Multi-Community Partnership to Reduce Nitrogen in Upper Buzzards Bay

Draft - FINAL REPORT

June 30, 2017

Project Background

This first-of-its-kind project joined all of the Head of the Bay communities – 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 two of upper Buzzards Bay's most critically nutrient impaired sub estuaries; the Agawam/Wareham River and Buttermilk and Little Buttermilk Bays, is feasible.

Through the completion of the five critical tasks funded by this grant, it is now clear 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.

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CE-96198501 to the Massachusetts Executive Office of Energy and Environmental Affairs Buzzards Bay National Estuary Program. The contents of this document do not necessarily reflect the views and polices of the Environmental Protection Agency, nor does EPA endorse trade names or recommend the use of commercial products mentioned in this document.

Community and Regional Need - Water Quality Challenges

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. Many are also struggling with how to reduce nitrogen entering harbors and coves in an effective, affordable, and sustainable way. This project capitalized on this collective need to solve the nitrogen pollution problem in two nitrogen-impaired upper Buzzards Bay estuaries while at the same time meeting the economic development needs in the town of Bourne, and will likely save a state educational institution from investing in costly upgrades to existing wastewater infrastructure.

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) wastewater treatment facility (WWTF) are the major sources of nitrogen pollution. While a 2004 upgrade had a positive water quality impact to the Agawam/Wareham River (see Figure 1), 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.

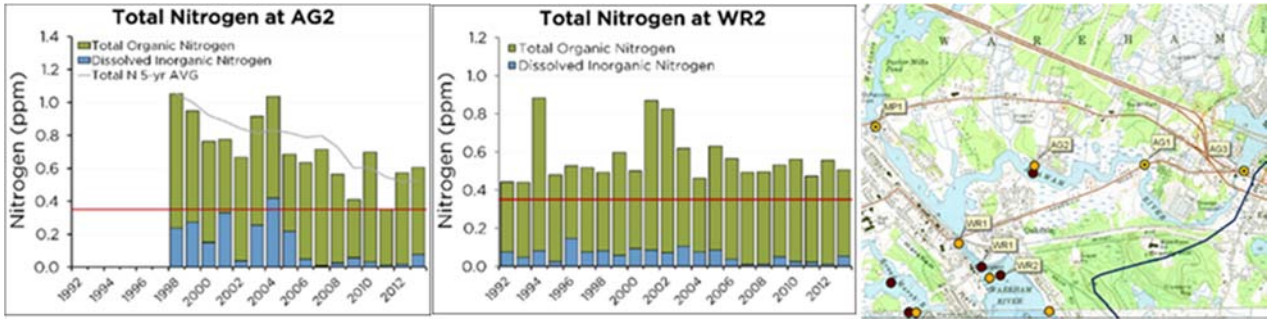


FIGURE 1. BBC data illustrate that the Agawam/Wareham River fails to meet the 0.35mg/L TN of other estuaries in southeastern Massachusetts. Also, note the reduction in N levels seen since the upgrade of the Wareham WWTF in 2004.

It is clear that excessive nitrogen pollution in this estuary has led to significant eelgrass losses. The MEP Report finds that the "virtual absence of eelgrass throughout the Wareham River Embayment System is consistent with the observed nitrogen and the chlorophyll levels. . ." (MEP ES at 7 and 142)

BBC and the town of Wareham have collaborated to reduce nitrogen from on-site septic systems for many years. In 2013 we worked together to pass a 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. The relocation of the Wareham WWTF 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.

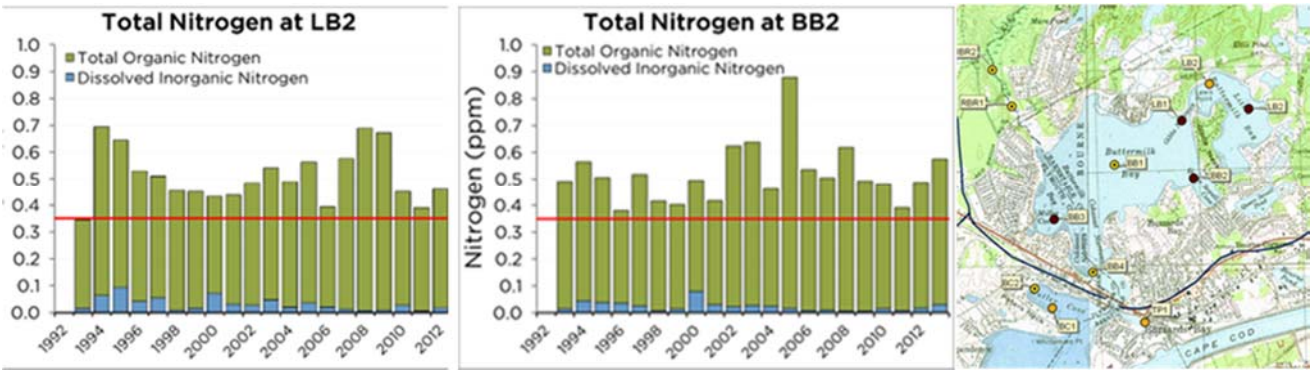


Figure 2. BBC data illustrate that the total nitrogen in Buttermilk Bay exceeds the 0.35mg/L TN (red line)

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.

This project supports both water quality restoration and economic development. A strategic benefit of this project is its ability to synthesize water quality restoration with the promotion of economic development in the town of Bourne's downtown. Bourne's March 19, 2015 Downtown Wastewater Plan states that the most pressing wastewater issue facing the town at this time is the limited treatment and disposal capacity in Buzzards Bay that is preventing further redevelopment of the downtown area. Currently the towns of Bourne and Wareham have an agreement which allows the town of Bourne to send up to 200,000gpd of wastewater to the Wareham WWTF for treatment and discharge to the Agawam River. However, the estimate of additional wastewater capacity needed to serve practical buildout projections of the downtown Main Street area is 335,000gpd over and above the 200,000gpd. As explained above, the town of Wareham cannot accept the additional 335,000gpd due to its discharge limitation to the Agawam River. However, the relocation of Wareham's WWTF discharge from the Agawam River to the Cape Cod Canal could allow Bourne to increase the amount of wastewater sent to the Wareham WWTF for advanced nitrogen treatment and discharge.

Massachusetts Maritime Academy –MMA's participation in this project makes this a truly innovative partnership. Currently, MMA operates a 77,000gpd wastewater treatment plant on campus and discharges at Taylors Point at the Cape Cod Canal. The WWTP does not treat for nitrogen resulting in approximately 18,276lbs of nitrogen discharged at Taylors Point per year. MMA's 2014 Master Plan anticipates future growth of students to 1,800, increasing wastewater volume. This project contemplates an MMA connection to the Wareham WWTF which reduces the nitrogen concentration in MMA's wastewater from 78mg/L (average 12-month concentration) to 3mg/L. Furthermore, it releases MMA from ongoing operation and maintenance of a WWTP and avoids future capital costs of anticipated infrastructure upgrades.

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.

Existing Nitrogen Load to Impaired Waterbodies		**Total Nitrogen Load Reductions from Impaired Waterbodies**
Relocate Wareham WWTP discharge from Agawam River to Cape Cod Canal. 1.56MGD at 3mg/L	14,241.27lbs/year	
Expand sewer to ~482 on-site systems in Gateway Shores. 159,060gpd at 35mg/L	16,940.72lbs/year	
Connect ~144 Mobile Home Units. 47,520gpd at 35mg/L	5,061.13lbs/year	
Total nitrogen reduction in Agawam River		**36,243.12lbs/year**
Expand sewer to ~485 on-site systems in south Plymouth. 160,050gpd at 35mg/L.	17,046.16lbs/year	
Expand sewer to ~800 on-site systems in Queen Sewell Park Neighborhood. 264,000gpd at 35mg/L.	28,117.38lbs/year	
Total nitrogen reduction for Buttermilk Bay		**45,163.54lbs/year**
Total Annual Nitrogen Load Removed from Impaired Estuaries		**81,406.66lbs/year**

Table 1. Estimates the amount of nitrogen load that could be reduced with the relocation of the Wareham WWTF discharge pipe and expanded sewering.

The goal of the project was to show how expanded sewering and relocation of an outfall pipe could reduce 81,406.66lbs of nitrogen per year.

Project Implementation

The partnership determined that the first five critical tasks to assess whether this regional idea had merit included:

1. Task 1 – Survey Railroad Right of Way to determine the feasibility of constructing a force main from Wareham to Bourne.
2. Task 2 – Sewer Needs Analysis to estimate the maximum volume of wastewater generated from each community.
3. Task 3 – Wastewater Treatment Facility Upgrade Needs Assessment to evaluate needed upgrades to accommodate increased volume and maintain excellent level of treatment.
4. Task 4 – Deploy Water Quality Monitoring Buoy to collect baseline water quality data.
5. Task 5 – Hydrodynamic Modeling to understand water quality impacts of increased discharge.

Task 1

Force Main Survey of Railroad to Assess Feasibility of Constructing Sewer Line

Contractor: Green Seal Environmental

Task 1: Force Main Survey of Railroad to Assess Feasibility of Constructing Sewer Line

Partners agreed at the outset that, if feasible, running a force main down the MassDOT Railroad line from Wareham to Academy Drive in Bourne would likely be the most cost effective alternative. In order to determine the feasibility of that alternative the project hired a qualified firm to field survey 19,500 linear feet of Railroad Right of Way, and about 400 feet from the facility across the river to the railroad.

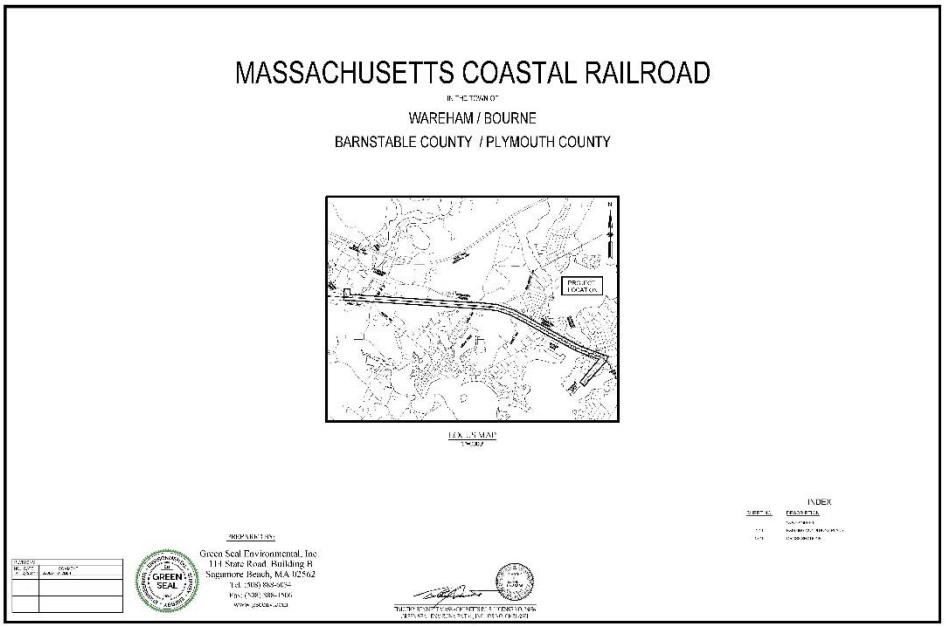
It was determined during the requisite project kick off meeting on February 24, 2016, at the Massachusetts Maritime Academy, that this task would be split into two subtasks. In order to prevent duplicative survey work, the first sub-task assessed what current survey information exists for the railroad in order to minimize the need for the full survey. The second sub-task would include a plan of existing conditions of the Railroad Right of Way to the extent a plan of existing conditions did not already exist.

On March 10, 2016, the Buzzards Bay Coalition released a Request for Proposals and received two compliant responses. Project partners reviewed and ranked the proposals and ultimately selected Green Seal Environmental to complete the task. The RFP and GSE's response are attached as Appendix A.

GSE completed the initial sub-task, review of existing information, and presented findings to CZM, the towns of Wareham and Bourne and the Coalition on April 25, 2016. While a substantial amount of information was obtained as part of this initial sub-task, no plans or survey data were found to be adequate to meet the requirements of the project. The information collected as part of this subtask is included in Appendix B. In summary the information collected included, copies of the railroad valuation maps, assessor's maps, title deeds, railroad plan index cards, a 1879 baseline survey, and 1915 valuation plans. On April 25, 2016, the review of the information procured as part of the initial subtask was presented to the project partners and CZM. It was recommended, and agreed, that a full survey was required for the railroad, contingent on the Massachusetts Department of Transportation (MassDOT) approving the scope of work.

MassDOT issued a "right to access" permit to enter and survey the railroad. The Existing Conditions and Right-of-Way survey was completed on March 24, 2017. The project was completed using a combination of aerial photography, GPS and Robotic Total Station Surveying. Two sets of plans are plotted with the pen weight plot style settings specified by MassDOT and two are plotted using the plot style for all Design plans. The Coalition and the town of Wareham each

have one complete set. The final report and supporting documents are attached here as Appendix C.



Survey Next Steps

GSE presented the final survey to project partners. Project partners were pleased to learn that it appears that sufficient space exists to construct a sewer main within the MassDOT railroad right-of-way. Armed with the knowledge that this alternative route is feasible, the project partners sought the help of State Representative Gifford to set up a meeting with MassDOT to discuss what the next steps are in achieving permission to design and construct a force main within the railroad right-of-way. The meeting with MassDOT was held in Boston at MassDOT offices on Monday June 19, 2017 and was attended by GSE, the town of Wareham, and the town's engineers. The survey presentation was well received by MassDOT. Project partners will continue to work with MassDOT to obtain permissions for design and construction.

Task 2

Sewer Needs Analysis for South Plymouth, Bourne, and Wareham to estimate maximum sewer need in the project area.

Contractor: GHD

Task 2: Sewer Needs Analysis for South Plymouth, Bourne, and Wareham to estimate maximum sewer need in the project area.

In order to determine the maximum sewer flow generated from the expansion of sewer to densely developed neighborhoods around Buttermilk Bay and the Wareham/Agawam River a sewer needs analysis is required. Project partners issued an RFP to retain a qualified engineering firm to compile available Board of Health records for existing septic systems in south Plymouth, the Queen Sewell Park neighborhood in Bourne, and Gateway Shores neighborhood in Wareham to determine the existing types of on-site systems, age, number of bedrooms served, Title 5 compliance, and repair records, where available. On July 22, 2016, the Coalition issue an RFP. Two firms provided a qualified response, Project partners reviewed and ranked the proposals and ultimately selected GHD as the contractor. The RFP and GHD response are attached as Appendix D.

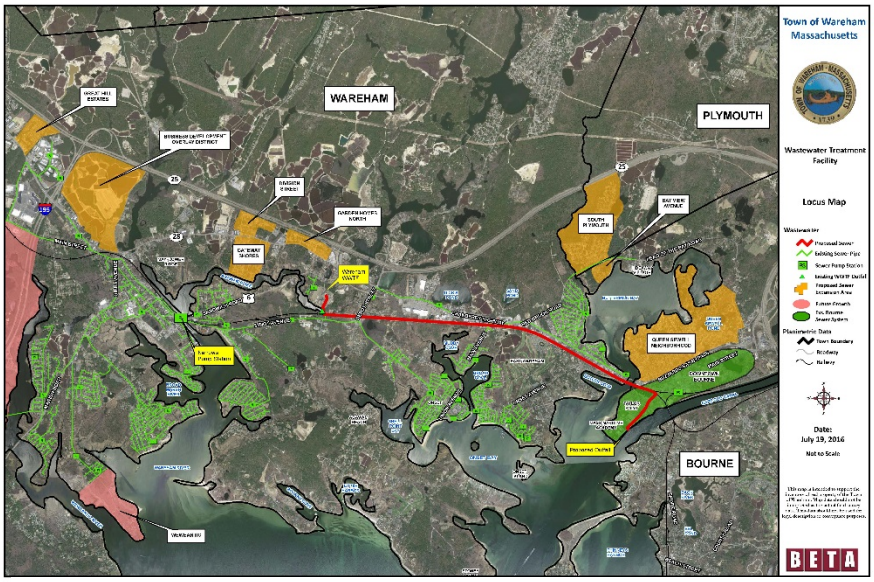


Figure 3. Original areas identified for expanded sewer for the needs analysis.

A needs analysis was completed within the designated areas (figure 3) in Bourne, Wareham, and Plymouth. Also included in the analysis were downtown Bourne, and expansion at the Massachusetts Maritime Academy. After much discussion and conference with MassDEP, the project partners agreed that the project was to use the water use data to estimate the design flows from the proposed sewer areas as opposed to Title 5 flows. Design flow estimates using water use data is a MassDEP preferred method of calculating wastewater flows. The proposed additional flow from the anticipated sewer expansion together with the existing flow from the Wareham WWTF is 5.1 million gallons per day.

Focus areas:

Figure 3 above, identifies the neighborhoods project partners identified for the needs analysis. This included, 872 parcels in the town of Bourne, 515 parcels in the town of Plymouth, and 337 in the town of Wareham. It also included planned expansion at the Massachusetts Maritime Academy and a previous sewer build out estimate for Downtown Bourne.

Town of Bourne:

GHD developed a master spreadsheet of the 872 parcels and GHD together with the Bourne Board of Health Agent entered the septic system specific data. Each system was categorized as a Title 5, Cesspool and Other. The "Other" type included specific information to better describe the system. GHD also met

with the Buzzards Bay Water District to acquire the water use data for the parcels within the project area. Based on this data, the average water use per residential property within the study area is 135 gallons per day. This water use average was then converted to an average wastewater flow of 122 gallons per day per residential property by applying a factor of 90%. This assumes that 90% of the water use is converted to wastewater.

Downtown Bourne:

Previously, the Cape Cod Commission partnered with CH2MHill to conduct a buildout analysis of the downtown area and projected a wastewater flow of 1.34 million gallons per day. That same analysis estimated a practical buildout of 335,000 gallons per day. In order to be conservative and capture all potential future expansion, project partners used the full buildout projection of 1.34 million gallons per day.

Massachusetts Maritime Academy:

MMA's wastewater treatment facility is running at full capacity, but MMA is planning to grow their student body by about 250 students which will double the current capacity to 154,000 gallons per day.

Town of Plymouth:

Similar to the master spreadsheet developed for Bourne, GHD worked with the town of Plymouth's Health Agent to enter the septic system specific data for all 515 properties. In order to estimate the wastewater flow from each system, the partners agreed to use the average water use from the town of Bourne and town of Wareham. The priority parcels in the town of Plymouth all have individual wells.

Town of Wareham:

The original scope of the RFP included four priority areas in the town of Wareham. However, in order to capture the largest potential sewer flow, project partners expanded that scope to include 13 subareas, including the Business Development Overlay District which AD Makepeace estimates to generate .5million gallons per day of wastewater as well as Cromeset Point and Onset Island as potential sewer expansion areas.

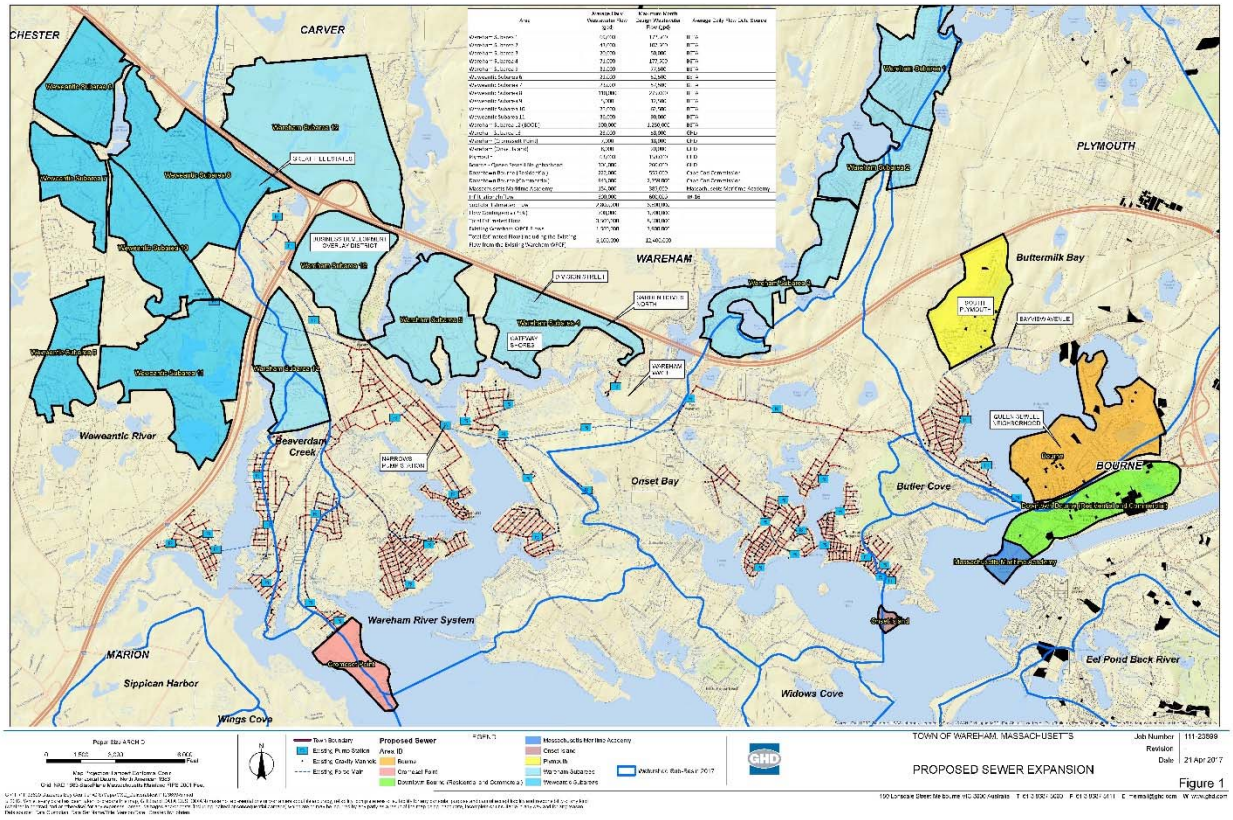


Figure 4. Expanded needs analysis area identified for expanded sewer.

Figure 4 shows that subareas 1 to 5 and 12 fall primarily within the Wareham River watershed. Subareas 6 to 11 fall primarily within the Weweantic River watershed, also a nitrogen impaired estuary.

The town of Wareham's engineering firm, BETA Inc., had already completed a sewer flow analysis for the 13 sewer subareas. In BETA's study, average daily flow were based on the town of Wareham's water use records. Applying a 90% usage factor, it was determined that the average wastewater flow from the town of Wareham was about 132 gallons per day per residential property.

GHD also estimated wastewater flow from Cromeset Point and Onset Island using Wareham water use data.

In addition to residential wastewater flows, there were a number of other flow considerations taken into account in the needs analysis.

- Industrial/Commercial Parcels. The vast majority of the wastewater generated in the project area is from residential properties. However commercial and industrial flows were also estimated.
- Infiltration and Inflow. Wet weather flow due to infiltration/inflow was considered. This was calculated by measuring the length of road in feet and applying a generally used allowance based on the diameter of the pipe. This report estimates that the total infiltration and inflow is 300,000 gallons per day.

- Flow contingency. A 25% contingency factor was added to the estimated flow to account for any unusual development, faulty water meters, or increase in flow that the project area may encounter in the future.

The final needs analysis for the expanded scope for the towns of Wareham, Bourne, Plymouth and the Massachusetts Maritime Academy produced an estimated average daily wastewater flow of 3.5million gallons per day. Combining the new flow with the existing flow of 1.56million gallons per day at the Wareham WWTP produces a **total average daily wastewater flow of 5,060,000 gallons per day.**

AREA	ESTIMATED AVERAGE DAILY WASTEWATER FLOW
Wareham Subareas 1 to 5 and 13	257,000
Wareham Subarea 12 (BDOD)	500,000
Wareham Subareas 6 to 11	220,000
Wareham Cromeset Point	7,000
Wareham Onset Island	8,000
Plymouth	63,000
Bourne	104,000
Downtown Bourne	1,165,000
Massachusetts Maritime Academy	154,000
Infiltration/ Inflow	300,000
SubTotal NEW FLOW TO WAREHAM WWTP	2,800,000
25% Contingency	700,000
Total NEW FLOW	**3,500,000**
Existing Wareham WWTP	**1,560,000**
TOTAL ESTIMATED FLOW	**5,060,000**

Table 2. Estimated Average Daily Wastewater flows for each sewer needs subarea.

Estimation of Maximum Month Design Wastewater Flows

The original scope of this task was to estimate the new average daily wastewater flow generated from the project area. However, in an effort to support task 3, the assessment of the upgrades needed to the current facility plant to accommodate the new flow, GHD also projected the maximum month design flow for the project. To estimate the maximum monthly design flow a peaking factor of 2.5 is applied to the projected flows.

Area	Maximum Month Design WW Flow
Wareham Subareas 1 to 5 and 13	643,000
Wareham Subarea 12 (BDOD)	1,250,000
Wareham Subareas 6 to 11	550,000
Wareham Cromeset Point	18,000
Wareham Onset Island	20,000
Plymouth	158,000
Bourne	260,000
Downtown Bourne	2,914,000
Massachusetts Maritime Academy	555,000
Infiltration/ Inflow	600,000
SubTotal NEW FLOW TO WAREHAM WWTP	6,800,000
25% Contingency	1,700,000
Total NEW FLOW	8,500,000
Existing Wareham WWTP Flow	3,480,000
TOTAL Estimated Monthly Max Design Flow	**11,980,000**

Table 3. Estimated Maximum Monthly Design Wastewater flows for each sewer needs

The final report for the Needs Analysis is attached as Appendix E.

Task 3

Preliminary assessment of required upgrades to Wareham Wastewater Treatment Facility.

Contractor: GHD

Task 3: Preliminary assessment of required upgrades to Wareham WWTF.

Another critical task was to assess whether the existing WWTF could be upgraded to accommodate the new flows estimated in Task 2. GHD conducted a preliminary assessment to identify treatment steps that will have to be modified to accommodate the future flows. GHD conducted a capacity assessment and identified the following options for expansion:

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.

Next steps – An alternatives analysis should be conducted for the three options.

The final report for the preliminary assessment is attached as Appendix F.

Task 4

Acquire, deploy and maintain monitoring buoy for data collection and water quality monitoring.

Contractors: Buzzards Bay Coalition and Massachusetts Maritime Academy

Task 4: Acquire, deploy and maintain monitoring buoy for data collection and water quality monitoring.

It is critical to understand whether or not an increased discharge at the Cape Cod Canal will impact water quality and the marine ecology. The first step in this understanding is to collect baseline water quality. Project partners, the Coalition and MMA, set out to monitor water quality via discrete surfaces samples and automated continuous measurements at the bottom with a sonde and buoy. The parameters measured included temperature, salinity, oxygen, pH, and chlorophyll a.

On April 5, 2016, the partners held a working group meeting to discuss the location and type of monitoring buoy to acquire. The sign in sheet is attached here as Appendix G. Several logistical challenges of siting a buoy in the Upper Bay were identified. The strong tidal currents in this area, together with the proximity to a major navigation channel, raised concerns about the potential damage or loss of the equipment. Coalition staff worked with staff at the Massachusetts Maritime Academy and others to identify a safe location that will also be representative of existing water quality conditions in the Upper Bay.

In order to determine a representative location for monitoring that is also safe and secure, project partners collected salinity and temperature data throughout the Upper Bay. The data was reviewed by Woods Hole Oceanographic Institution scientist James Churchill and by the Buzzards Bay Coalition's Science Advisory Committee. These experts determined that a sonde attached to the MMA pier was as representative of existing water quality conditions as all other locations. This location had the added benefits of being protected and easily accessible. Monthly grab samples for total nitrogen on incoming and outgoing tides at both surface and depth were also collected at this location (MMA1). Additional sampling sites included the eelgrass bed to the southwest of the MMA pier (MMA3) and the canal dolphins (MMA4).

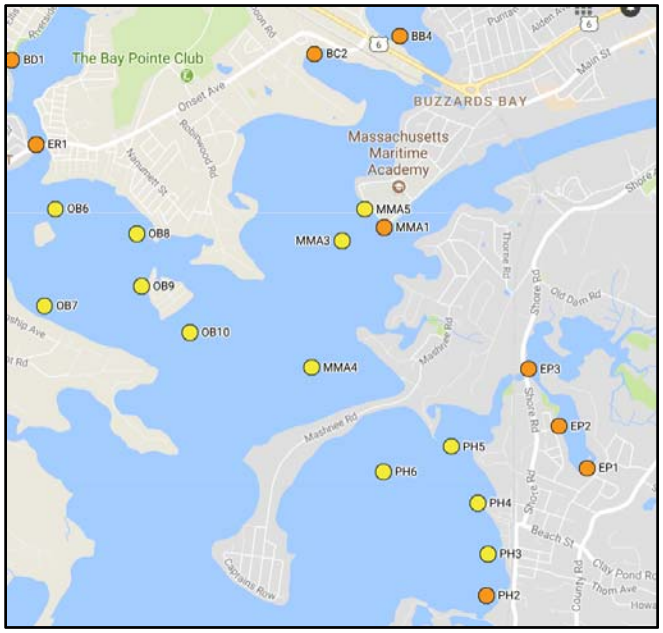


Figure 5. Map of Baywatchers Monitoring Program stations in Upper Buzzards Bay. Stations locations MMA1, MMA3, MMA4, and MMA5 were initiated through this project.

A QAPP was submitted and approved and is attached here as Appendix H.

The housing for the sonde was built by MMA staff led by Tom Pham. Sample collection was performed by MMA Professor Bill Hubbard and MMA cadets including Tyler Aldrich, Jordan Heffler Connor Ives, Ryan Kappel, and Chris Brown.

Data Collected

The sonde was deployed at MMA1 in October 2016. It has been collecting data continuously since then. MMA cadets under the supervision of Professor Bill Hubbard have been cleaning the sonde and checking its calibration approximately once a month, though fouling has not been a significant issue. Nine months of data have been collected. The sonde will continue to be deployed at the site beyond the course of the project.

Data is relayed to a computer screen in the Aquaculture Lab. Staff and students at MMA have come to regularly check the sonde output, particularly to see the water temperature. A researcher from the Massachusetts Institute of Technology, Maha Haji, also used the temperature and salinity data as part of her graduate studies.

Figure 6 displays data collected by the sonde deployed at MMA1:

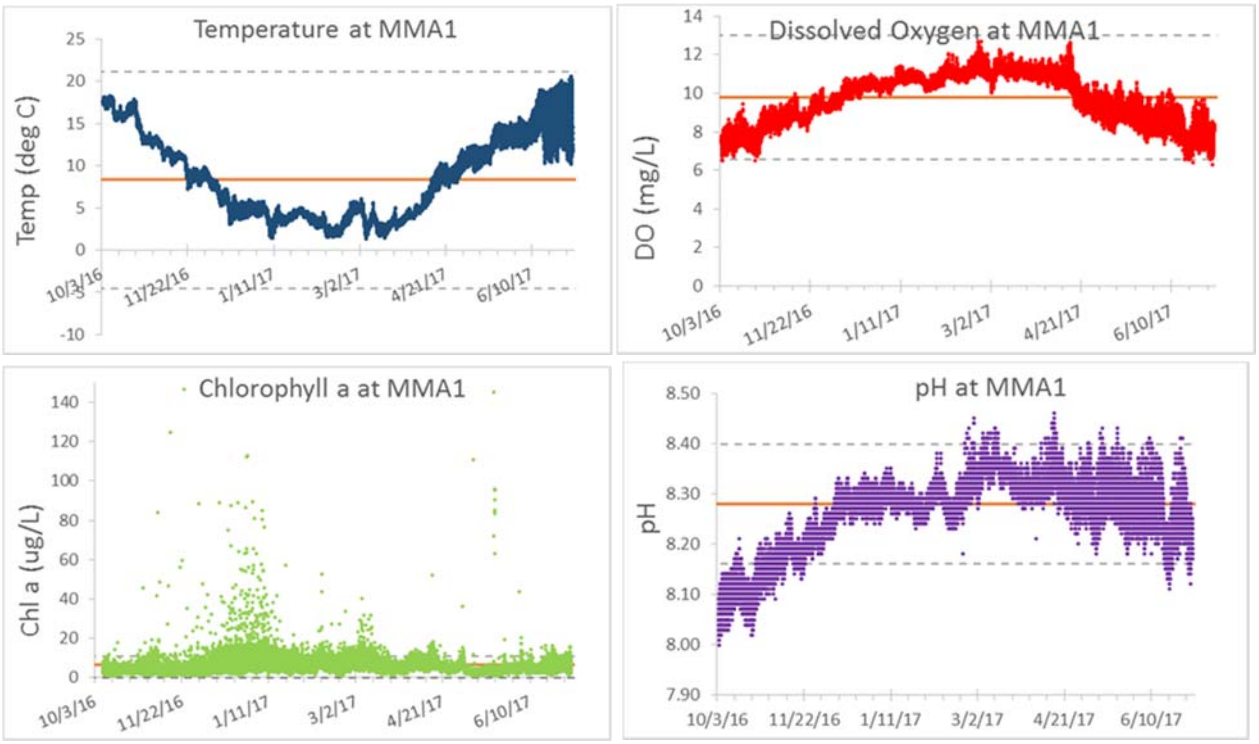


Figure 6. Data collected by sonde deployed at MMA1.

Discrete grab samples were collected on the ebb tide and flood tide monthly for 13 months. In July and August ebb tides only samples were collected as well (see graph below). Additional data from winter/spring nutrient sample collecting is not yet available and will be submitted when it is ready.

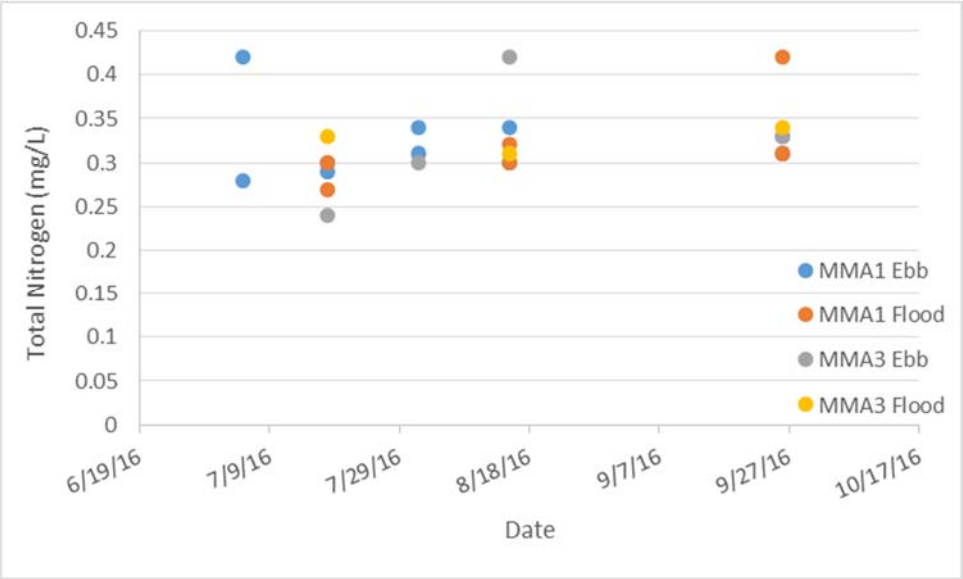


Figure 7. Total Nitrogen grab samples.

Task 5

Create Hydrodynamic Model to understand the water quality impacts of a potential increased discharge at Taylors Point.

Contractors: WHOI

Task 5: Create Hydrodynamic Model to understand the water quality impacts of a potential increased discharge at Taylors Point.

The primary purpose of this project is to significantly reduce nitrogen pollution in critically impaired waterbodies in Upper Buzzards Bay. It is well established that expanding municipal sewer and treating the wastewater to 90% nitrogen removal at a wastewater treatment plant provides a much better water quality result than the continued use of cesspools and Title 5 septic systems. 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 is 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.

Seen as a critical step in any future wastewater permitting of this concept, Coalition worked with CZM on the Request for Proposal to maximize the quality and content of responses. Coalition staff issued an RFP for this task on October 13, 2016 to eight potential respondents. Two proposals were submitted prior to the submission deadline. The Coalition worked with our project partners as well as CZM to review the responses. It was agreed that a contract award would be made to Dr. Jim Churchill at WHOI. The RFP and WHOI response are attached here as Appendix I.

WHOI was awarded the contract for this task. An initial analysis of Buzzards Bay Coalition water quality data established background concentrations of nitrogen as well as analysis of data acquired from the sonde deployed at the MMA pier. Preliminary water quality simulations have been carried out using a fully-forced FVCOM model. These findings were presented to Buzzards Bay Coalition staff. A water quality model to simulate the mixing and transport of a plume discharged from the MMA outfall site was adapted and WHOI used the water quality model with existing hydrodynamic data from a high-resolution tidal model to estimate the tidally-driven transport of effluent from the discharge site. Preliminary findings were presented at a kick off meeting at MMA in January 2017.

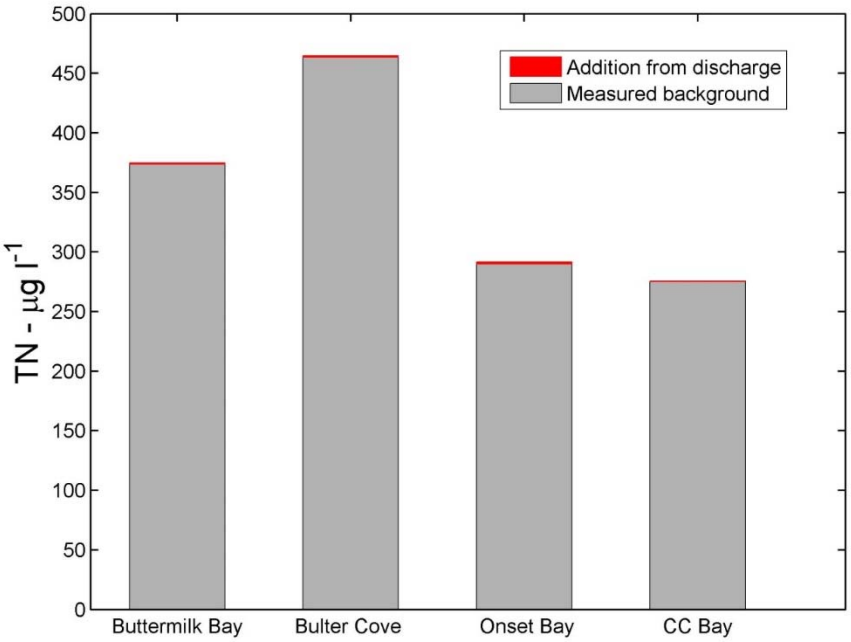
Summary Results

The Final Hydrodynamic report for this task is attached in Appendix J. In summary, the results of the model show that the projected increased discharge at the Cape Cod Canal should negligibly impact total nitrogen concentrations in Upper Buzzards Bay and its sub-estuaries. The average background nitrogen concentration at the location of the outfall today is 0.32mg/L. At a new discharge of 10million gallons per day that background nitrogen concentration increases to 0.3267mg/L total nitrogen – a mere 2.1% increase.

Location	Background Total Nitrogen Concentration - mg/L	Total Added Nitrogen Concentration After 10MGD Discharge - mg/L	Change in Nitrogen Concentration - %
Buttermilk Bay	0.37	0.0012	0.3
Butler Cove	0.46	0.0014	0.3
Onset Bay	0.29	0.0017	0.5
Cape Cod Bay	0.28	0.0003	0.1
Discharge Site	0.32	0.0067	2.1

Table 4. Modeled change in nitrogen subarea.

The model estimated that average additional effluent total nitrogen within the areas of interest is less than 1% of the estimated background concentration. The impact of effluent total nitrogen is predicted to be even smaller in Cape Cod Bay, where the averaged effluent-TN concentration of close to 0.1 % of the estimated background concentration. In short, the results indicate that the projected 10mgd discharge of wastewater treated to 3mg/L at the Cape Cod Canal will only negligibly impact TN concentrations in the designated areas of interest.



Dilution plays a significant role at this location. The concentration of total nitrogen at the outfall declines rapidly from the point of discharge.

Figure 8. Comparison of averaged measured TN concentration in areas of interest with the modeled added TN concentration from an effluent discharge of 10mgd.

Success of Regional Partnership

The entities brought together by this project readily acknowledge that nitrogen pollution fails to recognize municipal boundaries and therefore working together to protect the quality of their collective waters, is the most advantageous approach. With constant engagement, the project was met with wide support among the partnering communities. Over the course of the project, several meetings were held with state and federal appointed and elected officials to demonstrate the broad support of the concept. Each participating community sent representation to nearly all the meetings.

It is clear that this collaboration will continue as we move forward.

Next Steps

With a positive determination that this concept is feasible, partners will pursue the following next steps:

1. Work with MassDOT to secure permission to use the Railroad RROW.
2. Continue baseline monitoring.
3. Seek funding to conduct Massachusetts State Ocean Sanctuaries Act required, benthic and fisheries surveys.
4. Seek funding to commence the design of the force main for construction in the Railroad RROW.
5. Seek funding to design sewer expansion in impaired watersheds.
6. Seek funding to commence a needs analysis for construction of expanded sewers in impaired waterbodies.
7. Pursue permitting.