Rhode Island and Connecticut Coastal Nonstructural Assessment

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USACE National Nonstructural Flood Proofing Committee
in support of the USACE-New England District

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1 Introduction

This nonstructural assessment has been conducted in support of the USACE-New England District, to assess the flood risk within a defined coastal area of Rhode Island and Connecticut, generally focusing in the vicinity of Westerly and Wood River, RI, as well as Pawcatuck, CT. The structures contained within this assessment consist of residential and commercial buildings. The objective of the assessment is to identify the opportunity for potential flood risk adaptive measures, typically referred to as nonstructural mitigation measures. A location map of the general study is presented in Figure 1.

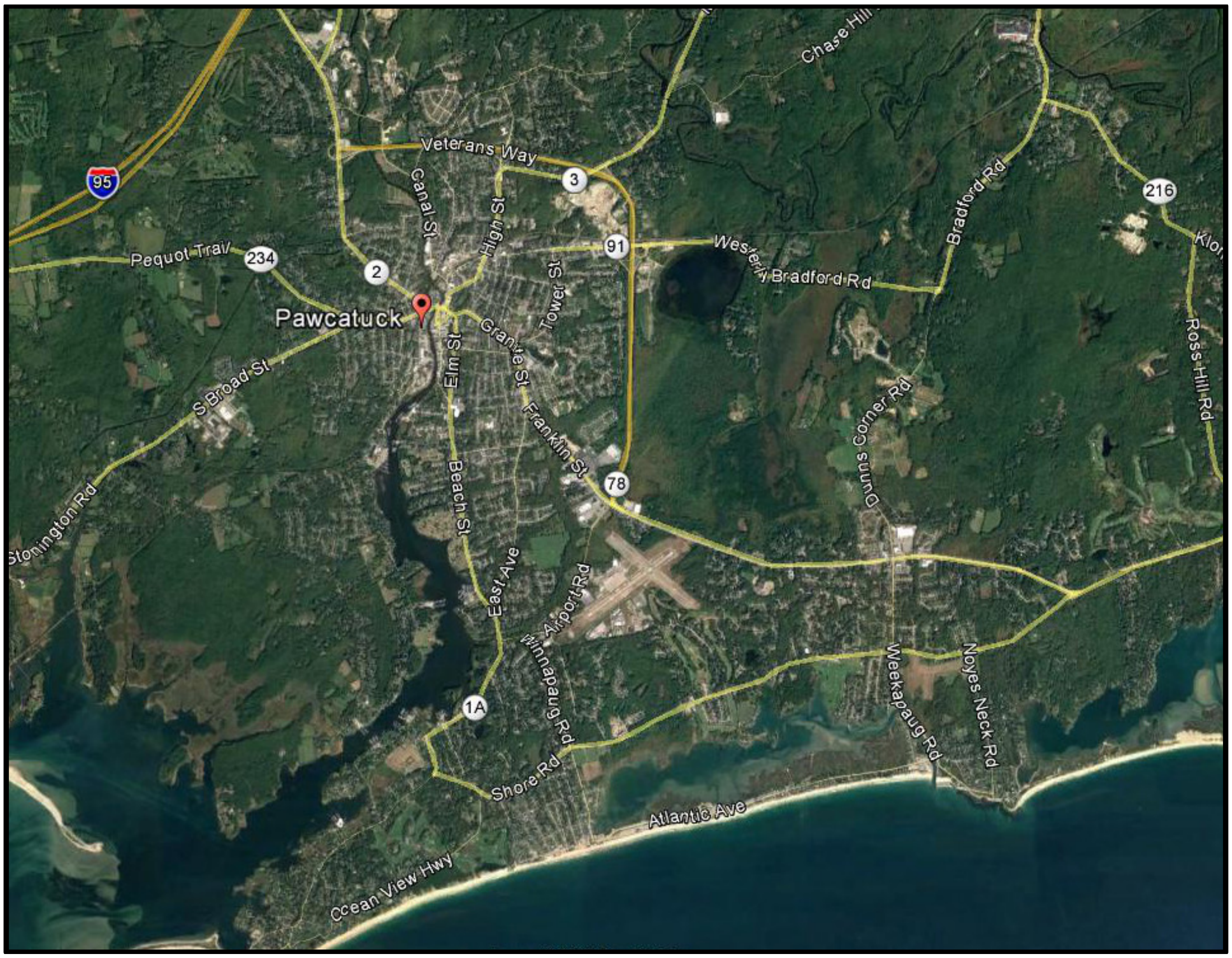

Figure 1
Rhode Island and Connecticut Coastal Assessment General Location Map

1.1 Description of Flood Risks

The assessment area is plagued by flooding from the Atlantic Ocean, area rivers and streams, and to a certain extent, tide affected riverine flooding. The pronounced historic development of this area is marked by densely populated commercial and residential structures. Critical facilities and infrastructure are located throughout the assessment area. There exists a potential for loss of life and extreme property damages for each occurrence of significant flooding.

Flooding within the assessment area requires the response and recovery efforts of federal, state, and regional agencies, as well as local and neighboring governments, residents and outside volunteers. When flooding occurs, the drain on human and financial resources is significant. Damage to residential, commercial and industrial facilities adversely impacts the local and regional workforce as well.

Whether hydrologic conditions remain the same or increase in the future, the structures located within the vicinity of the assessment area are at risk of flooding. This report focuses on a sampling of at-risk structures and contains a reconnaissance level assessment used for investigating the incorporation of nonstructural flood risk adaptive measures within the study area. Without the incorporation of nonstructural mitigation or other structural measures such as levees, floodwalls, and channel modifications, these structures are at risk of being damaged or destroyed from future significant flood events. Table 1 provides a list of the structures considered within this assessment.

Table 1
Structures Considered within Nonstructural Assessment

Location	Address	Occupancy	1% Flood depth
Westerly, RI	179 MAIN ST	commercial	6.2
	19 MARGIN ST	commercial	4.7
	106 MAIN ST	commercial	2.2
	1 COMMERCE ST	commercial	6.2
	12 HIGH ST	commercial	7.2
	26 HIGH ST	commercial	7.2
	37 MAIN ST	commercial	9.2
	2 BROAD ST	commercial	7.2
	23 BROAD ST	commercial	2.5
	148 ATLANTIC AVE	commercial	6.2
	25 SPRAY ROCK RD	commercial	2.3
	26 BREACH DR	commercial	7.4
	321 ATLANTIC AVE	commercial	3.8
	328 ATLANTIC AVE	commercial	10.2
	664 ATLANTIC AVE	commercial	6.9
	668 ATLANTIC AVE	commercial	7.4
	69 ATLANTIC AVE	commercial	6.8
	8 CRANDALL AVE	commercial	1.3
Richmond, RI	4 WOOD RIVER DR	residential	0.6
Pawcatuck, CT	34 CANAL ST	industrial	3.0
	9 HISCOX RD	residential	2.3
	3 SARATOGA AVE	residential	0.4
	5 SARATOGA AVE	residential	NA
	84 WHITE ROCK RD	industrial	2.0
	450 BRADFORD RD	commercial	4.5
	460 BRADFORD RD	industrial	3.8
	15 LIMA DR	residential	1.4
	30 POST OFFICE LN	residential	6.3
	20 WALNUT ST	commercial	1.7
	16 MECHANIC ST	commercial	0.9
	MODULAR / TRAILER	residential	NA

1.2 Floodplain and Flood Risk Characteristics

The source of the most major historic floods in the assessment area is from rainfall associated with localized rainfall events, from floodwaters occurring upstream and being conveyed through the assessment area, or from coastal storms.

The Federal Emergency Management Agency (FEMA) has defined varying levels of flood risk due to riverine and coastal flooding. The riverine flood risks are depicted on floodplain maps in areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage as an A Zone. The base flood elevations (BFE), the depth of flooding for a 1% annual exceedance chance flood event, are shown on A Zone floodplain maps. Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves, are referred to as V Zones. These areas also have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed hydrologic analyses are shown at selected intervals within the V Zone floodplain maps. Because the forces associated with the coastal storm waves may be significant, cautionary measures must be considered when mitigating structures located within the V Zone.

The floodplain located within assessment area consists of the entire spectrum of development; residential, commercial, light industrial and governmental/public. Age of development is from very old to relatively new and modern.

1.3 Assessment Background

While nonstructural flood risk adaptive measures are specific to the individual structure being investigated, when considered for the mitigation of flood damages, the cumulative effect is to determine a strategy for incorporating a full range of nonstructural mitigation measures which are economically feasible, socially acceptable, environmentally acceptable, and will reduce the cumulative risk of flooding. Each individual structure assessed may require a different nonstructural technique. While this assessment relies on data collected in the field for implementation, the assessment is not conclusive as to the ultimate feasibility of the alternative. Because of the limited nature of this level of investigation, this assessment was conducted as reconnaissance level detail.

Nonstructural flood risk adaptive measures require different implementation methods than structural measures. Since each structure is owned and typically occupied, nonstructural implementation agreements must be entered into with each individual owner. Nonstructural measures are proven methods and techniques specifically directed at reducing flood risk and flood damages in floodplains. Numerous structures across the nation are subject to reduced risk and damage or no risk and no damage due to implementation of nonstructural measures. Nonstructural mitigation measures are very effective for both short and long term flood risk and flood damage reduction and can be very cost effective when compared to other types of flood risk management (levee systems, detention, and channel modification) measures.

The ability of nonstructural measures to be implemented in very small increments, each increment producing flood risk reduction benefits is an important characteristic of this form of flood risk reduction. Also important is the ability to implement measures over intermediate and long periods such that layering of measures, each one providing a higher degree of risk reduction, is possible and given both Federal and non-Federal funding constraints, may be probable.

2 Nonstructural Flood Risk Adaptive Measures

The overall purpose of a nonstructural flood risk adaptive measure is to reduce flood risk, decrease flood damages, and to potentially eliminate life-loss. Flood risk adaptive measures reduce risk by modifying the characteristics of the vulnerable buildings and structures that are subject to flooding or modifying the behavior of people living in or near floodplains. In general, nonstructural measures do not modify the characteristics of floods (stage, velocity, duration) nor do they induce development in a floodplain that is inconsistent with reducing flood risk. Some nonstructural measures that can be formulated include removing buildings from the floodplain by relocation or acquisition; wet or dry flood proofing buildings; implementing flood warning and emergency preparedness activities; and implementing floodplain regulation. The National Flood Insurance Program (NFIP) is also considered among nonstructural flood risk adaptive measures since it contains programs to provide minimum standards for floodplain regulation, to provide flood insurance, and to provide flood hazard mitigation. Some flood risk adaptive measures considered for flood damage reduction by USACE, such as dry flood proofing a residential structure, does not result in a flood insurance premium reduction for the owner. The intent by USACE is to design an engineered application of dry flood proofing which will reduce future flood damages.

In contrast, structural alternatives reduce flood risk by modifying the probability or frequency of flooding at a particular location. Structural measures do not modify the characteristics of existing development in the floodplain. Structural measures, although they decrease the frequency of flooding, can actually increase flood risk if the consequences of flooding are allowed to increase through development.

Some of the *basic* considerations used to develop nonstructural flood risk adaptive measures are as follows:

- Relocate buildings from the floodplain to a flood-free location.
- Acquire floodplain land that is in existing open space use to prevent future development that could be at flood risk.
- Acquire and demolish buildings within the floodplain and enforce deed restrictions to prevent future development that could be at flood risk.
- Elevate buildings above a determined flood elevation.
- Dry flood proof buildings (traditional building waterproofing)
- Wet flood proof buildings (retrofit existing buildings with water resistant materials and allowing flood water to flow through the building).
- Develop flood warning and evacuation procedures.
- Develop and implement emergency flood preparedness plans.
- Employ educational outreach programs aimed at reducing flood risk.

Each of these general categories of nonstructural measures can be applied as a single measure or can be applied in combination with one another or with structural measures to reduce or eliminate flood risk. The range of benefits, costs, and residual damages associated with application of each measure is broad. The extent and severity of social and economic impacts associated with the various measures can be likewise broad and must be identified for any plan. Depending upon the nonstructural measures selected for application and the relative percentage of each applied, the future land use pattern of the area could look considerably different in specific areas.

The consequences associated with locating damageable property and people within floodplain areas can be extreme to property owners and floodplain occupants. Within the context of this assessment, an objective is to identify strategies and measures that can be used in tandem to reduce flood risk. Some strategies and measures may be more appropriate for Federal action while others will be more attuned to local regulatory action and administration. In either case, these measures must be effective, socially acceptable, environmentally suitable, and mindful of the existing neighborhood and community social and economic systems within which they would be implemented. It is the intent of this assessment to identify such nonstructural flood risk adaptive measures.

2.1 Executive Order 11988; Floodplain Management (EO11988)

This Executive Order (EO11988) was issued by President Carter on 24 May 1977. In issuing EO11988 the President stated "in order to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative, it is hereby ordered that each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities…". The nonstructural flood risk adaptive measures assessment contained herein was conducted in complete compliance with EO11988 meaning that any nonstructural measures that are incorporated into alternatives recommended for implementation support the vision of EO11988.

2.2 Critical Facilities

Structures/facilities which provide services for health and public safety may become inoperable during a flood event and result in additional adverse impacts or hardship on the effected population are considered critical facilities. They are essential during a flood to provide human safety, health, and welfare. Critical facilities are generally those services required during the flood such as police and fire protection, emergency operations, evacuation sites, and medical services. Facilities which house the elderly, disabled, or requiring medical assistance, require extensive evacuation time are considered significant. Facilities that could, if flooded, add to the severity of the disaster such as power stations, waste water treatment plants, and toxic material storage sites are considered critical. Each significant and critical facility within the guidelines of EO11988 should be located at a flood free site. If this is not possible or practicable, the facility should be located external to the 500-year floodplain. If this is not possible or practicable, the facility must be, at a minimum, protected to the 500-year event.

2.3 Common Nonstructural Flood Risk Adaptive Measures

The following flood risk adaptive measures are commonly utilized for reducing flood risk within urban and rural areas across the nation. Each measure must meet specific criteria that would make it acceptable to addressing the flood characteristics and site conditions. While many nonstructural measures are presented in detail, not all measures were found to be acceptable for implementation within the study area.

2.3.1 Acquisition of the Structure. This measure consists of buying the structure and the associated land as part of the measure. The structure is either demolished or the structure is sold to others and relocated to a location external to the floodplain. Development sites, if needed, can be part of a project in order to have locations where displaced people can build new homes or businesses. This measure is applicable within the study area.

2.3.2 Relocation of Structure. This measure requires physically moving the at-risk structure and buying the land upon which the structure is located. This measure achieves a high level of flood risk reduction when structures can be relocated from a high flood hazard area to an area that is located completely out of the floodplain. Development of relocation sites where structures could be moved to achieve the planning objectives of reducing flood risk and retaining such aspects as community tax base, neighborhood cohesion, or cultural and historic significance can be part of any relocation project. This measure could be applicable within the assessment area.

2.3.3 Removal of Crawlspace/Basement. This measure consists of relocation of basement storage, utilities, mechanical equipment, electrical panels and circuits to above the BFE. Fill in the existing basement without elevating the remainder of the structure if the structures' first floor is currently located above the BFE or above the design elevation or whichever is higher. Placing an addition onto the structure to compensate for the lost habitable basement space to house the furnace, water heater, and other appliances. If the addition could not be developed because of limited space within the property parcel or because the owner did not want it, compensation for the lost basement space would be in order to the owner. Typically basement area is not the same value as above ground space.

2.3.4 Elevation of Structure. This measure requires lifting the structure or habitable area to above a specific elevation, as shown in Figure 2. If a basement exists, compensation for removal of the basement space would be in order to the owner. Basement space is not the same value as above ground space. This measure is applicable within the study area unless the required elevation is greater than 12 feet above the adjacent grade, where the recommendation would be for acquisition or relocation. Velocity and hydrodynamic forces would also have to be considered to ensure stability of the structure.

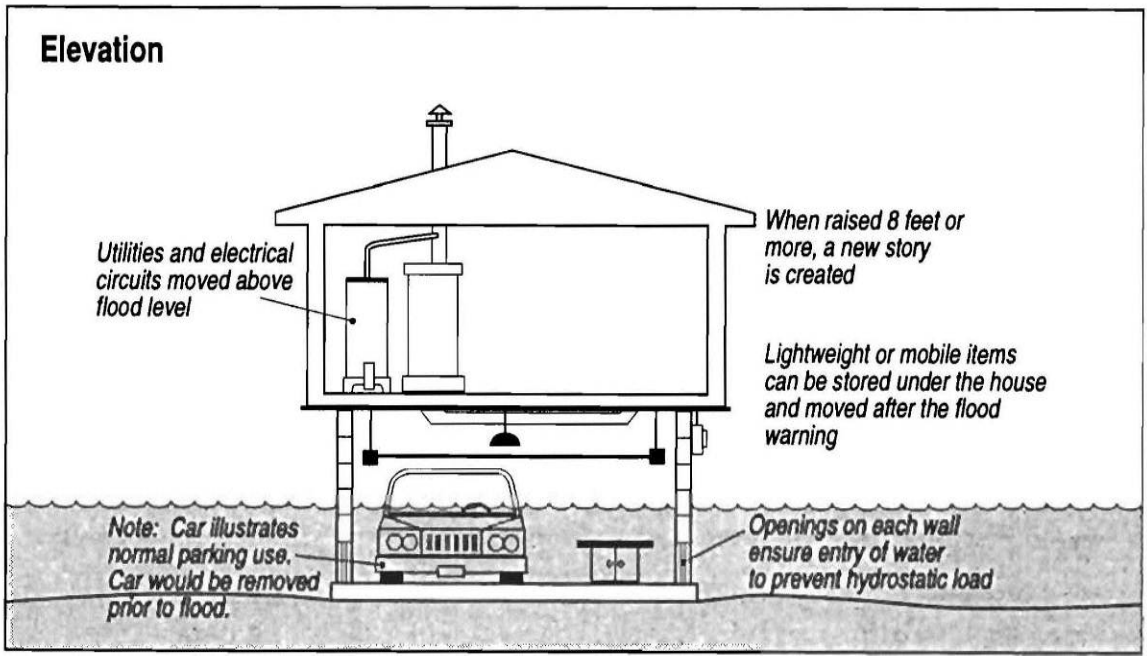

Figure 2
Elevation of Structure (Diagrammatic Section)

2.3.5 Dry Flood Proofing. This measure consists of waterproofing the structure. While this measure is generally acceptable with commercial buildings, it can be conducted on residential homes as well as all other types of structures. An example is shown in Figure 3. This measure achieves flood risk reduction benefits but it is not recognized by the NFIP for any flood insurance premium rate reduction if applied to residential structures. Based upon testing, a "conventional" built structure can generally be dry flood proofed up to 3 feet on the walls. A structural analysis of the wall strength would be required if it was desired to achieve higher protection. A sump pump and perhaps drain system may be required as part of the project to remove seepage or interior drainage. Closure panels are required for all openings. This concept does not work with basements or crawl spaces due to the possible long duration of flooding. For buildings with basements and/or crawlspaces, the only way that dry flood proofing could be considered to work is for the first floor to be made impermeable to the passage of floodwater.

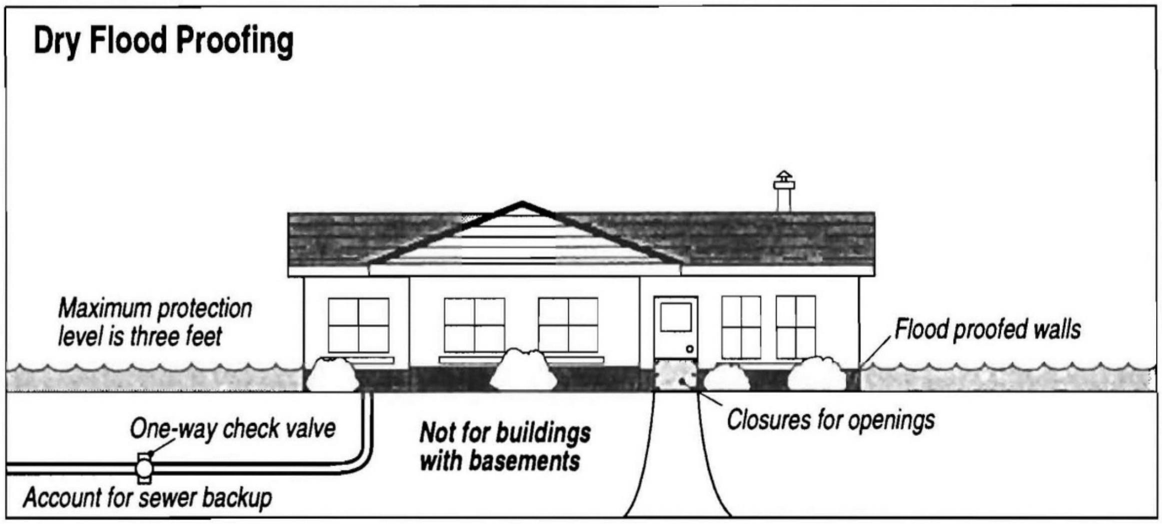

Figure 3
Dry Flood Proofing (Diagrammatic Detail)

2.3.6 Wet Flood Proofing. This measure is applicable as either a stand-alone measure or combined with other measures such as elevation. As a stand-alone measure, all construction materials and finishing materials to a specified height are required to be water resistant. An example is shown in Figure 4. All utilities must be elevated above the design flood elevation. Because of these requirements, wet flood proofing of finished residential structures is generally not recommended. Wet flood proofing is applicable to commercial and industrial structures and should be considered for combining with a flood warning system, flood preparedness, and flood response plan. This measure is generally not applicable to large flood depths and high velocity flows due to possible failure of structure walls.

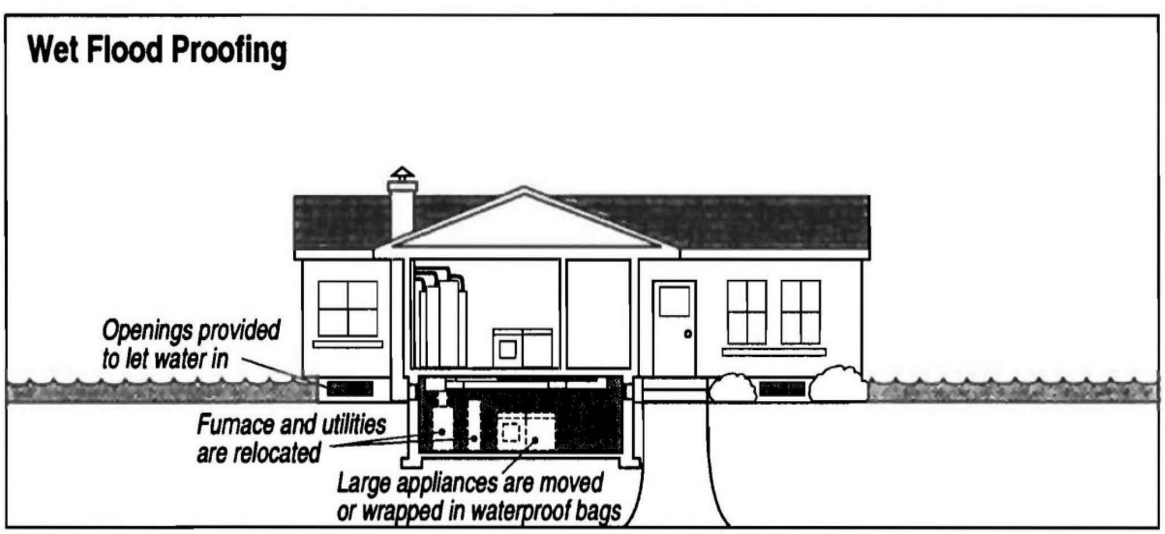

Figure 4
Wet Flood Proofing (Diagrammatic Detail/Section)

2.3.7 Berms, Levees, and Floodwalls. Although these items are structural in nature, and if considered for implementation by USACE, require standard USACE structural design criteria, they can sometimes be applied to individual structures without adversely impacting the floodplain. These measures are intended to reduce the frequency of flooding but not eliminate floodplain management and flood insurance requirements. An example is shown in Figure 5.

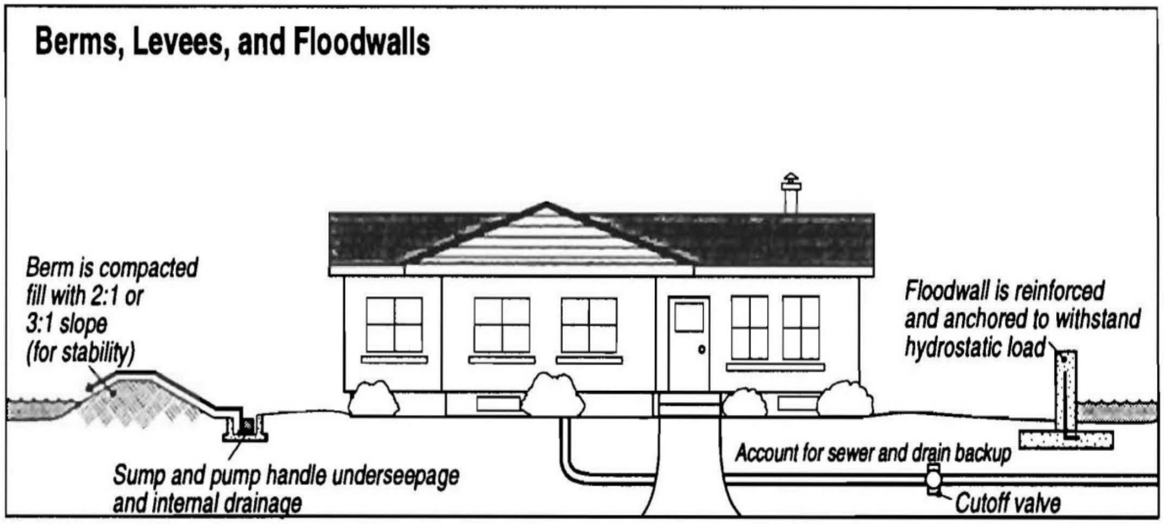

Figure 5
Berms, Levees, Floodwalls (Diagrammatic Detail)

2.3.8 Flood Warning, Preparedness, Evacuation Plans and Pertinent Equipment Installation. These nonphysical nonstructural measures are applicable to the entire study area. Any flood risk management plan should consider the development and implementation of flood warning systems and emergency preparedness planning. The development of such plans and the installation of pertinent equipment such as data collection devices (rain gages, stream gages) and data processing equipment for alerting the public can become an integral feature of a project.

2.3.9 Land Acquisition. Land acquisition can be in the form of fee title or permanent easement with fee title. Land use after acquisition is open space use via deed restriction that prohibits any type of development that can sustain flood damages or restrict flood flows. Land acquired as part of a nonstructural project can be converted to a new use such as ecosystem restoration and/or recreation that is open space based such as trails, shoreline access, and interpretive markers. Conversion of previously developed land to open space means that infrastructure no longer has need for utilities, streets, and sidewalks which can be removed as part of the project. The conversion to new use (ecosystem restoration and/or recreation) can also be part of a nonstructural project. By incorporating “ new uses of the permanently evacuated floodplains” into the nonstructural flood risk reduction project, economic feasibility of the buyout or relocation projects is enhanced due to transfer of some flood risk reduction costs to ecosystem restoration and by adding benefits and costs of recreation.

2.3.10 Floodplain Regulation and Floodplain Management. Floodplain regulation and floodplain management have proven to be very effective in reducing flood risk and flood damage. The basics principles of these tools are based in the National Flood Insurance Program (NFIP) which requires minimum standards of floodplain management and floodplain regulation for those communities that participate in the NFIP. While the minimum standards have not resulted in substantial flood risk reduction, incorporation of more stringent building codes and zoning ordinances may meet community objectives of eliminating flood risk.

2.3.11 National Flood Insurance Program (NFIP). The NFIP contains 3 basic parts; flood insurance, flood mitigation, and floodplain regulation. In terms of reducing flood risk, only flood mitigation and floodplain regulation have a direct impact in theory. In regard to the flood insurance part of the NFIP, flood insurance simply allows spreading the flood risk across multiple properties as does any insurance program. It does not reduce flood risk. It shares flood risk. In terms of the NFIP as a nonstructural measure to truly reduce flood risk, the flood mitigation and floodplain regulation parts of the NFIP are those measures. Five mitigation programs exist within the NFIP. They are the hazard mitigation grant program, pre disaster mitigation grant program, flood mitigation public assistance program, repetitive loss program, and severe repetitive loss program. Within the floodplain regulation part of the NFIP, this serves as a nonstructural mitigation measure indirectly through adoption of minimum floodplain management standards by communities participating in the NFIP.

3 Nonstructural Assessment Objectives and Procedures

The nonstructural assessment area consists of a large number of structures which are generally classified as residential or commercial. For a nonstructural assessment, each structure must be investigated for purposes of determining the flood risk to the structure and what type of flood risk adaptive measure is most appropriate for that particular structure given what it is, where it is located within the floodplain, what the flood characteristics are (velocities, stages, and duration), and other site conditions (soil, permeability, vegetation). A 1% annual chance exceedance flood was considered as the benchmark for implementation of nonstructural measures to mitigate the flood risk. Information was collected in the field, combined with additional information obtained through New England District and used to develop recommendations.

There were several considerations that had to be evaluated to determine if the nonstructural flood risk adaptive measures considered would be appropriate for a given structure. In particular, the structure had to be in relatively good condition, i.e., had to be structurally sound, in order to withstand elevation, relocation, or flood proofing. If the structure was in poor condition, then techniques are limited, as structures determined to be in poor condition may not withstand flooding or the application of specific mitigation may be too costly to perform.

For dry flood proofing, the depth of flooding has to be limited to three or four feet above ground elevation and the walls of the structure have to be of such structural integrity as to be able to withstand the forces applied by the floodwaters.

Relocation should be a consideration if the depth of flooding is determined to be so deep that the structure would be elevated to such a height that it would be unreasonable to inhabit the structure or if costs would increase due to the need for structural stability to resist wind forces on the elevated structure. Typically, elevation is limited to no greater than 12-feet.

3.1 Description of Nonstructural Structure Dataset

For this assessment, structure information was collected for a sampling of structures which were viewed during a site visit. The sample was randomly selected from throughout the floodplain. Structure categories are summarized in Table 2.

Table 2
Nonstructural Assessment Structure Category

Category	Number of Structures
Residential	7
Commercial	21
Industrial	3
Total	31

The assessment conducted was reconnaissance level in detail as surveys were not conducted to capture ground, lowest adjacent grade, or first floor elevations. If mitigation were to proceed for an individual structure, additional detailed data, including elevations and utilities would need to be obtained. For the current level of assessment, the data available is sufficient to identify potential nonstructural flood risk adaptive measures which could be effective in reducing future flood risk, life loss and property damage.

3.2 Description of Nonstructural Assessment

Structure inventory/data was obtained from New England District as well as from field reconnaissance conducted jointly by New England District and the NFPC. The field reconnaissance allowed the USACE team to observe each structure from the exterior. Structure, site characteristics, and flood elevations were compiled with field observations onto structure data/assessment sheets. The compiled information on the structure data/assessment sheets helped to demonstrate the potential flood risk and were used to identify potential nonstructural flood risk adaptive measures for recommendation to reduce the existing flood risk.

The Base Flood Elevation (1% annual exceedance flood elevation) was targeted for mitigation recommendations. Each structure was assessed using a similar format. The assessments and recommendations focused on mitigating structures utilizing elevation, dry flood proofing, wet flood proofing, or relocation. Only nonstructural flood risk adaptive measures which would be compliant with the National Flood Insurance Program (NFIP) and would reduce flood insurance premiums for the structure owner were considered.

The nonstructural measures presented in this report are stand-alone mitigation techniques for individual structures or combination techniques to provide the most effective level of flood risk reduction.

The following assumptions were incorporated into the assessment because of the limited access to the interior of structures and in some instances, to all exterior sides:

1. If basements existed in residential structures, they were assumed to be vacant and unfinished except for storage of HVAC equipment, water heater, electrical equipment, general storage, laundry, other.
2. Basement utilities, equipment and storage should be proposed to be relocated to an addition to the existing structure and above the mitigation flood elevation. A more detailed investigation would be required to determine the specific area to accommodate the addition.
3. Elevation greater than 12 vertical feet transitioned to a relocation recommendation due to the depth of flooding and potential risk to inhabitants and first responders.
4. Dry flood proofing was limited to four-feet in height unless the building appeared to have the structural integrity to be capable of withstanding greater forces.
5. Structures located within the coastal V Zone designation were predominantly recommended for relocation unless techniques such as elevation and wet flood proofing could be combined to provide justification for allowing the structure to remain at its existing location.

4 Recommendation of Nonstructural Flood Risk Adaptive Measures

Based upon the data collected for the sample structures and the potential depth of flooding for the 1% annual chance exceedance flood event, the recommended mitigation measures are identified in Table 3 for the 31 structures. In several instances the depth of flooding, if over 12-feet, dictates that relocation or acquisition of the structure be considered, unless the structure were a commercial building, whereas measures such as dry flood proofing or wet flood proofing could be considered. As discussed in Section 1.2, the general location of the structure played a significant role in the mitigation measure recommended. While all of the nonstructural flood risk adaptive measures are conceivable for riverine flooding, the wave surge associated with V Zone coastal flooding limits the type of mitigation measure recommended. Additional information regarding the reasoning behind the recommended technique for each structure is provided in Enclosure A.

Table 3
Recommended Nonstructural Mitigation Measures

Location	Address	Occupancy	NS Technique
Westerly, RI	179 MAIN ST	commercial	Dry Flood Proof
	19 MARGIN ST	commercial	Dry Flood Proof
	106 MAIN ST	commercial	Dry Flood Proof
	1 COMMERCE ST	commercial	Dry Flood Proof
	12 HIGH ST	commercial	Structural
	26 HIGH ST	commercial	Structural
	37 MAIN ST	commercial	Dry Flood Proof
	2 BROAD ST	commercial	Dry Flood Proof
	23 BROAD ST	commercial	Dry Flood Proof
	148 ATLANTIC AVE	commercial	Dry Flood Proof
	25 SPRAY ROCK RD	commercial	Dry Flood Proof
	26 BREACH DR	commercial	Dry Flood Proof
	321 ATLANTIC AVE	commercial	Relocate
	328 ATLANTIC AVE	commercial	Dry FP or Elevate
	664 ATLANTIC AVE	commercial	Dry FP or Elevate
	668 ATLANTIC AVE	commercial	Dry Flood Proof
	69 ATLANTIC AVE	commercial	Wet Flood Proof
	8 CRANDALL AVE	commercial	Dry Flood Proof
Richmond, RI	4 WOOD RIVER DR	residential	Dry Flood Proof
Pawcatuck, CT	34 CANAL ST	industrial	Dry Flood Proof
	9 HISCOX RD	residential	Elevate
	3 SARATOGA AVE	residential	Temp Dry FP
	5 SARATOGA AVE	residential	Temp Dry FP
	84 WHITE ROCK RD	industrial	Dry Flood Proof
	450 BRADFORD RD	commercial	Elevate
	460 BRADFORD RD	industrial	Earthen Berm
	15 LIMA DR	residential	Temp Dry / Wet FP
	30 POST OFFICE LN	residential	Elevate
	20 WALNUT ST	commercial	Temp Dry / Wet FP
	16 MECHANIC ST	commercial	None
	MODULAR / TRAILER	residential	Elevate

While it was beyond the scope of this study, in order to determine the economic feasibility of implementing any of the recommended nonstructural mitigation techniques, the total cost of each of the mitigation measures would be required, then annualized over a 50-year project life to determine the annual cost of providing flood risk management per individual structure. Similarly, if the annual benefits derived from each individual mitigation measure could be determined, by estimating the reduction in future flood damages prevented, where those benefits are proportionally weighed against the probability of future flood events and the damages which could have occurred to each individual structure from those future floods, a comparison of annual benefits and annual costs could be conducted. If the annual benefits for a structure are divided by the annual costs for that structure, a benefit to cost ratio (BCR) can be determined. A BCR greater than 1.0 indicates that the mitigation measure has more benefits than costs is worth further consideration for implementation.

5 Flood Insurance and the Benefits from Nonstructural Measures
Implementing nonstructural flood risk adaptive measures may result in reduced flood insurance premiums under the National Flood Insurance Program (NFIP) for specific type structures. Insurance premiums for structures located within the Special Flood Hazard Area are functions of the elevation of the first floor of the structure (which may be a basement or crawlspace, if either exists) with respect to the BFE. The lowest habitable floor elevation will dictate the premium rate for flood insurance.

Elevation of a structure, commercial or residential, onto an extended foundation wall, onto compacted fill material, piers, posts, or columns has the effect of reducing the flood insurance premium because the structure is being physically moved away from the flood risk. It is important to note that flood insurance is based upon a single flood event, the 1% annual chance exceedance flood event, and not a range of flood events. If the structure is elevated to the 1% flood elevation, there is still a possibility that a larger, more infrequent flood event could occur.

For commercial structures, a reduction in the annual flood insurance premiums may be obtained, if he structure can be dry flood proofed to at least the 1% flood elevation. The premium may be reduced further, if the structure can be reasonably dry flood proofed to a greater height. While dry flood proofing may reduce the flood insurance premium for a commercial structure, the NFIP does not currently recognize the effect of dry flood proofing on a residential structure. The homeowner should however be cognizant of damageable items located around the exterior of the structure, such as the air conditioner, the electric meter, electrical outlets, etc. which could add to out of pocket expenses if damaged during a flood event. Each of these items can be readily flood proofed in order to reduce future damages and expenses.

6 Assessment Conclusions
Coastal Rhode Island and Connecticut has numerous structures located within the 1% annual exceedance riverine floodplain and coastal V zone impacted by the ocean storms or riverine flood events. This nonstructural assessment was undertaken to identify potential flood risk adaptive measures which could be considered for potential implementation. This assessment considered 30 individual structures as a sampling of all structures within the general assessment area as to whether nonstructural flood risk adaptive measures would be a practical form of flood risk management. While the results indicate that there are potential mitigation techniques worth considering, a detailed investigation of costs and benefits could determine the economically feasible for implementation of individual mitigation techniques.

Rhode Island and Connecticut Coastal Nonstructural Assessment

Enclosure A

Nonstructural Assessment Structure Inventory Attribute Sheets

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof to 2% flood elevation

Structure Attributes

Structure Location:	179 Main Street, Westerly, RI
Occupancy / Built:	commercial / 1948
Structure Condition (visual):	good
1st Floor Area (sq ft):	4390
Exterior Wall Construction	CMU
Foundation Wall:	CMU
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows	2 pedestrian 1 vehicle / numerous
Garage:	none
Exterior Mechanical/Electrical/Fuel:	electric, oil, no AC
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
4.0	0.5	1.6	3.5	5.6	14.4

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
The exterior structure walls could resist flooding to possibly over 3-foot of depth. It is recommended that a water resistant sealant be applied to the walls to a height of four feet. The pedestrian entrances and vehicle entrances should be retrofitted with certified flood barriers and the structure windows should be retrofitted to either reduce the amount of glass and replace with similar exterior wall material or consider aquarium level of performance glass as a replacement.

Flood proofing beyond the 2% flood depth of 3.5 feet would require significant retrofits for all entrances and windows, as well as a structural assessment of exterior walls.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof to approximately1% flood elevation

Structure Attributes

Structure Location:	19 Margin Street, Westerly, RI
Occupancy / Built:	commercial / 1930
Structure Condition (visual):	good
1st Floor Area (sq ft):	3448
Exterior Wall Construction	wood shingle
Foundation Wall:	NA
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows	5 / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	AC, electric, gas
# Fireplace	0
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
5.5	0.5	0.1	2	4.1	12.9

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
The structure is extremely large and would thus be difficult to elevate above the 1% annual chance exceedance flood elevation. The construction appears to be wood frame, slab on grade. Dry flood proofing could be considered to a height of approximately 3- to 4-feet which could provide protection up to the 1% flood elevation. For permanent dry flood proofing the owner should consider retrofitting all entrances with certified flood barriers and removing the exterior siding to all incorporation of flood resistant material, after which the original siding could be replaced. For temporary measures, the owner could consider attaching a water impenetrable sheeting to the exterior of the structure, approximately 4-feet in height, all of the way around the exterior of the structure. The sheeting should be extended 4- to 5- feet away from the structure and weighted with sandbags to prevent flood waters from seeping under the sheeting. The temporary measure would require the removal of all vegetation within 5-feet from the exterior of the structure.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof to the 1% flood elevation

Structure Attributes

Structure Location:	106 Main St, Westerly, RI
Occupancy / Built:	commercial / 1985
Structure Condition (visual):	good
1st Floor Area (sq ft):	27,636
Exterior Wall Construction:	CMU
Foundation Wall:	CMU
Slab/Crawlspace/Basement:	Slab
# Entrances / # 1st Floor Windows:	NA / NA
Garage:	NA
Exterior Mechanical/Electrical/Fuel:	electric, gas
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
8.0	0.5	-2.4	-0.5	1.6	10.4

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This building appears to be a good candidate for dry flood proofing, based upon the exterior wall construction, access, and the height of windows. Can flood proof to at least 3-feet. Requires certified barriers for all entrances.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof to the 2 % flood elevation

Structure Attributes

Structure Location:	1 Commerce St, Westerly, RI
Occupancy / Built:	commercial / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	masonry / glass
Foundation Wall:	masonry
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows:	6 / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	electric, NA
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
4.0	0.5	0.0	1.9	4.0	12.8

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
For this entire structure to achieve flood risk reduction benefits, each portion of the structures should be dry flood proofed. If a bay does not dry flood proof, water could enter adjoining businesses through their common (party) wall. It would appear to be most cost effective to dry flood proof to the 2% flood event which has a depth of 1.9 feet. Going beyond this height may require significant modifications to the series of windows across the front of the structure. Certified barriers are recommended for each entrance.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Requires additional investigation. See assessment notes

Structure Attributes

Structure Location:	12 High St, Westerly, RI
Occupancy / Built:	commercial / 1910
Structure Condition (visual):	good
1st Floor Area (sq ft):	9,576
Exterior Wall Construction:	brick/masonry
Foundation Wall:	brick/masonry
Slab/Crawlspace/Basement:	basement
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	AC, electric, oil
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
3.0	0.5	2.6	4.5	6.6	15.4

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This is a complex flood risk management challenge, as the structure backs up to the river. The patio/walkway is cantilevered over the left-bank of the river. Unknown if high river flows could enter the structure from below the patio elevation. Although backside mechanicals have been elevated, concern over the integrity of the rear wall of structure for resisting flood flows. The 1% flood depth is 6.6 feet which would place significant hydrodynamic forces on the rear wall of structure. Recommend a structural review of the riverbank, patio structure, and commercial structure walls. This flood risk reduction may require structural floodwalls. The assessment is beyond the scope of this reconnaissance level investigation

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Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Requires additional investigation. See assessment notes

Structure Attributes

Structure Location:	26 High Street, Westerly, RI
Occupancy / Built:	commercial / 1900
Structure Condition (visual):	good
1st Floor Area (sq ft):	2,320
Exterior Wall Construction:	brick/masonry
Foundation Wall:	brick/masonry
Slab/Crawlspace/Basement:	basement
# Entrances / # 1st Floor Windows:	2 / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	AC, electric, gas
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
3.0	0.5	-5.6	-3.7	-1.6	7.2

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This is a complex flood risk management challenge, as the structure backs up to the river. Wile the first flow, front of structure appears to be well above the 1% flood depth, it is the backside of the structure, with its basement level which is a concern. Unknown if high river flows could enter the structure from below the patio elevation. Furnace is located in the basement. Concern over the integrity of the rear wall of structure for resisting flood flows. The 1% flood depth would place significant hydrodynamic forces on the rear wall of structure, which would be the basement area. Recommend a structural review of the riverbank, patio structure, and commercial structure walls. This flood risk reduction may require structural floodwalls. The assessment is beyond the scope of this reconnaissance level investigation. Although it would appear to be drastic, the owner could consider removal of the basement by filling it in. This would require relocation of utilities in the basement. Could consider partial filling, with a concrete cap. This would provide some flood risk reduction.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof to the 2% flood elevation

Structure Attributes

Structure Location:	37 Main St, Westerly, RI
Occupancy / Built:	commercial / 1900
Structure Condition (visual):	good
1st Floor Area (sq ft):	4,026
Exterior Wall Construction:	CMU / concrete
Foundation Wall:	CMU
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows:	2 / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	AC, electric, gas
# Fireplace	0
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

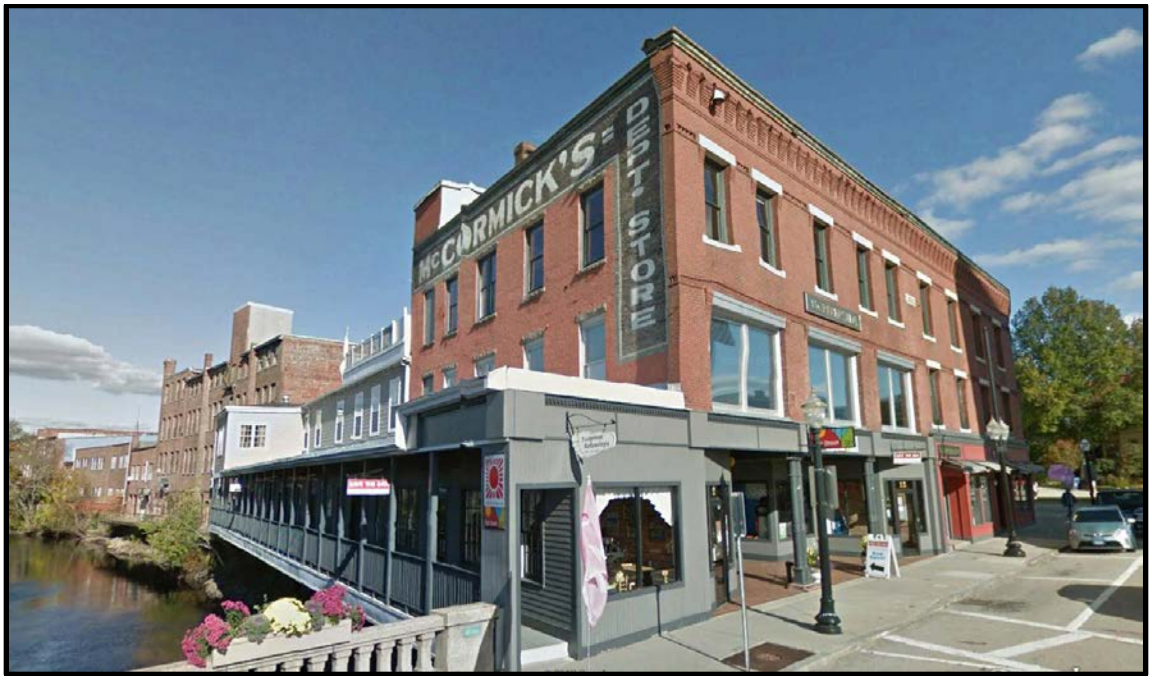
GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
1.0	0.5	4.6	6.5	8.6	17.4

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:

Since the exterior walls of this structure are constructed of masonry and concrete, it may be possible to provide flood protection up to the 2% flood depth of 6.5 feet. This would require application of a water resistant sealant over the exterior walls and certified flood barriers for each entrance. The exterior mechanical equipment appears to be located on the roof of the structure. Any wall penetrations would require sealant to prevent water from entering. The side and rear windows on the structure may require modification, such as changing the standard glass to aquarium or modifying the dimensions of the lower sill, by elevating them.

Structure Inventory Attribute Sheet



Recommended Nonstructural Technique Requires additional investigation. See assessment notes

Structure Attributes

Structure Location:	2 Broad St, Westerly, RI
Occupancy / Built:	commercial / 1882
Structure Condition (visual):	good
1st Floor Area (sq ft):	6,661
Exterior Wall Construction:	brick / masonry / clapboard
Foundation Wall:	brick / masonry
Slab/Crawlspace/Basement:	basement
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	AC, electric, gas
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
12.7	0.5	2.6	4.5	6.6	15.4

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This is a complex flood risk management challenge, as the structure backs up to the river. The patio/walkway is cantilevered over the left-bank of the river. Unknown if high river flows could enter the structure basement from below the patio elevation. Although backside mechanicals have been elevated, concern over the integrity of the rear wall of structure for resisting flood flows. The 1% flood depth is 6.6 feet which would place significant hydrodynamic forces on the rear wall of structure. Recommend a structural review of the riverbank, patio structure, and commercial structure walls. This flood risk reduction may require structural floodwalls. The assessment is beyond the scope of this reconnaissance level investigation

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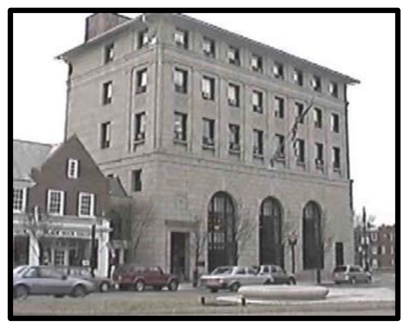
Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof to the 0.2 % flood elevation

Structure Attributes

Structure Location:	23 Broad St, Westerly, RI
Occupancy / Built:	commercial / 1900
Structure Condition (visual):	good
1st Floor Area (sq ft):	9,597
Exterior Wall Construction:	stone / masonry
Foundation Wall:	stone / masonry
Slab/Crawlspace/Basement:	basement
# Entrances / # 1st Floor Windows:	3 / 14
Garage:	none
Exterior Mechanical/Electrical/Fuel:	AC, electric, oil
# Fireplace	0
Landscaping and Shrubs:	0



Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
3.0	0.5	-7.1	-5.2	-3.1	5.7

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This is a structurally stout building. The walls are thick stone and masonry, providing the ability to resist flooding. Since the first floor is located approximately 3 feet above the flood elevation, there is the potential to consider certified flood barrier panels at entrances to a height equal to the lower window sill elevation to provide protection up to the 0.2% flood event. There is a concern that the basement could be adversely impacted by penetration of flood waters, as the floor elevation could be approximately 10-feet below the first floor elevation. The structure is located a distance away from the river, so flooding is not probable.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof to between 2% and 1% flood elevation

Structure Attributes

Structure Location:	148 Atlantic Ave, Westerly, RI
Occupancy / Built:	commercial / 1920's
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	wood / vinyl
Foundation Wall:	CMU
Slab/Crawlspace/Basement:	half basement/crawlspace
# Entrances / # 1st Floor Windows:	3-double / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	AC, electric
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	2.0	14 AE	3.7	5.2	6.2	9.2

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
According to the owner this structure has been retrofitted to minimize the flood risk due to historic flooding. The 2010 flood event flooded the first floor to a depth of 4-feet. The half basement is approximately 7-feet deep. All electrical has been modified to come from the top down, with all switches and receptacles 4-feet above first floor elevation. Since this property currently operates as a restaurant, early warning of impending storms is important for evacuating food supplies. If the first floor is approximately located 2-feet above the ground elevation, it is possible to dry flood proof the exterior walls to approximately between the 2% (5.2-feet) and 1% (6.2-feet) flood depth. An exterior water resistant sealant can be applied with a brick veneer on top in order to protect the sealant.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof, Elevate, or Earthen Berm to the 0.2% flood depth

Structure Attributes

Structure Location:	25 Spray Road, Westerly, RI
Occupancy / Built:	commercial / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	wood
Foundation Wall:	concrete, CMU
Slab/Crawlspace/Basement:	NA
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	NA
# Fireplace	NA
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	NA	13 AE	-0.2	1.3	2.3	5.3

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:

This structure is a large commercial hotel. Inventory information did not indicate if the first floor is elevated above the 1% flood depth or if a basement/crawlspace existed.

If first floor is above 1% flood depth, then consider temporary dry flood proof measures using visqueen and sandbags to provide protection of up to 3-feet in height above the first floor.

If first floor is below the 1% flood depth, then consider the following:

- Permanent dry flood proofing measures for a height of 3-feet above the first floor elevation. Requires application of water resistant sealant and incorporation of certified flood barriers at all entrances.
- Potential for combination earthen berm/floodwalls around the periphery of the complex to a height of the 0.2% flood depth. This option also requires an interior drainage system and emergency action plan
- Even though the structure is large, it could be elevated to above the 0.2% flood depth. This option would require sectioning the structure, so that it would be more manageable.

Structure Inventory Attribute Sheet


Recommended Nonstructural Technique: Dry Flood Proof individual structures

Structure Attributes

Structure Location: 26 Beach Drive, Westerly, RI
Occupancy / Built: industrial / NA
Structure Condition (visual): good
1st Floor Area (sq ft): NA
Exterior Wall Construction: concrete, brick
Foundation Wall: concrete, masonry
Slab/Crawlspace/Basement: NA
Entrances / # 1st Floor Windows: multiple / multiple
Garage: none
Exterior Mechanical/Electrical/Fuel: NA
Fireplace NA
Landscaping and Shrubs: yes

Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	NA	12 AE	4.9	6.4	7.4	10.4

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:

This is a large complex of several individual structures. They appear to have differing first floor elevations (see photos above). Structure inventory information did not indicate if the first floor is elevated above the 1% flood depth or if a basement/crawlspace existed. It appears that each structure is constructed of concrete, masonry, and brick.

Due to the apparent stoutness of each structure, recommend obtaining first floor elevation of each, then considering dry flood proofing the structure to a height of 3- to 4-feet above the first floor by applying a water resistant sealant. Depending upon the first floor elevation, most structures may be flood proofed to between the 4% and 1% flood depth. Certified flood barriers should be incorporated into each entrance.

If basements or crawlspaces exist, separate consideration of wet or dry flood proofing these areas, or removal by filling in, should be considered.

All exterior mechanical, electrical, cooling and heating equipment should be elevated onto platforms above the 0.2% flood depth to reduce future damages.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Relocate and Elevate

Structure Attributes

Structure Location:	321 Atlantic Avenue, Westerly, RI
Occupancy / Built:	commercial / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	CMU
Foundation Wall:	CMU
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	yes
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	NA	15 VE	1.8	3.1	3.8	7.8

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This large structure is located in the FEMA V Zone (BFE = 15 VE), which indicates that in addition to increased water surface elevations, wave surge is associated with flooding. Structure inventory information did not indicate the first floor elevation, or elevation of the seawall which abuts the ocean side of the property. Ground elevations and the top of seawall elevation would be required to determine the potential level of flood protection currently provided. If the property to the right, see upper photo, is elevated to above the 1% flood depth, then it would indicate that first floor elevation of 321 Atlantic Avenue is below this flood elevation.

Additionally, if the 1% flood depth is 3.8 feet, then the structure is located within the elevation of the BFE, at approximately 11.2 foot elevation. It is recommended that the entire structure be relocated on the property, to the farthest extent possible, reconstructed and elevated to above the 0.2% flood depth. With the threat of wave surge impacting the existing structure, relocation and elevation are the recommended techniques.

All exterior mechanical, electrical, cooling and heating equipment should be elevated onto platforms above the 0.2% flood depth to reduce future damages.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Elevate or Dry Flood Proof

Structure Attributes

Structure Location:	328 Atlantic Avenue, Westerly, RI
Occupancy / Built:	commercial / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	wood
Foundation Wall:	post/piers
Slab/Crawlspace/Basement:	none
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	yes
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	NA	13 AE	7.7	9.2	10.2	13.2

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This structure appears to be currently elevated approximately 6-feet above ground the ground. It is located in the FEMA AE Zone (BFE = 13 VE). Structure inventory information did not indicate the ground elevation or the first floor elevation.

If the 1% flood depth is 10.2 feet, then the ground elevation may be 2.8 feet (13 - 10.2) and the first floor is at elevation 8.8 feet (2.8 + 6). This would indicate that the first floor is approximately 1.4 feet below the 1% flood depth of 10.2 feet. The structure could be elevated 1.4 feet to place it at the BFE elevation. Since the structure is currently elevated, it may not be too complicated or expensive to elevate the structure higher.

There is also the potential to dry flood proof the existing structure approximately 1.4 feet to provide protection up to the 1% flood depth. A water resistant sealant would be required for the exterior of the structure and certified flood barriers would be required for all entrances.
All exterior mechanical, electrical, cooling and heating equipment should be elevated onto platforms above the 0.2% flood depth to reduce future damages.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof or Relocate

Structure Attributes

Structure Location:	664 Atlantic Avenue, Westerly, RI
Occupancy / Built:	commercial / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	masonry, stone
Foundation Wall:	masonry, stone
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows:	1 / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	electric, others NA
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	0.5	12 AE	4.4	5.9	6.9	9.9

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:

Although this structure is slab on grade, there is no indication that it is a structural slab, which would be required to elevate the structure. Typically, dry flood proofing is recommended to a height of only 3 feet above the floor elevation. From the photos, it appears that the low window sill is also approximately 3 feet above the floor elevation.

There is the potential to dry flood proof the existing structure approximately 3 to 4 feet in height which would not quite provide protection to the 4% flood elevation. Certified flood barriers would be required for all entrances. A water resistant sealant would be required for the exterior of the structure, either beneath the existing exterior material or applied to the surface, with a veneer applied over the surface. The stone covering may require removal to achieve the appropriate water resistant material. All exterior mechanical, electrical, cooling and heating equipment should be elevated onto platforms above the 0.2% flood depth to reduce future damages.

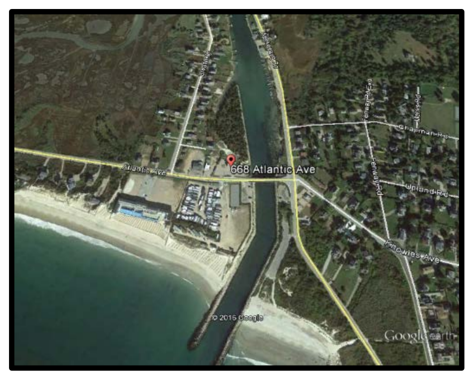
In order to achieve the greatest level of flood risk reduction, the structure should be relocated to a location of less flood risk.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof 3.5 feet within the 4% flood elevation of 4.9 feet

Structure Attributes

Structure Location:	668 Atlantic Ave, Westerly, RI
Occupancy / Built:	commercial / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	CMU
Foundation Wall:	CMU
Slab/Crawlspace/Basement:	none
# Entrances / # 1st Floor Windows:	3 / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	electric, propane
# Fireplace	0
Landscaping and Shrubs:	0



Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	0.0	12 AE	4.9	6.4	7.4	10.4

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
During the site visit, the owner indicated that the building was flooded to a depth of 1.5-feet during Hurricane Sandy. There are 3 pedestrian entrances and the windows appear to be at an elevation of approximately 3.5 feet. Since there are multiple windows at this elevation, the most cost effective flood risk reduction technique would be to dry flood proof up to the window sill elevation and to incorporate certified flood barriers for all entrances. Incorporate water resistant sealant over the CMU and cover with brick veneer. Recommend hurricane coverings for all windows. The projected flood protection of approximately 3.5 feet falls within the 4% flood depth of 4.9 feet.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Conversion to Wet Flood Proofing up to 0.2% flood depth

Structure Attributes

Structure Location:	69 Atlantic Avenue, Westerly, RI
Occupancy / Built:	commercial / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	wood shingle, concrete
Foundation Wall:	concrete
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	NA
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	NA	14 VE	4.8	6.1	6.8	10.8

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This large commercial motel complex is located in a FEMA V Zone, on the ocean front. In addition to significant flood depths, the V Zone is also associated with wave surge, which can produce waves of sufficient magnitude to destroy low lying structures. If the BFE is 14 and the 1% flood depth is 6.8, this indicates that the ground elevation is approximately 7.2 (14 - 6.8) at this location.

A recommendation for consideration is to convert the first floor of the structure to open space for wet flood proofing purposes. This may be accomplished by removing all lower level walls, specifically those positioned perpendicular to the direction of wave movement, and the removal of contents as well as relocating the office to the second level. Remaining lower level exterior materials should be water resistant. This technique would allow flood waters and wave surge to be convey through the lower level without resulting in excessive damage.

All exterior mechanical, electrical, cooling and heating equipment should be elevated onto platforms above the 0.2% flood depth to reduce future damages.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof between the 1% and 0.2% flood depth

Structure Attributes

Structure Location:	8 Crandall Avenue, Westerly, RI
Occupancy / Built:	commercial / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	wood shingle, concrete
Foundation Wall:	concrete
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	AC, electric
# Fireplace	0
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	0.5	11 AE	-1.2	0.3	1.3	4.3

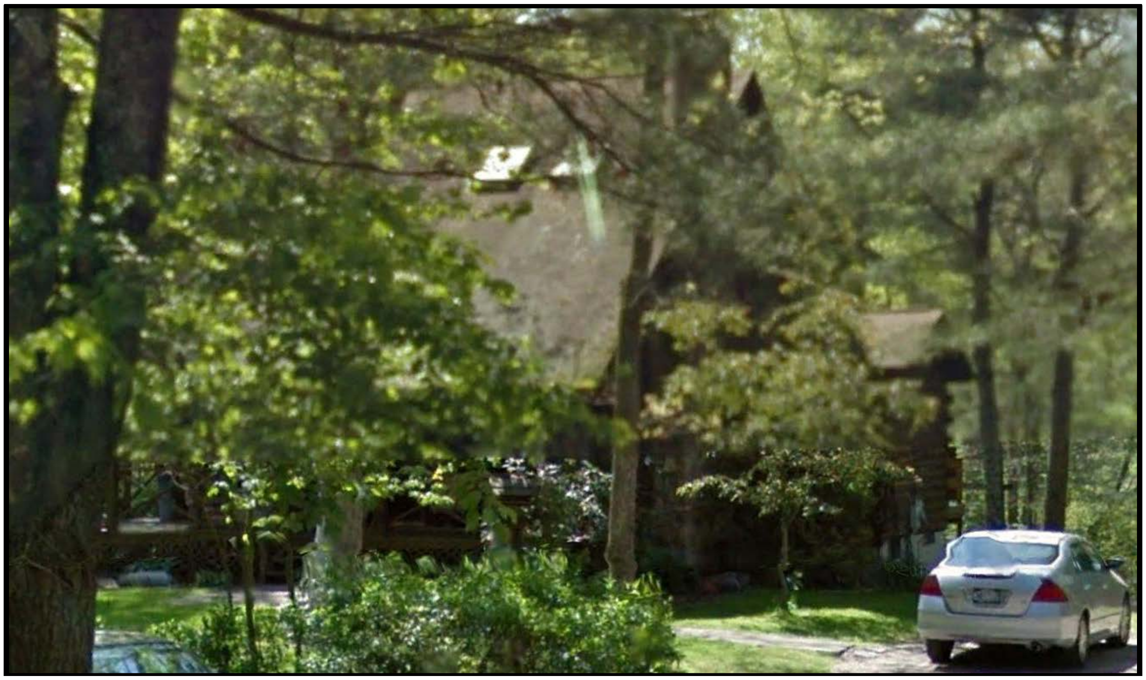
GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This large commercial motel is located in a FEMA A Zone, interior from the ocean front. If the BFE is 11 and the 1% flood depth is 1.3, this indicates that the ground elevation is approximately 9.7 (11 – 1.3) at this location. As can be seen from the upper photograph, fill material has been placed upon the land to provide a higher ground elevation.

A recommendation for consideration is to dry flood proof the first floor of the structure up to a height of 3 feet. This flood proofing height would provide greater risk reduction than the 1% annual chance exceedance flood depth of 1.3 feet. The flood proofing may be accomplished by removing the exterior 3 feet of the lower level and applying water resistant materials and sealants. All lower level entrances should incorporate certified flood barriers

All exterior mechanical, electrical, cooling and heating equipment should be elevated onto platforms above the 0.2% flood depth to reduce future damages.

Structure Inventory Attribute Sheet



Recommended Nonstructural Technique: Dry Flood Proof to the 0.2% flood elevation

Structure Attributes

Structure Location:	4 Wood River Drive, Richmond, RI
Occupancy:	residential
Structure Condition (visual):	good
Exterior Wall Construction	wood frame
Foundation Wall:	NA
Slab/Crawlspace/Basement:	NA
# Entrances / # 1st Floor Windows	2 / NA
Garage:	NA
Exterior Mechanical/Electrical/Fuel:	NA
# Fireplace	NA
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
99.8	3.0	-2.1	-1.5	-1.0	0.3

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
Even though this is a residential structure and flood insurance premiums would not be discounted for dry flood proofing, the structure appears to be elevated above the 0.2% flood elevation when considering the foundation height of 3-feet. Sandbags at entrances backed with plastic sheeting could prevent seepage of flood water during an infrequent extreme event. Utility penetrations into the foundation or the siding should be inspected for resistance to flood water.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Dry Flood Proof to the 0.2% flood elevation

Structure Attributes

Structure Location:	34 Canal Street, Pawcatuck, CT
Occupancy / Built:	Industrial / 1900
Structure Condition (visual):	good
1st Floor Area (sq ft):	63,778
Exterior Wall Construction:	brick / CMU
Foundation Wall:	concrete / CMU
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	electric, gas
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
7.4	0.5	-0.7	-0.1	0.5	2.5

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
The 0.2% (500-year) flood depth is 2.5 feet, which could readily be achieved for this structure by implementing dry flood proofing. All windows appear to be above 2.5 feet from the ground elevation. Recommend incorporating certified flood barriers for all entrances. Flood proofing would require determination of utility penetrations to flood proof.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Elevate to achieve the 0.2% flood elevation

Structure Attributes

Structure Location:	9 Hiscox Road, Westerly, RI
Occupancy / Built:	residential / 1928
Structure Condition (visual):	good
1st Floor Area (sq ft):	1,427
Exterior Wall Construction:	wood shingle / wood on sheath
Foundation Wall:	concrete
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows:	2 / multiple
Garage:	attached
Exterior Mechanical/Electrical/Fuel:	electric, oil
# Fireplace	1 stone
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
31.0	3.0	-1.8	-1.0	-0.1	1.9

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This structure achieves 1% flood protection in its existing condition. A greater level of protection, to the 0.2% flood event could be achieved by elevating the structure on extended foundation walls. The foundation would require flood vents to equalize hydrodynamic forces during flood conditions. The garage would not be elevated, but would remain at existing elevation.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Temporary Dry Flood Proof measures for exposed basement walls

Structure Attributes

Structure Location:	3 Saratoga Ave, Westerly, RI
Occupancy / Built:	residential / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	wood, clapboard
Foundation Wall:	concrete, CMU
Slab/Crawlspace/Basement:	basement (walkout)
# Entrances / # 1st Floor Windows:	3 / multiple
Garage:	attached
Exterior Mechanical/Electrical/Fuel:	NA
# Fireplace	1
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
32.8	3.0	-3.6	-2.8	-1.9	0.1

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:

Since the structure appears to be relatively new, it should be a post-FIRM structure and meet the requirements for the finished first floor being located above the 1% flood elevation, as it appears to from the table above. Without low adjacent grade elevation, it is unclear as to whether the 1% flood event could directly impact the basement walls which are exposed to the outside. If necessary, temporary measures utilizing visqueen (water resistant plastic sheeting) and sandbags could be placed along the exterior of the exposed basement walls prior to an impending flood event. These measures would be temporary at best and dependent upon the duration of the flood event.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Temporary Dry Flood Proof to the 0.2% flood elevation or Elevate

Structure Attributes

Structure Location: 5 Saratoga Ave, Westerly, RI
Occupancy / Built: residential / 2002
Structure Condition (visual): good
1st Floor Area (sq ft): 2,095
Exterior Wall Construction: wood, clapboard
Foundation Wall: CMU
Slab/Crawlspace/Basement: basement
Entrances / # 1st Floor Windows: 3 / multiple
Garage: attached
Exterior Mechanical/Electrical/Fuel: AC, electric, oil
Fireplace 1
Landscaping and Shrubs: yes

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
NA	2.0	NA	NA	NA	NA

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
The flood depths were not available for this building. Since it was constructed in 2002, it is a post-FIRM structure and should meet the requirements for being located above the 1% flood elevation. Depending upon the depth of flooding at this structure, and the frequency of flooding, temporary measures utilizing visqueen (water resistant plastic sheeting) and sandbags. If the frequency of flooding is such that additional permanent measures should be taken; 1) consider removal of the basement by filling it in and capping with concrete. Relocate utilities (oil heater, water heater, water softener, etc.) to higher elevation or into an addition, and 2) consider elevating the structure on extended foundation walls. Flood vents would be incorporated into the foundation to equalize hydrodynamic forces.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Earthen Berm or Dry Flood Proof to the 0.2% flood elevation

Structure Attributes

Structure Location:	84 White Rock Road, Westerly, RI
Occupancy / Built:	Industrial / 1849
Structure Condition (visual):	good
1st Floor Area (sq ft):	36,395
Exterior Wall Construction:	brick / masonry
Foundation Wall:	brick / masonry
Slab/Crawlspace/Basement:	basement
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	electric, steam, oil
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
17.0	0.5	-1.3	-0.7	-0.0	1.6

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
The 0.2% (500-year) flood depth is 1.6 feet, which could readily be achieved for this structure by either constructing a berm around the periphery of the compound, or by implementing dry flood proofing. All windows appear to be above 1.6 feet from the ground elevation. Recommend incorporating certified flood barriers for all entrances. Flood proofing would require determination of utility penetrations and view of backside of structure to confirm wall construction.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Elevate to the 0.2% flood elevation

Structure Attributes

Structure Location:	450 Bradford Road, Westerly, RI
Occupancy / Built:	commercial / 1990
Structure Condition (visual):	good
1st Floor Area (sq ft):	625
Exterior Wall Construction:	wood
Foundation Wall:	piers
Slab/Crawlspace/Basement:	none
# Entrances / # 1st Floor Windows:	1 / 4
Garage:	none
Exterior Mechanical/Electrical/Fuel:	electric, gas
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
34.6	2.0	1.9	2.1	2.4	4.1

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This structure is currently elevated on piers to approximately the 1% flood depth. Elevating the structure an additional 2 feet could protect the structure from floods up to and including the 0.2% flood event. Since the structure is already in a elevated state, the effort to prepare for an additional raise would not be too intense. Recommend investigating utility penetrations for water resistance.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Earthen Berm or Dry Flood Proof to the 1% or 0.2% flood elevation

Structure Attributes

Structure Location:	460 Bradford Road, Westerly, RI
Occupancy / Built:	Industrial / 1911
Structure Condition (visual):	good
1st Floor Area (sq ft):	292,815
Exterior Wall Construction:	brick / masonry / aluminum siding
Foundation Wall:	brick / masonry
Slab/Crawlspace/Basement:	slab
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	electric, steam, oil
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
35.0	0.5	-0.2	0.6	1.4	3.4

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
The 1% flood depth is 1.4 feet and the 0.2% flood depth is 3.4 feet, which could readily be achieved for this structure by implementing dry flood proofing or consideration of an earthen berm around the periphery of the compound. All windows appear to be above several feet above the ground elevation. Recommend incorporating certified flood barriers for all entrances. Flood proofing would require determination of utility penetrations, a view of all exterior sides of structure to confirm wall construction. A 2.5-foot berm with interior drainage and flood gate for vehicular entry may be more cost effective for the 1% flood than dry flood proofing the entire exterior of the structure with water resistant sealant and barriers at all entrances.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Wet Flood Proof Garage and use Temporary Measures for 0.2%

Structure Attributes

Structure Location:	15 Lima Drive, Westerly, RI
Occupancy / Built:	residential / 1980
Structure Condition (visual):	good
1st Floor Area (sq ft):	2,374
Exterior Wall Construction:	wood
Foundation Wall:	CMU
Slab/Crawlspace/Basement:	basement
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	attached
Exterior Mechanical/Electrical/Fuel:	AC, electric, oil
# Fireplace	1 stone
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
31.5	3.0	-2.7	-1.8	-0.9	1.0

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
The first floor of the residence is elevated almost 1-foot above the 1% flood event. Recommend using temporary measures such as sandbags and plastic sheeting at entrances around exterior of structure to provide protection to the 0.2% flood event. The attached garage appears to be located at a lower elevation than the residential structure. Recommend wet flood proofing the garage to allow flood waters to enter and equalize hydrodynamic forces during a flood event. Replace damageable material inside the garage with water resistant material to the 0.2% flood depth. Ensure all electrical is elevated to above the 0.2% flood depth.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Elevate to the 0.2% flood elevation

Structure Attributes

Structure Location:	30 Post Office Lane, Westerly, RI
Occupancy / Built:	residential / 1952
Structure Condition (visual):	below average
1st Floor Area (sq ft):	950
Exterior Wall Construction:	wood, wood shingle
Foundation Wall:	CMU
Slab/Crawlspace/Basement:	basement
# Entrances / # 1st Floor Windows:	2 / multiple
Garage:	attached
Exterior Mechanical/Electrical/Fuel:	electric, oil
# Fireplace	0
Landscaping and Shrubs:	yes

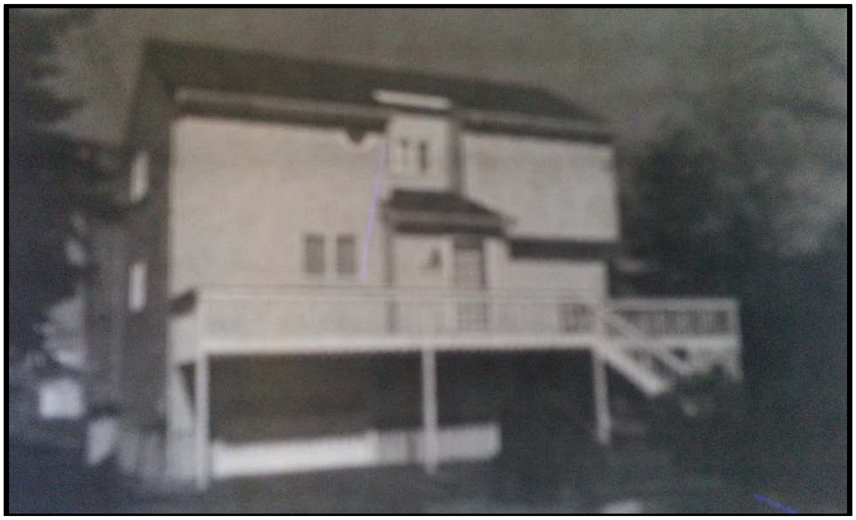
Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
23.6	0.5	2.5	3.2	4.2	6.2

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
This structure is pre-FIRM and is impacted by flooding more frequent than the 4% flood event. Since the 0.2% flood depth is 6.2 feet, recommend elevating structure on extended foundation walls to the 0.2% flood depth. Fill in the basement and cap with concrete. Relocate oil heater, electric, from basement to higher elevation, utilizing an addition if necessary to how utilities/appliances from the basement. Incorporate flood vents into the extended foundation walls to equalize hydrodynamic forces. Removal of the basement and elevation of the structure could result in a reduction in annual flood insurance premiums.

Structure Inventory Attribute Sheet



Recommended Nonstructural Technique: Temporary Dry or Wet Flood Proof to the 0.2% flood elevation

Structure Attributes

Structure Location:	20 Walnut St P, Stonington, CT
Occupancy / Built:	residential / 1990
Structure Condition (visual):	good
1st Floor Area (sq ft):	932
Exterior Wall Construction:	wood, vinyl siding
Foundation Wall:	concrete, CMU
Slab/Crawlspace/Basement:	basement
# Entrances / # 1st Floor Windows:	multiple / multiple
Garage:	attached
Exterior Mechanical/Electrical/Fuel:	electric, oil
# Fireplace	1
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
5.9	9.0	-2.1	-1.6	-0.9	1.2

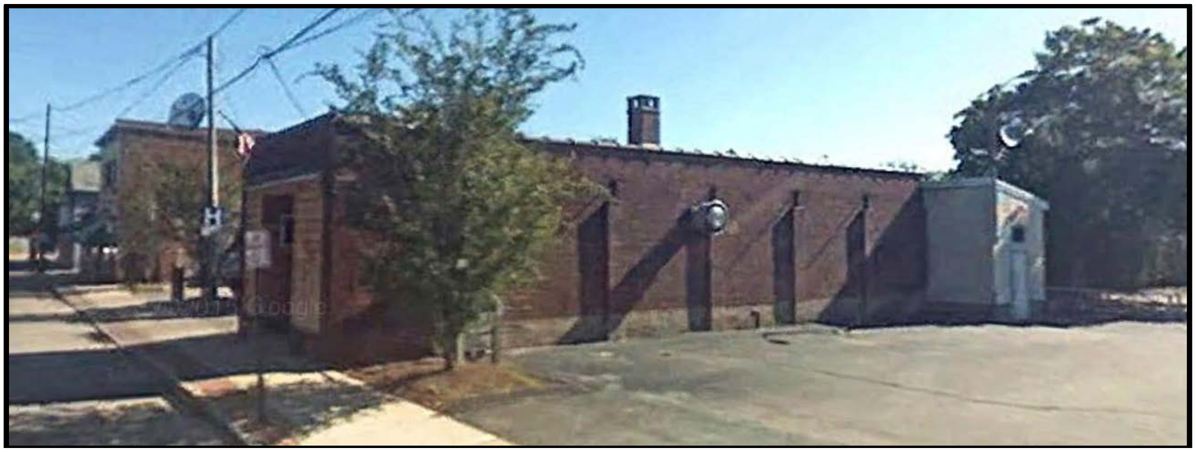
GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
The basement of this structure is located above ground and shares space with the attached garage. The 1% flood depth is approximately 0.9 feet below ground elevation. The 0.2% flood depth is 1.2 feet which would flood the basement and garage areas.

Temporary Dry Flood Proof. Since the 0.2% flood is very infrequent and to no more than 1.2 feet in depth, the owner could incorporate temporary measures, where visqueen (water resistant plastic sheeting) could be placed along the exterior walls with sandbags located at all ground level pedestrian and vehicular entrances.

Wet Flood Proof. The owner could retrofit the foundation walls with flood vents to allow water to enter the structure, equalizing hydrodynamic forces. This would require removal of the partially finished basement and to use that space only for storage purposes.

Structure Inventory Attribute Sheet



Recommended Nonstructural Technique: Already has flood protection to the 1% flood event

Structure Attributes

Structure Location:	16 Mechanic St, Stonington, CT
Occupancy / Built:	commercial / 1909
Structure Condition (visual):	below average
1st Floor Area (sq ft):	2,200
Exterior Wall Construction:	brick / masonry / wood
Foundation Wall:	brick / masonry
Slab/Crawlspace/Basement:	crawlspace
# Entrances / # 1st Floor Windows:	2 / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	AC, electric, oil
# Fireplace	0
Landscaping and Shrubs:	0

Structure/Flood Elevations (NAVD88):

GE	FHT	4% Depth	2% Depth	1% Depth	.2% Depth
5.4	1.5	-0.5	-0.4	-0.3	0.7

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
The first floor is elevated approximately 1.5 feet above the ground elevation, placing it above the 0.2% flood depth. However, there does exist a small crawlspace which could possibly encounter flooding for any event greater than the 1% annual chance exceedance flood. For the infrequent flood events, the owner could consider filling the crawlspace and relocating any utilities/appliances to a higher elevation.

Structure Inventory Attribute Sheet

Recommended Nonstructural Technique: Elevate to above the 1% flood depth (maximum 12 feet)

Structure Attributes

Structure Location:	Modular or Trailer Homes in AE Zone
Occupancy / Built:	residential / NA
Structure Condition (visual):	good
1st Floor Area (sq ft):	NA
Exterior Wall Construction:	wood, vinyl
Foundation Wall:	piers or columns
Slab/Crawlspace/Basement:	none
# Entrances / # 1st Floor Windows:	1 / multiple
Garage:	none
Exterior Mechanical/Electrical/Fuel:	varies
# Fireplace	0
Landscaping and Shrubs:	yes

Structure/Flood Elevations (NAVD88):

GE	FHT	BFE	4% Depth	2% Depth	1% Depth	.2% Depth
NA	2 to 3	AE	NA	NA	NA	NA

GRE = Ground Elevation FHT = Foundation Height

Assessment Notes:
Modular and trailer homes are susceptible to catastrophic damage if located within a high risk flood area. These structures should not be located within a FEMA V Zone as a precautionary measure to protect the inhabitants and/or first responders who may be required to provide assistance during a flood event.

A recommendation for consideration is to elevate these structure types above the projected flood depth, up to 12 feet above the ground elevation. If the projected depth of flooding is greater than 12 feet, then the recommendation is to relocate the structure to an area outside of the FEMA Special Flood Hazard Area (outside of the 1% flood boundary).

For modular or trailer homes which are being elevated, the structure should be placed onto, concrete piers, segmented piles, columns, or posts, whichever provide the structural integrity for achieving the required elevation.

All exterior mechanical, electrical, cooling and heating equipment should be elevated onto platforms to at least 1-foot above the 1% flood depth and to the 0.2% flood depth if practical.
