Study of Flood Hazard Mitigation and Design for the Main Street Business District

Village of Buzzards Bay, MA

FINAL REPORT: December 7, 2007

This document and included maps are intended as an inventory of existing flood hazard conditions and applicable regulations for planning purposes only. Maps are not adequate for legal boundary definition, regulatory interpretation or parcel level analysis. Seek help of a registered design professional for legal definition of parcels and required applicable codes. Regulations, guidelines and design ideas are summarized and abbreviated for simplicity to understand overall planning implications. In all instances, all recommendations are superseded by Town, State, and Federal by-laws and regulations.

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CREDITS:

Kennen Landscape Architecture, in association with Coastal Engineering Company and Ocean-US Architects, was retained by the Town of Bourne in July 2007 to complete this Study of Flood Hazard Mitigation and Design for the Main Street Business District in the Village of Buzzards Bay. The following report summarizes 6 months of inventory and analysis work of the existing site conditions related to flood hazard in the village. The consultant team would like to thank the Town Planner, Coreen Moore, the Bourne Financial Development Corporation (BFDC) and the Main Street Steering Committee for guiding the content and review of this work. In addition, we would like to thank the Cape Cod Commission for providing our team with valuable GIS data and initial input and coordination work.

The study is funded by a Smart Growth Technical Assistance Grant, awarded by the Commonwealth of Massachusetts to the Town of Bourne.

KEY CONSULTANT TEAM CONTRIBUTORS:

Kate Kennen, Landscape Architect, Kennen Landscape Architecture:
Kate Kennen is the founding principal of Kennen Landscape Architecture and is a registered Landscape Architect in Massachusetts. She completed her undergraduate studies in Landscape Architecture at Cornell University, and continued on to receive her masters degree in Landscape Architecture with honorable distinction from the Harvard University Graduate School of Design. Kate's work developing sustainable planning strategies on Cape Cod has received numerous awards. In the Town of Dennis, Kate assisted the Town in developing a new infill zoning strategy, 3D photorealistic visualizations and design guidelines for Dennisport that won the 2004 Massachusetts American Planners Association Honor award and 2004 MA Governor's Smart Growth award. In 2006 Kate received the same awards for work she completed in the downtown Hyannis revitalization project jointly with the Town of Barnstable, including drafting Hyannis' Design and Infrastructure Plan and the community's Growth Incentive Zone application. Kate has been an invited lecturer and studio critic at both the Harvard Graduate School of Design and Rhode Island School of Design.

John Bologna, Civil Engineer, Coastal Engineering Company
John A. Bologna, P.E. is the President & CEO of Coastal Engineering Company and has been with the company for 19 years. He is a registered Civil Engineer in Massachusetts since 1988 and has both and undergraduate and masters degrees in civil engineering from Rice University. John has over 27 years of experience in code analysis, civil and structural engineering design and construction. His design experience includes a working knowledge of steel, concrete, wood, and coastal construction techniques. John's experience also includes the structural evaluation and renovation of historic structures, feasibility studies, project management, and construction contract administration for public bid projects. John has served as an expert witness in construction litigation and arbitration cases and has been an adjunct lecturer at Cape Cod Community College.

Erik Hanson, Architect, Ocean-US
Erik Hanson is a Partner at Ocean-US and studied at the Minneapolis College of Art and Design receiving an associate's degree in environmental design before receiving a bachelors of architecture with commendation from the Boston Architectural Center. He has 16 years of experience working for prestigious firms nationally and in the Boston area as both a Design Director and Senior Project Manager on many award winning projects. Erik has developed project management and process delivery models designed to support and assure a high level of design in a rapidly changing industry. For 10 years he has served as a faculty member, thesis advisor, and committee member at the Boston Architectural Center teaching and mentoring the next generation of architects.

Table of Contents

1 Introduction

1.1 Study Intent and Project Goals

The intent of this study is to inventory the current flood hazard in the Main Street Business District in the Village of Buzzards Bay. The analysis considers what design opportunities exist to achieve two overall goals: 1) to mitigate flood hazards in the downtown area and 2) to revitalize and redevelop the Village of Buzzards Bay. Design strategies are considered on two scales. First, local parcel-scale architectural strategies are articulated to help property owners and the Town understand how existing buildings could be retrofitted to mitigate flood damage. Second, a summary of comprehensive village-scale design ideas showing potential larger-scale flood mitigation infrastructure projects and planning initiatives is included. This report concludes with a list of action items and funding sources the Town and its partners can pursue to reach the overall dual goals of flood mitigation and revitalization.

1.2 Project History

This study is part of a comprehensive planning effort undertaken by the Main Street Steering Committee, including the Town of Bourne and other partners, to revitalize Main Street Buzzards Bay into a year-round, economically diverse village center. This report is one of many studies currently underway that will be combined into an overall plan to strategically reposition the village for revitalization. The other studies currently being completed include a transportation study, wastewater study, market study and overall design visioning concept plan.

In pursuit of revitalization however, Buzzards Bay is faced with a specific challenge; it's entire downtown area lies within the 100-year and 500-year coastal floodplain of the Atlantic Ocean. Redevelopment of the area is costly, requiring significant rehabilitation of existing buildings and new construction to meet Federal Emergency Management Agency (FEMA) standards for coastal construction. Additionally, property owners are presented with the burden of paying for flood insurance. Lastly, even when properties are built to meet FEMA standards, both public safety and property may still be at risk if a catastrophic hurricane or other significant natural event were to occur.

This study uses GIS analysis to inventory the existing structures in the Main Street Business District to understand their compliance with selected existing floodplain construction standards. An easy-to-read set of maps is created showing which areas are most at risk if a flood were to occur. Following the analysis, each parcel is placed in a category corresponding to a set of potential architectural mitigation strategies that could be considered for that parcel.

Buzzards Bay has the opportunity to embrace the context of its natural system and let the pattern of flooding influence the design of a revitalized downtown. This could lead to a one-of-a kind village center creating a unique sense of place. This can be done on a parcel scale by retrofitting each individual structure to mitigate flood damage (see Section 4), or through larger comprehensive village wide strategies to target redevelopment activities away from the zones of greatest risk (see Section 5).

Either way, the revitalization of the village is about balance between flood prone land and the desire to grow. The question is not *if* a flood will occur but *when.* With this study, the community can now easily envision what potential areas of the village are most at risk, and utilize a mix of the suggested strategies to move forward with revitalization in a context-sensitive, responsible way.

1.3 Project Regional Context

The Village of Buzzards Bay is located on the north side of the Cape Cod Canal, at the northern tip of the Buzzards Bay watershed. It is located at one of the two main crossing points onto the 'arm' of Cape Cod. The village grew originally from this being an active port, naval base and the single rail road crossing point to the Cape Cod peninsula. Since the 1950s however, automobile decentralization resulted in a down turned Buzzards Bay economy with declining shops, storefronts and restaurants. Nonetheless, the village has significant infrastructure resources, making it a prime candidate for redevelopment. This is why both the Town's Local Comprehensive Plan and the Regional Policy Plan, presented by the Cape Cod Commission, support this as one of the few 'Smart Growth' centers currently targeted for the Cape redevelopment.

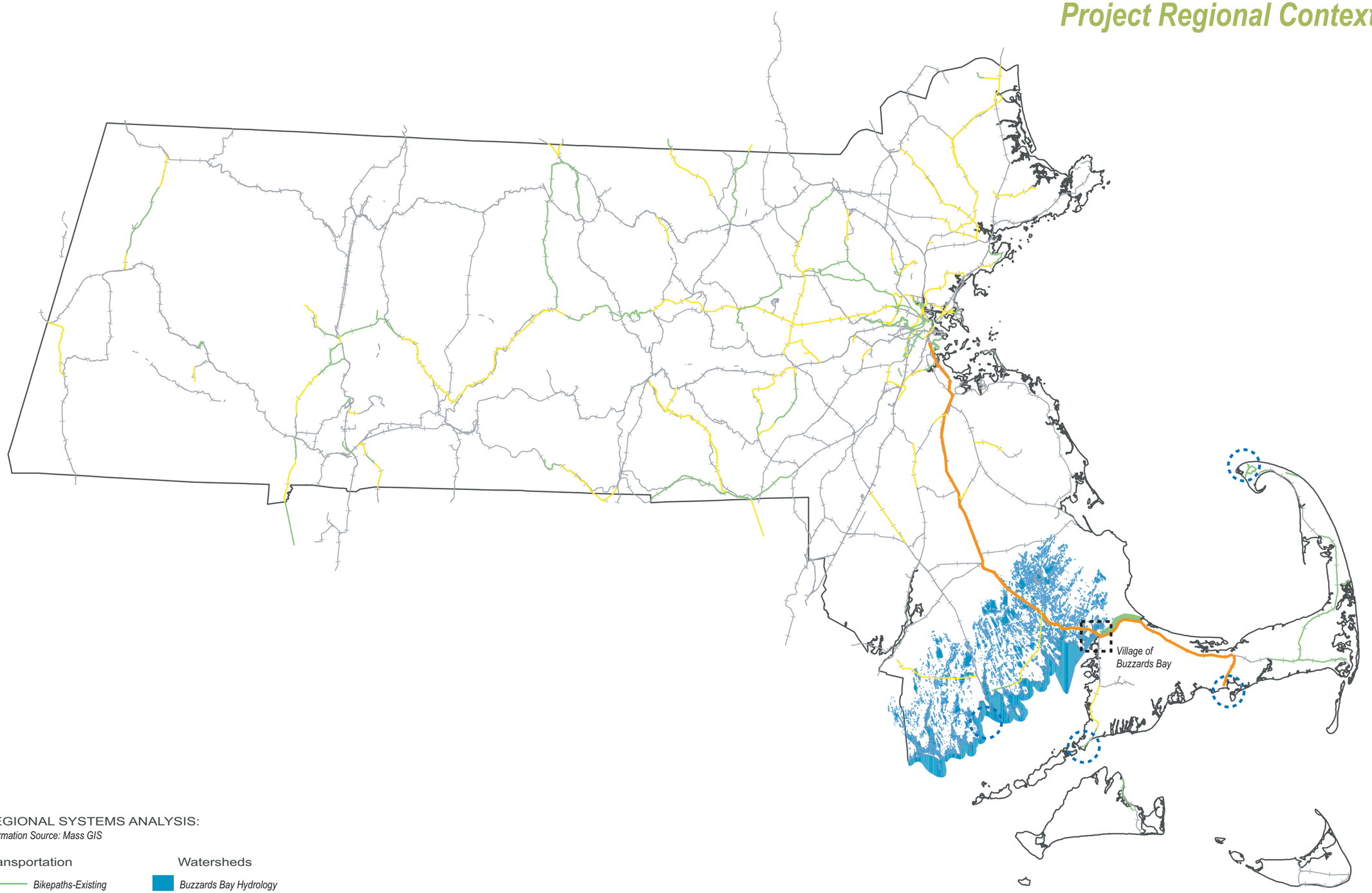
1.4 Project Study Area

The study area for the analysis consists of the core of the Main Street Business District in the Village of Buzzards Bay. It is bounded by the Bypass Road to the north, the Bourne Bridge to the east, Memorial Circle to the west and Cape Cod Canal to the south. The residential neighborhood and Maritime Academy community of Taylor's Point were not included in the Study Area. For the extent of the project area, please see Map 1b on page 7.
The Taylor's Point neighborhood was excluded since this is not an area specifically targeted for redevelopment and the Town does not currently have the data necessary to run that portion of the analysis. The consultant team however strongly urges the Town to consider flood mitigation strategies for the Taylor's Point neighborhood, as this area is the neighborhood most at risk since it is located in a Velocity Zone.

1.5 History of Flooding in the Village of Buzzards Bay

The Village of Buzzards Bay has historically been affected by a number of significant hurricane and storm events resulting in damage both from high winds and flooding. Following is a summary of the recorded major hurricane events that have occurred over the past 400 years, giving perspective as to why flood hazard mitigation is critical in the village. *The following hurricane information was directly quoted from www.smart-mass.org/document/NEHurricanes.doc*

The Great Colonial Hurricane of 1635, August 25, 1635
"This was the first historical record of an intense hurricane striking New England. The highest winds have been estimated at Category 3 level. A 20-foot tidal surge was reported in Boston, ruining farms throughout the area. Reports from Gover-



REGIONAL SYSTEMS ANALYSIS:
Information Source: Mass GIS

Transportation

- *Bikepaths-Existing*
- *Bikepaths- Proposed*
- *Rail- Existing*
- *Rail- Potential Commuter Connection*
- *Existing water-based transportation centers in Cape Cod region*

Watersheds

- *Buzzards Bay Hydrology*

This map illustrates Buzzards Bay's regional advantage as a potential 'Smart Growth' center with access to alternative, non-automotive transportation systems. The village resides at the only rail crossing over the Cape Cod Canal and is located at the end of a regionally important bike path.

nor William Bradford describing the drowning of dozens of Native Americans, the toppling of thousands of trees and the flattening of houses suggest that this storm possessed even greater intensity than the storms of 1815 and 1938."

The Great September Gale of 1815, September 23, 1815
"This storm was the first major hurricane to impact New England in 180 years. It initiated in the West Indies, growing to a Category 3 with winds creating an 11-foot storm surge along the coast. "

The September Gale of 1869, September 8, 1869
"A Category 3, this 'September Gale' was very compact, but intense. It was reported to have been only 60 miles wide, but it caused extensive damage in Rhode Island, Massachusetts and Maine. Fortunately, its arrival coincided with low tide lessening the storm surge and resulting damage."

Hurricane of September 21, 1938- This is the storm historically remembered and most talked about in the Village of Buzzards Bay
"This Category 5 was first detected in the Tropical Atlantic. Without warning, it made landfall as a Category 3, during an astronomically high tide along Long Island, New York and the Connecticut coast. The Blue Hill Observatory, outside of Boston, measured sustained winds of 121 mph, with gusts of 183 mph. Storm surges of 10 to 12 feet inundated portions of the coast from Long Island to Southeastern Massachusetts, most notably in Narragansett Bay and Buzzards Bay. Heavy rains of 3" to 6" produced severe flooding. Downtown Providence, Rhode Island was impacted by a 20-foot storm surge. Sections of the Towns of Falmouth and Truro on Cape Cod were under 8 feet of water. The widespread destruction resulting from this storm included 600 deaths and 1,700 injuries.' Specifically, in the Village of Buzzards Bay, a tidal wave hit and much of Main Street near the train station was underwater as deep as 8'."

The Great Atlantic Hurricane of 1944 September 14-15, 1944 & Hurricane Dog, September 11-12, 1950
"With 140 mph winds, this Category 4, produced hurricane force winds over a diameter of 600 miles. 70-foot high waves were also reported. Up to 11" of rain fell in areas of New England.'**'A strong Category 5, Hurricane Dog reached a peak intensity of 185 mph but this was a major hurricane that never actually made landfall, passing within 200 miles of Cape Cod."

Hurricane Carol, August 31, 1954 & Hurricane Edna, September 11, 1954
"This compact, but powerful Category 2 battered New England, killing 68. This was arguably the most destructive storm to hit Southern New England since 1938. Some consider 'Carol' the worst storm in the history of Cape Cod. 'Edna' arrived right on the heels of Hurricane Carol. Before striking New England, its eye split into two different ones, up to 60 miles apart at times, moving over Cape Cod & the Islands where peak gusts were recorded at 120 mph."

Hurricane Diane, August 17-19, 1955
"This storm reached Category 3 status. Maximum winds were recorded at 120 mph. Although it weakened to a Tropical Storm as it reached the Southern New England coast, 'Diane' dropped heavy rain of 10" to 20", setting flood records throughout the region."

Hurricane Donna, September 12, 1960
"From September 2nd to September 11th it sustained winds of 115 mph as it roamed the Atlantic for 17 days. It produced pockets of 4" to 8" of rain as well as 5 to 10-foot storm surges."

Hurricane Gloria, September 27, 1985
"Hurricane Gloria was a powerful Category 4 Cape Verde-type storm that prowled the Atlantic for 13 days, with highest winds of 145 mph. In spite of arriving during low tide, it did cause severe beach erosion along the New England coast, as well as the loss of many piers and coastal roads. There was a moderate storm surge of 6.8 feet in New Bedford, Massachusetts. The storm left over 2,000,000 people without power. It dropped up to 6" of rain in Massachusetts, causing many flooding issues in the region."

Hurricane Bob, August 19, 1991
"Over 60% of the residents of Southeastern Massachusetts and Southeastern Rhode Island lost power. There were 4 different reports of tornados as 'Bob' came ashore. Buzzards Bay saw a 9-foot storm surge that was reported as large as 15' in some areas. A number of south-facing beaches on the islands of Nantucket and Martha's Vineyard lost 50 feet of beach to erosion."

1.6 Report Organization

This report is divided into 5 sections. Sections 3, 4 & 5 make up the bulk of the report. Section 3 inventories the buildings and parcels in the Project Area and summarizes their existing level of flood compliance according to selected indexes. Each parcel is then assigned a category indicating its relative level of compliance in relationship to other structures downtown. For each assigned category, Section 4 then suggests design strategies on a parcel-scale that individual property owners could complete to mitigate the potential flood hazards identified. In Section 5, comprehensive flood hazard mitigation strategies are identified. These are potential design strategies that should be considered to achieve larger flood mitigation goals. These comprehensive strategies however, can only occur if larger cooperative public-private joint venture efforts are undertaken. These comprehensive strategies often address issues at both the scale of the block and the scale of the entire village. Lastly, In Section 6, a list of potential flood hazard mitigation action items and potential sources of funding to undertake these action items are outlined.

The report is intended to be an easy-to-read, map based document, so that anyone may be able to understand the relative susceptibility of land and buildings to flooding in the area of the Village targeted for redevelopment. It is not intended to be an all-encompassing report on potential flood hazards and mitigation strategies. Only structural building issues relating to redevelopment have been addressed. Issues including, but not limited to, critical facility location, evacuation routes, drinking water contamination, and flood relationship to other infrastructures such as wastewater and egress routes have not been addressed. Please reference the 2004 Town of Bourne Pre Disaster Mitigation Plan that addressed some of these additional issues.

Project Area

Map 1b

2 Applicable Flood Relevant Regulations and Studies

2.1 Regulatory Requirements

Flood relevant regulatory requirements are summarized below. For purposes of simplicity, the basic intent of requirements is indicated. The information is intended only to be used as a starting point to understand the relevant regulations. In all instances, the actual local, state and federal regulations prevail over what is indicated in this report, and it is the responsibility of each individual to ensure the actual regulations are being met.

2.1.0 Regulatory Requirements Relevant to Flood Hazard Mitigation in the Village of Buzzards Bay

Item #	Regulation	Reference	Website	Administrator/ Contact for More Information	Summary of Requirement relevant to Flood Hazards
2.1.1	Town of Bourne, Zoning Bylaws	Section 1210, page 1 of zoning	http://www.townofbourne.com/	Building Inspector (Flood Administrator) Town of Bourne, Town Hall, 24 Perry Avenue, Buzzards Bay, MA 02532 Phone: 508-759-0615 ex. 21, Fax: 508-759-0611	This section of the zoning requires that all alterations and new construction of buildings follow State Building Code. This referenced regulation does not specifically have any flood hazard mitigation requirements, but it promulgates regulations to comply with the NFIP and State Building Code that do have requirements. (See item 2.1.2 below)
2.1.2	State Building Code- 6th and 7th edition	6th Edition: 780 CMR 3107.0 7th Edition: 780 CMR 5323.0	http://www.mass.gov/Eeops/docs/dps/BuildingCode/780031.pdf	Building Inspector (Flood Administrator) Town of Bourne, Town Hall, 24 Perry Avenue, Buzzards Bay, MA 02532 Phone: 508-759-0615 ex. 21, Fax: 508-759-0611	The State Building Code requires that all new construction and any 'substantial improvements' to buildings must follow federal FEMA requirements if they are located in an A or V designated flood zone according to the FIRM (Flood Insurance Rate Maps) provided by FEMA. This means that in a designated flood zone, if a new structures is built or building renovations are made that exceed 50% of the existing building's market value, (not including land cost or design costs)' they must bring the entire structure into compliance with FEMA requirements. (For FEMA Requirements, see item 2.1.3 below) In addition, the State Building Code is currently being modified and a new 7th edition will be released in January 2008. The 7th edition will have new required hurricane resistant construction standards for all new construction and 'substantial improvements' of buildings within 1 mile of the coastline. Particularly, requirements for wind-borne debris and impact resistant windows are in the new edition. Please reference the new edition for these requirements as they are not included in this report.
2.1.3	FEMA (Federal Emergency Management Agency) Flood Plain Requirements: Summary of Coastal Construction Requirements- Home Builders Guide to Coastal Construction	FEMA Guide to Coastal Construction (Fact Sheet Series 499)	http://www.fema.gov/rebuild/mat/mat_fema499.shtm	Building Inspector (Flood Administrator) Town of Bourne, Town Hall, 24 Perry Avenue, Buzzards Bay, MA 02532 Phone: 508-759-0615 ex. 21, Fax: 508-759-0611	FEMA has flood mitigation requirements for structures located in A or V zones according to the most recent FEMA FIRM maps. A summary of FEMA requirements is indicated on Chart 2.2 on Page 10 of this report.
2.1.4	Massachusetts Wetlands Protection Act	Chapter 131: Section 40, 310 CMR 10.0	http://www.mass.gov/dep/service/regulations/	Town of Bourne Conservation Commission 24 Perry Ave., Buzzards Bay, MA 02532 Telephone: (508) 759-0600 Ext 343 or 344 Fax: (508) 759-8026	Regulates that any work within 100' of the coast or a wetland resource area shall minimize adverse impacts on the environment.
2.1.5	Bourne Wetland Protection Bylaw	Article 3.7in Zoning Bylaw	http://www.townofbourne.com/	Town of Bourne Conservation Commission 24 Perry Ave., Buzzards Bay, MA 02532 Telephone: (508) 759-0600 Ext 343 or 344 Fax: (508) 759-8026	Requires that any work within the high hazard flood plain (V Zone) does not include filling to elevate the grade so that storm flowage is not increased in other areas.

Properties that are most affected by flood hazard regulations are those shown in either A zones or V zones indicated on the FIRM (Flood Insurance Rate Maps) produced by FEMA. Map 2.1 shown on page 9 summarizes the flood zones from the FIRM maps.

Current FEMA flood maps are based on Flood Insurance Rate Maps (FIRM) dated August 9, 1999. FEMA FIRM maps are currently in the process of being updated. According to FEMA Region 1 planners, it is expected that these new maps with more accurate flood zones will be digitally available sometime in 2010. These new maps will supersede the information and analysis in this report.

Summary of FEMA FIRM Map Flood zones

Map 2.1

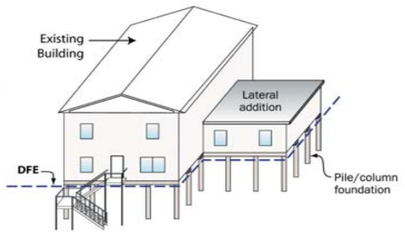
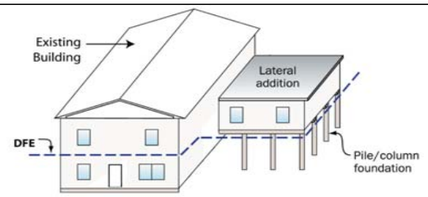
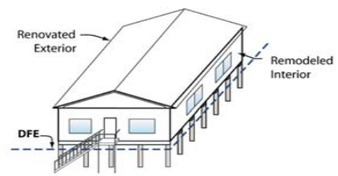
This map shows the extent of FEMA flood zones indicated on FIRM (Flood Insurance Rate Maps) released on 8/9/99. The A & V zones together make up the 100 year floodplain. There are specific regulatory requirements for any construction in these areas. The X zones together make up the 500 year floodplain. There are no additional building code regulatory requirements currently in the X Zone, however, flood damage is possible if a large event were to occur.

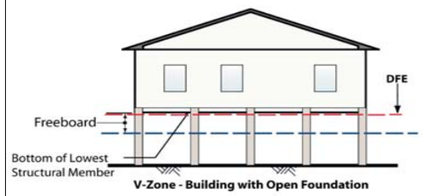
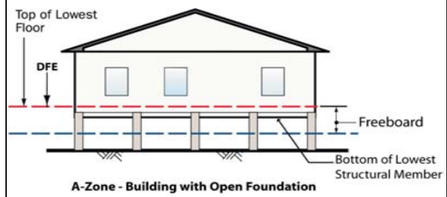
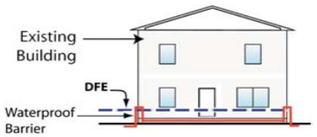
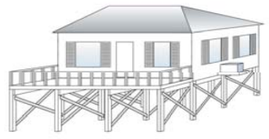
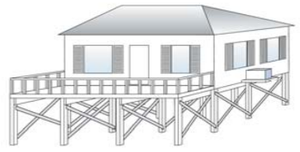
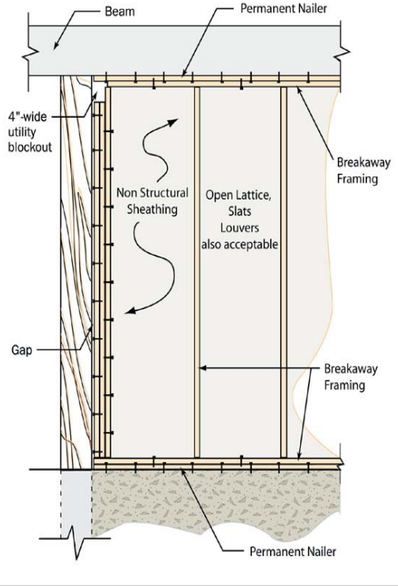
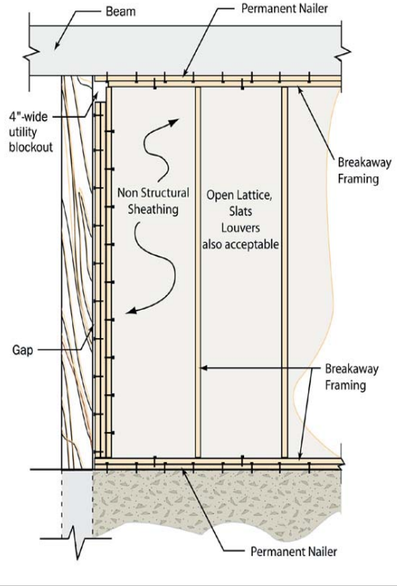
2.2 Summary of FEMA Requirements in A and V Zones

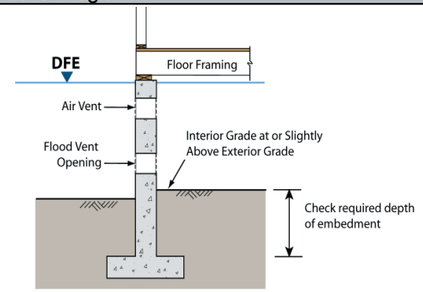
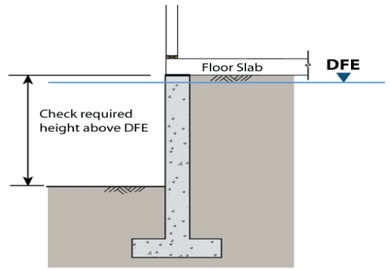
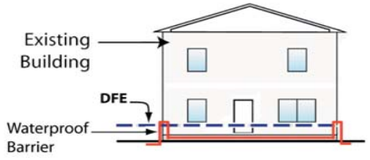
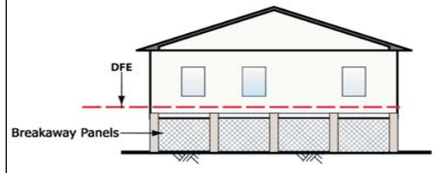
Below is a table summarizing FEMA requirements for structures located in an A zone or a V zone. This matrix is intended to be used as a summary of code requirements only. For actual regulations, refer to both the State Building Code and FEMA's technical fact sheets available at www. FEMA.gov

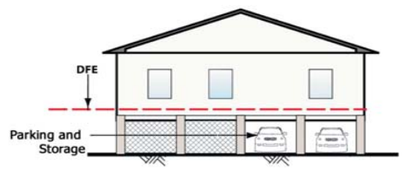
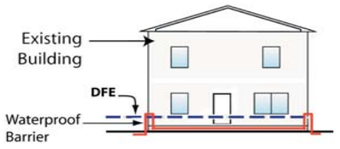
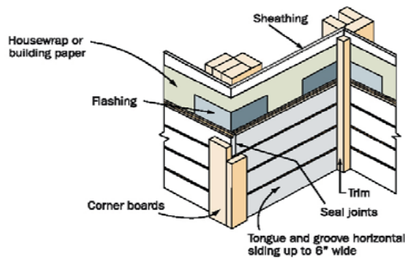
Definition: Design Flood Elevation (DFE): The term Design Flood Elevation (DFE) is used throughout this report. The DFE is the minimum flood elevation to which a project must be designed. In most cases, this will be the same elevation as the Base Flood Elevation (BFE) indicated on the FEMA Flood Insurance Rate Maps (FIRM) for a particular area. The BFE is the elevation at which, in any given year, there is a 1% chance that a flood will occur at that elevation. Currently, the Design Flood Elevation in Buzzards Bay is the same as the indicated Base Flood Elevation on FEMA FIRMs. However, communities can create additional bylaws to require that structures be built to a higher elevation therefor the designation 'Design Flood Elevation' rather than the 'Base Flood Elevation' is used to accommodate any future increase in the flood elevation. This report uses the term Design Flood Elevation to reference all flood elevation requirements.

2.2.0 Required FEMA Regulations- Summary

	Category	V Zone- Written Description	V Zone- Diagram	A Zone- Written Description	A Zone- Diagram	Reference
2.2.1	WHEN YOU MUST COMPLY					
2.2.2	New Construction	Must comply with V Zone Requirements		Must comply with A Zone Requirements		FEMA Series 499-Fact Sheet (FS) 02, p1
2.2.3	Substantial Improvement- In General	Substantial Improvement-If improvements are being made to the structure with cost totaling over 50% of the existing building's market value (Building cost only, no soft costs (design) or land value included), then this is considered a Substantial Improvement and the entire existing structure must be corrected to meet FEMA requirements. This excludes some types of lateral additions in A Zones, see 2.205 below		Substantial Improvement-If improvements are being made to the structure with cost totaling over 50% of the existing building's market value (Building cost only, no soft costs (design) or land value included), then this is considered a Substantial Improvement and the entire existing structure must be corrected to meet FEMA requirements. This excludes some types of lateral additions in A Zones, see 2.205 below		
2.2.4	Substantial Improvement-Vertical Additions & Basements/ Crawlspaces	Both renovations and existing conditions must be changed to follow FEMA requirements.		Both renovations and existing conditions must be changed to follow FEMA requirements.		FEMA FS 02, p6
2.2.5	Substantial Improvement- Lateral Addition	Both renovations and existing conditions must be changed to follow FEMA requirements.		In A zones, even if it is a substantial improvement, only the lateral addition must meet FEMA requirements as long as only work to existing building is limited to cutting a new entrance in the wall and connecting the addition.		FEMA FS 02, p5
2.2.6	Any Kind of work that is not a Substantial Improvement (Vertical, Lateral, Basements/ Crawlspaces)	If it is not a Substantial Improvement, full compliance with FEMA is not required. Requirements for the new work depend on date the existing bldg was constructed. For pre-FIRM buildings, there are no requirements for the new work. For Post-FIRM buildings, the new work must meet NFIP requirements in effect at time bldg was constructed		If it is not a Substantial Improvement, fixing the existing building is not required. Requirements for the new work depend on date the existing bldg was constructed. For pre-FIRM buildings, there are no requirements for the new work. For Post-FIRM buildings, the new work must meet NFIP requirements in effect at time bldg was constructed		FEMA FS 02, p5 & 6
2.2.7	Moving a building or rebuilding a destroyed building	Both renovations and existing conditions must be changed to follow FEMA requirements.	 Relocated or Rennovated Building	Both renovations and existing conditions must be changed to follow FEMA requirements.	Same as V Zone Requirements	FEMA FS 02, p7

	Category	V Zone- Written Description	V Zone- Diagram	A Zone- Written Description	A Zone- Diagram	Reference
2.2.8	RELATIONSHIP TO DESIGN FLOOD ELEVATION (DFE)					
2.2.9	Relationship to Design Flood Elevation- Commercial & Residential	Lowest Structural Member must be at or above Design Flood Elevation	 V-Zone - Building with Open Foundation	Top of Lowest Floor must be at or above Design Flood Elevation	 A-Zone - Building with Open Foundation	FEMA FS 05
2.2.10	Relationship to Design Flood Elevation- Alternate Option for Commercial			For commercial buildings only, space below the DFE may be waterproofed up to Design Flood Elevation rather than elevating		
2.2.11	FOUNDATION					
2.2.12	Option 1	Must have an open foundation		Open foundations recommended. Solid wall foundation allowed with flood vents.		FEMA FS 11
2.2.13	Option 2	Breakaway walls are allowed		Breakaways walls are recommended. Sold wall with flood vents ıllowed.		

	Category	V Zone- Written Description	V Zone- Diagram	A Zone- Written Description	A Zone- Diagram	Reference
2.2.14	Option 3	No obstructions are allowed- Solid foundations are not allowed		Solid Foundations with vents are allowed	 Recommended Floor Joist and Crawlspace with Flood Vent System	
2.2.15	Option 4	Structural fill is not allowed		Structural Fill is Allowed	 Slab on Grade atop Backfilled Stemwall if above the DFE	
2.2.16	Option 5	Waterproofing is not allowed.		Solid Wall Construction with waterproofing is allowed on Commercial buildings only		
2.2.17	ENCLOSURE BELOW DFE					
2.2.18	Basements & Crawlspaces- This is defined as any space that is enclosed on all four sides and is below the lowest adjacent grade of the land.	Not Allowed		Not Allowed		
2.2.19	Space Below Design Flood Elevation	The only allowed space below the DFE that is allowed is space made with breakaway wall systems that has one of the following uses only: Parking, Storage or unfinished building access		Allowed only if use is parking, storage or unfinished building access and foundation is constructed in a method listed under 2.211	See Section 2.211 (above) for Allowed Enclosures	

	Category	V Zone- Written Description	V Zone- Diagram	A Zone- Written Description	A Zone- Diagram	Reference
2.2.20	Use of any space below the Design Flood Elevation	Only UNFINISHED areas for parking, building access and storage area allowed.		Only UNFINISHED areas for parking, building access and storage area allowed. The only exception is for Commercial buildings in A Zones that are waterproofed below the Design Flood Elevation. These waterproofed areas are allowed to have other uses.	 Waterproofed areas with other uses are allowed in commercial buildings only	
2.2.21	Miscellaneous					
2.2.22	Building Materials	Must follow FEMA recommendations in an V Zone. For specific requirements, please reference FEMA fact sheets.		Must follow FEMA recommendations in an A Zone. For specific requirements, please reference FEMA fact sheets.	Same as V Zone Requirements	FEMA FS 1 & 8
2.2.23	Utilities	Utilities must be elevated above Design Flood Elevation. For specific requirements, please reference FEMA fact sheets.		Utilities including ductwork must be designed and elevated to prevent damage during flooding. For specific requirements, please reference FEMA fact	Same as V Zone Requirements	
2.2.24	Elevation Certification	Elevation Certificate signed by surveyor/ engineer/ or architect and building owner listing at completion of project: lowest floor elevations & lowest elevation of utilities etc. is required. This is also required to get insurance.		Elevation Certificate signed by surveyor/ engineer/ or architect and building owner listing at completion of project: lowest floor elevations & lowest elevation of utilities etc. is required. This is also required to get insurance.		
2.2.25	Structural Certification	Registered Engineer or Architect must certify that design methods and construction meet requirements		Registered Engineer or Architect must certify that design methods and construction meet requirements		FEMA FS 5

2.3 Summary of additional Flood Hazard Mitigation Recommendations Suggested by FEMA and other organizations

In addition to the mandatory regulations summarized above, FEMA also provides other highly recommended suggestions for additional flood hazard mitigation. A summary of FEMA's additional recommended building standards is indicated below.

In addition to FEMA, other organizations have completed studies documenting additional flood hazard threats that should be considered. These studies have documented the possibility of long term relative Sea Level Rise and the need to account for threats from coastal flooding, hurricane and storm surges. A summary of these additional recommendations that the Town of Bourne should consider in addition to what is actually regulated by FEMA is listed below. Precedent communities that have adopted additional regulations similar to these recommendations are also listed.

2.3.0 Additional Flood Relevant Regulations Suggested by Various Organizations (These are not currently enforced, just recommended by others that they should be adopted/ enforced)

	Suggested Regulation	Reference	Website	Precedent Community	Contact for More Information	Description of RECOMMENDATION
2.3.1	Raise Design Flood Elevation as high as possible is suggested to create additional freeboard. This is suggested in FEMA Additional Recommended Construction Techniques: 'Summary of Coastal Construction Recommendations- Home Builders Guide to Coastal Construction'	FEMA FS499- No 2 & No 4 and Scientific Recommendations for Performance Standards for Land Subject to Coastal Storm Flowage (LSCSF) published by MA EOEA, CZM 1995	www.fema.gov	Chatham, MA has adopted in their zoning a Design Flood Elevation that is 1' higher than what is required by FEMA and the State Building Code	Building Inspector (Flood Administrator) Town of Bourne, Town Hall, 24 Perry Avenue, Buzzards Bay, MA 02532 Phone: 508-759-0615 ex. 21 ~ Fax: 508-759-0611 and FEMA Region 1, 99 High Street, 6th Floor Boston, MA 02110(617)-956-7506	In addition to FEMA requirements, FEMA has a set of suggested recommendations to further flood-proof coastal buildings against damage. These include raising the Lowest Floor Elevation as high as possible above the Design Flood Elevation to account for wave and wind action and allow freeboard during a large event
2.3.2	Account for relative Sea Level Rise in Design Flood Elevation	Scientific Recommendations for Performance Standards for Land Subject to Coastal Storm Flowage (LSCSF) published by MA EOEA, CZM 1995	www.http://www.mass.gov/czm/	Chatham, MA has adopted in their Zoning a Design Flood Elevation that is higher than what is required by FEMA and the State Building Code. In addition, the Cape Cod Commission in its regional policy plan has adopted the performance standards in the LSCSF almost in its entirety as minimum performance standards for Developments of Regional Impact (DRIs)	Massachusetts Executive Office of Environmental Affairs, Office of Coastal Zone Management (CZM) 251 Causeway Street, Suite 800Boston, MA 02114 617-626-1200617-626-1240 (fax)	Studies have suggested that the sea is projected to rise a minimum average of 1' every 100 years. Studies suggest that the Design Flood Elevation should be increased to account for future rises in sea level at a minimum of an additional 1' in A zones and an additional 2' in V zones. In addition, communities should consider adopting the Regional Policy Plan's minimum performance standards for DRIs as a local zoning bylaw so they apply to all development within the coastal zone and not just DRIs.
2.3.3	Consider additional regulations and requirements for parcels in SLOSH Zones (Sea, Lake, and Overland Surge from Hurricanes) to prevent storm damage	Cape Cod Commission, Natural Hazards Pre-Disaster Mitigation Plan for Barnstable County http://www.capecodcommission.org/planning/RegionalPDMPlan-Final102704.pdf	http://www.fema.gov/plan/prevent/nhp/slosh_link.shtm		Cape Cod Commission Regional Planning Agency, P.O. Box 226 - 3225 Main Street - Barnstable, MA 02630 Phone: (508) 362-3828 - Fax: (508) 362-3136	SLOSH, which stands for Sea, Lake, and Overland Surge from Hurricanes, is a computerized model developed by the national Weather Service and applied to the region by the National Hurricane Center which identifies parcels that would potentially be inundated by a hurricane storm surge. It has been suggested by various entities that additional building regulations might be developed to help protect these parcels shown to be affected during storm events.
2.3.4	Recommend no net increase in square footage of structures in velocity zones (V zones)	FEMA Region 1 Planner	www.fema.gov	Brewster, Ma has adopted a Bylaw to allow no net increase in SF in V zones	FEMA Region 1, 99 High Street, 6th Floor Boston, MA 02110(617)-956-7506	Since Velocity zones are often where the most flood damage occurs, FEMA has recommended to communities that they adopt regulations to allow no net increase in the square footage of any building that is within a V Zone.
2.3.5	Remove structures in V Zones and do not allow rebuilding of structures that have been damaged in a V zone.	FEMA Region 1 Planner	www.fema.gov	Canton, ME	FEMA Region 1, 99 High Street, 6th Floor Boston, MA 02110(617)-956-7506	Communities create pro-active programs to remove structures in the most susceptible Flood Zones, especially V zones to undevelop the most susceptible land. In addition, it has been recommended to create a Bylaw to prevent rebuilding of repetitive loss properties.
2.3.6	In V zones, have 2' of freeboard below lowest structural member to account for relative Sea Level Rise and wave action; in A zones, recommend 1' of freeboard; allow no building expansion in V zones; allow no new infrastructure in V zones; require that buildings in barrier beaches & coastal dunes shall be on open foundations and at least 2' above grade.	Cape Cod Commission Regional Policy Plan-	www.capecodcommission.org		Cape Cod Commission Regional Planning Agency, P.O. Box 226 - 3225 Main Street - Barnstable, MA 02630 Phone: (508) 362-3828 - Fax: (508) 362-3136	These recommendations are included in the Cape Cod Commission Regional Policy Plan encouraging local communities to adopt these new standards and policies into their required Local Comprehensive Plans.

Sea, Lake and Overland Surges from Hurricanes

Map 2.3

This map shows the extent of SLOSH (Sea, Lake and Overland Surges from Hurricanes) generated by the Cape Cod Commission in 2007 using a computer model developed by the Army Corps of Engineers. Each color represents the projected extent of flooding that would occur if a Category 1 -4 hurricane impacts the area. These maps show that even though many properties in the Project Area are not within the regulated A or V Zones (100 year flood zone), they are still significantly at risk if a storm event were to occur.

3 Analysis of Existing Conditions

3.0 Introduction to the Analysis

In order to gain a general understanding of the degree of flood hazard susceptibility in the Project Area, the analysis of existing conditions assesses the degree of each individual parcel's compliance or noncompliance with the most basic FEMA required regulations. The flowchart to the right indicates the analytical process that was used to summarize this information.

The analysis was completed in GIS using the Town of Bourne's most current available data as of 11/7/07. The Town's 2006 tax assessor's tables were merged with the Bourne Planning Department's existing GIS parcel information. The flood lines from the 9/9/1999 FIRM maps were then digitized to add this layer to the analysis. Lastly, sill elevations of existing structures were compiled from the 1988 Main Street Sewer Project completed in the area and information on structures modified since 1988 was taken from available town records. (Please see the Appendix for a detailed description of the sources of information and details of the GIS analysis.)

The accuracy of the information provided is on a village wide scale and the maps presented in this report shall be used for planning purposes only. These maps are not adequate for legal boundary definition, regulatory interpretation or any specific parcel level analysis. It is the responsibility of the interested party to verify the accuracy of this information on a parcel level with the actual FIRM maps, a survey, and other needed data prior to the completion of any work. Any party interested in specific parcel information must seek the help of a registered design professional for legal definition of parcels and applicable code requirements.

Each grey box on the flow chart to the right indicates a GIS map query that was completed. Each one of these queries is described on the following pages in detail with accompanying maps. The resulting analysis assigns each parcel in the study area one category (color) indicating its degree of compliance and relative ease of adaptation to meet the most basic FEMA regulations. The assigned categories (colors) then relate to suggested design solutions illustrated in Section 4 of this report.

The flowchart primarily focuses on creating an analysis to show if and how existing buildings in A zones could potentially be renovated to meet FEMA requirements. Most parcels in the analysis are in A zones, so the most attention is given to illustrate strategies to renovate structures in these areas. For design strategies for new construction, please refer to FEMA's Fact Sheet Series 499- 'Guidelines for Coastal Construction.'

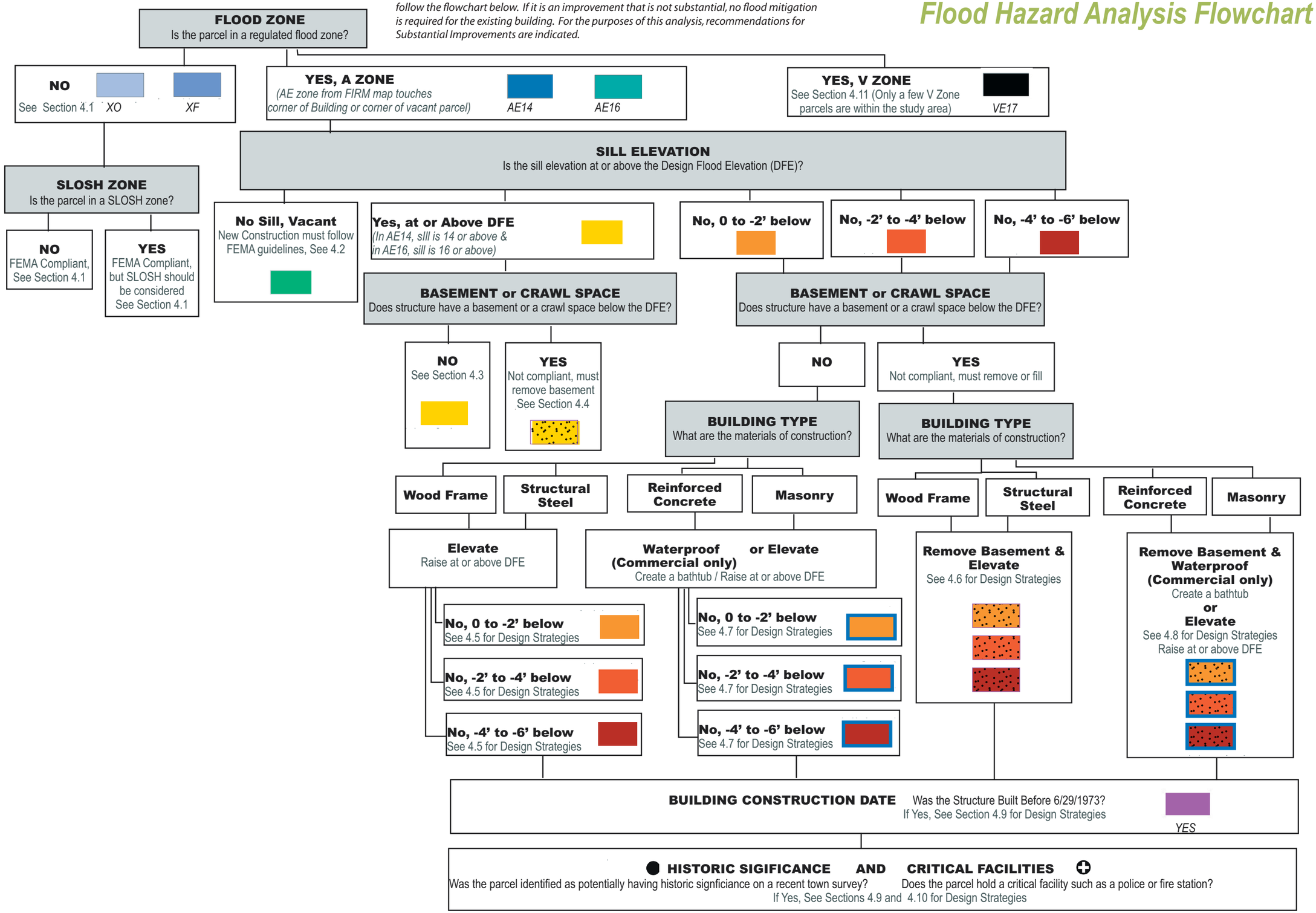
Lastly, the analysis uses sill elevations provided by the Town to determine if existing structures in the study area are compliant with the Design Flood Elevation in A zones. Actually, however, FEMA requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data, however, was the only information made available for the analysis. Therefore, for the purposes of this study, the published sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may, therefore, vary from what is indicated in this analysis for any given parcel.

The results and overall site analysis summary of the entire study area is shown on page 33.

Flood Hazard Analysis Flowchart

Chart 3.0

Before proceeding through the flowchart, first determine if the work will be a Substantial Improvement (See Chart 2.0 on page 10) or New Construction. If it qualifies as one of these, follow the flowchart below. If it is an improvement that is not substantial, no flood mitigation is required for the existing building. For the purposes of this analysis, recommendations for Substantial Improvements are indicated.



This flowchart indicates the analytical process that was used to summarize the existing degree of compliance and non compliance with current FEMA recommendations. Each grey box indicates a GIS map query that was completed. Each parcel in the study area was assigned one of the category colors indicating its degree of compliance and relative ease of adaptation to meet the most basic FEMA regulations. The category colors then relate to suggested design solutions illustrated in Section 4 of this report.

Analysis 3.1

Is the building or parcel in a regulated FEMA flood zone?.

3.1.1 Introduction- Why this Query?

The first thing to understand is which buildings and parcels in the Study Area are in a Flood Zone.

3.1.2 Query Specifics

The most recent 8/9/1999 FEMA FIRM maps delineating flood zones were used.

Each parcel is given the designation of the most restrictive flood zone touching any point of the PARCEL.

An Important Note: Many parcels are located within two or more different flood zones. Since the analysis is trying to determine the Study Area's level of current compliance, parcels are given the flood zone designation that is most restrictive. Included maps are not meant for parcel-level analysis and original FEMA FIRM maps must be referenced for parcel level information.

3.1.3 Next Steps

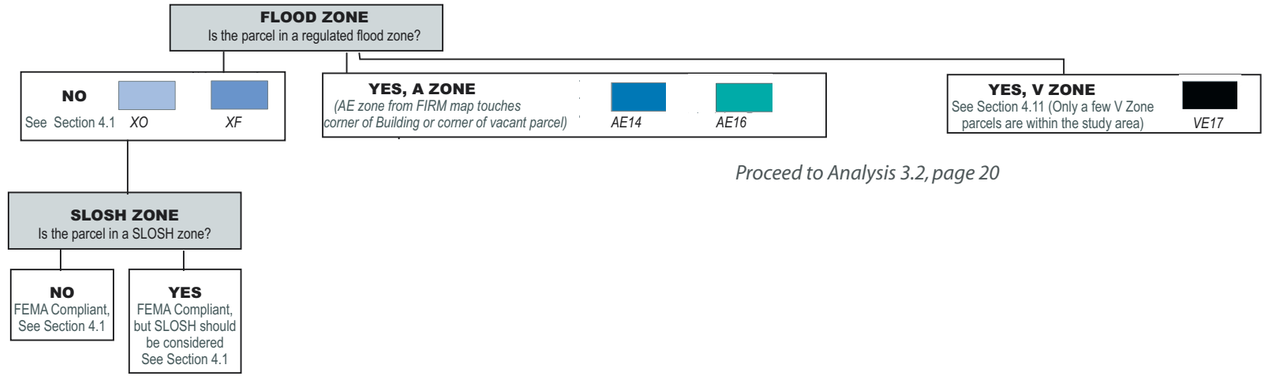
For design strategies and recommendations for any of these parcels, follow the section reference indicated on the flow chart to the right.

What it tells us: Every parcel in the Study Area is within some sort of Flood Zone.

VE17 Zone: *About 13% of the parcels (30 parcels) are in a VE17 Zone. This is the most severe flood zone of the Study Area. V, stands for Velocity Zone, indicating that these parcels are subject to wave action in a coastal flood. Thee Design Flood Elevation is 17, which is the number of feet above sea level the flood is expected to rise in an event. For design strategies and recommendations for the parcels, See Section 4.11 on page 46.*

A Zone: *About 70% of the parcels are in an A zone which means they are within a 100-year floodplain. Most are in AE14 meaning the Design Flood Elevation is 14 and a flood is expected to rise 14' above sea level. Two parcels are in AE16. Continue to Analysis 3.2 that describes the next step in determining if the built structure meets FEMA guidelines for structures in A zones.*

X Zone: *About 17% of the parcels are in XF or XO zones which are part of the 500 year floodplain. There are no FEMA regulations for these parcels. These are the parcels in the Study Area that will be most easy to build on from a flood regulation standpoint. For design strategies and recommendations for the parcels, see Section 4.1 on page 36.*

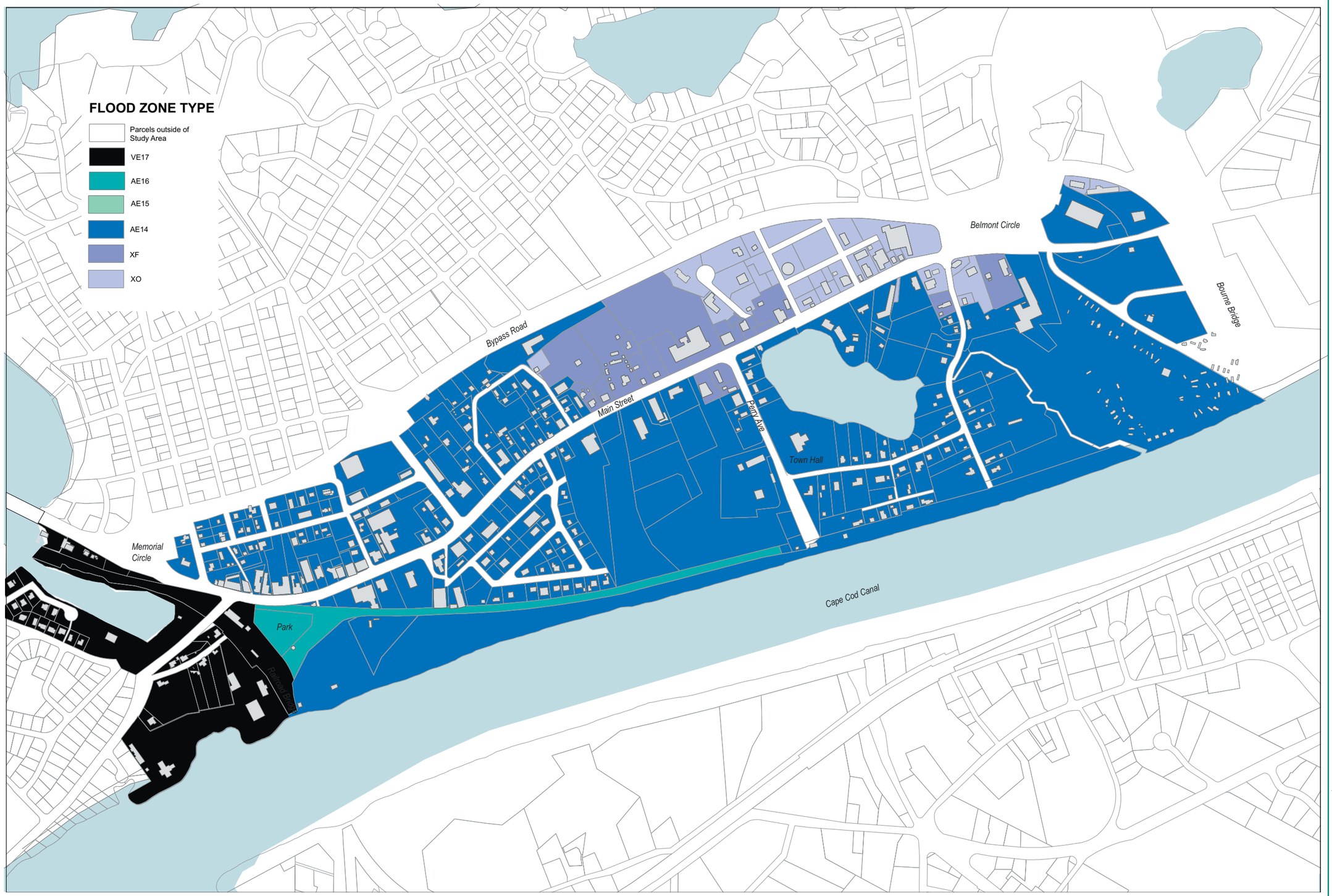


Proceed to Analysis 3.2, page 20

X Zone- SLOSH Analysis (Sea, Lake and Overland Surges from Hurricanes) Even though the X zones parcels are not subject to FEMA regulations, there are threats from both Floods and Hurricanes for these parcels. For additional information on a parcel's susceptibility to storm surge flooding, see Section 4.1 on page 36.

Parcel Analysis: FEMA FIRM map flood zones

Map 3.1



This map shows FEMA flood zone designation of parcels in the Project Area only. Additional white parcels shown also have a flood zone designation, but are not included because they are not in the study area.

Analysis 3.2

For buildings within regulated A zones, is the sill* above the required Design Flood Elevation (DFE)?

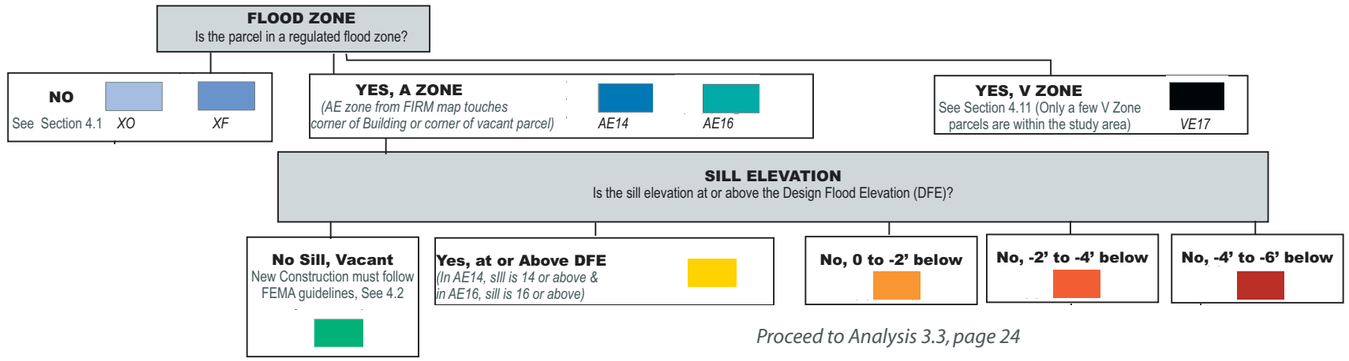
What it tells us: Only about 1/3 of the buildings in the A zone are compliant with FEMA's regulation that requires Finish Floor Elevation (FFE) to be at or above the DFE

At or Above DFE: *Only about 1/3 of the parcels in the A zone have all sill* elevations at or above the required DFE. This means that in an AE14 zone, the sill elevation is at 14 or above, and in an AE16 zone, the sill elevation is at 16 or above. However, these buildings still may not be compliant. Proceed to Analysis 3.3, page 24 to determine if the Lowest Floor Elevation is the sill, or a basement or crawlspace is present.*

Sill is Below DFE, Up to -2': *The sill of these parcels is lower than the DFE, but only by a couple of feet. The Lowest Floor Elevation would need to be raised to at or above the DFE to become compliant. Proceed to Analysis 3.3, page 24 to determine if the Lowest Floor Elevation is the sill, or a basement or crawlspace is present making the structure even more non-compliant.*

Sill is -2' to -4' Below DFE: *The sill of these parcels is lower than the DFE by up to 4'. The Lowest Floor Elevation would need to be raised to at or above the DFE to become compliant. Proceed to Analysis 3.3, page 24 to determine if the Lowest Floor Elevation is the sill, or a basement or crawlspace is present making the structure even more non-compliant.*

Sill is over -4' Below DFE: *The sill of these parcels is very low and the structure is at great risk of flooding. The Lowest Floor Elevation would need to be raised to at or above the DFE to become compliant. Proceed to Analysis 3.3, page 24 to determine if the Lowest Floor Elevation is the sill, or a basement or crawlspace is present making the structure even more non-compliant.*



Vacant- The assessor's data indicated no buildings or only accessory buildings are located on these parcels. These parcels are therefore labeled as vacant. Parcels owned by the Army Corps of Engineers are also included in this category. For recommendations and design strategies for building on these parcels, See section 4.2 on page 38.

3.2.1 Introduction- Why this Query?

For parcels within regulated flood zones, the next most important thing to know is if the sill* elevation is compliant with FEMA regulations.

In A Zones: The sill* must be at or above the Design Flood Elevation.

In V Zones: The lowest horizontal structural member must be above the Design Flood Elevation.

Unfortunately, there is no sill data available for the parcels located in the V zones. Please see Section 4.11 to determine if structures in this area are compliant. Since this makes up a small portion of the study area only, this should not greatly affect the study.

For A Zones, the map on the right shows the analysis of existing sill elevations with respect to the Design Flood Elevation.

3.2.2 Query Specifics

Sill elevations were obtained from two sources. First, sills were entered from the 1988 Main Street Sewer Study. For construction since 1988, sill data was manually taken from building department records where available by Town Planning Staff.

For each parcel, the distance is calculated between the Design Flood Elevation and the sill of any building on the site. The parcel is given the designation of the most non-compliant structure on the site. Parcels with no structures or only accessory buildings are labeled as vacant.

3.2.3 Next Steps

For design strategies and recommendations for any of these parcels, follow the section reference indicated on the flow chart to the right.

*An important note: The analysis uses sill elevations provided by the Town to determine if existing structures in the study area are compliant with the Design Flood Elevation in A zones. Actually, however, FEMA requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data, however, was the only information made available for the analysis. Therefore, for the purposes of this study, the published sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may, therefore, vary from what is indicated in this analysis for any given parcel.

Parcel Analysis: Distance between Design Flood Elevation (DFE) & Existing Sill* Elevation

Map 3.2.1

For buildings located in regulated A zones, this map shows if the building's recorded sill height is above or below the Design Flood Elevation.*

**An important note: The analysis uses sill elevations provided by the Town to determine if existing structures in the study area are compliant with the Design Flood Elevation in A zones. Actually, however, FEMA requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data, however, was the only information made available for the analysis. Therefore, for the purposes of this study, the published sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may, therefore, vary from what is indicated in this analysis for any given parcel.*

Map 3.2.2 Parcels with building sill* elevations below the DFE in A zones

This map shows the same information as Map 3.2.1 on the previous page, but the parcels with structures having sill elevations above the DFE have been removed. Non-compliant structures are therefore shown. Their degree of non-compliance is indicated by how far the sill elevation is below the DFE. The darker the red color, the more non-compliant according to their sill elevation.*

**An important note: The analysis uses sill elevations provided by the Town to determine if existing structures in the study area are compliant with the Design Flood Elevation in A zones. Actually, however, FEMA requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data, however, was the only information made available for the analysis. Therefore, for the purposes of this study, the published sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may, therefore, vary from what is indicated in this analysis for any given parcel.*

Summary of areas with non-compliant sill* elevations

Map 3.2.3

This map generalizes the sill information to show that the parcels with the greatest potential degree of non-compliance are concurrently located on the west end of Main Street. Alternately, the east end of Main Street, has the highest relative land topography and therefore the highest level of existing compliance in terms of sill elevation.*

**An important note: The analysis uses sill elevations provided by the Town to determine if existing structures in the study area are compliant with the Design Flood Elevation in A zones. Actually, however, FEMA requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data, however, was the only information made available for the analysis. Therefore, for the purposes of this study, the published sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may, therefore, vary from what is indicated in this analysis for any given parcel.*

Analysis 3.3

For buildings within regulated A zones, does it have a basement or crawl space?

What it tells us: About 50% of the buildings in the A zone might have an increased degree of non-compliance since the data indicates they may have a basement or crawlspace.

Basements and Crawlspaces: *Areas hatched with dots on the map on the right indicate parcels that may have a building with a non-compliant basement or crawlspace. About one half of the buildings in the A zone are shown to have some kind of basement or crawlspace. If the space is not built or used to FEMA standards, it will be considered the Lowest Floor Elevation, making the structure significantly non-complaint above and beyond having the sill* elevation below the Design Flood Elevation. For parcels shown as having compliant sill* elevations on the previous analysis 3.2, the structure must then be checked to see if it has a non compliant basement or crawlspace. If so, it must be removed. For recommendations and design strategies for this scenario, see Section 4.4 on pages 39. If the structure has a sill* elevation below the DFE, continue to Analysis 3.4 on page 36.*

3.3.1 Introduction- Why this Query?

For parcels within regulated flood zones, the next most important thing to know is if the structure has a basement or crawlspace. Put another way, is the sill elevation of the building the Lowest Floor Elevation?

Basements and enclosed crawlspaces are not allowed in A nor V zones below the Design Flood Elevation. The definition of a basement or crawlspace is any space that is enclosed on all four sides and is below the lowest adjacent grade of the land. Spaces below the Design Flood Elevation are only allowed if either they are not enclosed on all four sides, or the adjacent land grade on one side is as low as the floor of the basement or crawlspace. Even if it does meet either of these requirements, it additionally cannot be a finished basement and allowed uses below the DFE are only 1) Parking, 2) Storage or 3) Unfinished access to a building.

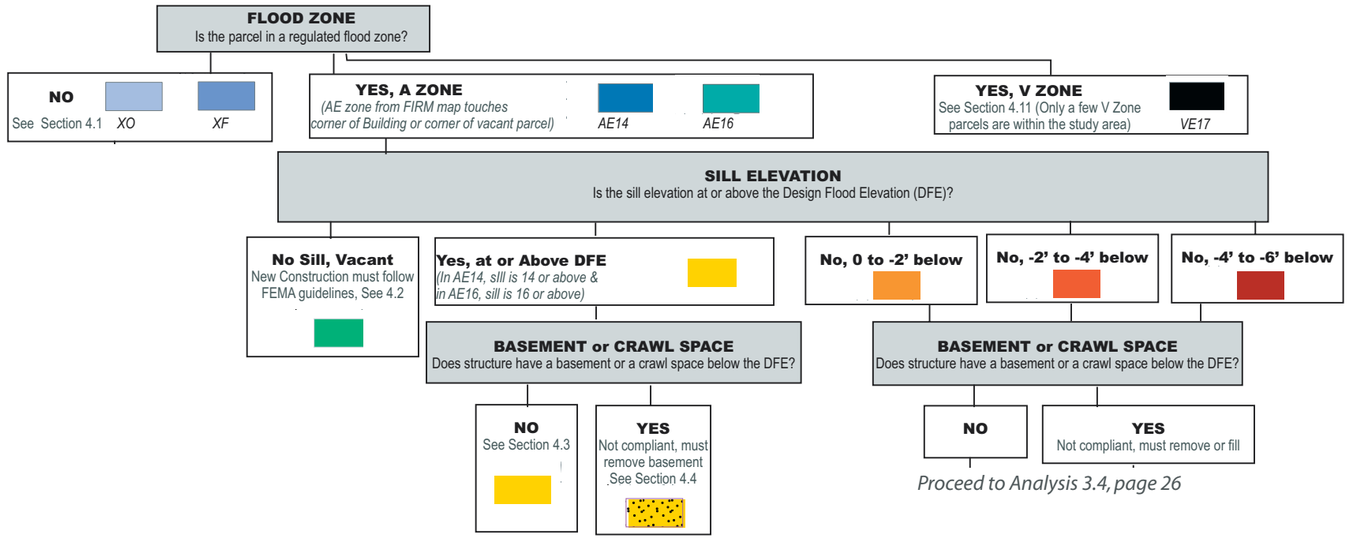
Since it is impossible to identify both the amount of enclosure and the use of these spaces in this analysis, any parcel with a building foundation shown as 'Floor/Wall (Full)' or 'Foundation Wall' on the assessors data has been hatched with dots on the maps on the right. These parcels potentially have buildings with a basement or crawlspace that is non-compliant.

3.3.2 Query Specifics

Any parcel with a building foundation shown as 'Floor/Wall (Full)' or 'Foundation Wall' on the assessors data has been hatched and identified as having a basement. A sample block of this designation of building was field-checked for accuracy. 95% of those field inventoried did in fact have a full basement or crawlspace.

3.3.3 Next Steps

For design strategies and recommendations for any of these parcels, follow the section reference indicated on the flow chart to the right.



Proceed to Analysis 3.4, page 26

**An important note: The analysis uses sill elevations provided by the Town to determine if existing structures in the study area are compliant with the Design Flood Elevation in A zones. Actually, however, FEMA requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data, however, was the only information made available for the analysis. Therefore, for the purposes of this study, the published sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may, therefore, vary from what is indicated in this analysis for any given parcel.*

Parcel Analysis: Buildings with basements and crawlspaces

Map 3.3

Basements and crawlspaces are not allowed below the Design Flood Elevation. This map shows parcels in the A zone with structures that potentially have a non-compliant basement or crawlspace.

Analysis 3.4

What type of construction is the existing building?

What it tells us: Many of the buildings in the lowest, most non-compliant sections of Main Street are also built with building materials difficult to renovate to FEMA standards

Masonry and Reinforced Concrete: *Parcels with masonry or reinforced concrete buildings are identified on the map on the right with a blue outline around the edge of the parcel. Buildings constructed with this type of material are often difficult to elevate, and other flood mitigation solutions need to be employed. Waterproofing of buildings can be considered (for commercial only, not residential) but this is both difficult and expensive to complete. Many of the buildings in this category also have very low sill elevations, significantly below the Design Flood Elevation. This means that the bottom of their windows are often below the DFE making them extremely difficult if not impossible to waterproof. For potential design strategies and recommendations, see Section 4.7 for structures without basements or crawlspaces, and Section 4.8 for structure with basement or crawlspaces.*

Wood Frame and Structural Steel Frame Buildings: *Buildings constructed with these materials are relatively the easiest to elevate. A sill at the bottom of the frame can often be identified from which the building can be lifted. For potential design strategies and recommendations for structures without basements, see Section 4.5. For structures with crawlspaces or basements, see Section 4.6.*

3.4.1 Introduction- Why this Query?

To assess the feasibility of making an existing structure flood resistant and complaint, it is important to know the materials and type of construction.

For example:

Wood Frame and Structural Steel Frame Buildings: These buildings are the easiest to elevate if the existing building needs to be elevated so that the Lowest Floor Elevation is above the DFE.

Masonry and Reinforced Concrete: These are the most difficult buildings to elevate. Often, there is no frame under the building that can be used to lift the existing building. A different, often more difficult and costly set of design strategies would need to be employed if the building is to be brought into compliance.

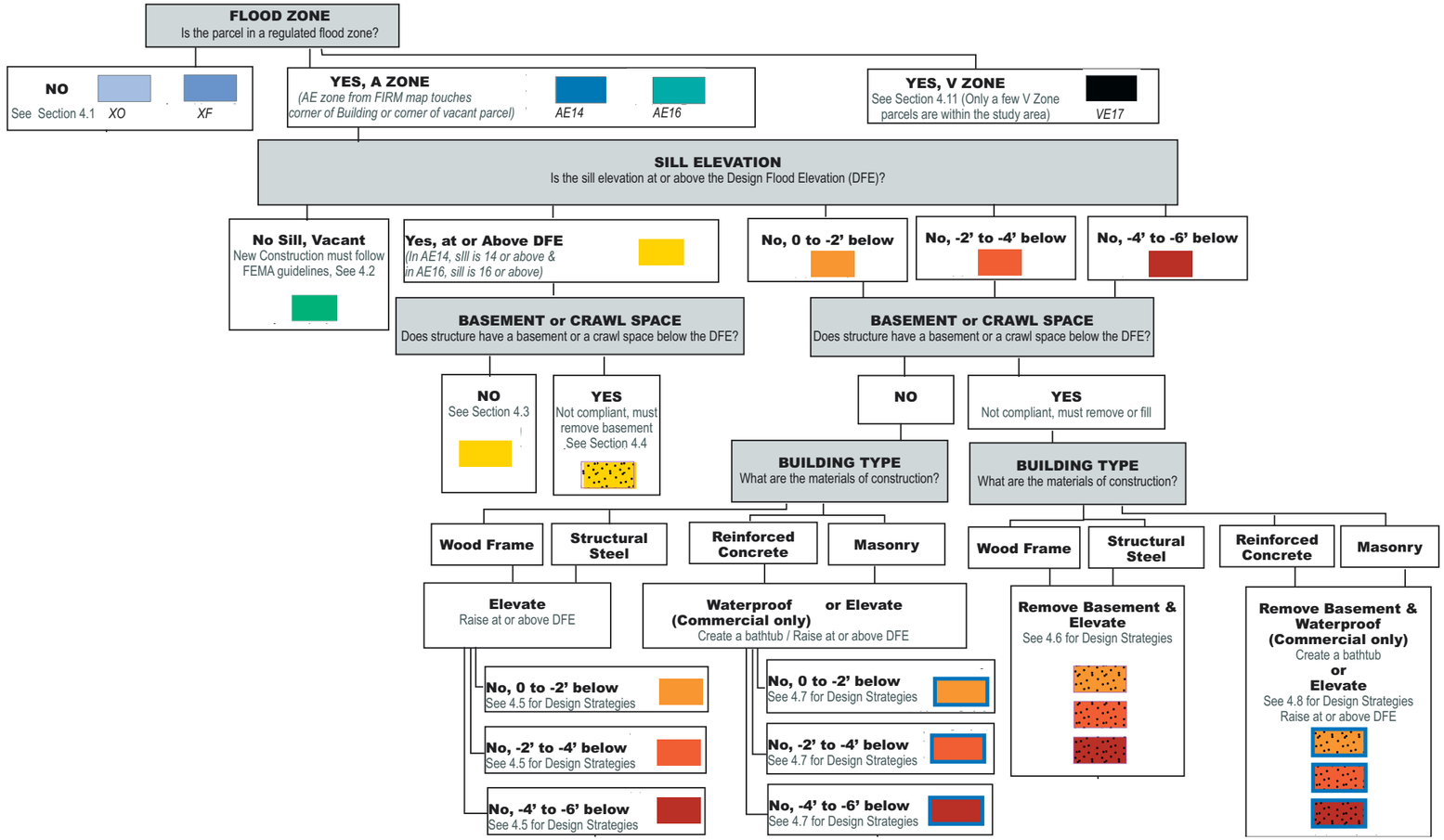
3.4.2 Query Specifics

The type of building materials were obtained from the 2006 Assessors Data and sorted into 2 categories: 1) Wood Frame and Structural Steel and 2) Masonry or Reinforced Concrete.

Parcels with any masonry or reinforced concrete buildings were pulled out and identified on the map to the right, with a blue outline around the parcel.

3.4.3 Next Steps

For design strategies and recommendations for any of these parcels, follow the section reference indicated on the flow chart to the right.



Parcel Analysis: Masonry and reinforced concrete building structure

Map 3.4

In the A Zone, parcels with masonry or reinforced concrete buildings are identified here with a blue outline. These buildings are often the most difficult to elevate and a different set of renovation strategies for flood mitigation should be considered.

Analysis 3.5

Was the building constructed prior to 6/29/1973?

3.5.1 Introduction- Why this Query?

In the Town of Bourne, FEMA construction standards were adopted as regulations in the Town on June 29,1973. Any buildings built prior to this date that have not been substantially improved are very likely to be non-compliant with other FEMA construction standards such as construction materials, location of utilities, etc. These buildings, if located in an A or V Zone, are likely to be significantly non-compliant.

3.5.2 Query Specifics

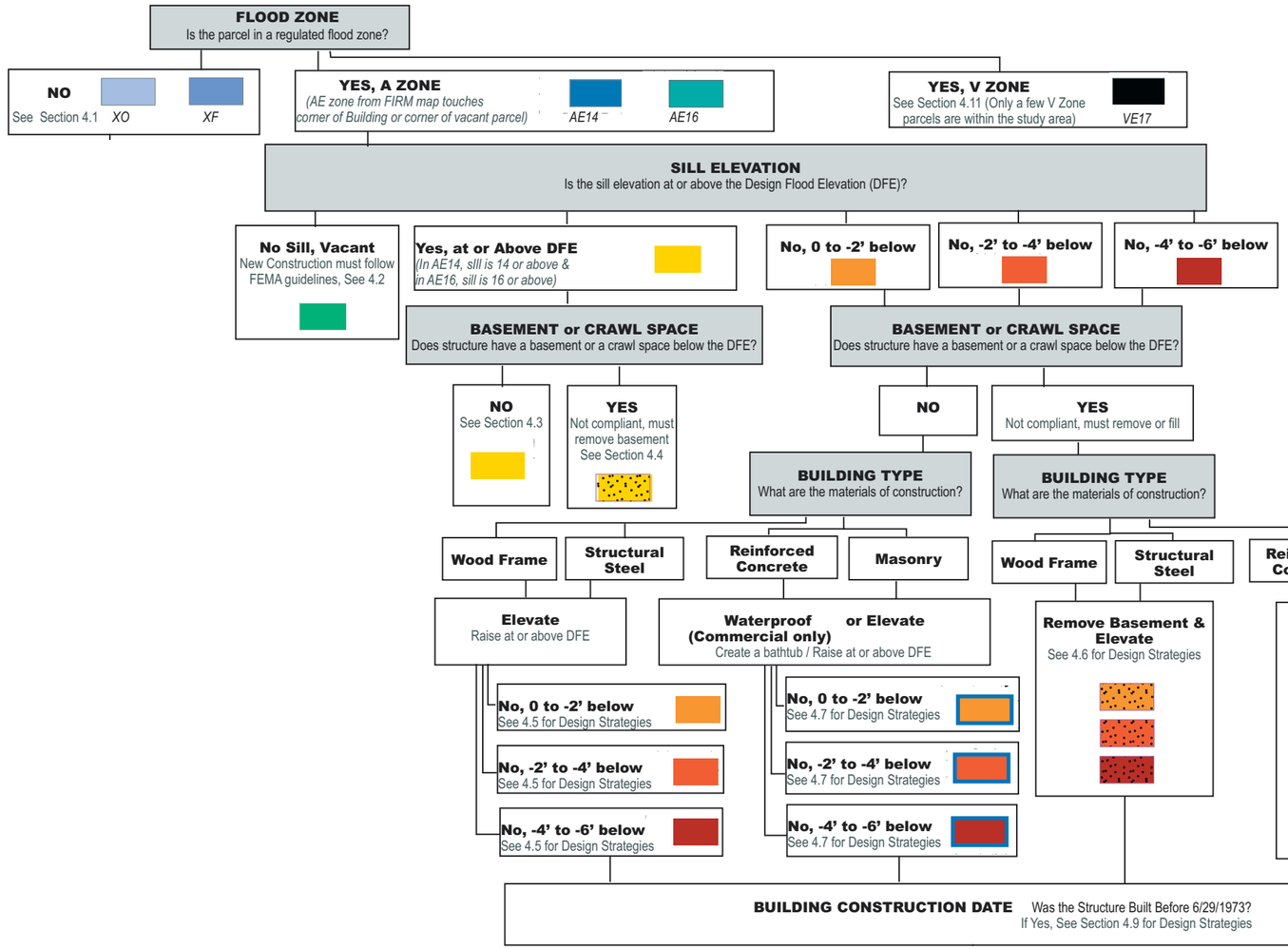
The date of construction was taken from the 2006 Assessors Data 'Effective Year Built.'

3.5.3 Next Steps

For design strategies and recommendations for any of these parcels, follow the section reference indicated on the flow chart to the right.

What it tells us: Most of the buildings in flood zones that have not been substantially improved since 1973 are residential structures.

According to the assessor's data, a significant number of structures have not been updated since 1973. Most of these are residential structures. It is more than likely that these structures will not only need to be elevated above the DFE, but will also required other building code compliance upgrades as well. See Section 4.9.



Parcel Analysis: Parcels with buildings constructed prior to 6/29/1973

Map 3.5

For parcel in A zones, this map indicates in purple parcels that have structures built in 1973 or before. These structures were built before FEMA construction standards were adopted, and are very likely to have additional issues of non-compliance including building construction techniques, utilities, etc.

Analysis 3.6

Is the existing building historically significant and/or is it a critical facility?

3.6.1 Introduction- Why this Query?

Two other factors should also be considered in the flood hazard analysis of the area:

1) Critical Facilities- Are there critical facilities in the flood zone and to what extent are they compliant?

2) Historic Significance- Does the structure or land potentially have some sort of historical significance that might make it more difficult to alter?

3.6.2 Query Specifics

Critical facilities were identified from GIS data provided by the Cape Cod Commission. Properties with potential historic significance were provided by the Town in GIS. These parcels were only identified as *potentially* having historic significance on a recent town survey. This data does not represent properties on the National Register of Historic Places nor the State Register of Historic Places. The properties identified are not regulated by any type of historic district.

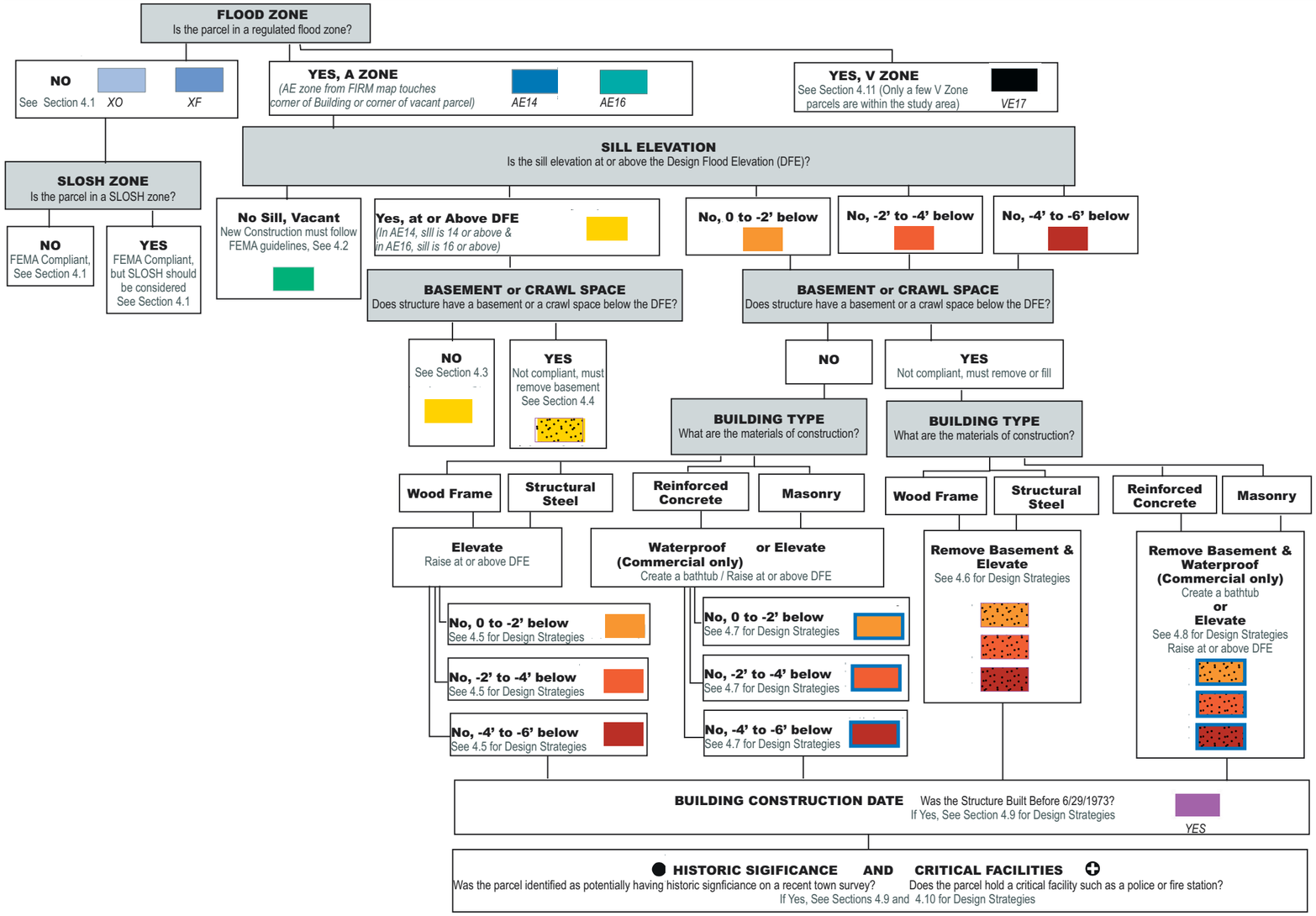
3.6.3 Next Steps

For design strategies and recommendations for any of these parcels, follow the section reference indicated on the flow chart to the right.

What it tells us: Most of the buildings in flood zones that have not been substantially improved since 1973 are residential structures.

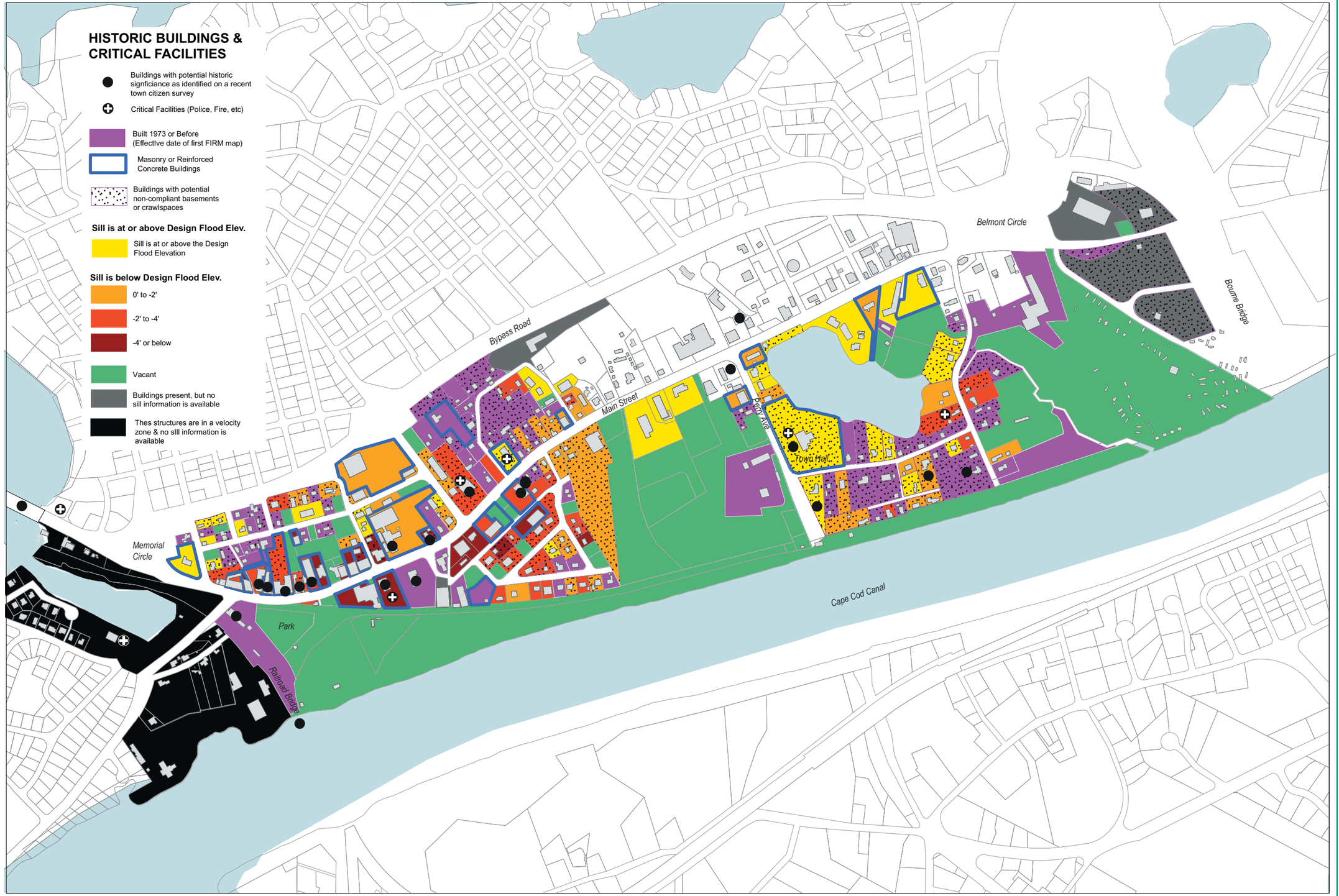
Critical Facilities- *A significant number of critical facilities are located in the flood zone. These facilities, even when built to FEMA code, would be inaccessible in the case of a flood. For design recommendations and strategies, see Section 4.10, page 45*

Potential Historic Significance- *About 20 parcels were identified as being possibly historically significant on a recent town survey, but this designation has no regulatory bearing. See Section 4.9, page 44.*



Parcel Analysis: Potential historical significance and critical facilities

Map 3.6



Parcels identified here have either potential historic significance or are indicated as critical facilities. The historic information was taken form a town survey summarizing citizen input. This information has no regulatory bearing.

Analysis Summary 3.7

In short, what is the level of flood hazard compliance in the study area?

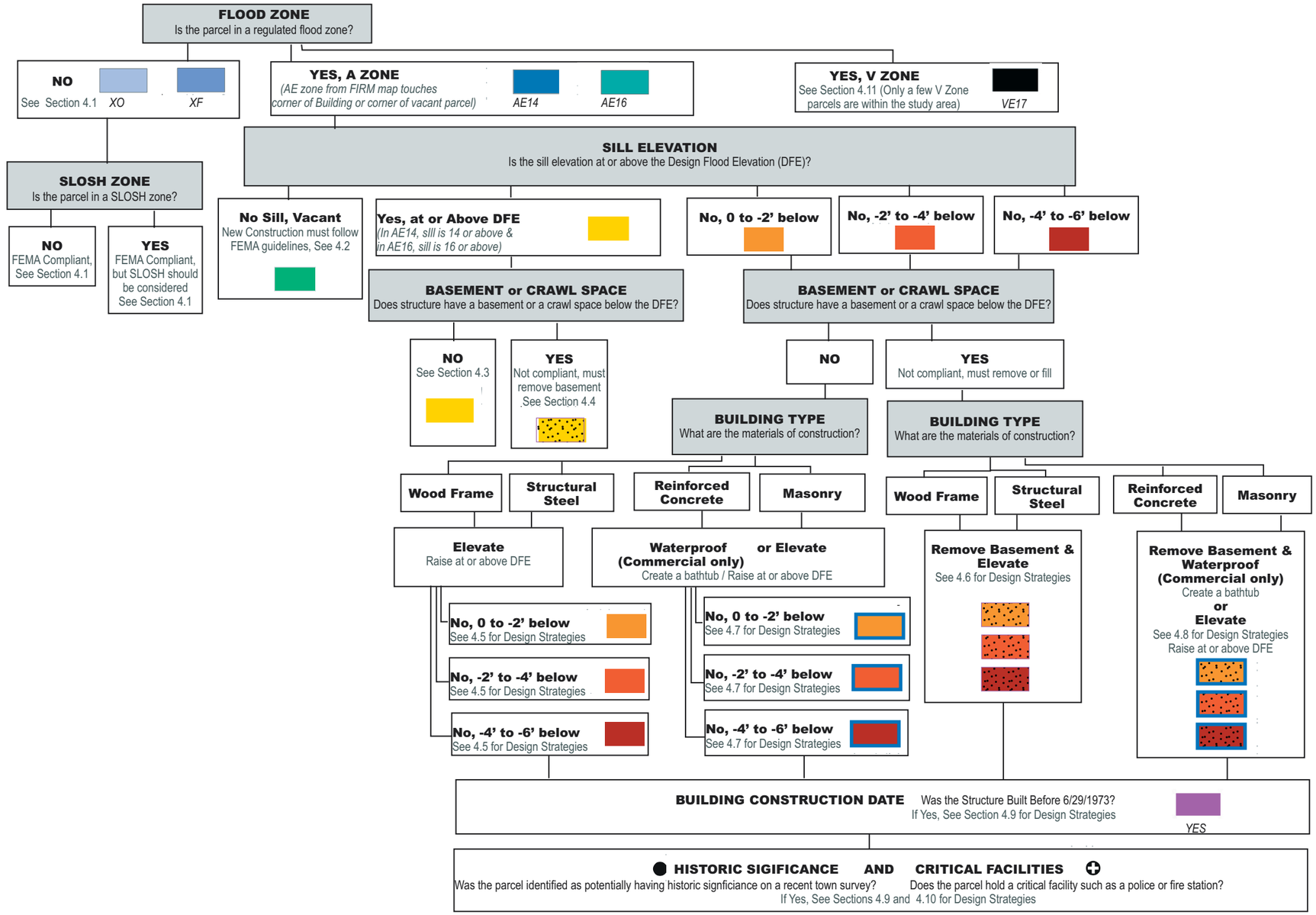
3.7.1 Summary of Existing Conditions

1) More than two thirds of the study area is located within the FEMA 100 year regulated floodplain where FEMA construction standards apply.

2) Of the buildings located within the regulated floodplain, very few are compliant. Even if the sill elevation is found to be above the Design Flood Elevation, most structures are likely to have a non-compliant basement or crawlspace, or have not been substantially improved since 6/29/73.

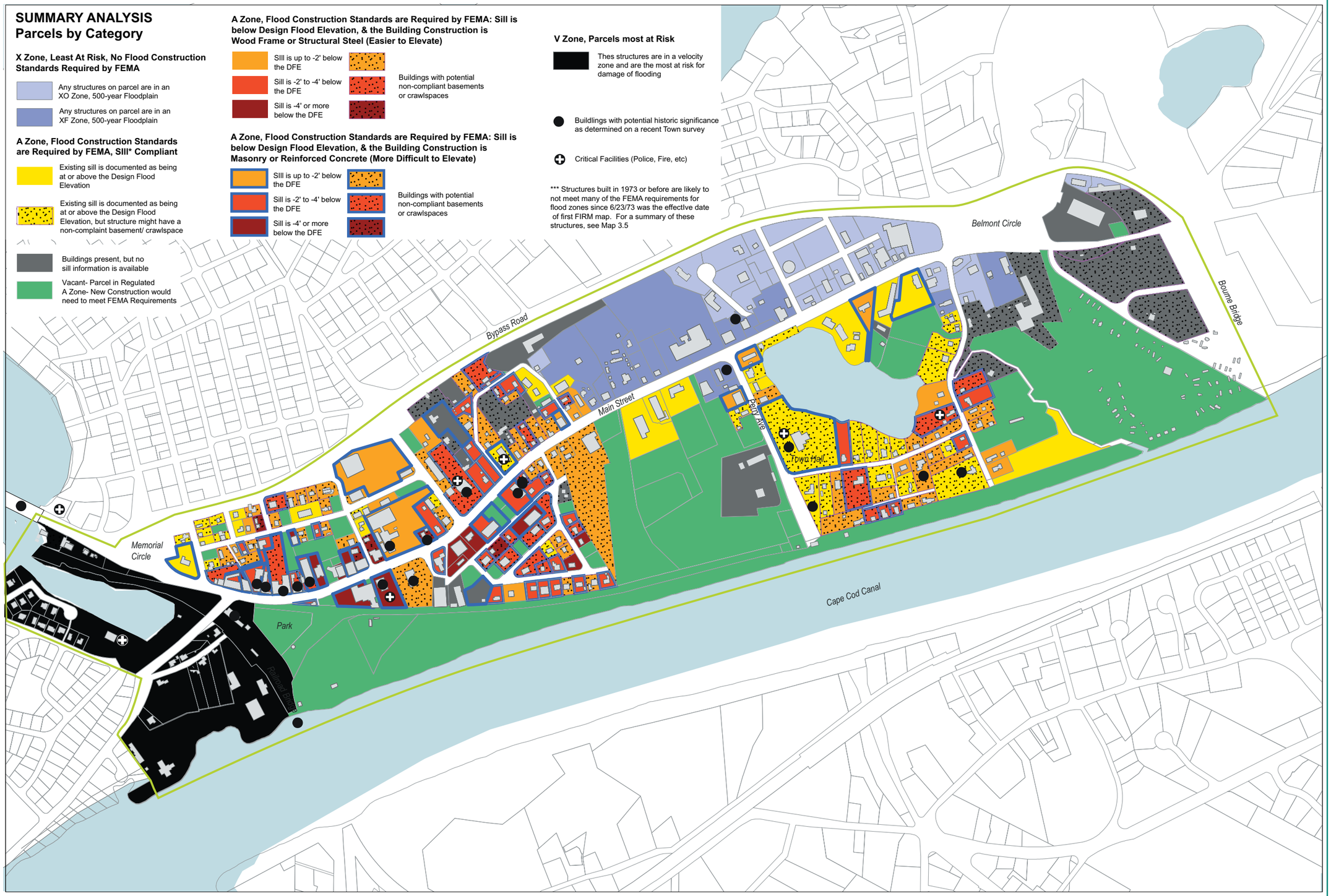
3) The buildings that are substantially lower than the Design Flood Elevation are along the west end of Main Street. Many of these buildings tend to be masonry, which makes them difficult to retrofit. They also tend to be commercial or mixed-use buildings. Some of them have been identified on a recent Town citizen survey that they contribute to the historical character of the Town.

4) The area most suitable for redevelopment from a flood hazard standpoint is the east end of Main Street. Many of the parcels are out of the 100 year flood zone and are only located in the 500 year flood zones and SLOSH zones. These areas still will be susceptible to storm and flood damage, but less so that other areas downtown.



Summary Analysis: Flood index map, existing conditions

Map 3.7



An important note: The analysis uses sill elevations provided by the Town to determine if existing structures in the study area are compliant with the Design Flood Elevation in A zones. Actually, however, FEMA requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data, however, was the only information made available for the analysis. Therefore, for the purposes of this study, the published sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may, therefore, vary from what is indicated in this analysis for any given parcel.

Design Solutions and Recommendations: Parcel Scale Approaches

4

PARCEL SCALE APPROACHES:

On the following pages are approaches individual property owners should consider to rehab their existing individual buildings to mitigate flood hazards. These strategies assume that changes would only be made on a parcel level rather than a block or village scale. The numbering of the strategies relates to the color categories of parcels defined in the flowchart within the previous section.

Recommended additional reference materials:

The following materials must be referenced to gain a full understanding of requirements and additional ideas for design options:

+ MA State Building Code: 780 CMR 6th Edition and 780 CMR 7th Edition
+FEMA Fact Sheet Series 499,'Guidelines for Coastal Construction' and relevant Technical Fact Sheets
+American Society of Civil Engineers 7-02, Minimum Design Loads for Buildings and Other Structures
+American Forest and Paper Association, Wood Frame Construction Manual
+American Forest and Paper Association, National Design Standard for Wood Construction

4.1

A. Description of Situation:

Parcel is in an X Zone (500-year floodplain) where FEMA does not require any additional flood mitigation. In addition the parcel is also not in a SLOSH (sea, Lake and Overland Surges from Hurricanes) Zone.

B. What is Required:

Nothing is required by FEMA, but interested party should verify on actual FIRM maps with Town Flood Administrator that property is in fact in an X Zone. New hurricane resistant construction standards in the new 7th edition of the MA State Building Code apply since property is located within 1 mile of the coastline.

C. What is Recommended:

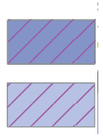
Parcel should be surveyed by a licensed engineer to ensure elevations indicated on the FIRM maps are correct. It is recommended that structure be additionally elevated as much as possible since potential for flooding still exists in a 500-year event. Construction techniques to prevent wind and storm damage are required as part of the State Building Code, 7th edition.

D. General Solution:

No additional flood mitigation solutions are required by FEMA, but interested party should consider storm proofing structure as much as possible. In addition, structure must meet new hurricane construction standards for structures in MA State Building Code, 7th edition.

E. Effect on Insurance Premium:

These parcels will have the lowest insurance premiums in the Study Area because they are located in an X Zone.



Map 4.1

A. Description of Situation:

Parcel is in an X Zone (500-year floodplain) where FEMA does not require any flood mitigation. Parcel however is located in a Sea Lake and Overland Surges from Hurricanes Zone (SLOSH) as determined by the Army Corps of Engineers SLOSH atlas and mapped using GIS by the Cape Cod Commission. Parcels within a SLOSH zone have the potential for flooding from surge inundation that may occur from wind and pressure forces of hurricanes.

B. What is Required:

Nothing is required by FEMA, but interested party should verify on actual FIRM maps with Town Flood Inspector that property is in fact in an X Zone. New hurricane resistant construction standards in the new 7th edition of the MA State Building Code apply since property is located within 1 mile of the coastline.

C. What is Recommended:

Construction techniques to prevent wind and storm damage are highly advised. Parcel should be surveyed by a licensed engineer to ensure elevations indicated on the FIRM maps are correct. It is recommended that structure be additionally elevated as much as possible since potential for flooding still exists in a 500-year event. Construction techniques to prevent wind and storm damage are required as part of the State Building Code, 7th edition.

D. General Solution:

No additional flood mitigation solutions are required by FEMA, but interested party should consider storm proofing structure as much as possible. In addition, structure must meet new hurricane construction standards for structures in MA State Building Code, 7th edition.

E. Effect on Insurance Premium:

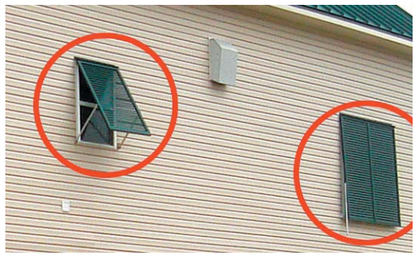
These parcels will have the lowest insurance premiums in the Study Area because they are located in an X Zone. Even though parcel is located in a SLOSH zone, this is not accounted for in insurance premiums.

Precedent Examples:

These precedents are shown to give an idea of what potential storm proofing solutions could look like.

Photo Source: www.fema.gov

1)



2)

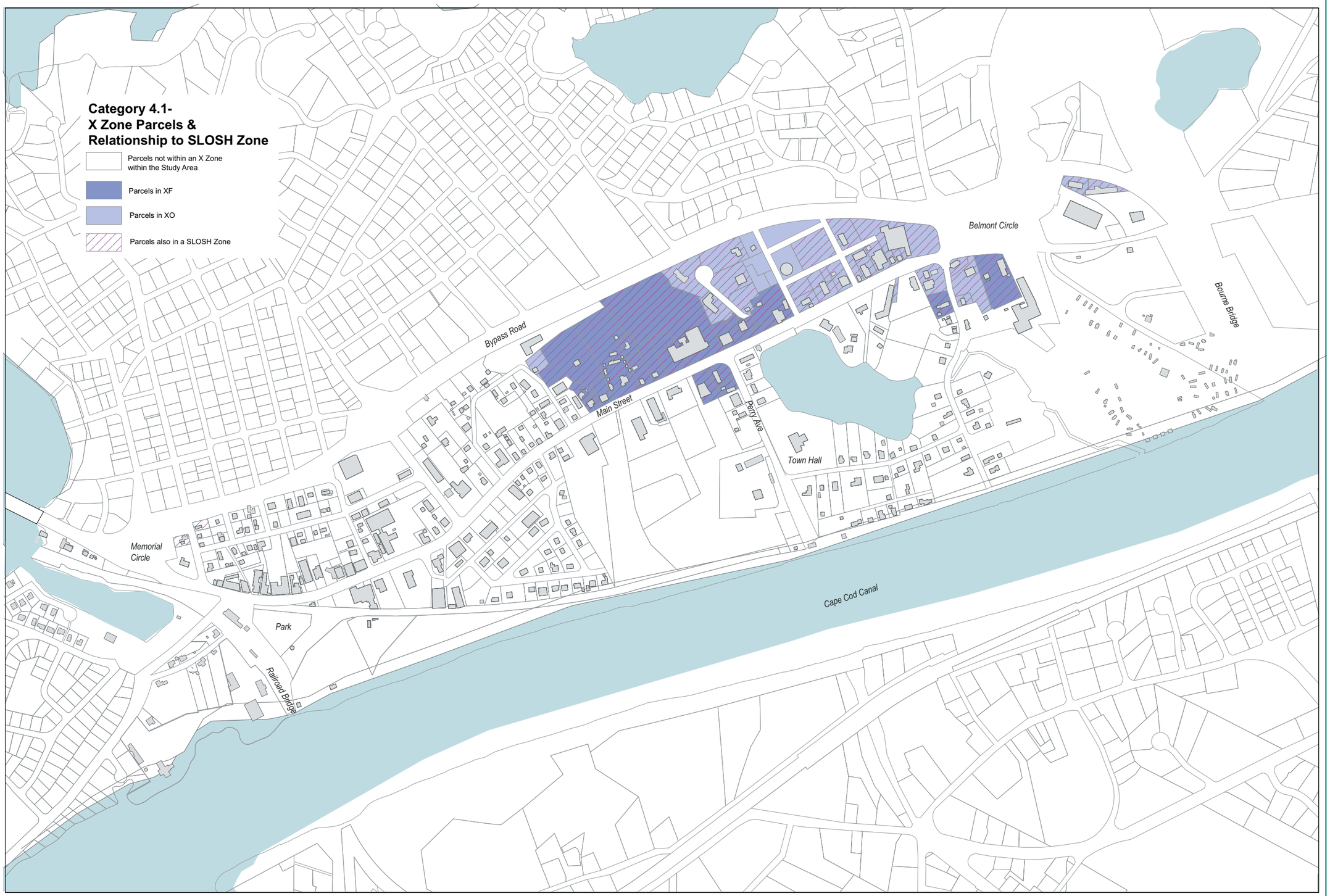
3)

4)

Additional wind-proofing of glass and building openings with working shutters is highly advised in addition to other storm protection best practices such as structural anchoring and roof modifications for wind loads. Some options for shutters include 1) vertically hung storm shutters 2) horizontal hung traditional shutters 3) manually installed panels that are slid-in before an event and 4) roll-down panels.

Parcels in X zones and SLOSH zones in Project Area

Map 4.1



This map shows the parcels within the Project Area that are located in FEMA, non-regulated X zones (500-year floodplain). Parcels also located in SLOSH zone are additionally hatched.

Design Solutions

4.2

A. Description of Situation:

Parcel is within a FEMA regulated A zone, but there is no existing building on the property, or it is an accessory building. Parcels owned by the Army Corps of Engineers are also included in this category.

B. What is Required:

If new structure is built, it must meet FEMA requirements for building in the zone identified on the FEMA FIRM Maps. Vacant parcels in the study area are all shown to be within A Zones. Contact the Town Flood Administrator to verify flood zone and FEMA requirements. In addition, new hurricane construction standards in MA State Building Code 7th edition apply since property is located within 1 mile of the coastline.

C. What is Recommended:

Parcel is in an A Zone, but consider exceeding requirements to meet V zone requirements. Elevate structure as high above the Design Flood Elevation (DFE) as possible. Every opportunity to design to a higher standard is recommended.

D. General Solution:

Elevate new structure and use construction techniques to meet FEMA requirements and MA State Building Code 7th edition hurricane standards. FEMA requirements are generally outlined in Section 2.2 of this report.

E. Effect on Insurance Premium:

Insurance premium will depend on how far the Lowest Floor Elevation is built above the DFE. Insurance premiums are reduced when the building is elevated above the minimum DFE.

Precedent Examples:

New Construction

Photo Source: www.architectureforhumanity.org Permission granted to use photos and designs in this report. Residence to right was designed by Brett Zamore Design, www.brettzamoredesign.com.

New construction can employ a host of flood hazard reduction strategies including elevating on piers to raise it above the Design Flood Elevation. See additional architectural elevation design ideas on following pages.

Design Solutions

4.3

A. Description of Situation:

Parcel is within a FEMA Regulated A zone, but the sill is above the DFE and there is no basement or crawlspace below the DFE. These parcels tend to have higher land elevations around the building therefore the sills are at or above the DFE

B. What is Required:

The structures Lowest Floor Elevation must be at or above the base flood elevation. Sill elevation on available town data is shown as complaint, but interested party should double check to insure their floor elevation is actually at or above the DFE. Verify flood zone and applicable codes on actual FIRM maps with Town Flood Administrator. New hurricane construction standards in MA State Building Code 7th edition apply since property is located within 1 mile of the coastline. In addition, FEMA guidelines for general building construction standards must be followed- See Chart 2.2

C. What is Recommended:

Parcel is in an A Zone, but consider exceeding requirements to meet V zone requirements. Build floor elevation as high above the Design Flood Elevation (DFE) as possible. Every opportunity to design to a higher standard is recommended.

D. General Solution:

Should ensure all elements of the building, not just sill elevation, meet FEMA standards.

E. Effect on Insurance Premium:

The higher the Lowest Floor Elevation is above the DFE, the lower the insurance premium will be.

Precedent Examples:

These buildings in the Study Area have their sill above the Design Flood Elevation, but should be checked to see if the structure meets other FEMA requirements.

Photo Source: Kennen Landscape Architecture

Town Marina building is elevated above the DFE using topography

This new multifamily structure built on Center Ave. is an example of a FEMA compliant structure with its sill above the DFE. It utilizes a series of decks, ramps and stairs to access the structure. FEMA construction standards for materials, utilities and unfinished crawlspace construction are followed.

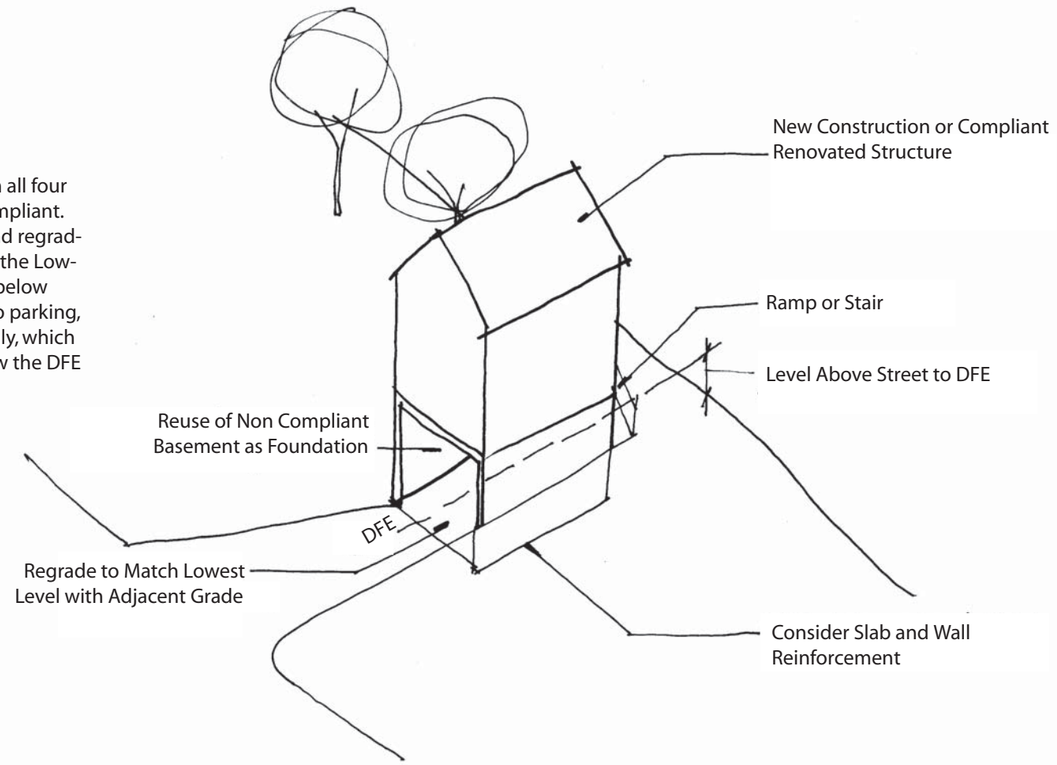
PARCEL SCALE APPROACHES:
STRATEGY 4.3:

Available data indicates that existing sill elevation of structures on these parcels is above the required Design Flood Elevation.

PARCEL SCALE APPROACHES:

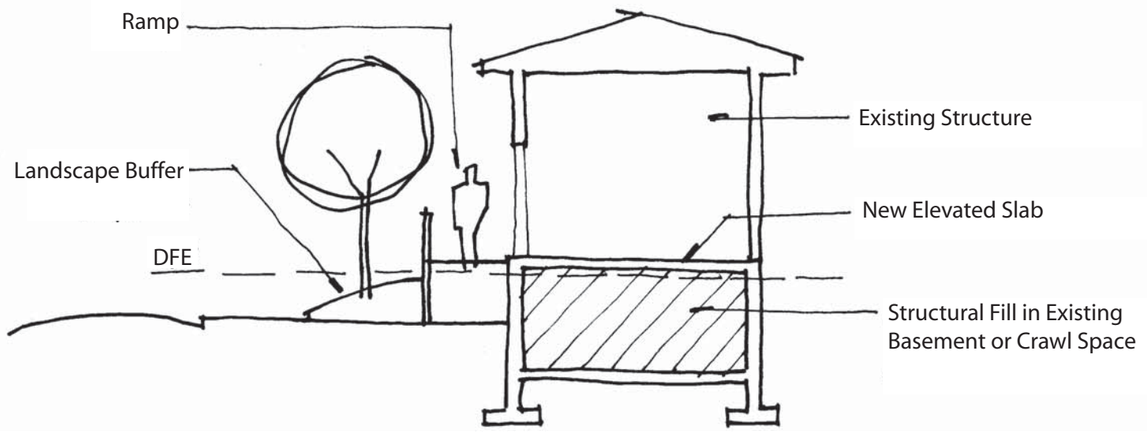
STRATEGY 4.4.1:

Basements and crawlspaces enclosed on all four sides must be eliminated to be flood compliant. This example shows removal of a wall and regrading of topography to allow car access to the Lowest Floor Elevation. The use of the area below the Design Flood Elevation is changed to parking, storage or unfinished building access only, which are the only uses allowed by FEMA below the DFE in an A Zone.



STRATEGY 4.4.2:

Fill basement or crawlspace so the Lowest Floor Elevation is the sill elevation which is at or above the DFE



A. Description of Situation:

Parcel is within a FEMA regulated A zone, the sill elevation according to GIS is above the DFE, but there potentially is a non-compliant basement or crawlspace below the DFE.

These parcels tend to have higher land elevations around the building therefore the sills are at or above the DFE, but any basements or crawlspaces must be removed. Options for retrofitting enclosed areas below the DFE are shown to the left. Adjacent land elevation must be modified to be at least as low as the basement or crawlspace floor.

B. What is Required:

The structure's Lowest Floor Elevation must be at or above the Design Flood Elevation. Interested party must check to see if any non-compliant basements or crawlspaces exist, and to what degree of non-compliance. Verify flood zone and applicable codes on actual maps (FIRM) with Town Flood Administrator. New hurricane construction standards in MA State Building Code 7th edition apply since property is located within 1 mile of the coastline. In addition, FEMA guidelines for general building construction standards must be followed- See Chart 2.2.

C. What is Recommended:

Parcel is in an A Zone, but consider exceeding requirements to meet V zone requirements. Build floor elevation as high above the Design Flood Elevation (DFE) as possible. Every opportunity to design to a higher standard is recommended.

D. General Solution:

Any finished basements and crawlspaces shall be eliminated. Only the allowed uses of parking, storage and unfinished building access can occur below the Design Flood Elevation.

Parcel scale solutions will most likely be effective in these areas and entire block strategies do not need to be taken because generally the land in these colored areas is not significantly below the DFE.

E. Effect on Insurance Premium:

Insurance premium will depend on how far the Lowest Floor Elevation is built above the DFE. Insurance premiums are reduced when the building is elevated above the minimum DFE.

Structural fill can be used to raise the Lowest Floor Elevation of new or existing buildings. This design, completed as part of the Biloxi Model Home program by Architecture For Humanity, shows how structural fill and retaining walls can be successfully utilized to create grade transitions. The Lowest Floor Elevation is raised above the DFE. Photo Source: www.architectureforhumanity.org Permission granted to use photos and designs in this report. Residence to left was designed by Huff and Gooden Architects, www.huffgooden.com.

Parking, storage and unfinished building access are the only allowed uses below the Design Flood Elevation. This precedent shows how parking can be located on the first floor of a structure.

Precedent Examples:

These precedents are shown to give an idea of what potential solutions could look like.
Photo Source; www.fema.gov

A. Description of Situation:

Parcel is within a FEMA regulated A zone, and the existing sill* elevation is shown to be below the DFE according to GIS. The structure is either wood frame or structural steel. There is no basement or crawl-space in the structure.

Orange- Sill* is up to 2' below the DFE
Red- Sill* is 2' to 4' below the DFE
Cranberry- Sill* is 4' or over below the DFE

B. What is Required:

Finish Floor must be elevated to be at or above existing Design Flood Elevation and other FEMA and State Building Code construction standards for materials and utilities apply- See Section 2.2. Verify flood zone and applicable codes on actual FIRM maps with Town Flood Administrator.

C. What is Recommended:

Parcel is in an A Zone, but consider exceeding requirements to meet V zone requirements. Build Floor Elevation as high about the Design Flood Elevation (DFE) as possible. Every opportunity to design to a higher standard is recommended.

D. General Solution:

Elevate the existing building or consider tearing it down and rebuilding if building is in poor condition to ensure the sill is at or above the DFE. Buildings constructed with these wood frame and structural steel materials are relatively the easiest to elevate. A sill at the bottom of the frame could potentially be identified from which the building can be lifted.

E. Effect on Insurance Premium:

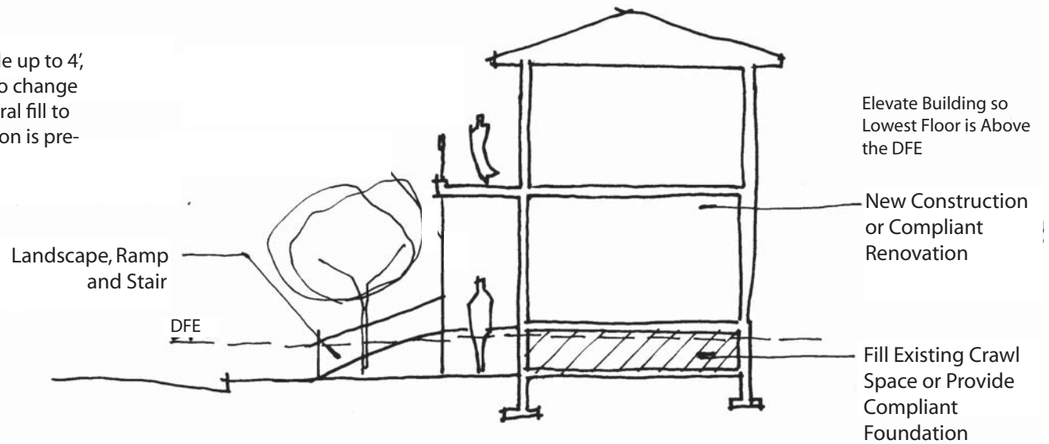
Insurance premium will be costly since the sill is below the DFE. Severity of premium will depend on how far the Lowest Floor Elevation is below the DFE. Insurance premiums are reduced when the building is elevated above the minimum DFE.

**An important note: The analysis uses sill elevations provided by the Town to determine if existing structures in the study area are compliant with the Design Flood Elevation in A zones. Actually, however, FEMA requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data, however, was the only information made available for the analysis. Therefore, for the purposes of this study, the published sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may, therefore, vary from what is indicated in this analysis for any given parcel.*

PARCEL SCALE APPROACHES:

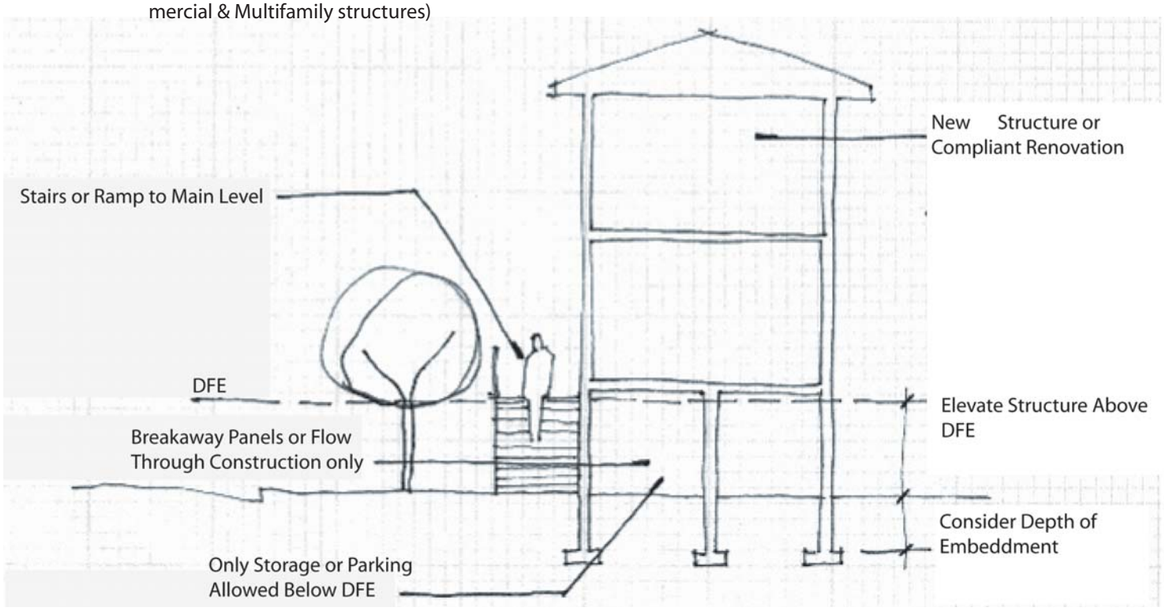
SOLUTION 4.5.1

For structures with sill elevations below grade up to 4', elevate sill, and use topography and ramps to change grade. Fill the area below grade with structural fill to elevate the building. Pier method for elevation is preferred- See Solution 4.5.2 below



SOLUTION 4.5.2:

For structures with sill elevations significantly below grade, Elevate Sill, and use stairs, ramps or topography to change grade (accessible entrance must also be provided for Commercial & Multifamily structures)



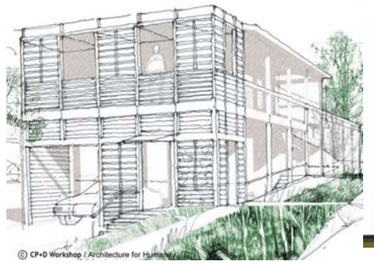
Proposed design for Biloxi Model Home Program, sponsored by Architecture for Humanity

Precedent Examples:

These precedents to the right are shown to give an idea of what potential solutions could look like. Architectural designs of residences were completed by: Rockhill and Associates, www.rockhillandassociates.com, Maurice Cox with CP+D Workshop, BuildingStudio, www.buildingstudio.net & MC2 Architects, www. mc2architects.com

Raise existing buildings onto piers as shown here. This is the preferred method. Photo Source: www.fema.gov

Pier construction details. Piers can be designed to have architectural character (right image) rather than being concrete.

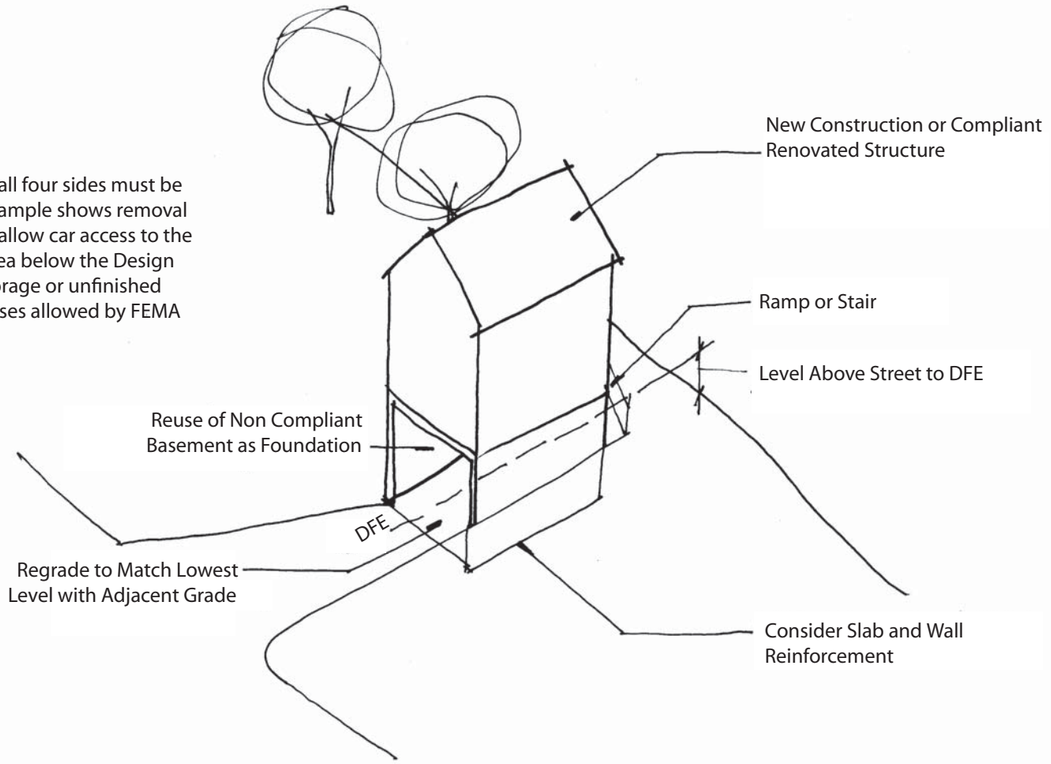


Ivy walls, integrated breakaway lattice, decks, stairs, and railings can be used to create architectural interest on elevated structures. Relationship to pedestrian scale is critical at the street level. These designs (above and to the left) were completed as part of the Biloxi Model Home program by Architecture For Humanity and show how architectural elements and landscape transitions can create interest on the street level. Photo Source: www.architectureforhumanity.org- Permission granted to use photos and designs in this report.

PARCEL SCALE APPROACHES:

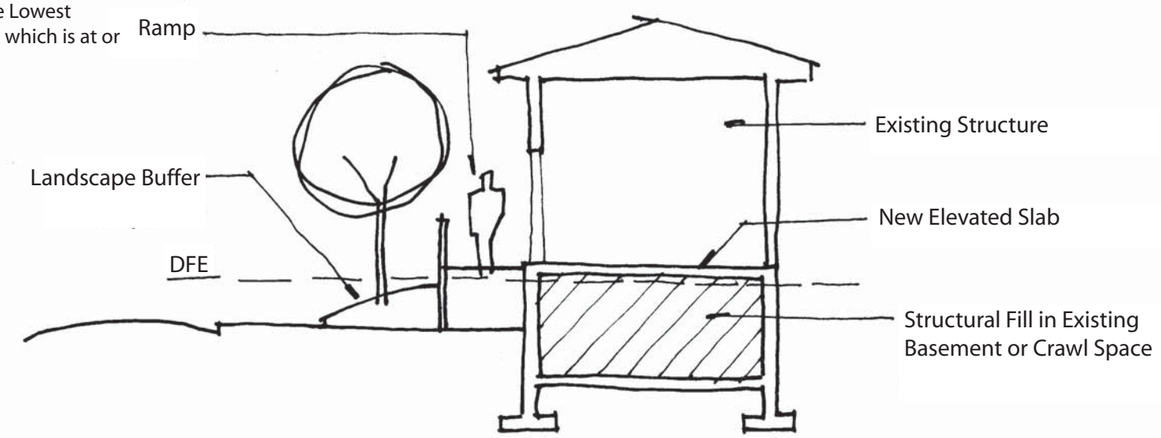
SOLUTION 4.6.1:

Basements and crawlspaces enclosed on all four sides must be eliminated to be flood compliant. This example shows removal of a wall and regrading of topography to allow car access to the Lowest Floor Elevation. The use of the area below the Design Flood Elevation is changed to parking, storage or unfinished building access only, which are the only uses allowed by FEMA below the DFE in an A Zone.



STRATEGY 4.6.2:

Fill basement or crawlspace so the Lowest Floor Elevation is the sill elevation which is at or above the DFE



A. Description of Situation:

Parcel is within a FEMA regulated A zone, and the existing sill elevation is shown to be below the DFE according to GIS. The structure is either wood frame or structural steel. However, there is potentially also a non-compliant basement or crawlspace that would need to be removed or retrofitted in addition to raising the sill elevation as shown in Solution 4.5.

B. What is Required:

The structure's Lowest Floor Elevation and basement or crawl space must be at or above the Design Flood Elevation Non-compliant basements or crawlspaces must be made compliant as shown in the diagrams to the left and the sill of the building must be elevated. One side of building can be regraded to match existing grade (see solution 4.6.1) or basement can be filled in so lowest floor elevation is above the DFE see solution 4.6.2) In addition, other FEMA and State Building Code construction standards for materials and utilities apply- See Section 2.2. Verify flood zone and applicable codes on actual FIRM maps with Town Flood Administrator.

C. What is Recommended:

Parcel is in an A Zone, but consider exceeding requirements to meet V zone requirements. Build Floor Elevation as high about the Design Flood Elevation (DFE) as possible. Every opportunity to design to a higher standard is recommended.

D. General Solution:

Elevate the existing building or consider tearing it down and rebuilding if building is in poor condition to ensure the lowest floor elevation is at or above the DFE. Buildings constructed with these wood frame and structural steel materials are relatively the easiest to elevate. A sill at the bottom of the frame could potentially be identified from which the building can be lifted.

E. Effect on Insurance Premium:

Insurance premium will be costly since the sill is below the DFE. Severity of premium will depend on how far the Lowest Floor Elevation is below the DFE. Insurance premium will depend on how far the Lowest Floor Elevation is built above the DFE. Insurance premiums are reduced when the building is elevated above the minimum DFE.

Ivy walls, integrated breakaway lattice, decks, stairs, and railings can be used to create architectural interest on spaces below the DFE. Relationship to pedestrian scale is critical at the street level. These designs (to the left) were completed as part of the Biloxi Model Home program by Architecture For Humanity and show how parking and uses below the DFE can be screened at the street level. Photo Source: www.architectureforhumanity.org- Permission granted to use photos and designs in this report. Architectural designs of residences were completed by: Studio/Gang/Architects, www.studiogang.net and Guild Hardy Architects, www.gharchitects.com

Parking, storage and unfinished building access are the only allowed uses below the Design Flood Elevation. This precedent shows how parking can be located on the first floor of a structure. Photo Source: www.fema.gov

Precedent Examples:

These precedents are shown to give an idea of what potential solutions could look like

A. Description of Situation:

Parcel is within a FEMA regulated A zone, and the existing sill* elevation is shown to be below the DFE. The structure is either masonry or reinforced concrete. There is no basement or crawlspace in the structure.

Orange- Sill is up to 2' below the DFE
Red- Sill is 2' to 4' below the DFE
Cranberry- Sill is 4' or over below the DFE

B. What is Required:

Finish Floor must be elevated to be at or above existing Design Flood Elevation. An alternative option for commercial structures in A zones only is to waterproof the building to a point above the DFE. In addition, other FEMA and State Building Code construction standards for materials and utilities apply- See Section 2.2

C. What is Recommended:

Parcel is in an A Zone, but consider exceeding requirements to meet V zone requirements. Build Floor Elevation as high about the Design Flood Elevation (DFE) as possible. Every opportunity to design to a higher standard is recommended.

D. General Solution:

If the building use is commercial, consider waterproofing the building above the DFE. Buildings constructed with masonry or reinforced concrete are very difficult if not impossible to elevate, therefore there are two options: 1) If commercial, waterproof the building above the DFE or 2) Fill in the structure, and use the masonry as a basis for a new foundation. In many instances, it will be more economical to tear down and rebuild the structure.

E. Effect on Insurance Premium:

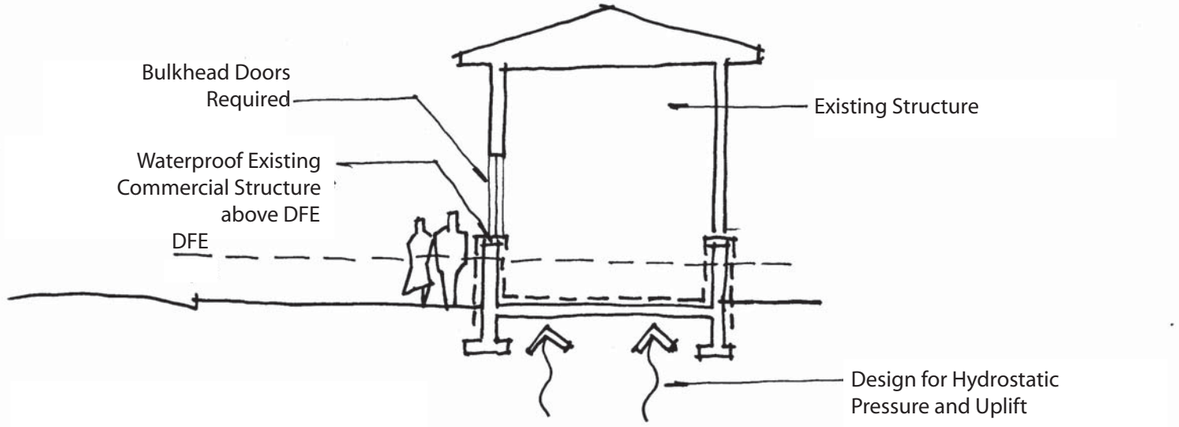
Insurance premium will be costly since the sill is below the DFE. Insurance premium will depend on how far the Lowest Floor Elevation is built above the DFE. Premiums are reduced when the building is elevated above the minimum DFE.

**An important note: The analysis uses sill elevations provided by the Town to determine if existing structures in the study area are compliant with the Design Flood Elevation in A zones. Actually, however, FEMA requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data, however, was the only information made available for the analysis. Therefore, for the purposes of this study, the published sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may, therefore, vary from what is indicated in this analysis for any given parcel.*

PARCEL SCALE APPROACHES

SOLUTION 4.7.1 FOR COMMERCIAL STRUCTURES IN A ZONES ONLY:

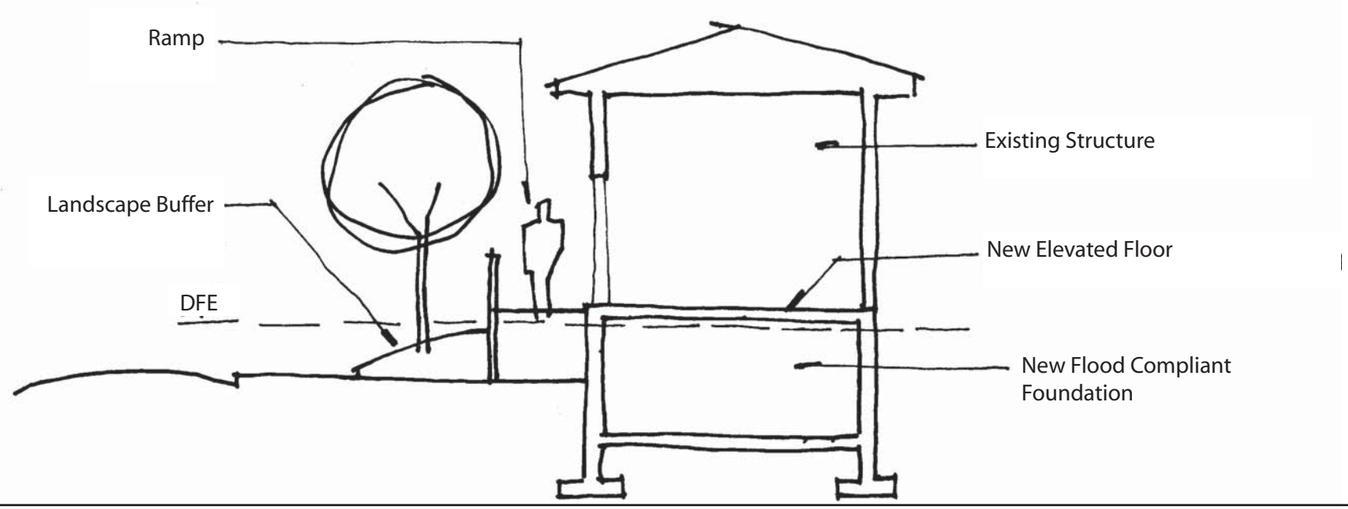
Waterproof to above the DFE. In A zones, commercial buildings are allowed to use waterproofing. It is difficult and expensive to rehab existing buildings. Often, window openings are too low for this to be a possibility.



PARCEL SCALE APPROACHES :

SOLUTION 4.7.2:

Fill in structure and use existing building as base foundation to get it above DFE



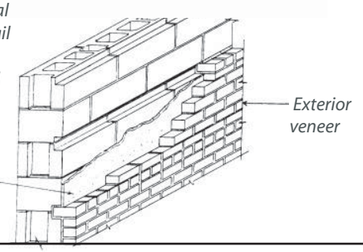
Precedent Examples:

These precedents are shown to give an idea of what potential solutions could look like

Where inside sill is higher than street elevation, use mid-level transition decks and planters to provide a grade transition as used here at Rowes Wharf in Boston.

Waterproofing a masonry building allows flood level to come higher than the finished floor while protecting the inside of the building.

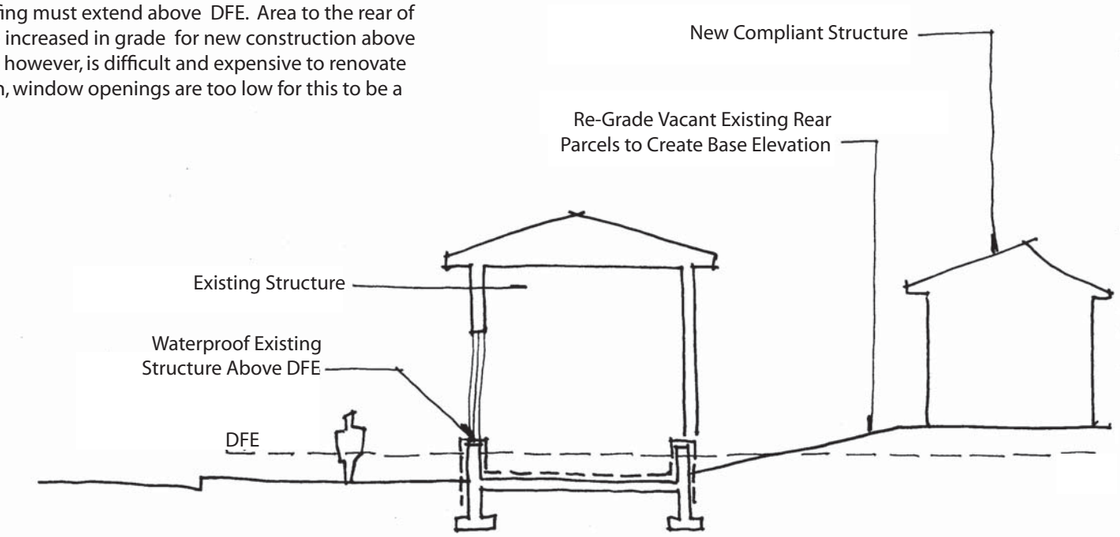
Diagram of a typical waterproofing detail applied between exterior veneer and structural wall



Where buildings are elevated on piers, ramps can be used below the Design Flood Elevation to access the structure. Ramps, as shown to the left, can be integrated into the building to create interesting architectural character. This design was completed as part of the Biloxi Model Home program by Architecture For Humanity. Photo Source: www.architectureforhumanity.org- Permission granted to use photos and designs in this report.

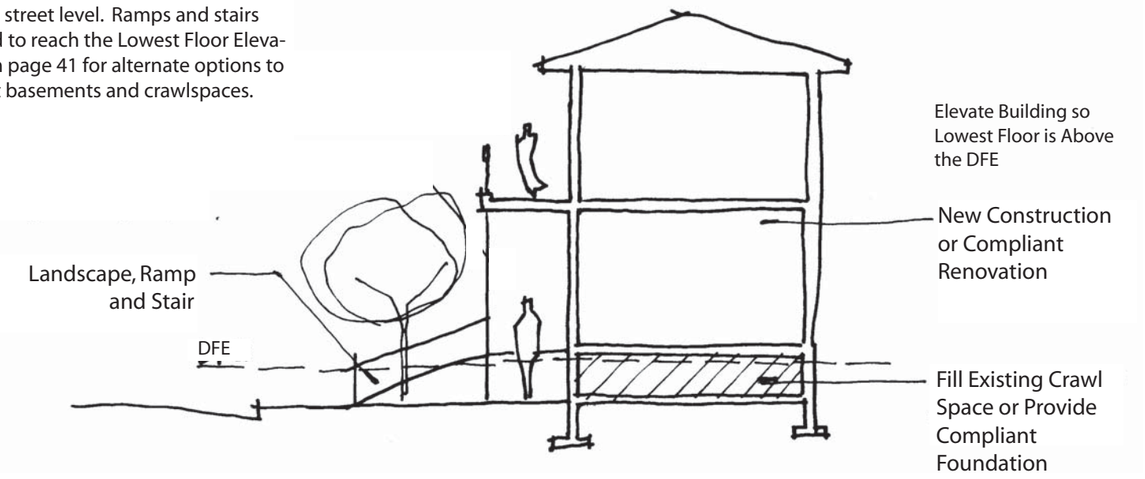
PARCEL SCALE APPROACHES
SOLUTION 4.7.3 FOR COMMERCIAL STRUCTURES ONLY IN A ZONES:

For masonry or reinforced concrete structures with basements or crawlspaces, waterproofing can be used to create a bathtub around the existing structure . This can only be used on commercial buildings in A zones. Hydrostatic water pressure underneath building must be strongly considered. Waterproofing must extend above DFE. Area to the rear of buildings could then be increased in grade for new construction above the DFE. Waterproofing however, is difficult and expensive to renovate existing buildings. Often, window openings are too low for this to be a possibility.



PARCEL SCALE APPROACHES:
SOLUTION 4.8.1:

All non-compliant basements and crawlspaces below the DFE must be removed or changed to be compliant. This drawing shows the easiest option to fill in the non-complaint basement or crawlspace with structural fill. An arcade could be added at the front of the structure transitioning the building to street level. Ramps and stairs would need to be added to reach the Lowest Floor Elevation. See Solution 4.6 on page 41 for alternate options to renovate non-compliant basements and crawlspaces.



A. Description of Situation:

Parcel is within a FEMA regulated A zone, and the existing sill* elevation is shown to be below the DFE. The structure is masonry or reinforced concrete and also has a basement or crawlspace.

Orange- Sill is up to 2' below the DFE
Red- Sill is 2' to 4' below the DFE
Cranberry- Sill is 4' or over below the DFE

B. What is Required:

The structures Lowest Floor Elevation must be at or above the Design Flood Elevation or for commercial structures only, there is the option of waterproofing above the DFE in A zones. The non-compliant basements/ crawlspaces must be made compliant. In addition, other FEMA and State Building Code construction standards for materials and utilities apply- See Section 2.2

C. What is Recommended:

Parcel is in an A Zone, but consider exceeding requirements to meet V zone requirements. Build Floor Elevation as high about the Design Flood Elevation (DFE) as possible. Every opportunity to design to a higher standard is recommended. Waterproofing is not allowed in V zones.

D. General Solution:

When building has a basement or crawlspace, it must be retrofitted or filled in. Buildings constructed with masonry or reinforced concrete are very difficult if not impossible to elevate, therefore there are two options: 1) If building has a commercial use, first consider waterproofing the building and basement to above the DFE or 2) Fill in the structure, and use the masonry as a basis for a new foundation. In many instances, it will be more economical to tear down and rebuild the structure.

E. Effect on Insurance Premium:

Insurance premium will be costly since the sill is below the DFE. Insurance premium will depend on how far the Lowest Floor Elevation is built above the DFE. Premiums are reduced when the building is elevated above the minimum DFE.

A. Description of Situation:

Parcel is identified in the Town GIS data base as potentially having historical significance. These properties are not on the historic register nor are they regulated by any registered historic district. These parcels were only identified as *potentially* having historic significance on a recent survey completed by town citizens.

B. What is Required:

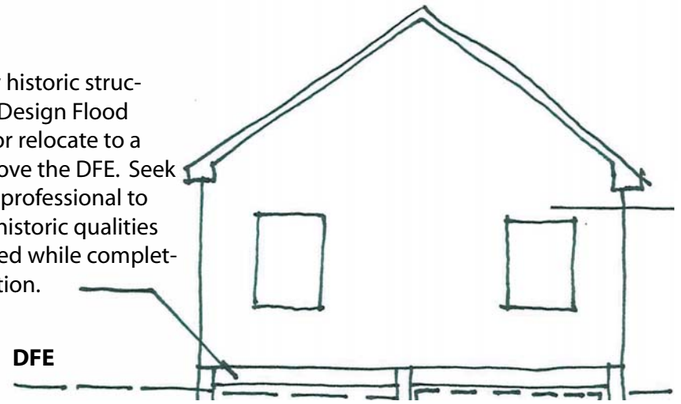
The same flood zone FEMA and State Building Code requirements apply- See Chart 2.2. In addition, there may be requirements for notification prior to demolition as well.

C. What is Recommended:

Hire a professional to complete a thorough assessment of the building structure and options for flood proofing to maintain historic qualities of the building.

D. Recommended additional reference materials:

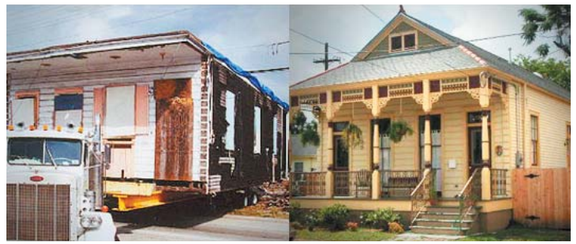
+Department of the Interior, Guidelines for Restoration of Historic Structures
+MA Historical Commission Design Guidelines
+ Cape Cod Commission, Regional Policy Plan
+ National Trust for Historic Preservation, Contact Agency at www.nationaltrust.org
+ Preservation Resource Center of New Orleans, Contact Agency at www.prcno.org



Raise potentially historic structures above the Design Flood Elevation (DFE) or relocate to a new location above the DFE. Seek help of a design professional to determine how historic qualities can be maintained while completing flood mitigation.

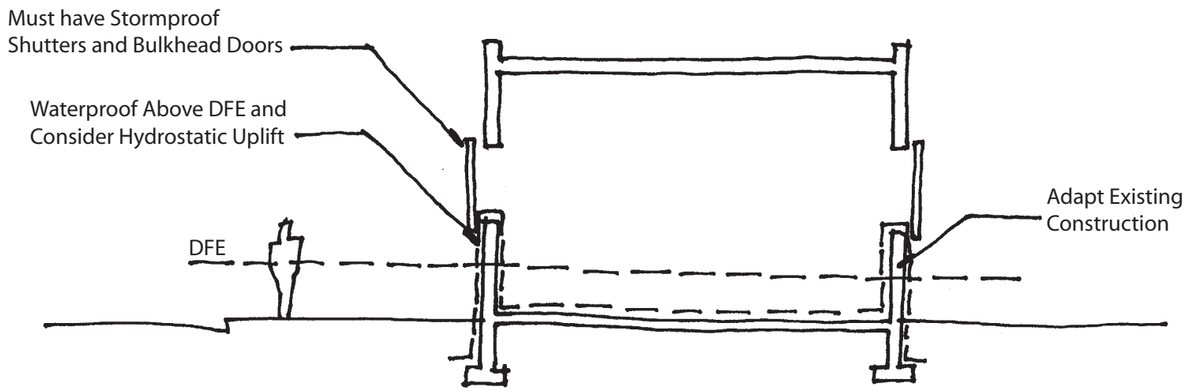
Interested parties should check with the Town Planner to understand any potential historic preservation concerns the community may have. Buildings identified by the Town as having potential historic significance may require notification and approval of demolition depending on the age of the structure.

Precedent Examples:

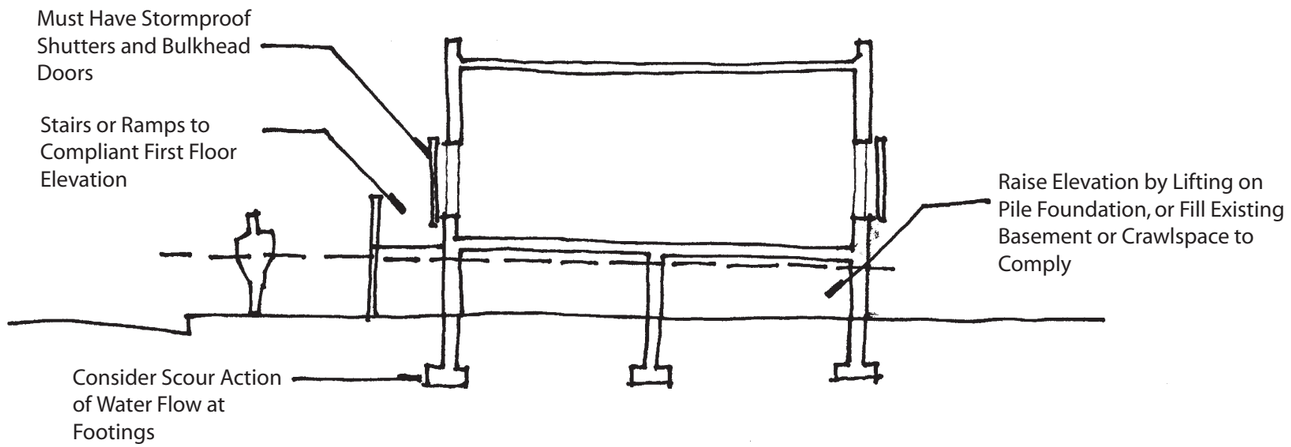


Where historic structures cannot be saved in their current location, sometimes they can be moved and transported to a new foundation above the Design Flood Elevation. Wood frame and structural steel structures are easiest to move. The project shown to the left is a flood damaged historic structure that was moved in New Oreleans and reconstructed by the Preservation Resource Center in a new location. Photo Source: www.prcno.org

PARCEL SCALE APPROACHES:
SOLUTION 4.10.1:
Waterproof all portions of structure below the DFE.



PARCEL SCALE APPROACHES:
SOLUTION 4.10.2:
Raise first floor of structure above the DFE on open, pier foundation or filled in foundation. Open foundation is preferred.



A. Description of Situation:
Parcel is within a FEMA flood zone and is a critical facility.

B. What is Required:
Waterproof to above the Design Flood Elevation or raise Lowest Floor Elevation at or above the Design Flood Elevation. Follow other FEMA and State Building Code requirements listed in Chart 2.2

C. What is Recommended:
Move the critical facility out of the flood zone since building access is limited during a flood event.

D. General Solution:
Relocate all critical facilities out of the flood zone. Move to areas as high above the DFE as possible. Meet not only FEMA requirements, but additional construction standards for high wind loads and storm damage prevention.

E. Recommended additional reference materials:
+American Society of Civil Engineers 7-05 Coastal Construction Manual.

In addition, some work has been completed to date that considers moving critical facilities out of the coastal flood zone. Please reference:
+Barnstable County Pre-Disaster Natural Hazards Mitigation Plan 2004 prepared by the Cape Cod Commission
+Town of Bourne, 2004 Pre Disaster Hazard Mitigation Plan

A. Description of Situation:

Parcel is in a velocity zone.

B. What is Required:

Structures in a V Zone must be certified by a registered engineer or architect for design and methods of construction to meet state and local codes and standards.

V Zone survey certification and FEMA Elevation Certificate are required.

C. What is Recommended:

Lowest horizontal structural member is above the DFE.

Structure is anchored to resist flotation, collapse, and lateral movement from combination of wind and water loads.

Utilities, panel boxes, and HVAC units are housed and secured above the DFE.

Consider not building.

D. General Solution:

Elevate habitable structure as high as possible and build to NFIP and FEMA recommended standards.

E. Effect on Insurance Premium:

Insurance premiums will be highest in a V zone. Strict standards and rigorous certification are required for federal insurance. Insurance premium will depend on how far the Lowest Floor Elevation is built above the DFE. Premiums are reduced when the building is elevated above the minimum DFE.

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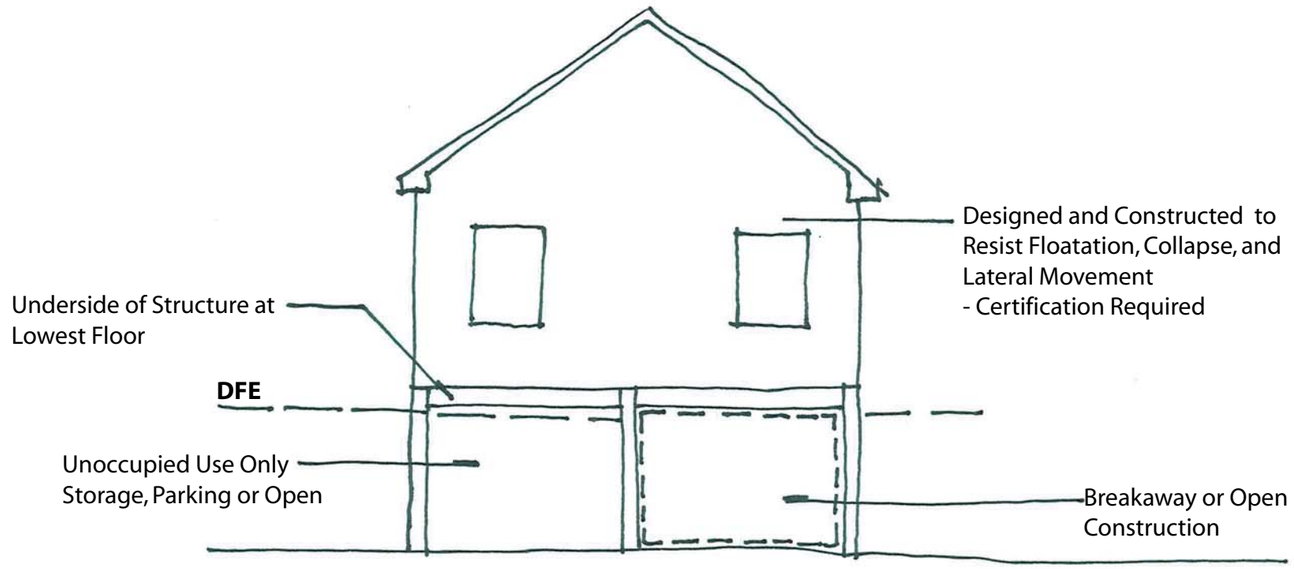
F. Recommended additional reference materials:

FEMA - Technical Fact Sheet No. 5
www.fema.gov



Precedent Examples:

These precedents are shown to give an idea of what potential solutions could look like

Open foundations are required in Velocity Zones.

COMPREHENSIVE VILLAGE & BLOCK SCALE APPROACHES:

On the following pages are comprehensive design strategies that would require multiple property owners and public entities to work together to make a more comprehensive solution. These strategies have been based on site analysis generated in Section 3 of this report. The village scale approaches assume that changes would often need to be made simultaneously in the public Right of Way, publicly owned parcels and on private properties to make the solutions feasible.

Design Strategy

5.1- Create integrated system of arcades and multi-level decks

A. Description of Situation:

Several areas have a series of adjacent structures with the Lowest Floor Elevations significantly below the DFE.

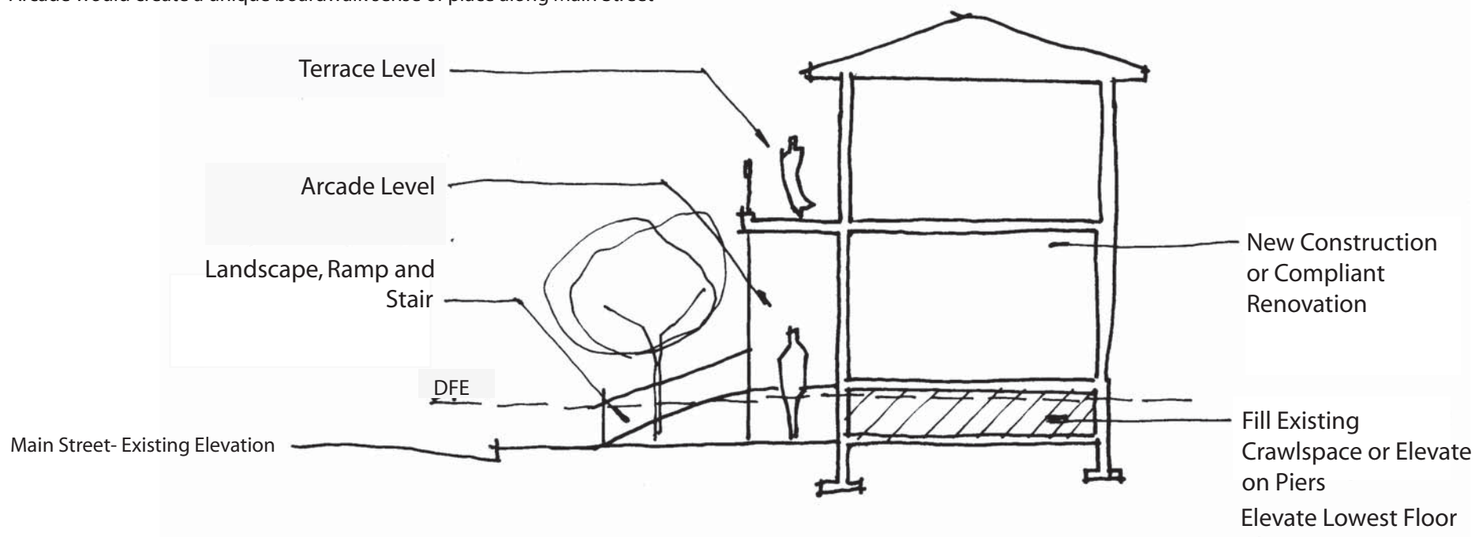
B. Potential Comprehensive solution:

Use 1/2 story decks and full story arcades that would bridge multiple parcels to provide access to areas above the Design Flood Elevation. Ramps and arcades would be constructed both in the public Right of Way and on private property. Handicapped ramp access could be provided at the end of blocks.

COMPREHENSIVE APPROACHES :

SOLUTION 5.1.1:

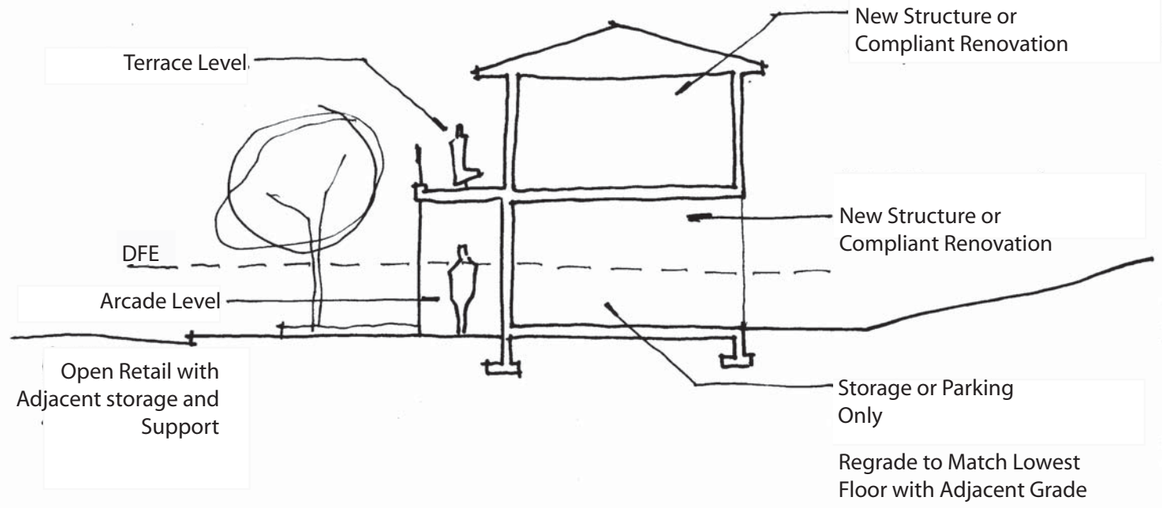
Provide block-long arcade to transition from building to building and between elevation of Main Street and elevation of new filled-in buildings. Arcade would create a unique boardwalk sense of place along Main Street



COMPREHENSIVE APPROACHES :

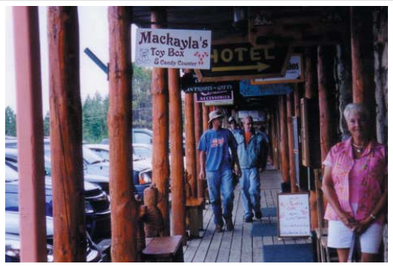
SOLUTION 5.1.2:

The existing floor elevations of all existing buildings are kept, but uses are changed on the 1st floor to one of the allowed uses below the DFE: parking, storage or unfinished access to the second floor. A block-long arcade is provided that has two levels. On the first level, temporary seasonal vendors sell merchandise, and their storage and parking is provided immediately behind the arcade on the first floor. The second floor is now the main level of the buildings. It is accessed by a terrace level arcade that transitions from building to building. At the end of the block, a long ramp and stairs would be provided to access the terrace level. This would prevent the need for elevators in every building.



SOLUTION 5.1 Plan View:
The arcade wraps the entire block and is accessed at the east and west ends of the block with ramps.

If existing buildings were filled-in or raised on piers approximately 5' to bring their sills above the DFE, an arcade could be built in the public Right of Way to transition from one building to another. This is shown in solution 5.1.1 on the previous page. Ramps would only need to be provided in one place at the end of the block to transition between the land elevation and the arcade elevation. Steps and landscape buffers could be placed between the edge of Main Street and the arcade.



If the arcade level is designed below the DFE as shown in solution 5.1.2 on the previous page, the lower arcade level could be used for temporary vendors to sell seasonal wares or farmer's market type items. Temporary seating could also be provided

Precedent Examples:
These precedents are shown to give an idea of what potential solutions could look like

Photograph of Existing Conditions: Main Street looking west.

Visualization of Arcade Design Strategy: An arcade level could be constructed incrementally as shown in the center building of this rendering. As each property is renovated, the arcade in the public Right of Way is constructed. In the space below the Design Flood Elevation, only allowed uses take place including parking, storage and building access. Over time, the arcades can be linked spanning the block. This rendering shows the arcade as a typical deck structure, but a more coastal vernacular boardwalk arcade could be created. In this rendering, the Port O'Call building is also renovated with waterproofing below the DFE and an addition is added to the top of the structure.

Design Strategy

5.2- Elevate Main Street

A. Description of Situation:

Several areas have a series of adjacent structures with the Lowest Floor Elevations significantly below the DFE.

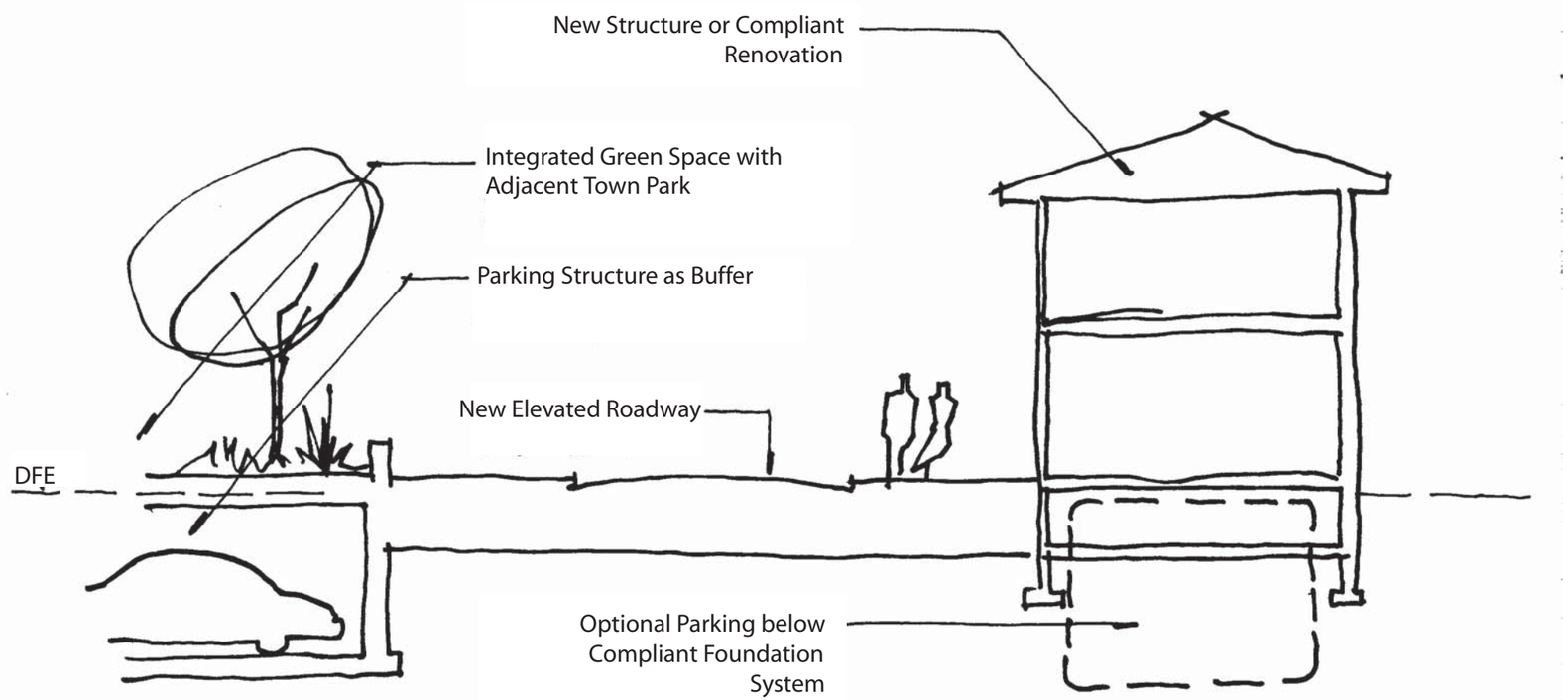
B. Potential Comprehensive solution:

Raise Main Street, integrating underground parking, and using park space to transition the grade back to the waterfront.

C. Recommended additional projects to reference:

Precedents to consider include:
1) Waterfront Redevelopment in Pittsburgh, Pennsylvania
2) Baton Rouge Proposed waterfront underground parking
3) Chattanooga Tennessee Waterfront Park Areas
4) Rowes Wharf Boston

The existing Maritime Academy is a good example to understand how filling topography can be used to bring areas out of hazardous flood zones. The Academy used topography to remap a significant portion of the campus from a flood prone V Zone to a more flood resistant A Zone. Significant portions of the campus have been filled resulting in building floor elevations above the Design Flood Elevation.

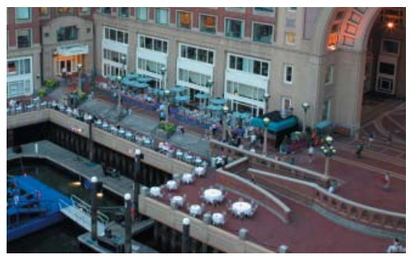


Precedent Examples:

These precedents are shown to give an idea of what potential solutions could look like

A similar project utilizing a filled park and landscape is proposed along the Baton Rouge waterfront. The design is currently being completed by Hargreaves Associates. Photo Source: www.hargreaves.com

In Chattanooga Tennessee, park space and stairs are used to transition to the water level, raising finish floor grades of adjacent buildings. The design was completed by Hargreaves Associates. Photo Source: www.hargreaves.com



Ramps, stairs and multi-level public plazas are used at Rowes Wharf in Boston to transition the elevated building grade to the waterfront. Underground parking is provided below the flood elevation.

COMPREHENSIVE APPROACHES :
SOLUTION 5.2:

Sill elevations of existing buildings are significantly below the Design Flood Elevation at the west end of Main Street. This concept proposes elevating a portion of Main Street and the adjacent blocks above the DFE. Underground parking structures could be provided both under the elevated blocks and adjacent Town park. Where cut materials are excavated for the new parking structure, they could be placed to raise adjacent blocks.

The difficulty in this approach is that a significant amount of work would need to take place on both private and public parcels, requiring extensive coordination and potentially some parcel acquisition. In addition, many of the existing buildings would most likely need to be removed.

Design Strategy

5.3- Move Targeted Downtown Center

A. Description of Situation:

Higher land, out of the 100-year floodplain exists on the east end of Main Street.

B. Potential Comprehensive solution:

Focus revitalization efforts in Buzzards Bay within this naturally higher topography and away from coastal high hazard areas. Redevelopment will be cheaper since there are no FEMA requirements. If redevelopment is focused here, this will be the easiest place with most financial reward for investor development. Once revitalization starts to occur and Buzzards Bay gains some momentum, it may eventually increase real estate values making other projects within the 100 year floodplain more financially feasible.

Another idea for implementation of this strategy would be to develop a Transfer of Development Rights Program (TDR) within Buzzards Bay to aid in relocation of the downtown center. The east-end of Main Street could be targeted as the receiving area, and the west-end flood prone parcels could be designated as the sending zone.

C. Recommended additional precedent references:

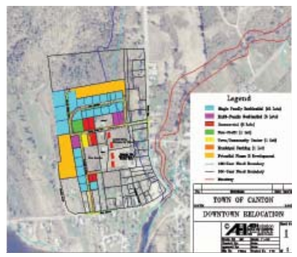
Other municipalities that have relocated their primary downtown centers out of the floodplain:

1) Canton, Maine
2) Fort Fairfield, Maine

Contact FEMA Region 1 for more information on these projects: www.fema.gov

Precedent Examples:

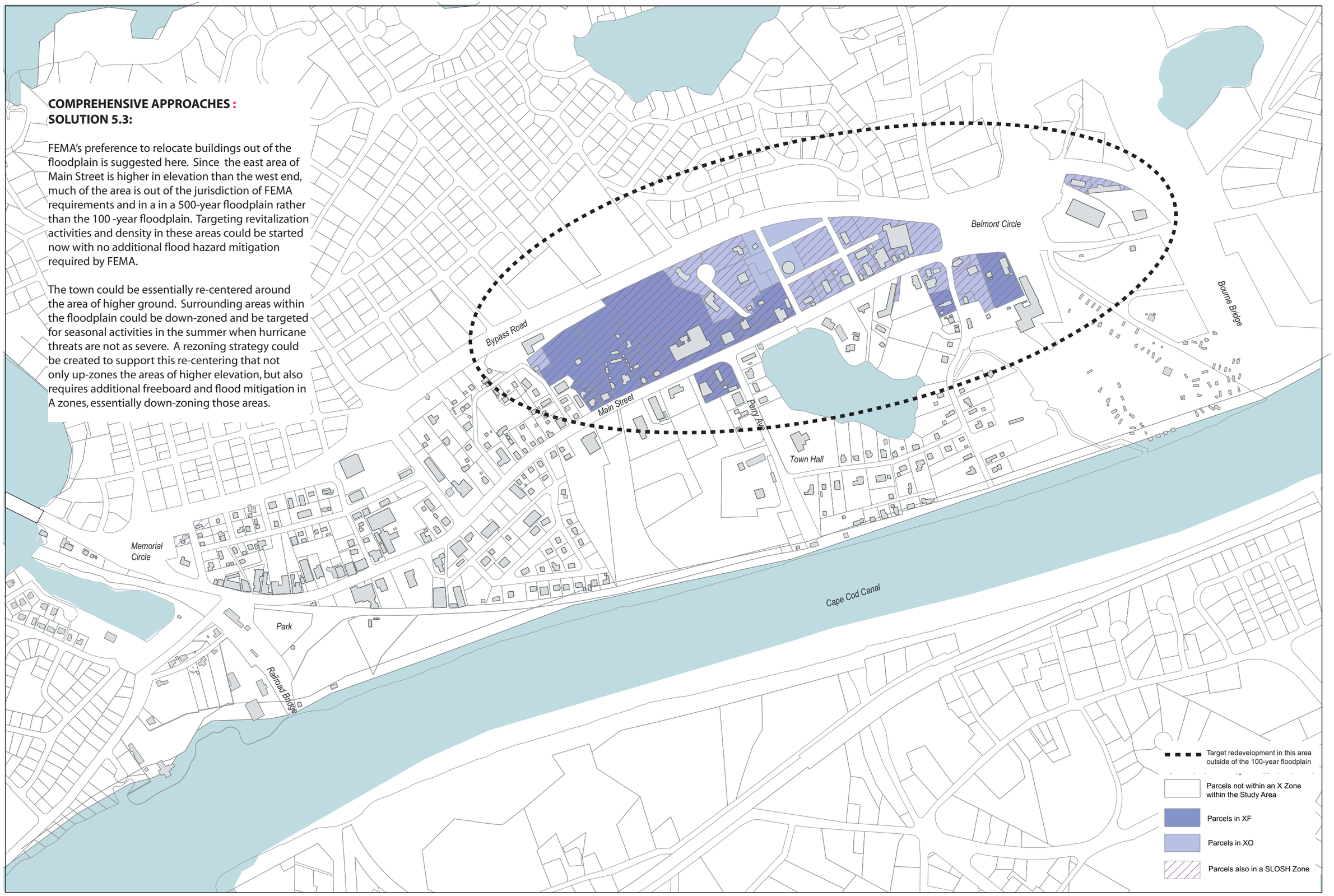
In Canton ME, the Town is in the process of relocating its downtown center from this flood prone zone to a new area outside of the floodplain. The community has sought the pro-bono help of academic collages and universities to assist in the planning work.



COMPREHENSIVE APPROACHES :
SOLUTION 5.3:

FEMA's preference to relocate buildings out of the floodplain is suggested here. Since the east area of Main Street is higher in elevation than the west end, much of the area is out of the jurisdiction of FEMA requirements and in a in a 500-year floodplain rather than the 100 -year floodplain. Targeting revitalization activities and density in these areas could be started now with no additional flood hazard mitigation required by FEMA.

The town could be essentially re-centered around the area of higher ground. Surrounding areas within the floodplain could be down-zoned and be targeted for seasonal activities in the summer when hurricane threats are not as severe. A rezoning strategy could be created to support this re-centering that not only up-zones the areas of higher elevation, but also requires additional freeboard and flood mitigation in A zones, essentially down-zoning those areas.



6 Next Steps and Action Items

6.0 Introduction to Next Steps

On the following pages is a list of action items the Town and its partners should consider taking to move towards the dual goals of both flood hazard mitigation and redevelopment in the Village of Buzzards Bay. The action items listed identify next steps and priority ranking of things the community can consider. These action items supplement the action items already identified in the Town's 2004 Pre-Disaster Hazard Mitigation Plan.

In addition, many of these action items require sources of funding both to complete planning activities and related construction. Following the list of action items, a list of funding sources specifically available for flood hazard mitigation activities is presented.

6.1 Action Items and Next Steps

Below are listed action items. The priority designation indicates in what order the actions would occur, not necessarily which is the highest priority.

6.10 Action Items/ Next Steps

Item #	Item	Description	Priority	Next Steps	Other Information/ Precedent Communities
	The following actions encourage 1) decreasing the flood hazard and 2) decreasing the cost of redevelopment				
6.11	Create a Local Hazard Mitigation Planning Committee (Could be similar in composition to the Pre-Disaster Mitigation (PDM) Community Planning Team that was created to write the 2004 Town-wide PDM Plan)	This Committee would spearhead all of the efforts outlined below. It would provide leadership and grant writing to ensure that the following projects and Action Items get completed. This could be a sub-committee in the Town or within the BFDC.	1	Determine how LHMPC Committee would be structured and form the Committee	Hilton Head, NC created a leadership committee to ensure flood mitigation activities are addressed.
6.12	Inform the Public: Create a flood hazard mitigation website	This website would serve 2 purposes: 1) It would present information in one place to help clarify flood issues to encourage redevelopment where appropriate 2) It would increase public safety by disseminating information on obtaining flood insurance, understanding what to do in a flood event, evacuation strategies etc. Maps and information from this study could be included.	1	LHMPC committee to seek funding to complete Website. Then hire consultant to complete Website.	Scituate, Massachusetts has a flood hazard mitigation website that is easily accessed by the public.
6.13	Participate in the FEMA Community Rating System (CRS)	Communities can apply to FEMA's National Flood Insurance Program to gain CRS status. Communities with lower CRS numbers gain community-wide discounts on insurance premiums. FEMA provides a checklist of minimal requirements communities must meet to apply. The following should first be completed:	1	Town to first complete sub-items listed under 6.13, then put together application for CRS status	CRS is a voluntary incentive program that rewards community floodplain management actions meeting 3 goals: 1) reduce flood losses 2) facilitate accurate insurance rating and 3) promote awareness of flood insurance. Chatham, MA is a precedent community with CRS Status and therefore receives reductions on insurance premiums.
		1) Obtain CRS Checklist. Document conditions that are already met			
		2) Maintain Elevation Certificates and create system to easily access the certificates			
		3) Consider additional Floodplain bylaws that are more restrictive than NFIP requirements indicated below. If more restrictive floodplain bylaws are passed, lower CRS status can be obtained.			Cape Cod Commission has a model floodplain bylaw that would create additional more restrictive standards. It is available on the commission website: www.capecodcommission.org

6.14	Complete Village Master Plan Strategy	The strategy should consider findings from this report and other studies completed recently for the village. It should makes recommendations for both physical design changes and infrastructure improvements to move development out of the floodplain and encourage redevelopment out of the floodplain whenever possible. The following options should be considered:	1	Town and its partners to seek funding and obtain consultant services for this next step to be taken after the visioning stage.	By moving centers of development out of the 100-year floodplain, redevelopment of the village will be much less costly since FEMA requirements will not need to be met. Flood insurance will also be less expensive. Not only will this benefit redevelopment, but also human safety. Precedent communities in the Northeast include the town of Canton, ME and Fort Fairfield, ME. Master Plans in these communities were completed to move the downtown area out of the floodplain.
		1) Option 1: Change the pattern of flooding and remap the flood zone. Elevate Main Street and associated blocks to raise them out of the floodplain. Where structures are raised, structured parking should be considered underneath.			Pair topography changes with other needed infrastructure projects such as transportation and sewer recommendations.
		2) Options 2: Focus redevelopment to existing areas such as the east end of Main Street that is already above the floodplain. Focus infrastructure improvements only in these areas. Discourage redevelopment within the floodplain.			
		3) Option 3: Retrofit existing structures to make them FEMA compliant. Use the public Right Of Way (ROW) to create strategies for the entire block to have raised walkways and arcades to access structures as they are elevated in the downtown area.			Town-funded grant incentive programs could be created to help encourage redevelopment of properties. Assistance would be given to property owners who completely retrofit their structures to FEMA Standards. Town could develop infrastructure projects to completed arcade and other elevated public walkway improvements in the public ROW.
6.15	Create New Zoning Bylaws to compliment findings of Master Plan to benefit flood hazard mitigation. Specific strategies to consider are listed below.	New Zoning Bylaws should be created to compliment the findings of the Village Master Plan Strategy. The Zoning should encourage redevelopment outside of the floodplain, retrofitting existing structures to be FEMA compliant, and prohibiting new building within the velocity zone (V Zone). In addition, it should consider a new bylaw to increase the Design Flood Elevation to account for Sea Level Rise.	2	Utilize technical assistance provided by the Cape Cod Commission to tailor and adopt the model floodplain district bylaw in Bourne. Obtain consultant services if needed to also consider a TDR strategy or other zoning initiatives to implement the Master Plan.	The Cape Cod Commission is in the process of reviewing and developing new standards for its model floodplain district bylaw. When this project is completed in 2008, Bourne should consider adopting the model bylaw
		Upzone a new center for development outside of the 100 year floodplain on the east-end of Main Street. Increase density and height allowances where necessary to provide an incentive for redevelopment.			
		Consider streamlining permitting process for pre-existing, non conforming structures when they are only increasing non-conformity due to flood mitigation activities.			
		Consider more stringent regulations exceeding FEMA requirements to increase public safety including the following:			
		*For buildings in the velocity zone, prevent increasing SF of existing structures and provide no new public infrastructure in these areas.			Brewster, MA initiated a similar ordinance
		*Require additional freeboard between Design Flood Elevation and floor level to account for projected Sea Level Rise and larger events			Chatham, MA initiated a similar ordinance
		*Require open foundations in A zones in addition to V Zones			
		water in large events. Consider green roofs and low impact development strategies. Consider regulations that lower carbon emissions relating to a reduction in Sea Level Rise.			
		*Create requirements for SLOSH zones in addition to FEMA regulated zones.			

Item #	Item	Description	Priority	Next Steps	Other Information/ Precedent Communities
6.16	Initiate a consultant structure-by-structure cost benefit analysis of flood proofing	Study can help property owners determine if it is economically viable to retrofit their structures, or if new construction is a better option. The results of this study can be used as a basis for a publicly funded Flood Prone Structures Retrofitting Grant Program, that allocates funds to private property owners to rehabilitate structures where it makes most sense.	3	LHMPC committee to seek funding and complete.	Scituate, MA
6.17	Create Flood Prone Structures Retrofitting Grant Program	Provide a grant funding program where funds are given to properties where redevelopment is wanted and flood hazards can be mitigated.	3	LHMPC committee to seek funding and complete.	Quincy, MA created a grant retrofitting program funded by FEMA through the Pre Disaster Mitigation Grant Program- (See Chart 6.2) and CDBG funds
6.18	Consider forming Redevelopment Authority	A Redevelopment Authority could be formed to help assemble parcels for private/ public joint redevelopment partnerships. This could be undertaken once the larger Master Plan Strategy is in place, where key parcels and blocks are targeted.	3		
6.19	Research Self-Insurance	Research potential to have an entity with bonding authority act as local insurance agent to self-insure the area.	3	LHMPC to research.	
6.2	Complete an analysis of supporting natural systems	Investigate any opportunities to improve absorptive natural system through beach nourishment, sand fencing & creation of dunes, and increasing wetland areas	3		
	Potential Dual Purpose Action Items Identified in other Recent Studies	*The below action items have been listed in other recently completed village studies as projects the Town should consider. These action Items are identified here as having potential to possibly also mitigate flood hazards if planned appropriately. When the Village Master Plan Strategy is completed, these projects should be carefully considered to provide dual purposes.*			
	Action Items in Transportation Plan that could consider working to mitigate floods:				
	Belmont Circle Reconfiguration				
	Memorial Circle Reconfiguration				
	Widening Route 25 Access Ramps				
	Pleasure Boat Basin- dredging and relocation of land				
	Extend Main Street sidewalk improvements to Belmont Circle				
	Commuter Parking Lot at Belmont Circle with Inter City Bus Terminal				
	Work with developers to provide parking facilities				
	Cohasset Bridge Replacement				
	More pedestrian access points between Main Street and canal access road				
	Commuter Rail Terminal and 1200 parking spaces				
	Ferry Terminal				
	Action Items in Sewer Study if planned, could mitigate floods:				
	Install new force main- roads could be raised as part of same project				

6.2 Potential Grant Funding Sources

Identified below are potential grant sources to fund flood mitigation activities and action items listed in 6.10.

6.20 Sources of Grant Funding for Action Items

Item #	Name of Funding Program	Who Administers	Goal	How Much	Application Deadline/ Grant Cycle	Competition	Contact Information	Special Information
6.21	Pre Disaster Mitigation Grant Program (PDM)	FEMA	To reach a higher level of risk management and risk reduction through hazard mitigation planning and the implementation of mitigation projects and activities prior to a disaster event. This funding is specifically targeted for implementation of flood mitigation projects.	TBD		National		Must apply through State Emergency Management Agencies
6.22	Hazard Mitigation Grant Program (HMGP)	FEMA	Funds to significantly reduce or permanently eliminate future risk to lives and property from natural hazards	Funds are based on a percentage of the total public assistance and individual assistance programs given during an event.	Available following a major disaster declaration if requested by the Governor.	State	http://www.mass.gov/dcr/stewardship/mitigate/grants.htm	
6.23	Flood Mitigation Assistance (FMA)	FEMA	To implement cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the NFIP.	Funding is an annual allocation to the State based on the number of NFIP insured properties and number of repetitive loss properties.	Available after a national event when the president releases funds.	State	http://www.mass.gov/dcr/stewardship/mitigate/grants.htm	
6.24	Community Development Action Grant (CDAG)	MA Department of Housing and Community Development	Funds for infrastructure improvements that result in job creation and economic growth. Provides support for publicly owned or managed projects in areas where private investment will not otherwise occur without the CDAG grant.	1,000,000 maximum	Rolling	State	http://www.mass.gov/dhcd/components/cs/1PrgApps/CDAG/default.HTM	
6.25	Regional Economic Development Pilot Program (REDPP)	Carnstable County, Cape Cod Economic Development	Funds for economic development projects in one of the 15 Cape Towns that meet one of the following funding priorities: 1) Main Street Redevelopment 2) Workforce Housing 3) Renewable Energy	up to 30,000 for 3 years (90,000 total)	Letter of Intent: October	Cape Cod Municipalities and Non Profit Organizations	http://www.capecodedc.org/licenseplategrantsintroduction.htm#REDPP	
6.26	CDBG Small Cities Program	HUD					http://www.hud.gov/offices/cpd/communitydevelopment/programs/	

7 Appendix

7.1 Details of GIS Analysis:

A GIS analysis was completed to generate the maps included in this report. The specifics of the analysis is described below.

Base Data:
The Town of Bourne Planning Department furnished the following base data:
-GIS layers for: parcels, town designated historic significance, buildings (including sill height information taken from 1988 Main Street Sewer Drawings), zoning, and ponds
-2006 Assessors data in excel spreadsheet format
-Hard copies of most recent FEMA FIRM maps- released 8/9/1999
-Hard copies of the 1988 Main Street Sewer Drawings

The Cape Cod Commission then generously digitized the infomation from the FEMA FIRM maps, including flood zones and contours, and entered the information into GIS. Also, the Cape Cod Commission's GIS department merged 2006 Assessors Database with the Town's GIS Parcel Layer to have one geo-referenced data source of parcel information. Lastly, the Cape Cod Commission provided GIS data layers for Sea Lake and Overland Surges from Hurricane Zones (SLOSH Zones) and Critical Facilities in the Town of Bourne.

The Analysis:
The following information details the GIS queries completed for the Flood Hazard Analysis:

Flood Zone Designation
The flood zone GIS layer created by the Cape Cod Commission (digitized 8/9/1999 FEMA FIRM maps) was used to assign flood zones.
Each parcel is assigned only ONE flood zone. The parcel is given the designation of the most restrictive flood zone touching any point of the PARCEL.

Each Parcel was assigned one of the following flood zones: XF, XO, A14, A15, V17
An Important Note: Many parcels are located within 2 or more different flood zones. Since the analysis is trying to determine the Study Area's level of current compliance, parcels with existing buildings are given a flood zone designation of the most restrictive flood zone touching the parcel. Included maps are not meant for parcel-level analysis and original FEMA FIRM maps must be referenced for parcel level information.

Sill Elevation Distance from the Design Flood Elevation*
For parcels in the **A zones only,** the sill elevation of any structure on the site was subtracted from the Design Flood Elevation of the parcel. If parcels had more than one structure, the parcel was assigned the sill distance with the greatest degree of non compliance. V zone parcels were not included in this analysis because sill elevations were not available for these structures. Parcels with an X Zone designation were not included since FEMA does not have flood mitigation requirements in these areas.

Parcels were Placed into 6 categories:
1) Sill is at or above Design Flood Elevation
2) Sill is up to -2' below the Design Flood Elevation
3) Sill is between -2' and -4' below the Design Flood Elevation
4) Sill is over -4' below the Design Flood Elevation
5) Buildings present, but no sill elevation was available
6) Vacant- There are either no structures on the parcel or accessory structures only according to the assessors data. Parcels in A Zones owned by the Army Corps of Engineers are also placed in this category even if the parcel has a structure.

*An important note: The analysis uses sill elevations provided by the Town to determine if existing structures in the study area are complaint with the Design Flood Elevation in A zones. However, the actual FEMA code requires that the Finish Floor Elevation (FFE), rather than sill elevation, be at or above the Design Flood Elevation in A zones. Sill elevation data however, was the only information made available for the analysis, therefore for the purposes of this study, sill elevation is assumed to be equal to the FFE. Actual FFEs and relative levels of compliance may therefore vary from what is indicated in this analysis. It is likely that the Finish Floor Elevation of most structures is actually higher than the sill elevations shown, therefore the study areas are likely more compliant than currently indicated on the distances below DFE documented in this analysis.

Basement & Crawlspace Designation
For parcels in the **A zones only,** any parcels with structures that potentially have basements or crawlspaces according the the assessors data were identified. If parcels had more than one structure, the parcel was assigned the greatest degree of non-compliance. (In this case, structures with basements and crawlspaces are more non-compliant than those without.) V zone parcels were not included in this analysis. Parcels with an X Zone designation were not included since FEMA does not have flood mitigation requirements in these areas.

In the parcel had a structure with one of the following fields in the Assessors data, it was given the designation that YES, the structure has a besement or crawlspace:
FLR/WALL(FULL), FOUN.WALL, FLR & WALL, FOUND.WALL
A sample block of this type of building was field-checked for accuracy and found that 95% of those field inventoried did have a basement or crawlspace.

Building Materials/ Structural Frame Designation
For parcels in the **A zones only,** parcels with structures were placed into one of two categories describing the structural frame of the building. If parcels had more than one building, the parcel was assigned the frame building material most difficult to elevate. (In this case, masonry or reinforced concrete buildings are the most difficult to elevate)

Assessor's Data was used to place the buildings into a structural category. It was double checked with the structural materials indicated on the 1988 Main Street Sewer study. If the two data sets did not agree, information was verified with the Town Planners Office.

In the parcel had a structure with one of the following fields in the Assessors data, it was given the designation the designation of MASONRY or REINFORCED CONCRETE
MASONRY, REINF. CC, MASONARY

In the parcel had a structure with one of the following fields in the Assessors data, it was given the designation the designation of WOOD FRAME or STRUCTURAL STEEL
WOOD FRAME, METAL, STRUC. STEEL. FR W/ VENEER, FRAME W/ VENEER, FR/VENEER, STEEL FRAME, POLE FRAME

A sample block of this type of building was field-checked for accuracy and found that 95% of those field inventoried appeared to be the structural system identified in the assessors data.

Designation that Structure was Built Prior to 6/29/1973
For parcels in the **A zones only,** parcels with buildings built in 1973 or before were identified. If parcels had more than one building, the parcel was assigned this designation if any building on the site had an effective construction date of 1973 or before.

The data for the year built was taken from the field 'EFFECTIVE YEAR BUILT' in the Assessor's Data.

Historic Significance Designation
The Town provided a GIS data layer indicating parcels with potential Historic Significance as determined in a recent citizen survey. Only project area parcels with potential historic significance were included in the analysis.

Critical Facility Designation
The Cape Cod Commission provided a GIS data layer indicating parcels with Critical Facilities. Only project area parcels with critical facilities were included in the analysis.