



# Town of Wareham Risk and Vulnerability Assessment

December 2015

# Table of Contents

## Glossary of Common Acronyms and Definitions

1.	Introduction.....	1
1.1	Background and Scope.....	1
1.2	Codes and Guidance Documents.....	1
1.3	Vulnerability Assessment Report Organization .....	2
1.4	Limitations.....	3
2.	Determining a Design Flood Elevation (DFE).....	4
2.1	FEMA Flood Classifications.....	4
2.2	Design Flood Elevation.....	5
2.3	Summary.....	9
3.	State and Local Code Analysis .....	12
3.1	Massachusetts Building Code .....	12
3.2	Town of Wareham Zoning Bylaws .....	14
3.3	Variances from Code Regulation.....	14
3.4	Summary.....	14
4.	Determining Flood Risk.....	15
4.1	Determining Threat Likelihood.....	15
4.2	Determining Total Loss.....	15
4.3	Summary.....	17
5.	Mitigation Measures .....	18
5.1	EPA Recommended Mitigation Measures .....	18
6.	Vulnerability Assessment.....	23
6.1	Wareham Water Pollution Control Facility (WPCF).....	23
6.2	Pump Stations within the VE Zone .....	23
6.3	Pump Stations within the Coastal Zone AE .....	47
6.4	Pump Stations Within the Zone AE .....	79
6.5	Mitigation Budgetary Costs.....	91
7.	Flood Risk .....	92

# Table Index

Table 1	Wareham Major Flood Events.....	5
Table 2	Estimated Sea Level Rise at Infrastructure’s End of Useful Life.....	7

Table 3 ASCE 24-14 Minimum Freeboard Requirements for Flood Design Class 3 and Flood Design Class 4 Structures .....	8
Table 4 Mitigation Measures .....	22
Table 5 Recommended Mitigation Measures Budgetary Costs .....	91
Table 6 Flood Risk for Pump Stations Within SFHA .....	92

## Figure Index

Figure 1 Coastal Flood Zones (Source: FEMA Coastal Flood Hazard Mapping Studies, May 2013) .....	4
Figure 2 Wareham Pump Station Vulnerability in Relation to Flood Zones .....	5
Figure 3 USACE Sea Level Change Curve Calculator (2014.88.1) Predicted Sea Level Rise .....	6
Figure 4 Applicability of ASCE 24-14 to Proposed Mitigation Measures (Source: ASCE 24-14) .....	12
Figure 5 Example of Pump Station that Requires Structural Reinforcement if Dry Flood-Proofed .....	13
Figure 6 Bay Street Pump Station .....	24
Figure 7 Bay Street Watertight Manhole Cover .....	25
Figure 8 Bay Street Select Proposed Mitigation Measures .....	26
Figure 9 South Boulevard Pump Station .....	27
Figure 10 South Boulevard Substructure .....	28
Figure 11 South Boulevard Select Proposed Mitigation Measures .....	29
Figure 12 Hill Street Jefferson Shores Pump Station .....	30
Figure 13 Hill Street Jefferson Shores Select Proposed Mitigation Measures .....	31
Figure 14 Saltworks Road Pump Station .....	32
Figure 15 Saltworks Road Select Proposed Mitigation Measures .....	33
Figure 16 Smith Pump Station .....	34
Figure 17 Smith Master Control Panel (MCC) .....	35
Figure 18 Smith Select Proposed Mitigation Measures .....	36
Figure 19 Cohasset Narrows Pump Station .....	37
Figure 20 Louvered Opening for Equipment Removal .....	38
Figure 21 Cohasset Narrows MCC .....	38
Figure 22 Cohasset Narrows Select Proposed Mitigation Measures .....	39
Figure 23 South Water Street Pump Station .....	40
Figure 24 South Water Street Select Proposed Mitigation Measures .....	41
Figure 25 Onset Pier Pump Station .....	42

Figure 26 Onset Pier Select Proposed Mitigation Measures .....	43
Figure 27 Ruggles Pump Station .....	44
Figure 28 Ruggles Potential Water Entry Points.....	45
Figure 29 Ruggles Select Proposed Mitigation Measures .....	46
Figure 30 Cromesett Road Pump Station .....	47
Figure 31 Cromesett Road Select Proposed Mitigation Measures .....	48
Figure 32 Leonard Street Pump Station.....	49
Figure 33 Leonard Street Select Proposed Mitigation Measures .....	50
Figure 34 Apple Street Pump Station.....	51
Figure 35 Apple Street Select Proposed Mitigation Measures .....	52
Figure 36 Onset Heights Pump Station.....	53
Figure 37 Onset Heights Select Proposed Mitigation Measures .....	54
Figure 38 Riverside Pump Station.....	55
Figure 39 Avenue A Pump Station .....	56
Figure 40 Avenue A Select Proposed Mitigation Measures.....	57
Figure 41 Briarwood Pump Station .....	58
Figure 42 Briarwood Select Proposed Mitigation Measures .....	59
Figure 43 Arnold Pump Station .....	60
Figure 44 Arnold Select Proposed Mitigation Measures .....	61
Figure 45 Narrows Pump Station .....	62
Figure 46 Narrows Pump Station Potential Water Entry Point.....	63
Figure 47 Narrows Select Proposed Mitigation Measures .....	64
Figure 48 Pinehurst Pump Station .....	65
Figure 49 Pinehurst Pump Station Water Entry Points Below DFE .....	66
Figure 50 Pinehurst Select Recommended Mitigation Measures .....	67
Figure 51 Dick's Pond Pump Station .....	68
Figure 52 Dick's Pond Pump Station Potential Water Entry Points .....	69
Figure 53 Dick's Pond Select Proposed Mitigation Measures .....	70
Figure 54 North Boulevard Pump Station .....	71
Figure 55 North Boulevard Wet Well Manhole Cover .....	72
Figure 56 North Boulevard Select Proposed Mitigation Measures .....	73
Figure 57 Hynes Field Pump Station .....	74
Figure 58 Potential Water Entry Points: Doors and Louver .....	75
Figure 59 Hynes Field Select Proposed Mitigation Measures .....	76

Figure 60 East Boulevard Pump Station .....	77
Figure 61 East Boulevard Watertight Door .....	78
Figure 62 Water Entry Point at Vents.....	78
Figure 63 Parkwood Pump Station.....	80
Figure 64 Parkwood Select Proposed Mitigation Measures .....	81
Figure 65 Indian Neck Pump Station .....	82
Figure 66 Indian Neck Select Proposed Mitigation Measures .....	82
Figure 67 Linwood Pump Station .....	83
Figure 68 Linwood Select Proposed Mitigation Measures.....	84
Figure 69 Hathaway Pump Station.....	85
Figure 70 Hathaway Select Proposed Mitigation Measures .....	86
Figure 71 Terry Lane/Pine Tree Estates (Terry Lane) Pump Station .....	87
Figure 72 Terry Lane Select Proposed Mitigation Measures.....	88
Figure 73 Green Street Pump Station.....	89
Figure 74 Green Street Select Proposed Mitigation Measures.....	90

## Appendices

Appendix A – Additional Figures

Appendix B – BCA Output Report

# Glossary of Common Acronyms and Definitions

## Acronyms:

ASCE	American Society of Civil Engineers
AWWA	American Water Works Association
BCA	Benefit Cost Analysis
BCR	Benefit Cost Ratio
BFE	Base Flood Elevation
CZM	Massachusetts Office of Coastal Zone Management
DEM	Digital Elevation Model
DFE	Design Flood Elevation
EPA	United States Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HAZUS	Hazards Untied States
IBC	International Building Code
LIMWA	Limit of Moderate Wave Action
MCC	Motor Control Center
MGD	Million Gallons Per Day
NEIWPCC	New England Interstate Water Pollution Control Commission
NOAA	National Oceanographic and Atmospheric Administration
SFHA	Special Flood Hazard Area
SLR	Sea Level Rise
USACE	United States Army Corps of Engineers
WPCF	Water Pollution Control Facility

## FEMA Definitions:

Base Flood	The one percent annual chance flooding event, commonly known as the 100 year flood.
Special Flood Hazard Area (SFHA)	The land area covered by the floodwaters of the Base Flood.

# 1. Introduction

## 1.1 Background and Scope

The Town of Wareham (Town) is a coastal community in Southeastern Massachusetts. The Town operates a wastewater system that serves approximately sixty percent of the Town. The system consists of 57 miles of gravity sewer and force mains, 43 pump stations, and a 1.5 million gallon per day (MGD) design capacity Water Pollution Control Facility (WPCF). The collection system has significant environmental and economic importance to the Town. It serves the most populated portion of the Town as well as the Town's large seasonal summer population and day-trippers. In addition, the collection system and treatment facility serve as an important environmental line of defense against wastewater contamination of groundwater, local rivers, streams, and Buzzards Bay.

The recently updated Federal Emergency Management Agency (FEMA) flood maps show that the majority of the Town's pump stations are in vulnerable areas with respect to the 100-year flood event and subsequent anticipated wave action. With anticipated sea level rise due to climate change, the pump stations vulnerability with respect to coastal flooding is expected to increase.

The Town of Wareham retained GHD to develop a Risk and Vulnerability assessment of the Town's wastewater infrastructure, as related to coastal flooding. The following tasks are included in the scope of the project:

1. Conduct an assessment of the existing conditions of the major infrastructure (pump stations and wastewater treatment facility) as it relates to vulnerability to coastal flooding and climate change. The analysis will utilize survey data provided by Green Seal Environmental, Inc.
2. Complete a Risk and Vulnerability Assessment as it relates to coastal flooding and climate change for the Town's major wastewater infrastructure.
3. Develop recommended improvements related to coastal flooding and climate change and budgetary costs.

## 1.2 Codes and Guidance Documents

The following codes and industry guidance documents were used to develop the methodology for the Town of Wareham Risk and Vulnerability Analysis Report:

### State and Local Regulations

- Massachusetts Building Code – 8th Edition
- Massachusetts Building Code – Draft 9th Edition
- Zoning By-Laws - Town of Wareham Massachusetts – Revised May 2014

### Town of Wareham Planning Documents

- Town of Wareham Comprehensive Emergency Management Plan

### FEMA Guidance Documents

- 2014 FEMA Flood Insurance Rate Maps (FIRM)

- '2012 Flood Insurance Study for Plymouth County, Massachusetts (All Jurisdictions)' Flood Insurance Study Number 25023CV001A', FEMA – effective July 17, 2012
- 'State and Local Mitigation Planning How-To Guide – Understanding Your Risks, Identifying Hazards and Estimating Losses;' FEMA 386-2, August 2001

#### **Massachusetts Office of Coastal Zone Management (CZM) Guidance Documents**

- 'Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning', CZM, December 2013

#### **American Water Works Association (AWWA) Guidance Documents**

- 'Risk Analysis and Management for Critical Asset Protection (RAMPCAP®) Standard for Risk and Resilience Management of Water and Wastewater Systems Using the ASME-ITI RAMCAP Plus® Methodology, 1st Edition (ANSI/AWWA J100-10(R13)) – this document is commonly referred to as J100

#### **United States Environmental Protection Agency (EPA) Guidance Documents**

- 'Flood Resilience: A Basic Guide for Water and Wastewater Utilities,' Office of Water (4680T) – EPA 817-B-14-006-September 2014

#### **New England Interstate Water Pollution Control Commission (NEIWPC) Guidance Documents**

- TR-16: Guides for the Design of Wastewater Treatment Works; NEIWPC, 2011 Edition

#### **American Society of Civil Engineers (ASCE) Guidance Documents**

- ASCE Standard 24-14 – Flood Resistant Design and Construction, 2014

#### **United States Army Corps of Engineers (USACE) Guidance Documents**

- USACE Sea Level Change Curve Calculator (2014.88.1)

### **1.3 Vulnerability Assessment Report Organization**

This report is divided into seven chapters, as follows:

- Chapter 1 presents general introductory information on the project and summarizes the documents that were used to develop the methodology for the Vulnerability Analysis.
- Chapter 2 discusses FEMA flood classifications, incorporation of climate change effects into the proposed mitigation measures, and the methodology that was used to determine a design flood elevation for proposed mitigation measures.
- Chapter 3 summarizes the State and local code analysis that was conducted to determine the types of mitigation measures that are allowable by current regulations.
- Chapter 4 summarizes the methodology that was used to determine the flood risk associated with vulnerable pump stations.
- Chapter 5 outlines the mitigation measures that were considered for the report.
- Chapter 6 provides a vulnerability assessment for each pump station within the Special Flood Hazard Area (SFHA).
- Chapter 7 summarizes the findings of the report.



## 1.4 Limitations

This document was produced solely for the purpose of developing budgetary allowances for future improvements to the Town's wastewater infrastructure. No design guidance is expressed or implied.

## 2. Determining a Design Flood Elevation (DFE)

### 2.1 FEMA Flood Classifications

FEMA defines the land area covered by the floodwaters of the Base Flood as a Special Flood Hazard Area (SFHA). The Base Flood is the 1% annual chance flooding event, also commonly known as the 100-year flood event. The SFHA is broken down into three different coastal flood zones, which are differentiated by expected wave height. The three zones are shown in Figure 1.

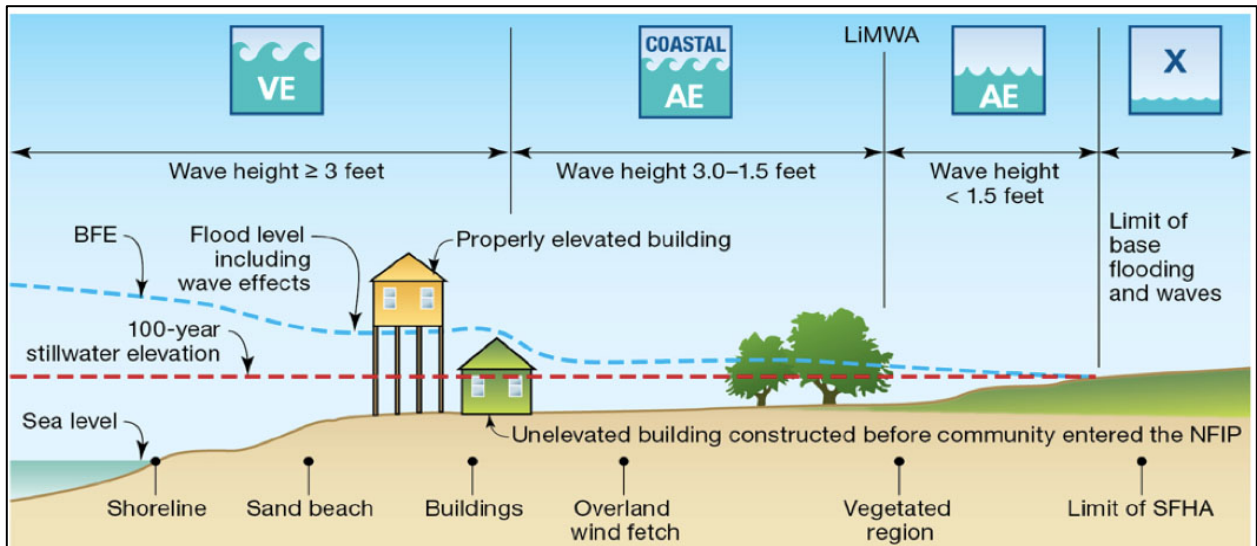


Figure 1 Coastal Flood Zones (Source: FEMA Coastal Flood Hazard Mapping Studies, May 2013)

Although at the time of this report the Coastal Zone AE is not shown on FEMA's Flood Insurance Rate Maps (FIRMs), FEMA guidance states that if a location meets the following two conditions it is located within a Coastal Zone AE:

1. A water depth sufficient to support waves between 1.5- and 3.0-feet high (stillwater depths of 2- to 4-feet at the site).
2. Wave heights between 1.5- and 3.0-feet high.

For this study it was assumed that all pump stations shown in the Zone AE on a FIRM map with more than 2-feet of standing water are within the Coastal Zone AE. Both the Zone VE and Coastal Zone AE are within the Limit of Moderate Wave Action (LiMWA), which has higher building standards for flood resilience.

Figure 2 shows the breakdown of the Wareham Pump Stations in relation to FEMA flood elevations. Twenty nine of the Town's forty three pump stations are located within the SFHA.

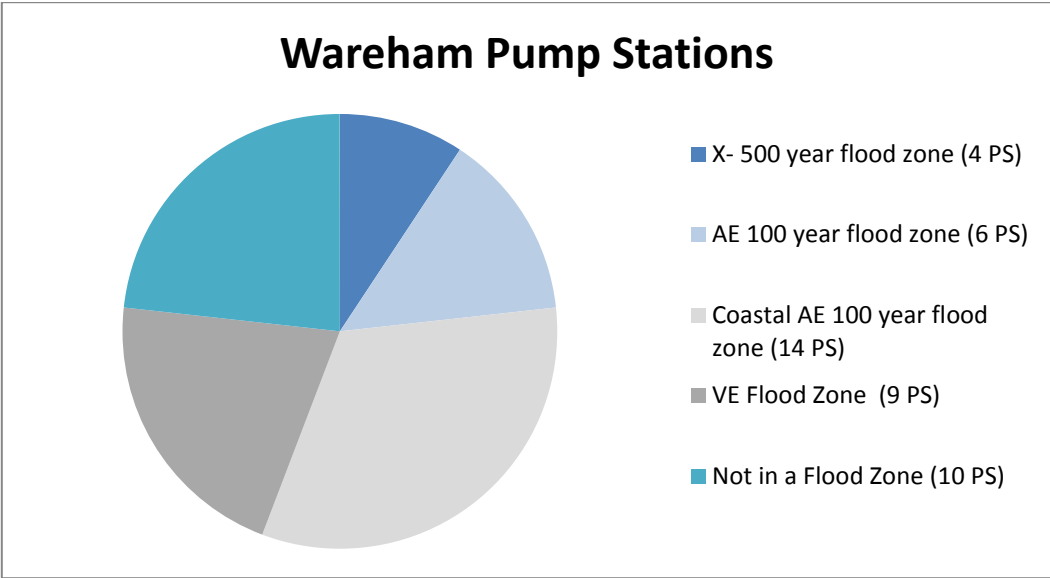


Figure 2 Wareham Pump Station Vulnerability in Relation to Flood Zones

## 2.2 Design Flood Elevation

The DFE for mitigation measures is determined by the following equation:

$$DFE = BFE + SLR + ASCE\ 24-14\ Minimum\ Freeboard\ Requirement$$

DFE = Design Flood Elevation

BFE = Base Flood Elevation (commonly known as the 100 year storm)

SLR = Sea Level Rise

Each variable is discussed in further detail below.

### 2.2.1 Design Flood Determination (BFE)

Industry guidance documents recommend that wastewater infrastructure is designed to be protected from the Base Flood, unless historical flood data has shown that the area has historically experienced more severe flooding events.

The 2012 Flood Insurance Study for Plymouth County, Massachusetts (All Jurisdictions), which was developed by FEMA, identifies two major historical flooding events. Table 1 shows the still water tide elevations of both major historical flooding events and the Base Flood event shown in the 2012 FEMA maps.

Table 1 Wareham Major Flood Events

Date	Still Water Tide Elevation	Annual Percent Chance of Occurrence
September 21, 1938	13.5 feet	1.18%
August 31, 1954	12.9	1.43%
2012 FEMA AE	14	1%

Since no more severe flooding events have been recorded, the Base Flood will be used as the design condition for all recommended wastewater infrastructure improvements in this report.

## 2.2.2 Climate Change and Sea Level Rise (SLR)

The Base Flood is expected to be impacted by Sea Level Rise (SLR) in future years. In order to be effective, any infrastructure improvements (mechanical or structural) that are made to the existing pump stations need to be designed to withstand the Base Flood at the end of that mitigation measures useful life, taking into account SLR. This approach is consistent with the 2011 FEMA Climate Change Adaption Policy Statement (Administrator Policy 2011-OPPA-01) and the 2014-2018 FEMA Strategic Plan.

In 2013 the Massachusetts Office of Coastal Zone Management (CZM) published a report entitled “Sea Level Rise: Understanding and Applying Trends and Future Scenarios for Analysis and Planning” which outlines several sea level rise scenarios using different assumptions for ocean warming and ice sheet melting rates.

The document recommends local conditions be determined for the specific planning area from long-term continuously operating reference stations or other available data. The nearest continuously operating reference station to the planning area is the National Oceanographic and Atmospheric Administration (NOAA) gauge in Woods Hole, Massachusetts. The NOAA sea level change projections output by the United States Army Corp of Engineers (USACE) Sea Level Change Curve Calculator (2014.88) was used to estimate relative sea level change projection for the planning area and is shown in Figure 3.

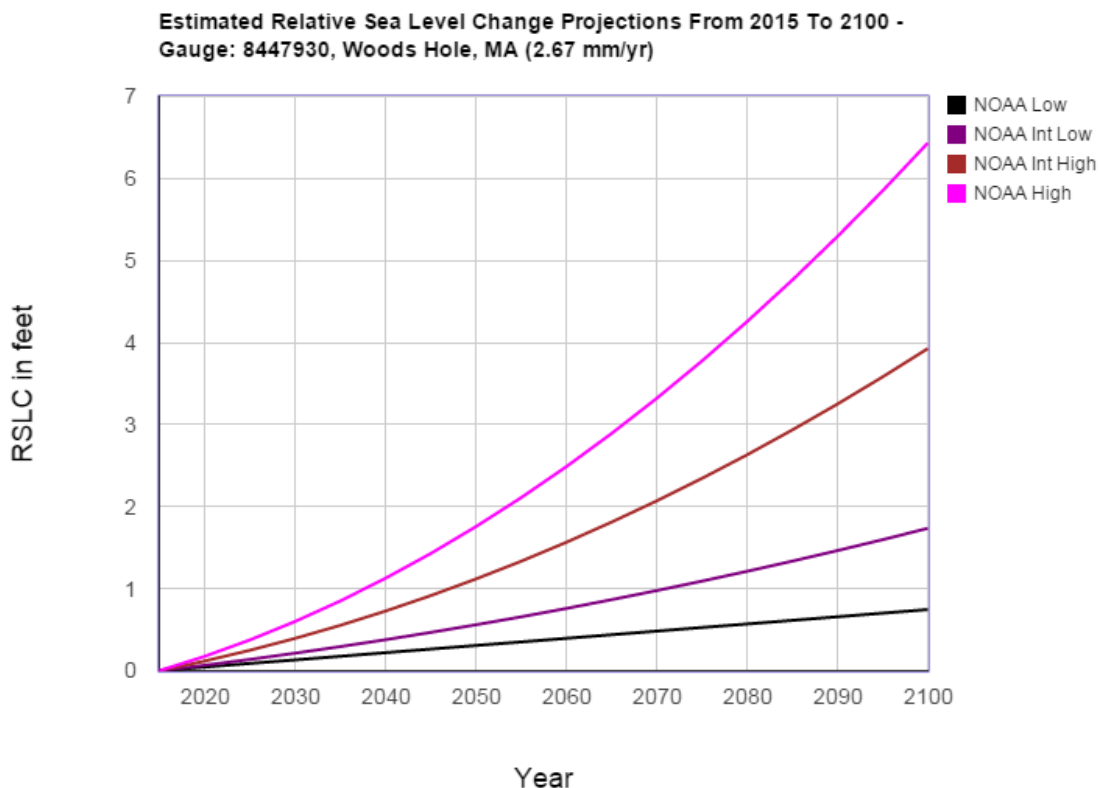


Figure 3 USACE Sea Level Change Curve Calculator (2014.88.1) Predicted Sea Level Rise

NOAA has published four different sea level rise scenarios, based on different assumptions of ocean warming and ice sheet loss. The document notes that based on historical observations both the “Low “ and “Intermediate Low” scenarios may considerably underestimate actual sea level rise,

especially for plans or projects with time horizons beyond 25 years. This leaves two scenarios. It would seem that a moderate approach to sea level rise would be reflected in the “Intermediate-high” scenario. This has a projected sea level rise of up to 3.9-feet by Year 2100.

Wastewater infrastructure components typically have the following life expectancies:

- Mechanical equipment, wooden buildings – 20 years
- Concrete and masonry – 50+ years

Table 2 outlines the estimated sea level rise at the end of each type of infrastructure’s useful life, based on the “intermediate-high” scenario produced by the USACE Sea Level Change Curve Calculator.

Table 2 Estimated Sea Level Rise at Infrastructure’s End of Useful Life

Infrastructure	Year Infrastructure Reaches End of its Useful Life	Estimated Sea Level Rise
New mechanical equipment, wooden building	2035	0.6 feet
Concrete and masonry	2063	1.8 feet

All recommended mitigation measures presented in this report should be designed to withstand the Base Flood, plus additional sea level rise estimated for the end of that mitigation measures useful life.

### 2.2.3 Minimum Freeboard Requirements (ASCE 24-14)

ASCE24-14 – Flood Resistant Design and Construction is a referenced standard in the 2015 International Building Code® (IBC) which classifies infrastructure by its criticality and designates a minimum freeboard requirement for each category of infrastructure. Minimum freeboard requirements are provided for the following two FEMA zones:

1. Zone AE
2. Coastal High Hazard Zones (Zone VE and Coastal Zone AE)

ASCE 24-14 outlines four flood design classes, ranking infrastructure from least critical (Class 1) through most critical (Class 4). The Town’s pump stations fall into two of these categories:

1. **Flood Design Class 3** structures are considered to be buildings and structures that pose a high risk to the public or a significant disruption to the community if they are unable to perform their intended function due to flooding. ASCE 24-14 specifically includes water and sewage treatment plants in this category. The majority of the Town’s pump stations are categorized as Flood Design Class 3.
2. **Flood Design Class 4** includes “buildings and structures that contain essential facilities and services necessary for emergency response and recovery” and ancillary structures that allow continued functioning of a Flood Design Class 4 facility after an emergency. Class 4 structures include hospitals, fire stations, police stations, emergency shelters, emergency operating centers, and structures that handle hazardous substances. Pump stations are considered ancillary structures essential to the continued functioning of Class 4 structures; therefore any pump station that either serves a Class 4 structure, or is in the critical

pathway between the Class 4 structure and the wastewater treatment facility, is categorized a Flood Design Class 4 structure.

The Town’s Emergency Management Plan includes a list of the Town’s critical infrastructure, health and medical facilities, fixed hazardous facilities, emergency operations shelters, and mass care shelters. The location of the infrastructure included in this list is shown in Figure 1 “Critical Infrastructure Facilities” included in Appendix A. Three pumping stations directly serve Flood Design Class 4 infrastructure:

1. The Narrows Pump Station serves Tobey Hospital and the Wareham Fire Station.
2. Onset Pier Pump Station serves the Onset Fire Department.
3. Cohasset Narrows Pump Station serves the Bourne Fire Station and Bourne Police Department through an inter-municipal agreement.

Figure 3-1 “ASCE 24-14 Wareham Pump Stations Flood Design Classes” included in Appendix A shows an interdependency diagram of Wareham’s pump stations. All pump stations in the critical path between Flood Design Class 4 infrastructure and the Wareham WPCF are also considered Flood Design Class 4 infrastructure. The following pump stations are in this critical path:

- Depot Street Pump Station (serves Cohasset Narrows Pump Station).
- Dick’s Pond Pump Station (serves Cohasset Narrows Pump Station).
- Hynes Field Pump Station (serves Onset Pier Pump Station).

All mitigation measures proposed for these stations will be designed to the Flood Design Class 4 minimum freeboard requirement. The remainder of the pump stations mitigation measures will be designed to Flood Design Class 3 minimum freeboard requirements.

Minimum freeboards for Class 3 and Class 4 structures DFEs, that are applicable to retrofit projects, are outlined in Table 3.

**Table 3 ASCE 24-14 Minimum Freeboard Requirements for Flood Design Class 3 and Flood Design Class 4 Structures**

Condition		ASCE 24-14 Minimum Freeboard Requirement	
		Flood Design Class 3	Flood Design Class 4
Minimum elevation below which flood damage-resistance materials shall be used.	Zone AE	BFE + 1 foot or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.
	Zone VE and Coastal Zone AE	BFE + 2 feet or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.
Minimum elevation of utilities and equipment.	Zone AE	BFE + 1 foot or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.
	Zone VE and Coastal Zone AE	BFE + 2 feet or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.

Condition		ASCE 24-14 Minimum Freeboard Requirement	
		Flood Design Class 3	Flood Design Class 4
Minimum elevation of dry flood-proofing of non-residential portions of mixed-use buildings.	Zone AE	BFE + 1 foot or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.
	Zone VE and Coastal Zone AE	Not permitted.	Not permitted.
Minimum elevation of wet flood-proofing.	Zone AE, Zone VE and Coastal Zone AE	BFE + 1 foot or DFE, whichever is higher.	BFE +2 feet or DFE, or 500 year flood elevation, whichever is higher.

### 2.3 Summary

The following calculation is used to determine design elevations for recommended mitigation measures:

Design Elevation = (Base Flood Elevation) + (Expected Sea Level Rise) + (ASCE 24-14 specified freeboard)

- Base Flood Elevation – taken from 2014 FEMA flood maps
- Sea Level Rise
  - 0.6 feet for mechanical equipment and wooden buildings
  - 1.8 feet for concrete and masonry
- Freeboard—recommended freeboard per ASCE 24-14

The DFE for each pump station is outlined in Table 2- 1.

Table 2- 1 Pump Station Design Flood Elevations

Pump Station	Flood Zone	BFE	ASCE 24-14 Freeboard	Mechanical Equipment		Structural Improvements	
				SLR	DFE	SLR	DFE
Bay Street	VE	17	2 ft	0.6 ft	<b>19.6</b>	1.8 ft	<b>20.8</b>
South Boulevard	VE	22	2 ft	0.6 ft	<b>24.6</b>	1.8 ft	<b>25.8</b>
Hill Street Jefferson Shores	VE	21	2 ft	0.6 ft	<b>23.6</b>	1.8 ft	<b>24.8</b>
Saltworks Road	VE	21	2 ft	0.6 ft	<b>23.6</b>	1.8 ft	<b>24.8</b>
Smith	VE	18	2 ft	0.6 ft	<b>20.6</b>	1.8 ft	<b>21.8</b>
Cohasset Narrows	VE	21	2 ft	0.6 ft	<b>23.6</b>	1.8 ft	<b>24.8</b>
South Water Street	VE	19	2 ft	0.6 ft	<b>21.6</b>	1.8 ft	<b>22.8</b>
Onset Pier	VE	22	2 ft	0.6 ft	<b>24.6</b>	1.8 ft	<b>25.8</b>

Pump Station	Flood Zone	BFE	ASCE 24-14 Freeboard	Mechanical Equipment		Structural Improvements	
				SLR	DFE	SLR	DFE
Ruggles	VE	20	2 ft	0.6 ft	<b>22.6</b>	1.8 ft	<b>23.8</b>
Cromesset	Coastal AE	16	2 ft	0.6 ft	<b>18.6</b>	1.8 ft	<b>19.8</b>
Leonard Street	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Apple Street	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Onset Heights	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Riverside	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Avenue A	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Briarwood	Coastal AE	15	2 ft	0.6 ft	<b>17.6</b>	1.8 ft	<b>18.8</b>
Arnold	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Narrows	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Pinehurst	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Dick's Pond	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
North Boulevard	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Hynes Field	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
East Boulevard	Coastal AE	14	2 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Parkwood	AE	15	1 ft	0.6 ft	<b>16.6</b>	1.8 ft	<b>17.8</b>
Indian Neck	AE	14	1 ft	0.6 ft	<b>15.6</b>	1.8 ft	<b>16.8</b>
Linwood	AE	14	1 ft	0.6 ft	<b>15.6</b>	1.8 ft	<b>16.8</b>
Hathaway	AE	14	1 ft	0.6 ft	<b>15.6</b>	1.8 ft	<b>16.8</b>
Pine Tree Estates (Terry Lane)	AE	14	1 ft	0.6 ft	<b>15.6</b>	1.8 ft	<b>16.8</b>
Green Street	AE	16	1 ft	0.6 ft	<b>17.6</b>	1.8 ft	<b>18.8</b>
Depot Street	X	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Kennedy Lane	X	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
French Street	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Kendrick (Industrial Park 1)	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Mattapoissett Road	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Minot	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Nanumette Air Station	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Oak Street	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Peter Cooper	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>



Pump Station	Flood Zone	BFE	ASCE 24-14 Freeboard	Mechanical Equipment		Structural Improvements	
				SLR	DFE	SLR	DFE
Police Station	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Springborn	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Thatcher (Industrial Park 2)	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Thirteenth Street	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>
Woodbury	N/A	N/A	N/A	N/A	<b>N/A</b>	N/A	<b>N/A</b>

### 3. State and Local Code Analysis

State and local building codes were reviewed to determine what mitigation options are allowable by these codes.

#### 3.1 Massachusetts Building Code

The current Building Code in effect for the State of Massachusetts is the Eighth Edition (August 2010). In accordance with the Commonwealth of Massachusetts Web site, the Massachusetts State Building Code (780 CMR) – Ninth Edition, Base Volume (2015 International Building Code (IBC) with amendments) is to be released sometime before mid-2016. Due to the time it would take to implement recommendations in this report, the assessment of Wareham’s pump stations is based upon the Ninth Edition of the Building Code, which references the ASCE 24-14: Flood Resistant Design and Construction design standard. Additionally, FEMA requires applicants for all structure elevation projects to comply with ASCE 24-14 (or latest edition) as a minimum design criterion.

##### 3.1.1 Applicability of ASCE 24-14 to Flood Mitigation Measures

As illustrated in Figure 4, the provisions of ASCE 24-14 are only applicable for new structures and for existing structures that are to undergo substantial improvements that cost fifty percent or more of the structure’s pre-improvement market value.

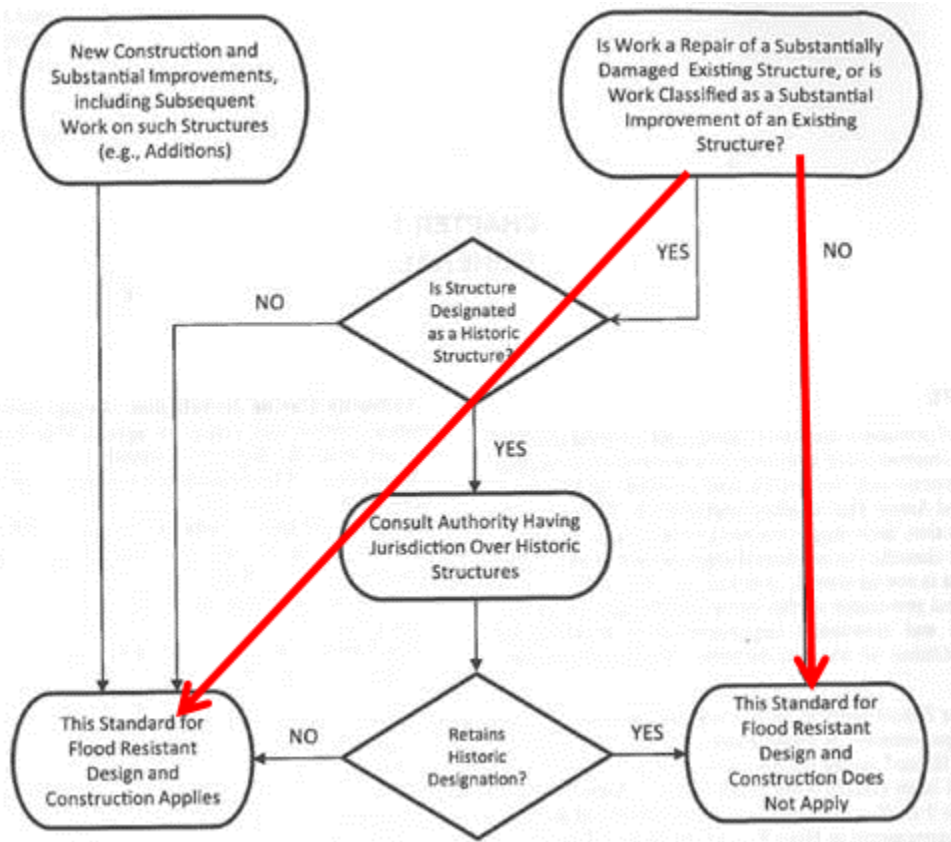


Figure 4 Applicability of ASCE 24-14 to Proposed Mitigation Measures (Source: ASCE 24-14)

ASCE 24-14 outlines two different mitigation options for structures within a flood plain:

- **“Dry Flood-proofing”** entails a combination of measures that results in a structure being able to withstand forces of a hydrostatic flood load while keeping the structure watertight.
- **“Wet flood-proofing”** entails provisions to relieve forces of a hydrostatic flood load by allowing the flood water to infiltrate into the structure, but making sure the exposed materials and utilities of the structure are not susceptible to water damage.

Both types of mitigation are discussed in further detail below.

### Dry Flood-Proofing

ASCE 24-14 does not allow structures in High Hazard Flood Areas/Zones (defined as Zone VE and Coastal Zone AE) to be dry flood proofed. This standard applies to any structure where flood-proofing the building is expected to cost fifty percent or more of the structures pre-improvement market value.

A preliminary structural review was conducted on the existing pump stations with superstructures to determine the approximate maximum hydrostatic pressure that the structures could withstand, prior to potential collapse. Based on assumed conditions typical of similar structures, the majority of the pump stations superstructures are constructed with a concrete sub-structure and an un-reinforced concrete masonry wall superstructure. It was estimated that the existing structures are not capable of withstanding more than 2.5 feet of hydrostatic pressure on the unreinforced masonry walls without the need to reinforce the structure.

Onset Pier Pump Station is shown in Figure 5 as an example of a pump station that would in danger of collapsing during the Base Flood if it were dry-flood proofed without being reinforced.



Figure 5 Example of Pump Station that Requires Structural Reinforcement if Dry Flood-Proofed

The costs associated with reinforcing structures where the BFE is more than 2.5-feet above the unreinforced masonry wall will likely exceed the fifty percent cost threshold which triggers the need for these particular existing structures to follow the guidelines of ASCE 24-14. Therefore, dry flood-proofing is not considered as a mitigation measure for pump stations that fall within this category.

Structures with less than 2.5-feet of hydrostatic pressure can likely be flood-proofed for less cost. Therefore, these structures do not need to follow the provisions of ASCE 24-14. However certain elements of ASCE 24-14, including designing to recommended ASCE 24-14 freeboards, will be implemented for good practice.

### **Wet Flood-Proofing**

Although ASCE 24-14 also limits the use of wet flood-proofing in these zones, it is interpreted that the existing pump stations can be “wet flood-proofed” on the basis that they are “structures that are functionally dependent on close proximity to water” as allowed per ASCE 24-14. This principle has been applied to pump stations in this report since they have a functional need at their location and cannot be moved. The close proximity of the pump stations to water might be coincidental, but they need to be close to water in order to serve their function.

## **3.2 Town of Wareham Zoning Bylaws**

The Town of Wareham Zoning Bylaws, updated May 2014, outlines development regulations for the flood plain district. The bylaws stipulate that structural requirements in floodplains and coastal high hazard areas, including substantial improvements, shall conform to the Massachusetts State Building Code (780 CMR).

## **3.3 Variances from Code Regulation**

When possible, recommended mitigation measures will comply with the guidance provided in ASCE 24-14. However, the Town has several dry pit/wet pit pumping stations with motor control centers (MCCs) that cannot be moved above the DFE. Four of these stations—Cohasset Narrows, South Water Street, Narrows, and Hynes Field—serve Flood Design Class 4 infrastructure.

Since there is no feasible way to wet flood-proof these stations, it is recommended that the stations with MCC panels are dry flood-proofed and that the unreinforced masonry walls for these stations be structurally reinforced to withstand the hydrostatic pressure of the Base Flood for 2065. This is a variance from the future 9<sup>th</sup> Edition of the Massachusetts Building Code and should be reviewed with local building officials prior to any implementation.

## **3.4 Summary**

Based on an analysis of State and local codes, the following flood mitigation measures are recommended for further consideration in this report:

- Superstructures with more than 2.5-feet of water on the building wall without MCC—wet flood-proofing.
- Superstructures with less than 2.5-feet of water on the building wall—dry flood-proofing.
- Superstructures with more than 2.5 feet of water and equipment that cannot be flood-proofed—dry flood-proofing and structural reinforcement of walls.

## 4. Determining Flood Risk

A Risk and Vulnerability Assessment was conducted using the risk and consequence approach outlined in “Risk Analysis and Management for Critical Asset Protection (RAMCAP®) Standard for Risk and Resilience Management for Risk and Resilience Management of Water and Wastewater Systems Using the ASTM-ITI RAMCAP Plus® Methodology, 1<sup>st</sup> Edition (ANSI/AWWA J100-10(R13))”, a document commonly referred to as “J100”. This document provides a methodology for communities, such as the Town of Wareham, to identify vulnerabilities within their system (as related to coastal flooding and climate change) and the risk associated with these vulnerabilities.

Flood risk is calculated for each pump station based on the expected monetary total loss for vulnerable infrastructure for both the Town and its citizens.

Since no as-built drawings were available for any of the pump stations for this report, vulnerabilities were determined based on observations made during field visits.

J-100 defines flood risk as a function of the 1) likelihood of a specific natural disaster and 2) the total estimated loss that can be anticipated from the disaster.

In equation form: (Flood Risk) = (Threat Likelihood) x (Total Loss)

The parameters used to determine the two variables used in the Flood Risk equation are outlined below.

### 4.1 Determining Threat Likelihood

AWWA J100-10 recommends that flood zones should consider a one percent annual chance of flooding (Base Flood). The threat of likelihood for this scenario is 0.01 events per year.

### 4.2 Determining Total Loss

AWWA J-100 defines total loss as the ‘sum of repair and replacement costs and losses due to lost production capability and other first effects’. This section outlines the methodology that was used to determine Total Loss for each pump station.

#### 4.2.1 HAZUS Modelling

The Hazards United States (HAZUS) model was developed by FEMA to estimate potential losses in disasters. The HAZUS flood model has the ability to perform flood loss estimations at three levels of complexity, which are separated by the completeness and precision of user input incorporated into the model. User input generally falls into two categories:

- 1) Information on the buildings and/or structures that are being affected, and
- 2) Information on the physical surroundings and makeup of the study area (e.g., coastline type, elevations, and channel sections).

Both of these inputs work in tandem to determine what the effects of a disaster will be and the relative accuracy of the results. To determine wastewater pump station losses the model uses damage functions which are based on the type of pump station (wet well/dry well or submersible) and the size of the lift station (measured as daily pumping capacity). These damage functions assume that pump stations become compromised once flood water has entered the base floor of the structure (commonly the elevation of the access door or hatch), and are reported as a percent

damage of the total structure. It is assumed at this depth of flooding, all electrical components have been compromised, and in the case of a wet well/dry well pump station the pump has also been compromised (the model assumes no damage to submersible wastewater pumps due to flooding). It is assumed that once flooded no additional damage is incurred.

When detailed coastline information is not available for a study area, the user can perform a level one analysis, wherein the HAZUS model performs an internal algorithm to determine the flood depth grid resulting from a user specified digital elevation model (DEM), flood stillwater elevations and wave setup, flood return period, and approximated coastal boundary. Although this can be a useful tool for getting a general understanding of the flood depths in an area, the hydraulic engine within HAZUS does not have the ability to accurately model and produce a flood depth grid on parity with other hydraulic modeling tools (e.g., HEC-RAS from the USACE). This can be especially common in areas with complex coastlines such as Wareham (i.e., bays and inlets, uneven coastlines with sheltered areas) where inlet channel cross-sections, wind fetch, and coastal compositions largely dictate the wave-driven depth contributions of a flood, and are not well represented in a level one analysis.

To more accurately produce the flooding depths that would be anticipated in an area such as Wareham, the user would generally increase the level of analysis by obtaining an established hydraulic model from a previous flood study (e.g., FIRM analysis from FEMA), or produce one internally, which is typically not time-effective or cost-effective. It was decided not to use the model and to pursue an alternative methodology to determine expected total losses to the Town's pump stations during a Base Flood event.

#### 4.2.2 FEMA Benefit Cost Analysis (BCA)

A Benefit Cost Analysis was developed using the FEMA software program BCA 5.1. This software analyzes a proposed projects costs and benefits, and produces a benefit-cost ratio (BCR). A project with a BCR great than or equal to 1.0 indicates that the benefits of the proposed mitigation measures justify the proposed costs of the project.

A project's costs and benefits are calculated by the program based on a series of user input variables. The benefits in the BCA analysis represent the total loss that would be incurred if the pump station failed during the Base Flood event and includes both direct and indirect economic losses.

A BCA was developed for each pump station with a superstructure. BCA only allows the user to run a flooding scenario if the infrastructure has a building associated with it. Costs and benefits for submersible pump stations with no superstructure were estimated using hand calculations based on the BCA methodology and the same assumptions that were used in the BCA analysis of pump stations with superstructures. The output reports for the BCA analyses and input parameters for all pump stations within the SFHA are included in Appendix B.

#### **BCA Input Assumptions**

The following assumptions were made for the BCA analysis:

## **Extent of Damage**

The following assumptions were made about the extent of damage suffered during a Base Flood event:

1. Once flood water has entered the base floor of the structure, all electrical components have been compromised and in the case of wet well/dry well pump station the pump has also been compromised.
2. Once the hydrostatic pressure on an unreinforced masonry wall is greater than 2.5-feet the structure has been comprised.

## **Volunteer Costs**

It was assumed that approximately twenty five percent of Wareham's firefighters would be required to assist in laying down sandbags prior to the flooding event, and cleanup services for approximately one month after the flooding event.

## **Social Benefits**

It was assumed that social benefit losses (mental stress, anxiety, and lost productivity) are equal to the number of people served by the sewershed and all sewersheds upstream of the pump station whose functionality would be impacted if the pump station was not operational.

## **Displacement Costs**

The monthly displacement cost was estimated for each pump station as the number of people dependent on that pump station and all sewersheds upstream of the pump station whose functionality would be affected if the pump station was not operational

## **Loss of Services**

A monetary cost was calculated for any station that is downstream of a fire department, police station, or hospital based on available data for each essential service.

## **4.3 Summary**

Flood risk for each pump station within the SFHA is calculated using the following formula:

$$\text{(Flood Risk)} = \text{(Threat Likelihood)} \times \text{(Total Loss)}$$

$$\text{Threat Likelihood (Base Flood)} = 0.01 \text{ events per year}$$

$$\text{Total Loss} = \text{Benefits output of FEMA BCA 5.1}$$

Results of the flood risk analysis are presented in Chapter 7.

# 5. Mitigation Measures

In order to reduce the impact of a flooding event, the Town can proactively make improvements to vulnerable infrastructure in order to protect it from flood damage. Mitigation measures can be implemented for one of two main objectives:

1. Keep the pump station operational during a flooding event.
2. Allow service to be restored rapidly following a storm or flooding event.

Mitigation measures for both options are discussed in this Chapter.

The Design Flood Elevation (DFE) for each mitigation measure is calculated through the formula described in Section 2:

Design Flood Elevation = (Base Flood Elevation) + (Expected Sea Level Rise) + (ASCE 24-14 specified freeboard)

- Base Flood Elevation – taken from 2014 FEMA flood maps
- Sea Level Rise
  - 0.6 feet for mechanical equipment and wooden buildings
  - 1.8 feet for concrete and masonry
- Freeboard—recommended freeboard per ASCE 24-14

## 5.1 EPA Recommended Mitigation Measures

The EPA guidance document “Flood Resilience: A Basic Guide for Water and Wastewater Utilities” recommends four options for mitigating flood risk at pump stations:

1. Prevent pump stations from flooding.
2. Protect critical components if pump stations do flood.
3. Maintaining pump station operations when the electrical grid is down.
4. Having a means of bypassing normal pump station operations when necessary.

### 5.1.2 Preventing a Pump Station from Flooding (Dry Flood-Proofing)

Flood risk can be mitigated at a pump station through infrastructure improvements intended to prevent flood water from entering the station. This option is also referred to as “dry flood-proofing” a building. As discussed in Section 2.3 dry flood-proofing entails a combination of measures that results in a structure being able to withstand forces of a hydrostatic flood load, which keeping the structure watertight.

Examples of EPA recommended measures that can be taken are outlined below:

1. Procure temporary flood barriers, such as sandbags, for use in minor floods.
2. Extend vent lines above the anticipated flood stage to prevent water from entering the pump station.
3. Install gates and backflow prevention devices on influent and emergency overflow lines to prevent inundation of the pump station by the collection system and the overflow.



4. Install permanent physical barriers, such as flood walls, levees, and sealed doors.
5. Install green infrastructure to attenuate or divert flood water and storm surges away from pump stations.

As discussed in Chapter 3, this mitigation alternative will only be considered for pump stations that have less than 2.5-feet of hydrostatic pressure on their walls during the Base Flood.

### Recommended Mitigation Options

The following dry flood-proofing mitigation options are considered in this report:

- Replace submersible station hatch with a water-tight hatch.
- Seal the interior surfaces and interfaces (joints) of the floor slab and walls (up to 2-feet high) to help prevent water seeping into the building. Any louvers or other wall openings below 2-feet should be raised up accordingly.
- Raise the pump station vent above the DFE.
- Install a flood wall around vulnerable equipment
- Raise louvers or other points of water entry above the DFE or install a flood door in front of the louver.
- For pump stations where the DFE is less than two feet above the lowest water entry point :
  - Install a 2-foot high stop plate (or flood door) inside the building. With this stop plate installed inside the building, the existing door can swing out into flood waters and a trapped individual can step over the stop plate. This arrangement would relieve the need to provide an emergency means of egress above the Base Flood Elevation (BFE).
- For pump stations where the DFE is more than two feet above the lower water entry point:
  - Install a watertight flood door. Structurally reinforce pump station walls to withstand the BFE in 2065 (end of structural improvements design life). Note – this option would require a code variance as discussed in Section 3.3.

#### 5.1.3 Protecting Critical Components if a Pump Station Does Flood

There are several situations where it may not be feasible, or advisable, to prevent flood water from entering the pump station. For example, required pump station improvements may not be deemed cost-effective. Secondly, if the expected flood level is more than a couple of feet, it may be advantageous to allow the water into the pump station in order to equalize the water pressure through the structure and avoid potential structural failure.

If flood water is allowed to enter the station it is imperative that critical components be protected from damage. EPA recommended mitigation options are outlined below:

1. Install unions in the conduit system to reduce the time required to repair damaged sections.
2. During upgrades or design of new equipment, develop capability to temporarily remove and safely store vulnerable components before a flood when there is enough advanced notice to do so.
3. Waterproof electrical components, controls, and circuitry.
4. Relocate or elevate electrical components above the flood stage.

5. Replace vulnerable components with a submersible option.
6. Replace a below-grade pump station with an above-grade station elevated above the flood elevation.

### **Recommended Mitigation Options**

The following options are considered in this report:

- Raise generator above the DFE.
- Install louvered openings in the wall in order to allow water into the building to equalize the hydrostatic pressure on the structure.
- Replace equipment with immersible equipment (ex. replace dry pit pumps with wet pit/dry pit pumps).
- Install immersible or watertight enclosures around critical electrical equipment.
- Relocate pump station control panel to above the DFE.
- Relocate pump station generator to above the DFE.

#### 5.1.4 Maintaining Operations When Electrical Grid is Down

Provisions should be made to maintain pump station operations, if possible, if the electrical grid is damaged by the flooding event. EPA recommended mitigation options are outlined below:

1. Consider options to procure either portable or permanent generators, increase fuel storage capacity, or install an alternative energy supply. The generators should be elevated above the flood elevation, have automated controls, and be sized appropriately. On-site fuel storage should also be elevated and secured to prevent flotation.
2. Install energy efficient equipment to increase the longevity of the fuel supply for backup generators.
3. Replace pumps with diesel drive or dual-option counterparts.

### **Recommended Mitigation Options**

The following options are considered in this report:

- Install a portable generator hook-up at stations that do not have a dedicated standby generator.
- Replace past useful life generator with a new generator.

#### 5.1.5 Means to Bypass Normal Pump Operations When Necessary

EPA-recommended options to bypass normal pump operations when necessary are outlined below:

1. Maintain a call-list of multiple vendors that can provide “pump around” services in an emergency or enter into an agreement with one.
2. Procure portable pumps to restore operation of a damaged pump station following an event.
3. Implement a regionalization project to enable diversion of wastewater flows to an alternative system for emergency wastewater collection and conveyance.

## Recommended Mitigation Options

The Town of Wareham currently has an agreement with Godwin pumps to provide rental equipment, including bypass pumps and backup electrical equipment, during an emergency situation.

### 5.1.6 Additional Mitigation Measures

Approximately half of the Town's pump stations have critical equipment which is past its design life. It is recommended that all equipment past its design life be replaced in order to increase the reliability of the station.

### 5.1.7 Summary

The seventeen mitigation options considered in this report are outlined in Table 4. A cost allowance was developed for each option which includes the cost of design, construction and contingency for larger projects and of only construction for smaller projects.

Mitigation measures are recommended for all pump stations where critical equipment is not elevated to the DFE for 2035.

If a pump station requires structural improvements (structural reinforcement of superstructure) it is recommended that the improvement be designed to the DFE for 2065.

Table 4 Mitigation Measures

Option	Mitigation Measure	Unit Cost
A	Install flood door.	2 foot flood door - \$30,000 Full flood door - \$60,000
B	Install watertight hatch on a submersible station.	\$30,000
C	Flood-proof painting.	\$200,000
D	Raise control panel above the DFE.	Relocate existing panel - \$30,000 Replace panel - \$50,000
E	Raise generator above the DFE.	Less than 1 ft - \$50,000 1 ft to 3 ft - \$125,000
F	Raise vent above DFE.	\$5,000
G	Install a louver to allow water to enter the station and equalize hydrostatic pressure.	\$150,000
H	Raise louver above the DFE or install a flood door in front of louver to protect to the DFE.	\$150,000
I	Replace equipment with immersible equipment.	Small station - \$1,800,000 Medium station - \$2,300,000 Large station - \$2,900,000
J	Install immersible or watertight enclosure on an existing control panel.	\$50,000
K	Relocate control panel above the DFE.	\$50,000
L	Relocate generator above the DFE.	Less than 1 foot - \$75,000 1 ft to 3 ft - \$150,000 3 ft to 5 ft - \$200,000 5ft + - \$300,000
M	Install a portable generator hook-up.	Non-submersible option - \$30,000 Submersible option - \$50,000
N	Replace past useful life equipment.	Small station - \$1,600,000 Medium station - \$2,100,000 Large station - \$2,600,000
O	Install watertight manhole cover.	\$10,000
P	Structurally reinforce walls.	\$500,000
Q	Install flood wall around vulnerable equipment	6" Curb - \$4,000 1 ft to 2 foot wall - \$30,000 2 ft to 3 foot wall - \$40,000

## 6. Vulnerability Assessment

A vulnerability assessment was conducted for the Wareham Water Pollution Control Facility (WPCF) and the pump stations within the SFHA. In this section, existing conditions and vulnerabilities are documented and mitigation measures from Table 4 are suggested for each station. For each station the BFE from the most current FEMA FIRM maps is shown.

As-built drawings were not available for any pump stations during the development of this report. The assessments and recommendations are based on survey data collected by Green Seal Environmental, Inc. and measurements obtained during site visits. All field data should be verified prior to final design of any of the proposed recommendations. Additionally, it should be noted that this Vulnerability and Risk Assessment was conducted for the sole purpose of establishing budgetary estimates to shore up vulnerable infrastructure. No design guidance is expressed or implied.

### 6.1 Wareham Water Pollution Control Facility (WPCF)

The Wareham WPCF is located outside the SFHA. However the WPCF will be affected by the increased amount of flow entering the facility during a coastal flooding event, which could potentially wash out the biological process at the facility. During a flooding event, additional flow will enter the system from non-watertight manholes and non-watertight submersible station hatches.

Many of the manholes within the SFHA have watertight manholes. It is recommended that a survey be conducted to identify which manholes are equipped with watertight manhole covers. Watertight covers should be installed on all manholes within the SFHA which do not currently have them. Additionally, existing watertight manhole covers should be inspected to determine whether the gasket has been damaged, then damaged covers should be replaced. Elevated vents at regular intervals will need to be considered during design for areas with watertight manholes.

### 6.2 Pump Stations within the VE Zone

The Town of Wareham has nine pump stations within the VE zone. The pump stations are located in areas subject to inundation by the Base Flood, with expected additional hazards due to storm-induced velocity wave action. These areas are expected to experience wave action greater than 3-feet.

The following design elevations are recommended for mechanical and structural components, respectively:

Mechanical equipment DFE = BFE + 0.6 ft (SLR) + 2 ft (ASCE 24-14 recommended freeboard)

Structural DFE = BFE + 1.8 ft (SLR) + 2 ft (ASCE 24-14 recommended freeboard)

## 6.2.1 Bay Street

### Existing Conditions

The Bay Street Pump Station is an ejector pump station, which was constructed in 1989 (Figure 6).



Figure 6 Bay Street Pump Station

The station has an underground concrete substructure, which is accessed through a manhole with a watertight cover. Ejector pumps are an antiquated technology and spare parts for the station need to be special ordered and custom manufactured resulting in a very long lead time for replacement parts. All of the equipment in the station is well past its useful life and no longer considered dependable.

The effectiveness of the watertight cover is limited by whether it has been closed properly and whether the gasket is undamaged (Figure 7). If the cover is not closed properly during the flooding event, all the equipment in the station will be inundated and likely suffer severe electrical damage.



Figure 7 Bay Street Watertight Manhole Cover

Neither the age of the watertight cover, nor the flood water depth that the cover was originally designed for are known. Since the BFE has changed in the Town since the stations construction, the cover was likely not designed for the new BFE and should be replaced.

The pump stations electrical panel is below the BFE and will likely suffer severe electrical damage during the Base Flood event. The station does not have a standby generator.

### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B - Install a new watertight cover capable of withstanding the hydrostatic pressure of the Base Flood event
- Mitigation Measure F – Raise vent above DFE
- Mitigation Measure J - Install an immersible panel around the electric panel
- Mitigation Measure M - Install a portable generator hookup
- Mitigation Measure N – Replace past useful life equipment

Select recommended mitigation measures are shown in Figure 8.

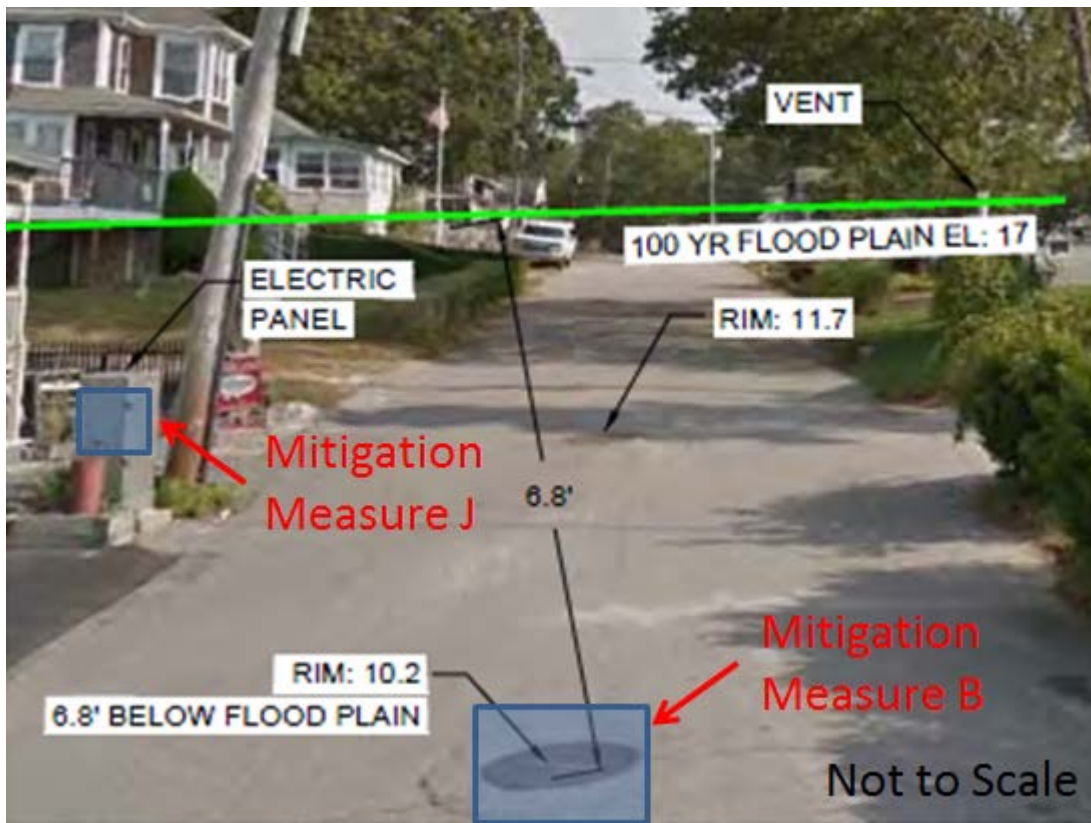


Figure 8 Bay Street Select Proposed Mitigation Measures



## 6.2.2 South Boulevard

### Existing Conditions

The South Boulevard Pump Station, shown in Figure 9, is a submersible ejector station, which was constructed in 1972. All of the station's equipment is well past its useful life and no longer considered dependable.



Figure 9 South Boulevard Pump Station

The station is accessed through a hatch which is not watertight and is below the DFE. During the Base Flood all of the equipment in the station would be inundated and would likely suffer severe electrical damage.

The station has a metal substructure, shown in Figure 10. Metal substructures are typically installed with a sacrificial anode pack which provides cathodic protection for the station. The anode packs are designed to last approximately 20 years. Since it is unknown whether the anode pack has been changed out at this station, the structural integrity of the substructure is unknown and cannot be relied on to be watertight. It is assumed that during the Base Flood event the substructure allow water into the pump station.



Figure 10 South Boulevard Substructure

### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight exterior hatch
- Mitigation Measure F – Raise vent above DFE
- Mitigation Measure J – Install immersible panel on the control panel
- Mitigation Measure M – Install portable generator hookup
- Mitigation Measure N – Replace past useful life equipment
- Mitigation Measure P – Structurally reinforce walls (replace past design life substructure in its entirety)

The location of select mitigation measures is shown in Figure 11.

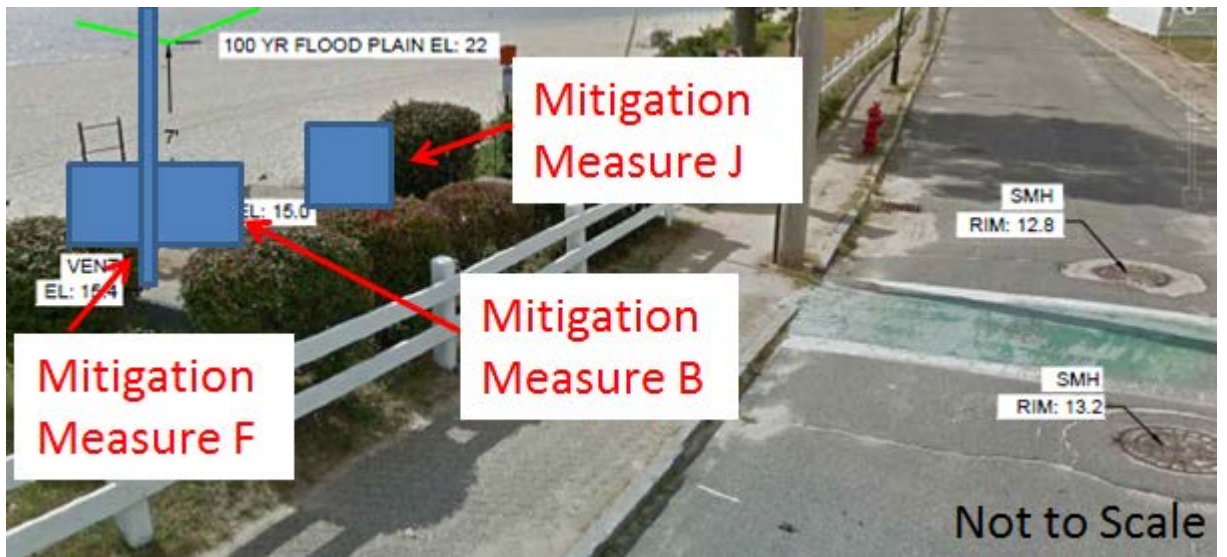


Figure 11 South Boulevard Select Proposed Mitigation Measures

### 6.2.3 Hill Street Jefferson Shores

#### Existing Conditions

Hill Street Jefferson Shores Pump Station is a submersible pump station with an unreinforced masonry superstructure, which was constructed in 1990. All of the equipment at the station is past its useful life. As shown in Figure 12, the station would be inundated during a Base Flood event. The pump stations' electrical equipment and emergency backup generator would likely suffer severe electrical damage in this event. Since the depth of water outside the station is above 2.5-feet, it is expected that the superstructure would collapse. The vault hatch is not watertight.



Figure 12 Hill Street Jefferson Shores Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch
- Mitigation Measure G – Install a louver to allow water to enter the station and equalize hydrostatic pressure
- Mitigation Measure J – Install immersible panel on the existing control panel
- Mitigation Measure L – Relocate generator above the DFE
- Mitigation Measure N – Replace past useful life equipment

The proposed location of select mitigation options is shown in Figure 13.



Figure 13 Hill Street Jefferson Shores Select Proposed Mitigation Measures

## 6.2.4 Saltworks Road

### Existing Conditions

Saltworks Road Pump Station is a submersible pump station, which was constructed in 1990. All of the equipment at the station is past its useful life. As shown in Figure 14 the station would be inundated during the 100-year flooding event. The pump stations' electrical equipment and emergency backup generator would likely suffer severe electrical damage in this event. Since the depth of water outside the structure is greater than 2.5-feet it is expected that the building would collapse. The vault hatch is not watertight.



Figure 14 Saltworks Road Pump Station

### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch
- Mitigation Measure F - Raise vent above DFE
- Mitigation Measure G- Install a louver to allow water to enter the station and equalize hydrostatic pressures
- Mitigation Measure J - Install immersible panel on the existing control panel
- Mitigation Measure L – Relocate generator above the DFE
- Mitigation Measure N – Replace past useful life equipment

Select mitigation measures are shown on Figure 15.



Figure 15 Saltworks Road Select Proposed Mitigation Measures

## 6.2.5 Smith

### Existing Conditions

The Smith Pump Station is a wet well/dry well pump station which was constructed in 1978 (Figure 16). The lower water entry point (the door) is below the DFE.

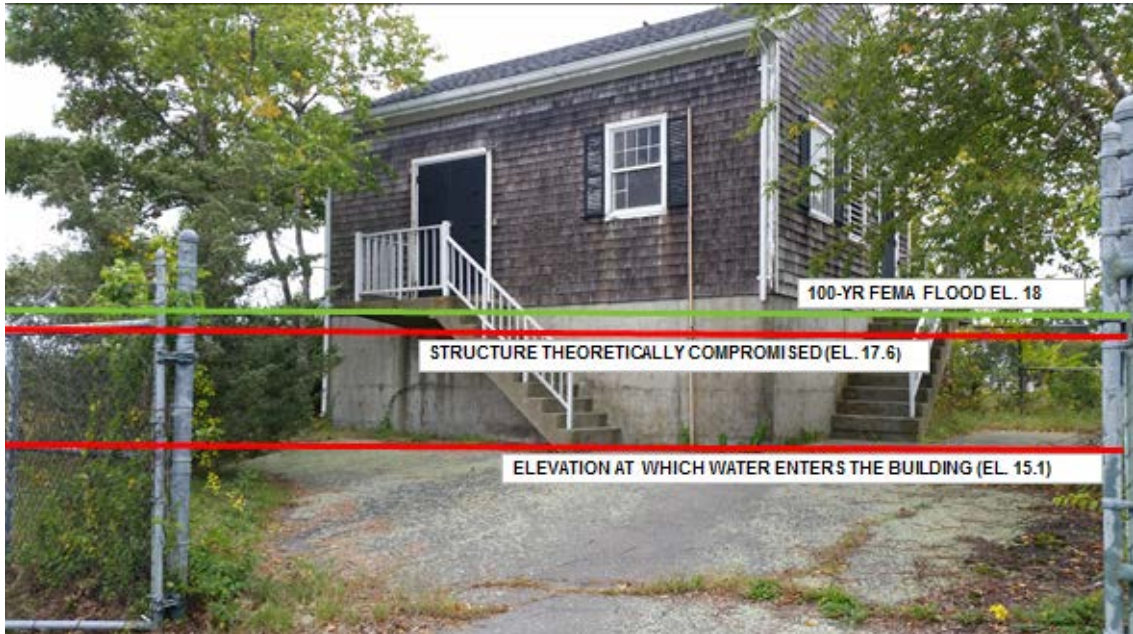


Figure 16 Smith Pump Station

The first floor elevation of the pump station is approximately 3-feet below the BFE. Once water enters the pump station, the electrical equipment (shown in

Figure 17), which is located approximately a foot above the first floor elevation of the pump station, would suffer severe electrical damage.





Figure 17 Smith Master Control Panel (MCC)

### Proposed Solutions

Since there is less than 2.5-feet of hydrostatic pressure on the unreinforced masonry wall at the anticipated 2065 BFE, it is recommended that the station is dry flood-proofed.

The following mitigation measures are recommended for this station:

- Mitigation Measure A - Install a 2-foot flood door at each door (2)
- Mitigation Measure C – Flood-proof paint the inside of the pump station
- Mitigation Measure N – Replace past useful life equipment

Select proposed mitigation measures are shown in Figure 18.

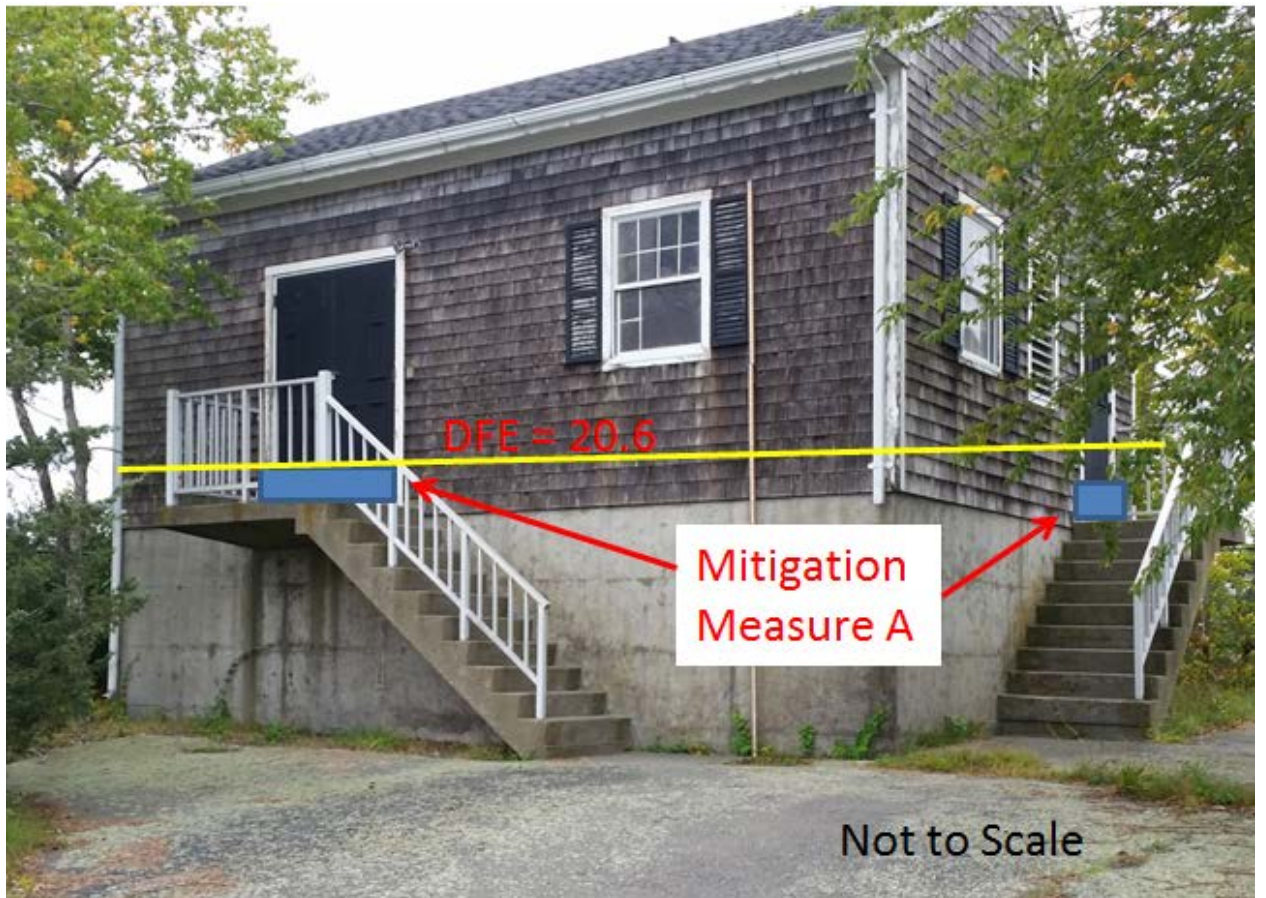


Figure 18 Smith Select Proposed Mitigation Measures

## 6.2.6 Cohasset Narrows

### Existing Conditions

The Cohasset Narrows Pump Station is a dry pit/wet pit pump station, which was constructed in 1989. As shown in Figure 19, the station would be inundated during the 100-year flooding event. The pump stations' electrical equipment and emergency backup generator would likely suffer severe electrical damage in this event. The depth of water on the unreinforced concrete masonry wall is 2.1-feet. However, when expected sea level rise is taken into account, the depth of water will be over 2.5-feet.



Figure 19 Cohasset Narrows Pump Station

The pump station has several potential water entry points, including both doors and the louver, shown in Figure 20.



Figure 20 Louvered Opening for Equipment Removal

The station also has an MCC panel that cannot be raised above the DFE (Figure 21).



Figure 21 Cohasset Narrows MCC

### Proposed Solutions

Since the pump station has a piece of critical equipment (MCC) that cannot be wet flood-proofed, it is recommended that the station be dry flood-proofed and that the unreinforced masonry walls be reinforced to withstand the hydrostatic pressure of the Base Flood in 2065.

The following mitigation measures are recommended for this station:

- Mitigation Measure A – Install a flood door at each door (2)
- Mitigation Measure C – Flood-proof painting
- Mitigation Measure H – Raise louver above the DFE or install a flood door in front of louver to protect to the DFE
- Mitigation Measure N – Replace past useful life equipment
- Mitigation Measure P – Structurally reinforce masonry walls

Select Proposed Mitigation measures are shown in Figure 22.

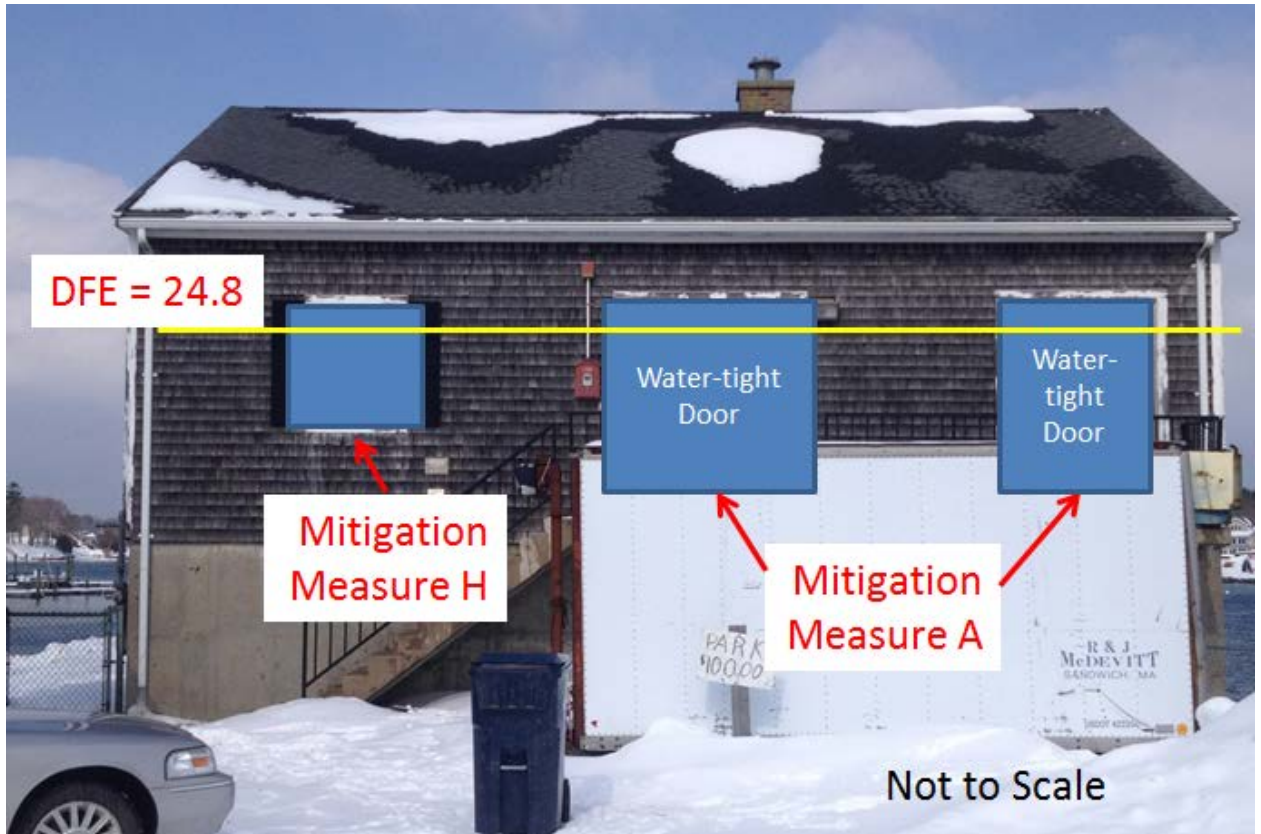


Figure 22 Cohasset Narrows Select Proposed Mitigation Measures

## 6.2.7 South Water Street

### Existing Conditions

The South Water Street Pump Station is a dry pit/wet pit pump station, which was constructed in 1971. All of the equipment in the station is well past its useful life. As shown in Figure 23 the station would be inundated during the Base Flood event. The pump stations' electrical and mechanical equipment and emergency backup generator would likely suffer severe electrical damage in this event. The depth of water outside the station is over 2.5-feet so it is expected the structure would collapse. The station has an MCC panel which cannot be raised above the DFE.



Figure 23 South Water Street Pump Station

### Proposed Solutions

Since the pump station has a piece of critical equipment (MCC) that cannot be wet flood-proofed, it is recommended that the station be dry flood-proofed and that the unreinforced masonry walls be reinforced to withstand the hydrostatic pressure of the Base Flood in 2065.

The following mitigation measures are recommended for this station:

- Mitigation Measure A – Install a watertight flood door
- Mitigation Measure C – Flood-proof painting
- Mitigation Measure E – Raise generator above DFE
- Mitigation Measure N – Replace past useful life equipment
- Mitigation Measure P – Structurally reinforce masonry walls

Select proposed mitigation measures are shown in Figure 24.



Figure 24 South Water Street Select Proposed Mitigation Measures

## 6.2.8 Onset Pier

### Existing Conditions

Onset Pier is a wet pit/dry pit pump station, which was constructed in 1971. All of the equipment in the station is past its useful life and no longer considered dependable. As shown in Figure 25 the station will be inundated during the Base Flood and all of the mechanical and electrical equipment in the station is expected to suffer severe electrical damage. The station has an MCC that cannot be relocated above the DFE.



Figure 25 Onset Pier Pump Station

### Proposed Solutions

Since the pump station has a piece of critical equipment (MCC) that cannot be wet flood-proofed, it is recommended that the station be dry flood-proofed and that the unreinforced masonry walls be reinforced to withstand the hydrostatic pressure of the Base Flood in 2065.

The following mitigation measures are recommended for this station:

- Mitigation Measure A – Install flood-proof door
- Mitigation Measure C – Flood-proof painting
- Mitigation Measure N - Replace past useful life equipment
- Mitigation Measure P – Structurally reinforce masonry wall to 2065 DFE

Select mitigation measures are shown in Figure 26.



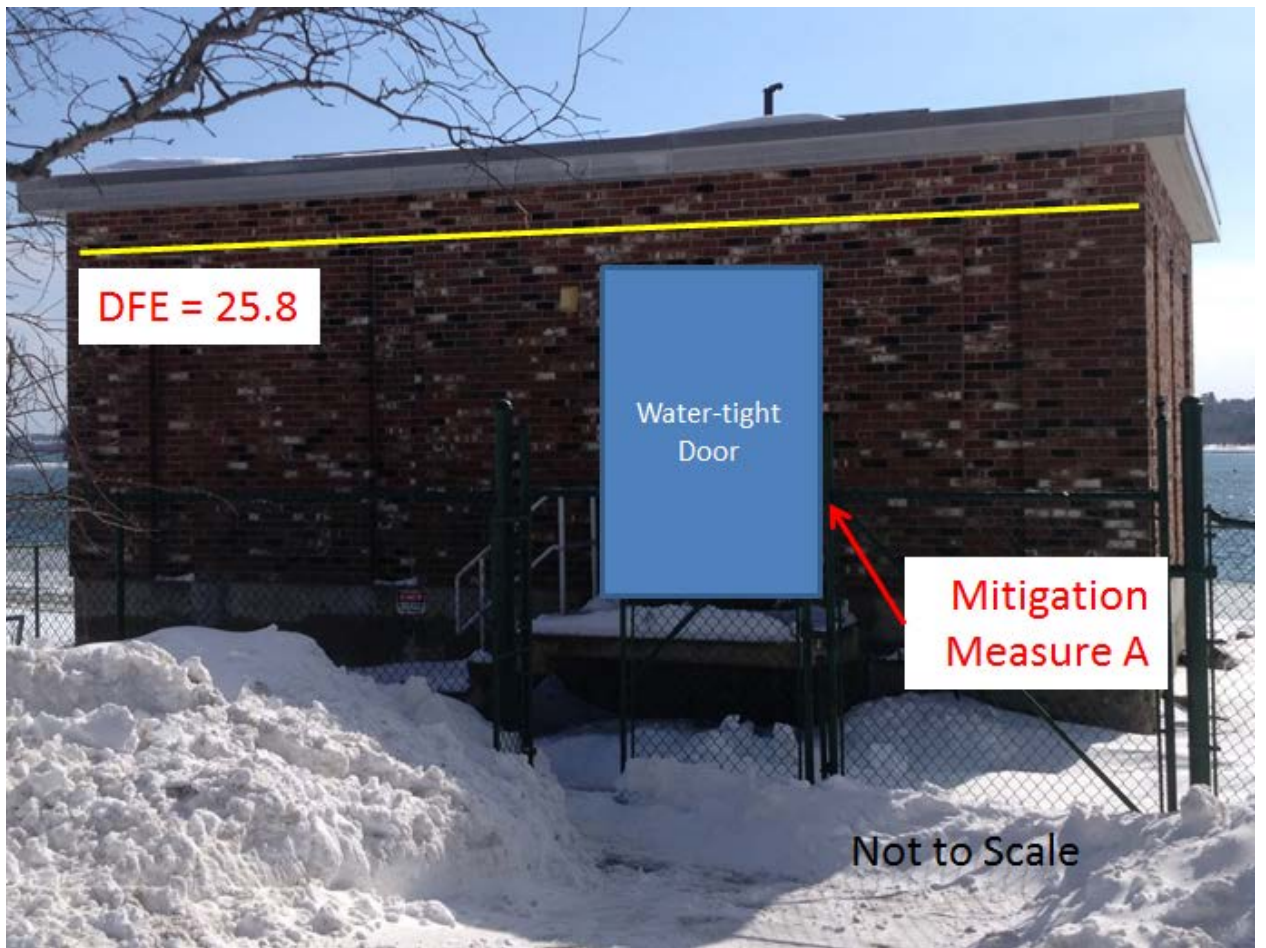


Figure 26 Onset Pier Select Proposed Mitigation Measures

## 6.2.9 Ruggles

### Existing Conditions

Ruggles Pump Station is a wet pit/dry pit pump station, which was constructed in 2012 (Figure 27). During the Base Flood the hydrostatic pressure on the unreinforced masonry wall is greater than 2.5-feet and the structure may collapse. All of the equipment in the stations is expected to suffer severe electrical damage. The station has an MCC unit that cannot be relocated above the DFE.



Figure 27 Ruggles Pump Station

The pump station has several water entry points below the DFE, including both doors, windows, and the louvers shown in Figure 28.



Figure 28 Ruggles Potential Water Entry Points

### Proposed Solutions

Since the pump station has a piece of critical equipment (MCC) that cannot be wet flood-proofed, it is recommended that the station be dry flood-proofed and that the unreinforced masonry walls be reinforced to withstand the hydrostatic pressure of the Base Flood in 2065.

The following mitigation measures are recommended for this station:

- Mitigation Measure A – Install flood-proof door
- Mitigation Measure C- Flood-proof painting
- Mitigation Measure H – Raise louver above the DFE or install a flood-proof door in front of louver to protect to the DFE
- Mitigation Measure P – Structurally reinforce masonry wall to 2065 DFE

Select mitigation measures are shown in Figure 29.

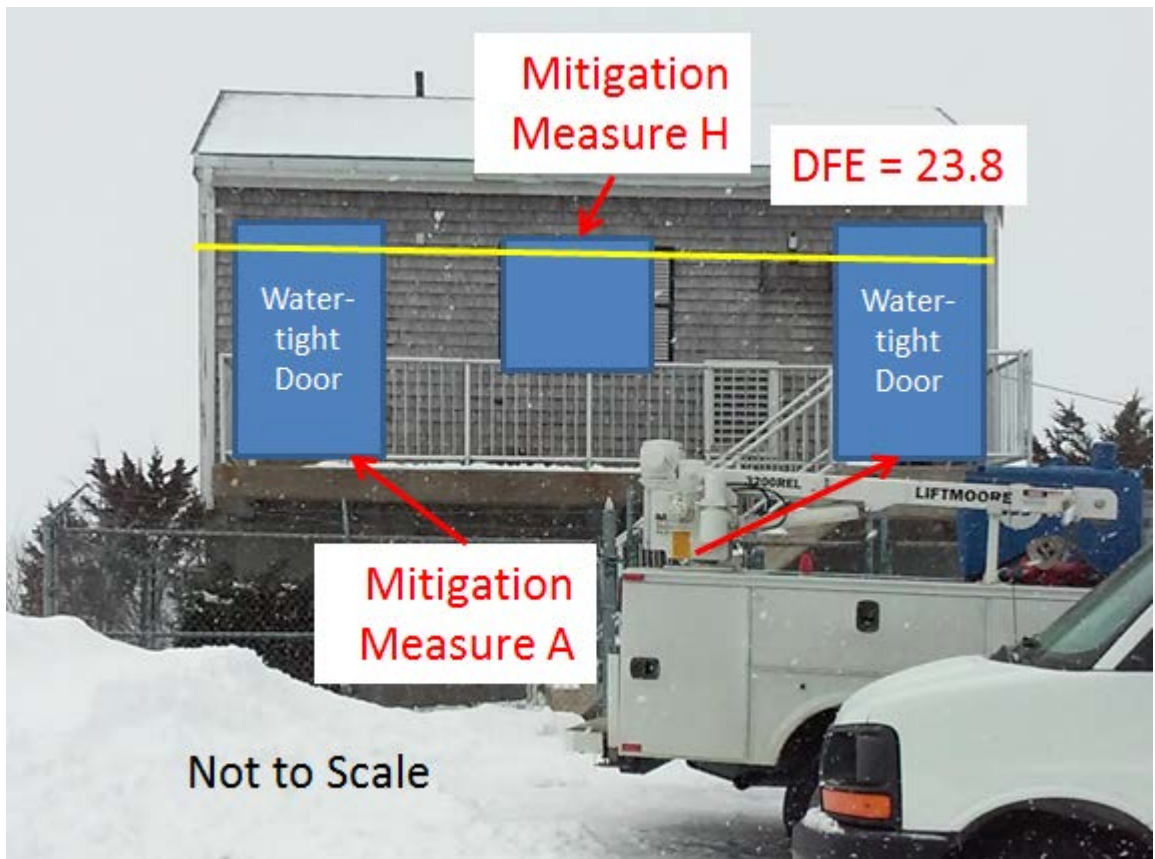


Figure 29 Ruggles Select Proposed Mitigation Measures

## 6.3 Pump Stations within the Coastal Zone AE

The Town has 14 pump stations within the Coastal Zone AE. The pump stations are located in areas subject to inundation by the Base Flood with potential for breaking waves and erosion. These areas are expected to experience wave action between 1.5- and 3-feet.

The following design elevations are recommended for mechanical and structural components, respectively:

Mechanical equipment DFE = BFE + 0.6 ft (SLR) + 2 ft (ASCE 24-14 recommended freeboard)

Structural DFE = BFE + 1.8 ft (SLR) + 2 ft (ASCE 24-14 recommended freeboard)

### 6.3.1 Cromessett Road

#### Existing Conditions

Cromessett Road Pump Station is a submersible pump station, which was constructed in 2012 (Figure 30). The generator, control panel, and pump station hatch are all below the DFE.



Figure 30 Cromessett Road Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch on a submersible station
- Mitigation Measure F – Raise vent above the DFE
- Mitigation Measure Q – Install flood wall around vulnerable equipment

Select mitigation measures are shown in Figure 31.

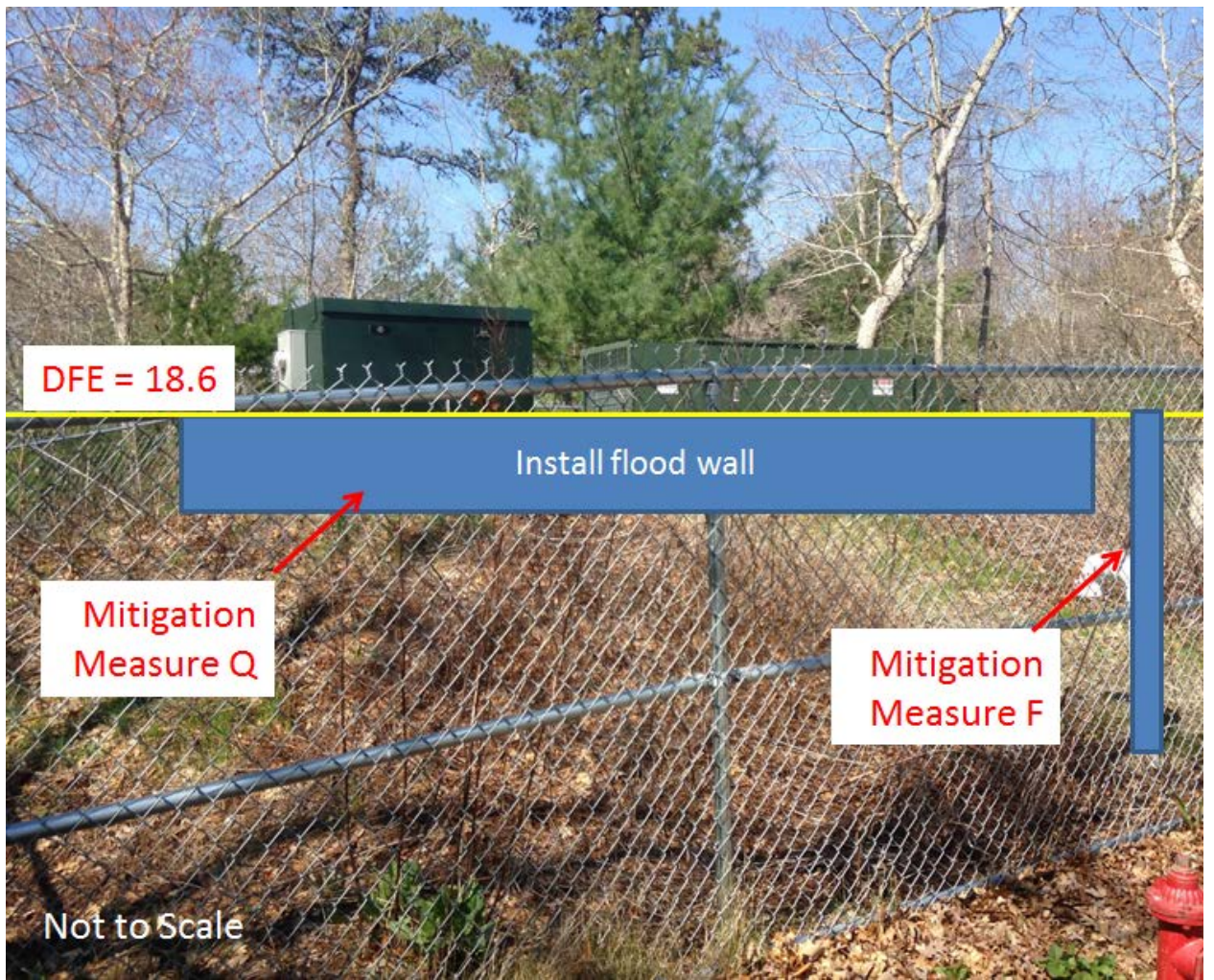


Figure 31 Cromesett Road Select Proposed Mitigation Measures

### 6.3.2 Leonard Street

#### Existing Conditions

Leonard Street Pump Station is a submersible pump station, which was constructed in 2006 (Figure 32). The station has a portable generator hookup. The control panel, vent, and pump station hatch are all below the DFE. The vault hatch is not watertight.

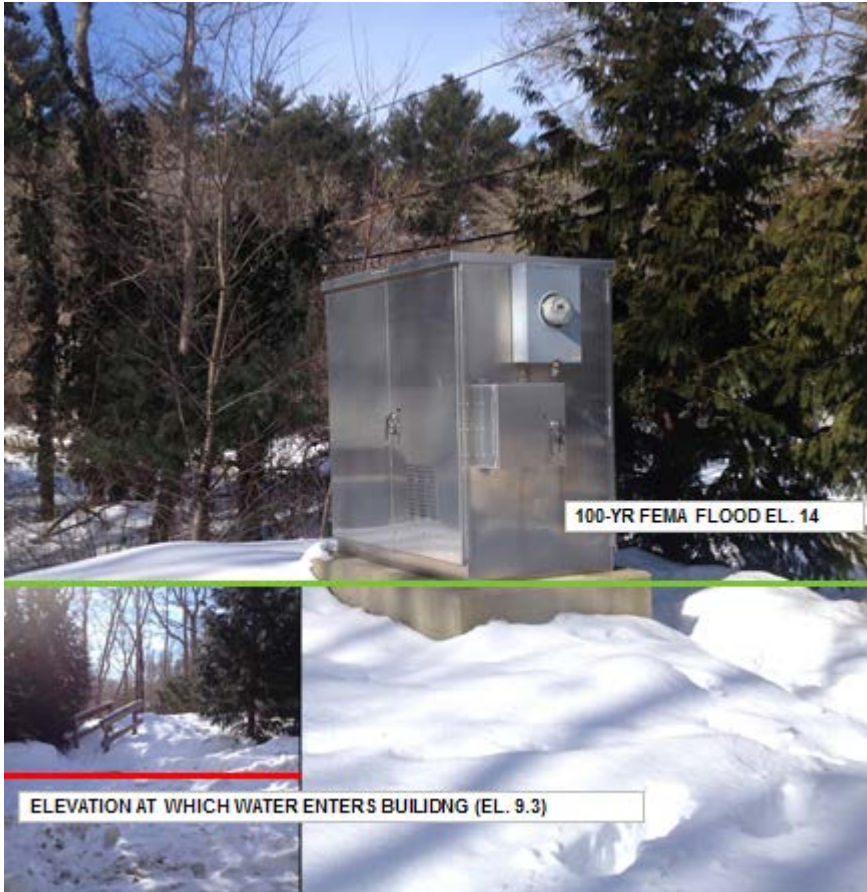


Figure 32 Leonard Street Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch on a submersible station
- Mitigation Measure F – Raise vent above DFE
- Mitigation Measure Q – Install floodwall around vulnerable equipment

The proposed mitigation measures are shown on Figure 33.



Figure 33 Leonard Street Select Proposed Mitigation Measures



### 6.3.3 Apple Street

#### Existing Conditions

Apple Street Pump Station is a submersible pump station, which was constructed in 2012 (Figure 34). The pump station hatch, generator, control panel, and vent are all below the DFE. The vault hatch is not watertight.

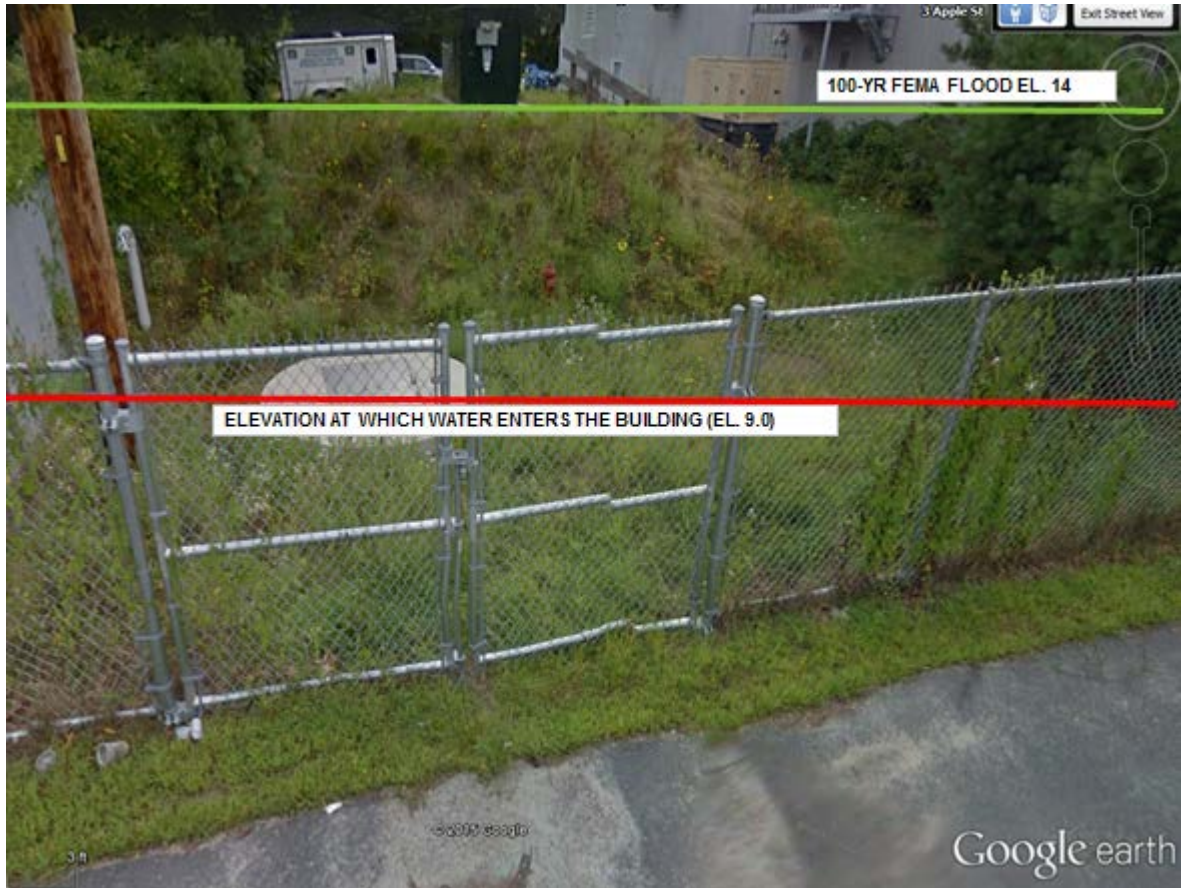


Figure 34 Apple Street Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch on a submersible station
- Mitigation Measure E – Raise generator above the DFE
- Mitigation Measure F – Raise vent above the DFE
- Mitigation Measure Q – Install flood wall around control panel

Select mitigation measures are shown in Figure 35.

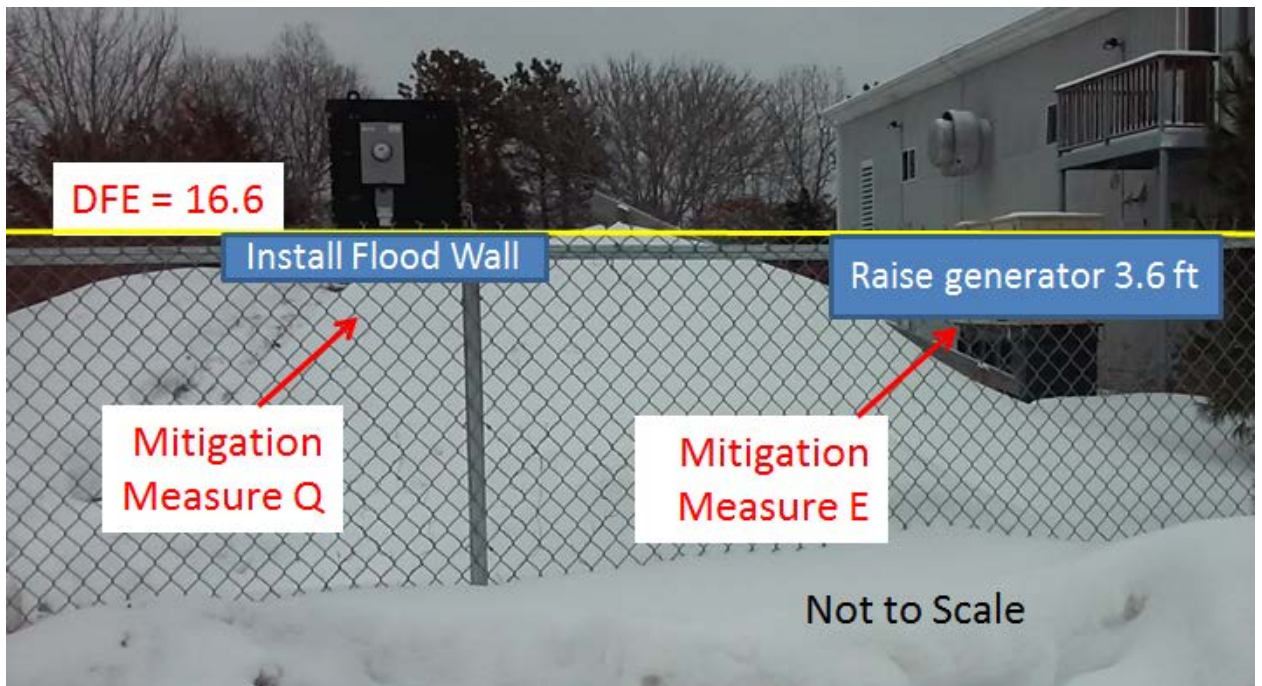


Figure 35 Apple Street Select Proposed Mitigation Measures

### 6.3.4 Onset Heights

#### Existing Conditions

Onset Heights Pump Station is a submersible pump station, which was constructed in 1996 (Figure 36). The vault hatch, control panel, vent, and generator are all below the DFE. The vault hatch is not watertight.



Figure 36 Onset Heights Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch on a submersible station
- Mitigation Measure F - Raise vent above the DFE
- Mitigation Measure Q – Install Flood Wall around vulnerable equipment

Select mitigation measures are shown on Figure 37.

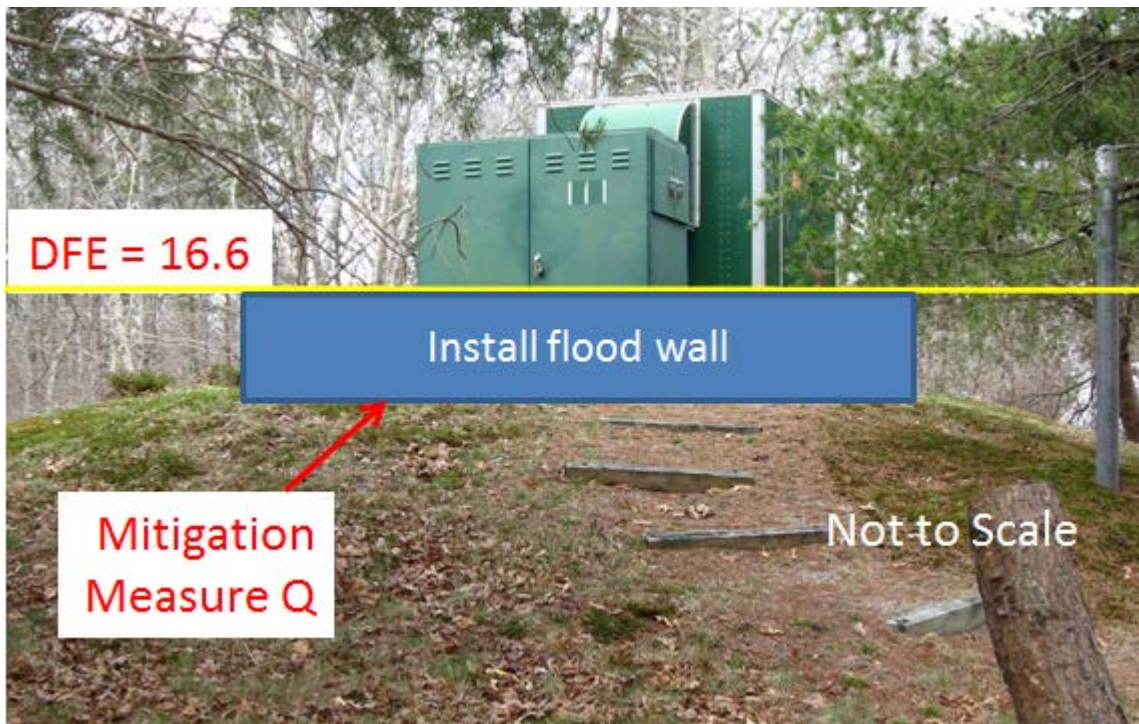


Figure 37 Onset Heights Select Proposed Mitigation Measures

### 6.3.5 Riverside

#### Existing Conditions

Riverside Pump Station is a submersible pump station, which was constructed in 1996 (Figure 38). All of the equipment at the station is past its useful life and is no longer considered reliable. The station has a control panel and generator, which are located at a higher elevation on Riverside Road, down the street from the station. The elevations of both pieces of equipment are below the DFE. The vault hatch is not watertight.



Figure 38 Riverside Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B - Install a watertight hatch on the submersible pump station
- Mitigation Measure D – Raise control panel above DFE
- Mitigation Measure E – Raise generator above DFE
- Mitigation Measure I - Replace all equipment, including control panel and generator

### 6.3.6 Avenue A

#### Existing Conditions

Avenue A Pump Station is a submersible pump station, which was constructed in 2011 (Figure 39). The vault hatch, vent, control panel, and generator are all below the DFE. The vault hatch is not watertight and would allow water in during the Base Flood event.



Figure 39 Avenue A Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install a watertight hatch on a submersible station
- Mitigation Measure F – Raise vent above DFE
- Mitigation Measure Q – Install flood wall around vulnerable equipment

Select proposed mitigation measures are shown in Figure 40.



Figure 40 Avenue A Select Proposed Mitigation Measures

### 6.3.7 Briarwood

#### Existing Conditions

Briarwood Pump Station is a submersible pump station, which was constructed in 2006 (Figure 41). The vault hatch, vent, generator, and control panel are below the DFE. The vault hatch is not watertight.

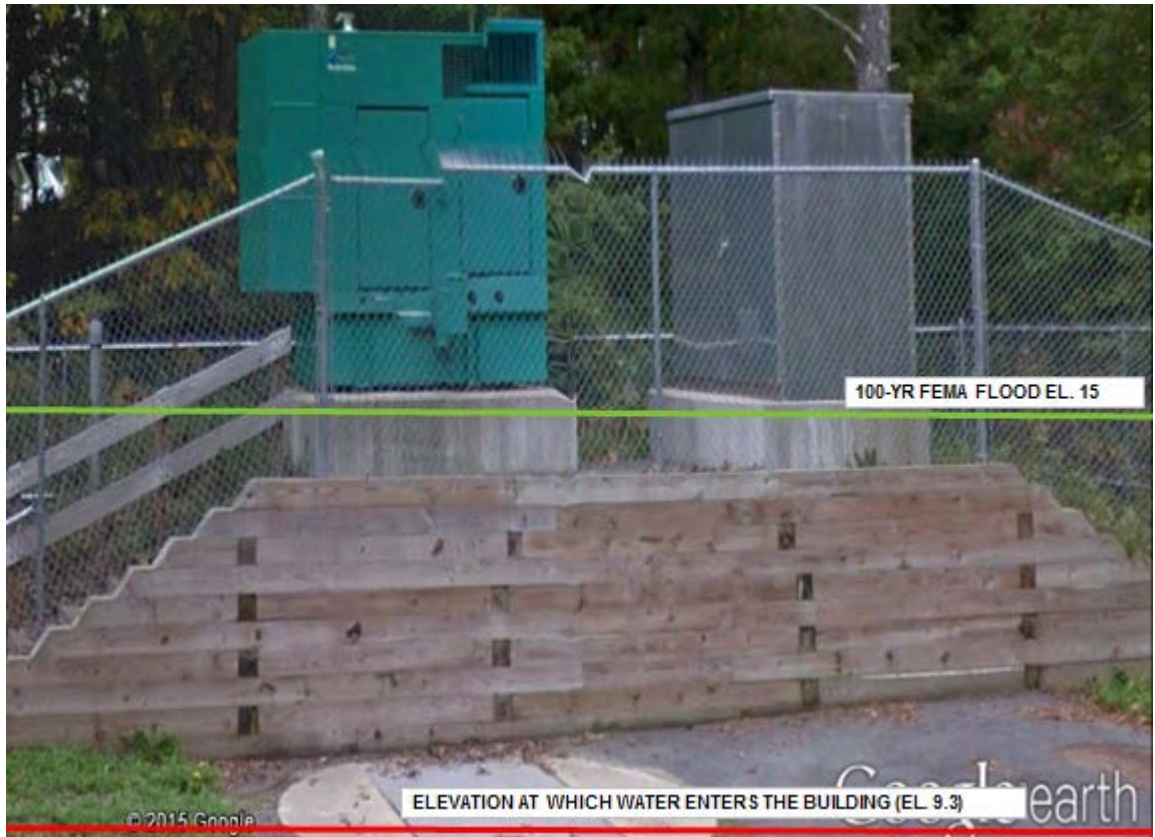


Figure 41 Briarwood Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install a watertight hatch on a submersible station
- Mitigation Measure F – Raise vent above the DFE
- Mitigation Measure Q – Install floodwall around vulnerable equipment

Select proposed mitigation measures are shown in Figure 42.



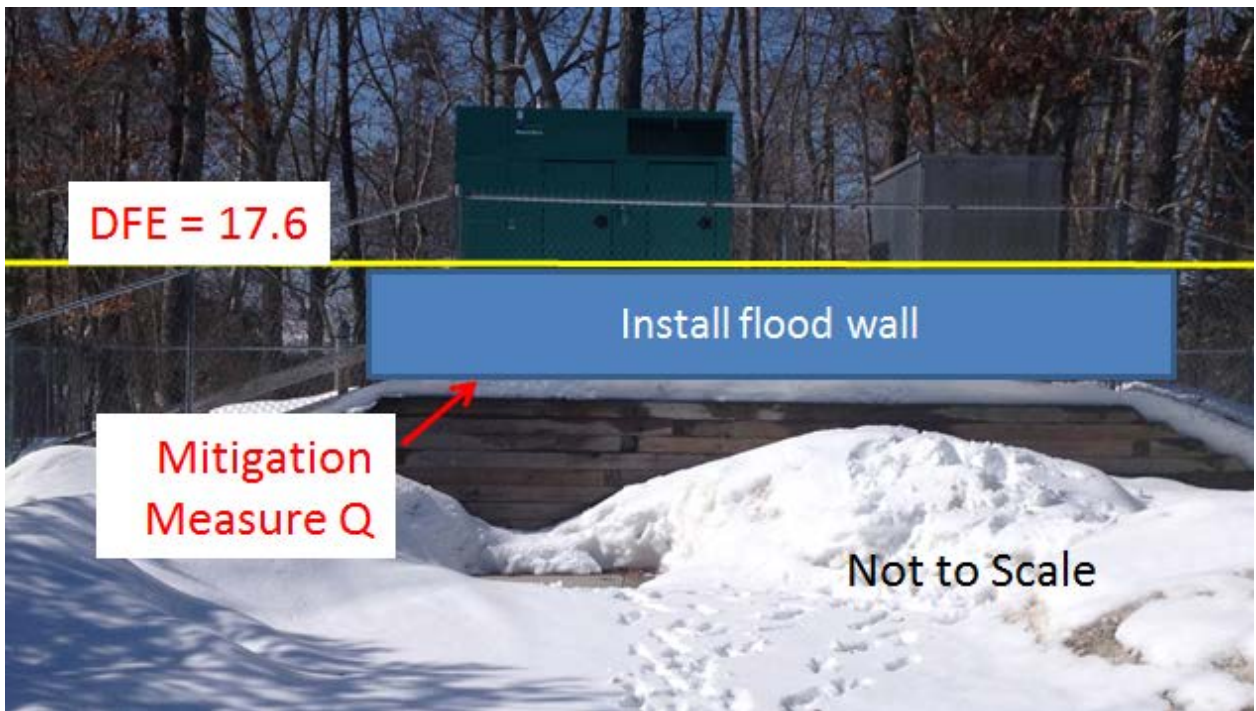


Figure 42 Briarwood Select Proposed Mitigation Measures

### 6.3.8 Arnold

#### Existing Conditions

Arnold Pump Station is a submersible pump station, which was constructed in 2006 (Figure 43). The vault hatch, control panel, generator, and lowest vent are below the DFE. The vault hatch is not watertight.



Figure 43 Arnold Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install a watertight hatch on a submersible station
- Mitigation Measure F – Raise vent above the DFE
- Mitigation Measure Q – Install flood wall around vulnerable equipment

Select mitigation measures are shown in Figure 44.

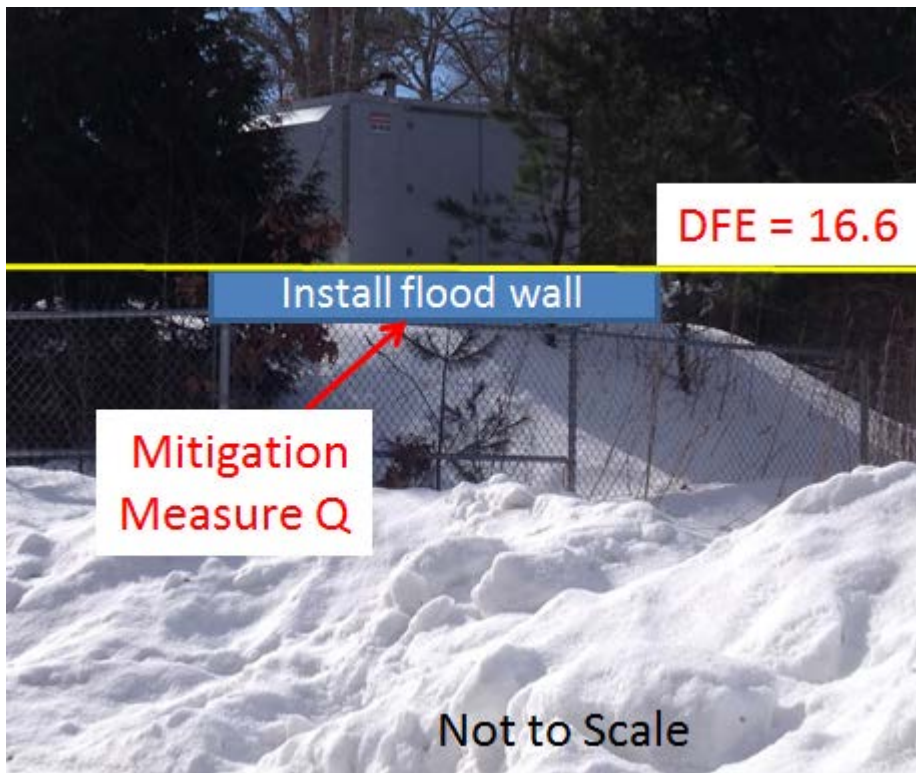


Figure 44 Arnold Select Proposed Mitigation Measures

### 6.3.9 Narrows

#### Existing Conditions

The Narrows Pump Station is a wet pit/dry pit pump station, which was constructed in 1970 (Figure 45). All of the equipment in the station dates to its original construction and is well past its useful life. The elevation at which the concrete foundation transitions to unreinforced masonry wall is estimated at elevation 10.75-feet. During the Base Flood the structure would have more than 2.5-feet of hydrostatic pressure on the building and is expected to collapse.



Figure 45 Narrows Pump Station

The station is also not watertight, with potential water entries through the door and through a louver at the back of the station (shown in Figure 46). None of the equipment within the station is water-resistant and is expected to suffer severe electrical damage during the BFE. The station has an MCC panel that cannot be relocated to above the DFE.



Figure 46 Narrows Pump Station Potential Water Entry Point

### Proposed Solutions

Since the pump station has a piece of critical equipment (MCC) that cannot be wet flood-proofed, it is recommended that the station be dry flood-proofed and that the unreinforced masonry walls be reinforced to withstand the hydrostatic pressure of the Base Flood in 2065.

The following mitigation measures are recommended for this station:

- Mitigation Measure A - Install a watertight flood door
- Mitigation Measure C – Flood-proof painting
- Mitigation Measure H – Raise louver above the DFE or install a flood door in front of louver to protect to the DFE
- Mitigation Measure N – Replace past useful life equipment.
- Mitigation Measure P – Structurally reinforce masonry wall to 2065 DFE

Select mitigation measures are shown in Figure 47.

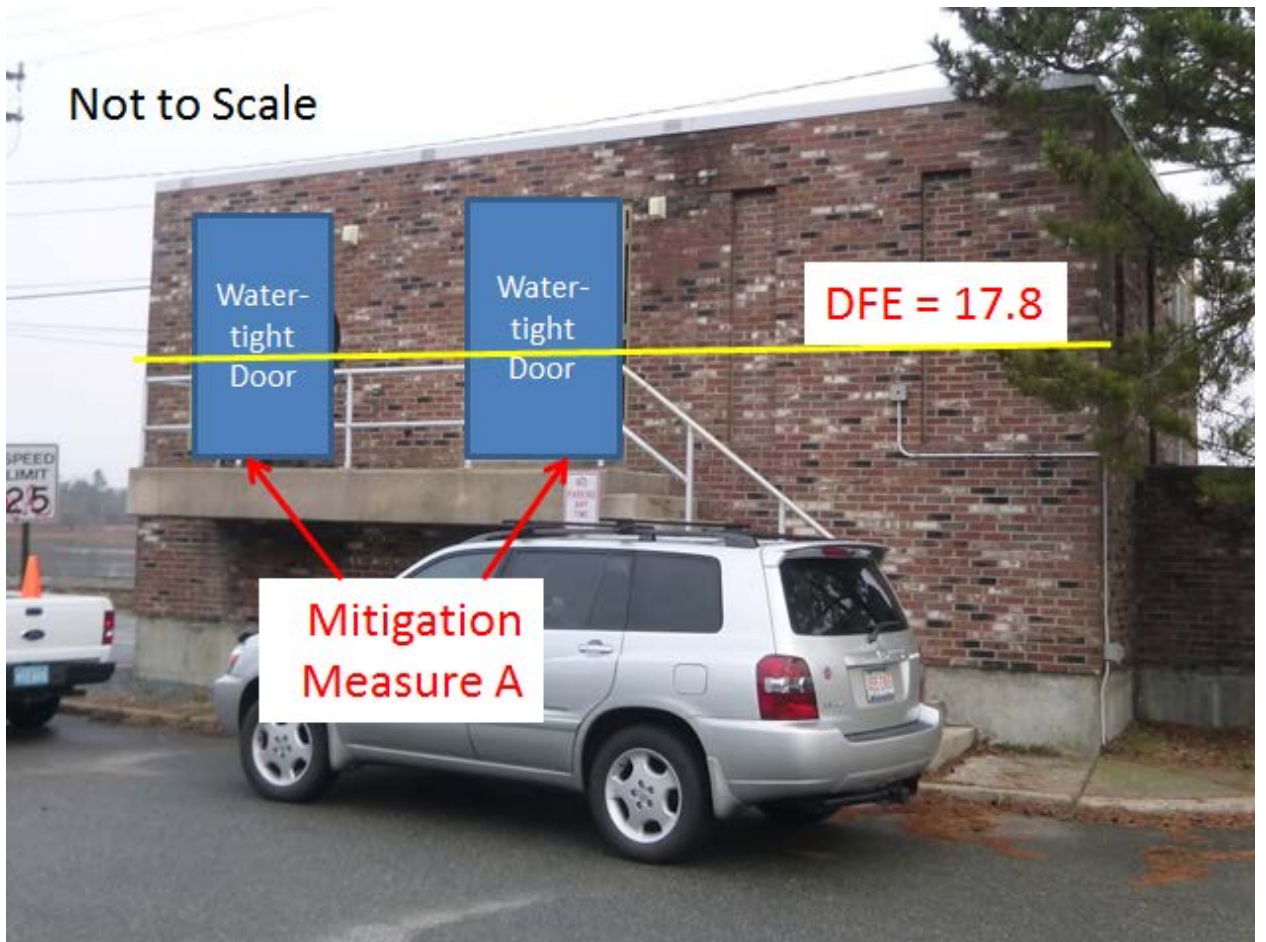


Figure 47 Narrows Select Proposed Mitigation Measures

### 6.3.10 Pinehurst

#### Existing Conditions

Pinehurst Pump Station is a wet pit/dry pit station, which was constructed in 1978. All of the equipment in the station is well past its useful life.



Figure 48 Pinehurst Pump Station

Both of the doors and the louver, shown in Figure 49, are below the DFE.

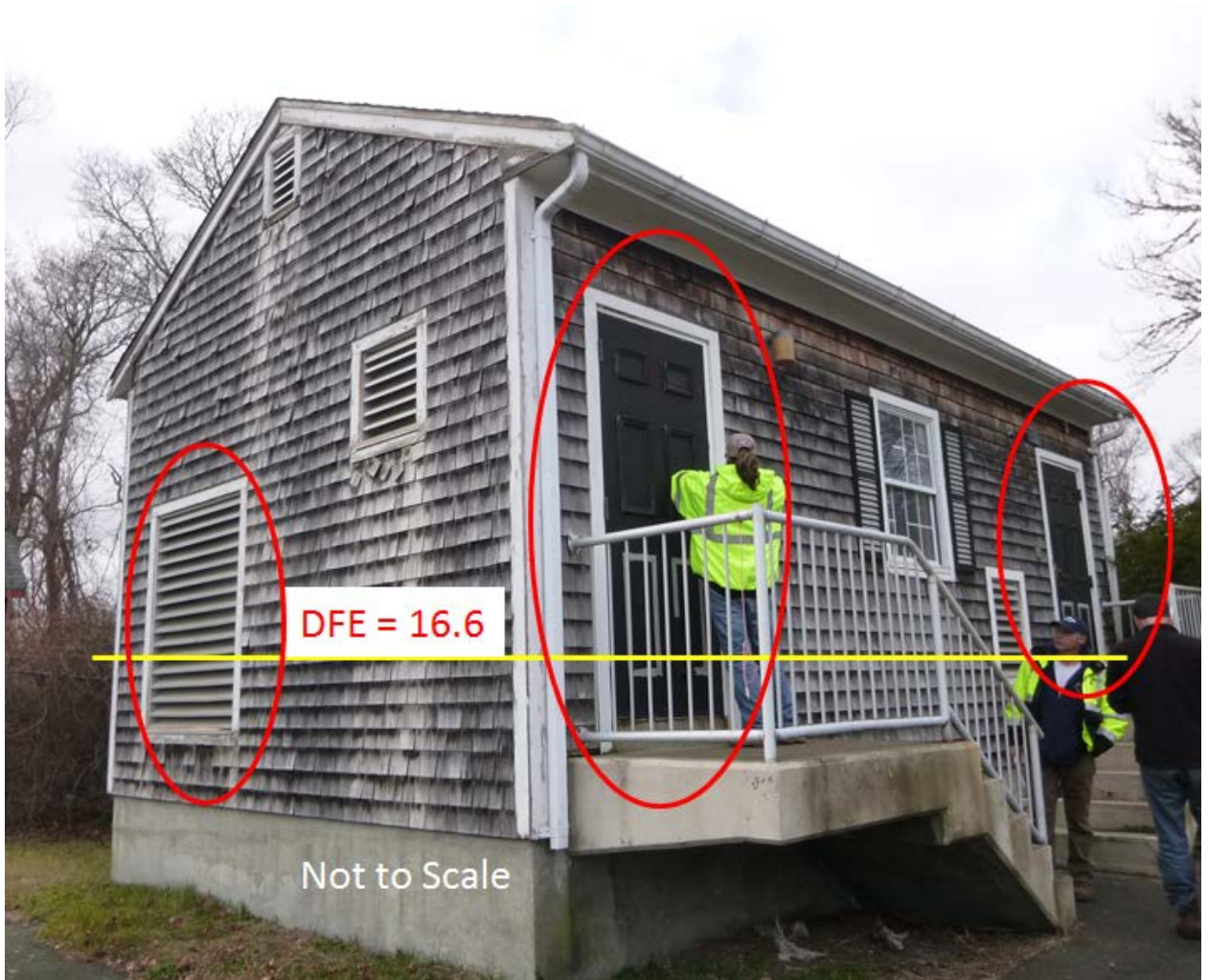


Figure 49 Pinehurst Pump Station Water Entry Points Below DFE

### Proposed Solutions

Since there is less than 2.5-feet of hydrostatic pressure on the unreinforced masonry walls it is recommended that the station be dry flood-proofed.

The following mitigation measures are recommended for this station:

- Mitigation Measure A - Install a 2-foot flood door at each door (2)
- Mitigation Measure C – Flood-proof painting
- Mitigation Measure H – Raise louver above the DFE or install a flood door in front of louver to protect to the DFE
- Mitigation Measure N – Replace equipment past its useful life

Select mitigation options are shown in Figure 50.





Figure 50 Pinehurst Select Recommended Mitigation Measures

### 6.3.11 Dick's Pond

#### Existing Conditions

Dick's Pond Pump Station is a wet-pit/dry-pit pump station, which was constructed in 1989 (Figure 51). All of the equipment in the station is dated to the original construction and is well past its useful life.



Figure 51 Dick's Pond Pump Station

The station has several potential water entry points below the DFE as shown in Figure 52.

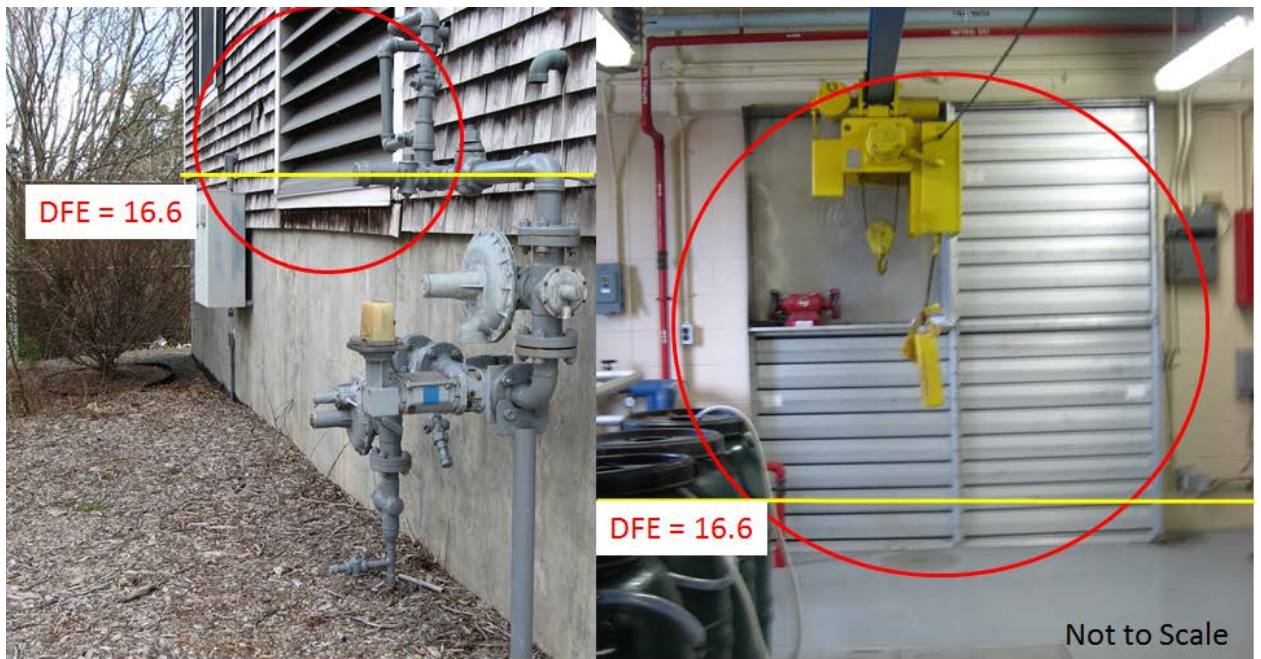


Figure 52 Dick's Pond Pump Station Potential Water Entry Points

### Proposed Solutions

Since there is less than 2.5-feet of hydrostatic pressure on the unreinforced masonry walls it is recommended that the station be dry flood-proofed.

The following mitigation measures are recommended for this station:

- Mitigation Measure A – Install a 2-foot flood door at each door (2)
- Mitigation Measure C – Flood-proof painting
- Mitigation Measure H – Raise louver above the DFE or install a flood door in front of the louver to protect to the DFE.
- Mitigation Measure N – Replace past useful life equipment

Select proposed mitigation measures are shown in Figure 53.



Figure 53 Dick's Pond Select Proposed Mitigation Measures

## 6.3.12 North Boulevard

### Existing Conditions

North Boulevard Pump Station is a dry pit/wet pit pump station, which was constructed in 1971. All of the equipment dates to the station's original construction and is well past its useful life. During a site visit the transition between the station's concrete foundation and the unreinforced masonry wall was estimated to be approximately at elevation 11.2 ft. During the Base Flood the hydrostatic pressure on the walls will be greater than 2.5-feet and the building may potentially collapse. The station has an MCC that cannot be relocated above the DFE.



Figure 54 North Boulevard Pump Station

As shown in Figure 55, the wet well entrance is accessed through a manhole outside the building.



Figure 55 North Boulevard Wet Well Manhole Cover

### Proposed Solutions

Since the pump station has a piece of critical equipment (MCC) that cannot be wet flood-proofed, it is recommended that the station be dry flood-proofed and that the unreinforced masonry walls be reinforced to withstand the hydrostatic pressure of the Base Flood in 2065.

The following mitigation measures are recommended for this station:

- Mitigation Measure A – Install a flood door
- Mitigation Measure C – Flood-proof painting
- Mitigation Measure H – Raise louver above the DFE or install a flood door in front of louver to protect the DFE
- Mitigation Measure L – Relocated generator above DFE
- Mitigation Measure O – Install watertight manhole cover
- Mitigation Measure P – Structurally reinforce masonry wall to 2065 DFE

Select mitigation measures are shown in Figure 56.



Figure 56 North Boulevard Select Proposed Mitigation Measures

### 6.3.13 Hynes Field

#### Existing Conditions

Hynes Field Pump Station is a wet pit/dry pit pump station, which was constructed in 1971. All of the equipment is from the station's original construction and well past its useful life.



Figure 57 Hynes Field Pump Station

The station is not sealed, with water entry possible through the two doors and the louver shown in Figure 58. None of the equipment within the station is water-resistant and the majority of the equipment is anticipated to experience severe electrical damage during the Base Flood. The station has an MCC that cannot be raised above the DFE.





Figure 58 Potential Water Entry Points: Doors and Louver

### Proposed Solutions

Since the pump station has a piece of critical equipment (MCC) that cannot be wet flood-proofed, it is recommended that the station be dry flood-proofed and that the unreinforced masonry walls be reinforced to withstand the hydrostatic pressure of the Base Flood in 2065.

- Mitigation Measure A - Install watertight flood door (2)
- Mitigation Measure C – Flood-proof painting
- Mitigation Measure H – Raise louver above the DFE or install a flood door in front of louver to protect to the DFE
- Mitigation Measure N – Replace past useful life equipment
- Mitigation Measure P – Reinforce masonry wall to DFE 2065

Select mitigation options are shown in Figure 59.

Not to Scale



Figure 59 Hynes Field Select Proposed Mitigation Measures

### 6.3.14 East Boulevard

#### Existing Conditions

East Boulevard Pump Station is an ejector pump station, which was constructed in 1971. Ejector pumps are an antiquated technology and spare parts for the station need to be special ordered and custom manufactured resulting in a very long lead time for replacement parts.



Figure 60 East Boulevard Pump Station

While the pump station has a watertight door (shown in Figure 61), water can enter through vents (Figure 62) that are below the BFE. Additionally, the BFE is above the skylight on the roof of the structure. If the skylight cannot support the weight of water above it, it will also become an entry for water. The equipment in this station would likely suffer severe electrical damage during the Base Flood. It is not known whether the station can withstand the buoyancy forces of the updated Base Flood elevations. It is recommended that an analysis of the buoyancy forces on the pump station be conducted. If the pump station can withstand the buoyancy forces of the Base Flood it may be more cost effective to prevent water entry into the structure.



Figure 61 East Boulevard Watertight Door



Figure 62 Water Entry Point at Vents

### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure G – Install a louver to allow water to enter the station and equalize hydrostatic pressure
- Mitigation Measure I – Replace equipment with immersible equipment
- Mitigation Measure J – Install immersible panel on control panel
- Mitigation Measure M – Install a portable generator hook-up

## 6.4 Pump Stations Within the Zone AE

The Town has six pump stations within the Zone AE. The pump stations are located in areas subject to inundation by the base flood with shallow flooding and low potential for breaking waves and erosions. Waves in this area are expected to be less than 1.5-feet in height.

The following design elevations are recommended for mechanical and structural components, respectively:

Mechanical equipment DFE = BFE + 0.6 ft (SLR) + 1 ft (ASCE 24-14 recommended freeboard)

Structural DFE = BFE + 1.8 ft (SLR) + 1 ft (ASCE 24-14 recommended freeboard)

## 6.4.1 Parkwood

### Existing Conditions

Parkwood Pump Station is a submersible pump station, which was constructed in 2010. As shown in Figure 63, both the control panel and standby generator are expected to be inundated and suffer severe electrical damage during the Base Flood. The pump stations hatch is not watertight and will allow flood waters into the wet well.



Figure 63 Parkwood Pump Station

### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch on a submersible station
- Mitigation Measure F – Raise vent above DFE
- Mitigation Measure Q – Construct flood wall around vulnerable equipment

Select recommended mitigation measures are shown on Figure 64 .

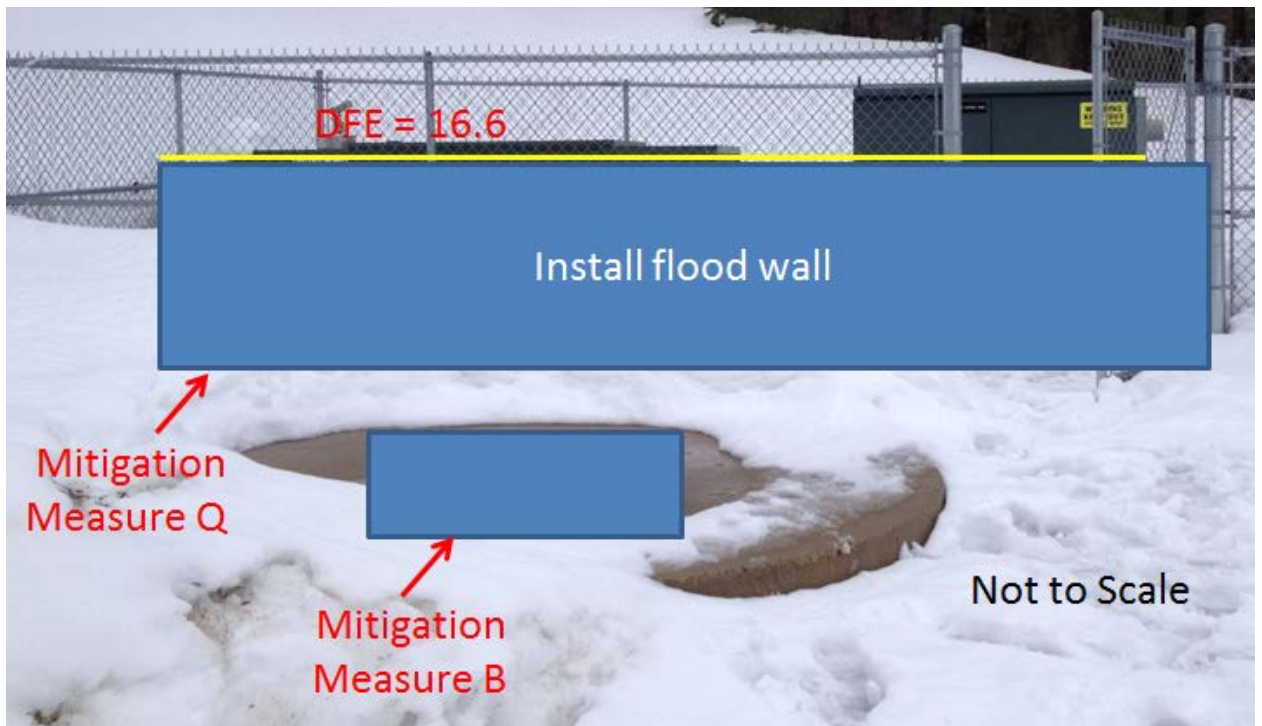


Figure 64 Parkwood Select Proposed Mitigation Measures

## 6.4.2 Indian Neck

### Existing Conditions

Indian Neck Pump Station is a submersible pump station, which was constructed in 2010 and is shown in Figure 65. The generator and control panel are both below the DFE. The pump stations hatch is not water tight and will allow flood waters into the wet well.



Figure 65 Indian Neck Pump Station

### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch on a submersible station
- Mitigation Measure F – Raise vent above the DFE
- Mitigation Measure Q – Construct floodwall around vulnerable equipment

Select mitigation measures are shown in Figure 66.



Figure 66 Indian Neck Select Proposed Mitigation Measures



### 6.4.3 Linwood

#### Existing Conditions

Linwood Pump Station is a submersible pump station, which was constructed in 2005. The station has a portable generator hookup (Figure 67). The control panel is below the DFE. The pump station hatch is not watertight and will allow flood waters into the wet well.



Figure 67 Linwood Pump Station

#### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch
- Mitigation Measure Q – Install flood wall around vulnerable equipment

Select mitigation measures are shown in Figure 68.



Figure 68 Linwood Select Proposed Mitigation Measures

#### 6.4.4 Hathaway

##### Existing Conditions

Hathaway Pump Station, shown in Figure 69, is a submersible pump station, which was constructed in 2006. Both the control panel and the pump station hatch are below the DFE. The vault hatch is not watertight.



Figure 69 Hathaway Pump Station

##### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure B – Install watertight hatch on a submersible station
- Mitigation Measure Q – Install flood wall around vulnerable equipment

Proposed mitigation measures are shown in Figure 70 .

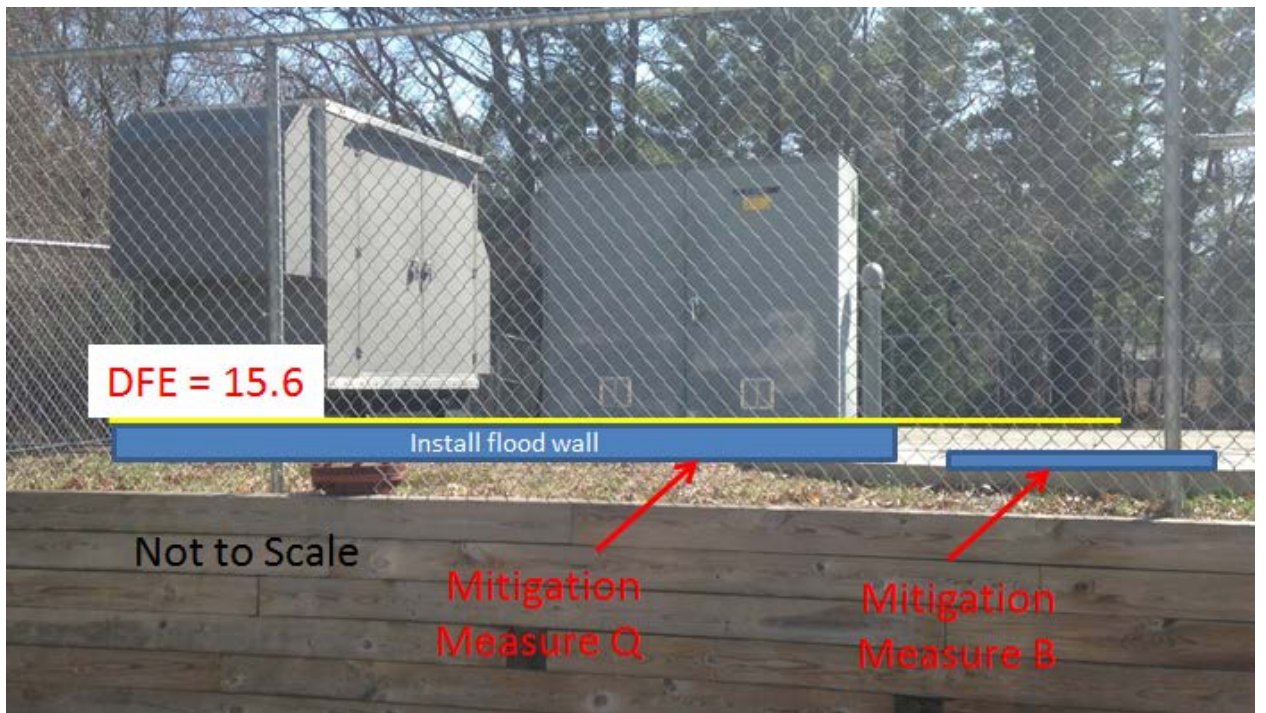


Figure 70 Hathaway Select Proposed Mitigation Measures

## 6.4.5 Terry Lane/Pine Tree Estates (Terry Lane)

### Existing Conditions

Terry Lane/Pine Tree Estates (Terry Lane) Pump Station is a submersible pump station with an unreinforced masonry superstructure, which was constructed in 1992. All of the equipment at the station is well past its useful life. The first entry to water (the door) is below the DFE. The vault hatch is not watertight.



Figure 71 Terry Lane/Pine Tree Estates (Terry Lane) Pump Station

### Proposed Solutions

Since there is less than 2.5-feet of hydrostatic pressure on the unreinforced masonry walls during the base flood, it is recommended that the station be dry-proofed.

The following mitigation measures are recommended for this station:

- Mitigation Measure A – Install a 2-foot flood door at every door (2)
- Mitigation Measure B – Install a watertight hatch
- Mitigation Measure C – Flood-proof painting
- Mitigation Measure F – Raise vent above DFE
- Mitigation Measure H – Raise Louver above the DFE
- Mitigation Measure N – Replace past useful life equipment

Proposed mitigation measures are shown in Figure 72.

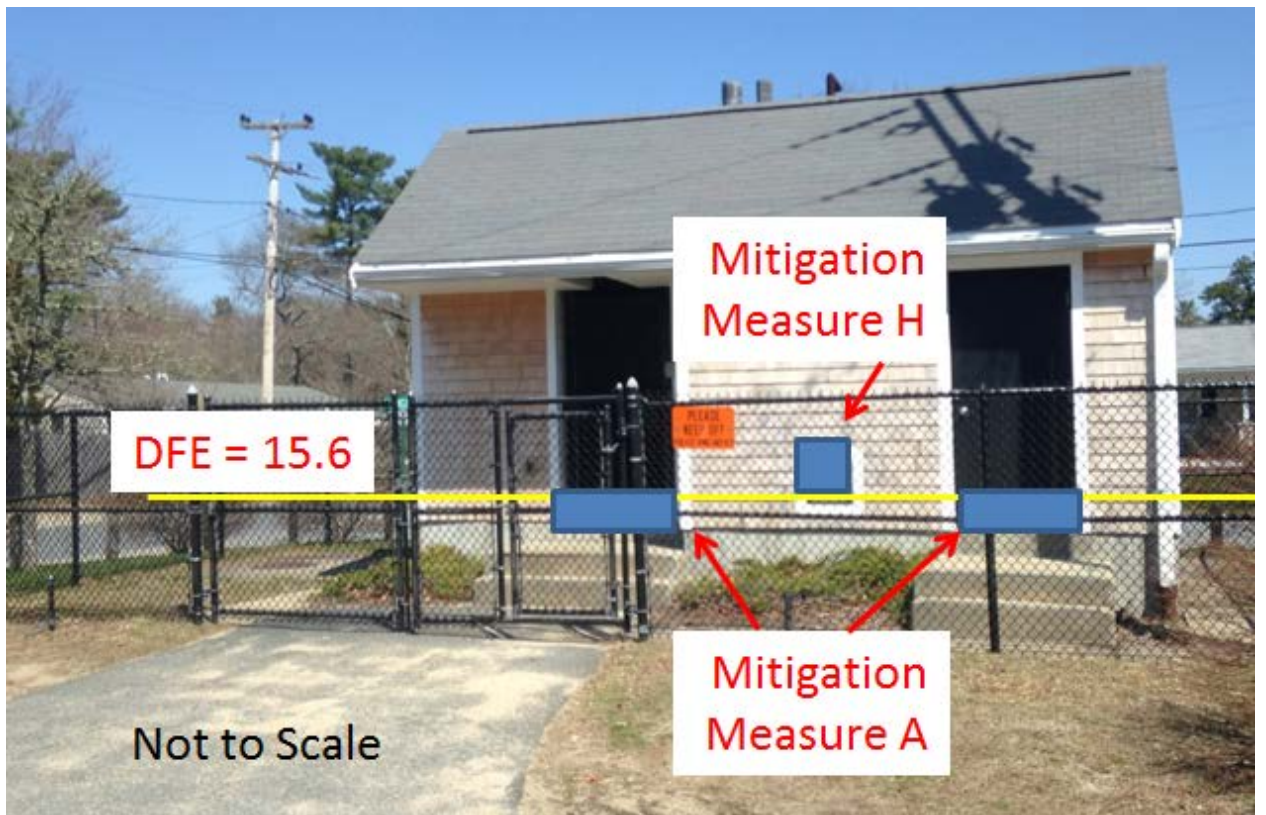


Figure 72 Terry Lane Select Proposed Mitigation Measures

#### 6.4.6 Green Street

##### Existing Conditions

Green Street Pump Station is an ejector pump station, which was constructed in 1989. Ejector pumps are an antiquated technology and spare parts for the station need to be special ordered and custom manufactured resulting in a very long lead time for replacement parts. All of the stations' equipment is well past its useful life. The elevation at which water enters the building is below the DFE of 17.6. If water enters the structure the equipment in the station is expected to suffer severe electrical damage.



Figure 73 Green Street Pump Station

##### Proposed Solutions

The following mitigation measures are recommended for this station:

- Mitigation Measure A - Install a 2-foot flood door
- Mitigation Measure C – Flood-proof painting

- Mitigation Measure M – Install a portable generator hookup
- Mitigation Measure N – Replace past useful life equipment

Proposed mitigation measures are shown in Figure 74.

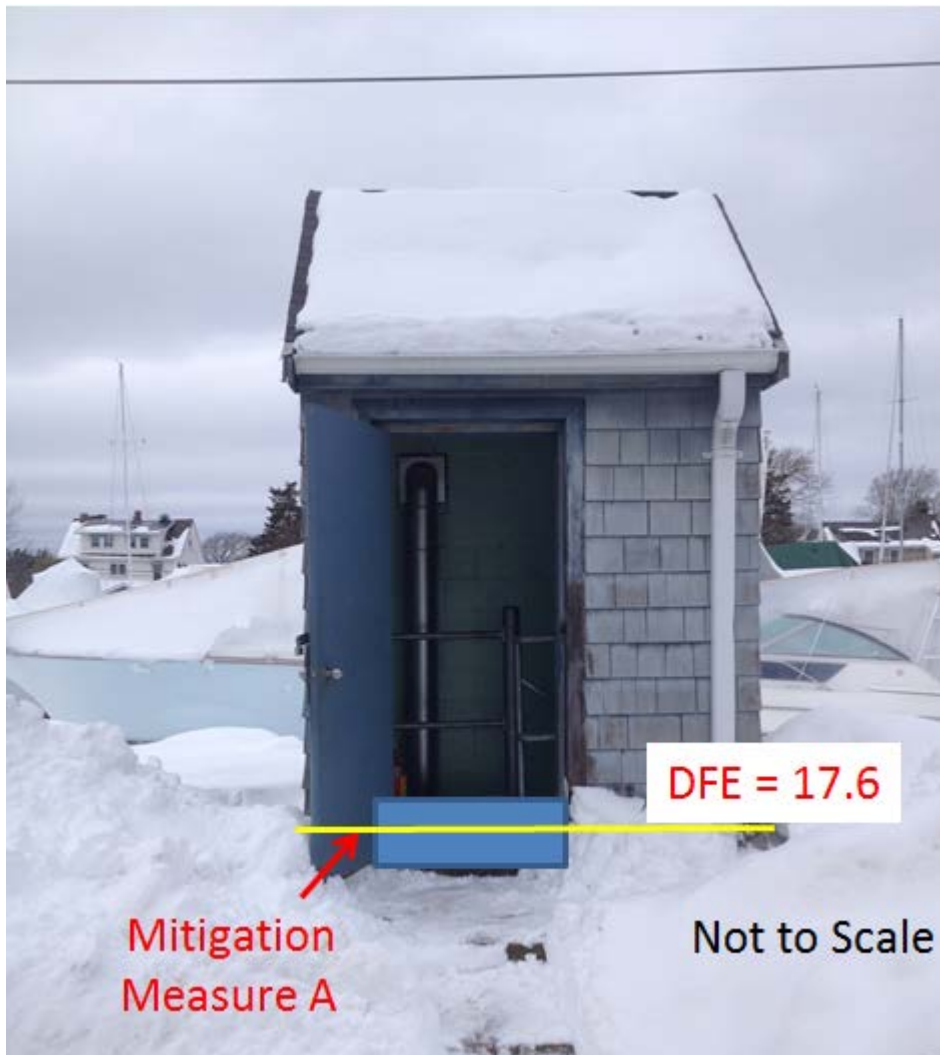


Figure 74 Green Street Select Proposed Mitigation Measures



## 6.5 Mitigation Budgetary Costs

Budgetary costs were developed for the recommended mitigation measures described in this section and are summarized in Table 5. The budgetary costs represent the sum of the mitigation measure allowances for each pump station, based on the allowances outlined in Section 5, Table 4.

Table 5 Recommended Mitigation Measures Budgetary Costs

Street	Cost
Apple Street	\$190,000
Arnold	\$80,000
Avenue A	\$80,000
Bay Street	\$1,720,000
Briarwood	\$40,000
Cohasset Narrows	\$2,670,000
Cromesett Road	\$80,000
Dick's Pond	\$2,510,000
East Boulevard	\$2,030,000
Green Street	\$1,860,000
Hathaway	\$30,000
Hill Street Jefferson Shores	\$2,130,000
Hynes Field	\$2,670,000
Indian Neck	\$70,000
Leonard Street	\$80,000
Linwood	\$60,000
Narrows	\$2,630,000
North Boulevard	\$2,920,000
Onset Heights	\$80,000
Onset Pier	\$2,460,000
Parkwood	\$80,000
Pinehurst	\$2,510,000
Riverside	\$1,630,000
Ruggles	\$870,000
Saltworks Road	\$2,640,000
Smith	\$2,830,000
South Boulevard	\$1,920,000
South Water Street	\$2,760,000
Terry Lane/Pine Tree Estates	\$2,550,000
<b>TOTAL</b>	<b>\$42,180,000</b>

## 7. Flood Risk

A flood risk was calculated for the pump stations in SFHA using the methodology described in Chapter 4. The flood risk is the summation of the costs borne by the Town and its citizens. Costs to the Town include replacement of damaged or destroyed equipment and loss of essential services – such as the services of a hospital, police station or fire department. Costs to citizens include relocation costs during the period that their house has no sewer service and volunteer costs for clean-up efforts. The Risk for each station is shown in Table 6.

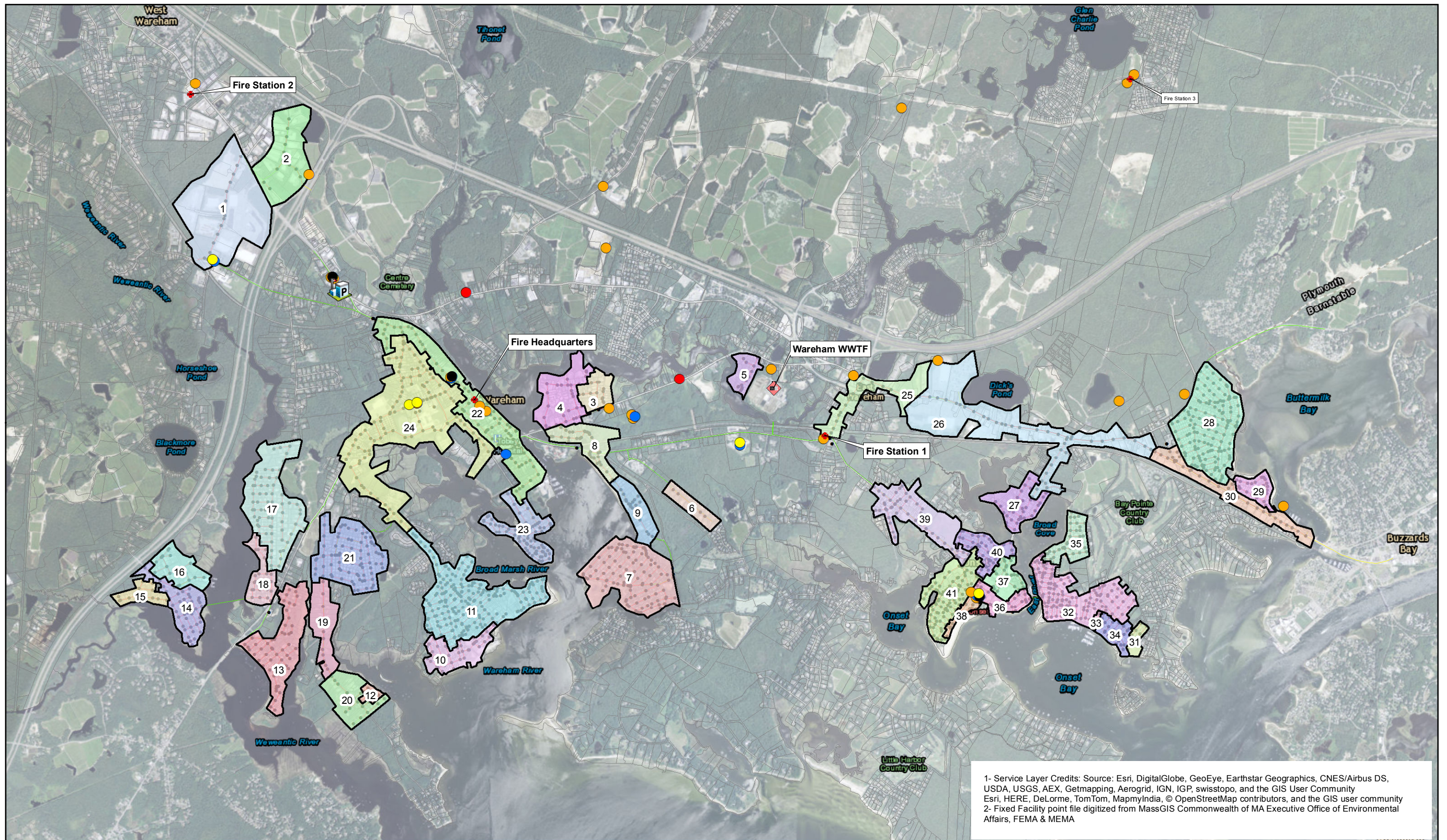
It is recommended that the Town prioritize projects with the highest annual flood risk.

Table 6 Flood Risk for Pump Stations Within SFHA

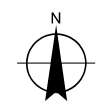
Pumping Station	Threat Likelihood	Total Loss	Annual Flood Risk
Narrows	0.01	\$99,800,000	\$998,000
Hynes Field	0.01	\$65,600,000	\$656,000
Smith	0.01	\$56,900,000	\$569,000
Dick's Pond	0.01	\$46,000,000	\$460,000
Onset Pier	0.01	\$45,200,000	\$452,000
Hathaway	0.01	\$44,100,000	\$441,000
South Water Street	0.01	\$43,000,000	\$430,000
Cohasset Narrows	0.01	\$42,800,000	\$428,000
Saltworks Road	0.01	\$39,800,000	\$398,000
Indian Neck	0.01	\$37,700,000	\$377,000
Pine Tree Estates (Terry Lane)	0.01	\$35,400,000	\$354,000
Parkwood	0.01	\$34,800,000	\$348,000
Pinehurst	0.01	\$33,800,000	\$338,000
East Boulevard	0.01	\$33,400,000	\$334,000
Arnold	0.01	\$31,700,000	\$317,000
Ruggles	0.01	\$31,500,000	\$315,000
Briarwood	0.01	\$31,100,000	\$311,000
North Boulevard	0.01	\$31,000,000	\$310,000
Cromesett	0.01	\$29,700,000	\$297,000
Onset Heights	0.01	\$29,600,000	\$296,000
Avenue A	0.01	\$29,500,000	\$295,000
Riverside	0.01	\$29,100,000	\$291,000
Bay Street	0.01	\$28,400,000	\$284,000
Hill Street Jefferson Shores	0.01	\$27,600,000	\$276,000
South Boulevard	0.01	\$27,400,000	\$274,000
Leonard Street	0.01	\$27,300,000	\$273,000
Apple Street	0.01	\$27,300,000	\$273,000
Linwood	0.01	\$27,200,000	\$272,000
Green Street	0.01	\$26,500,000	\$265,000

# Appendices

# Appendix A – Additional Figures



Paper Size ARCH D  
 0 1,250 2,500 5,000 Feet  
 Map Projection: Lambert Conformal Conic  
 Horizontal Datum: North American 1983  
 Grid: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001 Feet



LEGEND

Sewershed (TYP)  
(with ID Number)

Facility

- Critical Infrastructure
- Health & Medical Facility
- Fixed Hazard Facilities
- Emergency Operations Center
- Mass Care Shelters



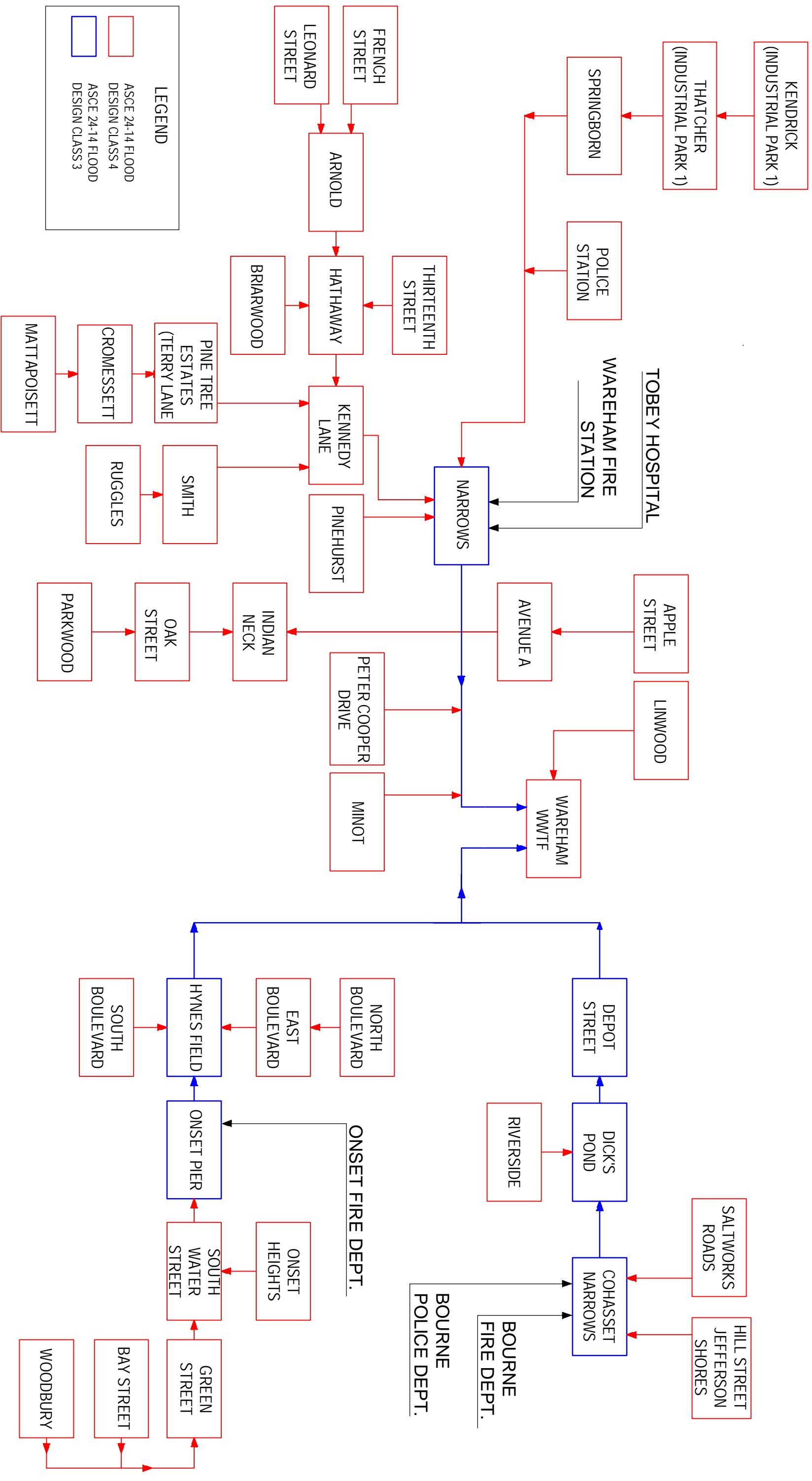
Town of Wareham, Ma  
 Capital Improvement Plan

CRITICAL INFRASTRUCTURE  
 FACILITIES

Job Number | 86-18489  
 Revision | A  
 Date | 29 Oct 2015

Figure 1

N:\US\Hyannis\Projects\8618712\GIS\Maps\MXD\_Deliverables\Fixed Hazardous Facilities F1.mxd  
 © 2012. Whilst every care has been taken to prepare this map, GHD (and DATA CUSTODIAN) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.  
 Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: jobrien



TOWN OF WAREHAM, MASSACHUSETTS  
 VULNERABILITY ASSESSMENT

ASCE 24-14 WAREHAM PUMP STATIONS  
 FLOOD DESIGN CLASSES

Job Number 86-18712  
 Date NOV 2015

Figure 3-1

# Appendix B – BCA Output Report

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 1 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Project Summary:**

Project Number:

Disaster #:

Program:

Agency: Town of Wareham

Analyst:

Point of Contact:

Phone Number:

Address: Massachusetts

Email:

Comments:

**Structure Summary For:**

Bay Street, 7 1/2 Terry Lane, Wareham, Massachusetts, 02571

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$0

Costs: \$0

BCR: 0.00

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	0.00	\$0	\$0

Briarwood Drive, 15 Briarwood Drive, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$0

Costs: \$0

BCR: 0.00

Mitigation	Hazard	BCR	Benefits	Costs
Elevation	Flood	0.00	\$0	\$0



24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 2 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Cohasset Narrows, 3254 Cranberry Highway, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$42,838,093

Costs: \$2,670,000

BCR: 16.04

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	16.04	\$42,838,093	\$2,670,000

Dick's Pond, 3018 Cranberry Highway, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$46,046,466

Costs: \$2,510,000

BCR: 18.35

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	18.35	\$46,046,466	\$2,510,000

East Blvd, 37 East Blvd, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$33,436,554

Costs: \$2,030,000

BCR: 16.47

Mitigation	Hazard	BCR	Benefits	Costs
Other flood proofing measures	Flood	16.47	\$33,436,554	\$2,030,000

Green Street, 1 1/2 Green Street, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$26,505,574

Costs: \$1,860,000

BCR: 14.25

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	14.25	\$26,505,574	\$1,860,000

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 3 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Hill Street Jefferson Shores, 9 1/2 Hill Street, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$27,556,400

Costs: \$2,130,000

BCR: 12.94

Mitigation	Hazard	BCR	Benefits	Costs
Other flood proofing measures	Flood	12.94	\$27,556,400	\$2,130,000

Hynes Field, 248 Onset Ave., Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$65,587,358

Costs: \$2,670,000

BCR: 24.56

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	24.56	\$65,587,358	\$2,670,000

Narrows, 1 Merchants Way, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$99,761,561

Costs: \$2,630,000

BCR: 37.93

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	37.93	\$99,761,561	\$2,630,000

North Blvd, 17 North Blvd, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$31,033,069

Costs: \$2,920,000

BCR: 10.63

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	10.63	\$31,033,069	\$2,920,000

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 4 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Onset Pier, 178 Onset Ave., Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$45,152,146

Costs: \$2,460,000

BCR: 18.35

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	18.35	\$45,152,146	\$2,460,000

Parkwood Drive, 89 Parkwood Drive, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$0

Costs: \$0

BCR: 0.00

Mitigation	Hazard	BCR	Benefits	Costs
Elevation	Flood	0.00	\$0	\$0

Pinehurst, 23 Franconia Ave., Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$33,838,998

Costs: \$2,510,000

BCR: 13.48

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	13.48	\$33,838,998	\$2,510,000

Ruggles, 7 Ruggles Street, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$31,491,408

Costs: \$870,000

BCR: 36.20

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	36.20	\$31,491,408	\$870,000

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 5 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Saltworks, 1 Wychunas Ave, Wareham MA, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$39,786,226

Costs: \$2,640,000

BCR: 15.07

Mitigation	Hazard	BCR	Benefits	Costs
Other flood proofing measures	Flood	15.07	\$39,786,226	\$2,640,000

Smith Avenue, 5 Smith Avenue, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$56,943,111

Costs: \$2,830,000

BCR: 20.12

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	20.12	\$56,943,111	\$2,830,000

South Blvd, 42 South Blvd, Wareham, Massachusetts, 01570, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$0

Costs: \$0

BCR: 0.00

Mitigation	Hazard	BCR	Benefits	Costs
Other flood proofing measures	Flood	0.00	\$0	\$0

South Water Street, 1 South Water Street, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$43,016,957

Costs: \$2,760,000

BCR: 15.59

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	15.59	\$43,016,957	\$2,760,000

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 6 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Terry Lane / Pine Tree Estates, 7 1/2 Terry Lane, Wareham, Massachusetts, 02571, Plymouth

Structure Type: Building

Historic Building: No

Contact:

Benefits: \$35,381,700

Costs: \$2,550,000

BCR: 13.88

Mitigation	Hazard	BCR	Benefits	Costs
Dry Flood Proofing	Flood	13.88	\$35,381,700	\$2,550,000

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 7 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** Bay Street, 7 1/2 Terry Lane, Wareham, Massachusetts, 02571

Benefits: \$

Costs: \$

BCR: .00

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude: 41.738433000000

Longitude: -70.644386000000

Size of Building:

BRV (\$/sf): \$0.00

Total BRV: \$0

Residential: No

Building Type:

Obstruction: No

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 0.00

First Floor Being Raised:

Demolition Threshold: 0.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 0

Effective FIS Date: 07/17/2012

FIRM Panel Number: 0

FIRM Effective Date: 01/01/1900

Project Useful Life:

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal V

Loss of Rent:

Building Contents: \$1,600,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 0.00

Flood Zone Determination: Coastal V

Breaking Wave Height: 0.00

Utilities that are not elevated: No

Height FFE Above Grade: 0.00

One Time Displacement Costs: \$4,650

NFIP: No

Displacement Costs: \$837,000

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 0      Number of Hours Volunteered/Person: 0

Cost of Volunteers Time (\$/Hour/Person): \$0.00      Number of Days Lodging/Volunteer: 0

Per-Person Cost of Lodging for a Volunteer: \$0.00      Cost of Volunteers: \$0.00

**Social Benefits**

**Mental Stress and Anxiety**

**Lost Productivity**

Number of Person: 0      Number of Worker: 0

Treatment Costs per person: \$2,443.00      Productivity Loss per person: \$8,736.00

Total Mental Stress and Anxiety Cost: \$0.00      Total Lost Productivity Cost: \$0.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 0.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 0.0000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: 0

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.00

Base Flood Elevation With Sea Level Rise: 17.00

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.0	0.0	0.0
50	2.00%	0.0	0.0	0.0	0.0
100	1.00%	0.0	0.0	0.0	0.0
500	0.20%	0.0	0.0	0.0	0.0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$0	9.2%	0.0%	\$0
2.0	14.5%	0.0%	\$0	14.5%	0.0%	\$0
3.0	17.7%	0.0%	\$0	17.7%	0.0%	\$0
4.0	22.6%	0.0%	\$0	22.6%	0.0%	\$0
5.0	27.9%	0.0%	\$0	27.9%	0.0%	\$0
6.0	29.7%	0.0%	\$0	29.7%	0.0%	\$0
7.0	32.9%	0.0%	\$0	32.9%	0.0%	\$0
8.0	36.8%	0.0%	\$0	36.8%	0.0%	\$0
9.0	38.4%	0.0%	\$0	38.4%	0.0%	\$0
10.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
11.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
12.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
13.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
14.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
15.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
16.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		14.0%	0.0%	
2.0	25.0%	0.0%	\$400,000	25.0%	0.0%	\$400,000
3.0	37.0%	0.0%	\$592,000	37.0%	0.0%	\$592,000
4.0	47.0%	0.0%	\$752,000	47.0%	0.0%	\$752,000
5.0	55.0%	0.0%	\$880,000	55.0%	0.0%	\$880,000
6.0	63.0%	0.0%	\$1,008,000	63.0%	0.0%	\$1,008,000
7.0	74.0%	0.0%	\$1,184,000	74.0%	0.0%	\$1,184,000
8.0	83.0%	0.0%	\$1,328,000	83.0%	0.0%	\$1,328,000
9.0	84.0%	0.0%	\$1,344,000	84.0%	0.0%	\$1,344,000
10.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
11.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
12.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
13.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
14.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
15.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
16.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			45.0		
2.0	90.0		\$2,476,603	90.0		\$2,476,603
3.0	135.0		\$3,714,904	135.0		\$3,714,904
4.0	180.0		\$4,953,205	180.0		\$4,953,205
5.0	225.0		\$6,191,507	225.0		\$6,191,507
6.0	270.0		\$7,429,808	270.0		\$7,429,808
7.0	315.0		\$8,668,110	315.0		\$8,668,110
8.0	360.0		\$9,906,411	360.0		\$9,906,411
9.0	405.0		\$11,144,712	405.0		\$11,144,712
10.0	450.0		\$12,383,014	450.0		\$12,383,014
11.0	450.0		\$12,383,014	450.0		\$12,383,014
12.0	450.0		\$12,383,014	450.0		\$12,383,014
13.0	450.0		\$12,383,014	450.0		\$12,383,014
14.0	450.0		\$12,383,014	450.0		\$12,383,014
15.0	450.0		\$12,383,014	450.0		\$12,383,014
16.0	450.0		\$12,383,014	450.0		\$12,383,014

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			45.0		
2.0	90.0		\$0	90.0		\$0
3.0	135.0		\$0	135.0		\$0
4.0	180.0		\$0	180.0		\$0
5.0	225.0		\$0	225.0		\$0
6.0	270.0		\$0	270.0		\$0
7.0	315.0		\$0	315.0		\$0
8.0	360.0		\$0	360.0		\$0
9.0	405.0		\$0	405.0		\$0
10.0	450.0		\$0	450.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 13 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$0
Present Value:	\$0

Annual:	\$0
Present Value:	\$0

Annual:	\$0
Present Value:	\$0

Mitigation Benefits: \$0

Mitigation Costs: \$0

Benefits Minus Costs: \$0

Benefit-Cost Ratio: NaN

24 Nov 2015

Project: **Wareham Vulnerability  
Assessment**

Pg 14 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):

Construction Type:

Mitigation Project Cost:

Detailed Scope of Work:

Yes

Annual Project Maintenance Cost: \$0

Detailed Estimate for Entire Project:

Yes

Final Mitigation Project Cost: \$0

Years of Maintenance:

0

Cost Basis Year:

Present Worth of Annual Maintenance Costs:

\$0

Construction Start Year:

Estimate Reflects Current Prices:

Yes

Construction End Year:

Project Escalation:

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 15 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
Annual Project Maintenance Cost	No anticipated increase in pump station O&M	
First Floor Elevation	Approximate elevation of electrical panel	
Mitigation Type - Other	Scope of Work: 1. Install watertight exterior hatch 2. Replace past useful life equipment with immersible equipment 3. Install immersible panel on control panel 4. Install portable generator hookup	
Number of Persons:	Number of people in the sewershed who will not have sewer service while pumping station is inoperable.	
Number of Workers:	Number of people in sewershed that will not have sewer service while pumping station is inoperable	
Project useful life	Useful life equals the projected useful life of the equipment installed.	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 16 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:**

Briarwood Drive, 15 Briarwood Drive, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$

Costs: \$

BCR: .00

Hazard: **Flood**

Mitigation Option: Elevation

Latitude: 41.738666000000

Longitude: -70.741474000000

Size of Building:

BRV (\$/sf): \$0.00

Total BRV: \$0

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 0.00

First Floor Being Raised: 0.00

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 0

Effective FIS Date: 07/17/2012

FIRM Panel Number: 0

FIRM Effective Date: 01/01/1900

Project Useful Life: 0

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$210,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 0.00

Flood Zone Determination: Outside Coastal A

Breaking Wave Height: 0.00

Utilities that are not elevated: No

Height FFE Above Grade: 0.00

One Time Displacement Costs: \$10,625

NFIP: No

Displacement Costs: \$1,912,500

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Volunteer Costs**

Number of Volunteers Required: 0      Number of Hours Volunteered/Person: 0

Cost of Volunteers Time (\$/Hour/Person): \$0.00      Number of Days Lodging/Volunteer: 0

Per-Person Cost of Lodging for a Volunteer: \$0.00      Cost of Volunteers: \$0.00

**Social Benefits**

**Mental Stress and Anxiety**

**Lost Productivity**

Number of Person: 0      Number of Worker: 0

Treatment Costs per person: \$2,443.00      Productivity Loss per person: \$8,736.00

Total Mental Stress and Anxiety Cost: \$0.00      Total Lost Productivity Cost: \$0.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 0.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped:

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: 0

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.00

Base Flood Elevation With Sea Level Rise: 15.00

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.0	0.0	0.0
50	2.00%	0.0	0.0	0.0	0.0
100	1.00%	0.0	0.0	0.0	0.0
500	0.20%	0.0	0.0	0.0	0.0



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$0	9.2%	0.0%	\$0
2.0	14.5%	0.0%	\$0	14.5%	0.0%	\$0
3.0	17.7%	0.0%	\$0	17.7%	0.0%	\$0
4.0	22.6%	0.0%	\$0	22.6%	0.0%	\$0
5.0	27.9%	0.0%	\$0	27.9%	0.0%	\$0
6.0	29.7%	0.0%	\$0	29.7%	0.0%	\$0
7.0	32.9%	0.0%	\$0	32.9%	0.0%	\$0
8.0	36.8%	0.0%	\$0	36.8%	0.0%	\$0
9.0	38.4%	0.0%	\$0	38.4%	0.0%	\$0
10.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
11.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
12.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
13.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
14.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
15.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0
16.0	40.5%	0.0%	\$0	40.5%	0.0%	\$0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		14.0%	0.0%	
2.0	25.0%	0.0%	\$52,500	25.0%	0.0%	\$52,500
3.0	37.0%	0.0%	\$77,700	37.0%	0.0%	\$77,700
4.0	47.0%	0.0%	\$98,700	47.0%	0.0%	\$98,700
5.0	55.0%	0.0%	\$115,500	55.0%	0.0%	\$115,500
6.0	63.0%	0.0%	\$132,300	63.0%	0.0%	\$132,300
7.0	74.0%	0.0%	\$155,400	74.0%	0.0%	\$155,400
8.0	83.0%	0.0%	\$174,300	83.0%	0.0%	\$174,300
9.0	84.0%	0.0%	\$176,400	84.0%	0.0%	\$176,400
10.0	86.0%	0.0%	\$180,600	86.0%	0.0%	\$180,600
11.0	86.0%	0.0%	\$180,600	86.0%	0.0%	\$180,600
12.0	86.0%	0.0%	\$180,600	86.0%	0.0%	\$180,600
13.0	86.0%	0.0%	\$180,600	86.0%	0.0%	\$180,600
14.0	86.0%	0.0%	\$180,600	86.0%	0.0%	\$180,600
15.0	86.0%	0.0%	\$180,600	86.0%	0.0%	\$180,600
16.0	86.0%	0.0%	\$180,600	86.0%	0.0%	\$180,600

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			45.0		
2.0	90.0		\$5,658,904	90.0		\$5,658,904
3.0	135.0		\$8,488,356	135.0		\$8,488,356
4.0	180.0		\$11,317,808	180.0		\$11,317,808
5.0	225.0		\$14,147,260	225.0		\$14,147,260
6.0	270.0		\$16,976,712	270.0		\$16,976,712
7.0	315.0		\$19,806,164	315.0		\$19,806,164
8.0	360.0		\$22,635,616	360.0		\$22,635,616
9.0	405.0		\$25,465,068	405.0		\$25,465,068
10.0	450.0		\$28,294,521	450.0		\$28,294,521
11.0	450.0		\$28,294,521	450.0		\$28,294,521
12.0	450.0		\$28,294,521	450.0		\$28,294,521
13.0	450.0		\$28,294,521	450.0		\$28,294,521
14.0	450.0		\$28,294,521	450.0		\$28,294,521
15.0	450.0		\$28,294,521	450.0		\$28,294,521
16.0	450.0		\$28,294,521	450.0		\$28,294,521

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			45.0		
2.0	90.0		\$0	90.0		\$0
3.0	135.0		\$0	135.0		\$0
4.0	180.0		\$0	180.0		\$0
5.0	225.0		\$0	225.0		\$0
6.0	270.0		\$0	270.0		\$0
7.0	315.0		\$0	315.0		\$0
8.0	360.0		\$0	360.0		\$0
9.0	405.0		\$0	405.0		\$0
10.0	450.0		\$0	450.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 22 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$0
Present Value:	\$0

Annual:	\$0
Present Value:	\$0

Annual:	\$0
Present Value:	\$0

Mitigation Benefits: \$0

Mitigation Costs: \$0

Benefits Minus Costs: \$0

Benefit-Cost Ratio: NaN

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 23 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	0	Construction Type:	
Mitigation Project Cost:	\$0	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$0	Years of Maintenance:	0
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	Yes
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 24 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
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24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 25 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:**

Cohasset Narrows, 3254 Cranberry Highway, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$42,838,093

Costs: \$2,670,000

BCR: 16.04

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude: 41.747840000000

Longitude: -70.622400000000

Size of Building: 1,200

BRV (\$/sf): \$250.00

Total BRV: \$300,000

Residential: No

Building Type:

Obstruction: No

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 18.90

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 25023C0601J

FIRM Effective Date: 07/17/2012

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal V

Loss of Rent:

Building Contents: \$2,100,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 11.60

Flood Zone Determination: Coastal V

Breaking Wave Height: 29.78

Utilities that are not elevated: No

Height FFE Above Grade: 7.30

One Time Displacement Costs: \$36,950

NFIP: No

Displacement Costs: \$6,651,000

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

Number of Person: 1,478

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$3,610,754.00

**Lost Productivity**

Number of Worker: 1,478

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$12,911,808.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 21.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 24.8000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 21.60

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$27,600	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$43,500	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$53,100	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$67,800	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$83,700	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$89,100	29.7%	0.0%	\$89,100
7.0	32.9%	0.0%	\$98,700	32.9%	0.0%	\$98,700
8.0	36.8%	0.0%	\$110,400	36.8%	0.0%	\$110,400
9.0	38.4%	0.0%	\$115,200	38.4%	0.0%	\$115,200
10.0	40.5%	0.0%	\$121,500	40.5%	0.0%	\$121,500
11.0	40.5%	0.0%	\$121,500	40.5%	0.0%	\$121,500
12.0	40.5%	0.0%	\$121,500	40.5%	0.0%	\$121,500
13.0	40.5%	0.0%	\$121,500	40.5%	0.0%	\$121,500
14.0	40.5%	0.0%	\$121,500	40.5%	0.0%	\$121,500
15.0	40.5%	0.0%	\$121,500	40.5%	0.0%	\$121,500
16.0	40.5%	0.0%	\$121,500	40.5%	0.0%	\$121,500

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$525,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$777,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$987,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$1,155,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,323,000	63.0%	0.0%	\$1,323,000
7.0	74.0%	0.0%	\$1,554,000	74.0%	0.0%	\$1,554,000
8.0	83.0%	0.0%	\$1,743,000	83.0%	0.0%	\$1,743,000
9.0	84.0%	0.0%	\$1,764,000	84.0%	0.0%	\$1,764,000
10.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
11.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
12.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
13.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
14.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
15.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
16.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$19,679,671	0.0		\$0
3.0	135.0		\$29,519,507	0.0		\$0
4.0	180.0		\$39,359,342	0.0		\$0
5.0	225.0		\$49,199,178	0.0		\$0
6.0	270.0		\$59,039,014	270.0		\$59,039,014
7.0	315.0		\$68,878,849	315.0		\$68,878,849
8.0	360.0		\$78,718,685	360.0		\$78,718,685
9.0	405.0		\$88,558,521	405.0		\$88,558,521
10.0	450.0		\$98,398,356	450.0		\$98,398,356
11.0	450.0		\$98,398,356	450.0		\$98,398,356
12.0	450.0		\$98,398,356	450.0		\$98,398,356
13.0	450.0		\$98,398,356	450.0		\$98,398,356
14.0	450.0		\$98,398,356	450.0		\$98,398,356
15.0	450.0		\$98,398,356	450.0		\$98,398,356
16.0	450.0		\$98,398,356	450.0		\$98,398,356

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		(\$1,488,049)	0.0		\$0
3.0	135.0		(\$2,232,074)	0.0		\$0
4.0	180.0		(\$2,976,098)	0.0		\$0
5.0	225.0		(\$3,720,123)	0.0		\$0
6.0	270.0		(\$4,464,148)	270.0		(\$4,464,148)
7.0	315.0		(\$5,208,172)	315.0		(\$5,208,172)
8.0	360.0		(\$5,952,197)	360.0		(\$5,952,197)
9.0	405.0		(\$6,696,221)	405.0		(\$6,696,221)
10.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
11.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
12.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
13.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
14.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
15.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
16.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 31 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

## Other Benefits

### Other Benefits Before Mitigation

No Data

### Other Benefits After Mitigation

No Data

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Loss of Services**

**Police Station:**

Type of Area Served by this Police Station:	City
Number of people Served by this Police Station:	19,754
Number of Police Officers Working at this Police Station:	45
Number of Police Officers That Would Serve the Same Area If The Station Were Shut Down Due to a Disaster:	74

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual: \$19,006,562	Annual: \$0	Annual: \$19,006,562
Present Value: \$42,838,093	Present Value: \$0	Present Value: \$42,838,093

Mitigation Benefits: \$42,838,093

Mitigation Costs: \$2,670,000

Benefits Minus Costs: \$40,168,093

Benefit-Cost Ratio: 16.04

**Cost Estimate**

Project Useful Life (years): 20	Construction Type:
Mitigation Project Cost: \$2,670,000	Detailed Scope of Work: Yes
Annual Project Maintenance Cost: \$0	Detailed Estimate for Entire Project: Yes
Final Mitigation Project Cost: \$2,670,000	Years of Maintenance: 20
Cost Basis Year:	Present Worth of Annual Maintenance Costs: \$0
Construction Start Year:	Estimate Reflects Current Prices: No
Construction End Year:	Project Escalation:

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 33 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
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24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 34 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:**

Dick's Pond, 3018 Cranberry Highway, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$46,046,466

Costs: \$2,510,000

BCR: 18.35

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude: 41.758680000000

Longitude: -70.660318000000

Size of Building: 710

BRV (\$/sf): \$250.00

Total BRV: \$177,500

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 10.90

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 493J

FIRM Effective Date: 07/17/2012

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$2,100,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 9.80

Flood Zone Determination: Coastal A

Breaking Wave Height: 19.85

Utilities that are not elevated: No

Height FFE Above Grade: 1.10

One Time Displacement Costs: \$44,125

NFIP: No

Displacement Costs: \$4,972,500

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

Number of Person: 1,765

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$4,311,895.00

**Lost Productivity**

Number of Worker: 1,765

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$15,419,040.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 14.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 17.8000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 0.00

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$16,330	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$25,738	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$31,418	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$40,115	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$49,523	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$52,718	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$58,398	32.9%	0.0%	\$58,398
8.0	36.8%	0.0%	\$65,320	36.8%	0.0%	\$65,320
9.0	38.4%	0.0%	\$68,160	38.4%	0.0%	\$68,160
10.0	40.5%	0.0%	\$71,888	40.5%	0.0%	\$71,888
11.0	40.5%	0.0%	\$71,888	40.5%	0.0%	\$71,888
12.0	40.5%	0.0%	\$71,888	40.5%	0.0%	\$71,888
13.0	40.5%	0.0%	\$71,888	40.5%	0.0%	\$71,888
14.0	40.5%	0.0%	\$71,888	40.5%	0.0%	\$71,888
15.0	40.5%	0.0%	\$71,888	40.5%	0.0%	\$71,888
16.0	40.5%	0.0%	\$71,888	40.5%	0.0%	\$71,888

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$525,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$777,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$987,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$1,155,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,323,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,554,000	74.0%	0.0%	\$1,554,000
8.0	83.0%	0.0%	\$1,743,000	83.0%	0.0%	\$1,743,000
9.0	84.0%	0.0%	\$1,764,000	84.0%	0.0%	\$1,764,000
10.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
11.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
12.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
13.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
14.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
15.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
16.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$14,713,151	0.0		\$0
3.0	135.0		\$22,069,726	0.0		\$0
4.0	180.0		\$29,426,301	0.0		\$0
5.0	225.0		\$36,782,877	0.0		\$0
6.0	270.0		\$44,139,452	0.0		\$0
7.0	315.0		\$51,496,027	315.0		\$51,496,027
8.0	360.0		\$58,852,603	360.0		\$58,852,603
9.0	405.0		\$66,209,178	405.0		\$66,209,178
10.0	450.0		\$73,565,753	450.0		\$73,565,753
11.0	450.0		\$73,565,753	450.0		\$73,565,753
12.0	450.0		\$73,565,753	450.0		\$73,565,753
13.0	450.0		\$73,565,753	450.0		\$73,565,753
14.0	450.0		\$73,565,753	450.0		\$73,565,753
15.0	450.0		\$73,565,753	450.0		\$73,565,753
16.0	450.0		\$73,565,753	450.0		\$73,565,753

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		(\$1,488,049)	0.0		\$0
3.0	135.0		(\$2,232,074)	0.0		\$0
4.0	180.0		(\$2,976,098)	0.0		\$0
5.0	225.0		(\$3,720,123)	0.0		\$0
6.0	270.0		(\$4,464,148)	0.0		\$0
7.0	315.0		(\$5,208,172)	315.0		(\$5,208,172)
8.0	360.0		(\$5,952,197)	360.0		(\$5,952,197)
9.0	405.0		(\$6,696,221)	405.0		(\$6,696,221)
10.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
11.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
12.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
13.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
14.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
15.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)
16.0	450.0		(\$7,440,246)	450.0		(\$7,440,246)

24 Nov 2015

Project: **Wareham Vulnerability  
Assessment**

Pg 40 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachus  
etts**

Point of Contact:

Analyst:

## Other Benefits

### Other Benefits Before Mitigation

No Data

### Other Benefits After Mitigation

No Data

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 41 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Loss of Services**

**Police Station:**

Type of Area Served by this Police Station:	City
Number of people Served by this Police Station:	19,754
Number of Police Officers Working at this Police Station:	45
Number of Police Officers That Would Serve the Same Area If The Station Were Shut Down Due to a Disaster:	74

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual: \$22,214,935	Annual: \$0	Annual: \$22,214,935
Present Value: \$46,046,466	Present Value: \$0	Present Value: \$46,046,466

Mitigation Benefits: \$46,046,466

Mitigation Costs: \$2,510,000

Benefits Minus Costs: \$43,536,466

Benefit-Cost Ratio: 18.35

**Cost Estimate**

Project Useful Life (years): 20	Construction Type:
Mitigation Project Cost: \$2,510,000	Detailed Scope of Work: Yes
Annual Project Maintenance Cost: \$0	Detailed Estimate for Entire Project: Yes
Final Mitigation Project Cost: \$2,510,000	Years of Maintenance: 20
Cost Basis Year:	Present Worth of Annual Maintenance Costs: \$0
Construction Start Year:	Estimate Reflects Current Prices: Yes
Construction End Year:	Project Escalation:



24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 42 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
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24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 43 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** East Blvd, 37 East Blvd, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$33,436,554

Costs: \$2,030,000

BCR: 16.47

Hazard: **Flood**

Mitigation Option: Other flood proofing measures

Latitude: 41.744290000000

Longitude: -70.656645000000

Size of Building: 200

BRV (\$/sf): \$250.00

Total BRV: \$50,000

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 5.60

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 581K

FIRM Effective Date: 02/05/2014

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$1,600,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 4.71

Flood Zone Determination: Coastal A

Breaking Wave Height: 19.85

Utilities that are not elevated: No

Height FFE Above Grade: 0.89

One Time Displacement Costs: \$15,925

NFIP: No

Displacement Costs: \$2,866,500

ICC: No

### Street Maintenance Details

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

### Volunteer Costs

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

**Lost Productivity**

Number of Person: 637

Number of Worker: 637

Treatment Costs per person: \$2,443.00

Productivity Loss per person: \$8,736.00

Total Mental Stress and Anxiety Cost: \$1,556,191.00

Total Lost Productivity Cost: \$5,564,832.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 14.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped:

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 14.60

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.0	0.0	0.0
50	2.00%	0.0	0.0	0.0	0.0
100	1.00%	0.0	0.0	0.0	0.0
500	0.20%	0.0	0.0	0.0	0.0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$4,600	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$7,250	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$8,850	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$11,300	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$13,950	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$14,850	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$16,450	0.0%	0.0%	\$0
8.0	36.8%	0.0%	\$18,400	0.0%	0.0%	\$0
9.0	38.4%	0.0%	\$19,200	0.0%	0.0%	\$0
10.0	40.5%	0.0%	\$20,250	0.0%	0.0%	\$0
11.0	40.5%	0.0%	\$20,250	0.0%	0.0%	\$0
12.0	40.5%	0.0%	\$20,250	0.0%	0.0%	\$0
13.0	40.5%	0.0%	\$20,250	0.0%	0.0%	\$0
14.0	40.5%	0.0%	\$20,250	0.0%	0.0%	\$0
15.0	40.5%	0.0%	\$20,250	0.0%	0.0%	\$0
16.0	40.5%	0.0%	\$20,250	0.0%	0.0%	\$0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$400,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$592,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$752,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$880,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,008,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,184,000	0.0%	0.0%	\$0
8.0	83.0%	0.0%	\$1,328,000	0.0%	0.0%	\$0
9.0	84.0%	0.0%	\$1,344,000	0.0%	0.0%	\$0
10.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
11.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
12.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
13.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
14.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
15.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
16.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0					
-1.0	0.0					
0.0	0.0					
1.0	45.0					
2.0	90.0		\$8,481,699			\$0
3.0	135.0		\$12,722,548			\$0
4.0	180.0		\$16,963,397			\$0
5.0	225.0		\$21,204,247			\$0
6.0	270.0		\$25,445,096			\$0
7.0	315.0		\$29,685,945			\$0
8.0	360.0		\$33,926,795			\$0
9.0	405.0		\$38,167,644			\$0
10.0	450.0		\$42,408,493			\$0
11.0	450.0		\$42,408,493			\$0
12.0	450.0		\$42,408,493			\$0
13.0	450.0		\$42,408,493			\$0
14.0	450.0		\$42,408,493			\$0
15.0	450.0		\$42,408,493			\$0
16.0	450.0		\$42,408,493			\$0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0					
-1.0	0.0					
0.0	0.0					
1.0	45.0					
2.0	90.0		\$0			\$0
3.0	135.0		\$0			\$0
4.0	180.0		\$0			\$0
5.0	225.0		\$0			\$0
6.0	270.0		\$0			\$0
7.0	315.0		\$0			\$0
8.0	360.0		\$0			\$0
9.0	405.0		\$0			\$0
10.0	450.0		\$0			\$0
11.0	450.0		\$0			\$0
12.0	450.0		\$0			\$0
13.0	450.0		\$0			\$0
14.0	450.0		\$0			\$0
15.0	450.0		\$0			\$0
16.0	450.0		\$0			\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 49 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$9,605,023
Present Value:	\$33,436,554

Annual:	\$0
Present Value:	\$0

Annual:	\$9,605,023
Present Value:	\$33,436,554

Mitigation Benefits: \$33,436,554

Mitigation Costs: \$2,030,000

Benefits Minus Costs: \$31,406,554

Benefit-Cost Ratio: 16.47



24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 50 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	20	Construction Type:	
Mitigation Project Cost:	\$2,030,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$2,030,000	Years of Maintenance:	20
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	No
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 51 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
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24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 52 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** Green Street, 1 1/2 Green Street, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$26,505,574

Costs: \$1,860,000

BCR: 14.25

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude: 41.741030000000

Longitude: -70.646409000000

Size of Building: 100

BRV (\$/sf): \$250.00

Total BRV: \$25,000

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 17.10

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 482J

FIRM Effective Date: 11/24/2015

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$1,600,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 16.50

Flood Zone Determination: Coastal A

Breaking Wave Height: 22.69

Utilities that are not elevated: No

Height FFE Above Grade: 0.60

One Time Displacement Costs: \$425

NFIP: No

Displacement Costs: \$76,500

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

**Lost Productivity**

Number of Person: 17

Number of Worker: 17

Treatment Costs per person: \$2,443.00

Productivity Loss per person: \$8,736.00

Total Mental Stress and Anxiety Cost: \$41,531.00

Total Lost Productivity Cost: \$148,512.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 16.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 19.0000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 0.00

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.0	0.0	0.0
50	2.00%	0.0	0.0	0.0	0.0
100	1.00%	0.0	0.0	0.0	0.0
500	0.20%	0.0	0.0	0.0	0.0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$2,300	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$3,625	14.5%	0.0%	\$3,625
3.0	17.7%	0.0%	\$4,425	17.7%	0.0%	\$4,425
4.0	22.6%	0.0%	\$5,650	22.6%	0.0%	\$5,650
5.0	27.9%	0.0%	\$6,975	27.9%	0.0%	\$6,975
6.0	29.7%	0.0%	\$7,425	29.7%	0.0%	\$7,425
7.0	32.9%	0.0%	\$8,225	32.9%	0.0%	\$8,225
8.0	36.8%	0.0%	\$9,200	36.8%	0.0%	\$9,200
9.0	38.4%	0.0%	\$9,600	38.4%	0.0%	\$9,600
10.0	40.5%	0.0%	\$10,125	40.5%	0.0%	\$10,125
11.0	40.5%	0.0%	\$10,125	40.5%	0.0%	\$10,125
12.0	40.5%	0.0%	\$10,125	40.5%	0.0%	\$10,125
13.0	40.5%	0.0%	\$10,125	40.5%	0.0%	\$10,125
14.0	40.5%	0.0%	\$10,125	40.5%	0.0%	\$10,125
15.0	40.5%	0.0%	\$10,125	40.5%	0.0%	\$10,125
16.0	40.5%	0.0%	\$10,125	40.5%	0.0%	\$10,125

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$400,000	25.0%	0.0%	\$400,000
3.0	37.0%	0.0%	\$592,000	37.0%	0.0%	\$592,000
4.0	47.0%	0.0%	\$752,000	47.0%	0.0%	\$752,000
5.0	55.0%	0.0%	\$880,000	55.0%	0.0%	\$880,000
6.0	63.0%	0.0%	\$1,008,000	63.0%	0.0%	\$1,008,000
7.0	74.0%	0.0%	\$1,184,000	74.0%	0.0%	\$1,184,000
8.0	83.0%	0.0%	\$1,328,000	83.0%	0.0%	\$1,328,000
9.0	84.0%	0.0%	\$1,344,000	84.0%	0.0%	\$1,344,000
10.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
11.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
12.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
13.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
14.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
15.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000
16.0	86.0%	0.0%	\$1,376,000	86.0%	0.0%	\$1,376,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$226,356	90.0		\$226,356
3.0	135.0		\$339,534	135.0		\$339,534
4.0	180.0		\$452,712	180.0		\$452,712
5.0	225.0		\$565,890	225.0		\$565,890
6.0	270.0		\$679,068	270.0		\$679,068
7.0	315.0		\$792,247	315.0		\$792,247
8.0	360.0		\$905,425	360.0		\$905,425
9.0	405.0		\$1,018,603	405.0		\$1,018,603
10.0	450.0		\$1,131,781	450.0		\$1,131,781
11.0	450.0		\$1,131,781	450.0		\$1,131,781
12.0	450.0		\$1,131,781	450.0		\$1,131,781
13.0	450.0		\$1,131,781	450.0		\$1,131,781
14.0	450.0		\$1,131,781	450.0		\$1,131,781
15.0	450.0		\$1,131,781	450.0		\$1,131,781
16.0	450.0		\$1,131,781	450.0		\$1,131,781

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$0	90.0		\$0
3.0	135.0		\$0	135.0		\$0
4.0	180.0		\$0	180.0		\$0
5.0	225.0		\$0	225.0		\$0
6.0	270.0		\$0	270.0		\$0
7.0	315.0		\$0	315.0		\$0
8.0	360.0		\$0	360.0		\$0
9.0	405.0		\$0	405.0		\$0
10.0	450.0		\$0	450.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0



24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 58 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$2,674,043
Present Value:	\$26,505,574

Annual:	\$0
Present Value:	\$0

Annual:	\$2,674,043
Present Value:	\$26,505,574

Mitigation Benefits: \$26,505,574

Mitigation Costs: \$1,860,000

Benefits Minus Costs: \$24,645,574

Benefit-Cost Ratio: 14.25

24 Nov 2015

Project: **Wareham Vulnerability  
Assessment**

Pg 59 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	20	Construction Type:	
Mitigation Project Cost:	\$1,860,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$1,860,000	Years of Maintenance:	20
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	No
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 60 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
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24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 61 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:**

Hill Street Jefferson Shores, 9 1/2 Hill Street, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$27,556,400

Costs: \$2,130,000

BCR: 12.94

Hazard: **Flood**

Mitigation Option: Other flood proofing measures

Latitude:

Longitude:

Size of Building: 360

BRV (\$/sf): \$250.00

Total BRV: \$90,000

Residential: No

Building Type:

Obstruction: No

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 15.00

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 249J

FIRM Effective Date: 01/01/1900

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal V

Loss of Rent:

Building Contents: \$1,600,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 13.80

Flood Zone Determination: Coastal V

Breaking Wave Height: 29.78

Utilities that are not elevated: No

Height FFE Above Grade: 1.20

One Time Displacement Costs: \$2,775

NFIP: No

Displacement Costs: \$499,500

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

Number of Person: 111

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$271,173.00

**Lost Productivity**

Number of Worker: 111

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$969,696.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 21.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped:

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 21.60

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$8,280	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$13,050	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$15,930	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$20,340	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$25,110	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$26,730	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$29,610	0.0%	0.0%	\$0
8.0	36.8%	0.0%	\$33,120	0.0%	0.0%	\$0
9.0	38.4%	0.0%	\$34,560	0.0%	0.0%	\$0
10.0	40.5%	0.0%	\$36,450	0.0%	0.0%	\$0
11.0	40.5%	0.0%	\$36,450	0.0%	0.0%	\$0
12.0	40.5%	0.0%	\$36,450	0.0%	0.0%	\$0
13.0	40.5%	0.0%	\$36,450	0.0%	0.0%	\$0
14.0	40.5%	0.0%	\$36,450	0.0%	0.0%	\$0
15.0	40.5%	0.0%	\$36,450	0.0%	0.0%	\$0
16.0	40.5%	0.0%	\$36,450	0.0%	0.0%	\$0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$400,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$592,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$752,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$880,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,008,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,184,000	0.0%	0.0%	\$0
8.0	83.0%	0.0%	\$1,328,000	0.0%	0.0%	\$0
9.0	84.0%	0.0%	\$1,344,000	0.0%	0.0%	\$0
10.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
11.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
12.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
13.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
14.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
15.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0
16.0	86.0%	0.0%	\$1,376,000	0.0%	0.0%	\$0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0					
-1.0	0.0					
0.0	0.0					
1.0	45.0					
2.0	90.0		\$1,477,973			\$0
3.0	135.0		\$2,216,959			\$0
4.0	180.0		\$2,955,945			\$0
5.0	225.0		\$3,694,932			\$0
6.0	270.0		\$4,433,918			\$0
7.0	315.0		\$5,172,904			\$0
8.0	360.0		\$5,911,890			\$0
9.0	405.0		\$6,650,877			\$0
10.0	450.0		\$7,389,863			\$0
11.0	450.0		\$7,389,863			\$0
12.0	450.0		\$7,389,863			\$0
13.0	450.0		\$7,389,863			\$0
14.0	450.0		\$7,389,863			\$0
15.0	450.0		\$7,389,863			\$0
16.0	450.0		\$7,389,863			\$0



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0					
-1.0	0.0					
0.0	0.0					
1.0	45.0					
2.0	90.0		\$0			\$0
3.0	135.0		\$0			\$0
4.0	180.0		\$0			\$0
5.0	225.0		\$0			\$0
6.0	270.0		\$0			\$0
7.0	315.0		\$0			\$0
8.0	360.0		\$0			\$0
9.0	405.0		\$0			\$0
10.0	450.0		\$0			\$0
11.0	450.0		\$0			\$0
12.0	450.0		\$0			\$0
13.0	450.0		\$0			\$0
14.0	450.0		\$0			\$0
15.0	450.0		\$0			\$0
16.0	450.0		\$0			\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 67 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$3,724,869
Present Value:	\$27,556,400

Annual:	\$0
Present Value:	\$0

Annual:	\$3,724,869
Present Value:	\$27,556,400

Mitigation Benefits: \$27,556,400

Mitigation Costs: \$2,130,000

Benefits Minus Costs: \$25,426,400

Benefit-Cost Ratio: 12.94

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 68 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	20	Construction Type:	
Mitigation Project Cost:	\$2,130,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$2,130,000	Years of Maintenance:	20
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	Yes
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 69 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
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24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 70 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** Hynes Field, 248 Onset Ave., Wareham, Massachusetts, 02571, Plymouth

Benefits: \$65,587,358

Costs: \$2,670,000

BCR: 24.56

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude: 41.745332000000

Longitude: -70.662266000000

Size of Building: 630

BRV (\$/sf): \$250.00

Total BRV: \$157,500

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 10.89

First Floor Being Raised:

Demolition Threshold: 100.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 581K

FIRM Effective Date: 02/05/2014

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$2,100,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 6.40

Flood Zone Determination: Coastal A

Breaking Wave Height: 19.85

Utilities that are not elevated: No

Height FFE Above Grade: 4.49

One Time Displacement Costs: \$87,825

Grade:

NFIP: No

Displacement Costs: \$15,808,500

ICC: No

### Street Maintenance Details

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

### Volunteer Costs

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

Number of Person: 3,513

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$8,582,259.00

**Lost Productivity**

Number of Worker: 3,513

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$30,689,568.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 14.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 17.8000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 14.60

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$14,490	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$22,838	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$27,878	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$35,595	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$43,943	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$46,778	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$51,818	32.9%	0.0%	\$51,818
8.0	36.8%	0.0%	\$57,960	36.8%	0.0%	\$57,960
9.0	38.4%	0.0%	\$60,480	38.4%	0.0%	\$60,480
10.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
11.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
12.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
13.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
14.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
15.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
16.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$525,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$777,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$987,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$1,155,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,323,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,554,000	74.0%	0.0%	\$1,554,000
8.0	83.0%	0.0%	\$1,743,000	83.0%	0.0%	\$1,743,000
9.0	84.0%	0.0%	\$1,764,000	84.0%	0.0%	\$1,764,000
10.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
11.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
12.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
13.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
14.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
15.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
16.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$46,775,836	0.0		\$0
3.0	135.0		\$70,163,753	0.0		\$0
4.0	180.0		\$93,551,671	0.0		\$0
5.0	225.0		\$116,939,589	0.0		\$0
6.0	270.0		\$140,327,507	0.0		\$0
7.0	315.0		\$163,715,425	315.0		\$163,715,425
8.0	360.0		\$187,103,342	360.0		\$187,103,342
9.0	405.0		\$210,491,260	405.0		\$210,491,260
10.0	450.0		\$233,879,178	450.0		\$233,879,178
11.0	450.0		\$233,879,178	450.0		\$233,879,178
12.0	450.0		\$233,879,178	450.0		\$233,879,178
13.0	450.0		\$233,879,178	450.0		\$233,879,178
14.0	450.0		\$233,879,178	450.0		\$233,879,178
15.0	450.0		\$233,879,178	450.0		\$233,879,178
16.0	450.0		\$233,879,178	450.0		\$233,879,178

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$5,558	0.0		\$0
3.0	135.0		\$8,338	0.0		\$0
4.0	180.0		\$11,117	0.0		\$0
5.0	225.0		\$13,896	0.0		\$0
6.0	270.0		\$16,675	0.0		\$0
7.0	315.0		\$19,454	315.0		\$19,454
8.0	360.0		\$22,234	360.0		\$22,234
9.0	405.0		\$25,013	405.0		\$25,013
10.0	450.0		\$27,792	450.0		\$27,792
11.0	450.0		\$27,792	450.0		\$27,792
12.0	450.0		\$27,792	450.0		\$27,792
13.0	450.0		\$27,792	450.0		\$27,792
14.0	450.0		\$27,792	450.0		\$27,792
15.0	450.0		\$27,792	450.0		\$27,792
16.0	450.0		\$27,792	450.0		\$27,792

24 Nov 2015

Project: **Wareham Vulnerability  
Assessment**

Pg 76 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachus  
etts**

Point of Contact:

Analyst:

## Other Benefits

### Other Benefits Before Mitigation

No Data

### Other Benefits After Mitigation

No Data

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 77 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Loss of Services**

**Fire Station:**

Number of People Served by this Fire Station: 2,700

Type of Area Served by this Fire Station: Urban

Distance in miles between this fire station and the fire station that would provide fire protection for the geographical area normally served by this fire station: 0.50

Fire Station Provide Emergency Medical Services (EMS)? No

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$41,755,827
Present Value:	\$65,587,358

Annual:	\$0
Present Value:	\$0

Annual:	\$41,755,827
Present Value:	\$65,587,358

Mitigation Benefits: \$65,587,358

Mitigation Costs: \$2,670,000

Benefits Minus Costs: \$62,917,358

Benefit-Cost Ratio: 24.56

**Cost Estimate**

Project Useful Life (years): 20

Construction Type:

Mitigation Project Cost: \$2,670,000

Detailed Scope of Work: Yes

Annual Project Maintenance Cost: \$0

Detailed Estimate for Entire Project: Yes

Final Mitigation Project Cost: \$2,670,000

Years of Maintenance: 20

Cost Basis Year:

Present Worth of Annual Maintenance Costs: \$0

Construction Start Year:

Estimate Reflects Current Prices: Yes

Construction End Year:

Project Escalation:

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 78 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
Annual Project Maintenance Cost	No anticipated increase in O&M for the pump station	
Building contents - other	Estimated cost of equipment.	
Displacement costs	Housing @ \$150/night for all the people dependent on PS for sewer service.	
Dry Flood Proofing/Flood Barrier	Scope of project - Install watertight doors, floodproof painting, raise louver above the DFE, replace past useful life equipment, structurally reinforce masonry wall	
Mitigation Project Cost	Allowance.	
Number of Hours Volunteered/Person	Working 16 hours a day for a month	
Number of Persons:	Number of people dependent on pump station.	
Number of Volunteers Required	Quarter of the fire department volunteering to help cleanup after station has flooded.	
Number of Workers:	Number of people dependent on pump station	
One-Time displacement costs	1/2 tank of gas per person displaced to find alternative lodging.	
Project useful life	Industry standard for mechanic life.	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 79 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** Narrows, 1 Merchants Way, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$99,761,561

Costs: \$2,630,000

BCR: 37.93

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude:

Longitude:

Size of Building: 630

BRV (\$/sf): \$250.00

Total BRV: \$157,500

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 10.75

First Floor Being Raised:

Demolition Threshold: 100.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 489

FIRM Effective Date: 02/05/2014

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$2,600,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 6.50

Flood Zone Determination: Coastal A

Breaking Wave Height: 19.85

Utilities that are not elevated: No

Height FFE Above Grade: 4.25

One Time Displacement Costs: \$164,250

NFIP: No

Displacement Costs: \$29,565,000

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

**Lost Productivity**

Number of Person: 6,570

Number of Worker: 6,570

Treatment Costs per person: \$2,443.00

Productivity Loss per person: \$8,736.00

Total Mental Stress and Anxiety Cost: \$16,050,510.00

Total Lost Productivity Cost: \$57,395,520.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 14.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 17.8000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 0.00

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$14,490	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$22,838	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$27,878	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$35,595	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$43,943	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$46,778	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$51,818	0.0%	0.0%	\$0
8.0	36.8%	0.0%	\$57,960	36.8%	0.0%	\$57,960
9.0	38.4%	0.0%	\$60,480	38.4%	0.0%	\$60,480
10.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
11.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
12.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
13.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
14.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
15.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788
16.0	40.5%	0.0%	\$63,788	40.5%	0.0%	\$63,788



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$650,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$962,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$1,222,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$1,430,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,638,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,924,000	0.0%	0.0%	\$0
8.0	83.0%	0.0%	\$2,158,000	83.0%	0.0%	\$2,158,000
9.0	84.0%	0.0%	\$2,184,000	84.0%	0.0%	\$2,184,000
10.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
11.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
12.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
13.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
14.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
15.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
16.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$87,480,000	0.0		\$0
3.0	135.0		\$131,220,000	0.0		\$0
4.0	180.0		\$174,960,000	0.0		\$0
5.0	225.0		\$218,700,000	0.0		\$0
6.0	270.0		\$262,440,000	0.0		\$0
7.0	315.0		\$306,180,000	0.0		\$0
8.0	360.0		\$349,920,000	360.0		\$349,920,000
9.0	405.0		\$393,660,000	405.0		\$393,660,000
10.0	450.0		\$437,400,000	450.0		\$437,400,000
11.0	450.0		\$437,400,000	450.0		\$437,400,000
12.0	450.0		\$437,400,000	450.0		\$437,400,000
13.0	450.0		\$437,400,000	450.0		\$437,400,000
14.0	450.0		\$437,400,000	450.0		\$437,400,000
15.0	450.0		\$437,400,000	450.0		\$437,400,000
16.0	450.0		\$437,400,000	450.0		\$437,400,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$264,762	0.0		\$0
3.0	135.0		\$397,143	0.0		\$0
4.0	180.0		\$529,524	0.0		\$0
5.0	225.0		\$661,905	0.0		\$0
6.0	270.0		\$794,286	0.0		\$0
7.0	315.0		\$926,667	0.0		\$0
8.0	360.0		\$1,059,048	360.0		\$1,059,048
9.0	405.0		\$1,191,429	405.0		\$1,191,429
10.0	450.0		\$1,323,810	450.0		\$1,323,810
11.0	450.0		\$1,323,810	450.0		\$1,323,810
12.0	450.0		\$1,323,810	450.0		\$1,323,810
13.0	450.0		\$1,323,810	450.0		\$1,323,810
14.0	450.0		\$1,323,810	450.0		\$1,323,810
15.0	450.0		\$1,323,810	450.0		\$1,323,810
16.0	450.0		\$1,323,810	450.0		\$1,323,810

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 85 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

## Other Benefits

### Other Benefits Before Mitigation

No Data

### Other Benefits After Mitigation

No Data

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 86 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Loss of Services**

**Hospital:**

Number of People Served by this Hospital: 20,822

Distance in miles between this hospital and the hospital that would treat these people in the event this hospital was inoperative: 18.20

Number of People Normally Served by the Alternate Hospital: 56,468

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$75,930,030
Present Value:	\$99,761,561

Annual:	\$0
Present Value:	\$0

Annual:	\$75,930,030
Present Value:	\$99,761,561

Mitigation Benefits: \$99,761,561

Mitigation Costs: \$2,630,000

Benefits Minus Costs: \$97,131,561

Benefit-Cost Ratio: 37.93

**Cost Estimate**

Project Useful Life (years): 20

Construction Type:

Mitigation Project Cost: \$2,630,000

Detailed Scope of Work: Yes

Annual Project Maintenance Cost: \$0

Detailed Estimate for Entire Project: Yes

Final Mitigation Project Cost: \$2,630,000

Years of Maintenance: 20

Cost Basis Year:

Present Worth of Annual Maintenance Costs: \$0

Construction Start Year:

Estimate Reflects Current Prices: Yes

Construction End Year:

Project Escalation:

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 87 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
Annual Project Maintenance Cost	No anticipated O&M increase at pump station.	
Displacement costs	Cost of housing displaced population at a hotel for \$150/night	
Distance between hospitals	Distance between Tobey Hospital and New Bedford St. Luke's Hospital	
How many people are normally served by the alternate hospital	New Bedford's population	
How many people are served by this hospital	Population of Wareham	
Mitigation Project Cost	Scope of work - install watertight door, floodproof painting, raise louver above the DFE, replace all past useful life equipment, structurally reinforce masonry wall to withstand hydrostatic pressure of BFE	
One-Time displacement costs	cost of half a tank of gas for each person displaced to find alternative lodging.	
Per-Person Cost of Lodging for a Volunteer	Require quarter of fire department to clean up contamination after pump station flooding. Estimated month long clean-up time.	
Project useful life	Industry standard for equipment useful life.	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 88 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** North Blvd, 17 North Blvd, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$31,033,069

Costs: \$2,920,000

BCR: 10.63

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude: 41.747852000000

Longitude: -70.659357000000

Size of Building: 270

BRV (\$/sf): \$250.00

Total BRV: \$67,500

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 11.14

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 581K

FIRM Effective Date: 02/05/2014

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$2,100,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 6.90

Flood Zone Determination: Coastal A

Breaking Wave Height: 19.85

Utilities that are not elevated: No

Height FFE Above Grade: 4.24

One Time Displacement Costs: \$10,550

NFIP: No

Displacement Costs: \$1,899,000

ICC: No

### Street Maintenance Details

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

### Volunteer Costs

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

**Lost Productivity**

Number of Person: 422

Number of Worker: 422

Treatment Costs per person: \$2,443.00

Productivity Loss per person: \$8,736.00

Total Mental Stress and Anxiety Cost: \$1,030,946.00

Total Lost Productivity Cost: \$3,686,592.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 14.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 17.8000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 14.60

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$6,210	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$9,788	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$11,948	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$15,255	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$18,833	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$20,048	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$22,208	32.9%	0.0%	\$22,208
8.0	36.8%	0.0%	\$24,840	36.8%	0.0%	\$24,840
9.0	38.4%	0.0%	\$25,920	38.4%	0.0%	\$25,920
10.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
11.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
12.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
13.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
14.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
15.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
16.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$525,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$777,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$987,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$1,155,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,323,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,554,000	74.0%	0.0%	\$1,554,000
8.0	83.0%	0.0%	\$1,743,000	83.0%	0.0%	\$1,743,000
9.0	84.0%	0.0%	\$1,764,000	84.0%	0.0%	\$1,764,000
10.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
11.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
12.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
13.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
14.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
15.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
16.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$5,618,959	0.0		\$0
3.0	135.0		\$8,428,438	0.0		\$0
4.0	180.0		\$11,237,918	0.0		\$0
5.0	225.0		\$14,047,397	0.0		\$0
6.0	270.0		\$16,856,877	0.0		\$0
7.0	315.0		\$19,666,356	315.0		\$19,666,356
8.0	360.0		\$22,475,836	360.0		\$22,475,836
9.0	405.0		\$25,285,315	405.0		\$25,285,315
10.0	450.0		\$28,094,795	450.0		\$28,094,795
11.0	450.0		\$28,094,795	450.0		\$28,094,795
12.0	450.0		\$28,094,795	450.0		\$28,094,795
13.0	450.0		\$28,094,795	450.0		\$28,094,795
14.0	450.0		\$28,094,795	450.0		\$28,094,795
15.0	450.0		\$28,094,795	450.0		\$28,094,795
16.0	450.0		\$28,094,795	450.0		\$28,094,795

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$0	0.0		\$0
3.0	135.0		\$0	0.0		\$0
4.0	180.0		\$0	0.0		\$0
5.0	225.0		\$0	0.0		\$0
6.0	270.0		\$0	0.0		\$0
7.0	315.0		\$0	315.0		\$0
8.0	360.0		\$0	360.0		\$0
9.0	405.0		\$0	405.0		\$0
10.0	450.0		\$0	450.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 94 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$7,201,538
Present Value:	\$31,033,069

Annual:	\$0
Present Value:	\$0

Annual:	\$7,201,538
Present Value:	\$31,033,069

Mitigation Benefits: \$31,033,069

Mitigation Costs: \$2,920,000

Benefits Minus Costs: \$28,113,069

Benefit-Cost Ratio: 10.63

24 Nov 2015

Project: **Wareham Vulnerability  
Assessment**

Pg 95 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	20	Construction Type:	
Mitigation Project Cost:	\$2,920,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$2,920,000	Years of Maintenance:	20
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	No
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 96 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Justification/Attachments

Field	Description	Attachments
Barrier Elevation	DFE for 2065 (estimated structural life)	
Building contents - other	Estimated equipment replacement cost.	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 97 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** Onset Pier, 178 Onset Ave., Wareham, Massachusetts, 02571, Plymouth

Benefits: \$45,152,146

Costs: \$2,460,000

BCR: 18.35

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude: 41.741487000000

Longitude: -70.657673000000

Size of Building: 270

BRV (\$/sf): \$250.00

Total BRV: \$67,500

Residential: No

Building Type:

Obstruction: No

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 15.00

First Floor Being Raised:

Demolition Threshold: 100.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 581K

FIRM Effective Date: 02/05/2014

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal V

Loss of Rent:

Building Contents: \$2,100,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 11.70

Flood Zone Determination: Coastal V

Breaking Wave Height: 31.20

Utilities that are not elevated: No

Height FFE Above Grade: 3.30

One Time Displacement Costs: \$42,125

NFIP: No

Displacement Costs: \$7,582,500

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

Number of Person: 1,685

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$4,116,455.00

**Lost Productivity**

Number of Worker: 1,685

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$14,720,160.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 22.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 25.8000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 0.00

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$6,210	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$9,788	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$11,948	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$15,255	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$18,833	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$20,048	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$22,208	0.0%	0.0%	\$0
8.0	36.8%	0.0%	\$24,840	0.0%	0.0%	\$0
9.0	38.4%	0.0%	\$25,920	0.0%	0.0%	\$0
10.0	40.5%	0.0%	\$27,338	0.0%	0.0%	\$0
11.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
12.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
13.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
14.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
15.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
16.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$525,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$777,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$987,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$1,155,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,323,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,554,000	0.0%	0.0%	\$0
8.0	83.0%	0.0%	\$1,743,000	0.0%	0.0%	\$0
9.0	84.0%	0.0%	\$1,764,000	0.0%	0.0%	\$0
10.0	86.0%	0.0%	\$1,806,000	0.0%	0.0%	\$0
11.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
12.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
13.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
14.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
15.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
16.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$22,435,890	0.0		\$0
3.0	135.0		\$33,653,836	0.0		\$0
4.0	180.0		\$44,871,781	0.0		\$0
5.0	225.0		\$56,089,726	0.0		\$0
6.0	270.0		\$67,307,671	0.0		\$0
7.0	315.0		\$78,525,616	0.0		\$0
8.0	360.0		\$89,743,562	0.0		\$0
9.0	405.0		\$100,961,507	0.0		\$0
10.0	450.0		\$112,179,452	0.0		\$0
11.0	450.0		\$112,179,452	450.0		\$112,179,452
12.0	450.0		\$112,179,452	450.0		\$112,179,452
13.0	450.0		\$112,179,452	450.0		\$112,179,452
14.0	450.0		\$112,179,452	450.0		\$112,179,452
15.0	450.0		\$112,179,452	450.0		\$112,179,452
16.0	450.0		\$112,179,452	450.0		\$112,179,452

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$0	0.0		\$0
3.0	135.0		\$0	0.0		\$0
4.0	180.0		\$0	0.0		\$0
5.0	225.0		\$0	0.0		\$0
6.0	270.0		\$0	0.0		\$0
7.0	315.0		\$0	0.0		\$0
8.0	360.0		\$0	0.0		\$0
9.0	405.0		\$0	0.0		\$0
10.0	450.0		\$0	0.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 103 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

## Other Benefits

### Other Benefits Before Mitigation

No Data

### Other Benefits After Mitigation

No Data

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 104 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Loss of Services**

**Fire Station:**

Number of People Served by this Fire Station: 2,700

Type of Area Served by this Fire Station: Urban

Distance in miles between this fire station and the fire station that would provide fire protection for the geographical area normally served by this fire station: 0.50

Fire Station Provide Emergency Medical Services (EMS)? No

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual: \$21,320,615	Annual: \$0	Annual: \$21,320,615
Present Value: \$45,152,146	Present Value: \$0	Present Value: \$45,152,146

Mitigation Benefits: \$45,152,146

Mitigation Costs: \$2,460,000

Benefits Minus Costs: \$42,692,146

Benefit-Cost Ratio: 18.35

**Cost Estimate**

Project Useful Life (years): 20	Construction Type:	
Mitigation Project Cost: \$2,460,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost: \$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost: \$2,460,000	Years of Maintenance:	20
Cost Basis Year:	Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:	Estimate Reflects Current Prices:	Yes
Construction End Year:	Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 105 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
Displacement costs	Estimated equipment cost	



24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 106 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** Parkwood Drive, 89 Parkwood Drive, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$

Costs: \$

BCR: .00

**Structure and Mitigation Details For:** Pinehurst, 23 Franconia Ave., Wareham, Massachusetts, 02571, Plymouth

Benefits: \$33,838,998

Costs: \$2,510,000

BCR: 13.48

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude:

Longitude:

Size of Building: 270

BRV (\$/sf): \$250.00

Total BRV: \$67,500

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 14.60

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 0

FIRM Effective Date: 01/01/1900

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$2,100,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 11.20

Flood Zone Determination: Coastal A

Breaking Wave Height: 19.85

Utilities that are not elevated: No

Height FFE Above Grade: 3.40

One Time Displacement Costs: \$16,825

NFIP: No

Displacement Costs: \$3,028,500

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 107 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

**Lost Productivity**

Number of Person: 673

Number of Worker: 673

Treatment Costs per person: \$2,443.00

Productivity Loss per person: \$8,736.00

Total Mental Stress and Anxiety Cost: \$1,644,139.00

Total Lost Productivity Cost: \$5,879,328.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 14.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 16.6000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 14.60

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 108 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$6,210	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$9,788	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$11,948	17.7%	0.0%	\$11,948
4.0	22.6%	0.0%	\$15,255	22.6%	0.0%	\$15,255
5.0	27.9%	0.0%	\$18,833	27.9%	0.0%	\$18,833
6.0	29.7%	0.0%	\$20,048	29.7%	0.0%	\$20,048
7.0	32.9%	0.0%	\$22,208	32.9%	0.0%	\$22,208
8.0	36.8%	0.0%	\$24,840	36.8%	0.0%	\$24,840
9.0	38.4%	0.0%	\$25,920	38.4%	0.0%	\$25,920
10.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
11.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
12.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
13.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
14.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
15.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338
16.0	40.5%	0.0%	\$27,338	40.5%	0.0%	\$27,338

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$525,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$777,000	37.0%	0.0%	\$777,000
4.0	47.0%	0.0%	\$987,000	47.0%	0.0%	\$987,000
5.0	55.0%	0.0%	\$1,155,000	55.0%	0.0%	\$1,155,000
6.0	63.0%	0.0%	\$1,323,000	63.0%	0.0%	\$1,323,000
7.0	74.0%	0.0%	\$1,554,000	74.0%	0.0%	\$1,554,000
8.0	83.0%	0.0%	\$1,743,000	83.0%	0.0%	\$1,743,000
9.0	84.0%	0.0%	\$1,764,000	84.0%	0.0%	\$1,764,000
10.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
11.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
12.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
13.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
14.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
15.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
16.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$8,961,041	0.0		\$0
3.0	135.0		\$13,441,562	135.0		\$13,441,562
4.0	180.0		\$17,922,082	180.0		\$17,922,082
5.0	225.0		\$22,402,603	225.0		\$22,402,603
6.0	270.0		\$26,883,123	270.0		\$26,883,123
7.0	315.0		\$31,363,644	315.0		\$31,363,644
8.0	360.0		\$35,844,164	360.0		\$35,844,164
9.0	405.0		\$40,324,685	405.0		\$40,324,685
10.0	450.0		\$44,805,205	450.0		\$44,805,205
11.0	450.0		\$44,805,205	450.0		\$44,805,205
12.0	450.0		\$44,805,205	450.0		\$44,805,205
13.0	450.0		\$44,805,205	450.0		\$44,805,205
14.0	450.0		\$44,805,205	450.0		\$44,805,205
15.0	450.0		\$44,805,205	450.0		\$44,805,205
16.0	450.0		\$44,805,205	450.0		\$44,805,205

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$0	0.0		\$0
3.0	135.0		\$0	135.0		\$0
4.0	180.0		\$0	180.0		\$0
5.0	225.0		\$0	225.0		\$0
6.0	270.0		\$0	270.0		\$0
7.0	315.0		\$0	315.0		\$0
8.0	360.0		\$0	360.0		\$0
9.0	405.0		\$0	405.0		\$0
10.0	450.0		\$0	450.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 113 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$10,007,467
Present Value:	\$33,838,998

Annual:	\$0
Present Value:	\$0

Annual:	\$10,007,467
Present Value:	\$33,838,998

Mitigation Benefits: \$33,838,998

Mitigation Costs: \$2,510,000

Benefits Minus Costs: \$31,328,998

Benefit-Cost Ratio: 13.48



24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 114 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	20	Construction Type:	
Mitigation Project Cost:	\$2,510,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$2,510,000	Years of Maintenance:	20
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	Yes
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 115 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
Displacement costs	Estimated equipment replacement cost.	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 116 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** Ruggles, 7 Ruggles Street, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$31,491,408

Costs: \$870,000

BCR: 36.20

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude:

Longitude:

Size of Building: 320

BRV (\$/sf): \$250.00

Total BRV: \$80,000

Residential: No

Building Type:

Obstruction: No

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 14.60

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 0

FIRM Effective Date: 01/01/1900

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal V

Loss of Rent: \$0

Building Contents: \$2,600,000 (Other)

Value of Crawlspace Contents: \$0

Ground Surface Elevation: 5.90

Flood Zone Determination: Coastal V

Breaking Wave Height: 0.00

Utilities that are not elevated: No

Height FFE Above Grade: 8.70

One Time Displacement Costs: \$11,575

NFIP: No

Displacement Costs: \$2,083,500

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

Number of Person: 463

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$1,131,109.00

**Lost Productivity**

Number of Worker: 463

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$4,044,768.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 20.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 23.8000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 20.60

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$7,360	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$11,600	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$14,160	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$18,080	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$22,320	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$23,760	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$26,320	0.0%	0.0%	\$0
8.0	36.8%	0.0%	\$29,440	0.0%	0.0%	\$0
9.0	38.4%	0.0%	\$30,720	0.0%	0.0%	\$0
10.0	40.5%	0.0%	\$32,400	40.5%	0.0%	\$32,400
11.0	40.5%	0.0%	\$32,400	40.5%	0.0%	\$32,400
12.0	40.5%	0.0%	\$32,400	40.5%	0.0%	\$32,400
13.0	40.5%	0.0%	\$32,400	40.5%	0.0%	\$32,400
14.0	40.5%	0.0%	\$32,400	40.5%	0.0%	\$32,400
15.0	40.5%	0.0%	\$32,400	40.5%	0.0%	\$32,400
16.0	40.5%	0.0%	\$32,400	40.5%	0.0%	\$32,400

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$650,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$962,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$1,222,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$1,430,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,638,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,924,000	0.0%	0.0%	\$0
8.0	83.0%	0.0%	\$2,158,000	0.0%	0.0%	\$0
9.0	84.0%	0.0%	\$2,184,000	0.0%	0.0%	\$0
10.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
11.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
12.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
13.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
14.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
15.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000
16.0	86.0%	0.0%	\$2,236,000	86.0%	0.0%	\$2,236,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$6,164,877	0.0		\$0
3.0	135.0		\$9,247,315	0.0		\$0
4.0	180.0		\$12,329,753	0.0		\$0
5.0	225.0		\$15,412,192	0.0		\$0
6.0	270.0		\$18,494,630	0.0		\$0
7.0	315.0		\$21,577,068	0.0		\$0
8.0	360.0		\$24,659,507	0.0		\$0
9.0	405.0		\$27,741,945	0.0		\$0
10.0	450.0		\$30,824,384	450.0		\$30,824,384
11.0	450.0		\$30,824,384	450.0		\$30,824,384
12.0	450.0		\$30,824,384	450.0		\$30,824,384
13.0	450.0		\$30,824,384	450.0		\$30,824,384
14.0	450.0		\$30,824,384	450.0		\$30,824,384
15.0	450.0		\$30,824,384	450.0		\$30,824,384
16.0	450.0		\$30,824,384	450.0		\$30,824,384

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$0	0.0		\$0
3.0	135.0		\$0	0.0		\$0
4.0	180.0		\$0	0.0		\$0
5.0	225.0		\$0	0.0		\$0
6.0	270.0		\$0	0.0		\$0
7.0	315.0		\$0	0.0		\$0
8.0	360.0		\$0	0.0		\$0
9.0	405.0		\$0	0.0		\$0
10.0	450.0		\$0	450.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0



24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 122 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$7,659,877
Present Value:	\$31,491,408

Annual:	\$0
Present Value:	\$0

Annual:	\$7,659,877
Present Value:	\$31,491,408

Mitigation Benefits: \$31,491,408

Mitigation Costs: \$870,000

Benefits Minus Costs: \$30,621,408

Benefit-Cost Ratio: 36.20

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 123 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	20	Construction Type:	
Mitigation Project Cost:	\$870,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$870,000	Years of Maintenance:	20
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	Yes
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 124 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
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24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 125 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** Saltworks, 1 Wychunas Ave, Wareham MA, Massachusetts, 02571, Plymouth

Benefits: \$39,786,226

Costs: \$2,640,000

BCR: 15.07

Hazard: **Flood**

Mitigation Option: Other flood proofing measures

Latitude: 41.757227000000

Longitude: -70.630452000000

Size of Building: 299

BRV (\$/sf): \$250.00

Total BRV: \$74,750

Residential: No

Building Type:

Obstruction: No

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 14.80

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 249J

FIRM Effective Date: 01/01/1900

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal V

Loss of Rent:

Building Contents: \$2,100,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 12.10

Flood Zone Determination: Coastal V

Breaking Wave Height: 29.78

Utilities that are not elevated: No

Height FFE Above Grade: 2.70

One Time Displacement Costs: \$30,125

NFIP: No

Displacement Costs: \$5,422,500

ICC: No

### Street Maintenance Details

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

### Volunteer Costs

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

Number of Person: 1,205

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$2,943,815.00

**Lost Productivity**

Number of Worker: 1,205

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$10,526,880.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 21.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped:

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 0.00

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.0	0.0	0.0
50	2.00%	0.0	0.0	0.0	0.0
100	1.00%	0.0	0.0	0.0	0.0
500	0.20%	0.0	0.0	0.0	0.0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$6,877	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$10,839	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$13,231	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$16,894	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$20,855	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$22,201	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$24,593	0.0%	0.0%	\$0
8.0	36.8%	0.0%	\$27,508	0.0%	0.0%	\$0
9.0	38.4%	0.0%	\$28,704	0.0%	0.0%	\$0
10.0	40.5%	0.0%	\$30,274	0.0%	0.0%	\$0
11.0	40.5%	0.0%	\$30,274	0.0%	0.0%	\$0
12.0	40.5%	0.0%	\$30,274	0.0%	0.0%	\$0
13.0	40.5%	0.0%	\$30,274	0.0%	0.0%	\$0
14.0	40.5%	0.0%	\$30,274	0.0%	0.0%	\$0
15.0	40.5%	0.0%	\$30,274	0.0%	0.0%	\$0
16.0	40.5%	0.0%	\$30,274	0.0%	0.0%	\$0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$525,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$777,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$987,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$1,155,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,323,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,554,000	0.0%	0.0%	\$0
8.0	83.0%	0.0%	\$1,743,000	0.0%	0.0%	\$0
9.0	84.0%	0.0%	\$1,764,000	0.0%	0.0%	\$0
10.0	86.0%	0.0%	\$1,806,000	0.0%	0.0%	\$0
11.0	86.0%	0.0%	\$1,806,000	0.0%	0.0%	\$0
12.0	86.0%	0.0%	\$1,806,000	0.0%	0.0%	\$0
13.0	86.0%	0.0%	\$1,806,000	0.0%	0.0%	\$0
14.0	86.0%	0.0%	\$1,806,000	0.0%	0.0%	\$0
15.0	86.0%	0.0%	\$1,806,000	0.0%	0.0%	\$0
16.0	86.0%	0.0%	\$1,806,000	0.0%	0.0%	\$0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0					
-1.0	0.0					
0.0	0.0					
1.0	45.0					
2.0	90.0		\$16,044,658			\$0
3.0	135.0		\$24,066,986			\$0
4.0	180.0		\$32,089,315			\$0
5.0	225.0		\$40,111,644			\$0
6.0	270.0		\$48,133,973			\$0
7.0	315.0		\$56,156,301			\$0
8.0	360.0		\$64,178,630			\$0
9.0	405.0		\$72,200,959			\$0
10.0	450.0		\$80,223,288			\$0
11.0	450.0		\$80,223,288			\$0
12.0	450.0		\$80,223,288			\$0
13.0	450.0		\$80,223,288			\$0
14.0	450.0		\$80,223,288			\$0
15.0	450.0		\$80,223,288			\$0
16.0	450.0		\$80,223,288			\$0



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0					
-1.0	0.0					
0.0	0.0					
1.0	45.0					
2.0	90.0		\$0			\$0
3.0	135.0		\$0			\$0
4.0	180.0		\$0			\$0
5.0	225.0		\$0			\$0
6.0	270.0		\$0			\$0
7.0	315.0		\$0			\$0
8.0	360.0		\$0			\$0
9.0	405.0		\$0			\$0
10.0	450.0		\$0			\$0
11.0	450.0		\$0			\$0
12.0	450.0		\$0			\$0
13.0	450.0		\$0			\$0
14.0	450.0		\$0			\$0
15.0	450.0		\$0			\$0
16.0	450.0		\$0			\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 131 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual: \$15,954,695

Present Value: \$39,786,226

Annual: \$0

Present Value: \$0

Annual: \$15,954,695

Present Value: \$39,786,226

Mitigation Benefits: \$39,786,226

Benefits Minus Costs: \$37,146,226

Mitigation Costs: \$2,640,000

Benefit-Cost Ratio: 15.07

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 132 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	20	Construction Type:	
Mitigation Project Cost:	\$2,640,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$2,640,000	Years of Maintenance:	20
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	Yes
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 133 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
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24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 134 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** Smith Avenue, 5 Smith Avenue, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$56,943,111

Costs: \$2,830,000

BCR: 20.12

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude: 41.743024000000

Longitude: -70.715688000000

Size of Building: 570

BRV (\$/sf): \$250.00

Total BRV: \$142,500

Residential: No

Building Type:

Obstruction: No

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 15.10

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 25023C0577J

FIRM Effective Date: 07/17/2012

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal V

Loss of Rent: \$0

Building Contents: \$98,325 (Default)

Value of Crawlspace Contents: \$0

Ground Surface Elevation: 8.80

Flood Zone Determination: Coastal V

Breaking Wave Height: 25.53

Utilities that are not elevated: No

Height FFE Above Grade: 6.30

One Time Displacement Costs: \$0

NFIP: No

Displacement Costs: \$0

ICC: No

### Street Maintenance Details

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs

\$0.00

### Volunteer Costs

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 135 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$150.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$120.00

Cost of Volunteers: \$3,024,000.00

**Social Benefits**

**Mental Stress and Anxiety**

**Lost Productivity**

Number of Person: 2,228

Number of Worker: 2,228

Treatment Costs per person: \$2,443.00

Productivity Loss per person: \$8,736.00

Total Mental Stress and Anxiety Cost: \$5,443,004.00

Total Lost Productivity Cost: \$19,463,808.00

0

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 18.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 20.6000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 18.60

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.6	0.0	0.6
50	2.00%	0.0	0.6	0.0	0.6
100	1.00%	0.0	0.6	0.0	0.6
500	0.20%	0.0	0.6	0.0	0.6

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$13,110	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$20,663	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$25,223	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$32,205	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$39,758	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$42,323	29.7%	0.0%	\$42,323
7.0	32.9%	0.0%	\$46,883	32.9%	0.0%	\$46,883
8.0	36.8%	0.0%	\$52,440	36.8%	0.0%	\$52,440
9.0	38.4%	0.0%	\$54,720	38.4%	0.0%	\$54,720
10.0	40.5%	0.0%	\$57,713	40.5%	0.0%	\$57,713
11.0	40.5%	0.0%	\$57,713	40.5%	0.0%	\$57,713
12.0	40.5%	0.0%	\$57,713	40.5%	0.0%	\$57,713
13.0	40.5%	0.0%	\$57,713	40.5%	0.0%	\$57,713
14.0	40.5%	0.0%	\$57,713	40.5%	0.0%	\$57,713
15.0	40.5%	0.0%	\$57,713	40.5%	0.0%	\$57,713
16.0	40.5%	0.0%	\$57,713	40.5%	0.0%	\$57,713

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$24,581	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$36,380	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$46,213	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$54,079	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$61,945	63.0%	0.0%	\$61,945
7.0	74.0%	0.0%	\$72,761	74.0%	0.0%	\$72,761
8.0	83.0%	0.0%	\$81,610	83.0%	0.0%	\$81,610
9.0	84.0%	0.0%	\$82,593	84.0%	0.0%	\$82,593
10.0	86.0%	0.0%	\$84,560	86.0%	0.0%	\$84,560
11.0	86.0%	0.0%	\$84,560	86.0%	0.0%	\$84,560
12.0	86.0%	0.0%	\$84,560	86.0%	0.0%	\$84,560
13.0	86.0%	0.0%	\$84,560	86.0%	0.0%	\$84,560
14.0	86.0%	0.0%	\$84,560	86.0%	0.0%	\$84,560
15.0	86.0%	0.0%	\$84,560	86.0%	0.0%	\$84,560
16.0	86.0%	0.0%	\$84,560	86.0%	0.0%	\$84,560



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$0	0.0		\$0
3.0	135.0		\$0	0.0		\$0
4.0	180.0		\$0	0.0		\$0
5.0	225.0		\$0	0.0		\$0
6.0	270.0		\$0	270.0		\$0
7.0	315.0		\$0	315.0		\$0
8.0	360.0		\$0	360.0		\$0
9.0	405.0		\$0	405.0		\$0
10.0	450.0		\$0	450.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$264,762	0.0		\$0
3.0	135.0		\$397,143	0.0		\$0
4.0	180.0		\$529,524	0.0		\$0
5.0	225.0		\$661,905	0.0		\$0
6.0	270.0		\$794,286	270.0		\$794,286
7.0	315.0		\$926,667	315.0		\$926,667
8.0	360.0		\$1,059,048	360.0		\$1,059,048
9.0	405.0		\$1,191,429	405.0		\$1,191,429
10.0	450.0		\$1,323,810	450.0		\$1,323,810
11.0	450.0		\$1,323,810	450.0		\$1,323,810
12.0	450.0		\$1,323,810	450.0		\$1,323,810
13.0	450.0		\$1,323,810	450.0		\$1,323,810
14.0	450.0		\$1,323,810	450.0		\$1,323,810
15.0	450.0		\$1,323,810	450.0		\$1,323,810
16.0	450.0		\$1,323,810	450.0		\$1,323,810

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 140 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

## Other Benefits

### Other Benefits Before Mitigation

No Data

### Other Benefits After Mitigation

No Data

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 141 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Loss of Services**

**Fire Station:**

Number of People Served by this Fire Station: 20,335

Type of Area Served by this Fire Station: Urban

Distance in miles between this fire station and the fire station that would provide fire protection for the geographical area normally served by this fire station: 2.10

Fire Station Provide Emergency Medical Services (EMS)? No

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual: \$27,930,812	Annual: \$0	Annual: \$27,930,812
Present Value: \$56,943,111	Present Value: \$0	Present Value: \$56,943,111

Mitigation Benefits: \$56,943,111

Mitigation Costs: \$2,830,000

Benefits Minus Costs: \$54,113,111

Benefit-Cost Ratio: 20.12

**Cost Estimate**

Project Useful Life (years): 20	Construction Type:	
Mitigation Project Cost: \$2,830,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost: \$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost: \$2,830,000	Years of Maintenance:	20
Cost Basis Year:	Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:	Estimate Reflects Current Prices:	Yes
Construction End Year:	Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 142 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
Annual Project Maintenance Cost	Annual pump station maintenance not expected to increase as a result of this project.	
Dry Flood Proofing/Flood Barrier	Scope of project: Installation of a 2' tall flood barrier at each of the pump stations doors, applying flood proof paint to the inside of the station and replacing equipment which is past its useful life.	
First Floor Elevation	First floor elevation	
Mitigation Project Cost	Estimated cost to install 2' flood doors at each door in the pumping station, apply flood proof paint to the interior of the station and replace all mechanical equipment which is past its useful life.	
Number of Persons:	Number of people dependent on Smith Pump Station (people within Smith Pump Station sewershed and all upstream pump stations that would not be able to function if Smith Pump Station was down).	
Number of Workers:	Number of people that would not have sewer service - both in Smith Pump Station sewershed and sewersheds upstream of the station that would also be affected if it were down.	
Other Elevation Source	Survey data from Greenseal Environmental, Inc.	
Project useful life	Industry specified useful life for mechanical equipment.	
Total size of building	Estimated square footage for building footprint.	
Value of building (BRV) (\$/sf)	Estimated based on experience from similar projects.	
Value of Projected SLR Increase	USACE Sea Level Calculator estimation of SLR for 2035 (end of equipment useful life)	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 143 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:** South Blvd, 42 South Blvd, Wareham, Massachusetts, 01570, Plymouth

Benefits: \$

Costs: \$

BCR: .00

Hazard: **Flood**

Mitigation Option: Other flood proofing measures

Latitude: 41.739953000000

Longitude: -70.663207000000

Size of Building:

BRV (\$/sf):

Total BRV:

Residential: Yes

Building Type:

Obstruction: No

Foundation Type:

Basement: No

Building Primary Use:

Structure Type:

Historic Building: No

Structure Elevation: 0.00

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 0

Effective FIS Date: 07/17/2012

FIRM Panel Number: 0

FIRM Effective Date: 02/05/2014

Project Useful Life: 0

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal V

Loss of Rent: \$0

Building Contents: \$0 (Default)

Value of Crawlspace Contents: \$0

Ground Surface Elevation: 0.00

Flood Zone Determination: Coastal V

Breaking Wave Height: 0.00

Utilities that are not elevated: No

Height FFE Above Grade: 0.00

One Time Displacement Costs: \$0

Grade:

NFIP: No

Displacement Costs: \$0 (Default)

ICC: No

Current federal lodging per diem: \$77

Population affected : 0

Current federal meals per diem: \$46

Cost per person to eat meals at home: \$7

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Volunteer Costs**

Number of Volunteers Required:	0	Number of Hours Volunteered/Person:	0
Cost of Volunteers Time (\$/Hour/Person):	\$0.00	Number of Days Lodging/Volunteer:	0
Per-Person Cost of Lodging for a Volunteer:	\$0.00	Cost of Volunteers:	\$0.00

**Social Benefits**

**Mental Stress and Anxiety**

**Lost Productivity**

Number of Person:	0	Number of Worker:	0
Treatment Costs per person:	\$2,443.00	Productivity Loss per person:	\$8,736.00
Total Mental Stress and Anxiety Cost:	\$0.00	Total Lost Productivity Cost:	\$0.00

**Coastal Flood Elevations**

Flood Source Name:  
 Base Flood Elevation: 0.00      Flood Profile Number:  
 Elevation At Which Barrier Will Be Overtopped:  
 FEMA Elevation Certificate Diagram Description: Diagram 9      Other Elevation Source:  
 Has Sea Level Rise Been Included? No      Sea Level Rise Increase: 0.00  
 Base Flood Elevation With Sea Level Rise: 0.00

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.0	0.0	0.0
50	2.00%	0.0	0.0	0.0	0.0
100	1.00%	0.0	0.0	0.0	0.0
500	0.20%	0.0	0.0	0.0	0.0

24 Nov 2015

Project: **Wareham Vulnerability  
Assessment**

Pg 145 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachus  
etts**

Point of Contact:

Analyst:



24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 146 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual:	\$0
Present Value:	\$0

Annual:	\$0
Present Value:	\$0

Annual:	\$0
Present Value:	\$0

Mitigation Benefits: \$0

Mitigation Costs: \$0

Benefits Minus Costs: \$0

Benefit-Cost Ratio: NaN

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 147 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	0	Construction Type:	
Mitigation Project Cost:	\$0	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$0	Years of Maintenance:	0
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	No
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 148 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
Annual Project Maintenance Cost	Scope of project - raise vent above FED, replace well past useful life equipment with immersion equipment, enclose electrical panel with immersible enclosure, install portable generator hookup	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 149 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:**

South Water Street, 1 South Water Street, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$43,016,957

Costs: \$2,760,000

BCR: 15.59

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude:

Longitude:

Size of Building: 620

BRV (\$/sf): \$250.00

Total BRV: \$155,000

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 14.80

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 0

FIRM Effective Date: 11/13/2015

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$2,100,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 9.50

Flood Zone Determination: Coastal A

Breaking Wave Height: 26.95

Utilities that are not elevated: No

Height FFE Above Grade: 5.30

One Time Displacement Costs: \$37,350

NFIP: No

Displacement Costs: \$6,723,000

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

Number of Person: 1,494

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$3,649,842.00

**Lost Productivity**

Number of Worker: 1,494

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$13,051,584.00

0

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 19.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 22.8000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: Survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 0.00

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.0	0.0	0.0
50	2.00%	0.0	0.0	0.0	0.0
100	1.00%	0.0	0.0	0.0	0.0
500	0.20%	0.0	0.0	0.0	0.0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$14,260	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$22,475	0.0%	0.0%	\$0
3.0	17.7%	0.0%	\$27,435	0.0%	0.0%	\$0
4.0	22.6%	0.0%	\$35,030	0.0%	0.0%	\$0
5.0	27.9%	0.0%	\$43,245	0.0%	0.0%	\$0
6.0	29.7%	0.0%	\$46,035	0.0%	0.0%	\$0
7.0	32.9%	0.0%	\$50,995	0.0%	0.0%	\$0
8.0	36.8%	0.0%	\$57,040	36.8%	0.0%	\$57,040
9.0	38.4%	0.0%	\$59,520	38.4%	0.0%	\$59,520
10.0	40.5%	0.0%	\$62,775	40.5%	0.0%	\$62,775
11.0	40.5%	0.0%	\$62,775	40.5%	0.0%	\$62,775
12.0	40.5%	0.0%	\$62,775	40.5%	0.0%	\$62,775
13.0	40.5%	0.0%	\$62,775	40.5%	0.0%	\$62,775
14.0	40.5%	0.0%	\$62,775	40.5%	0.0%	\$62,775
15.0	40.5%	0.0%	\$62,775	40.5%	0.0%	\$62,775
16.0	40.5%	0.0%	\$62,775	40.5%	0.0%	\$62,775

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$525,000	0.0%	0.0%	\$0
3.0	37.0%	0.0%	\$777,000	0.0%	0.0%	\$0
4.0	47.0%	0.0%	\$987,000	0.0%	0.0%	\$0
5.0	55.0%	0.0%	\$1,155,000	0.0%	0.0%	\$0
6.0	63.0%	0.0%	\$1,323,000	0.0%	0.0%	\$0
7.0	74.0%	0.0%	\$1,554,000	0.0%	0.0%	\$0
8.0	83.0%	0.0%	\$1,743,000	83.0%	0.0%	\$1,743,000
9.0	84.0%	0.0%	\$1,764,000	84.0%	0.0%	\$1,764,000
10.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
11.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
12.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
13.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
14.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
15.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
16.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$19,892,712	0.0		\$0
3.0	135.0		\$29,839,068	0.0		\$0
4.0	180.0		\$39,785,425	0.0		\$0
5.0	225.0		\$49,731,781	0.0		\$0
6.0	270.0		\$59,678,137	0.0		\$0
7.0	315.0		\$69,624,493	0.0		\$0
8.0	360.0		\$79,570,849	360.0		\$79,570,849
9.0	405.0		\$89,517,205	405.0		\$89,517,205
10.0	450.0		\$99,463,562	450.0		\$99,463,562
11.0	450.0		\$99,463,562	450.0		\$99,463,562
12.0	450.0		\$99,463,562	450.0		\$99,463,562
13.0	450.0		\$99,463,562	450.0		\$99,463,562
14.0	450.0		\$99,463,562	450.0		\$99,463,562
15.0	450.0		\$99,463,562	450.0		\$99,463,562
16.0	450.0		\$99,463,562	450.0		\$99,463,562



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$0	0.0		\$0
3.0	135.0		\$0	0.0		\$0
4.0	180.0		\$0	0.0		\$0
5.0	225.0		\$0	0.0		\$0
6.0	270.0		\$0	0.0		\$0
7.0	315.0		\$0	0.0		\$0
8.0	360.0		\$0	360.0		\$0
9.0	405.0		\$0	405.0		\$0
10.0	450.0		\$0	450.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 155 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual: \$19,185,426

Present Value: \$43,016,957

Annual: \$0

Present Value: \$0

Annual: \$19,185,426

Present Value: \$43,016,957

Mitigation Benefits: \$43,016,957

Benefits Minus Costs: \$40,256,957

Mitigation Costs: \$2,760,000

Benefit-Cost Ratio: 15.59

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 156 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	20	Construction Type:	
Mitigation Project Cost:	\$2,760,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$2,760,000	Years of Maintenance:	20
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	Yes
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 157 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Justification/Attachments

Field	Description	Attachments
Building contents - other	Estimated equipment replacement cost.	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 158 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Structure and Mitigation Details For:**

Terry Lane / Pine Tree Estates, 7 1/2 Terry Lane, Wareham, Massachusetts, 02571, Plymouth

Benefits: \$35,381,700

Costs: \$2,550,000

BCR: 13.88

Hazard: **Flood**

Mitigation Option: Dry Flood Proofing

Latitude: 41.746777000000

Longitude: -70.733731000000

Size of Building: 300

BRV (\$/sf): \$250.00

Total BRV: \$75,000

Residential: No

Building Type:

Obstruction: N/A

Foundation Type:

Basement:

Building Primary Use: Protective Services

Structure Type: Engineered

Historic Building: No

Structure Elevation: 14.70

First Floor Being Raised:

Demolition Threshold: 50.00%

Source of Flood Data: FIS

Project in SFHA: Yes

Community ID Number: 255223

Effective FIS Date: 07/17/2012

FIRM Panel Number: 576K

FIRM Effective Date: 02/05/2014

Project Useful Life: 20

H&H Study Title:

H&H Effective Date:

Flood Zone: Coastal A

Loss of Rent:

Building Contents: \$2,100,000 (Other)

Value of Crawlspace Contents:

Ground Surface Elevation: 12.50

Flood Zone Determination: Coastal A

Breaking Wave Height: 19.85

Utilities that are not elevated: No

Height FFE Above Grade: 2.20

One Time Displacement Costs: \$20,275

NFIP: No

Displacement Costs: \$3,649,500

ICC: No

**Street Maintenance Details**

Street maintenance budget (\$)

Miles of street (miles)

Length of road (miles)

Total Reduced Street Maintenance Costs \$0.00

**Volunteer Costs**

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

Number of Volunteers Required: 40

Number of Hours Volunteered/Person: 480

Cost of Volunteers Time (\$/Hour/Person): \$120.00

Number of Days Lodging/Volunteer: 30

Per-Person Cost of Lodging for a Volunteer: \$150.00

Cost of Volunteers: \$2,484,000.00

**Social Benefits**

**Mental Stress and Anxiety**

Number of Person: 811

Treatment Costs per person: \$2,443.00

Total Mental Stress and Anxiety Cost: \$1,981,273.00

**Lost Productivity**

Number of Worker: 811

Productivity Loss per person: \$8,736.00

Total Lost Productivity Cost: \$7,084,896.00

**Coastal Flood Elevations**

Flood Source Name:

Base Flood Elevation: 14.00

Flood Profile Number:

Elevation At Which Barrier Will Be Overtopped: 16.7000

FEMA Elevation Certificate Diagram Description: Other

Other Elevation Source: survey

Has Sea Level Rise Been Included? Yes

Sea Level Rise Increase: 0.60

Base Flood Elevation With Sea Level Rise: 14.60

Recurrence Interval (yr)	Percent Annual Chance (%)	Stillwater Elevation Before Mitigation	Stillwater Elevation Before Mitigation With SLR	Stillwater Elevation After Mitigation	Stillwater Elevation After Mitigation With SLR
10	10.00%	0.0	0.0	0.0	0.0
50	2.00%	0.0	0.0	0.0	0.0
100	1.00%	0.0	0.0	0.0	0.0
500	0.20%	0.0	0.0	0.0	0.0

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Building Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
-1.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
0.0	0.0%	0.0%	\$0	0.0%	0.0%	\$0
1.0	9.2%	0.0%	\$6,900	0.0%	0.0%	\$0
2.0	14.5%	0.0%	\$10,875	14.5%	0.0%	\$10,875
3.0	17.7%	0.0%	\$13,275	17.7%	0.0%	\$13,275
4.0	22.6%	0.0%	\$16,950	22.6%	0.0%	\$16,950
5.0	27.9%	0.0%	\$20,925	27.9%	0.0%	\$20,925
6.0	29.7%	0.0%	\$22,275	29.7%	0.0%	\$22,275
7.0	32.9%	0.0%	\$24,675	32.9%	0.0%	\$24,675
8.0	36.8%	0.0%	\$27,600	36.8%	0.0%	\$27,600
9.0	38.4%	0.0%	\$28,800	38.4%	0.0%	\$28,800
10.0	40.5%	0.0%	\$30,375	40.5%	0.0%	\$30,375
11.0	40.5%	0.0%	\$30,375	40.5%	0.0%	\$30,375
12.0	40.5%	0.0%	\$30,375	40.5%	0.0%	\$30,375
13.0	40.5%	0.0%	\$30,375	40.5%	0.0%	\$30,375
14.0	40.5%	0.0%	\$30,375	40.5%	0.0%	\$30,375
15.0	40.5%	0.0%	\$30,375	40.5%	0.0%	\$30,375
16.0	40.5%	0.0%	\$30,375	40.5%	0.0%	\$30,375

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Contents Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (pct)	Before Mitigation User Entered (pct)	Before Mitigation (\$)	After Mitigation (pct)	After Mitigation User Entered (pct)	After Mitigation (\$)
-2.0	0.0%	0.0%		0.0%	0.0%	
-1.0	0.0%	0.0%		0.0%	0.0%	
0.0	0.0%	0.0%		0.0%	0.0%	
1.0	14.0%	0.0%		0.0%	0.0%	
2.0	25.0%	0.0%	\$525,000	25.0%	0.0%	\$525,000
3.0	37.0%	0.0%	\$777,000	37.0%	0.0%	\$777,000
4.0	47.0%	0.0%	\$987,000	47.0%	0.0%	\$987,000
5.0	55.0%	0.0%	\$1,155,000	55.0%	0.0%	\$1,155,000
6.0	63.0%	0.0%	\$1,323,000	63.0%	0.0%	\$1,323,000
7.0	74.0%	0.0%	\$1,554,000	74.0%	0.0%	\$1,554,000
8.0	83.0%	0.0%	\$1,743,000	83.0%	0.0%	\$1,743,000
9.0	84.0%	0.0%	\$1,764,000	84.0%	0.0%	\$1,764,000
10.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
11.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
12.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
13.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
14.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
15.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000
16.0	86.0%	0.0%	\$1,806,000	86.0%	0.0%	\$1,806,000



Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Displacement Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$10,798,521	90.0		\$10,798,521
3.0	135.0		\$16,197,781	135.0		\$16,197,781
4.0	180.0		\$21,597,041	180.0		\$21,597,041
5.0	225.0		\$26,996,301	225.0		\$26,996,301
6.0	270.0		\$32,395,562	270.0		\$32,395,562
7.0	315.0		\$37,794,822	315.0		\$37,794,822
8.0	360.0		\$43,194,082	360.0		\$43,194,082
9.0	405.0		\$48,593,342	405.0		\$48,593,342
10.0	450.0		\$53,992,603	450.0		\$53,992,603
11.0	450.0		\$53,992,603	450.0		\$53,992,603
12.0	450.0		\$53,992,603	450.0		\$53,992,603
13.0	450.0		\$53,992,603	450.0		\$53,992,603
14.0	450.0		\$53,992,603	450.0		\$53,992,603
15.0	450.0		\$53,992,603	450.0		\$53,992,603
16.0	450.0		\$53,992,603	450.0		\$53,992,603

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Depth-Damage Functions Using Protective Services (Default)**

Loss of Function Flood Depth (ft)	Before Mitigation Values:			After Mitigation Values:		
	Before Mitigation (Days)	Before Mitigation User Entered (Days)	Before Mitigation (\$)	After Mitigation (Days)	After Mitigation User Entered (Days)	After Mitigation (\$)
-2.0	0.0			0.0		
-1.0	0.0			0.0		
0.0	0.0			0.0		
1.0	45.0			0.0		
2.0	90.0		\$0	90.0		\$0
3.0	135.0		\$0	135.0		\$0
4.0	180.0		\$0	180.0		\$0
5.0	225.0		\$0	225.0		\$0
6.0	270.0		\$0	270.0		\$0
7.0	315.0		\$0	315.0		\$0
8.0	360.0		\$0	360.0		\$0
9.0	405.0		\$0	405.0		\$0
10.0	450.0		\$0	450.0		\$0
11.0	450.0		\$0	450.0		\$0
12.0	450.0		\$0	450.0		\$0
13.0	450.0		\$0	450.0		\$0
14.0	450.0		\$0	450.0		\$0
15.0	450.0		\$0	450.0		\$0
16.0	450.0		\$0	450.0		\$0

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 164 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Other Benefits**

**Other Benefits Before Mitigation**

No Data

**Other Benefits After Mitigation**

No Data

**Summary Of Benefits**

Expected Annual Damages Before Mitigation

Expected Annual Damages After Mitigation

Expected Avoided Damages After Mitigation (Benefits)

Annual: \$11,550,169

Present Value: \$35,381,700

Annual: \$0

Present Value: \$0

Annual: \$11,550,169

Present Value: \$35,381,700

Mitigation Benefits: \$35,381,700

Benefits Minus Costs: \$32,831,700

Mitigation Costs: \$2,550,000

Benefit-Cost Ratio: 13.88

24 Nov 2015

Project: **Wareham Vulnerability  
Assessment**

Pg 165 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

### Cost Estimate

Project Useful Life (years):	20	Construction Type:	
Mitigation Project Cost:	\$2,550,000	Detailed Scope of Work:	Yes
Annual Project Maintenance Cost:	\$0	Detailed Estimate for Entire Project:	Yes
Final Mitigation Project Cost:	\$2,550,000	Years of Maintenance:	20
Cost Basis Year:		Present Worth of Annual Maintenance Costs:	\$0
Construction Start Year:		Estimate Reflects Current Prices:	Yes
Construction End Year:		Project Escalation:	

24 Nov 2015

Project: **Wareham Vulnerability Assessment**

Pg 166 of 166

Total Benefits: **\$658,375,621**

Total Costs: **\$36,040,000**

BCR: **18.27**

Project Number:

Disaster #:

Program:

Agency: **Town of Wareham**

State: **Massachusetts**

Point of Contact:

Analyst:

**Justification/Attachments**

Field	Description	Attachments
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Pump Station	Flood Zone	Project Useful Life (yrs)	Mitigation Project Cost	Annual O&M Cost	# of Volunteers Required	# of Hours Volunteered/Person	Cost of Volunteers Time (\$/Hr/Person)	Number of Days Lodging/Volunteer	Per Person Cost of Lodging for a Volunteer	Volunteers Cost	Number of Persons - Mental Stress and Anxiety	Lost Productivity - Number of Workers	Total Social Cost
Narrows	Coastal AE	50	\$ 2,630,000	0	40	480	120	30	150	\$ 2,484,000	6570	6570	\$ 73,446,030
Hynes Field	Coastal AE	50	\$ 2,670,000	0	40	480	120	30	150	\$ 2,484,000	3513	3513	\$ 39,271,827
Smith	VE	20	\$ 2,830,000	0	40	480	120	30	150	\$ 2,484,000	2228	2228	\$ 24,906,812
Dick's Pond	Coastal AE	20	\$ 80,000	0	40	480	120	30	150	\$ 2,484,000	1765	1765	\$ 19,730,935
Onset Pier	VE	50	\$ 2,460,000	0	40	480	120	30	150	\$ 2,484,000	1685	1685	\$ 18,836,615
Hathaway	AE	20	\$ 30,000	0	40	480	120	30	150	\$ 2,484,000	1591	1591	\$ 17,785,789
South Water Street	VE	50	\$ 2,760,000	0	40	480	120	30	150	\$ 2,484,000	1494	1494	\$ 16,701,426
Cohasset Narrows	VE	50	\$ 2,670,000	0	40	480	120	30	150	\$ 2,484,000	1478	1478	\$ 16,522,562
Saltworks Road	VE	20	\$ 2,640,000	0	40	480	120	30	150	\$ 2,484,000	1205	1205	\$ 13,470,695
Indian Neck	AE	20	\$ 70,000	0	40	480	120	30	150	\$ 2,484,000	1014	1014	\$ 11,335,506
Pine Tree Estates (Terry Lane)	NA	20	\$ 2,550,000	0	40	480	120	30	150	\$ 2,484,000	0	0	\$ -
Parkwood	AE	20	\$ 80,000	0	40	480	120	30	150	\$ 2,484,000	755	755	\$ 8,440,145
Pinehurst	Coastal AE	20	\$ 2,510,000	0	40	480	120	30	150	\$ 2,484,000	673	673	\$ 7,523,467
East Boulevard	Coastal AE	20	\$ 2,670,000	0	40	480	120	30	150	\$ 2,484,000	637	637	\$ 7,121,023
Arnold	Coastal AE	20	\$ 80,000	0	40	480	120	30	150	\$ 2,484,000	480	480	\$ 5,365,920
Ruggles	VE	50	\$ 870,000	0	40	480	120	30	150	\$ 2,484,000	463	463	\$ 5,175,877
Briarwood	Coastal AE	20	\$ 40,000	0	40	480	120	30	150	\$ 2,484,000	425	425	\$ 4,751,075
North Boulevard	Coastal AE	50	\$ 2,920,000	0	40	480	120	30	150	\$ 2,484,000	422	422	\$ 4,717,538
Cromesett	VE	20	\$ 80,000	0	40	480	120	30	150	\$ 2,484,000	1478	1478	\$ 16,522,562
Onset Heights	Coastal AE	20	\$ 80,000	0	40	480	120	30	150	\$ 2,484,000	290	290	\$ 3,241,910
Avenue A	Coastal AE	20	\$ 80,000	0	40	480	120	30	150	\$ 2,484,000	286	286	\$ 3,197,194
Riverside	Coastal AE	20	\$ 1,630,000	0	40	480	120	30	150	\$ 2,484,000	246	246	\$ 2,750,034
Bay Street	VE	20	\$ 1,720,000	0	40	480	120	30	150	\$ 2,484,000	186	186	\$ 2,079,294
Hill Street Jefferson Shores	VE	20	\$ 2,130,000	0	40	480	120	30	150	\$ 2,484,000	111	111	\$ 1,240,869
South Boulevard	VE	20	\$ 1,920,000	0	40	480	120	30	150	\$ 2,484,000	99	99	\$ 1,106,721
Leonard Street	Coastal AE	20	\$ 80,000	0	40	480	120	30	150	\$ 2,484,000	87	87	\$ 972,573
Apple Street	Coastal AE	20	\$ 190,000	0	40	480	120	30	150	\$ 2,484,000	85	85	\$ 950,215
Linwood	Coastal AE	20	\$ 60,000	0	40	480	120	30	150	\$ 2,484,000	87	87	\$ 972,573
Green Street	AE	20	\$ 1,860,000	0	40	480	120	30	150	\$ 2,484,000	17	17	\$ 190,043

Pump Station	FIRM Panel Number	Sea Level Rise	Elevation of Lowest Floor Member	Ground Surface Elevation	First Floor Elevation Above Grade (ft)	BFE	BFE + SLR	Building Size (SF)	Value of Building (\$/sf)	Demolition Damage Threshold	Type of Structure	Primary Use of Building	Building Contents	Displacement Costs (\$/month)	One Time Displacement Costs
Narrows	489K	1.8	10.75	6.5		14	15.8	630	250	50%	Engineered	Protective Serv	\$ 2,600,000	\$ 29,565,000	\$ 164,250
Hynes Field	581K	1.8	10.9	6.4		14	15.8	630	250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 15,808,500	\$ 87,825
Smith	577J	0.6	18	8.8		18	18.6	570	250	50%	Engineered	Protective Serv	\$ 2,600,000	\$ 10,026,000	\$ 55,700
Dick's Pond	493J	0.6	14.7	9.8		14	14.6	710	250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 7,942,500	\$ 44,125
Onset Pier	581K	1.8	15	11.7		22	23.8	270	250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 7,582,500	\$ 42,125
Hathaway	576K	0.6		15.2		14	14.6		250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 7,159,500	\$ 39,775
South Water Street	582K	1.8	14.8	9.5		19			250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 6,723,000	\$ 37,350
Cohasset Narrows	501J	1.8		11.6		21	22.8	1200	250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 6,651,000	\$ 36,950
Saltworks Road	249J	0.6	14.8	12.1		21	21.6	300	250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 5,422,500	\$ 30,125
Indian Neck	489K	0.6		14.6		14	14.6		250	50%	Engineered	Protective Serv	\$ 2,600,000	\$ 4,563,000	\$ 25,350
Pine Tree Estates (Terry Lane)	576K	0.6	14.7	12.5		14	14.6	300	250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ -	\$ -
Parkwood	577J	0.6		12.7		15	15.6		250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 3,397,500	\$ 18,875
Pinehurst	577J	0.6	14.6	11.2		14	14.6	430	250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 3,028,500	\$ 16,825
East Boulevard	581K	0.6		4.71		14	14.6	200	250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 2,866,500	\$ 15,925
Arnold	576K	0.6		6.8		14	14.6		250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 2,160,000	\$ 12,000
Ruggles	577J	1.8	14.6	5.9		20	21.8	620	250	50%	Engineered	Protective Serv	\$ 2,600,000	\$ 2,083,500	\$ 11,575
Briarwood	576K	0.6	18.9	9.3		15	15.6		250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 1,912,500	\$ 10,625
North Boulevard	581K	1.8	11.15	6.9		14	15.8	270	250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 1,899,000	\$ 10,550
Cromessett	576K	0.6		11.5		16	16.6		250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 6,651,000	\$ 36,950
Onset Heights	582K	0.6		7.4		14	14.6		250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 1,305,000	\$ 7,250
Avenue A	489K	0.6		7.1		14	14.6		250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 1,287,000	\$ 7,150
Riverside	294J	0.6		7.3		14	14.6		250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 1,107,000	\$ 6,150
Bay Street	482J	0.6		10.2		17	17.6		250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 837,000	\$ 4,650
Hill Street Jefferson Shores	249J	0.6	15	13.8		21	21.6	360	250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 499,500	\$ 2,775
South Boulevard	581K	0.6		13.2		22	22.6		250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 445,500	\$ 2,475
Leonard Street	557K	0.6		9.3		14	14.6		250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 391,500	\$ 2,175
Apple Street	489K	0.6		8.5		14	14.6		250	50%	Engineered	Protective Serv	\$ 2,100,000	\$ 382,500	\$ 2,125
Linwood	493J	0.6		14.1		14	14.6		250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 391,500	\$ 2,175
Green Street	482J	0.6		17		16	16.6		250	50%	Engineered	Protective Serv	\$ 1,600,000	\$ 76,500	\$ 425

Pump Station	Total Displacement		Annual Benefit	Present Value	Annual Flood R
	Displacement	Cost			
Narrows	18	\$ 532,334,250	\$ 75,930,030	\$ 99,800,000	\$ 998,000
Hynes Field	18	\$ 284,640,825	\$ 41,755,827	\$ 65,600,000	\$ 656,000
Smith	18	\$ 180,523,700	\$ 27,390,812	\$ 56,900,000	\$ 569,000
Dick's Pond	12	\$ 95,354,125	\$ 22,214,935	\$ 46,000,000	\$ 460,000
Onset Pier	18	\$ 136,527,125	\$ 21,320,615	\$ 45,200,000	\$ 452,000
Hathaway	9	\$ 64,475,275	\$ 20,269,789	\$ 44,100,000	\$ 441,000
South Water Street	18	\$ 121,051,350	\$ 19,185,426	\$ 43,000,000	\$ 430,000
Cohasset Narrows	12	\$ 79,848,950	\$ 19,006,562	\$ 42,800,000	\$ 428,000
Saltworks Road	18	\$ 97,635,125	\$ 15,954,695	\$ 39,800,000	\$ 398,000
Indian Neck	9	\$ 41,092,350	\$ 13,819,506	\$ 37,700,000	\$ 377,000
Pine Tree Estates (Terry Lane)	9	\$ -	\$ 2,484,000	\$ 35,400,000	\$ 354,000
Parkwood	9	\$ 30,596,375	\$ 10,924,145	\$ 34,800,000	\$ 348,000
Pinehurst	9	\$ 27,273,325	\$ 10,007,467	\$ 33,800,000	\$ 338,000
East Boulevard	12	\$ 34,413,925	\$ 9,605,023	\$ 33,400,000	\$ 334,000
Arnold	12	\$ 25,932,000	\$ 7,849,920	\$ 31,700,000	\$ 317,000
Ruggles	18	\$ 37,514,575	\$ 7,659,877	\$ 31,500,000	\$ 315,000
Briarwood	12	\$ 22,960,625	\$ 7,235,075	\$ 31,100,000	\$ 311,000
North Boulevard	12	\$ 22,798,550	\$ 7,201,538	\$ 31,000,000	\$ 310,000
Cromesett	12	\$ 79,848,950	\$ 19,006,562	\$ 29,700,000	\$ 297,000
Onset Heights	12	\$ 15,667,250	\$ 5,725,910	\$ 29,600,000	\$ 296,000
Avenue A	12	\$ 15,451,150	\$ 5,681,194	\$ 29,500,000	\$ 295,000
Riverside	12	\$ 13,290,150	\$ 5,234,034	\$ 29,100,000	\$ 291,000
Bay Street	12	\$ 10,048,650	\$ 4,563,294	\$ 28,400,000	\$ 284,000
Hill Street Jefferson Shores	12	\$ 5,996,775	\$ 3,724,869	\$ 27,600,000	\$ 276,000
South Boulevard	18	\$ 8,021,475	\$ 3,590,721	\$ 27,400,000	\$ 274,000
Leonard Street	12	\$ 4,700,175	\$ 3,456,573	\$ 27,300,000	\$ 273,000
Apple Street	12	\$ 4,592,125	\$ 3,434,215	\$ 27,300,000	\$ 273,000
Linwood	9	\$ 3,525,675	\$ 3,456,573	\$ 27,200,000	\$ 272,000
Green Street	9	\$ 688,925	\$ 2,674,043	\$ 26,500,000	\$ 265,000
				<b>\$ 1,093,200,000</b>	<b>\$ 10,932,000</b>



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