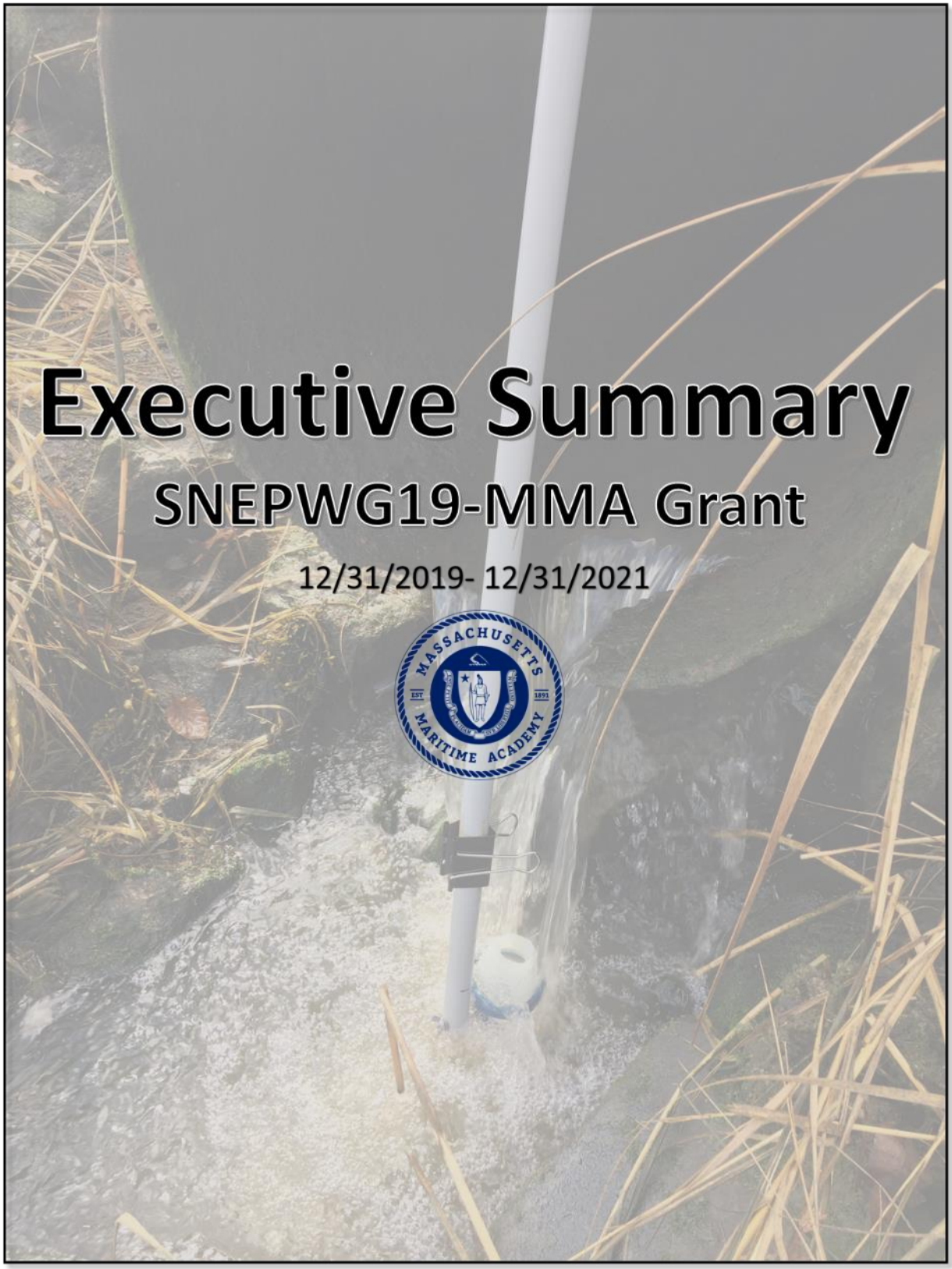


Executive Summary

SNEPWG19-MMA Grant

12/31/2019- 12/31/2021

EXECUTIVE SUMMARY

The SNEPWG19-11-MMA Grant was the pivotal point in establishing the long-term program of the Buzzards Bay Stormwater Project. It initiated the future opportunity for the Stormwater Collaborative to continue assessing water quality and stormwater issues in Buzzards Bay, MA. The Massachusetts Maritime Academy and the Buzzards Bay National Estuary Program will continue to work together under follow-up funding provided by local towns in the watershed. Having a long-term effort funded by municipalities is truly the measure of success from the EPA Southern New England Program funding investment!

Stormwater discharges convey nutrients, bacteria, and toxic contaminants which contribute to water quality degradation, habitat loss, and loss of economic uses of coastal waters and ecosystems. While the importance of the role of stormwater pollutants contributing to environmental degradation is widely recognized, the lack of water quality data characterizing individual stormwater networks has stymied efforts to direct limited government resources to manage those discharges. Granting agencies are often faced with reviewing requests to remediate a particular stormwater discharge when there is no objective basis to decide whether that discharge should be a priority for funding. An additional challenge for municipalities is the lack of sufficiently trained entry-level personnel to undertake an expansive monitoring effort and the costs of hiring consultants to undertake these tasks can be immense. Many municipalities have hundreds of stormwater discharges which make it difficult to manage stormwater in a comprehensive manner.

The Buzzards Bay Stormwater Project addressed all these problems by integrating an existing stormwater collaborative monitoring program into the environmental course curriculum of MMA and through the training of municipal staff in stormwater monitoring. This project also delivered additional stormwater infrastructure mapping, stormwater monitoring, and analysis to identify problem areas in the Buzzards Bay Watershed.

The Buzzards Bay Watershed is located within the western most part of Cape Cod, Southeastern Massachusetts, and the Elizabeth Islands. The bay is 28 miles long, averages 8 miles in width, with its coastline stretching over 350 miles. Below is a map that depicts the entire area that discharges stormwater into Buzzards Bay.

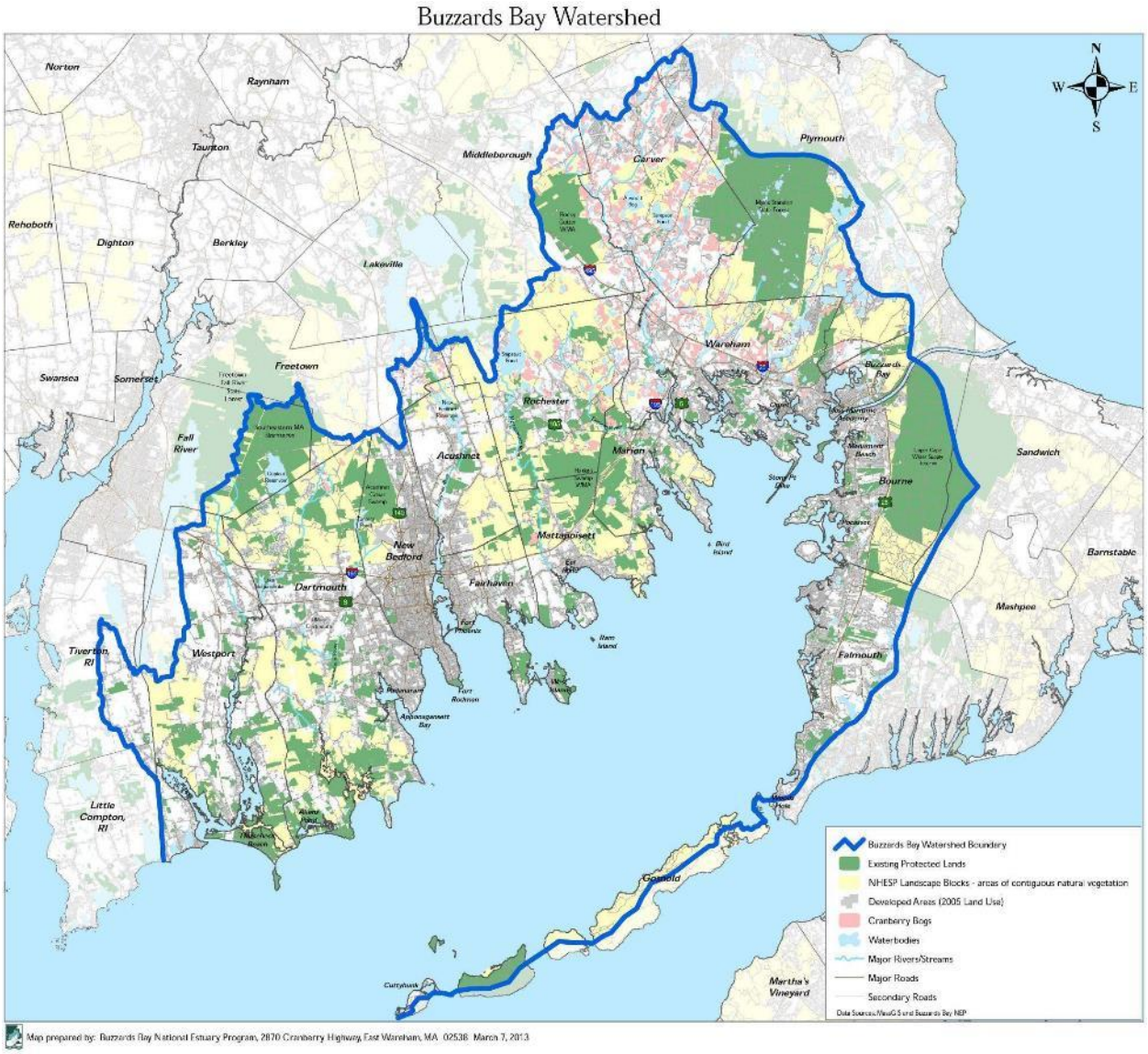


Figure 1 shows the towns and areas that discharge stormwater into Buzzards Bay

The eleven towns that share the coastline of the bay include New Bedford, Westport, Dartmouth, Acushnet, Fairhaven, Mattapoisett, Marion, Wareham, Bourne, Falmouth, and Gosnold. There are five additional towns which contribute to the watershed through streams and rivers including Rochester, Plymouth, Carver, Middleborough, and Fall River. The Buzzards Bay watershed also includes portions of three communities in Rhode Island. The towns within the watershed cover a combined area of 434 square miles.

In 2019 Massachusetts Maritime Academy (MMA) began a partnership with the Buzzards Bay National Estuary Program (BBNEP) and eight municipalities (Bourne, Wareham, Marion, Mattapoisett, Fairhaven, Acushnet, Dartmouth, and Westport) to continue mapping stormwater

networks and monitoring stormwater discharges that contribute to water quality degradation in Buzzards Bay. This project was funded by a previous SNEP grant provided to the BBNEP, which allowed MMA to hire a full-time program coordinator and fund cooperative education (Co-Op) students. These new members worked with the BBNEP and municipal staff to undertake a stormwater network mapping and discharge monitoring program. In January of 2020, MMA created a seamless transition of the 2019 Stormwater Collaborative to this SNEPWG19-11-MMA Grant.

Every semester a new group of students were chosen to complete their co-ops with the Stormwater Project using funds provided under the SNEPWG19-11-MMA Grant. They were trained extensively on the water quality data collection effort, the first component being stormwater collection and field analysis. During wet weather, co-op students collected samples from outfalls. During dry weather, if outfalls were dishcharging, samples were also collected and analyzed. All samples were tested in the field for pH, Temperature, Salinity, Conductivity, Ammonia, and Chlorine. Certain outfalls were inaccessible during specific tides, others were not accessible due to fences, being buried, or protruding from the sides of steep embankments. If a stormwater sample could not be collected at an outfall, the sample was collected at the stormwater structure most closely connected. The Town's Department of Public Works lifted nearby structure covers if samples could not be collected from their outfalls.

MMA Co-op student collects samples from an outfall during wet weather. Another Co-op student samples a catch basin up-stream from an inaccessible outfall during dry weather.

The second component of the water quality data effort was the analyses of samples for Nitrates and Surfactants by Co-op students in a lab on MMA's campus. Students are trained on sample chemical analysis and reading results from comparaters.

MMA *Co-op students test stormwater samples for Nitrates and Surfactants using compareters.*

The last component of this water quality analysis effort was to bring samples to a certified lab for *Enterococcus* or Fecal Coliform testing.

Over the course of this SNEPWG19-11-MMA Grant students were able to collect and analyze over 350 wet and dry weather samples. Once results from all tests conducted on the samples were completed, they were entered into a stormwater atlas database, made available to municipalities for future comparative analysis and decision making. This database was created and is maintained by the Buzzards Bay NEP and is continuously updated to reflect the growing number of outfalls being inventoried and the increasing number of samples being collected.

This database introduces a starting point in identifying the sources of pollution. The degree of pollution recorded at these outfalls directly reflects problems within their corresponding catchments. Catchments can drain a relatively small neighborhood area or can provide drainage for much larger areas spanning several acres. This stormwater project uses a five step approach in defining an outfall's catchment:

Step 1: Obtain and scan municipal engineering drawings. Once scanned these drawings are imported onto a GIS software.

Step 2: Georeference scanned images using real world coordinates.

Step 3: GPS map all the stormwater structures suggested in the previously scanned engineering drawings. Verify the stormwater structures exist and are in the suggested locations. GPS all structures in the field even if they are not shown on the map.

Step 4: Inventory outfalls. GPS the outfall's location. Fill out an inventory form. Take a close-up picture of the pipe. Capture a context picture with a permanent landmark or structure nearby. Import GPSed structures to GIS. Update the stormwater atlas.

Step 5: Verify connectivity between stormwater structures. Start at an outfall and work up the catchment. Open every stormwater structure to confirm pipe connectivity. Update GIS database as needed.

Over the course of the SNEPWG19-11-MMA Grant Co-op students were able to scan and georeference several hundred drawings. They were able to locate and inventory hundreds of outfalls and GPSed thousands of stormwater structures.

MMA Co-op student fills out an inventory sheet while two other Co-op students measure an outfall during the pipe inventory process.

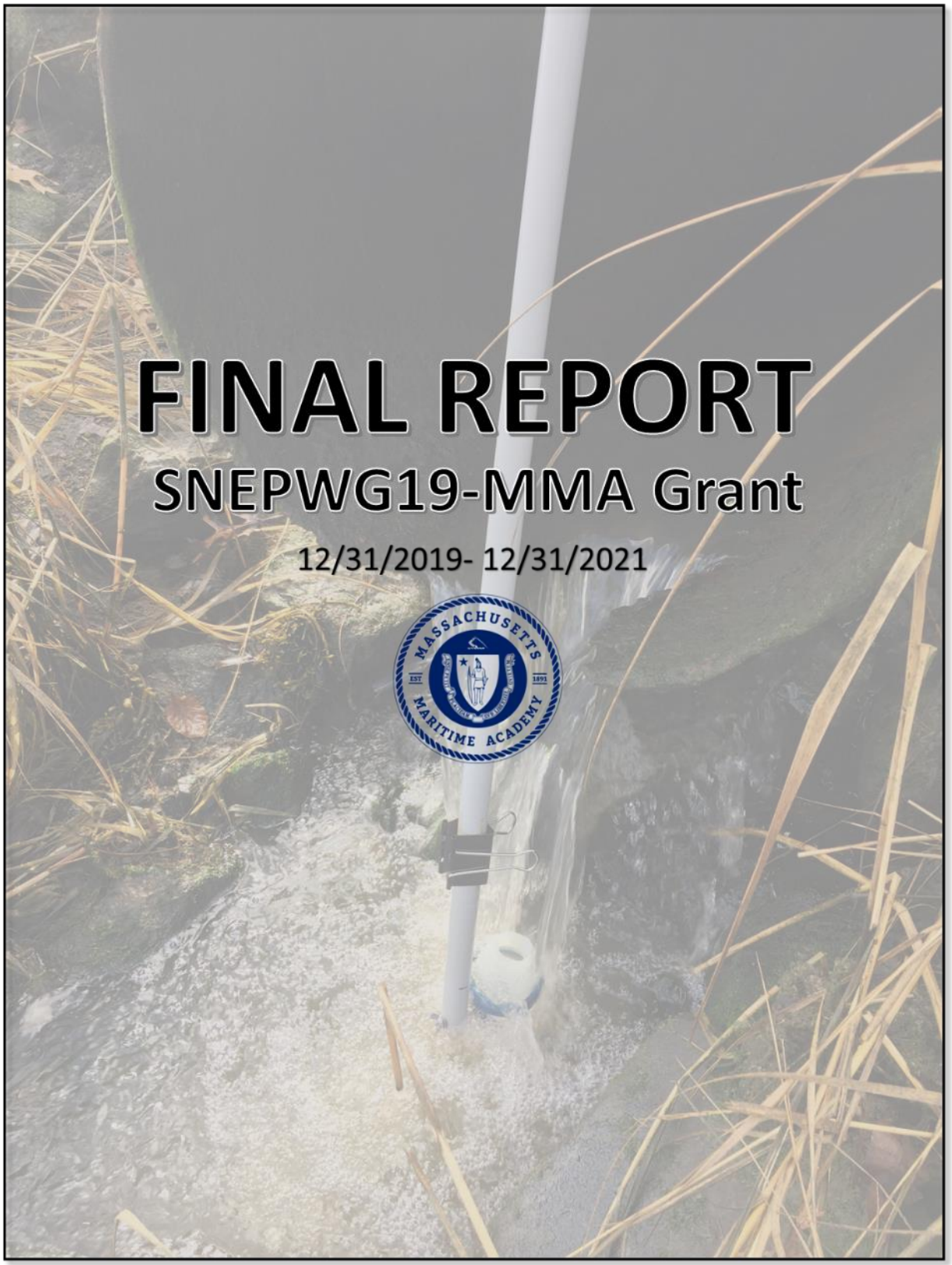
The mapping data that was collected became too dense and complicated to show on paper maps. The solution to this problem was to create a web map. The web map stormwater atlas is supported by MMA, powered by ArcGIS Online and, allows the viewer to see all the stormwater structures, outfall points, hydrology, 303(d) listed waters, MS4 permit information, and monitoring data collected since the inception of the Collaborative. The ArcGIS Online map can be viewed at: https://massmaritime.maps.arcgis.com/apps/webappviewer/index.html?id=ee16aa4641cf490dba88636dc7809f61l

Not long after activity for SNEPWG19-11-MMA Grant commenced the COVID-19 pandemic began. Due to the rigid restrictions set in place by MMA and the Commonwealth, community involvement was cautiously minimal. All interactions with the community collaborators took place outside in the field. Community members and residents lent their knowledge of structure connectivity or outfall locations to team members. Residents were often very enthusiastic and cared deeply about the purpose of the work being done under the SNEPWG19-11-MMA Grant. Although community involvement was hindered due to the pandemic, the Stormwater Project still maintained a strong outreach within the community. The achievements of the program as well as the stormwater processes were often communicated through online presentations. The work under the SNEPWG19-11-MMA Grant was the topic of many online discussions including those of the Buzzards Bay Action Committee and at one of the Massachusetts Statewide

Municipal Stormwater Coalition meetings. Co-op students also submitted articles to local newspapers discussing the effects that pet waste and illicit connections had on stormwater. In the midst of the pandemic the Buzzards Bay Stormwater Collaborative created a YouTube channel detailing the stormwater monitor processes, safety precautions in field work, and GPS mapping and GIS updates. This channel was shared throughout municipalities and is available to the public at https://www.youtube.com/channel/UCVaiE4R67VIFAffiizInTJw.

During the duration of the SNEPWG19-11-MMA Grant, MMA received additional funding from other grants and town contracts. The efforts funded by these grants and contracts coincided with the objectives of the Stormwater Project and created a seamless collaboration between all parties involved. The SNEPWG19-11-MMA Grant was the pivotal point in the successfulness of the Buzzards Bay Stormwater Project. It provided the opportunity for the Stormwater Collaborative to become self-sustaining and to continue assessing water quality and stormwater issues in Buzzards Bay. MMA and the BBNEP will continue to work together under contracts with local towns.

These efforts of mapping catchments and monitoring stormwater prepared the Stormwater Project for its next phase in stormwater remediation. MMA received a MassDEP grant in March of 2020 to construct an Illicit Discharge Detection and Eliminate (IDDE) investigation trailer. The trailer is outfitted with an array of equipment which will be used to find sources of point source pollution within a catchment and aid towns in their MS4 compliance. The work that was done under the SNEPWG19-11-MMA Grant has paved the way for a self-sustainable stormwater program that will continue to advance its approaches in stormwater remediation.



FINAL REPORT

SNEPWG19-MMA Grant

12/31/2019- 12/31/2021

Professor William A. Hubbard

Marine Science, Safety & Environmental Protection Department

101 Academy Drive

Buzzards Bay, MA 02532

31 January 2022

RE: SNEP Watershed Grant – Final Report Transmittal
SNEPWG19-11-MMA 09/01/2019-12/31/2021
Final Report – Grant Period- 09/01/2019-12/31/2021

Attached please find the final report per SNEPWG19-11-MMA Grant. Four previous reports have covered activity from Grant award through 31 July 2021. The Grant activity documented here is for 09 September 2019 through 31 December 2021. We look forward to continuing this successful stormwater remediation program, as this grant has given way to numerous other fiscal revenues, including additional grants and contracts with the municipalities of Buzzards Bay for improving storm water management in Buzzards Bay.

Please do not hesitate to contact me at (508) 292-0251 or whubbard@maritime.edu.

Sincerely,

William A. Hubbard

Professor; Marine Ecologist

PROJECT REPORT NARRATIVE

The Buzzards Bay Stormwater Collaborative was launched as a partnership between the Buzzards Bay National Estuary Program (NEP), the Buzzards Bay Action Committee (BBAC), and five municipalities (Dartmouth, Acushnet, Fairhaven, Mattapoisett, and Wareham). This initiative was funded by a U.S. EPA Region I Healthy Communities grant. The purpose of the Collaborative was to map stormwater infrastructure and monitor both wet and dry weather discharges. An essential task of the program was to identify and precisely locate all stormwater discharges along the coast.

In 2019 Massachusetts Maritime Academy (MMA) began a partnership with the Buzzards Bay NEP and eight municipalities (Bourne, Wareham, Marion, Mattapoisett, Fairhaven, Acushnet, Dartmouth, and Westport) to continue mapping stormwater networks and monitoring stormwater discharges that contribute to water quality degradation in Buzzards Bay. This project was funded by SNEP funds provided to the Buzzards Bay NEP, which allowed MMA to hire a program coordinator and fund cooperative education (Co-Op) students, The MMA team worked with Buzzards Bay NEP and municipal staff to undertake a stormwater network mapping and discharge monitoring program. The BBAC contributed the monitoring test kits and Buzzards Bay NEP staff provided training to MMA Co-Op students. In January of 2020, MMA created a seamless transition of the 2019 Stormwater Collaborative effort to start the SNEPWG19-11-MMA Grant.

The Massachusetts Maritime Academy initiated student and supervisor team field activities for January through mid-March before the COVID-19 pandemic began. Within the first couple weeks of March all students were sent off campus and non-emergency staff was forced to work from home. Due to this MMA was not able to implement a full semester of student field activity, and therefore rescheduled that activity to the Spring 2021 semester. The project supervisor was able to complete outreach, training, and long-term sustainability tasks during the COVID-19 closure. Also, team focus temporarily shifted to a Massachusetts Department of Environmental Protection (MassDEP) MS4 municipal assistance grant to construct and outfit an Illicit Discharge Detection and Elimination (IDDE) trailer. The efforts that were to be made by this trailer coincided with the objectives of the SNEPWG19-11-MMA Grant. The additional funding

provided team salaries during COVID restrictions that allowed continued staffing without losing the future field salaries for post COVID sampling. By summer 2020, COVID-19 restrictions for students were partially lifted, allowing field activities for the SNEPWG19-11-MMA Grant to resume. Students continued GPS mapping of stormwater structures, inventorying outfalls, and testing stormwater during dry and wet weather.

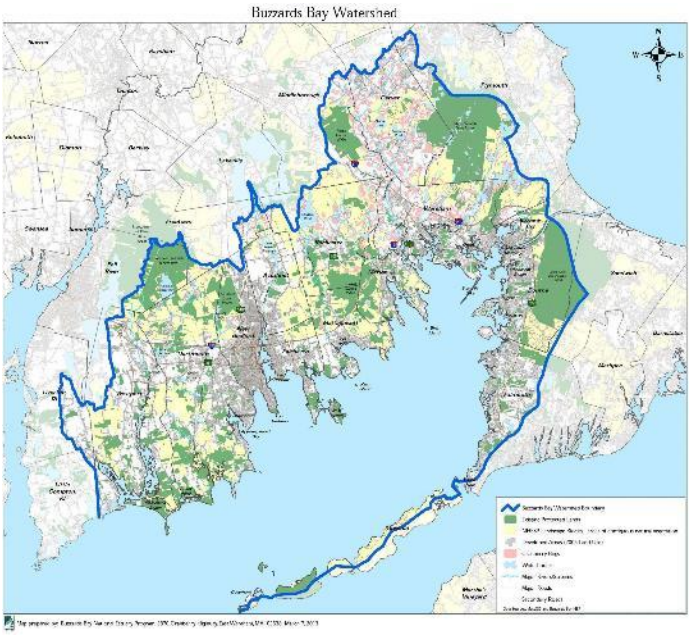
One of the goals of the SNEPWG19-11-MMA Grant was to continue the efforts of previous grants in building a self-sustaining stormwater monitoring program. Throughout the duration of this grant several towns have shown their support by signing contracts to continue funding the stormwater assessment efforts in their communities. The services provided under these contracts include the GPS mapping of stormwater structures, inventorying of outfalls, dry and wet weather sampling, and IDDE investigation. Towns continue to contract with MMA, the Buzzards Bay NEP continues to provide guidance, technical support, and data analysis, and MMA continues to supply staff, all the instrumentation of the stormwater trailer and students to carry out the work. As a result of the SNEPWG19-11-MMA Grant funding, the Buzzards Bay Stormwater Project is evolving into a self-sustainable program that will continue its efforts in improving the health of Buzzards Bay through stormwater remediation.

2.A. PROJECT RESULTS

Stormwater discharges convey nutrients, bacteria, and toxic contaminants which contribute to water quality degradation, habitat loss, and loss of economic uses of coastal waters and ecosystems. While the importance of the role of stormwater pollutants contributing to environmental degradation is widely recognized, the lack of water quality data characterizing individual stormwater networks has stymied efforts to direct limited government resources to manage those discharges. Granting agencies are often faced with reviewing requests to remediate a particular stormwater discharge when there is no objective basis to decide whether that discharge should be a priority for funding. An additional challenge for municipalities is the lack of sufficiently trained personnel to undertake an expansive monitoring effort and the costs of hiring consultants to undertake these tasks can be immense. Many municipalities have hundreds of stormwater discharges which make it difficult to manage stormwater in a comprehensive manner.

Even when stormwater samples can be collected, the lack of infrastructure mapping limits the ability of managers to quantify pollutant loading and appropriately manage problem discharges. These issues are exacerbated by the lack of available entry-level employees with the specific skill sets in stormwater sampling and the start-up cost of implementing a monitoring program. The Buzzards Bay Stormwater Project addressed all these problems by integrating an existing stormwater collaborative monitoring program into the environmental course curriculum of MMA and through the training of municipal staff in stormwater monitoring. This project also delivered additional stormwater infrastructure mapping, stormwater monitoring, and analysis to identify problem areas in the Buzzards Bay Watershed.

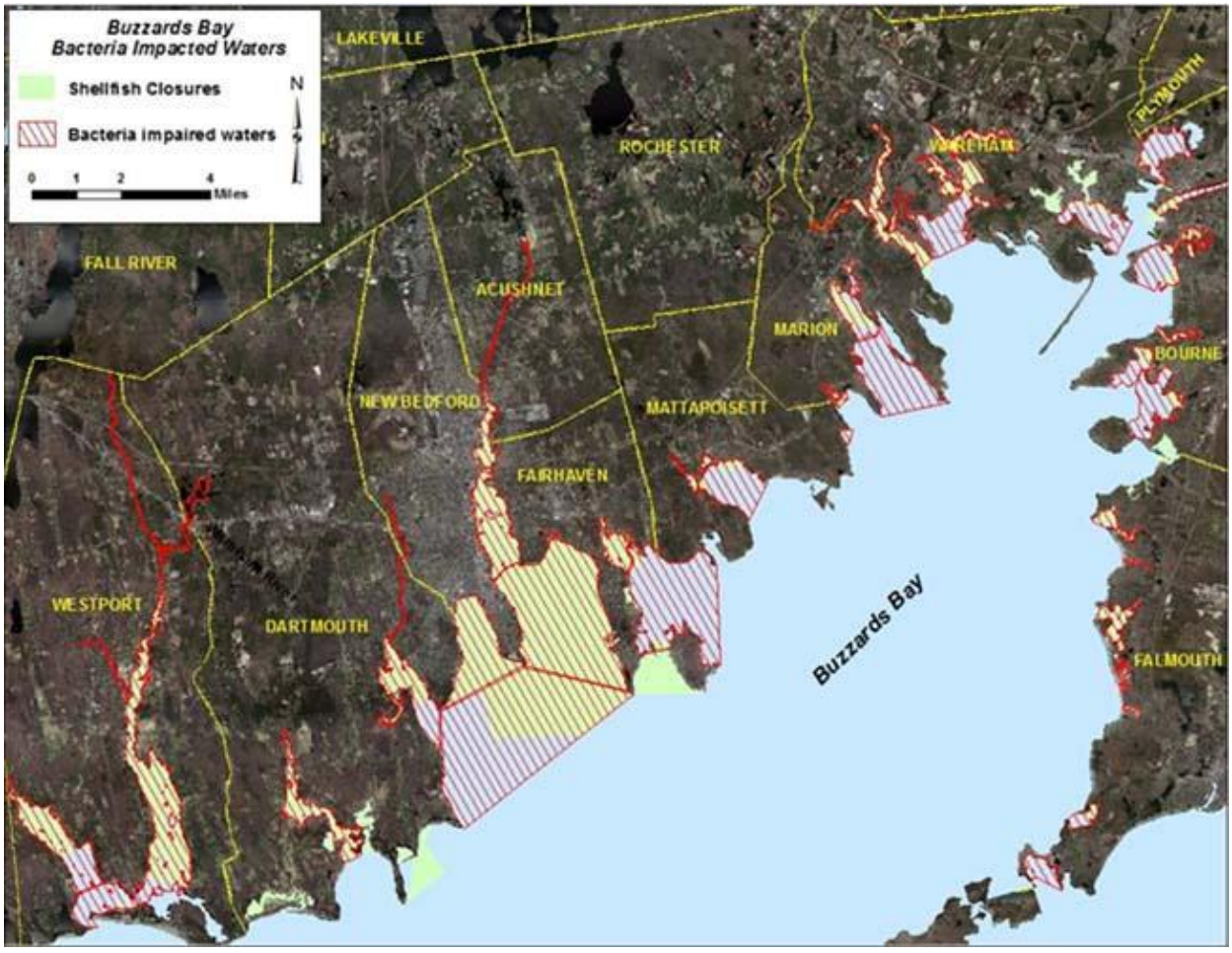
The Buzzards Bay Watershed is located within the western most part of Cape Cod, Southeastern Massachusetts, and the Elizabeth Islands. The bay is 28 miles long, averages 8 miles in width, with its coastline stretching over 350 miles.



The eleven towns that share the coastline of the bay include New Bedford, Westport, Dartmouth, Acushnet, Fairhaven, Mattapoisett, Marion, Wareham, Bourne, Falmouth, and Gosnold. There are five additional towns which contribute to the watershed through streams and rivers including Rochester, Plymouth, Carver, Middleborough, and Fall River. The Buzzards Bay watershed also includes portions of three communities in Rhode Island. The towns within the watershed cover a combined area of 434 square miles.

Of this area there are roughly 15,000 acres of shellfish beds that are closed seasonally, temporarily, or permanently. If there is a rain accumulation of 0.2 inches or more, 6,000 of those

acres are forced to close for a period of time. Below is a map of bacteria impaired waters and the permanently closed shellfish beds.



Bacteria impaired waters and the shellfish beds within those areas that are permanently closed,

The temporary closings of shellfish beds after rainfall is directly related to the amount of pollutants being expelled into the bay from stormwater outfalls. In order to address this problem, MMA staff and Co-Op students continued to monitor outfalls in both wet and dry weather. Outfalls deemed high priority were sorted further by their geographic location and accessibility during the fluctuation of tides. They were then organized into work order binders. During rain events these binders were distributed to Co-Op students. The sheets in these binders included outfall IDs, locations, and sampling parameters. The objective was to collect a sample from each outfall during different rain events. Multiple samples collected at an outfall provided greater water quality data. If access to an outfall was impaired due to the tide, the catchment was sampled at the stormwater structure closest in connection to its outfall. If there was more than

one incoming pipe to said structure, then multiple samples were taken, each with its own unique sample ID. The towns being sampled provided in-kind staff assistance with lifting catchbasin and manhole covers through their Department of Public Works (DPW). During the SNEPWG19-11-MMA grant duration Co-Op students and staff collected a total of 315 wet and dry weather samples. Each outfall was also visited numerous times during dry weather. During this grant's duration 1100 dry weather observations of 'no flow' were conducted. During these dry visits if an outfall was found to be flowing a sample was collected and processed. The water quality data collection effort consisted of three components – field observations and testing, indoor analysis of nitrates and surfactants, and certified laboratory analysis for bacteria. The basic methods and equipment for each component is described below in Tables 1, 2, and 3. The QAPP for the study contains additional details.

Table 1 - Field Testing

Parameter	Equipment	Operating Range	Resolution	Accuracy
Ammonia	Hach Test Strips	0-6 ppm	0.25 ppm	± one half of a color block
Conductivity	HachPocket Pro, Multi 2	0 to 200 µS/cm or 2.00-19.9 mS/cm (auto-range)	0.01mS/0.1µS/1.0uS (range dependent)	±1.0%
Salinity	HachPocket Pro, Multi 2	0 to 10 ppt	0.01 ppt	±1%
Temperature	HachPocket Pro, Multi 2	0 to 50°C (32 to 122°F)	0.1°C	±0.5°C
pH	HachPocket Pro, Multi 2	0.0-14.0	0.01	0.02
Free Chlorine	Hanna HI-762	0-500 ppb	1 ppb	±20 ppb ±4%

Table 2 – Indoor (MMA lab) Analysis

Parameter	Equipment	Operating Range	Resolution	Accuracy	Holding Time
Surfactants (detergents as MBAS)	CHEMetrics K-9400	0-3 ppm	+ 1 color standard increment	+ 30% error	48 hours
Nitrates	LaMotte Nitrate-Nitrogen (3615-01)	0.00 to 1.00 ppm	0.1ppm	0.1ppm	24 hours

Table 3 - Certified Laboratory Analysis

Parameter	Sample Container	Holding Time	Field Processing	Method	Units
Fecal Coliform	100 ml sterilize polyethylene	6 hours	Collect, label, store on blue ice	Membrane Filtration, wastewater, SM9222D, 21th Edition 2005	cfu /100ml
Enterococci	100 ml sterilize polyethylene	6 hours	Collect, label, store on blue ice	EPA Office of Water, Method 1600, Membrane Filter Test EPA 821-R-97-004.	cfu /100ml

All results are maintained in a database available for future comparative analysis research. This database was created and is maintained by the Buzzards Bay NEP and is continuously updated to reflect the growing number of outfalls being inventoried and the increasing number of samples being collected. This database can be used to generate specific reports. The rain accumulation in the 72 hours leading up each sample being taken was also recorded and entered. Each outfall has a report with maps, outfall characteristics, and sampling results. See below for an example of a report and refer to the supporting materials for a complete set of the reports and an explanation of the reports. These reports have given municipalities the ability to characterize individual stormwater networks and evaluate which ones should be a priority for remediation projects.

Stormwater Report for: BBB1008PI
in the Town of Bourne

Report Created on: 1/20/2022

Buttermilk Bridge

2016 Massachusetts Integrated Listed Water

Discharge directly to Pocasset Harbor

MA95-17 | Catagory 5 Estuary

Pollutants: Estuarine Bioassessments, Fecal Coliform

Sampling Parameters: Fecal

SNEP Project: Yes
Urbanized: Y
Sewered:

6 No Flow Observations

Rating by Weather (0-5):
Wet: 4
Dry: 3

Recommnedation: Pipe: Circular 8 inch Cast Iron

MS4 Ranking: High
Status:

Status and Recommendation based on the opinion of the BBNEP.

Stormwater Report for: BBB1008PI

Report Created on: 1/20/2022

Field Results

SampleID	SampleDate	FacilityID	SampleType	Last Rain	48hr Rain	Sensory	pH	Temp.	Salinity	Ammonia	Chlorine	Nitrate	Surfactants
0BN30OCT11-A	10/30/2020	BBB1008PI	pipe	0 hrs	2.62 in	none	7.32	13.7 C	0.02 ppt	0 ppm	0 ppb	0.88 ppm	0.25 ppr
BO01APR06-A	4/1/2021	BBB1008PI	sump	1 hrs	0.93 in	none	7.53	13.9 C	0.9 ppt	0.25 ppm	0 ppb	0.88 ppm	0.5 ppr
BO03JUN01-A	6/3/2021	BBB1008PI	pipe	79 hrs	0 in	none	7.92	17.6 C	0.28 ppt	0.5 ppm	16 ppb	0.88 ppm	3 ppr

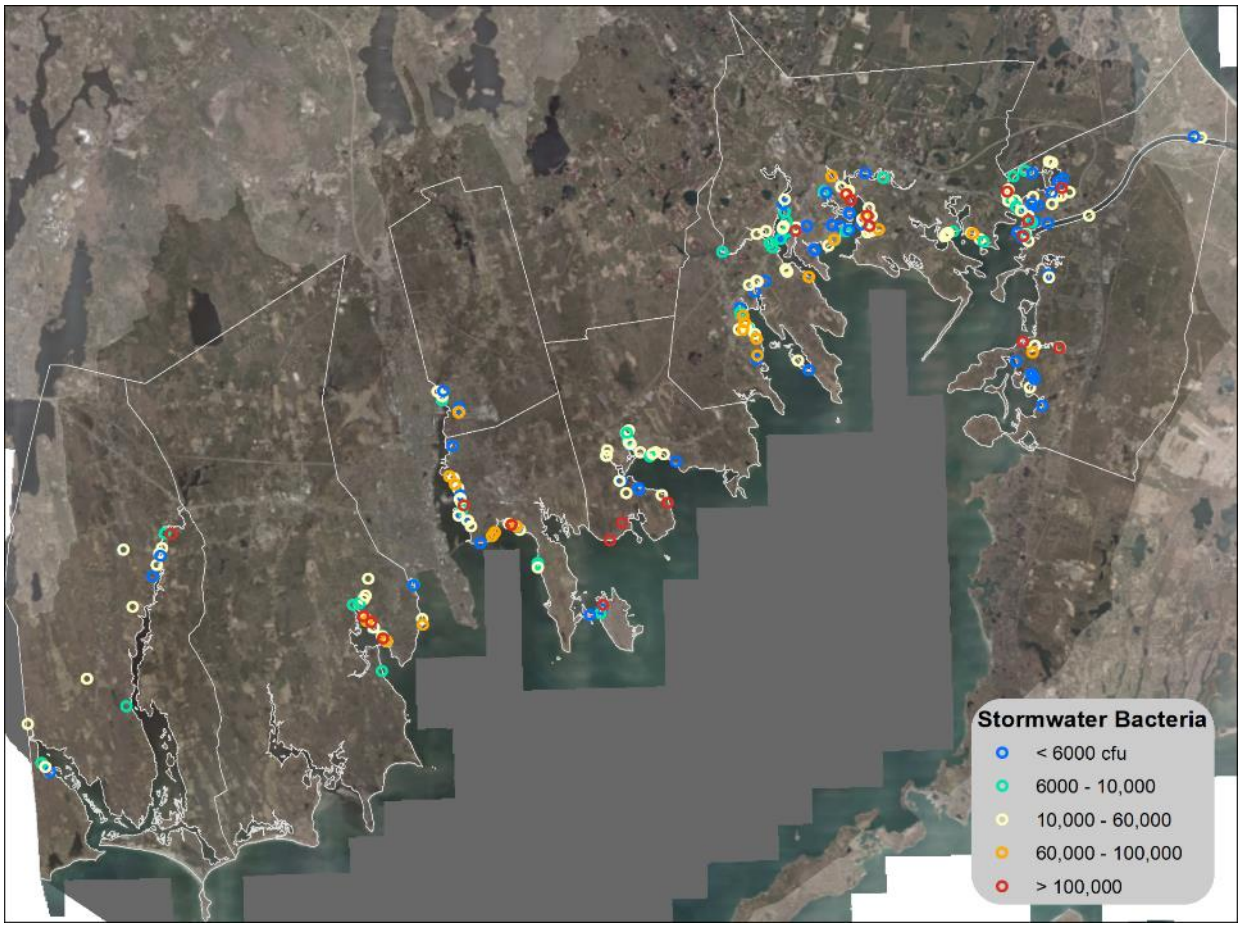
Certified Laboratory Results

SampleID	Entero.	Fecal C.	E. coli	Kjeldhal N	Ammonia N	Nitrate N	Nitrite N	Total N	Total P	TSS	DO	BOD	HydroCarbo
0BN30OCT11-A	< 1000			BRL	< 0.5 mg/L	0.24 mg/L	BRL						
BO01APR06-A		40000		0.84 mg/L		12 mg/L	0.258 mg/L	13 mg/L					
BO03JUN01-A		1000		2 mg/L		0.59 mg/L	BRL	2.6 mg/L					

Example of Outfall Monitoring Report (see Supporting Materials for interpretation information)

Below is a map of Buzzards Bay generated to illustrate results from bacteria testing. The circles represent the locations of the outfalls, with their color depicting the measurements of bacteria

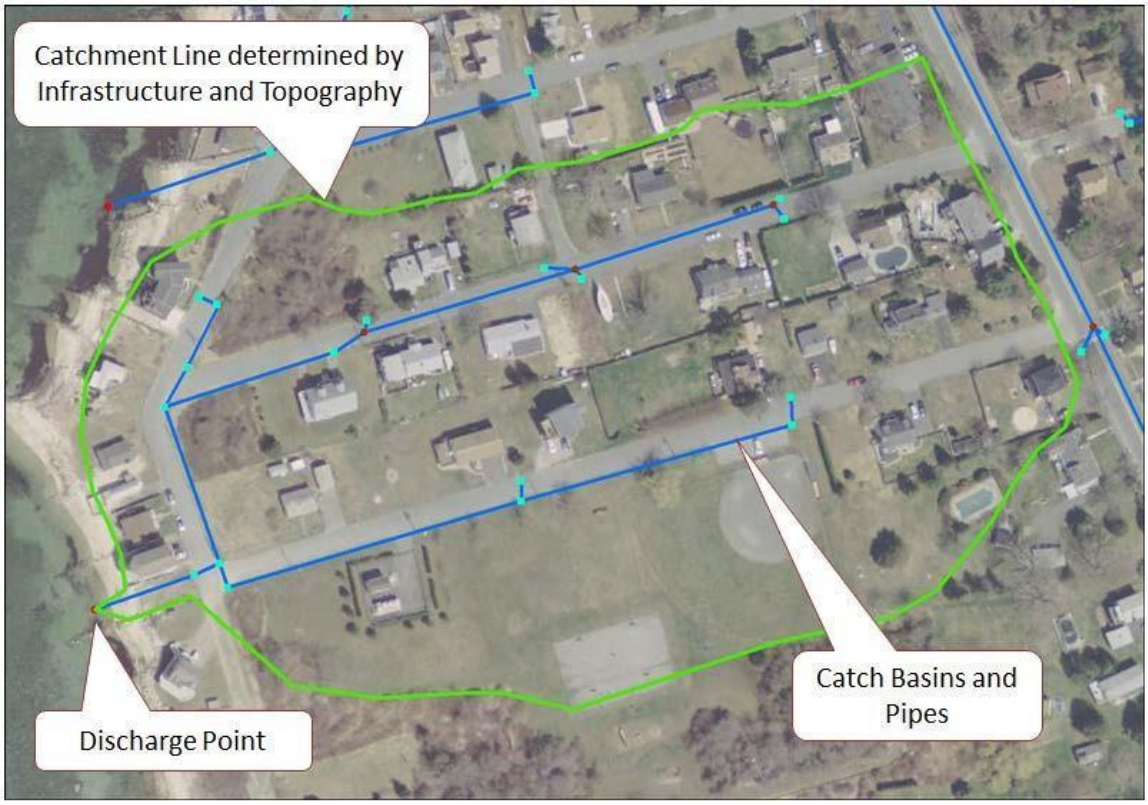
found in the samples collected. Values are either *Enterococcus* or fecal coliform in colony forming units (cfu) and collected during a rain event.



Map of the study area showing bacteria levels measured at 274 monitoring locations.

The water quality data generated from the hundreds of stormwater samples collected in previous years as well as the hundreds of samples collected during this SNEPWG19-11-MMA Grant period has identified areas in need of further investigation in Buzzards Bay. This data introduces a starting point in identifying the sources of pollution. The degree of pollution recorded at these outfalls directly reflects problems within their corresponding catchments. Catchments can drain a relatively small area or can provide drainage for much larger areas spanning several acres. Understanding the area being drained to a specific outfall is crucial in remediating the source of pollution. Below is an example of a catchment. The blue squares represent catch basins, the

brown circles represent manholes, the blue lines represent the pipes connecting structures, and the green line is a catchment delineation of the contributing area to the discharge point.



Drainage area associated with a single outfall

The figure shown above is the end result of a meticulous five step process in identifying stormwater catchments. The first of these steps consisted of obtaining and scanning engineering drawings. Much of this scanning was completed by interns supported from previous grants. After being scanned these drawings were georeferenced in GIS to associate the drawing with real-world coordinates. This task was completed in the early months of this SNEPWG19-11-MMA Grant.

The third step, once all images were georeferenced, was confirming the location of the stormwater structures illustrated on those images. An important part of this GIS work was field verifying and GPS mapping of stormwater structures. Co-op students visited the eight cooperative towns in Buzzards Bay GPS mapping every stormwater manhole, catch basin, and treatment structure. This process included walking up and down every street and hovering the

GPS over the center of the structure until its precise position was collected. Students had a drop-down menu on the GPS to label the point of the specific type of structure being collected. Students started off with maps of specific areas to GPS that indicated the approximate location of these structures. However, oftentimes students were able to GPS structures not previously accounted for or confirm the non-existence of structures. Thousands of points were collected and imported into GIS to update an extensive stormwater atlas for the Buzzards Bay towns.

The fourth step of pipe digitization was mostly completed by MMA staff and the Buzzards Bay NEP. These details were built upon the plan digitizing and GPS mapping efforts. With the network mostly mapped in GIS, locating outfall pipes was the final step in getting a comprehensive understanding of the stormwater catchment.

Digitizing pipes required previously georeferenced images and GPS points to provide an outline as to how the structures in a catchment were connected. Using the editing tool in GIS, the connections were manually created between structures. Information from the scanned images was also inputted as attributes, such as size and material of the pipe. Digitizing the stormwater pipes began to define catchments and provide insight as to how much land a certain catchment covered and how many structures correlated to each individual outfall.

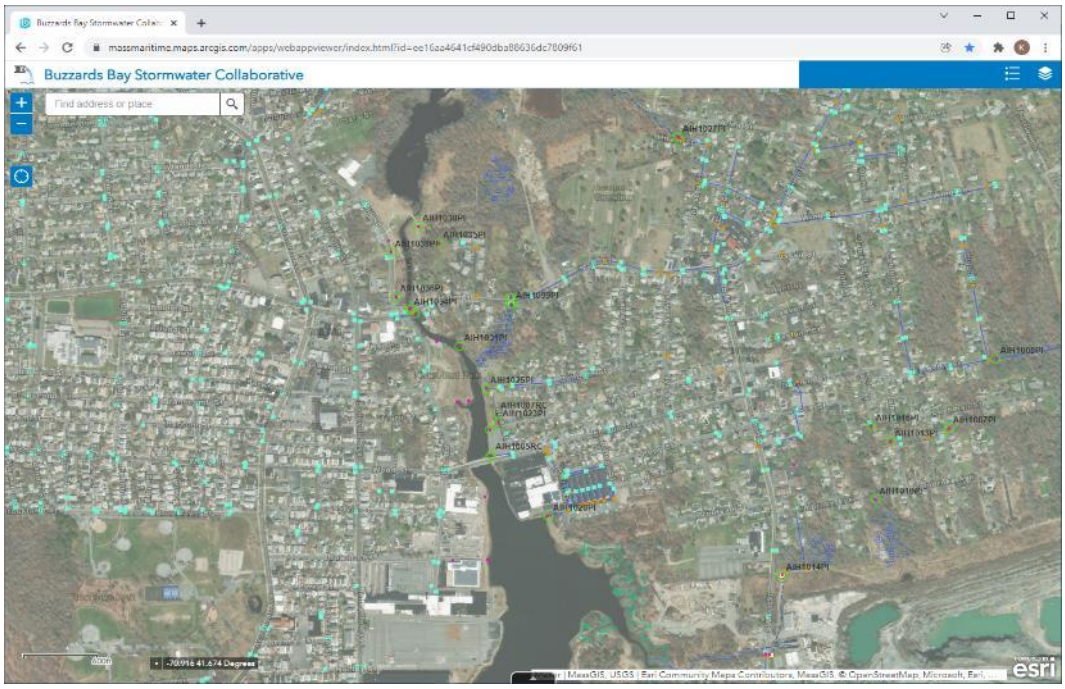
Processing the information collected up to this point was vital in the inventorying of outfalls. The town drawings provided an increase in knowledge of where the outfalls were presumably located. Field verifying stormwater structures assisted in the expectation that these outfalls existed in those locations. It also prevented searching for outfalls that did not exist. In past years, the Buzzards Bay NEP had already inventoried a large number of outfalls in Buzzards Bay municipalities. Now with the teams of Co-op students another 500 outfall locations were field verified and documented in the eight Collaborative towns.

This final step, called outfall inventory, was challenging and time consuming. Outfalls were often hidden in overgrown brush or buried in dirt. Others were obscured depending on the tide. Some did not actually exist as outfalls but rather were underground treatment structures. One outfall could take hours to locate. When outfalls were located their position was collected with a mapping grade GPS and photographed. An inventory sheet was filled out indicating the pipe’s size, material, location, accessibility, and sampling strategy. A copy of this inventory sheet is

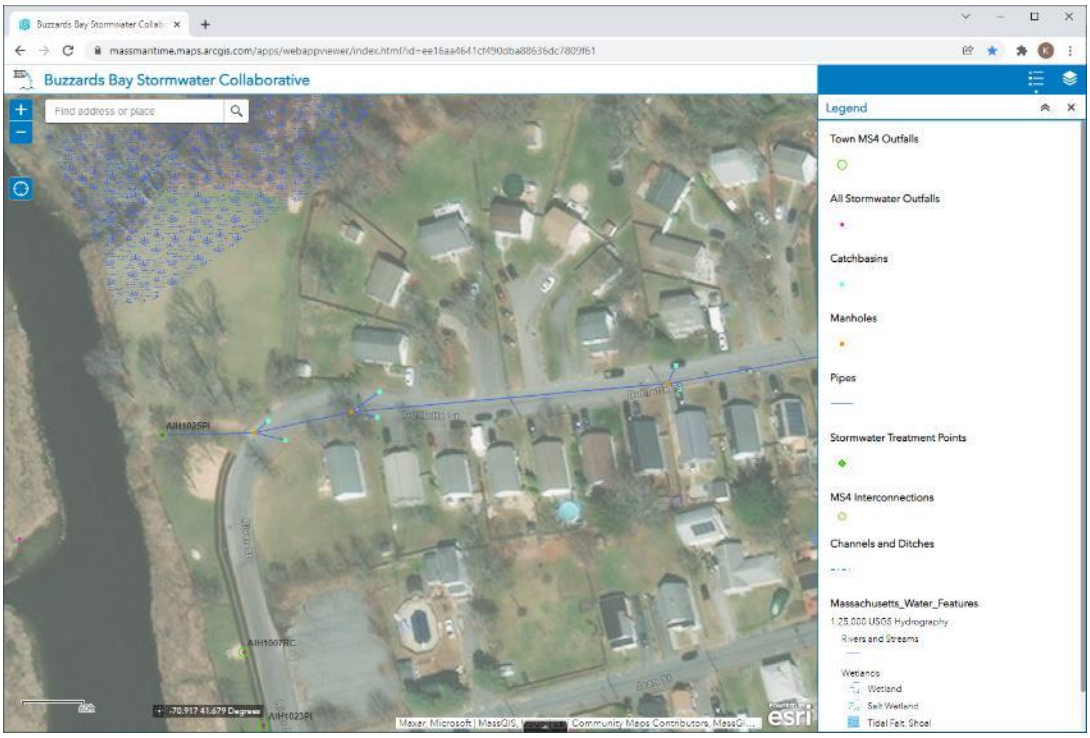
provided in Supporting Materials. The outfall inventory was used to update the stormwater GIS atlas and the sampling database.

This grant funded the start of these steps for ultimately analyzing *all* the stormwater catchments in each of the eight Collaborative towns. In December 2020 several towns began to contract MMA with additional funds for their services. These funds will be used to complete these steps for MS4 regulated areas as to fulfill requirements for their permit and to enhance their understanding of stormwater issues in their communities.

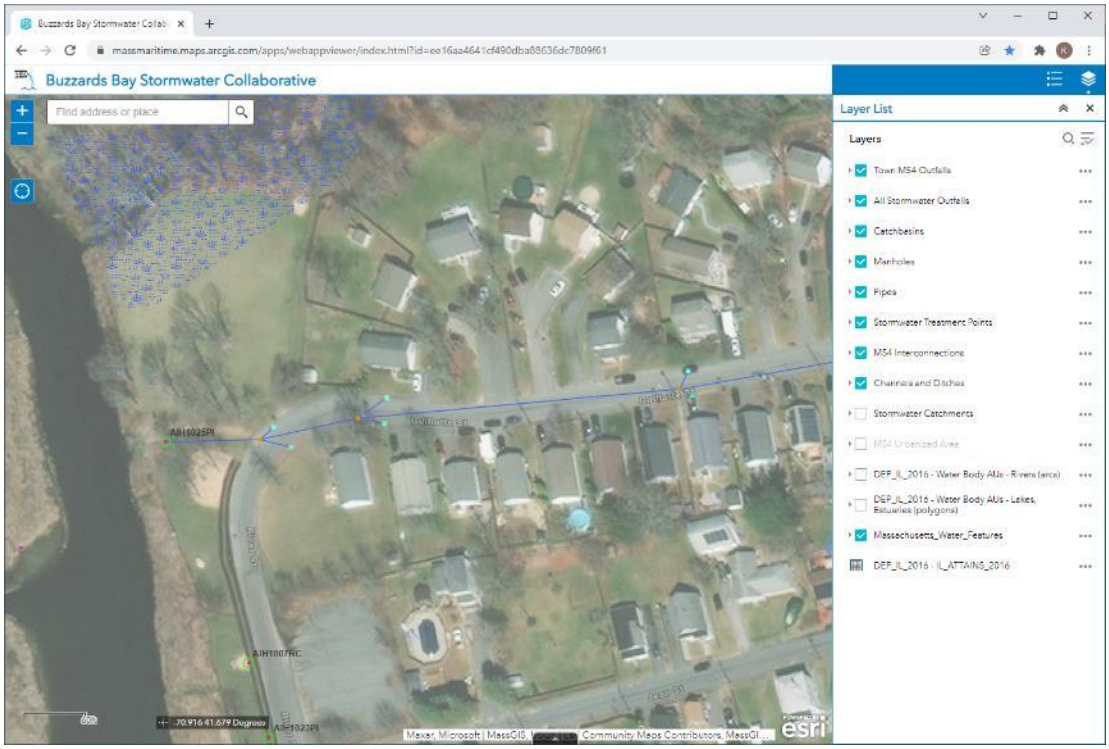
One of the products created from the GIS atlas, in addition to the continuous stormwater monitoring, is a comprehensive web-based map that displays the Collaborative's GIS data and provides spatial access to the monitoring reports. The mapping data that was collected became too dense and complicated to show on paper maps. This web map, supported by MMA and powered by ArcGIS Online, allows the viewer to see all the stormwater structures, outfall points, hydrology, 303(d) listed waters, MS4 permit information, and monitoring data collected since the inception of the Collaborative. The ArcGIS Online map can be viewed at: https://massmaritime.maps.arcgis.com/apps/webappviewer/index.html?id=ee16aa4641cf490dba88636dc7809f61 The figures below describe some of the features.



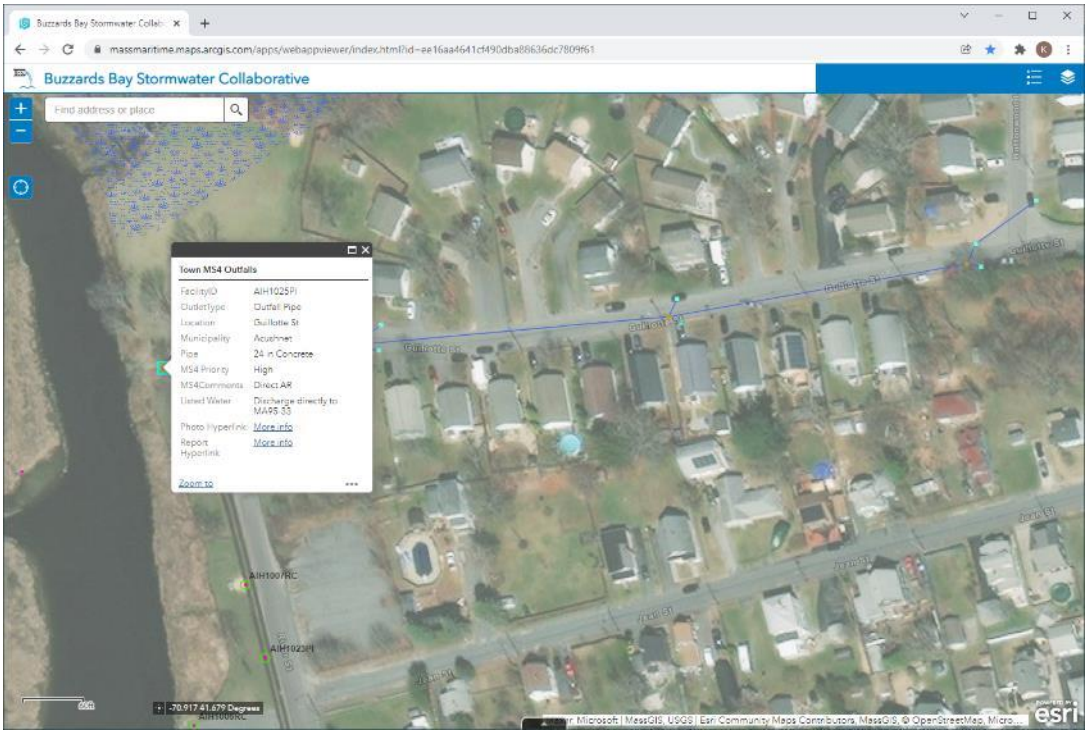
The ArcGIS Online map includes the stormwater GIS for the entire Buzzards Bay watershed with details for the eight municipalities participating in the Collaborative.



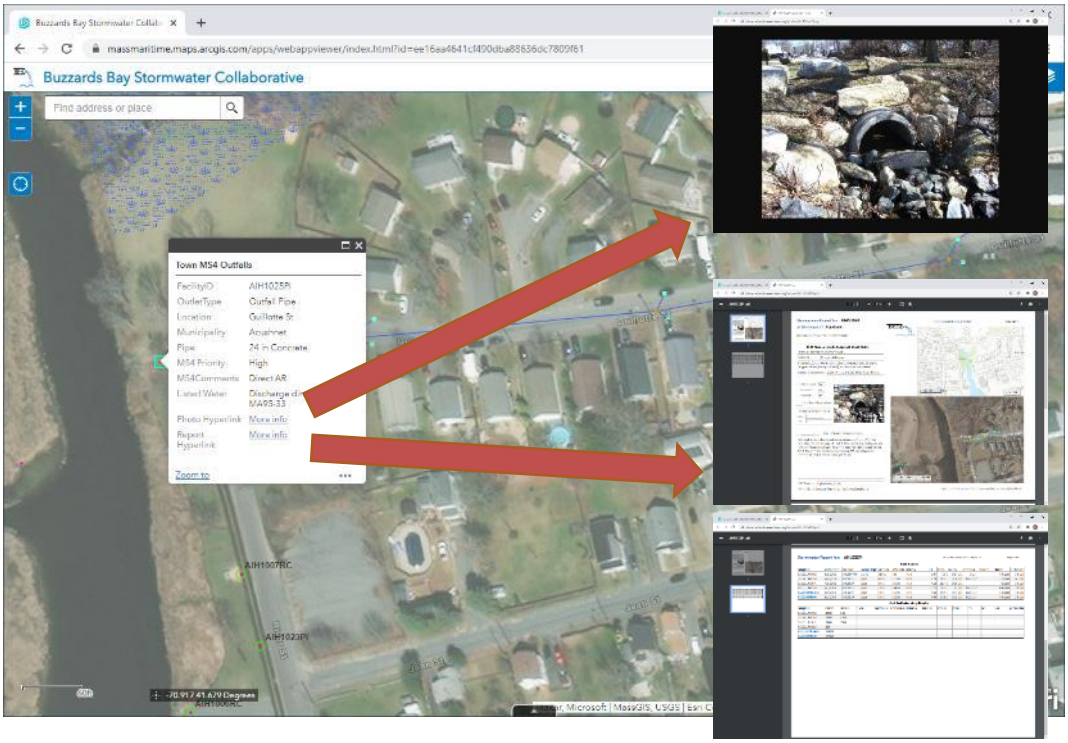
Stormwater structures are shown by default with imagery, roads, and hydrology in the background.



Other features such as stormwater catchments, urbanized areas, and listed waters can be turned on and viewed by the user.



Outfalls with green circles can be selected to view a pop-up box with details about the outfall.



Hyperlinks in the pop-up box opens pages for outfall photographs or monitoring reports associated with that outfall.

Once these catchments had been defined, their accuracy and condition could be assessed with the IDDE trailer to further determine pollution sources and water quality impacts. This process was labor intensive and costly as it required an inspection of every structure in the field and was beyond the scope of this grant. The remaining funds under the SNEPWG19-11-MMA Grant could not cover the entirety of this looming expense. MMA was awarded a MassDEP grant to construct an IDDE trailer to be used locate illicit connections within the Collaborative towns. With the larger goal being to improve the overall health of Buzzards Bay. the process to find these illicit connections will continue under town funded contracts with the MMA/Buzzards Bay NEP team.

As part of the IDDE process, every structure needed to be opened, inspected, and documented. Connections between structures were confirmed and further inspected to ensure no discharges were illicitly connected. The MassDEP trailer equipment grant that supported this work complemented the SNEPWG19-11-MMA Grant. Cameras, catchment grate lifts, smoke tests and field support materials provided shared information was crucial in the success of investigation objectives. Every catchment in every town could not be completed due to limits of funding and time under existing grants. However due to the success of the SNEP grants, towns have now contracted with MMA to fund the Stormwater Collaborative to continue mapping stormwater catchments, sampling outfalls, and investigating for illicit connections.

The process of evaluating catchments is important in identifying sources of pollution. The results of every stormwater sample collected now represents the overall quality of a specific area. Outfalls can be better prioritized for remediation and locating the source of pollution in a large catchment is more plausible. The work done under the SNEPWG19-11-MMA Grant has drastically improved each municipality's infrastructure mapping. This progress has increased the ability of managers to quantify pollutant loading and appropriately manage problem discharges. So far only preliminary sampling has been conducted at outfalls, but it has provided the project with areas of interest worth further investigation. Additional sampling can focus on structures in high-risk catchments. The Collaborative can continue work funded by municipalities to determine the location of pollution entry. The sampling and mapping processes of the SNEPWG19-11-MMA Grant and the equipment from the

IDDE trailer can then be utilized to pinpoint the source of pollution and improve the water quality of Buzzards Bay.

The extensive amount of work completed for these eight towns funded under this SNEPWG19-11-MMA Grant was done in large part by cadets from the Massachusetts Maritime Academy. MMA provided students, who were then sufficiently trained to contribute to this expansive mapping and monitoring effort. Cadets were recruited from the Marine Science, Safety and Environmental Protection Department. This major focuses on environmental ecology, safety and environmental regulations. In the spring of 2020 the first group of students to take part in this grant began their 120-hour (3-credit) co-op. Students who completed their co-ops during the spring and fall semester contributed 120 hours of work each. Students who completed their co-ops in the summer contributed 240 hours of work each, giving them 6 academic credits for the internship. Below is a table illustrating the number of cadets who participated each semester and the total amount of credits earned by each group of Co-op students.

Semester	Number of Students	Total Credits Earned
Spring 2020 COVID/ CO-OP CANCELED	– – – – – – – – – – – – – – –	– – – – – – – – – – – – – – –
Summer 2020 June-August	6	36 Credits
Fall 2020 September-December	5	15 Credits
Spring 2021 March-June	4	12 Credits
Summer 2021 June-August	5	30 Credits
Fall 2021 September-December	3	9 Credits

Co-Ops and credits were achieved by students under the SNEPWG19-11-MMA Grant.

Over the course of this grant more than 20 students were able to complete a co-op required for the completion of their B.S degree. Students were an imperative reason as to why this SNEPG19-MMA grant was so successful. Students inventoried hundreds of outfalls in Buzzards Bay, GPSed thousands of stormwater structures, collected hundreds of stormwater samples, completed thousands of dry weather no-flow observations, and georeferenced hundreds of engineering drawings.

Students were able to receive hands-on experience in a vast amount of applications, using what they learned in the field to succeed in their classrooms. This is the kind of experience that future employers will value. The towns these students worked in also benefited from their participation. The incredible amount of work done allowed the towns to see actual progress while staying within their tight budgets. It created relationships between the organizations that will continue beyond the completion of this SNEPWG19-11-MMA Grant.

Previous grants and funding from the Buzzards Bay NEP covered the start-up cost of implementing a stormwater program and starting the Stormwater Collaborative. This SNEPWG19-11-MMA Grant continued to develop this program by funding entry level personnel and having the Buzzards Bay NEP providing technical expertise and consultation.

An innovative adaptation occurred in March 2020 when the World Health Organization declared COVID-19 pandemic and students were ordered to leave campus. A week later all non-emergency MMA staff were ordered to work from home. Some activities for SNEP could continue from home such as georeferencing and pipe digitizing. However, sampling outfall inventory, and GPS mapping were no longer operable. To continue working with municipalities in Buzzards Bay under these extreme restrictions, the Buzzards Bay Stormwater Project created a YouTube channel:

https://www.youtube.com/channel/UCVaiE4R67VIFAffiizInTJw

Municipalities were made aware of this channel and encouraged to use it as an additional tool in training their personnel on everything stormwater. This channel will remain on YouTube and can continue to be used as much as needed. Through the course of the seven videos, viewers learn stormwater terminology, sampling techniques, safety precautions for field work, and how data collected in the field is then used to update the GIS database. This channel was made public and

has had many views. These videos have also proven to be a great tool for new co-op students to refer back to while in the field. In July of 2020 MMA reopened partially. Work for the SNEPWG19-11-MMA Grant resumed. Strict COVID-19 policies were put in place and can be viewed in the supporting materials.

During the duration of the SNEPWG19-11-MMA Grant, MMA coordinated additional funding from other grants and town contracts. The efforts funded by all these grants and contracts coincided with the objectives of the Stormwater Project and created a seamless collaboration between all parties involved. Below is a table that lists the grants and contracts that have continuously supported the Buzzards Bay Stormwater Project since its inception in 2016.

Grant	Period	Applicant	Amount
2015 U.S. EPA Region I Healthy Communities	2016-2018	BBAC (5 Towns, BBNEP)	$200,000
2017 EPA HQ Year-End Request	2017	BBAC (5 Towns, BBNEP)	$36,940
Five Town Contribution	2018	BBAC (5 Towns, BBNEP)	$25,000
2018 SNEP funding from BBNEP	2019-2020	MMA (8 Towns)	$160,000
2019 SNEP Grant	2020-2021	MMA (8 Towns, BBNEP)	$176,581
Various Town Contracts	2020		$11,200
2019 MassDEP MS4 Assistance Grant	2020	MMA (8 Towns, BBNEP)	$46,000
2020 MassDEP MS4 Assistance Grant	2021	MMA (8 Towns, BBNEP)	$47,000
Various Town Contracts	2021	MMA	$20,900
2021 SNEP funding from BBNEP	2022	MMA (8 Towns)	$25,000
Various Town Contracts	2022	MMA	$39,300

The SNEPWG19-11-MMA Grant was the pivotal point in the successfulness of the Buzzards Bay Stormwater Project. It provided the opportunity for the Stormwater Collaborative to become self-sustaining and to continue assessing water quality and stormwater issues in Buzzards Bay.

2.B. NEXT STEPS AND RECOMMENDATIONS

One of the major benefits of this project is the data that can be used to assess point sources of stormwater pollution into Buzzards Bay. The Buzzards Bay NEP has already started the process of data analysis to identify areas for remediation. In 2021, the Buzzards Bay NEP contracted an engineering company to evaluate 15 sites identified by this project as sources of stormwater pollution. The results of this contract were six concept designs and three construction ready designs for treatment projects. The three municipalities where the designs are located are working on securing funding to implement these designs. Additional design and construction projects are currently being planned by the Buzzards Bay NEP. These will be tangible improvements to the water quality of Buzzards Bay based on the funded actions of the SNEP grant program.

The next step for the Buzzards Bay Stormwater Collaborative is to continue work in monitoring, mapping, and investigating stormwater outfalls. This continuing effort is already being realized through individual town contracts with MMA to progress with 2022 and beyond stormwater work to meet the town's MS4 permit requirements.

The detailed stormwater network investigations that are done with the students and the Stormwater Collaborative IDDE trailer is another pathway forward. The tools and techniques developed during this project will continue to provide support to municipalities to determine pollution sources and to remediate them.

The water quality data collected during this project and the previous stormwater collaborative work is extensive. With about 1000 samples under various conditions, this data can be used to determine generic impacts on stormwater quality and applied universally. This data is available to researchers from the Buzzards Bay NEP upon request.

2.C. COMPLIANCE

All work for stormwater sampling complies under agreed QAPP procedures. The program coordinator ensured quality control and consistency for procedures involving stormwater sampling and analysis. The complete QAPP is included in supplemental materials.

2.D. PROJECT PARTNERS

Partners for this project include Buzzards Bay National Estuary Program, Massachusetts Office of Coastal Zone Management, and the municipalities of Bourne, Wareham, Marion, Mattapoisett, Fairhaven, Acushnet, Dartmouth, and Westport. All work for this grant involved involve these partners, as evidenced by numerous management meetings and collaborative field activities. This SNEP funding meets the Buzzards Bay National Estuary Program's Comprehensive Conservation and Management Plan priorities. The leadership and staff at the Buzzards Bay NEP have tremendously guided the implementation of this stormwater collaborative with exceptional technical and management support.

2.E. VOLUNTEER AND COMMUNITY INVOLVEMENT

Volunteer and community involvement was extremely limited due to the extent of the COVID-19 pandemic. Outings in the field often turned into public displays between residents and our project members. Most residents showed great interest and passion in the purpose of the project. Oftentimes they had valuable knowledge of connections between structures or locations of outfalls. The YouTube channel and online mapping has provided the community involvement in this period of COVID isolation.

2.F. OUTREACH AND COMMUNICATIONS

Below is a summary table of the outreach carried out under the SNEPWG19-11-MMA Grant. Photos, articles, and posters are included under supporting materials.

Date:	**Format:**	**Audience:**	**Description:**
Ongoing	Buzzardsbay.org	Buzzards Bay Communities/ Public	The NEP website continues to update the public on the achievements of the Stormwater Project and ongoing partnership. between the NEP and MMA.
October 11th,	Poster	SNEP Watershed	The SNEPWG19-11-MMA Grant

2019		Recipients	recipients gathered in Falmouth, where they displayed a poster of the work to be done under the grant and answered questions from the public.
October 23rd, 2019	Poster	Public	A Co-op student presendented a poster of the Stormwater Project at a co-op fair on campus.
October 25th, 2019	Article	Massachusetts Maritime Academy/ Public	An article was published on the Maritime website acknowledging the awarded SNEPWG19-11-MMA Grant and describing the goals of the project and the partnership between the NEP and MMA.
February 27th, 2020	Presentation	Buzzards Bay Action Committee	The Program Coordinator from MMA discussed co-op students' accomplishments. They also discussed future goals of the project.
April 8th, 2020	Youtube Video	Public	A YouTube channel was created for the Buzzards Bay Stormwater Collaborative. The first video was an overview of the entire project.
September 15th, 2021	Presentation	Massachusetts Maritime cadets	The Program Coordinator from MMA spoke to students about the Stormwater Project's purpose and Co-op opportunities.
May 13th, 2021	Presentation	MA Statewide Municipal Stormwater Coalition	The Program Coordinator from MMA spoke at the quarterly Statewide Municipal Stormwater Coalition meeting. They discussed the goals under the SNEPWG19-11-MMA Grant, stormwater sampling strategies, and the partnership between the BBNEP and MMA.
May 28th, 2021	Presentation	Buzzards Bay Action Committee	A project member updated the municipalities of work completed under the SNEPWG19-11-MMA

			Grant to date.
April 22, 2021	Presentation	Buzzards Bay Action Committee	A project member updated the municipalities of work completed under the SNEPWG19-11-MMA Grant.
August 12th, 2021	Newspaper Article	Fairhaven Residents/ Public	A Co-op student wrote and submitted an article to a Fairhaven newspaper. The article discussed the harmful impact of pet waste in stormwater and ways to reduce the impact of it.
December 7th, 2021	Press Release	Communities in Buzzards Bay/ Public	A press release was published describing the work being done by co-op students and their contributions to the Stormwater Project.
January 22nd, 2022	Newspaper Article	Wareham Residents/ Public	Co-op students wrote and submitted an article to a local Wareham newspaper. The article discussed illicit connections and ways to reduce nonpoint pollution sources.

3. PROJECT BUDGET REPORT

The Summary Budget Report below represents project effort through 31 December 2021.

3(a). Summary Budget Tables:

The below **Final Invoice** represents the expenditures for the 1 July through 31 December 2021 expenses.

DESCRIPTION	AMOUNT
1 Jul 2021-31 Dec 2021	
MMA Administrator	600.00
MMA Science Supervisor	600.00
Stormwater Coordinator	7,875.00
Coop Students	20,160.00
Mileage - Field Work	1,944.50
Miscellaneous supplies	1,721.11
MMA overhead 25%	8,225.15
TOTAL	$ 41,125.76

The $41,125.76 Final Invoice was sent by the Massachusetts Maritime Academy Controller's Office on 20 January 2022 and no further invoicing is anticipated. The 2-year effort expended 95% of the $176,581 awarded funding.

Cumulative budget activity

Cost Item or Category	Cost Basis	RAE SNEP Request	Total Non-Fed Match	Match Source	Total Project Cost	INVOICE 1	INVOICE 2	INVOICE 3	INVOICE 4	INVOICE 5	INVOICE 6	Balance	Match This Invoice	Match Previous Invoices	Match Total
								1JUL-2OCT	2OCT-31DEC						
Personnel															
MMA Administrator	40 hrs @ $75/hr	$3,000	$0		$3,000	$ 600.00		$ 1,200.00	$ 600.00		$600.00	$0.00			
MMA Science Supervisor	93 hrs @ $75/hr	$6,975	$0		$6,975	$ 1,200.00		$ 3,600.00	$ 1,575.00		$600.00	$0.00	$ 3,400.00	$ 1,200.00	$ 4,600.00
Stormwater Coordinator	2128 hrs @ $30/hr	$63,840	$0		$63,840	$ 10,185.00	$ 3,480.00	$ 14,730.00	$ 14,730.00	$ 12,840.00	$7,875.00	$0.00			
Coop Students	See Narrative	$46,970	$0		$46,970	$ -	$ 1,918.00	$ 14,231.00	$ 5,495.00	$ 4,888.80	$20,160.00	$277.20			
Town DPW Workers	360 hrs @ $25/hr		$9,000	Towns	$9,000								$ 4,000.00	$ 8,000.00	$ 12,000.00
Town Officials	60 hrs @ $50/hr		$3,000	Towns	$3,000								$ 1,500.00	$ 3,500.00	$ 5,000.00
NEP Staff	2250 hrs			BB NEP (fed)											
Total Personnel		**$120,785**	**$12,000**		$132,785	**$ 11,985.00**	**$ 5,398.00**								
Fringe															
Fringe MMA		$0			$0										
Fringe, Towns	28%		$3,360	Towns	$3,360								$ 1,316.00	$ 3,220.00	$ 4,536.00
Total Fringe:		**$0**	**$3,360**		$3,360										
Travel															
Mileage for Field work	6000 miles @ $0.58/mile	$3,480			$3,480	$ 178.70		$ 1,448.51	$ 1,184.66	$ 1,758.12	$ 1,944.50	($3,034.49)			
Town DPW Vehicles	360 hrs @ $20/hr		$7,200	Towns	$7,200								$ 1,200.00	$ 3,600.00	$ 4,800.00
Total Travel		**$3,480**	**$7,200**		$10,680	**$ 178.70**									
Equipment															
Total Equip.		**$0**	**$0**		$0										
Supplies															
Sampling Supplies	300 samples @ $10/sample	$3,000	$0		$3,000							$3,000.00			
Misc. Supplies	office, experiments, meters	$8,000	$0		$8,000	$ 1,860.22		$ 292.81	$ 478.71	$ 2,743.05	$1,721.11	$904.10			
Total Supplies		**$11,000**	**$0**		$11,000	**$ 1,860.22**									
Contractual															
Laboratory Analysis	300 samples @ $20/sample	$6,000	$0		$6,000							$6,000.00			
Total Contractual		**$6,000**	**$0**		$6,000	**$ -**									
Other															
MMA Chemistry Lab	80 hrs @ $150/hr		$12,000	MMA	$12,000								$ 3,600.00	$ 10,800.00	$ 14,400.00
MMA GIS Computer Lab	50 hrs @ $75/hr		$3,750	MMA	$3,750								$ 2,600.00	$ 4,750.00	$ 7,350.00
Total Other		**$0**	**$15,750**		$15,750	$ -									
TOTAL DIRECT		**$141,265**	**$38,310**		$179,575	**$ 14,023.92**	**$ 5,398.00**	**$ 35,502.32**	**$ 24,063.37**	**$ 22,229.97**	**$ 32,900.61**	$ 7,146.81			
Total Direct Costs		$141,265	$38,310		$179,575										
Indirect 25% (10% on town match)	NICRA 32%	$35,316	$15,792	7% MMA 10% of munic.	$51,108	$ 3,506.00	$ 1,349.50	$ 8,875.58	$ 6,015.84	$ 5,557.49	$ 8,225.15	$1,786.68			
TOTAL		**$176,581**	**$63,991**		$240,572	**$ 17,529.92**	**$ 6,747.50**	**$ 44,377.90**	**$ 30,079.21**	**$ 27,787.46**	**$ 41,125.76**				
	Non-Federal Match as Percentage of Request: 36.2%										**7%**	**7%**	**$ 2,878.80**	**$ 7,449.51**	$ 10,328.31
													$ 20,494.80	$ 42,519.51	
					7% MMA match	$ 1,227.09	$ 472.33	$ 3,106.45	$ 2,105.54	$ 1,945.12	$ 2,878.80				
													Total match to date=		**$ 63,014.31**
					Match	$ 5,300.00	$ 3,791.00	$ 2,846.00	$ 16,222.00	$ 14,361.00					

3(b). Budget Narrative:

The Grant Award was **$176,581**. Invoices totaling **$167,647** were submitted for payment. Predominantly all the labor was expended, but the $6K Contractual line item for Laboratory Analysis was not required as one of our partners, the Buzzards Bay National Estuary Program paid for the analyses. Other minor non-labor items were under budget and mileage was over budget. The remaining unused balance was $7,147 that would have had a 25% indirect rate of $1,787 for a total project completed under budget by **$8,934** or approximately 5% (8,934/176,581).

All labor was expended except for $277 in student CoOp funding. The students were each awarded paid CoOps for either 120 hours (3-credit) or 240 hours (6-credit) and the balance was a rounding function for the original estimated total. The Sampling Supplies and Miscellaneous Supplies totaled $11,000 and expended supplies totaled $7,905, leaving an unused balance of $3,904. The Contractual Line item for $6,000 in Laboratory Analysis was unused as discussed above, that testing being paid by the Buzzards Bay National Estuary Program.

One financial issue that has been previously identified was a COVID induced increase in mileage for students and staff. Original estimates – broad estimates – anticipated $3,480 for mileage. Obviously, carpooling was anticipated for staff and students, but COVID protocol changed that activity. All students and staff were required to commute to the project field sites separately. This significantly increased the reimbursable mileage for MMA teams. Therefore, the mileage category was $3,034.49 over budget. We respectively request the Supplies excess of $3,904 or the unused Laboratory Analysis of $6,000 be reallocated to cover this deficit.

The project is complete, and the invoiced amount leaves a total unused balance of $8,934 or 5%.

The Grant Award projected "Services in Kind" (Match) was **$63,991**. The total match accomplished was $63,014. This match was 99% of the estimated, even with the local municipalities encountering significant COVID issues. One match that we feel was greatly exceeded, but we did not document, was GIS Computer Laboratory time (line item 187).

186	MMA Chemistry Lab	80 hrs @ $150/hr		$12,000	MMA	$12,000
187	MMA GIS Computer Lab	50 hrs @ $75/hr		$3,750	MMA	$3,750

Students and staff were often working in that lab, greatly exceeding the 50-hour estimate. Therefore, we feel our match commitments were met in full.

4. SUPPORTING MATERIALS

Available is a pdf document shared file with all supporting materials, including five appendices.

A. Project Photos

B. Forms Developed for the Project

C. The QAPP

D. Outfall Reports with Sampling Data

E. Outreach Materials

Note – even compressed these files exceed emailing limits and therefore a shared drive link is available.
Future reviewers can ask for the SNEPWG19-11-MMA 09/01/2019-12/31/2021 Appendices from the MMA Marine Lab Technical Notes publications by contacting MMA Library Services or Prof. Bill Hubbard – whubbard@maritime.edu.

5. CERTIFICATION

By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and objectives set forth in the terms and conditions of the Federal award. I am aware that any false, fictitious, or fraudulent information, or the omission of any material fact, may subject me to criminal, civil or administrative penalties for fraud, false statements, false claims or otherwise. (U.S. Code Title 18, Section 1001 and Title 31, Sections 3729–3730 and 3801–3812).

William A. Hubbard
Professor, Marine Ecologist
30 January 2022
Massachusetts Maritime Academy