BUILDING INNOVATION 2019
National Institute of BUILDING SCIENCES
CONFERENCE & EXPO

National Institute of Building Sciences

Provider Number: G168

Improving the Flood Resistance of Buildings and Mitigation Techniques

WE3B

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January 9th, 2019

CONTINUING EDUCATION AIA

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Course Description

Severe flooding can endanger life, but even moderate levels of flooding can lead to extensive damages and disruption of building operations. Water source contamination and inhibited access are significant problems, coupled with damages to structures and interior contents. Contaminated water can destroy electrical infrastructure, mechanical systems, etc. Business interruption can last from a few days to over a year. Due to climate change and revisions to FEMA flood maps in 2016, many buildings not previously categorized as being at risk are now categorized as subject to flooding. As a result, insurers are informing their clients of the potential risks and associated increases in flood insurance coverage, if flood mitigation procedures are not enacted. This presentation will discuss how to identify areas of facilities vulnerable to flooding, and the options and systems available to protect properties from potentially catastrophic damages to structures, building contents and impacts on building operations. The speakers will focus on addressing potential hazards at existing facilities. It is usually not as easy as building a levee around the property. Oftentimes, a hybrid solution must be developed, incorporating a variety of systems, including barriers, flood gates, deployable flood walls, backflow devices, storage tanks and ejector pumps, upgraded stormwater systems, etc.

CONTINUING EDUCATION AIA

Learning Objectives

At the end of the this course, participants will be able to:

1. Identify areas of facilities vulnerable to flooding
2. Identify options available to mitigate flooding
3. Review process of flood mitigation design and associated construction phasing.
4. Create a flood emergency response plan

Weather Trends and Effects Upon Sea Level Rise and Rainfall Amounts

Types of Flooding / Design Criteria

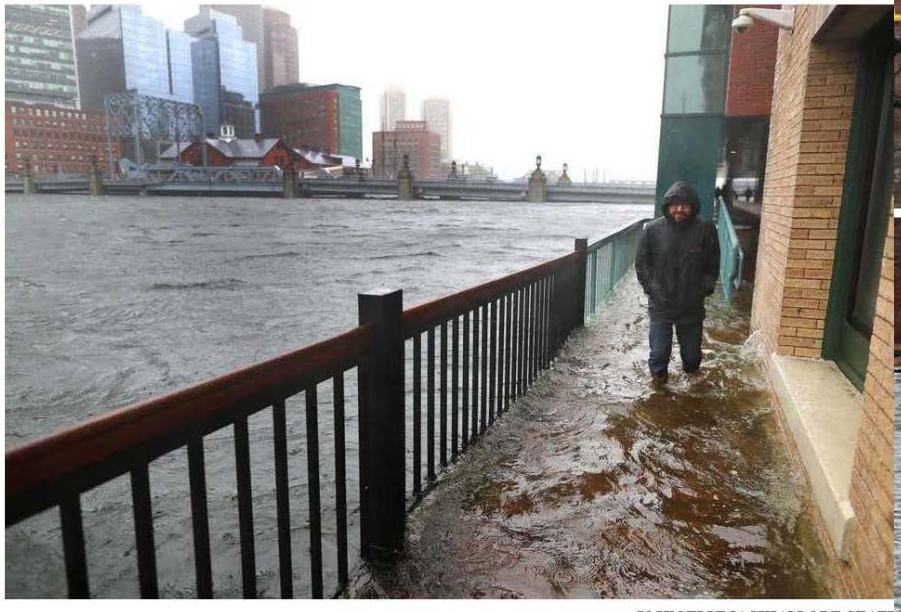
Understanding Floodplain Mapping

Flood Hazard Mitigation / Management Plans

Case Studies

EDITORIAL

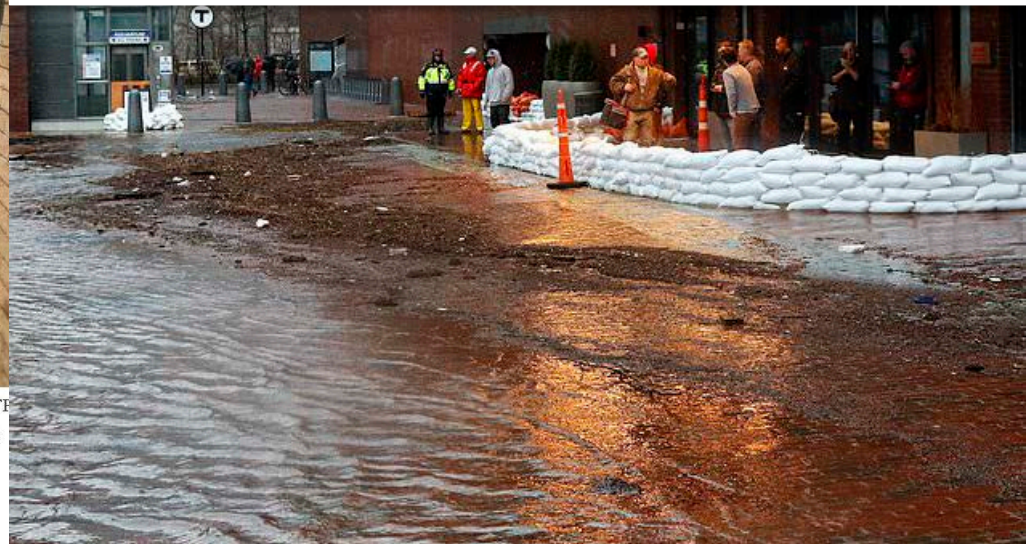
Boston's bill for climate change is coming due



JOHN TLUMACKI/GLOBE STAFF

A man walks through a flooded sidewalk off Congress Street, where water was flowing over from Fort Point Channel in the Seaport District on March 2.

OCTOBER 18, 2018



Ellicott City, Md., deluged by flash flooding as heavy rain soaks area

Maryland Gov. Larry Hogan has declared a state of emergency

Rescue personnel walk along Main Street in Ellicott City, Md., Sunday, May 27, 2018. Roaring flash floods struck the Maryland city Sunday that had been wracked by similar devastation two years ago, its main street turned into a raging river ... more >

By - *Associated Press* - *Sunday, May 27, 2018*

Miami Herald

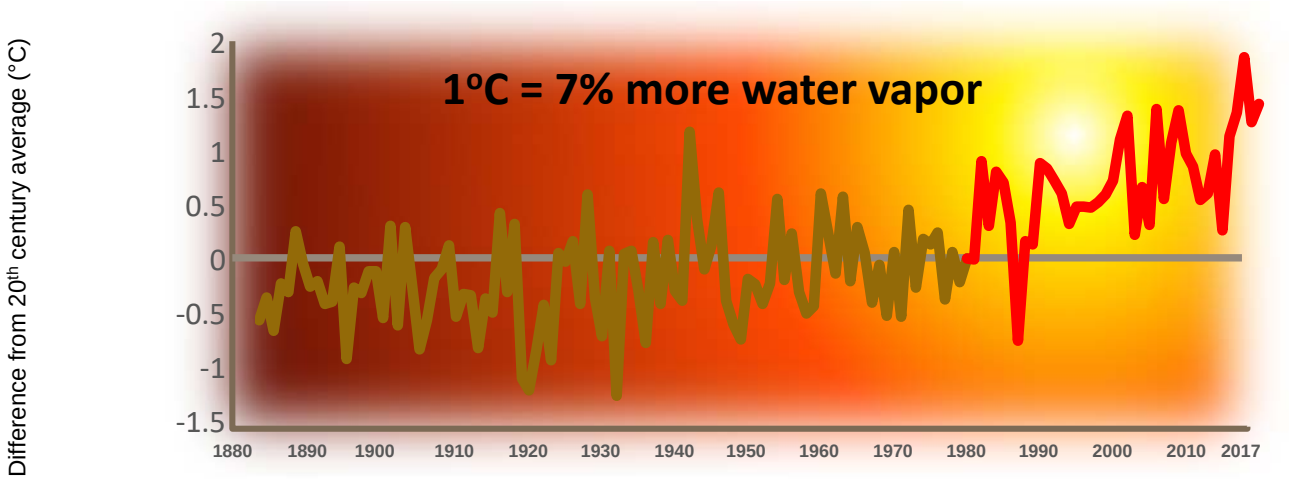
MIAMI BEACH

Before sea level rises, Miami Beach officials want to raise West Avenue 1½ to 2 feet

BY JOEY FLECHAS
jflechas@MiamiHerald.com

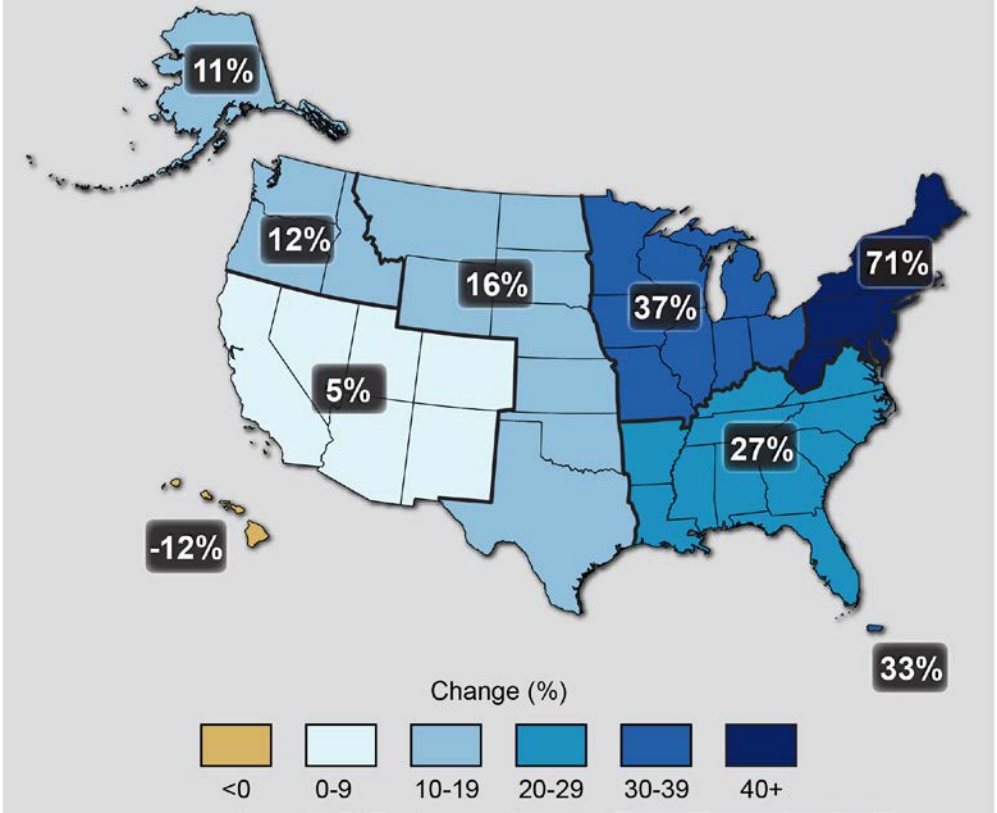
January 22, 2015 06:00 PM
Updated January 23, 2015 06:18 PM

In an area that has seen its fair share of roadwork during the past few years, city officials want to raise West Avenue between 1½ to 2 feet during the next few years in an effort to prepare one of the lowest-lying points of Miami Beach for anticipated sea level rise.



NOAA National Centers for Environmental information, Climate at a Glance: Global Time Series, published January 2018, from http://www.ncdc.noaa.gov/cag/

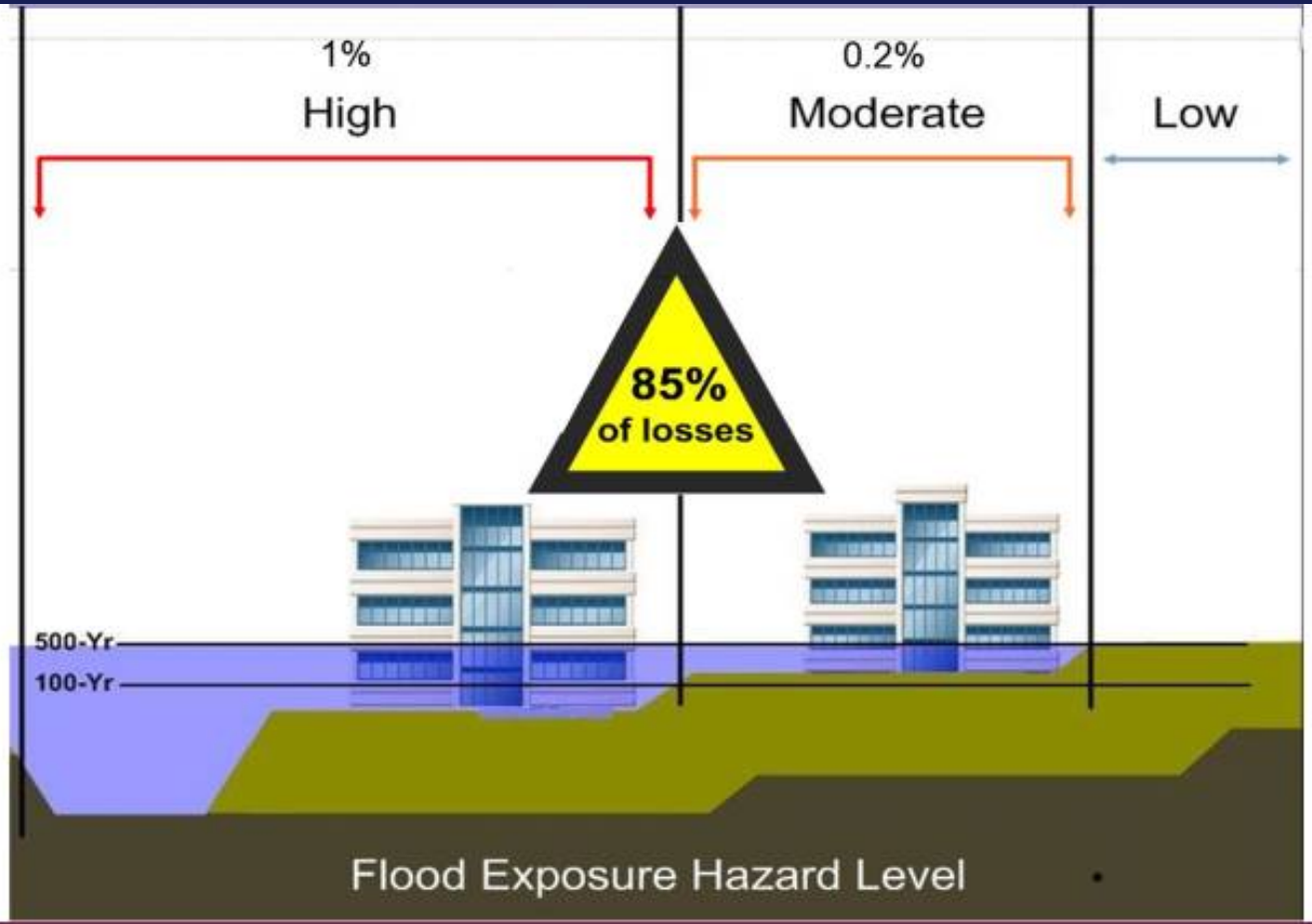
Global Mean Temperature is Increasing



NCA3_Climate_Change_Impacts

Observed Change in Very Heavy Precipitation

Types of Flooding



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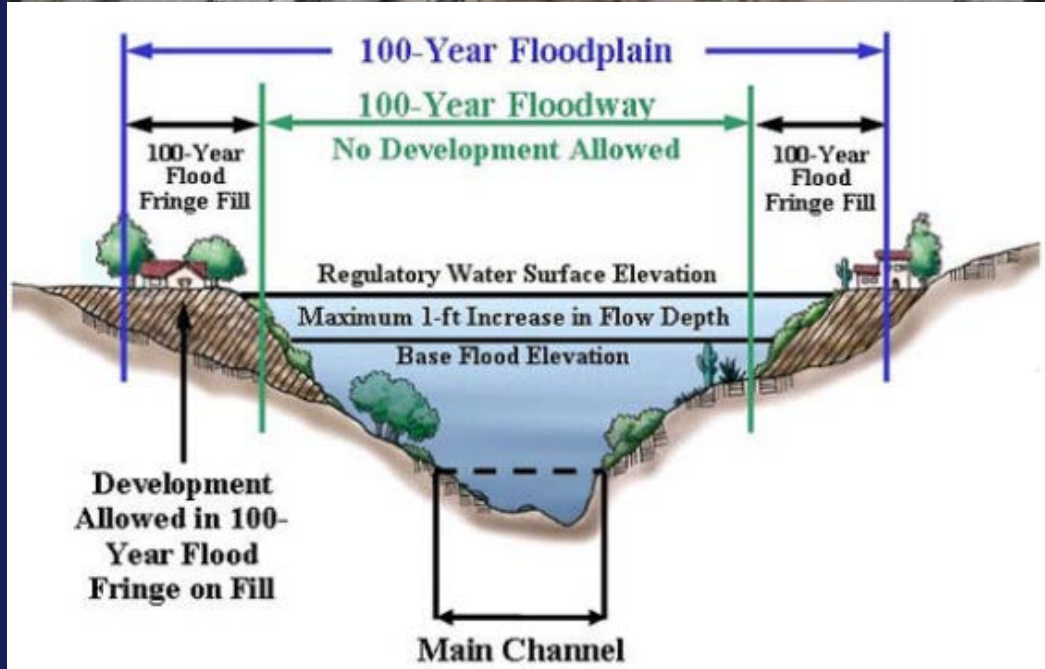
Sheet Flow

- Localized Site Flooding
- Not Associated with a FEMA Flood Zone

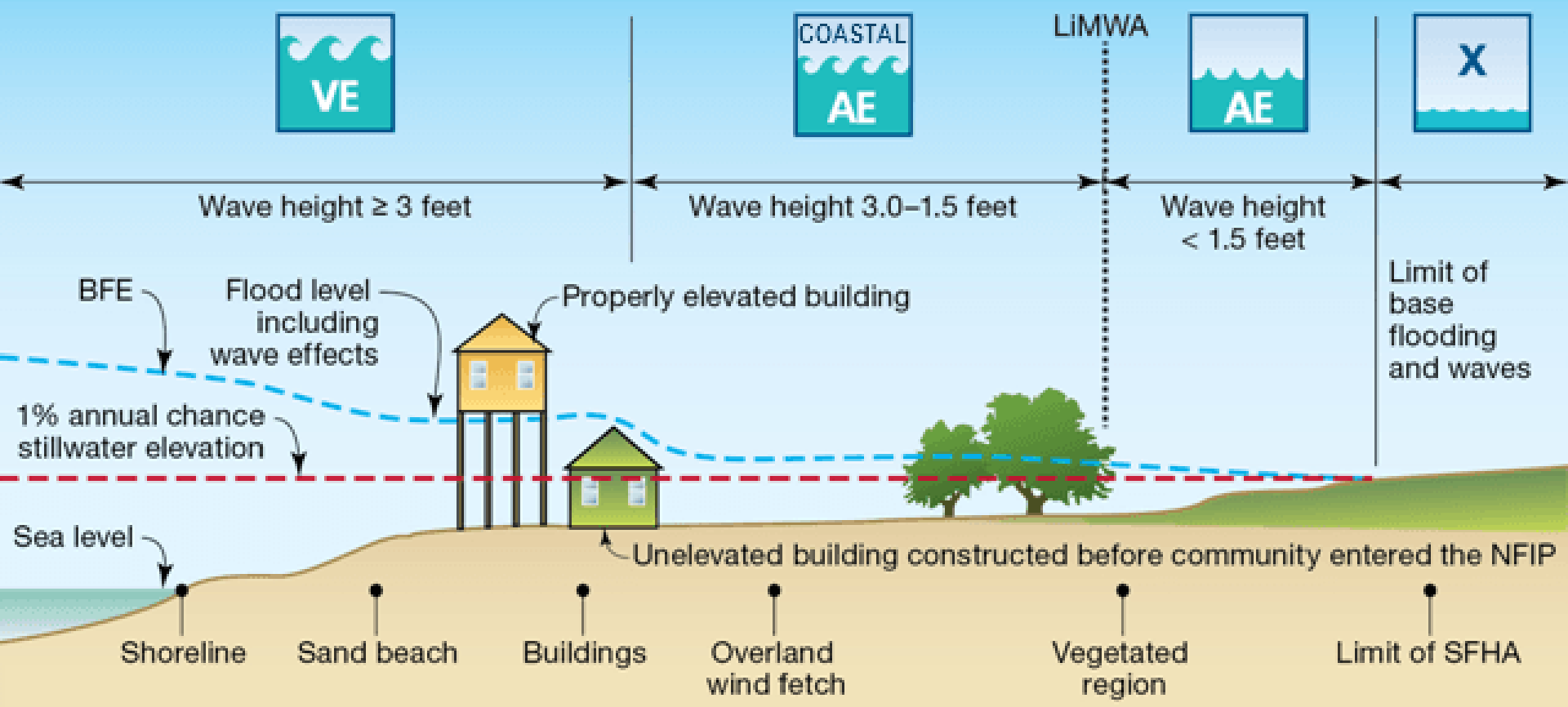
Rivers and Streams

- Zone A / AE
  - 1% Base Flood Elevation (100 year flood plain)
- Floodway –Velocity Zone
- Zone X - 0.2% Base Flood Elevation (500 year flood plain)



Coastal

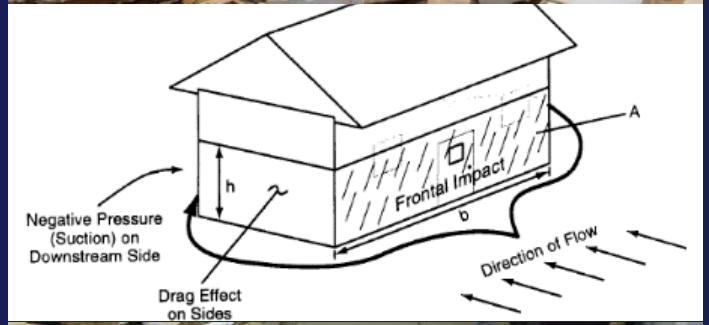
- Coastal Zone VE & A/AE
  - Wave Action
- Zone A/AE
  - Stillwater (1% BFE)
- Zone X
  - Stillwater (0.2% BFE)



Coastal FEMA Flood Zones

Types of Flood Damage:

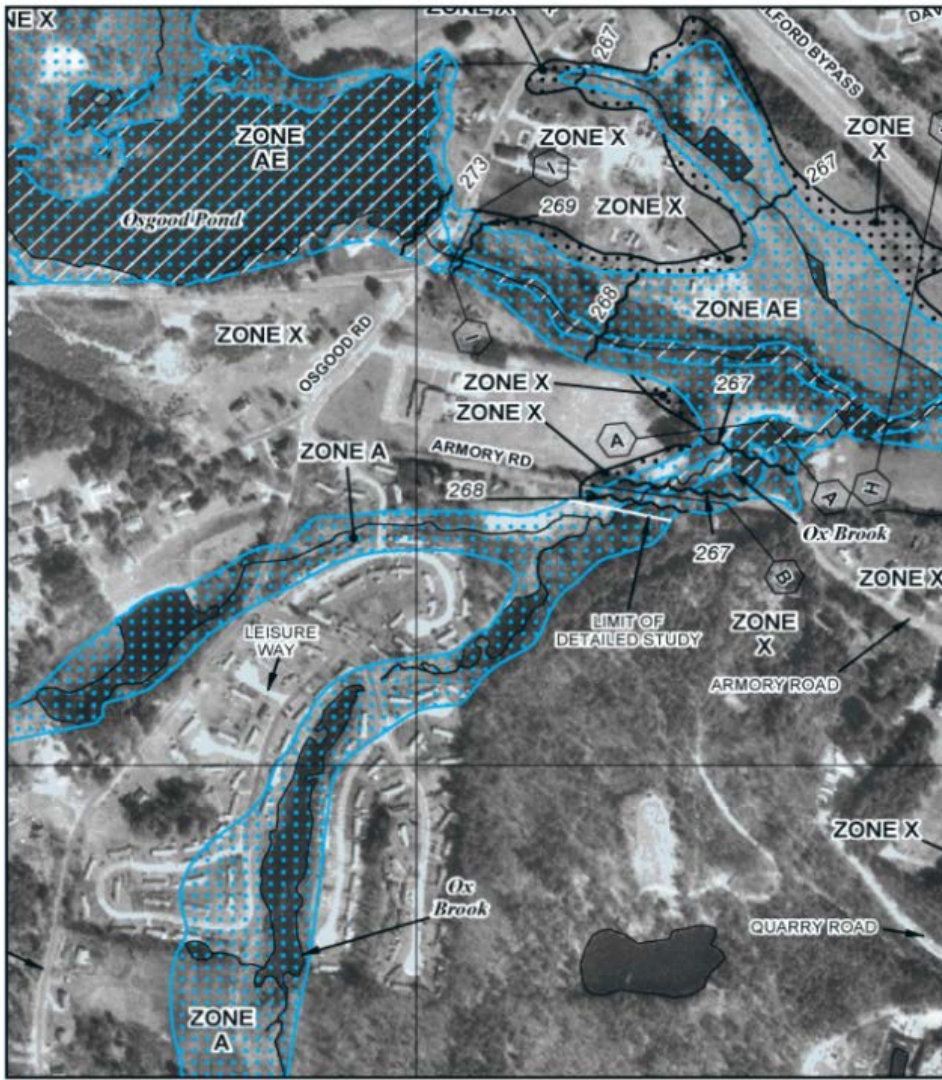
- Hydrodynamic Forces
- Debris Impact
- Hydrostatic Forces
- Soaking
- Sediment and Contaminants



Understanding Floodplain Mapping

National Flood Insurance Program (NFIP)

- Created in 1968; changes under National Flood Insurance Reform Act of 1994
- Based on a mutual agreement between Federal Government and community
- Three basic parts
  - Mapping
  - Insurance
  - Regulations



NOTES TO USERS

LEGEND

PANEL 0417E

FIRM

FLOOD INSURANCE RATE MAP

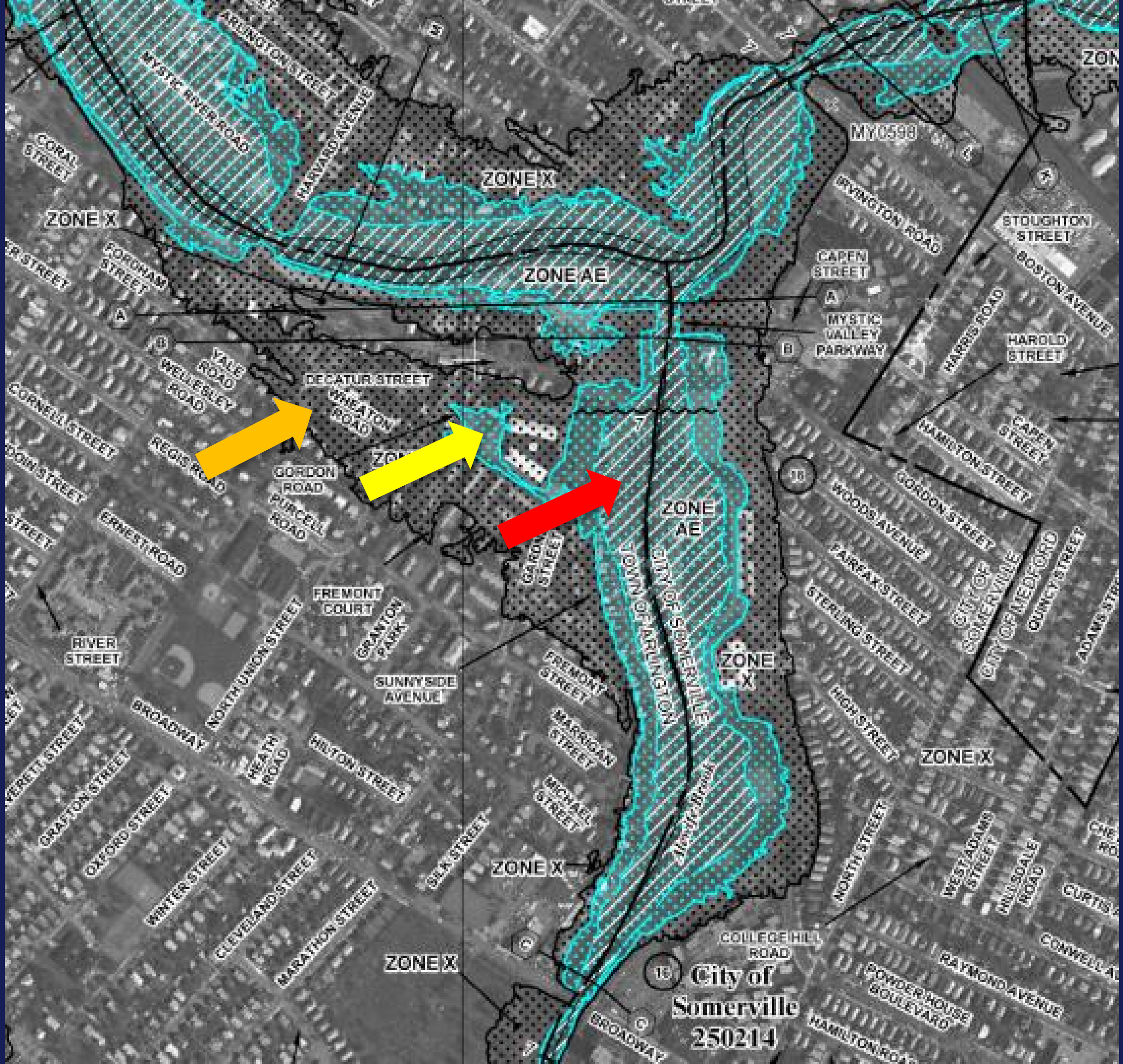
MIDDLESEX COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

PANEL 417 OF 656

MAP NUMBER 25017C0417E

EFFECTIVE DATE JUNE 4, 2010

Federal Emergency Management Agency



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

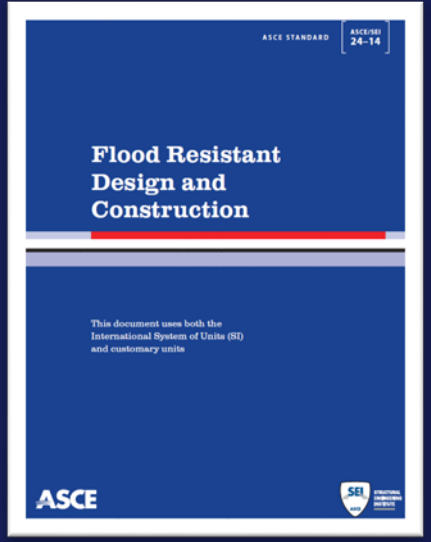
ZONE D — Areas in which flood hazards are undetermined, but possible.

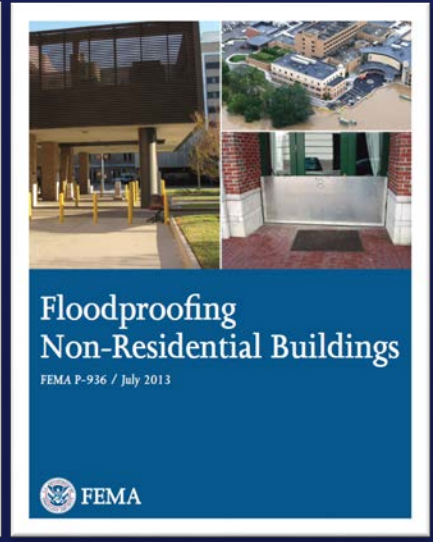
COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

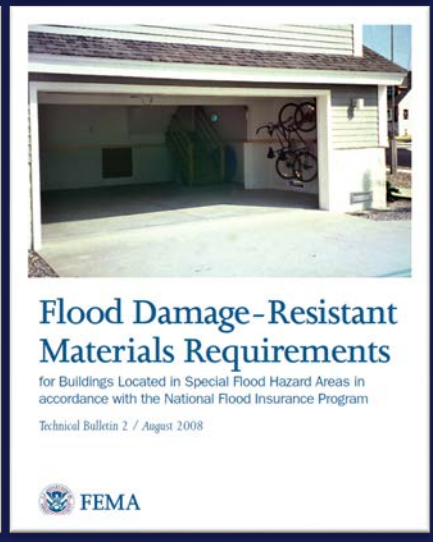
OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- **ASCE 24 – Flood Resistant Design & Construction**
  - Minimum design and construction of structures in flood hazard areas (new construction, substantial Improvements, historic structure exceptions)
  - Meets or Exceeds NFIP regulations
  - Requirements are functions of Flood Hazard Areas (Zone A, V, other high risk) and Structure Classification
- **FEMA Technical Bulletins**
- **FEMA P936 – Floodproofing Non-Residential Buildings**
- **National Flood Insurance Program (NFIP) Regulations (44 CFR Parts 59 and 60)**
- **International Building Codes (I-Codes)**







Nature of Occupancy	Category
Buildings and other structures that present a **low hazard to human life** in the event of failure (e.g., agricultural facilities, certain temporary facilities, minor storage facilities)	I
All buildings and other structures **except those listed in Categories I, III, and IV** (e.g., most residential buildings)	II
Buildings and other structures that present a **substantial hazard to human life** in the event of failure (e.g., schools, theaters, jails)	III
Buildings and other structures **designated as essential facilities** (e.g., hospitals, fire stations, police stations, emergency operations centers, power generating stations and other public utility facilities required in an emergency)	IV

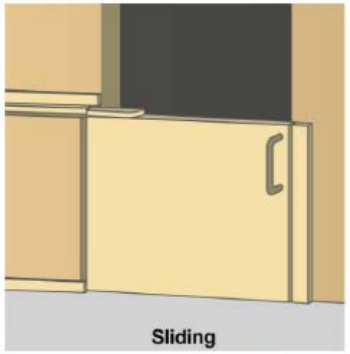
See next page for description of Flood Design Classes →

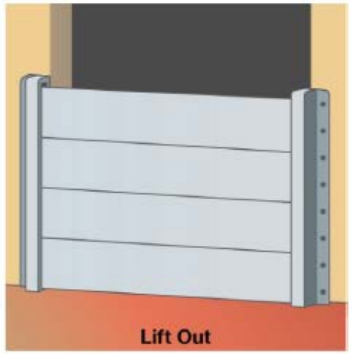
		Flood Design Class 1	Flood Design Class 2	Flood Design Class 3	Flood Design Class 4
Minimum Elevation* of Lowest Floor (Zone A: ASCE 24-14 Table 2-1)	Zone A not identified as Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher
Minimum Elevation of Bottom of Lowest Horizontal Structural Member (Zone V: ASCE 24-14 Table 4-1)	Coastal High Hazard Areas (Zone V) and Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher
Minimum Elevation Below Which Flood-Damage-Resistant Materials Shall be Used (Table ASCE 24-14 5-1)	Zone A not identified as Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher
	Coastal High Hazard Areas (Zone V) and Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher

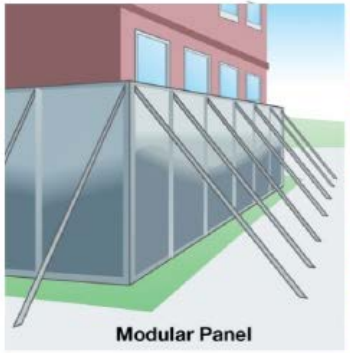
Dry Flood Proofing:

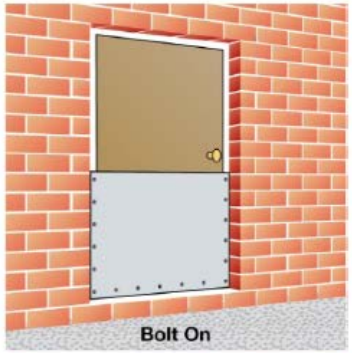
A combination of measures that results in a structure, including the attendant utilities and equipment, being watertight with all elements substantially impermeable to the entrance of floodwater and with structural components having the capacity to resist flood loads.

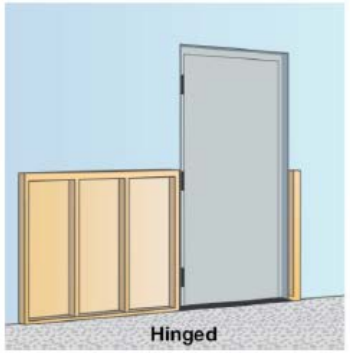
- **Building strength/building locations**
- **Warning time**
- **Flood characteristics**
- **Level of protection**
- **Seepage considerations**
- **Utilities**







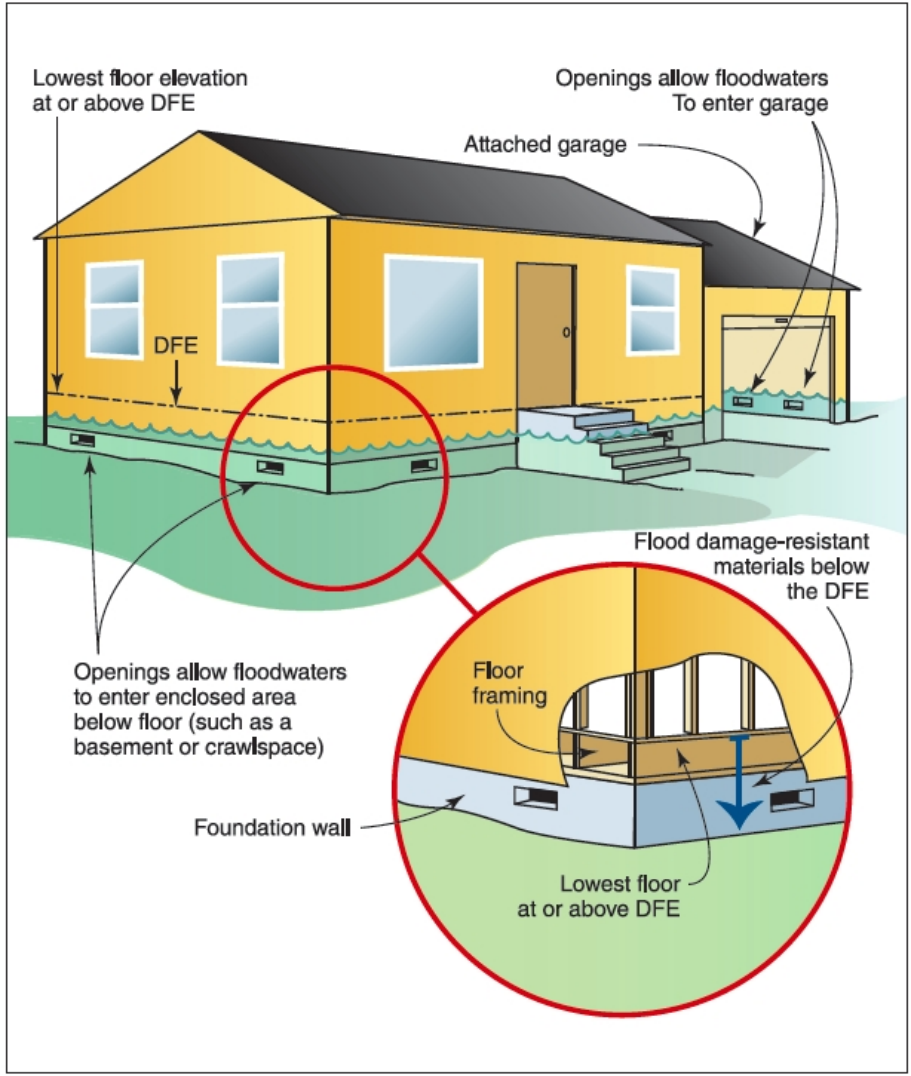


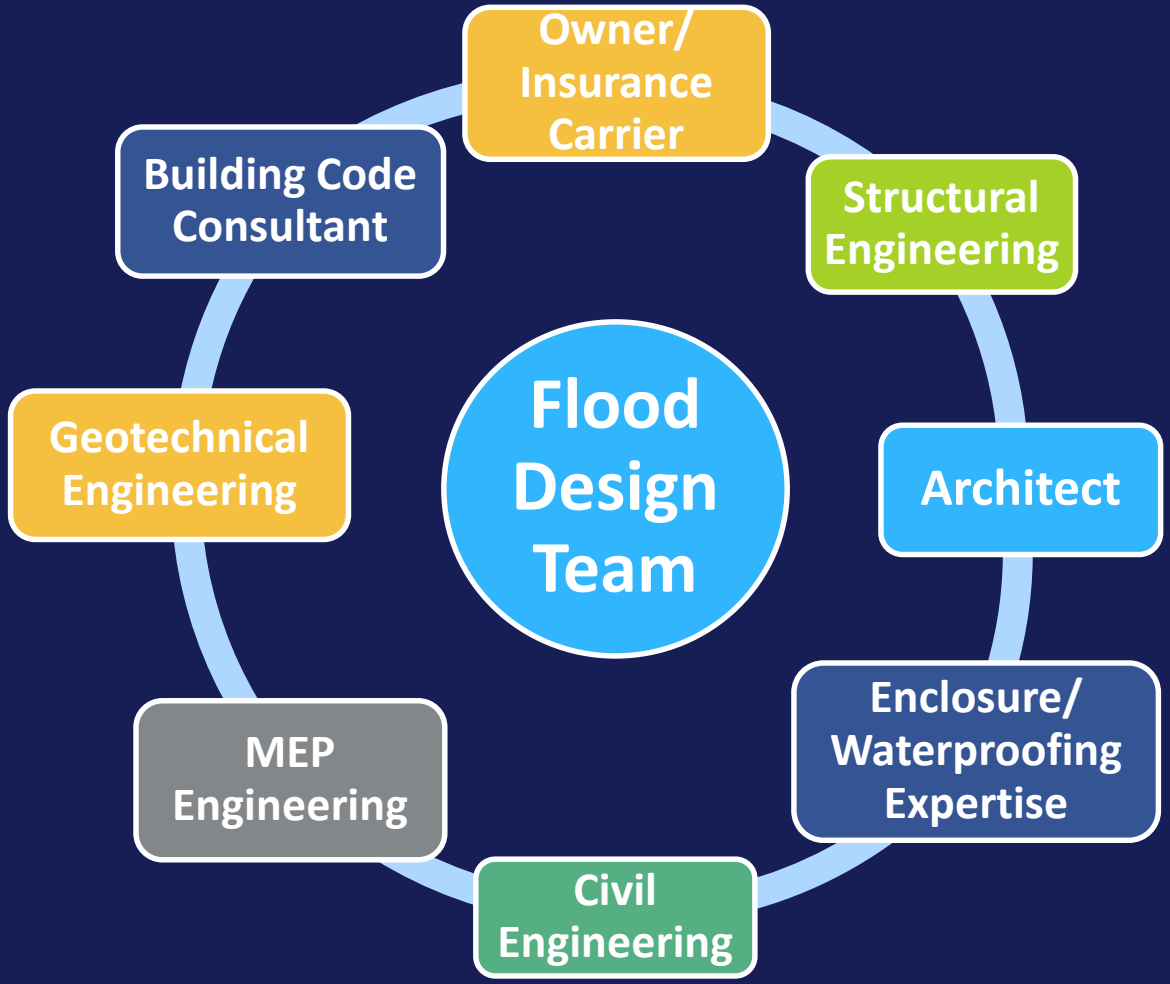


Wet Flood Proofing:

The use of flood-damage-resistant materials and construction techniques to minimize flood damage to areas below the flood protection level of a structure, which is intentionally allowed to flood.

- **Building strength**
- **Warning time**
- **Flood-damage-resistant-materials**
- **Utilities**




Flood Design Team
Owner/ Insurance Carrier
Structural Engineering
Architect
Enclosure/ Waterproofing Expertise
Civil Engineering
MEP Engineering
Geotechnical Engineering
Building Code Consultant

Flood Risk…

2017: 3 Hurricanes, 26 Days, 2500 loss locations, $75-$145 billion loss estimated industry wide

Hurricane Harvey was a Flood Event

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The Value of Risk Improvement

Hurricane Harvey

FM Global clients completed physical improvements and reduced their **overall** loss exposure by **$820 million/$23 million average**

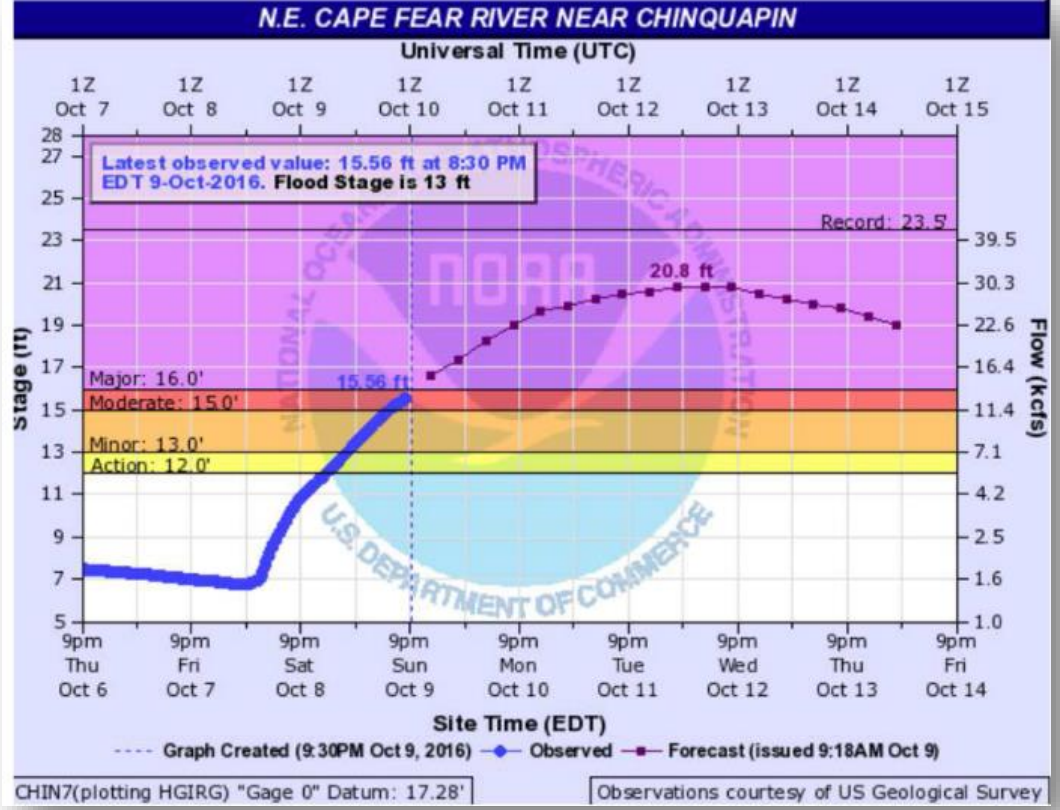
Hurricane Harvey

Flood Hazard Mitigation:

- Resiliency Goals
- Identifying areas of facilities vulnerable to flooding
- Develop flood emergency response plan (FERP)
- Identify options available to mitigate flooding
- ANSI/FM 2510 Approved Products

FERP - Simple Steps During Normal Working Hours to Mitigate Loss

- Monitor Weather
- Authority to Activate
- Ample Time
- Plan for Recovery
- Review after each Implementation



Match the Right Solution to the Scenario (Warning and Installation Time)

If you are flood exposed, what can you do?

Besides moving out of the flood zone!

Relocate stock, particularly high-value items or those critical to continued operation

Relocate equipment, such as portable electronic equipment, computers, testing and quality-control devices, dies and patterns, etc.

Relocate vehicles that will be needed after the flood, such as plant trucks, forklifts, tractor-trailers, etc.

Relocate critical drawings, records, files

Raise Equipment and Supplies

Flood Barrier Examples

Protect Openings

Check all water entry points:

- Front door
- Side door
- Loading dock door
- Windows
- Vents
- Pipe penetrations
- Underground pipes

Protect individual pieces of equipment or portions of the building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ELEVATOR TO TRAINS
AQUARIUM
TO TRAINS
Boston's Best Sightseeing Tour
BUY ONLINE & SAVE
TrolleyTours.com

Flood Mitigation Products – Perimeter Barriers

Permanent Flood Protection Barriers

All Barriers Should Meet ANSI/FM 2510 Standards

Perimeter flood panel system

Flood Protection for Subway Vents – Queens, NY

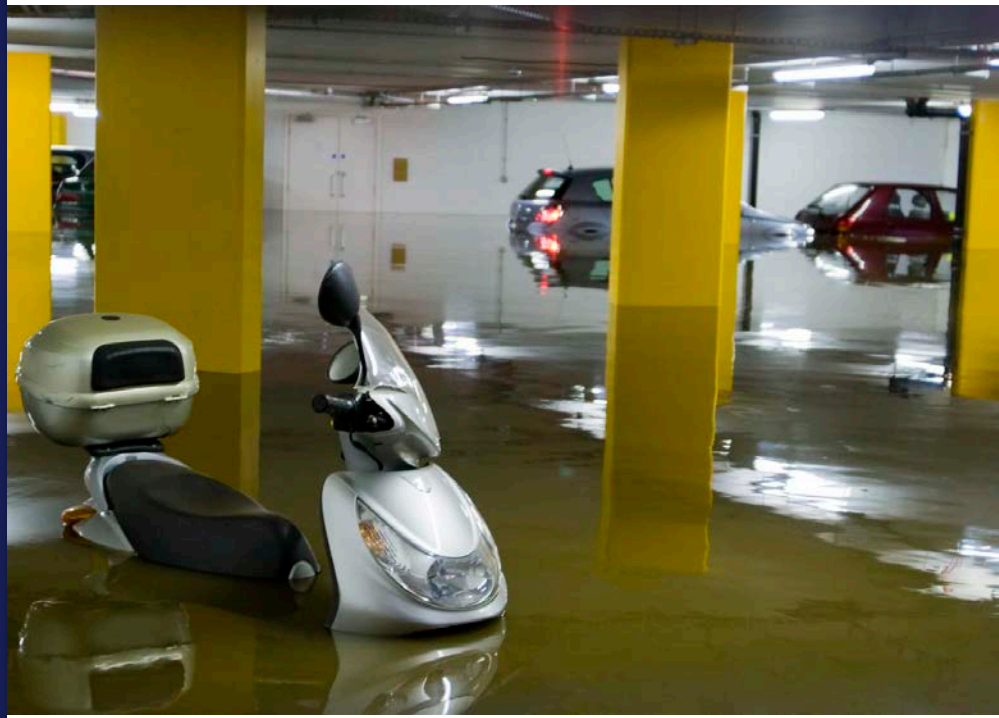
Flood Mitigation Products – Opening Barriers

Automatic Pop-Up

Manually Deployed Opening Barrier

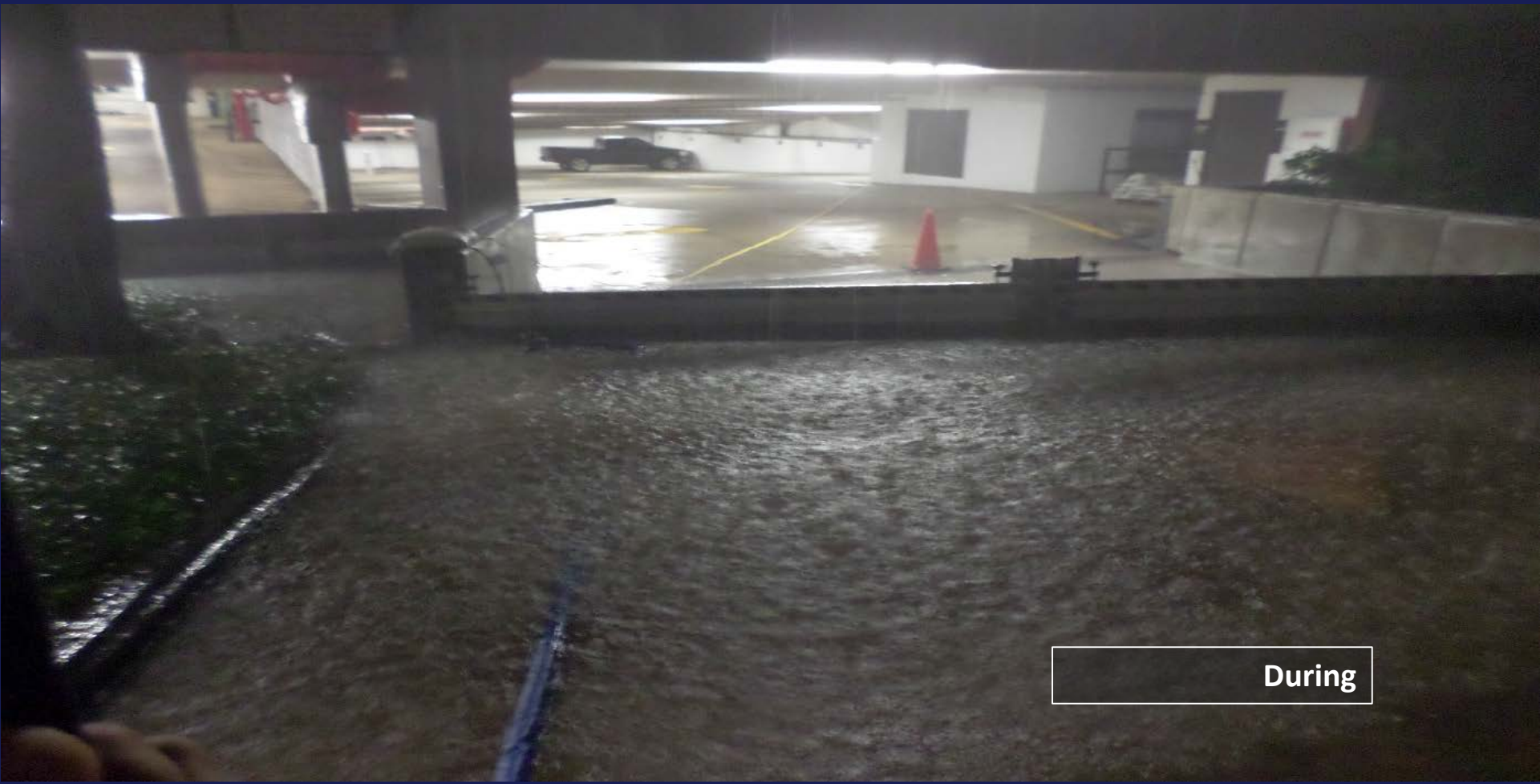
One Client's Story: Flooded in May 2015 and April 2016

- Office tower
- Outside the 500-year zone
- Four feet of water in garage
- Building utilities located in garage



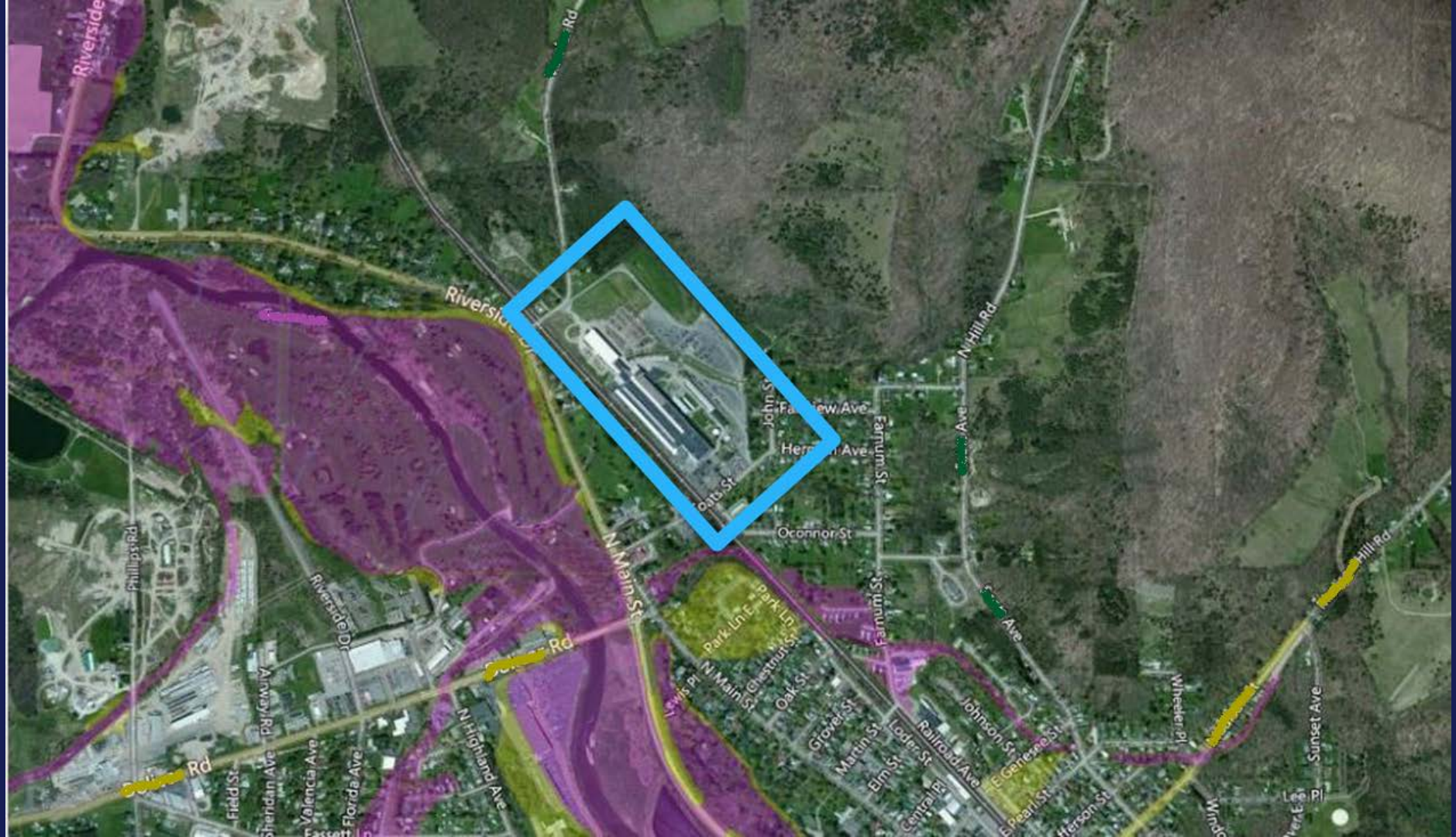

DO NOT ENTER
FDC
FDC


CONTRACT & GARAGE VISITOR PARKING
CLEARANCE 6'7"


During

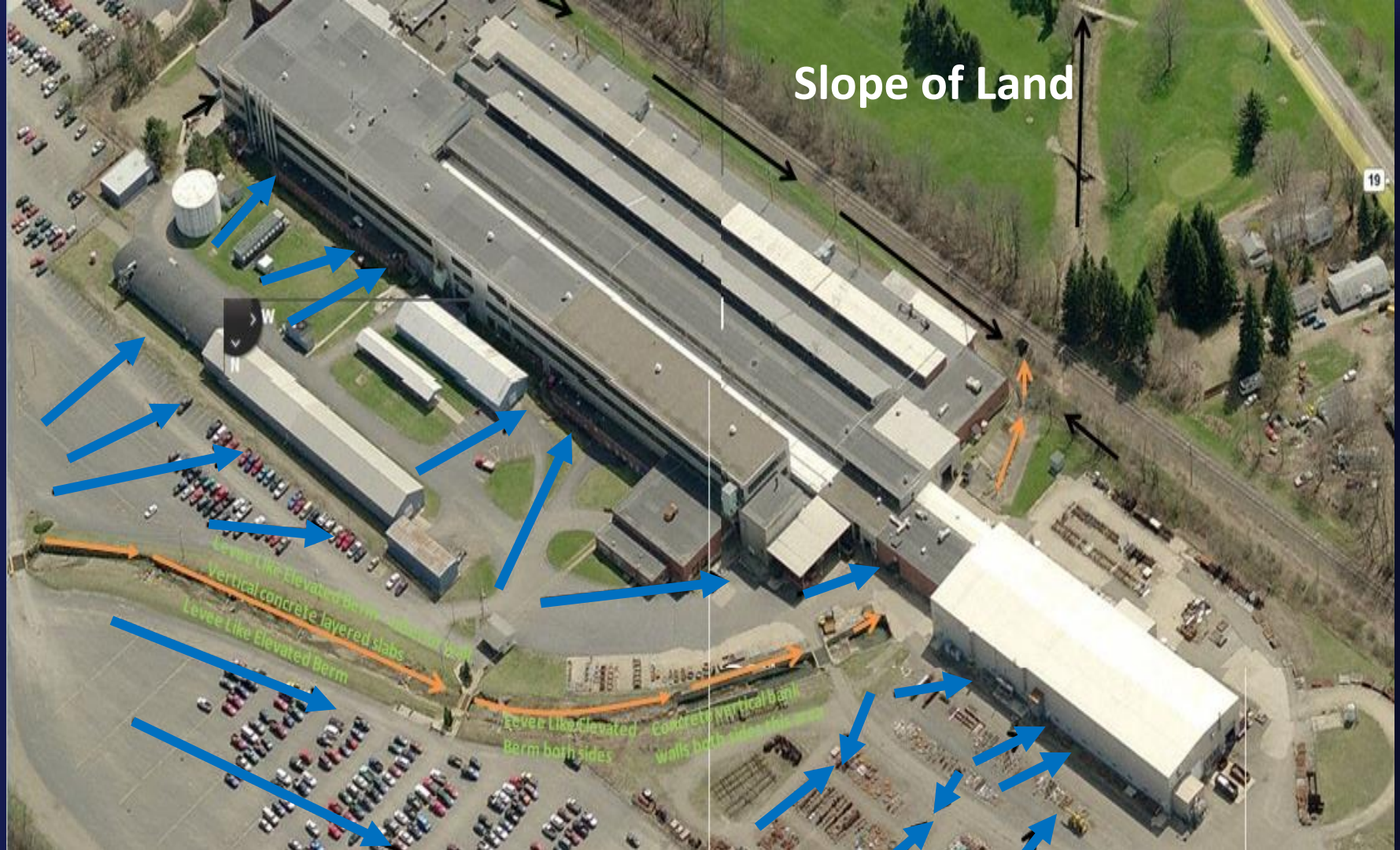

The Result

Case Study – River / Stream


Riverside Dr
N Main St
N Hill Rd
Oconnor St
Farnum St
Oak St
Grover St
Martin St
Elm St
Railroad Ave
Johnson St
Sunset Ave
Lee Pl
Phillips Rd
N Highland Ave
Sheridan Ave
Florida Ave
Park Ln E
Park Ln
Chestnut St
Lewis Pl
Loder St
Central St
Pearl St
Wheeler Pl


Riverside Dr
Riverside Dr
Ave
Ave
Ave
Ave
St
St
St
St
St
St


Close to Building


Slope of Land
Levee Like Elevated Berm
Vertical concrete layered slabs
Levee Like Elevated Berm
Levee Like Elevated Berm both sides
Concrete vertical bank walls both sides
19

A River Runs Through It

Case Study: Lexington, MA


Kiln Brook
Wetlands associated with Shawsheen River

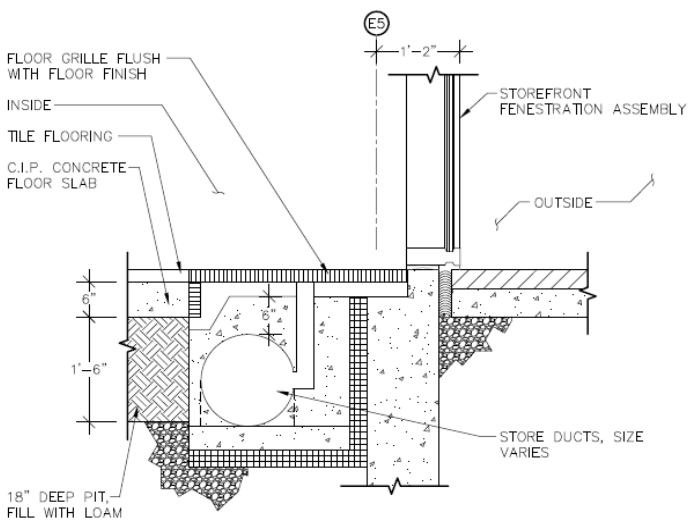
SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

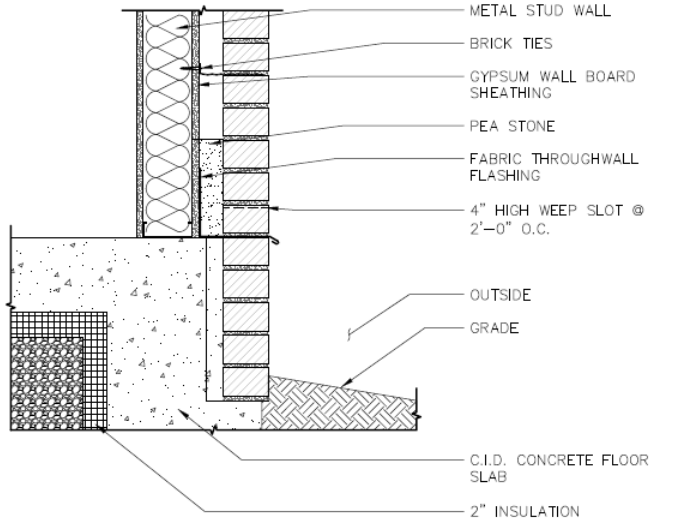
SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) Zone A, V, A99
	With BFE or Depth Zone AE, AO, AH, VE, AR
	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
	Future Conditions 1% Annual Chance Flood Hazard Zone X
	Area with Reduced Flood Risk due to Levee. See Notes. Zone X
	Area with Flood Risk due to Levee Zone D
OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard Zone X
	Effective LOMRs
	Area of Undetermined Flood Hazard Zone D
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Levee, Dike, or Floodwall
OTHER FEATURES	20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
	Coastal Transect
	Base Flood Elevation Line (BFE)
	Limit of Study
	Jurisdiction Boundary
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature

- Site within AE Zone and Regulatory Floodway
- Base Flood Elevation (BFE) is 118.50

- Base Flood Elevation (BFE) is 118.50
- Surveyed first floor found to be at 118.00
- Building is 6” below BFE

Floor mounted HVAC vents





Electrical/Mechanical Equipment Located on First Floor

Proposed Building Use: Office, Laboratory Space, and Cleanrooms

Flood Mitigation Options:

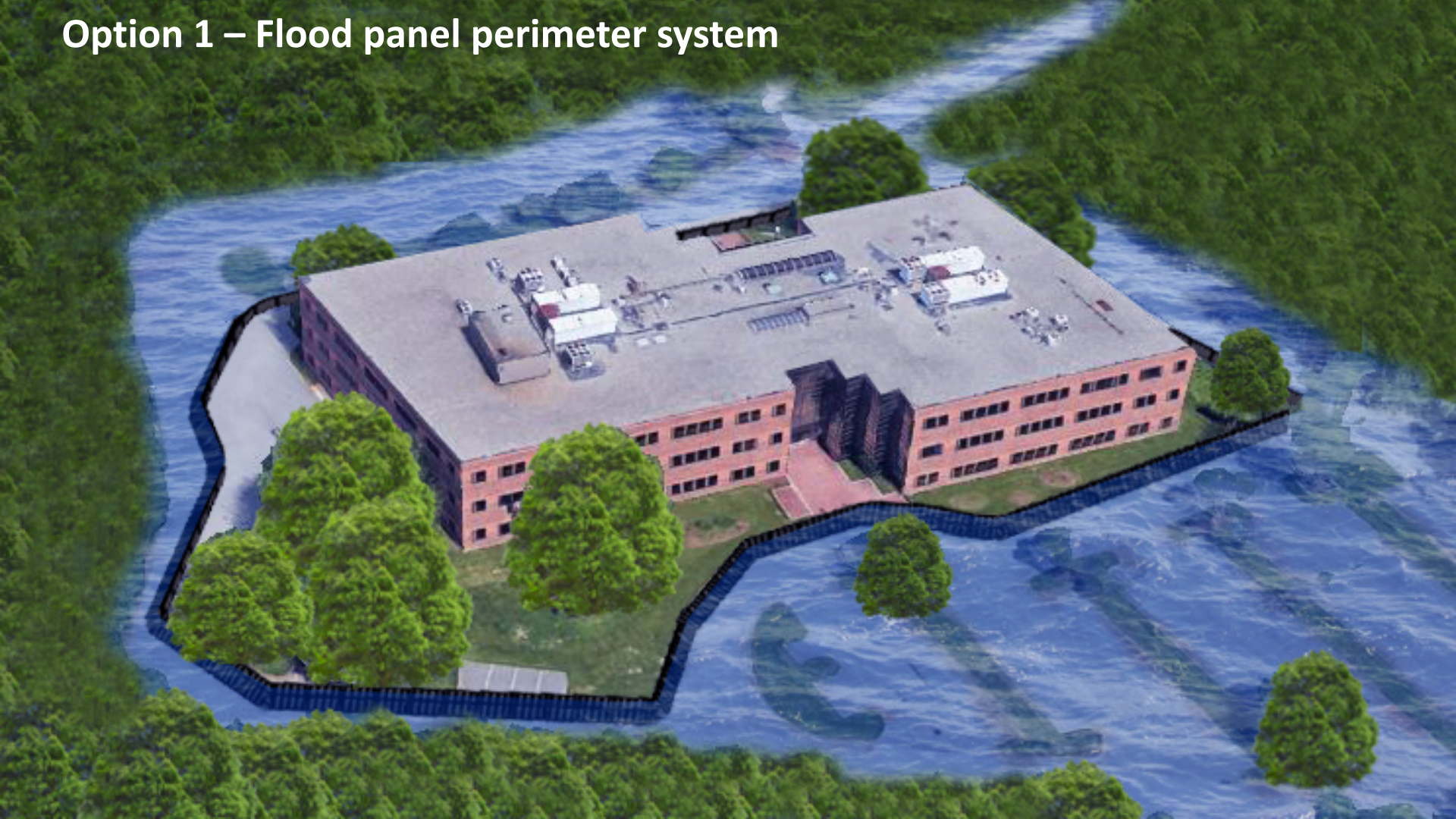
Wet Flood Proofing

Relocating all laboratory and cleanrooms to the second floor and installing isolated interior protection around mechanical , electrical, and communications rooms

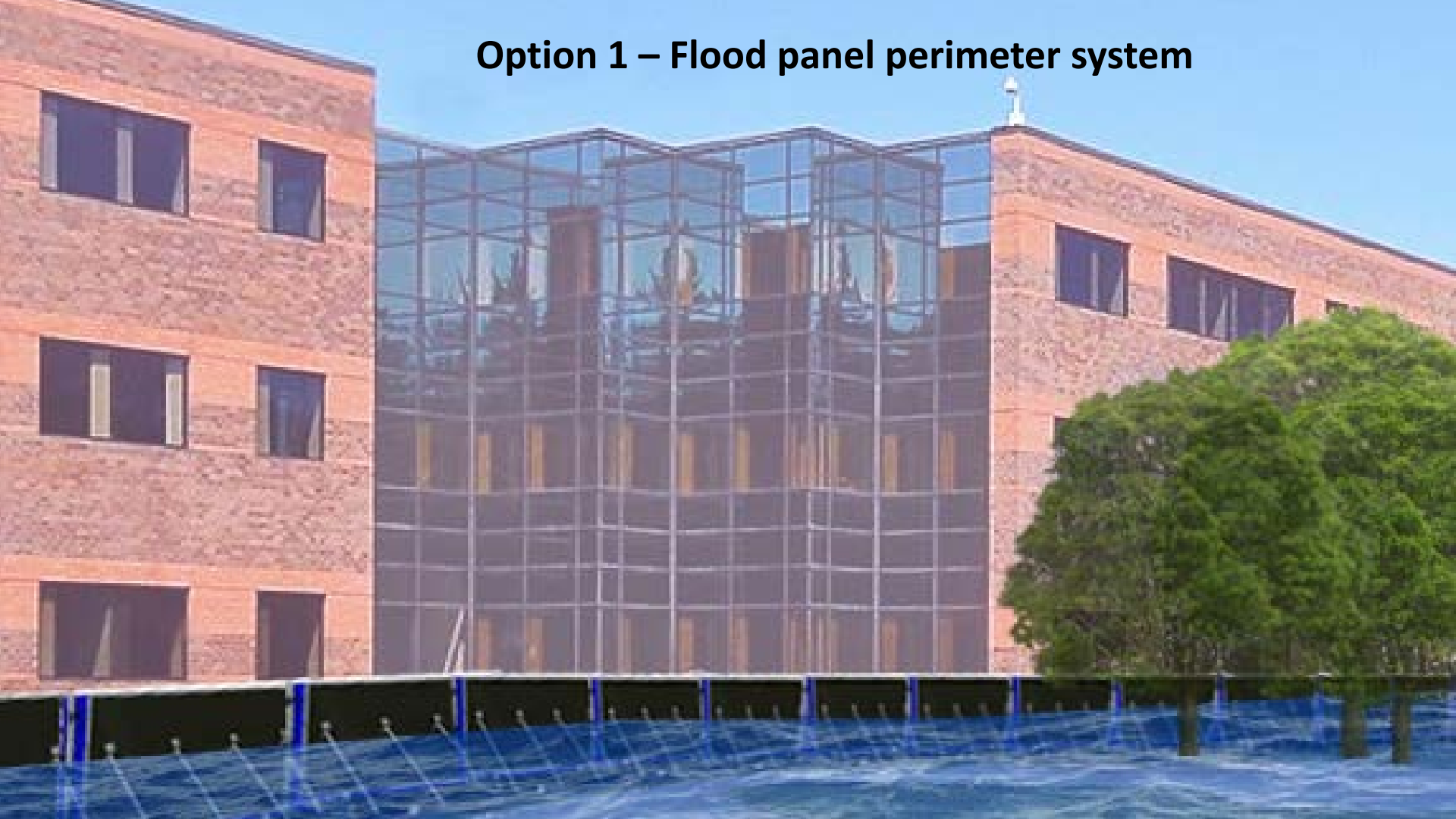
Dry Flood Proofing

Providing full building perimeter protection by installing permanent and/or temporary flood mitigation measures.

Option 1 – Flood panel perimeter system

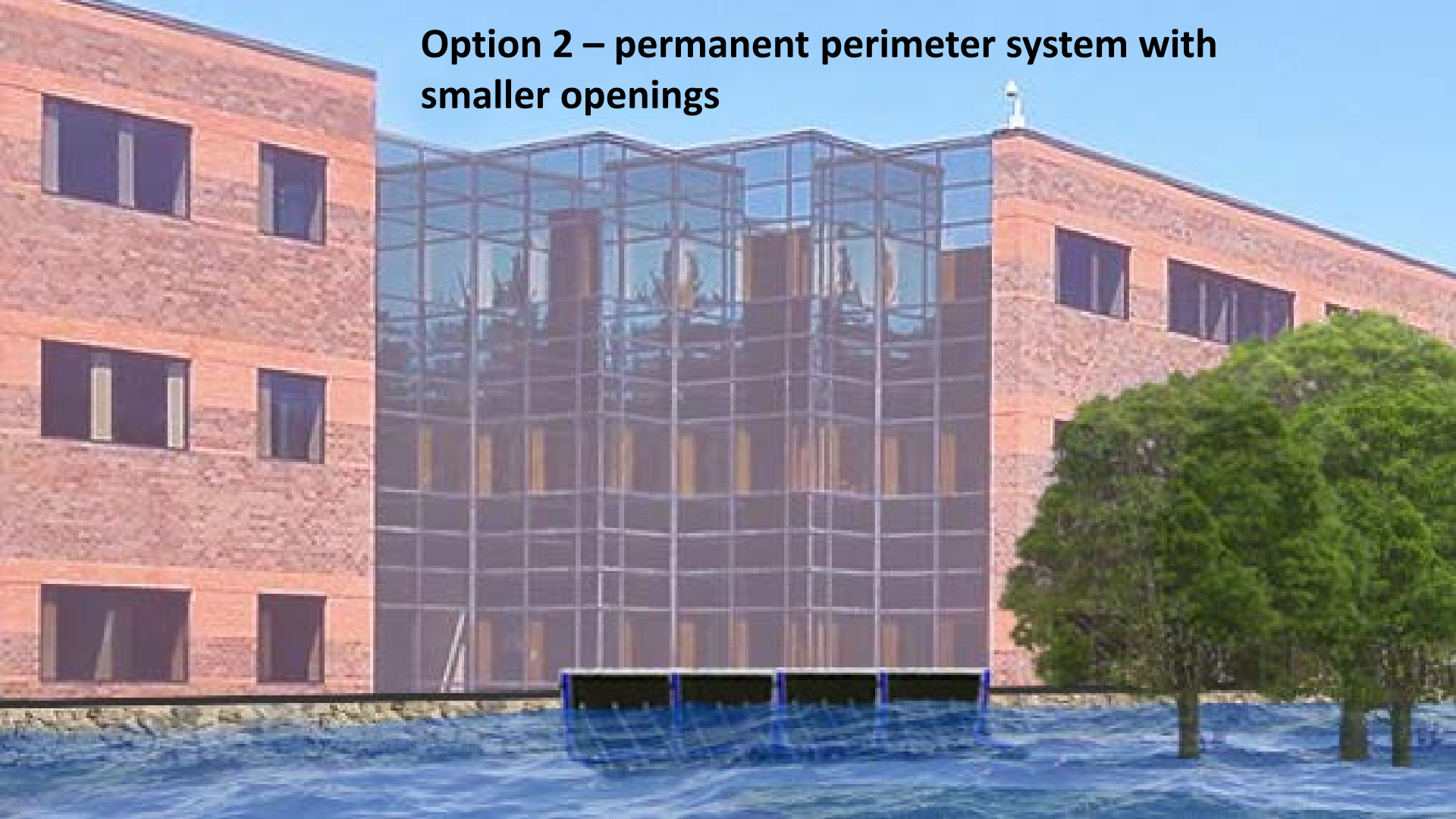


Option 1 – Flood panel perimeter system



Option 2 – permanent perimeter system with smaller openings

Option 2 – permanent perimeter system with smaller openings



Case Study: Atlantic Avenue, Boston, MA

FEMA Flood Map / AE Zone, BFE Elev. 10

First Floor / Garage, ELEV=10.2’ BFE=10’
First Floor 2” above BFE
Basement 9 ½’ below BFE

Lower Level Basement Access
Open Grated for Boiler Ventilation

Louver Penetrations

View from Sidewalk, Concrete Grade Beam

Continuous and Approved Flood Barrier

Main Entrance – Unprotected

Flood Barrier at Entrance, Garage and Basement Access

Changing How We Think

What Does It Take to Make “Futuristic” Ideas the Norm?

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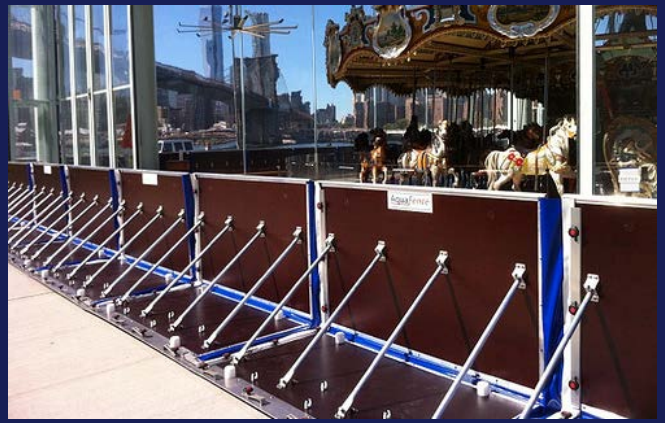

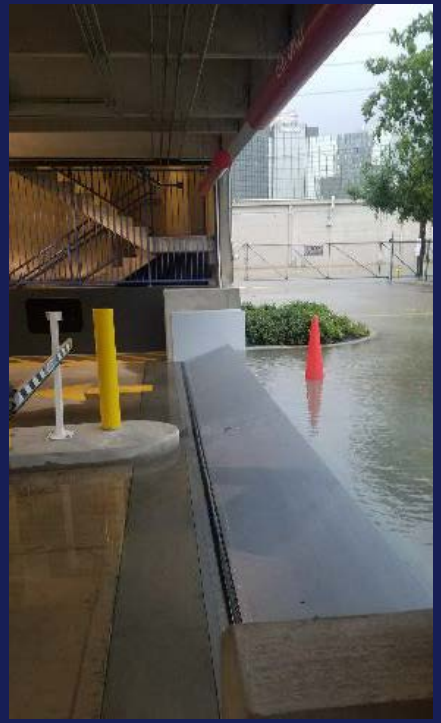

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Key Takeaways

- Storms Have Increased in Severity and Frequency
- Even if You're Not in Flood Zone, You May Still Be Flood Exposed
- If You Are Exposed, There Are Things You Can Do to Minimize Risk

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