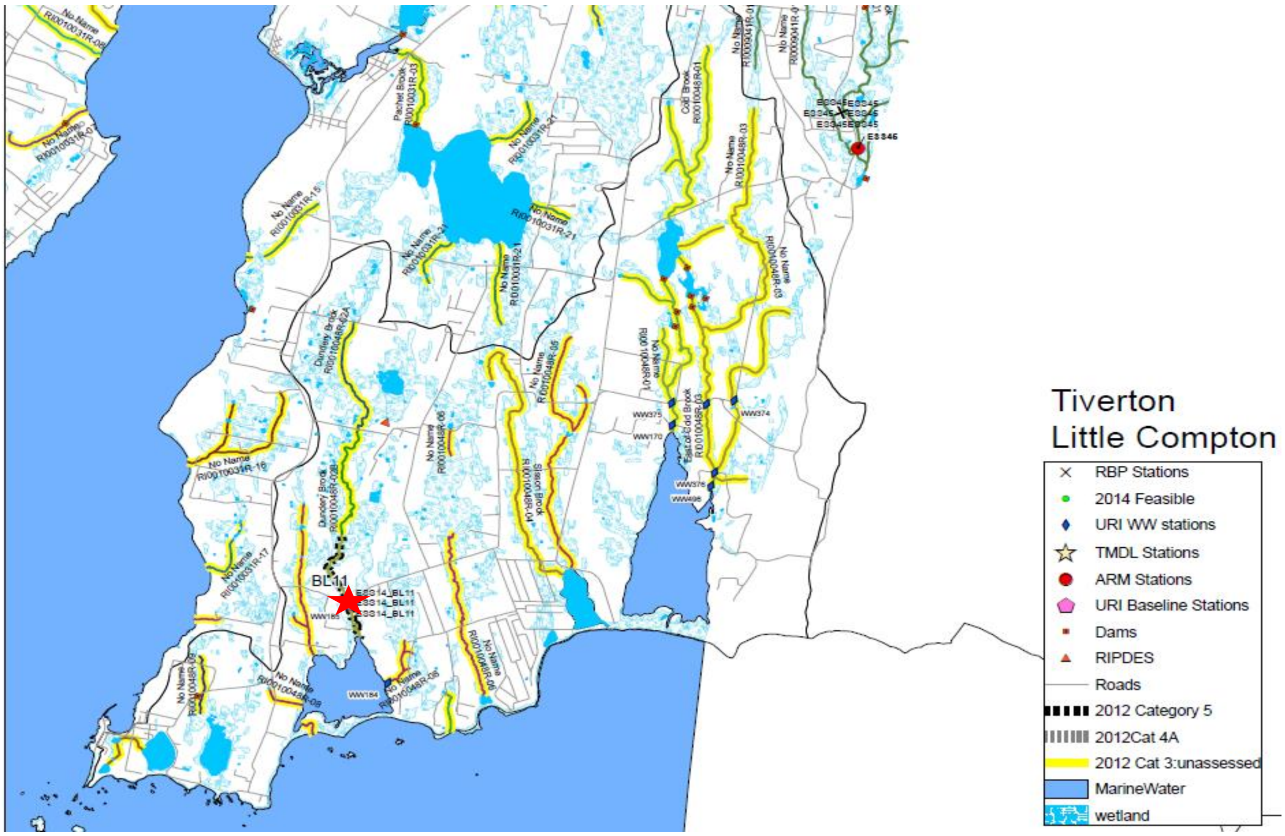
*Due to cessation of a sanitary discharge into Dundery Brook & Tribs, segmentation is no longer needed. For the 2016 Integrated Reporting assessment cycle, segments A, B, and C were retired, and the original waterbody ID of RI0010048R-02 was reinstated, which includes all of Dundery Brook.

Benthic-Macroinvertebrate Bioassessments – Dundery Brook is listed on RI's 2014 303(d) List of Impaired Waters as not supporting aquatic life designated use due to benthic-macroinvertebrate bioassessments. This impairment was first listed on RI's 2010 303(d) list/Integrated Report (IR) based on macroinvertebrate data in accordance with a Quality Assurance Program Plan, under the Rhode Island Department of Environmental

Management's Wadeable Stream Biomonitoring Program. Sampling was conducted at a station (ESS14-red star on the map below) on Swamp Road in 2002, 2003 and 2004.

RIDEM efforts over the last ten years to refine its biological monitoring and assessment program have resulted in a modification in the way that macroinvertebrate data is used and how the cause benthic macroinvertebrate bioassessments is applied in the assessment of Aquatic Life Use. More details are listed on pg. 66. Current Rhode Island protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat. Reconnaissance of the station in Wilbour Woods indicates riffle habitat does not exist in this reach (see Figure below), and therefore no recent biological samples have been taken in this waterbody segment. The benthic macroinvertebrate bioassessment cause is not appropriate in this waterbody type and will be delisted. Rhode Island has not yet developed a biological indicator for low gradient, non-riffle streams. Therefore, no causes will be added, and water chemistry collected in 2014 by the ARM program shows this segment to be fully supporting aquatic life use. These results show dissolved oxygen, pH, temperature, turbidity, and chloride are all meeting water quality criteria supportive of the aquatic life use designation. Water quality associated with the original listing is expected to have improved with elimination of the upstream sanitary discharge from the Josephine F. Wilbur School. The wastewater discharge to surface waters ceased by redirecting the discharges to an Onsite Wastewater Treatment System (OWTS), and the RIPDES discharge permit was terminated on 12/18/2006.

Dundery Brook at Wilbour Woods



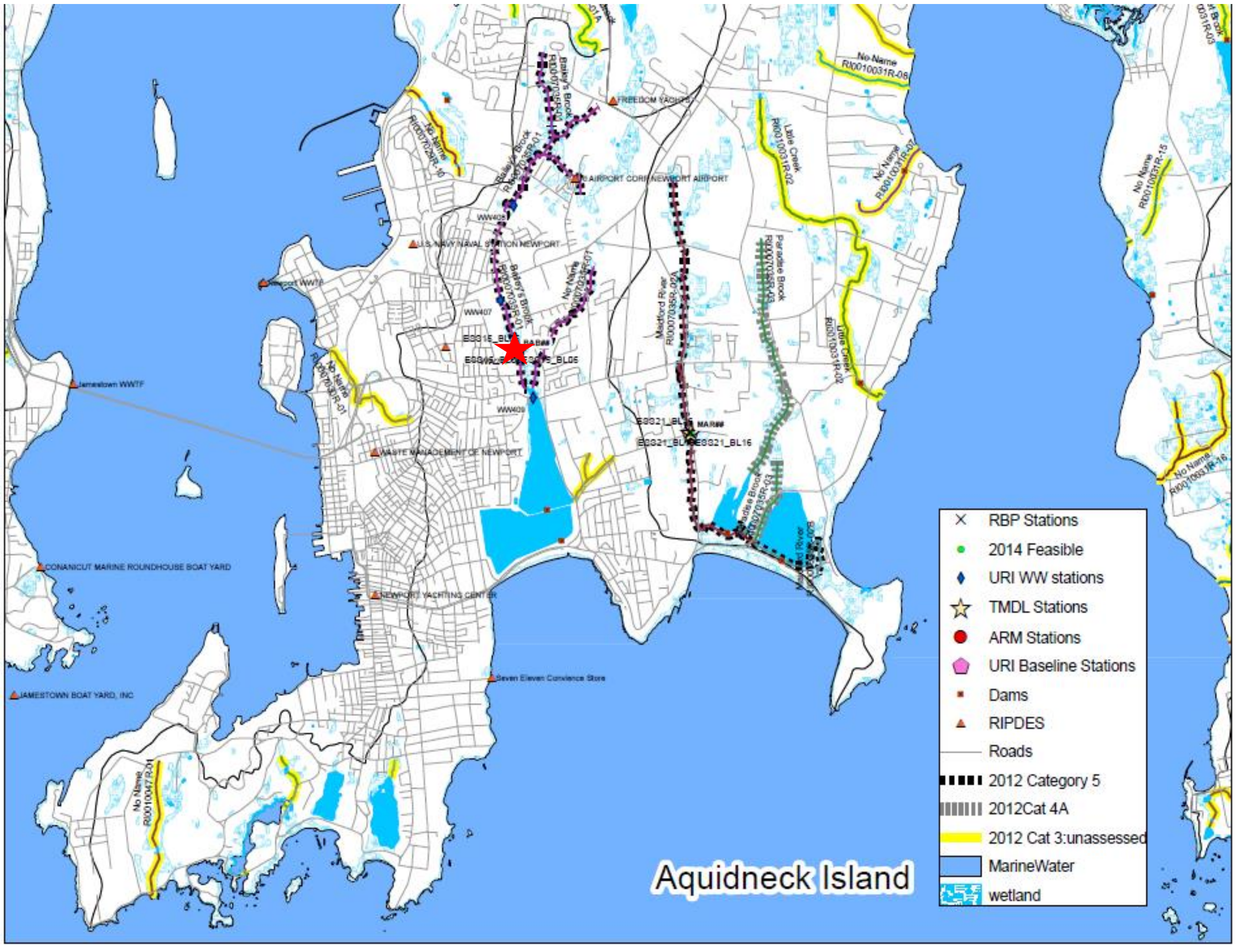
13. Bailey's Brook & Tribs (RI0007035R-01)

Bailey's Brook and tributaries. Middletown

Benthic-Macroinvertebrate Bioassessments – Bailey's Brook & Tribs is listed on RI's 2014 303(d) List of Impaired Waters as not supporting aquatic life designated use due to benthic-macroinvertebrate bioassessments. This impairment was first listed on RI's 1996 303(d) list based on coarse (family-level) macroinvertebrate data, summarized below, collected by Roger Williams University (RWU). Sampling was conducted at a station (RWU05) by Kempenaar's Clambake in Middletown on nine occasions between 1991 and 2002 (red star on the map below). RIDEM efforts over the last ten years to refine its biological monitoring and assessment program have resulted in a modification in the way that macroinvertebrate data is used and how the cause benthic macroinvertebrate bioassessments is applied in the assessment of Aquatic Life Use. RIDEM's current biological monitoring and assessment program uses macroinvertebrate data identified to genus, at a minimum, and to species, when possible. Family level identification may miss changes within the community or inaccurately identify problems. Furthermore, RIDEM's current biological monitoring and assessment program has also refined where it is appropriate to use a timed kick of riffle habitat. More details are listed on pg. 66.

Current RBP protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat. Reconnaissance of RWU05 indicates riffle habitat does not exist in this reach (see Figure below), and therefore no recent macroinvertebrate samples have been taken in this waterbody segment. The benthic macroinvertebrate bioassessment cause is not appropriate in this waterbody type and will be delisted. Rhode Island has not yet developed a biological indicator for low gradient, non-riffle streams. However, RIDEM is aware there are nutrient impacts in this waterbody. Therefore, RIDEM is adding aquatic life use impairment causes for phosphorus (total) to more accurately reflect available information.

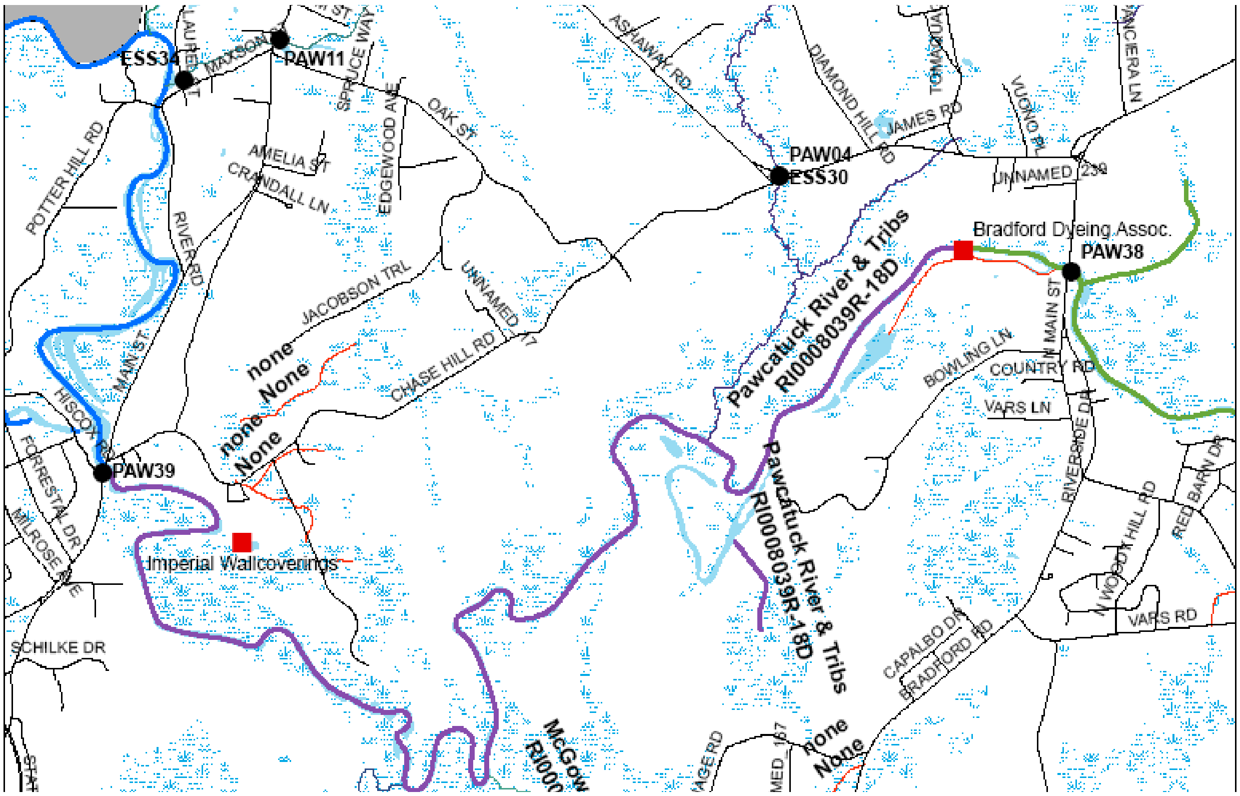
Bailey's Brook at Kempenaar's Clam Bake


Aquidneck Island
RBP Stations
2014 Feasible
URI WW stations
TMDL Stations
ARM Stations
URI Baseline Stations
Dams
RIPDES
Roads
2012 Category 5
2012Cat 4A
2012 Cat 3:unassessed
MarineWater
wetland

14. Pawcatuck River & Tribs (RI0008039R-18D)

Pawcatuck River from the Bradford Dyeing Associates WWTF discharge point to the Route 3 bridge crossing. Hopkinton, Westerly

Benthic-Macroinvertebrate Bioassessments – This segment of the Pawcatuck River & Tribs is listed on RI's 2014 303(d) List of Impaired Waters as not supporting aquatic life designated use due to benthic-macroinvertebrate bioassessments. This waterbody segment stretches 5.23 miles from Bradford Dyeing Associates (BDA) WWTF discharge point to the Route 3 bridge crossing – the purple segment on the map below.



This impairment was first listed on RI's 1998 303(d) list as impaired due to biodiversity impacts (BI) as a cause. In 2008, when RI's 303(d) List of Impaired Waters was reformatted in accordance with specifications of the Integrated Report, the term biodiversity impacts was phased out to using new cause terms that better characterized the listing according to the type of biological data and evaluation that led to the listing. For this waterbody segment, the impairment cause was changed to benthic macroinvertebrate bioassessment (see the 2008 RIDEM 303(d) List of Impaired Waters). The 2014 Consolidated Assessment and Listing Methodology (CALM) specifies benthic macroinvertebrate bioassessment is determined by sampling of riffles in wadeable streams/rivers, using the Rapid Bioassessment Protocol (RBP). Based on a thorough review of all associated data files, no RBP data exist for this non-wadeable river segment.

The 1998 listing was based on a 1997 visual observation, by RIDEM OWR staff, of excessive amounts of sulfur-fixing bacteria that were observed in the river just upstream of BDA's discharge. At the time, it was suspected this was a result of BDA's use of sulfuric acid in an unlined pH neutralization lagoon. Since then, DEM RIPDES Permitting Program required BDA to modify its neutralization process so they no longer used the lagoon and instead use an indoor computerized system to maintain pH (OWR Inter-office Memo "Changes to Bradford Dyeing Association's Whole Effluent Toxicity (WET) Limits" dated May 24, 2005). Subsequent visual inspection of the shoreline by boat in 2011 by RIDEM OWR staff along the entire length of the segment to document conditions found no visual evidence of a white substance or sulfur-fixing bacteria. In 2015, the Bradford Dyeing Association Facility ceased discharge of effluent, and no future discharges are anticipated.

Pawcatuck River & Tribs (RI0008039R-18D) lies in the Long Island Sound Coastal Lowland and is considered a low gradient river, with the watershed at the most down-stream point on the segment where it crosses Route 3 draining an area 239 square miles. The river is wide and flat throughout the segment, with no riffle habitat and it can become deep in some areas, making it non-wadeable. Given these conditions, it is inappropriate to sample this river using the wadeable stream methods of the Rapid Bioassessment Protocol as detailed in the CALM; therefore, no benthic macroinvertebrate data has been collected from this River Segment. Since there is no benthic macroinvertebrate data from this segment, historic or otherwise, RIDEM is de-listing the benthic-macroinvertebrate bioassessment impairment.

As detailed in the CALM, where no adequate macroinvertebrate data exist, conventional water quality parameters and metals data may be used to assess the aquatic life use. As part of the RIDEM Ambient River Monitoring Program, dry weather samples were collected and analyzed in accordance with the Quality Assurance Program Plan. Water quality data was collected at PAW39 (at Route 3; located on the border of Segments D and E, but represents segment D) in both 2011 and 2015. These results show dissolved oxygen, pH, temperature, turbidity, chloride, cadmium, copper, iron, zinc and lead concentrations are all meeting water quality criteria supportive of the aquatic life use designation.

15. <u>Maidford River (RI0007035R-02B)*</u>

Maidford River from the water supply diversion near Paradise Ct. to Hanging Rock Rd., Middletown.

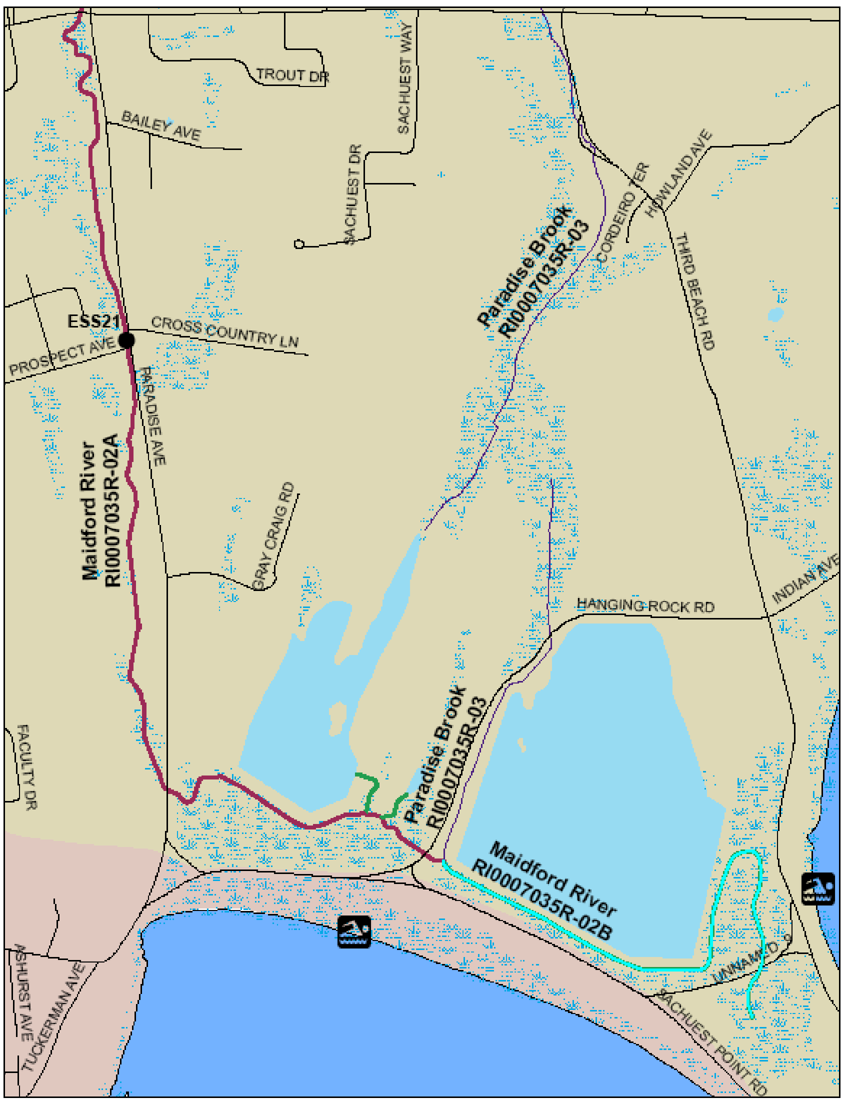
**Segmentation of the Maidford River has changed several times over the past two decades in response to available information. With this 2016 Integrated Reporting assessment cycle, the Maidford River segments have been updated to more accurately reflect salinity and other conditions on Maidford River. Segment 2A is now defined as extending from the headwaters to the diversion structure of the Newport Water Division (NWD) on Paradise Avenue, and Segment 2B is defined as extending from the NWD diversion structure to Hanging Rock Road. A new waterbody ID, classified as salt water based on salinity readings has been added for the lower reach from Hanging Rock Road to Third Beach (RI0007035E-01).*

<u>Benthic-Macroinvertebrate Bioassessments</u> – Maidford River (Segment 2B) is listed on RI's 2014 303(d) List of Impaired Waters as not supporting aquatic life designated use due to benthic-macroinvertebrate bioassessments. This impairment was first listed on RI's 1996 303(d) List due to biodiversity impacts when Maidford River was assessed as one waterbody identification number (RI0007035R-02). The 1996 impairment on Maidford River (RI0007035R-02) was based on coarse (family level) macroinvertebrate data collected by Roger Williams University in 1991 & 1992 at a station (RWU27 aka ESS21) located on Prospect Avenue in Middletown (in what is now Maidford River Segment 2A). RIDEM efforts over the last ten years to refine its biological monitoring and assessment program have resulted in a modification in the way that macroinvertebrate data is used and how the cause benthic macroinvertebrate bioassessments is applied in the assessment of Aquatic Life Use. RIDEM's current biological monitoring and assessment program uses macroinvertebrate data identified to genus, at a minimum, and to species, when possible. Family level identification may miss changes within the community or inaccurately identify problems. Furthermore, RIDEM's current biological monitoring and assessment program has also refined where it is appropriate to use a timed kick of riffle habitat. More details are listed on pg. 66.

Maidford River was split into two segments for the 2000 State of the State's Water Report due to water quality samples collected (July and August 2000) near Third Beach showing the lower reach's recreation/swimming use was impaired for pathogens (shown in the first map below). All impairments from the once unified Maidford River assessment unit, including the biodiversity impairment from station RWU27/ESS21, were applied to the new segments. The benthic macroinvertebrate impairment documented at Station RWU27/ESS 21 at Paradise Avenue should not be applied downstream to either the newly defined segment 2B due to this reach's watershed/stream characteristics or the newly created salt water segment RI0007035E-01, as further described below.

Current RBP protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat. Reconnaissance of several locations along the newly defined Segment 2B (from the Newport Water Supply diversion to Hanging Rock Road) of the Maidford River by RIDEM in 2013 show this riffle habitat does not exist in this reach, and therefore no recent biological samples have been taken in this waterbody segment. The benthic macroinvertebrate bioassessment cause is not appropriate in this waterbody type and will be delisted. Rhode Island has not yet developed a biological indicator for low gradient, non-riffle streams.

Maidford River is a freshwater, wadeable stream up to Hanging Rock Road where it becomes brackish (1.8 ppt), as defined in the RI Water Quality Regulations, and salinity continues to increase at two points further downstream (Sachuest Point Road measured 24.7 ppt and Third Beach Road measured 30.6 ppt). The new salt water segment (RI0007035E-01) begins at Hanging Rock Road until it empties into the Sakonnet River at Third Beach. This segment would not support freshwater benthic macroinvertebrates and should not be listed for benthic macroinvertebrate bioassessments. The new segment (RI0007035E-01) will be listed as a Category 3, since data has not been collected in this segment, and the downstream extrapolation of an impairment, especially one based on freshwater data and analysis is inappropriate.



Maidford River and Paradise Brook segmentation 2000 - 2014 IR Assessment Cycles

Maidford River segmentation for 2016 IR Assessment Cycle

Maidford River Segment 2A is still considered Not Supporting (Impaired) for aquatic life use with benthic-macroinvertebrate bioassessments as one cause (also listed for turbidity, lead, and total phosphorus as aquatic life impairment causes) based on the samples for the original impairment listing at ESS21.

Photo: The lower Maidford River (RI0007035E-01) is located in Estuarine Emergent Wetlands along Sachuest Point Road (Photo taken 10-23-2013).

Maidford River Segment 2A at RWU27/ESS21 (Maidford River at Prospect Ave) is a wadeable freshwater stream (photo taken 8/27/2004).

METALS DELISTINGS

During the U.S. EPA's review of the State's rotating basin program's Quality Assurance Project Plan (QAPP; RIDEM 2010: http://www.dem.ri.gov/pubs/qapp/ambirivr2.pdf), the suggestion was made to discontinue using a rope and Teflon bucket sampler to collect sterile bacteria samples. The rope and basket method was retired 6-9-2011, and all sampling changed to a direct grab and composite method. While this change was in response to sterile bacteria samples, this reporting cycle includes many delistings of metals originally listed in 2010 that would have been previously sampled using the rope and Teflon bucket method. Some of the improvement may be due to the cleaner, more precise sampling of metals, as well as management activities as noted below (#16-23).

Freshwater aquatic life criteria for certain metals are expressed as a function of hardness, because hardness can affect the toxicity of these metals. Increasing hardness has the effect of decreasing the toxicity of metals. Ambient hardness values reported in mg/l as CaCO3 are used to determine applicable acute and chronic metals criteria following US EPA recommended equations provided in Appendix B of RIDEM's Water Quality Regulations (RIDEM, 2010).

16. Branch River (RI0001002R-01B)

Branch River and tributaries from the outlet of the Slatersville Reservoir to the confluence with the Blackstone River. North Smithfield

Dissolved Copper (Cu) – This segment of the Branch River was on RI's 2014 303(d) list for exceedances of freshwater dissolved copper (Cu) criteria. It was first listed as impaired for copper in 2010, as a result of USGS 2007-2008 sampling. USGS samples in all conditions, so dry and wet weather samples may be included. As part of the Rhode Island Department of Environmental Management Ambient River Monitoring (ARM) program, dry weather samples were collected in 2013 on the mainstem of the river at BNC01 (red circle on the map below) at the Route 146A crossing near Forestdale, RI. Grab samples were collected on three separate dates under dry weather conditions, where measured rainfall for forty-eight hours prior to sampling is less than 0.1 inch. The dry weather data, presented below show that there was one exceedance of the chronic criteria for dissolved copper in June 2013. As noted in the CALM, grab samples are considered sufficient to assess acute criteria, and chronic criteria should be assessed using data representative of conditions, including hydrologic conditions, during a four day averaging period.

RIDEM ARM Station BNC01 at Forestdale, RI								
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[1] (mg/L)	Copper Criteria (µg/L)		Average Daily Flow (cfs)	Flow Percentile (%)
					Acute	Chronic		
6/18/2013	0.167	1.00	**1.46**	9.60	1.48	1.21	389	9.4%
8/19/2013	0.167	1.00	1.29	15.84	2.37	1.85	31	85.7%
9/30/2013	0.167	1.00	1.18	24.00	3.5	2.65	15	98.0%

[1]Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals. Exceedances of criteria are show in **bold** type

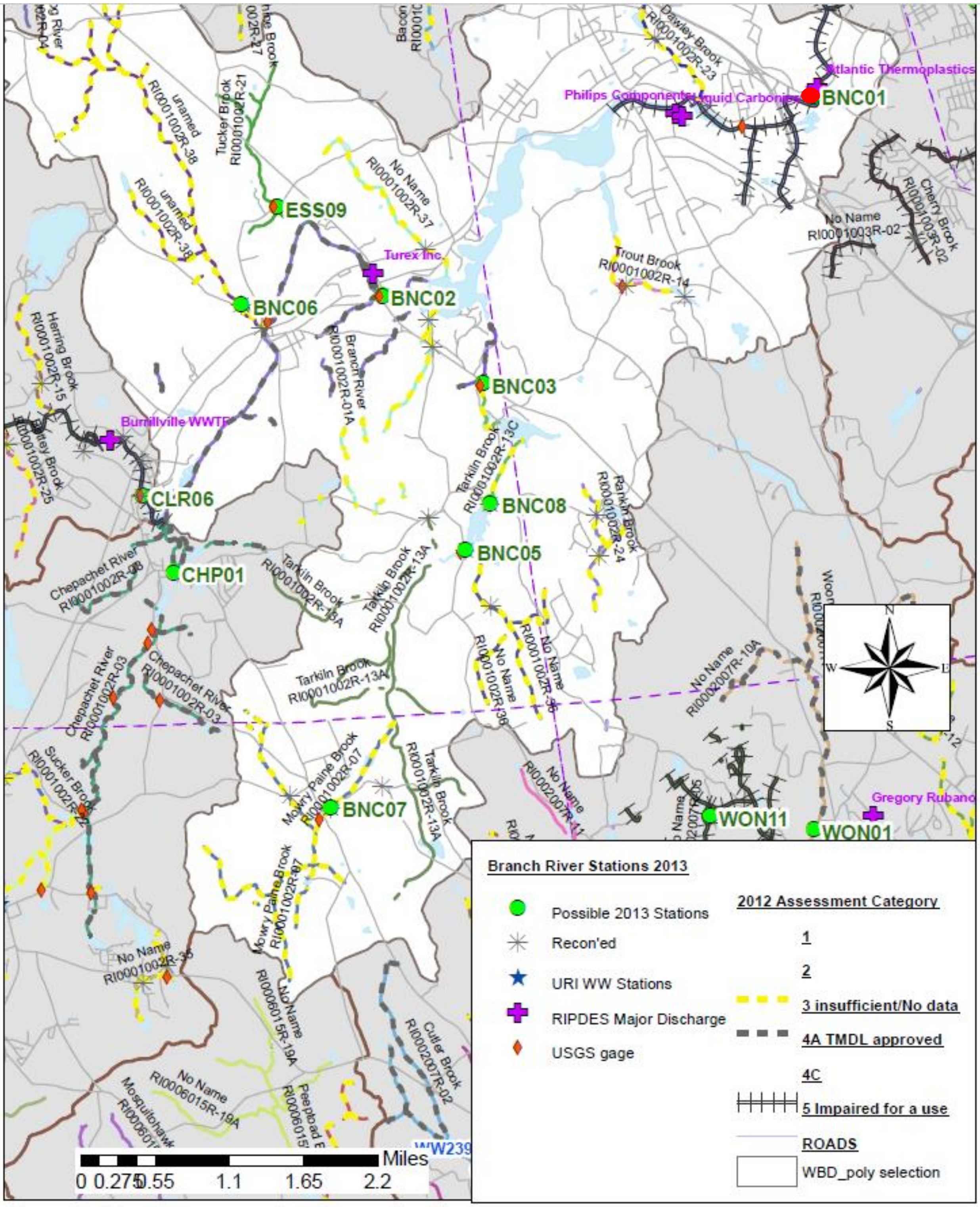
The Route 146A crossing is also the location of the USGS gauging station (01111500) for the Branch River where flow and water quality data were collected under both dry and wet weather conditions. During the period from March 2009 to March 2016, USGS collected twenty-nine water quality samples for the Branch River. The observed averaged daily flows at the station ranged from a minimum of 4.6cfs in 2015 to a maximum of 3,980cfs in 2010. The table below shows the average daily flow in the Branch River on the day the samples were collected as well as the percentile for the volume of flow. The dates that may be considered under wet weather conditions are those periods where the accumulated precipitation for the previous forty-eight hours was greater than 0.10 inches. Fourteen of the twenty-nine samples collected fall into the wet weather category.

The table below shows that under both high and low flows, as well as wet and dry weather conditions, there was one exceedance of the acute and two exceedances of the chronic dissolved copper criteria that occurred for the December 2009 and March 2010 surveys. Since that time, no exceedances of the freshwater aquatic acute or chronic criteria were observed in the Branch River for the twenty-four surveys conducted by the USGS staff. From June 2010 to March 2016, a total of twenty-seven samples (USGS and ARM) have been collected on this segment of the Branch River. The observed data for this period of time show that the water quality of this segment consistently meets the State of Rhode Island's criteria for dissolved copper. This segment will not be included on the 2016 303(d) list as impaired for dissolved copper.

Branch River USGS Gauging Station 01111500 at Forestdale, RI									
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[3] (mg/L)	Copper Criteria (µg/L)		Rainfall 48 Hrs Prior to sampling (in)	Average Daily Flow (cfs)	Flow Percentile (%)
					Acute	Chronic			
3/24/2009	0.5	1.0	1.00	14.10	2.12	1.68	0	172	36.1%[2]
6/23/2009	0.5	1.0	1.50	14.70	2.21	1.74	0.22	167	37.4%[2]
9/16/2009	0.5	1.0	0.93	18.30	2.71	2.10	0	31	85.7%
12/8/2009	0.5	1.0	**4.50**	9.60	1.53	1.25	0	276	17.9%[2]
3/22/2010	0.5	1.0	**1.20**	9.44	1.45	1.19	0.08[1]	360	11.1%[2]
6/29/2010	0.5	1.0	1.20	15.90	2.38	1.86	0	45	76.9%
9/21/2010	0.5	1.0	0.72	22.00	3.23	2.46	0	17	96.9%
1/3/2011	0.5	0.5	0.75	16.00	2.39	1.87	0.24	254	20.5%[2]
3/29/2011	0.5	0.5	0.76	13.10	1.98	1.58	0	194	30.7%[2]
6/28/2011	0.5	0.5	1.00	14.80	2.22	1.75	0	108	53.4%
9/28/2011	0.5	0.5	0.99	13.60	2.05	1.63	0	121	49.6%
12/29/2011	0.8	0.8	0.80	11.20	1.71	1.38	0	315	14.2%[2]
3/28/2012	0.8	0.8	0.86	16.30	2.43	1.90	0	61	69.8%
6/27/2012	0.8	0.8	1.30	15.70	2.35	1.84	1.21	55	72.1%
9/26/2012	0.8	0.8	0.89	20.90	3.07	2.35	0	16	97.5%
11/1/2012	0.8	0.8	1.10	13.30	2.01	1.60	1.41	217	26.1%[2]
12/27/2012	0.8	0.8	1.60	14.80	2.22	1.75	1.11[1]	395	9.2%[2]
4/2/2013	0.8	0.8	0.80	12.90	1.95	1.56	0.04	219	25.7%[2]
4/25/2013	0.8	0.8	0.82	15.70	2.35	1.84	0.04	118	50.5%
6/27/2013	0.8	0.8	1.20	13.30	2.01	1.60	0.08	138	44.8%
4/2/2014	0.8	0.8	0.88	9.35	1.44	1.18	0.38	603	3.5%[2]
6/23/2014	0.8	0.8	0.97	18.80	2.78	2.15	0	42	78.3%
9/23/2014	0.8	0.8	<0.80	23.90	3.49	2.64	0.04[1]	22	93.2%
12/17/2014	0.8	0.8	1.30	16.00	2.39	1.87	0.4	197	30.0%[2]
3/23/2015	0.8	0.8	0.83	17.80	2.64	2.05	0.13	173	35.9%[2]
6/29/2015	0.8	0.8	0.92	19.30	2.85	2.20	0	135	45.6%
9/28/2015	0.8	0.8	<0.80	26.50	3.85	2.88	0	6.2	100.0%
1/4/2016	0.8	0.8	0.94	22.60	3.31	2.51	0	91	59.0%
3/29/2016	0.8	0.8	<0.80	18.70	2.77	2.14	0.54	212	27.0%[2]

1. Rainfall occurred on date the samples were collected.
2. Flow percentile values below 40% are considered to be under moist conditions.
3. Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.

Exceedances of criteria are show in **bold** type


Branch River Stations 2013
Possible 2013 Stations
Recon'ed
URI WW Stations
RIPDES Major Discharge
USGS gage
2012 Assessment Category
1
2
3 insufficient/No data
4A TMDL approved
4C
5 Impaired for a use
ROADS
WBD_poly selection
BNC01
BNC02
BNC03
BNC05
BNC06
BNC07
BNC08
ESS09
CLR06
CHP01
WON11
WON01
Atlantic Thermoplastics
Philips Components
Turex Inc.
Burrillville WWTF
Gregory Rubano
Miles
0 0.275 0.55 1.1 1.65 2.2

17. Chipuxet River and Tribs (RI0008039R-06B)

Chipuxet River and tributaries from outlet of Yawgoo Mill Pond to the entrance of Hundred Acre Pond. Exeter, South Kingstown

Dissolved Cadmium (Cd) - This segment of Chipuxet River and Tributaries was on Rhode Island's 2014 303(d) list for exceedances of the freshwater criteria for dissolved cadmium (Cd). It was first listed as impaired for dissolved cadmium in 2002, as a result of baseline, dry weather surveys in 1999/2000. As part of the Rhode Island Department of Environmental Management Ambient River Monitoring (ARM) program, dry weather samples were collected in 2011 and 2015 at two stations on the main stem of the river between the outlet of Yawgoo Mill Pond and the inlet of Hundred Acre Pond in Exeter, RI. The northern most station is PAW36 (red star on map below) located on the downstream side of the river at Yawgoo Valley Road crossing. Station PAW05 (red circle on map below) is approximately 1.0 mile south of the northern station on the downstream side of the Wolf Rocks Road crossing of the Chipuxet River.

Dry weather surveys are conducted on those days where the measured rainfall for the previous forty-eight hours prior to sampling is less than 0.10 inches. The land use in the watershed does not indicate sources of dissolved cadmium (Brushland/Forest-58.5%, Commercial/Industrial 0.8%, Other 4.9%, Residential 15.4%, Open Water 0.8%, Agriculture 19.6%). This watershed is 6.53% impervious cover, and given that this watershed is extensively Brushland/Forest and Agriculture, we do not expect exceedances of dissolved cadmium criteria during wet weather. The dry weather, grab sample data, presented below for both stations, indicate that the water quality of this segment is meeting the State of Rhode Island's water quality criteria for dissolved cadmium that allows for one exceedance every three years and will not be included on the 2016 303(d) list as impaired for dissolved cadmium. As noted in the CALM, grab samples are considered sufficient to assess acute criteria, and chronic criteria should be assessed using data representative of conditions, including hydrologic conditions, during a four day averaging period.

Station PAW05

Chipuxet River and Tributaries RI0008039R-06B ARM Dissolved Cadmium						
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[1] (mg/L)	Cadmium Criteria (µg/L)	
					Acute	Chronic
6/20/2011	0.050	0.046	< 0.05	22.90	0.477	0.088
9/15/2011	0.046	0.046	**0.097**	24.79	0.517	0.093
10/12/2011	0.046	0.05	< 0.046	26.70	0.557	0.098
6/10/2015	0.073	0.073	<0.073	25.90	0.540	0.096
8/19/2015	0.073	0.073	<0.073	27.50	0.573	0.100
9/9/2015	0.073	0.073	<0.073	34.90	0.723	0.118

1. Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.
Exceedances of criteria are show in **bold** type

Station PAW36

Chipuxet River and Tributaries RI0008039R-06B ARM Dissolved Cadmium						
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[1] (mg/L)	Cadmium Criteria (µg/L)	
					Acute	Chronic
6/20/2011	0.050	0.046	<0.05	25.90	0.540	0.096
9/15/2011	0.046	0.046	0.065	24.80	0.517	0.093
10/12/2011	0.046	0.050	<0.05	25.60	0.534	0.095
6/10/2015	0.073	0.073	< 0.073	23.70	0.494	0.090
8/19/2015	0.073	0.073	< 0.073	27.70	0.577	0.101
9/9/2015	0.073	0.073	< 0.073	37.10	0.767	0.123

1. Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.

<u>Dissolved Copper (Cu)</u> - This segment of Chipuxet River and Tributaries was on Rhode Island's 2014 303(d) list for exceedances of the freshwater criteria for dissolved copper (Cu). It was first listed as impaired for dissolved copper in 2006, as a result of baseline, dry weather sampling 2000-2003. As part of the Rhode Island Department of Environmental Management Ambient River Monitoring (ARM) program, dry weather samples were collected in 2011 and 2015 at PAW05 and PAW36 on the main stem of the river between the outlet of Yawgoo Mill Pond and the inlet of Hundred Acre Pond in Exeter, RI. The land use in the watershed does not indicate sources of dissolved copper (Brushland/Forest-58.5%, Commercial/Industrial 0.8%, Other 4.9%, Residential 15.4%, Open Water 0.8%, Agriculture 19.6%). This watershed is 6.53% impervious cover, and given that this watershed is extensively Brushland/Forest and Agriculture, we do not expect exceedances of dissolved copper criteria during wet weather. The dry weather data, presented below for both stations, indicate that the water quality of this segment is meeting the State of Rhode Island's water quality criteria for dissolved copper and will not be included on the 2016 303(d) list as impaired for dissolved copper.

Station PAW05

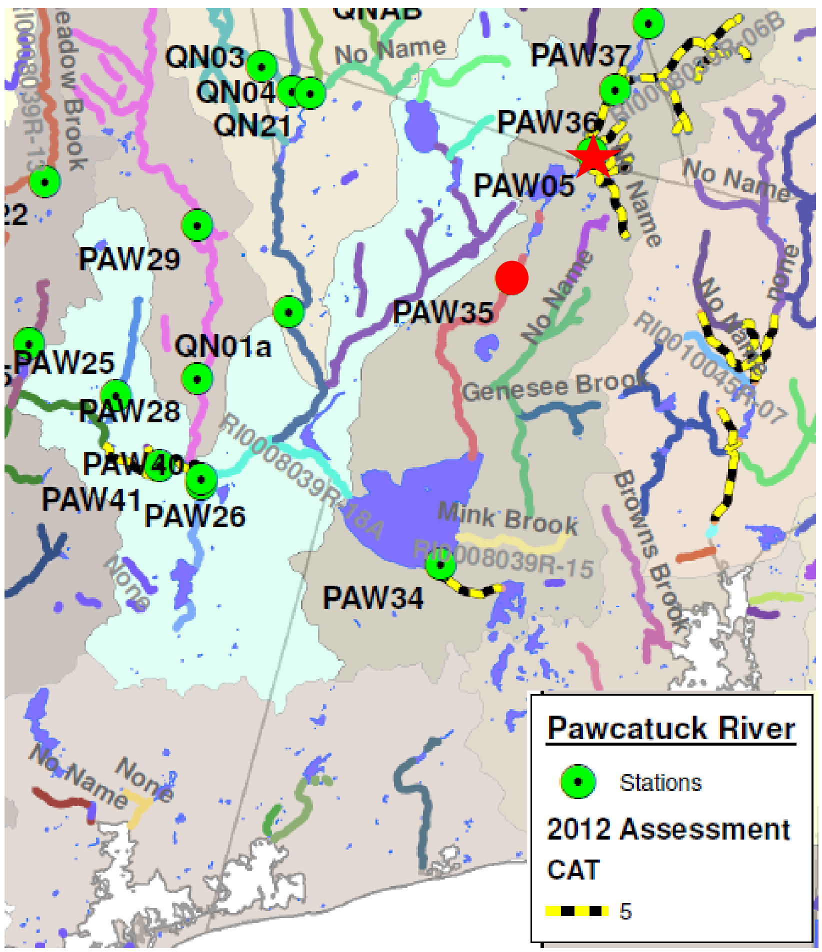
Chipuxet River and Tributaries RI0008039R-06B ARM Dissolved Copper						
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[1] (mg/L)	Copper Criteria (µg/L)	
					Acute	Chronic
6/20/2011	0.13	0.13	1.10	22.90	3.35	2.54
9/15/2011	0.13	0.13	1.98	24.79	3.61	2.72
10/12/2011	0.13	0.13	0.71	26.70	3.87	2.90
6/10/2015	0.154	0.154	1.19	25.90	3.76	2.82
8/19/2015	0.154	0.154	1.69	27.50	3.98	2.97
9/9/2015	0.154	0.154	0.71	34.90	4.98	3.64

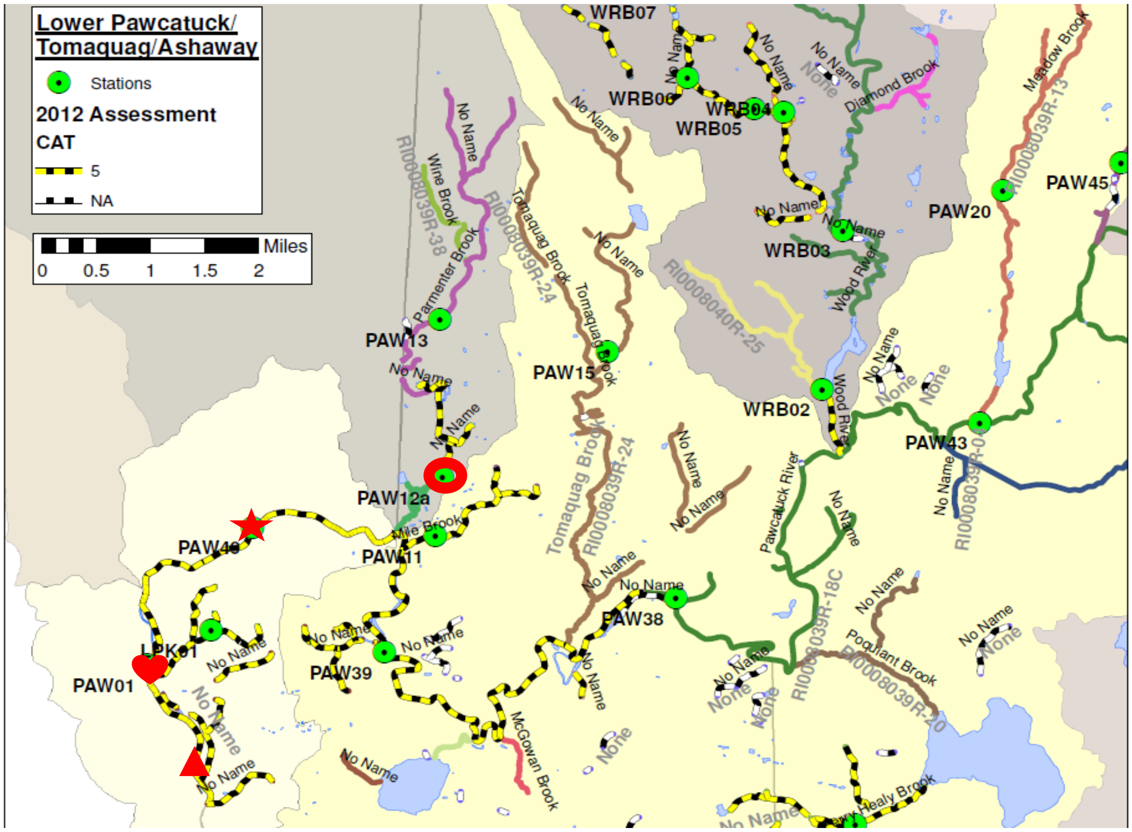
1. Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.

Station PAW36

Chipuxet River and Tributaries RI0008039R-06B ARM Dissolved Copper						
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[1] (mg/L)	Copper Criteria (µg/L)	
					Acute	Chronic
6/20/2011	0.13	0.13	1.22	25.90	3.76	2.82
9/15/2011	0.13	0.13	2.33	24.80	3.61	2.72
10/12/2011	0.13	0.13	0.82	25.60	3.72	2.80
6/10/2015	0.154	0.154	0.89	23.70	3.46	2.62
8/19/2015	0.154	0.154	1.44	27.70	4.01	2.99
9/9/2015	0.154	0.154	0.90	37.10	5.28	3.84

1. Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.





18. Ashaway River & Tribs (RI0008039R-02A)

Ashaway River headwaters including tributaries, south to the Ashaway Road highway bridge. Hopkinton

<u>Dissolved Cadmium (Cd)</u> - This segment of Ashaway River was on RI's 2014 303(d) list for exceedances of the freshwater criteria for dissolved cadmium (Cd). It was first listed as impaired for cadmium in 2002, as a result of 1999/2000 baseline, dry weather sampling. As part of the Rhode Island Department of Environmental Management Ambient River Monitoring (ARM) program, dry weather samples were collected in 2011 and 2015 on the main stem of the river at the High Street Bridge crossing in Ashaway, RI. In 2011, the samples were collected on the upstream side (PAW12) of a dam at the bridge crossing. In 2015, the sample location was moved to the downstream side (PAW12a-red rind on the map above) to provide a more representative sample of the water quality for that stream segment, and the 1999/2000 baseline station is noted as below Route 216, which is the location of PAW12a.

The dry weather data, presented below, shows that over the two surveys, there were no exceedances of either the acute or the chronic freshwater dissolved cadmium criteria. The land use in the watershed does not indicate any sources of dissolved cadmium

(Brushland/Forest-63.1%, Commercial/Industrial 3.5%, Other 7.3%, Residential 16.7%, Open Water 1.4%, Agriculture 8.0%). This watershed is 8.23% impervious cover, and given that this watershed is primarily Brushland/Forest and Residential, we do not expect any exceedance of dissolved cadmium criteria during wet weather. This segment of the river is meeting the State of Rhode Island's water quality criteria for dissolved cadmium that allows for one exceedance every three years and will not be included on the 2016 303(d) list as impaired for dissolved cadmium.

Station PAW12a (PAW12)

Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[1] (mg/L)	Cadmium Criteria (µg/L)	
					Acute	Chronic
5/11/2011	0.050	0.050	**0.20**	18.08	0.375	0.075
8/24/2011	0.046	0.046	<0.05	24.46	0.510	0.092
9/28/2011	0.046	0.046	<0.05	19.26	0.400	0.078
6/8/2015	0.073	0.073	<0.073	25.4	0.530	0.095
8/17/2015	0.073	0.073	<0.073	38.3	0.791	0.126
9/3/2015	0.073	0.073	<0.073	49.8	1.022	0.151

1. Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.
Exceedances of criteria are show in **bold** type

19. Pawcatuck River & Tribs (RI0008039R-18E)

Pawcatuck River and tributaries from the Route 3 bridge crossing to the Route 1 highway bridge at the junction of Main Street and Broad Street in Westerly. Westerly

Total Iron (Fe) – This segment of the Pawcatuck River was listed on RI's 2014 303(d) list for exceedances of freshwater criteria for total iron (Fe). It was first listed as impaired for iron in 2010, as a result of 2005/2006 Ambient River Monitoring (ARM) dry weather sampling. As part of the Rhode Island Department of Environmental Management ARM program, dry weather samples were collected in 2011 at two stations on the river. Station PAW49 (red star on the map above) is the upstream station located at the Boombridge Road crossing, while PAW01 (red heart on the map above) is further downstream at the White Rock Bridge Road crossing, both in the Westerly, RI area. The following tables show the average daily flow on the date the samples were collected, the percentile flow, and the amount of rainfall over the area up to 48 hours prior to the sample collection. RIDEM ARM samples are all collected under dry weather conditions where the rainfall is 0.10 inches or less for the two days prior to sampling. Another indicator of moist conditions are those flow percentiles below 40%. Using the flow percentile criteria of 40% or lower, all of the 2011 samples collected at PAW01 can be considered to be under moist conditions.

The United States Geological Service (USGS) maintains a water quality and flow gauging station (01118500, red triangle on map above) in Westerly, RI approximately 1 mile (1.6 KM) downstream from Station PAW01, still within the 18E Segment of the Pawcatuck River. From March 2009 through September 2012, the USGS collected fifteen water quality samples for the Pawcatuck River. The observed averaged daily flows at the station ranged from a minimum of 62cfs to a maximum of 8,700cfs, both extremes occurring in 2010. The table below shows the average daily flow in the Pawcatuck River on the day the samples were collected as well as the flow percentile for that flow value. The USGS samples under all conditions and doesn't identify whether the samples were under dry or wet conditions. However, using the criteria above, samples collected on ten of the fifteen sampling dates for the Westerly, RI station can be considered to be wet or moist conditions.

Total iron toxicity is not affected by the hardness of the water, but is a single chronic value of 1000µg/L for all conditions. The data, presented below, show that the chronic total iron criteria was not exceeded at any time. This segment will not be included on the 2016 303(d) list as impaired for iron.

Station PAW01

Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Iron Chronic Criteria (µg/L)	Rainfall 48 Hrs Prior (in)	Average Daily Flow (ft^3/sec)	Flow Percentile (%)
5/10/2011	3.83	3.83	323	1000	0.03	628	35.7%[2]
8/18/2011	3.83	3.83	678	1000	0.00	1,210	10.2%[2]
9/27/2011	3.83	3.83	864	1000	0.00	645	34.5%[2]

1. Rainfall occurred on date the samples were collected.
2. Flow percentile values below 40% are considered to be under moist conditions.

Station PAW49

Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Iron Chronic Criteria (µg/L)	Rainfall 48 Hrs Prior (in)	Average Daily Flow (ft^3/sec)	Flow Percentile (%)
5/12/2011	3.83	3.83	428	1000	0.00	569	40.0%[2]
8/24/2011	3.83	3.83	724	1000	0.35	304	63.8%
9/28/2011	3.83	3.83	808	1000	0.10[1]	560	40.7%

1. Rainfall occurred on date the samples were collected.
2. Flow percentile values below 40% are considered to be under moist conditions.

Pawcatuck River & Tribs USGS Gauging Station 01118500 at Westerly, RI							
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Iron Chronic Criteria (µg/L)	Rainfall 48 Hrs Prior (in)	Average Daily Flow (ft^3/sec)	Flow Percentile (%)
3/25/2009	7.0	14.0	176	1000	0.00	676	32.5%[2]
6/25/2009	7.0	14.0	619	1000	0.06	595	38.1%[2]
9/17/2009	7.0	14.0	460	1000	0.08	215	74.6%
12/10/2009	4.6	9.2	384	1000	1.34	1,690	3.4%[2]
3/25/2010	4.6	9.2	211	1000	3.68	3,740	0.2%[2]
7/1/2010	4.6	9.2	388	1000	0.00	237	71.6%
9/23/2010	4.6	9.2	266	1000	0.29	68	98.6%
1/6/2011	4.6	4.6	238	1000	0.00	384	56.4%
3/31/2011	4.6	4.6	194	1000	0.32[1]	632	35.4%[2]
6/30/2011	4.6	4.6	624	1000	0.26	395	55.4%
9/29/2011	4.6	4.6	683	1000	0.39[1]	568	40.0%
1/5/2012	4.6	4.6	285	1000	0.00	729	29.2%[2]
3/29/2012	4.6	4.6	318	1000	0.25	351	59.3%
6/28/2012	4.6	4.6	494	1000	0.00	368	57.8%
9/27/2012	4.6	4.6	287	1000	0.00	120	90.7%

1. Rainfall occurred on date the samples were collected.
2. Flow percentile values below 40% are considered to be under moist conditions.

20. Perry Healy Brook & Tribs (RI0008039R-19)

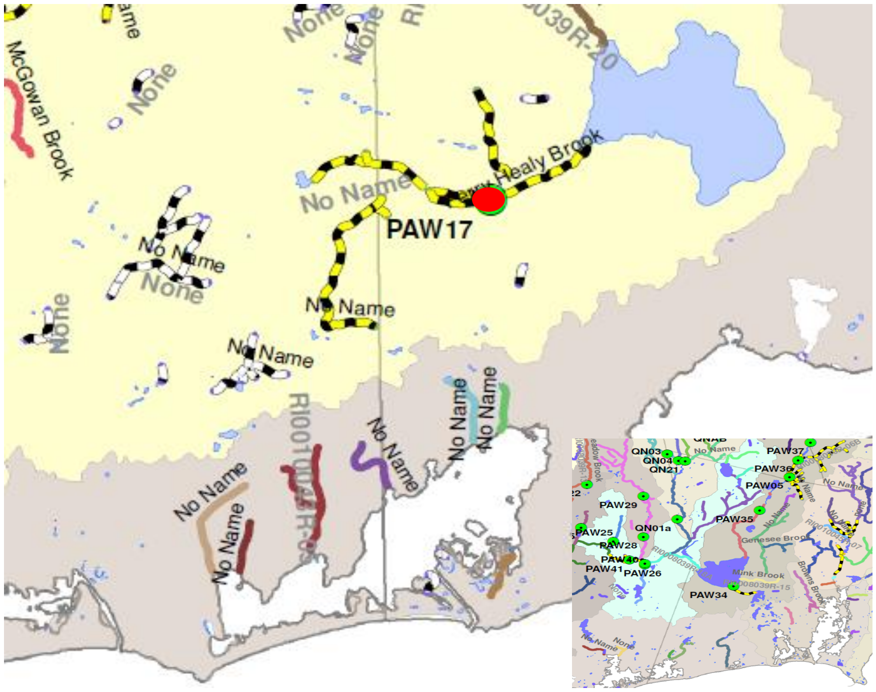
Perry Healy Brook and tributaries. Westerly, Charlestown

Dissolved Copper (Cu) - This segment of Perry Healy Brook and Tributaries was on RI's 2014 303(d) list for exceedances of the freshwater criteria for dissolved copper (Cu). It was first listed as impaired for copper in 2010, as a result of 2005/2006 Ambient River Monitoring (ARM) dry weather sampling. As part of the Rhode Island Department of Environmental Management ARM program, dry weather samples were collected in 2011 and 2015 from Station PAW17 at the Klondike Road crossing for the brook near Bradford, RI. The land use in the watershed does not indicate sources of dissolved copper (Brushland/Forest 84.7%, Commercial/Industrial 0.4%, Other 7.3%, Residential 5.9%, Open Water 1.2%, Agriculture 0.5%). This watershed is 2.95% impervious cover, and given that this watershed is extensively Brushland/Forest, we do not expect exceedance of dissolved copper criteria during wet weather. The dry weather data, presented below, indicate that the water quality of this segment is meeting the State of Rhode Island's water quality criteria and will not be included on the 2016 303(d) list as impaired for dissolved copper.

Station PAW17

Perry Healy Brook and Tribs RI0008939R-19 ARM Dissolved Copper						
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness (mg/L)	Copper Criteria (µg/L)	
					Acute	Chronic
5/11/11	0.13	0.13	1.48	14.97	2.25	1.77
8/24/11	0.13	0.13	0.54	22.41	3.28	2.49
9/28/11	0.13	0.13	0.64	18.71	2.77	2.14
7/7/15	0.15	0.15	0.73	22.00	3.23	2.46
8/31/15	0.15	0.15	0.71	37.30	5.31	3.86
9/17/15	0.15	0.15	0.58	37.80	5.37	3.90

1. Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.



21. Queens Fort Brook & Tribs (RI0008039R-31B)

Queens Fort Brook from ¾ mile south of Victory Highway (Route 102) to the confluence with the Queens River. Exeter

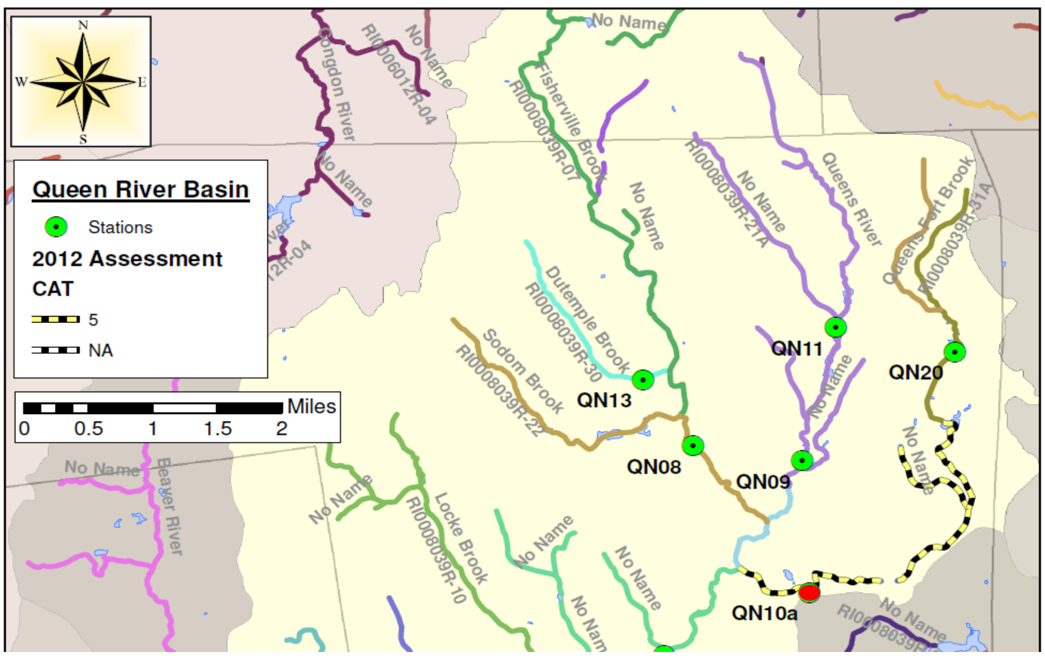
Dissolved Lead (Pb) – This segment of the Queens Fort Brook was listed on RI's 2014 303(d) list for exceedances of freshwater criteria for dissolved lead (Pb). It was first listed as impaired for lead in 2010, as a result of 2006/2007 Ambient River Monitoring (ARM) dry weather sampling. As part of the Rhode Island Department of Environmental Management ARM program, dry weather samples were collected in 2011 and 2015 on the Queens Fort Brook sampling station (QN10a) adjacent to Dawley Road in Exeter, RI. Sampling was conducted on five separate dates under dry weather conditions, where measured rainfall for forty-eight hours prior to sampling is less than 0.1 inch.

As shown in the table below, there were no exceedances of the acute or chronic freshwater criteria for dissolved lead in the Queens Fort Brook samples collected in 2011 and 2015. The land use in the watershed does not indicate sources of dissolved lead (Brushland/Forest 50.4%, Commercial/Industrial 2.1%, Other 6.7%, Residential 9.3%, Open Water 1.3%, Agriculture 30.3%). This watershed is 8.37% impervious cover, and given that this watershed is primarily Brushland/Forest and Agriculture, we do not expect exceedances of dissolved lead criteria during wet weather. This segment is meeting the State of Rhode Island's water quality regulations and will not be included on the 2016 303(d) list as impaired for dissolved lead.

Station QN10a

Queens Fort Brook RI0008039R-31B Dissolved Lead						
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness (mg/L)	Lead Criteria (µg/L)	
					Acute	Chronic
6/21/2011	0.08	0.08	0.47	24.8	13.73	0.54
9/21/2011	0.08	0.08	0.14	36.0	20.90	0.81
10/17/2011	0.08	0.08	0.25	26.4	14.76	0.58
6/10/2015	0.093	0.093	0.16	28.0	15.77	0.61
8/19/2015	0.093	0.093	<0.093	45.2	26.94	1.05

1. Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.



22. Canonchet Brook & Tribs (RI0008040R-04A)

Canonchet Brook headwaters including tributaries, excluding all ponds, to Route 3 in Hopkinton. Hopkinton

Dissolved Copper (Cu) - This segment of Canonchet Brook and Tributaries was on RI's 2014 303(d) list for exceedances of the freshwater criteria for dissolved copper (Cu). It was first listed as impaired for copper in 2006, as a result of 2004/2005 Ambient River Monitoring (ARM) dry weather sampling. As part of the Rhode Island Department of Environmental Management ARM program, dry weather samples were collected in 2011 at one station WRB07 on Marshall Driftway Road (white circle on the map below) and 2015 at two stations on the main stem of the brook at WRB37 (red star on the map below) downstream of the outlet of Ashville Pond off of Canonchet Road and WRB38 (red circle on the map below) downstream of Lawton Foster Road off of Canonchet Road. WRB07 was discontinued due to poor flow, which was not representative of the stream.

The dry weather data, presented below, indicate that the water quality of this segment is meeting the State of Rhode Island's water quality criteria for dissolved copper that allows for one exceedance every three years. The land use in the watershed does not indicate sources of dissolved copper (Brushland/Forest-88.2%, Commercial/Industrial 0.2%, Other 2.0%, Residential 3.8%, Open Water 4.6%, Agriculture 1.2%). This watershed is 1.66% impervious cover, and given that this watershed is extensively Brushland/Forest, we do not expect exceedances of dissolved copper during wet weather. While there are two data points exceeding acute criteria, the high values occur on the same data within the same waterbody segment. This equates to a single violation for the waterbody segment capture twice, which meets the allowance a single violation every three years, and will not be included on the 2016 303(d) list as impaired for dissolved copper.

Station WRB07

Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[1] (mg/L)	Copper Criteria (µg/L)	
					Acute	Chronic
5/12/2011	0.13	0.13	0.26	5.20	0.83	0.72
9/12/2011	0.13	0.13	0.32	5.10	0.81	0.70
10/3/2011	0.13	0.13	0.69	5.15	0.82	0.71

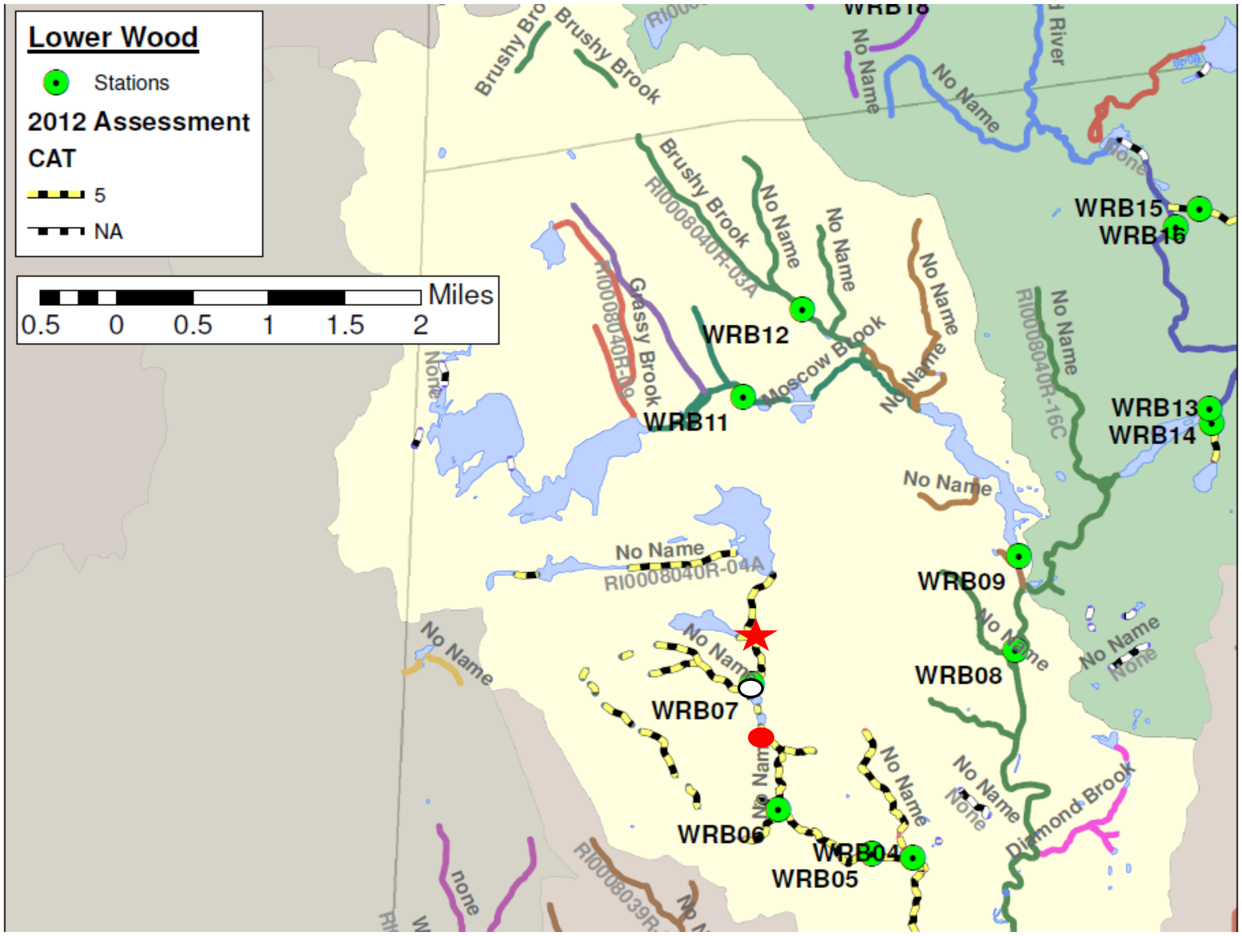
Station WRB37

Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[1] (mg/L)	Copper Criteria (µg/L)	
					Acute	Chronic
7/7/2015	0.154	0.154	**0.69**	3.30	0.54	0.49
8/31/2015	0.154	0.154	0.25	3.30	0.54	0.49
9/17/2015	0.154	0.154	0.28	6.66	1.05	0.88

Station WRB38

Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness[1] (mg/L)	Copper Criteria (µg/L)	
					Acute	Chronic
7/7/2015	0.154	0.154	**1.39**	8.8	1.36	1.12
8/31/2015	0.154	0.154	0.615	12.7	1.92	1.54
9/17/2015	0.154	0.154	0.616	12.9	1.95	1.55

[1]Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.
Exceedances of criteria are show in **bold** type



23. Coney Brook & Tribs (RI0008040R-05)

Coney Brook and tributaries. West Greenwich

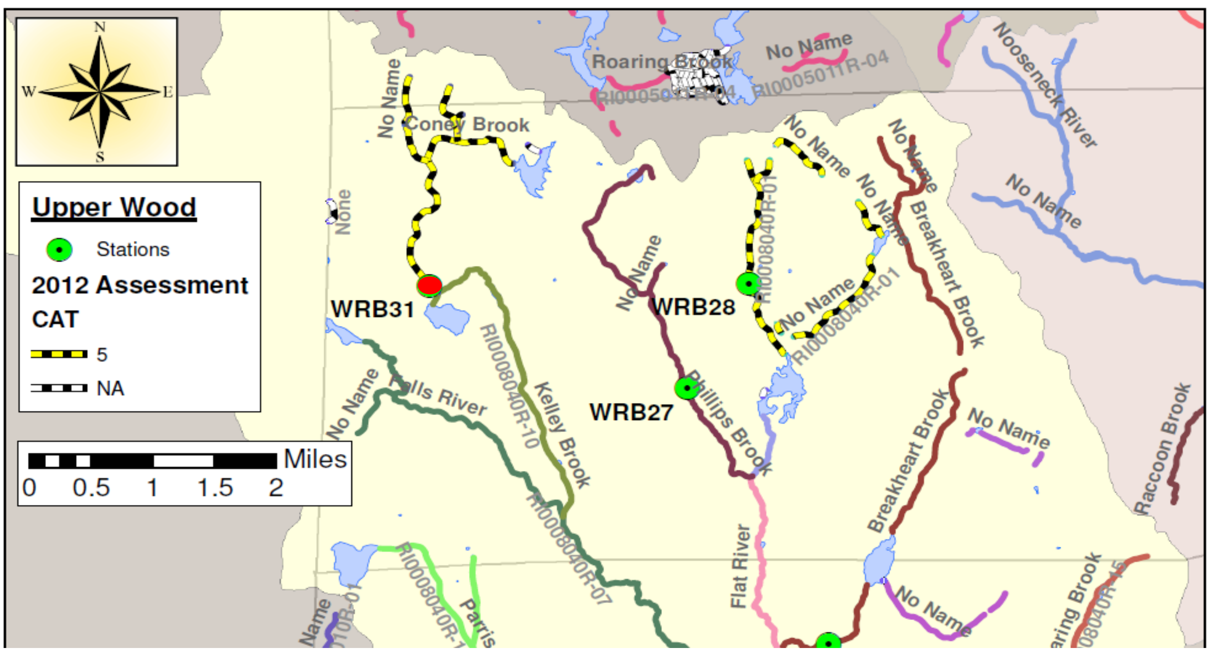
Dissolved Copper (Cu) - Coney Brook and Tributaries was on Rhode Island's 2014 303(d) list for exceedances of the freshwater criteria for dissolved copper (Cu). It was first listed as impaired for dissolved copper in 2006, as a result of 2004/2005 Ambient River Monitoring (ARM) dry weather sampling. As part of the Rhode Island Department of Environmental Management Ambient River Monitoring (ARM) program, samples were collected under dry weather conditions in 2011 and 2015 from Station WRB31 (red circle on the map below) at the Muddy Brook Road crossing of the stream near West Greenwich, RI. WRB31 was stagnant and not flowing on 09/02/15, and on 09/22/15, there was standing water in the pool at the culvert. Therefore, only one sample was collected in 2015.

Dry weather surveys are conducted on those days where the measured rainfall for the previous forty-eight hours prior to sampling is less than 0.10 inches. The land use in the watershed does not indicate sources of dissolved copper (Brushland/Forest-90.3%, Commercial/Industrial 0.0%, Other 1.2%, Residential 1.2%, Open Water 1.4%, Agriculture 5.9%). This watershed is 0.89% impervious cover, and given that this watershed is extensively Brushland/Forest, we do not expect any exceedances of dissolved copper criteria during wet weather. The dry weather data, presented below, indicate that the water quality of this segment is meeting the State of Rhode Island's water quality criteria and will not be included on the 2016 303(d) list as impaired for dissolved copper.

Station WRB31

Coney Brook and Tribs RI0008040R-05 ARM Dissolved Copper						
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Hardness (mg/L)	Copper Criteria (µg/L)	
					Acute	Chronic
6/22/2011	0.13	0.13	0.36	10.53	1.61	1.31
9/26/2011	0.13	0.13	0.42	9.24	1.43	1.17
10/18/2011	0.13	0.13	0.22	8.31	1.29	1.07
7/13/2015	0.154	0.154	1.03	8.46	1.31	1.09

1. Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.



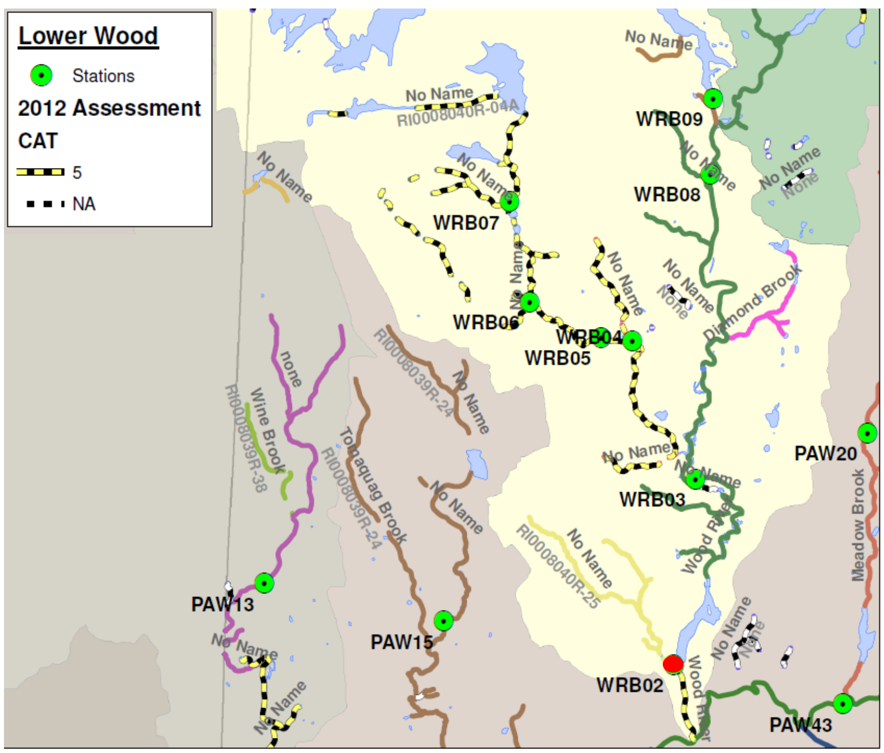
24. Wood River & Tribs (RI0008040R-16D)

Wood River from the Alton Pond dam to the confluence with the Pawcatuck River. Richmond, Hopkinton, Charlestown

Benthic-Macroinvertebrate Bioassessments & Ambient Bioassays-Chronic Aquatic Toxicity – This segment of the Wood River & Tribs is listed on RI's 2014 303(d) List of Impaired Waters as not supporting aquatic life designated use due to copper, benthic-macroinvertebrate bioassessments, and ambient bioassays-chronic aquatic toxicity. This segment was first listed as impaired for aquatic life on RI's 1998 303(d) list as biodiversity impacts based on RIDEM OWR's 1997 observations at a RIDEM Office of Waste Management State Site Remediation project at the "Charbert Site (Richmond)", and in 2000, the cause unknown toxicity was added. In 1992, DEM approved an Underground Injection Control (UIC) to discharge process wastewater to lagoons near this segment of the Wood River. Subsequently, in groundwater monitoring reports submitted to RIDEM, and in a 1997 UIC Status Report, concentrations of hazardous substances were documented in groundwater including chlorinated volatile organic compounds (VOCs) (RIDEM, 2004 Office of Compliance and Inspection Notice of Violation). Though macroinvertebrate assemblage data was not collected from the river at that time, RIDEM/OWR staff reported observing zero taxa in the river. Therefore, RIDEM found this Wood River segment did not support aquatic life due to waste discharge to the lagoon and groundwater leachate, and in 1998 it was listed as impaired (causes listed were Biodiversity Impacts in 1998 and Unknown Toxicity in 2000, which was changed on the 2008 303(d) list to the cause terms Benthic Macroinvertebrate Bioassessments and Ambient Bioassays-Chronic Aquatic Toxicity).

Macroinvertebrate assemblage data was subsequently collected by a RIDEM contractor, following RBP protocol though no riffle habitat were present at the site, in 2002-2004. These data showed improvement from the earlier observations; total taxa reported in 2004 was 28 and included the presence of nematodes, considered highly sensitive. RIDEM efforts over the last ten years to refine its biological monitoring and assessment program have resulted in a modification in the way that macroinvertebrate data is used and how the cause benthic macroinvertebrate bioassessments is applied in the assessment of Aquatic Life Use. With refinements made in our biological monitoring and assessment program, we now know that the cause of benthic macroinvertebrate was inappropriately applied to non-wadeable rivers, like the Wood River. Given that benthic macroinvertebrate bioassessments is now an inappropriate cause for this type of waterbody, a non-wadeable river, the benthic macroinvertebrate bioassessments cause will be delisted. Furthermore, new observations by RIDEM staff in 2011 and 2015 found many taxa, further documenting qualitative improvements first noted in early 2000's. RIDEM/OWR staff observed amphibians, adult damselflies, and mussels in this segment. Rhode Island has not yet developed a biological indicator for non-wadeable rivers. We will continue to use water chemistry data as a means to assess non-wadeable streams, until a suitable biological indicator is developed. The 2016 303d list continues to identify this river segment as having an Aquatic Life Use impairment cause of copper.

Ongoing efforts with the RIDEM Office of Waste Management State Site Remediation Program from 1998 to present have resulted in site remediation and extensive compliance monitoring under a currently approved Remedial Action Plan (2011 Revised Environmental Monitoring Plan). The facility ceased operations in February 2008. Site remediation reports document surface water samples collected from the Wood River in this vicinity on January 30, 2009, did not contain any VOCs (2009 Technical Memo regarding Remedial Activities). Groundwater samples collected from diffusion bags in the Wood River buried 8-12 inches in river sediment, in 2008 through 2015, suggest that the air sparge curtain along the Wood River is effectively reducing the mass of contaminants discharging to the river (2016 Annual Environmental Monitoring Report). The groundwater collected from the diffusion bags was analyzed for chemicals of interest from the Charbert remediation. There were no recent surface water samples collected at the site. Given acceptable groundwater quality results in recent years indicating effective reduction in the mass of contaminants discharging to the river, the cause Ambient Bioassays-Chronic Aquatic Toxicity will be delisted. As noted above, the 2016 303d list continues to identify this river as having an Aquatic Life Use impairment cause of copper.



25. Canob Brook (RI0008040R-23)

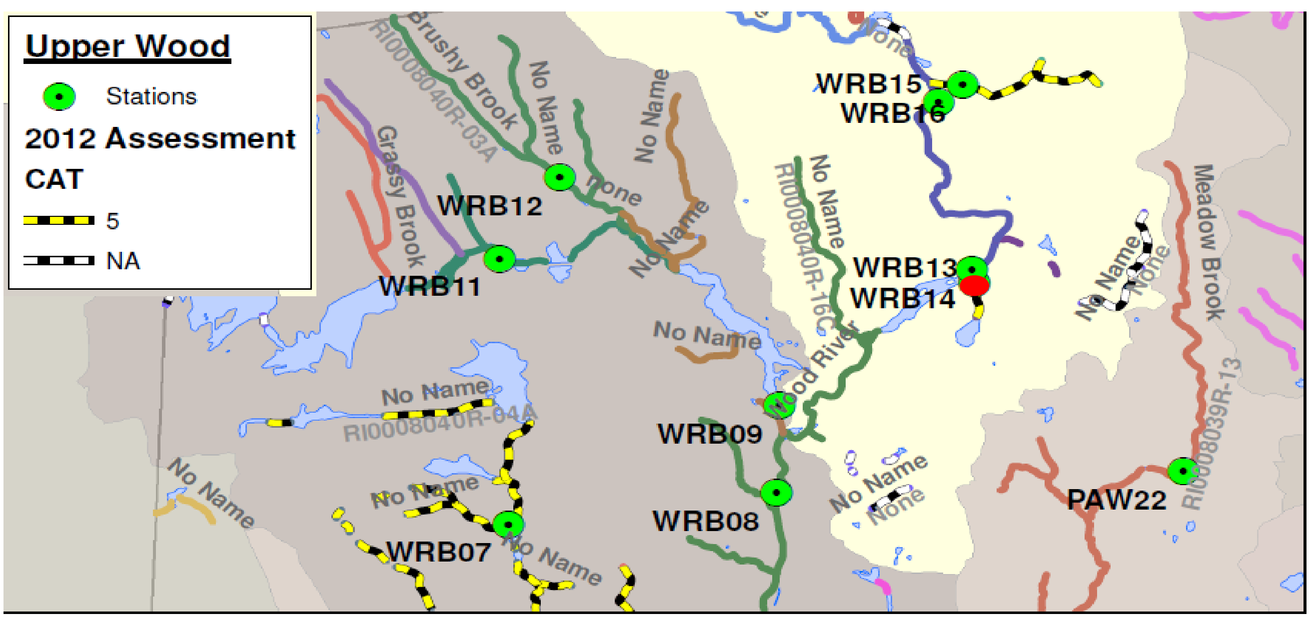
Canob Brook. Richmond

Total Iron (Fe) –Canob Brook was listed on RI's 2014 303(d) list for exceedances of freshwater criteria for total iron (Fe). It was first listed as impaired for iron in 2008, as a result of 2004/2005 Ambient River Monitoring (ARM) dry weather sampling. As part of the Rhode Island Department of Environmental Management Ambient River Monitoring (ARM) program, dry weather samples were collected in 2011 at the Canob Brook station (WRB13) at the Nooseneck Hill Road crossing in Wyoming, RI. Sampling was conducted on four separate dates under dry weather conditions, where measured rainfall for forty-eight hours prior to sampling is less than 0.1 inch.

Total iron toxicity is not affected by the hardness of the water, but is a single chronic value of 1000µg/L for all conditions. There were no exceedances of the freshwater iron chronic criteria in any of the surveys. The land use in the watershed is predominately Brushland/Forest (39.5%) with an overall impervious cover of 19.0%. However, the majority of the more urbanized land use occurs in the upper watershed that drains to an impoundment and the majority of the brook itself is bound by riparian buffer, therefore exceedances of the total iron criteria during wet weather is not expected. The data, presented below, show that this stream segment is meeting the State of Rhode Island's water quality regulations and will not be included on the 2016 303(d) List as impaired for iron.

Station WRB13

Canob Brook RI0008040R-23 Total Iron				
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Concentration (µg/L)	Iron Chronic Criteria (µg/L)
6/14/2011	3.83	3.83	632	1000
9/14/2011	3.83	3.83	958	
10/11/2011	3.83	3.83	855	
10/25/2011	3.83	3.83	677	



26. Pawtuxet River Main Stem (RI0006017R-03)

Pawtuxet River from the confluence of the North and South Branches at Riverpoint to the Pawtuxet Cove Dam at Pawtuxet. West Warwick, Warwick, Cranston

Dissolved Cadmium (Cd) – This segment of the Pawtuxet River was on RI's 2014 303(d) list for exceedances of freshwater dissolved cadmium (Cd) criteria. It was first listed as impaired for cadmium in 2006, based on 1997-2002 USGS data. USGS collects the samples on a set schedule under both dry and wet weather conditions. In 2012 and 2016, as part of the Rhode Island Department of Environmental Management Ambient River Monitoring (ARM) program, dry weather samples were collected at six stations along the mainstem of the river. Sampling was conducted on three separate dates under dry weather conditions, where measured rainfall for forty-eight hours prior to sampling is less than 0.1 inch. Additionally, the US Geological Survey (USGS) maintains two stations within this segment of the Pawtuxet River. One site measures the flows in the river and is located upstream of the Cranston Waste Water Treatment Facility and the water quality station is at the Warwick Avenue (RT1A) crossing of the Pawtuxet River. The USGS collected twenty-eight water quality samples on the Pawtuxet River from March 2009 through March 2016. As noted, USGS collects the samples on a set schedule under both dry and wet weather conditions, and the analysis includes hardness so that the freshwater criteria can be calculated for trace metals. The figure below shows the location of these stations.

The acute criteria was calculated using the Water Effect Ratio for the river. Section 131.11(b)(1)(ii) of the Federal water quality standards regulation provides States with the opportunity to adopt water quality criteria that are modified to reflect local environmental conditions. Following the procedures outlined in RIDEM's "Site Specific Aquatic Life Water Quality Criteria Development Policy", as amended, and EPA's "Interim Guidance on Determination and Use of Water- Effect Ratios for Metals", (February 1994, EPA-823-B-94-001), acute Water Effect Ratios (WERs) were developed for 5 metals: cadmium, copper, lead, silver and zinc for portions of the Pawtuxet River. The criteria derived from these WERs apply to the segments of the Pawtuxet River classified as B1 and apply to the Pawtuxet River main stem segment. The WER procedure provides for the use of a WER that is intended to take into account relevant differences between the toxicities of the chemical in laboratory dilution water and in site water. These WERs are then used to derive acute site specific criteria. For cadmium, there are no national acute to chronic ratios. Therefore, only acute criteria can be evaluated using the WER for total cadmium concentrations (RIDEM ARM 2012 and 2016 data), and chronic criteria were calculated for dissolved cadmium concentrations (USGS 2009-2016 data) using the equation in the Rhode Island Water Quality Regulations (Table 2).

Mean daily streamflow for the 2012 surveys ranged from 149cfs in June to 183cfs for the October survey. All of the flows are considered to be under dry conditions when checked against the flow duration curve for the Pawtuxet River at the Cranston, RI USGS site, ranging between 65 to 75 flow percentiles. The data, presented below, show that the water quality is meeting the dissolved cadmium standard which allows for one exceedance in three years. These flows are considered relatively low in the context of observed averaged daily flows at the USGS station ranging from a minimum of 33 cfs in 2016 to a maximum of 14,000cfs in 2010.

Sample Station	Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Total Cd Concentration (µg/L)	Hardness[1] (mg/L)	Cadmium Acute Criteria (µg/L)
PXT06	6/20/2012	0.06	0.06	0.09	17.8	0.81
	10/22/2012	0.06	0.06	<0.06	20.8	0.95
	12/3/2012	0.06	0.06	<0.06	21.6	0.99
	6/28/2016	0.054	0.054	<0.054	26.4	1.21
	8/29/2016	0.054	0.054	<0.054	22.4	1.03
	10/17/2016	0.054	0.054	<0.054	19.4	0.89
PXT07a	6/20/2012	0.06	0.06	<0.06	31.6	1.45
	10/22/2012	0.06	0.06	<0.06	24.2	1.11
	12/3/2012	0.06	0.06	<0.06	29.5	1.36
	6/28/2016	0.054	0.054	<0.054	41.0	1.90
	8/29/2016	0.054	0.054	<0.054	39.8	1.84
	10/17/2016	0.054	0.054	<0.054	6.98	0.31
PXT08	6/20/2012	0.06	0.06	<0.06	33.9	1.56
	10/22/2012	0.06	0.06	<0.06	26.8	1.23
	12/3/2012	0.06	0.06	<0.06	30.9	1.42
	6/28/2016	0.054	0.054	<0.054	33.5	1.54
	8/29/2016	0.054	0.054	<0.054	40.9	1.89
	10/17/2016	0.054	0.054	<0.054	34.5	1.59
PXT09	6/20/2012	0.06	0.06	<0.06	37.3	1.72
	10/22/2012	0.06	0.06	<0.06	30.2	1.39
	12/3/2012	0.06	0.06	<0.06	36.5	1.68
	6/28/2016	0.054	0.054	<0.054	43.5	2.01
	8/29/2016	0.054	0.054	<0.054	50.6	2.35
	10/17/2016	0.054	0.054	<0.054	48.6	2.25
PXT10	6/20/2012	0.06	0.06	<0.06	45.1	2.09
	10/22/2012	0.06	0.06	<0.06	35.9	1.66
	12/3/2012	0.07	0.06	0.07	43.9	2.03
	6/28/2016	0.054	0.054	<0.054	61.4	2.86
	8/29/2016	0.054	0.054	<0.054	66.8	3.11
	10/17/2016	0.054	0.054	<0.054	34.6	1.60
PXT11	6/20/2012	0.06	0.06	<0.06	46.6	2.16
	10/22/2012	0.06	0.06	<0.06	36.6	1.69
	12/3/2012	0.06	0.06	<0.06	50.3	2.33
	6/28/2016	0.054	0.054	<0.054	61.2	2.85
	8/29/2016	0.054	0.054	<0.054	55.8	2.59
	10/17/2016	0.054	0.054	<0.054	49.0	2.27

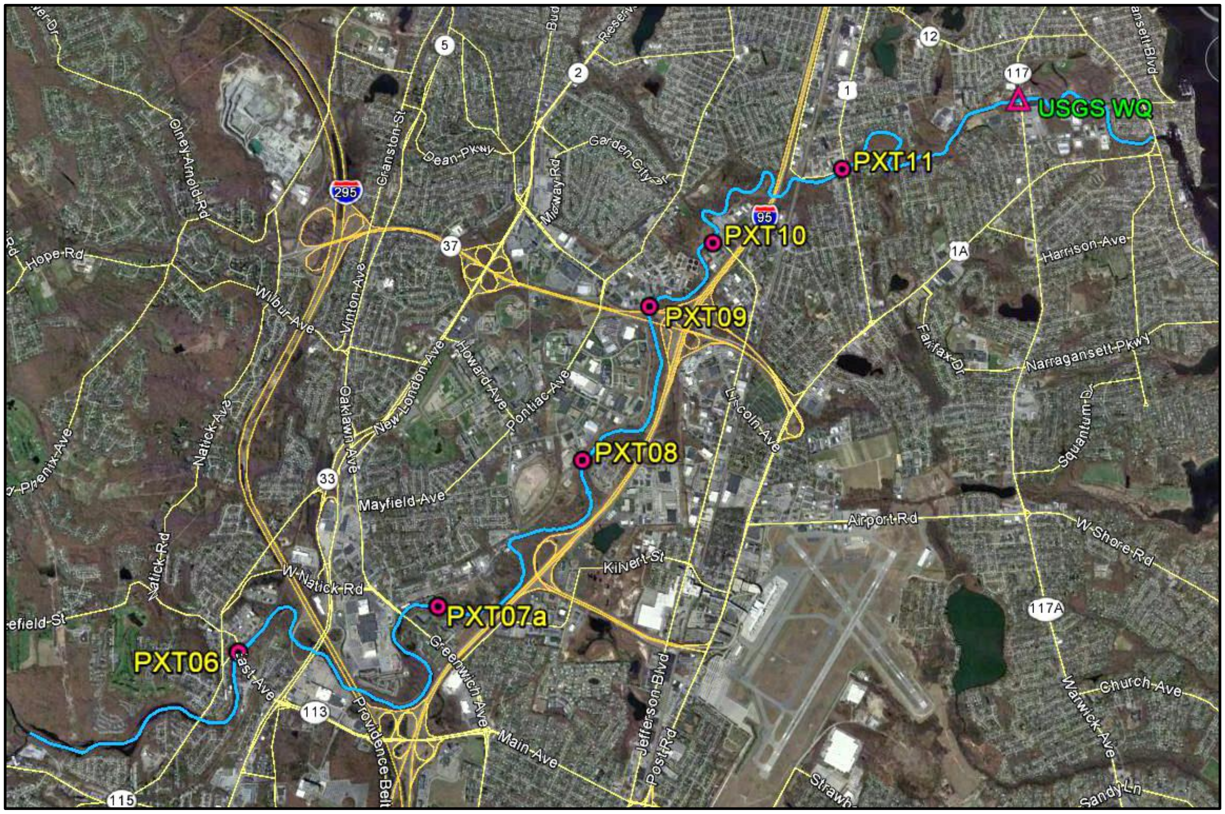
[1]Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.

The following table shows the observed hardness and cadmium concentrations as well as the chronic criteria for dissolved cadmium that was calculated for data collected at the USGS station. Included are the observed mean daily flows in the Pawtuxet River on the sampling dates and the amount of precipitation reported at the T.F. Green airport during the forty-eight hours prior to the samples being collected. Fourteen of the thirty-two samples were collected under wet weather conditions.

USGS Gauging Station 01116617 at Route1A (Warwick Ave.)								
Sample Date	Detection Limit (µg/L)	Quantitation Limit (µg/L)	Dissolved Cd Concentration (µg/L)	Hardness[3] (mg/L)	Cadmium Chronic Criteria (µg/L)	Rainfall 48 Hrs Prior to sampling (in)	Average Daily Flow (cfs)	Flow Percentile (%)
3/26/09	0.010	0.02	0.08	38.4	0.13	0.20[1]	295	41.8%
6/24/09	0.010	0.02	0.05	44.9	0.14	0.23	232	52.8%
9/16/09	0.010	0.02	0.04	50.5	0.15	0	107	88.6%
12/9/09	0.010	0.02	**0.26**	32.5	0.11	1.23[1]	647	13.7%[2]
3/24/10	0.010	0.02	0.05	14.5	0.06	3.38	3,000	0.1%[2]
6/30/10	0.010	0.02	0.08	42.1	0.13	0.66	111	87.2%
9/22/10	0.010	0.02	0.04	56.1	0.16	0	88	94.0%
1/4/11	0.016	0.016	0.08	46.5	0.14	0	173	67.5%
3/30/11	0.016	0.016	0.07	39.6	0.13	0	329	37.0%[2]
6/29/11	0.016	0.016	0.04	46.3	0.14	0.04[1]	200	60.2%
9/27/11	0.016	0.016	0.04	39.5	0.13	0	408	28.4%[2]
1/4/12	0.016	0.016	0.08	32.6	0.11	0	403	28.9%[2]
3/27/12	0.016	0.016	0.06	49.1	0.15	0	170	68.4%
6/26/12	0.016	0.016	0.04	32.2	0.11	1.34	427	26.6%[2]
9/25/12	0.016	0.016	0.04	60.6	0.17	0.17	94	92.3%
12/18/12	0.016	0.016	0.03	33.8	0.12	1.08[1]	396	29.5%[2]
3/26/13	0.016	0.016	0.06	30.7	0.11	0.05	449	24.7%[2]
4/30/13	0.016	0.016	0.04	37.4	0.12	0	220	55.3%
6/25/13	0.016	0.016	0.04	33.7	0.12	0	384	30.7%[2]
3/31/14	0.03	0.03	0.05	26.3	0.10	5.34[1]	1,560	1.0%[2]
6/24/14	0.03	0.03	0.04	45.6	0.14	0	89	93.7%
9/25/14	0.03	0.03	0.05	77.0	0.21	0.08[1]	57	98.9%
12/16/14	0.03	0.03	0.06	35.4	0.12	0	445	25.1%[2]
3/24/15	0.03	0.03	0.10	39.2	0.13	0	378	31.4%[2]
6/30/15	0.03	0.03	0.04	41.9	0.13	1.77	262	47.3%
9/30/15	0.03	0.03	<0.030	22.4	0.09	2.08[1]	619	14.9%[2]
12/28/15	0.03	0.03	0.04	45.4	0.14	0.20	227	53.8%
3/30/16	0.03	0.03	0.05	47.7	0.15	0.33	230	53.2%
6/26/2016	0.03	0.03	<0.03	62.4	0.18	0[4]	96	91.8%
9/28/2016	NR[5]	0.03	0.03	61.5	0.18	0.26[4]	58	98.8%
12/20/2016	NR[5]	0.03	0.059	44.1	0.14	0.12	257	48.1%
3/28/2017	NR[5]	0.03	0.064	36.1	0.12	0[4]	412[6]	28.0%[2]

[1]Rainfall occurred on date the samples were collected.
[2]Flow percentile values below 40% are considered to be under moist conditions.
[3]Observed hardness is used to calculate the freshwater aquatic life criteria for certain metals because hardness can affect the toxicities of these metals. Increasing hardness has the effect of decreasing the toxicity of metals.
[4]Trace amounts noted, no measureable precipitation
[5]Downloaded data from USGS site did not include method detection limit
[6]Provisional data
Exceedances of criteria are show in **bold** type

Examination of the two data sets show that there was one exceedance of the dissolved cadmium chronic criteria, at the USGS station in December 2009, and no exceedances of the acute criteria for total cadmium. This data indicates that the water quality of this segment of the Pawtuxet River is meeting the State of Rhode Island's water quality criteria for dissolved cadmium and will not be included on the 2016 303(d) list as impaired for dissolved cadmium.



IMPROPER BIOASSESSMENT IMPAIRMENT LISTINGS

RIDEM efforts to refine its biological monitoring and assessment program have resulted in a modification to the way that the causes aquatic macroinvertebrate and benthic macroinvertebrate bioassessments are applied in the assessment of Aquatic Life Use. Historically, the terms were used when data or field observations indicated any kind of biological impairment. Beginning in 2010, the State began to recognize that continuing to use the causes in this manner was not appropriate, nor reflective of on-going efforts to develop a stronger biological monitoring and assessment program. With refinements made in our biological monitoring and assessment program over the past ten years or so, we now know that these causes were inappropriately applied to streams in the state's Lowland ecoregions, lakes, and non-wadeable rivers.

RIDEM's development of a stronger biological monitoring and assessment program has highlighted the need to move from using a Reference Site Approach to a Reference Condition Approach, where possible. Historically, RIDEM used a Reference Site Approach statewide to evaluate macroinvertebrate communities in RI rivers and streams in conducting Aquatic Life Use support decisions, when macroinvertebrate data was available. Under the Reference Site Approach, biological conditions in rivers and streams were measured against conditions observed at a reference station. Because healthy biological communities may vary, instead of using one reference station, the Reference Condition Approach is developed using multiple stations to account for natural differences. Further details on the Reference Condition Approach to biological assessments are in the 2014 CALM.

Data limitations restrict applicability of the new Reference Condition Approach to only the Coastal Plains and Hills ecoregion of the state (generally the interior, non-coastal areas of RI). Within the state's two Lowland ecoregions (Long Island Sound and Narragansett/Bristol), core sites with minimal disturbance have not been identified in sufficient numbers to support index development in these areas of the state. Furthermore, because streams in the state's Lowland ecoregions are more typically characterized by non-riffle low gradient systems, it is not appropriate to apply the new approach, which was developed using riffle habitat data, to these lowland streams. Similarly, due to significant differences in stream order, size of contributing watershed, and other physiographic features, the developed approach and wadeable, riffle metrics are also not applicable to the state's larger non-wadeable rivers. Furthermore, this approach has not been applied in lakes or ponds.

In some instances, noted earlier in the document (Clear River RI0001002R-05D, Wood River RI0008040R-16D, Bailey's Brook & Tribs RI0007035R-01, Maidford River RI0007035R-02B, and Dundery Brook & Tribs RI0010048R-02C), the timed kick of riffle habitat method was historically misapplied in non-wadeable and low gradient areas. These segments are proposed for delisting the cause benthic macroinvertebrates bioassessments in this cycle in other sections of this document.

The 2014 CALM, used in this 2016 assessment cycle, reflects the work to date to develop a stronger biological monitoring and assessment program, and specifically notes how benthic macroinvertebrate data should be applied. The outcome of this process is the determination that it is only appropriate to apply the benthic macroinvertebrate bioassessment cause to waterbodies that contain perennial wadeable riffle habitat.

Lakes, non-wadeable rivers, and rivers not containing riffle habitat listed for either aquatic macroinvertebrate or benthic macroinvertebrate bioassessments as a cause of Aquatic Life Use impairment are proposed for de-listing (#27-. Many of the original listings, dating to 1990's and early 2000's, the cause biodiversity impacts was used for various biological impairments, which were later converted to benthic macroinvertebrate bioassessments or aquatic macroinvertebrate bioassessments. With the refinements in the State's biological monitoring program detailed in this section, the use of these cause terms is inappropriate and not reflective of the nature of aquatic life use impairment. Almost all the waterbodies continue to be impaired for aquatic life use, most often for nutrients and/or metals.

Work towards developing appropriate sampling protocol and index development for Lowland sites and non-wadeable large rivers are important future tasks that ideally can be pursued on a regional basis with neighboring states. In the interim, the State uses water chemistry as the primary means to assess the aquatic life use of these waterbodies. The 2014 CALM, used for this 2016 assessment cycle, further details the process to assess Aquatic Life Use in non-wadeable, large rivers using water chemistry data. In lakes, the Aquatic Life Use is not specifically defined but would also be assessed with conventional water chemistry data as the core indicator.

27. <u>Saugatucket Pond (RI0010045L-01)</u>

Saugatucket Pond. South Kingstown

This waterbody was originally listed in 1998 for biodiversity impacts and noxious aquatic plants native in 2000. These impairments were changed to benthic-macroinvertebrate bioassessments. As detailed above, Rhode Island's field sampling protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat, and the Reference Condition Approach in assessments is only applicable in perennial, wadeable riffle habitat of streams in the Coastal Plains and Hills ecoregion. Given that this is now an inappropriate cause for this type of waterbody, a lake, the benthic-macroinvertebrate bioassessments cause will be delisted. The 2016 303d list continues to identify this pond as having an Aquatic Life Use impairment cause of phosphorus (total). Water quality associated with the original impairment is expected to have improved with work completed at the upstream Superfund site at Rose Hill Landfill.

28. <u>Valley Falls Pond (RI0001003L-02)</u>

Valley Falls Pond. Cumberland

This waterbody was originally listed in 1998 for biodiversity impacts. This impairment was changed to benthic-macroinvertebrate bioassessments. As detailed above, Rhode Island's field sampling protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat, and the Reference Condition Approach in assessments is only applicable in perennial, wadeable riffle habitat of streams in the Coastal Plains and Hills ecoregion. Given that this is now an inappropriate cause for this type of waterbody, a lake, the benthic-macroinvertebrate bioassessments cause will be delisted. The 2016 303d list continues to identify this pond as having Aquatic Life Use impairment causes of phosphorus (total), lead, and dissolved oxygen. Furthermore, due to a recent survey (8/9/2017) of Valley Falls Pond, a substantial population of invasive water chestnut was discovered. The cause Aquatic Invasive Species will be added to the Aquatic Life Use impairment in this cycle as well.

29. Branch River (RI0001002R-01B)

Branch River and tributaries from the outlet of the Slatersville Reservoir to the confluence with the Blackstone River. North Smithfield

This waterbody was originally listed in 1998 for biodiversity impacts. The cause was changed to aquatic macroinvertebrates bioassessments. As detailed above, Rhode Island's field sampling protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat, and the Reference Condition Approach in assessments is only applicable in perennial, wadeable riffle habitat of streams in the Coastal Plains and Hills ecoregion. Given that this is now an inappropriate cause for this type of waterbody, a non-wadeable river, the aquatic macroinvertebrate bioassessments cause will be delisted. The 2016 303d list continues to identify this river segment as having Aquatic Life Use impairment cause of dissolved lead (Note: Copper is being delisted in this assessment cycle).

30. Ten Mile River & Tribs (RI0004009R-01B)

Ten Mile River and tributaries downstream of Turner Reservoir South to the Omega Pond inlet. East Providence

This waterbody was originally listed in 1998 for biodiversity impacts. This impairment was changed to benthic-macroinvertebrate bioassessments. As detailed above, Rhode Island's field sampling protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat, and the Reference Condition Approach in assessments is only applicable in perennial, wadeable riffle habitat of streams in the Coastal Plains and Hills ecoregion. Given that this is now an inappropriate cause for this type of waterbody, a non-wadeable river, the benthic-macroinvertebrate bioassessments cause will be delisted. The 2016 303d list continues to identify this river segment as having Aquatic Life Use impairment causes of aluminum and cadmium. Water quality associated with the original impairment is expected to have improved with work completed at the upstream WWTF improvements.

31. Runnins River & Tribs (RI0007021R-01)

Runnins River from the MA-RI border to the Mobil Dam in East Providence. Providence, East Providence

This waterbody was originally listed in 1998 for biodiversity impacts. This impairment was changed to benthic-macroinvertebrate bioassessments. As detailed above, Rhode Island's field sampling protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat, and the Reference Condition

Approach in assessments is only applicable in perennial, wadeable riffle habitat of streams in the Coastal Plains and Hills ecoregion. This river segment is a wadeable segment, but it does not contain riffle habitat for RBP macroinvertebrate field methods. Given that this is now an inappropriate cause for this type of waterbody, non-riffle habitat, the benthic-macroinvertebrate bioassessments cause will be delisted. The 2016 303d list continues to identify this river segment as having Aquatic Life Use impairment causes of lead and dissolved oxygen.

32. Blackstone River (RI0001003R-01A)

Blackstone River from the MA-RI border to the CSO outfall located River and Samoset Streets in Central Falls. Woonsocket, North Smithfield, Cumberland, Lincoln and Central Falls.

This waterbody was originally listed in 1996 for biodiversity impacts. This impairment was changed to benthic-macroinvertebrate bioassessments. As detailed above, Rhode Island's field sampling protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat, and the Reference Condition Approach in assessments is only applicable in perennial, wadeable riffle habitat of streams in the Coastal Plains and Hills ecoregion. Given that this is now an inappropriate cause for this type of waterbody, a non-wadeable river, the benthic-macroinvertebrate bioassessments cause will be delisted. The 2016 303d list continues to identify this river segment as having Aquatic Life Use impairment causes of cadmium, lead, dissolved oxygen, phosphorus (total), iron, aquatic invasive species, and milfoil. Water quality associated with the original impairment is expected to have improved with work completed at the upstream WWTF improvements.

33. Blackstone River (RI0001003R-01B)

Blackstone River from the CSO outfall located at River and Samoset Streets in Central Falls to the Slater Mill Dam. Central Falls, Pawtucket.

This waterbody was originally listed in 1996 for biodiversity impacts. This impairment was changed to benthic-macroinvertebrate bioassessments. As detailed above, Rhode Island's field sampling protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat, and the Reference Condition Approach in assessments is only applicable in perennial, wadeable riffle habitat of streams in the Coastal Plains and Hills ecoregion. Given that this is now an inappropriate cause for this type of waterbody, a non-wadeable river, the benthic-macroinvertebrate bioassessments cause will be delisted. The 2016 303d list continues to identify this river segment as having Aquatic Life Use impairment causes of dissolved oxygen, phosphorus (total), and iron. Water quality associated with the original impairment is expected to have improved with work completed at the upstream WWTF improvements.

34. Pawtuxet River Main Stem (RI0006017R-03)

Pawtuxet River from the confluence of the North and South Branches at Riverpoint to the Pawtuxet Cove Dam at Pawtuxet. West Warwick, Warwick, Cranston

This waterbody was originally listed in 1994 for biodiversity impacts. This impairment was changed to benthic-macroinvertebrate bioassessments. As detailed above, Rhode Island's field sampling protocols for benthic macroinvertebrate biomonitoring require sampling in freshwater environments with riffle habitat, and the Reference Condition Approach in assessments is only applicable in perennial, wadeable riffle habitat of streams in the Coastal Plains and Hills ecoregion. Given that this is now an inappropriate cause for this type of waterbody, a non-wadeable river, the benthic-macroinvertebrate bioassessments cause will be delisted. The 2016 303d list continues to identify this river segment as having Aquatic Life Use impairment causes of phosphorus (total) and aquatic invasive species. Water quality associated with the original impairment is expected to have improved with work completed at the upstream WWTF improvements.

MT. HOPE BAY TEMPERATURE DELISTING

35. Mt. Hope Bay (RI0007032E-01A)

*Mt. Hope Bay south and west of the MA/RI border, and east of a line from Touisset Point to the channel marker buoy R "4" and south and east of a line from buoy R "4" to the southernmost landward end of Bristol Point and south of a line from Bristol Point to the Hog Island shoal light, to the southwestern extremity of Arnold Point in Portsmouth where a RIDEM range marker has been established; and west of a line from the end of Gardiner's Neck Road, Swansea to buoy N"2", through buoy R4 to Common Fence Point, Portsmouth excluding the waters defined in RI0007032E-01E below. Warren, Portsmouth**

* Note: This is the description from the Water Quality Regulations (RIDEM 2009). RI0007032E-01E is not described below in this document. See: http://www.dem.ri.gov/pubs/regs/regs/water/h20q09a.pdf for RI0007032E-01E description.

36. Mt. Hope Bay (RI0007032E-01B)

Mt. Hope Bay waters north and west of a line from the southernmost landward end of Bristol Point to buoy R "4" and west of a line from buoy R "4" to the DEM range marker on Touisset Point, and south of the Bristol Narrows. Bristol, Warren

37. Mt. Hope Bay (RI0007032E-01C)

Mt. Hope Bay waters south of a line from Borden's Wharf, Tiverton, to buoy R "4" and west of a line from buoy R "4" to Brayton Point, Somerset, MA., and east of a line from the end of Gardiner's Neck Road in Swansea to buoy N "2", through buoy R4 to Common Fence Point, Portsmouth, and north of a line from Portsmouth to Tiverton at the railroad bridge at "The Hummocks" on the northeast point of Portsmouth. Portsmouth

38. Mt. Hope Bay (RI0007032E-01D)

Mt. Hope Bay waters south and west of the MA-RI border and north of a line from Borden's Wharf, Tiverton to buoy R "4" and east of a line from buoy R "4" to Brayton Point in Somerset, MA. Bristol, Portsmouth and Tiverton.

Introduction

The four assessment units in the RI portion of Mt. Hope Bay (RI0007032E-01A, RI0007032E-01B, RI0007032E-01C, RI0007032E-01D) were originally listed as impaired aquatic life use with temperature, water as a cause in 2000. The cause of this impairment was found to be Brayton Point Station's thermal discharge. Located on the shores of Mt. Hope Bay in Somerset Massachusetts, Brayton Point Station, owned and operated by Dominion Energy, at one point was the largest fossil fuel burning power plant in New England. With issuance of the Brayton Point NPDES Permit (No. MA 0003654) requiring reduction of the annual heat discharge to the bay by 96% and water withdrawal from the bay by approximately 94%, the cause of temperature, water was reclassified from Category 5 (303d list) to Category 4B (other pollution control requirements are expected to result in attainment of the water quality standard associated with the impairment) in 2008.

Prior analyses had indicated that Mt. Hope Bay water surface temperature was elevated by approximately 0.8 °C due to the Brayton Point plant thermal discharge; although this fluctuates seasonally with the greatest temperature elevation during late summer and autumn (Sen, 1996; Carney, 1997; Mustard et al., 1999). The installation of closed cycle cooling in 2012 was expected to reduce the water temperature impairment in Mt. Hope Bay. Now with Brayton Point Station permanently shut down as of June 2017, thermal discharges to Mt. Hope Bay have essentially stopped. The data analysis presented here examines available Mt. Hope Bay water temperature data to quantify changes in water temperature associated with the May 2012 conversion to closed-cycle cooling at the Brayton Point plant. The data presented document compliance with RI's Water Quality Standards for temperature in the RI portion of Mt Hope Bay, and these segments will not be listed as aquatic life use impaired with temperature, water as a cause in the 2016 Integrated Report. However, these segments will continue to be listed as impaired for aquatic life use with causes of fishes bioassessments, nitrogen (total), and dissolved oxygen and impaired for shellfishing use (Segments A and B) and primary and secondary contact use (Segments C and D) with cause fecal coliform as the cause.

Background

Brayton Point Energy, LLC has a NPDES permit (No. MA 0003654) and a memo of agreement with US EPA, MA DEP and RI DEM that limits the cooling water heat load allowed to be discharged into Mt. Hope Bay. The October 2003 NPDES permit required Brayton Point Station to reduce:

- Total annual heat discharge to the bay by 96%, from 42 trillion BTUs/year to 1.7 trillion BTUs/year, and
- Water withdrawal from the bay by approximately 94%, from nearly 1 billion gallons/day to 56 million gallons/day.

The current NPDES permit went into effect on May 13, 2012, coincident with the conversion of the plant to closed-cycle cooling *via* two 500 ft. tall natural draft cooling towers. The current permit allows 1.7 TBTU (trillion BTU) per year heat load to Mt. Hope Bay and a 70 MGD intake flow limit. The increased intake flow limit of 70 MGD in the 2012 permit corrects an inadvertent omission of including "blow-down" and "make up" water for one of the cooling towers in the intake flow limit established in the earlier permit. (US EPA, 2012) The conversion to closed cycle cooling dramatically reduced the heat load discharged into Mt. Hope Bay (Fig. 1), with the annual heat loading falling from 30-50 TBTU annually prior to closed-cycle cooling to 2.4 TBTU annually during 2012 (conversion year) to 0.8 TBTU in 2013 and 0.6 TBTU in 2014 after conversion. The post-closed cycle cooling heat load was less than 5% of that experienced prior to the 2012 conversion (Fig. 1).

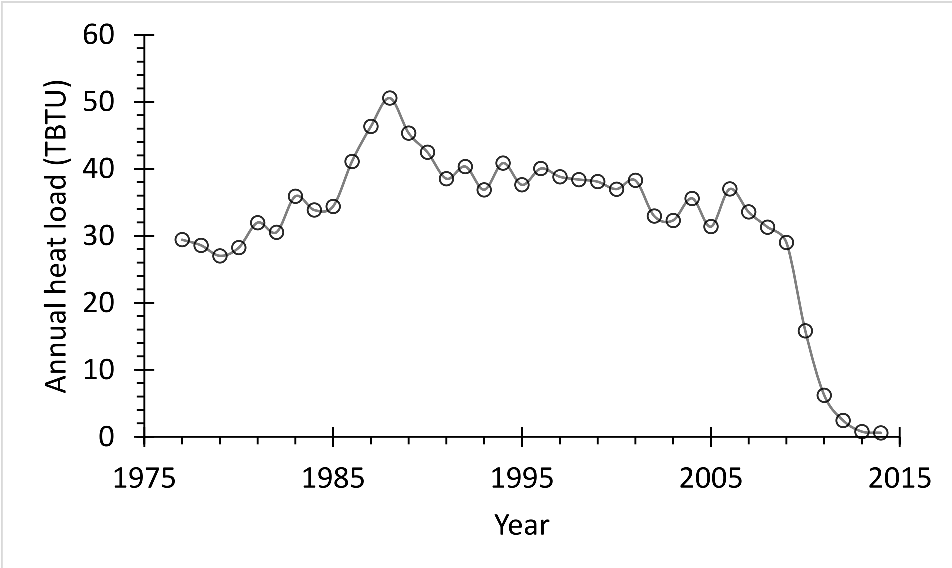


Figure 1: Annual heat load (units are trillions BTU per year) from Brayton Point cooling water 1977 to 2014. (Data source: Table 1-5 of 2014 Brayton Point Annual Report).

Data Sources:
Several data sources were used in the evaluation of Mt. Hope Bay water temperature:

1. Mount Hope Bay thermistor buoys. Water temperature data from eight (8) buoys maintained by Brayton Point or its consultants (Normandeau Associates). Temperature was recorded by thermistors every 15 minutes at near surface and near bottom depths. Data from April 2008 through October 2015 were analyzed, with approximately 264,000 15-minute observations compiled for each buoy-depth combination. Data were analyzed for three buoys in RI waters of Mt. Hope Bay (Buoys 6, 7, 8) and for two buoys (Buoys 1 and 5) located in MA waters near the RI state line. These data were used for the comparison to class-specific temperature criteria. Locations of the thermistor buoys in Mt. Hope Bay are shown in Figure 2.

2. Water temperature from NOAA-PORTS sensors were collected every 6 minutes at Borden Flats Light (Fall River, MA, NOAA station # 8447387), Conimicut Point Light (Warwick, RI, NOAA station # 8452944), Quonset Point (North Kingstown, RI, NOAA station # 8454049) and at Newport, RI (NOAA station # 8452660) during the 2008-2015 period of interest. These high-frequency temperature observations were compiled into 2,913 daily averaged water temperature readings over the January 2008 (1/1/2008) to December 2015 (12/22/2015) time period. Raw data were processed (QA/QC data for ‘0’ and anomalous negative readings (sensor down); dataset has a few data gaps).

Figure 2: Location of thermistor buoys in Mt. Hope Bay. Thermistor temperature data were collected at near surface and near bottom depths at eight locations in the Bay and at the 'Straight Bridge' in the discharge canal. (Figure 3-2 copied from 2012 Brayton Point Annual Report).

Comparison to RI Class-Specific Criterion for Temperature

Four assessment units (water body ID RI0007032E-01A, RI0007032E-01B, RI0007032E-01C, RI0007032E-01D) of the RI portion of Mt. Hope Bay are listed as impaired aquatic life use due to temperature, water. Two specific water temperature criteria are listed for RI marine waters:

1. <u>activities</u> shall not cause water temperature to exceed 83°F (28.3°C) and;

2. <u>activities</u> shall not cause the temperature to rise greater than 1.6°F (0.9°C) above normal during June 16th through September and greater than 4°F (2.2°C) above normal from October until June 16th (State of RI Water Quality Regulations, July 2006, amended December 2010; Table 2.8 D (3); page 16).

The fifteen-minute (instantaneous) thermistor buoy temperature readings collected by Brayton Point Energy, LLC and its contractors were used to evaluate changes in the frequency of water temperature violations of these criteria. The high frequency instantaneous temperature observations were compiled for approximately 3.5 years prior-to (April 2008 to September 2011) and approximately 3.5 years after (June 2012 to December 2015) the conversion to closed-cycle cooling. These temperature observations were analyzed for the frequency of exceeding the 83°F maximum water temperature criteria. Additionally, the water temperature data collected from NOAA –Ports Sensors at four locations in Narragansett Bay were evaluated for comparison with the Mt Hope Bay temperature data to assess change in temperature from “normal”.

83°F Maximum Water Temperature Criterion

The frequency of 83°F threshold exceedance was relatively uncommon prior to the conversion to closed cycle cooling, with a maximum of 0.22% of observations (254 exceedances out of 117,754 observations) exceeding the threshold at the surface of the Gardiner’s Neck station (Buoy 1S, in MA waters). Following the conversion to closed cycle conversion, the frequency of exceeding 83 °F declined significantly at multiple locations (Table 1). Frequency of 83 °F declined significantly at Buoys 1S and 1B (Gardiner’s Neck, surface and bottom depths, in MA waters), Buoy 5S ((Mid-Bay, north of Spar Island, in MA waters) and at Buoy 8S (Sakonnet, RI waters). At the other buoys (*i.e.*, 6S, 7S, 5B, 6B, 7B, 8B), there was no statistically significant change in 83 °F frequency because the frequency was near 0% both before- and after- the conversion to closed cycle cooling (Table 1). With the exception of Buoy 1S, there were less than four (out of ~111,000 to 120,000) post-closed cycle cooling instantaneous readings of 83 °F or greater (Table 1). While Buoy 1S had a statistically significant post-closed cycle cooling decline in frequency of 83 °F exceedance, there were still 126 (of 119,627) instantaneous temperature readings of greater than 83 °F during the post- closed cycle cooling period. Most (120 of 126) of the temperature exceedances at Buoy 1S occurred during July 2013 heat waves. Two heat waves (three consecutive days or more with maximum temperature of 90 °F or greater) occurred during July 2013 (July 6 to 8 and July 18 to 21) during which air temperature at Taunton Municipal Airport reached 97 °F. During these heatwaves, most 83 °F temperature exceedances at Buoy 1S (Gardiner’s Neck) occurred during ebb tides. The shallow location of Buoy 1S at the mouth of the Cole River is subject to ebb tide tidal flow from the shallow ‘Ocean Grove’ area draining up-Bay of the buoy. No other 83 °F exceedances were recorded at Buoy 1S during subsequent heat waves. For example, July 19-21, 2015 and August 16-18, 2015 had air temperatures in the 90s and no 83 °F water temperature exceedances were detected at Buoy 1S.

Table 1: Comparison of frequency of water temperature exceeding 83 °F (28.3 °C) at surface and near-bottom depths at five locations in Mt. Hope Bay before versus after conversion to closed cycle cooling. Instantaneous (every 15 minutes) temperature observations were used and pre- vs. post- cooling frequency of 83 °F exceedances were compared using Fisher's exact test. Stations 1 and 5 are in MA waters, stations 6, 7, 8 are located in the RI portion of Mt. Hope Bay; S designates surface and B designates bottom.

Location	Pre- Frequency (# exceed 83°F/ # observations)	Post- Frequency (# exceed 83°F/ # observations)	P value (change?)
Surface 1S	254 / 117,754	126 / 119,627	0.0001 (decline)
5S	80 / 120,623	1 / 117,756	0.0001 (decline)
6S	0 / 115,049	2 / 115,017	0.4794 (no change)
7S	1 / 117,179	3 / 111,893	0.5849 (no change)
8S	12 / 120,714	1 / 119,696	0.0058 (decline)
Bottom 1B	38 / 117,789	0 / 119761	0.0001 (decline)
5B	0 / 120,704	0 / 117,760	1.0000 (no change)
6B	0 / 115,049	2 / 115,017	0.4794 (no change)
7B	3 / 118,176	0 / 118,893	0.9937 (no change)
8B	0 / 120,708	0 / 119,707	1.0000 (no change)

Observation of temperature exceeding 83 °F at the near-bottom of Mt. Hope Bay was more uncommon than at the surface and no statistically significant changes in the frequency of 83 °F exceedance were detected for the bottom waters of the RI portion of Mt. Hope Bay. Exceeding 83 °F in the bottom water was an uncommon event (it was never observed at some stations) before the conversion to closed-cycle cooling and it remained an uncommon event (maximum of 2 out of 115,017 observations at Buoy 6B) in RI portions of Mt. Hope Bay after the conversion to closed cycle cooling (Table 1). The bottom waters of Gardiner's Neck, near the mouth of the Cole River (Buoy 1, in MA waters), experienced a statistically significant decline in frequency of exceeding the 83 °F criteria after the conversion to closed cycle cooling (Table 1); no observations of 83 °F or greater water temperature were noted at Buoy 1B (bottom) after the conversion to closed-cycle cooling.

Seasonal Temperature Rise Criteria

Reference Station Selection and Calculation

The seasonal temperature rise criteria for RI estuarine and marine waters states that a temperature increase of 1.6 °F (0.9 °C) above normal temperature shall not be exceeded during the summer (June 16 through September) and a temperature rise of 4 °F (2.2 °C) above normal shall not be exceeded from October until June 16th. EPA guidance (US EPA, 1986) indicates that a 7-day rolling average temperature, calculated from thermistor observations is an appropriate measure, or reference, to quantify compliance with RI estuarine water temperature seasonal delta-T regulations. Several nearby locations have marine water temperature data available for use as a reference to which the Mt. Hope Bay water temperatures may be compared. Water temperature observations collected every 6 minutes at Borden Flats Light (Fall River, MA, NOAA station # 8447387), Conimicut Point Light (Warwick, RI, NOAA station # 8452944), Quonset Point (North Kingstown, RI, NOAA station # 8454049) and at Newport, RI (NOAA station # 8452660) during the 2008-2015 period of interest are available for evaluation.

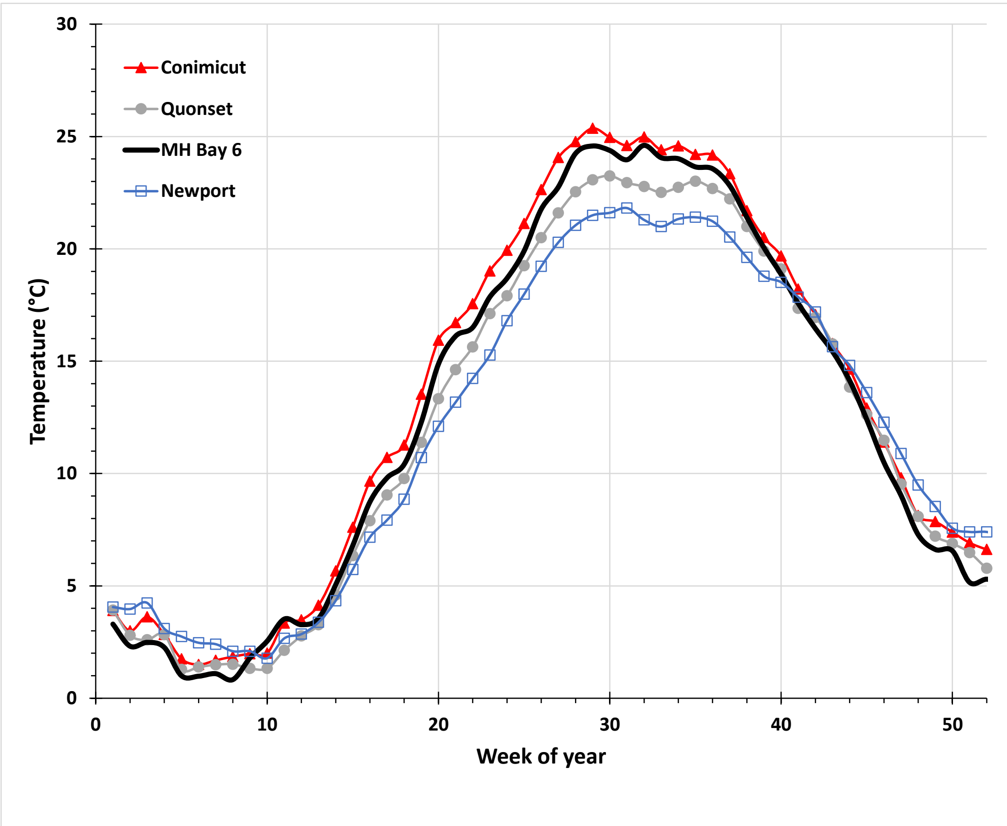


Figure 3: Comparison of water temperature mean annual cycle at Mount Hope Bay Buoy 6 (south of Spar Island) to those at Conimicut Point, Quonset Point and Newport Harbor. Means are based on NOAA observations during 2012-2015.

The Borden Flats site was deemed unsuitable for use as a reference because it is in Mt. Hope Bay, relatively near to the Brayton Point thermal discharge and may be subject to the same potential influence from thermal discharge – even after conversion to closed cycle cooling - as other Mt. Hope Bay stations. The annual water temperature patterns during the 2012-2015 post-cooling period at several potential reference sites (Newport, Quonset Point, and Conimicut Point) were compared (Fig. 3). While annual water temperature patterns were generally similar, several key differences were apparent. Most importantly, Newport and Quonset Point had much cooler (1.0° to 2.5° C cooler) water temperature than Mount Hope Bay during the critical summer period (Fig. 3). In addition, there was a seasonal pattern of Newport and Quonset water temperature changing from warmer than Mt. Hope Bay during winter to cooler than Mt. Hope Bay during summer while Conimicut Point consistently followed the Mt. Hope Bay temperature cycle, with Conimicut Pt. usually being slightly warmer than Mt. Hope Bay Buoy 6 (Fig. 3). For these reasons, Conimicut Point was chosen as the reference station to which Mt. Hope Bay water temperature was compared for evaluation of changes in compliance with RI water temperature seasonal rise (delta-T) criteria.

Water temperature at near-surface and near bottom sensors were compiled from the 15-minute buoy observations at Buoy locations 1, 5, 6, 7 and 8 in Mt. Hope Bay and at the NOAA Conimicut Pt. reference location (Warwick, RI, NOAA station # 8452944). Following EPA 'Gold Book' methodology (US EPA, 1986), the 7-day rolling average temperature was calculated from the 15-minute thermistor observations and this was used as a reference to calculate seasonally varying delta-T temperatures. The frequency of exceeding RI seasonal temperature delta-T criteria for marine waters prior to-and after conversion of the Brayton Point plant to closed cycle cooling was evaluated using 2X2 contingency tables (# days meet vs # days exceed criteria by Pre- vs. Post-cooling periods) and Fisher's exact test. Frequency of exceeding the RI summer temperature delta-T criteria (June 16th through September; mean temperature +0.9 °C) and winter temperature delta-T criteria (October through June 15th; mean temperature + 2.2 °C) were tested separately.

Frequency of Seasonal delta-T Exceedances

Summer seasonal delta-T exceedance frequency

Frequency of exceeding the summer seasonal temperature delta-T criteria (mean reference temperature +0.9 °C; in effect 16 June through the last day of September) declined significantly in the surface waters at all locations examined (Buoys 1, 5, 6, 7, 8) following the conversion to closed cycle cooling (Fig. 4). Locations in RI waters of Mt. Hope Bay displayed statistically significant declines in frequency of exceeding summer delta-T temperature criteria: Buoy 6S (south of Spar Island) had a decline from 11.8% to 0.2% of days exceeding summer delta-T criteria, Buoy 7S (near Mt. Hope) experienced a decline from 5.7% to 0%, and Buoy 8S (approach to Sakonnet) experienced a decline from 8.1% to 0.5% of days exceeding the summer seasonal delta-T criteria (Fig. 4, top).

Surface water at locations in MA waters of Mt. Hope Bay also experienced significant declines in the frequency of violating the summer delta-T criteria (Fig. 4), but station 1S, located in the shallow waters of upper Mt. Hope Bay (west of Gardiner's Neck) still exceeded seasonal delta-T criteria approximately 15% of the time following closed cycle cooling. The post-closed cycle cooling summer delta-T exceedances at Gardiners Neck (Buoy 1) were primarily during July and August 2015 heat waves. Heat waves (three consecutive days or more with maximum temperature of 90 °F or greater) occurred during July 19-21, 2015 and August 16-18, 2015 during which air temperature at Taunton Municipal Airport reached 93-94 °F. As described in the 83 °F criteria section, the shallow location of Buoy 1S at the mouth of the Cole River is subject to ebb-tide tidal flow from the warmer (in summer) and shallow 'Ocean Grove' area draining up-Bay of the 1S Buoy. Tidal currents tend to push surface water from the Brayton Point area to the west during ebb tides (Swanson et al., 2006) such that discharge from the plant may have also contributed to violation of surface water delta-T exceedance at Buoy 1S in the Gardiner's Neck area (MA waters) close to the power plant discharge during these heat waves. No other violations of the summer delta-T criteria were observed at this location, including during ebb tides.

The frequency of bottom water summer season delta-T exceedance was lower than that observed at the surface, as one might expect. In RI waters of Mt. Hope Bay (stations 6B, 7B, 8B), no summer seasonal delta-T exceedances were noted prior to or after the conversion to closed cycle cooling (Fig. 4, bottom). For buoy locations in MA waters (stations 1B and 5B), the frequency of summer delta-T temperature exceedances declined significantly, with no bottom water summer delta-T exceedances occurring after the conversion to closed cycle cooling (Fig. 4, bottom).

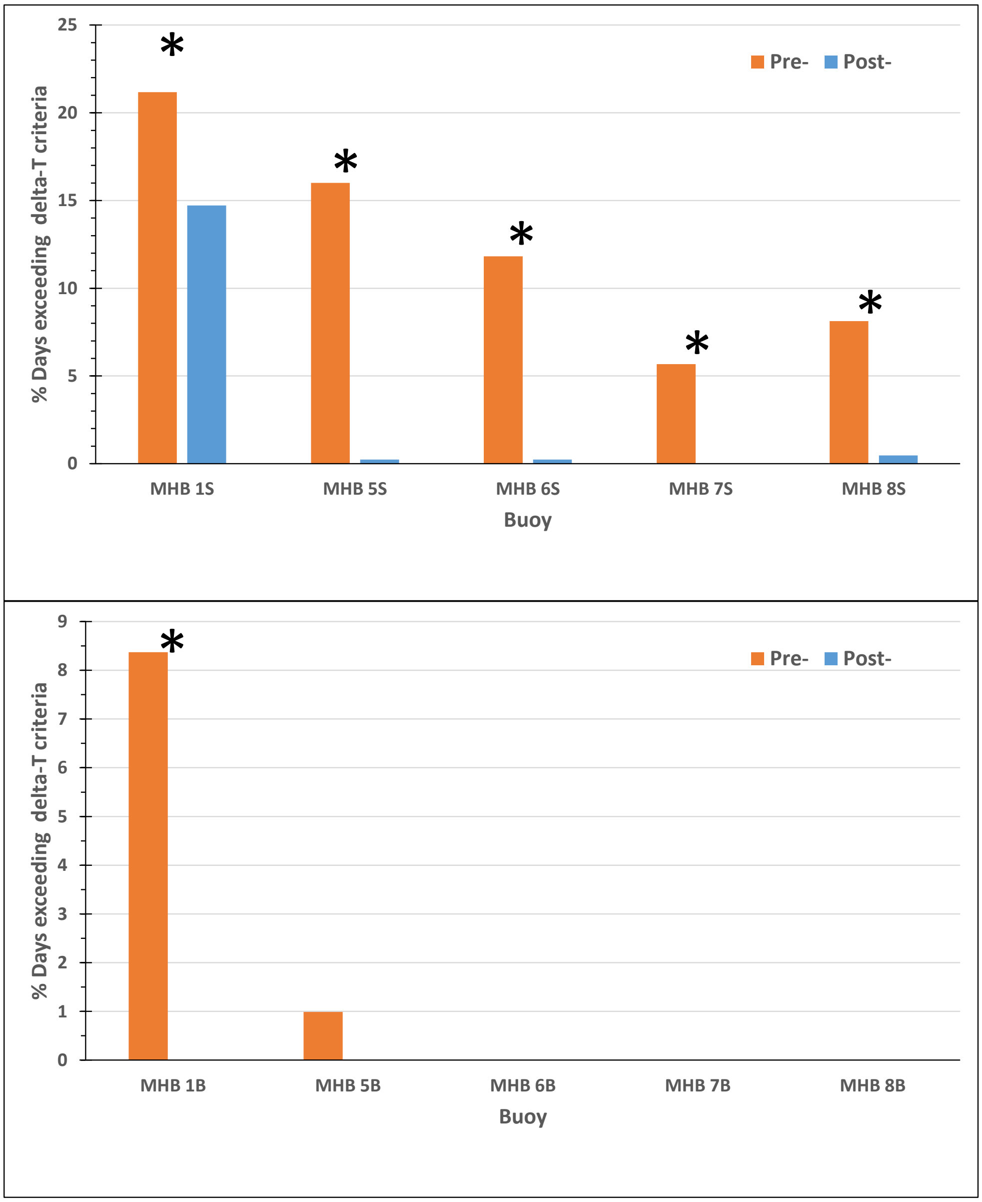


Figure 4: Comparison of frequency of days exceeding *summer* (7-day rolling average temperature + 0.9°C) seasonal delta-T temperature criteria using Conimicut Pt. as a reference prior to ('Pre') and following ('Post') conversion to closed cycle cooling at five buoy locations in Mt. Hope Bay. Pre- and post- frequencies compared with Fisher's exact test; statistically significant differences in frequencies designated with asterisk. Top panel is surface temperature and bottom panel is bottom temperature summer threshold exceedance frequency. Buoys 1 and 5 are in MA waters, buoys 6, 7 and 8 are located in RI waters of Mt. Hope Bay.

Winter seasonal delta-T exceedance frequency

Frequency of exceeding the winter seasonal temperature delta-T criteria (mean temperature + 4°F (2.2°C) above normal; in effect from October 1st until June 16th) was generally lower than the frequency of summer delta-T threshold exceedance, both before and after the conversion to closed cycle cooling. At most locations (5S, 6S, 7S, 8S, 1B, 5B, 6B, 8B) no (frequency = 0%) winter delta-T exceedances were noted prior to- and after- the conversion to closed cycle cooling (Fig. 5). However, declines in frequency of winter delta-T criteria after conversion to closed cycle cooling were noted at two locations (Buoy 1S in MA waters and buoy 7B in RI waters). Frequency of winter delta-T exceedance post-closed cycle cooling declined from 0.6% to 0% of days at the surface of the Gardiner's Neck station (1S) and declined from 3.3% of days to 0.7% (5 of 757 days) of days at the bottom water of the Mt. Hope station (7B; Fig. 5). The five days on which the winter delta-T criteria was exceeded at Buoy 7B (Mt. Hope) were on January 14-18, 2015. At this time a cold front moved into the area and ice was forming on Mt. Hope Bay. The extent of ice during the cold snap and subsequent record-cold winter of 2015 resulted in Buoy 7 being moved off its mooring. Buoy 7 was pushed ashore by the ice and was later recovered and deployed at its long-term location on 3/27/2015 (Brayton Point Station 2015 Annual Report, Table 3-9). The five January 2015 temperature exceedances at Buoy 7B (Fig. 5) likely reflect a change in the buoys position (ice pushed it ashore) rather than bottom water temperatures during January 14-18, 2015.

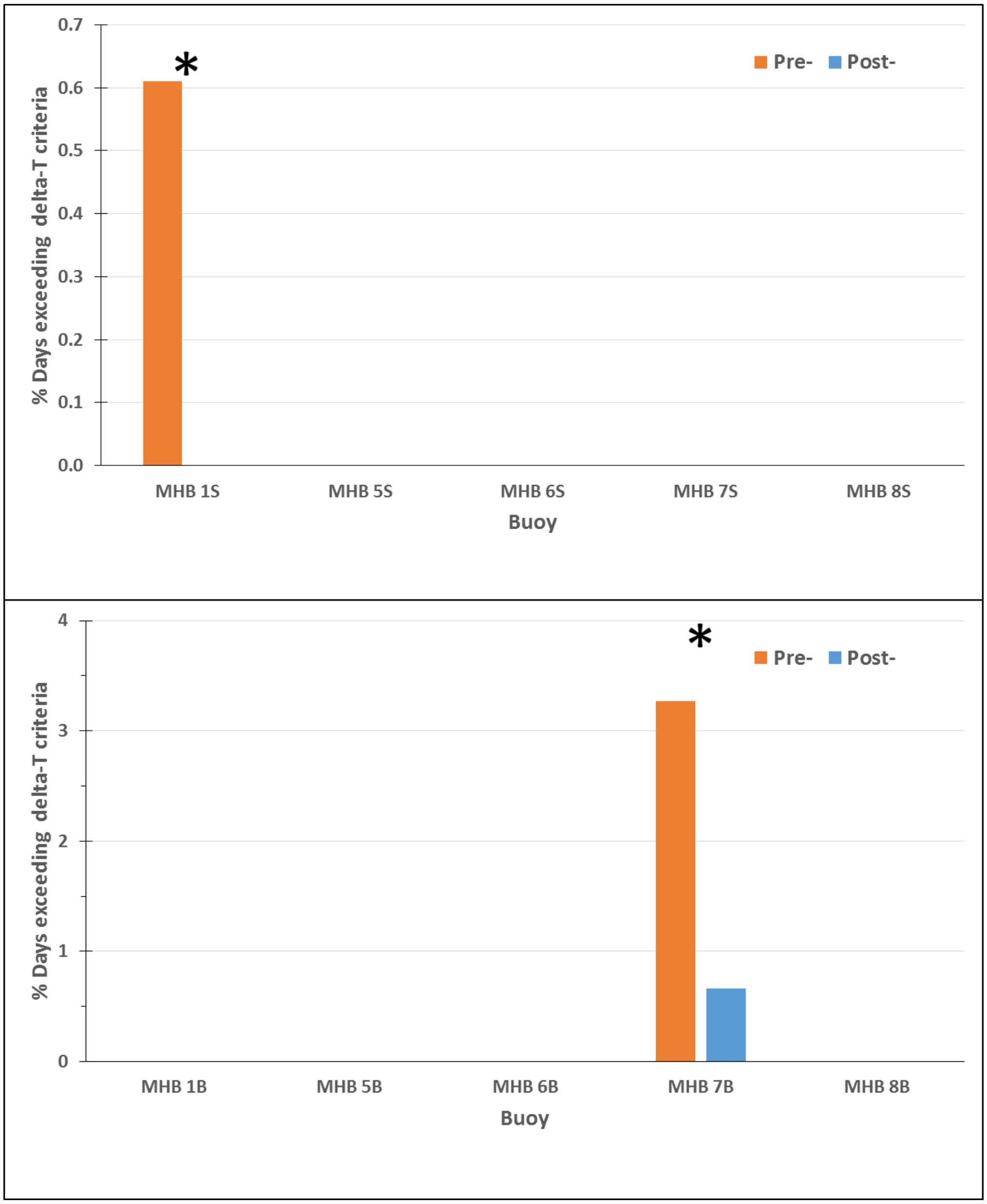


Figure 5: Comparison of frequency of days exceeding *winter* (mean temperature + 2.2°C) seasonal delta-T temperature criteria using Conimicut Pt. as a reference prior to ('Pre') and following ('Post') conversion to closed cycle cooling at five buoy locations in Mt. Hope Bay. Pre- and post- frequencies compared with Fisher's exact test; statistically significant differences in frequencies designated with asterisk. Top panel is surface temperature and bottom panel is bottom winter temperature exceedance frequency. Buoys 1 and 5 are in MA waters, buoys 6, 7 and 8 are located in RI waters of Mt. Hope Bay.

Summary and Conclusions

1. **83 °F Criterion:** The frequency of exceeding the 83 °F maximum water temperature criteria declined significantly in RI waters of Mt. Hope Bay after the conversion of Brayton Point Power to closed-cycle cooling (Table 1). Declines in frequency of 83 °F exceedance were greater at the surface than the bottom and stations in the northern portion of Mt. Hope Bay had the greatest decline in 83 °F exceedance.

2. **Seasonal delta-T criteria:** Statistically significant declines in the frequency of exceeding the summer seasonal delta-T criteria for RI marine waters occurred following the conversion to closed cycle cooling (Fig. 3, Fig. 4).
    a. During **summer**, the surface waters of the RI portion of Mt. Hope Bay (Buoys 6, 7, 8) experienced a decline from water temperature exceeding the summer delta-T threshold ~6% to 12% of the time to only ~0% to 0.5% of the time after conversion to closed cycle cooling (Fig. 4). Bottom waters of the RI portion of Mt Hope Bay did not exceed summer delta- criteria either before (2008-2011) or after (2012-2015) the conversion to closed cycle cooling.
    b. During **winter**, the surface waters of RI portions of Mt. Hope Bay had no exceedances of delta-T criteria before (2008-2011) or after (2012-2015) the change to closed cycle cooling (Fig. 5). Prior to the conversion to closed-cycle cooling, the bottom waters of Mt. Hope Bay had exceedance of winter delta-T criteria only at Buoy 7B (bottom depth, East Passage, near Mt. Hope). After the cooling conversion, there was a significant decline in frequency of winter delta-T exceedance (from 3.3% of the time to 0.7% of the time) at Buoy 7B.

Collectively, the analyses presented above and analysis of Mt. Hope Bay water temperature compared to regional water temperature patterns (RIDEM, 2017) converge on an overall decline in the RI portions of Mt. Hope Bay surface water temperature of ~0.3 to 1.0°C (dependent on analysis method). This temperature decline is similar to the 0.80°C (Mustard et al., 1999) to 1.24°C (Swanson, 2015) temperature elevation predicted to have been caused by operation of the Brayton Point plant prior to the 2012 conversion to closed cycle cooling. RI portions of Mt. Hope Bay (RI0007032E-01A, RI0007032E-01B, RI0007032E-01C, RI0007032E-01D) are currently listed as impaired aquatic life use with temperature, water as a cause. We have documented significant declines in the frequency of violation of two specific RI marine water temperature criteria (83 °F maximum temperature criteria and seasonal delta-T criteria). After the installation of closed cycle cooling, there was a significant decline in exceedance of the 83 °F maximum temperature and there was a significant decline in frequency of summer and winter seasonal delta-T violations.

These results indicate that Brayton Point Energy activities after the installation of closed cycle cooling during 2008-2015 were:

1. Not causing Mt. Hope Bay water temperature to exceed 83°F (28.3°C) and;

2. The activities were not causing Mt. Hope Bay water temperature to rise greater than 1.6°F (0.9°C) above normal during June 16th through September and greater than 4°F

(2.2°C) above normal from October until June 16th (State of RI Water Quality Regulations, July 2006, amended December 2010; Table 2.8 D (3); page 16).

The analyses presented here have documented a reduction in impact on water temperature in Mt. Hope Bay and attainment of RI marine water temperature water quality criteria in the RI portion of Mt. Hope Bay (WBIDs RI0007032E-01A, RI0007032E-01B, RI0007032E-01C, RI0007032E-01D).

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