SNEP Watershed Grants

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Multi-Community Collaboration to Reduce Nitrogen in Upper Buzzards Bay – Phase II – Baseline Assessment & Alternatives Selection

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September 1, 2018 – September 30, 2020

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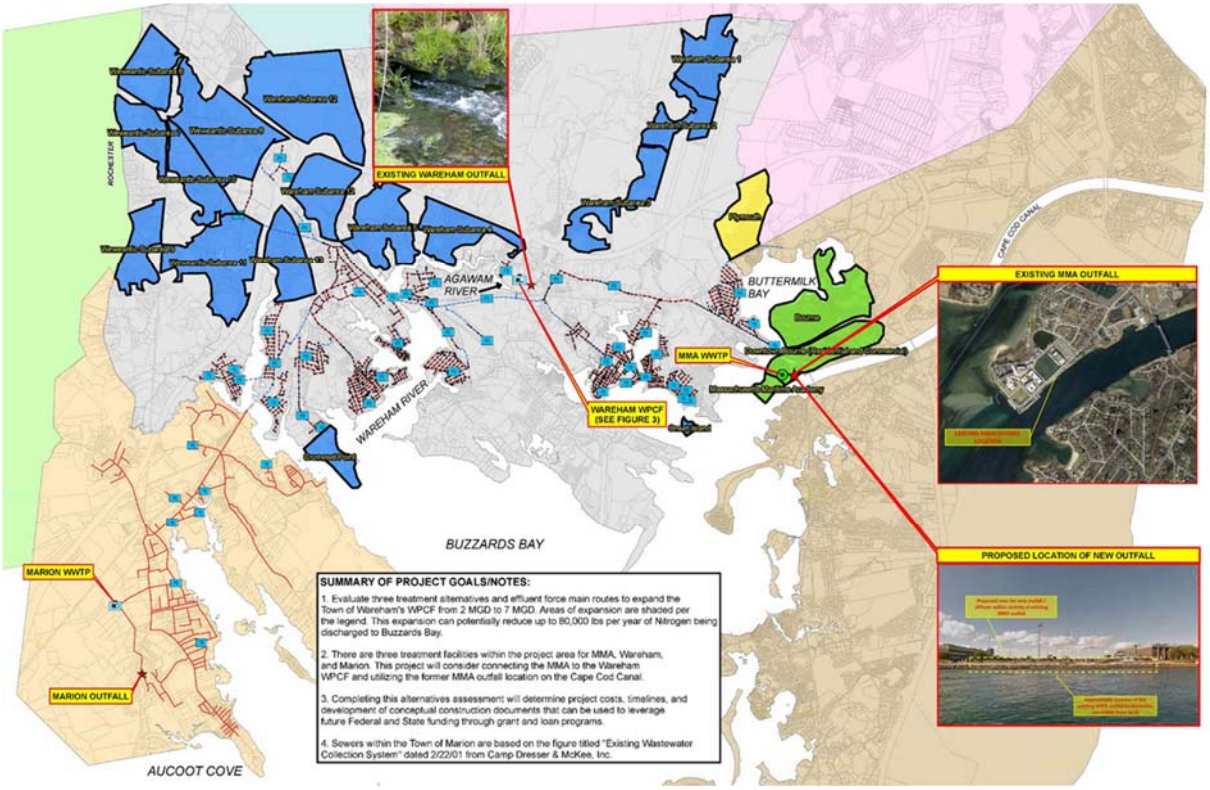
The Multi-Community Collaboration to Reduce Nitrogen to Buzzards Bay – Phase II – Baseline Assessment & Alternatives Selection

Executive Summary

In 2015, the Coalition brought together the towns of Wareham, Bourne, and Plymouth – together with the Massachusetts Maritime Academy to determine whether a regional wastewater solution to reduce nitrogen pollution in two of upper Buzzards Bay's most critically nutrient impaired sub estuaries; the Agawam/Wareham River and Buttermilk and Little Buttermilk Bays, was feasible. This first phase of the project, the "Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay" funded by the United States Environmental Protection Agency set out to determine whether the Wareham WPCF discharge pipe could be relocated from the Agawam River to the Cape Cod Canal, determined the maximum wastewater treatment capacity needed by each of the partners, and commenced the science needed to establish a water quality baseline at the canal in support of a permit under the state Ocean Sanctuaries Act. Phase I also completed a hydrodynamic model to determine whether the flushing capacity at the canal was sufficient to assimilate a large regional discharge.

Phase I concluded **that expanding sewer around nitrogen impaired waterbodies and discharging that highly treated wastewater to the Cape Cod Canal is feasible, will result in significant nitrogen reductions on a region-wide basis, and must be actively pursued.**



The “Multi-Community Collaboration to Reduce Nitrogen in Upper Buzzards Bay – Phase II – Baseline Assessment & Alternatives Selection “ (Upper Bay Project) set out to complete four essential tasks to move this effort towards implementation.

1. Complete habitat and water quality baseline assessments required to support the first-ever relocation of a wastewater ocean discharge under the 2014 amendments to the Massachusetts State Ocean Sanctuaries Act,

2. Evaluate state-of-the-art alternatives for expanding the capacity of the WPCF from 2 MGD to 7 MGD to accommodate the needs of the Project’s partners while at the same time maintain exceptional treatment,

3. Assess and select the most economic relocation route for the treated effluent force main leading to a new outfall (abandoning both the existing Wareham outfall discharging to the Agawam River and existing MMA outfall which does not treat for Nitrogen discharging to the Cape Cod Canal) to a suitable location at the Cape Cod Canal, and,

4. Evaluate and recommend whether a regional-based governing structure is warranted to manage and finance the implementation of this project.

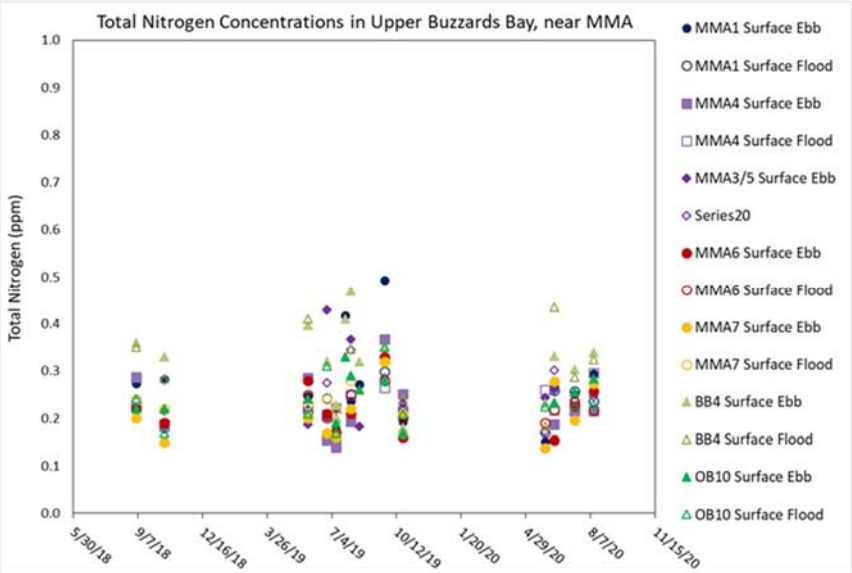
In April 2020, the Coalition proposed an additional task, complete a ratepayer analysis, to understand how current sewer rates in the partner communities are impacted by the costs of the regional wastewater solution versus a wastewater solution that the communities pursue on their own.

Furthermore, the partnership was expanded to include the town of Marion in an effort to evaluate whether the town should invest in improving existing wastewater assets or participate in a regional wastewater solution.

If implemented, this project could reduce an estimated 90,000lbs of nitrogen per year from critically impaired estuaries in upper Buzzards Bay.

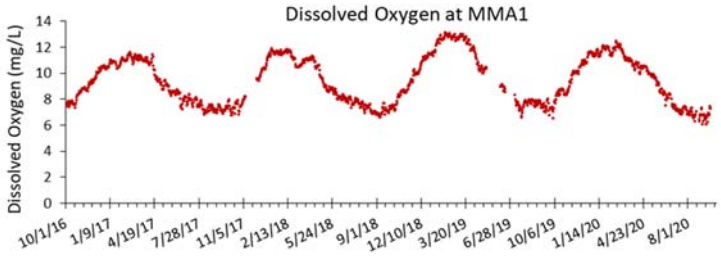
Science

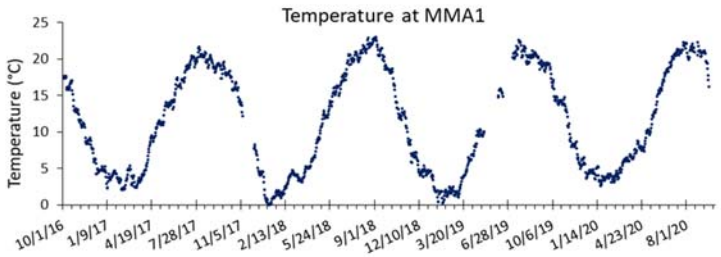
The first task was completing baseline water quality and habitat assessments for the State's first ever relocation of a municipal wastewater discharge pipe. Four scientific reports were complete under this grant. Water Quality Monitoring - Water quality was monitored via discrete surface and bottoms samples and by automated continuous measurements in the bottom waters. This data collection completed the 24 months of baseline water quality data needed for regulatory evaluation under the State Ocean Sanctuaries Act. A total of 274 discrete samples were collected for nutrient analysis as a part of this SNEP project, which builds upon samples collected through the earlier SNEP Upper Bay project, historic BBC Baywatchers program sampling, and sampling performed by the Town of Wareham.



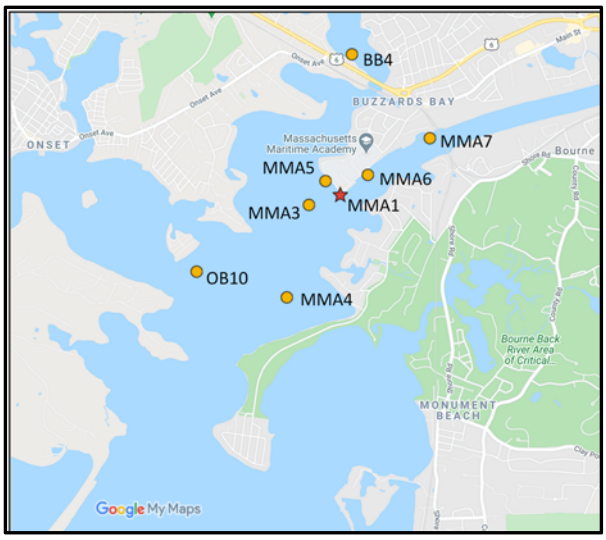
Through this grant, the water quality sonde deployed at the MMA dock collected around 60,000 measurements of dissolved oxygen, temperature, salinity, chlorophyll, and pH. The measurements show how parameters vary over the course of the year, with expected seasonal patterns in temperature and dissolved oxygen (Figure 9). Oxygen concentrations at this location were generally high and close to saturation with the air.

The water quality parameters at this location are strongly influenced by the tide with colder, saltier waters from Cape Cod Bay flowing from the Cape Cod Canal into the area at low tide.

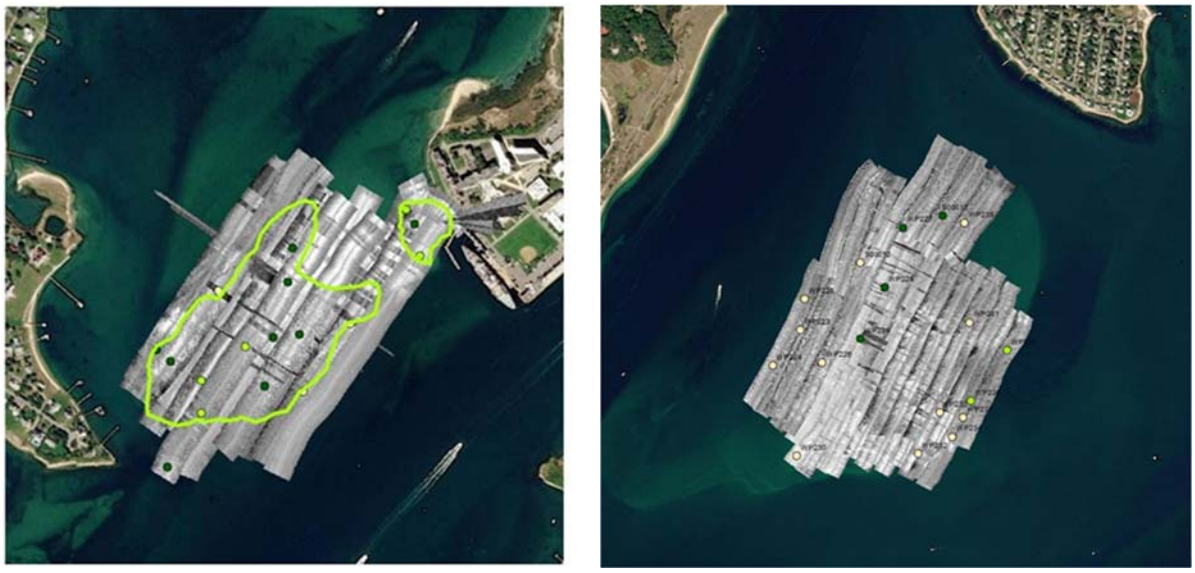




Benthic Analysis - At the bottom of the water column, the area around the seafloor – or benthic environment – collects particles that sink, including dead plankton, fecal pellets of marine organisms, and sediment. The benthic environment, thus collects material from the water column over time, providing an indication of the ecosystem status of the waters above. The sediment characteristics and the organisms present in the sediments provide valuable information about overall ecosystem health. Benthic analysis occurred at five stations in Upper Buzzards Bay (MMA3, MMA4, MMA5, MMA6, and MMA7) in October 2018. Surficial sediments were analyzed for benthic fauna, total organic content, and sediment grain size. Stations located outside of the canal (MMA3, MMA4, MMA5) generally had higher diversity indices compared to stations located within the canal (MMA6 and MMA7). This is consistent with the extremely strong currents through the canal that can scour sediments making it a challenging environment for benthic species.



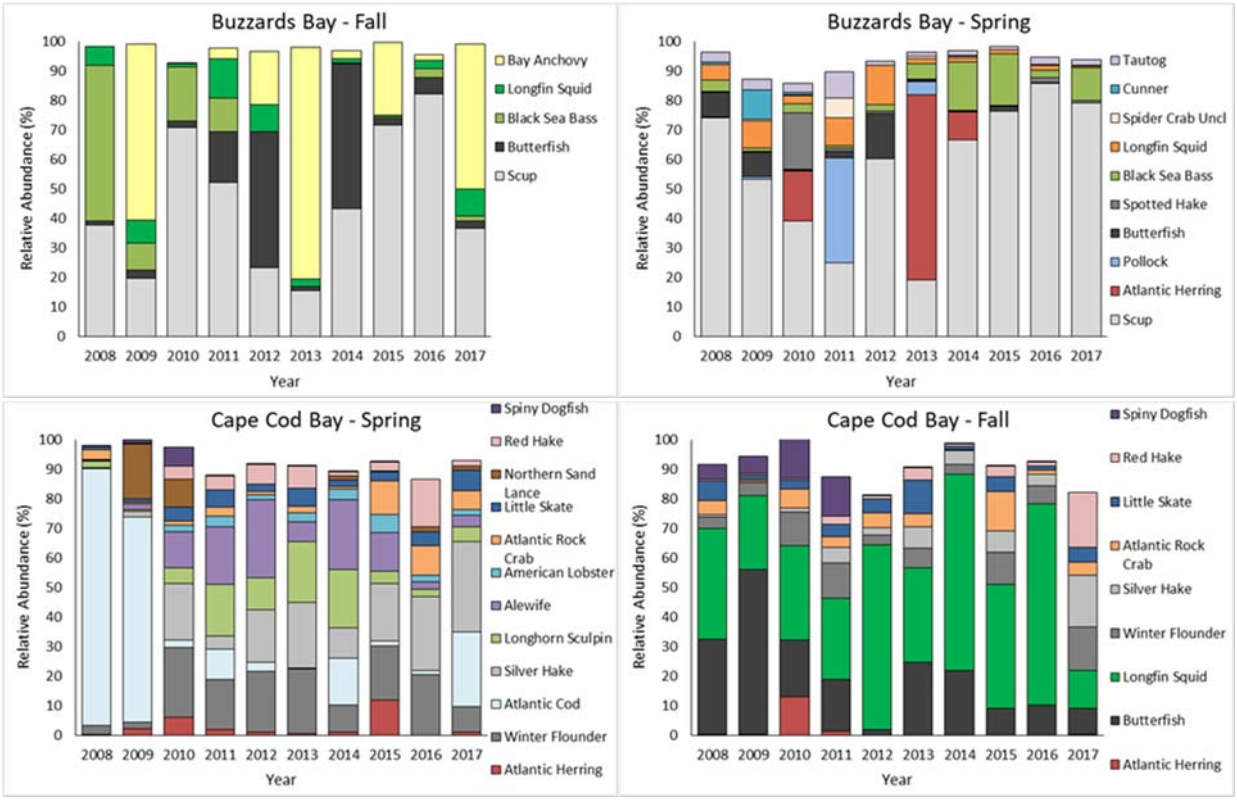
Submerged Aquatic Vegetation - Eelgrass beds are highly productive underwater areas that act as a nursery, habitat, and feeding ground for many fish, waterfowl, and invertebrates. The sensitivity of eelgrass to pollution also make it an ideal indicator species for changes in water quality. The extent of eelgrass beds was assessed at two locations to provide baseline data on an area in close proximity to the new discharge location and on an area considered out of the area of influence of the new discharge location.



Side scan sonar data (gray) overlying maps of the potential impact site (left) and the reference site (right). The extent of the eelgrass beds is indicated with the green line.

Fisheries Resource Assessment - The location of the proposed discharge in the Cape Cod Canal is unique. It sits in an area with vigorous currents and tidal flows – it is estimated that roughly 56-80 billion gallons

of water flows through the canal every day. This environment makes the Canal primarily a short-term habitat used by fish, with migrating fish passing through the Canal and the type of fish in the Canal changing over the course of the year. To assess the baseline conditions of finfish resources near the proposed discharge, trawl data was compiled for 10 years from Upper Buzzards Bay and Cape Cod Bay near the Canal exits. To assess the baseline conditions of finfish resources near the proposed discharge, trawl data was compiled for a 10-year period from Upper Buzzards Bay and Cape Cod Bay near the Canal exits. Data from 250 trawls were analyzed and showed clear differences in the species and patterns observed each season and in Buzzards Bay and Cape Cod Bay. This is evident in the relative abundance of the most prevalent species, which show how the dominant species change between spring and fall in both Buzzards Bay and Cape Cod Bay and how the two regions differ from one another.



Wareham Water Pollution Control Facility Expansion

Currently, the Wareham WPCF has the capacity to treat up to 2MGD average daily flow but discharge only 1.56MGD average daily flow. The short-term (20-years) flows needed from all partners, including current flows, is estimated at 3.5MGD with a full theoretical buildout of 7MGD. The Coalition contracted with GHD for this task as this work builds on the needs analysis GHD completed in Phase I. The overall goal of this task is to review and assess three options for wastewater liquid treatment and three options for wastewater sludge treatment under future expansion conditions for flows of up to 7 MGD at the WPCF. This task includes a conceptual design, cost estimate and memorandum identifying the steps taken to reach the selected alternative.

GHD concluded that expanding the existing MLE facility was the preferred alternative. This facility has shown to operate well and meet the treatment limits. The MLE system had moderately lower capital construction costs as well as lower operating and maintenance costs compared to other technologies evaluated. GHD developed a conceptual layout of a 3.5MGD plant expanding on the current MLE technology currently in use.

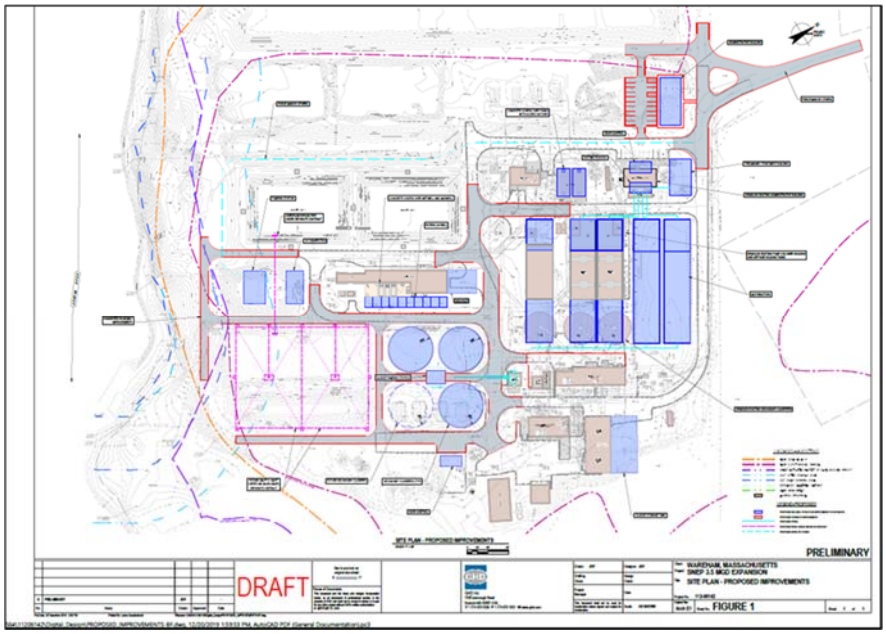


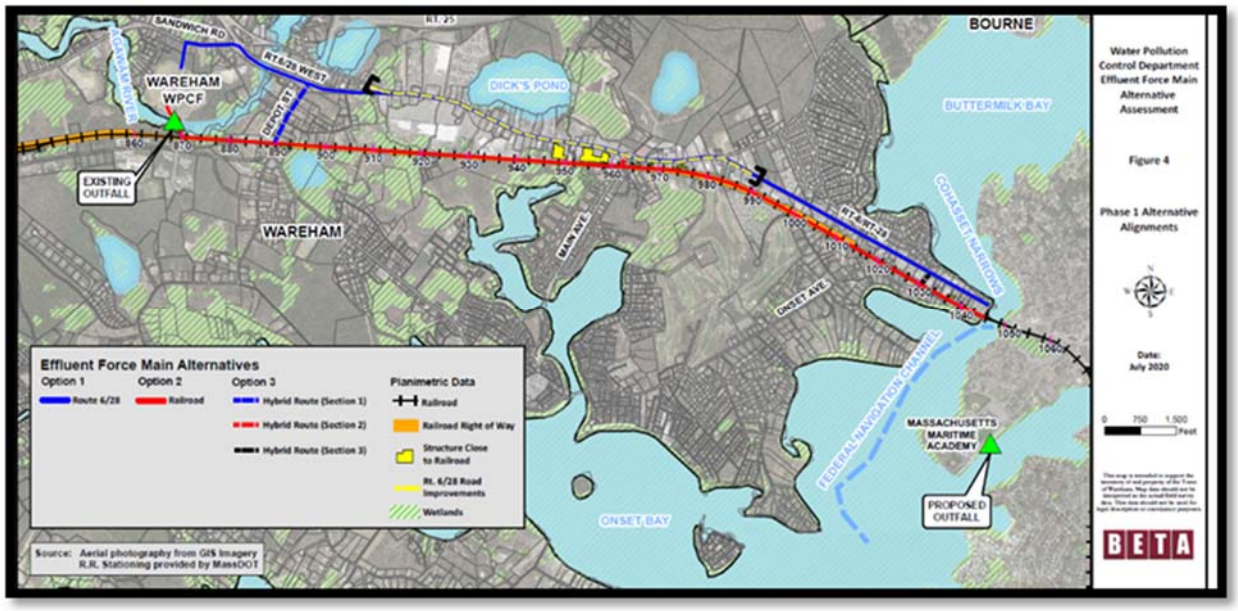
Table 7.1 Engineers' Opinion of Probable Construction Costs for MLE

Component	Incremental Cost Existing Plant To 2.5 MGD	Incremental Cost 2.5 MGD to 3 MGD	Incremental Cost 3 MGD to 3.5 MGD	Total Upgrade Probable Cost Existing Plant to 3.5 MGD
Preliminary Treatment	$2,100,000	$0	$0	$2,100,000
MLE Reactors	$8,700,000	$2,300,000	$2,300,000	$14,100,000
Clarifiers	$4,400,000	$1,700,000	$0	$6,000,000
Denitrification Filters	$3,200,000	$400,000	$400,000	$4,000,000
UV Disinfection	$1,800,000	$200,000	$200,000	$2,200,000
Effluent Pump Station	$3,600,000	$100,000	$0	$3,600,000
Solids Treatment	$3,300,000	$200,000	$200,000	$3,600,000
Septage Receiving Building Rehab	$400,000	$0	$0	$400,000
Odor Control	$900,000	$900,000	$0	$1,800,000
Process & Filter Building	$1,500,000	$700,000	$0	$2,200,000
Operations Building Allowance	$0	$0	$500,000	$500,000
Administration Building	$0	$1,100,000	$0	$1,100,000
Electrical & Instrumentation	$4,500,000	$1,100,000	$500,000	$6,200,000
HVAC	$900,000	$200,000	$100,000	$1,200,000
Yard Piping	$1,500,000	$400,000	$200,000	$2,100,000
Site Work	$1,500,000	$400,000	$200,000	$2,100,000
Plumbing, Painting	$600,000	$100,000	$100,000	$800,000
General Conditions	$3,600,000	$900,000	$400,000	$5,000,000
Subtotal of Construction Costs	**$42,000,000**	**$11,000,000**	**$5,000,000**	**$59,000,000**
Contingency[1]	$12,700,000	$3,200,000	$1,500,000	$17,700,000
TOTAL CONSTRUCTION[2,3] (ENR - Oct 2019 = 11326)	**$55,000,000**	**$14,000,000**	**$7,000,000**	**$77,000,000**
Fiscal, Legal, Engineering Allowance	$16,500,000	$4,200,000	$2,100,000	$23,100,000
Total Capital Costs[4] (ENR - Oct 2019 = 11326)	**$72,000,000**	**$18,000,000**	**$9,000,000**	**$100,000,000**

Engineers' Opinion of Probable Costs for infrastructure were developed as part of this initial planning process. It is important to note that as the project progresses, it is critical that these costs are refined and updated. The total capital costs to upgrade the existing 2MGD plant to 3.5MGD is estimated at $100,000,000.

Pipe Realignment

Relocating the treated force main is paramount to the success of this regional project. The overall goal of this task is to review and assess three options for a new treated effluent force main to discharge highly treated wastewater to a new ocean outfall near the existing MMA wastewater outfall in the Cape Cod Canal and cease the discharge of wastewater into the sensitive Agawam River. Development of feasible alternatives along with a preliminary cost projection is the first step in this process. Three different alignments were considered for each of the phases included; route 6/28, railway corridor, and a hybrid approach. BETA also considered various construction methods.



Based on the alternatives reviewed, the recommended route to relocate the Wareham WPCF discharge pipe from the Agawam River to the Cape Cod Canal is to install a forcemain pipe along route 6/28 roadway corridor from the WPCF to Cohasset Narrows. BETA recommends the construction of an independent utility bridge to cross the Narrows. Finally, installation of pipe north of route6/28 to Academy Drive to get from the Narrows to the Canal. BETA encourages a paired use of the utility bridge with a bikeway or pedestrian pass.

Preliminary cost estimates for the selected alternative were also provided.

Table 9	
Overall Project Opinion of Cost - Concept Plan Level	
Construction	**Cost**
Phase 1 Construction	$ 22,400,000
Phase 2 Construction	$ 4,300,000
Phase 3 Construction	$ 10,300,000
Effluent Pump Station	$ 10,000,000
Effluent Force Main Outfall	$ 4,000,000
Construction Subtotal	**$ 51,000,000**
Engineering	
Design (10%)	$ 5,300,000
Construction - Resident Inspection (15%)	$ 7,800,000
Project Total	**$ 64,100,000**

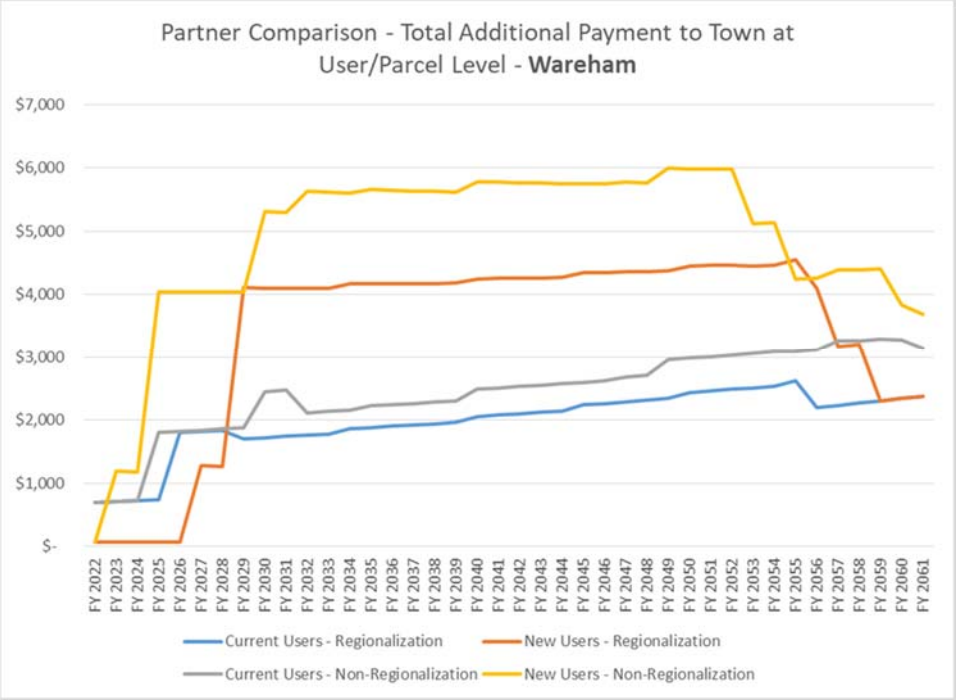
Governing Structure

The goal of this task is to reach consensus on a governing structure that defines how the partnership will formally work together in the future to operate a regional wastewater treatment facility. This task specifically evaluated whether the creation of a regional wastewater district or the negotiation of multiple inter-municipal agreements is the most effective and acceptable way to govern this regional nitrogen-reducing project. The Governing Structure Task Force reviewed two primary examples of how the partnership could formally define the relationships among and between the partners. The first was an Intermunicipal Agreement (IMA) and the second was a Wastewater District.

The Mansfield-Norton-Foxboro (MNF) Regional Wastewater District quickly became the model for the Task Force to study. The Task Force met several times to go over specific provisions of the draft legislation to form the district in addition to the draft district agreement.

Ratepayer Analysis

The purpose of the ratepayer analysis was to create a financial model to determine how current sewer rates in the partner communities are impacted by the costs of the regional wastewater solution and compare that to the impact on current sewer rates if a partner implemented an independent wastewater solutions. In other words, the partners needed a model to determine whether it was it more economical to participate in a regional solution or upgrade individual wastewater treatment facilities and collection systems to attain the same environmental benefit.



The model has the ability to illustrate the added costs to the average parcel in partner communities over 40 years. This graph illustrates the per parcel cost for partnering on regionalization versus a non regional solution. The model is incredibly flexible and allows for user inputs to change as well as financing scenarios.

Next Steps

With the bulk of the technical and estimated costs now in hand, we are grateful that the third and final phase of this project has received funding from SNEP. The next step is to contract with a communications firm to develop a public outreach strategy for the project.

The Multi-Community Collaboration to Reduce Nitrogen to Buzzards Bay is supported by the Southeast New England Program (SNEP) Watershed Grants. SNEP Watershed Grants are funded by the US Environmental Protection Agency (EPA) through a collaboration with Restore America's Estuaries (RAE). For more on SNEP Watershed Grants, see www.snepgrants.org.

2. Project Report Narrative

a. Project Background

Nitrogen pollution is the greatest long term threat to the health of Buzzards Bay including the Agawam/Wareham River, Buttermilk and Little Buttermilk Bay, Aucoot Cove, Sippican Harbor and the Weweantic River. **All these estuaries fail to meet water quality standards due to nitrogen pollution** and all are listed on the State's 303(d) Integrated List of Impaired Waters. Combined, these subwatersheds make up 34% of the entire Buzzards Bay watershed. Twenty-nine years of data collected by the Buzzards Bay Coalition (Coalition) document how nitrogen decreases the quality of coastal ecosystem habitats in these estuaries. Data show high levels of nitrogen and chlorophyll and low levels of dissolved oxygen and water clarity - symptomatic of nitrogen pollution. Wastewater from individual septic systems and municipal water pollution control facilities (WPCFs) are the main sources of nitrogen pollution to Buzzards Bay. Solving the wastewater nitrogen problem is paramount to restoring water quality in these estuaries and across southeastern Massachusetts.

It is well established that communities throughout southeastern Massachusetts and Cape Cod depend on good water quality to support their local economies and quality of life. Yet, our communities struggle with how to reduce nitrogen entering harbors and coves in an effective, affordable, and sustainable way. This first-of-its-kind project joined all of the communities in Upper Buzzards Bay – Marion, Wareham, Bourne, and Plymouth – together with the Massachusetts Maritime Academy and the Buzzards Bay Coalition – to determine whether a regional wastewater solution to reduce nitrogen pollution in upper Buzzards Bay is feasible. This project capitalized on a collective need to solve the

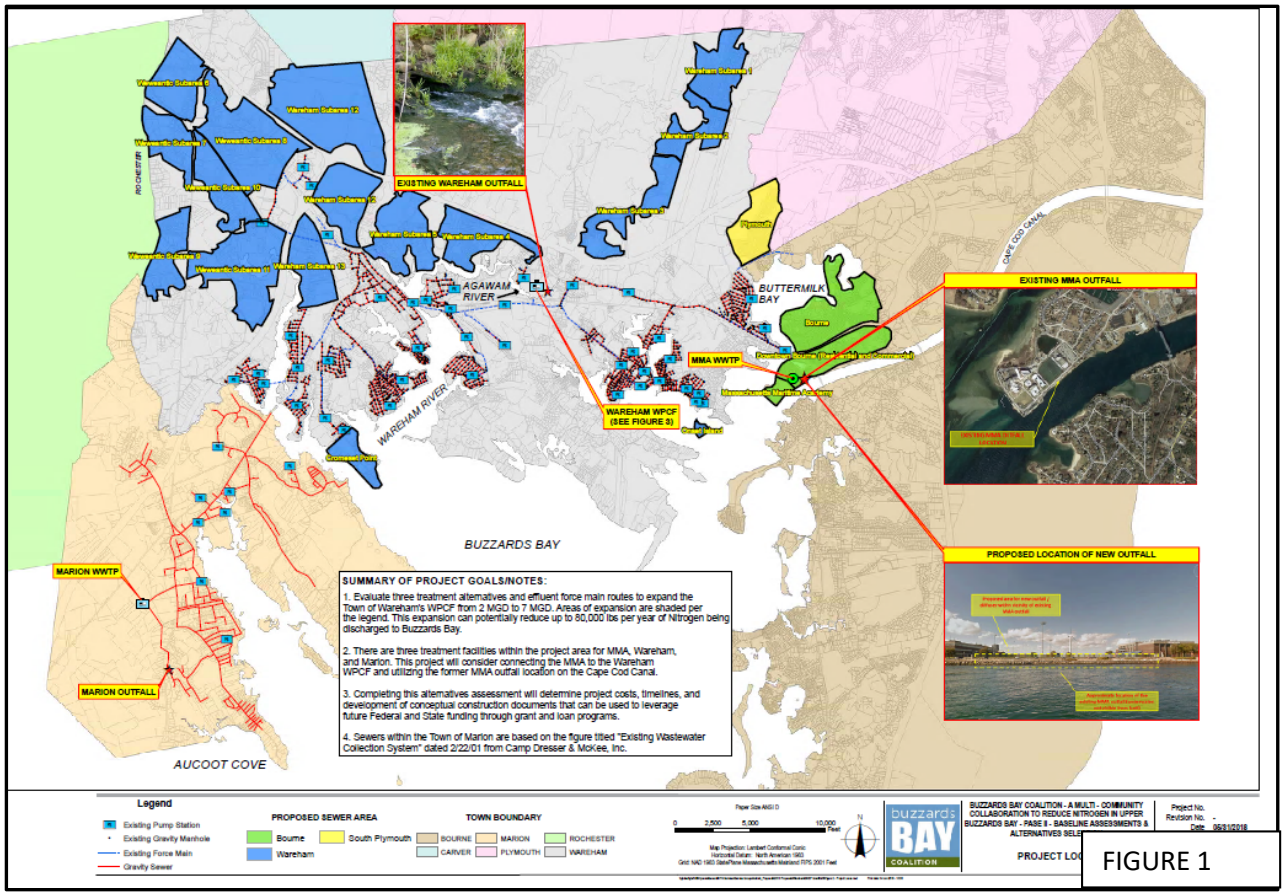


FIGURE 1

nitrogen pollution problem, while at the same time meeting the economic development needs in the town of Bourne, wastewater upgrade needs in the town of Marion, discharge needs in the town of Wareham and expansion needs of the Massachusetts Maritime Academy. Figure 1.

In addition to completing the requisite science to support a wastewater discharge at the Cape Cod Canal, this project also developed planning level costs for the upgrade at the WPCF to meet the wastewater treatment needs of the partners as well as the cost to realign the treated wastewater discharge from the sensitive Agawam River to the well-flushed Cape Cod Canal. This project evaluated different governing structure models to memorialize how a regional wastewater partnership might work and developed a ratepayer model to reflect how different projects impact ratepayers and taxpayers in each of the partner communities.

i. Water Quality Challenges

Initially, the project focused on two nitrogen-impaired upper Buzzards Bay estuaries, the Wareham/Agawam River and Buttermilk/Little Buttermilk Bay. The project quickly evolved to include Aucoot Cove, Sippican Harbor and the Weweantic River - all coastal waters impaired by nitrogen pollution failing to meet water quality standards. While some of these waters have been listed as impaired for decades, none of the waters have an EPA-approved Total Maximum Daily Load.

Wareham/Agawam River - Initially listed as nutrient impaired in 1998, the Agawam/Wareham River suffers from nitrogen pollution. Individual septic systems and Wareham's 1.56 million gallon per day (MGD) water pollution control facility (WPCF) are the major sources of nitrogen pollution. While a 2004 upgrade had a positive water quality impact to the Agawam/Wareham River (see Figure 2), more nitrogen must be removed from the watershed in order to restore water quality in the river. The Wareham River Draft MEP Report (MEP Report) estimates that one third of the existing nitrogen from within the watershed must be eliminated.

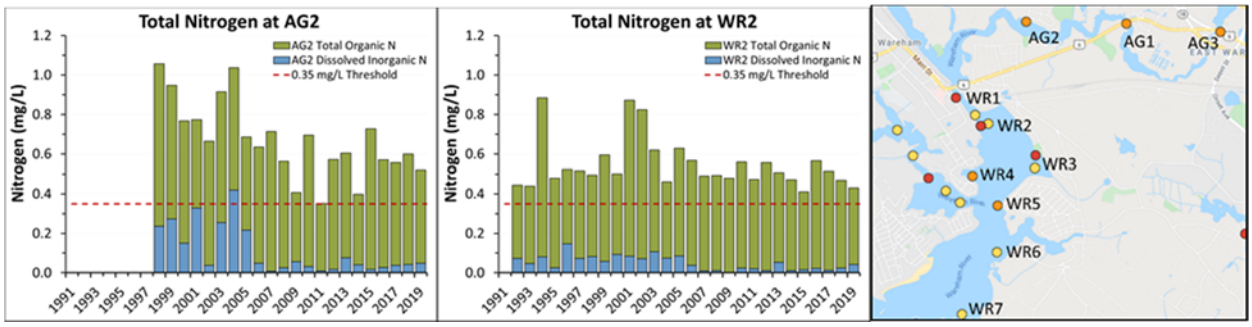


Figure 2. Coalition data illustrate that the total nitrogen in Buttermilk Bay exceeds the 0.35mg/L TN (red line).

The town of Wareham was one of the first Bay communities to take action to reduce new nitrogen from on-site septic systems with the passage of their 2013 Board of Health regulation requiring nitrogen reducing septic systems for new construction. In addition, the 2010 Wareham Nitrogen Consensus Action Plan – the product of the BBC-lead effort to bring consensus to the nitrogen pollution problem in Wareham – stated that expanded sewering in the Gateway Shores neighborhood and connection of existing mobile home parks to municipal sewer as a priority.

However, Wareham cannot expand wastewater infrastructure and collect more volume without first finding an alternative discharge location and expanding treatment capacity. The relocation of the Wareham WPCF discharge pipe from the Agawam River to a less sensitive location could eliminate approximately 14,241.27lbs/yr of nitrogen from the Agawam River while at the same time allow the town to connect Gateway Shores and mobile home parks to utilize the approximately 500,000 gallons per day (gpd) of existing excess treatment capacity at the WWTF. This sewer expansion could yield an additional 22,001.85lbs/yr of nitrogen removal from the Agawam/Wareham River.

Buttermilk and Little Buttermilk Bay - Listed in 2012 as impaired for estuarine bioassessment due to nutrient pollution, Buttermilk Bay is a shallow embayment formerly known for abundant eelgrass coverage. However, today, eelgrass beds have died off due to eutrophication from nitrogen pollution. "The losses of eelgrass in the deep portions of the Bay and in some poorly flushed coves appear related to nutrient loading or increased turbidity. Today, eelgrass is absent from areas with the highest nutrient concentrations, depth of growth in Buttermilk Bay correlates with dissolved inorganic nitrogen content of seawater." (Costa, 1988).

Like the Agawam/Wareham River, excessive amounts of nitrogen polluting Buttermilk and Little Buttermilk Bay led to significant eelgrass die off.

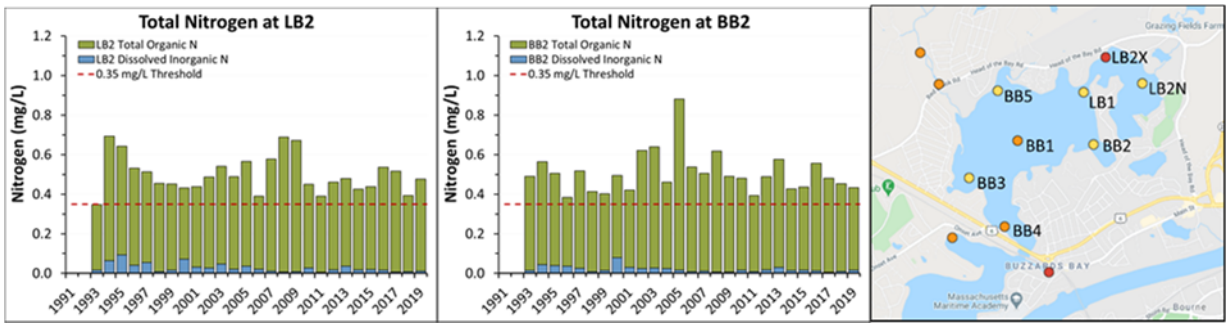


Figure 3. Coalition data illustrate that the total nitrogen in Buttermilk Bay exceeds the 0.35mg/L TN (red line)

Densely developed homes in Bourne and Plymouth using septic systems and cesspools contribute significant amounts of nitrogen to Buttermilk and Little Buttermilk Bay. Expansion of sewer infrastructure to approximately 800 homes in Bourne, and 485 homes in south Plymouth could yield approximately 45,163.54lbs/yr reduction to this estuary and reverse the loss of eelgrass habitat and restore ecosystem services.

Aucoot Cove-Listed in 2008 as impaired due to nutrient pollution, Aucoot Cove is rimmed with approximately 132 acres of saltmarsh and once abundant eelgrass beds. In addition to the many septic systems that discharge nitrogen to Aucoot Cove, the town of Marion's wastewater treatment facility discharges effluent to a fresh water tributary to Aucoot Cove. Figure 3 shows the twenty-nine years of Buzzards Bay water quality data show excessive amounts of nitrogen. In an effort to prevent water quality from declining further, the Marion Board of Health, with the aid of the Coalition, adopted a regulation in the summer of 2020 which requires all new construction to install a nitrogen reducing septic system. Furthermore, the town is currently undergoing a CWMP to evaluate options to meet federal permit requirements at the wastewater treatment plant. Marion's new permit requires the town to either upgrade treatment processes at the WWTP to reduce nitrogen and phosphorus, relocate

the discharge from the freshwater stream to Aucoot Cove, or join the regional wastewater district which removes the nitrogen load from Aucoot Cove entirely.

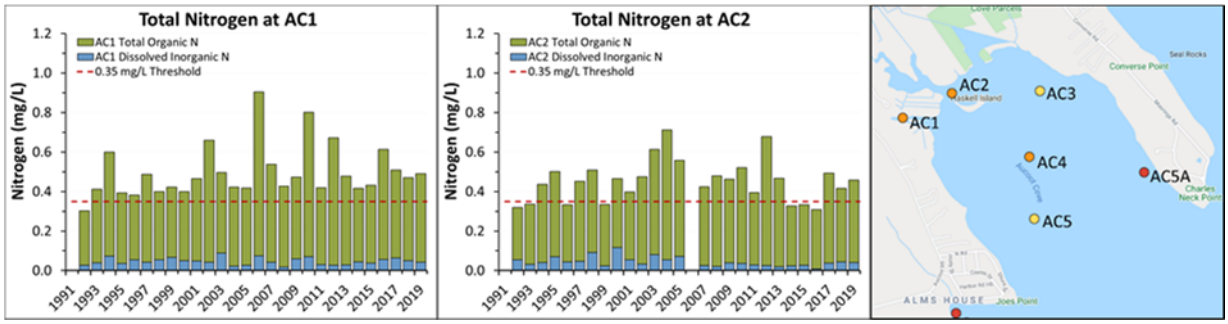


Figure 4. Coalition data illustrate that the total nitrogen in Aucoot Cove exceeds the 0.35mg/L TN (red line)

Sippican Harbor- Listed in 2008 as impaired for total nitrogen and nutrient/eutrophication biological indicators. Sippican Harbor supports a high degree of recreational resurces and has one of the largest population of boats. Sippican Harbor receives nitrogen pollution from septic systems as well as a nitrogen from the town's historic wastewater lagoons. Until 2020 these lagoons were unlined and used to store untreated wastewater. The town has since made important investments in lining the primary lagoon.

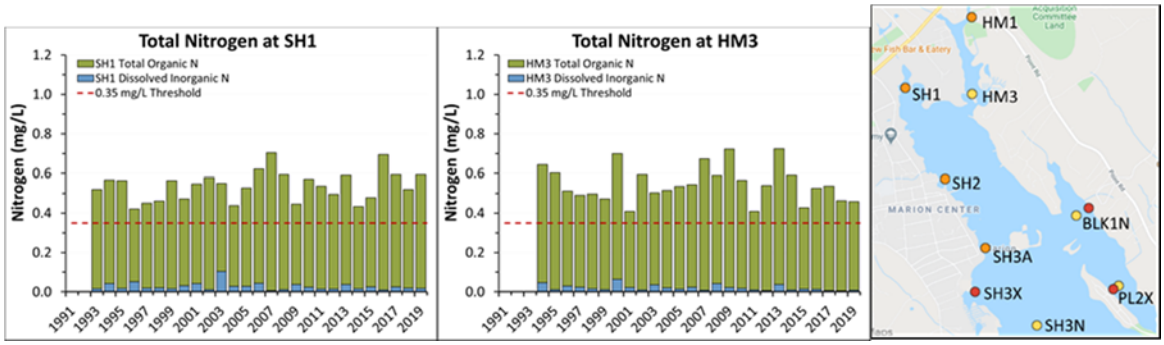


Figure 5. Coalition data illustrate that the total nitrogen in Sippican Harbor exceeds the 0.35mg/L TN (red line)

Weweantic River- Listed in 2010 as impaired for total nitrogen and estuarine bioassessment due to nutrient pollution, the Weweantic River has the largest watershed in the entire Buzzards Bay basin and contributes nearly 20% of the total freshwater inflow to Buzzards Bay. Nitrogen from wastewater is a major source of pollution contributing to impairment.

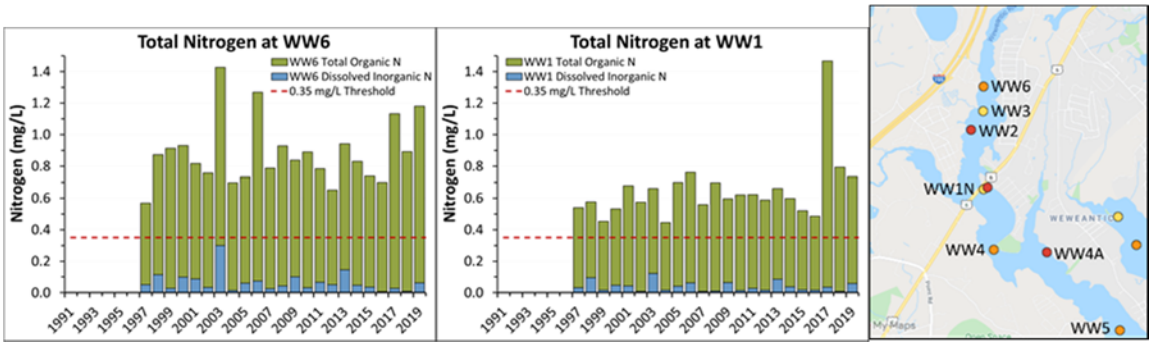


Figure 6. Coalition data illustrate that the total nitrogen in the Weweantic River exceeds the 0.35mg/L TN (red

ii. Background on Phase I – Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay

In 2015, the Coalition brought together the towns of Wareham, Bourne, and Plymouth – together with the Massachusetts Maritime Academy to determine whether a regional wastewater solution to reduce nitrogen pollution in two of upper Buzzards Bay's most critically nutrient impaired sub estuaries; the Agawam/Wareham River and Buttermilk and Little Buttermilk Bays, was feasible. Funded by the United States Environmental Protection Agency, the partnership set out to answer the following questions:

Can the Wareham WPCF discharge pipe be relocated from the Agawam River to the Cape Cod Canal? In an effort to answer this question, the partnership hired Green Seal Environmental to survey the railroad right-of-way to assess whether space existed for a treated effluent pipe. The survey was complete and the conclusion was that sufficient room existed based on the survey.

What was the maximum wastewater treatment capacity needed by each of the partners? This information was needed in order to answer two additional questions; Is there sufficient circulation at the Canal to accommodate a large treated wastewater discharge without adverse environmental impacts as well as to understand what upgrades were needed at the Wareham WPCF to treat additional flow from the partners. In the absence of Comprehensive Wastewater Management Plans for each of the communities, GHD Inc., was hired to complete a sewer needs analysis to estimate the maximum volume of wastewater generated from each community.

Does the Cape Cod Canal have sufficient flushing capacity to accept an increased wastewater discharge at the Massachusetts Maritime discharge pipe? The primary purpose of the overall project is to significantly reduce nitrogen pollution in critically impaired waterbodies in Upper Buzzards Bay. In order to be a success, the project also needed to evaluate whether collecting and treating and then discharging a significant amount of wastewater reduces water quality in other areas. Developing and running a hydrodynamic model to show where the discharge will flow and what impact it may or may not have, was critical.

With baseline water quality and estimated wastewater flows in hand, the project hired the Woods Hole Oceanographic Institute (WHOI) to develop a hydrodynamic model to understand what impact an

increased discharge would have on the upper Bay. The results of the model showed that the projected increased discharge at the Cape Cod Canal should negligibly impact total nitrogen concentrations in Upper Buzzards Bay and its sub-estuaries.

What treatment processes must be expanded or upgraded at the Wareham WPCF in order to treat increased wastewater flow? A preliminary assessment to identify treatment steps that will have to be modified to accommodate the future flows was finished. It was determined that the following options for expansion must be further assessed:

1. Replace the current facility with a new facility.
2. Construct a parallel facility on the property to treat future flows.
3. Increase the treatment capacity of existing facility by expanding the preliminary treatment process, convert existing aeration tanks and secondary clarifiers to a secondary process with a smaller footprint (such as a Membrane Biological Reactor system) and construct additional secondary treatment tanks. Expand denitrification and UV processes.

Finally, the first phase of the Upper Bay project commenced the baseline data collection needed to support the permitting of a discharge at the Canal location.

The first phase of the project concluded **that expanding sewer around nitrogen impaired waterbodies and discharging that highly treated wastewater to the Cape Cod Canal is feasible, will result in significant nitrogen reductions on a region-wide basis, and must be actively pursued.**

Significant nitrogen reductions can be realized in the Agawam River by the relocation of the Wareham Wastewater Treatment Facility's (Wareham WWTF) ocean discharge to the Cape Cod Canal. This project illustrates through hydrodynamic modeling that the Cape Cod Canal's ability to assimilate nitrogen from highly treated wastewater is significant. Furthermore, this project determined through a full survey of the MassDOT railroad right-of-way that locating a sewer force main for treated effluent in the right of way of the MassDOT railroad is possible, and upgrades to the Wareham WWTF can be made to accommodate the sewer needs of the partners to reduce nitrogen pollution to impaired waterbodies.

At the outset of this project, the goal was to show how an estimated 81,406.66lbs of nitrogen per year could be reduced from impaired estuaries in upper Buzzards Bay. Table 1 below, illustrates the original estimates.

b. Project Results

i. Goals of the project and outcomes.

The "Multi-Community Collaboration to Reduce Nitrogen in Upper Buzzards Bay – Phase II – Baseline Assessment & Alternatives Selection " (Upper Bay Project) set out to complete four essential tasks.

1. Complete habitat and water quality baseline assessments required to support the first-ever relocation of a wastewater ocean discharge under the 2014 amendments to the Massachusetts State Ocean Sanctuaries Act,

2. Evaluate state-of-the-art alternatives for expanding the capacity of the WPCF from 2 MGD to 7 MGD to accommodate the needs of the Project's partners while at the same time maintain exceptional treatment,

3. Assess and select the most economic relocation route for the treated effluent force main leading to a new outfall (abandoning both the existing Wareham outfall discharging to the Agawam River and existing MMA outfall which does not treat for Nitrogen discharging to the Cape Cod Canal) to a suitable location at the Cape Cod Canal, and,

4. Evaluate and recommend whether a regional-based governing structure is warranted to manage and finance the implementation of this project.

In April 2020, the Coalition proposed an additional task, complete a ratepayer analysis, to understand how current sewer rates in the partner communities are impacted by the costs of the regional wastewater solution versus a wastewater solution that the communities pursue on their own.

1. Science

The first task was completing baseline water quality and habitat assessments for the State's first ever relocation of a municipal wastewater discharge pipe. Until 2014, Massachusetts law prohibited the permitting of a new municipal wastewater ocean discharge in state-designated ocean sanctuaries, including Buzzards Bay. The passage of Chapter 259 of the Acts of 2014 allows the Massachusetts Department of Environmental Protection (MassDEP) to approve ocean discharges in ocean sanctuaries if the discharge receives advanced treatment for nitrogen and when robust scientific evidence shows that there is no adverse impact to ocean water quality. State law requires that twenty-four months of baseline water quality and habitat assessment data be collected prior to applying for outfall relocation in an ocean sanctuary. The FY15 SNEP Project collected 13 months of water quality data. This project completed the remaining months of water quality data as well as collecting baseline information on the benthic habitat, eelgrass resources, and fish resources.

a. Water Quality Monitoring

i. Purpose.

Task 1.1 assessed water quality in the vicinity of the discharge site and surrounding areas. Water quality was monitored via discrete surface and bottoms samples and by automated continuous measurements in the bottom waters. This data collection completed the 24 months of baseline water quality data needed for regulatory evaluation under the State Ocean Sanctuaries Act.

ii. Summary of Report

Measurements of dissolved oxygen, salinity, water temperature, water clarity, and nutrient concentrations were made at seven stations in Upper Buzzards Bay as identified on Figure 7. Discrete water samples for laboratory nutrient analysis were collected monthly under both ebb and flow conditions from September – October 2018, May – October 2019, and May – August 2020. Continuous measurements of dissolved oxygen, temperature, salinity, and chlorophyll were collected every 15 minutes 1 meter above the sea floor adjacent to the MMA dock for the majority of the period from September 2018 through August 2020. Sampling and analysis procedures followed an EPA-approved Quality Assurance Project Plan[1].

[1] Buzzards Bay Coalition, Massachusetts Maritime Academy, and Marine Biological Laboratory (2018). Quality Assurance Project Plan For Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay. 14 p.

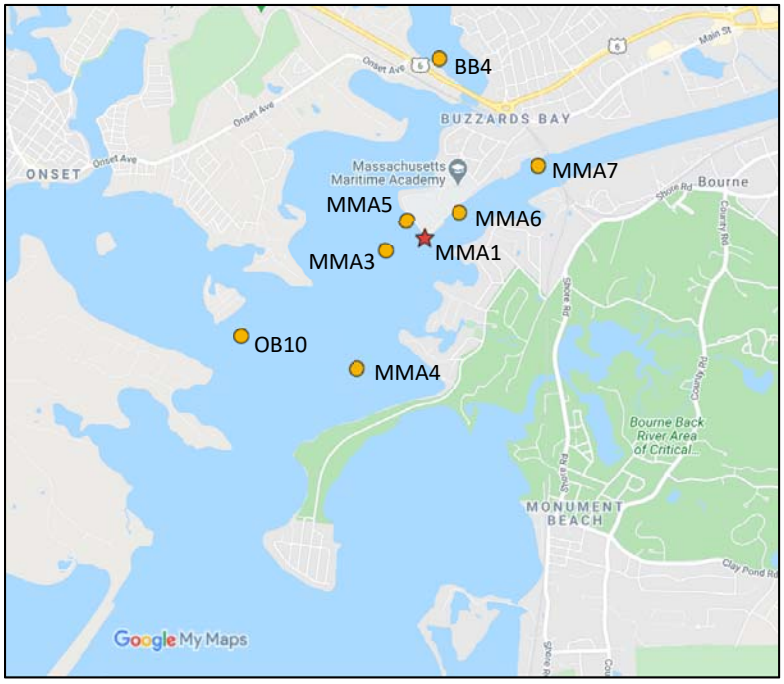


Figure 7. Upper Bay Monitoring Sites.

A total of 274 discrete samples were collected for nutrient analysis as a part of this SNEP project, which builds upon samples collected through the earlier SNEP Upper Bay project, historic BBC Baywatchers program sampling, and sampling performed by the Town of Wareham. The broad results of the discrete nutrient sampling are that the total nitrogen concentrations are generally low in Upper Buzzards Bay and that the nutrient concentrations across all the stations generally followed a similar pattern over time (Figure 8).

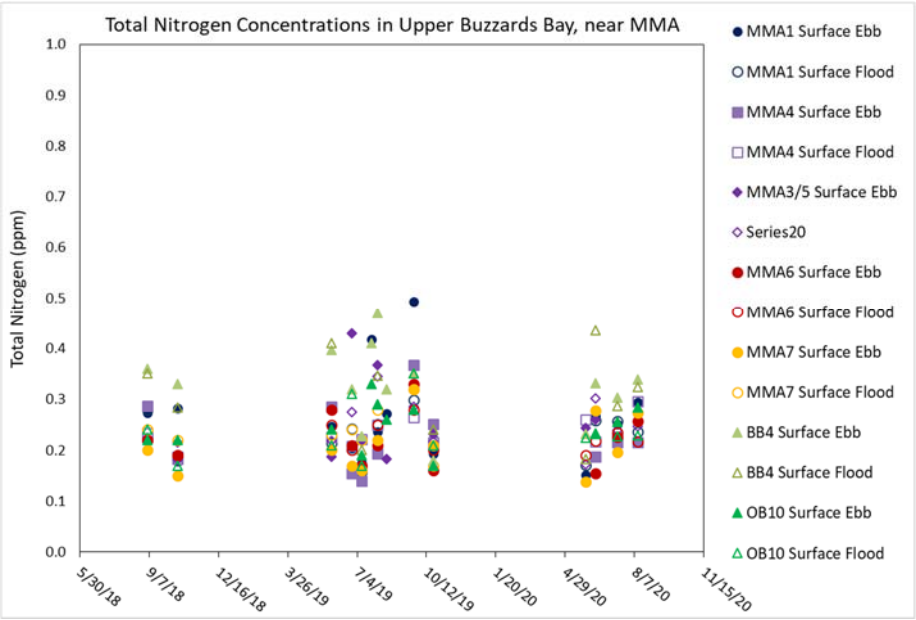


Figure 8. Total nitrogen concentrations measured in Upper Buzzards Bay

Through this grant, the water quality sonde deployed at the MMA dock collected around 60,000 measurements of dissolved oxygen, temperature, salinity, chlorophyll, and pH. The measurements show how parameters vary over the course of the year, with expected seasonal patterns in temperature and dissolved oxygen (Figure 9). Oxygen concentrations at this location were generally high and close to saturation with the air.

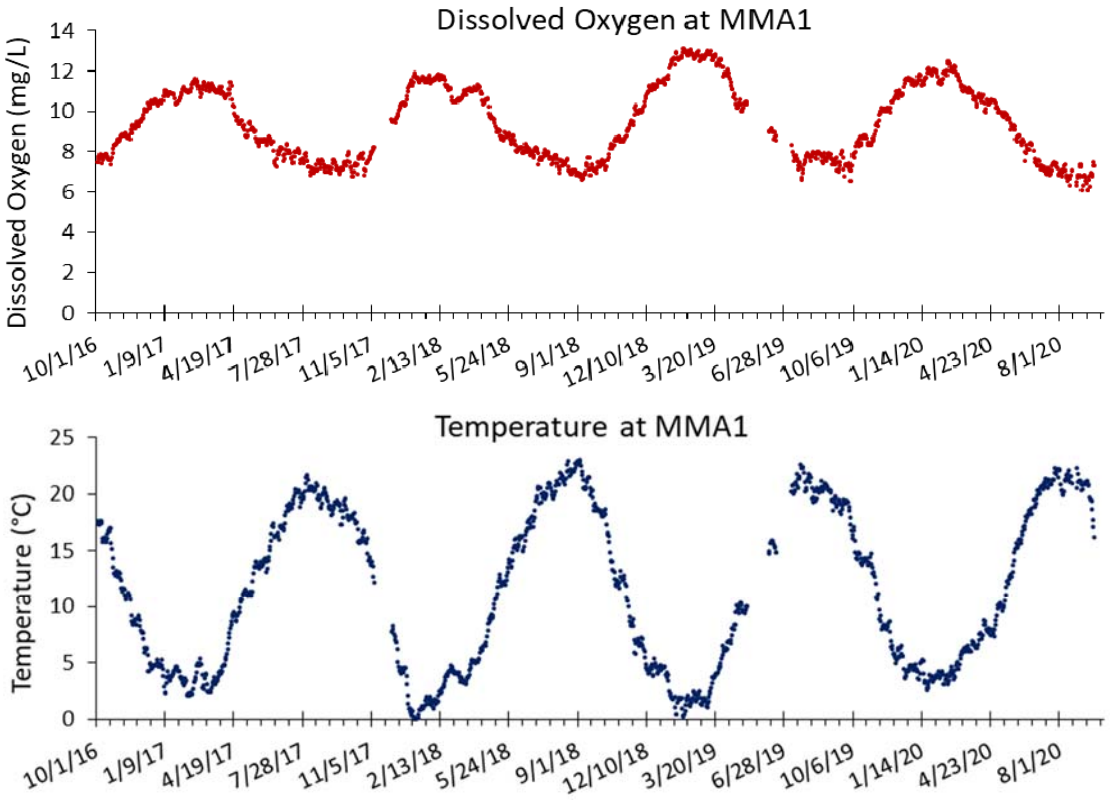


Figure 9. Daily averages of dissolved oxygen and temperature from the water quality sonde deployed at the MMA dock.

The water quality parameters at this location are strongly influenced by the tide with colder, saltier waters from Cape Cod Bay flowing from the Cape Cod Canal into the area at low tide. A full description of the BBC's water quality monitoring of Upper Buzzards Bay is included in the attached report, Attachment 1, "Buzzards Bay Coalition Water Quality Monitoring in Upper Buzzards Bay: Summary of Four Years of Data Collection."

iii. **Project Partner Contribution**

The water quality monitoring was a team effort. Staff from the Town of Wareham, MMA, and BBC all supported the collection of discrete water samples. A boat for sample collection was provided for six sampling events each by the Town of Wareham Harbormaster and by the MMA. BBC staff coordinated and led the sampling and filtering with assistance from MMA cadets and volunteers. BBC staff delivered the samples to the Marine Biological Laboratory in Woods Hole. BBC and Marine Biological Laboratory staff performed quality assurance checks on the samples and data. The operation and maintenance of the continuous water quality sonde was performed in partnership with the BBC and MMA. MMA cadets

under the supervision of MMA Professor Bill Hubbard cleaned the sonde and checked its calibration approximately once a month, though fouling was not a significant issue. Maintenance by the manufacturer was overseen by BBC Director of Monitoring Programs, Tony Williams. Data management was performed by BBC Science Director, Rachel Jakuba.

iv. Volunteer and Community Involvement

Volunteers helped to collect and filter the discrete water quality samples. Staff and students at MMA regularly checked the sonde output, which is displayed in real-time on a computer monitor in the MMA Aquaculture Lab, particularly to see the water temperature prior to scuba diving in the area.

v. Outreach and Communication

In November 2018, the BBC Board of Directors and staff visited the MMA to learn about the project. The BBC Board of Directors includes 17 influential individuals from around the Buzzard Bay watershed and the BBC staff is about 20 people that work on a range of projects and interact with members of the public while leading programs, performing field work, or interacting with volunteers. MMA President Rear Admiral Francis McDonald greeted the BBC visitors and expressed his appreciation for the project and the partnership with the BBC. The Board and staff had an opportunity to view some of the benthic organisms magnified with a microscope, see where the sensor is deployed and the data it generates, view the location of the proposed outfall relocation, and learn about the type of research the MMA conducts.

vi. **QAPP**

The final version of the QAPP for the water quality analysis that EPA approved was submitted on October 31, 2018.

b. Benthic Analysis

i. Purpose

At the bottom of the water column, the area around the seafloor – or benthic environment – collects particles that sink, including dead plankton, fecal pellets of marine organisms, and sediment. The benthic environment, thus collects material from the water column over time, providing an indication of the ecosystem status of the waters above. The sediment characteristics and the organisms present in the sediments provide valuable information about overall ecosystem health.

ii. Summary of report

Benthic analysis occurred at five stations in Upper Buzzards Bay (MMA3, MMA4, MMA5, MMA6, and MMA7, see Figure 7) in October 2018. Surficial sediments were analyzed for benthic fauna, total organic content, and sediment grain size. Sample collection and analysis followed an EPA-approved Quality Assurance Project Plan[2].

[2] Jakuba, R. W. and Hubbard, W. 2018. Quality Assurance Project Plan for Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay - Benthic Analysis. 25 p.

This study of Upper Buzzards Bay benthic environments showed that there are a variety of different communities and substrates within the study area. At MMA6 and MMA7, located in the fast-current Cape Cod Canal, the seafloor was predominately a mussel bed and cobble (Figure 10). Located within MassDEP mapped eelgrass, the seafloor at site MMA4 consisted of eelgrass and coarse and medium sand bottoms, whereas MMA3, also located within MassDEP mapped eelgrass beds, had a coarse sand bottom without eelgrass present. Lastly, the seafloor at MMA5 was covered with a slipper shell community and was where the highest number of species and individual organisms were present.

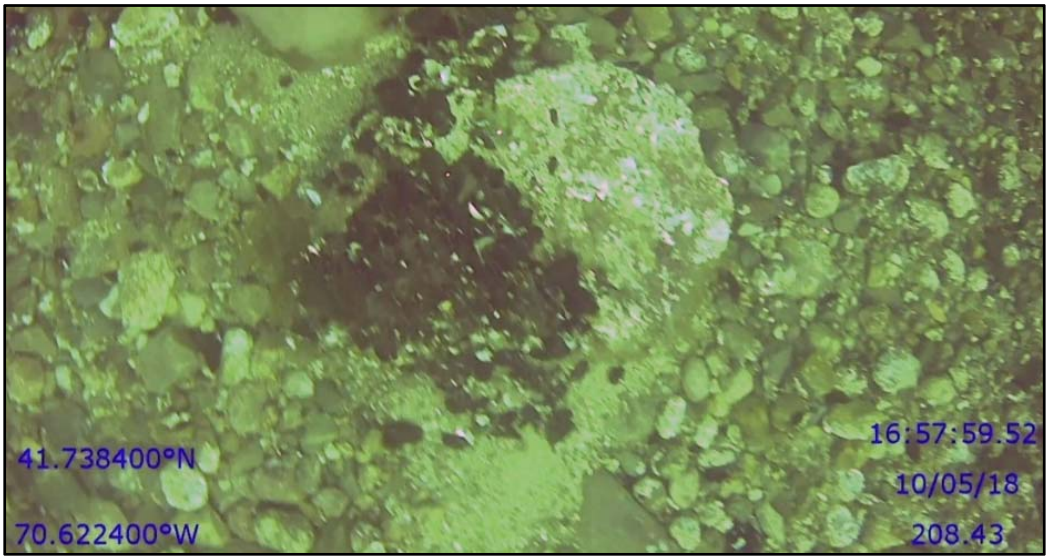


Figure 10 Image from station MMA6 within the Cape Cod Canal showing a widespread mussel bed with cobble.

While each area is unique, the benthic survey demonstrated that all areas supported benthic macrofauna communities with between 16 and 42 total species per site and total individuals ranging from 174 to 797 (Table 1). The diversity indices provide insight on the relative habitat suitability of the different benthic environments. Stations located outside of the canal (MMA3, MMA4, MMA5) generally had higher diversity indices compared to stations located within the canal (MMA6 and MMA7). This is consistent with the extremely strong currents through the canal that can scour sediments making it a challenging environment for benthic species. The full results are described in the attached report "Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay – Benthic Analysis." (Attachment 2).

Table 1: Summary of the number of species and individuals present and most abundant species at each benthic station.

Station	Total Species	Total Individuals	Most Abundant	2nd Most Abundant	3rd Most Abundant
MMA3	25±9	253±167	*Microphthalmus aberrans*	*Parapionosyllis longcirrata*	*Leitoscoloplos fragilis*
MMA4	35±7	327±139	*Salvatoria clavata*	*Mediomastus ambiseta*	*Dodecaceria coralii*
MMA5	42±7	797±218	*Mediomastus ambiseta*	*Lembos websteri*	*Astyris lunata*
MMA6	16±1	174±75	*Mytilus edulis*	*Idotea balthica*	*Astyris lunata*

MMA7	20±2	504±118	*Mytilus edulis*	*Idotea balthica*	*Astyris lunata*

iii. Project Partner Contribution

The benthic analysis was performed with personnel from MMA and BBC project partners. The QAPP was drafted by MMA and BBC personnel in consultation with MassDEP officials and their consultants who were in the process of preparing a QAPP for benthic analysis associated with the Massachusetts Estuaries Project. Benthic sample collection was performed by MMA and BBC personnel using MMA and BBC equipment while onboard a MMA research vessel. Sample analysis was performed by BBC Research Assistant Christine Gurdon and MMA cadets, overseen by MMA professor Bill Hubbard. The final report was written by BBC staff Christine Gurdon and Rachel Jakuba and MMA professor Bill Hubbard.

iv. Volunteer and Community Involvement

Volunteers were not involved in this portion of the work; however, MMA cadets did take part in the sampling and analysis of the benthic samples.

v. Outreach and Communication

There was significant outreach and communication in the development of the sampling plan and QAPP. Sampling stations were identified after consulting with officials from MassDEP, Massachusetts Office of Coastal Zone Management (CZM), Massachusetts Division of Marine Fisheries, and scientific experts from the Marine Biological Laboratory, the Woods Hole Oceanographic Institution, and the Woods Hole Research Center. The QAPP was developed in consultation with MassDEP and CZM officials and their consultants to ensure this project's QAPP was consistent with benthic analysis associated with the Massachusetts Estuaries Project. The resultant report has been provided to officials at CZM and the Buzzards Bay National Estuary Program. Results were presented to all the project partners in August 2019 and in October 2019 to officials from MassDEP, CZM, Massachusetts Division of Marine Fisheries and the Buzzards Bay National Estuary Program.

vi. QAPP

The final version of the QAPP for the benthic analysis that EPA approved was submitted on October 16, 2018.

c. Evaluation of Submerged Aquatic Vegetation

i. Purpose

Eelgrass beds are highly productive underwater areas that act as a nursery, habitat, and feeding ground for many fish, waterfowl, and invertebrates. The Buzzards Bay National Estuary Program's Comprehensive Conservation and Management Plan identifies loss of eelgrass due to excess nitrogen as a priority concern. The sensitivity of eelgrass to pollution also make it an ideal indicator species for changes in water quality. The extent of eelgrass beds was assessed at two locations to provide baseline data on an area in close proximity to the new discharge location and on an area considered out of the area of influence of the new discharge location. The location in close proximity to the discharge (off of Taylor's Point) was mapped in

order to have a baseline to compare potential impact of the discharge. The location out of the area of influence (off of Mashnee Island) will provide a control bed for comparison in order to account for impacts unrelated to the discharge (e.g., temperature, disease).

ii. Summary of report

Initial delineations of the eelgrass beds were taken from MassDEP's ArcGIS eelgrass layer, which is developed based on aerial imagery. A pilot study of only the area close to the discharge site was surveyed in 2018. In 2019, both areas were mapped in the field using sidescan sonar for preliminary delineation of the eelgrass beds, and underwater video was used to verify the sonar data. The survey was done using standard methods and with a 50% spatial coverage overlap of track lines. The data was processed into a basic mosaic that delineates the extent of the eelgrass beds (Figure 11). The full results are described in the attached report "Eelgrass Surveys for Wareham Wastewater Treatment Plant Project 2018-2019." Attachment 3.

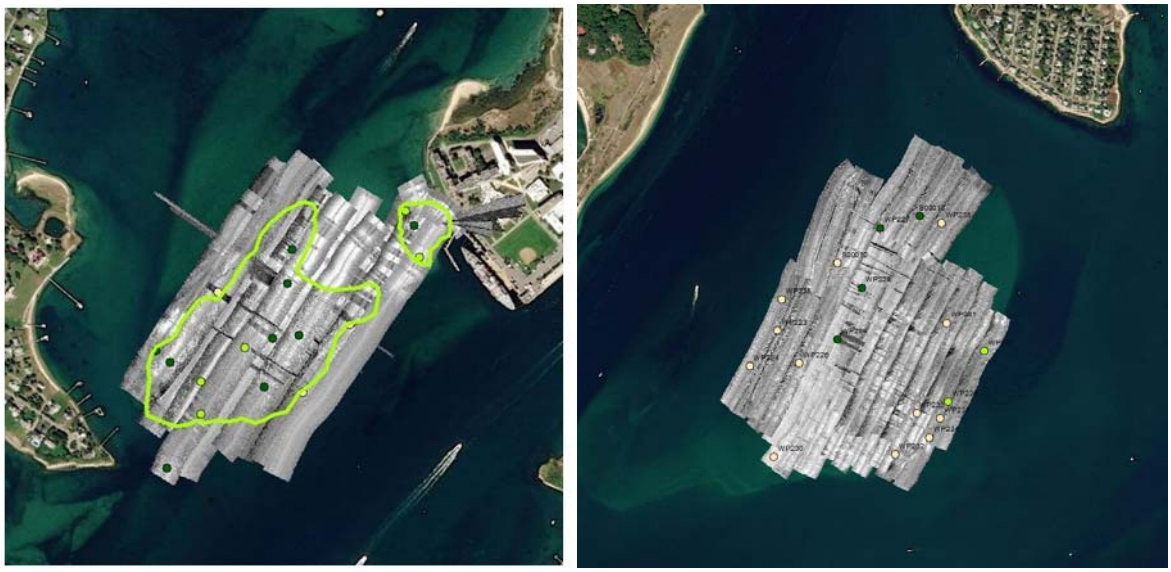


Figure 11. Side scan sonar data (gray) overlying maps of the potential impact site (left) and the reference site (right). The extent of the eelgrass beds is indicated with the green line.

iii. Project Partner Contribution

The evaluation of Submerged Aquatic Vegetation was performed by DMF staff Kathryn Ford and Steven Voss. DMF staff developed the initial eelgrass bed delineations, performed the field mapping using side-scan sonar with underwater video for groundtruthing, completed the data processing and quality control checks, and wrote the summary report.

iv. Volunteer and Community Involvement

There was no volunteer or community involvement as a part of this work.

v. Outreach and Communication

The results were presented in October 2019 to officials from MassDEP, CZM, MMA, and the Buzzards Bay National Estuary Program.

d. Fisheries Resource Assessment

i. Purpose

The location of the proposed discharge in the Cape Cod Canal is unique. It sits in an area with vigorous currents and tidal flows – it is estimated that roughly 56-80 billion gallons of water flows through the canal every day. This environment makes the Canal primarily a short-term habitat used by fish, with migrating fish passing through the Canal and the type of fish in the Canal changing over the course of the year. To assess the baseline conditions of finfish resources near the proposed discharge, trawl data was compiled for 10 years from Upper Buzzards Bay and Cape Cod Bay near the Canal exits.

ii. Summary of report

The DMF Resource Assessment Project has conducted annual spring and fall bottom trawl surveys of Massachusetts territorial waters since 1978.To assess the baseline conditions of finfish resources near the proposed discharge, trawl data was compiled for a 10-year period from Upper Buzzards Bay and Cape Cod Bay near the Canal exits. Data from 250 trawls were analyzed and showed clear differences in the species and patterns observed each season and in Buzzards Bay and Cape Cod Bay. This is evident in the relative abundance of the most prevalent species, which show how the dominant species change between spring and fall in both Buzzards Bay and Cape Cod Bay and how the two regions differ from one another (Figure 12).

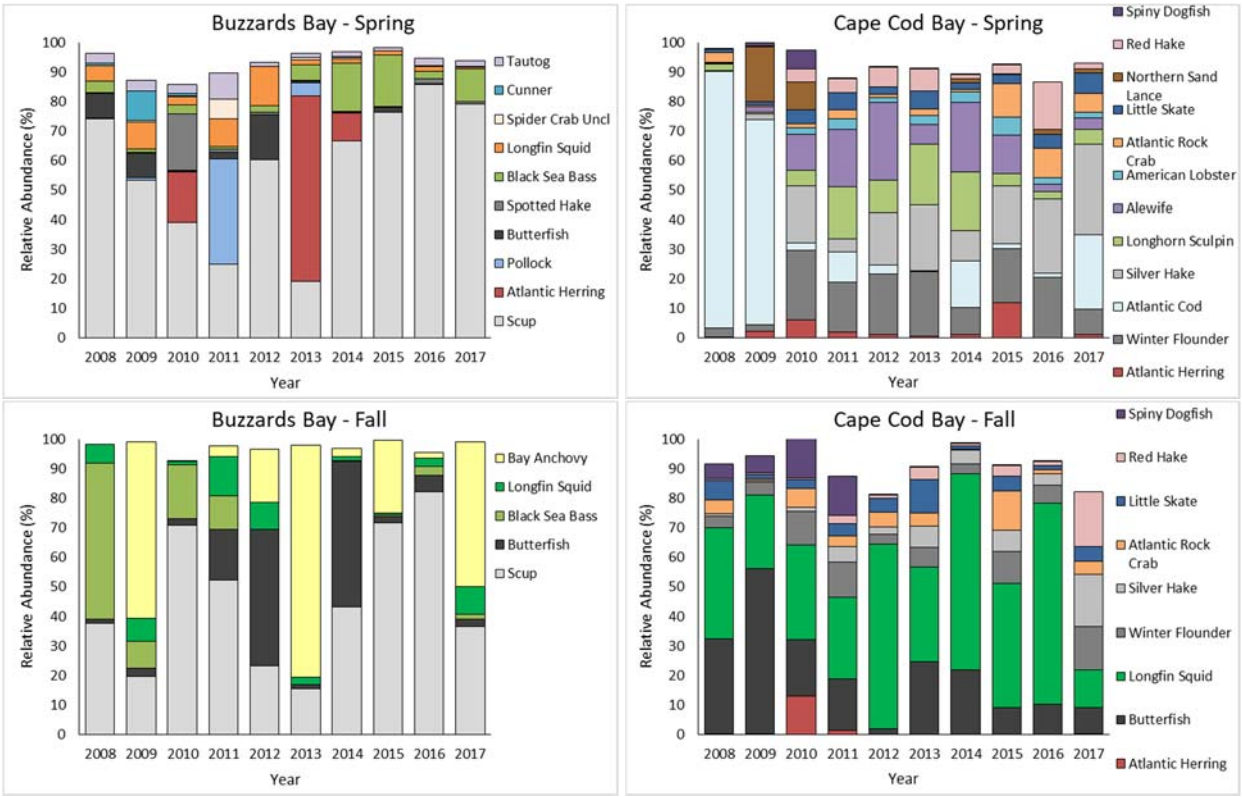


Figure 12. Relative abundance of the most prevalent species in each basin, each season.

Inter-annual variability is expected in biological surveys. To establish whether there are any temporal trends in the survey data that reflect changes over time, as opposed to inter-annual variability, a trend analysis using linear regressions were performed. Trend analysis was performed on the number of individuals, the number of species, the total biomass, the average fish size, and the number of individuals and size of the most abundant species. In general, there are not strong trends over time in the metrics analyzed. When the data was adjusted for level of effort, during the spring season only in Buzzards Bay, there was an increasing trend in the number of individuals collected per trawl station, the biomass collected per trawl station, and the number of Scup collected per trawl, which was the most abundant species. In Cape Cod Bay during the spring surveys, there were statistically significant increasing trends in the number of Silver Hake collected in total and per trawl and the number of Atlantic Cod collected per trawl. In Buzzards Bay, there was a decreasing trend in the average weight of Atlantic Herring in the spring, and in the fall, there was an increasing trend in the average weight of two of the most abundant species, Longfin Squid and Bay Anchovy.

In summary, the results of this analysis show that there are dynamic populations of fin fish that utilize Upper Buzzards Bay and Cape Cod Bay on either side of the Canal exit. The detailed results are described in the attached report "Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay – Fisheries Resource Analysis." Attachment 4.

iii. Project Partner Contribution

The trawl data were provided by staff from the DMF. BBC staff developed the QAPP, performed the statistical analysis, and wrote the report.

iv. Volunteer and Community Involvement

There was no volunteer or community involvement as a part of this work.

v. Outreach and Communication

The results of this analysis have been shared with DMF staff.

vi. QAPP

The EPA approved the QAPP for the fisheries resource analysis[3] on August 24, 2020.

[3] Jakuba, R. (2020) Quality Assurance Project Plan for Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay – Fisheries Analysis. 18 pp.

2. WWTP Upgrade – Treatment Capacity & Technology and Alternatives Analysis

The treatment capacity of the Wareham WPCF must be increased in order to treat the existing and future sewer needs of the partners. Currently, the Wareham WPCF has the capacity to treat up to 2MGD average daily flow but discharge only 1.56MGD average daily flow. The short-term (20-years) flows needed from all partners, including current flows, is estimated at 3.5MGD with a full theoretical buildout of 7MGD. The Coalition contracted with GHD for this task as this work builds on the needs analysis GHD completed in Phase I. GHD's Full Draft-Final Report "DRAFT Wareham WPCF Expansion Memorandum" dated September 16, 2020 is attached hereto as Attachment 5.

a. Purpose. The overall goal of this task is to review and assess three options for wastewater liquid treatment and three options for wastewater sludge treatment under future expansion conditions for flows of up to 7 MGD at the WPCF. This task includes a conceptual design, cost estimate and memorandum identifying the steps taken to reach the selected alternative.

b. Summary of Report.

i. Refine Partner Needs Analysis :

GHD, together with the Coalition, worked with each of the partners to refine needed wastewater flows. This work refined the Sewer Needs Assessment completed in 2015 as part of Phase I of the project. The 2015 Sewer Needs Assessment took a conservative approach looking at all potential areas of possible expansion and estimated a 7 MGD (full buildout) need. This conservative approach was necessary in 2015 in order to identify the maximum amount of potential wastewater to be discharged at the Cape Cod Canal. That maximum volume was needed to support the hydrodynamic modeling. However, that theoretical buildout number was not a practical number on which to base the design of a wastewater treatment facility. With that upper volume identified, GHD and the Coalition worked with each of the communities to identify a more practical 20-year flow need. After several meetings and communications with each of the partners' engineers, it was determined that a 3.5 MGD average daily influent flow was needed to design a wastewater treatment plant to meet the partners' 20-year needs. Table 2 identifies each communities estimated flows.

TABLE 2 **Influent Flow by Community**

	Flow[1] (gpd)	I/I[1] (gpd)	Total[1] (gpd)
Existing Flow at Wareham WPCF	999,000	Included in Flow[2]	999,000
Future Wareham Flows	666,000	167,000	833,000
Future Bourne Flows	309,000	77,000	386,000
Future MMA Flows	100,000	Included in Flow[2]	100,000
Future Plymouth Flows	63,000	16,000	79,000
Future Marion Flows	820,000	62,000[3]	882,000
Contingency	200,000	Included in Flow	200,000
TOTAL	**3,200,000**	**300,000**	**3,500,000**

Notes:
1. Community flow values rounded to the thousands place and Total flows rounded to the hundred thousand place.
2. The existing flow at Wareham WPCF and Future MMA flows include the I/I in the flow value.
3. Marion I/I represents the future I/I from new residential and commercial connections. I/I currently flowing to the Marion WWTF is included in the flow value.

Without more refined estimates provided by updated Comprehensive Wastewater Management Plans (CWMPs), the flow needs for the partners will likely continue to evolve. As of the drafting of this final report, all partners CWMPs were in progress but not yet complete to a point to finalize flow numbers. In the absence of that information, GHD and the Coalition outlined expected contribution based on several conversations and meetings with partners and the best data available at the time was used. However, these numbers continue to evolve.

ii. Treatment Process Selection

Three separate liquid options were considered for the WPCF expansion including; improved technology, a new treatment plant, or additional tanks and processes. These liquid treatment options were evaluated and compared through a number of workshops, cost comparisons, and layout analyses to determine the best options with which to proceed and are fully explained in the April 29, 2020 GHD Memo.

Enhance existing MLE process through improved technology. Integrated fixed film activated sludge, membrane bioreactor, Nereda, and BioMag were all technologies evaluated to assess whether they could provide additional treatment capacity and performance at the WPCF. Vendors for each technology were contacted to discuss specific need of Wareham such as flow rates and process locations.

Development of a new treatment facility. GHD also evaluated the design and construction of a new treatment facility using activated sludge secondary treatment process. This alternative was ruled out as cost/logistically infeasible.

Addition of tanks/process to existing MLE technology. Finally, GHD considered the addition of tanks and process components at the existing facility keeping the current Modified Ludzeck-Ettinger (MLE) configuration.

GHD further developed and evaluated a membrane bioreactor system and the addition of tanks and processes to the existing MLE configuration. Ultimately, GHD recommended that the secondary treatment process using the MLE method. GHD concludes that the existing facility is an MLE system and has been shown to operate well and meet the treatment limits. The MLE system had moderately lower capital construction costs as well as lower operating and maintenance costs compared to the MBR.

Three separate options for solids treatment were considered for the expansion of the facility including thickening and dewatering sludge, thickening-digestions-dewatering, and thickening-dewatering and alternative process such as drying or composting.

Thickening and Dewatering. In order to create thickened sludge, which can be pumped and transported as a liquid, solids are stored in tanks then pumped to a thickening unit. Thickened sludge goes to a second set of storage tanks before it is pumped to trucks to deliver to an offsite facility. To create dewatered sludge, the solids are stored in a tank and then pumped into a dewatering system. The dewatered sludge comes out as a solid cake that can be conveyed to dumpsters and hauled away by flatbed truck.

Thickening, Digestion and Dewatering. The second option evaluated involves the digestion of the sludge in addition to dewatering and thickening. To complete sludge digestion, an anaerobic digester

would need to be constructed. In limited uses, some of this sludge can be applied to some soils as fertilizer. Use of a digester produces biogas including methane which can be burned to create energy. However, an anerobic digester is only recommended for larger plants with primary treatment, absent at the WPCF.

Thickening, Dewatering, and Alternative Process Such as Drying or Composting. The final option considered included the onsite composting of the sludge which could also be more readily used as a fertilizer. Composting or drying processes can release some odorous compounds which is a concern for this location as it is surrounded by residential homes.

Ultimately, flexibility to switch between thickened and dewatered sludge was required due to the volatility in the sludge disposal market and a shortage of disposal locations. This gives the plant the flexibility to dispose of thickened sludge when the thickened sludge market is favorable and dewatered sludge when the dewatered sludge market is more favorable. One of the major disadvantages of the other alternatives considered was the cost to construct the additional processes and the viability of disposal and use as a fertilizer because of the presence of perflouroalkyl and polyfluoroalkyl (PFAS) substances in the sludge.

Conceptual Design: The following illustration, Figure 13, shows the conceptual layout of a 3.5MGD plant expanding on the current MLE technology currently in use. A full buildout to 7MGD was also considered as part of this project in order to ensure that a twenty year 3.5MGD design would accommodate future expansion.

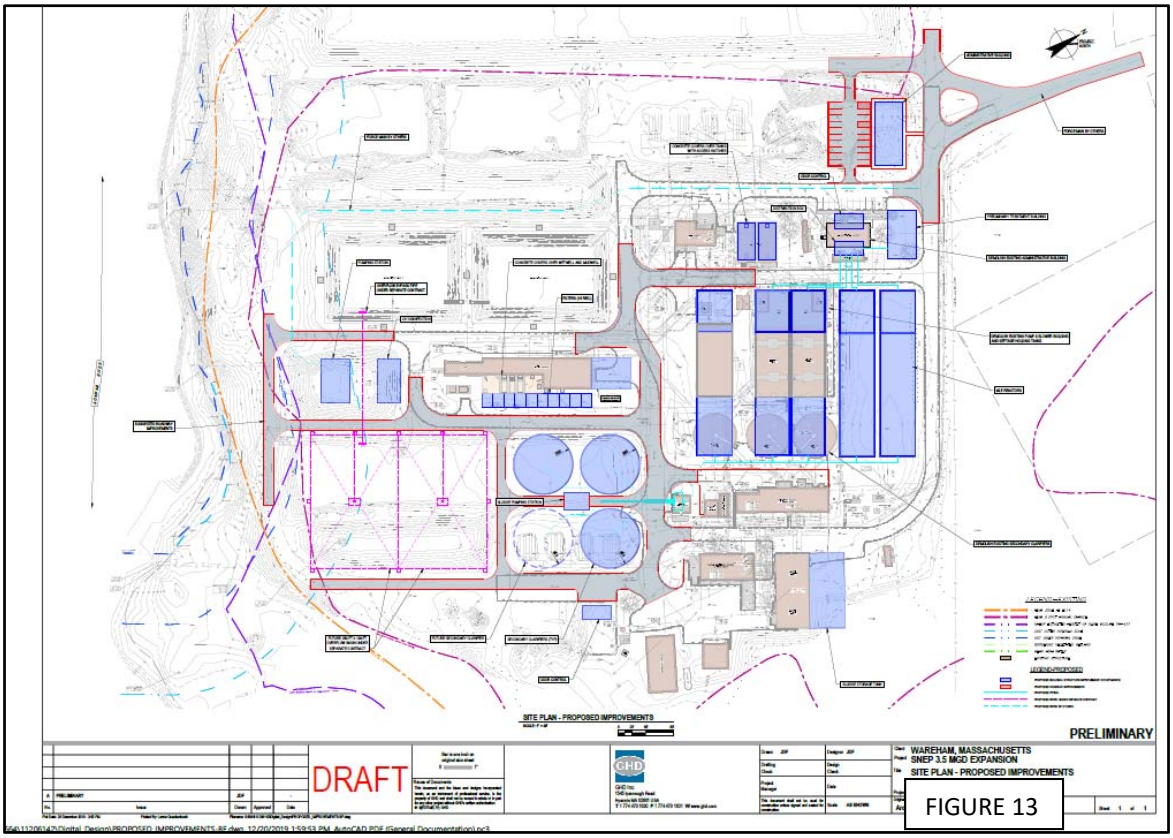


FIGURE 13

Costs: Engineers' Opinion of Probable Costs for infrastructure were developed as part of this initial planning process and are outlined in Table 3. It is important to note that as the project progresses, it is critical that these costs are refined and updated. The total capital costs to upgrade the existing 2MGD plant to 3.5MGD is estimated at $100,000,000. A plant of this size is estimated to be able to take and treat all of the partners 20-year existing and design flows.

The full implementation of this project will take several years to build out. In other words, it will take many years to expand sewer in the partner communities and generate the estimated 3.5MGD the project envisions. In order to account for a phased approach, some areas coming on line several years before others, the cost estimates to expand the WPCF were broken down into increments.

TABLE 3 **Engineers' Opinion of Probable Construction Costs for MLE**

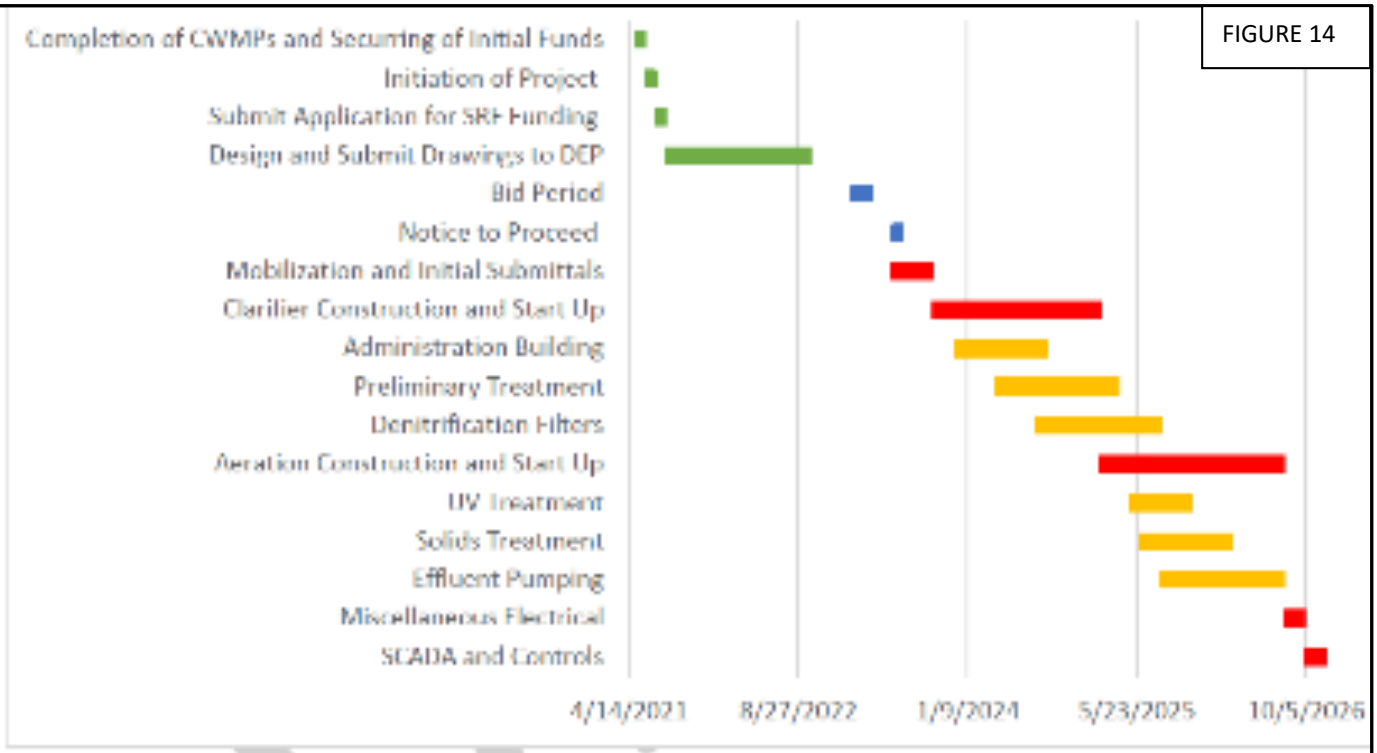
Component	Incremental Cost Existing Plant To 2.5 MGD	Incremental Cost 2.5 MGD to 3 MGD	Incremental Cost 3 MGD to 3.5 MGD	Total Upgrade Probable Cost Existing Plant to 3.5 MGD
Preliminary Treatment	$2,100,000	$0	$0	$2,100,000
MLE Reactors	$8,700,000	$2,300,000	$2,300,000	$14,100,000
Clarifiers	$4,400,000	$1,700,000	$0	$6,000,000
Denitrification Filters	$3,200,000	$400,000	$400,000	$4,000,000
UV Disinfection	$1,800,000	$200,000	$200,000	$2,200,000
Effluent Pump Station	$3,600,000	$100,000	$0	$3,600,000
Solids Treatment	$3,300,000	$200,000	$200,000	$3,600,000
Septage Receiving Building Rehab	$400,000	$0	$0	$400,000
Odor Control	$900,000	$900,000	$0	$1,800,000
Process & Filter Building	$1,500,000	$700,000	$0	$2,200,000
Operations Building Allowance	$0	$0	$500,000	$500,000
Administration Building	$0	$1,100,000	$0	$1,100,000
Electrical & Instrumentation	$4,500,000	$1,100,000	$500,000	$6,200,000
HVAC	$900,000	$200,000	$100,000	$1,200,000
Yard Piping	$1,500,000	$400,000	$200,000	$2,100,000
Site Work	$1,500,000	$400,000	$200,000	$2,100,000
Plumbing, Painting	$600,000	$100,000	$100,000	$800,000
General Conditions	$3,600,000	$900,000	$400,000	$5,000,000
Subtotal of Construction Costs	**$42,000,000**	**$11,000,000**	**$5,000,000**	**$59,000,000**
Contingency[1]	$12,700,000	$3,200,000	$1,500,000	$17,700,000
TOTAL CONSTRUCTION[2,3] (ENR - Oct 2019 = 11326)	**$55,000,000**	**$14,000,000**	**$7,000,000**	**$77,000,000**
Fiscal, Legal, Engineering Allowance	$16,500,000	$4,200,000	$2,100,000	$23,100,000
Total Capital Costs[4] (ENR - Oct 2019 = 11326)	**$72,000,000**	**$18,000,000**	**$9,000,000**	**$100,000,000**

Notes:

Operations and Maintenance Costs: The current operations and maintenance costs of the Wareham WPCF are $5,700,000. That cost would increase by $1,200,000 (2025 dollars) with an expansion to 3.5MGD. These costs would be spread among all the partners in the proportion of partner usage.

Timeline: A planning level timeline has been created for the project. The timeline in Figure 14 covers the design, bidding and construction of the 3.5MGD expansion. The design phase is approximately 16 months, the bidding is approximately five months, and the construction is approximately three and a half years. Notably, this is an ambitious schedule and assumes all partners complete their individual CWMPs.

FIGURE 14



Notes:
Only major tasks are shown in project schedule
Design shown in green
Bidding shown in blue
Critical pathway of construction shown in red
Remaining construction in orange

c. Project Partner Contribution and Volunteer Involvement–

The town of Wareham contributed $39,842.40 in cash match towards the completion of this task. Significant effort was made on the part of all partners in using the best available information to estimate wastewater needs for the next 20 years. Emphasis must be placed on the fact that all of the municipal officials participating in this effort are volunteers and are continually committing significant time towards this project. While municipal staff time, MMA staff time and Coalition staff time was recorded as match, many of the hours devoted by elected and appointed officials (Boards of Selectmen and Sewer

Commissioners) were not captured as in-kind hours formally under the grant. Further, the Coalition contracted with Wright Pierce to perform a 3rd party review on the GHD and BETA reports and provided $1,112.68 of cash match towards that review.

d. Communication and Outreach –

It was critical to keep each partner up-to-date with grant progress and have the opportunity to provide feedback. There are multiple boards for each municipal partner that have a role in this project and all must be kept up-to-date including Sewer Commissioners, Boards of Selectmen, Boards of Health and Planning Boards. Because all of these boards for each partner community are volunteer boards, it is sometimes difficult to get them all at the same meeting and was prohibitive as of March 2020 due to covid 19. To ensure that each partner is fully briefed on the grants status and opportunity for participation and feedback clear, Coalition staff often met with members on an individual basis.

3. Pipe Realignment

Identifying the best place to discharge treated wastewater so as to avoid adverse impacts to water quality and habitat health continues to be a challenge for communities in the SNEP region. Here, the town of Wareham discharges highly treated effluent to the Agawam River, a shallow, sensitive, poorly flushed estuarine river. In order to capitalize on the Wareham WPCF's ability to treat wastewater to a high degree, an alternative discharge location needs to be identified. In Phase I of the project, a hydrodynamic model was completed by WHOI which determined that a discharge of treated wastewater at the canal would not adversely impact water quality. In fact, relocating the discharge pipe from the Agawam River to the Cape Cod Canal, alone without increased sewering, would result in a 14,241.27lbs/yr reduction of nitrogen to the Agawam River. With the expanded sewering forecasted by this project, an estimated 90,000 lbs of nitrogen could be removed from nitrogen impaired waters.

In an effort to determine the most cost effective approach to relocating the pipe from the Agawam River to the Cape Cod Canal, the Coalition contracted BETA group to perform the alternatives analysis. Their full report, "WPCF Effluent Force Main Routing Alternatives Analysis" is attached hereto as Attachment 6.

a. **Purpose:** Relocating the treated force main is paramount to the success of this regional project. The overall goal of this task is to review and assess three options for a new treated effluent force main to discharge highly treated wastewater to a new ocean outfall near the existing MMA wastewater outfall in the Cape Cod Canal and cease the discharge of wastewater into the sensitive Agawam River. Development of feasible alternatives along with a preliminary cost projection is the first step in this process.

b. **Summary of Report:** Based on the projected treated wastewater flows, BETA determined that the size of the new force main would be 24-inch diameter and run approximately 4.4 miles from the Wareham WPCF to the Cape Cod Canal. Figure 15 identifies the three alternatives reviewed. The route was divided into three phases; WPCF to Cohasset Narrows, Crossing of Cohasset Narrows, Cohasset Narrows to the Outfall at the Canal. Three different alignments were considered for each of the phases included; route 6/28, railway corridor, and a hybrid approach. BETA also considered various construction methods. Table 4 summarizes the variety of installation methods for each phase.

FIGURE 15

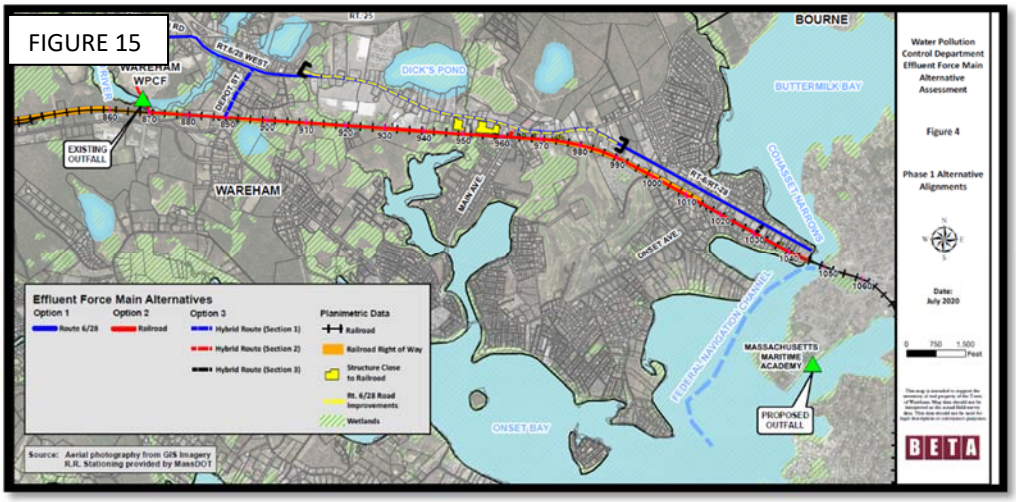


TABLE 4 **Project Phases**

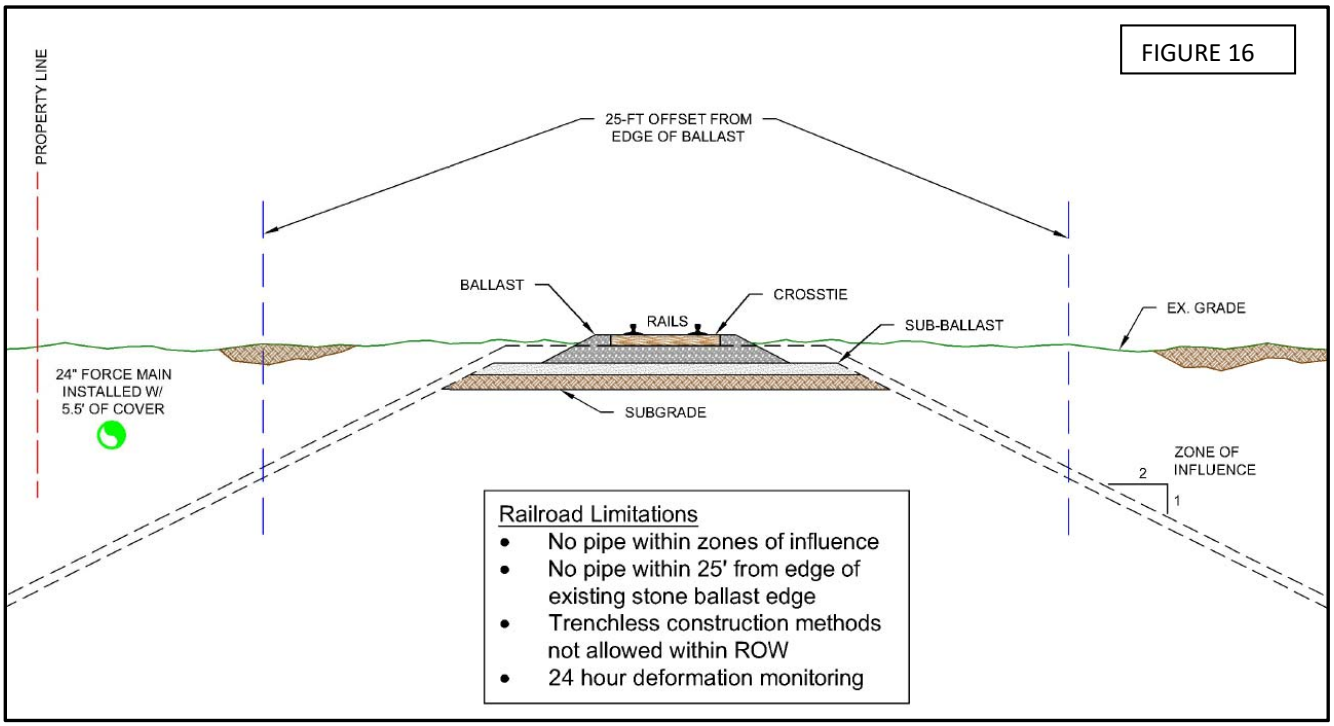
FM SECTION	ALIGNMENT ALTERNATIVE	CONSTRUCTION METHODS CONSIDERED
Phase 1: WPCF to Sta. 1045 (Cohasset Narrows)		
WPCF to Sta. 910 (Section-1) (±4,500 Linear Feet)	Option 1: RT-6/RT-28 (MassDOT Route 6 and 28) Option 2: Railway Corridor Option 3: Hybrid Route	- Open Cut - Trenchless Method & Open Cut - Trenchless Method & Open Cut
Sta. 910 to Sta. 985 (DOT RT-6 Project Limits) (Section-2) (±7,500 linear feet)	Option 1: RT-6/RT-28 (MassDOT Route 6 and 28) Option 2: Railway Corridor Option 3: Hybrid Route	- Open Cut - Trenchless Method & Open Cut - Trenchless Method & Open Cut
Sta. 985 to Sta. 1045 (Section-3) (±6,000 linear feet)	Option 1: RT-6/RT-28 (MassDOT Route 6 and 28) Option 2: Railway Corridor Option 3: Hybrid Route	- Open Cut - Trenchless Method & Open Cut - Trenchless Method & Open Cut
Phase 2: Sta. 1045 to 1052 (Cohasset Narrows Crossing)		
Sta. 1045 to Sta. 1052 (±700 linear feet)	Option 1: Bridge (1A – Independent Utility Bridge, 1B - MassDOT RT-6, and 1C - Railroad) Option 2: North side of bridge Option 3: South side of bridge	- Independent utility bridge - Attach pipe bridge to existing Road bridge - Attach pipe bridge to existing RR bridge - Trenchless Method & Dredging - Trenchless Method & Dredging
Phase 3: Sta. 1052 to Outfall		
Sta. 1052 to Outfall (±4,000 linear feet)	- Various Routes	- Trenchless Method & Open Cut

The following existing information was procured and reviewed in support of this task:

- MassDOT Boring Logs for bridge design and construction
- MassDOT Boring Logs for Route 6 and 28 Improvement project
- MassDOT Bridge Drawings
- MassDOT Route 6 and 28 Improvement Plans
- MassDOT Route 6 Plans depicting crossing of the Agawam River
- Railway Right of Way Requirements and Limitations
- Railway Adjacent Parcel Ownerships and Potential Easements

Railroad Alignment - Meetings with MassDOT were held to discuss preliminary design alignment within Railroad Right-Of-Way (completed under the FY15 SNEP grant) between the WPCF and Cohassett Narrows. The following information was determined at this meeting and with follow-up communications:

- The use of trenchless construction techniques will not be considered for longitudinal construction (along the railroad). Trenchless techniques could be used to cross the railroad (perpendicular crossing) if used with pipe jacking techniques and entry and receiving pits for the directional drill shall be positioned outside Right-of-way.
- Sheeting would be required for the installation of pipeline within the railway zone of influence.
- Any pipeline must be more than 25 feet from the edge of the stone ballast. In certain stretches, this 25-foot limitation will require the pipeline to be installed outside of the Right-of-Way. This would result in increased wetland impact and require private property easements, Figure 16.



Cranberry Highway – A meeting with MassDOT was held to discuss potential coordination with current MassDOT Route 6 and 28 Improvement project. Route 6 and 28 Improvement Project is a three (3) year construction project with planned receipt of bids in the spring 2019. Route 6 and 28 State Road Right of Way (SR R.O.W, approx. 20,000 Linear Feet). The project limits are within the potential new force main alignment for approximately 8,500 linear feet. It was determined that MassDOT could not add the work as a change order to the existing project but would coordinate with a separate contractor. MassDOT shared the plans for Route 6 Improvements including surveyed utility information and State Highway limits and BETA used this information to develop conceptual alignment, text and figures for their final report.

Crossing the Narrows - Significant effort was made to evaluate the crossing at Cohassett Narrows. Various options were reviewed including the use of the existing bridge, an independent utility bridge, the MassDOT Railroad Bridge and use of trenchless technologies.

With respect to the evaluation of the subsurface geotechnical information, the boring logs for the MassDOT Bridge project indicate the presence of boulders and cobbles at various depths in the Narrows.

Boulders and cobbles are obstructions for trenchless construction techniques and reduce the potential for use of trenchless construction for crossing at Cohassett Narrows. The evaluation of the bridge plans indicates that the bridge was not designed to support the proposed loads associated with the effluent force main.

The ACOE Meeting encourages the selection of an alignment that does not cross the federal navigation channel. Permitting associated with a navigation channel crossing requires demonstration that no other alternatives exist. Therefore, we will continue to focus north of the channel. A MassDOT meeting about the potential to support the new effluent pipeline to the existing Route 6 bridge revealed that the Bridge does not have an available utility bay for the effluent force main, an bridge design does not have enough capacity to support the pipeline. Finally MassDOT stated that supporting the pipeline from bridge piers would limit MassDOT ability to conduct required bridge maintenance. Alignment considerations for the Cohassett Narrows crossing were focused north of the bridge considering advisement from the Army Corps of Engineers to avoid the south side of bridge due to the presence of the Federal Navigation Channel.

Permitting Requirements. The requisite permits for the pipe realignment task were also assessed and outlined by BETA including but not limited to the following:

- Massachusetts Environmental Policy Act
- Ocean Sanctuaries Act
- National Pollution Discharge Elimination Systems
- Local Wetlands Permitting
- Army Corps of Engineers General Permit
- Massachusetts Department of Transportation Access Permit
- 401 Water Quality Certification

Conclusion - Based on the comparisons, the recommended route to relocate the Wareham WPCF discharge pipe from the Agawam River to the Cape Cod Canal is to install a forcemain pipe along route 6/28 roadway corridor from the WPCF to Cohasset Narrows. BETA recommends the construction of an independent utility bridge to cross the Narrows. Finally, installation of pipe north of route6/28 to Academy Drive to get from the Narrows to the Canal. BETA encourages a paired use of the utility bridge with a bikeway or pedestrian pass.

Costs – Project costs for the recommended route for the proposed 24-inch effluent force main is shown in Table 5.

TABLE 5

Overall Project Opinion of Cost - Concept Plan Level		
Construction		**Cost**
Phase 1 Construction	$	22,400,000
Phase 2 Construction	$	4,300,000
Phase 3 Construction	$	10,300,000
Effluent Pump Station	$	10,000,000
Effluent Force Main Outfall	$	4,000,000
Construction Subtotal	**$**	**51,000,000**
Engineering		
Design (10%)	$	5,300,000
Construction - Resident Inspection (15%)	$	7,800,000
Project Total	**$**	**64,100,000**

c. **Project Partner Contributions and Volunteer Involvement:** The town of Wareham contributed $41,277 in cash towards the completion of this task. Further, the Coalition contributed $1,112.68 in cash towards a third party review by Wright Pierce of the GHD and BETA reports. There was no direct volunteer involvement.

d. **Communications and Outreach:** As noted in detail in the full BETA report attached, several meetings and communications with MassDOT highway and railroad divisions as well as with the Army Corp of Engineers were required in order to guide the feasibility of the alternatives assessed.

4. Governing Structure

a. Purpose. The goal of this task is to reach consensus on a governing structure that defines how the partnership will formally work together in the future to operate a regional wastewater treatment facility. This task specifically evaluated whether the creation of a regional wastewater district or the negotiation of multiple inter-municipal agreements is the most effective and acceptable way to govern this regional nitrogen-reducing project.

b. Summary of Report. In order to address many of the competing and conflicting needs of the partners, at the outset it was thought that a qualified facilitator was required to reach consensus on which governing structure is best suited for this region. A "Governing Structure Task Force" including decision-maker level participants from each community (selectmen and sewer commissioners), was created to approve the scope of the Request for Proposals (RFP) to select a facilitator. As this group worked together it became clear that a professional facilitator was unnecessary.

The Governing Structure Task Force reviewed two primary examples of how the partnership could formally define the relationships among and between the partners. The first was an Intermunicipal Agreement (IMA) and the second was a Wastewater District.

Regional Wastewater District. The Mansfield-Norton-Foxboro (MNF) Regional Wastewater District quickly became the model for the Task Force to study. The MNF was established in 2015 and contained the mix of infrastructure assets, including a wastewater treatment facility located in one town and discharges located in neighboring communities, is analogous to the mix of assets and ownership we have here. Furthermore, this relatively recent creation will provide an outline of how this partnership, should they choose to adopt a regional model, may move forward. Documents creating this district were obtained and reviewed. Lee Azinheira, the Executive Director of the Mansfield-Foxboro-Norton Regional Wastewater District, came down to present to the Task Force about MFN's experience in regionalizing and how it operates now. Decision Makers from every partner attended and asked questions. While it took the MFN Regional Wastewater District several years to form, it is operating extremely well today. Task Force also met with State Representative Jay Barrows, who is the state Representative who assisted in the negotiation of the Mansfield Norton Foxboro agreement and sponsored the enabling legislation to formalize the authority. State Representative Susan Williams Gifford assisted in coordinating this meeting.

Intermunicipal Agreements. There are several examples of IMAs including the one between Bourne and Wareham. The Task Force sought examples and advice from outside the partnership as well. Jack Hamm from the City of Taunton presented the IMA between the City of Taunton and Raynham to the Task Force. Decision Makers from every community were present.

By April 2019, the Task Force informally determined that further exploration of a regional wastewater district was preferred to separate IMA agreements. The virtues of a district include independent bonding authority and independent decision making (i.e. no town meeting votes).

The MNF Agreement was used as a model. The Task Force met several times to go over specific provisions of the draft legislation to form the district in addition to the draft district agreement. Draft legislation and a Draft District Agreement documents are attached hereto as Attachments 7 and 8. These documents have not been formally reviewed or approved by the partners but can serve as a starting point if partners decide to move forward with a regional district.

The provisions of the district agreement will define how this project is governed into the future including how capital projects are agreed upon and paid for. It will also define how annual budgets are voted on and paid for.

c. Partner Contribution. All partners contributed substantial time and effort in thinking through how to tailor a governing structure to this region.

d. Volunteer and Community Involvement. Extensive time from all partners' executives was committed in order to understand the implications of what an agreement of this nature would mean for each community.

e. Outreach and Communication A total of 6 meetings were held between the Task Force on this specific task. Agenda's and sign-in sheets and power point presentations attached (Attachment 9) Many phone calls and electronic communications also occurred.

5. Ratepayer Analysis

In April 2020 the Coalition proposed and received authorization to amend the scope of the project by adding the ratepayer analysis task.

a. **Purpose.** The purpose of the ratepayer analysis was to create a financial model to determine how current sewer rates in the partner communities are impacted by the costs of the regional wastewater solution and compare that to the impact on current sewer rates if a partner implemented an independent wastewater solutions. In other words, the partners needed a model to determine whether it was it more economical to participate in a regional solution or upgrade individual wastewater treatment facilities and collection systems to attain the same environmental benefit.

b. **Summary of Model.** The Coalition contracted with the Abrahams Group and consulted with Mark Abrahams, CPA and President of the Abrahams Group. Mr. Abrahams is an independent consultant and has served on numerous similar water and sewer rate projects. He has worked with several of the communities in the SNEP Region including developing sewer financing plans for Orleans and Provincetown, and served as a consultant to the Cape's 208 Area Wide Management Plan. The Abrahams Group was known and respected by many of the partners.

Together with the Coalition, the Abrahams met virtually with each of the partners to present the ratepayer project approach and discuss data needs, answer and ask questions and commence a dialogue with the towns.

Additional Data and Costing Needs: In order to compare the impact of a regional solution versus independent community solutions, a significant amount of additional financial and cost data beyond the information provided in Task 2 and Task 3 was required. The following additional sewer and financial data was requested and obtained from the partners:

- Number of current sewer users and wastewater flow by town. Number of new sewer users and wastewater flow after 20-year build-out for both a regional solution and non regional (independent) solution.
- Annual costs for each community's wastewater system today and in 20 years.
- Annual voted budget, FY21, as budgeted.
- Schedules A-2 of the recap sheet if enterprise fund, FY20.
- Balance sheets if enterprise fund, FY19.
- Retained earnings certification if enterprise fund, FY19.
- Existing debt service schedule.
- Any funding or revenue sources available to reduce the burden on rates; grants, tax revenue, septage revenue, wastewater fees or charges (other than rates), reserves (like retained earnings, stabilization funds), and the like.
- Provide amounts, timing, and whether it is a one-time funding or multiple-time funding (if multiple, how often and when).
- SRF borrowing assumptions.
- Current property tax rates and average single family home value for each town.

All partners provided the Abrahams Group with current wastewater budgets as well as current and planned capital projects, and debt service schedules. This information was used to populate the model for each partner with their current funding information including current sewer rates, tax rates, annual operation and maintenance budgets as well as current and known debt service for capital projects.

Tasks 2 and 3 (WPCF Upgrade and Pipe Realignment) provided the partners with the cost of upgrading the facility to accommodate a regional solution as well as the cost to relocate the pipe. Two other sets of costing data were required in order to compare the cost of a regional solution to an independent wastewater solution.

Collection System Costs: The cost to expand sewer into the priority areas to collect wastewater from existing title 5 systems was still unknown. In an effort to estimate these costs and estimate a total cost of the project, partners worked with Environment One and FR Mahoney to develop preliminary designs and planning level costs of low pressure sewer systems for each of the communities' potential sewer expansion areas. Topographical maps of the sewer area were provided and FR Mahoney and Environment One provided a desktop layout and estimated costs. This service free of charge but valued at more than $40,000. This estimate provides the communities with an order of magnitude costs for sewer expansion which was necessary in order to understand how the cost of the total project impacts ratepayers over time. Once CWMPs are complete, partners will need to select engineering firms to complete a more final design for collection systems. At that point these costs can be modified in the model. Figure 17 shows the potential sewer layout for one area of potential expansion in Bourne.

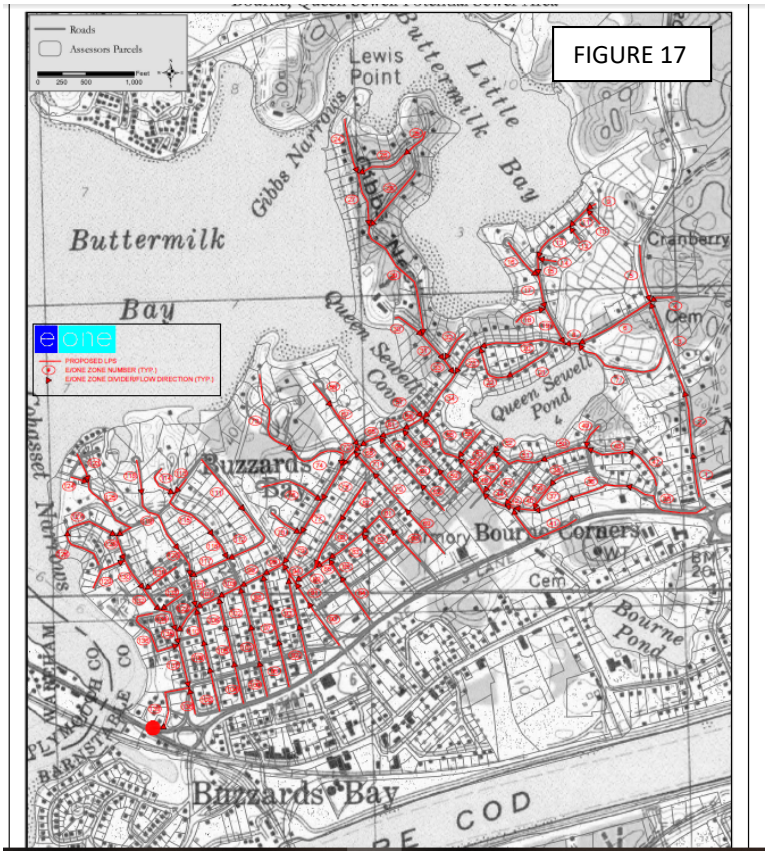


FIGURE 17

Individual Upgrade Needs:

In order to compare the cost of a regional solution to each partner against the cost of the partner solving the wastewater challenge independently of a regional solution, the partners needed to estimate the cost of the independent solution. Estimating these costs in the absence of completed CWMPs was challenging, but each partner was able to provide an order of magnitude estimate using the best information available.

The costs obtained to date are planning level costs and will need to be refined in the future. The model was created in such a way as to provide sufficient flexibility for partners to amend cost estimates, predicted revenues and financing assumptions. In other words, once the community has a final CWMP with more refined cost estimates, those new costs can be input into the model to run the cost comparison.

Hypothetical Model Scenario Run:

The excel model has the ability to run endless scenarios. A model run for the entire project is attached as Attachment 10. For the purposes of this final report, the following scenario was input into the model to illustrate and example of the financial output.

The following line graphs show the added costs to the average parcel in partner communities over 40 years. The graphs illustrate the per parcel cost for partnering on regionalization versus a non regional solution. For this Hypothetical run, it was assumed that expanded collection systems were paid for 100% by the new users in the areas of expansion.

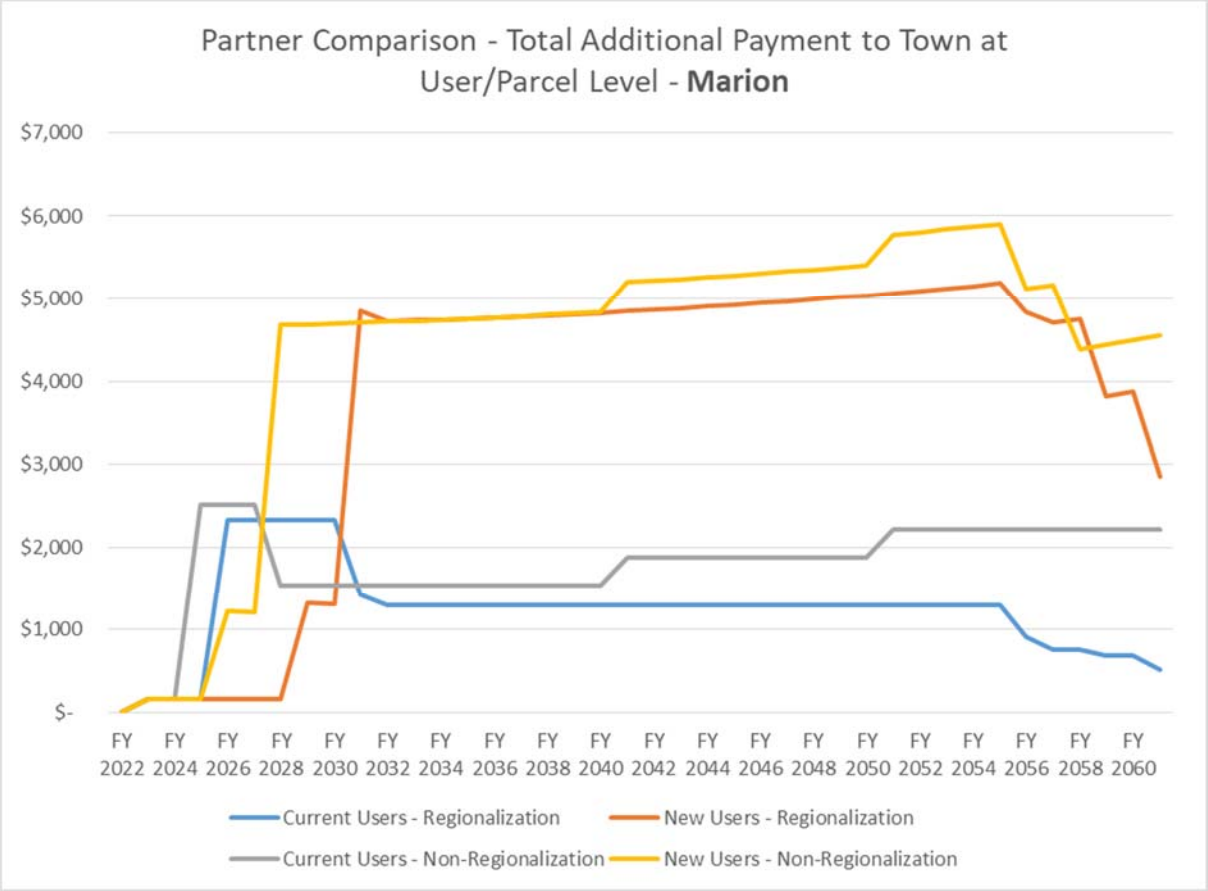


Figure 18

Figure 18 illustrates the cost to each home. Current sewer users in the town of Marion save money over time (blue line) if they regionalize as compared to an independent solution (gray line). Similarly, for new

users coming on line with an expanded collection system, the regional solution is less expensive than the non regional solution.

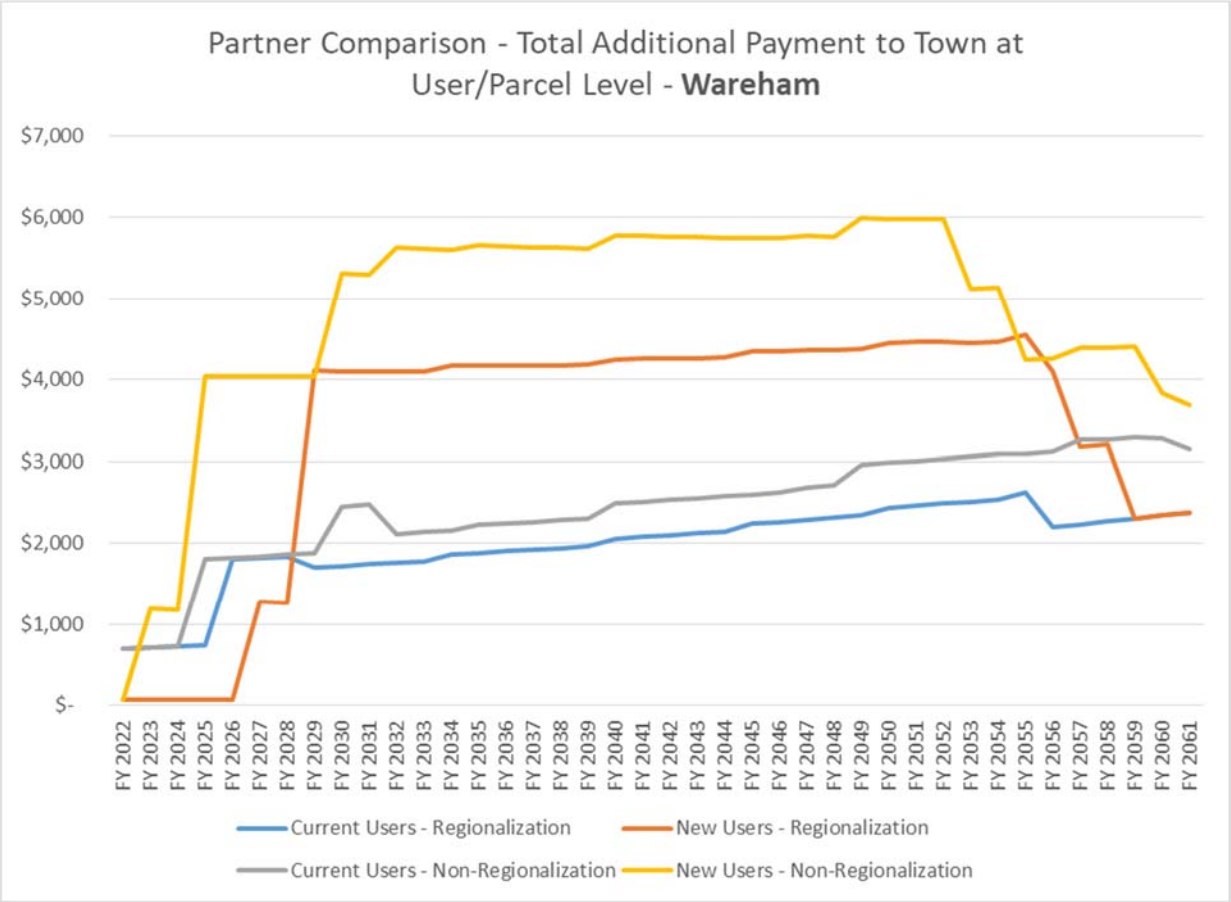


Figure 19

Figure 19 illustrates the financial result to the town of Wareham.

In an effort to ensure that we optimized the utility of this model, the Coalition requested that former town managers and municipal finance professionals review the model performance.

Conclusion

With the bulk of the technical and estimated costs now in hand, we look forward to working with a communications firm, funded in 2020 by SNEP for the Final Phase of this project, on a public outreach strategy.

3. Project Budget Report

A total of $745,809.65 was committed to the completion of this phase of the project. That includes $419,006.08 from the SNEP watershed grant and $326,803.57 of partner match. This project budget report provides an overall budget summary as well as expenditures and explanation by task.

Final Budget Summary September 2020

Budget Category	Total Budgeted Grant Funds	Total Budgeted Match	Total Budgeted Grant + Match	Grant Funds Expended Cumulative	Match Funds Expended Cumulative	Match Source	Actual Expended Grant + Match
Personnel	$55,945.22	$59,232.87	115,178.09	70791.54	$144,250.31	Partners	215041.85
Fringe	$14,853.84	$7,311.45	22,165.29				
Travel	111.25	557.54	668.79	111.25	$1,781.52	BBC	1892.77
Equipment	0	6000	6000	0	$6,400.00	MMA/Wareham	6400
Supplies	3262.82		3262.82	3194.56	$0.00		3194.56
Contractual	344832.95	92775.97	437608.92	344908.73	$149,496.96	Wareham/BBC	494405.69
Other	0	0	0	0	$129.39	BBC	129.39
Total Direct	$419,006.08	$165,877.83	$584,883.91	$419,006.08	$302,058.18		$721,064.26
Indirect (NICRA + 10% MTD)		$26,220.13			$24,745.39	Partners	$24,745.39
Total	$419,006.08	$192,097.96	$611,104.04	$419,006.08	$326,803.57		$745,809.65

Budget changes over the course of the project:

Three budget adjustments occurred over the course of the project leaving the bottom grant-funded line unchanged. In November 2019 a budget adjustment was made leaving the bottom line unchanged. The adjustment was less than 10% of the total grant allocation. The $15,000 allocated for a third party contractor to facilitate the Task 4 governing structure was reallocated to offset staff time spent on guiding the group to consensus and drafting documents as well as to offset staff time on benthic surveys. Other small changes in the budget included the reallocation of a $237.18 underspend in the supplies line to personnel and $1,775.88 shift from an underspend in the Task 1 contractual line item to personnel.

Original Budget

	Personnel		Travel	Equipment	Supplies	Contractual task 1	Contractual task 2	Contractual task 3	Contractual task 4	Other	Grant Total
Budget	$55,315.28		$3,581.97	$1,600.00	$1,900.00	$33,340.80	$151,369.60	$156,898.43	$15,000.00		$419,006.08

Revised Budget 11-19

	Personnel		Travel	Equipment	Supplies	Contractual task 1	Contractual task 2	Contractual task 3	Contractual task 4	Other	Grant Total
Budget	$72,328.34		$3,581.97	$1,600.00	$1,662.82	$31,564.92	$151,369.60	$156,898.43	$0.00		$419,006.08

In March 2020 a scope and budget adjustment was made and authorized in order to fund the new Ratepayer Analysis Task. The project reduced the Personnel line by $5,000 and the Contractual line items for tasks 2 and 3 each by $15,000 to commit $35,000 to the Ratepayer task. Again, the bottom line remained unchanged. It should also be noted that the original budget approved did not require the separation of personnel rate and fringe rate. This separation began in April 2020.

Revised Budget 4-3-20

	Personnel										
	Rate	Fringe	Travel	Equipment	Supplies	Contractual task 1	Contractual task 2	Contractual task 3	Contractual task 4	Contractual task 5	Grant Total
Budget	**$55,945.22**	**$14,853.84**	$111.25	$0.00	$3,262.82	$31,564.92	$136,369.60	$141,898.43	$0.00	$35,000.00	$419,006.08
Change	-$1,528.94		-$3,470.72	-$1,600.00	$1,600.00	$0.00	-$15,000.00	-$15,000.00	$0.00	$35,000.00	$0.34

In the final invoice the underspend in the contractual line item in Task 1 of $2,011.54, the underspend in the supplies item of $68.26 and the underspend of $7.52 in personnel was used to help offset the cost of the third party review of the BETA and GHD engineering reports by Wright Pierce. The total cost of that contract was $3,200. The Coalition provided $1,11.68 of cash match to cover that cost and is using the underspend in the budget categories of $2,087.32 to offset that cost.

The following tables provide detail grant expenses and match contributions for each major task under the grant.

Task 1 – BASELINE WATER QUALITY AND HABITAT ASSESSMENTS

Tables 1 and 2 for Task 1 identifies the total expenses incurred per budget category for each quarter from over the course of the project beginning, September 21, 2018.

Table 1:

Task 1 Expenses						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 1
Total Project Budget	$39,328.21	$0.00	$0.00	$3,262.82	$31,564.92	$74,155.95
Total Quarter 1	$16,916.15	$0.00	$0.00	$2,498.74	$490.00	$19,904.89
Total Quarter 2	$6,641.98	$0.00	$0.00	$446.83	$1,970.73	$9,059.54
Total Quarter 3	$3,085.67	$0.00	$0.00	$248.99	$737.74	$4,072.40
Total Quarter 4	$7,545.76	$0.00	$0.00	$0.00	$2,757.95	$10,303.71
Total Quarter 5	$3,756.12	$0.00	$0.00	$0.00	$4,293.42	$8,049.54
Total Quarter 6	$337.44	$0.00	$0.00	$0.00	$0.00	$337.44
Total Quarter 7	$570.00	$0.00	$0.00	$0.00	$8,955.84	$9,525.84
Total Quarter 8	$0.00	$0.00	$0.00	$0.00	$10,347.70	$10,347.70
Total	$38,853.11	$0.00	$0.00	$3,194.56	$29,553.38	$71,601.05
Amount Remaining	$475.10	$0.00	$0.00	$68.26	$2,011.54	$2,554.90

Table 2:

Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 1
Total Project Budget	$3,120.00	$0.00	$6,000.00	$0.00	$11,668.00	$20,788.00
Total Quarter 1	$6,329.77	$669.20	$1,600.00	$0.00	$0.00	$8,598.97
Total Quarter 2	$13,692.64	$433.72	$0.00	$0.00	$0.00	$14,126.36
Total Quarter 3	$3,095.20	$235.47	$1,600.00	$0.00	$0.00	$4,930.67
Total Quarter 4	$1,784.29	$120.22	$2,400.00	$17.99	$0.00	$4,322.50
Total Quarter 5	$3,139.95	$48.20	$800.00	$0.00	$11,139.41	$15,127.56
Total Quarter 6	$1,124.31	$0.00	$0.00	$0.00	$0.00	$1,124.31
Total Quarter 7	$1,204.11	$0.00	$0.00	$0.00	$0.00	$1,204.11
Total Quarter 8	$2,545.89	$0.00	$0.00	$0.00	$0.00	$2,545.89
Total	$32,916.17	$1,506.81	$6,400.00	$17.99	$11,139.41	$51,980.38
Amount Remaining	-$29,796.17	-$1,506.81	-$400.00	-$17.99	$528.59	-$31,192.38

Task 2 – TREATMENT CAPACITY & TECHNOLOGY ALTERNATIVES ANALYSIS

Table 3 for Task 2 identifies the total expenses for each quarter incurred per budget category from September 21, 2018. A total of $7,898.25 went towards personnel on this task and $136,369.60 for contractual work. While total personnel cost for this task exceeded the estimate for this task, we are still within the overall budget personnel cost. See Table 12.

TABLE 3.

Task 2 Expenses						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 2
Total Project Budget	$4,600.00	$111.25	$0.00	$0.00	$136,369.60	$141,080.85
Total Quarter 1	$1,147.50	$0.00	$0.00	$0.00	$4,359.44	$5,506.94
Total Quarter 2	$1,500.00	$0.00	$0.00	$0.00	$9,522.59	$11,022.59
Total Quarter 3	$993.75	$0.00	$0.00	$0.00	$0.00	$993.75
Total Quarter 4	$2,425.50	$0.00	$0.00	$0.00	$30,938.75	$33,364.25
Total Quarter 5	$1,831.50	$111.25	$0.00	$0.00	$31,779.42	$33,722.17
Total Quarter 6	$0.00	$0.00	$0.00	$0.00	$58,752.30	$58,752.30
Total Quarter 7	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Quarter 8	$0.00	$0.00	$0.00	$0.00	$1,017.10	$1,017.10
Total	$7,898.25	$111.25	$0.00	$0.00	$136,369.60	$144,379.10
Amount Remaining	-$3,298.25	$0.00	$0.00	$0.00	$0.00	-$3,298.25

Table 4 for Task 2 identifies the match accrued for the task for each quarter beginning on September 21, 2018. A total of $8,679.35 of personnel match was contributed by the Coalition towards the completion of this task as well as a total of $39,842.40 of cash match was contributed by Wareham towards the completion of this task.

TABLE 4.

Task 2 Match						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 2
Total Project Budget	$1,400.00	$0.00	$0.00	$0.00	$39,830.40	$41,230.40
Total Quarter 1	$997.31	$0.00	$0.00	$0.00	$0.00	$997.31
Total Quarter 2	$332.20	$0.00	$0.00	$0.00	$0.00	$332.20
Total Quarter 3	$220.08	$0.00	$0.00	$0.00	$0.00	$220.08
Total Quarter 4	$2,026.64	$0.00	$0.00	$0.00	$0.00	$2,026.64
Total Quarter 5	$1,530.32	$0.00	$0.00	$0.00	$0.00	$1,530.32
Total Quarter 6	$1,511.57	$0.00	$0.00	$0.00	$29,872.80	$31,384.37
Total Quarter 7	$2,061.23	$0.00	$0.00	$0.00	$0.00	$2,061.23
Total Quarter 8	$1,557.37	$0.00	$0.00	$0.00	$9,969.60	$11,526.97
Total	$8,679.35	$0.00	$0.00	$0.00	$39,842.40	$50,079.12
Amount Remaining	-$7,279.35				-$12.00	-$8,848.72

TASK 3 – ALTERNATIVES ANALYSIS FOR RELOCATION OF TREATED FORCE MAIN

Table 5 for Task 3 identifies the total expenses incurred per budget category for each quarter beginning on September 21, 2018.

TABLE 5.

Task 3 Expenses						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 3
Total Project Budget	4600	$0.00	$0.00	$0.00	$141,898.43	$146,498.43
Total Quarter 1	900	$0.00	$0.00	$0.00	$9,413.91	$10,313.91
Total Quarter 2	$631.13	$0.00	$0.00	$0.00	$43,714.89	$44,346.02
Total Quarter 3	$173.25	$0.00	$0.00	$0.00	$8,061.91	$8,235.16
Total Quarter 4	$730.13	$0.00	$0.00	$0.00	$40,793.59	$41,523.72
Total Quarter 5	$445.50	$0.00	$0.00	$0.00	$0.00	$445.50
Total Quarter 6	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Quarter 7	$0.00	$0.00	$0.00	$0.00	$31,379.69	$31,379.69
Total Quarter 8	$0.00	$0.00	$0.00	$0.00	$10,622.08	$10,622.08
Total	$2,880.00	$0.00	$0.00	$0.00	$143,986.07	$146,866.07
Amount Remaining	$1,720.00				-$2,087.64	-$367.64

Table 6 for Task 3 identifies the match accrued for the task, by quarter, beginning on September 21, 2018. The Coalition contributed a total of $3,077.87 of in-kind match towards the completion of this task. The town of Wareham contributed a total of $41,277.57 of cash match towards the completion of this task.

TABLE 6.

Task 3 Match						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 3
Total Project Budget	$1,400.00	$0.00	$0.00	$0.00	$41,277.57	$42,677.57
Total Quarter 1	$782.20	$0.00	$0.00	$0.00	$0.00	$782.20
Total Quarter 2	$527.34	$0.00	$0.00	$0.00	$0.00	$527.34
Total Quarter 3	$144.76	$0.00	$0.00	$0.00	$0.00	$144.76
Total Quarter 4	$610.06	$0.00	$0.00	$0.00	$0.00	$610.06
Total Quarter 5	$372.24	$0.00	$0.00	$0.00	$0.00	$372.24
Total Quarter 6	$274.83	$0.00	$0.00	$0.00	$1,651.10	$1,925.93
Total Quarter 7	$366.44	$0.00	$0.00	$0.00	$39,626.47	$39,992.91
Total Quarter 8	$595.47	$0.00	$0.00	$0.00	$1,112.68	$1,708.15
Total	$3,077.87	$0.00	$0.00	$0.00	$42,390.25	$46,063.59
Amount Remaining	-$1,677.87	0	0	0	-$1,112.68	-$3,386.02

TASK 4 – REGIONAL BASED GOVERNING STRUCTURE EVALUATION

Table 7 for Task 4 identifies the total expenses incurred per budget category for each quarter beginning September 21, 2018. The budget readjustment mentioned above shifted $10,000 from this task's contractual line to the personnel line. The remaining $5,000 of this contractual line was shifted to personnel for task 1.

TABLE 7.

Task 4 Expenses						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 4
Total Project Budget	$16,500.00	$0.00	$0.00	$0.00	$0.00	$16,500.00
Total Quarter 1	$2,868.75	$0.00	$0.00	$0.00	$0.00	$2,868.75
Total Quarter 2	$2,400.75	$0.00	$0.00	$0.00	$0.00	$2,400.75
Total Quarter 3	$1,076.63	$0.00	$0.00	$0.00	$0.00	$1,076.63
Total Quarter 4	$1,410.75	$0.00	$0.00	$0.00	$0.00	$1,410.75
Total Quarter 5	$1,987.50	$0.00	$0.00	$0.00	$0.00	$1,987.50
Total Quarter 6	$841.50	$0.00	$0.00	$0.00	$0.00	$841.50
Total Quarter 7	$1,323.00	$0.00	$0.00	$0.00	$0.00	$1,323.00
Total Quarter 8	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	$11,908.88	$0.00	$0.00	$0.00	$0.00	$11,908.88
Remaining	$4,591.13					$4,591.13

Table 8 for Task 4 identifies the match accrued for the task for each quarter beginning September 21, 2018. Total "personnel" match reported in table 8 is BBC only. BBC has been met and exceeded match for this task by $1,950.39. While, Table 8 does not capture the entire match provided for this task. Table 11 details the match provided from all partners.

Table 8.

Task 4 Match						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 4
Total Project Budget	$3,500.00	$0.00	$0.00	$0.00	$0.00	$3,500.00
Total Quarter 1	$2,493.26	$0.00	$0.00	$0.00	$0.00	$2,493.26
Total Quarter 2	$1,097.36	$0.00	$0.00	$0.00	$0.00	$1,097.36
Total Quarter 3	$240.85	$0.00	$0.00	$0.00	$0.00	$240.85
Total Quarter 4	$1,178.76	$0.00	$0.00	$0.00	$0.00	$1,178.76
Total Quarter 5	$440.17	$0.00	$0.00	$0.00	$0.00	$440.17
Total Quarter 6	$703.12	$0.00	$0.00	$0.00	$0.00	$703.12
Total Quarter 7	$417.95	$0.00	$0.00	$0.00	$0.00	$417.95
Total Quarter 8	$1,007.71	$0.00	$0.00	$0.00	$0.00	$1,007.71
Total	$7,579.17	$0.00	$0.00	$0.00	$0.00	$7,579.17
Remaining	-$4,079.17					-$4,079.17

TASK 5– RATEPAYER ANALYSIS

Table 9 for Task 5 identifies the total expenses incurred per invoice period.

Table 9:

Task 5 Expenses						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 4
Total Project Budget	$0.00	$0.00	$0.00	$0.00	$35,000.00	$35,000.00
Total Quarter 6	$0.00	$0.00	$0.00	$0.00	$4,000.00	$4,000.00
Total Quarter 7	$0.00	$0.00	$0.00	$0.00	$6,000.00	$6,000.00
Total Quarter 8	$0.00	$0.00	$0.00	$0.00	$25,000.00	$25,000.00
Total	$0.00	$0.00	$0.00	$0.00	$10,000.00	$35,000.00
Remaining	$0.00	$0.00	$0.00	$0.00	$25,000.00	$0.00

Table 10.

Task 5 Match						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total Task 4
Total Project Budget	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Quarter 6	$4,946.94	$0.00	$0.00	$0.00	$0.00	$4,946.94
Total Quarter 7	$7,809.75	$0.00	$0.00	$0.00	$0.00	$7,809.75
Total Quarter 8	$9,756.47	$0.00	$0.00	$0.00	$0.00	$9,756.47
Totals	$22,513.16	$0.00	$0.00	$0.00	$0.00	$22,513.16

Table 10 identifies the match provided by the Coalition to complete this task.

GRANT ADMINISTRATION

Significant time is devoted to the administration and management of this grant. Tables 11 and 12 below detail the time spent by Korrin Petersen towards the grant effort for each quarter to date. It is divided between time billed to the grant and match. The Coalition budgeted $2,300 for this task and given the amount of time staff has spent with project partners, that number has been exceeded by $5,345.88. However, the grant is still within its overall Personnel budget line item. A total of $23,623.90 of in kind time has been spent on administering this grant.

Table 11.

Grant Admin Grant						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total
Total Project Budget	$2,300.00	$0.00	$0.00	$0.00	$0.00	$2,300.00
Total Quarter 1	$2,250.00	$0.00	$0.00	$0.00	$0.00	$2,250.00
Total Quarter 2	$3,180.38	$0.00	$0.00	$0.00	$0.00	$3,180.38
Total Quarter 3	$1,782.00	$0.00	$0.00	$0.00	$0.00	$1,782.00
Total Quarter 4	$433.50	$0.00	$0.00	$0.00	$0.00	$433.50
Total Quarter 5	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Quarter 6	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Quarter 7	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Quarter 8	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total	-$5,345.88	$0.00	$0.00	$0.00	$0.00	-$5,345.88

Table 12.

Grant Admin Match						
Invoice Period	Personnel	Travel	Equipment	Supplies	Contractual	Total
Total Quarter 1	$1,955.50	$0.00	$0.00	$0.00	$0.00	$1,955.50
Total Quarter 2	$2,657.38	$0.00	$0.00	$0.00	$0.00	$2,657.38
Total Quarter 3	$1,488.96	$0.00	$0.00	$0.00	$0.00	$1,488.96
Total Quarter 4	$3,459.93	$0.00	$0.00	$0.00	$0.00	$3,459.93
Total Quarter 5	$3,526.99	$0.00	$0.00	$0.00	$0.00	$3,526.99
Total Quarter 6	$3,320.86	$0.00	$0.00	$0.00	$0.00	$3,320.86
Total Quarter 7	$3,893.43	$0.00	$0.00	$0.00	$0.00	$3,893.43
Total Quarter 8	$3,320.86	$0.00	$0.00	$0.00	$0.00	$3,320.86
Total	$23,623.90	$0.00	$0.00	$0.00	$0.00	$23,623.90

The following table 13 provides a breakdown of budget category by each invoice.

Table 13.

Budget										
0	Personnel	Travel	Equipment	Supplies	Contractual task 1	Contractual task 2	Contractual task 3	Contractual task 5	Other	Total Invoiced
Budget	**70,799.06**	**111.25**	**0**	**3262.82**	**31,564.92**	**136,369.60**	**141,898.43**	**35000**	**0**	**419,006.08**
Invoice 1	24,082.40	0	0	2498.74	490.00	4,359.44	9,413.91	0	0	40844.49
Invoice 2	15,495.45	0	0	446.83	1,970.73	9,522.59	43,714.89	0	0	71150.49
Invoice 3	7,323.37	0	0	248.99	737.74	0.00	8,061.91	0	0	16372.01
Invoice 4	12,545.76	0	0	0.00	2,757.95	30,938.75	40,793.59	0	0	87036.045
Invoice 5	8,020.62	111.25	0	0.00	4,293.42	31,779.42	0.00	0	0	44204.71
Invoice 6	1,178.94	0	0	0.00	0.00	0.00	0.00	4000	0	5178.94
Invoice 7	2,145.00	0	0	0.00	8,955.84	58,752.30	31,379.69	6000	0	107232.83
Invoice 8	0.00	0	0	0.00	10,347.70	1,017.10	8,534.76	25000	2087	46,986.56
Total Billed	70,791.54	111.25	0	3194.56	29,553.38	136,369.60	141,898.75	35000	0	419006.075
Remainder	**7.52**	**0**	**0**	**68.26**	**2,011.54**	**0.00**	**-0.32**	**0**	**0**	**0.01**

Table 14 is a summary of the match provided by each partner.

Table 14.

TOTAL MATCH BY PARTNER	Wareham	Bourne	Marion	Plymouth	MMA	BBC	DMF	FR Mahoney	10% MTD	Total In Kind
Personnel	$15,290.00	$15,028.00	$4,559.43	$904.46	$29,838.31	$78,630.11	0	0		$144,250.31
Travel	0	0	0	0	0	$1,781.52	0	0		1781.52
Equipment	$3,200.00	0	0	0	$3,200.00	0	0	0		$6,400.00
Contractual	$97,244.97	0	0	0	0	$1,112.68	$11,139.41	40000		$149,497.06
NICRA	0	0	0	0	0	$14,302.78	0	0		$14,302.78
10% MTD for Non NICRA	0	0	0	0	0	0	0	0	$10,442.62	$10,442.62
Other	0	0	0	0	0	$129.38	0	0		$129.38
TOTAL PROJECT MATCH	**$115,734.97**	**$15,028.00**	**$4,559.43**	**$904.46**	**$33,038.31**	**$95,956.47**	**$11,139.41**	**$40,000.00**	**$10,442.62**	**$326,803.67**

4. Supporting Materials

The following reports are attached hereto:

Attachment Number	Report Title	Task
Attachment 1	Buzzards Bay Coalition Water Quality Monitoring in Upper Buzzards Bay: Summary of Four Years of Data Collection	Task 1
Attachment 2	Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay – Benthic Analysis	Task 1
Attachment 3	Eelgrass Surveys for Wareham Wastewater Treatment Plant Project 2018-2019	Task 1
Attachment 4	Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay – Fisheries Resource Analysis	Task 1
Attachment 5 (with appendices)	DRAFT Wareham WPCF Expansion Memorandum	Task 2
Attachment 6 (with appendices)	WPCF Effluent Force Main Routing Alternatives Analysis	Task 3
Attachment 7	Draft Legislation	Task 4
Attachment 8	Draft District Agreement	Task 4
Attachment 9	Sign In Sheets and Power Points	Task 4
Attachment 10	Model Run	Task 5

5. Certification

The undersigned verifies that the descriptions of activities and expenditures in this final report are accurate to the best of my knowledge; and that the activities were conducted in agreement with the grant contract. I also understand that matching fund levels established in the grant contract must be met.

Grantee Signature:

Name: Korrin Petersen

Job Title: Senior Attorney

Date: September 30, 2020

Organization: Buzzards Bay Coalition