March 2019

Stormwater Management and Site Redevelopment of Memorial Beach

Davianna Marie Vasconcelos
Worcester Polytechnic Institute

Emily Claire Cafarelli
Worcester Polytechnic Institute

Joseph Daniel Genga
Worcester Polytechnic Institute

Follow this and additional works at: https://digitalcommons.wpi.edu/mqp-all

Repository Citation
STORMWATER MANAGEMENT AND SITE REDEVELOPMENT OF MEMORIAL BEACH

WEBSTER, MASSACHUSETTS

A MAJOR QUALIFYING PROJECT OF WORCESTER POLYTECHNIC INSTITUTE

AUTHORED BY:
EMILY CAFARELLI, CIVIL ENGINEERING
JOSEPH GENGA, CIVIL ENGINEERING
DAVIANNA VASCONCELOS, ENV. ENGINEERING

SUBMITTED TO:
SUZANNE LEPAGE, DEPT. OF CIVIL ENGINEERING

SPONSORED BY:
THE TOWN OF WEBSTER, MA

MARCH 15th, 2019
ABSTRACT

Seasonal lake activity draws crowds to Memorial Beach annually, but stagnating infrastructure and amenities restrict its potential as a recreational cornerstone of Webster, MA. This project provided the Town of Webster with a stormwater management plan for the parking lot and a catalog of redevelopment options to help fulfill this potential and advance the social and economic status of the community. Each redevelopment option was assessed based on its cost, constraints, and overall importance to the functionality of Memorial Beach.
EXECUTIVE SUMMARY

Project Overview

Webster, Massachusetts, a small residential town, established long-term goals of redeveloping its Memorial Beach on Webster Lake. To assist in determining and developing these goals, a project team from Worcester Polytechnic Institute collaborated with the Memorial Beach Planning Committee and produced a catalog of redevelopment options for the Town to consider and potentially implement. Along with the catalog, the team designed a new stormwater management system for the existing parking lot and boat launch.

![Figure 1: Overhead view of Memorial Beach in Webster, MA (photo taken by team).](image)

Project Objectives

This project aimed to provide Webster with a redevelopment catalog and a stormwater management plan for Memorial Beach to fulfill the potential of the space as a recreational pillar of Webster and to advance the social and economic status of the community. To reach this goal, the five main objectives of this project were to assess the current conditions of Memorial Beach, engage with municipal committees and community members, develop a list of potential redevelopment options for Memorial Beach, create a redevelopment catalog, and create a stormwater management design.
Redevelopment Catalog

This catalog reviews a number of redevelopment options and designs that could enhance the recreational potential of the space. Project options include the following: bathroom maintenance, a new pavilion, parking lot stormwater management, signage and directories, a boat wash, landscaping, a new pet area, new bike racks, new picnic tables, new lifeguard chairs, playground updates, and a parking expansion.

Each of the profiles includes a description of the project details, an analysis of multiple constraints, an assigned level of priority, and related recommendations. This catalog was designed for the Town of Webster to use as a guide throughout the continued redevelopment of Memorial Beach.

Stormwater Management Plan

To begin the stormwater analysis, the catchment area of the beach was determined, which enveloped the parking lot and the boat launch. Flow rates over the surfaces were calculated using the Rational Method, which included identifying the surface materials, establishing a slope percentage, determining rainfall intensity, and measuring the area. Assumptions made during this process included the rainfall intensity remaining constant over the entire drainage area and uniform over a time duration equal to the time of concentration.

Best management practices (BMPs) were chosen from the Massachusetts Department of Environmental Protection’s Stormwater Handbook and Stormwater Standards. This stormwater plan addresses runoff from the current parking lot and boat launch by using pea gravel diaphragms around the perimeter of the parking area and a grated trench across the boat launch. Placement and size were designed to meet the necessary flow rates found through the calculations.
ACKNOWLEDGEMENTS

The project team would like to acknowledge the following people for their contributions to the completion of this Major Qualifying Project:

Suzanne LePage; Worcester Polytechnic Institute Project Advisor
Doug Willardson; Webster Town Administrator
Paul LaFramboise; Chairman of the Memorial Beach Planning Committee
Carole Marchand; Director of Parks & Recreation
Members of the Memorial Beach Committee
CAPSTONE DESIGN STATEMENT

This Major Qualifying Project (MQP) is a culmination of undergraduate studies, coursework, and projects in the fields of Civil and Environmental Engineering. Following Accreditation Board of Engineering and Technology (ABET) requirements, this MQP bridges theoretical planning with real-world constraints and stakeholders. It is subject to constructability, economic, environmental, ethical, safety, social, and political factors, among many others. All of these factors came together to influence the design plan for redevelopment of Memorial Beach, a town-owned recreational area along the shore of Webster Lake in Webster, MA. In an effort to improve the usability of Memorial Beach and the economy of Webster, this project resulted in a redevelopment catalog and stormwater management plan.

Constructability: Many potential designs for Memorial Beach included infrastructure development and renovation. Feasible limits of construction in this area, either due to zoning regulations or environmental constraints, such as wetlands, soil types, and tree coverage, needed to be taken into great consideration. Regarding design of the stormwater management layout for the parking lot, much of the impervious surfaces at Memorial Beach are nearly flat. Thus, it was necessary to accurately determine the flow paths of stormwater runoff in order to accurately place the stormwater management system.

Economics: All municipal projects require local, state, federal, or private funding. It was imperative to consider the financial constraints of the Town of Webster when providing a plan recommendation. Cost was a significant factor in determining the optimal land use option(s). Included in the final report was a cost analysis of each redevelopment option.

Environmental: Most, if not all, planning projects need to consider environmental constraints. Especially given the fragile ecosystem for the designated area on Lake Chargoggagoggmanchauggagoggchaubunagungamaugg (Webster Lake), several environmental features, such as watershed areas and woodlands, needed to be taken into account and should be unaffected by project designs. Furthermore, stormwater runoff can greatly affect nearby ecosystems as it carries sediment, debris, and other pollutants. At Memorial Beach, much of the stormwater in the parking lot appears to flow directly into Webster Lake via the boat launch. It is imperative to minimize this contamination and strive to protect local habitats and resources.

Ethical: As outlined by the American Society of Civil Engineers in their Code of Ethics, engineers shall “hold paramount the safety, health and welfare of the public and shall strive to
comply with the principles of sustainable development in the performance of their professional duties”, in addition to “perform services only in areas of their competence” and “issue public statements only in an objective and truthful manner” (ASCE, n.d.). Throughout this project, members sought to provide informed recommendations that are strictly within their field of knowledge and would not jeopardize the Town of Webster or anyone else involved.

**Safety:** Project procedures (i.e. site visits, gathering aerial photographs, etc.) must not, intentionally or unintentionally, put any lives of team members or the public into harm. Likewise, final redevelopment recommendations must take careful attention to the safety of vehicular, bicycle, and pedestrian traffic, as well as the safety of beachgoers.

**Social:** There were numerous different options to consider when planning the redevelopment of Memorial Beach, many of which had social components and impacts. It was imperative to appraise the wants and needs of Webster residents, beachgoers, and anyone else who benefits from or is associated with the space, and then balance these needs in our recommendations. Beyond these social influences, there can be social benefits to redevelopment, as well. Enhanced use of the open space and the aesthetic attractiveness could increase the reputation and invitingness of the beach, ultimately making it a safer place for residents, especially younger generations.

**Political:** Throughout this project, team members consulted with Town officials and acted in accordance with Town policies and procedures. Through this partnership with the Town of Webster and some of its committees, team members remained politically indifferent, but were also cognizant of potential political barriers to the project. Among the residents of the lake, other residents of the Town, visitors, and other people affected by development on Memorial Beach, there were a lot of valuable opinions regarding the redevelopment. Feedback from Memorial Beach Planning Committee members was pivotal in gathering the thoughts and opinions from people affected by the project.
AUTHORSHIP

This project was completed in collaboration among all project team members. Each member was responsible for specific goals and sections that highlighted the strengths of each member. Several sections of the report not mentioned below were completed collectively as a team. All sections of the report and catalog were reviewed and edited by each team member. Below is an overview of the initial delegation of tasks that were then completed by each member:

Emily Cafarelli wrote the introduction, Section 2.1 of Background Research, Section 3.3 of Objectives and Methods, and Section 4.2 of Results and Analysis, as well as the pet area, updated playground, and signage and directories options of the redevelopment catalog.

Joseph Genga wrote the Capstone Design Statement, Section 3.1, 3.2, and 3.3 of Objectives and Methods, and Section 4.1 of Results and Analysis, as well as the bike racks, picnic tables, lifeguard chairs, landscaping, and bathroom options of the redevelopment catalog. Joseph was also responsible for taking the drone photographs included in the report.

Davianna Vasconcelos wrote Section 2.3 of Background Research, Section 3.5 of Objectives and Methods, and Section 4.3 of Results and Analysis, as well as the pavilion, parking expansion, and stormwater management options of the catalog. Davianna also completed the necessary flow rate calculations and volume designs for the stormwater management design plan.
# TABLE OF CONTENTS

ABSTRACT ........................................................................................................................................... ii
EXECUTIVE SUMMARY ................................................................................................................... iii
   Project Overview .......................................................................................................................... iii
   Project Objectives .......................................................................................................................... iii
   Redevelopment Catalog ................................................................................................................ iv
   Stormwater Management Plan ....................................................................................................... iv
ACKNOWLEDGEMENTS ..................................................................................................................... v
CAPSTONE DESIGN STATEMENT ...................................................................................................... vi
AUTHORSHIP ....................................................................................................................................... viii
TABLE OF CONTENTS ........................................................................................................................ ix
LIST OF FIGURES .............................................................................................................................. xi
LIST OF TABLES .................................................................................................................................. xii
1.0: INTRODUCTION .......................................................................................................................... 1
2.0: BACKGROUND RESEARCH ........................................................................................................ 3
   2.1: Past Webster Open Space Plans ............................................................................................. 3
   2.2: Webster’s Town Government .................................................................................................. 3
   2.3: Stormwater Management ........................................................................................................ 4
3.0: OBJECTIVES AND METHODS .................................................................................................. 9
   3.1: Assessed current conditions of Memorial Beach. ................................................................. 9
   3.2: Engaged with municipal committees and community members. ....................................... 9
   3.3: Developed a list of potential redevelopment options for Memorial Beach.......................... 10
   3.4: Created a Redevelopment Catalog ....................................................................................... 12
   3.5: Designed a Stormwater Management Plan .......................................................................... 13
4.0: RESULTS AND ANALYSIS ....................................................................................................... 18
4.1: Current Conditions of Memorial Beach ..........................................................18
4.2: The Town’s Opinions and Views ...................................................................21
4.3: List of Potential Redevelopment Options .......................................................22
5.0: REDEVELOPMENT OPTION CATALOG ........................................................26
   Bathroom Functionality .........................................................................................27
   Pavilion ..................................................................................................................29
   Signage and Directories .........................................................................................31
   Parking Lot Stormwater Management .................................................................33
   Landscaping ..........................................................................................................35
   Picnic Tables, Bike Racks, & Lifeguard Chairs ....................................................37
   Playground Upgrade .............................................................................................39
   Pet Area ..................................................................................................................41
   Parking Expansion ..................................................................................................43
   Boat Wash Station ..................................................................................................45
6.0: DESIGN PLAN – PARKING LOT STORMWATER MANAGEMENT ..............47
7.0: CONCLUSIONS AND RECOMMENDATIONS ..............................................51
BIBLIOGRAPHY ......................................................................................................53
APPENDICES ........................................................................................................54
   Appendix A: Project Proposal ..............................................................................54
   Appendix B: Site Visit Reports .............................................................................64
   Appendix C: Memorial Beach Planning Committee Meeting Minutes ..............66
   Appendix D: Drone Site Pictures .........................................................................68
LIST OF FIGURES

Figure 1: Overhead view of Memorial Beach in Webster, MA ..................................iii
Figure 2: Shore of Memorial Beach on Webster Lake .............................................1
Figure 3: Recommended Runoff Coefficients [C] For Rational Method [For Surface Type] .................................................................5
Figure 4: Average Velocities for Overland Flow .......................................................6
Figure 5: Intensity - Duration - Frequency Curve for Worcester, MA .......................7
Figure 6: Ranking worksheet given to the beach committee members for completion .................................................................11
Figure 7: Stormwater flow directions based on slope of area ................................14
Figure 8: Catchment area shaded in blue .................................................................14
Figure 9: Undeveloped open space at Memorial Beach ........................................18
Figure 10: Memorial Beach parking lot .................................................................18
Figure 11: Rust and paint chipping on picnic table and bike rack ..........................19
Figure 12: Old and rusting playground equipment on the beachfront at Memorial Beach ..................................................................................19
Figure 13: Memorial Beach Planning Committee members completing the post-it note exercise .................................................................21
Figure 14: Modified parking curb stop to permit stormwater flow ......................48
Figure 15: Sketch showing a modified vegetated filter strip based on MassDEP’s Stormwater Handbook and Stormwater Standards ........................................48
Figure 16: Placement of the BMPs ....................................................................49
Figure 17: Dimensions of the BMPs used .............................................................49
LIST OF TABLES

Table 1: Outline of team analysis of redevelopment options. ...............................12
Table 2: Calculated areas and percent coverage..................................................15
Table 3: Runoff coefficient calculations................................................................16
Table 4: Rainfall intensity variables and calculations. ...........................................16
Table 5: Current condition of infrastructure and amenities at Memorial Beach. ......19
Table 6: Priority rankings based on beach committee worksheet..........................23
Table 7: Priority rankings based on team constraint analysis. .........................24
Table 8: Flow rate calculation using Rational Method equation. .....................47
Table 9: Calculated dimensions of pea gravel diaphragms and trench.............50
1.0: INTRODUCTION

Webster (herein referred to as “the Town”) is a municipality in Massachusetts located in southern Worcester County, along the border of northeast Connecticut. With only 16,000 residents, this rather small community was once fairly popular but is since struggling economically with a decline of its once positive reputation. Webster had a higher rate of poverty in comparison to most Massachusetts towns in 2016 and experienced further issues regarding crime. Town officials and committees are actively seeking renovations and improvements to the Town to address these issues (Town of Webster).

![Figure 2: Shore of Memorial Beach on Webster Lake (photo taken by team).](image)

While some areas of the Town of Webster have been struggling, Lake Chargoggagoggmanchauggagoggchaubunagungamaugg (also known as Webster Lake), remains a positive asset to the Town. Situated on the northwest shore of Webster Lake, Memorial Beach serves as a community cornerstone for family recreation and tourist attraction in town. Although the beach remains open and is used for activities such as swimming, town events, and boating, years of traffic and overuse have left a roughed-up landscape and outdated equipment along the waterfront. As it stands, Memorial Beach receives a lot of seasonal activity, but is an unorganized space with untapped potential. Therefore, if the Town of Webster was to invest in renovations and additions to the beach area it could enhance the experience for residents and visitors, thus influencing them to return. Ultimately, this would lead to increased
revenue from more frequent beach visits and could create more attraction to the Town of Webster, thus improving its reputation.

The goal of this project was...

...to provide Webster with a redevelopment catalog and a stormwater management plan for Memorial Beach to assist the fulfilment of the potential of the space as a recreational pillar of Webster and to advance the social and economic status of the community.

There were several steps taken to accomplish this goal. First, the current conditions of Memorial Beach were analyzed to fully understand the layout, boundaries, and infrastructure of the area. Once the conditions of the beach were inventoried, it was imperative to consider the financial and environmental constraints, as well as the social implications of redevelopment of the area. This list of potential renovations to Memorial Beach was analyzed and prioritized, which led to a final list of redevelopment options to include in the catalog. Among these options was a stormwater management plan for the parking lot and boat launch that would prevent runoff from entering Webster Lake. Consultations occurred frequently throughout this process with the Memorial Beach Planning Committee, members of which provided consistent and helpful feedback. Ultimately, the committee received the redevelopment catalog upon conclusion of the project. The Town may continue moving forward with the redevelopment options described or choose to further investigate additional redevelopment options.
2.0: BACKGROUND RESEARCH

This chapter compiles research on topics that were relevant throughout the completion of this project. Collecting information on the history of recreation and open space planning in Webster, Webster’s planning committees, and information on stormwater management provided key knowledge toward the assessment of a redevelopment plan for Memorial Beach.

2.1: Past Webster Open Space Plans

The Town of Webster completed an open space plan in 2009 which included goals and actions for the Town and its improvements. Webster Lake itself had its own goal which is established as “...[to] preserve the quality and character of Webster Lake for all residents to enjoy”. The related actions for the section included protecting the water quality of the lake, identifying and preserving important viewsheds at Webster Lake, and retain the classic, scenic, and family friendly atmosphere of Memorial beach. These goals and actions served as guidelines throughout the completion of this project.

The Town had other goals related to the beach, such as “...[to] improve and expand the town’s open space and recreation facilities for the enjoyment of all residents of Webster.” This goal was particularly applicable to this project as the beach has potential space for recreational development (Town of Webster 2009a).

2.2: Webster’s Town Government

Webster’s government is made up of a Town Administrator and several boards and committees. This project primarily collaborated with the Memorial Beach Planning Committee.

The Memorial Beach Planning Committee is a group of nine members, seven of whom are volunteers that are asked by the Town’s Board of Selectmen to serve. Three of the seven volunteers must live on Webster Lake, three others must be residents of Webster, and the last volunteer must be a veteran and live in Webster. The other two members are Webster’s Recreation Director and a member of Webster’s Planning Board. The central mission of this committee is to act as the main adversaries for use and development at Memorial Beach, which can include creating new ways to optimize the space and increase the usage. They will be the main point of contact within the Town’s government throughout this project (Town of Webster).
2.3: Stormwater Management

Stormwater management is the practice of reducing storm runoff and improving water quality before it discharges into a body of water. Storm runoff is often rain or melted snow that travels over impermeable surfaces such as pavement. Stormwater management has a number of purposes with the most significant being the prevention of flooding, reduction of erosion, and the preservation of the receiving body of water. This preservation can be seen mostly through the reduction of pollution. According to the Massachusetts Department of Environmental Protection’s Stormwater Handbook and Stormwater Standards, stormwater runoff is the largest source responsible for water quality impairments in Massachusetts.

To begin to understand the necessary steps in stormwater management, it is important to quantify the flow of the runoff of the area. To do this, a procedure called the *Rational Method* is used. The Rational Method procedure, along with the tables and charts use, can be found in the Massachusetts Highway Department Project Development & Design Guide, 2006. The Rational Method makes the following assumptions:

- The peak flow occurs when the entire watershed is contributing to the flow.
- The rainfall intensity is the same over the entire drainage area.
- The rainfall intensity is uniform over a time duration equal to the time of concentration.
- The coefficient of runoff is the same for all storms of all recurrence probabilities.

Because of these assumptions, the Rational Method should only be applied to areas smaller than 50 acres. After these assumptions have been made, the Rational Method procedure is summarized as follows:

The Rational Method Procedure uses Equation 1 to determine the runoff flow.

\[ Q = C_iA \]  
(Equation 1)

Where:
- \( Q \) = peak discharge, cubic feet per second
- \( C \) = runoff coefficient, unitless
- \( i \) = average rainfall intensity, in./hr, for a storm duration equal to the time of concentration, \( T \)
- \( A \) = catchment area, acres
The first step in the Rational Method is to establish a catchment area. This is the area from which the rainfall will run off and flow into the stormwater system. This can be measured in any unit of area however for the calculations, the area must be in acres.

The second step is to calculate the runoff coefficient, C. This is done by identifying the surface type and using a recommended runoff coefficients table, Figure 3, to determine the proper constant. Once the surface type and storm intensity have been identified and the numerical values have been found, the system’s runoff coefficient can be calculated by multiplying the two. Depending on the area being analyzed, there may be more than one surface type. In this case, a weighted average must be taken to determine the overall C value. This is done by calculating the C values for all of the identified surface types as well as determining the percentages of which they take up within the catchment area. The overall C value is a weighted average obtained from the sum of the products of all C values and their corresponding percentages of the area.

![Figure 3: Recommended Runoff Coefficients (C) For Rational Method [For Surface Type] (Massachusetts Highway Department Project Development & Design Guide, 2006).](image)

The third step of the Rational Method is to calculate the average rainfall intensity, i. This is done by measuring and using the slope of the catchment area and correlating it with the specific surface type on an average velocity chart, Figure 4, that results in the average velocities for overland flow, V. Subsequently, the distance travelled by the runoff, d, should be measured and divided by the identified average velocity, V, to determine the time of concentration, T. This can be seen in Equation 2.
\[ T_c = \frac{d}{V} \]  

(Equation 2)

Where:

- \( T_c \) = Time of concentration, minutes or hours
- \( d \) = Distance travelled by runoff, feet
- \( V \) = Average velocity, feet per second

**Figure 4: Average Velocities for Overland Flow** (Massachusetts Highway Department Project Development & Design Guide, 2006).
A calculated $T_c$ value and chosen recurrence interval are utilized in an intensity - duration - frequency curve chart, Figure 5, to determine the average rainfall intensity.

*Figure 5: Intensity - Duration - Frequency Curve for Worcester, MA (Massachusetts Highway Department Project Development & Design Guide, 2006).*
After knowing all of the variables, Equation 1 can be used to calculate the flow of runoff from the established catchment area.

A calculated flow rate then determines how much stormwater the management system should be able to withhold. There are several stormwater management systems that have different purposes, efficiencies, and capacities. There are numerous best management practices (BMPs) to choose from, each with a distinct method of water filtration and distribution. Some practices include naturally-occurring materials, such as rocks and plants, while other practices use man-made structures, such as metal grades and concrete catch basins.

One example of a BMP is a vegetated filter strip. Vegetated filter strips are relatively flat surfaces covered in native vegetation and can sometimes include a gravel filter strip. This BMP reduces runoff volumes and slows runoff velocities while being naturally aesthetic. Another BMP often used is a rain garden, which is made up of sandy soil, dense vegetation, and various microbes that treat stormwater prior to infiltration or discharge. The benefit of rain gardens is that they can be specifically designed for groundwater recharge and help preserve the balance of the water table on site (Massachusetts Department of Environmental Protection’s Stormwater Handbook and Stormwater Standards). These designs, along with all other BMPs, are important to consider in any stormwater management system so that the appropriate and effective design is chosen for the given conditions.
3.0: OBJECTIVES AND METHODS

As aforementioned, the goal of this project was to provide Webster with a redevelopment catalog for Memorial Beach to assist the fulfilment of the potential of the space as a recreational pillar of Webster and to advance the social and economic status of the community. There were several steps taken to accomplish this goal, all of which are illustrated in this chapter.

3.1: Assessed current conditions of Memorial Beach.

Before all else, it was imperative to assess and understand the current uses, layouts, and conditions of Memorial Beach. Many site visits were completed to gather this initial information. Field notes were recorded during these visits, including information on the current spatial constraints, necessary infrastructure enhancements, and initial redevelopment ideas. Members of the team met with Doug Willardson, the Town Administrator for Webster, at Memorial Beach to walk through the various elements of the beach, discuss existing redevelopment ideas, and brainstorm potential further improvements.

In addition to taking first-hand field observations, a DJI Phantom camera drone was used to capture visual information on the layout of Webster Lake and surrounding areas. This was useful in understanding the parameters of working on a redevelopment project in this area. For example, it was imperative to know the land boundaries being worked within, as well as the locations of watersheds and other areas to avoid or protect.

3.2: Engaged with municipal committees and community members.

The Memorial Beach Planning Committee is a municipal group dedicated to the maintenance and betterment of the beach and provided key insight into residents’ opinions. This committee was a valuable asset to bridge the gap between project goals and the wants and needs of Webster citizens. Meetings between the project team and this committee occurred often throughout this project ensuring that this project was aligned with the vision of the Town of Webster.

In addition to meeting with the Beach Committee, the team met with two town personnel, the Head of Webster Recreation Committee and a member of the Webster Water and Sewer Department, to gather information while at the beach. The information gathered
included the layout and functionality of the amenities of the beach including the bathrooms and pump station.

### 3.3: Developed a list of potential redevelopment options for Memorial Beach

It was important for ideas of Memorial Beach’s redevelopment to be initially constructed and deliberated before beginning the process of generating a deliverable. Once the relationship with the committee was established, the collaboration led to ideas being thought up together. During the first committee meeting that was attended by the team, a brainstorming activity was carried out together. During the activity, both the team along with the members of the committee created post-it notes with their ideas and placed them on the wall. The post-it notes were then organized into categories which allowed for overall themes within the various ideas to be identified. Prior to this meeting, the team had already brainstormed various redevelopment options during the initial site visit and discussion with the Town Administrator along with various other team meetings following the site visit.

After the initial brainstorming was completed to form thoughts of multiple plans for redevelopment, it was necessary to prioritize the various potential projects in order to find the optimal solution. To do this the team created a worksheet (Figure 6) for the Memorial Beach Planning Committee members to fill out, thus giving the team a semblance of what the Town and its residents’ preferences are for redevelopment at the beach. The responses from the worksheet were organized into a spreadsheet afterwards so the team could gain a concise representation of the data.
Although the Town was able to provide their hopes for the potential redevelopment, not every project was feasible. Due to this, it was important to further research possible constraints for each option. The major constraints considered were the constructability, cost, and the environmental impact. These factors, along with the importance of project to the town, were evaluated using a point system to better determine which options were of high, medium, and low priority. Two different rankings were used to assess the redevelopment options: one completed by the team and one compiled from the input of the committee members through the above worksheet.

For the team-based ranking, each item was assigned a scaled value for constructability, cost, environmental impact, and importance to the functionality of the beach, as a whole. Constructability was measured on a scale of 1-5, with 1 signifying simple construction and 5 signifying complicated construction. Similarly, other categories were measured on scales of 1-5, except for cost, which was given more weight and scaled from 1-10. Given the restricted budget of the Town, the cost of each option was deemed extra relevant to the final ranking. In
each category, a lower score correlates to simpler constructability, lower cost, lower impact, and higher importance to the beach, as seen below:

<table>
<thead>
<tr>
<th>Constructability (out of 5)</th>
<th>Importance (out of 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = simple construction</td>
<td>1 = urgent</td>
</tr>
<tr>
<td>5 = complicated construction</td>
<td>5 = non-urgent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost (out of 10)</th>
<th>Environmental Impact (out of 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = low-cost</td>
<td>1 = low-impact</td>
</tr>
<tr>
<td>10 = high-cost</td>
<td>5 = high-impact</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOTAL (out of 25)</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-10</td>
<td>High</td>
</tr>
<tr>
<td>10-20</td>
<td>Medium</td>
</tr>
<tr>
<td>20+</td>
<td>Low</td>
</tr>
</tbody>
</table>

Thus, options with cumulative values of 4-10, 10-20, and 20+ were assigned high, medium, and low levels of priority, respectively. These rankings were compared with the input of the beach committee to determine their recommended prioritization.

3.4: Created a Redevelopment Catalog

After compiling a comprehensive list of redevelopment projects and prioritizing them based on their relevance and urgency to the functionality of the beach, each project was presented within a catalog. Each option in the catalog included a description of the project details, an analysis of multiple constraints, an assigned level of priority, and related recommendations.

Included in these details were approximate costs of completing the project, which would consist of expenses for materials, construction, and/or labor, depending on the specific project. These estimations were derived from existing projects found through online research and calculating the prices of necessary materials. A low-to-high price range was provided for each option to allow for buffer room in case of any unexpected costs and provide the Town of
Webster with the option to choose either a low-cost and simple design or a more thorough and costly design. Photographs of example design options were included in some of the catalog projects to provide an idea of what the redevelopment could look like.

This catalog was reviewed by the Memorial Beach Planning Committee before it was presented the final copy. Members of the committee provided additional feedback on the layout and presentation of the catalog, ensuring that it would fit their needs as a municipality and was presented in the most informational, yet understandable way.

**3.5: Designed a Stormwater Management Plan**

To properly develop the design criteria, the contaminants of the beach were characterized during the design process as to how they would affect the system. Contaminants were determined from the assessment of the conditions of Memorial Beach and documented in the site visit reports. These contaminants were then classified into two categories, organic and inorganic, to better understand their impacts on the system. It was important to consider the presence of bacteria and fecal coliforms entering the lake from stormwater runoff and the environmental impacts that they may have on marine life and water quality. Negative impacts of sediments, specifically ones from the parking areas that may be contaminated by vehicle byproducts, were also considered as they may affect the quality of the lake. This stormwater design sought to alleviate the effects of these contaminants by capturing and retaining them.

To design a stormwater management system for the beach, the catchment area needed to be established. First, the team analyzed the stormwater flow patterns and identified the discharge areas where the stormwater would typically enter the lake. The flow arrows in Figure 7 show the approximate direction of flow for stormwater runoff.
Once flows were determined, the catchment area was established as the main parking lot area, part of the street, and the waterfront soil on the lakeside edge of the parking lot. This area can be seen shaded in blue in Figure 8. This area was then measured using Google Earth.
It was then important to understand how much of the established area was permeable (can absorb water) and how much was impermeable (absorbs little-to-no water). To do this, Google Earth was used to measure the permeable soil areas, which was subtracted from the total area to find the impermeable area. The percentages of each classification were also calculated and can be seen in Table 2.

Table 2: Calculated areas and percent coverage.

<table>
<thead>
<tr>
<th></th>
<th>Area</th>
<th>Unit</th>
<th>Ratio</th>
<th>Percent Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Area</td>
<td>120000</td>
<td>Sq. ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permeable Area</td>
<td>16400</td>
<td>Sq. ft</td>
<td>0.14</td>
<td>14%</td>
</tr>
<tr>
<td>Impermeable Area</td>
<td>103600</td>
<td>Sq. ft</td>
<td>0.86</td>
<td>86%</td>
</tr>
</tbody>
</table>

After determining the area, quantifying the flow of runoff was important in order to analyze how much runoff the designed system would have to account for. The Rational Method was used to quantify the flow rates. Refer to Section 2.3, Stormwater Management, for the Rational Method procedure. A 10-year, 24-hour storm was used as a model based on Standard 2 of the Massachusetts Department of Environmental Protection’s Stormwater Handbook and Stormwater Standards in Volume 1, Chapter 1.

The Massachusetts Highway Department Project Development & Design Guide, 2006 contained ranges for runoff coefficients based on surface type, which can be seen in Figure 3 in Section 2.3. The team took the average of this range for asphaltic and concrete pavement for the parking lot surface and flat, 2 percent, lawns, sandy soil for the soil areas. These numbers were then used to calculate a weighted average based on their percent coverage to determine an overall C value for the area. These calculations can be seen in Table 3.
The next step in the Rational Method was to determine the rainfall intensity value, $i$, which was done using the duration and storm recurrence interval in the chart shown in Figure 5 in Section 2.3. The values and calculations can be seen in Table 4.

The calculated runoff coefficients and rainfall intensity, along with the established area were then used in Equation 1 to determine the stormwater runoff flow rate, $Q$. 

### Table 3: Runoff coefficient calculations.

<table>
<thead>
<tr>
<th>C (impermeable surface)</th>
<th>Low</th>
<th>High</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.7</td>
<td>0.95</td>
<td>0.83</td>
</tr>
<tr>
<td>C (permeable surface)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.05</td>
<td>0.1</td>
<td>0.08</td>
</tr>
<tr>
<td>Impermeable Surface</td>
<td></td>
<td></td>
<td>C Weighted</td>
</tr>
<tr>
<td>Percentage</td>
<td>0.86</td>
<td>0.14</td>
<td>0.72</td>
</tr>
<tr>
<td>C</td>
<td>0.83</td>
<td>0.08</td>
<td>0.72</td>
</tr>
</tbody>
</table>

### Table 4: Rainfall intensity variables and calculations.

<table>
<thead>
<tr>
<th>Slope (%)</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Paved Area</td>
</tr>
<tr>
<td>Velocity (ft/sec)</td>
<td>2</td>
</tr>
<tr>
<td>Distance (ft)</td>
<td>400</td>
</tr>
<tr>
<td>Time of Concentration (sec)</td>
<td>200</td>
</tr>
<tr>
<td>Time of Concentration (min)</td>
<td>$3.33 \approx 5$</td>
</tr>
<tr>
<td>Recurrence Interval (Years)</td>
<td>10</td>
</tr>
<tr>
<td>$i$ (in/hr)</td>
<td>5.7</td>
</tr>
</tbody>
</table>
\[ Q = CiA \] (Equation 1)

It was important to review a number of different styles of best management practices (BMPs) to ensure the optimal choice for the design plan. For this, the project team consulted the Massachusetts Department of Environmental Protection’s (MassDEP) Stormwater Handbook and Stormwater Standards. Considerations when evaluating various styles of BMPs included size requirements, material requirements, and efficiency of contaminant removal.

After reviewing a number of different styles of BMPs, the appropriate styles were chosen and designed to fit the area, as well as to meet the necessary flows of stormwater runoff. MassDEP’s handbook guidelines provided a basis for determining the length, width, and depth of the designs. Furthermore, the team designated the positioning of the BMPs based on the direction of stormwater flow and arranging them where they would capture the highest amount of runoff. The lengths of the BMPs were established by measuring the range of the area where stormwater could deposit into the lake and were separated in sections based on ground surface type. BMP width was determined from the recommendations in MassDEP’s handbook. Lastly, depth was calculated based on the established length and width to meet the required volume for a minimum fill time of one minute with the expected runoff flow rate. Fill time is defined as the amount of time it takes for water to fill the void space of a specific volume.

These design parameters were then compared with the dimensions of the parking lot boundaries to ensure the length, width, and depth were all feasible for the area.
4.0: RESULTS AND ANALYSIS

Upon completing the steps outlined above in Chapter 3.0, the team recorded and analyzed results and observations, which ultimately determined the final scope and conclusion of the project.

4.1: Current Conditions of Memorial Beach

To assess the current state of infrastructure and Memorial Beach, as a whole, the project team completed several site visits in the Fall and Winter of 2018. Initial visits were intended to record field notes and observations of current infrastructure. Other visits were completed for obtaining aerial imagery of the full landscape and layout of Memorial Beach. A DJI Phantom III Standard camera drone captured birds-eye views of the entire area, which was further used for planning purposes. These images can be found throughout the report and the full record of photographs is located in Appendix D.

On September 28th, 2018, the team walked through Memorial Beach with Doug Willardson, the Town Administrator. From talking with Mr. Willardson, it was apparent that the Town of Webster already received approval and funding to install a pavilion next to the main facilities building; thus, the exact placement and stormwater management for the structure would be a definite aspect of the project. Additional redevelopment ideas involved reuse of open space and improvements to the parking areas (Figures 9 & 10).

Figure 9 (left): Undeveloped open space at Memorial Beach (photo taken by team).

Figure 10 (right): Memorial Beach parking lot (photo taken by team).
Other observations revealed some outdated accessories on the beachfront, including picnic tables, lifeguard chairs, bike racks, and playground equipment. Many of these items appeared rusted, bent, and unappealing (pictured below).

![Figure 11 (left): Rust and paint chipping on picnic table and bike rack (photo taken by team).](image1)

![Figure 12 (right): Old and rusting playground equipment on the beachfront at Memorial Beach (photo taken by team).](image2)

From these visits and observations, it was clear that some of the infrastructure at Memorial Beach was in great need of repair, replacement, or redesign. Below is a summary of each item noted:

<table>
<thead>
<tr>
<th>Item</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathrooms</td>
<td>- Reports of clogging in the bathroom sewage pipes</td>
</tr>
<tr>
<td></td>
<td>- Two bathrooms on site (men and women)</td>
</tr>
<tr>
<td></td>
<td>- 3+ toilets in each, plus 3 urinals in men’s room</td>
</tr>
<tr>
<td></td>
<td>- Functioning sinks and hand dryers</td>
</tr>
<tr>
<td></td>
<td>- Stains and blemishes on floors, walls, and stalls</td>
</tr>
<tr>
<td></td>
<td>- Bathroom pipes lead to nearby pump, which sends water to the main Webster wastewater system</td>
</tr>
<tr>
<td>Bike Racks</td>
<td>- 2 bike racks found in rusted and old condition</td>
</tr>
<tr>
<td>Area</td>
<td>Problem</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Boat Launch</td>
<td>No stormwater management, leading to unabated runoff into Webster Lake</td>
</tr>
<tr>
<td>Landscaping</td>
<td>Unorganized mulch areas</td>
</tr>
<tr>
<td></td>
<td>Patchy grass throughout multiple areas</td>
</tr>
<tr>
<td></td>
<td>Lack of garden space</td>
</tr>
<tr>
<td>Lifeguard Chairs</td>
<td>2 newer chairs found</td>
</tr>
<tr>
<td></td>
<td>3 old and rusting chairs also found</td>
</tr>
<tr>
<td>Open Space</td>
<td>Covered in gravel and patchy grass</td>
</tr>
<tr>
<td></td>
<td>Used for overflow parking</td>
</tr>
<tr>
<td></td>
<td>Mostly surrounded by trees</td>
</tr>
<tr>
<td>Parking Lot</td>
<td>No stormwater management around lot</td>
</tr>
<tr>
<td></td>
<td>Low vehicle capacity during large events</td>
</tr>
<tr>
<td>Pavilion</td>
<td>The Town already has the intention of installing a pavilion and has funding secured</td>
</tr>
<tr>
<td>Picnic Tables</td>
<td>Several old tables found with paint chipping and splitting/rotting wood</td>
</tr>
<tr>
<td>Playground</td>
<td>Some equipment old and rusting</td>
</tr>
<tr>
<td></td>
<td>Some graffiti on playscape</td>
</tr>
<tr>
<td>Signage/Directories</td>
<td>Signs missing or not updated to reflect current rules</td>
</tr>
<tr>
<td></td>
<td>Difficult navigation of space</td>
</tr>
</tbody>
</table>
4.2: The Town’s Opinions and Views

To gain an understanding of the Town’s opinions and views, the team attended multiple Memorial Beach Committee meetings. These meetings provided a deeper understanding of the Beach’s functions and current challenges along with the residents’ wishes for the space. Through the initial brainstorming activity, the committee’s values surfaced. It was clear that the committee sees the space further developing into an area where the Webster community could convene through possible developments with more recreation areas, a pavilion, and event opportunities. These findings can be located in Appendices B and C in the Site Visit Reports and Meeting Minutes, respectively.

Further developed ideas were presented to the committee and noted the Town’s thoughts upon them. They found the pavilion and bathrooms renovations of high importance and also liked the idea of a pet area. Aesthetically enhancing the beach was another interest of the committee. This can also be found in Appendix C. Through the meetings with the town, the team was able to scope the project, create a catalog, and prioritize development options.
4.3: List of Potential Redevelopment Options

After collaborating with the beach committee and analyzing various aspects of the beach that needed improvement, a list of potential development options was compiled. These ideas were generated from team observations during site visits, as well as committee input at multiple meetings. This list was as follows:

- new and improved signage and directories,
- a newly constructed pavilion,
- new or updated picnic tables,
- replacing and adding bike racks,
- replacing lifeguard chairs,
- updating the playground area,
- a newly implemented pet area,
- improved landscaping,
- functioning bathrooms,
- a new boat wash,
- an event stage, baseball field, or other attraction on available open space,
- stormwater management on impervious surfaces, and
- an expanded parking lot.

To determine which options to further look into and incorporate into the redevelopment catalog, these options were put into two ranking systems, one completed by the team and one based on feedback from the Memorial Beach Planning Committee, as outlined in Section 3.3. Table 6 displays the results of the worksheet responses by the committee.
Separate from the committee-based analysis, the team assessed each option based on constructability, importance, estimated cost, and environmental impact. Each option was assessed by the team and assigned certain scaled values. This analysis can be seen in the following table:

<table>
<thead>
<tr>
<th>Option</th>
<th>Person A</th>
<th>Person B</th>
<th>Person C</th>
<th>Person D</th>
<th>Person E</th>
<th>Person F</th>
<th>Total</th>
<th>Average</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathroom Pump Repair</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>High</td>
</tr>
<tr>
<td>Bathroom Renovation</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>High</td>
</tr>
<tr>
<td>Bike Racks</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>14</td>
<td>2</td>
<td>Medium</td>
</tr>
<tr>
<td>Boat Wash</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>Medium</td>
</tr>
<tr>
<td>Expanded Parking Design</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>16</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td>Landscaping</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>2</td>
<td>Medium</td>
</tr>
<tr>
<td>Lifeguard Chairs</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>16</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td>Open Field Space</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>16</td>
<td>3</td>
<td>Low</td>
</tr>
<tr>
<td>Pavilion</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>High</td>
</tr>
<tr>
<td>Pet Area</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>14</td>
<td>2</td>
<td>Medium</td>
</tr>
<tr>
<td>Picnic Tables</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>10</td>
<td>2</td>
<td>Medium</td>
</tr>
<tr>
<td>Playground Update</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>14</td>
<td>2</td>
<td>Medium</td>
</tr>
<tr>
<td>Signage and Directories</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>12</td>
<td>2</td>
<td>Medium</td>
</tr>
<tr>
<td>Stormwater Management</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>13</td>
<td>2</td>
<td>Medium</td>
</tr>
<tr>
<td>Other (please specify)</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>
### Table 7: Priority rankings based on team constraint analysis.

<table>
<thead>
<tr>
<th>Project</th>
<th>Constructability (out of 5)</th>
<th>Importance (out of 5)</th>
<th>Cost (out of 10)</th>
<th>Environmental Impact (out of 5)</th>
<th>TOTAL (out of 25)</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseball field</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td>22</td>
<td>Low</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>10</td>
<td>High</td>
</tr>
<tr>
<td>Bike Racks</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>High</td>
</tr>
<tr>
<td>Boat Wash</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>15</td>
<td>Medium</td>
</tr>
<tr>
<td>Event Stage</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>2</td>
<td>17</td>
<td>Medium</td>
</tr>
<tr>
<td>Expanded Parking Design</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>3</td>
<td>19</td>
<td>Medium</td>
</tr>
<tr>
<td>Landscaping</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>10</td>
<td>High</td>
</tr>
<tr>
<td>Lifeguard Chairs</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>High</td>
</tr>
<tr>
<td>Pavilion*</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>High</td>
</tr>
<tr>
<td>Pet Area</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>8</td>
<td>High</td>
</tr>
<tr>
<td>Picnic tables</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>High</td>
</tr>
<tr>
<td>Playground Upgrade</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>8</td>
<td>High</td>
</tr>
<tr>
<td>Signage and Directories</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>High</td>
</tr>
</tbody>
</table>

1 = simple construction, 1 = urgent, 1 = low-cost, 1 = low-impact

*already funded

5 = complicated construction, 5 = non-urgent, 10 = high-cost, 5 = high-impact

Based on the comparison between team and committee prioritization, the team decided not to move forward with potential redevelopment options (event stage and baseball field) for the open space area at Memorial Beach. As it stands, this area is used for overflow parking during large summer events. A variety of different attractions could be implemented in this area, but it would require significant feedback from the Town and its residents and would likely
require a great amount of funding. All other options continued to be further assessed because of their urgency and/or feasibility of completion.

These redevelopment options each came with their own constraints which were addressed in creating their respective designs. The Capstone Design Statement standards (constructability, economics, environmental, ethical, safety, social, and political constraints) were used to evaluate the constraints of each of the development options. These constraints were included in the redevelopment catalog for review.
5.0: REDEVELOPMENT OPTION CATALOG

Contained in the following catalog are several projects for the redevelopment of Memorial Beach in Webster, Massachusetts. Each project has been analyzed by the project team based on the constraints outlined in the Capstone Design Statement. Understanding that budgeting is pivotal to any proposed project, it is not expected that all of these projects are completed at once. Hence, this catalog is organized in decreasing order of priority. ‘High’ priority items have been deemed urgent based on their immediate impact to the functionality of Memorial Beach. Items with ‘Medium’ to ‘Low’ priority also serve purpose to the beach but are not imminently necessary. Priority of the items was determined based on the constraint analysis by the project team, as well as direct input from the Memorial Beach Planning Committee.
Bathroom Functionality

Project Description: From talking with a representative of the Department of Public Works at Memorial Beach, there does not appear to be an issue with neither the bathroom pump system nor the piping itself. Rather, any blockages in the system are likely caused by the improper disposal of paper and other materials not suitable for bathroom sewage pipes.

There are two bathrooms (men and women), each of which has 3-4 toilets, plus an additional 3 urinals in the men’s room. Currently, the waste disposal system is reported functional, but is not in use during the off-season. Therefore, minimal troubleshooting could be performed by the project team. A proper diagnosis of the issue at hand, if there is one, should be completed as soon as possible. If there is a current blockage in the system, it will need to be removed by the municipality or a third-party company. If there is no immediate problem, the Town should look into eventually hiring a plumbing company to provide a detailed report on the current state of the system. Furthermore, the company should provide a full blueprint of the sewage and pump system to keep on file for future reference and to ensure that the current design meets the current standards.
Priority: High

Estimated Cost: $0-$5,000, pending full diagnosis; based on approximate repair costs.

Economic Constraints: The Town must acquire the funding to complete initial repair(s), if necessary, which will hopefully alleviate future blockages in the sewage disposal system. Further funding will be necessary to complete a full analysis of the system.

Social Constraints: Functional bathrooms are extremely imperative for this high-capacity location.

Environmental Constraints: Any digging and repairs should be contained as to avoid disturbing the nearby lake and ecological systems.

Constructability Constraints: Any adjustments made to the sewage line must fit within the dimensions of the full system.

Recommendations: Given the limited analysis of the situation at hand, the project team recommends the following:

1. Determine the current functionality of the bathrooms as soon as possible and determine whether or not the system needs to be unclogged or repaired.
2. Hire a third-party plumbing or waste management company to complete a full analysis of the bathroom plumbing system and provide detailed blueprints to keep on file for future reference.
3. Post signs in bathrooms for proper waste disposal, especially advising that only human waste and bath tissue are flushed in the toilet stalls.
4. Re-paint the inside of each bathroom to cover up any blemishes on the floors, walls, and bathroom stalls.
Pavilion

**Project Description:** The Town of Webster has received funding for the installation of a new pavilion on the shore of Memorial Beach. This pavilion will serve as a new seating area and event space throughout the year. After talking with the Town Administrator about where to place the structure, the team determined that the pavilion would be best suited to the left of the beach house.

This area will have a beautiful view of the water, beach, and cove near the boat launch. Installation of the pavilion would include construction and paving a rectangular base for the pavilion to rest on. Within the pavilion, there is potential for additional picnic tables or open event space, both of which would allow visitors to have a comfortable, shaded area to congregate or relax.
Priority: High

Estimated Cost: N/A; funding provided by State of Massachusetts grant.

Economic Constraints: The Town has received the funding for the construction and installation of an event pavilion at Memorial Beach. There should be no additional related expenses other than infrequent upkeep of the structure.

Social Constraints: An event pavilion offers a communal space for visitors to enjoy together or rent for event space.

Environmental Constraints: Stormwater from the roof of the structure and concrete base will need to be managed. This may include a pea gravel diaphragm around the perimeter of the pavement or gutters along the edges of the roof that dispose of the water in a constructed catch basin.

Constructability Constraints: Recommended dimensions of the pavilion are 39 feet in length by 28 feet in width by 14 feet in height, not including the recommended concrete base. Precise placement of the pavilion will depend on the structural support of the soil underneath to avoid sinking and cracking in the concrete foundation.

Recommendations: Based on the location and constraints of the installation of the pavilion, the project team recommends the following:

1. Locate a firm plot of land within the recommended area to the left of the beach house and lay a concrete foundation for the pavilion.
2. Hire a third-party company to facilitate construction and installation of the structure.
3. Provide a rain catchment system, either using gutters that direct to a small catch basin or a pea gravel diaphragm around the perimeter of the base, to catch runoff from the roof.
4. Provide extra seating (benches, picnic tables, or other) for beachgoers to use underneath the structure to promote the use of the pavilion as a gathering space.
Signage and Directories

Project Description: Entering Memorial Beach, there are some signs indicating safety notices, beach rules, and entry fees. However, there are very few directional signs that point to the various aspects of the beach, including the boat launch, walking track, secondary walking track, and playground. To improve the navigability of the space, there should be additional signs to help guide visitors to all that Memorial Beach has to offer.

Along Memorial Beach Drive, directories would be added at the entrance and central locations so beachgoers are able to get a full understanding of the space. Signs would be added to help direct people to where they desire to go and ease the navigation. A common color and design theme among these signs would also help add aesthetic allure to the beach.

Furthermore, the current regulation sign (see left below) is incomplete and inaccurate. All posted signs should be reviewed and replaced, if necessary.

Example map directory (primesignprogram.com).
Priority: High

Estimated Cost: $100-1,000 per sign; based on range of prices from signage companies.

Economic Constraints: The Town will need to acquire funding to cover the cost of printing and installation of the signs.

Social Constraints: Additional signs throughout Memorial Beach, beginning at the entrance and carrying on through the parking lot and beach area, would greatly improve the navigability of the space for visitors.

Environmental Constraints: N/A

Constructability Constraints: New signs would need to be installed and old signs would need to be removed and disposed of.

Recommendations: Given the lack and inaccuracy of signage at Memorial Beach, the project team recommends the following:

1. Design a beach map and hire a printing company to create map directories and add to both the beachfront area and the entrance on Memorial Beach Drive. Select a color and design theme that will be uniform among all signs on the beach.
2. Add directional signs for the boat launch and other beach features.
3. Review and reestablish the rules and regulations of the beach and print a new sign. Remove all old and inaccurate signs.
Parking Lot Stormwater Management

**Project Description:** With the current layout of the parking lot and lack of a stormwater management system, rainfall carries sediment, debris, and other pollutants towards the boat launch and directly into Webster Lake. These materials can be disruptive to marine life in the water and cause environmental harm. Adding a stormwater management boundary to the parking lot would help reduce the materials and pollutants going into the lake. This would primarily be done by implementing pea gravel diaphragms along the lakeside edge of the parking area, which includes a grated trench across the boat ramp area. Exact measurements and calculations for the diaphragms can be found in Section 6.0, “Design Plan – Parking Lot Stormwater Management”.

![Diagram of Parking Lot with Curb Stop and Pea Gravel Diaphragm](image)
Priority: Medium

Estimated Cost: $12,000-$25,000, plus annual maintenance fees; based on price of pea gravel and approximate cost of excavation and installation of gravel diaphragms.

Economic Constraints: The Town will need to acquire funding to complete the project. Yearly inspection and maintenance will be required to ensure full functionality of the system.

Social Constraints: Effective and aesthetic design can be attractive to visitors and improve water flow throughout the parking lot.

Environmental Constraints: Initial digging and filling of the diaphragms may disturb land close to the lake, but environmental benefits largely outweigh the potential concerns.

Constructability Constraints: Installation of pea gravel diaphragms would require digging several feet down along the lakeside edge of the parking lot, which has the potential to disturb the soil or groundwater there. Slight adjustments may need to be made to accommodate environmental features.

Recommendations: Given the lack of stormwater management on the parking lot and boat launch, plus the consequences of unabated runoff on Webster Lake, the project team recommends the following:

1. Implement a stormwater design plan for the parking lot to help eliminate contaminants that may cause environmental damage by entering the lake. A full design plan can be found in Section 6.0 of this report.
2. Continually inspect the implemented designs for obstructions and changes.
3. Look into stormwater management practices for remaining areas of Memorial Beach, including building structures, pavement and roads, and open space.
Landscaping

Project Description: Some areas of Memorial Beach, especially near the beach house, parking lot, and entry road could benefit from a landscaping renovation. This would involve seeding new grass, laying new mulch, adding garden features, and adding rock barriers to existing gardens and vegetated areas. Areas where professional landscaping or redesign would be highly beneficial include the front and sides of the beach house, the playground area, the senior park near the boat launch, the row of trees along Memorial Beach Drive, and the tentative location of the future pavilion.
Priority: Medium

Estimated Cost: $5,000-$25,000, depending on the scale of work; based on price of materials and labor from a third-party business for a very large space.

Economic Constraints: The Town will need to fund the landscaping from the Webster Department of Public Works or a third-party business.

Social Constraints: Creating a more aesthetically appealing venue will help enhance the experience of returning residents and pull in new visitors.

Environmental Constraints: Any landscaping (seeding, weed control, etc.) should avoid using toxic chemicals that could contaminate soils or lake water. Native species of grass and plants should be used as to avoid introducing invasive species to the beach.

Constructability Constraints: All landscaping would require merely surface changes to the landscape and minor digging for any additional vegetation.

Recommendations: Given the current state of the gardens and vegetated areas of Memorial Beach, the project team recommends the following:

1. Add new mulch around the flagpole and contain it with a rock barrier.
2. Lay new grass seed, of a native species, on areas around Memorial Beach where the grass is patchy or missing.
3. Add garden space to the existing senior park near the boat launch.
4. Add a rain garden around the front and side edges of the beach building to collect rainwater falling from the roof.
5. Add other garden features around blighted areas of the beach to add aesthetic appeal.
Picnic Tables, Bike Racks, & Lifeguard Chairs

**Project Description:** Current equipment on the beachfront, including bike racks, picnic tables, and lifeguard chairs are either rusting, splintering, or losing paint. They appear unattractive and hardly usable. Many of these items would benefit greater from replacement rather than refurbishing.

There are multiple bike racks on the beachfront that hold nearly 20 bikes. Other models typically hold 8-10 bikes. Thus, multiple units may be required. These racks should be anchored into the ground to prevent beachgoers from intentionally or unintentionally moving them. There are two new lifeguard chairs on the beach, but three old units remain and should be replaced with the newer model. Lastly, there are several picnic tables on the beach that could be either refurbished or replaced. Newer models that are weather-proof and will not splinter or lose color would be very beneficial long-term. Similar to the bike rack(s), tables should be anchored in the ground. Additional picnic tables should be provided if and/or when the pavilion is built.
Priority: Medium

Estimated Cost: $200-800 per picnic table; $200-500 per bike rack; $400-$800 per lifeguard chair; based on available items for sale online.

Economic Constraints: The Town would need to fund the purchase and installation of the picnic tables, bike rack units, and lifeguard chairs.

Social Constraints: Clean and comfortable picnic tables provide gathering spaces for families and groups to relax and eat. Bike racks allow for easy and safe storage of bicycles, which especially caters to younger residents who enjoy biking to Memorial Beach. Comfortable and spacious lifeguard chairs are more pleasant for lifeguards to seat themselves for their shift.

Environmental Constraints: N/A

Constructability Constraints: Items would be purchased pre-built and would simply need to be installed around Memorial Beach in advantageous locations. For some units, especially the bike rack(s) and picnic tables, it would likely be beneficial to anchor them into the ground to prevent people from moving them.

Recommendations: Given the current state of the equipment on the beachfront at Memorial Beach, the project team recommends the following:

1. Purchase and install one (1) new bike rack near the basketball court. It may be beneficial to bolt the rack into the ground. Each bike rack, depending on the model, holds about 8-10 bikes. If a higher capacity is necessary, the team recommends installing additional racks.

2. Purchase at least five (5) new picnic tables and place in various spots throughout the beach. It may be beneficial to bolt the tables into the ground. Once the pavilion is installed, the Town may want to purchase additional picnic tables to place underneath.

3. Purchase two (2) additional white lifeguard chairs to replace the two oldest ones.
Playground Upgrade

**Project Description:** Located on the shore of Memorial Beach, the playground is covered with graffiti and has experienced many years of heavy use. In its current state, the playground could benefit from temporary or permanent repair or replacement to make it safer and more enjoyable for children and create an appealing look to visitors.

Some of the wood structures on the playground require some minor repairs and repainting, while other features, such as the metal slide (see above) are outdated and should be replaced. Additionally, the mulch in the playground area can be difficult to maintain and can be dangerous for children to run and fall on. Rather, a porous rubber surface or artificial turf would be another, more long-term renovation to this feature of the beach.

![Example turf playground (smartgrassamerica.com).](image-url)
Priority: Medium

Estimated Cost: $250-$20,000, depending on the extent of renovation and option to either replace or refurnish; based on price of materials and equipment for sale online.

Economic Constraints: The Town would need to acquire funding for the project materials; however, this would be a good opportunity for town volunteers to help renovate the beach.

Social Constraints: The current playground is covered with graffiti, along with some profanities that are not kid-friendly and that take away from the aesthetics of the structure. Painting or replacing the playground would make it appear ‘new’ again.

Environmental Constraints: N/A

Constructability Constraints: Temporary renovations (painting, minor repairs, etc.) are simple solutions, but replacing the playground would require long-term planning and design.

Recommendations: Based on the current state of the playground, the project team recommends the following:

1. Refurbish the main structure of the playground but remove and replace any features that are outdated and unusable. Paint over graffiti and where else it is necessary.
2. Seek volunteer help from Webster youth groups to get young residents involved and invested in the upkeep of Memorial Beach.
3. In the long-term, investigate replacing the mulch with artificial turf or porous rubber to provide a safer playing surface for kids of all ages.
Pet Area

Project Description:
Currently, there are no designated areas at Memorial Beach for pet owners to bring their animals to walk. Based on discussions with the Memorial Beach Planning Committee, this is a concern shared by many residents and there is great public interest in the implementation of a pet park somewhere at the beach.

Ideally, this pet area would be built across the footbridge in the middle of the secondary walking track. This park would consist of two fenced-in areas, one for big dogs and one for smaller dogs. Other amenities would include garbage receptacles and water hose. This hose serves multiple purposes, including hydration for pets and for breaking up a dog fight, which is an infrequent yet realistic concern with these parks.
**Priority:** Medium

**Estimated Cost:** $750-$2,500, depending on accessory furnishings and amenities; based on approximate price of fencing and installation.

**Economic Constraints:** The Town will need to acquire funding for the fencing and other amenities, as well as installation.

**Social Constraints:** This would be a great place for residents to gather and socialize where their pets can run free and play together, and the location would be isolated from other beach guests. The attraction of a pet area could also increase the popularity of Memorial Beach for locals.

**Environmental Constraints:** Increased use of this land over time could lead to a degradation of the landscape and may need infrequent upkeep of the soil and grass. Animal waste would need to be controlled and disposed of.

**Constructability Constraints:** The installation of fencing is straightforward, depending on the material and design. A water supply for the hose would need to be located, either from the lake or a public water line.

**Recommendations:** Based on the social implications and other details of a pet area, the project team recommends the following:

1. Place the pet area within the secondary walking track in the undeveloped space.
2. Divide the pet area in two sections to provide separate play spaces for big and small dogs.
3. Install a water hose to have nearby in case of emergencies. A water source would need to be secured.
4. Stations with animal waste containers (doggy-bags) and garbage receptacles should be added to facilitate easy clean-up.
5. Strongly consider the Parking Expansion catalog option to provide convenient parking for the walking track and pet area.
Parking Expansion

Project Description: During large beach events (i.e. 4th of July), the parking lot at Memorial Beach breeches capacity, forcing cars to park on the undeveloped open space area across from the boat launch. A parking expansion would allow for designated parking during these larger-sized events.

This expansion is located on the dirt way parallel to the road leading to the beach. This area has the potential to hold 129 vehicles while abiding by the Town’s parking bylaws. There is enough space for two rows of 90° parking and two aisles for two-way traffic.

To reduce cost and environmental impact, the lot would remain unpaved. Instead, curbs or barriers would be placed on each side of the roadway to designate the location of each parking space.
Priority: Low

Estimated Cost: $7,000-$15,000, depending on space markings used; based on price of various parking curbs and installation.

Economic Constraints: The Town would need to acquire funding for the project, which would include the purchase and installation of 100+ parking curbs or other barriers to mark spaces.

Social Constraints: With increased parking comes the ability to host larger events in the space. The extra space may allow for more people to use the beach at any given time or could be reserved for a private event.

Environmental Constraints: Since there will be no paved surfaces, there should be minimal environmental effects, other than increased disturbance of the terrain due to heightened traffic on this area.

Constructability Constraints: Uneven terrain may cause difficulty for some vehicles when travelling through the area. This area would remain unpaved and would instead use segmented barriers or curbs to delineate parking spots.

Recommendations: Based on the above constraints and initial designs, the project team recommends the following:

1. Designate at least 100 spaces in this area for overflow parking to the beach.
2. Instead of paving, use other markings that sufficiently delineate separate parking spots.
3. During planned events, have an employee of the beach help direct cars through the parking lot to maximize parking efficiency.
4. Keep the end nearest to the veteran memorial closed to prohibit drivers from entering or exiting there and potentially damaging the landmark.
5. If the pet area is implemented across the nearby walking bridge, it would be lucrative to complete this project in conjunction to provide pet owners with a more convenient area to park.
Boat Wash Station

Project Description: Invasive plant species and bacteria can have very negative consequences on the quality of water in Webster Lake. One of the easiest ways for these species to enter the lake is from the bottoms of unwashed boats that enter the water without being cleaned from the last location they were exposed to. A preventative measure to combat this issue would be the implementation of a boat wash station before the boat launch.

Placement of the boat wash would have to be precise to avoid creating a significant line of vehicles at the beach. Ideally, cars (with boats in tow) would park on the wash station, spray their vessel for a few minutes, and proceed to the boat launch. Washing after exiting the water would be unnecessary and would likely cause traffic issues. One of the biggest concerns with a boat wash station is water supply and drainage. The Town would have to lay new pipes under a section of the parking lot to transport the water to the public wastewater system. Despite the environmental benefits, the high cost and constructability concerns put a boat wash station at a low priority level for the foreseeable future.
Priority: Low

Estimated Cost: $100,000-$250,000, plus staffing wages and maintenance; based on approximate cost of installation.

Economic Constraints: The Town would need to acquire funding for a full boat wash system, which includes water supply, drainage, and repaving, and is often very expensive. Additional costs would likely follow from staffing the boat wash during the summer season.

Social Constraints: The traffic pattern of the boat launch may be affected and that could lead to complaints from the beachgoers.

Environmental Constraints: The boat wash would help prevent contaminants and invasive species from entering Webster Lake, which is a large concern for the health of the lake ecosystem.

Constructability Constraints: A boat wash would require water supply and wastewater drainage; thus, locating a source of water and connecting a drainage system to the Town wastewater treatment line would be imperative.

Recommendations: Based on the cost-benefit concerns above, the project team recommends the following:
1. Look into the placement of a boat wash station that would least affect the flow of traffic at the boat launch and entire beach. The team recommends the pathway outlined in the first figure in this section.
2. Given the significant budget requirement, this will likely take several years of planning before implementation. The team recommends planning funding well in advance and seeking potential grants from the State of Massachusetts.
6.0: DESIGN PLAN – PARKING LOT STORMWATER MANAGEMENT

The contaminants found during the assessment of the area were as follows:

*Organic*: animal waste, food scraps, sediments, and nutrients

*Inorganic*: plastics (food containers, utensils, etc.), gasoline

With the absence of a stormwater system, these contaminants had the ability to flow directly into the lake and cause environmental harm to the water and marine life.

After completing the Rational Method calculations, the flow rate was found to be 11.3 cubic feet per second, based on a 10-year, 24-hour storm model. These calculations can be seen in Table 8.

<table>
<thead>
<tr>
<th>Recurrence Interval (Years)</th>
<th>C</th>
<th>i (in/hr)</th>
<th>A (acres)</th>
<th>Q (cu. ft/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.72</td>
<td>5.7</td>
<td>2.8</td>
<td>11.3</td>
</tr>
</tbody>
</table>

After reviewing Volume 2, Chapter 2, “Stormwater Best Management Practices” of MassDEP’s handbook, the team considered the following BMPs:

**Sediment Forebay** - “a post-construction practice consisting of an excavated pit, bermed area, or cast structure combined with a weir, designed to slow incoming stormwater runoff and facilitating the gravity separation of suspended solids.”

**Vegetated Filter Strip** - “uniformly graded vegetated surfaces (i.e., grass or close-growing native vegetation) that receive runoff from adjacent impervious areas.”

**Bioretention Areas & Rain Gardens** - “shallow depressions filled with sandy soil topped with a thick layer of mulch and planted with dense native vegetation... There are two types of bioretention cells: those that are designed solely as an organic filter filtering bioretention areas and those configured to recharge groundwater in addition to acting as a filter exfiltrating bioretention areas.”

After various BMPs were reviewed from MassDEP’s handbook, the team determined that a modified version of the vegetated filter strip would be used for the perimeter of the
parking areas adjacent to the water. This included pea gravel diaphragms while using the existing vegetation as a grass filter strip. A modified curb stop was included in the design that will allow for the flow of water to pass underneath through a designated channel. An example of this curb design can be seen in Figure 14.

![Figure 14: Modified parking curb stop to permit stormwater flow (drawn by team).](image)

This layout was chosen because the size can vary, it has limited disturbance to the surrounding environment, and it fits into the aesthetic of the beach. A layout of this design can be seen in Figure 15, which is a modified version of the vegetated filter strip diagram found in MassDEP’s handbook.

![Figure 15: Sketch showing a modified vegetated filter strip based on MassDEP’s Stormwater Handbook and Stormwater Standards (drawn by team).](image)

As for the boat launch, the team determined a modified pea gravel diaphragm could be used. A trench for the diaphragm would be dug across the width of the ramp. Then, a metal slotted grate would be placed over its top to allow vehicles to drive over. Within the trench
would be a layer of pea gravel and about 1 foot of additional space between the gravel and grate. The layout of the different BMPs can be seen in the figure below:

![Figure 16: Placement of the BMPs [red and purple - pea gravel diaphragms; green - pea gravel diaphragm with grate] (photo taken and edited by team).]

These designs were then placed and sized to fit the flow rate of the catchment area. Since the volume of the diaphragms would be partially filled by pea gravel, the team assumed 25% void space for the pea gravel volume. Width and depth of the BMPs were designed to meet the necessary volume while not digging too deep as to avoid reaching the water table. Dimensions of the BMPs can be seen in the following figure and table:

![Figure 17: Dimensions of the BMPs used - not drawn to scale (drawn by team).]
Table 9: Calculated dimensions of pea gravel diaphragms and trench.

<table>
<thead>
<tr>
<th></th>
<th>Length (ft)</th>
<th>Decimal of whole</th>
<th>Percent of whole</th>
<th>Overall Flow</th>
<th>Individual Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>235</td>
<td>0.49</td>
<td>49%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green</td>
<td>115</td>
<td>0.24</td>
<td>24%</td>
<td>11.3 ft³/s</td>
<td>2.7 ft³/s</td>
</tr>
<tr>
<td>Purple</td>
<td>125</td>
<td>0.26</td>
<td>26%</td>
<td></td>
<td>3.0 ft³/s</td>
</tr>
<tr>
<td>Total</td>
<td>475</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pea Gravel Diaphragm (Red) Grated Trench (Green) Pea Gravel Diaphragm (Purple)

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Wide</th>
<th>Depth</th>
<th>Volume</th>
<th>Solids</th>
<th>Void</th>
<th>Fill time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>235 ft</td>
<td>2 ft</td>
<td>3 ft</td>
<td>1410.0 ft³</td>
<td>1057.5 ft³</td>
<td>352.5 ft³</td>
<td>62.8 sec</td>
</tr>
<tr>
<td>Green</td>
<td>115 ft</td>
<td>1 ft</td>
<td>3 ft</td>
<td>345.0 ft³</td>
<td>172.5 ft³</td>
<td>172.5 ft³</td>
<td>62.8 sec</td>
</tr>
<tr>
<td>Purple</td>
<td>125 ft</td>
<td>2 ft</td>
<td>3 ft</td>
<td>750.0 ft³</td>
<td>562.5 ft³</td>
<td>187.5 ft³</td>
<td>62.8 sec</td>
</tr>
<tr>
<td>Total</td>
<td>475 ft</td>
<td>1 ft</td>
<td>3 ft</td>
<td>2400 ft³</td>
<td>1725 ft³</td>
<td>1875 ft³</td>
<td>1 min</td>
</tr>
</tbody>
</table>

The total necessary volume of pea gravel is approximately 2400 cubic feet.
7.0: CONCLUSIONS AND RECOMMENDATIONS

Based on observations and discussions with the Webster Town Administrator and Memorial Beach Planning Committee, there are several amenities at Memorial Beach that require repair, redevelopment, or redesign. Thus, the first recommendation from the project team is addressed to the Memorial Beach Planning Committee and the Town of Webster and is to use the catalog to begin planning redevelopment projects at the beach. Beginning with reading and understanding the material in the catalog, the Town can decide which projects to move forward with, especially given the budget availability. However, it is also important to understand that the material in the catalog will change over time, and with the implementation of different projects. As outlined in the recommendations of some options in the catalog, some options influence one another. For example, if a pet area is added across the walking bridge, it would be a prerequisite to expand the parking lot as described in a different catalog option. Beyond the implementation of the redevelopment options, the team has additional recommendations for the future of Memorial Beach.

During our meetings with the Memorial Beach Planning Committee, one of their focuses was to finalize the boating regulations and restrictions (i.e. what watercraft are allowed at the boat launch and how much to charge for entry), but we would also recommend revisiting the rules of the beach, as a whole. This location should be a safe haven for residents and visitors of all ages. Thus, concrete rules about park usage, permitted behavior, etc. will help control and manage beach activity. These rules would have to be strictly enforced by beach staff, police, or other public services.

Furthermore, the team recommends the Town utilize the beach for organized gatherings to boost the morale of the community and enhance the reputation of the Town through attracting new visitors. Memorial Beach is a fortuitous location to host frequent events in conjunction with the Webster Recreation Department, such as food truck festivals, 5k races, and charity fundraisers. Many members of the beach committee expressed their interest in creating new and interesting event ideas at the beach. Coupled with improved amenities and infrastructure, increased programming at Memorial Beach can benefit not only the attractiveness of the spot, but the reputation of Webster, as a whole.

Lastly, the team recommends that the citizens of the Webster get more involved in the planning, advocation, and maintenance of Memorial Beach. Ultimately, the beach belongs to the Town and its residents, so it important that community members voice their opinions and
work to help make Memorial Beach and Webster Lake a safe, healthy, and enjoyable attraction for visitors of all ages and walks of life. Citizens should strive to be stewards of the beach by taking care of the space and leaving it in better condition than they found it.


APPENDICES

Appendix A: Project Proposal

Designing the Redevelopment of Memorial Beach
Webster, Massachusetts
Emily Cafarelli, CE ‘19
Joseph Genga, CE ‘19
Davianna Vasconcelos, EVE ‘19
Advised by: Suzanne LePage, Civil and Environmental Engineering Department, WPI
Sponsored by: Town of Webster, MA
A Worcester Polytechnic Institute Major Qualifying Project Proposal
October 12th, 2018

Capstone Design Statement

This Major Qualifying Project (MQP) is a culmination of undergraduate studies, coursework, and projects in the fields of Civil and Environmental Engineering. Following Accreditation Board of Engineering and Technology (ABET) requirements, this MQP bridges theoretical planning with real-world constraints and stakeholders. It is subject to constructability, economic, environmental, ethical, safety, social, and political factors, among many others. All of these factors will come together to influence our design plan for redevelopment of Memorial Beach, a town-owned recreational area along the shore of Webster Lake in Webster, MA. In an effort to improve the usability of Memorial Beach and the economy of Webster, we will design a redevelopment plan.

**Constructability:** Many potential designs for Memorial Beach could include commercial and/or structural development. We must consider the feasible limits of construction in this area, either due to zoning regulations or environmental restraints, such as wetlands, soil types, and tree coverage.

**Economics:** All municipal projects require local, state, federal, or private funding. It is imperative to consider the financial constraints of the Town of Webster when providing a plan recommendation. Cost will be a significant factor in determining the optimal land use option(s). We will provide a cost analysis of our design plan and outline where the Town may obtain funding. Furthermore, we will inventory potential sources of revenue if the plan includes commercial redevelopment.

**Environmental:** Most, if not all, planning projects need to consider environmental constraints. Especially given the fragile ecosystem for our designated area on Lake
Chargoggagoggmanchauggagoggchaubunagungamaugg, we will need to analyze and take into account the environmental conditions, such as watershed areas and woodlands.

**Ethical:** As outlined by the American Society of Civil Engineers in their Code of Ethics, engineers shall “hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties”, in addition to “perform services only in areas of their competence” and “issue public statements only in an objective and truthful manner” (ASCE, n.d.). This is relevant to our completion of this project because we shall not attempt to provide uninformed recommendations that are out of our field of knowledge or that might jeopardize the Town of Webster or anyone else involved.

**Safety:** We must ensure that our designs do not, intentionally or unintentionally, put any lives into harm. In our plans, we must take careful consideration of the safety of vehicular, bicycle, and pedestrian traffic, as well as the safety of beachgoers.

**Social:** There are numerous different options to consider when planning the redevelopment of Memorial Beach, many of which have social components. It is imperative that we consider the social wants and needs of beachgoers and anyone else who benefits from or is associated with the space.

**Political:** Throughout this project, we will be working with Town officials and in accordance with Town policies and procedures. Through our partnership with the Town of Webster and some of its committees, we must remain politically indifferent, but also be cognizant of potential political barriers to the project. Among the residents of the lake, other residents of the Town, visitors, and other people affected by development on Memorial Beach, there are a lot of valuable opinions regarding the redevelopment. We will need to work diligently to gather thoughts and opinions from people affected by the project throughout public outreach and communications with Town officials.

**1.0: Introduction**

Webster (herein referred to as “the Town”) is a municipality in Massachusetts located near the city of Worcester and along the border of northeast Connecticut. With only 16,000 residents, this rather small community had various hubs within its boundaries. Webster struggled economically and faced a decline of its once positive reputation. Webster had a higher rate of poverty in comparison to most Massachusetts towns and was experiencing further issues regarding crime. Town officials and committees actively sought renovations and improvements to the Town to address these issues.
While some areas of Webster were struggling, Lake Chargoggagoggmanchauggagoggchaubunagungamaugg (also known as “Webster Lake”), though, remained a positive asset to the Town. Situated on the northwestern shore of Webster Lake, Memorial Beach served as a community cornerstone for family recreation and tourist attraction. The beach was ideal for activities such as swimming, town events, and boating. Unfortunately, years of traffic and overuse have left merely a barren, dried up parking lot, and an outdated playground along the sandy beach. As it stood, Memorial Beach received a lot of seasonal activity, but as an unorganized space with untapped potential.

If the Town was to invest in renovations and additions to the beach area then visitors and residents would more likely have a memorable experience and be more likely to return, as well as share the experience with friends and explore what else Webster has to offer. Enhancement of the beach area could help the Town in its entirety by drawing in more visitors, thus benefiting the economy and reputation of Webster.

The goal of this project was to provide Webster with a redevelopment plan for Memorial Beach to assist the fulfillment of the potential of the space as a recreational pillar of Webster and to advance the social and economic status of the community. There were several steps taken in order to accomplish this goal. First, the current conditions of Memorial Beach were analyzed to fully understand the layout, boundaries, and infrastructure of the area. Once the conditions of the beach were inventoried, it was imperative to consider the financial and environmental constraints, as well as the social implications of redevelopment of the area. A list of potential renovations to Memorial Beach was studied and analyzed to determine the optimal options to move forward with in the format of a
catalog. Consultations occurred frequently throughout this process with the Webster Planning Board and Memorial Beach Planning Committee, and these officials will receive the redevelopment catalog upon conclusion of the project, with which they may continue moving forward or choose to continue investigating redevelopment options.

2.0: Background Research

This chapter compiles research on topics that will be relevant throughout the completion of this project. Collecting information on the history of recreation and open space planning in Webster, Webster’s planning committees, and the methods and benefits of open space planning will provide key knowledge toward the assessment of a redevelopment plan for Memorial Beach.

2.1 Past Webster Open Space Plans

The town of Webster completed an open space plan in 2009. The plan included goals and subgoals for the Town and its improvements. Webster Lake itself had its own goal which is established as “...[to] preserve the quality and character of Webster Lake for all residents to enjoy”. The related subgoals for the section include protecting the water quality of the lake, identifying and preserving important viewsheds at Webster Lake, and retain the classic, scenic, and family friendly atmosphere of Memorial beach. These goals and subgoals will serve as guidelines throughout the completion of this project.

The Town had other goals related to the beach, such as “...[to] improve and expand the town’s open space and recreation facilities for the enjoyment of all residents of Webster.” This goal is particularly applicable to this project as the beach has potential space for recreational development.

2.2: Webster’s Town Government

Webster’s government is made up of a Town Administrator and several boards and committees. This project will primarily collaborate with the Town’s Planning Board and the Memorial Beach Planning Committee. The mission statement for the Planning Board is as follows:

“*The Webster Department of Planning and Development is committed to community-based planning that guides the future of the Town. It provides technical planning guidance and assistance to public and private entities in the areas of land use planning,*
zoning, economic development, as well as public outreach and engagement. The
Department implements projects and programs designed to improve the economy,
environment, and physical infrastructure of the Town. It is committed to providing
dependable, cost effective, high-quality customer service while assisting the public in
achieving their land use goals without compromising the
ordinances of the Town of Webster” (Town of Webster, n.d.).

The Memorial Beach Planning Committee is a group of nine members, seven of whom are
volunteers that are asked by the Town’s Board of Selectmen to serve. Three of the seven volunteers
must live on Webster Lake, three others must be residents of Webster, and the last volunteer must be a
veteran and live in Webster. The other two members are Webster’s Recreation Director and a member
of Webster’s Planning Board. The central mission of this committee is to act as the main adversaries
for use and development at Memorial Beach which can include creating new ways to optimize the
space and increase the usage. They will be the main point of contact within the Town’s government
throughout this project.

2.3: An Overview of Open Space Planning

Open space planning is the practice of designating an undeveloped area within a naturally
occurring system and designing a model with a purpose for utilization with minimal environmental
disturbances. The concept of open space planning was believed to have started in 18th century and was
more widely used during the 20th century with the rapid metropolitan growth and urban sprawl. This
idea, or using the environment to human advantage, was a product of the advancing technology which
allowed for a better understanding of ecological processes and operations. Open space planning was a
wide-ranging concept with no definitive approach; therefore various models were adopted based on the
specifications of a given project.

There are multiple model types that could be used in this project. One model is the ecological
determinism which focuses on the natural characteristics and attributes of the area. This model has a
simple application; however, it can come with rather high expenses and long processes. Another model
that could be used is the park system model which connects various open spaces in a geographical area
and can be useful in urban areas where the options for large open spaces are limited. This model
generally has a medium difficulty of application with relatively low costs and a short process of
implementation (Maruani, 2007).
Though these planning conventions may vary in purpose or methods, they all remain focused on the same values. The first value all open space planning taken into consideration is sustainable development. This idea of using what resources are available while conserving them for future generations plays a tremendous role in open space planning. Other values in can include what is known as the 3 E’s; environmental concern, social equity, and economics. These values can flex based on project restrictions and methods, however they are all important factors to consider during the planning process (Maruani, 2007).

There are two main benefits to open space planning: recreation or service to society and conservation of natural values. Recreation or service to society provides the residents of the area with a scenic environment to relax and explore while learning about environmental topics and ethics. Open space planning can provide the potential uses and activities of an area that a community may need or want. The conservation of natural values preserves the valuable ecological services that the system provides to the environment. Since these services are difficult to quantify economically, many individuals find it difficult to understand their value (Steiner, 2007).

Beach planning can vary from general open space planning in that there is a water feature that should be the highlight of the project while other pieces become supports. In order to understand the different properties of the beach, various ideas should be considered such as the uses, the perception, and the available services (Cervantes, 2008). These ideas will play an important role in this project by acting as an advisory set of concepts in the design plans.

3.0: Project Outline and Steps

As aforementioned, the goal of this project is to provide Webster with a redevelopment plan for Memorial Beach to optimize the recreational usage of the land and advance the social and economic status of the Webster community. There are several steps that need to be taken in order to accomplish this goal that are illustrated in this chapter.

3.1: Assess current conditions of Memorial Beach.

Before all else, it is imperative to assess and understand the current uses, layouts, and conditions of Memorial Beach. Initial gathering of this information will come from the completion of a walking site visit. A set of field notes will be comprised during this visit, including information on the current spatial constraints, necessary infrastructure enhancements, and initial redevelopment ideas. The
Town Administrator will accompany the walk-through to point out areas of concern and redevelopment options that have already been or are under consideration by Town officials.

In addition to taking first-hand field observations, there is GIS data available online that provides visual information on the layout of Webster Lake and surrounding areas. This will help with the comprehension of the parameters of working on a redevelopment project in this area. For example, it is imperative to know the land boundaries being worked within, as well as the locations of watersheds and other areas to avoid or protect. Even further, the Town Administrator is able to provide more data and planning files for Webster Lake and Memorial Beach.

3.2: Engage with municipal committees and community members.

One of the points of focus for this project is the public perception of redevelopment of Memorial Beach. If there are contrasting opinions on changing the current state of this land, it is very important to consider and understand these testimonies, and then strive toward a solution that fits the interests of Webster citizens.

The Memorial Beach Planning Committee is dedicated to the maintenance and betterment of the land and should be able to provide key insight into residents’ opinions. This committee is a valuable asset to bridge the gap between project goals and the wants and needs of Webster citizens. Meetings between the project group and this committee will occur early and often throughout this process. Meeting with members frequently will help ensure that this project is aligned with the vision of the Town of Webster.

Another key relationship for this project lies between the project group and the Webster Planning Board. These members may provide highly relevant knowledge and insight from their experiences with open space planning in Webster. Furthermore, the project group must adhere to the zoning regulations and other Town policies. Engaging with Town planners will ensure that projected redevelopment options coincide with what is allowable.

3.3: Develop design criteria.

Although the idea of redevelopment is intended to have positive outcomes, it is necessary to acknowledge both the benefits and the drawbacks of such a project. Primarily, there may be several economic restraints that would greatly affect the feasibility of completing a large-scale redevelopment plan. It will likely be necessary to prioritize certain improvements over others because there will be a
monetary limit on the plan. Thus, identifying local, state, private, and federal sources of funding for a proposed plan and determining that limit is key.

On the other hand, commercial redevelopment of Memorial Beach can lead to increased economic revenue for the Town, and it is also important to highlight those potential opportunities. It is expected that by improving the usability of Memorial Beach, there would be an increase in public recreation and tourism at the site. Not only does this have an economic effect, but a social effect, as well, and it is wise to anticipate the positive and negative consequences on the beach and the Town, as a whole.

A comprehensive list of necessary and desired improvements to Memorial Beach will be assessed based on economic, environmental, and social constraints, as well as the expected duration of completion and the urgency of that upgrade. Each redevelopment idea will be analyzed on this basis and ideas will be compared. A full breakdown of each improvement will be provided as illustrated in Table 1, below.

<table>
<thead>
<tr>
<th>Improvement</th>
<th>Estimated Cost</th>
<th>Duration of Completion</th>
<th>Environmental Impacts</th>
<th>Benefits</th>
<th>Urgency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-paving Existing Roadways</td>
<td>$100,000</td>
<td>1 year</td>
<td>Potential petroleum run-off</td>
<td>Smoother roads</td>
<td>Low</td>
</tr>
<tr>
<td>Replacing Outdated Playscape</td>
<td>$10,000</td>
<td>1-2 months</td>
<td>None</td>
<td>More attractive, safer equipment</td>
<td>Medium-High</td>
</tr>
<tr>
<td>Constructing New Building</td>
<td>$500,000</td>
<td>1-3 years</td>
<td>Possible deforestation; resource consumption; waste management</td>
<td>Potential revenue from commercial vendor</td>
<td>Low-Medium</td>
</tr>
</tbody>
</table>

3.4: Select viable redevelopment(s) to pursue and create a design plan.

Recorded values that are input in Table 1 will be analyzed for each potential redevelopment proposition. A thorough written review, based on these evaluations, will be provided for each piece. After comparing the reviews, the project group will decide which option(s) are most practicable to work into a redevelopment plan for Memorial Beach. The decision to go forward with, or reject, a redevelopment option will be based on several factors, including economic constraints, environmental constraints, the urgency, the predicted outcomes, and other relevant variables.

After determining the optimal renovations to Memorial Beach, GIS and AutoCAD files will be designed to illustrate a redevelopment option for Memorial Beach. These files will include a
redesigned layout of the area, in addition to preliminary designs of added structures. At this point, there will be frequent consultations with the Webster Planning Board and Memorial Beach Planning Committee to match the design with the expectations of Town officials.

To accompany the design, there will be an approximate timeline of completion of the redevelopment to inform the Town of the expected length of seeing the plan through to fruition. There will also be a thorough assessment of costs related to the project to provide the Town with an estimate of the prices of all aspects, including materials and construction. All components of the plan will be presented to Town officials, which they can further continue to investigate or seek to implement the design.

4.0: Conclusion

Situated along spacious Webster Lake in small-town Webster, MA, Memorial Beach is a great location for family recreation. Yet, there is so much more that this underdeveloped area has to offer. Redevelopment of the space, including renovations to existing infrastructure and potentially adding small-scale commercial opportunities, could bring new life to not only the beach, but the Town of Webster, as a whole.

To get to a final redevelopment plan, it is imperative to conduct sufficient background research and assess the many social, economic, and environmental constraints, among others, of the project.
Research into the benefits, drawbacks, and procedures of open space planning has provided an overview of the approach to redevelopment. Further information collected on the history of Webster and its Open Space Plan has brought forth insight into this specific redevelopment scenario.

Through this compiled knowledge, an outline of project objectives and steps was crafted to put this process into order. Beginning with assessing the current conditions of Memorial Beach, then predicting the benefits and drawbacks of redevelopment along this area of Webster Lake, and finally completing a thorough redevelopment plan, the goal of this project is to provide Webster with a redevelopment plan for Memorial Beach in order to fulfill the potential of the space and advance the social and economic status of the Webster community.
Appendix B: Site Visit Reports

Site Visit Report
Date: 09/28/18
Location: Memorial Beach, Webster, MA
Weather: Overcast, light rain
Attending: Joey, Emily, Doug Willardson

Field Notes:
1. Beach and Playground:
   Playground equipment, lifeguard chairs, and picnic tables are old and out-of-date.
   Pavilion likely to be built next to recreation building.
   Building is slightly old and could use some renovation.
   Maybe add signage or improve path to peninsula.
2. Extra Parking Space:
   Covered in rough gravel and dying grass.
   Potential space for a stage, baseball field, etc.
   Only used during fireworks for extra parking.
3. Grassy Field (across from pump station):
   Mostly used for pictures.
   No significant access.
   Potential space for a picnic area.
4. Animal Shelter:
   Potential dog park next door.
5. Narrow Dirt Road (next to memorial):
   Could be extra space for parking.
6. Walking Park (across footbridge):
   Possible location for small hotel.
   Redeveloper has considered this with the Town.

Other Notes:
1. Additional or improved signage or directory around the space.
2. Walking track is well-used and shouldn’t need to be updated.
Site Visit Report
Date: 10/16/18
Location: Memorial Beach, Webster, MA
Weather: Partly cloudy
Attending: Joey, Emily, Davianna

Used a DJI Phantom III Standard camera drone to capture pictures of the landscape.

Noted contaminants of the area:
Organics: animal waste, food scraps
Inorganics: food containers, utensils, napkins, other paper and plastic
Appendix C: Memorial Beach Planning Committee Meeting Minutes

Memorial Beach Planning Committee Meeting
Tuesday, November 20th, 2018
Webster Public Library, 6:00 PM

- Introductions
- Finance review
  - Went over reports with past profits and expenses
  - Discussed changing prices of entry
    - Out of town rates
    - Jet ski allowed again
- State Grant opportunities
  - 750k initial grant with money to maintain each year
  - Would become state property?
  - Talked about concerns such as safety
  - Talked about how to spend the money
  - New beach rules
- Presentation
  - We gave a modified version of the presentation we had created
  - Explained our project requirements
  - Discussed ideas
- Activity
  - Waiting on final result as we left during activity
  - Categorized and prioritized ideas
  - Gained a better understanding of residents wants
Memorial Beach Planning Committee Meeting
Wednesday, December 12th, 2018
Webster Library, 6:00 PM

- Discussion about boat capacity on lake and closing/keeping Lakeside boat launch vs. having boat launch at Memorial Beach
  - Desire to keep Memorial Beach community-friendly and oriented toward Webster residents, rather than non-residents

- Project Presentation
  - Recommendations:
    - Potentially expanding entry road to two lanes
    - Improve the check-in building
    - Stormwater management in the parking lot
    - Picnic area near the pump station
    - Pet-friendly area fits well over the bridge
    - Food Truck space availability
    - Pavilion dimensions: 39’ x 28’
Appendix D: Drone Site Pictures