

Market to Metacom:
Adaptation and Economic Development Plan
SNEP Contract # SNEPWG20-2-WARR-M2M

Final Report



Town of Warren
Warren, Rhode Island

December 29, 2021

Table of Contents

Market to Metacom: Adaptation and Economic Development Plan Town of Warren, Rhode Island

1	Introduction.....	1
2	Methodology.....	1
2.1	Data Sources.....	3
3	Existing Conditions Assessment	4
3.1	Introduction.....	4
3.2	Market Street Area.....	4
3.2.1	Location and Land Use.....	4
3.2.2	Utilities and Infrastructure	8
3.2.3	Transportation Infrastructure.....	10
3.2.4	Property Values and Tax Generation.....	11
3.2.5	RIDEM-Regulated Facilities	13
3.2.6	Wetlands.....	14
3.2.7	Impervious Surfaces, Drainage Patterns, and Water Quality.....	15
3.3	Metacom Avenue Corridor	17
3.3.1	Location and Land Use.....	17
3.3.2	Utilities and Infrastructure	20
3.3.3	Transportation Infrastructure.....	21
3.3.4	Property Values and Tax Generation.....	22
3.3.5	DEM-regulated Facilities	24
3.3.6	Wetlands.....	25
3.3.7	Impervious Surfaces, Drainage Patterns, and Water Quality.....	25
3.4	Designated Flood Zones	26
4	Sea Level Rise Projections and Impacts.....	27
4.1	Sea Level Rise Projections – Market Street Project Area.....	27
4.2	Sea Level Rise Projections for 100-Year Storm Events – Market Street Area.....	30
4.3	Sea Level Rise Impacts – Market Street.....	34
4.4	Sea Level Rise Projection – Metacom Avenue Corridor	34
4.5	Sea Level Rise Impacts – Metacom Avenue Corridor.....	36
5	Existing Regulations and Planning.....	37
5.1	Zoning.....	37
5.1.1	Market Street Area.....	37
5.1.2	Metacom Avenue Area.....	39
5.1.3	Special Flood Hazard Areas.....	40

Table of Contents

Market to Metacom: Adaptation and Economic Development Plan Town of Warren, Rhode Island

5.2	Local Stormwater Regulations.....	40
5.3	State Regulations.....	41
5.4	State Transportation Planning.....	41
5.4.1	State of Rhode Island Transportation Improvement Program FFY 2017-2025	41
5.4.2	Moving Forward RI 2040: State Guide Plan Element 611 Report Number 123, December 2020.....	41
5.4.3	RI Statewide Planning Program Warren, RI Coastal Sea Level Rise and Storm Surge: Transportation Fact Sheet.....	42
6	Key Findings from Existing Conditions Assessment	43
7	No Action Scenario.....	45
7.1	Overview and Assumptions.....	45
7.2	Impacts to the Market Street Area.....	45
7.2.1	Overview of Community and Financial Impacts.....	45
7.2.2	Environmental Impacts.....	57
7.2.3	Roadway Impacts.....	58
7.3	Precedents for Reactive Community Response.....	63
7.3.1	Superstorm Sandy.....	63
7.3.2	Hurricane Katrina.....	63
7.3.3	Louisiana Bayou Communities.....	63
8	Phased Relocation and Restoration Scenario.....	65
8.1	Overview and Assumptions.....	65
8.2	Relocation and Restoration Phases and Costs	67
8.2.1	Phase 1 (2025-2035).....	67
8.2.2	Phase 2 (2035-2050).....	68
	Phase 3 (2050-2070).....	69
	Phase 4 (2070-2100).....	70
8.2.3	Summary of Phased.....	71
8.3	Utility Adaptation.....	72
8.4	Environmental Impacts.....	72
8.5	Recreational Value of Revegetated Land.....	74
8.6	Precedents.....	76
8.6.1	Gloucester County, Virginia	76
	Onion Creek, Austin, Texas.....	78

Table of Contents

Market to Metacom: Adaptation and Economic Development Plan Town of Warren, Rhode Island

	Warwick, Rhode Island.....	81
	8.6.2 Brookhaven, NY.....	82
8.7	Implementation.....	83
	8.7.1 Recommendations for Actions.....	83
	8.7.2 Funding Sources.....	83
9	Metacom Avenue Corridor Redevelopment Scenario	84
9.1	Overview.....	84
9.2	Roadway and Utility Reconfiguration.....	86
9.3	Redevelopment Scenarios.....	88
	9.3.1 Job Lot Plaza Site (Block D).....	90
	9.3.2 CVS Block (Block C).....	92
	9.3.3 Pasqua/Healey (Block A).....	93
	9.3.4 Ridgeway & Canario (Block B).....	94
	9.3.5 Patterson & Homestead (Block E).....	95
	9.3.6 AT&T Block (Block F).....	96
	9.3.7 Summary.....	97
9.4	Precedents.....	97
	9.4.1 Mixed Use Buildings.....	97
	9.4.2 Multifamily Buildings.....	98
9.5	Implementation.....	99
	9.5.1 Tax Income.....	99
	9.5.2 Recommendations for Actions.....	99
10	Conclusions.....	100

Table of Contents

Market to Metacom: Adaptation and Economic Development Plan Town of Warren, Rhode Island

Tables	Page
Table 1. Summary of Data Used for Scenario Development and Analysis.....	3
Table 2. Market Street Land Uses.....	7
Table 3 - Metacom Avenue Land Uses.....	19
Table 4 – Metacom Avenue Tax Generation.....	22
Table 5 – 2025-2035 Sea Level Rise Impacts.....	47
Table 6 - 2025-2035 100-Year Storm Event Impacts.....	48
Table 7 - 2035-2050 Sea Level Rise Impacts.....	49
Table 8 - 2023-2050 100-Year Storm Event Impacts.....	50
Table 9 – 2050-2070 Sea Level Rise Impacts.....	51
Table 10 – 2050-2070 100-Year Storm Event Impacts.....	52
Table 11 – 2070-2100 Sea Level Rise Impacts.....	53
Table 12 – 2070-2100 100-Year Storm Event Impacts.....	54
Table 13 – No Action Scenario – Community Impacts Summary Table.....	55
Table 14 – No Action Scenario Estimated Costs Summary Table.....	56
Table 15 – No Action Scenario Estimated Costs Summary Chart.....	56
Table 16 – Summary of Phase 1.....	67
Table 17 – Summary of Phase 2.....	68
Table 18 – Summary of Phase 3.....	69
Table 19 – Summary of Phase 4.....	70
Table 20 – Impervious Area Removed and Vegetated Area Created Phase.....	73
Table 21 – Block D Summary Table.....	91
Table 22 - Block C Summary Table.....	92
Table 23 – Block A Summary Table.....	93
Table 24 – Block B Summary Table.....	94
Table 25 - Block E Summary Table.....	95
Table 26 – Block F Summary Table.....	96
Table 27 – Metacom Sample Sites Summary Table.....	97
Table 28 – Summary of Metacom Avenue Tax Income Changes.....	99

Figures	Page
Figure 1. Market to Metacom Project Areas.....	1
Figure 2. Market Street Project Area.....	5
Figure 3. Metacom Avenue Project Area in 1939.....	6
Figure 4. Market Street Sanitary Sewer and Water Infrastructure (with 2050 High Tide).....	8

Table of Contents

Market to Metacom: Adaptation and Economic Development Plan Town of Warren, Rhode Island

Figure 5. Market Street Drainage Infrastructure (with 2050 High Table).....	9
Figure 6. Market Street Property Values.....	11
Figure 7. Market Street Property Tax Generation (Annual).....	12
Figure 8. RIDEM Regulated Facilities (with 100 Year Storm).....	13
Figure 9. Market Street Wetlands.....	14
Figure 10. Market Street Impervious Area.....	15
Figure 11. Metacom Avenue Project Area.....	17
Figure 12. Metacom Avenue Project Area in 1939.....	18
Figure 13. Metacom Avenue Sanitary Sewer and Water Infrastructure.....	20
Figure 14. Metacom Avenue Drainage Utilities/ Infrastructure.....	21
Figure 15. Metacom Avenue Property Values.....	22
Figure 16. Metacom Avenue Property Tax Generation (Annual).....	23
Figure 17. RIDEM-Regulated Facilities with 100-Year Storm.....	24
Figure 18. Metacom Avenue Impervious Area.....	25
Figure 19. FEMA Flood Zones.....	26
Figure 20. Market Street – Sea Level Rise Projection for 2020.....	27
Figure 21. Market Street – Sea Level Rise Projection for 2035.....	28
Figure 22. Market Street – Sea Level Rise Projection for 2050.....	29
Figure 23. Market Street – Sea Level Rise Projection for 2070.....	29
Figure 24. Market Street – Sea Level Rise Projection for 2100.....	30
Figure 25. Market Street - Sea Level Rise Projection for 2020 (with 100-Year Storm).....	31
Figure 26. Market Street – Sea Level Rise Projection for 2035 (with 100-Year Storm).....	32
Figure 27. Market Street – Sea Level Rise Projection for 2050 (with 100-Year Storm).....	32
Figure 28. Market Street – Sea Level Rise Projection for 2070 (with 100-Year Storm).....	33
Figure 29. Market Street – Sea Level Rise Projection for 2100 (with 100-Year Storm).....	33
Figure 30. Metacom Avenue – Sea Level Rise Projection for 100-Year Storm for 2020.....	34
Figure 31. Metacom Avenue – Sea Level Rise Projection for 100-Year Storm for 2050.....	35
Figure 32. Metacom Avenue – Sea Level Rise Projection for 100-Year Storm for 2100.....	35
Figure 33. Market Street Project Area Zoning Map.....	37
Figure 34. Metacom Avenue Project Area Zoning Map.....	39
Figure 35. Market Street – Sea Level Rise Projection for 2035.....	47
Figure 36. Market Street – 100-Year Storm Event Sea Level Rise Projection for 2035.....	48
Figure 37. Market Street – Sea Level Rise Projection for 2050.....	49
Figure 38. Market Street – 100-Year Storm Event Sea Level Rise Projection for 2050.....	50
Figure 39. Market Street – Sea Level Rise Projection for 2070.....	51
Figure 40. Market Street – 100-Year Storm Event Sea Level Rise Projection for 2070.....	52
Figure 41. Market Street – Sea Level Rise Projection for 2100.....	53
Figure 42. Market Street – 100-Year Storm Event Sea Level Rise Projection for 2100.....	54

Table of Contents

Market to Metacom: Adaptation and Economic Development Plan Town of Warren, Rhode Island

Figure 43. No Action Scenario – Community Impacts Summary Chart	55
Figure 44. RIDEM Regulated Facilities (with 100 Year Storm).....	58
Figure 45. Major Routes at Risk from 100-Year Storm Impacts.....	59
Figure 46. Image of High Tide Flooding on Market Street, 2019.....	60
Figure 47. Emergency Facilities at Risk from Sea Level Rise.....	61
Figure 48. Emergency Facilities at Risk from 100-Year Storm.....	62
Figure 49. Flooding in Louisiana on August 30, 2021, caused by Hurricane Ida.....	64
Figure 50. Phase 1 Plan (2025-2035).....	67
Figure 51. Phase 2 Plan (2035-2050).....	68
Figure 52. Phase 3 Plan (2050-2070).....	69
Figure 53. Phase 4 Plan (2070-2100).....	70
Figure 54. Overview of All Phases.....	71
Figure 55. Impervious Area within the Market Street Project Area.....	73
Figure 56. Conceptual Plan for Market Street Area in 2070.....	74
Figure 57. Images of the Cape Cod Marsh Walk.....	75
Figure 58. Image of Flooding in Gloucester County, Virginia.....	76
Figure 59. Gloucester County Buy-Out Map.....	77
Figure 60. Image of Flooding in Austin, Texas.....	78
Figure 61. Onion Creek Buy-Out Map.....	79
Figure 62. Onion Creek Buy-Out Map.....	80
Figure 63. Image of End of Road Retrofit Construction on Mill Cove Road.....	81
Figure 64. Image of Flooded Roadway at Mastic Beach.....	82
Figure 65. Project Area Topography and Sea Level Rise.....	84
Figure 66. Project Area Topography and 100-Year Storm.....	85
Figure 67. Existing and Proposed Metacom Avenue Configurations.....	87
Figure 68. Overall Metacom Avenue Conceptual Master Plan.....	89
Figure 69. Job Lot Plaza (Block D) Concept Plan.....	90
Figure 70. Job Lot Plaza (Block D) Conceptual Rendering.....	91
Figure 71. CVS Block (Block C) Concept Plan.....	92
Figure 72. Pasqua/Healy Block (Block A) Concept Plan.....	93
Figure 73. Ridgeway & Canario (Block B) Concept Plan.....	94
Figure 74. Patterson & Homestead (Block E) Concept Plan.....	95
Figure 75. AT&T Block (Block F) Concept Plan.....	96
Figure 76. Mixed Use Buildings and Public Space – South County Commons, RI.....	97
Figure 77. Multi-Family Buildings – City Row, Madison, WI.....	98

1 Introduction

The Town of Warren, Rhode Island received grant funding from the Southeast New England Program (SNEP) of the US Environmental Protection Agency and administered by Restore America's Estuaries (RAE) to develop a neighborhood plan for the Market Street and Metacom Avenue project areas to holistically address water quality and climate change challenges, while promoting economic redevelopment. Warren has a population of 11,147 residents and is located ten miles southeast of Providence, Rhode Island.

The Market Street project area is a dense, mixed-use neighborhood which directly abuts Belcher Cove, a part of the Palmer River watershed. The area is densely developed with commercial and residential uses and currently faces tidal flooding impacts and is threatened by significant projected sea level rise impacts. The Metacom Avenue project area is primarily a retail and commercial corridor but abuts fully developed residential areas to the east and west. Due to its location along a ridge, the Metacom area is located outside of tidal flooding areas, however, its high percentage of paved impervious surface area produces large volumes of stormwater runoff, which may have significant water quality impacts on the adjacent Palmer and Kickemuit Rivers and Narragansett Bay. The two project areas are approximately 1,750 feet apart.

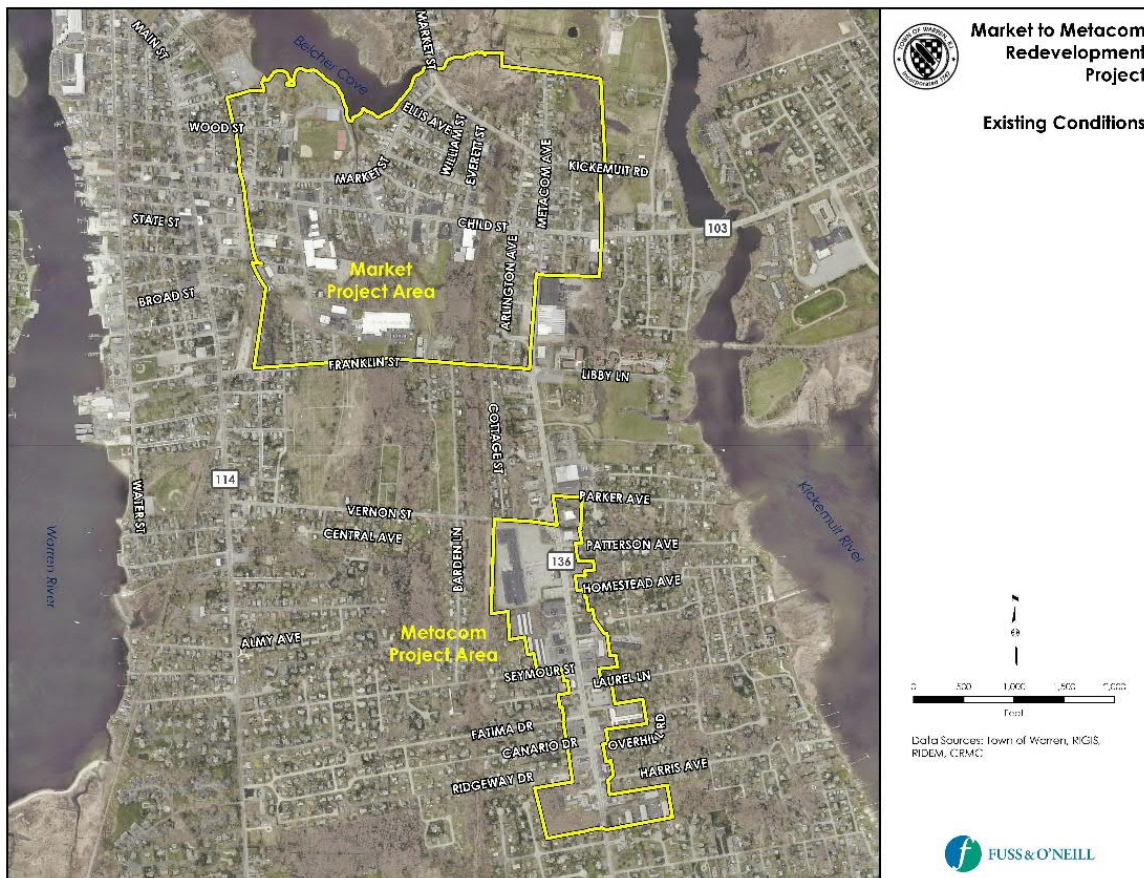


Figure 1. Market to Metacom Project Areas

2 Methodology

At the start of the project, Fuss & O'Neill assessed existing land uses, property values, infrastructure, regulations, and flooding, as well as the projected sea level rise impacts to the Market Street and Metacom Avenue project areas. The findings of this assessment are presented in the *Existing Conditions* prepared by Fuss & O'Neill, dated April 27, 2021. A public workshop to present these findings was held on May 12, 2021.

Using the data in the *Existing Conditions*, Fuss & O'Neill collaborated with the Town of Warren and Union Studio Architecture and Community Design to develop and analyze two scenarios for the future of the Market Street project areas. The two scenarios considered in this analysis are a "No Action Scenario" and a "Phased Relocation and Restoration Scenario":

- The "No Action Scenario" is a baseline scenario which assumes no actions are taken to adapt to the climate-related impacts facing Market Street.
- The "Phased Relocation and Restoration Scenario" assumes a proactive approach is taken to address Market Street flooding projections while reimagining the Metacom Avenue area as an opportunity for redevelopment to accept uses transferred from Market Street. The analysis of these two scenarios includes impacts to housing and business, infrastructure, the environment, and municipal finances, as well as estimates of cost of redevelopment and restoration.

The scenarios were presented at a public workshop on July 14, 2021 to solicit input from community members, property owners, and businesses regarding the impacts facing these two neighborhoods, the two potential future scenarios and potential steps forward. Based on input from these sessions and from Warren officials it is recommended that the Town of Warren, with its partners at the State and Federal levels, move forward with simultaneous implementation of two complementary scenarios:

- Move forward with the Phased Relocation and Restoration Scenario for the Market Street area by implementing a buy-out program for properties threatened by frequent flooding. At the same time, this would include making transportation more resilient to climate change impacts where possible to maintain regional and local transportation connectivity, especially for evacuation routes, and utility infrastructure
- Begin the Metacom Avenue Redevelopment plan by changing the zoning in the project area to Form-Based Code and allowing higher density, mixed-use development that encourages both commercial development along with upper floor residential housing of various price points.

This *Market to Metacom Final Report* presents a vision for a future resilient Warren and summarizes the findings and conclusions regarding the potential futures for the Market Street and Metacom Avenue neighborhoods. This report also includes relevant climate adaptation case studies, regulatory considerations, and potential funding sources for implementing adaptation and redevelopment.

2.1 Data Sources

Data for existing conditions assessment, climate change impact projections and for the framing of the scenarios relied on a variety of municipal, state, and federal data products, projections, and planning documents. Each data source and project used is the most relevant and up-to-date version of available information as of the time of this report (October 2021). Data products were not available for all utilities in the project area.

Table 1. Summary of Data Used for Scenario Development and Analysis

	Data Source	Data Product ¹	Use
Local	Town of Warren	Tax Parcel Data Zoning Maps	Property tax impacts Housing unit impacts
		Stormwater System Water Distribution Sanitary Sewer Collection	Utility impacts
State	Rhode Island Departments of Administration and Transportation	Technical Papers 164, 167 – Vulnerability of [Municipal] Transportation Assets to Sea Level Rise and Storm Surge Transportation Improvement Plan	Transportation impacts
	RIGIS	Land Use Wetlands Impervious Cover	Water quality impacts
	CRMC	STORMTOOLS	Future Flooding Extent Projection
National	NOAA	Sea Level Rise Projection	Future Climate Conditions Assessment
	FEMA	Flood Insurance Rate Maps	Current Flooding Extent Estimates
	Flood Factor	First Street Foundation National Flood Model	Water Depth Damage Estimates

The Market to Metacom project provides concept level planning scenarios and order of magnitude estimates on costs and financial impacts.

¹ Data products were not available for all utilities in the project area

3 Existing Conditions Assessment

3.1 Introduction

The purpose of this assessment is to summarize the existing conditions within both the Market Street and Metacom Avenue project areas. This includes existing land development patterns, drainage patterns and land cover, existing infrastructure and utilities, and existing flooding. The assessment summarizes sea level rise (SLR) impacts based on mapped projections in various scenarios. Several of the figures in the report incorporate SLR forecasts to show the extent to which existing features and facilities are affected. Lastly, this report identifies relevant local and state regulations affecting development and stormwater management requirements within each project area. Taken together, this information provides a base of knowledge for understanding the dynamics in the project areas and creating potential scenarios for the future.

3.2 Market Street Area

3.2.1 Location and Land Use

The Market Street project area is located south of Belcher Cove and north of Franklin Street. In addition to the southern portion of Market Street, the project area includes the northernmost 1,900 linear feet of Metacom Avenue, as well as approximately 2,400 linear feet of Child Street. The total area within the Market Street project boundary (Figure 2), including roadways, is approximately 215 acres. The parcels of land within this project area total approximately 184 acres.

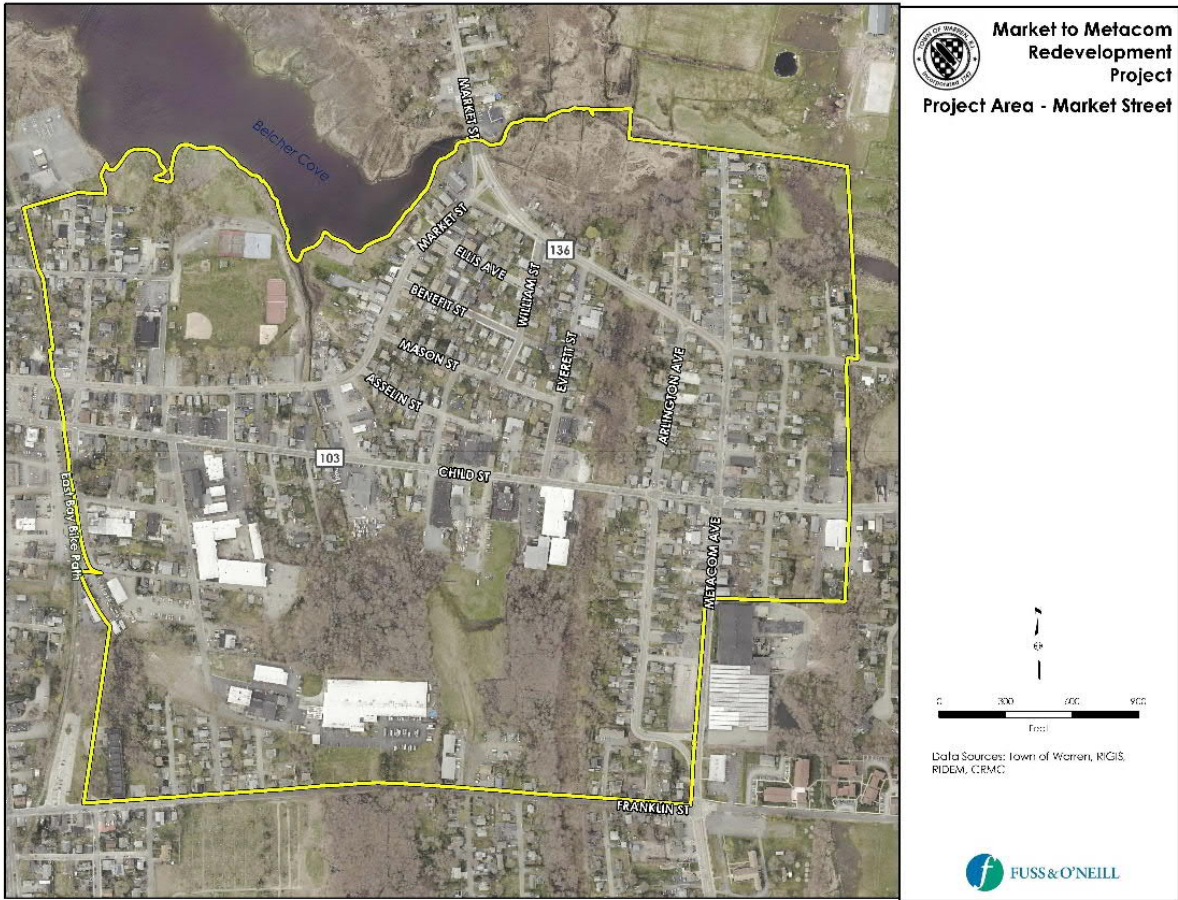


Figure 2. Market Street Project Area

The Market Street area historically consisted of farmland and wetlands until its development to meet the need for housing around the center of Warren with the development of mills in the late 19th and early 20th centuries (see Figure 3).



Figure 3. Metacom Avenue Project Area in 1939

The area now contains approximately 400 buildings with over 700 housing units and 30 businesses. Land use in the project area is primarily medium and high-density residential, with pockets of commercial, light industrial, and active recreation. The historical platting of the larger tracts of open farmland and filling of marshes into housing blocks has yielded lots that are generally less than 10,000 square feet, developed with mainly two- and three-family structures.

Table 2 below lists the land uses within the Market Street project area, and the approximate percentage of the total parcel area each use occupies.

Table 2. Market Street Land Uses

Land Use	Percentage of Total Parcel Area
Single Family Residences	19%
2-5 Family Residences	18%
Vacant Commercial/ Industrial	15%
Commercial	10%
Industrial	8%
Utility/Railroad	8%
Municipal	7%
Residential – Vacant	5%
Apartments	2%
State	2%
Other	6%
Total	100%

While multi-family lots comprise a slightly lower percentage of land area than single-family lots within the Market Street project area, multi-family lots account for approximately sixty-two (62) percent of the housing units in the project area, while single family homes account for twenty-six (26) percent of housing units. The remaining twelve (12) percent of the total units are provided by apartment buildings.

3.2.2 Utilities and Infrastructure

Existing utilities within the Market Street project area include sanitary sewer, water, overhead electric, and drainage infrastructure. Each of the public rights-of-way within the project area have public sanitary sewer and water mains, as well as overhead power lines operated by National Grid. Several drainage structures and pipes exist within the project area. One drainage outfall discharges to Belcher Cove northwest of Jamiel's Park. Two additional drainage outfalls exist just north of Franklin Street.

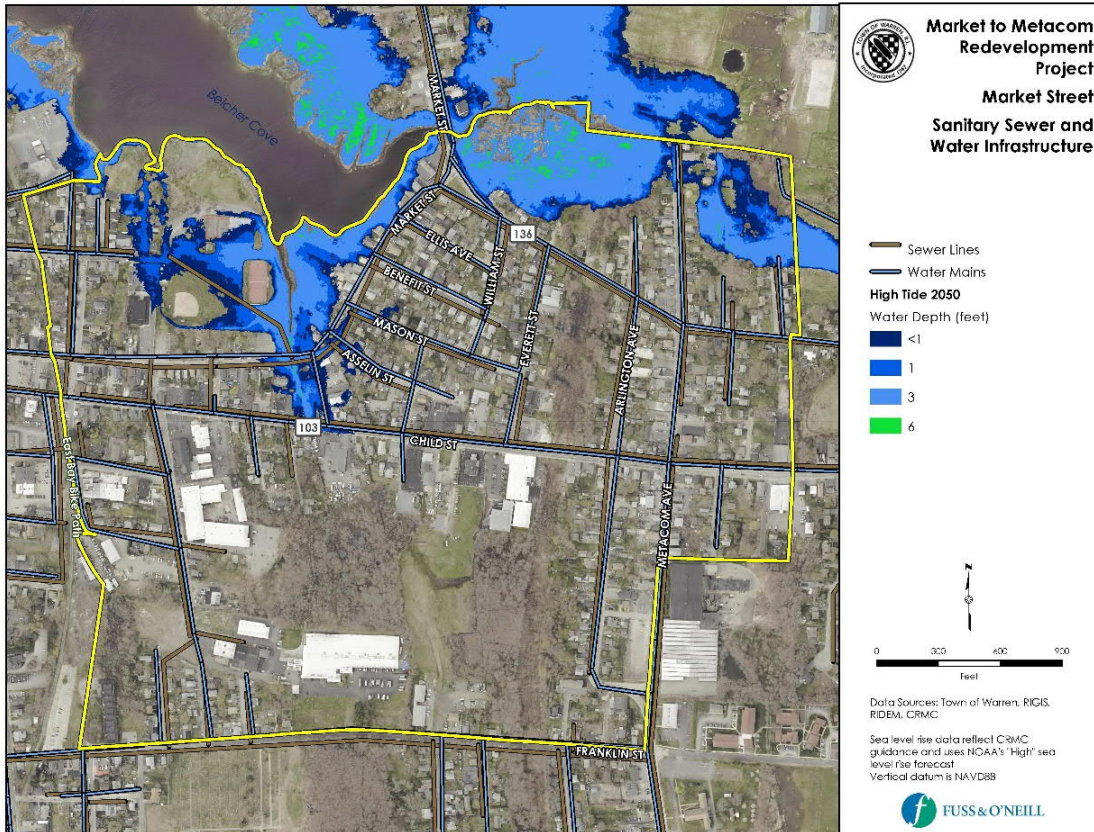


Figure 4. Market Street Sanitary Sewer and Water Infrastructure (with 2050 High Tide)

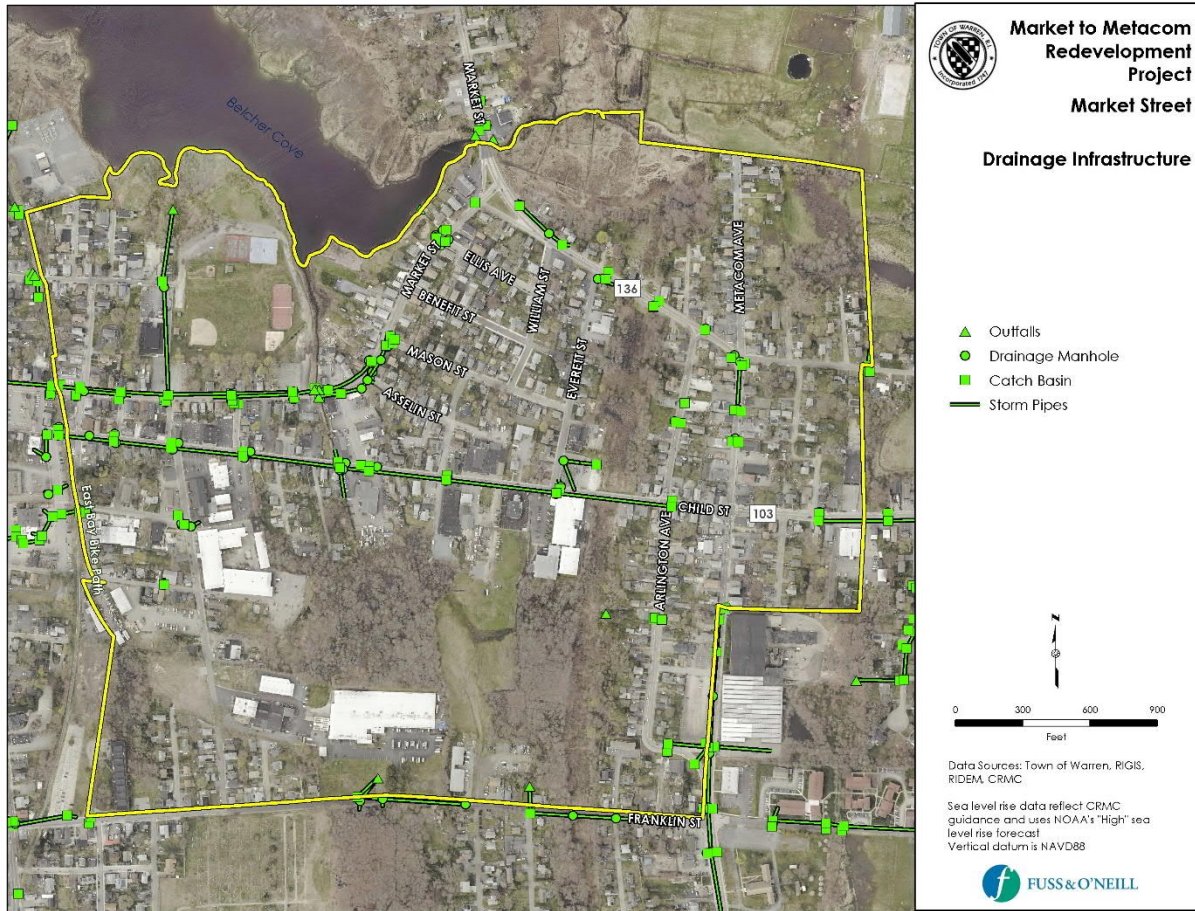


Figure 5. Market Street Drainage Infrastructure (with 2050 High Table)

3.2.3 Transportation Infrastructure

The Market Street project area includes several major surface transportation facilities that are critical to local and regional traffic, including:

- RI-136 – Market Street/Kickemuit Avenue is classified as a minor arterial road and an evacuation route. It serves as a segment of the north-south route connecting traffic from the Metacom Avenue corridor and Downtown Warren with points north including the connections to Interstate 195 in Seekonk and the regional highway system.
- RI-103 – Child Street is classified as a principal arterial road and an evacuation route. It serves as a primary east-west route connecting traffic from the Metacom Avenue corridor and Downtown Warren with points east including the connections to Interstate 195 in Swansea and the regional highway system.
- The East Bay Bike Path is immediately adjacent to project area and is a major north-south bicycle transportation route.

3.2.4 Property Values and Tax Generation

According to the Warren Tax Assessor database, the total value of the parcels within the Market Street project area is approximately \$138,313,000. The Market Street project area contains 586 parcels, with an average property value of approximately \$236,000. Approximately thirty-eight (38) percent of the total value is land value and sixty (60) percent is the value of existing buildings.

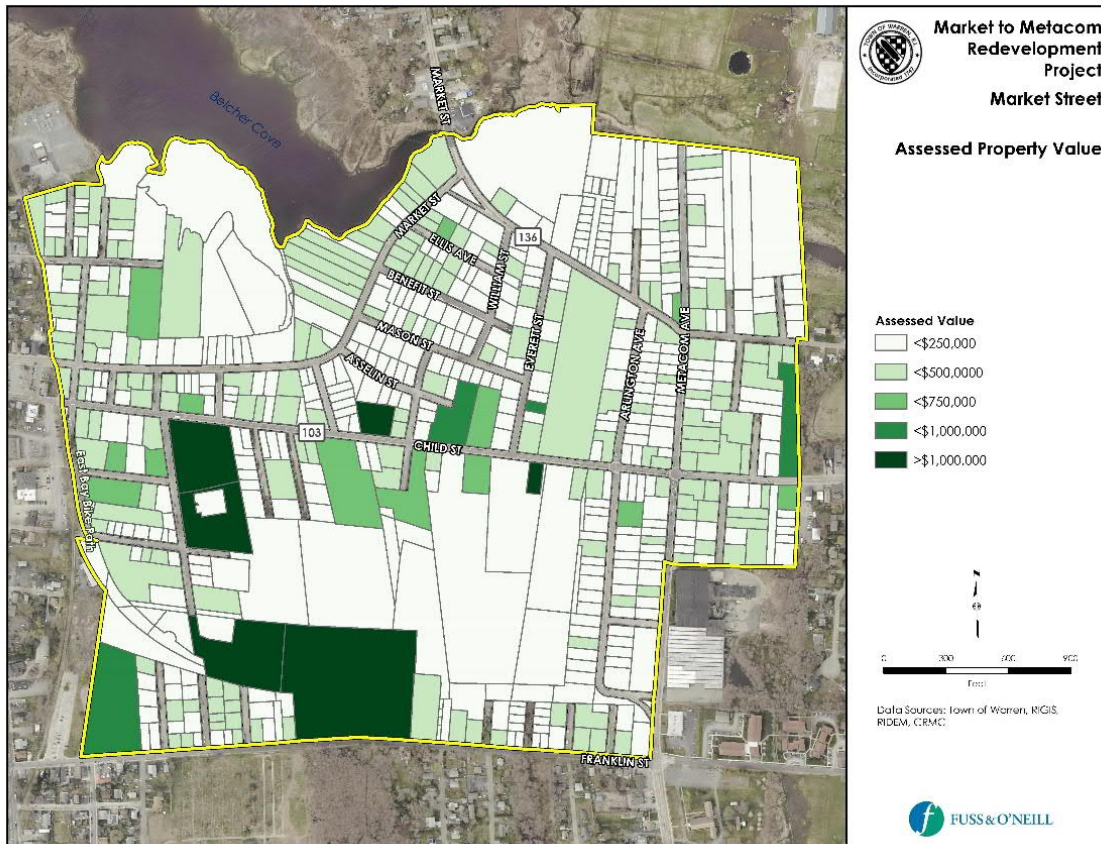


Figure 6. Market Street Property Values

The current annual property tax revenue generated by the parcels within this area is approximately \$2,401,000.

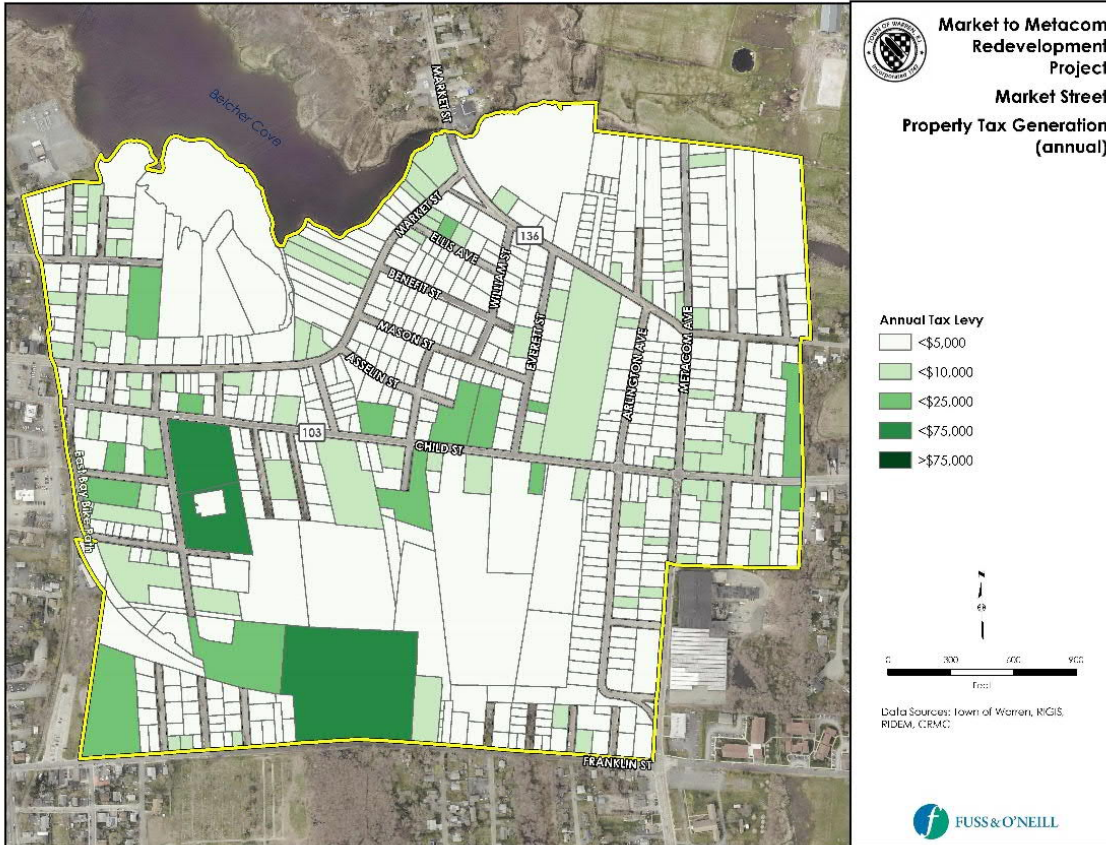


Figure 7. Market Street Property Tax Generation (Annual)

3.2.5 RIDEM-Regulated Facilities

The Market Street area contains twelve (12) underground storage tanks and one RIPDES Sanitary Waste Site, according to the list of RIDEM-regulated facilities.

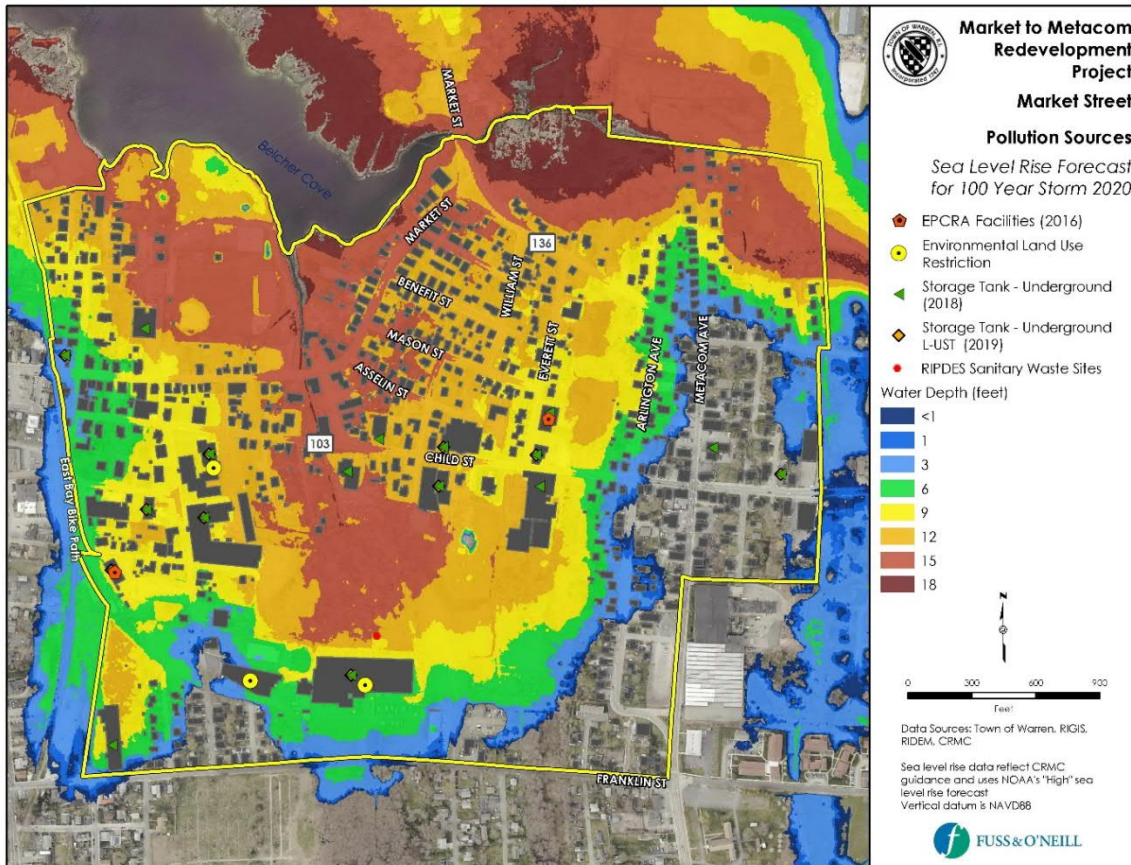


Figure 8. RIDEM Regulated Facilities (with 100 Year Storm)

3.2.6 Wetlands

According to Rhode Island Department of Environmental Management (RIDEM) mapping, there are 39 acres of wetlands in the Market Street area, including emergent marsh/wet meadow, estuarine emergent wetlands, deciduous forested wetlands, palustrine open water, and scrub-shrub swamps. These wetland areas comprise the majority of the undeveloped, vegetated land within the Market Street area.

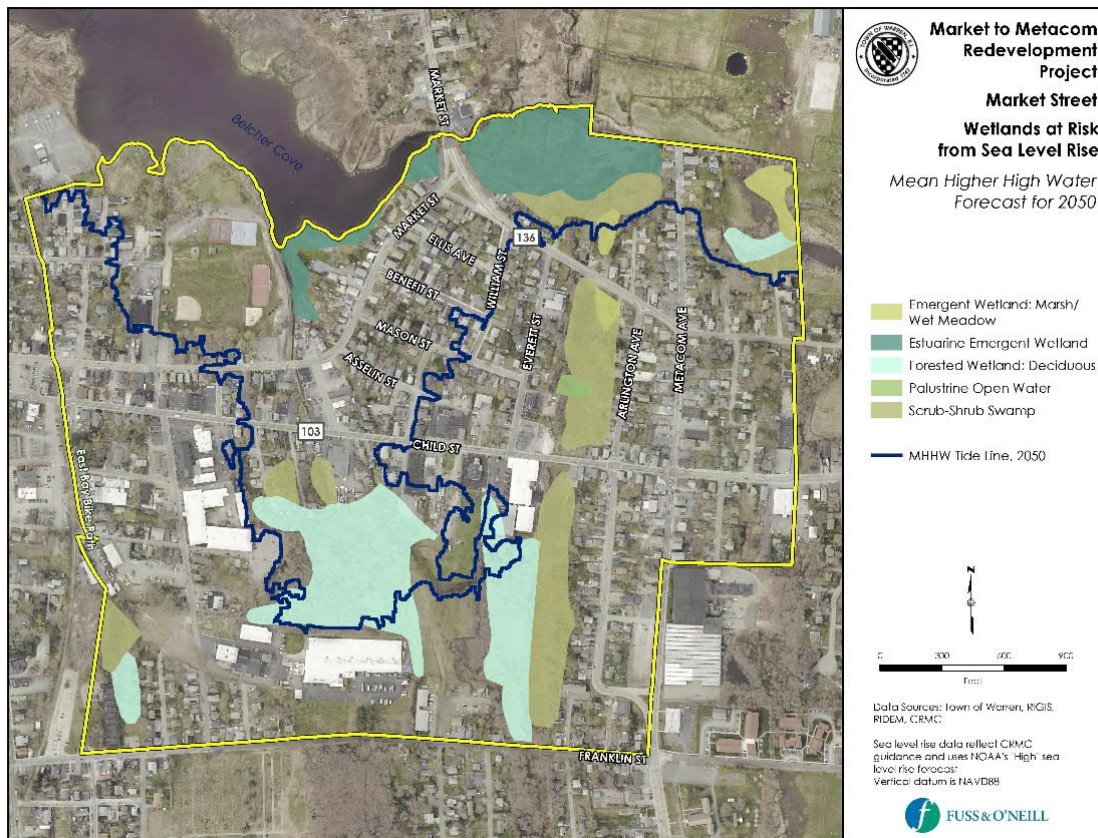


Figure 9. Market Street Wetlands

3.2.7 Impervious Surfaces, Drainage Patterns, and Water Quality

Impervious cover (IC) is any land surface covered by asphalt, concrete, brick, or similar material that does not allow rainwater to infiltrate into the soil. The percentage of land surface covered by IC is a useful metric or indicator for examining the impact of urbanization on the health of freshwater systems and water supplies (Allan, 2004). Larger areas of directly connected impervious cover generally results in larger volumes of stormwater runoff and can lead to localized flooding.

Approximately forty-six (46) percent of the land area within Market Street is covered with impervious surfaces. This includes, but is not limited to, roadways, driveways, parking lots, rooftops, and sidewalks.

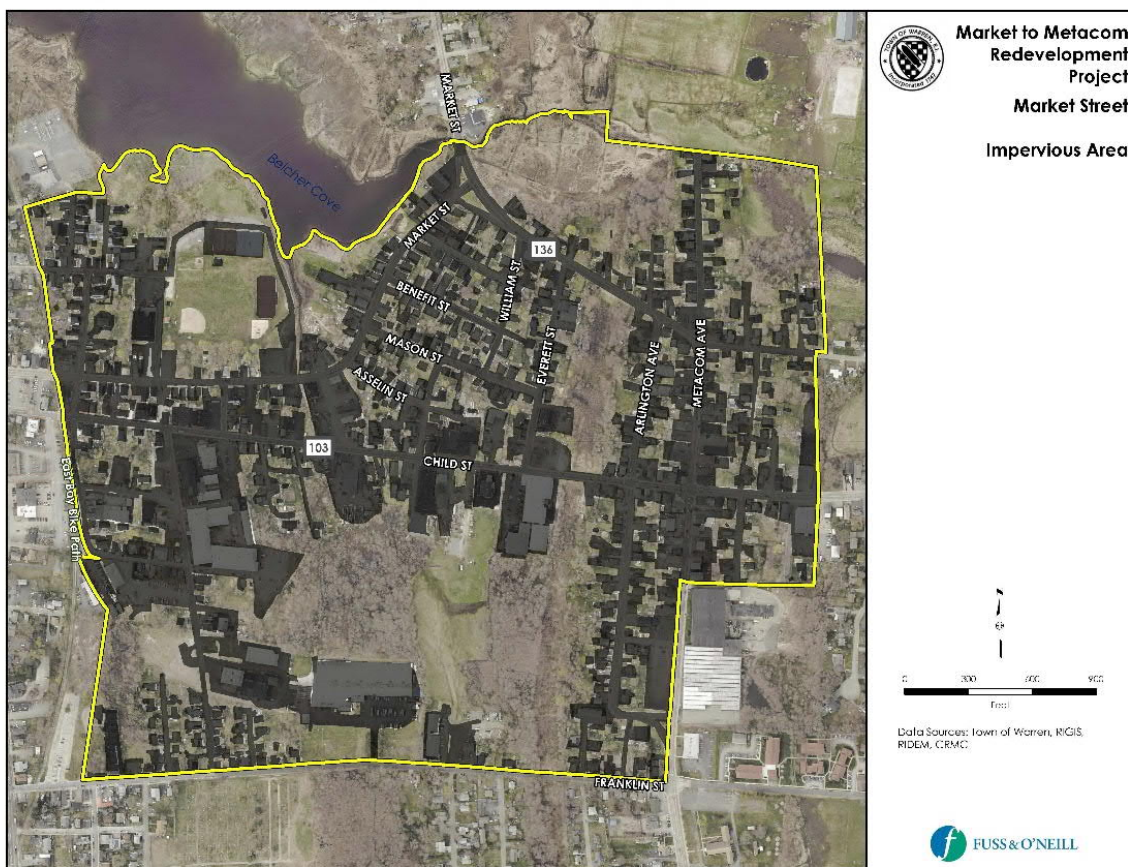


Figure 10. Market Street Impervious Area

The Market Street project area is located within the Palmer River Subwatershed (RI 0007022E-01A). The Palmer River has total nitrogen, dissolved oxygen, and fecal coliform impairments with a total maximum daily load (TMDL) in place for fecal coliform. It is a special resource water identified as critical habitat for rare and endangered species, as well as a conservation area.

The Market Street area generally drains to the north, to Belcher Cove, which is part of the Palmer River. An unnamed tributary to the Palmer River runs from a wetland south of Franklin Street, to the north through a



series of culverts and open channels within the Market Street project area, emptying east of Jamiel Park. The majority of stormwater from this project area drains untreated overland and through storm drains directly to its receiving waterbody.

3.3 Metacom Avenue Corridor

3.3.1 Location and Land Use

The Metacom Avenue project area includes the parcels abutting Metacom Avenue (RI Route 136) located south of Vernon Street and Parker Avenue. The southern boundary of the project area is located between Harris Avenue and Jameson Drive. The total area within the Metacom Avenue project boundary, including roadways, is approximately 81 acres.

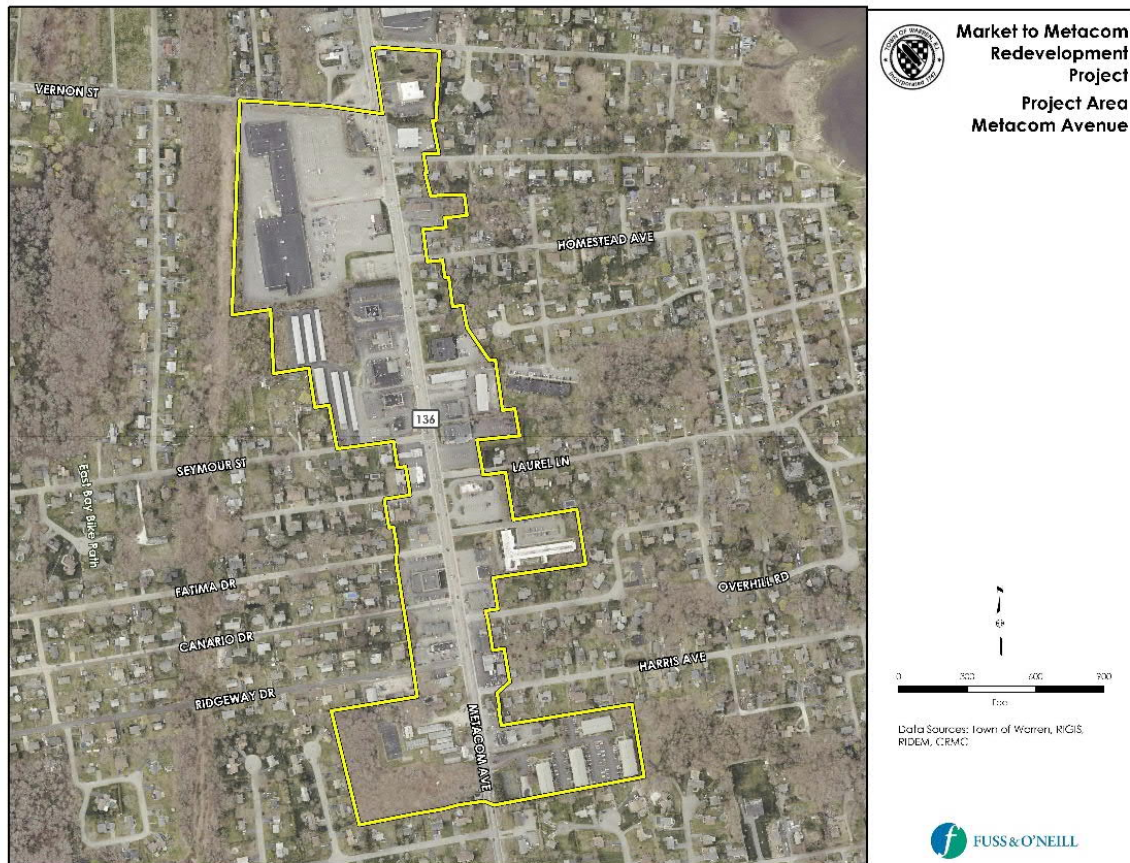


Figure 11. Metacom Avenue Project Area

Through the early history of Bristol and Warren, Metacom Avenue was a secondary north-south roadway along the ridge above the Kickemuit River. Land uses were primarily agricultural with scattered farms. During the late 19th and early 20th centuries there was no significant development on Metacom Avenue itself and limited development of seasonal housing along the shore of the Kickemuit River and Mount Hope Bay.



Figure 12. Metacom Avenue Project Area in 1939

The period between 1965 and 1985 saw the development of Metacom Avenue as retail/commercial corridor with a widening of the roadway and associated private development that catered to automobile traffic. There is currently little infrastructure to accommodate pedestrians between or within parcels, and no separated paths or designated lanes for bicyclists.

Table 3 lists the land uses within the Metacom Avenue project area and the approximate percentage of the total parcel area each use occupies.

Table 3 - Metacom Avenue Land Uses

Land Use	Percentage of Total Parcel Area
Commercial/ Industrial	39%
Single Family Residences	23%
Multi-Family Residences	12%
Vacant Improved Land	13%
State/Railroad/Utility	7%
Vacant Unimproved Land	6%
Total	100%

3.3.2 Utilities and Infrastructure

Within the Metacom Avenue project area, existing utilities include sanitary sewer, water, electric, and drainage infrastructure. Public sanitary sewer and water mains are present within the public rights-of-way within the project area. Overhead electrical lines operated by National Grid are located along Metacom Avenue and the intersecting streets within the project area. Several drainage structures and pipes exist within the project area with outfall discharges to the Kickemuit River.

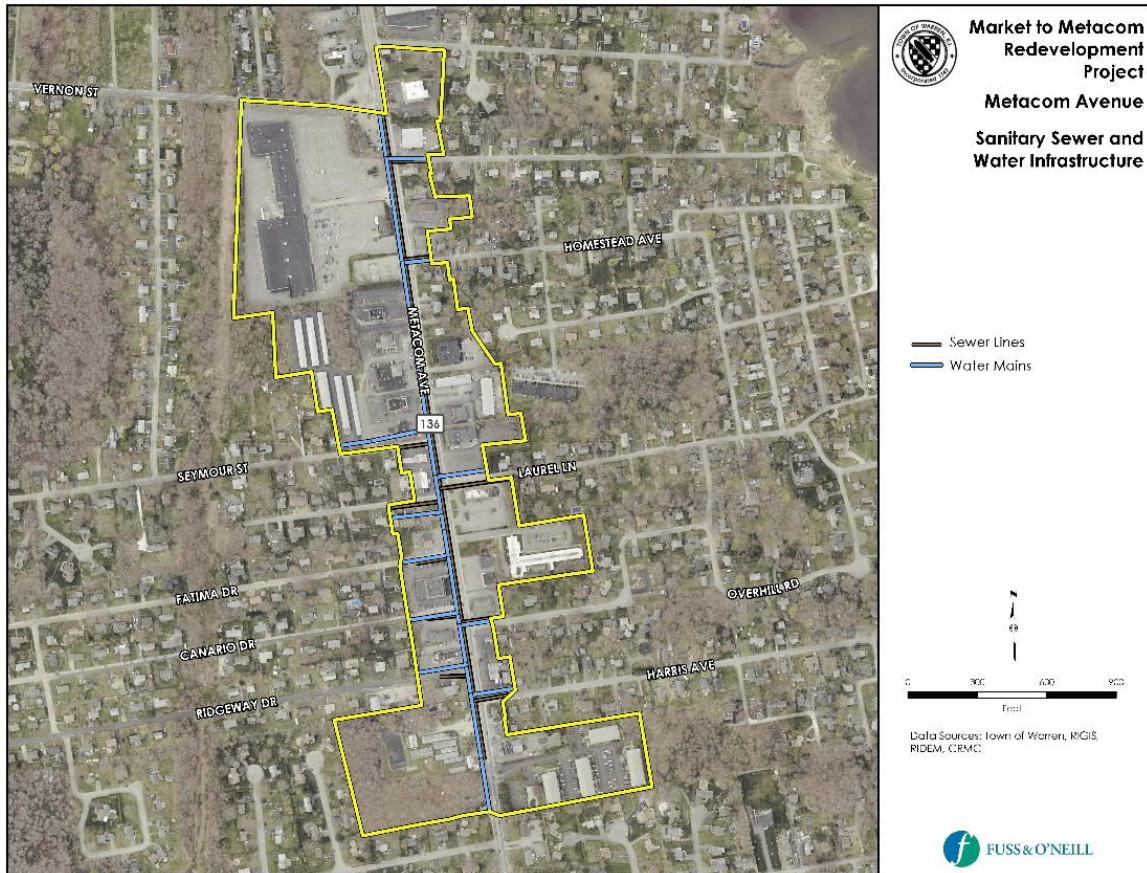


Figure 13. Metacom Avenue Sanitary Sewer and Water Infrastructure



Figure 14. Metacom Avenue Drainage Utilities/Infrastructure

3.3.3 Transportation Infrastructure

RI-136 - Metacom Avenue is a major north-south surface transportation facility that is critical to local and regional traffic. The section of Metacom within the project area is classified as a minor arterial road and an evacuation route. It serves as a segment of the north-south route connecting traffic from Bristol and Warren with points north including the connections to Interstate 195 in Seekonk and the regional highway system. It is also one of the two primary routes connecting south to Bristol and the Mount Hope Bridge. This segment of Metacom Avenue also connects just north of the project area with RI-103 – Child Street which is classified as a principal arterial road and an evacuation route. RI-103 serves as a primary east-west route connecting traffic from the Metacom Avenue corridor and Downtown Warren with points east including the connections to Interstate 195 in Swansea and the regional highway system.

3.3.4 Property Values and Tax Generation

The Metacom Avenue project area contains 116 parcels, with a total value, according to the Warren Tax Assessor, of approximately \$59 million dollars. Approximately 31% of the total value is land value and 62% is the value of existing buildings. The current tax revenue generated by the parcels in this project area is approximately \$1,025,000.

Table 4 lists the tax generation percentage for various uses within the Metacom Avenue project area.

Table 4 – Metacom Avenue Tax Generation

Land Use	Percentage of Total Tax Generation
Commercial/ Industrial	50%
Single Family Residences	24%
Multi-Family Residences	22%
Other	4%
Total	100%

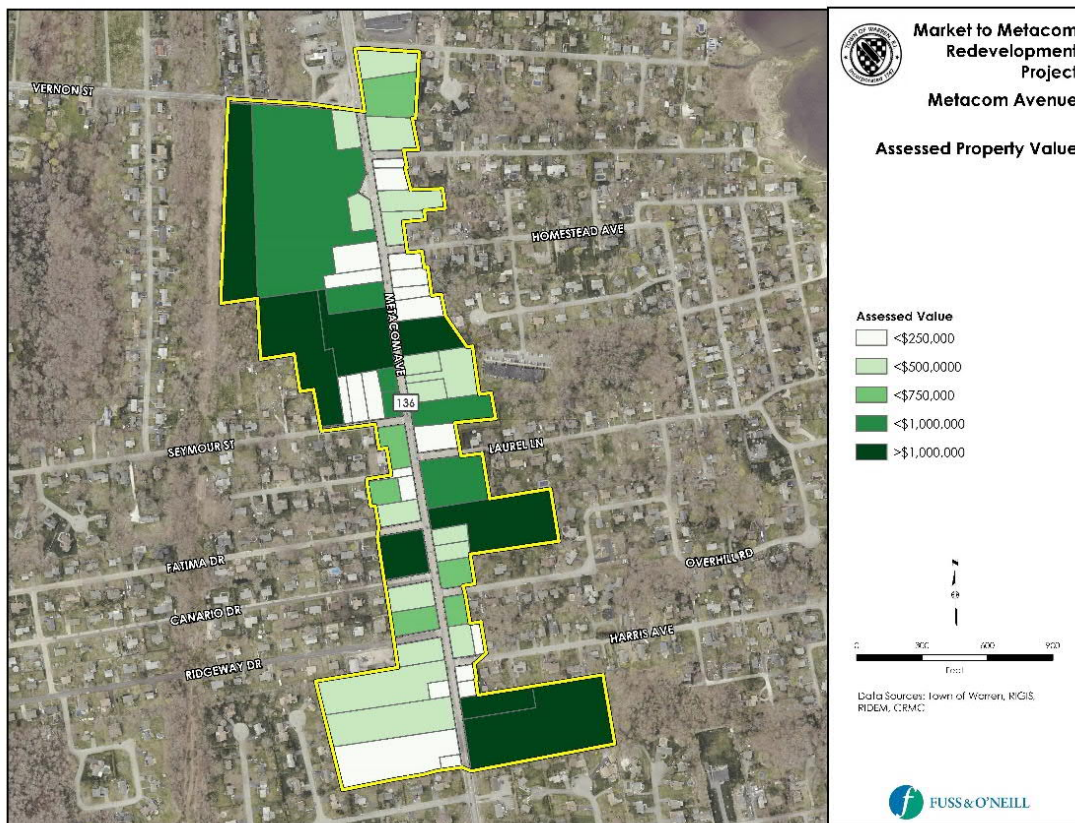


Figure 15. Metacom Avenue Property Values

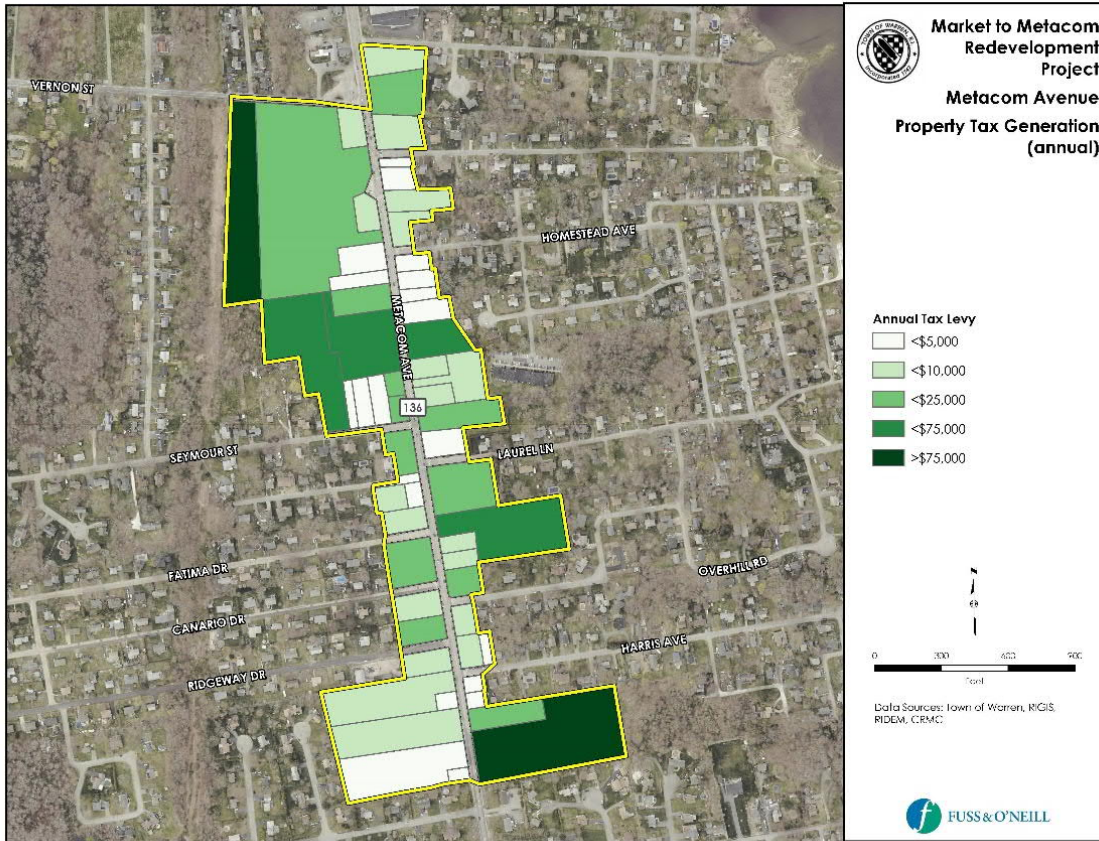


Figure 16. Metacom Avenue Property Tax Generation (Annual)

3.3.5 DEM-regulated Facilities

The Metacom Avenue area contains six (6) underground storage tanks, according to the list of RIDEM-regulated facilities. None of them are subject to forecast SLR impacts through the period 2050.

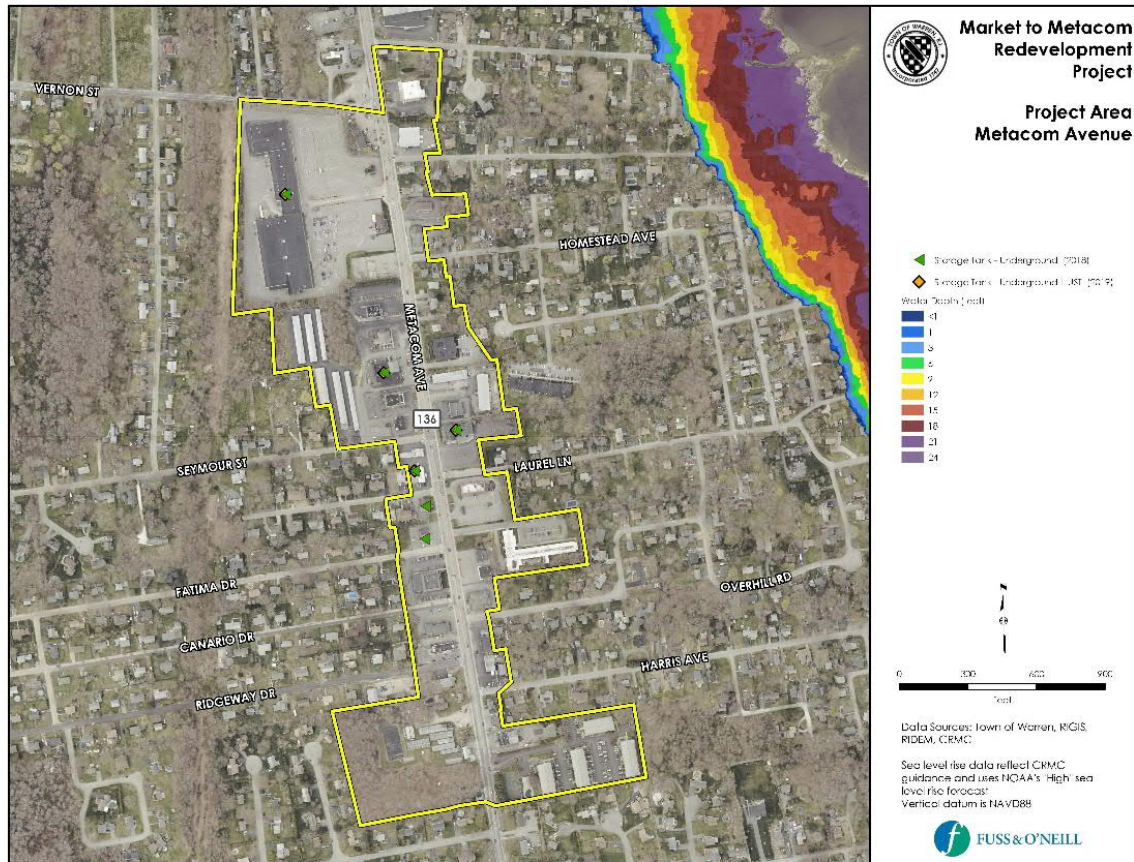


Figure 17. RIDEM-Regulated Facilities with 100-Year Storm

3.3.6 Wetlands

According to Rhode Island Department of Environmental Management (RIDEM) mapping, there are no wetlands within the Metacom Avenue project area.

3.3.7 Impervious Surfaces, Drainage Patterns, and Water Quality

The majority of precipitation that falls on impervious surfaces in the Metacom project area is captured by conventional stormwater infrastructure and directed to the Kickemuit River. Approximately 76% of the total project area, including roadways, is impervious. This high percentage of impervious area results in large volumes of stormwater runoff. Catch basins within roadways capture some runoff within this project area and the storm drains discharge at several outfalls to the Kickemuit River. Impairments listed for the Kickemuit River include fecal coliform and phosphorus.

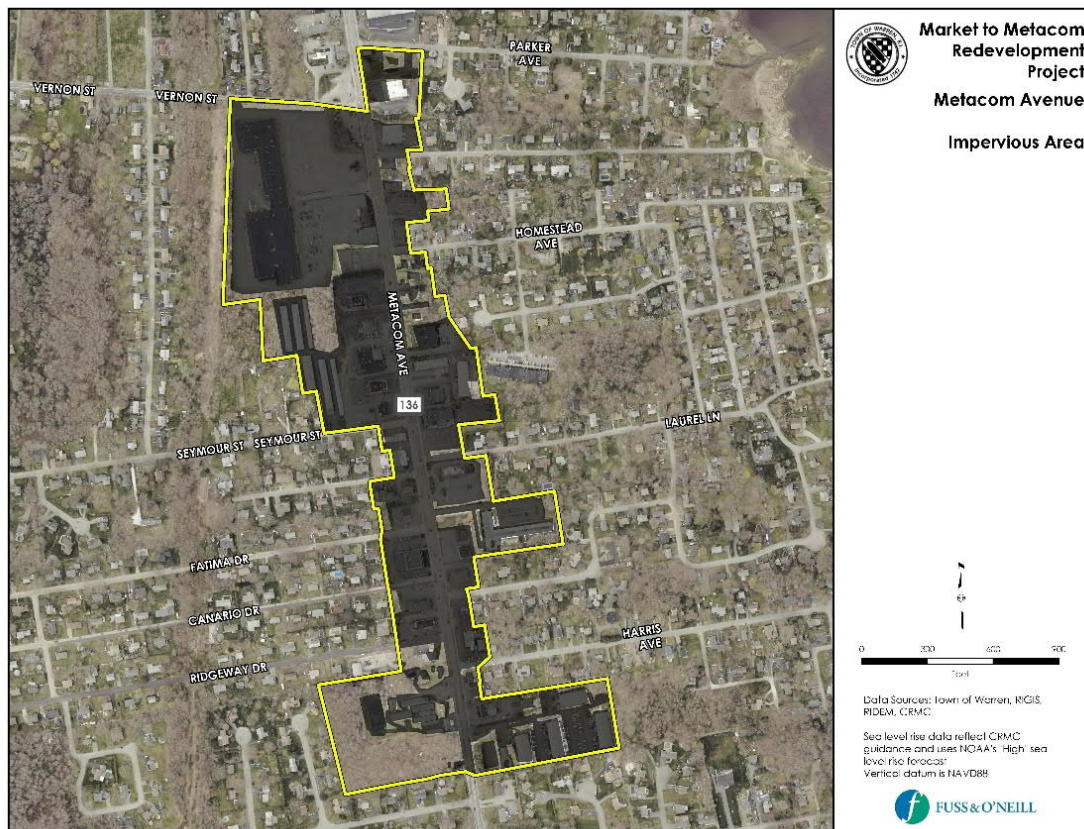


Figure 18. Metacom Avenue Impervious Area

3.4 Designated Flood Zones

Forty-eight percent (48%) of the Market Street project area lies within the 100-year flood zone (Zone AE), with a flood elevation of 13' (NAVD 88), according to FEMA Flood Insurance Rate Map (FIRM) No. 44001C0008H, effective July 7, 2014. Sixteen percent (16%) of the Market Street project area is within Zone X, an area inundated by the 500-year flood.

The Metacom Avenue project area is outside of the 100-year and 500-year flood zones (Figure 19). The 100-year flood zone is a designated area that has a 1-in-100 chance (or 1% chance) of flooding in any given year. This also means it can flood more than once within a 100-year period, and can even flood more than once in the same year. The 500-year flood zone has a 1-in-500 chance (or .02% chance) of flooding in any given year.

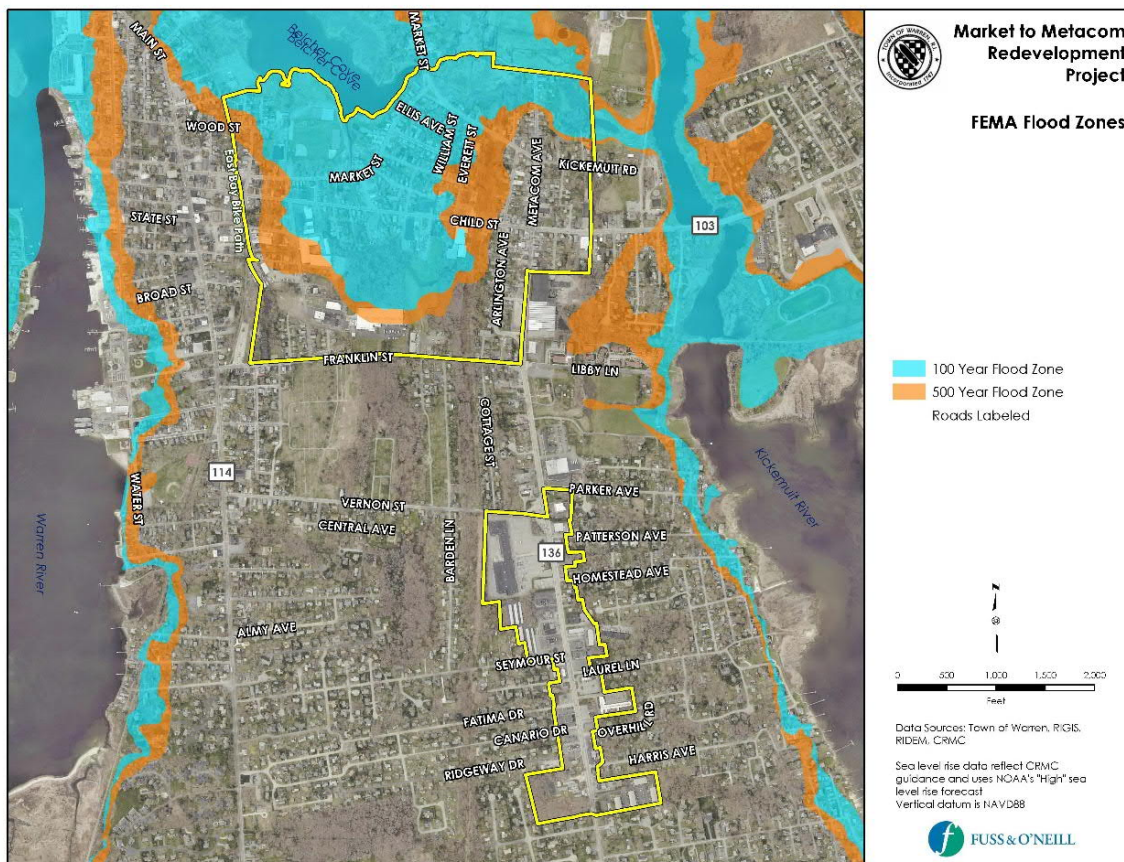


Figure 19. FEMA Flood Zones

4 Sea Level Rise Projections and Impacts

4.1 Sea Level Rise Projections – Market Street Project Area

The following figures (Figures 20 through 24) reflect the National Oceanic and Atmospheric Administration's (NOAA's) "high" SLR forecast for the Market Street project area. Figures show the mean higher high water (MHHW), which is defined as the average height of the highest tide recorded at a tide station each day during the recording period. As shown on Figure 20, MHHW in 2020 already inundates a portion of the Market Street project area east of Jamiel Park, as well as the wetland east of Route 136.

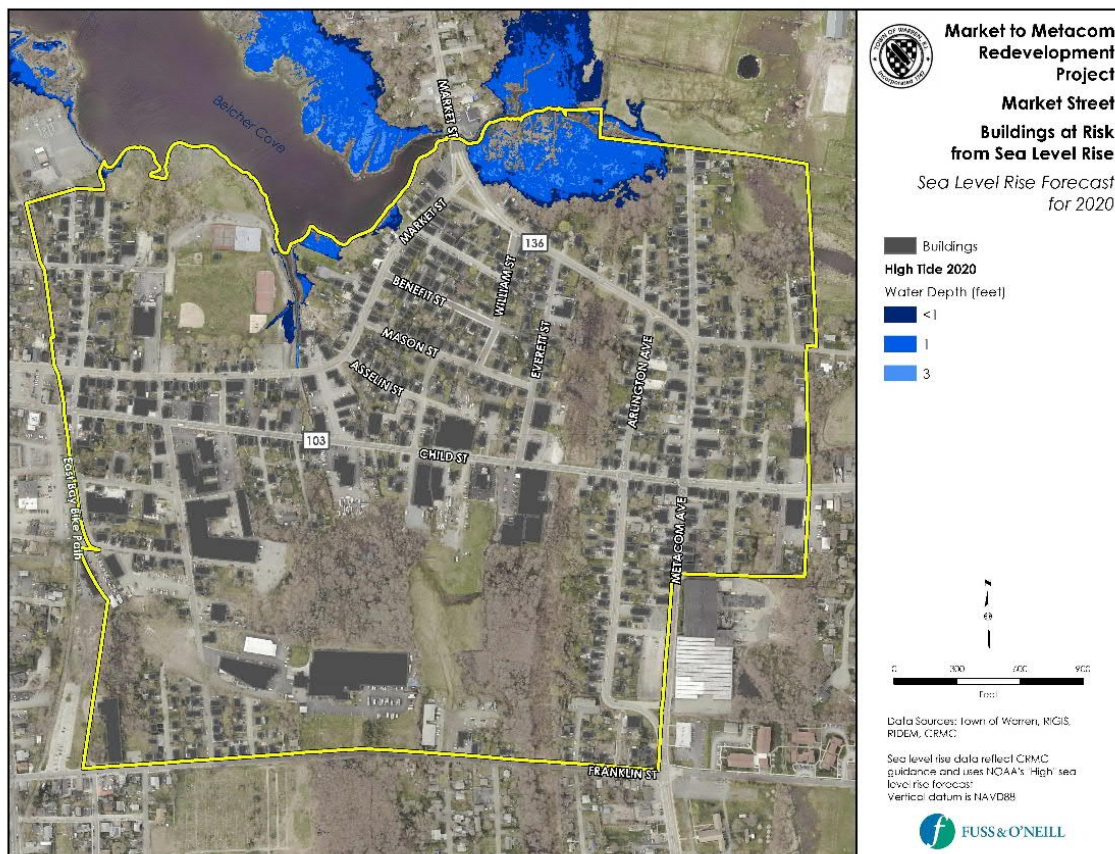


Figure 20. Market Street – Sea Level Rise Projection for 2020

These impacted areas are projected to expand over time, causing at least one foot of flooding within Market Street by 2035. By 2050, the lowest-lying portions of Market Street are projected to have three feet of flooding during MHHW, a portion of Child Street will have up to one foot of flooding, and many of the properties between Belcher Cove and Market Street will be impacted. Projections for the year 2070 indicate that a substantial portion of Market Street and the surrounding neighborhood will be inundated by three feet of water, with lowest areas, including wetlands, experiencing six-foot flood depths (Figure 23). In 2100, SLR at high tide is projected to impact the majority of the Market Street project area, with flood depths reaching nine feet within much of Market Street and maximum depths of 12 feet within the project area (Figure 24).

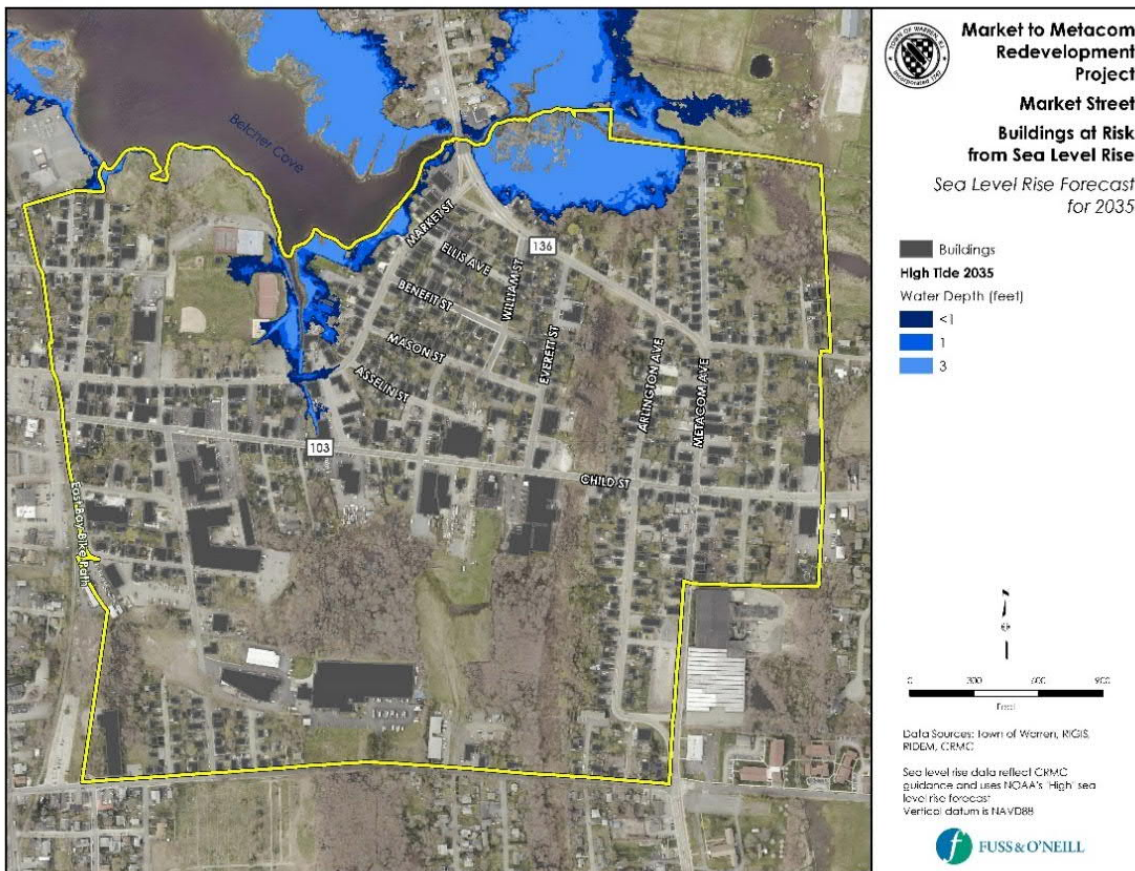


Figure 21. Market Street – Sea Level Rise Projection for 2035

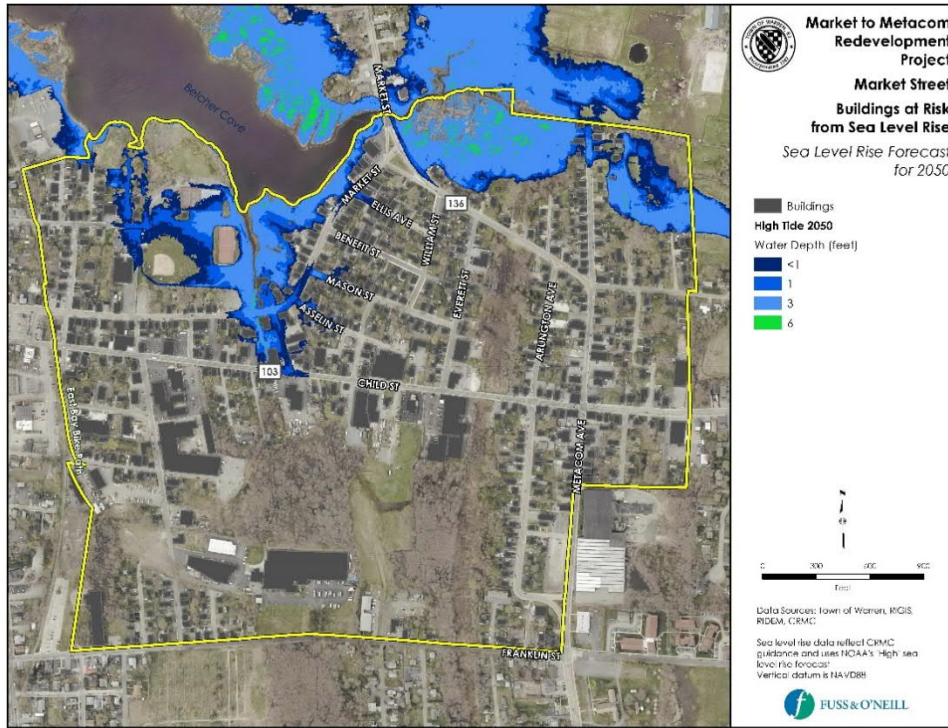


Figure 22. Market Street – Sea Level Rise Projection for 2050

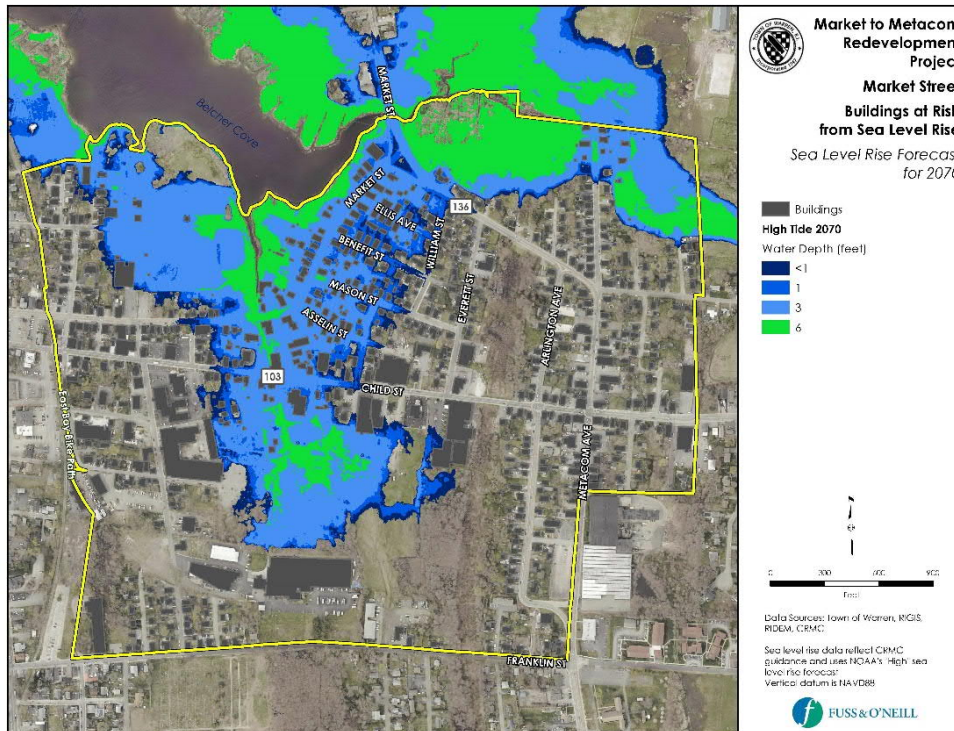


Figure 23. Market Street – Sea Level Rise Projection for 2070

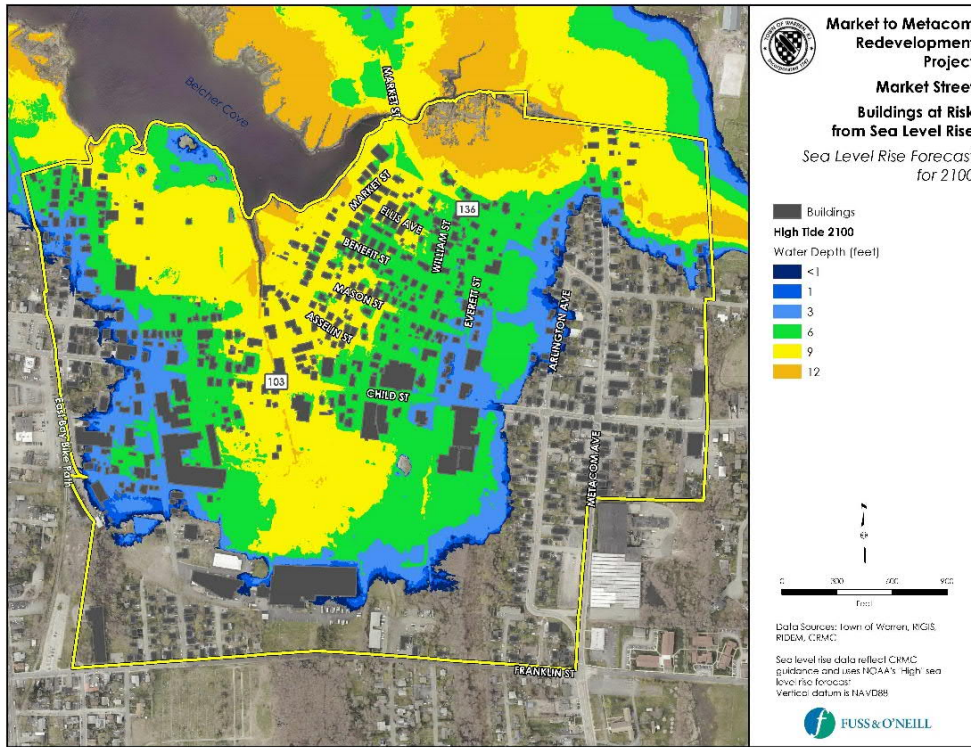


Figure 24. Market Street – Sea Level Rise Projection for 2100

4.2 Sea Level Rise Projections for 100-Year Storm Events – Market Street Area

The following figures (Figures 25 through 29) reflect CRMC SLR guidance and NOAA projections of flood depths during the 100-year storm for the Market Street project area. Under current (2020) conditions, the 100-year storm inundates the majority of the Market Street project area, with Market Street, a portion of Child Street, and many properties in the area under five to fifteen feet of water, and some wetland areas experiencing twenty feet of flooding (Figure 25). The figures for future projections show that flooding during the 100-year storm will continue to expand through the Market Street project area and will increase in severity. By 2070, almost the entire Market Street project area will be inundated during the 100-year storm, with maximum flood depths of twenty feet. Projections for 2100 show that the entire Market Street project area will be inundated by the 100-year storm, with twenty-five-foot flood depths within a large area of the neighborhood.

Sea level rise will cause flood impacts associated with the 100-year storm to increase over time along the Kickemuit River, however, the Metacom Avenue project area is not projected to be flooded under the 100-year storm through the year 2100.

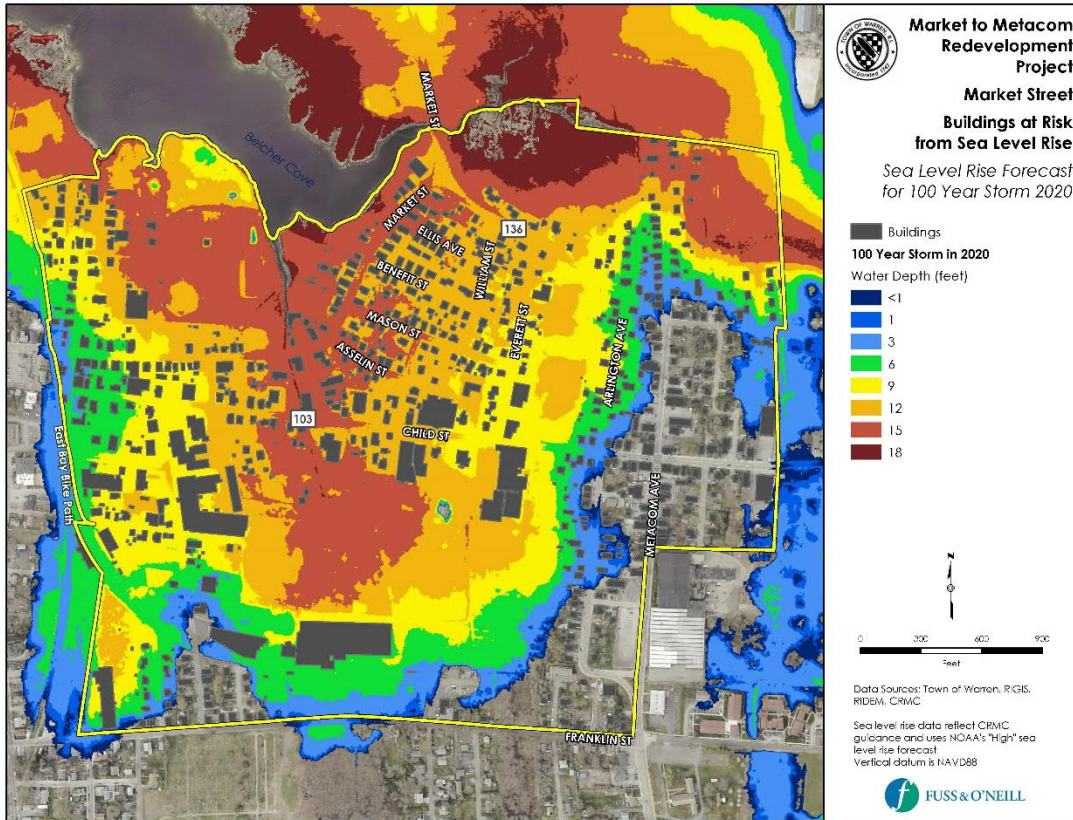


Figure 25. Market Street - Sea Level Rise Projection for 2020 (with 100-Year Storm)

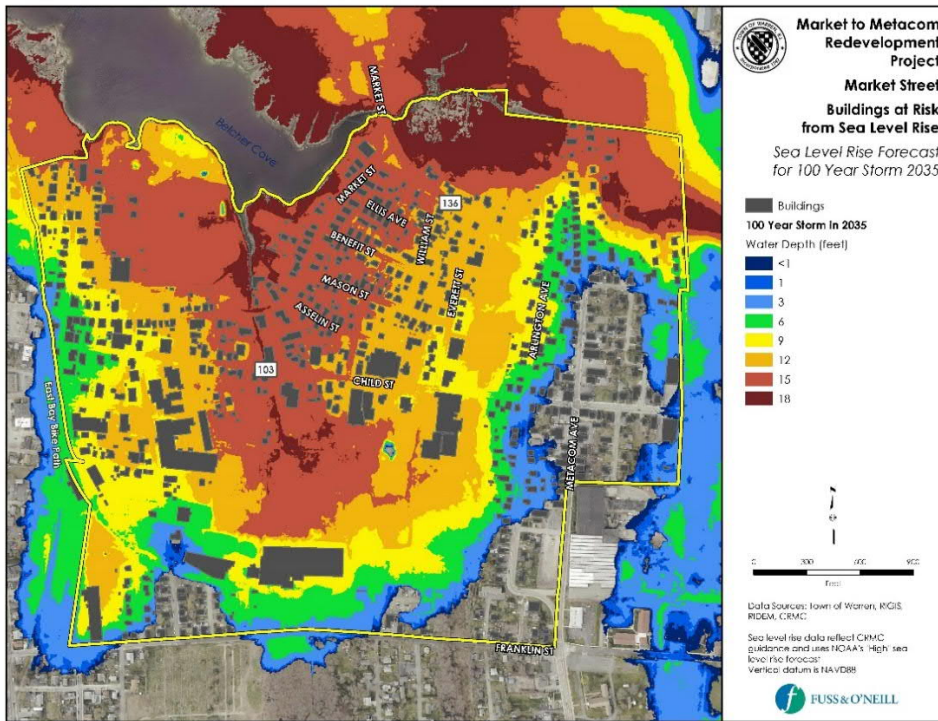


Figure 26. Market Street – Sea Level Rise Projection for 2035 (with 100-Year Storm)

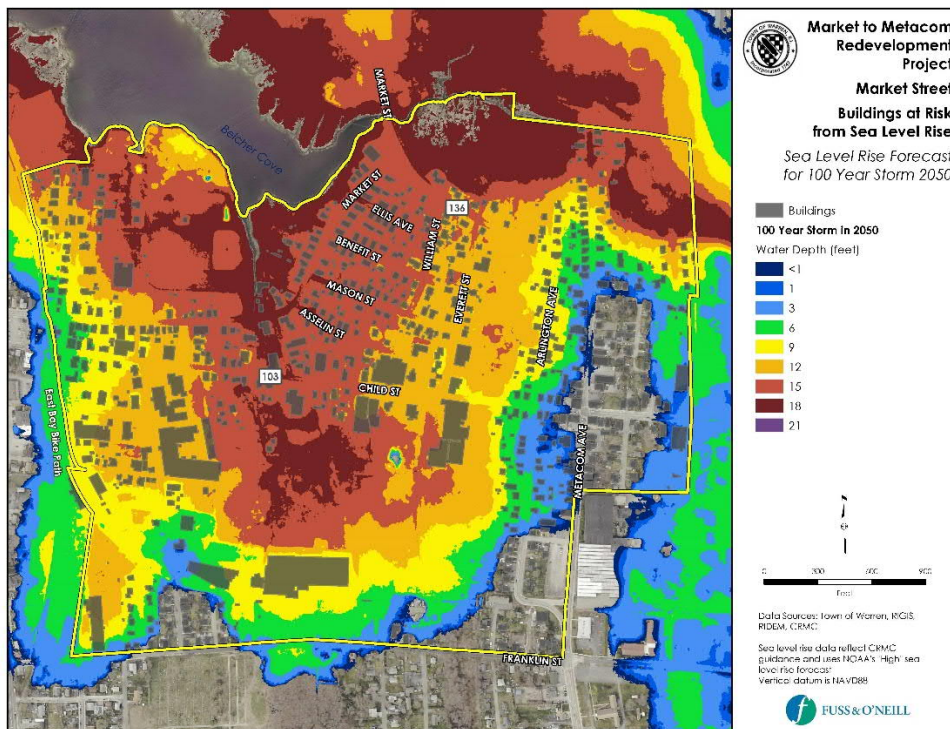


Figure 27. Market Street – Sea Level Rise Projection for 2050 (with 100-Year Storm)

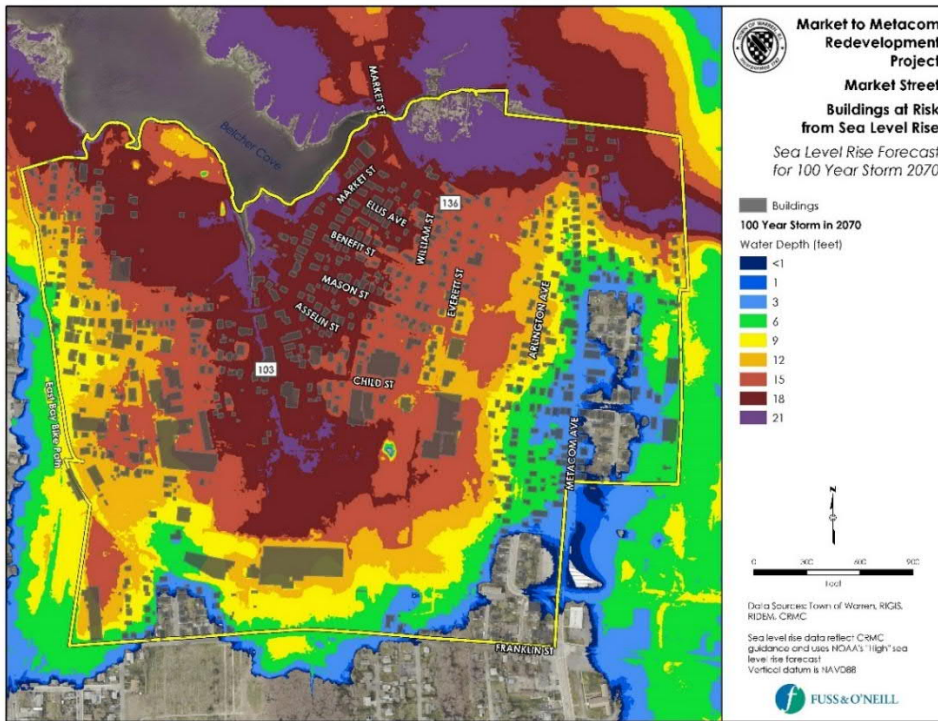


Figure 28. Market Street – Sea Level Rise Projection for 2070 (with 100-Year Storm)

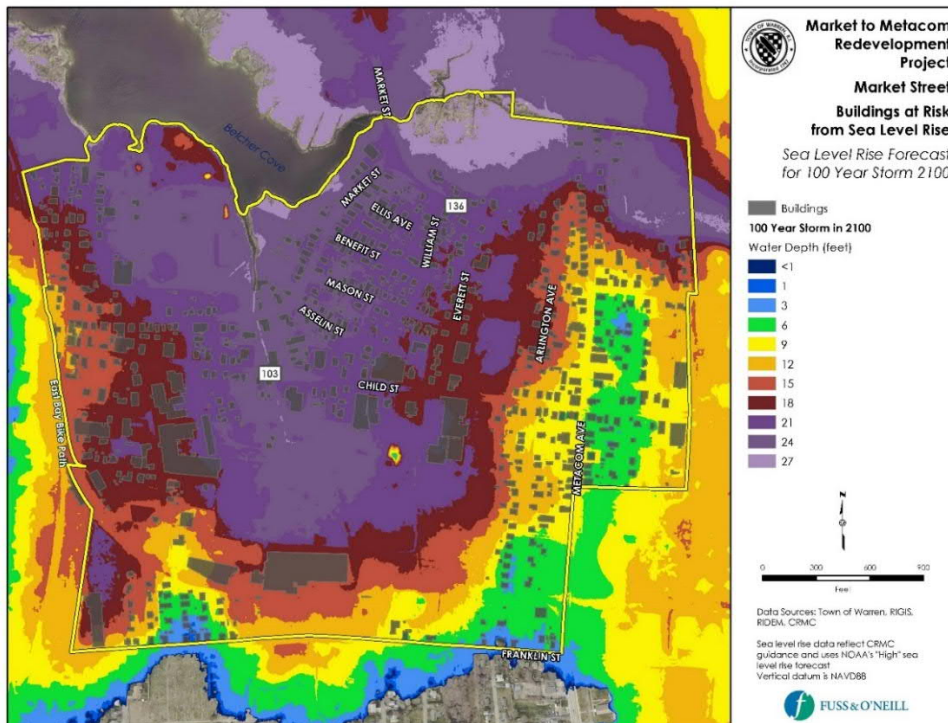


Figure 29. Market Street – Sea Level Rise Projection for 2100 (with 100-Year Storm)

4.3 Sea Level Rise Impacts – Market Street

The low-lying neighborhood around Market Street will be inundated with increasing frequency and severity due to SLR and increased severity of precipitation/storm events. This will have significant impacts including environmental impacts related to repeated flooding of existing fuel tanks, septic systems, and building materials. Existing wetlands within the Market Street project area will become increasingly inundated, eliminating these valuable resource areas that provide critical habitat and natural coastal buffers. Increased runoff from climate impacts in this neighborhood will also exacerbate water quality issues in Belcher Cove and the Palmer River. These physical impacts have the potential for extensive economic impacts that will affect residents, property owners, businesses, and the Town.

4.4 Sea Level Rise Projection – Metacom Avenue Corridor

While SLR will impact properties along the Kickemuit River, the Metacom Avenue project area is not projected to experience flooding during MHHW through the year 2100, even during the projected 100-year storm events or smaller.

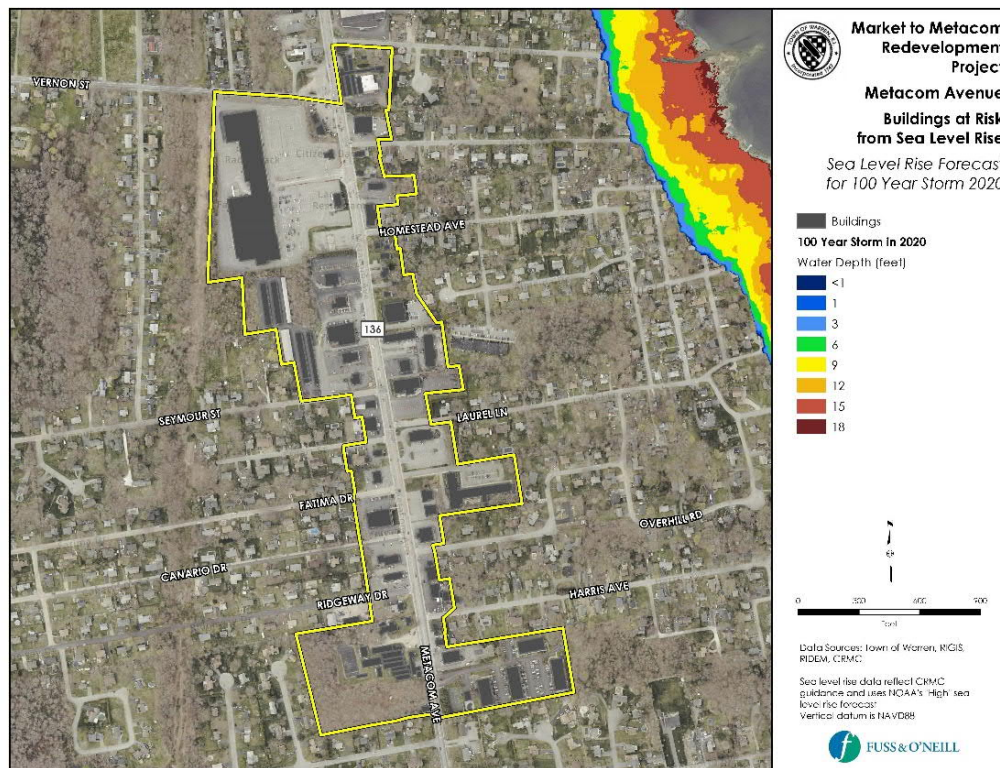


Figure 30. Metacom Avenue – Sea Level Rise Projection for 100-Year Storm for 2020

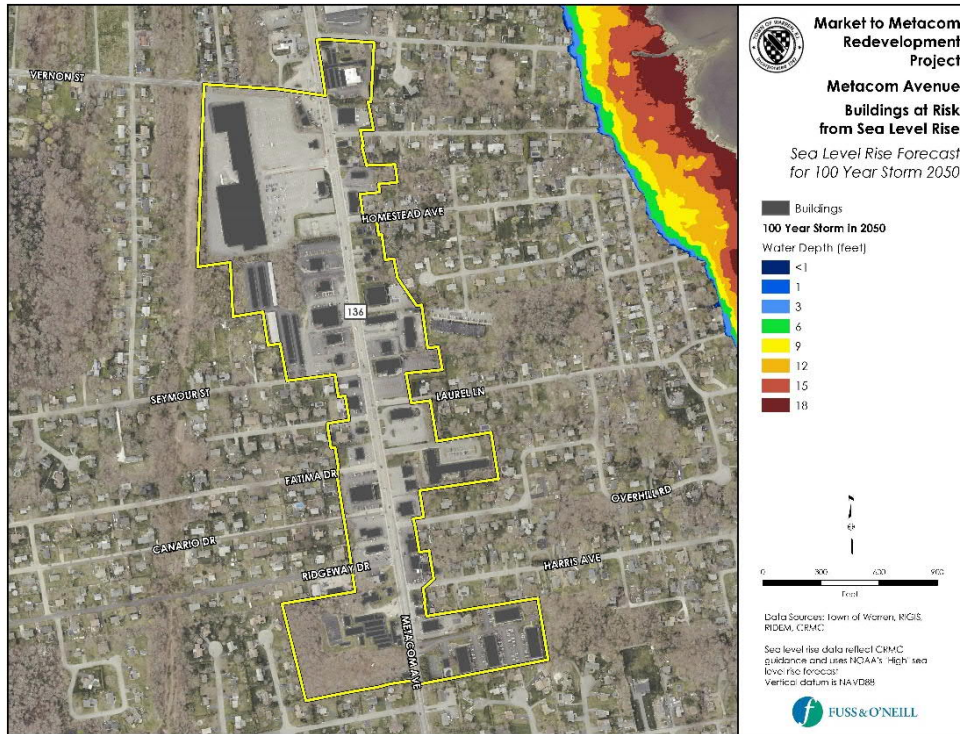


Figure 31. Metacom Avenue – Sea Level Rise Projection for 100-Year Storm for 2050

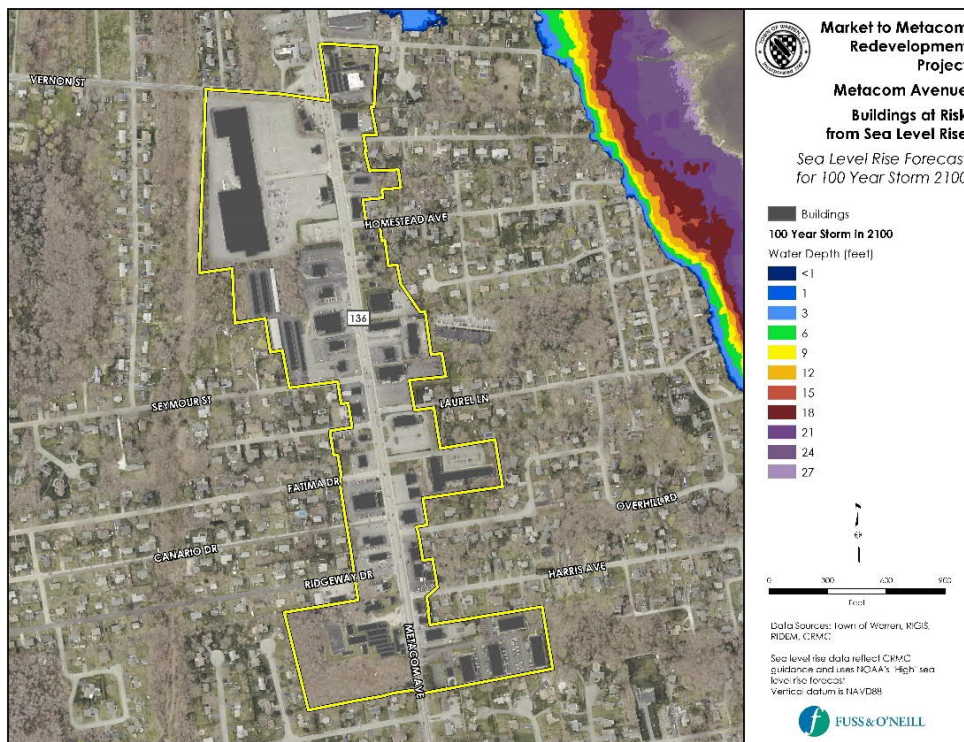


Figure 32. Metacom Avenue – Sea Level Rise Projection for 100-Year Storm for 2100

4.5 Sea Level Rise Impacts – Metacom Avenue Corridor

Because of its topography and elevation above surrounding waterbodies, the properties in the Metacom Avenue project area are less affected by SLR and flooding events directly. However, SLR will inundate the primary transportation connections to the north along RI-136 and to the west along RI-103. Unless these roadways are retrofitted or rerouted to avoid inundation from SLR and storm events, the Metacom Avenue corridor will be disconnected from the regional road network, potentially created an “island” with limited access/egress during flooding events.

The increasing frequency and severity of precipitation/storm events have the potential to overwhelm existing stormwater drainage systems that were designed and constructed to handle smaller flows. Increased stormwater runoff from these precipitation events in this area with high impervious cover will likely also exacerbate water quality issues in the Kickemuit River. Existing wetlands within the Market Street project area will become increasingly inundated, eliminating these valuable resource areas that provide critical habitat and natural coastal buffers.

5 Existing Regulations and Planning

The following section summarizes the existing local and state regulatory systems and planning documents as they relate to land use, stormwater management and transportation in the project areas.

5.1 Zoning

5.1.1 Market Street Area

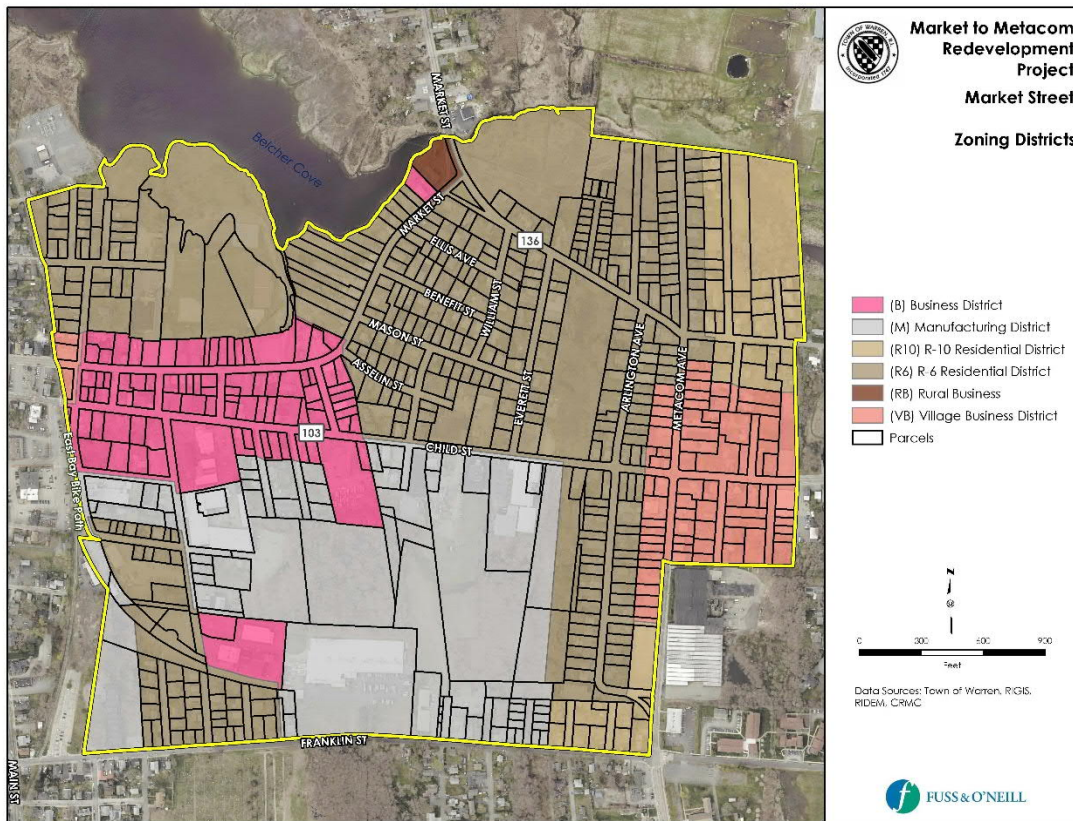


Figure 33. Market Street Project Area Zoning Map

The Market Street project area is comprised of the following zoning districts: (M) Manufacturing, R6 Residential, Village Business, Business, R-10 Residential, Special, and Conservation. The largest districts within the project area are R-6 Residential and Manufacturing, with Business and Village Business representing the next largest land use types.

Within the R-6 Residential zone, permitted uses include single-family dwellings, community residences, and Town-owned parks. Uses permitted by special permit within the R-6 zone include, but are not limited to, apartment complexes, bed and breakfasts, two-family and multi-family dwellings, and churches.

The following dimensional requirements apply to the R-6 Residential district:

- Minimum Lot Area: 6,000 SF for single family dwellings, 8,000 SF for two-family dwellings, 20,000 SF for hotel/motel
- Minimum Lot Frontage: 60 feet for single-family dwellings, 70-feet for two- and multi-family dwellings, 120 feet for hotel/motel
- Minimum Front Yard Depth: 20 feet for dwellings, 30 feet for hotel/motel
- Minimum Rear Yard Depth: 30 feet
- Minimum Side Yard: 10 feet for single- and two-family, 15 feet for multi-family, and 20 feet for hotel/motel
- Maximum Building Lot Coverage: 25%

Within the Manufacturing district, uses permitted by-right include, but are not limited to, offices for a wholesale or manufacturing use, indoor wholesale business and storage, commercial nursery or greenhouse, and Town-owned parks. Within the manufacturing district, uses permitted with a special permit include, but are not limited to, open lot storage of new building materials or machinery; utility uses, such as electrical power generating substations; and services such as plumbing, and automotive repair or body shops.

The following dimensional and parking requirements apply to the Manufacturing district:

- Min Lot Frontage and width: 100 feet
- Min Distance of Structure from residential district: 50 feet
- Min Front Yard: 30 feet
- Min Rear Yard: 40 feet
- Max Side Yard: 30 feet
- Max building Lot Coverage: 40%
- Max Building Height: 35 feet
- Business, commercial or office uses in buildings: 5 spaces plus 1 space per 250 feet floor space
- Schools, churches, theaters, restaurants: 1 space per 4 seats or per 4 persons of capacity
- Single- and two-family dwellings: 1.5/family unit
- Multi-family and apartment buildings: 2 spaces, plus 1 per rented room

A small portion of the Market Street project area is located in the Kickemuit Reservoir Watershed Overlay District. Within this overlay district, uses that could impact water quality within the reservoir are prohibited. These uses include, but are not limited to, commercial car washes, landfills, machine shops, dry-cleaning, and petroleum storage.

5.1.2 Metacom Avenue Area

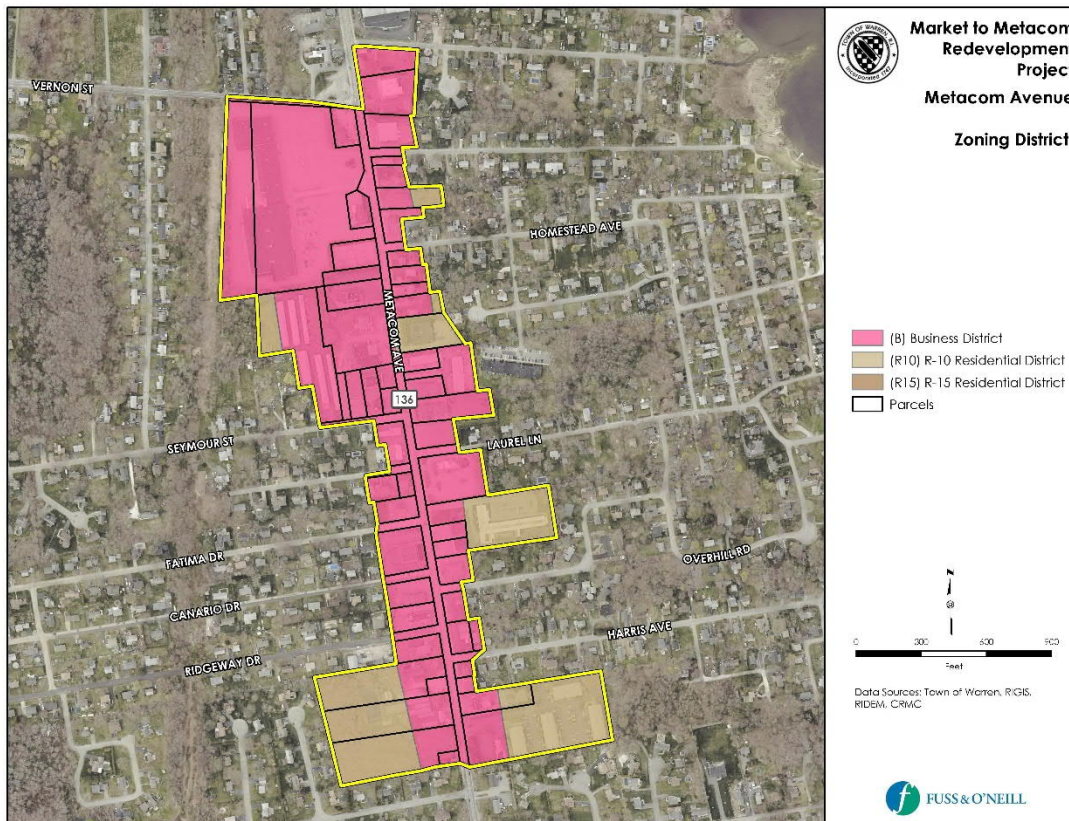


Figure 34. Metacom Avenue Project Area Zoning Map

The majority of the Metacom Project area is in the Business district. Uses permitted in the Business district include, but are not limited to, retail business; services, such as barbers, laundry, and landscaping businesses; offices; banks; public schools; town-owned recreation; and small-scale agriculture. Within the Business district, uses permitted by special permit include, but are not limited to, restaurants, hotels/motels, private schools, gas stations, auto repair shops, light manufacturing uses, and retail spaces larger than 1,500 square feet. In regard to residential uses, within the Business district multi-family, two-family and single-family dwellings are not permitted. Hotel and mixed-use residential is permitted by special use permit only.

The following dimensional requirements apply to the Business district:

- Min Lot Frontage and Width: 100 feet
- Min Distance of Structure from Residential District: 40 feet
- Min Front Yard: 25 feet
- Min Rear Yard: 20 feet
- Max Side yard: 10 feet
- Max Building Lot Coverage: 25%
- Max Building Height: 35 feet

The remaining portion of the Metacom Project area is located in the R-10 Residential district. Uses permitted in the R-10 district include, but are not limited to, single-family dwellings, community residence, cluster development, residential agriculture; Town-owned park/recreation facility; and public schools. Within the R-10 district, uses permitted by special permit include, but are not limited to, two-family and multi-family dwellings; assisted living homes; and private schools.

Within the R10 district, the following dimensional regulations apply:

- Minimum lot area: 15,000 SF for two-family dwellings; 10,000 SF for all other uses
- Minimum lot frontage: 110 feet for two family dwellings; 90 feet for all other uses
- Minimum Front Yard: 25 feet
- Minimum Rear Yard: 35 feet
- Minimum Side Yard: 15 feet
- Maximum Building Coverage: 20% of lot area

Parking regulations for the most common permitted uses within the Metacom project area are as follows:

- Business, commercial or office uses in buildings: 5 spaces plus 1 space per 250 feet floor space
- Schools, churches, theaters, restaurants: 1 space per 4 seats or per 4 persons of capacity
- Single and two-family dwellings: 1.5/family unit
- Multi-family and apartment buildings: 2 spaces, plus 1 per rented room

5.1.3 Special Flood Hazard Areas

Article XCII of the Zoning Ordinance establishes the development standards for special flood hazard areas and flood fringe lands within the Town. Special flood hazard areas are defined as areas identified as “A” zones and “V” zones by FEMA Flood Insurance Rate Maps (FIRMs). Flood fringe lands are continuous lands adjacent to and within one foot higher than special flood hazard areas. The special standards required by Section 32-100 of the Zoning Ordinance include setback requirements, demonstration that construction will not increase the base flood elevation by more than one foot, and prohibition of encroachment within the regulatory floodway. This ordinance also requires that all construction or other development projects in these regulated areas obtain a development permit from the building inspector.

According to FIRM No. 44001C0008H, effective 07/07/2014, the Market Street project area is in Zone AE and is therefore subject to the standards of this Article of the Zoning Ordinance. The Metacom Avenue project area is not located within an “A” or “V” zone and is not considered a Special Flood Hazard Area.

5.2 Local Stormwater Regulations

Under the Post-Construction Stormwater Control Ordinance (Chapter 22 of the Town Ordinances), development and redevelopment projects require Planning Board approval of a stormwater management plan, site plan, and maintenance agreement. This excludes construction or alteration of single-family and multi-family homes less than 1,000 square feet, provided it is not within 100-feet of a watercourse and does not require disturbance of slopes steeper than ten percent. Minor earthwork activities are also exempt from

this ordinance. Projects subject to this ordinance are required to conform to the standards of the Rhode Island Stormwater Design and Installations Standards Manual (RISDISM).

5.3 State Regulations

The State of Rhode Island's regulations regarding stormwater do not generally require stormwater improvements for projects on small, residential lots that are not part of a common development plan. Instead, the State recommends conformance with regulations and offers resources for best practices. Most regulation and support information is from the RI Department of Environmental Management (RIDEM).

A Rhode Island Pollution Discharge Elimination System (RIPDES) permit is required for projects that disturb one acre of land or greater (or that are part of a larger project that will disturb at least one acre). Projects requiring a RIPDES permit must construct stormwater management systems in accordance with the RISDISM.

5.4 State Transportation Planning

The project areas are served by several State Roads. The planning for these roadways by the State and Federal agencies, municipalities and associated planning entities determines upcoming physical work on the roads that will affect planning within this project.

5.4.1 State of Rhode Island Transportation Improvement Program FFY 2017-2025

The Rhode Island State Transportation Improvement Program (STIP) adopted September 2016 is a list of transportation projects that the state intends to implement in the period of 2017 through 2025 with the use of United States Department of Transportation funds.

Route 136 in Warren from the Bristol Town line to the Massachusetts State Line is planned to be resurfaced, along with limited sidewalk replacement and extension and installation of handicapped ramps in 2023-2025 (STIP Financial Tables, page 259). Route 136 in Bristol from the Warren Town line to Ferry Road is planned to be resurfaced, along with limited sidewalk replacement and installation of handicapped ramps in 2023-2025 (STIP Financial Tables, page 213). The section of Vernon Street between Route 114 and 136 is planned to be resurfaced in 2024-2025 (STIP Financial Tables, page 258). Safety Improvements were planned for 2018 on Main Street (RI 114) at Market Street/Miller Street and Metacom Avenue (RI 136) at Seymour Street/Laurel Lane (STIP Financial Tables, page 298). Bridge preservation work was planned for 2017-2019 on the Kickemuit Bridge at Child Street and the Belcher's Cove Bridge at Market Street (STIP Financial Tables, page 99).

5.4.2 Moving Forward RI 2040: State Guide Plan Element 611 Report

Number 123, December 2020

The Moving Forward RI 2040 plan establishes a long-range course for investing in Rhode Island's transportation system over the 20 year period of 2020-2040. There are no projects mentioned in this plan that are in or near Warren, RI.

5.4.3 RI Statewide Planning Program Warren, RI Coastal Sea Level Rise and Storm Surge: Transportation Fact Sheet

The *Coastal Sea Level Rise and Storm Surge Transportation Fact Sheet* provides a survey of Warren's transportation infrastructure that may be affected by sea level rise and storm surge and outlines strategies that may help in adapting to these conditions. The document notes that "Warren's roads (state and local) are the tenth most vulnerable in the state of Rhode Island to sea level rise" (page 2).

Several roadways in the section of Market Street (RI-136) within the project area are listed in the "Top 10 Road Assets in Warren Vulnerable to Sea Level Rise" table and the "Top 10 Road Assets in Warren Vulnerable to 100-Year Surge Events" table.

- Market Street between Main Street and Kickemuit Road is classified as a minor arterial road and an evacuation route. 1,104 feet of Market Street is predicted to be inundated by three feet of SLR (SLR) with an additional 1,381 feet impacted by five feet of SLR and another 361 feet impacted by seven feet of SLR. The current 100 year storm surge event effects 5,669 feet of Market Street. One foot of SLR would increase the storm surge impact by 218 feet, three feet of SLR would increase it by another 419 feet, five feet of SLR would increase it by another 191 feet, and seven feet of SLR would increase the impacted length of road by another 158 feet.
- Child Street is classified as a principal arterial road and an evacuation route. One foot of SLR would inundate 27 feet of Child Street, three feet of SLR would impact an additional 327 feet, five feet of SLR would impact an additional 892 feet, and seven feet of SLR would impact an additional 903 feet of street. Child Street is also vulnerable to storm surge as 4,196 feet of road is currently impacted by the 100 year storm surge event. One foot of SLR would increase the impacted road length by 551 feet, three feet of SLR would increase it a further 420 feet, five feet of SLR would increase it a further 571 feet, and seven feet of SLR would increase it a further 122 feet.
- Arlington Avenue is a minor arterial road connecting Kickemuit Road and Metacom Ave. Currently 1,242 feet of Arlington Avenue is vulnerable to the 100 year storm surge event. One foot of SLR would cause another 233 feet of the road to be affected, three feet of SLR would impact another 181 feet, five feet of SLR would impact another 461 feet, and seven feet of SLR would impact an additional 407 feet of road.
- Kickemuit Bridge which carries Child Street (RI-103) over the Kickemuit River is an evacuation route with an average annual daily traffic of 7,800 vehicles. Seven feet of SLR would cause the bridge to have zero inches of freeboard normally and negative 172 inches of freeboard during a 100 year storm surge event. Kickemuit Bridge is ranked 20th in assets vulnerable to SLR in the state and ranked 36th in assets vulnerable to 100 year surge events under SLR.

The section of Metacom Ave (RI-136) within the project area will not be greatly affected by SLR and storm events because of its elevated topography. However, the section of RI-136 that connects the Metacom Avenue corridor to the north is in a very low-lying area and will be greatly impacted by SLR and storm events. From Franklin Street northward for a distance of 1.3 miles the roadway is listed in the “Top 10 Road Assets in Warren Vulnerable to Sea Level Rise” table and the “Top 10 Road Assets in Warren Vulnerable to 100-Year Surge Events” table.

- The section of Metacom Avenue (RI-136) north of Kickemuit Road is a local road vulnerable to SLR. With three feet of SLR, 234 feet of Metacom Ave would be inundated, five feet of SLR would cause an additional 75 feet to be impacted, and seven feet of SLR would impact a further 66 feet of the road. The section of Metacom Avenue north of Franklin Street is classified as a minor arterial road and an evacuation route. This section of the Metacom Avenue is vulnerable to storm surge with 795 feet of the road impacted by the current 100 year surge event. An additional 59 feet would be impacted by 100 year storm surge with one foot of SLR, another 760 feet with three feet of SLR, another 1,152 feet with five feet of SLR, and another 152 feet with seven feet of SLR.
- Belcher’s Cove Bridge which carries Market Street (RI-136) over Belcher’s Cove is an evacuation route with an average annual daily traffic of 10,000 vehicles. Seven feet of SLR would cause the bridge to have negative 18 inches of freeboard normally and negative 194 inches of freeboard during a 100 year storm surge event. Belcher’s Cove Bridge is ranked 13th in assets vulnerable to SLR in the state and ranked 35th in assets vulnerable to 100 year surge events under SLR.

6 Key Findings from Existing Conditions Assessment

Review of the existing conditions show us that the Market Street area is facing severe impacts from climate change, including SLR and severe precipitation and storm events. These impacts will negatively affect the community in the coming ten to thirty (10-30) years and will have the potential to severely damage and destroy private homes and businesses, State- and Town-owned facilities, disrupt local and regional transportation routes, flood environmentally sensitive sites and damage utilities. Forecast impacts have the potential to destroy or degrade hundreds of housing units.

The Metacom Avenue corridor is a largely commercial corridor which is similar to many auto-centric districts in RI and the United States. Demand for real estate in these environments continues to decline and there is a potential opportunity for redevelopment of the Metacom Avenue corridor as a mixed-use Main Street that contains retail, employment facilities and housing in a Main Street setting.

The Town, working with property owners, State government and regional partners has a limited-time opportunity to plan for a linked future for both Market Street and Metacom Avenue where it may be able to adapt to climate change impacts and minimize flood vulnerability and environmental risk. At the same time, an improved Metacom Avenue corridor can be the location for replacement of housing lost to climate change and a livable center for Warren’s citizens.

Scenario Planning

In order to compare potential futures for the Market Street area, staff from the Town of Warren and the project consultant team created two alternative scenarios. The No Action Scenario assumes that the stakeholders take no proactive actions to mitigate against the impacts of climate change and that SLR continues as forecast. The Relocation and Restoration Scenario assumes that the Town of Warren, in concert with local, State, Federal and regional partners take proactive actions to buy-out properties in danger of repetitive flooding and storm damage, remove most local streets and utilities and restore vegetated wetlands for protective buffering and flood storage.

7 No Action Scenario

7.1 Overview and Assumptions

This analysis of the No Action Scenario seeks to quantify the Market Street area which will be potentially impacted by sea level rise and precipitation/storm events, as well as describe the potential impact resulting from discharge of pollutants and infrastructure failure/degradation due to flooding/storm damage. For the purposes of this analysis, sea level rise is assumed to be consistent with NOAA projections for Rhode Island of one foot of rise by 2035, three feet by 2050, and six feet by 2070.

The No Action Scenario assumed that the Town of Warren takes no actions to prepare for climate change impacts. It is also assumed that state agencies and utilities take no action to prepare for climate change impacts. Sea level rise is assumed to be aligned with NOAA projections of one foot of rise by 2035, three feet of rise by 2050, and six feet of rise by 2070. An increase in frequency and severity of precipitation and storm events including hurricanes and nor'easters is assumed under future conditions compared to historical averages.

7.2 Impacts to the Market Street Area

7.2.1 Overview of Community and Financial Impacts

This section assesses the financial and community impacts that are estimated to occur in the Market Street project area because of flooding from sea level rise and future 100-year storm events. (The 100-year storm event refers to an event that has a 1% chance of occurring within a given year.) These SLR impacts are estimated for four time periods between 2025 and 2100 in this analysis:

- 1.75 foot by 2035,
- Three (3) feet by 2050,
- Five (5) feet by 2070 and
- Nine (9) feet by 2100.

For each of these four time periods, the quantified impacts include properties and buildings flooded, housing units lost, residents displaced, and the associated financial impacts due to sea level rise, as well as the costs of flood damage and lost business revenue caused by flooding from the 100-year storm event. These estimates reflect the National Oceanic and Atmospheric Administration's (NOAA's) 2017 "high" sea level rise (SLR) projection and RI Coastal Resource Management Council's (CRMC) projections of flooding depths during the 100-year storm for the Market Street project area. It should also be noted that these are "still water" depths and do not include wave action, which can increase flooding levels.

Financial impacts assessed in this report for each time period include:

- Costs to Property Owners/Insurers
 - The number of properties and buildings that are predicted to be flooded by sea level rise has been determined based on the MHHW for a given time period. These buildings include residential and commercial properties. The total building loss cost was determined by totaling the assessed values of the buildings predicted to be flooded.
 - The estimated damage to these affected buildings from future flood events has been calculated based on the extent of SLR over time combined with projections for the frequency of future 100-year storm events.
- Business Losses
 - The number of commercial buildings flooded has been calculated based on the extent of SLR over time combined with projections for the frequency of future 100-year storm events. An estimate of the number of lost operational days for these flooded businesses was used to predict the total business revenue loss due to the flooding.
- Municipal Financial Impacts
 - The total loss of annual tax revenue has been estimated based on the current tax information for the properties that are predicted to be regularly flooded by SLR during each time period (separated from storm events).
 - Environmental pollution and clean-up costs have been assessed for future damage to the landfill at Jamiel's Park and DEM-registered sites in the project area.
 - The financial impact of future repair or replacement of municipal infrastructure effected by sea level rise and flood events has been assessed.

Community Impacts assessed in this report include:

- Housing Units Lost and Residents Displaced
 - The predictions for number of properties lost is based on projections for SLR and its impacts to specific properties and their existing type (i.e., single family, multi-family, etc.) and unit density. The number of residents displaced by sea level rise in the project area was estimated based on the number of housing units lost and a demographically typical density of two person per unit.

7.2.1.1 2025-2035 Time Period

MHHW in 2020 already inundates a portion of the Market Street project area east of Jamiel Park, as well as the wetland east of Route 136. These impacted areas are projected to expand over time, causing at least one foot of flooding within Market Street by 2035.

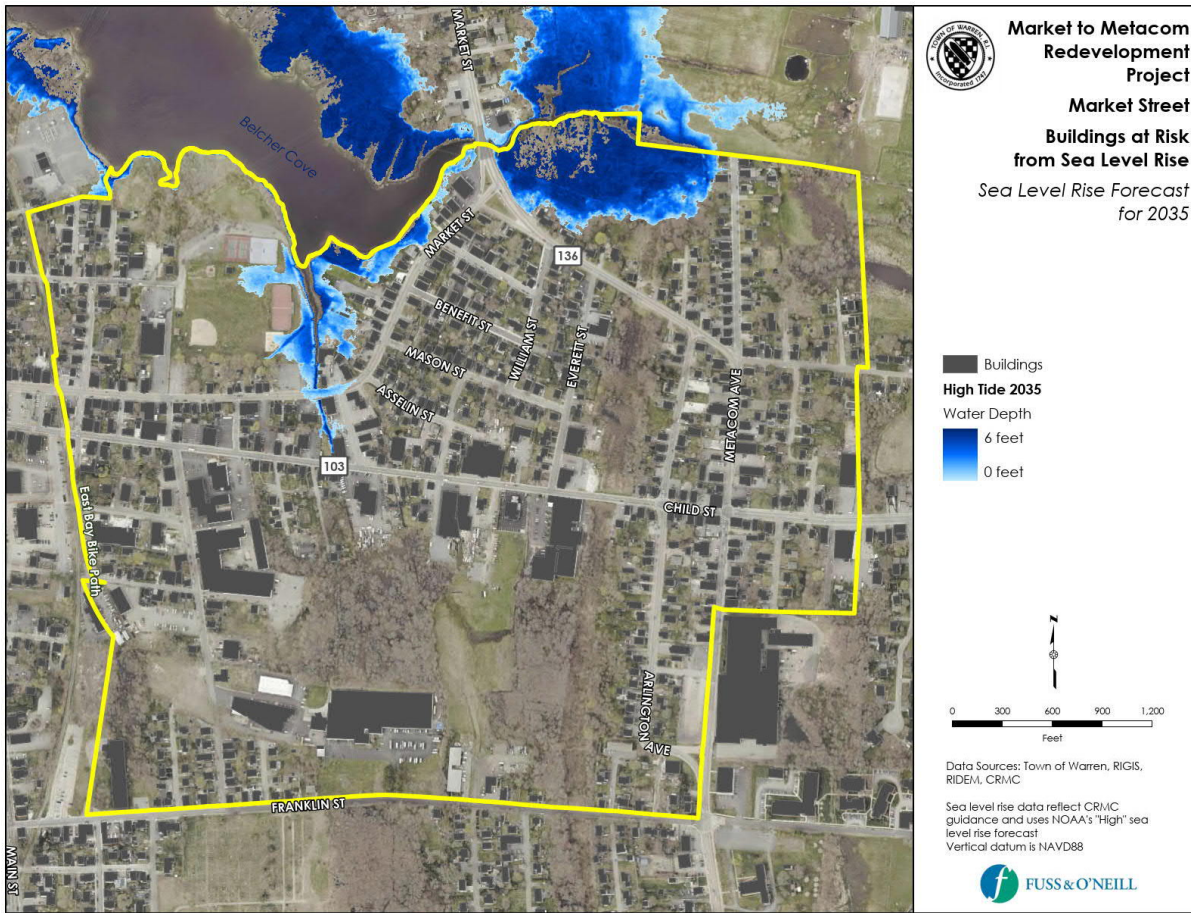


Figure 35. Market Street – Sea Level Rise Projection for 2035

Table 5 – 2025-2035 Sea Level Rise Impacts

Properties Flooded	58
Buildings Flooded	31
Housing Units Lost	57
Residents Displaced	86
Lost Annual Tax Revenue	\$200,000
Building Loss Cost	\$8,100,000

Under the projected conditions for 2035, the 100-year storm will result in flooding to the majority of the Market Street project area, with Market Street, a portion of Child Street, and many properties in the area under five to fifteen feet of water, and some wetland areas experiences twenty feet of flooding (Figure 25).

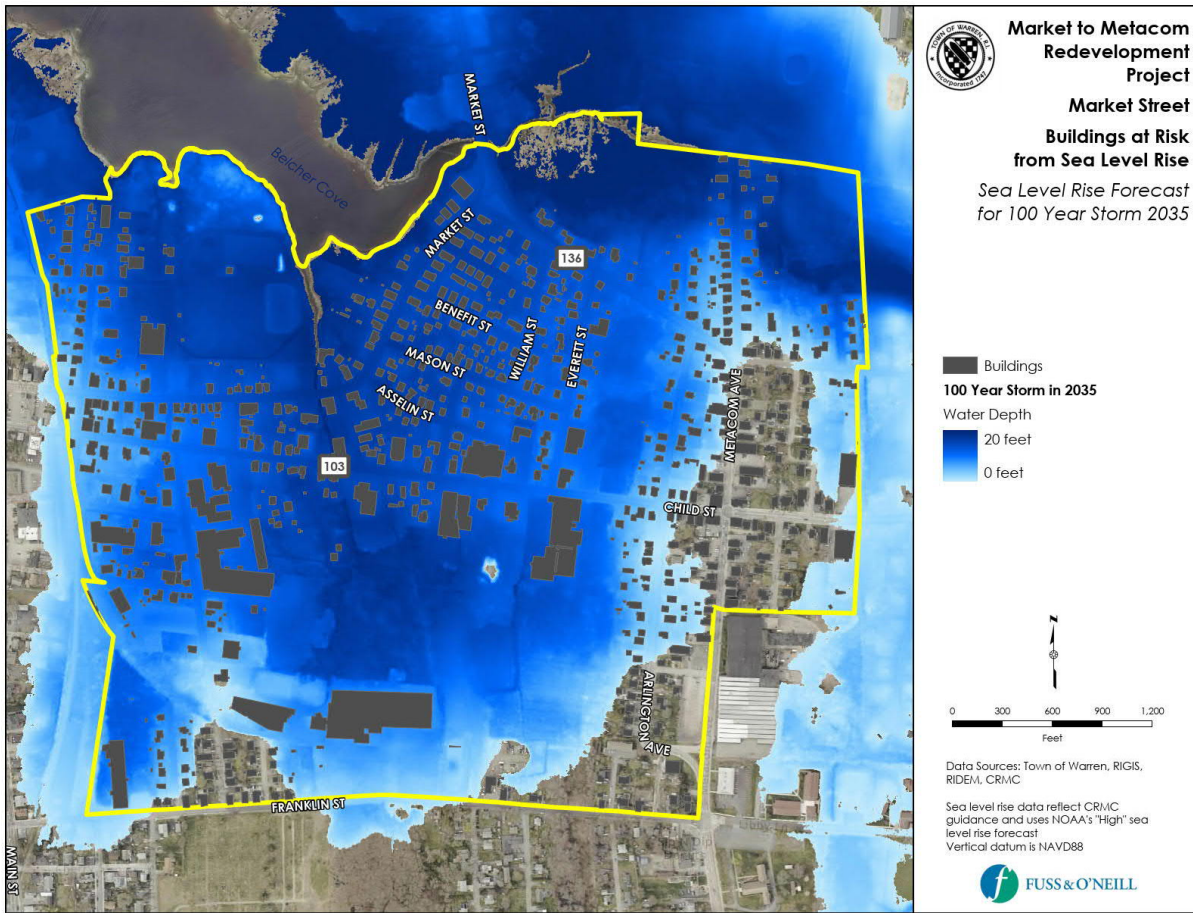


Figure 36. Market Street – 100-Year Storm Event Sea Level Rise Projection for 2035

Table 6 - 2025-2035 100-Year Storm Event Impacts

Flood Damage	\$3,500,000
Lost Business Revenue	\$5,400,000
Total Flood Impacts	\$8,900,000

7.2.1.2 2035-2050 Time Period

By 2050, the lowest-lying portions of Market Street are projected to have three feet of flooding during MHHW. A portion of Child Street will have up to one foot of flooding and many of the properties between Belcher Cove and Market Street will be impacted.

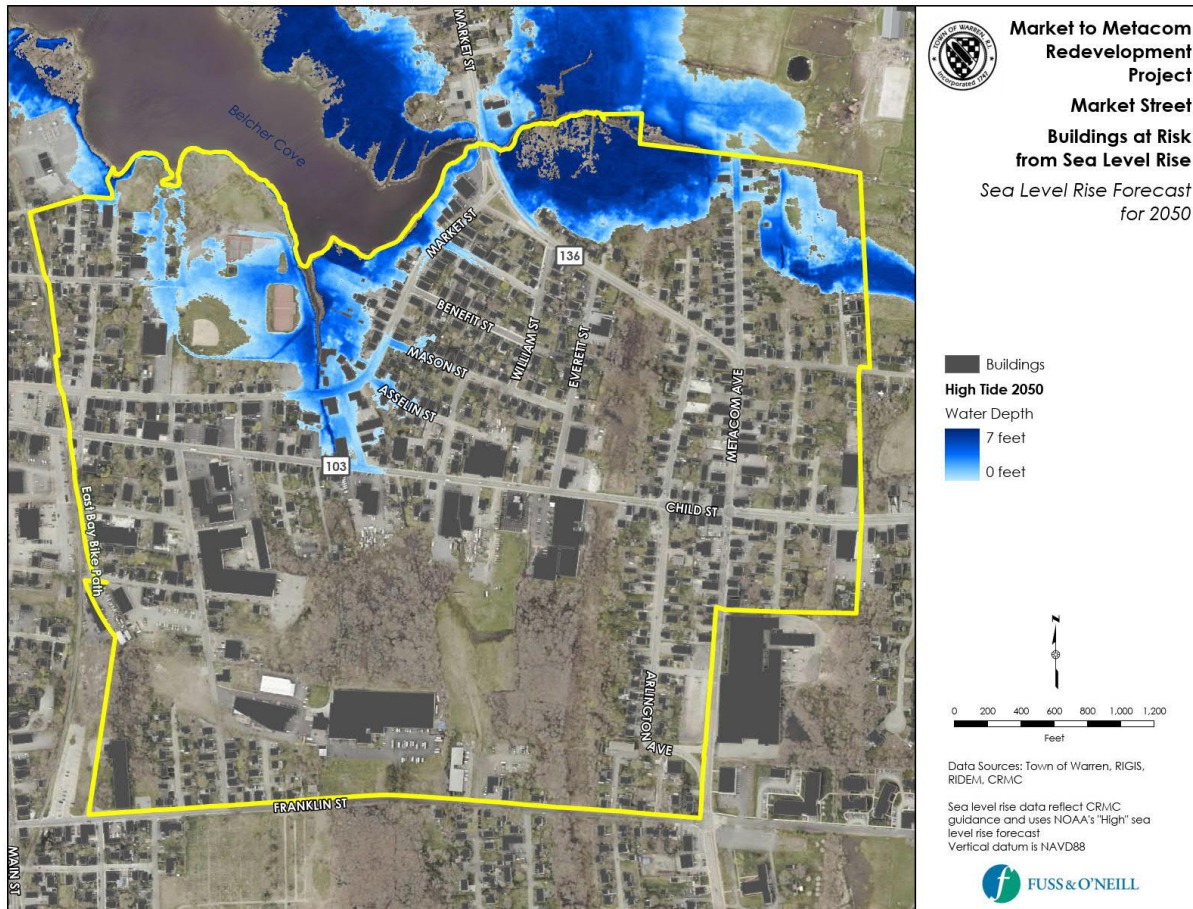


Figure 37. Market Street – Sea Level Rise Projection for 2050

Table 7 - 2035-2050 Sea Level Rise Impacts

Properties Flooded	75
Buildings Flooded	65
Housing Units Lost	121
Residents Displaced	182
Lost Annual Tax Revenue	\$300,000
Building Loss Cost	\$16,600,000

Projections for 2050 show that flooding during the 100-year storm will continue to expand through the Market Street project area and will increase in severity by increasing in depth.

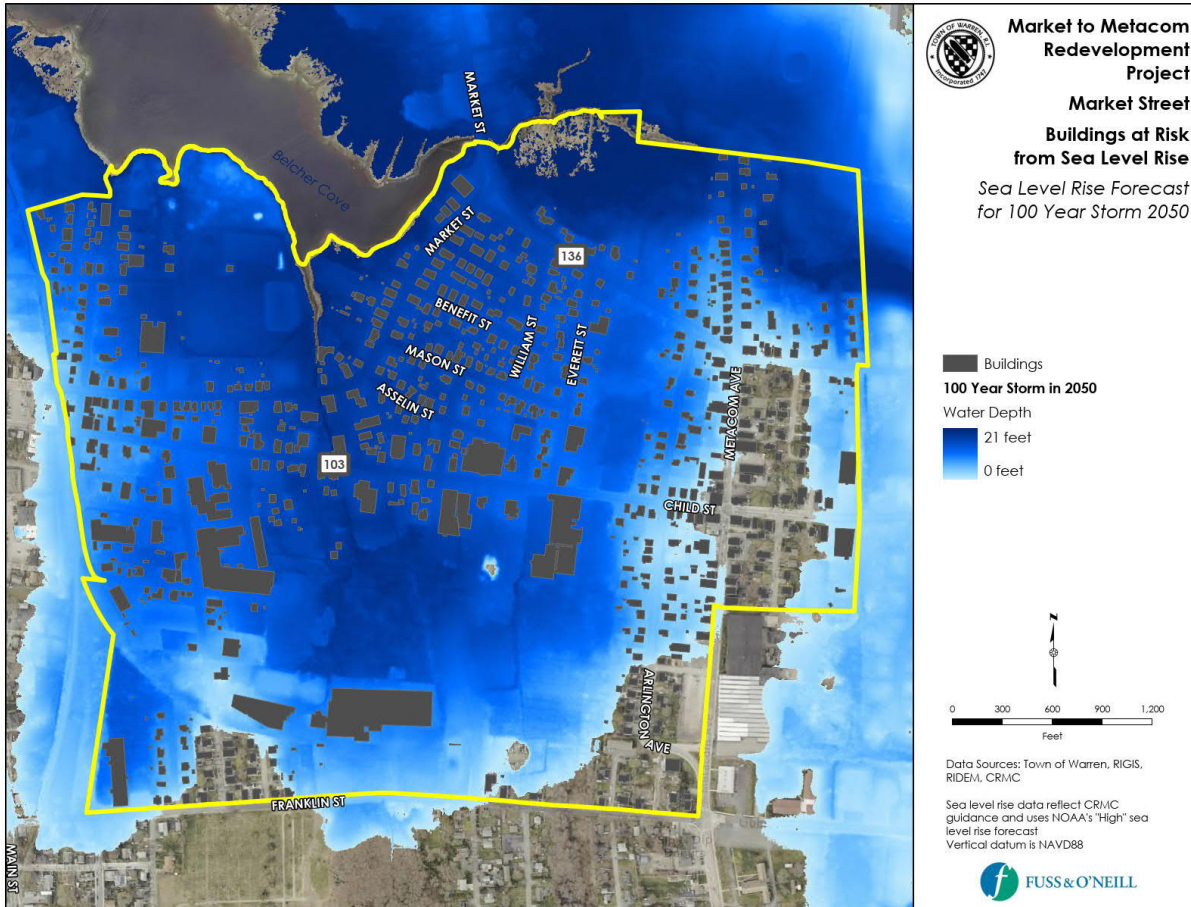


Figure 38. Market Street – 100-Year Storm Event Sea Level Rise Projection for 2050

Table 8 - 2023-2050 100-Year Storm Event Impacts

Flood Damage	\$8,500,000
Lost Business Revenue	\$3,600,000
Total Flood Impacts	\$12,100,000

7.2.1.3 2050-2070 Time Period

Projections for the year 2070 indicate that a substantial portion of Market Street and the surrounding neighborhood will be inundated by three feet of water, with the lowest elevation areas, including wetlands, experiencing six-foot flood depths.

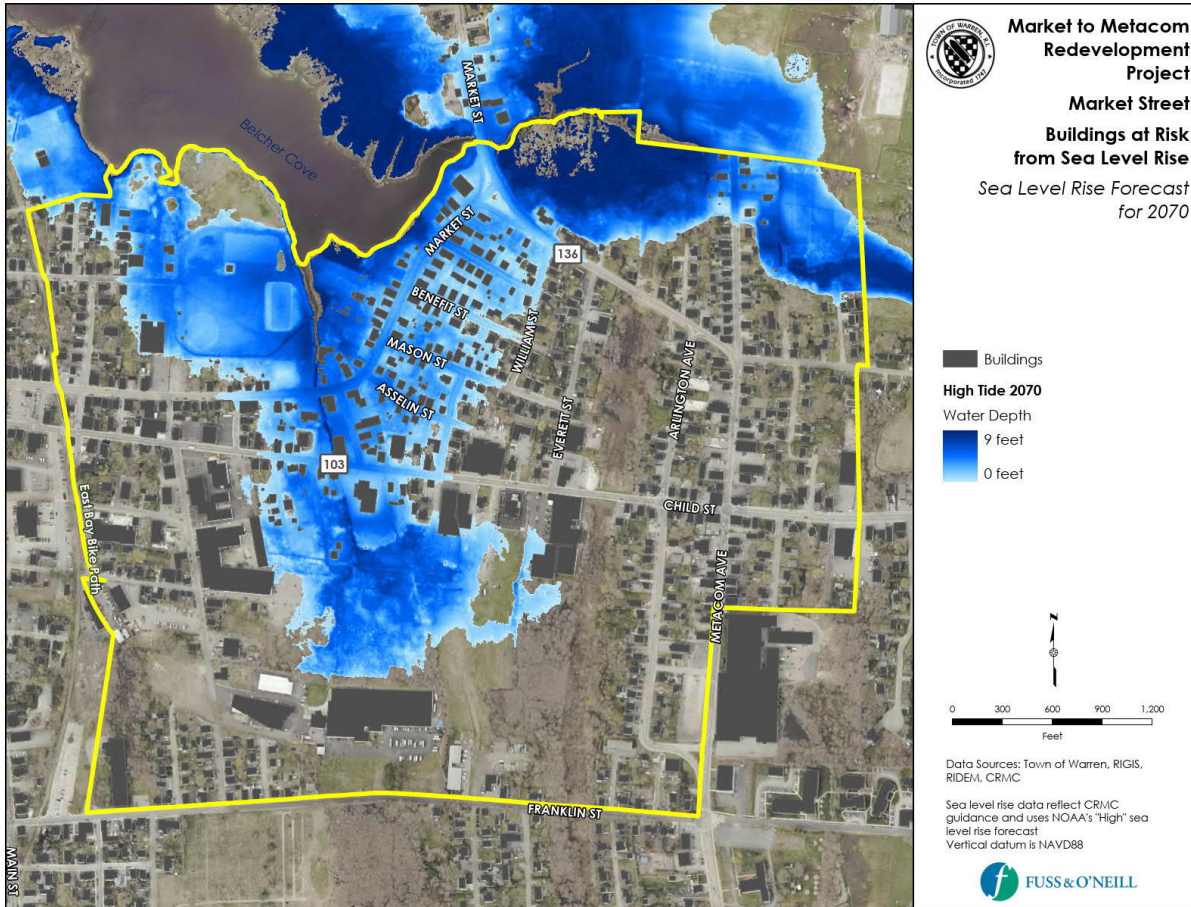


Figure 39. Market Street – Sea Level Rise Projection for 2070

Table 9 – 2050-2070 Sea Level Rise Impacts

Properties Flooded	113
Buildings Flooded	92
Housing Units Lost	162
Residents Displaced	243
Lost Annual Tax Revenue	\$400,000
Building Loss Cost	\$23,000,000

By 2070, almost the entire Market Street project area will be inundated during the 100-year storm, with maximum flood depths of twenty feet.

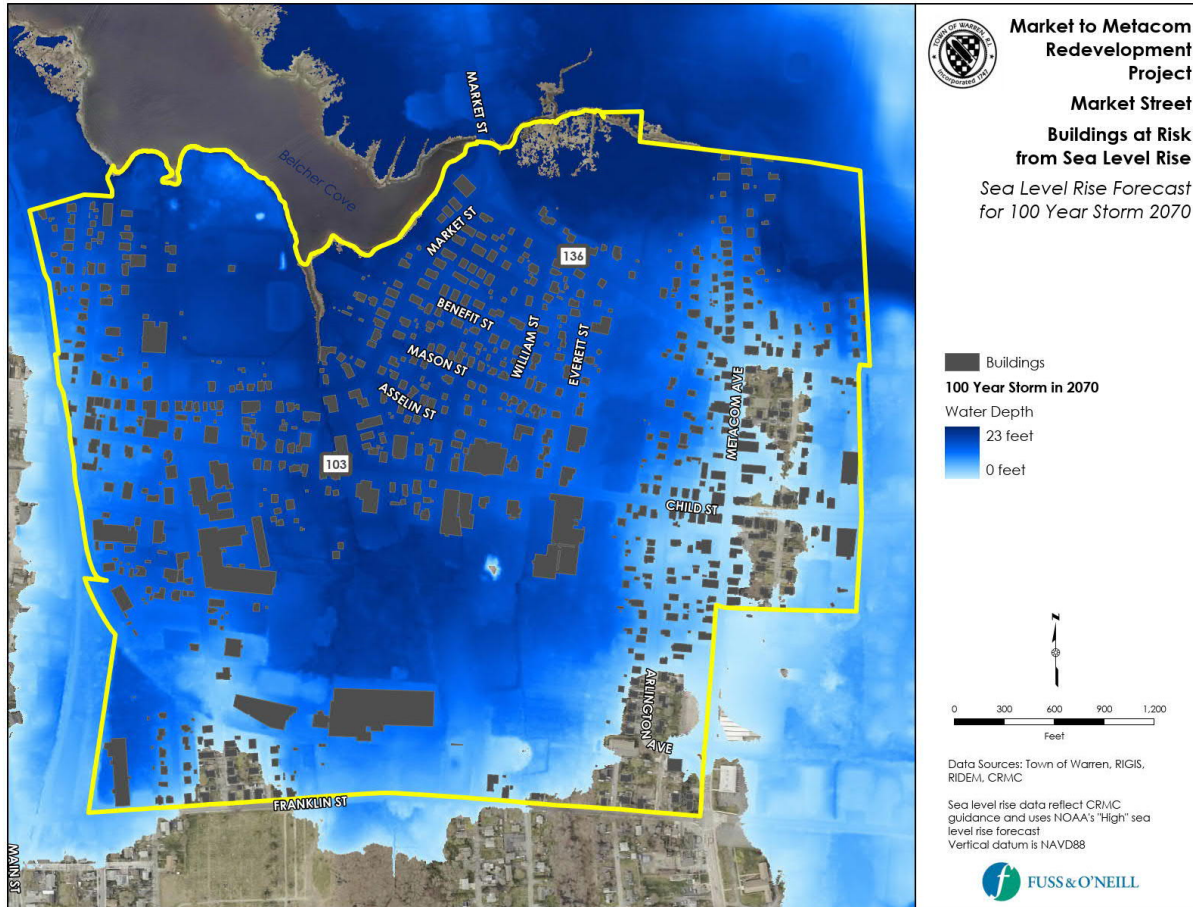


Figure 40. Market Street – 100-Year Storm Event Sea Level Rise Projection for 2070

Table 10 – 2050-2070 100-Year Storm Event Impacts

Flood Damage	\$13,100,000
Lost Business Revenue	\$22,000,000
Total Flood Impacts	\$35,100,000

7.2.1.4 2070-2100 Time Period

In 2100, high tide with a projected sea level rise of is projected to impact the majority of the Market Street project area, with water depths reaching nine feet within much of Market Street and maximum depths of 12 feet within the project area.

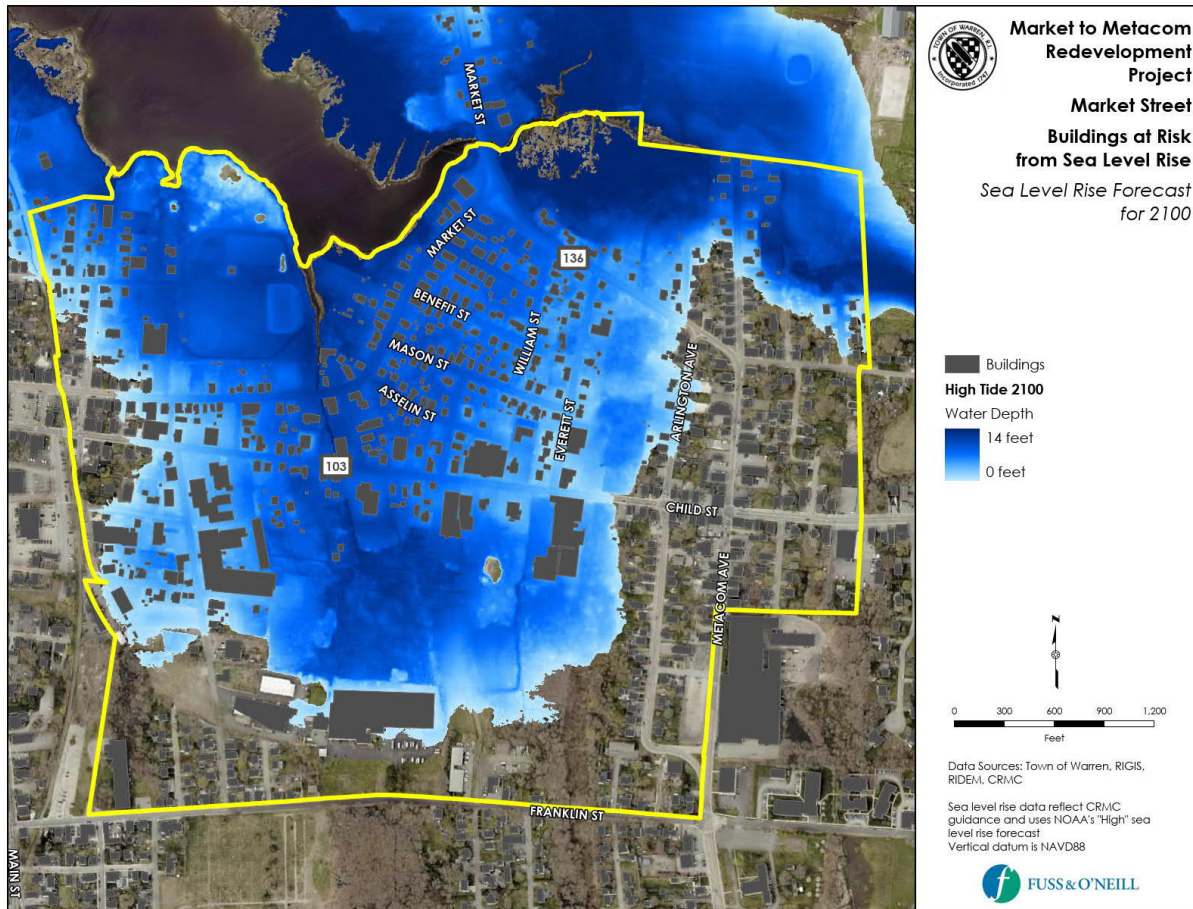


Figure 41. Market Street – Sea Level Rise Projection for 2100

Table 11 – 2070-2100 Sea Level Rise Impacts

Properties Flooded	137
Buildings Flooded	118
Housing Units Lost	201
Residents Displaced	302
Lost Annual Tax Revenue	\$700,000
Building Loss Cost	\$38,100,000

Projections for 2100 show that the entire Market Street project area will be inundated by the 100-year storm, with twenty-five-foot flood depths within a large area of the neighborhood.

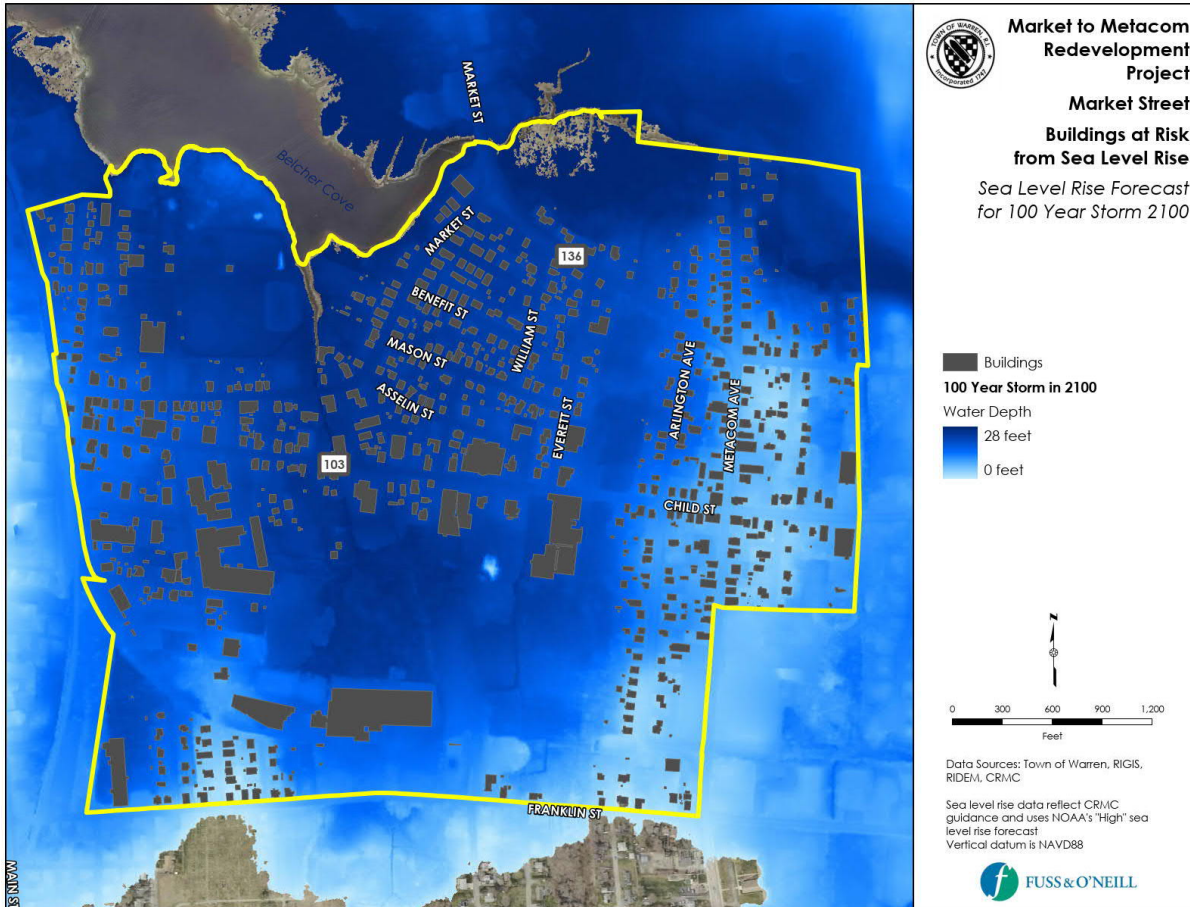


Figure 42. Market Street – 100-Year Storm Event Sea Level Rise Projection for 2100

Table 12 – 2070-2100 100-Year Storm Event Impacts

Flood Damage	\$27,500,000
Lost Business Revenue	\$95,200,000
Total Flood Impacts	\$122,700,000

7.2.1.5 Summary of Community Impacts and Costs

As seen in the summary table below, the community impacts due to sea level rise continue to increase in each time period. Between now and 2100, a total of 812 residents in the Market Street project area are predicted to be displaced due to flooding resulting from sea level rise. This represents approximately 7% of the current population of the Town of Warren that may lose their residences before 2100.

Table 13 – No Action Scenario – Community Impacts Summary Table

Time Period	2025-2035	2035-2050	2050-2070	2070-2100	Total by 2100
Properties Flooded by Sea Level Rise	58	75	113	137	383
Buildings Flooded by Sea Level Rise	31	65	92	118	306
Housing Units Lost	57	121	162	201	541
Estimated Residents Displaced	86	182	243	302	812

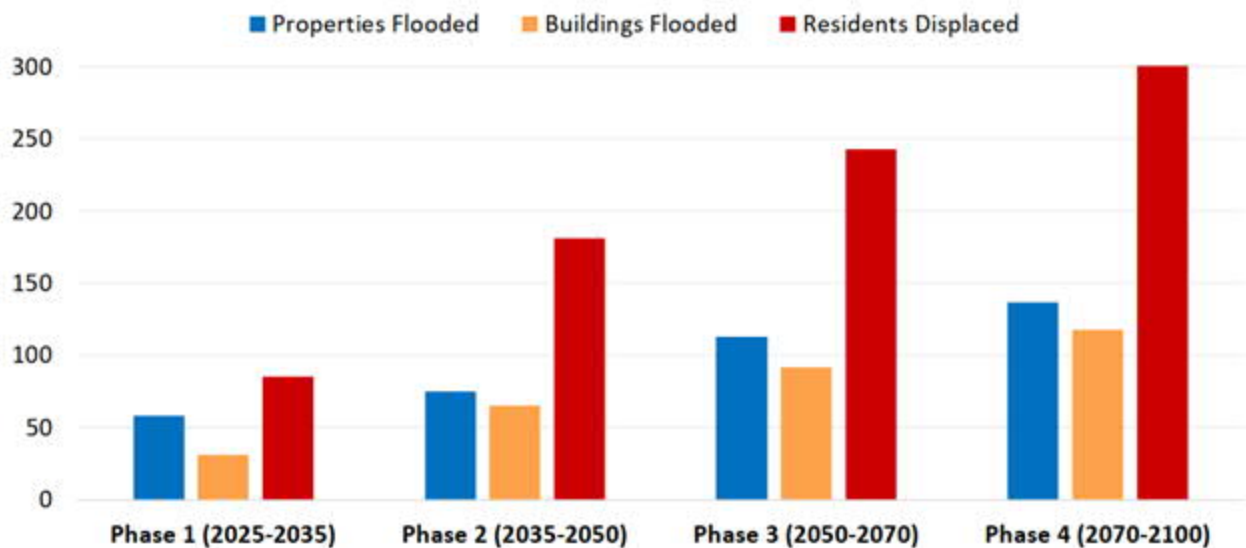
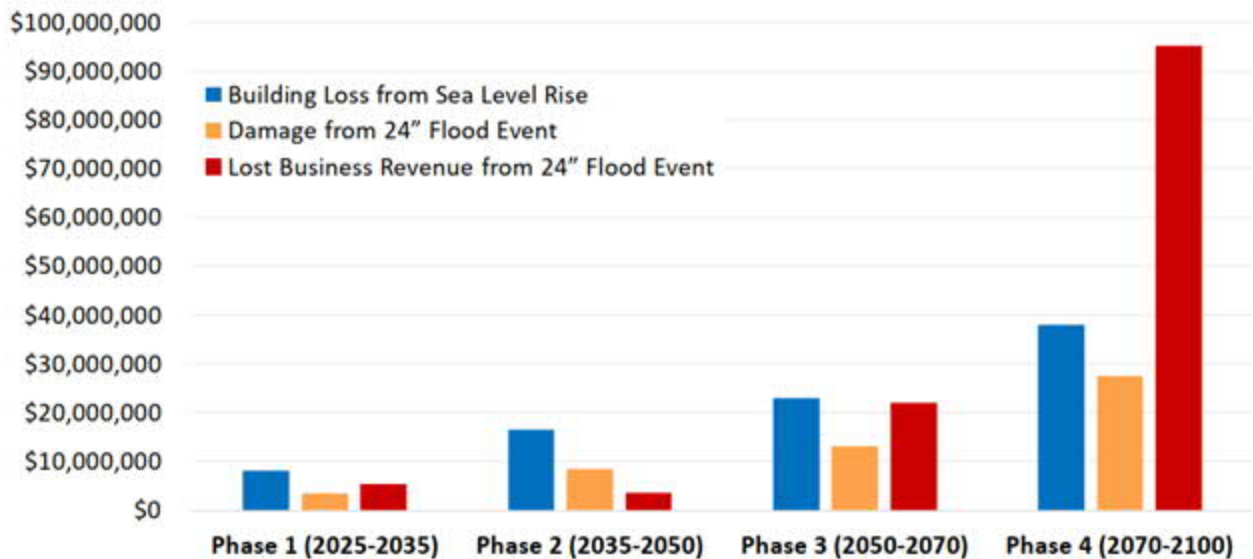


Figure 43. No Action Scenario – Community Impacts Summary Chart

Table 14 – No Action Scenario Estimated Costs Summary Table

Time Period	2025-2035	2035-2050	2050-2070	2070-2100	Total by 2100
Properties Flooded by Sea Level Rise	58	75	113	137	383
Buildings Flooded by Sea Level Rise	31	65	92	118	306
Building Loss Cost	\$8,100,000	\$16,600,000	\$23,000,000	\$38,100,000	\$85,800,000
Damage from 24" Flood Event	\$3,500,000	\$8,500,000	\$13,100,000	\$27,500,000	\$52,700,000
Lost Business Revenue from 24" Flood Event	\$5,400,000	\$3,600,000	\$22,000,000	\$95,200,000	\$126,300,000

Table 15 – No Action Scenario Estimated Costs Summary Chart



7.2.2 Environmental Impacts

The Market Street project area is located within the Palmer River Subwatershed (RI 0007022E-01A). Water quality in the Palmer River is degraded with elevated concentrations of the nutrient nitrogen and fecal coliform bacteria, and reduced concentrations of dissolved oxygen. Because of the elevated fecal coliform concentrations, a total maximum daily load (TMDL) has been established for fecal coliform. A TMDL is a regulatory calculation that sets the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that particular pollutant. The Palmer River is also a Special Resource Protection Water identified by the State of Rhode Island as a critical habitat for rare and endangered species, and a locally designated conservation area. The majority of stormwater from the Market Street project area drains untreated overland and through storm drains directly to the Palmer River.

Increased runoff from climate impacts in this neighborhood will exacerbate water quality issues in Belcher Cove and the Palmer River. Increased frequency and intensity of storm events causes increased volumes of stormwater runoff, which results in increased migration of pollutants and sediment into storm drains and waterways. Existing wetlands within the Market Street project area will become increasingly inundated, eliminating these valuable resource areas that provide critical habitat and natural coastal buffers.

As sea level rise and storms cause damage to buildings and infrastructure, some owners may decide to abandon their properties. Abandonment of properties without appropriate removal or disposal of potential hazardous material has the potential to have significant environmental impacts related to repeated flooding of existing fuel tanks, septic systems, and building materials.

The Landfill at Jamiel's Park is predicted to be fully inundated during the 100-year storm in 2035 and partially flooded at high tide, even in the absence of a storm event, by 2050. The U.S. EPA has identified typical potential risks to landfills because of climate change². Although this site is capped, flooding here poses a risk of contaminants leaching into Belcher Cove, and erosion of the soil cap and shoreline. Extreme storm events and significant floods may cause landfill waste along the shoreline to be washed away.

The flooding of Rhode Island Department of Environmental Management (RIDEM) registered sites in the project area could also cause environmental pollution. The Market Street area contains twelve (12) underground storage tanks and one RIPDES Sanitary Waste Site, according to the list of RIDEM-regulated facilities. As shown in Figure X-X, these sites are already within the area subject to flooding due to the current 100-year storm. As sea level rise increases, all of these sites will be regularly flooded at high tide by the year 2100.

² <https://semspub.epa.gov/work/11/175853.pdf>

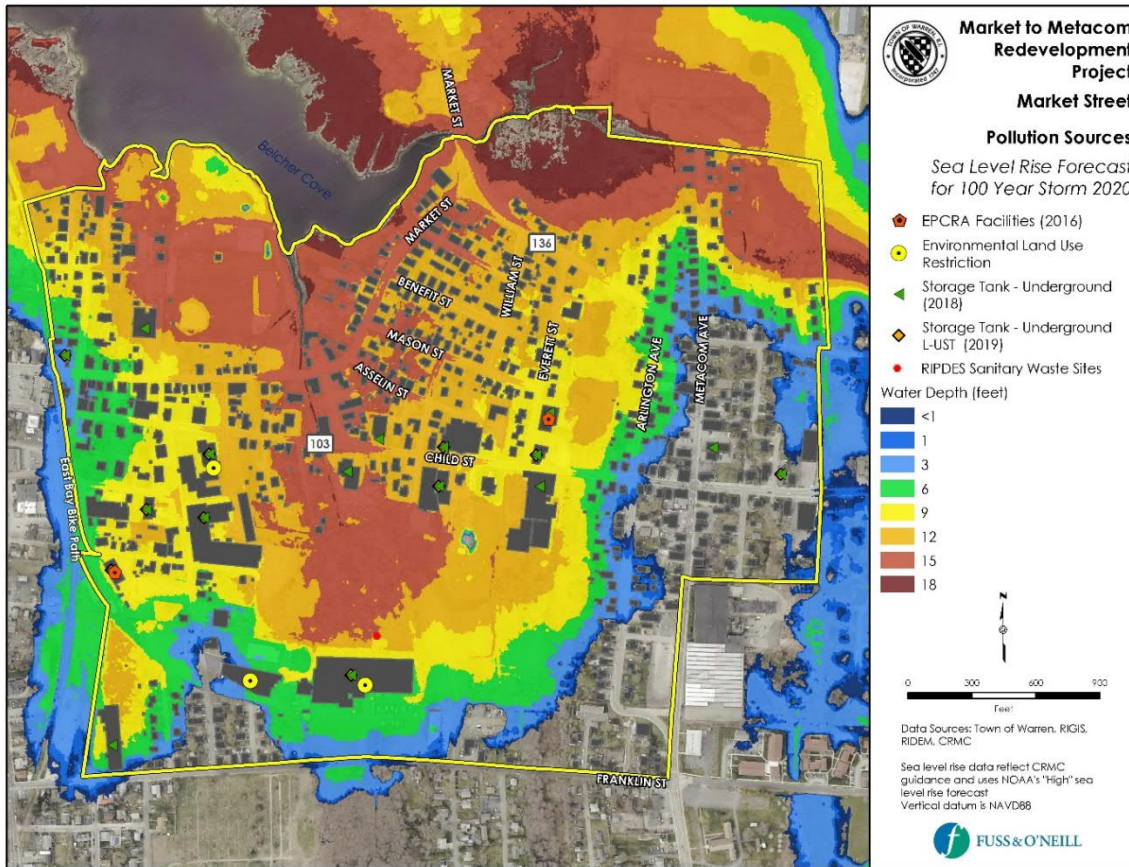


Figure 44. RIDEM Regulated Facilities (with 100 Year Storm)

7.2.3 Roadway Impacts

The Market Street project area includes several major surface transportation facilities that are critical to local and regional traffic, including:

- RI-136 – Market Street/Kickemuit Avenue is classified as a minor arterial road and an evacuation route. It serves as a segment of the north-south route connecting traffic from the Metacom Avenue corridor and Downtown Warren with points north, including the connections to Interstate 195 in Seekonk and the regional highway system.
- RI-103 – Child Street is classified as a principal arterial road and an evacuation route. It serves as a primary east-west route connecting traffic from the Metacom Avenue corridor and Downtown Warren with points east, including the connections to Interstate 195 in Swansea and the regional highway system.

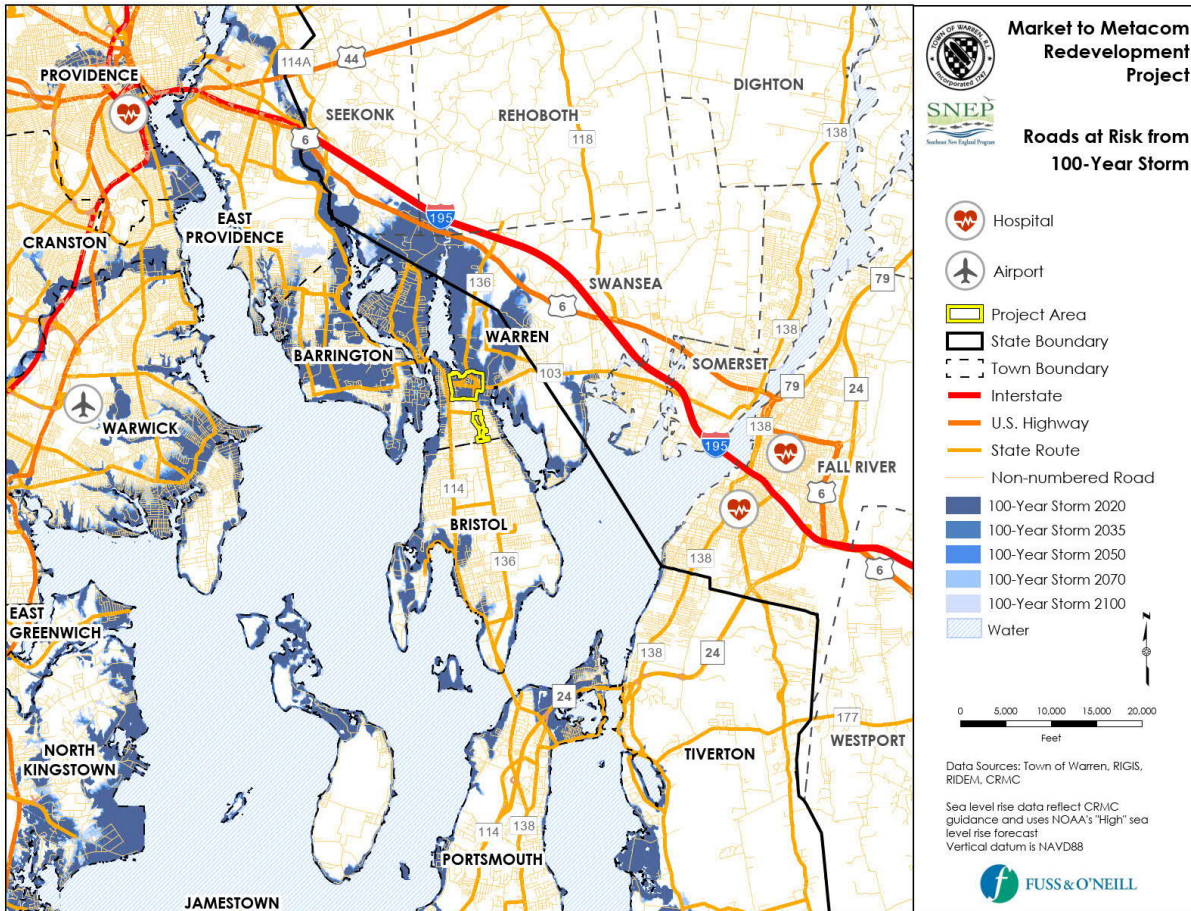


Figure 45. Major Routes at Risk from 100-Year Storm Impacts

7.2.3.1 Impossible Roads

During 100-year storm events, many of the roads in the project area are predicted to be flooded by the year 2035. Market Street at Redmond Street is predicted to be flooded at high tide by 2035. Child Street and Belcher Cove Bridge are predicted to be flooded every day by 2050 due to sea level rise and tidal flooding.

As depths and extents of roadway flooding during high tides and storm events increases, impacts to traffic and public safety will worsen. If these impacted roads are not relocated or elevated to avoid or reduce flooding, traffic will need to be rerouted away from these roads during high tide on a daily basis. This will result in an inability for road users and emergency services to access properties along the affected sections of road, as well as impacting through-traffic. Several of the roads that are projected to experience increased flooding during high tide and storm events, including Market Street and Route 136, are designated as emergency evacuation routes. Closure of these roadways due to flooding eliminates essential evacuation routes for the residents of Warren and neighboring towns.

Route 136 and Child Street (Route 103) both serve as major connections between Rhode Island and Massachusetts. They also provide access to the closest major hospitals: Saint Anne's and Charlton Memorial Hospitals in Fall River and Rhode Island Hospital in Providence. If Route 136 and 103 are both impassible, it will be difficult for residents of the Market Street area to access emergency medical care at these facilities in a timely manner. Facilities in and near the project area such as fire stations, police stations, and schools may also become inaccessible during storm events. Road closures may also compound storm-related utility outages by limiting access to restore critical utility infrastructure.

Flooding within roadways causes significant risks to public safety. Ponding water within roadways is a major hazard for drivers, as well as pedestrians and bicyclists. Shallow ponding may cause vehicles to hydroplane, and deeper flooding may cause drivers to lose control and vehicles to stall or be swept away, as flood depths are often difficult for drivers to gauge. Damage to roadways and other infrastructure due to flooding also poses significant risk to road users.



Figure 46. Image of High Tide Flooding on Market Street, 2019

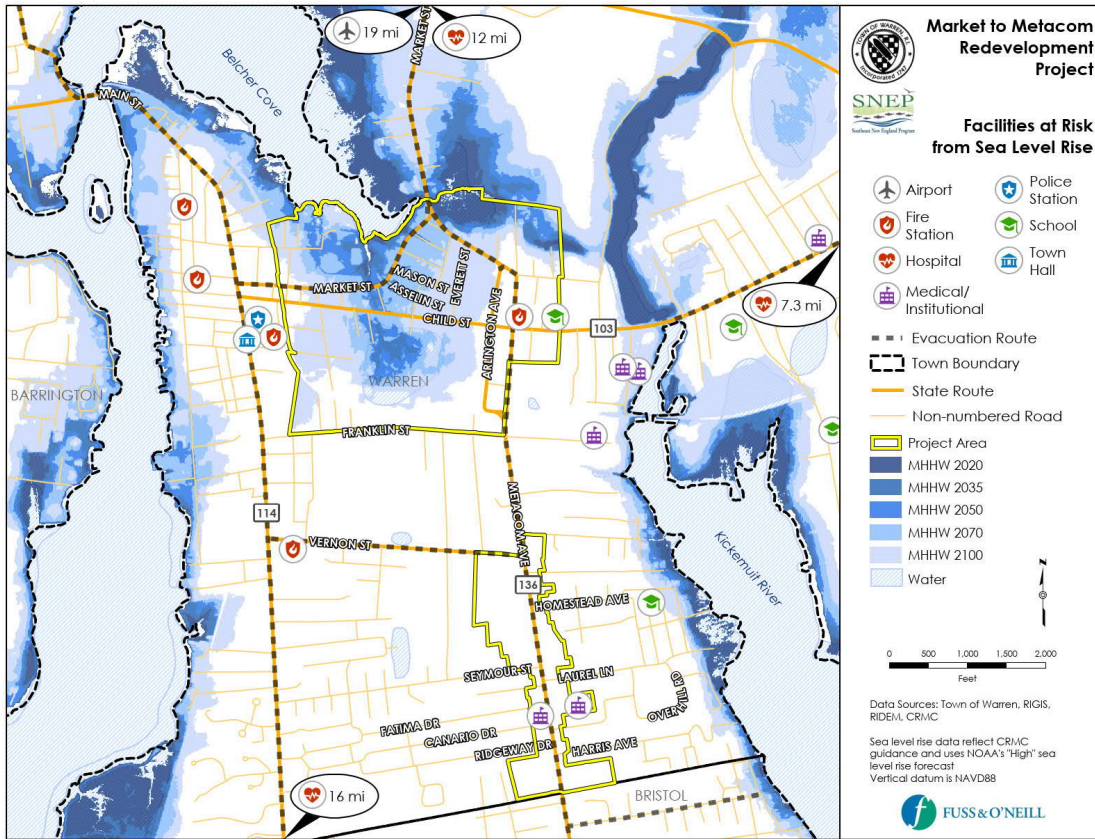


Figure 47. Emergency Facilities at Risk from Sea Level Rise

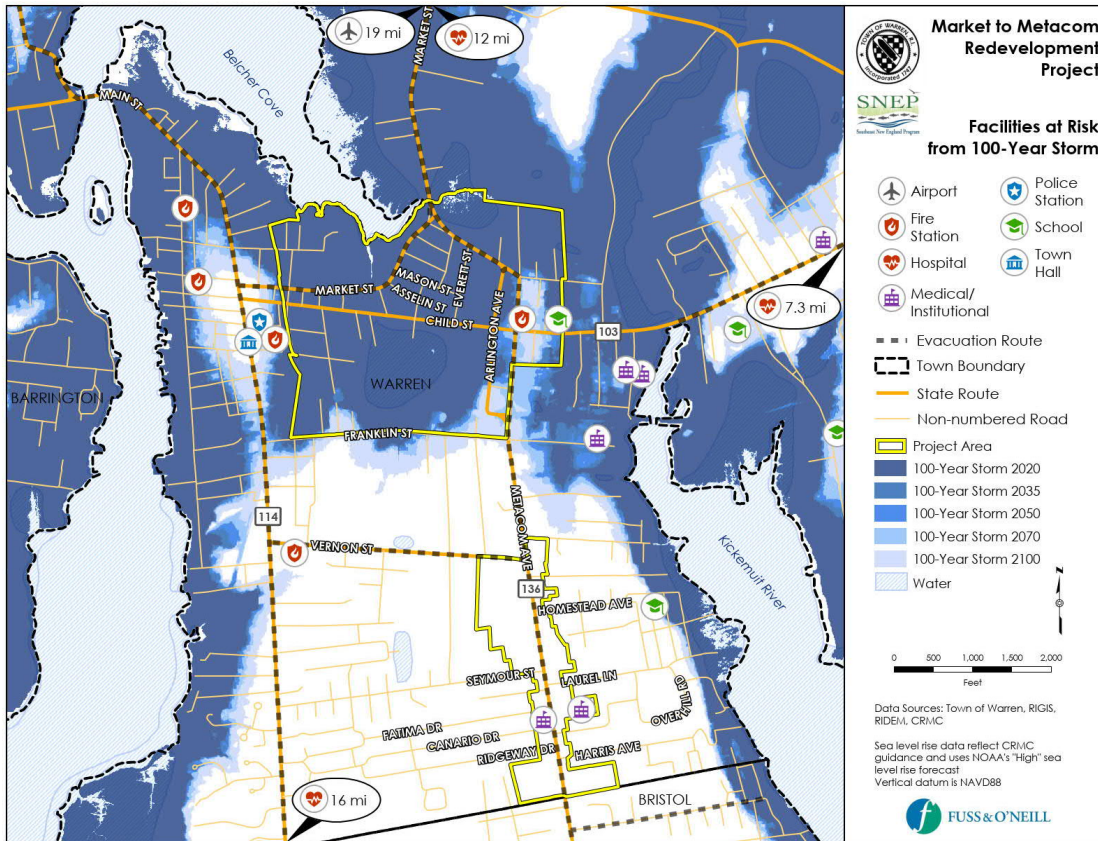


Figure 48. Emergency Facilities at Risk from 100-Year Storm

7.2.3.2 Increased Damage to Roadways, Storm Drains and Utilities

The increasing intensity and frequency of storm-related flooding in the Market Street area will exacerbate flooding impacts to roadway infrastructure. Severe flooding may cause direct damage to roadways and bridges, as upward pressure of water within pavement base materials and subsurface soils makes pavement and foundations prone to uplift. This type of roadway failure is costly to repair and can result in extended road closures. Repeated flooding also reduces pavement's overall lifespan, as flood waters increase surface pavement damage, like cracking and potholes. Accelerated deterioration of roadways caused by flooding will increase the need for routine annual maintenance costs required for state and local roadways in the area to remain operational. Flood-related failure of culverts and rupturing of stormwater systems can also cause catastrophic failure to roadways and other infrastructure.

In addition to increased needs for roadway repairs, maintenance, and reconstruction, the increasing severity of storms will result in increased costs associated with post-storm-event cleanup. Flooding causes migration of debris and sediment into roadways, which requires additional municipal maintenance to remove. In order for stormwater infrastructure to remain functional, sediment and debris will need to be removed from catch

basins and storm drains with increased frequency. Storm events may also cause roadway obstructions due to large debris and downed trees, which put additional strain on the Town's Public Work staff and funds.

7.3 Precedents for Reactive Community Response

For the most of communities in the U.S. faced with SLR and flooding from storm events, are not taking major actions to adapt on a large scale to reduce future impacts. There are many historical and recent precedents for communities struggling to recover from disastrous storm and flooding events after the fact. These communities rely largely on the after-incident responses from State and Federal agencies such as FEMA and the Department of Housing and Urban Development (HUD) for rebuilding. Typically, a successful response relies on a disaster declaration and federal appropriations of disaster recovery funds.

7.3.1 Superstorm Sandy

Superstorm Sandy hit Rhode Island in October of 2012 and caused winds up to 86 miles per hour along the coast of Rhode Island. Moderate to major coastal flooding occurred along nearly the entire Rhode Island shoreline. Most of the damage was caused by a five-foot storm surge and waves up to 30 feet in height³. In the most severely affected areas, Sandy destroyed thousands of homes, eight million residents lost electrical power and an estimated 181 people in the U.S. died due to the storm. Total property damage is estimated at a total of \$65 billion of damage.

7.3.2 Hurricane Katrina

Hurricane Katrina struck the southeastern U.S. in August of 2005. It was one of the most powerful Atlantic storms on record with up to 170 mile per hour winds. It caused a storm surge of more than 26 feet and flooded 80% of the city of New Orleans with up to 20 feet of water. Hurricane Katrina caused more than \$160 billion of damage and resulted in the deaths of 1,800 people. It is currently ranked as the costliest natural disaster in U.S. history.

7.3.3 Louisiana Bayou Communities

Many bayou communities along the coast of Louisiana face repeated flooding and massive damage from hurricanes. One community of 3,700 residents called Pointe-aux-Chênes was devastated by Hurricane Ida in late August 2021. After the storm, 80% of the homes in the area were uninhabitable and the entire community was left without power or running water and the community has faced similar damage from other storms in the past. Many residents raised their homes 12 feet off the ground when they rebuilt after hurricane Katrina in 2005, but they were unable to avoid the damage caused by hurricane Gustav in 2008, hurricane

³ https://www.weather.gov/media/box/science/Sandy_summary_BOX.pdf accessed 9/24/21

Isaac in 2012 and again by hurricane Ida in 2021.⁴ This type of repetitive loss may become more frequent in the future and there is uncertainty if Federal and State programs will have the capacity to support rebuilding given the likelihood of more severe storms in the future.



Figure 49. Flooding in Louisiana on August 30, 2021, caused by Hurricane Ida
(Source: Washington Post)

⁴ <https://www.wsj.com/articles/after-hurricane-ida-louisiana-bayou-community-contemplates-moving-or-rebuilding-11631439002> - accessed 10/15/21

8 Phased Relocation and Restoration Scenario

8.1 Overview and Assumptions

The Phased Relocation and Restoration Scenario seeks to avoid the negative impacts that would occur under the No Action scenario. This scenario involves taking proactive steps to adapt and make Warren more resilient to climate impacts. This scenario involves the relocation and restoration of properties in the Market Street project area. It is divided into four phases over the next fifty (50) to seventy (70) years. In each phase, the owners of properties at risk of repetitive flooding and storm damage would be offered the opportunity for a buy-out of their property at fair market value. This would allow owners to utilize their financial equity in the purchase of a new residence in a safer location of their own choosing.

The buildings on the buy-out properties would be demolished and the foundations, driveways, utilities and other site improvements removed. Local streets within the area of projected flooding that are no longer serving as access to existing residents or as regional transportation connectors would be removed. The Market Street project area would be redeveloped as a restoration area that provides recreation and/or coastal access, flood storage, and coastal buffering. Reuse of this area, for example as a floodable park, would significantly reduce the threat to life and property associated with both chronic sea level rise and the impact of coastal storm events.

Consistent with the information presented in earlier sections, SLR impacts are estimated for four time periods between 2025 and 2100 in this analysis:

- 1.75 foot by 2035,
- Three (3) feet by 2050,
- Five (5) feet by 2070 and
- Nine (9) feet by 2100.

The total cost of each phase of relocation and restoration has been estimated on an order of magnitude scale, and is the sum of the cost to acquire the properties, demolish the existing buildings on the properties, remove existing utilities, and clear and restore the land to wetlands.

- The costs of acquiring properties within the project area are assumed to be consistent with their current tax assessed values.
- The costs to demolish the existing buildings are based on per square foot demolition cost estimates from R.S. Means Construction Cost Estimating Service. Quantities of building square footages to be demolished are based on the building area provided by the Warren tax assessors database.
- Costs for removal of water supply and sewer lines are based on cost estimates from R.S. Means Construction Cost Estimating Service. Quantities for removal of water supply and sewer lines are based on estimates of main and service line lengths from the Town of Warren GIS mapping.
- Costs for clearing non-building site improvements and restoring the area with native species . Quantities of land area for clearing and replanting are based on the lot area of the properties within the specific scenario phases from the Warren tax assessors database

Government-led acquisition and removal of flood-prone properties are often known as floodplain buyouts programs and are frequently used by communities to reduce future flood damages. Funding sources are available from several existing Federal and State programs, such as the Hazard Mitigation Assistance programs of the Federal Emergency Management Agency (FEMA) including Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC) and Flood Mitigation Assistance Grant Program (FMA). There are some restrictions to these programs; they can take a lengthy amount of time to secure funding and implement buyouts. Some funding sources are limited to areas identified in FEMA's often outdated federal flood maps and others are restricted for use on properties that have already suffered documented flood damage. Under these programs, FEMA has funded over 40,000 buyouts across the United States since the 1980s.

There are additional programs through the Environmental Protection Agency (EPA) through its Pre-Disaster Mitigation Grants, the Department of Housing and Urban Development (HUD), the Army Corps of Engineers (ACE) and Natural Resources Conservation Service (NRCS). Many of the Federal programs require a match from non-Federal sources, frequently 25%. Locally, Rhode Island offers funding for coastal adaptation through the RI Infrastructure Bank and its Municipal Resilience Program. There are also multiple programs available for improvements to the water supply, sewer and stormwater management systems through Federal and State agencies.

Locally, Warren can establish a Tax Incremental Financing (TIF) program from future tax income from redevelopment within Metacom Avenue corridor. This is an opportunity to link the separate issues in Market Street area and Metacom Avenue corridor together and use the opportunity to help fund the capital costs of property buy-outs with adaptation activities and infrastructure improvements.

8.2 Relocation and Restoration Phases and Costs

8.2.1 Phase 1 (2025-2035)

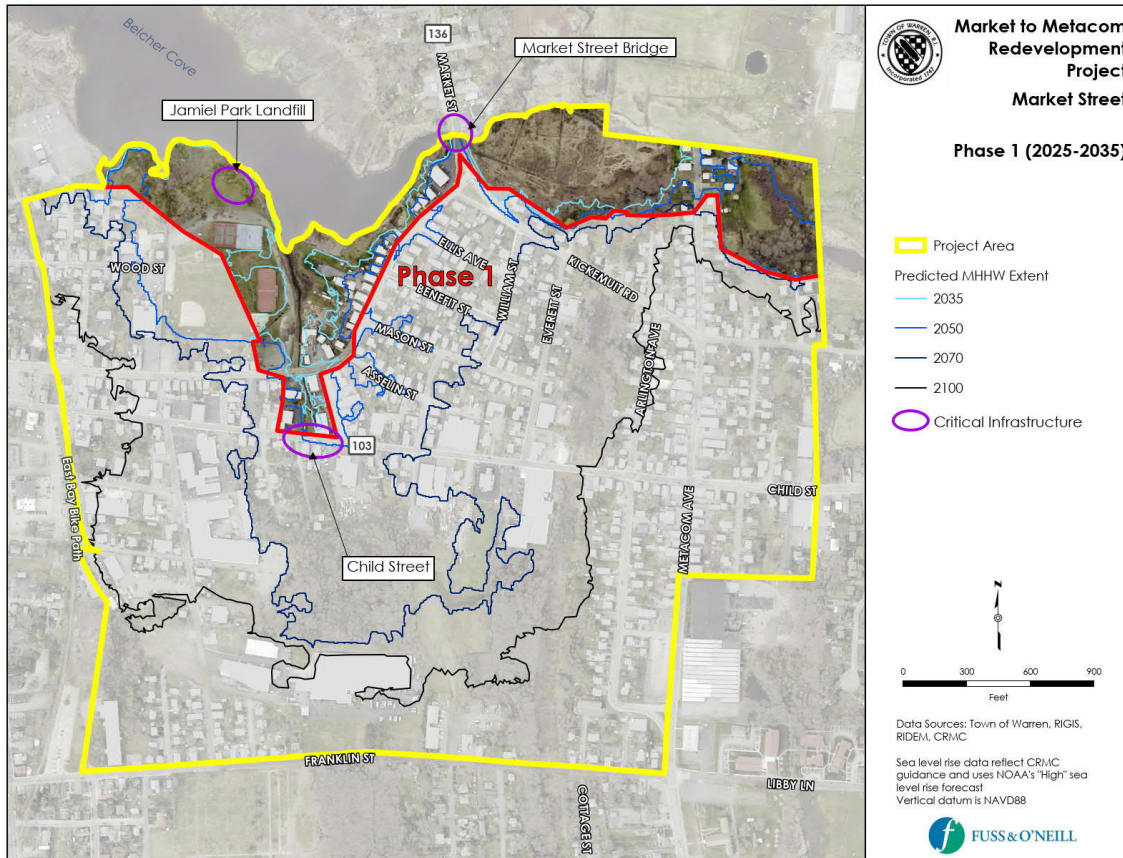


Figure 50. Phase 1 Plan (2025-2035)

Table 16 – Summary of Phase 1

Number of Properties	58
Number of Buildings	31
Property Acquisition Cost	\$9,400,000
Demolition Cost	\$2,800,000
Utility Removal Cost	\$700,000
Site Clearing and Restoration Cost	\$2,000,000
Total Cost	\$14,900,000
Federal Funding	\$11,200,000
Local/Private Funding	\$3,700,000
Lost Annual Tax Revenue	\$200,000

8.2.2 Phase 2 (2035-2050)

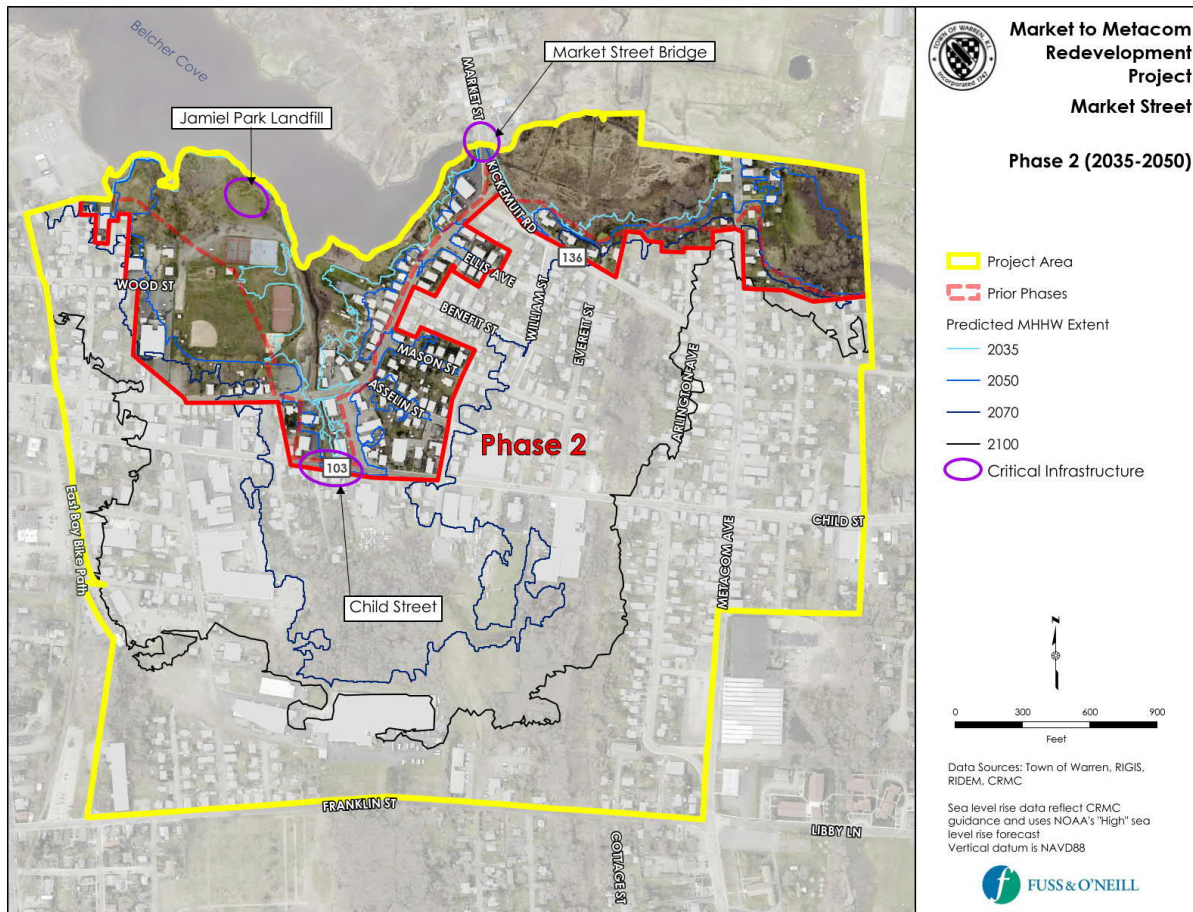


Figure 51. Phase 2 Plan (2035-2050)

Table 17 – Summary of Phase 2

Number of Properties	75
Number of Buildings	65
Property Acquisition Cost	\$17,500,000
Demolition Cost	\$5,800,000
Utility Removal Cost	\$400,000
Site Clearing and Restoration Cost	\$900,000
Total Cost	\$24,600,000
Federal Funding	\$18,400,000
Local/Private Funding	\$6,200,000
Lost Annual Tax Revenue	\$300,000

Phase 3 (2050-2070)

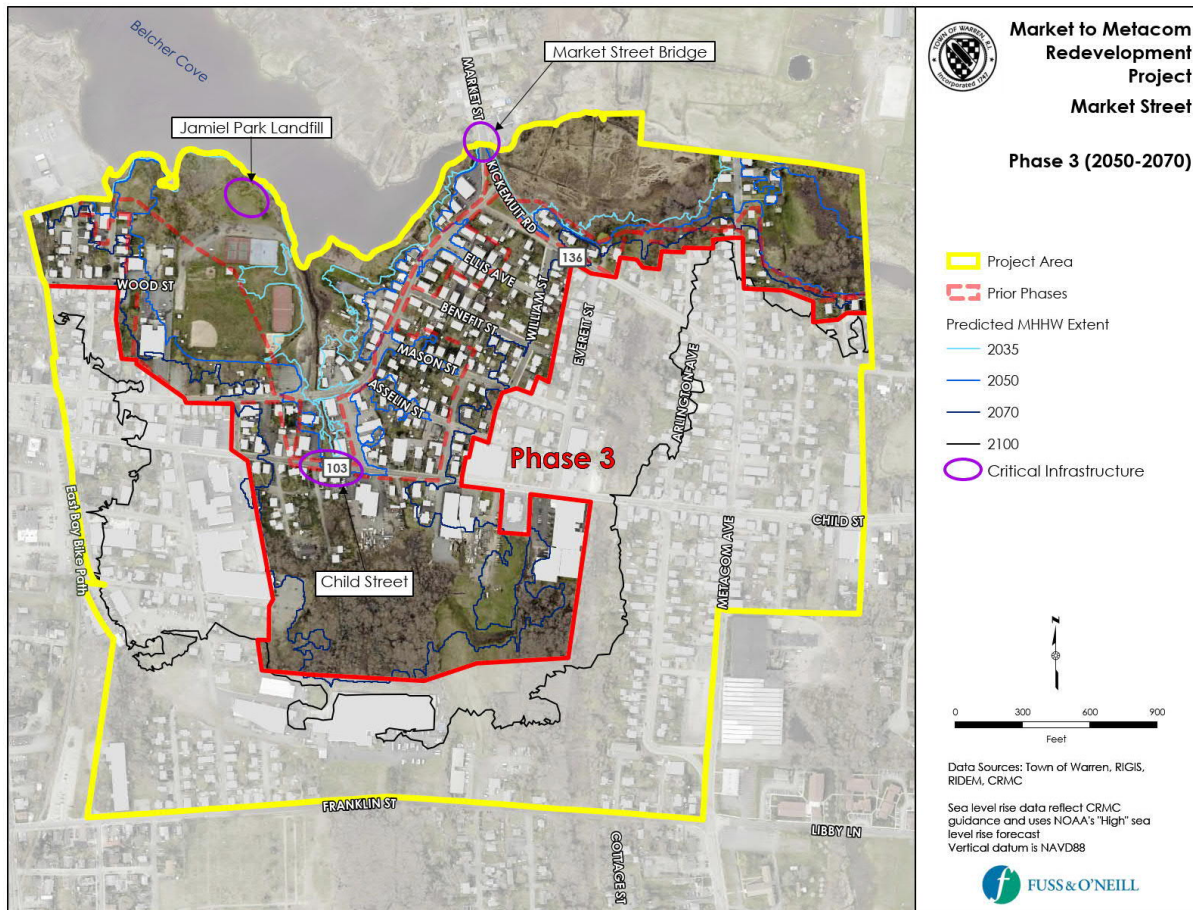


Figure 52. Phase 3 Plan (2050-2070)

Table 18 – Summary of Phase 3

Number of Properties	113
Number of Buildings	92
Property Acquisition Cost	\$24,500,000
Demolition Cost	\$9,000,000
Utility Removal Cost	\$800,000
Site Clearing and Restoration Cost	\$2,300,000
Total Cost	\$36,600,000
Federal Funding	\$27,500,000
Local/Private Funding	\$9,100,000
Lost Annual Tax Revenue	\$400,000

Phase 4 (2070-2100)

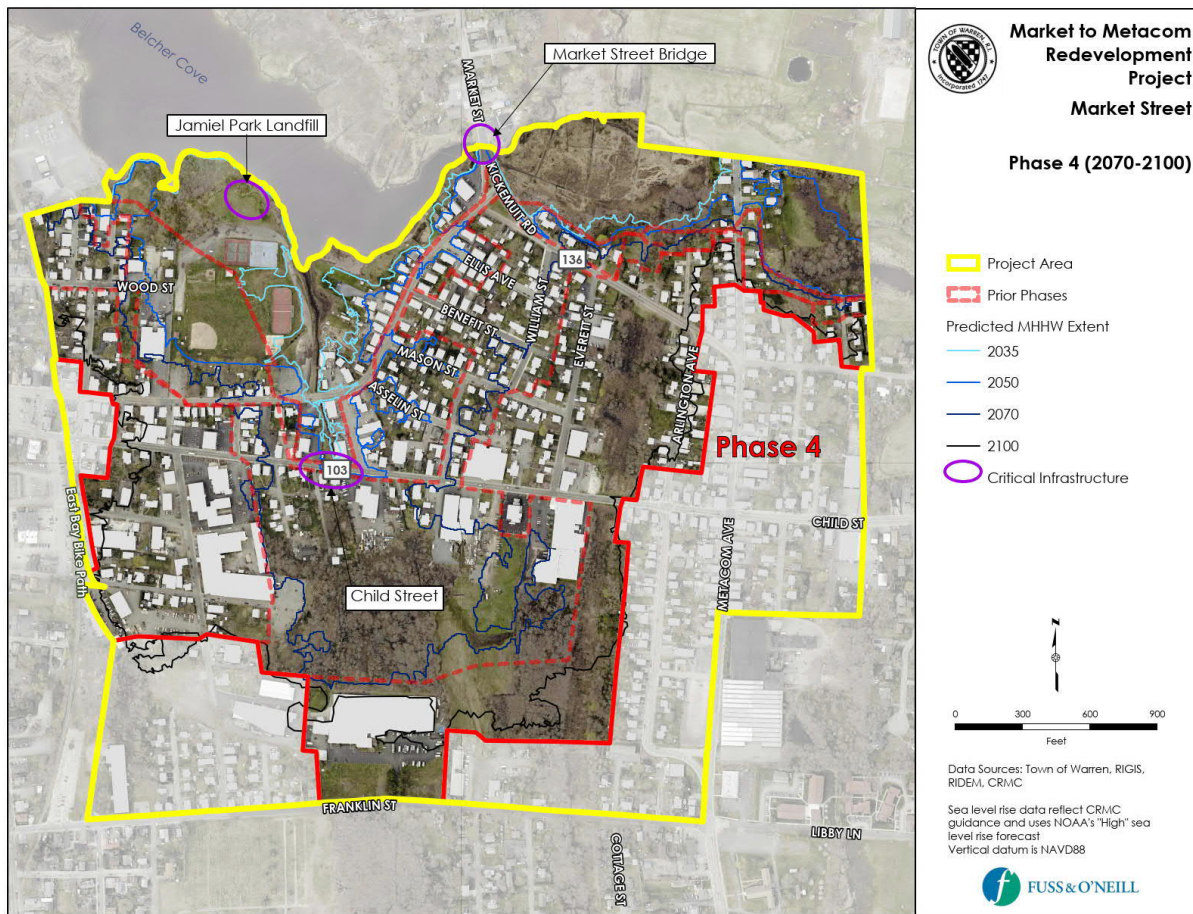


Figure 53. Phase 4 Plan (2070-2100)

Table 19 – Summary of Phase 4

Number of Properties	137
Number of Buildings	118
Property Acquisition Cost	\$39,700,000
Demolition Cost	\$18,800,000
Utility Removal Cost	\$1,100,000
Site Clearing and Restoration Cost	\$2,500,000
Total Cost	\$62,100,000
Federal Funding	\$46,600,000
Local/Private Funding	\$15,500,000
Lost Annual Tax Revenue	\$700,000

8.2.3 Summary of Phased

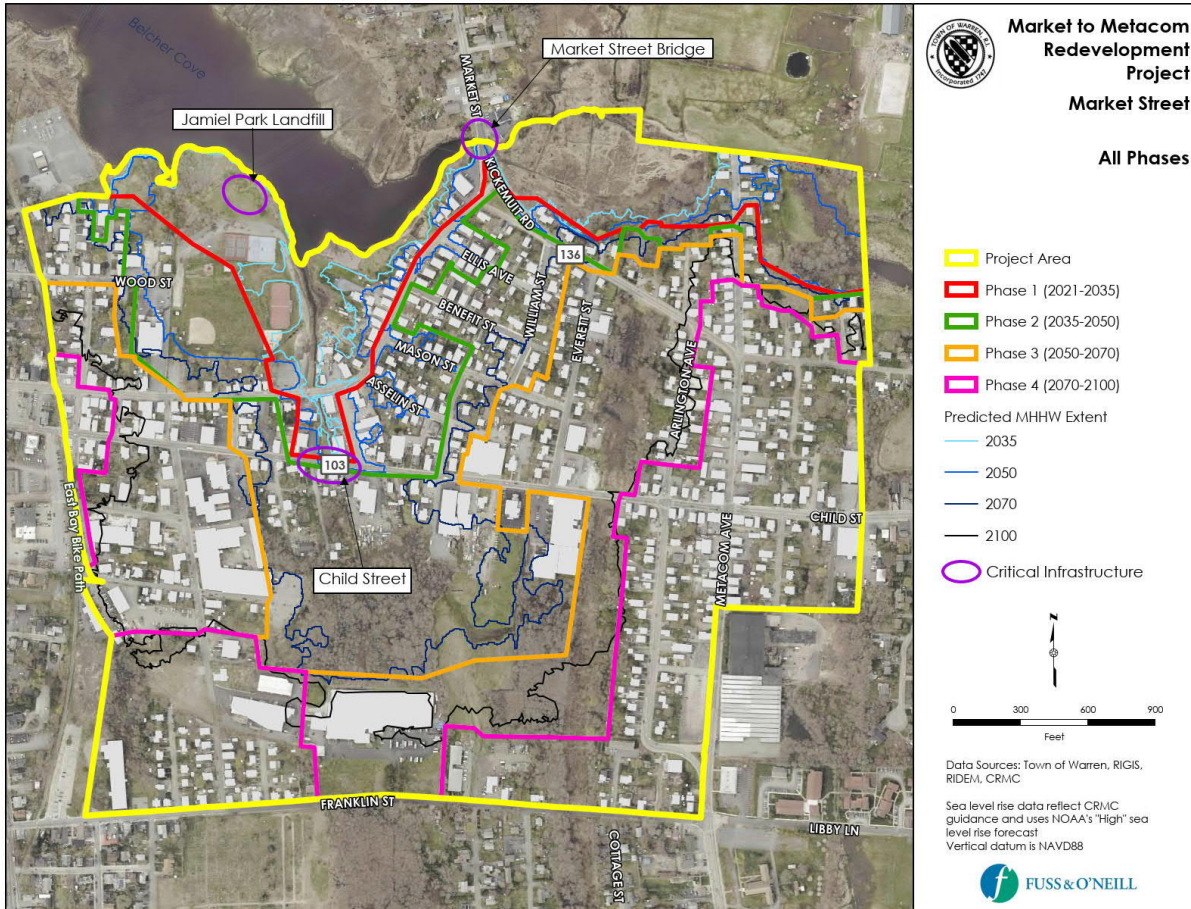


Figure 54. Overview of All Phases

8.3 Utility Adaptation

In addition to the parcel-based utility service removals included in the above Phase 1 through 4 cost estimates, utility mains within each of the roadways will need to be considered as part of the phased retreat planning process. Existing utilities within the Market Street project area include sanitary sewer, water, overhead electric, and drainage infrastructure. Each of the public rights-of-way within the project area have public sanitary sewer and water mains, as well as overhead power lines operated by National Grid. Several drainage structures and pipes exist within the project area. One drainage outfall discharges to Belcher Cove northwest of Jamiel's Park. Two additional drainage outfalls exist just north of Franklin Street.

Utility main removals will need to consider the connectivity of utilities beyond the boundaries of each phase, including areas outside of the project area that are serviced by these mains. Phasing of utility removals, realignments, and/or modifications may be separate from the four phases discussed above. For example, large areas north and east of the Market Street project area rely on the sewer mains within Market Street and Child Street. The Wood Street pump station also serves the majority of the Market Street project area, and thus, will be a critical component of the utility planning for this area and resilience-planning for other areas of Warren. Some of the utility mains within local roadways, such as Mulberry Street, may be removed during the roadway removal associated with their respective phase of retreat. Further assessment of utilities will be required and will need to be coordinated with roadway removals/realignments to ensure that utilities remain operational and accessible until utility relocation and/or adaptation can be achieved.

8.4 Environmental Impacts

There are several potential positive environmental impacts of the Relocation and Restoration Scenario.

- The removal of environmental contaminants that are stored in the project area can result in significant risk reduction, avoiding the potential environmental damage that may result during flooding events. There are more than thirty (30) fuel and chemical tanks and twelve (12) underground storage tanks and one RIPDES Sanitary Waste Site, according to the list of RIDEM-regulated facilities. There are an estimated 200 unregistered domestic fuel oil tanks as well as storage of household chemicals and fuel containers.)
- The removal or encapsulation of the landfill at the Town-owned Jamiel Park can prepare the site for future inundation and avoid potential pollution impacts.
- The removal of impervious cover from the areas of relocation has the potential to improve water quality by filtering stormwater runoff through reestablished negotiated wetland areas and associated stormwater control structures.
- The reestablishment of natural vegetated and wetland areas between the remaining developed areas and adjacent bodies of water creates habitat for a variety of species as well as a natural buffer to minimize wave action and flood storage areas that can protect remaining residences, businesses, infrastructure, and roadway/transportation connections.

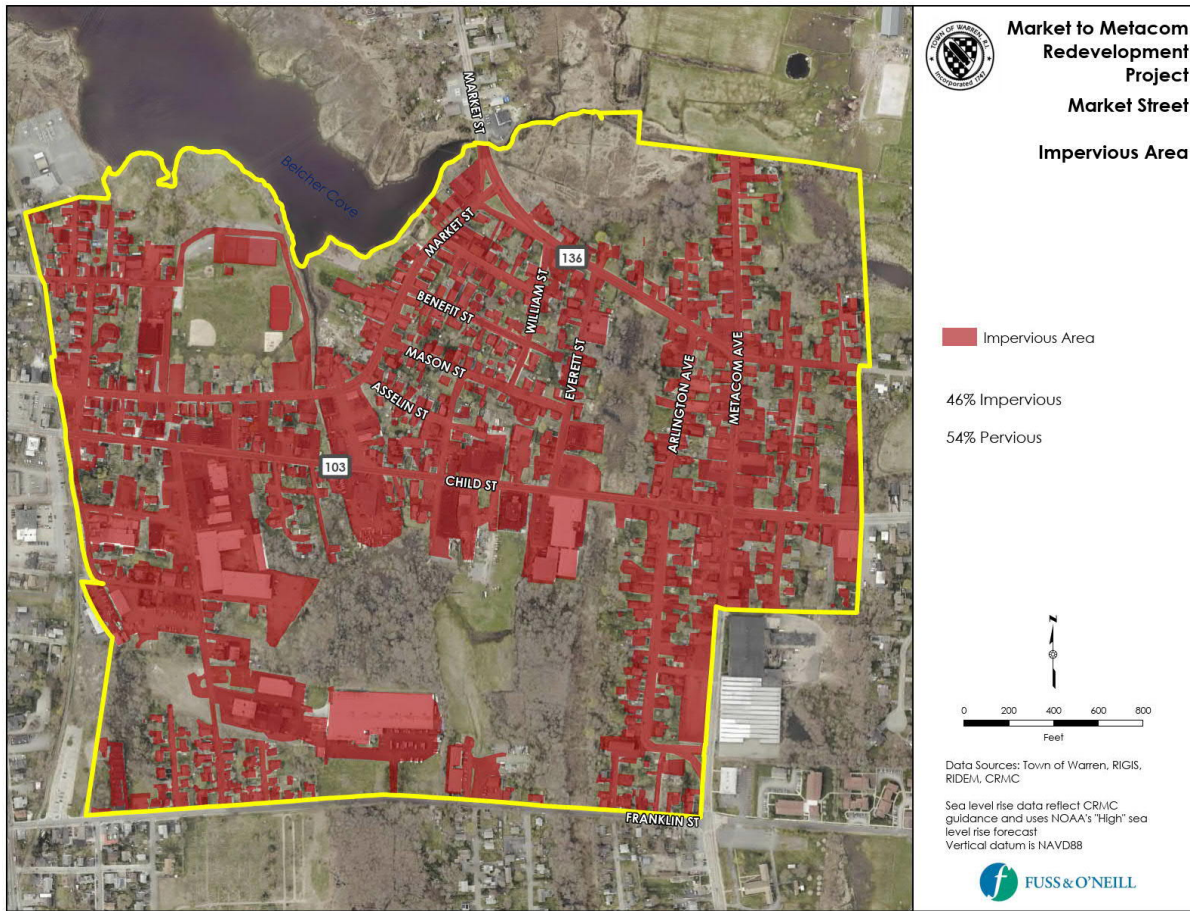


Figure 55. Impervious Area within the Market Street Project Area

Table 20 – Impervious Area Removed and Vegetated Area Created Phase

Phase	Impervious Removed			Vegetated Area Created (acres)
	Area of Impervious Surfaces Removed (acres)	% Roofs	% Pavement	
Phase 1	8	33%	67%	34
Phase 2	10	55%	45%	21
Phase 3	17	49%	51%	42
Phase 4	29	60%	40%	56
Total	63	53%	47%	153

These quantities are based on the assumption that Route 103 and Route 136 will remain but all other roads and buildings within the phase areas will be removed and revegetated.

8.5 Recreational Value of Revegetated Land

The revegetated land created in the Relocation and Restoration Scenario has the potential to provide recreational as well as environmental benefits to the community. Conceptually, the land would be utilized as an accessible recreation and conservation area. Site design would include elevated walking paths and view platforms to observe the natural scenery and views to Belcher Cove. The paths would provide recreational opportunities for the community including walking, running, and bird watching. A kayak launch is proposed to provide access to Belcher's Cove. The figure below shows a conceptual plan for the marsh park that could be constructed following the 2070 phase of the relocation and restoration plan.



Figure 56. Conceptual Plan for Market Street Area in 2070

Recreation area similar to the one proposed in this plan already exist in several locations along the coast of New England. An example of a similar park can be seen at the Cape Cod Marsh Walk. The park's trail network provides views of a salt marsh, barrier beach, pine woodlands, and a harbor. The wildlife sanctuary attracts visitors with an educational nature center and excellent opportunities for bird watching. Another example of a marsh park can be seen at Ocean View Farm Reserve in Dartmouth, MA. This park overlooks a coastal salt pond system that is recognized as one of the most significant coastal habitats in Southern New England. The reserve provides views of Buzzard's Bay as well as a protected space for grassland birds and migratory songbirds.



Figure 57. Images of the Cape Cod Marsh Walk

8.6 Precedents

8.6.1 Gloucester County, Virginia

Gloucester County, Virginia has been repeatedly flooded by storms, especially the Guinea area residing in the low-lying southeast portion of the county. After the damage caused by Hurricane Isabel in 2003, the county enrolled in FEMA and VDEM Hazard Mitigation Grants to establish a voluntary property acquisition and home elevation program. The goal of this program was to reduce potential loss of life and property by assisting residents in relocating to safer, less flood-prone areas.



Figure 58. Image of Flooding in Gloucester County, Virginia

The County-run program ran from 2003 to 2016 and utilized FEMA grants to acquire properties and assist with elevating houses. Property owners were able to voluntarily enroll in the program to either sell their properties to the County or receive financial assistance to elevate their homes. The owners who elected to sell their properties to the County received the properties' pre-storm market value. The structures on the acquired properties were demolished and septic tanks were crushed or filled, and the land was placed under the management of the County's Open Space Hazard Mitigation Plan. Funding for the property acquisition and home elevation program included \$11 million in grant money between 2003 and 2016. Property owner requests for assistance exceeded the funds available, prompting the County to prioritize repetitive flood loss properties and residential properties. A total of 59 buildings were removed and over 57 buildings were elevated through the program. As a result, more than 100 acres of flood-prone land was converted to open space.⁵

⁵ <https://vims-wm.maps.arcgis.com/apps/MapJournal/index.html?appid=bea8d4142fcf47bc90078e845e296d64#>

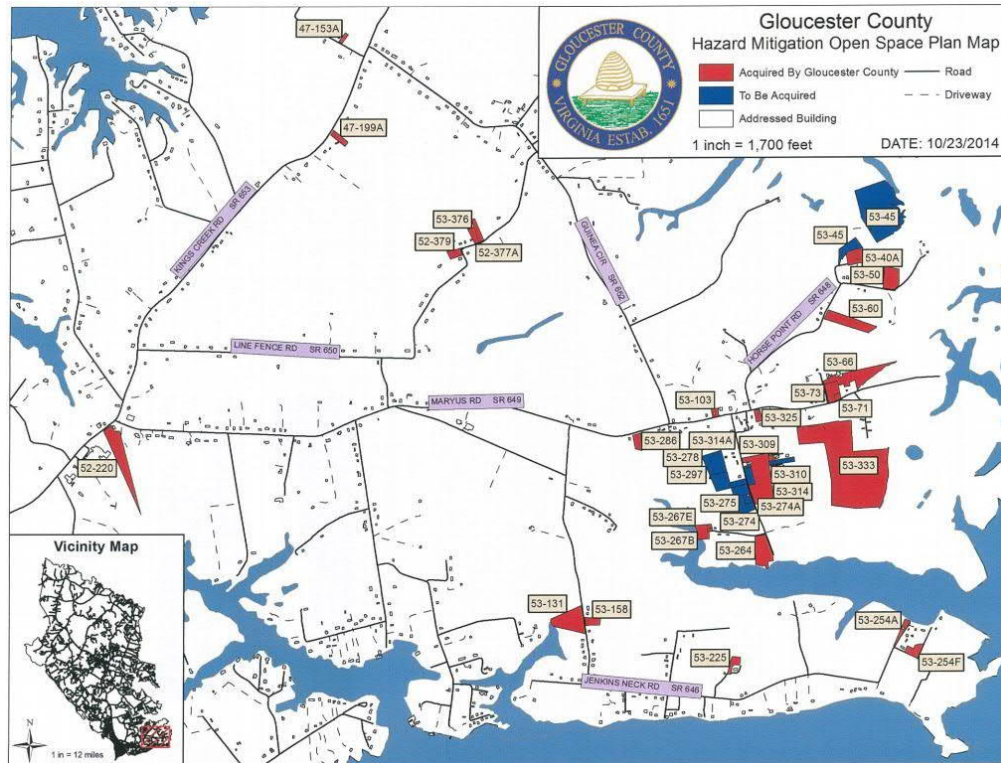


Figure 59. Gloucester County Buy-Out Map

Onion Creek, Austin, Texas

The Onion Creek watershed is one of the largest watersheds in Austin, Texas. The creek received rainfall from 344 square miles of land, producing deep flood flows in the downstream sections of the creek. Much of the development along the downstream portion of Onion Creek occurred before current floodplain regulations were established and before the full breadth and depth of the floodplain was determined. As a result, many of the homes in the area were constructed within the floodplain and are subject to severe repeated flooding.



Figure 60. Image of Flooding in Austin, Texas

In response to flooding in October 2013, the City of Austin initiated a study of the Onion Creek watershed and a feasibility study for the area was completed in 2017. This study recommended buyouts for 138 houses in the Onion Creek area to mitigate flood risk. The buyout project was divided into a recovery phase and phases one through three. The recovery and phase one buyouts are complete and included the purchase of 58 of the 59 homes indicated for the first phase. Phase two indicated 79 homes for buyouts and was approved by the City Council in March of 2019. The second phase is currently in-progress with 70 homes purchased as of July 2021. Phase three includes the buyout of eight homes that may become isolated by the buyout of neighboring properties. This phase was approved in March of 2019 and as of July 2021, the City has purchased two of the homes.

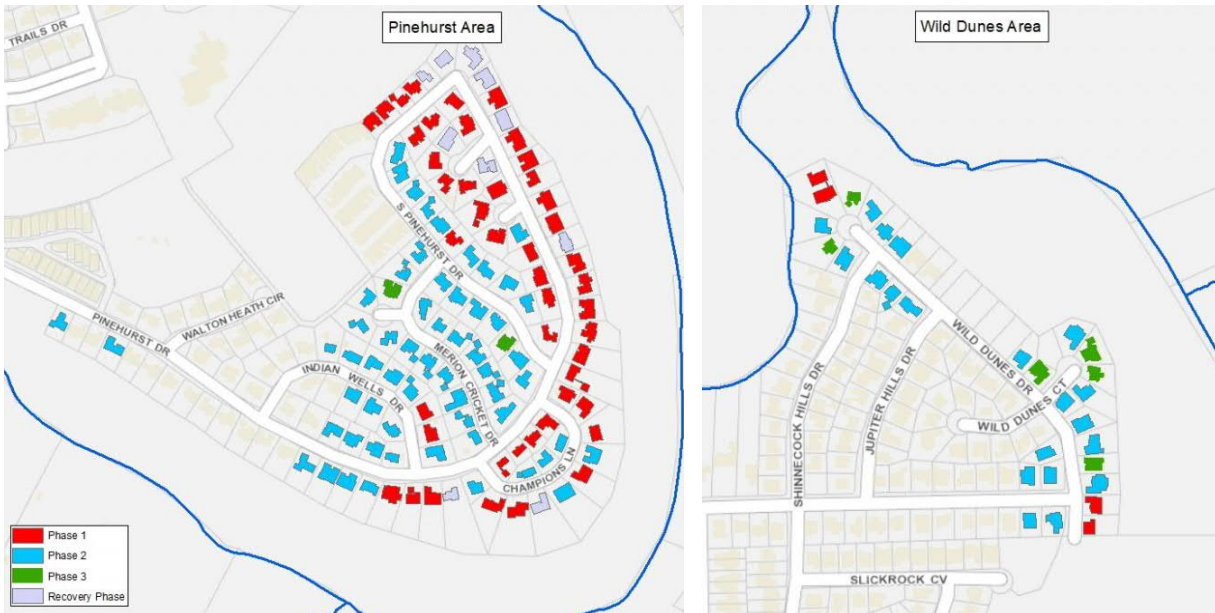


Figure 61. Onion Creek Buy-Out Map

The buyout program prioritized acquisition of homes based on their risk of structural flooding, proceeding from the highest risk to the lowest risk as funding became available. The estimated cost for the project is \$77,500,000 and the estimated annual operation and maintenance cost for the land is \$105,000. These estimates include real estate services, appraisals, acquisition costs, relocation/moving expenses, asbestos testing/abatement, demolition, and property management.

The homes purchased through this program are demolished and foundations, walkways, driveways, and utility lines are removed to the edge of the right of way. The lots are then regraded and revegetated, and the land is designated for open space. Over 290 acres of Onion Creek flood zone has been acquired and converted to open space so far. The purchased properties have been added to the City's vegetation control schedule for regular mowing during the growing season. The City plans to work with the neighborhood to develop plans for the land in the future. Possible options being considered include nature trails, community gardens, wildflower meadows, and open space.⁶

⁶ <http://www.austintexas.gov/department/upper-onion-creek-flood-risk-reduction-project> accessed 9/15/21

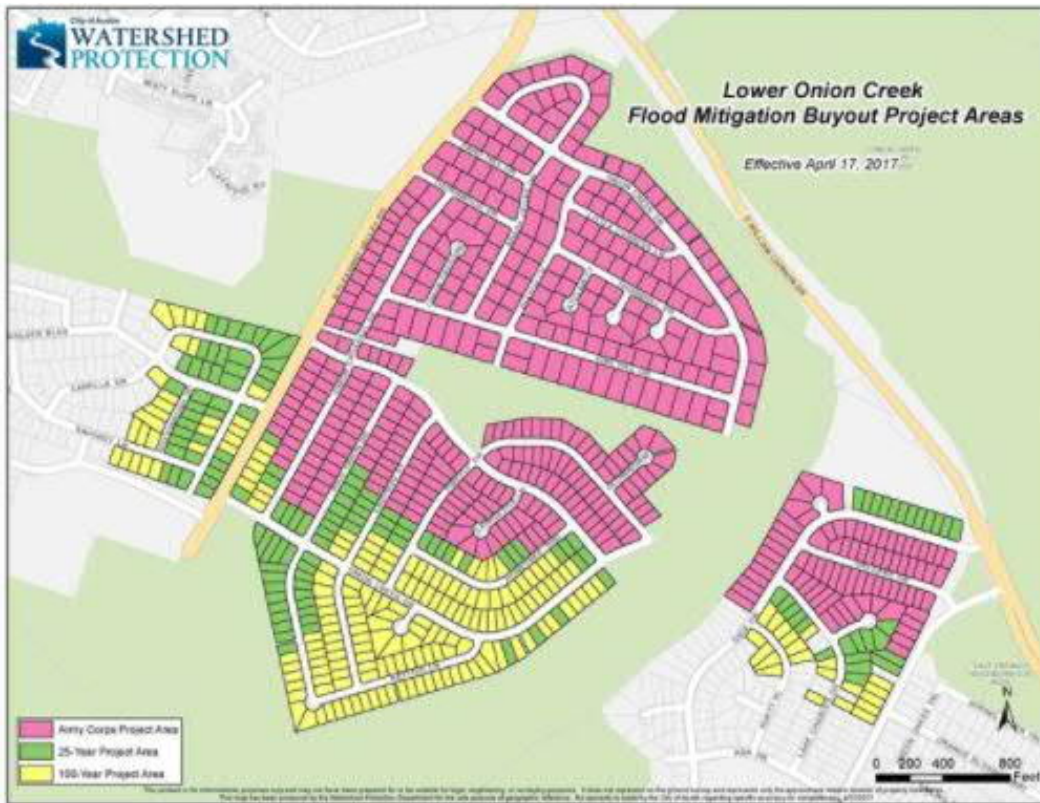


Figure 62. Onion Creek Buy-Out Map

Warwick, Rhode Island

As sea levels rise and storms hit the Warwick coastline, streets that once led to the beach are now dangerously close to high tide. These roads are vulnerable to erosion and flooding and convey untreated stormwater directly to the Narragansett Bay. The marshes at the ends of several dead-end roads have already eroded and past hurricanes have crumbled the pavement at these sites. In the summer of 2014, Save the Bay worked with the City of Warwick to remove pavement at the end of five dead-end roads along the Bay. After the pavement was removed, filter strips were installed to slow and filter road runoff. These filter strips will reduce the flow of pollutants into the Bay. The restored coastal areas were planted with grasses and incorporated improved public access to the shore. The end of road retrofits improved coastal habitat, coastal protection, and public access while reducing stormwater pollution and road maintenance. The retrofits cost \$5,000 to \$10,000 per road and could be implemented in similar locations throughout Warwick.



Figure 63. Image of End of Road Retrofit Construction on Mill Cove Road

This project was funded by a \$1 million National Oceanic and Atmospheric Administration (NOAA) grant. This grant also funded the recontouring of the beach at City Park after Hurricane Irene. The storm eroded the beach, damaging the boardwalk and overlook. The damaged structures were removed, and the beach was pulled back.⁷

7

<https://johnstonsunrise.net/stories/end%20of%20road%20projects%20respond%20to%20rising%20sea%20level.94200> accessed 9/15/21

8.6.2 Brookhaven, NY

In 2019, the Audubon Society received a grant to support wetland restoration in partnership with the Town of Brookhaven, NY. The area includes Mastic Beach which was severely impacted by Superstorm Sandy and continues to be impacted by sea level rise. The wetland restoration project is part of a larger ongoing multi-faceted coastal retreat and floodplain restoration on the 7,600-acre Mastic Beach/Shirley peninsula. Restoration will target priority coastal habitat to return the area to a tidal marsh and remove portions of a coastal road that regularly floods due to sea-level rise. Funding came from the National Coastal Resilience Fund and the total project cost was \$488,944.



Figure 64. Image of Flooded Roadway at Mastic Beach

8.7 Implementation

8.7.1 Recommendations for Actions

In order to affect change in the Market Street Project area, the Town of Warren, in partnership with State, Federal and regional partners should take the following actions:

- Educate property owners about impending climate change impacts and their role in the process
- Prepare for increased impacts from storm and flooding events
- Update Comprehensive Community Plan for Market Street including language to support goals for:
 - property buyouts and retreat in Market Street area
 - increased resilience for evacuation routes and regional transportation connections
- Amend local zoning ordinance for Market Street
 - Risk reduction through strict zoning and building height policies
 - Limitations on hazardous materials storage in flood zones
- Advocate for supportive State actions
 - RIDOT adapts vulnerable sections of Routes 136 and 103 to withstand sea level rise and storm events and potentially become part of flood control system
- Secure funding for property buyout programs from State and Federal sources
- Set up property buyout programs
- Set up redevelopment agency to facilitate actions to achieve Comprehensive Plan goals
- Remove infrastructure and utilities as property buyouts occur

8.7.2 Funding Sources

Warren and its partners at the State and Federal levels should establish partnerships and seek funding from programs and funding sources who share the mission of risk reduction and adaptation to climate change impacts. This includes the following sources of potential funding:

- Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance programs
 - Hazard Mitigation Grant Program (HMGP),
 - Building Resilient Infrastructure and Communities (BRIC) and
 - Flood Mitigation Assistance Grant Program (FMA).
- US Environmental Protection Agency (EPA) Pre-Disaster Mitigation Grants
- Department of Housing and Urban Development (HUD)
- US Army Corps of Engineers (ACE)
- Natural Resources Conservation Service (NRCS)
- RI Infrastructure Bank
 - Municipal Resilience Program
 - Water supply infrastructure financing and grants
 - Wastewater infrastructure financing and grants
 - Stormwater infrastructure financing and grants
- Tax Incremental Financing (TIF) program

9 Metacom Avenue Corridor Redevelopment Scenario

9.1 Overview

Due to its higher elevation, the Metacom Avenue project area lies outside of the area subject to flooding as a result of both sea level rise and 100-year storm events through 2100. See [Figures X and X](#) below.

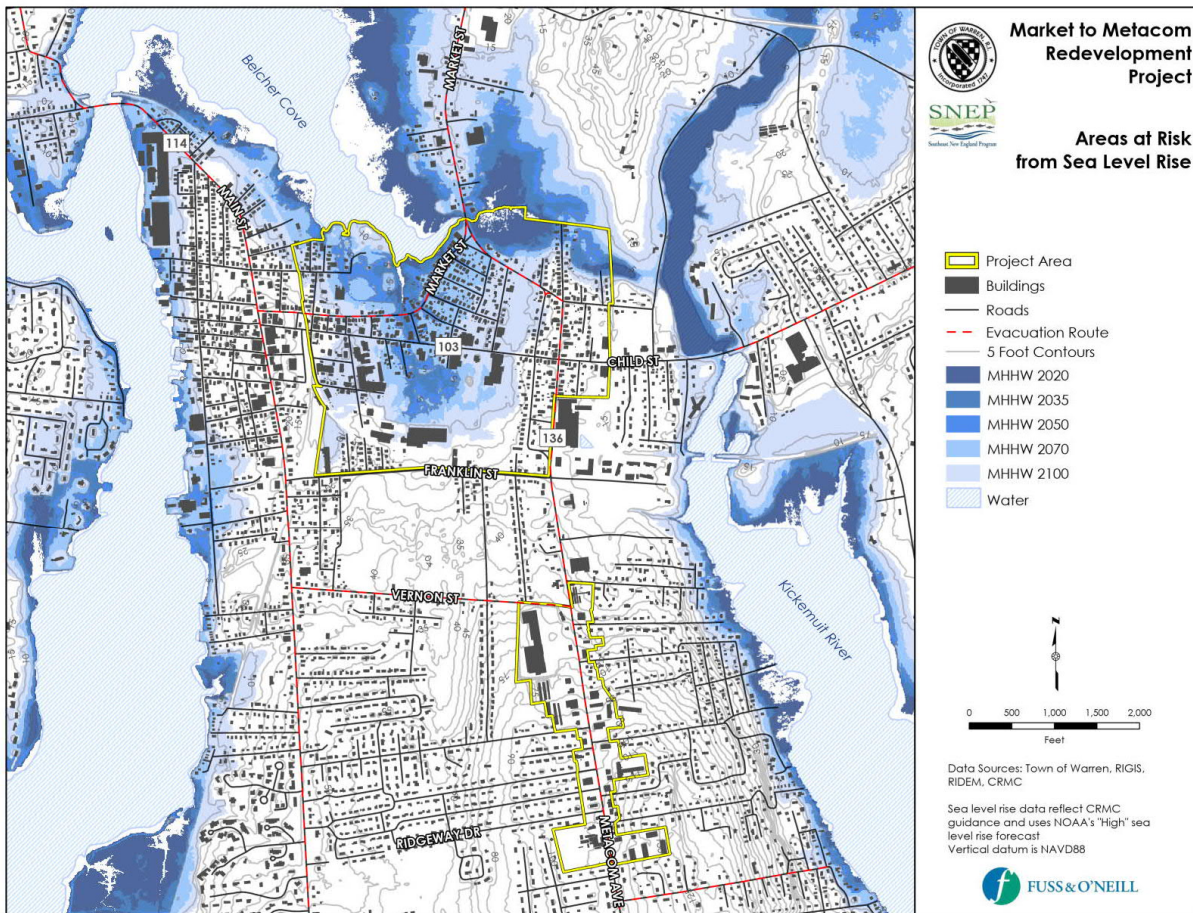


Figure 65. Project Area Topography and Sea Level Rise

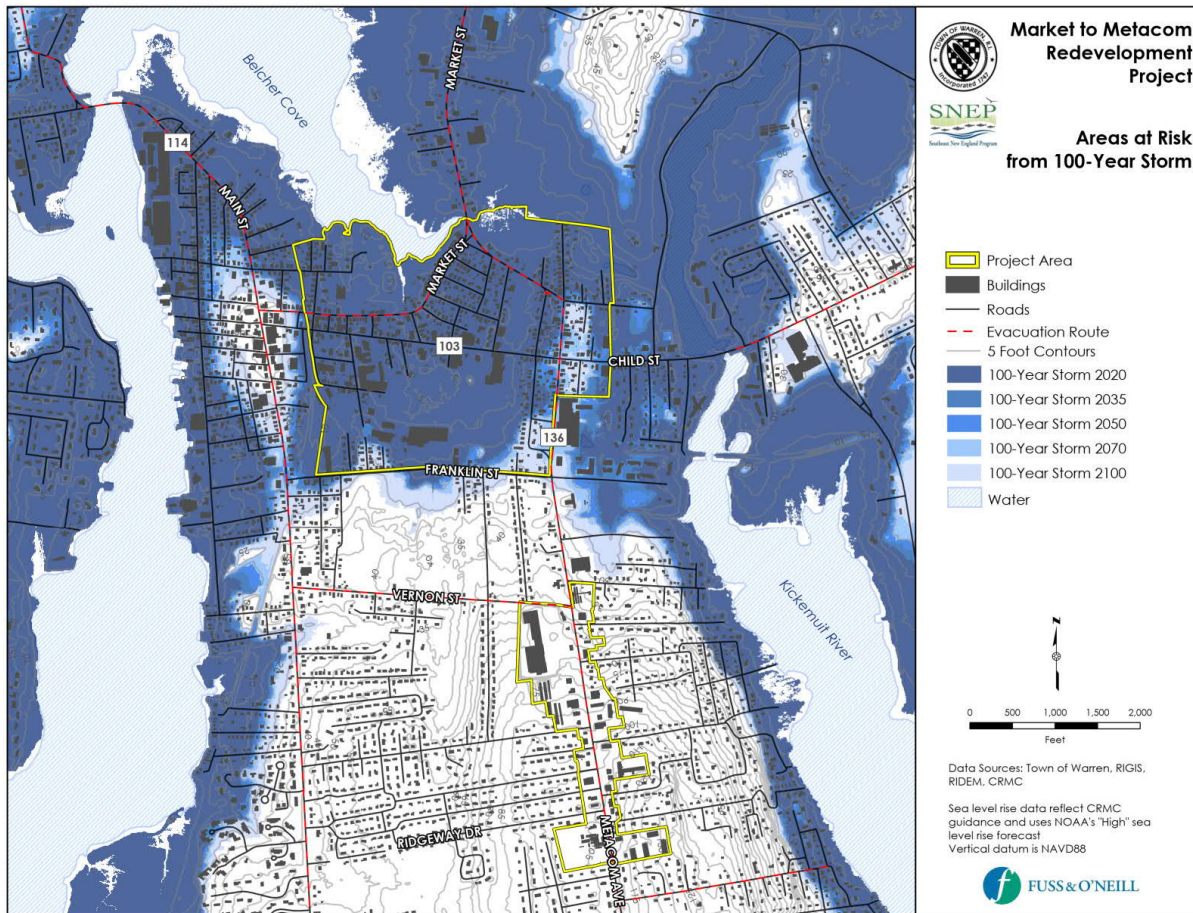


Figure 66. Project Area Topography and 100-Year Storm

The Metacom Avenue corridor has very low risk from flooding due to its location on an elevated ridge. This makes it an ideal location for redevelopment and a replacement of housing units and business that may be relocated from the Market Street area. The current development of the Metacom Avenue consists primarily of strip retail commercial buildings and parking lots, which lack a sense of place, connectivity, and pedestrian and bicycle-inclusive infrastructure. The Metacom Avenue Corridor Redevelopment Scenario reimagines this area as a denser mixed-use center, which interfaces gradually with the surrounding residential neighborhoods.

This Scenario would involve Town changes to the Zoning Ordinance to create a new framework for redevelopment focused on form-based code rather than dimensional and use-based zoning. The code would permit mixed-use/residential uses within this area and allow for increased density within the form-based guidelines. The goal would be to encourage replacement of large parking lots and strip retail with development that improves the streetscape and overall character of the built environment within this vital corridor of the Town.

This Scenario also presents an opportunity for improved stormwater management within this project area. The majority of precipitation that falls on impervious surfaces in the Metacom project area is captured by conventional stormwater infrastructure and directed to the Kickemuit River. Approximately 76% of the total project area, including roadways, is impervious. Most redevelopment projects within this area would be required to conform to current (or improved) Zoning, which would likely result in increased pervious area/green space. Redevelopment projects would also be required to conform to RI Water Quality Regulations and the Town's Stormwater Regulations. This will require projects one-acre or larger obtain a Rhode Island Pollution Discharge Elimination System (RIPDES) permit and construct stormwater management systems which provide treatment of stormwater prior to discharging it to the Town's storm drain system and the Kickemuit River.

In addition to existing regulations, this Scenario could involve improved Town Stormwater Regulations to require increased stormwater management treatment for redevelopment projects in this corridor. Under RI Water Quality Regulations, projects which qualify as "redevelopment" have reduced water quality requirements, as well as exemptions from several of the Minimum Standards of the Rhode Island Stormwater Design and Installations Standards Manual. However, in order to maximize the water quality improvement impacts that are possible in this Metacom Avenue corridor, full treatment of the water quality volume (one-inch of runoff from proposed impervious areas) could be required under a more stringent local stormwater regulation.

9.2 Roadway and Utility Reconfiguration

Metacom Avenue currently consists of four travel ways, each eleven feet wide, with a one-foot paved shoulder and five-foot-wide sidewalk on each side. The current configuration is vehicle-centric and there is currently no bike lane within this section of Metacom Avenue.

The width of Metacom Avenue presents an opportunity to reconfigure the roadway to accommodate bicycles, and incorporate a center turning lane. The resulting roadway would consist of two eleven-foot wide travel lanes, one 12' wide turning lane, and two six-foot wide accessible shoulders. Existing five-foot wide sidewalks would be improved to be more accessible. This configuration would allow existing curb lines to be maintained and would not require relocation of stormwater infrastructure or utilities. Costs for this type of reconfiguration are typically moderate, since the main changes are to lane striping and signage while paved surfaces are maintained in their existing configuration.

This type of alternate road configuration has traffic calming effects and is associated with vehicular and pedestrian safety improvements. The center two-way left-turn lane (TWLTL) would allow for reduced traffic disruption related to vehicles turning off this dense portion of Metacom Avenue. The reduction in number of travel ways also improves the ability for vehicles to make left turns across traffic. A study conducted by The Federal Highway Administration showed significant reductions in head-on and rear-end crashes resulting from installation of TWLTLs. TWLTLs may reduce head-on collisions by creating a buffer between travel lanes.⁸

⁸ Safety Evaluation of Center Two-Way Left-Turn Lanes on Two-Lane Roads
<https://www.fhwa.dot.gov/publications/research/safety/08046/index.cfm> accessed 9/12/21

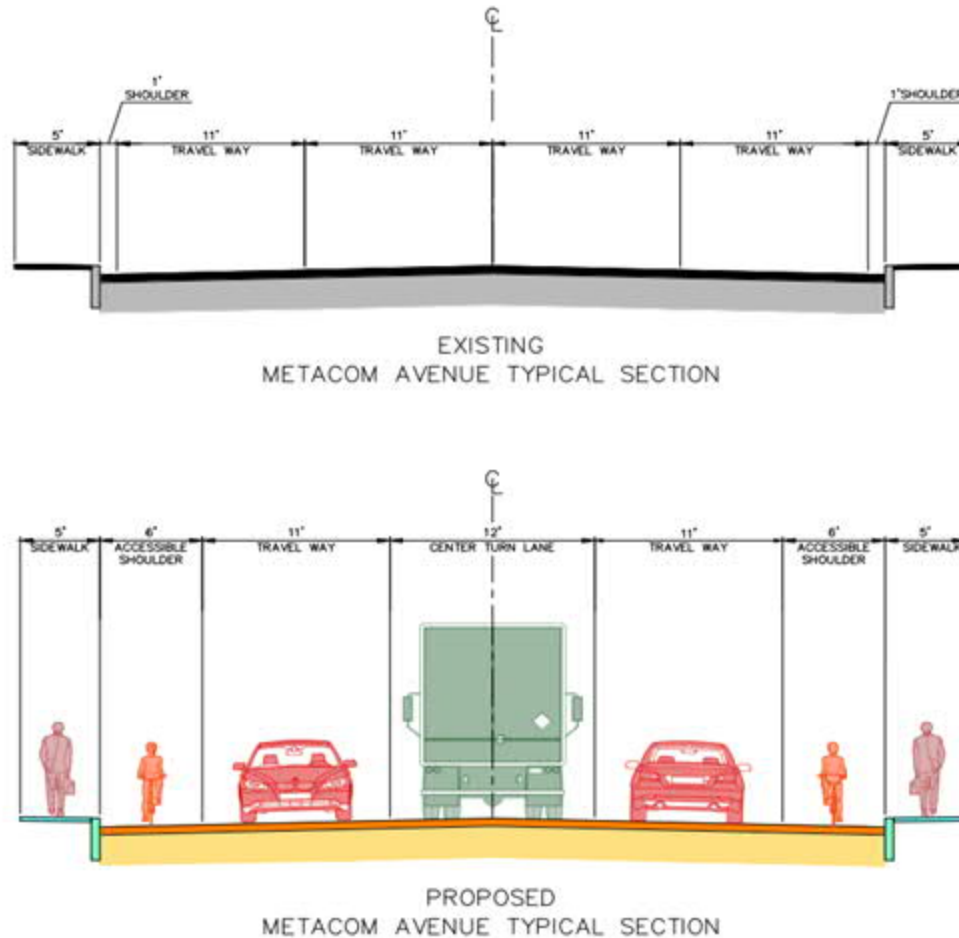


Figure 67. Existing and Proposed Metacom Avenue Configurations

There are available State and Federal funding for these types of infrastructure upgrades, including transportation funding through the RI Department of Environmental Management and Federal Highway Administration. The Town of Warren can apply to the Department of Planning as the Metropolitan Planning Organization to have a Metacom Avenue infrastructure revitalization process placed on the State Transportation Improvement Program (STIP) as a top priority.

The redevelopment of Metacom Avenue offers an opportunity for the improved management and volume reduction of impervious cover from the project area. This, in turn, has the potential to improve water quality by filtering stormwater runoff through new and improved stormwater management systems. Stormwater management system upgrades that affect an impaired watershed like the Kickemuit River can qualify for the RIDOT Stormwater Credit program. They can also qualify for funding through the RI Infrastructure Bank and associated Federal funding sources for clean water and environmental protection. Nature-based stormwater system design has become common as a best practice and there are many precedents within commercial areas like Metacom Avenue.

9.3 Redevelopment Scenarios

To assess the capacity and potential for redevelopment within this Metacom Avenue corridor, several conceptual plans have been developed by Union Studio Architecture and Community Development. For this Master Plan assessment, six different “blocks” demonstrating varying scales of development opportunity within this project area were chosen. These Master Plans do not indicate intent from these properties’ respective owners to redevelop their properties at this time.

Figure X, below, illustrates the overall master plan for Blocks “A” through “E” within the Metacom Avenue area. The following Sections provide detail regarding each of these blocks.



MARKET TO METACOM
 METACOM AVENUE CONCEPTUAL MASTER PLAN
 JULY 2019
 UNLION STUDIO
 10000 METACOM AVENUE

Figure 68. Overall Metacom Avenue Conceptual Master Plan

9.3.1 Job Lot Plaza Site (Block D)



Figure 69. Job Lot Plaza (Block D) Concept Plan



Figure 70. Job Lot Plaza (Block D) Conceptual Rendering

Table 21 – Block D Summary Table

Civic or Institutional Space	33,500 sf
Commercial Space	27,500 sf
Residential: Multi-Family	159 units
Residential: Single-Family	20 units
Total Residential Units	179 units
Total Parking Spaces	470 spaces

9.3.2 CVS Block (Block C)

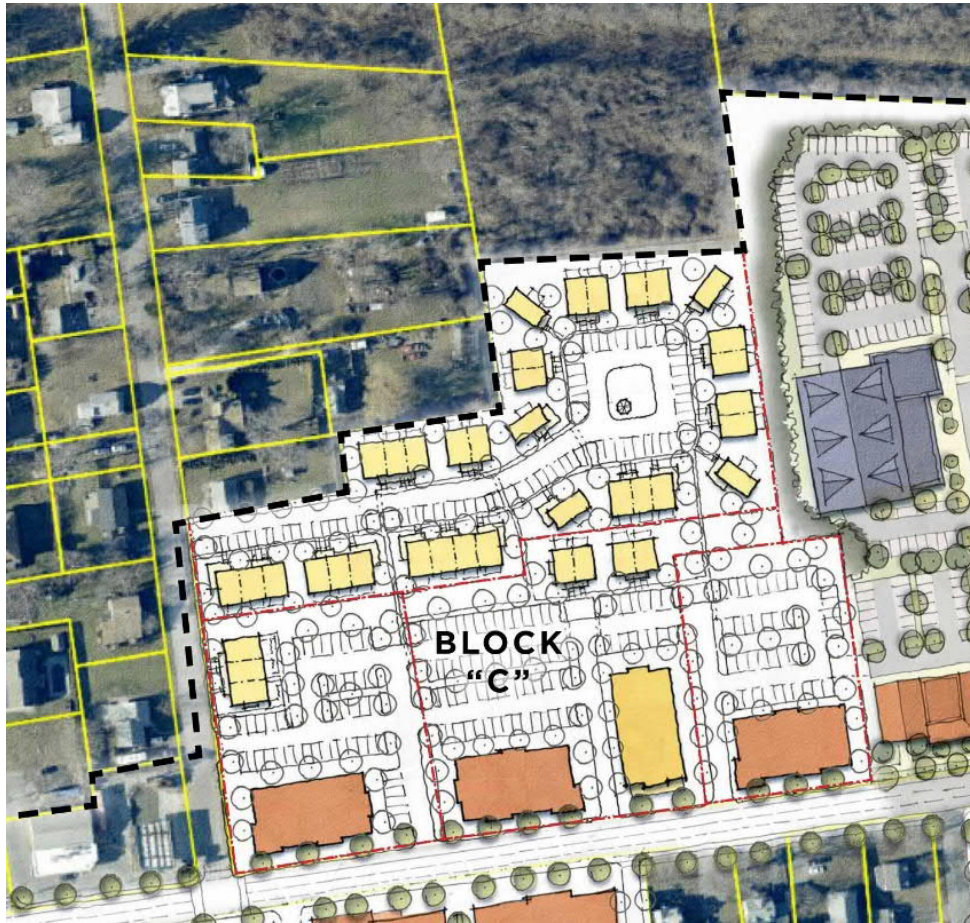


Figure 71. CVS Block (Block C) Concept Plan

Table 22 - Block C Summary Table

Civic or Institutional Space	(N/A)
Commercial Space	24,000 sf
Residential: Multi-Family	72 units
Residential: Single-Family	33 units
Total Residential Units	105 units
Total Parking Spaces	210 spaces

9.3.3 Pasqua/Healey (Block A)

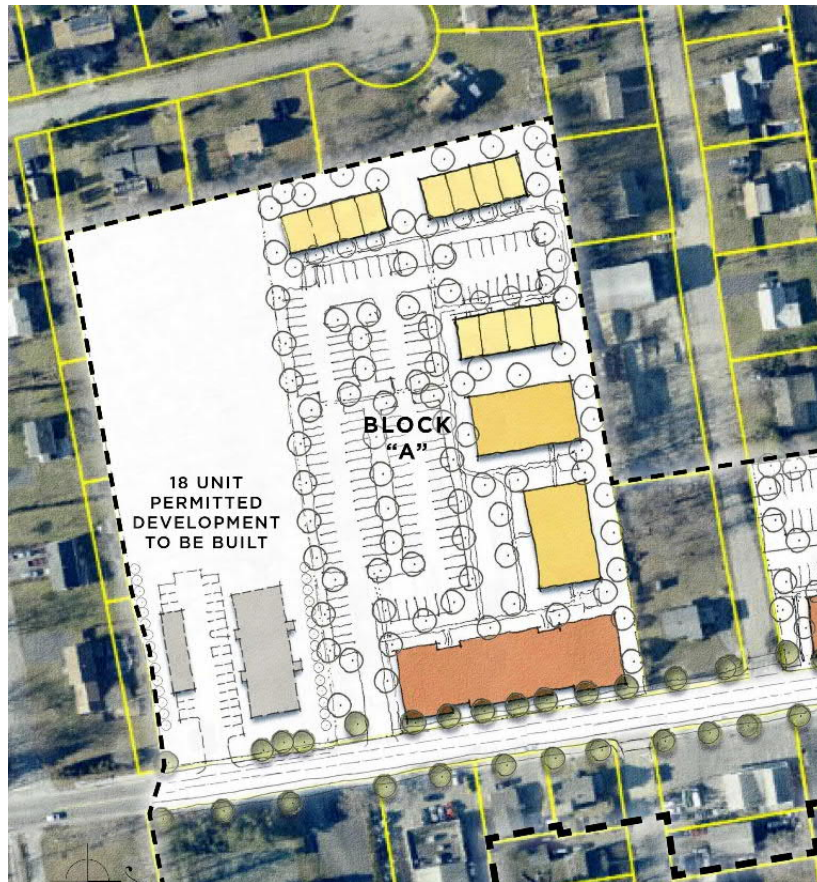


Figure 72. Pasqua/Healy Block (Block A) Concept Plan

Table 23 – Block A Summary Table

Civic or Institutional Space	(N/A)
Commercial Space	13,000 sf
Residential: Multi-Family	74 units
Residential: Single-Family	12 units
Total Residential Units	86 units
Total Parking Spaces	135 spaces

9.3.4 Ridgeway & Canario (Block B)

Between Ridgeway Drive and Canario Drive

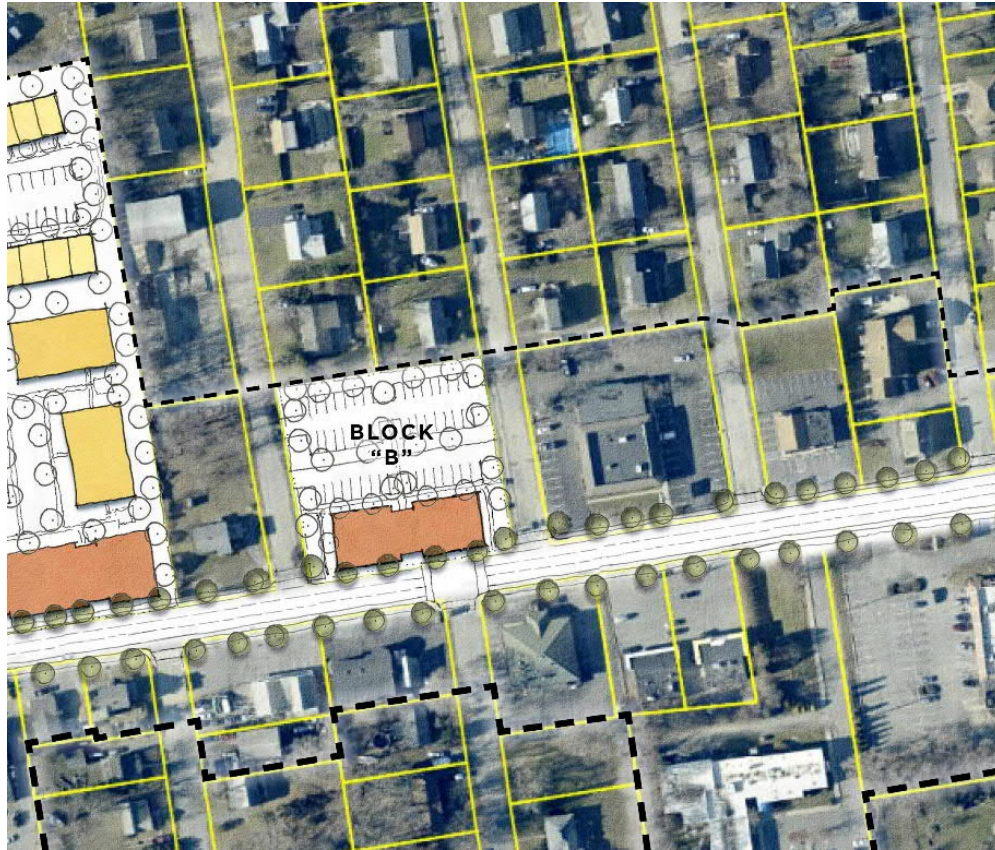


Figure 73. Ridgeway & Canario (Block B) Concept Plan

Table 24 – Block B Summary Table

Civic or Institutional Space	(N/A)
Commercial Space	9,600 sf
Residential: Multi-Family	20 units
Residential: Single-Family	(N/A)
Total Residential Units	20 units
Total Parking Spaces	48 spaces

9.3.5 Patterson & Homestead (Block E)

Between Patterson Avenue and Homestead Avenue

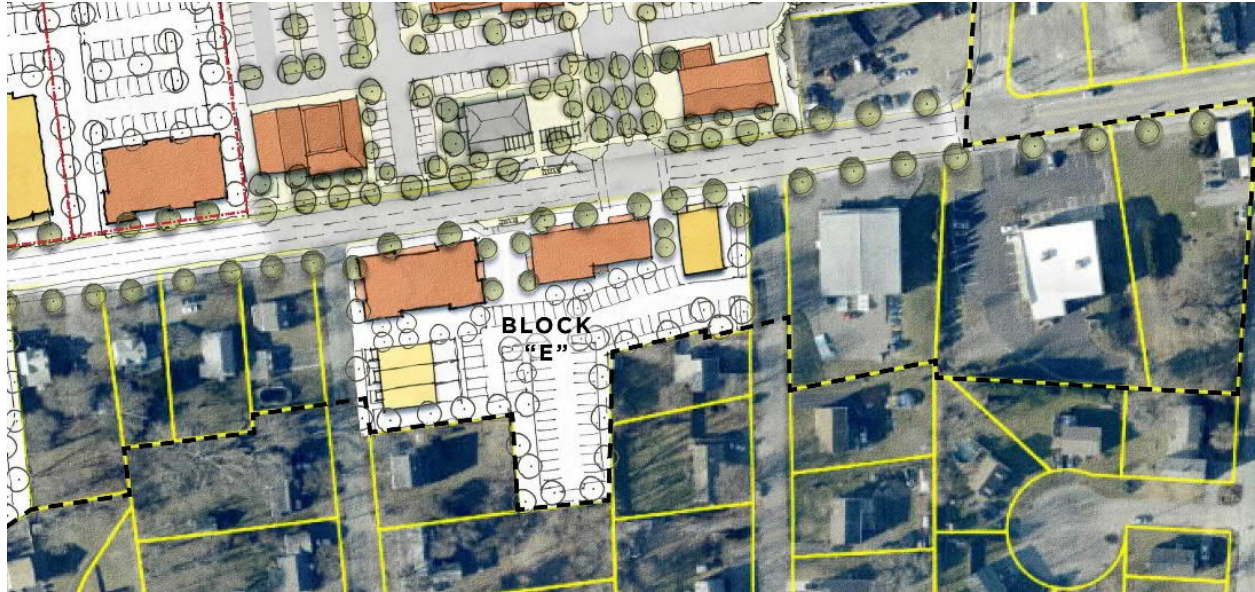


Figure 74. Patterson & Homestead (Block E) Concept Plan

Table 25 - Block E Summary Table

Civic or Institutional Space	(N/A)
Commercial Space	10,400 sf
Residential: Multi-Family	25 units
Residential: Single-Family	3 units
Total Residential Units	28 units
Total Parking Spaces	70 spaces

9.3.6 AT&T Block (Block F)

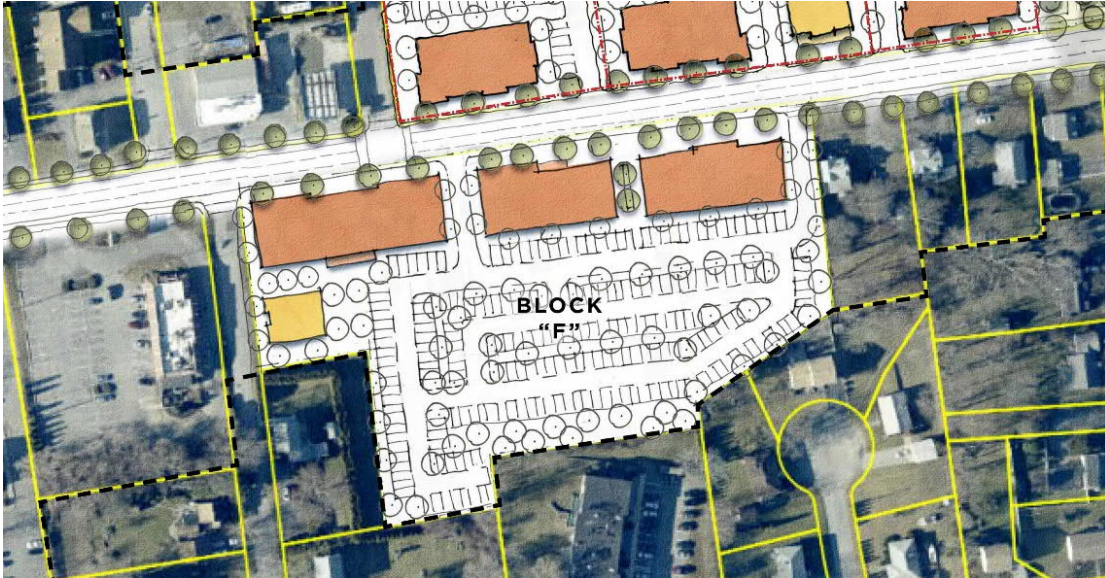


Figure 75. AT&T Block (Block F) Concept Plan

Table 26 – Block F Summary Table

Civic or Institutional Space	(N/A)
Commercial Space	23,000 sf
Residential: Multi-Family	102 units
Residential: Single-Family	(N/A)
Total Residential Units	102 units
Total Parking Spaces	197 spaces

9.3.7 Summary

Table 27 – Metacom Sample Sites Summary Table

Civic or Institutional Space	33,500 sf
Commercial Space	107,500 sf
Residential: Multi-Family	452 units
Residential: Single-Family	68 units
Total Residential Units	520 units
Total Parking Spaces	1,130 spaces

9.4 Precedents

To understand how the redevelopment of Metacom Avenue would appear upon completion, it is useful to examine precedents where communities have permitted and incentivized the development of mixed-used areas that have commercial uses on lower floors and housing units and offices on upper floors.

9.4.1 Mixed Use Buildings



Figure 76. Mixed Use Buildings and Public Space – South County Commons, RI

9.4.2 Multifamily Buildings



Figure 77. Multi-Family Buildings – City Row, Madison, WI

9.5 Implementation

9.5.1 Tax Income

The redevelopment of Metacom Avenue at higher density, with a mixture of land uses, allows for new buildings which have the potential to yield more taxable real estate value for the Town of Warren. Assuming the build-out shown in the six (6) scenarios above, there is the potential for a significant increase to annual tax revenues for the Town.

Table 28 – Summary of Metacom Avenue Tax Income Changes

Parcel	Commercial (square footage)	Residential Units	Existing Value	Future Value	Existing Property Tax Payment	Future Property Tax Payment	Increase in Taxes to Town
A - Pasqua/Healey	13,000	104	\$1,288,200	\$15,198,855	\$22,363	\$264,460	\$242,097
B - Ridgeway & Canario	9,600	20	\$936,900	\$3,460,567	\$16,265	\$60,214	\$43,949
C - CVS Block	24,000	105	\$6,736,900	\$17,792,728	\$116,953	\$309,593	\$192,641
D - Job Lot Plaza	27,500	179	\$7,545,600	\$37,006,435	\$130,992	\$643,912	\$512,920
E - Patterson & Homestead	10,400	28	\$1,497,000	\$5,934,071	\$25,988	\$103,253	\$77,265
F - AT&T Block	23,000	102	\$4,019,500	\$13,479,109	\$69,778	\$234,537	\$164,758
TOTALS	107,500	538	\$22,024,100	\$92,871,765	\$382,338	\$1,615,969	\$1,233,631

9.5.2 Recommendations for Actions

In order to affect these changes in the Metacom Avenue Project area, the Town of Warren, in partnership with State, Federal and regional partners should take the following actions:

- Update Warren's Comprehensive Community Plan for Metacom Avenue including language to support goals for:
 - redeveloped Metacom Avenue corridor
 - mixed-use redevelopment
 - development of workforce housing
 - complete streets redesign for Metacom Avenue
 - upgraded utilities to support higher density redevelopment
 - Increased RIPTA service
- Amend local zoning ordinance for Metacom Avenue
 - Form-based code for Metacom Avenue

- Permit mixed use development by right
- Permit high density residential land uses by right
- Enact Stormwater Overlay District
- Advocate for supportive State actions
 - RIDOT undertakes complete street design for Metacom Avenue
 - RIDOT adapts vulnerable sections of Route 136 to withstand sea level rise and storm events and potentially become part of flood control system
 - RIPTA increases transit service to the Metacom Avenue corridor to support high-density residential uses
- Secure funding for infrastructure improvements from State and Federal sources
- Set up redevelopment agency to enact Comprehensive Community Plan goals
- Upgrade utilities to support higher density redevelopment and make resilient to climate change impacts
- Reconfigure stormwater management systems
- Enact Tax Incremental Financing to support buy-out programs and infrastructure upgrades in the project areas

10 Conclusions

Review of the existing conditions show us that the Market Street area is facing severe impacts from climate change, including SLR and severe precipitation and storm events. Because of the high vulnerability of this area, these impacts will negatively affect the community in the coming ten to thirty (10-30) years and will have the potential to severely damage and destroy private homes and businesses, State- and Town-owned facilities, disrupt local and regional transportation routes, environmentally sensitive sites and damage utilities. Projected impacts have the potential to destroy or degrade hundreds of housing units.

The Metacom Avenue corridor is a largely commercial corridor and similar to many auto-centric districts in Rhode Island and across the United States. It's vulnerability to climate change impacts, especially flooding, is substantially lower than the Market Street area. Demand for real estate in land use environments like Metacom continues to decline and there is a potential opportunity for redevelopment of the Metacom Avenue corridor as a mixed-use, human-scaled street that contains retail, employment facilities and housing in a "Main Street-type" setting.

The Town has a limited-time opportunity to work with property owners, State and Federal government agencies and regional partners to plan for a linked future for both Market Street and Metacom Avenue where it may be able to adapt to climate change impacts and minimize flood vulnerability and environmental risk. At the same time, an improved Metacom Avenue corridor can be the location for replacement of housing lost to climate change and a livable center for Warren's citizens.