

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

**Conditional Area Management Plan (CAMP) for the
Conditionally Approved Providence River Shellfish
Growing Area (Growing Area 16)**

December 2021

Table of Contents

| | |
|---|------------|
| Table of Contents | i |
| List of Figures | ii |
| List of Tables | ii |
| Preface | iii |
| A. Understanding and Commitment to the Conditions by all Authorities | 1 |
| B. Providence River Conditional Area | 3 |
| 1. <i>General Description of the Growing Area</i> | 3 |
| 2. <i>Size of GA16</i> | 10 |
| 3. <i>Legal Description of Providence River (GA 16):</i> | 11 |
| 4. <i>Growing Area Demarcation / Signage and Patrol</i> | 13 |
| 5. <i>Pollution Sources</i> | 14 |
| i. <i>Waste Water Treatment Facilities (WWTF)</i> | 14 |
| ii. <i>Rain Events, Combined Sewer Overflows and Stormwater</i> | 15 |
| C. Sanitary Survey | 22 |
| D. Predictable Pollution Events that cause Closure | 22 |
| 1. <i>Meteorological Events</i> | 22 |
| 2. <i>Other Pollution Events that Cause Closures</i> | 24 |
| E. Water Quality Monitoring Plan | 24 |
| 1. <i>Frequency of Monitoring</i> | 24 |
| 2. <i>Monitoring Stations</i> | 25 |
| 3. <i>Analysis of Water Samples</i> | 25 |
| 4. <i>Toxic or Chemical Spills</i> | 25 |
| 5. <i>Harmful Algae Blooms</i> | 26 |
| 6. <i>Annual Evaluation of Compliance with NSSP Criteria</i> | 26 |
| F. Closure Implementation Plan for the Providence River Conditional Area (GA 16) | 28 |
| 1. <i>Implementation of Closure</i> | 28 |
| G. Re-opening Criteria | 29 |
| 1. <i>Flushing Time</i> | 30 |
| 2. <i>Shellstock Depuration Time</i> | 30 |
| 3. <i>Treatment Plant Performance Standards</i> | 31 |
| H. Annual Reevaluation | 33 |
| I. Literature Cited | 33 |

| | |
|---|-----------|
| Appendix A: Conditional Area Closure Checklist | 35 |
| Appendix B: Quahog tissue metals and PCB results | 37 |

List of Figures

| | |
|--|----|
| Figure 1: Providence River, RI location map. | 6 |
| Figure 2: Providence River watershed with municipal sewer service areas | 7 |
| Figure 3: Surface water temperature (F) at Conimicut Point Lighthouse..... | 9 |
| Figure 4: Area map of the lower Providence River. | 10 |
| Figure 5: Providence River GA-16 Growing Area Classification Map, May 2021. | 12 |
| Figure 6: Fecal coliform concentration during dry and wet weather..... | 17 |
| Figure 7: Growing Area 16 Water Quality Monitoring Stations. | 27 |

List of Tables

| | |
|---|----|
| Table 1: Air temperature at TF Green Airport (NOAA station KPVD). | 8 |
| Table 2: Average rain and wind annual patterns in the GA16 area. | 9 |
| Table 3: WWTF specifications and recent upgrade history..... | 15 |
| Table 4: Growing area 16 annual fecal coliform compliance statistics 2016 to 2019..... | 17 |
| Table 5:Fecal coliform conditions in GA16 following closure rainfall of >0.5” rain. | 19 |
| Table 6: Fecal coliform observations made 3-5 days after a closure rainfall of >0.5”..... | 20 |
| Table 7: Providence River (GA 16) annual precipitation and days in open status | 23 |
| Table 8: Quahog (<i>Mercenaria mercenaria</i>) meatfecal coliform results. | 31 |

Preface

The Conditional Area Management Plan and related operating procedures for the Providence River Conditionally Approved Shellfish Growing Area (Growing Area 16; GA16) have been prepared by the Rhode Island Department of Environmental Management, Division of Water Resources. The GA16 Conditional Area Management Plan has been developed to ensure that the safety of shellfish for human consumption harvested from this area is maintained and that a plan is in place dictating the actions necessary to maintain these minimum requirements as established by the National Shellfish Sanitation Program (NSSP) within the US Food and Drug Administration (FDA). The NSSP 2019 Model Ordinance Guidance Document Section IV, Chapter II, .09 “Management Plans for Growing Areas in the Conditional Classification” was adhered to in the updating of this plan.

Two (2) conditional criteria as described and contained in this management plan may initiate the closure of GA16, as summarized below:

Conditional Criteria Requiring Closure:

WWTF Operational Criteria:

Condition: Notification of an emergency condition at the NBC Bucklin Point WWTF, the City of East Providence WWTF, or the NBC Fields Point WWTF resulting in complete loss of treatment and the discharge of untreated sewage that could affect the microbiological water quality of conditionally approved waters.

Re-opening criteria: Return of the WWTF to normal operation followed by either a) a 21-day closed period or b) a 7-day closed period and demonstration that shellstock in the growing area have MSC levels of 50 pfu/100 grams or less; or shellfish are at or below established background MSC levels for that growing area.

Basis for re-opening criteria: Reopening criteria after WWTF loss of disinfection is based on return to normal WWTF operation and either a 21-day closure or a 7-day closure and testing for MSC levels in shellfish consistent with NSSP 2019, IV @03 A. (5) (d) (ii) and Chapter IV @ 03 C. (2) (c) (iii).

Precipitation (rain and snowmelt) Criteria:

Condition: Greater than 0.5” of precipitation (rainfall or equivalent snow melt) within any 24-hour period measured at the NOAA NWS station at TF Green Airport in Warwick RI or at the NBC Fields Point or at the NBC DOT rain gauges (NBC and DOT rain gauges available Monday-Friday only). Continuing precipitation beyond the initial closure criteria will require an extension of the minimum 7-day closure if the additional precipitation exceeds the initial 0.5” in 24-hour closure criteria. At no time shall a closure be of less than 7 days duration following the end time of any precipitation event that exceeds 0.5” within any 24-hour period.

Re-opening criteria: Automatic re-opening on the eighth day following the end of the last rain event (seven-day closure).

Basis for re-opening criteria: Bacteria levels within the water column return to acceptable conditions within three to four (3-4) days as established in the Providence River Conditional Area Management Plan maintained in the program’s permanent files. An additional two days is added for self-cleansing of shellfish (NSSP 2019, IV @03 C 2

c {i – iii}). Total closure time required is six (6) days, actual practice is seven (7) days. Supplemental monitoring conducted in recent years supports this as described in the management plan.

Emergency closures due to HABs (Harmful Algae Blooms), wastewater spills, toxic spills, elevated monitoring result and other unpredictable events will be initiated when required as described in the management plan. Administrative criteria such as failure to comply with this management plan and failure to annually review growing area compliance statistics may also result in administrative closures as described in the management plan.

There have been no previous management plans for this growing area. The Providence River in its entirety has historically been classified as Prohibited (May 2020 Notice of Polluted Shellfishing Grounds). Due to extensive improvements to WWTF, capture and treatment of combined sewer overflows and stormwater controls in the greater Providence area there has been a general reduction of bacteria loadings in the watershed and concomitant improvements in microbial water quality in the lower portion of the Providence River such that the area is now suitable to support a conditionally approved shellfish classification. In addition, a revised evaluation of WWTF performance and dilution zones is incorporated into the CAMP based on the analysis presented in the RIDEM document entitled “Establishing the Closure Zones and Shellfish Water Classifications Adjacent to Waste Water Treatment Facilities (WWTF) in the Providence River (GA16)”, RIDEM February 2021.

Quahogs (*Mercenaria mercenaria*) will be the only bivalve molluscan shellfish to be harvested in the Providence River conditional area (GA16-4). DEM and the RI Department of Health have evaluated historic and recent quahog tissue data for the presence of poisonous and deleterious substances and determined that quahogs in this area are safe for direct human consumption. This analysis is presented in the RIDEM document: “Providence River Shellfish Tissue Analysis Summary” (RIDEM 2021; in Appendix B of this document). This management plan is the initial Conditional Area Management Plan (CAMP) for the Providence River shellfish growing area (GA16) implemented when the area was re-classified as Conditionally Approved in May 2021.

This Operating Procedure is expected to serve as a flexible document to guide the management of the Providence River that will be referred to as the Providence River Conditionally Approved Growing Area (GA16). The remaining portions of GA16 will remain classified as Prohibited at this time. Certain items of this management plan may be revised periodically due to changing circumstances within the watershed upon review and consensus by FDA and State personnel.

A. Understanding and Commitment to the Conditions by all Authorities

The Conditionally Approved classification of the Providence River (Growing Area 16) is a classification in which the agreement of all authorities involved, including but not limited to state and local officials, federal agencies, the affected shellfish industry and persons responsible for the proper operation of treatment plants that discharge to tributaries or directly to the Providence River. All involved parties must understand and agree to the conditions of this management plan. It is understood by the WWTF that they are to report any permit violations within 24-hours and are required to immediately report any loss of disinfection to the RIDEM Operations and Maintenance as part of their permit.

At the local level, WWTF operators whether by municipal, private or quasi-public agencies operate these facilities within the requirements of their National Pollution Discharge Elimination Permits Program. Effluent limitations, monitoring requirements and agency notification are detailed within each permit and adherence with these conditions is tantamount to acceptance of the conditions of this management plan.

No person shall conduct within this state any shellfish business until that person has obtained a license from the Department of Health and RI Department of Environmental Management. RI Shellfish Growers, Harvesters and Processors are required under RI General Law to comply with current statutory requirements of those laws pertaining to the harvesting, processing and distribution of shellstock within the state. This statutory oversight by RIDOH and RIDEM incorporates by proxy this management plan as a condition imposed by the Health Department to ensure compliance with the Department's mission to protect the health of consumers by regulating the processing and distribution of molluscan shellfish.

Within RIDEM the Office of Water Resources, Division of Marine Fisheries and the Division of Law Enforcement are the agencies that agree to the conditions inherent to this management plan in varying capacities. The Office of Water Resources maintains the Growing Area master files and conducts the monitoring and classification of the growing area waters. The DEM OWR program is responsible for the annual review of the plan and reevaluation of compliance with this plan to assure public health protection.

Shellstocks are managed entirely within state waters by the Division of Marine Fisheries (RIDMF) with advice from the Rhode Island Marine Fisheries Council. The Department, through the RIDMF, uses a set of management areas and limitations and a rotational transplant/harvest system to manage the resource. Permanent and conditional pollution closures restrict the fishery in addition to seasons, possession limits, and management closures. All commercial and non-resident shell fishers must obtain a license from RIDEM.

RIDEM's Division of Law Enforcement Marine Officer's duties include enforcing both recreational and commercial shellfishing laws and regulations. Marine officers provide security for Marine Safety Zones as well as for emergency shellfish harvest closures. The Dem Enforcement Division provides 24-hour, 7 day a week, 365 days a year coverage for dispatching to enforcement officers any conditional or emergency shellfish closures.

The Food and Drug Administration (FDA) makes an annual review of each States shellfish control program, including the inspection of a representative number of shellfish processing plants and publishes a monthly list of valid interstate shellfish shipper certificates. The State of RI as a shellfish-shipping state has adopted

adequate laws and regulations for the sanitary control of the shellfish industry, completes sanitary surveys of growing areas, delineates and patrols all areas, inspects shellfish plants and conducts such additional inspections, laboratory investigations, and control measures as are necessary to ensure that the shellfish reaching the consumer were grown, harvested and processed in a sanitary manner.

The State of Rhode Island is a member of the Interstate Shellfish Sanitation Conference (ISSC) which was formed in 1982 to foster and promote shellfish sanitation through the cooperation of state and federal regulatory agencies, the shellfish industry, and academia. Rhode Island is also a National Shellfish Sanitation Program (NSSP) cooperative state for which the NSSP provides regulatory guidance for the sanitary control of shellfish.

B. Providence River Conditional Area

1. General Description of the Growing Area

The Providence River is a tidal river formed by the confluence of the Woonasquatucket and Moshassuck Rivers flowing from the west and the Seekonk/Blackstone River flowing from the northeast. These rivers converge southeast of downtown Providence near Fox Point to form the Providence River Estuary which extends southward approximately 7 miles (11.5 km) to Conimicut Point where the Providence River joins upper Narragansett Bay (Figure 1). The cities of Providence, Cranston, and Warwick lie to the west of the river, while the City of East Providence and the Town of Barrington lie to the east. The portion of RI DEM shellfish growing area 16 (GA16) that is classified as Conditionally Approved is an approximately 1,900 acre (7.69 hectare) portion of the Providence River located in the southern region of the Providence River Estuary approximately bounded by Gaspee Point to the north and a line from Conimicut Point to Nyatt Point to the south (Figure 5). This east to west line between Conimicut and Nyatt Points is also the dividing line between GA16 and Upper Narragansett Bay Growing Area 1 Conditionally Approved Area “A” (GA1A).

Depth and bottom topography: The Conditionally Approved region of GA16 is in the southern portion of the Providence River Estuary. The depth of this portion of the growing area transitions from shallow, 1 to 5 meter (3 to 16 feet) depth shoals along the eastern and western shores to deeper 5 to 10 meter (16 to 33 feet) deep in the central part of the growing area (NOAA chart 13224). Greene Island, a small sandbar island that is nearly submerged at high tide, is located near the western shore of the growing area. The Port of Providence is New England’s second largest deep-water port and a 27 km (16.8 mile) long, 40 foot (12 m) depth dredged ship channel transects GA16 and continues northward to the Port of Providence terminal at Fields Point and the hurricane barrier near downtown Providence. In addition to this major channel a smaller channel was constructed in 1959 that connects from the deep-water Providence River channel to Bullocks Cove. The Bullock’s Cove channel is approximately 75’ in width and varies in depth from 6 – 8 feet. The bottom sediments in the Conditionally Approved portion of GA16 are generally silty sand and mud with a gravel bottom in the deeper central region of the growing area and a shift to sandy sediments in the southern portion of the growing area near Conimicut Point (USGS, 2003).

Freshwater input and tides: The Providence River is tidally influenced from its confluence with Narragansett Bay at Conimicut Point northward to Pawtucket Falls, near Slater’s Mill on the Blackstone/Seekonk River, upstream to near Rising Sun Mills in Olneyville for the Woonasquatucket River, and upstream to near crossing under Canal Street in Providence for the Moshassuck River. The largest sources of freshwater input to Narragansett Bay are in the GA16 area. Approximately 68% (Spaulding and Swanson, 2008) to 85% (Pilson, 1985) of total freshwater flow to Narragansett Bay is from the Blackstone, Moshassuck, Woonasquatucket and Pawtucket Rivers. These major freshwater rivers provide drainage to approximately 1,754 km² of the Blackstone, Woonasquatucket, Moshassuck and Pawtucket watersheds and this drainage flows into the Providence River. Although influenced by freshwater input, the Providence River also has strong semi-diurnal tides, with a tidal range of 1.16 meters (at Conimicut Point) to 1.40 meters at Pawtucket (Spaulding and Swanson, 2008). Similarly, NOAA operates a real-time tide gauge on the Providence River in the northern section above Fields Point. They report that the mean tidal range for the Providence River of 1.35 meters (4.42 feet) and a tidal range of 1.48 meters (4.84 feet) at Fields Point (NOAA 2020). Because of the strong tidal input, salinity in the Providence River quickly increases from near freshwater (0-5 psu salinity) in the upper Seekonk River to approximately 15 psu salinity at Fox Point, 25 psu at Field’s Point, approximately 28 psu at Gaspee Point and 30-32 psu at Conimicut Point (Spaulding and Swanson, 2008). The combination of freshwater input and strong tidal flow result in a rapid flushing time of approximately 0.9 to 1.0 day for the GA16 area of the lower Providence River (Spaulding and

Swanson, 2008) and 0.8 to 4.4 days dependent on freshwater flow in the upper Providence River (Asselin and Spaulding, 1993). The Conditionally Approved region of GA16 in the Providence River has salinity (28-32 psu) and flushing times (approximately 1 day) that are similar to that of Upper Narragansett Bay shellfish growing area 1A.

Watershed population and Wastewater Treatment: The Providence River watershed covers approximately 8,575 hectares (21,192 acres, 33.11 square miles) encompassing major urban areas of Rhode Island and extending into the adjacent state of Massachusetts. The watershed is populated by approximately 820,000 residents (2000 Census, RIGIS). The majority of the Providence River – Seekonk River watershed is urban, with approximately 86% of land in the watershed listed as urban (NBEP, 2017). Population density in the Providence-Seekonk River watershed has remained fairly stable at 10 people per acre during 1990 to 2010 (NBEP, 2017). Based on 2012 data available from the RIDEM GIS database, approximately one third (1/3) of the watershed is serviced by municipal sewers while the remaining population utilizes on-site wastewater treatment facilities (OWTS) to treat wastewater. Although the majority of the watershed is dependent upon OWTS the areas and neighborhoods immediately adjacent to the Conditionally Approved portion of the lower Providence River are largely served by municipal sewers. This indicates that fecal coliform input to the growing area from sub-standard or failing OWTS should be limited. Potential wastewater impacts to the Conditionally Approved portion of the growing area are discussed later in this document.

Water quality classification: The Providence River is divided into two water quality segments with different water use classifications. The northern reach is classified as SB1{a} while the southern reach, south of Pawtuxet Neck is classified as SB{a}. The portion of GA16 classified as Conditionally Approved is within SB{a} classified waters. Note: as of May 2021, EPA has not approved the assignment of partial use {a} to any waterbody segments in RI. RIDEM water quality regulations (250-RICR-150-05-1) describe SB{a} and SB1{a} waters as:

1.9.C

2. Class SB - These waters are designated for primary and secondary contact recreational activities; shellfish harvesting for controlled relay and depuration; and fish and wildlife habitat. They shall be suitable for aquacultural uses (other than shellfish for direct human consumption), navigation, and industrial cooling. These waters shall have good aesthetic value.

a. Waterbody segments may have partial use designations assigned to them as noted in § 1.9(D) of this Part.

3. Class SB1 - These waters are designated for primary and secondary contact recreational activities and fish and wildlife habitat. They shall be suitable for aquacultural uses (other than shellfish for direct human consumption), navigation, and industrial cooling. These waters shall have good aesthetic value. Primary contact recreational activities may be impacted due to pathogens from approved wastewater discharges. However, all Class SB criteria must be met.

a. Waterbody segments may have partial use designations assigned to them as noted in § 1.9(D) of this Part.

1.9 D Partial Uses - In accordance with § 1.21 (Modification of Water Quality Standards) of this Part, the Department may designate a partial use for the above listed water use classifications. Partial use denotes specific restrictions of use assigned to a waterbody or waterbody segment that may affect the application of criteria. Additional partial uses may be so designated by the Director if provided in accordance with § 1.21 of this Part.

1. CSO - These waters will likely be impacted by combined sewer overflows in accordance with approved CSO Facilities Plans and in compliance with rule § 1.21(E)(1) of this Part. Therefore, primary contact recreational activities; shellfishing uses; and fish and wildlife habitat will likely be restricted.

2. Concentration of Vessels - Waters in the vicinity of marinas and/or mooring fields are subject to seasonal shellfishing closures as determined by RIDEM pursuant to R.I. Gen. Laws Chapter 20-8.1; All Class SA criteria must be attained.

3. Partial use designations are represented by the lower-case letters, "a" or "b", which appear in brackets { } next to the classification as found in § 1.25 of this Part of the water quality regulations. The full text of these regulations can be found here:

<https://rules.sos.ri.gov/regulations/part/250-150-05-1>

The northern reach of the river, north of Naushon Avenue in Warwick is classified as SB1{a} and is densely developed and the riverbanks above Fields Point are used extensively for commercial marine activities. This management plan and supporting documentation is intended to address only the Conditionally Approved of the southern class SB{a} Providence River, which contains only those waters south of a line between Gaspee Point and Bullocks Neck as shown and highlighted in yellow as GA16-4 in Figure 5. Although shellfish harvesting for direct human consumption is not a designated use of SB{a} waters, once it is determined all FDA/NSSP requirements for shellfish harvesting for direct consumption are met, it will become an existing use protected by the provisions of 250-RICR-150-05-1.20 and 250-RICR-150-05-1.11 of the RIDEM water quality regulations

Figure 1: Providence River, RI location map.

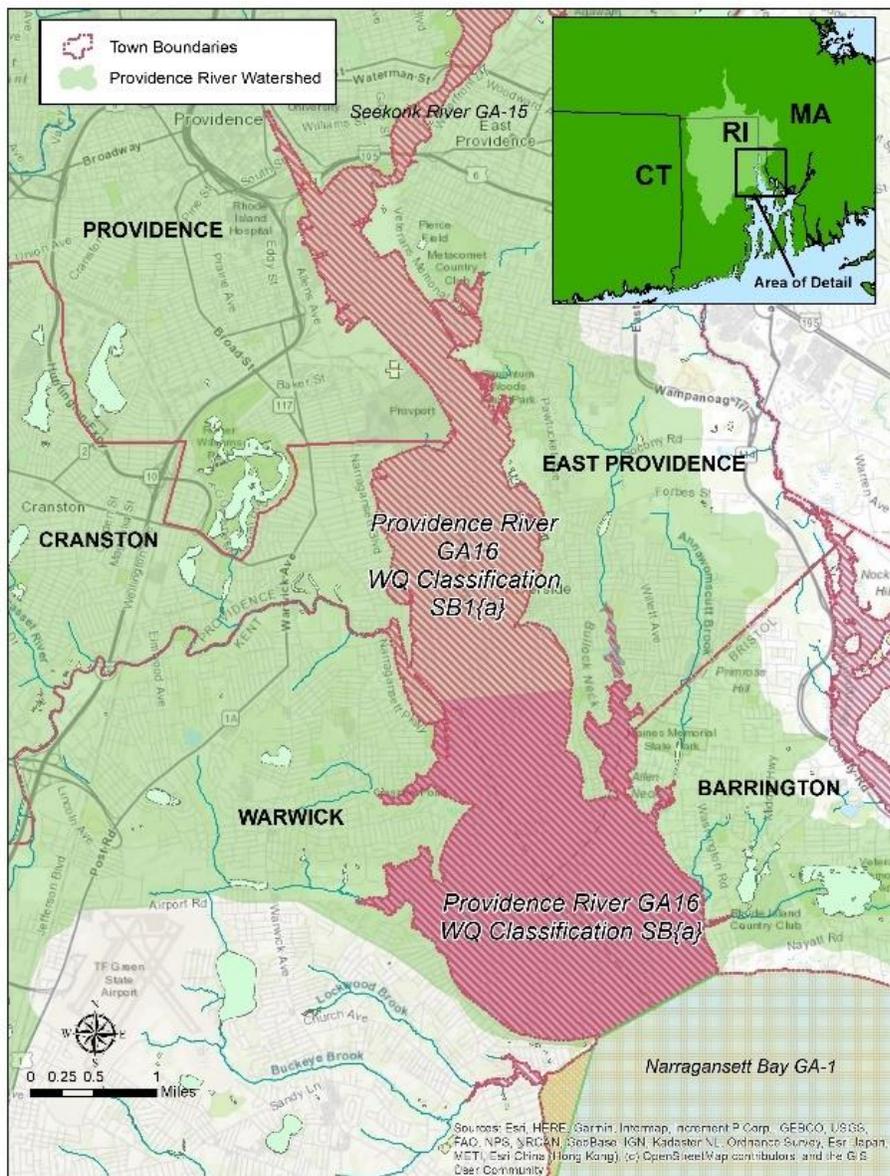
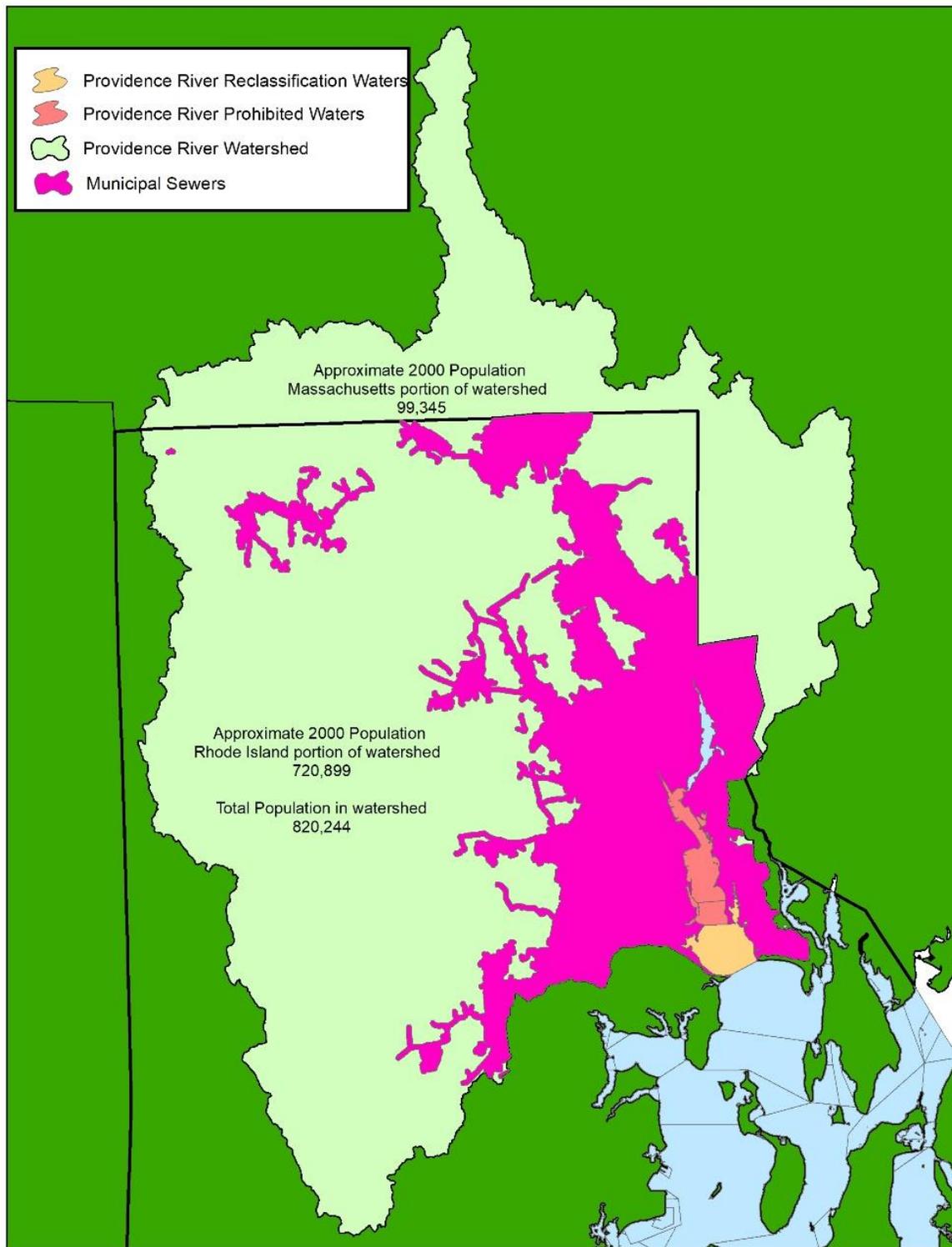


Figure 2: Providence River watershed with municipal sewer service areas indicated.



Meteorology: The Providence area has a strong seasonal temperature cycle, with mean air temperatures varying from below freezing during January and February to greater than 70 °F during July and August (Table 1). Within this pattern there is considerable variability in that any season can have much colder or warmer mean temperatures than usual in a given year. For example, in the past twenty years mean air temperature during February varied from a low of 18.4 °F during 2015 to a maximum of 39.6 °F during 2006 – a 21.2 °F difference. Similarly, summer temperatures can vary by 9 °F between a cool summer (July 2001, 69.8 °F) and a warm summer (July 2013, 78.4 °F). Overall, the mean air temperature in the region is 51.7 °F.

Table 1: Mean, maximum and minimum monthly air temperature at TF Green Airport (NOAA station KPVD) during 2000 to 2019. The KPVD weather station is located approximately 3.5 miles from GA16.

| Month | Air Temperature (F) | | | | |
|--------------------|---------------------|-------------|------|-------------|------|
| | Mean | Max | Year | Min | Year |
| Jan | 30.0 | 37.2 | 2006 | 21.4 | 2004 |
| Feb | 31.9 | 39.6 | 2018 | 18.4 | 2015 |
| Mar | 39.1 | 46.3 | 2012 | 32.7 | 2015 |
| Apr | 49.3 | 53.8 | 2010 | 45.4 | 2003 |
| May | 59.0 | 63.0 | 2018 | 53.4 | 2005 |
| Jun | 68.0 | 71.3 | 2008 | 64.4 | 2009 |
| Jul | 74.4 | 78.4 | 2013 | 69.8 | 2001 |
| Aug | 73.3 | 77.0 | 2018 | 70.2 | 2000 |
| Sep | 66.2 | 69.1 | 2015 | 63.0 | 2009 |
| Oct | 54.8 | 61.2 | 2017 | 51.7 | 2003 |
| Nov | 44.6 | 49.2 | 2006 | 40.5 | 2019 |
| Dec | 35.4 | 46.0 | 2015 | 28.9 | 2000 |
| Annual mean | 51.7 | 53.8 | | 43.6 | |

Water temperature in GA16 also has a seasonal pattern and considerable annual variability (Figure 3). The NOAA PORTS system maintains a real-time water temperature sensor at the Conimicut Point lighthouse, near the southern end of Growing Area 16. Data from this sensor were compiled to illustrate the range of water temperature in the growing area during recent years. As with air temperature, there is a strong seasonal variation in water temperature, with an approximately 50 °F range in winter versus summer water temperature (Figure 3). Winter water temperature can vary annually from years having prolonged periods of <32 °F water with formation of sea ice in the growing area, as was seen during 2015, to warm winters such as 2019 in which the water temperature never dropped below 35 °F. Similarly, maximum summer water temperature at Conimicut Point can vary from approximately 76 °F during a cool summer to up to 80.7 °F during a warm summer (Figure 3). Annual average water temperature at Conimicut Point during recent years (2015-2019) was 54.8 °F.

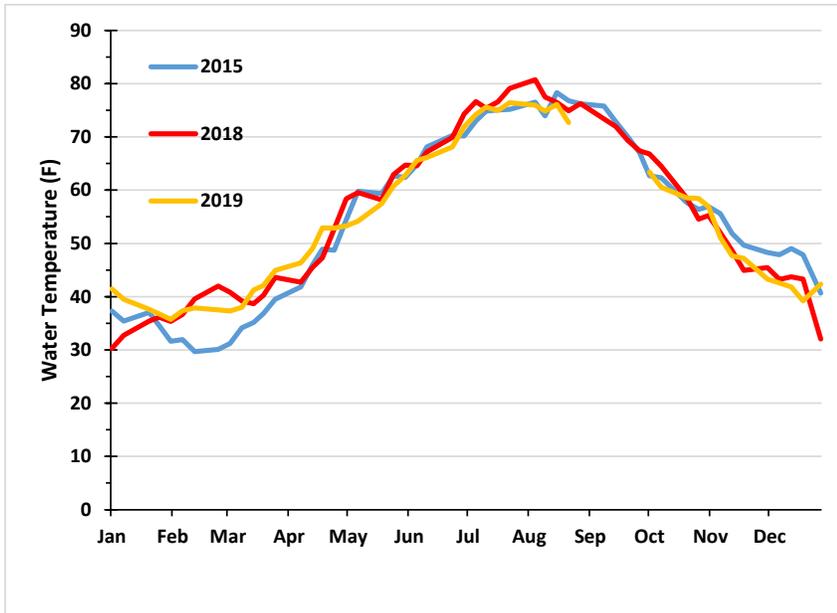


Figure 3: Surface water temperature (F) at Conimicut Point Lighthouse during 2015 (a cold winter), 2018 (warm winter) and during 2019. Temperatures taken every 6 minutes at NOAA PORTS station 8452944 Conimicut Light, RI.

Unlike air and water temperature, there is no strong seasonal pattern in rainfall in the Providence River (GA16) region (Table 2). Rainfall is fairly evenly distributed in each month of the year, although spring months of March – April and the autumn months of November – December tend to have increased rainfall (Table 2). Winds in the region follow a seasonal shift from winds predominantly from the northwest during the fall through spring and southwest winds dominant from April through September (Table 2). Summer winds tend to be calmer, but occasional tropical storms or hurricanes can bring elevated wind speeds during summer and early autumn.

Table 2: Average rain and wind in the GA16 area (1904-2018 averages from NOAA KPVD weather station at TF Green Airport). The KPVD weather station is located approximately 3.5 miles from GA16.

| Month | Rainfall | | Avg. Windspeed (mph) | Prevailing Wind Direction |
|----------------------------|-----------------------|----------------------------------|----------------------|---------------------------|
| | Avg Rainfall (inches) | Minimum Rainfall (inches & year) | | |
| January | 3.79 | 0.51 (1970) | 11.66 (1979) | NW |
| February | 3.32 | 0.39 (1987) | 7.2 (1984) | NNW |
| March | 4.06 | 0.07 (1915) | 16.34 (2010) | WNW |
| April | 3.86 | 0.72 (1942) | 12.74 (1983) | SW |
| May | 3.33 | 0.57 (1939) | 10.58 (1948) | SW |
| June | 3.25 | 0.05 (1949) | 11.08 (1982) | SW |
| July | 3.11 | 0.32 (1952) | 10.52 (2009) | SW |
| August | 3.67 | 0.71 (1984) | 12.24 (1946) | SSW |
| September | 3.58 | 0.48 (1914) | 10.99 (2008) | SW |
| October | 3.41 | 0.15 (1924) | 15.38 (2005) | NW |
| November | 3.92 | 0.31 (1917) | 11.01 (1983) | SW |
| December | 3.97 | 0.58 (1955) | 10.75 (1969) | WNW |
| Annual total (rain) | | | | |
| Annual avg (wind) | 43.25 | 25.44 (1965) | 67.52 (1983) | SW |

2. Size of GA16

The entire Providence River from Providence south to Conimicut Point has a surface area of approximately 5,400 acres (2,175 hectares) . Only a portion of the southern reach (Figure 5; GA16-4) is being re-classified from Prohibited to Conditionally Approved and from this point forward this document will be using the term Providence River GA16-4 as meaning only those Conditionally Approved waters south of Gaspee and Bullocks Neck as shown in Figure 5. These waters contain a portion of the Bullock Point Reach and the Conimicut Point Reach shipping channels. Occupessatuxet on the western shore (Figure 4) and the waters of and adjacent to Bullock Cove and a smaller cove identified locally as Drown Cove (Figure 4) in the Bay Spring neighborhood north of Annawamscutt located on the eastern shore of the growing area will remain Prohibited. The area to be reclassified from Prohibited to Conditionally Approved is designated GA16-4 and it covers approximately 1,900 acres (769 hectares) of the southern portion of the Providence River. The Conditionally Approved section of the Providence River is further defined below.



Figure 4: Area map of the lower Providence River.

As noted previously in this report, the land use adjacent to the entire length of the Providence River is highly developed, with heavy commercial, industrial and working maritime development along the shorelines within the city of Providence, to a shift to less-developed along the southern shorelines which are dominated by densely populated residential use properties. The southern section has a limited number of moorings or docks due to its very shallow nature. Bullocks Cove does support several commercial marinas and associated moorings. Because of this, Bullocks Cove is not included in the Conditionally Approved area and shall remain classified as Prohibited due to the concentration of marinas (see GA16-3 description, below).

3. Legal Description of Providence River (GA 16):

The current legal description of the waters of the Providence River includes all tidal waters and their landward estuarine tributaries waters north and west of a line from the Rhode Island Department of Environmental Management range marker on a pole located on Conimicut Point to the center of the Old Tower at Nayatt Point including any tributaries north of this line.

As of sunrise May 26, 2021 the legal descriptions of the Providence River growing area were changed to reflect the change in classification of the southern portion (GA16-4) of the growing area from Prohibited to Conditionally Approved. The legal descriptions of GA16 are below and the reflective GA16 classification map is shown in Figure 5.

Prohibited

GA 16 - 1 All waters of the Providence River and its tributaries north of a line from the RIDEM range marker at Gaspee Point to the northern most tip of the rock seawall on the opposite shore of Bullock Neck in East Providence.

GA16 - 2 All waters of Occupessatuxet Cove north and west of a line from the landward end of the CRMC permitted dock # 073 on the Warwick shoreline opposite #6 Meadow Road to Pole # 67 at 11 Namquid Drive on south Gaspee Point in Warwick

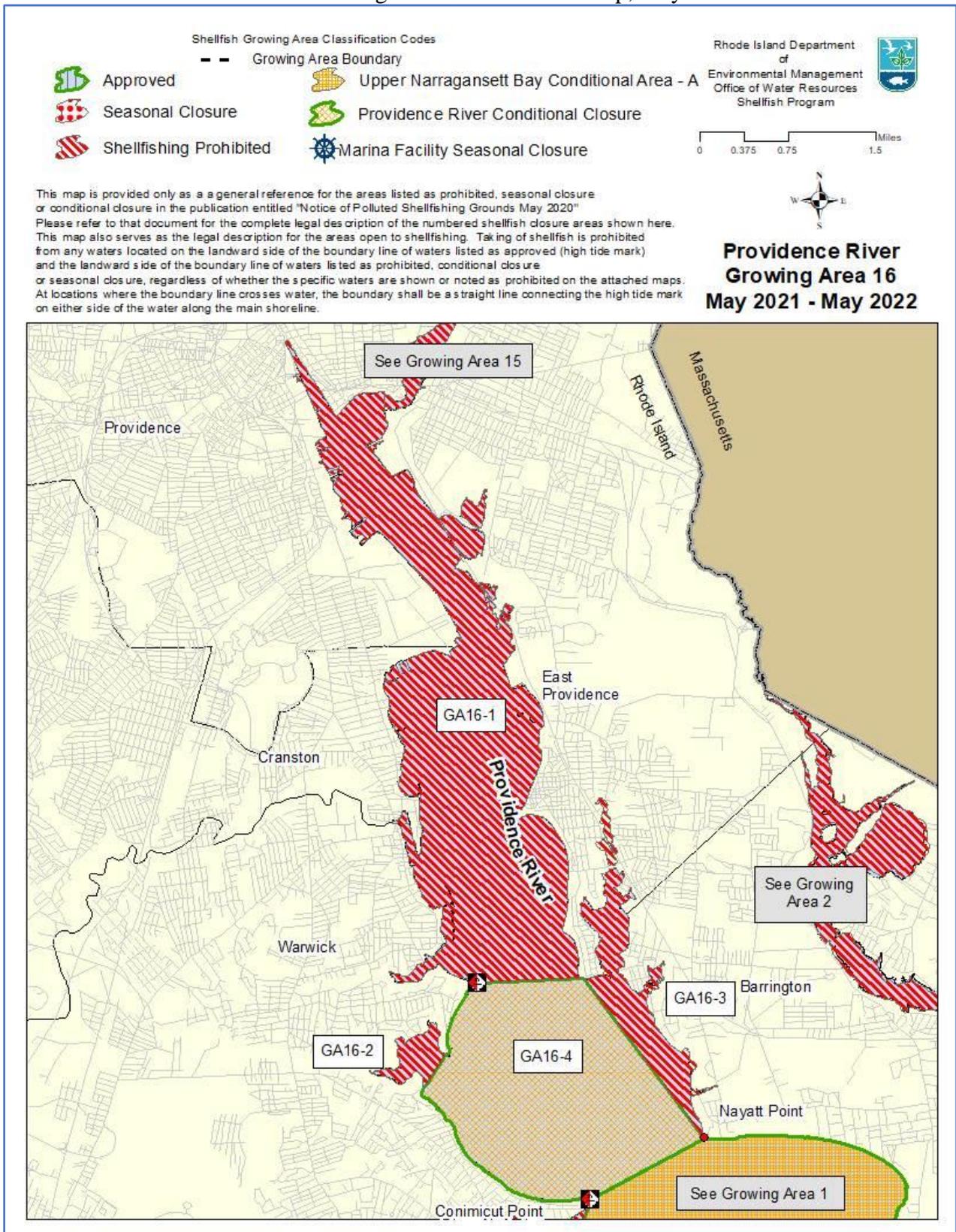
GA16 – 3 All waters north and east of a line from the northern most tip of the rock seawall on the west shore of Bullock Neck to the center of the tower at Nayatt Point.

Conditionally Approved

Providence River Conditional Area E:

GA16 – 4 All waters of the Providence River bounded by a line from the Department of Environmental Management range marker on a pole located on Conimicut Point to the center of the Old Tower at Nayatt Point to the northern most tip of the rock seawall on the shoreline of Bullock Neck in East Providence to the RIDEM range marker on Gaspee Point, excluding all waters of Occupessatuxet Cove (GA16 - 2).

Figure 5: Providence River GA-16 Growing Area Classification Map, May 2021.



4. Growing Area Demarcation / Signage and Patrol

Currently a Polluted Area/Shellfishing Prohibited range marker sign is located on a pole at Conimicut Point as indicated in Figure 5 by this symbol . All other existing closure lines are demarcated by a physical structure identified in the legal description of the area, such as lighthouses, piers, towers or prominent points of land, with the point as indicated in Figure 5 being the center of the old light tower at Nayatt Point as this symbol . Enforcement officers can visually sight the closure lines from shore and are also successful at enforcing closures from patrol boats when necessary. The range lines marking the boundaries of GA16 are accessible and visible from several land points. The areas are also within easy reach of the Department's Marine Enforcement Division patrol boats out of their Wickford base. This is conducive to the Department's ability to manage this area under the conditional limitations outlined in this management plan and incorporated into the program's standard operating procedures. The Department's Marine Enforcement Division maintains records of patrol activities, enforcement actions and risk assessment in the growing area.

Figure 5 shows the classification map of the Providence River GA-16 growing area delineating the conditionally approved and prohibited waters of the growing area. The legal description of the growing area is given in the previous section (section B 3).

5. Pollution Sources

i. Waste Water Treatment Facilities (WWTF)

An important concern in Rhode Island is the continued satisfactory operation and maintenance of Wastewater Treatment Facilities (WWTF). Poor operation and maintenance and the increased age of equipment diminish treatment plant efficiency and negate advancements toward improved water quality made under the Clean Water Act. Building wastewater treatment systems does not assure desired water quality improvements unless these systems are properly operated, maintained, and upgraded in a timely manner. To ensure satisfactory operation and maintenance, the State requires that WWTFs submit Operation and Maintenance Plans, track and submit monthly reports of key operational parameters (i.e. Monthly Operating Reports, MORs or DMRs) and perform periodic inspections of the wastewater treatment plants. The purpose of these MORs and inspections is to identify problems, determine possible corrective actions, and ensure that action is taken before violations of permit limits and water quality degradation occur.

The Rhode Island Pollution Discharge Elimination System Program (RIPDES) is responsible for permitting all industrial and municipal waste discharges to waterbodies of the state. There are three (3) wastewater treatment facilities that discharge upstream of the conditionally approved waters (GA16-4) of the Providence River. The Narragansett Bay Commission operates two, the Fields Point and the Bucklin Point facilities while the City of East Providence operates the third. All three facilities discharge to the prohibited portions of the Seekonk or Providence River and their discharge points are at least two (2) miles upstream of the division line between prohibited and conditionally approved. In 2021 a new analysis of the potential impacts that these WWTFs have on the water quality of the shellfish waters of the Providence River was completed. This report entitled “Establishing the Closure Zones and Shellfish Water Classifications Adjacent to Waste Water Treatment Facilities (WWTF) in the Providence River (GA16)” (RIDEM, 2021) is available for review in the program’s permanent files and is incorporated by reference to this document. The basis to warrant the upward reclassification of the southern waters of the Providence River are supported by the analyses in this tandem report.

As documented in the WWTF Closure Zone report (RIDEM, 2021), GA16-4 is outside the influence of the WWTF discharges to the waters of either the Seekonk River (NBC Bucklin Point facility) or the upper Providence River (NBC Fields Point and East Providence facilities). The waters of GA16-1 are classified as prohibited and meet the dilution requirements established within the NSSP Model Ordinance (NSSP Section II Model Ordinance – Chapter IV. Shellstock Growing Areas, E.5).

WWTF Operational Criteria:

Condition: Notification of an emergency condition at the NBC Bucklin Point WWTF, the City of East Providence WWTF, or the NBC Fields Point WWTF resulting in complete loss of treatment and the discharge of untreated sewage that could affect the microbiological water quality of conditionally approved waters.

Re-opening criteria: Return of the WWTF to normal operation followed by either a) a 21-day closed period or b) a 7-day closed period and demonstration that shellstock in the growing area have MSC levels of 50 pfu/100 grams or less; or shellfish are at or below established background MSC levels for that growing area.

Basis for re-opening criteria: Reopening criteria after WWTF loss of disinfection is based on return to normal WWTF operation and either a 21-day closure or a 7-day closure and testing for

MSC levels in shellfish consistent with NSSP 2019, IV @03 A. (5) (d) (ii) and Chapter IV @ 03 C. (2) (c) (iii).

ii. Rain Events, Combined Sewer Overflows and Stormwater

Rivers entering the Providence River and growing area 16 (GA16) deliver a large percentage of the freshwater entering Narragansett Bay, with approximately 68% (Spaulding and Swanson, 2008) to 85% (Pilson, 1985) of total freshwater flow to Narragansett Bay coming from the Blackstone, Moshassuck, Woonasquatucket and Pawtuxet Rivers. This freshwater flow may be a mechanism for delivery of fecal coliform bacteria to GA16 and studies have documented increased fecal coliform concentration extending to the southern Providence River (GA16) and upper Narragansett Bay during wet weather. During the late 1980s (surveys during 1988-89), analysis of wet-weather fecal coliform sources to the Providence River indicated that 81% of the fecal coliform loading was from point sources – primarily CSOs – that discharged to the Providence River and its tributaries during wet weather (Wright et al., 1991). The same study also indicated that elevated fecal coliform loading occurred after rainfall of 0.5” or greater during a 24-hour period and that fecal coliform levels returned to background levels 5-days after the end of rainfall (Wright et al., 1991). Guidance derived from this and other studies was used to successfully manage the Upper Narragansett Bay Conditional Area (Growing Area 1A) including the ‘Conimicut Triangle” adjacent to the southern portion of GA16 with a 0.5” rain closure of 7-days duration (5 days to return to acceptable fecal coliform levels plus 2 days shellfish cleansing) during the 1990s through 2017.

There has been considerable investment in eliminating, consolidating, and capturing CSOs for treatment, and improving stormwater control and treatment in the Providence area since the 1990s (Table 3; RI DEM, 2016). The three major WWTFs discharging to the Providence River (East Providence WWTF, NBC Bucklin Point WWTF and the NBC Fields Point WWTF) have implemented several treatment upgrades to improve wastewater treatment (e.g. improving disinfection and reducing levels of nitrogen discharge). Most importantly, tunnels were installed in bedrock beneath Providence to capture CSO runoff and store it prior to treatment and discharge at the Fields Point treatment facility. The WWTF upgrades and the 26-foot diameter, 3-mile long CSO storage tunnel have resulted in an 80% reduction in discharge of untreated CSO and WWTF bypass flows and a 41% reduction in fecal coliform bacteria concentration in the Providence River (Narragansett Bay Commission, 2014). Following construction of the CSO tunnels, waters in upper Narragansett Bay experienced reduced fecal coliform concentration such that the rain fall trigger in the upper Bay Area 1A was increased from 0.5” to 0.8” of rain in 2011 and the rain closure threshold for Area A was further increased to 1.2” in 2017. In addition, the rainfall closure trigger for Conditional Area B was increased to 1.5” and after several years of documented improved fecal coliform water quality, Area B was reclassified as Approved waters in 2017. The investment in CSO abatement and the CSO storage tunnel have been reflected in substantial reductions in Upper Bay fecal coliform concentration and an increase in the conditional area rain closure threshold with a concomitant increase in the number of days that Upper Bay Area A has been open to shellfish harvest. Prior to the completion of CSO tunnel phase 2 (December 2014) Area A was open to shellfish harvest approximately 165 days per year. Following the completion of CSO phase 2 (December 2014), improved water quality allowed an increase in the Area A closure rain trigger to 1.2”. Since completion of the phase 2 CSO tunnel and concomitant increase in closure rainfall to 1.2”, Upper Bay Area A has been in the open status an average of 265 days per year – an increase of approximately 100 days open per year. Similar fecal coliform concentration reductions have also occurred in the Providence River (GA16), as described below.

Table 3: GA16 WWTF specifications and recent upgrades (data from RI DEM, 2016).

| | NBC Field's Point | NBC Bucklin Point | East Providence |
|---------------------------------|--|--|------------------------|
| Year built | 1901 | 1954 | 1952 |
| Population served | 226,000 | 120,000 | 46,100 |
| Year secondary treatment | 1934 | 1972 | 1976 |
| Design flow (MGD) | 65.0 109 (wet weather) | 31.0 | 14.2 |
| Latest major upgrades | 2008: (Phase 1 CSO tunnel) 2013: (N reduction) January 2015: (Phase 2 CSO tunnel) | 2005: (UV disinfection) 2014: (N reduction) | 2012: (N reduction) |

Although previously classified as Prohibited, the waters of GA16 have been routinely monitored for fecal coliform by the RI DEM Shellfish Program for many years. A total of 451 fecal coliform samples have been collected in the southern portion of GA16 (stations shown in Figure 7) since the completion of the CSO tunnel (Phase 2 in 2015). Of these, 254 were collected during dry weather (<0.5", 7 days) and 195 samples were collected during wet weather. While water quality is still impacted by wet weather, evaluation of these fecal coliform data has demonstrated that *all stations in the area meet NSSP criteria during dry weather* (< 0.5" rain in 7 days prior to sample collection; Figure 6). Remarkably, four of six stations in the southern-most area of GA16 also meet NSSP criteria for Approved waters *during wet weather* (samples collected 0 to 7 days after rain of 0.5" or greater; Figure 6). ***Under a Conditionally Approved scenario with a 0.5" rain in prior 7 days closure criteria, the stations in GA16 have met NSSP criteria for Conditionally Approved waters since 2016 (2016, 2017, 2018, 2019; Table 4).*** This demonstrates that improvements in CSO wastewater treatment with subsequent improvements in fecal coliform water quality in GA16 are a regular feature that has persisted during both dry years (2016, 40.0" inches annual rainfall compared to 49.0" mean annual rainfall at NOAA KPVD) and wet years (2018, 63.5" inches annual rainfall compared to 49.0" mean annual rainfall at NOAA KPVD; Table 4).

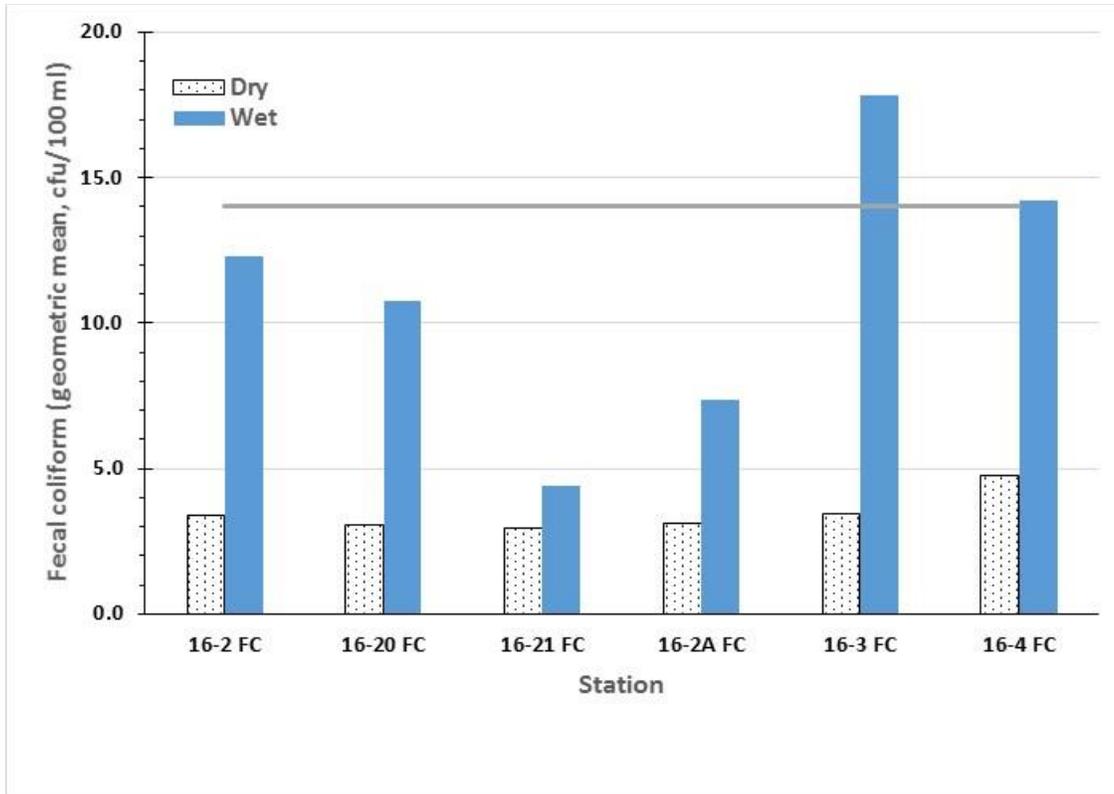


Figure 6: Geometric mean fecal coliform concentrations at stations in GA16 during dry (<0.5" rain in prior 7 days) and wet (> 0.5" rain in prior 7 days) weather. NSSP geometric mean standard of 14 cfu / 100 mL shown for reference (horizontal line). See Figure 7 for station locations.

Table 4: Growing area 16 annual fecal coliform compliance statistics (expressed as geometric mean / % exceed 31 cfu/100 mL) calculated under a Conditionally Approved scenario (rain closure at 0.5" rain in prior 7 days) for post-CSO tunnel years 2016 to 2019. Rainfall is at NOAA station KPVD at TF Green Airport. Compliance statistics represent recent 15 observations at the end of each calendar year. Statistics expressed as geometric mean / % exceeding 31 cfu/100 ml. All stations have met NSSP criteria under a 0.5" rain closure Conditionally Approved scenario since 2016. Stations 16-21 and 16-2A reached the minimum 15 samples in data set in 2019. Station locations shown in Figure 7.

| Year | 2016 | 2017 | 2018 | 2019 |
|------------------------|---------|---------|---------|---------|
| Annual Rain (") | 40.0 | 49.0 | 63.5 | 52.0 |
| Station 16-2 | 2.4 / 0 | 3.0 / 0 | 3.2 / 0 | 3.4 / 0 |
| Station 16-3 | 3.0 / 0 | 3.6 / 0 | 3.2 / 0 | 2.8 / 0 |
| Station 16-4 | 4.6 / 0 | 3.7 / 0 | 4.2 / 0 | 3.8 / 0 |
| Station 16-20 | 2.4 / 0 | 2.4 / 0 | 2.9 / 0 | 2.7 / 0 |
| Station 16-21 | | | | 2.4 / 0 |
| Station 16-2A | | | | 3.3 / 0 |

The analyses presented above demonstrate that the southern portion of GA16 meets NSSP fecal coliform criteria during dry weather (<0.5" rain in prior 7 days) and that management of the area as Conditionally Approved with a 0.5" rain closure is appropriate. In addition to meeting criteria during dry weather the

water quality in the growing area also quickly returns to acceptable levels after wet weather (rainfall of 0.5” or greater). Previous studies have indicated that the lower Providence River has a rapid flushing time. The rapid flushing of the lower Providence River estuary is due to the strong estuarine circulation induced by freshwater riverine input, with deep, higher salinity water flowing northwards into the area and surface, low salinity flowing southward out of the area (Codiga et al., 2012). Flushing time estimates for the lower Providence River ranged from 0.8 days to 4.4 days, with an average flushing time of 2.5 days (Asselin and Spaulding, 1993). Consistent with this, a microbial indicator study found that Providence River and Upper Narragansett Bay fecal coliform concentrations declined towards low, dry-weather background levels two to three days after rain (Cabelli et al., 1990). Further, because of the strong estuarine circulation, most of the fecal coliform input associated with freshwater input appears to be entrained in the surface (upper 1 meter) layer (Wright et al., 1991). Similarly, a study of paired surface and bottom samples in GA16 indicated that fecal coliform concentration was elevated in the surface layer relative to the fecal coliform levels on the bottom; with bottom fecal coliform concentration being one-sixth (17%) of that observed in the surface layer (Cabelli et al., 1990). The combination of strong estuarine circulation and rapid flushing time in GA16 suggests that fecal coliform levels will recover, or return to low, dry-weather background levels several days after wet-weather fecal coliform input has subsided.

Since the upgrades in WWTF and stormwater treatment in the Providence area, RI DEM has completed many wet weather studies in GA16 to document the response and recovery of the microbial water quality of the growing area. Post CSO tunnel observations made during 2014 to June 2020 included a total of 53 sampling trips during which 217 water column fecal coliform observations were completed. These observations indicate that the microbial water quality of GA16 recovers quickly after closure rainfall of >0.5”. Three sets of ‘storm tracking’ sampling trips documented the recovery of the growing area from unacceptable to acceptable water quality over days one to four after a closure rain event of >0.5” rain (Table 5). All three of these studies demonstrated that fecal coliform concentration exceeded NSSP criteria one to two days after rain of 0.98 to 1.27” but quickly recovered to acceptable fecal coliform levels on days three and four after the rain ended (Table 5). Note that the tracked storms were of much larger magnitude (0.98 to 1.27” rain) than the conditional closure rain threshold of 0.5”. Consistent with the high flushing rate for the area, fecal coliform levels fell quickly from wet-weather elevated levels to low levels of 2-20 cfu/100 mL on day 3-4 after the rain event (Table 5). This demonstrates that a 7-day duration rain closure is of sufficient duration to allow 4-5 days for fecal coliform levels to return to low background levels (Table 5) plus two (2) additional days for shellfish to self-cleanse and equilibrate to the acceptable water quality levels (NSSP, 2019, IV@03.C 2(c), NSSP, 2019, p. 313) .

Table 5: Results of ‘storm tracking’ sampling cruises to document recovery of fecal coliform conditions in GA16 following closure rainfall of >0.5” rain.

| Date | Rain | Days after rain | Station 16- | | | | | |
|-----------|------|-----------------|-------------|----|-----|----|-----|----|
| | | | 2 | 2A | 3 | 4 | 20 | 21 |
| 4/22/2015 | 1.03 | 1 | 31 | | 102 | 70 | 32 | |
| 4/23/2015 | 1.03 | 2 | 33 | | 50 | 11 | 22 | |
| 4/24/2015 | 1.03 | 3 | 7 | | 9 | 4 | 7 | |
| | | | | | | | | |
| 6/23/2015 | 1.27 | 2 | 36 | | 44 | 50 | 42 | |
| 6/24/2015 | 1.27 | 3 | 14 | | 14 | 9 | 10 | |
| 6/25/2015 | 1.27 | 4 | 2 | | 6 | 2 | 10 | |
| | | | | | | | | |
| 1/2/2019 | 0.98 | 1 | 22 | | 80 | 29 | 100 | |
| 1/4/2019 | 0.98 | 3 | 9 | 4 | 20 | 7 | 4 | 10 |

The three storm tracking cruises described above (Table 5) documented the elevation and then decline in GA16 fecal coliform 3-4 days after rain events of 0.5” or greater. In addition, numerous single day sampling (not storm tracking; Table 6) has shown that the vast majority of fecal coliform observations made on days 3-5 after closure rain of 0.5” or greater had acceptable water quality. For example, 84% (79 of 99 observations) of fecal coliform observations made 3-5 days after a closure rain event (>0.5”) were < 14 cfu/100 mL. (Table 6). Only the central portion of GA16 will be classified as Conditionally Approved, with only stations 16-1, 16-3 and 16-20 located in the Conditionally Approved area. For these three stations located within the Conditionally Approved boundaries 84% (37 of 44) of observations on days 3-5 after rain had fecal coliform values that were <14 cfu/100 mL. (Table 6). In addition, by day 5 after rain 91% of observations at all stations and 100% of observations at Conditionally Approved stations had fecal coliform values of < 14 cfu/100 mL (Table 6). Overall, the analyses demonstrate that fecal coliform water quality in the Conditionally Approved portion of GA16 returns to acceptable fecal coliform water quality (14 cfu/100 mL or less) three- to five-days after rainfall of 0.5” or greater. Accordingly, a Conditionally Approved management strategy of a 0.5” rain in 24-hours initiating a 7-day shellfish closure will provide ample time for the growing area waters to return to acceptable fecal coliform water quality plus an additional 2-day period for shellfish self-cleansing.

Table 6: GA16 fecal coliform observations made 3-5 days after a closure rainfall event of 0.5” or greater. Note that the area would in the closed status (0.5”, 7-day conditional closure) when these observations were made. Note that only station 16-1,16-3, 16-20 have Conditionally Approved classification and that 100% of observations at these stations were <14 cfu/100 mL on day 5 after rain of 0.5” to 2.55”. Fecal coliform values >14 cfu/100 mL in red highlight.

| Date | Rain | Days after rain | Station and Classification | | | | | | |
|------------|------|-----------------|----------------------------|------|-------|------|-------|------|-------|
| | | | 16-1 | 16-3 | 16-20 | 16-2 | 16-2A | 16-4 | 16-21 |
| | | | CA | CA | CA | P | P | P | P |
| 6/7/2018 | 0.53 | 3 | | 4 | 2 | 4 | | 14 | |
| 7/27/2017 | 0.55 | | | 6 | 7 | 9 | | 8 | |
| 6/8/2016 | 0.58 | | | 4 | 2 | 2 | | 2 | |
| 7/20/2016 | 0.61 | | | 2 | 2 | 2 | | 4 | |
| 12/21/2015 | 0.7 | | | 4 | 2 | 2 | | 31 | |
| 6/7/2017 | 0.75 | | | 320 | 154 | 18 | | 64 | |
| 12/19/2018 | 0.85 | | | 14 | 20 | 4 | | 34 | |
| 1/4/2019 | 0.98 | | | 20 | 4 | 9 | 4 | 7 | 10 |
| 4/24/2015 | 1.03 | | | 9 | 7 | 7 | | 4 | |
| 6/24/2015 | 1.27 | | | 14 | 10 | 14 | | 9 | |
| 12/2/2016 | 1.58 | | | 25 | 11 | 2 | | 34 | |
| 3/6/2018 | 2.55 | | 3.5 | | | 6 | | | 12 |
| 12/16/2020 | 0.52 | 4 | | 2 | 1.9 | 12 | 16 | 8 | 18 |
| 6/28/2017 | 0.66 | | | 8 | 2 | 4 | | 18 | |
| 10/4/2017 | 1.19 | | | | 2 | | | | |
| 6/25/2015 | 1.27 | | | | 6 | 10 | 2 | | 2 |
| 9/17/2018 | 1.39 | | | 4 | 1.9 | 2 | 2 | 14 | 1.9 |
| 12/10/2020 | 2.65 | 4.5 | | 66 | 78 | 20 | 34 | 34 | 12 |
| 5/2/2018 | 0.67 | 5 | 1.9 | 1.9 | 1.9 | 2 | 1.9 | 1.9 | 1.9 |
| 7/5/2019 | 0.7 | | | 6 | 1.9 | 2 | 1.9 | 4 | 2 |
| 8/9/2018 | 1.62 | | | 1.9 | 4 | 64 | | 16 | |
| 1/29/2019 | 2.33 | | | 14 | 1.9 | 2 | 1.9 | 1.9 | 1.9 |

iii. Back-to-back Rainstorms

The lower Providence River south of Gaspee Point (GA16) was reclassified as a conditionally approved area in May of 2021. A retrospective analysis of consecutive rain closures due to ‘back-to-back’ storms of greater than the conditional rain closure was completed for nearby growing area 1 (GA1, Upper Narragansett Bay). This effort was part of the “RI DEM Shellfish Program 2018 Action Plan” in response to the 2017 FDA PEER. The fecal coliform response after three ‘back-to-back’ storms in which two or more greater than 0.5” rain events occurred within 7-days were captured. Additional information on the fecal coliform water quality response of GA1 to back-to-back storms may be found in the “RI DEM Shellfish Program 2018 Action Plan” and in the document “Back-to-back Rain Analysis” available in the Program’s permanent files. A synopsis of those data is presented here.

Three back-to-back rain events exceeding the GA1 rain threshold (1.2” in 24 hours) and requiring overlapping closures were documented in the Upper Bay (GA1A) during 2014-2020. The first event occurred in June 2015, with 1.32” of rain on 6/15/15 followed by 1.19” of rain on 6/21/15. Water samples collected on 6/23/15 and 6/24/15, 2 and three days after the second rain event indicated that fecal coliform levels in the water were slightly elevated. By 6/25/15, day 4 after the second storm and 10 days after the first storm, water column fecal coliform levels had declined to acceptable levels. The second event also occurred during June 2015, with 1.19” of rain on 6/21/15 and a second storm (1.77” rain) on 6/28/15. Water samples collected on 6/30/15, 9 days after the first storm and 2 days after the second storm indicated that water column fecal coliform concentration had returned to near background levels. January 2019 was a period of wet weather with 6.5” of precipitation falling at TF Green Airport compared to a January mean precipitation of 3.9”. Rain of 2.04” fell on 1/20/2019 followed by rain of 2.33” on 1/24/2019. Water samples collected on 01/29/2019, 5 days after the first storm and 3 days after the second storm indicated that water column fecal coliform concentration had returned to near background levels.

The summary of the microbial water quality response after overlapping closure due to back-to-back storms of greater than the 1.2” rain closure for GA1 has demonstrated that the 7-day rain closure is protective of public health for both single and overlapping rain storms. The waters of nearby GA16 (the lower Providence River) are expected to behavior in a similar manner, with a return to acceptable fecal coliform levels five to seven days after overlapping rain closures. RI DEM staff will continue to compile data on the response of GA16 to back-to-back storms as this conditional area is monitored.

iv. Excessive Rain Emergency Closures

Extreme rain events in excess of typical rainfall patterns occur infrequently. These extreme events may impact the water quality of shellfish growing areas and may require emergency closures to safeguard public health. A retrospective analysis of the effects of extreme rain events on the microbial water quality of RI shellfish growing areas was completed by RI DEM Shellfish staff. These analyses are described in the document “Determination of Excess Rain Closures for RI Shellfish Growing Areas” available in the shellfish programs permanent files. The analyses identified the excess rainfall thresholds at which unacceptable water quality was observed in the growing areas and also identified the duration of time after rainfall ceased required for water quality to return to acceptable levels.

If emergency rain closure precipitation amounts are exceeded, the growing area will be placed in the closed status within 12-hours of the rainfall amount reaching the closure threshold. The shellfish growing area will remain in the closed status until acceptable microbial water quality is either demonstrated through analysis of water samples or for the duration previously identified in the excess rain analysis (“Determination of Excess Rain Closures for RI Shellfish Growing Areas”).

For the lower Providence River conditional area (GA16) an emergency excessive rain closure of 10-days duration will be enacted if greater than 3” up to 6” of rain falls in a 24-hour period. For rainfall of greater than 6” in a 24-hour period an emergency closure shall be instated ‘until further notice’, with collection and analysis of water samples to demonstrate return of the growing area to acceptable microbial water quality.

C. Sanitary Survey

A 12-year Sanitary Shoreline Survey must be completed to maintain the “Conditionally Approved” classification. A thorough evaluation and investigation of the growing area must be conducted to safely harvest shellfish and protect public health when a shellfish area is placed in the “Conditionally Approved” classification. The development of this management plan is based on the information gathered during these investigations. A compliance reevaluation of this plan is completed annually to maintain public health protection.

A comprehensive Sanitary Shoreline Survey of the Conditionally Approved portion of Growing Area 16 (the region from Gaspee Point south to Conimicut Point) was completed in 2009. The 2009 survey identified 32 actual or potential pollution sources. Of these, five (5) had fecal coliform results of greater than 240 cfu/100 mL and no (0) sources had fecal coliform results of greater than 2,400 cfu/100 ml in the 2009 survey. A portion of Growing Area 16 (the region south of Gaspee Point to Conimicut Point) has had shoreline survey updates every year during 2009 through 2019. The growing area had a comprehensive Triennial Shoreline Survey in 2017. The 2017 survey identified eighty-one (81) actual and potential shoreline pollution sources. Of these, twenty-nine (29) sources were actually flowing during the time of the survey. The vast majority of these sources had low flow and low fecal coliform concentration. Only three (3) sources had fecal coliform of greater than 240 cfu/100 mL and a flow of a trickle or greater. Only a single source (source #2017-16-118; a 24” reinforced concrete pipe with tidal flow under the East Bay bike path in East Providence) had fecal coliform of greater than 2,400 cfu/100 ml. This source flows into Bullock Cove which is classified as Prohibited and there is adequate dilution within Bullock Cove prior to the source reaching the Conditionally Approved waters of GA16 which are 1.9 km (1.2 miles) from this source.

Complete documentation for the Sanitary Shoreline Surveys of GA16 including the 2009 12-year Survey, 2017 Triennial Survey and the 2019 Annual update are maintained in the program’s files.

D. Predictable Pollution Events that cause Closure

1. Meteorological Events

Due to the relationship between rainfall and fecal coliform concentration in GA16 described above and documented by the RI DEM, the following meteorological condition is placed on the Conditionally Approved portion of Growing Area 16 (Providence River). The area shall only be open for shellfish harvest during dry weather (< 0.5” rain in prior 7 days) as described below:

Precipitation (rain and snowmelt) Criteria: Greater than 0.5” of precipitation (rainfall or equivalent snow melt) within any 24-hour period measured at the NOAA NWS station at TF Green Airport in Warwick RI or at the NBC Fields Point or at the NBC DOT rain gauges (NBC and DOT rain gauges available Monday-Friday only). Continuing precipitation beyond the initial closure criteria will require an extension of the minimum 7-day closure if the additional precipitation exceeds the initial 0.5” in 24-hour closure criteria. At no time shall a closure be of less than 7 days duration following the end time of any precipitation event that exceeds 0.5” within any 24-hour period.

Re-opening criteria: Automatic re-opening on the eighth day following the end of the last rain event (seven-day closure).

Basis for re-opening criteria: Bacteria levels within the water column return to acceptable conditions within three to four (3-4) days as established in the Providence River Conditional Area Management Plan maintained in the program’s permanent files. An additional two days is added for self-cleansing of shellfish (NSSP 2019, IV @03 C 2 c {i – iii}). Total closure time required is six (6) days, actual practice is seven (7) days. Supplemental monitoring conducted in recent years supports this as described in the management plan.

A review of rainfall data for the past ten years (2010 to 2019) indicates that the area will receive an average of approximately 49” of rain per year (range of 40” to 56”) and the average monthly rainfall is 3.98”. (Source: <https://w2.weather.gov/climate/xmacis.php?wfo=box>.) Typically the higher rainfall events occur in the months of November through March. In addition to the above sources, the program maintains a closure document recording all the data, rainfall, and emergencies that initiated closures of Conditionally Approved areas. Based on these program records from 2010 to 2019 for Greenwich Bay (which has the same 0.5” rain closure threshold as GA16), rainfall data indicate that the area will receive an average of 33.1 rainfall events exceeding 0.5” each year and that the area is predicted to be in the open status for an average of 50.0% of days per year. When reviewing program records from 2010-2019 there have been three “wet” years (>49” rain), these years had an average of 157.5 days closed to shellfishing, or that the area would be open to shellfishing 43.2% of the time. The remaining 7 years would be considered “dry” in that there was less than 49” of rain per year. These years showed an average of 193 days open per year or 52.9% of the time that the Providence River would have been open to shellfish harvest (Table 7). Based on this, one would expect the GA16-4 growing area to be open approximately 35 additional days per year in a dry year versus a wet year.

Table 7: Providence River (GA 16-4) annual precipitation, annual number of days and percent days the area would be in the open status 2010-2019. Rainfall recorded at TF Green airport (NOAA KPVD weather station).

| <u>Year</u> | <u>Annual Rainfall (Inches)</u> | <u>Days Open</u> | <u>% Days Open</u> |
|--------------------|--|-------------------------|---------------------------|
| 2010 | 53.5 | 170.5 | 46.7 |
| 2011 | 56.3 | 140.5 | 38.5 |
| 2012 | 41.2 | 193.0 | 52.9 |
| 2013 | 45.5 | 182.5 | 50.0 |
| 2014 | 47.2 | 194.0 | 53.2 |
| 2015 | 40.8 | 222.5 | 61.0 |
| 2016 | 40.0 | 203.0 | 55.6 |
| 2017 | 46.2 | 194.5 | 53.3 |
| 2018 | 45.4 | 161.5 | 44.2 |
| 2019 | 52.0 | 161.5 | 44.2 |
| AVG | 46.8 | 182.4 | 50.0 |

2. Other Pollution Events that Cause Closures

1. Notification of a WWTF emergency, such as loss of disinfection, at the NBC Fields Point WWTF, the NBC Bucklin Point WWTF, or the East Providence WWTF that may result in pollution of the conditional area. The emergency conditions in which WWTF effluent may impact the microbial water quality of GA16 were determined by dilution analyses described in the document “Establishing the Closure Zones and Shellfish Water Classifications Adjacent to Waste Water Treatment Facilities (WWTF) in the Providence River (GA16)” (RIDEM February 2021, available in the Program’s permanent files). The WWTF emergency conditions that will initiate a GA16 closure are loss of disinfection for greater than six (6) hours at the Bucklin Point WWTF, East Providence WWTF, or the Fields Point WWTF.
2. Indications that the provisions of the Operating Procedures are not being met.
3. Discovery of sewer system failures (damaged or overflowing sewer lines, uncorrected or illegal overflows during dry weather, or other pollution events) wherein the area in the open condition would be adversely affected.
4. In the event of a significant toxic spill or HAB biotoxin producing algae bloom.

The closure of the Providence River (GA16-4) conditional area will become effective within approximately 12 hours after any aspect of the closure criteria has been met. This is generally the amount of time required to inform all the required agencies, the local shellfishing industry, the local press and the general public that a temporary closure is being implemented.

In the case of an emergency requiring the immediate closure of the conditional area(s), the Office of Water Resources shall notify RIDEM’s Division of Law Enforcement. The Enforcement Division maintains an emergency 24-hour phone service and employs a staff of Environmental Police Officers that work around the clock 365 days a year. The officers have access to patrol boats that can be immediately dispatched to the conditional area, at which time any shellfish harvesting can be immediately suspended. The shellfish closure hotline (401-222-2900) will be updated with the current status of any area closed to shellfishing whether due to routine established conditions or for any emergency closure. A standard operation procedure (SOP) for the closure notification process is maintained in the Program’s files. All RI WWTF operators are required to notify RI DEM immediately if there is a loss of disinfection.

E. Water Quality Monitoring Plan

A conditionally approved classification indicates that at predictable times the area is suitable to safely harvest shellfish. In order to maintain this classification adequate monitoring of these waters during those “open” conditions is warranted. FDA through their National Shellfish Sanitation Program (NSSP) dictates the amount, location and frequency of routine monitoring necessary to maintain this conditionally approved status. See the [Guide for the Control of Molluscan Shellfish, 2019](#) at FDA’s website. Rhode Island as a member of the Interstate Shellfish Sanitation Conference (ISSC) has chosen to operate their routine shellfish monitoring program based on the systematic random sampling procedures outlined in the NSSP guidance and as such adheres to the following guidance in monitoring to support the conditionally approved classification of the Providence River Growing Area 16.

1. Frequency of Monitoring

Water quality in Providence River (Growing Area 16) is impacted by non-point sources of pollution such as rainfall events and stormwater runoff. The program guidance requires that in WWTF performance impacted

areas, water samples are collected on a monthly basis when the growing area is in the open status per Section II. Chapter IV @.03(3)(b)(ii) of the FDA guidance document. If due to environmental constraints the monthly sample cannot be collected, an additional sample can be collected in the following month (two samples in that month). For non-point sources such as rainfall events the minimum sampling frequency for the systematically random sampling regimen is six (6) sets during open conditions Section II. Chapter IV @.03(3)(b)(iv) which is satisfied by the more frequent monthly (12 per year) requirement for wastewater treatment plant events. The conditionally approved waters of GA16 will be monitored in parallel with adjacent conditionally approved GA1.

2. Monitoring Stations

There are sixteen (16) monitoring stations in the Providence River (Growing Area 16). Routine monitoring of the southern portion of the Providence River is done at seven (7) of these stations: three (3) stations are in the Conditionally Approved area (GA16-4) itself, with four (4) added stations in the Prohibited waters of the western shore (Occupessatuxet Cove) and eastern shore (near Bullock Cove) adjacent to the Conditional Area. In addition, there are nine (9) monitoring stations located in the Prohibited waters of the growing area north of Gaspee Point. Figure 7 identifies and locates these stations within the growing area. Samples are collected following the standard operating procedures described in the “RI DEM Shellfish Program Growing Area Monitoring Standard Operating Procedures, updated April 2020” on file in the Programs permanent files. Briefly, water samples are collected 0.5 m (1.5 feet) below the water surface (using 125 ml sterile Nalgene bottles or other acceptable sample bottles provided by RI DOH). The water temperature at time of collection of the first sample is recorded. Samples are immediately placed on ice in insulated coolers and are transported to the Rhode Island Department of Health (RIDOH) Laboratory. These station locations were established with assistance from the FDA and are believed to be adequate in distribution and location so as to represent the overall water quality of the growing area. As needed, “emergency” or additional stations are added on a temporary basis should situations arise due to unexpected or newly identified pollution sources.

3. Analysis of Water Samples

Analysis of water samples for determination of fecal coliform concentration is conducted by the Food/Water Microbiology Laboratory at the Rhode Island Department of Health using the mTEC technique as described in the Standard Methods for the Examination of Water and Wastewater (RI DOH method SM48, similar to Standard Method 9213D “E. coli by membrane filtration on mTEC agar”). Results from this analysis will yield estimates of fecal coliform abundance in units of colony forming units per 100 ml of seawater (cfu/100 ml). The RIDOH produces and transmits the results via laboratory result sheets to the program which are then entered into the central shellfish database for statistical analysis. Any anomalies (outliers) or abnormal results noted during this initial entry phase will be investigated further as to cause and consequences. On an annual basis compliance with NSSP fecal coliform standards is evaluated based on statistical analysis (geometric mean and variability criteria) of the most recent fifteen results per station.

4. Toxic or Chemical Spills

RIDEM’s Office of Water Resources and Division of Marine Fisheries in conjunction with RIDOH and with guidance by FDA will make any necessary arrangements for water and or shellfish meat sampling and analysis in the event of a significant toxic chemical spill in the growing area. Emergency closures would be instituted per the program’s Standard Operating Procedures if warranted.

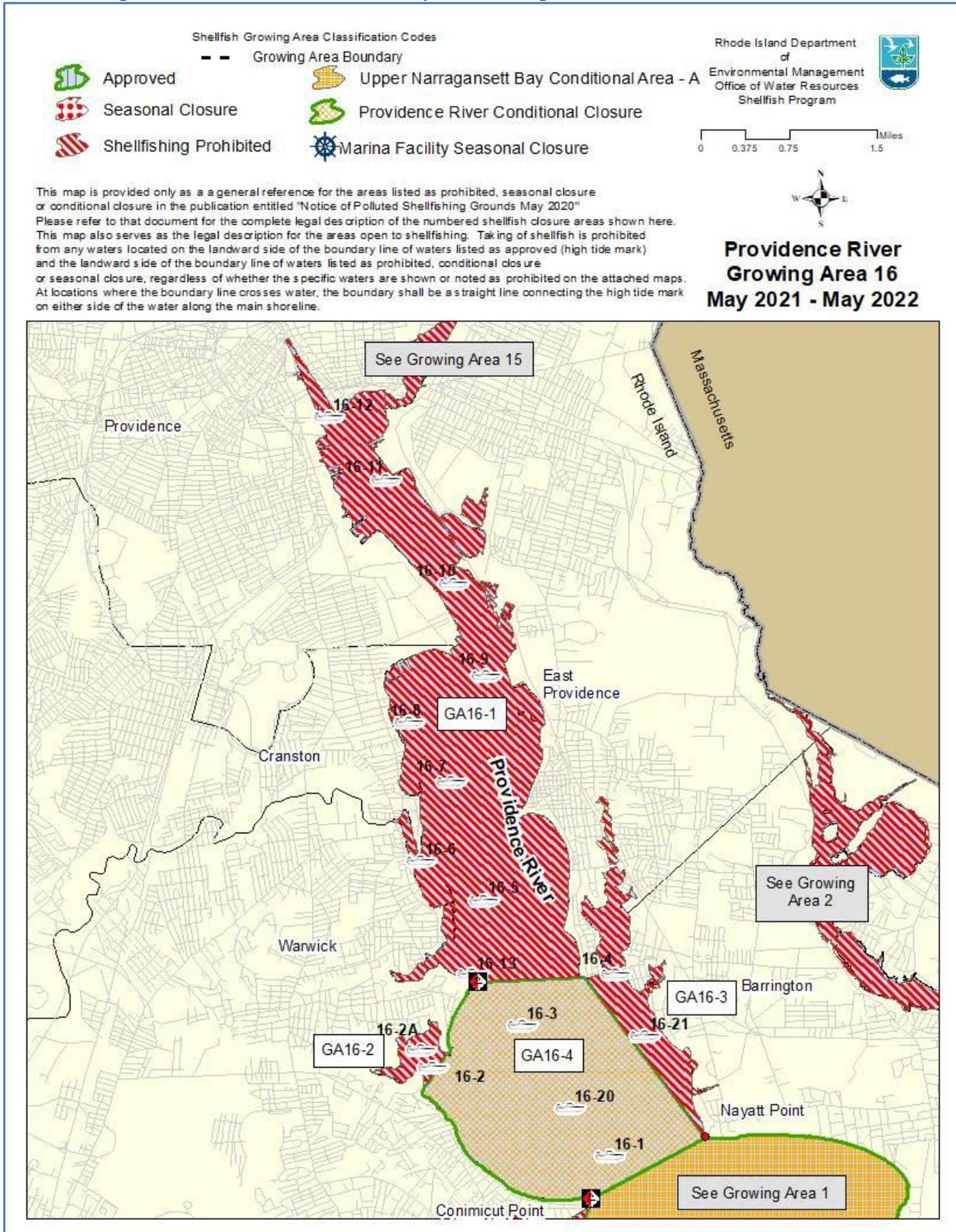
5. Harmful Algae Blooms

RIDEM's Office of Water Resources and Division of Marine Fisheries in conjunction with RIDOH monitor RI shellfish growing waters for the presence of potentially harmful biotoxin producing phytoplankton. The RI Harmful Algal Bloom and Shellfish Biotoxin Monitoring and Contingency Plan (available at: <http://www.dem.ri.gov/programs/benviron/water/shellfish/pdf/habplan.pdf> , updated April 2020) describes HAB monitoring and shellfish growing area closure procedures that will be followed in the event of a harmful algae bloom.

6. Annual Evaluation of Compliance with NSSP Criteria

Administrative oversight is required to ensure that fecal coliform monitoring is conducted and that pathogen indicator levels remain below NSSP thresholds in the growing area. At least annually, the fecal coliform data collected in Conditionally Approved growing area while the area was in the open status will be evaluated for compliance with NSSP criteria for shellfish harvest. Failure of the most recent 15 open status observations to comply with NSSP microbiological criteria will result in an investigation and may result in a closure of the area. Analysis of data excluding samples taken less than 7-days following rainfall events greater than 0.5" or more in a 24-hour period collected annually between January and December, at a minimum of seven days following the end of a precipitation event requiring a closure shall indicate that all stations within the Conditionally Approve area of GA16 (lower Providence River) will meet the statistical criteria for a Conditionally Approved Classification as described in the current NSSP MO. This supports management of this area based on the rainfall of 0.5" or more within a 24 -hour period.

Figure 7: Growing Area 16 Routine Water Quality Monitoring Stations.



F. Closure Implementation Plan for the Providence River Conditional Area (GA 16)

RIDEM's Office of Water Resources, Shellfish Program personnel are responsible for determining compliance with all aspects of this plan, including the tracking of precipitation closure criteria. RIDEM's Office of Water Resources, Operations and Maintenance program staff, Wastewater Treatment facilities personnel and or Division of Law Enforcement dispatchers are the parties responsible for transmitting WWTF operations information to shellfish program personnel. Staff within the shellfish program have established a rotating responsibility for a 24-7 'on-call' coverage assignment to ensure adequate adherence to this plan.

1. Implementation of Closure

Conditional area shellfish closures due to precipitation and emergency closures can happen any time of the day or any day of the week. During routine working hours, DEM shellfish program staff are responsible to monitor any on-going rain or snow melt event. The assigned staff person is typically the person who will be on-call for the up-coming weekend coverage, which rotates between three staffers on a tri-weekly basis. Staff are required to frequently access web sites to track rainfall at NOAA weather stations (Providence, Theodore Francis Green State Airport (KPVD); Taunton, Taunton Municipal Airport (KTAN); Westerly Airport (KWST)) and in the case of the Providence River the NBC rain stations at their Fields Point facility and the DOT station in Providence. Decisions to close a conditional area because of rain are made by 9:00 am for a noon time closure and by 3:00 pm for a sunrise next day closure.

As part of DEM OWR's management of conditional areas, weekend and holiday coverage is required. On weekends and holidays the shellfish program staff person on weekend/holiday coverage will check rainfall totals at TF Green (KPVD) twice per day (approximately 0730 in the morning and 1530 in the afternoon). NBC rain data is not available currently on weekends. In addition, the DEM-OWR email alert system will notify DEM OWR Shellfish staff of any WWTF emergencies, spills or other emergency conditions that may impact the growing area.

When rain amounts exceed the closure criteria of the conditionally approved shellfish growing area, a harvesting closure is enacted. These closures are based on the management plan that has been developed for each area. The weekend on call WWTF status and precipitation checks at 0730 and 1530 allow sufficient time to implement a closure within 12 hours of the rainfall total reaching a closure trigger. Shellfish staff use a Department-issued iPad to complete the twice-daily weekend and holiday precipitation checks for conditional areas.

DEM-OWR has established several communications to alert the community when a conditional area or emergency is required. These notification systems are updated to reflect the current status of conditional areas and any emergency closures. The notification system includes:

1. Shellfish Hotline (401-222-2900) which has a recording of the current status of all shellfish conditional areas and emergency closures.
2. Shellfish Listserve which communicates email notification of changes in conditional area status and notification of emergency closures.
3. DEM Shellfish Webpage (<http://www.dem.ri.gov/programs/water/shellfish/>) which is updated to reflect the current status of all shellfish conditional areas and emergency closures.

The checklist used by DEM Shellfish staff for implementing shellfish closures is shown in Appendix A.

G. Re-opening Criteria

The two (2) conditional criteria for closure of the Providence River Conditional Area (GA 16) are summarized below (details of each are in the relevant section of the CAMP).

Conditional Closure Criteria:

WWTF Operational Criteria:

Condition: Notification of an emergency condition at the NBC Bucklin Point WWTF, the City of East Providence WWTF, or the NBC Fields Point WWTF resulting in complete loss of treatment and the discharge of untreated sewage that could affect the microbiological water quality of conditionally approved waters.

Re-opening criteria: Return of the WWTF to normal operation followed by either a) a 21-day closed period or b) a 7-day closed period and demonstration that shellstock in the growing area have MSC levels of 50 pfu/100 grams or less; or shellfish are at or below established background MSC levels for that growing area.

Basis for re-opening criteria: Reopening criteria after WWTF loss of disinfection is based on return to normal WWTF operation and either a 21-day closure or a 7-day closure and testing for MSC levels in shellfish consistent with NSSP 2019, IV @03 A. (5) (d) (ii) and Chapter IV @ 03 C. (2) (c) (iii).

Precipitation (rain and snowmelt) Criteria:

Condition: Greater than 0.5” of precipitation (rainfall or equivalent snow melt) within any 24-hour period measured at the NOAA NWS station at TF Green Airport in Warwick RI or at the NBC Fields Point or at the NBC DOT rain gauges (NBC and DOT rain gauges available Monday-Friday only). Continuing precipitation beyond the initial closure criteria will require an extension of the minimum 7-day closure if the additional precipitation exceeds the initial 0.5” in 24-hour closure criteria. At no time shall a closure be of less than 7 days duration following the end time of any precipitation event that exceeds 0.5” within any 24-hour period.

Re-opening criteria: Automatic re-opening on the eighth day following the end of the last rain event (seven-day closure).

Basis for re-opening criteria: Bacteria levels within the water column return to acceptable conditions within three to four (3-4) days as established in the Providence River Conditional Area Management Plan maintained in the program’s permanent files. An additional two days is added for self-cleansing of shellfish (NSSP 2019, IV @03 C 2 c {i – iii}). Total closure time required is six (6) days, actual practice is seven (7) days. Supplemental monitoring conducted in recent years supports this as described in the management plan.

Re-opening of areas following a conditional closure shall adhere to this management plan which dictates the duration of the closure, as summarized below:

For emergency conditions, such as a loss of disinfection, at the NBC Fields Point WWTF, NBC Bucklin Point WWTF or East Providence WWTF, the growing area will remain in the closed status for either a) 21 days or b.) a 7-day closed period and collection of shellstock after 7-days to demonstrate that shellstock in the growing area have MSC levels of < 50 pfu/100 grams or at or below established background MSC levels, consistent with NSSP 2019, IV @03 A. (5) (d) (ii) and Chapter IV @ 03 C. (2) (c) (iii). The

emergency conditions in which WWTF effluent may impact the microbial water quality of GA16 were determined by dilution analyses described in the document “Establishing the Closure Zones and Shellfish Water Classifications Adjacent to Waste Water Treatment Facilities (WWTF) in the Providence River (GA16)” (RIDEM February 2021, available in the Program’s permanent files).

For precipitation closures, the closure shall remain in effect for a minimum of seven days following the end of the discrete event that initiated the closure. Should additional precipitation meeting the closure criteria happen subsequent to the initial event then the closure shall be extended additional days from the end of the subsequent closure event such that no closure shall be less than seven days from the end of any precipitation event meeting the closure criteria. The area shall not be returned to the Open status until all conditional criteria are met.

1. Flushing Time

The Providence River is tidally influenced from its confluence with Narragansett Bay at Conimicut Point landward to its freshwater sources. Tidal range is approximately 1.48 m. The largest sources of freshwater input to Narragansett Bay flow into the GA16 area. Approximately 68% (Spaulding and Swanson, 2008) to 85% (Pilson, 1985) of total freshwater flow to Narragansett Bay is from the Blackstone, Moshassuck, Woonasquatucket and Pawtuxet Rivers which are in the GA16 area. The combination of freshwater input and strong tidal flow result in strong estuarine circulation in the lower Providence River estuary, with higher salinity water flowing northwards into the area at depth (near bottom) and low salinity water flowing southward out of the area at the surface (Codiga et al., 2012). A rapid flushing time of approximately 0.9 to 1.0 day for the GA16 area of the lower Providence River (Spaulding and Swanson, 2008) and 0.8 to 4.4 days (2.5 day average) dependent on freshwater flow in the upper Providence River (Asselin and Spaulding, 1993) has been estimated for the lower Providence River.

2. Shellstock Depuration Time

Previous studies, summarized in section B-5-ii and G-1 (above), have established that tidal flushing and dilution rapidly dissipates fecal coliform from non-point sources in the Providence River such that ambient fecal coliform concentrations return to acceptable background, dry weather levels 3-4 days after rainfall in excess of the 0.5” closure rainfall. The 7-day conditional closure after greater than 0.5” rainfall allows sufficient time (2-4 days) for dilution of rain-associated bacterial contamination and an additional depuration period of two days during which bacterial concentration in filter feeding shellstock can equilibrate with the reduced ambient bacteria levels in the water column.

Water column fecal coliform bacteria are used to monitor the microbial water quality of shellfish growing areas. However, occasional sampling of shellstock in GA16 has indicated shellfish have acceptable bacteria levels during both wet weather (>0.5” rain in prior 7-days) and immediately after a 7-day rain closure of the conditional area (Table 8). All tissue tests indicated fecal coliform levels of less than the former shellfish meat standard of 230 mpn/100 grams and six (6) of the eight (8) quahog meat samples collected in GA16 had tissue fecal coliform levels that were below the detection limit of 20 mpn/100 grams tissue (Table 8). In addition, the available data indicate that shellfish in the growing area quickly equilibrate to acceptable bacterial levels during the 7-day conditional (>0.5” rain) closure. For example, quahogs sampled on 7/3/1990 (2 days after 0.63” rain) and 11/2/2015 (5 days after 0.75” rain) had fecal coliform levels that were either below the 20 mpn/100 grams detection level (3 of 4 samples) or below the former 230 mpn/100 grams

standard (all 4 samples). These results augment the water column monitoring results and support that the 7-day closure duration which includes 3-4 days for the water column to return to background fecal coliform levels and an approximate 3-4 day “cleansing” period for depuration of the shellstock is more than sufficient for shellstock to return to acceptable microbial quality during the 7-day conditional area precipitation closure. Additional information on shellstock cleansing time may be found in the “RI DEM Shellfish Program 2018 Action Plan”.

Table 8: Fecal coliform (mpn/100 grams) results for quahog (*Mercenaria mercenaria*) meats collected in the GA16 conditional area. Rain amounts and days since rain at time of sample collection also given. Test limit of detection is 20 mpn/100 grams.

| Sample Date | Sample ID | Location | Shellfish | Fecal Coliform (MPN/gram) | Days since rain | Rain (inches) | wet/dry |
|-------------|------------|---------------------|---------------|---------------------------|-----------------|---------------|---------|
| 7/3/1990 | | Gaspee Pt. | M. mercenaria | 140 | 2 | 0.63 | wet |
| 7/3/1990 | | Nyatt Pt. | M. mercenaria | 19 | 2 | 0.63 | wet |
| 11/2/2015 | | Providence River | M. mercenaria | 19 | 5 | 0.79 | wet |
| 11/2/2015 | | Providence River | M. mercenaria | 19 | 5 | 0.79 | wet |
| 3/11/2020 | 2001519-01 | PR-2020-1 (GA16 CA) | M. mercenaria | 19 | 8 | 0.25 | dry |
| 3/11/2020 | 2001519-02 | PR-2020-2 (GA16 CA) | M. mercenaria | 19 | 8 | 0.25 | dry |
| 3/11/2020 | 2001519-03 | PR-2020-3 (GA16 CA) | M. mercenaria | 19 | 8 | 0.25 | dry |
| 3/11/2020 | 2001519-04 | PR-2020-4 (GA16 CA) | M. mercenaria | 50 | 8 | 0.25 | dry |

3. Treatment Plant Performance Standards

Previous analyses have indicated that NBC Fields Point WWTF, NBC Bucklin Point WWTF and the East Providence WWTF are the only WWTF that are likely to have an impact on the fecal coliform water quality of the conditionally approved shellfish growing waters of the Providence River (GA16); see “Establishing the Closure Zones and Shellfish Water Classifications Adjacent to Waste Water Treatment Facilities (WWTF) in the Providence River (GA16)”, RIDEM February 2021. These WWTF are regulated by Rhode Island Department of Environmental Management. RIDEM’s Office of Water Resources, Operations and Maintenance Section works with the WWTF operators to monitor wastewater facilities and to ensure compliance with permit requirements. The operators of each facility are required to maintain records of their operations as outlined below:

- (A) Establish and maintain records of operation and maintenance.

- (B) Create and submit reports, including but not limited to monthly operating reports, alarm calibration and testing reports, etc.
- (C) Install, calibrate, use and maintain monitoring equipment or methods.
- (D) Sample discharges in accordance with such methods at locations, at intervals, and in a manner as the Director shall prescribe. Such sampling may be in addition to that required by RIPDES (NPDES for MA permits) monitoring requirements.
- (E) Provide other information relating to discharges into the state waters or into a Wastewater Treatment Facility as the Director may reasonably require.

Should a complete loss of disinfection occur at the NBC Fields Point, NBC Bucklin Point or East Providence WWTF, dilution within the prohibited safety zone near each WWTF outfall would not be adequate to safeguard the conditionally approved waters of Providence River (GA16). Therefore, a condition for the conditionally approved waters of GA16 to be placed in the closed status is loss of disinfection at the NBC Fields Point, NBC Bucklin Point or East Providence WWTF, as described above. These WWTF are required to notify RI DEM immediately in event of a loss of disinfection or any upset in the treatment process at the WWTF. The WWTF 24-hour, 7-day per week emergency notification process to alert Shellfish Program staff of such emergency events is described in section F of this document and in the Shellfish Program's emergency notification SOP.

A review of 2018-2020 effluent monitoring data for the three WWTF in the area via EPA ECHO DMR data (www.echo.epa.gov) indicated that these WWTF are well-managed and that effluent flow and microbial quality (as fecal coliform) are well below permitted discharge levels. The Narragansett Bay Commission's Fields Point WWTF (NPDES permit RI0100315) is an advanced treatment facility with BOD removal, metals removal, synthetic organics removal and advanced nutrient (nitrogen, phosphorus, ammonia) removal. Chlorination / de-chlorination is used for disinfection of the effluent. The Field Point facility has a permitted maximum monthly flow of 65 MGD (123 MGD maximum flow capacity) and serves a population of approximately 209,000 people. A review of 2018 and 2019 effluent data indicated no flow or fecal coliform violations, with a mean daily flow of 24.5 MGD (2019) to 28.0 MGD (2018) compared to a permit flow of 65 MGD. Effluent fecal coliform was usually <10 mpn/100 mL far below the permitted 200 mpn/100 mL effluent maximum.

The NBC Bucklin Point WWTF (NPDES permit RI0100072) has a permitted flow of 31 MGD (monthly average). Flow through the WWTF was an average of 10.8 MGD (2018) and 10.2 MGD (2019), well below the design flow. A review of DMR data indicated a single flow exceedance, with a monthly average of 32.0 MGD recorded in November 2018 compared to the 31 MGD permitted flow. November 2018 was extremely wet in the Providence area, with 10.6 inches of rain recorded at TF Green Airport (NOAA weather station KPVD) compared to an average November rainfall of 4.5". The Bucklin Point WWTF uses UV disinfection and a review of DMR data demonstrated that UV irradiance levels were maintained at 40 MW sec cm⁻² or greater. Fecal coliform in the treated effluent usually had a concentration of 50 mpn / 100 mL or less indicating efficient sanitation of the effluent prior to discharge.

The East Providence WWTF (NPDES RO0100048) has a permitted monthly average flow maximum of 14.2 MGD. Flows through the WWTF were 7.9 MGD average during 2018 and 6.9 MGD during 2019. The East Providence WWTF uses chlorination / de-chlorination for disinfection of the effluent. A review of DMR records indicated that fecal coliform levels in the effluent discharged from the East Providence WWTF were usually < 5 mpn / 100 mL. The above review of WWTF effluent data indicated that the treatment facilities in the area are well-managed and are meeting performance standards for wastewater

treatment consistent with NSSP guidance for growing areas subject to WWTF discharge [2017 NSSP MO Chapter IV@.09(H.) (1.)]. Maintaining acceptable microbiological quality of Providence River waters is contingent on these WWTF continuing to meet permitted performance standards. Effluent and operational data will be reviewed as part of RIDEM's annual reassessment of all conditional areas.

H. Annual Reevaluation

RIDEM's Shellfish Program commits to reevaluating this management plan on an annual basis and includes this as part of the Shellfish Growing Area 16 (Providence River) annual reviews using the reevaluation requirements as outlined in the NSSP Model Ordinance. Growing Area Classification Guidelines (NSSP MO Chapter IV@.03(C.) (3.) (a.) (i-vi) NSSP, 2017).

I. Literature Cited

- Asselin, S and Spaulding, ML. 1993. Flushing times for the Providence River based on tracer experiments. *Estuaries* 16: 830-839.
- Cabelli, Victor J, 1990. Microbial Indicator Levels in the Providence River and Upper Narragansett Bay. Report NBP-90-33. 81 pages. Available at: <http://nbep.org/publications/NBP-90-33.pdf>.
- Narragansett Bay Commission, 2014. Combined sewer overflow (CSO) tunnel water quality improvements. Available at: http://snapshot.narrabay.com/Services/MossFile.ashx?file=/s/emda/snapshot/Documents/Publications/Fact%20Sheets/NBCfactsheets_CS0%20improvements.pdf.
- NBEP (Narragansett Bay Estuary Program), 2017. The state of Narragansett Bay and its watershed: Technical Report. 500 pages. Available at: NBEP.org.
- NOAA Chart 13224. National Oceanic and Atmospheric Administration Navigation Chart # 13224: Providence River and the Head of Narragansett Bay. Available at: <https://www.charts.noaa.gov/OnLineViewer/13224.shtml>.
- NOAA, 2020. National Oceanic and Atmospheric Administration, Center for Operational Oceanographic Products and Services, tide data available at: <https://tidesandcurrents.noaa.gov/stationhome.html?id=8454000>.
- Pilson, MEQ. 1985. On the residence time of water in Narragansett Bay. *Estuaries* 8:2-15.
- RI DEM, 2016. History of Rhode Island Wastewater Treatment Facility Construction & Upgrades. 9 pages. Available at: <http://www.dem.ri.gov/programs/benviron/water/permits/wtf/pdfs/conuphis.pdf>.
- RI DEM. 2021. Establishing the Closure Zones and Shellfish Water Classifications Adjacent to Wastewater Treatment Facilities (WWTF) in the Providence River (GA16) and Upper Narragansett Bay (GA1). RI DEM Office of Water Resources, Shellfish Program. 61 pages. Available in the Shellfish Program's permanent files.
- RIDEM, 2021. Providence River Shellfish Tissue Analysis Summary. Available in the Shellfish Program's permanent files and also in Appendix B of this document.
- Spaulding, ML and Swanson, C. 2008. Circulation and transport dynamics in Narragansett Bay. Chapter 8 in *Science for Ecosystem Based Management: Narragansett Bay in the 21st Century*. Springer Publishing. Pages 233-280.

USGS, 2003. United States Geologic Survey Report # 03-001. Surficial sediment data from the Gulf of Maine, Georges Bank, and Vicinity: A GIS compilation. Available at: <https://pubs.usgs.gov/of/2003/of03-001/index.htm> and <https://pubs.usgs.gov/of/2003/of03-001/maps/narragansett.htm>.

Wright, R.M. and co-authors. 1991. Problem assessment and source identification and ranking of wet weather discharges entering the Providence and Seekonk Rivers. Narragansett Bay Estuary Project NBP-92-86. Available at: <http://nbep.org/publications/NBP-92-86-EXECUTIVE-SUMMARY.pdf>

Appendix A: Conditional Area Closure Checklist

Conditional Area Closure Checklist

Date: _____ Prepared by: _____ Date Signed: _____

- Closure Conditional Area "A" (1.2" TFG or NBC D.O.T or NBC F. Pt.)
- Closure Providence River (0.5" TFG or NBC D.O.T or NBC F. Pt.)
- Closure Greenwich Bay (0.5" TFG)
- Closure Kickemuit River and Mt. Hope Bay (0.5" Taunton)
- Closure Pt. Judith Pond (1.4" Westerly)
- Closure Mouth of Warren River (Warren WWTF emergency)
- Closure Narragansett Bay emergency closure, from South Prudence, north including the Kickemuit River and Mt. Hope Bay Closure
- Emergency Closure all waters of the state

- Update website
- Update email listserv
- Update Shellfish Hotline
- Call Enforcement 222-2284, 222-3070, 222-3071
- Complete affidavit and legal docs
- Check Recording
- Change dates on boards

Give reason for closure of conditional areas (include dates of rain / other events): _____

Comments: _____

Record WWTF bypass amounts below:

Bucklin Pt NDS: _____ Bucklin Pt WWF: _____
 Fields Pt: _____ Other: _____

| Closure # | Upper Narragansett Bay Area "A" | | | Providence River | Greenwich Bay | Mt. Hope Bay Kickemuit River | Pt Judith Pond | Other: |
|--|---------------------------------|-------------------------------|----------------------------|-------------------------------|----------------------------|-------------------------------|----------------------------|-------------------------------|
| | TFG | NBC | IFG NBC | | | | | |
| Amount of Rainfall (Snow Melt) at onset of closure | | | | | | | | |
| Total Event Rainfall | | | | | | | | |
| Start of Closure | <input type="radio"/> Noon | <input type="radio"/> Sunrise | <input type="radio"/> Noon | <input type="radio"/> Sunrise | <input type="radio"/> Noon | <input type="radio"/> Sunrise | <input type="radio"/> Noon | <input type="radio"/> Sunrise |
| 1 st Day of closure | | | | | | | | |
| Last day of closure | | | | | | | | |
| End of closure | <input type="radio"/> Noon | <input type="radio"/> Sunrise | <input type="radio"/> Noon | <input type="radio"/> Sunrise | <input type="radio"/> Noon | <input type="radio"/> Sunrise | <input type="radio"/> Noon | <input type="radio"/> Sunrise |
| Duration | | | | | | | | |

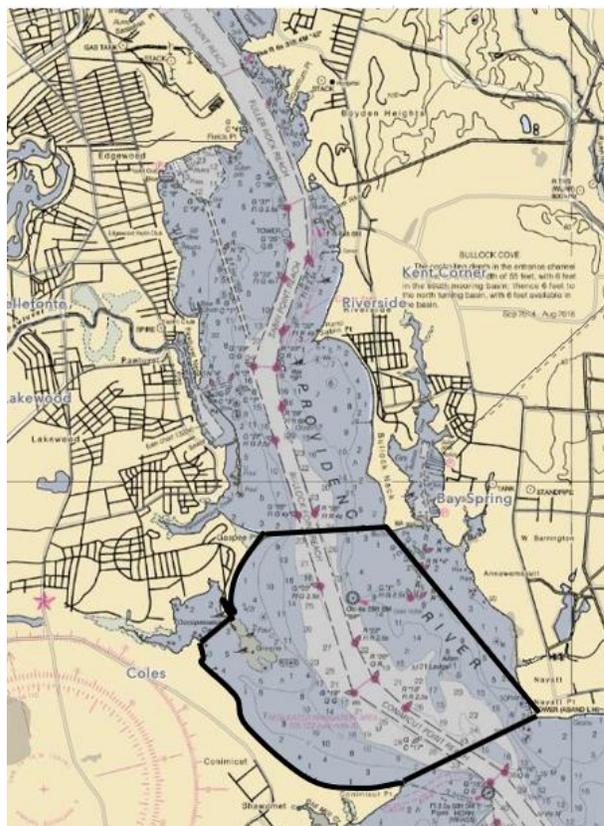
Appendix B: Quahog tissue metals and PCB results

Providence River Shellfish Tissue Analysis Summary

Background

The Office of Water Resources has conducted a review of the lower Providence River (Gaspee Point to Conimicut Point) and determined that at rainfall amounts of up to 0.5” inches of rainfall in the prior 7-days the water quality of the region meets NSSP guidelines for safe shellfish harvest. In addition, all requirements of the ISSC are met. DEM’s review has included: fecal coliform bacteria levels, a shoreline survey to assess actual and potential pollution sources and assessment of the potential impact from upstream WWTFs. The final assessment is being completed but it is anticipated that a new conditional area approximately the waters within the black lines in Figure 1 will be established. It may also be necessary to close the area based on loss of treatment at one or more of the upstream WWTFs.

Figure 1. Draft lower Providence River Conditional Area



Existing RIDEM Division of Marine Fisheries Shellfish Regulations establish the entire Providence and Seekonk Rivers) as a single management area (250-RICR-90-00-4.12.2.

Within this management area shellfish harvesting is prohibited except for the harvest of bay scallops by dip-netting from a boat during the open season for bay scallops. The Division of Marine fisheries is currently evaluating population dynamics and anticipates establishing a new management area that would allow quahog harvesting within the conditional area under development by OWR. The remainder of the Providence River and the entire Seekonk River would be a new management area that would continue the current bay scallop only management restriction.

This document focuses on an assessment of whether shellfish tissues values are below acceptable levels. Recent and historic shellfish tissue data is presented. It should be noted that since the 1980s large reductions in the discharge of heavy metals and organic contaminants to the Providence and Seekonk Rivers have been achieved by: implementing industrial pretreatment, improving wastewater treatment and capture and treatment of combined sewer overflows.

FDA Shellfish Tissue Action Levels Tolerances and Guidance Levels (“FDA thresholds”)

As noted in Section IV Guidance Documents – Chapter II. Growing Areas of the Guide for the Control of Molluscan Shellfish 2017 Revision:

“The FDA has established action levels, tolerances, and guidance levels for poisonous or deleterious substances to control the levels of contaminants in human food, including seafood (FDA Federal Register, 1977; FDA, 2002). ...Action levels and tolerances represent limits at or above which FDA will take legal action to remove adulterated products, including shellfish, from the market. Action levels and tolerances are established based on the unavoidability of the poisonous or deleterious substance and do not represent permissible levels of contamination where it is avoidable. Guidance levels are used to assess the public health impact of the specified contaminant. Table 1 lists action levels, tolerances and guidance levels established by the FDA for poisonous or deleterious substances in seafood, including shellfish.”

Table 1 of Section IV Guidance Documents – Chapter II. Growing Areas of the Guide for the Control of Molluscan Shellfish 2017 Revision, is included as Appendix A.

With the exception of 1.0 ppm for methyl mercury, the 2017 Guide for the Control of Molluscan Shellfish does not list any action levels tolerances or guidance levels for metals. RIDOH refers to the values for metals from the 2007 Guide for the Control of Molluscan Shellfish, listed below (email C. White RIDOH Food Protection, 2019). There are currently no tolerance or action levels available to compare concentrations of Zinc or Copper in shellfish tissues samples.

Table 2. FDA (NSSP Guide, Sec IV, Chapter II, .04, 2007) action levels for heavy metal concentrations in shellfish consumption by humans (all values are ug/g or ppm wet weight).

FDA Accepted Levels (2007)

| | | |
|----------|-----|------|
| Lead | 1.7 | ug/g |
| Arsenic | 86 | ug/g |
| Chromium | 13 | ug/g |
| Cadmium | 4 | ug/g |
| Nickel | 80 | ug/g |

Comparison of Quahog Tissue Levels to FDA Thresholds

Heavy Metals

In August 2019, samples consisting of ~20 individual Quahogs (*Mercenaria mercenaria*) were collected from four locations (19-30, 19-19, 19-16, and 19-29) in the Providence River and analyzed for heavy metals and Bacteria Coliphage concentrations (see Figure 2. below for specific site locations within area 19). Sites were selected on both sides of the lower Providence River (South of Gaspee Point) so as to best assess areas of potential future harvesting. The results are listed in the table below (Table 1), along with the acceptable concentrations according to both the FDA and NOAA (Table 2).

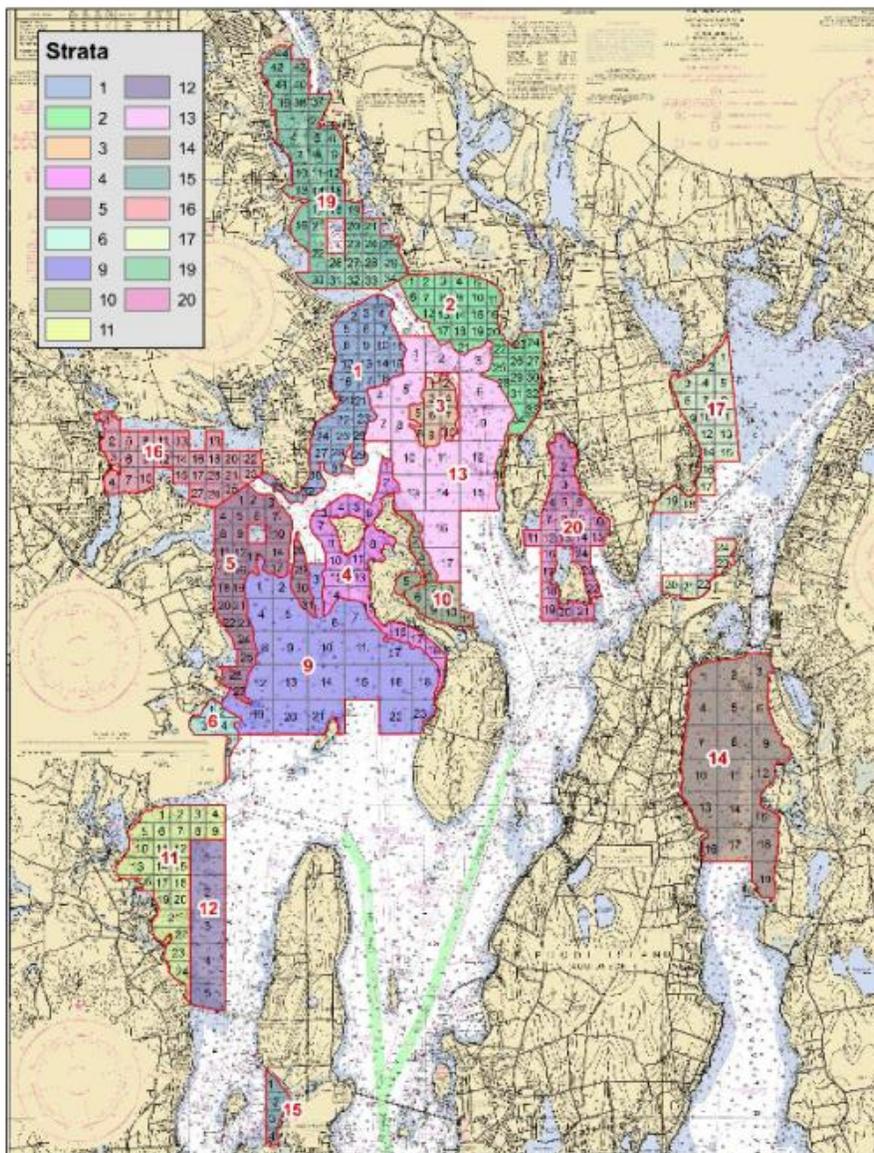


Figure 2 . Map Depicting Quahog sampling locations Sample stations are identified by Strata and quadrant (i.e. 19-16).

Samples were collected on 8/21/17 (station 19-29) and 8/22/2017 (stations 19-30, 19-19, and 19-16) and analyzed for Lead, Chromium, Nickel, Cadmium, Arsenic and male specific bacteriophage. Sample collection occurred during dry weather conditions with the most recent rain event on 8/18/2017 of 0.3” (NOAA TF Green rain gauge). Water temperatures during the sample collection dates had a low of 72.5°F and a high of 74.8°F based on samples collected at the NOAA monitoring station at Conimicut Light located at Conimicut Point see Figure 3.

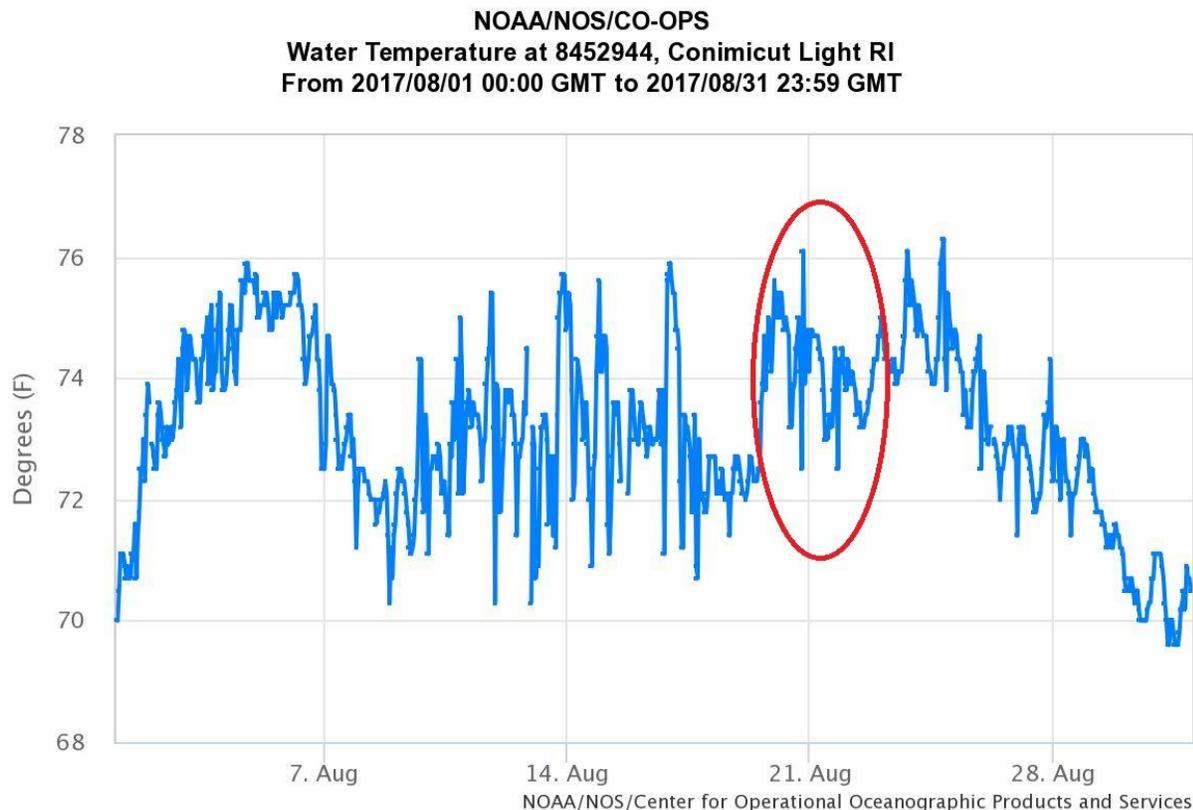


Figure 3: NOAA monitoring station at Conimicut Light located at Conimicut Point, Providence River, RI. Water temperatures corresponding to the quahog sampling dates for August 21st and 22nd 2017 are marked

As noted in Table 1, every sample analyzed was below all FDA and NOAA threshold concentrations for heavy metals. Lead was the closest to a threshold level at station 19-19 with a concentration of 0.57 mg/kg compared to the NOAA standard of 0.8 mg/kg and less than half of the FDA action level of 1.7 ug/g. The lead results ranged from 0.45-0.57 mg/kg across all stations. **All male specific bacteriophage results were below detectable levels (<2.0 PFU/100ml) at all stations.**

Table 1. Results from RIDOH analysis of Providence River Quahog meat samples 9/8/17.

| Station: 19-30 | | | | |
|-----------------------|-----------------------------|--------|-----------|---------------|
| Test | Test Code | Result | Units | Analysis date |
| ICPMS | Lead | 0.45 | mg/kg | 9/7/2017 |
| ICPMS | Chromium | 1.05 | mg/kg | 9/7/2017 |
| ICPMS | Nickel | 1.04 | mg/kg | 9/7/2017 |
| ICPMS | Cadmium | <0.5 | mg/kg | 9/7/2017 |
| ICPMS | Arsenic | 7.33 | mg/kg | 9/7/2017 |
| | Male Specific Bacteriophage | <2.0 | PFU/100ml | 9/7/2017 |

| Station: 19-19 | | | | |
|-----------------------|-----------------------------|--------|-----------|---------------|
| Test | Test Code | Result | Units | Analysis date |
| ICPMS | Lead | 0.57 | mg/kg | 9/7/2017 |
| ICPMS | Chromium | 4.09 | mg/kg | 9/7/2017 |
| ICPMS | Nickel | 1.19 | mg/kg | 9/7/2017 |
| ICPMS | Cadmium | <0.05 | mg/kg | 9/7/2017 |
| ICPMS | Arsenic | 10.6 | mg/kg | 9/7/2017 |
| | Male Specific Bacteriophage | <2.0 | PFU/100ml | 9/7/2017 |

| Station: 19-16 | | | | |
|-----------------------|-----------------------------|--------|-----------|---------------|
| Test | Test Code | Result | Units | Analysis date |
| ICPMS | Lead | 0.46 | mg/kg | 9/7/2017 |
| ICPMS | Chromium | 2.84 | mg/kg | 9/7/2017 |
| ICPMS | Nickel | 1.11 | mg/kg | 9/7/2017 |
| ICPMS | Cadmium | <0.05 | mg/kg | 9/7/2017 |
| ICPMS | Arsenic | 8.43 | mg/kg | 9/7/2017 |
| | Male Specific Bacteriophage | <2.0 | PFU/100ml | 9/7/2017 |

| Station: 19-29 | | | | |
|-----------------------|-----------------------------|--------|-----------|---------------|
| Test | Test Code | Result | Units | Analysis date |
| ICPMS | Lead | 0.48 | mg/kg | 9/7/2017 |
| ICPMS | Chromium | 3.34 | mg/kg | 9/7/2017 |
| ICPMS | Nickel | 1.56 | mg/kg | 9/7/2017 |
| ICPMS | Cadmium | <0.05 | mg/kg | 9/7/2017 |
| ICPMS | Arsenic | 9.64 | mg/kg | 9/7/2017 |
| | Male Specific Bacteriophage | <2.0 | PFU/100ml | 9/7/2017 |

Bender et. al. 1989 (<http://nbep.org/publications/NBP-89-25.pdf>) summarized all trace metals quahog tissue data that spanned a period of approximately 20 years. At the time of this publication, three separate studies were available that collected quahog samples for trace metals analysis that included stations located between

Gaspee Point and Conimicut Point: 1) RI Department of Health collected approximately monthly samples that were analyzed for **Lead, Cadmium, Chromium**, Copper, and Zinc from 1971-1985, 2). Cullen 1984 conducted two sampling surveys and analyzed for **Ni, Zn, Cd, Pb**, Fe, Mn and Copper. 3)Thibeault / Bubby Associates (1987) <http://www.nbep.org/publications/NBP-89-26.pdf> collected two sets of samples, November 1985 and June 1986 that were analyzed for Cd, Cu, **Cr, Pb, Ni**, Zn and **Hg**. The metals with FDA threshold values are shown in bold.

Below is a summary of the results collected in the area of interest (i.e. between Gaspee and Conimicut Point).

RIDOH – none of the 92 samples collected from three locations between 1980 and 1985 exceeded any FDA threshold. (a single exceedance for lead was reported but suspect because it was nearly an order of magnitude higher than all other samples).

Cullen - none of the 22 samples from 2 locations between exceeded any FDA thresholds.

Thibeault/Bubby Associates – Only 2 of the 80 samples from 4 locations between 1985 and 1986 exceeded FDA Pb thresholds. It should be noted that this is the only study that included Mercury and all values were below FDA thresholds.

Organic Compounds

Quinn et.al. (<http://nbep.org/publications/NBP-92-111.pdf>) conducted a 2-year study of organic contaminants in Narragansett Bay that included samples of quahogs from two locations in Providence River between Gaspee and Conimicut Point. Samples were analyzed for Congeners CB 101 and CB 138 in place of Ar1254 Petroleum hydrocarbons (PHC), polycyclic aromatic hydrocarbons (PAHs), substituted benzotriazoles (BZTs), bis (2-ethylhexyl) phthalate (DEHP) and coprostanol (COP). In some cases, PCBs were measured as specific chlorobiphenyl (CB) congeners).

Of the compounds studied FDA has only established a threshold values for PCBs (2.0 ppm). As noted in Table 5 from Quinn et.al. Note all values are reported on a dry weight basis in ppb and **all samples collected were well below the FDA PCB threshold.**

Table 5. Surface sediment and clam contaminant concentration data for various sites throughout Narragansett Bay. All concentrations are on a dry weight basis.¹

| | ng/gm | | ng/gm | | µg/gm | | ng/gm | |
|---------------|----------------|----------------|----------------|----------------|--------------|--------------|------------------------------|------------------------------|
| | CB 101 CLAM | CB 101 SEDS | CB 138 CLAM | CB 138 SEDS | ΣPHC CLAM | ΣPHC SEDS | C ₁₀ -BZT CLAM | C ₁₀ -BZT SEDS |
| Sabin Pt. | 22.8 | 31.4 | 16.1 | 32.7 | 359 | 1190 | 659 | 10900 |
| Gaspee Pt. | 19.5 | 37.3 | 16.4 | 41.0 | 249 | 2710 | 634 | 8840 |
| Conimicut Pt. | 5.87 | 15.7 | 4.81 | 17.0 | 211 | 1170 | 282 | 8650 |
| Rocky Pt. | 2.03 | 10.9 | 1.76 | 11.1 | 105 | 506 | 4.5 | 3340 |
| Ohio Ledge | 12.1 | 15.8 | 12.4 | 21.3 | 70.8 | 587 | 229 | 2940 |
| Appon. Cove | 6.62 | 18.8 | 5.42 | 11.1 | 44.0 | 581 | 7.3 | 50 |
| Sally Rock | 3.67 | 4.43 | 3.18 | 5.78 | 38.9 | 345 | 13.1 | 400 |
| Mount View | 7.31 | 4.23 | 7.06 | 5.65 | 61.1 | 193 | 107 | 510 |
| Wickford | 3.38 | 2.53 | 3.65 | 3.13 | 59.2 | 127 | 2.7 | 90 |
| Block Island | 0.50 | 0.50 | 0.50 | 0.50 | 8.0 | 10 | 1.0 | 1 |

| | ng/gm | | ng/gm | | ng/gm | | ng/gm | |
|---------------|----------------|----------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | Cl BZT CLAM | Cl BZT SEDS | COP CLAM | COP SEDS | FLR CLAM | FLR SEDS | PYR CLAM | PYR SEDS |
| Sabin Pt. | 112 | 1560 | 3860 | 8320 | 125 | 881 | 155 | 912 |
| Gaspee Pt. | 121 | 1830 | 3180 | 1760 | 93.6 | 1070 | 83 | 1070 |
| Conimicut Pt. | 56.4 | 1550 | 1010 | 6710 | 118 | 849 | 97 | 795 |
| Rocky Pt. | 1.0 | 530 | 1590 | 1240 | 55.0 | 361 | 48 | 298 |
| Ohio Ledge | 48.1 | 410 | 490 | 2160 | 56.8 | 510 | 58 | 355 |
| Appon. Cove | 2.4 | 1 | 640 | 3260 | 50.4 | 1370 | 65 | 1370 |
| Sally Rock | 2.1 | 160 | 210 | 2380 | 44.0 | 220 | 40 | 361 |
| Mount View | 21.4 | 90 | 750 | 990 | 91.7 | 75 | 126 | 52 |
| Wickford | 0.5 | 20 | 850 | 530 | 56.1 | 94 | 37 | 85 |
| Block Island | 1.0 | 1 | 2090 | 200 | 36.0 | 30 | NA | NA |

¹Average dry weight = 13%

NA = not analyzed

In addition, Pruell et.al. (1988) sampled 5 locations between Gaspee and Conimicut Prov (PR13, PR15, PR30, PR47 and PR49) during November 85 and June 86. As noted in Table 4 from Pruell et.al. all samples were well below the FDA PCB threshold. (see <http://nbep.org/publications/NBP-88-05.pdf>). Note all values are reported on a dry weight basis in ppb.

Table 4. Concentrations of selected contaminants found in quahogs from Narragansett Bay. Values shown are the mean values for all samples irrespective of size class for that specific date and location. Concentrations are as ng/g dry weight. A blank space indicates that no sample was available.

| STATION | Sum PCBs | | Sum DDTs | | Sum Chlordanes | | Sum PAHs | | Sum BZTs | |
|----------|----------|------|----------|------|----------------|------|----------|------|----------|------|
| | 11/85 | 6/86 | 11/85 | 6/86 | 11/85 | 6/86 | 11/85 | 6/86 | 11/85 | 6/86 |
| PR-1,2 | 496 | 559 | 16.6 | 20.8 | 14.0 | 13.6 | 681 | 587 | 2110 | 1720 |
| PR-13,15 | 288 | 432 | 14.9 | 18.1 | 13.5 | 12.8 | 523 | 443 | 2510 | 1740 |
| PR-30 | 243 | 219 | 13.4 | 12.5 | 11.3 | 9.09 | 393 | 199 | 1100 | 884 |
| PR-47 | 259 | 375 | 11.3 | 14.5 | 7.90 | 9.28 | 374 | 314 | 1430 | 1110 |
| PR-49 | 364 | 362 | 14.2 | 15.3 | 11.7 | 10.4 | 462 | 358 | 2630 | 1310 |

March 2020 Quahog tissue analysis for metals, bacteria and PCBs

In March 2020 RI DEM and RI DOH collected and analyzed additional quahog tissue samples from the lower Providence River. The quahogs were collected from four (4) locations in or just adjacent to the planned conditional area (GA16-4; Figure 4). The quahog tissue was analyzed for metals, bacteriological indicators, and PCBs. These analyses were done in support of a shellfish relay and in support of potential reclassification of the area as conditionally approved.

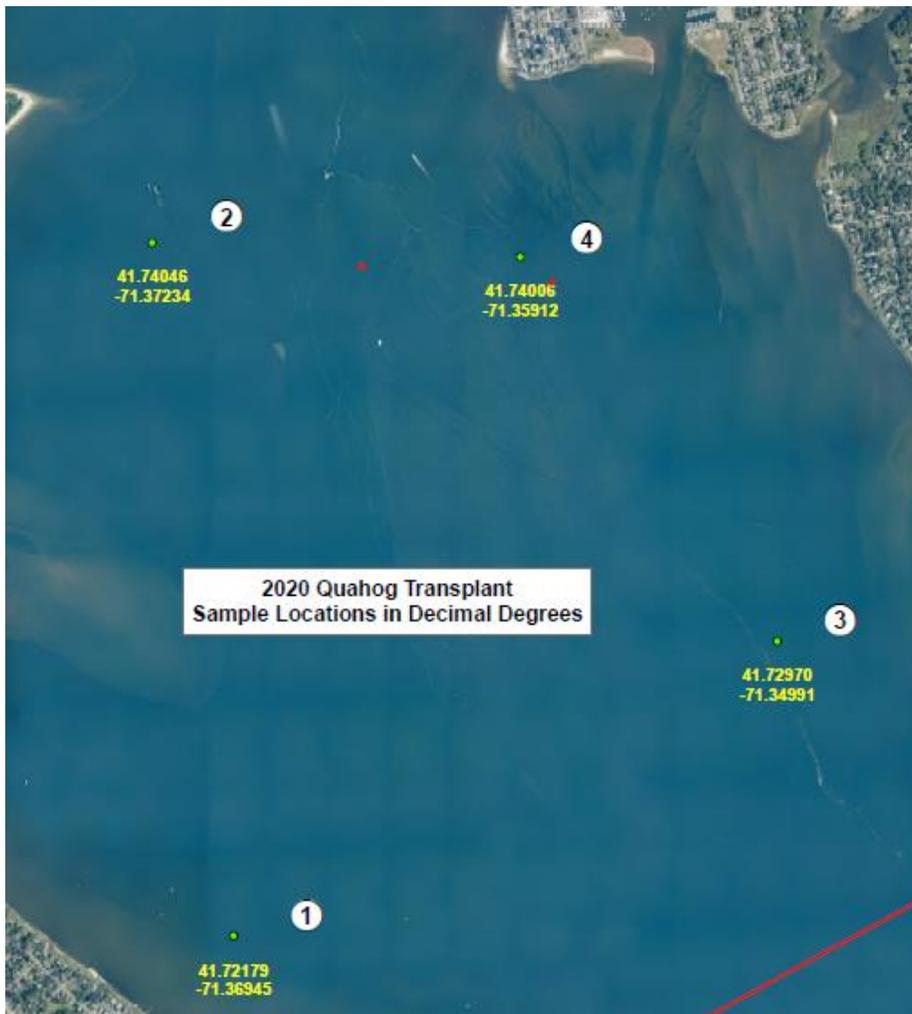


Figure 4: Location of four sites in the lower Providence River at which quahog samples were collected in March 2020 for metals, bacteria, and PCB tissue analyses.

Results (below) demonstrated that all samples had cadmium, chromium, lead and nickel levels that were well below former FDA standards. Concentrations of mercury and zinc were either below or just above detection limits. Fecal coliform and standard bacteria plate count results indicated low bacteria abundance in Providence River shellfish, with these results below detection for three of four fecal coliform samples and all four standard plate counts.

Providence River Quahog Meats, Metals and bacteria analysis, March 2020

| Analyte | LabSampleID | | | | Units | former FDA standard |
|-----------------------------|-------------|------------|------------|------------|---------------|---------------------|
| | 2001519-01 | 2001519-02 | 2001519-03 | 2001519-04 | | |
| ARSENIC | 9.7 | 5.9 | 17.8 | 15.6 | mg/kg | |
| CADMIUM | <0.50 | <0.50 | <0.50 | <0.50 | mg/kg | 4.0 |
| CHROMIUM | 1.8 | 0.4 | 1.2 | 0.8 | mg/kg | 13.0 |
| IRON | 34.7 | 33.4 | 33.1 | 57.8 | mg/kg | |
| LEAD | 0.6 | 0.2 | 0.3 | 0.7 | mg/kg | 1.7 |
| MERCURY | 0.10 | <0.08 | 0.08 | <0.08 | mg/kg | |
| NICKEL | 1.7 | 0.5 | 1.5 | 1.1 | mg/kg | 80.0 |
| ZINC | 21.2 | <20.0 | <20.0 | 24.2 | mg/kg | |
| FECAL COLIFORM | <50 | <50 | <50 | 50 | MPN / gram | |
| MALE SPECIFIC BACTERIOPHAGE | 130 | 44 | 270 | 170 | PFU/100 grams | |
| STANDARD PLATE COUNT | <250 | <250 | <250 | <250 | cfu/ gram | |

Values of < indicate below detection for that analyte

In addition, quahog meats were also analyzed for the presence of PCBs by ESS Labs. The analysis was for a suite of PCB congeners (8082A-congeners and Aroclor 1254) on the four quahog samples. Three samples had ‘No Detect’ for all PCBs tested for. One sample (4-NE) had a PCB content of 0.045 ppm (for congener BZ#8). This concentration is about 2% of the previous FDA guidance of 2.0 ppm for safe consumption of shellfish. Summary results are below. The March 2020 analyses demonstrated that PCBs were either absent or below detection in three samples and PCBs were at very low levels in one sample (sample 4-NE). All analyses indicated that PCBs were either absent (below detection) or present at acceptable, very low levels(2% of former standards) in the quahogs harvested from the lower Providence River in March 2020.

Providence River Quahogs PCB results (collected March 2020)

| Station | Aroclor 1254 (ppm wet weight) | Total PCBs (ppm wet weight) |
|---------|-------------------------------|-----------------------------|
| 1-SW | No detect | No detect |
| 2-NW | No detect | No detect |
| 3-SE | No detect | No detect |
| 4-NE | No detect | 0.045 |

Past FDA guidance = 2 ppm wet weight

Summary

This review of historic and recent quahog (*Mercenaria mercenaria*) tissue data has demonstrated that quahogs harvested from the lower Providence River in the vicinity of the proposed conditional area (GA16-4) meet standards for safe consumption of shellfish. Concentration of metals, bacteriological indicators and PCBs in the quahog tissue samples was low, with concentration of all analytes below levels established for safe shellfish consumption.

Appendix A

**Table 1
Action Levels, Tolerances and Guidance Levels for Poisonous or Deleterious Substances in
Seafood**

| Class of Substance | Substance | Level | Food Commodity | Reference | |
|--|---|--|--|---|-----------------|
| Deleterious Substance | Aldrin/Dieldrin ^c | 0.3 ppm | All Fish | CPG sec 575.100b | |
| | Chlordane | 0.3 ppm | All Fish | CPG sec 575.100b | |
| | Chlordecone ^d | 0.3 ppm | All Fish | CPG sec 575.100b | |
| | DDT, DDE, TDE ^e | 5.0 ppm | All Fish | CPG sec 575.100b | |
| | Diquat ^g | 2.0 ppm | All Fish | 40 CFR 180.226 | |
| | Diquat ^g | 20.0 ppm | Shellfish | 40 CFR 180.226 | |
| | Glyphosate ^g | 0.25 ppm | Fin Fish | 40 CFR 180.364 | |
| | Glyphosate ^g | 3.0 ppm | Shellfish | 40 CFR 180.364 | |
| | Carbaryl | 0.25 ppm | Oysters | 40 CFR 180.169 | |
| | Endothall and its Monomethyl ester | 0.1 ppm | All Fish | 40 CFR 180.293 | |
| | Methyl Mercury | 1.0 ppm | All Fish | CPG sec 540.600 | |
| | Heptachlor / Heptachlor Epoxide ^f | 0.3 ppm | All Fish | CPG sec 575.100 | |
| | Mirex | 0.1 ppm | All Fish | CPG sec 575.100 | |
| | Polychlorinated Biphenyls (PCBs) ^h | 2.0 ppm | All Fish | 21 CFR 109.30 | |
| | 2,4-D ^g | 0.1 ppm | Fish | 40 CFR 180.142 | |
| | 2,4-D ^g | 1.0 ppm | Shellfish | 40 CFR 180.142 | |
| | Chemotherapeutics | Chloramphenicol | No Residue | All Fish | 21 CFR 530.41 |
| Clenbuterol | | No Residue | All Fish | 21 CFR 530.41 | |
| Diethylstilbestrol (DES) | | No Residue | All Fish | 21 CFR 530.41 | |
| Demetridazole | | No Residue | All Fish | 21 CFR 530.41 | |
| Ipronidazole and other nitroimidazoles | | No Residue | All Fish | 21 CFR 530.41 | |
| Furazolidone and other nitrofurans | | No Residue | All Fish | 21 CFR 530.41 | |
| Fluoroquinolones | | No Residue | All Fish | 21 CFR 530.41 | |
| Glycopeptides | | No Residue | All Fish | 21 CFR 530.41 | |
| Natural Toxins | | Paralytic Shellfish Poisoning (PSP) toxins | 80 µg/100g | All Fish | CPG sec 540.250 |
| | | Neurotoxic (NSP) toxins | Shellfish Poisoning 20 MU/100g | Clams, mussels, oysters, fresh frozen or canned | NSSP MO |
| | Azaspiracid (AZP) toxins | Shellfish Poisoning 0.16 mg/kg | Clams, mussels, oysters, fresh frozen or canned | NSSP MO | |
| | Diarrhetic Shellfish Poisoning (DSP) toxins | 0.16 mg/kg | Clams, mussels, oysters, fresh frozen or canned | NSSP MO | |
| | Amnesic Shellfish Poisoning (ASP) toxins | 20 mg/kg | All Fish (except in the viscera of Dungeness crab where 30 mg/kg is permitted) | Compliance Program 7303.842 | |

Note: the term "fish" refers to fresh or saltwater fin fish, crustaceans, other forms of aquatic animal life

References

Literature Cited

- Bender, M et al. Distribution of trace metals in the water column sediments and shellfish of Narragansett Bay. Report NBEP-89-25, 240 pages. (<http://nbep.org/publications/NBP-89-25.pdf>).
- Cullen, JD. 1984. Copper and Nickel in Narragansett Bay waters and quahogs. MS Thesis, University of Rhode Island, 141 pages.
- Food and Drug Administration. 2007. Guide for the Control of Molluscan Shellfish. U.S. Department of Health and Human Services, Public Health Service, Office of Seafood (HFS-416), 200 C Street, SW, Washington, DC 20204.
- Pruell et.al. 1988. Organic contaminants in quahogs (*Mercenaria mercenaria*) collected from Narragansett Bay. Report NBP-88-05. 45 pages. (<http://nbep.org/publications/NBP-88-05.pdf>).
- Quinn, JG et al. 1992. Assessment of organic contaminants in Narragansett Bay sediments and hard shell clams. Report NBEP-92-111, 214 pages. (<http://nbep.org/publications/NBP-92-111.pdf>)
- RI Department of Health. Unpublished. Narragansett Bay Quahog tissue metals data base. (Lead, Cadmium, Chromium, Copper, and Zinc analysis of quahog tissue, 1971-1985)
- Thibeault / Bubby Associates. 1987. Trace metals in quahog clams from Narragansett Bay. Report NBEP-90-26, 33 pages (<http://www.nbep.org/publications/NBP-89-26.pdf>).