* Photo URI Coastal Resources Center*

Catalog of Adaptation Techniques for Coastal and Waterfront Businesses:

Options to help deal with the impacts of storms & sea level rise

Coastal Resources Center
GSO
The University of Rhode Island
Sea Grant Rhode Island

How to Use this Catalog

This catalog is to act as a guide to help business owners understand their exposure and risks from climate change, while also providing links and information on adaptation techniques for any identified exposures or risks.

Certain adaptation techniques will not be applicable in all situations and many require professional assistance to ensure structural integrity.

Catalog created with funding provided by:

RHODE ISLAND FOUNDATION

PRINCE CHARITABLE TRUSTS

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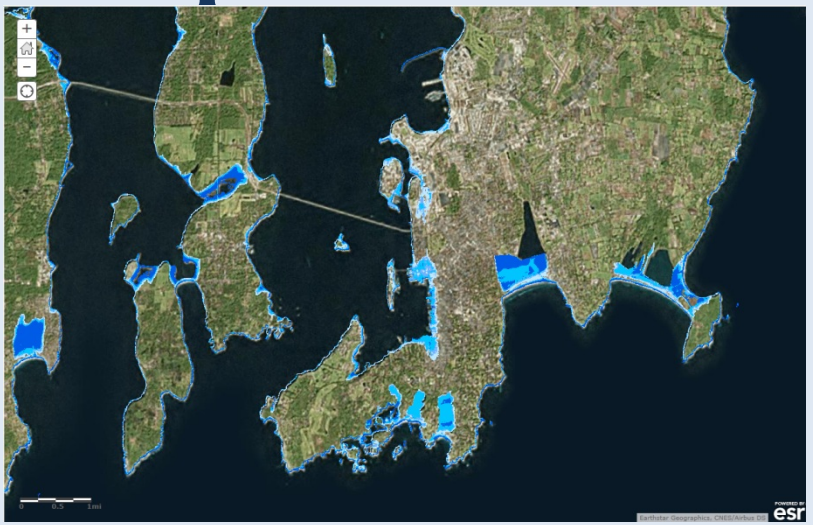
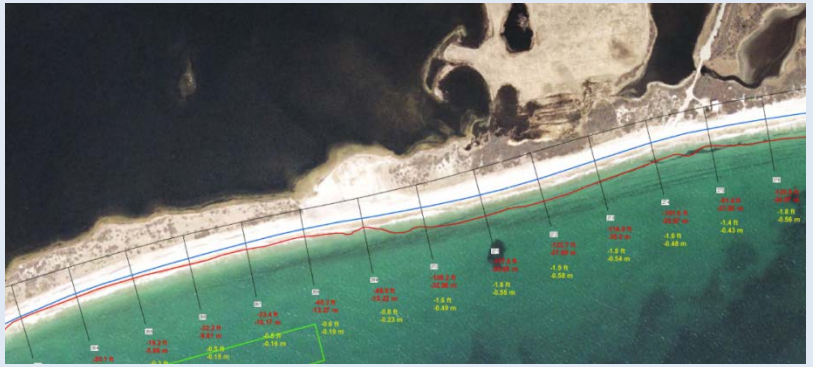
Tools to Understand Your Exposure

- Risk from Storms Today
  - Click here to see National Flood Insurance Program Maps
- Future Risk of Storms and Sea Level Rise
  - Click here to view Sea Level Rise Maps
- Erosion and Shoreline Change
  - Click here to view Shoreline Change Maps
- Migrating Wetlands with Sea Level Rise
  - Click here to view Migrating Wetlands Maps



Courtesy of RI Beach SAMP www.beachsamp.org



Courtesy of RI CRMC

Where do you have flooding now? It is likely to get worse!

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Siting of New Construction

These are some examples of what you should discuss with a professional before beginning construction:

- ❑ Check for soil stability
- ❑ Determine maximum potential wind speeds
- ❑ Estimate potential wave height of the area using fetch
  - Particularly marinas
- ❑ Determine potential heights of elevated tidal and storm surge
  - Particularly marinas
- ❑ Find an area that requires minimal excavating, filling or dredging
- ❑ Choose a location that provides shelter from storm surge

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SEVERE STORM PROTECTION SYSTEMS

- Voluntary construction guidelines for new and existing buildings to reduce future storm damage
- Hurricane Standard - 3 incremental levels:
  - *Bronze* – more resilient roof covering and provide electrical connections for backup power
  - *Silver* – Bronze and opening protection; and provide on-site backup power for critical utilities
  - *Gold* – Bronze and Silver; and structural protection in the form of a continuous load path connecting roof to walls to foundation
- Click here to locate the building standards

* Courtesy of the Insurance Institute for Business & Home Safety*

Insurance Institute for Business & Home Safety

FORTIFIED®
A program of the Insurance Institute for Business & Home Safety

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Retrofitting Your Building: Structural Elements

- Evaluating Roof
- Considerations for Re-Roofing
- Retrofitting without Re-Roofing
- Roof Structure
  - Roof Sheathing Attachments
  - Roof-to-Wall Connections
  - Gable End Overhangs
- Roof Mounted Equipment

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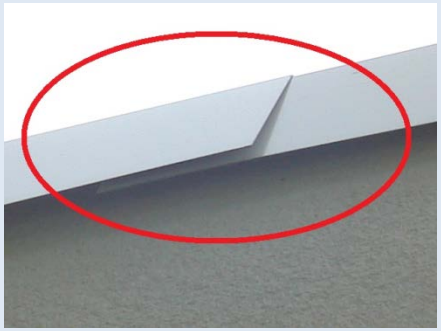
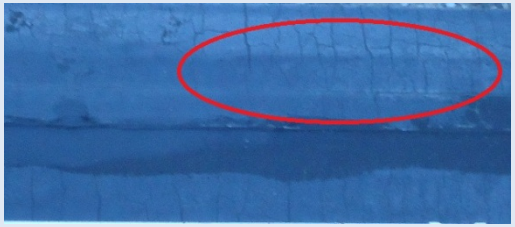
Evaluating Roof

- Look for signs of loose edge flashing, membrane cracking, bubbling, water pooling on flat roofs, or shingle damage on steep sloped roofs
- For a complete shingle roof inspection checklist please click here
- Examples of what to look for:





* Courtesy of Institute of Business and Home Safety*

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What to do if You Need to Re-Roof a Steep Sloped Roof

- Check out the Insurance Institute for Business & Home Safety Re-Roofing Checklist

- Once you've decided to replace your roof cover, you'll need to find a qualified roofing contractor. Be sure to pick a reputable roofer, since proper installation directly impacts the performance of your roof. Create a stronger, more hurricane-resistant roof by ensuring that the basic steps outlined below are followed by your roofing professional:
  - ❑ Remove the old roof cover and expose the roof deck.
  - ❑ Inspect for damage
  - ❑ Re-nail the roof deck to provide a wind resistant connection to the roof framing.
  - ❑ Anchor gable end outlookers: Improve the anchorage of roof deck/outlookers at gable ends (if any)
  - ❑ Seal roof deck after determining which option is best for your roof type.
  - ❑ Install flashing and be sure that the roof has proper drip edge and flashing.
  - ❑ Roof cover installation of a high wind-rated covering
  - ❑ Roof vents should all be high wind-rated and properly installed.
  - ❑ Soffits should be retrofitted to ensure they remain in place in high winds.

How to Retrofit Without Re-roofing

- If re-roofing is not the best option, make sure to discuss these factors with your contractor:
  - How to strengthen the attachment of the roof sheathing to the roof framing
  - How to strengthen or replace roof vents
  - How to improve the wind resistance of your existing roof cover
- For instructions and examples on how to do so click here.

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Improving Membrane Roofs

Patches have been developed to repair portions of roofs where cracks or holes may occur

*** Courtesy of Florida Division of Emergency Management***

Quality flashings are needed around any objects coming through the roof

*** Courtesy of Insurance Institute for Business & Home Safety***

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Enhancing Roof Sheathing Attachment

EXAMPLES:

Apply a bead of wood sub-floor adhesive between roof sheathing and rafters to better secure the connection

*** Courtesy of Florida Division of Emergency Management***

Blocks of wood with adhesive on two sides helps stabilize

Quarter round wood strips significantly increase connection strength

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Strengthening Roof-To-Wall Connections

Strapping the rafters to the double plate and the double plate to the studs evenly distribute the uplift force

Follow this link from the IBHS Research institute to see how vulnerable a structure can be without the proper connections
http://vimeo.com/17764719

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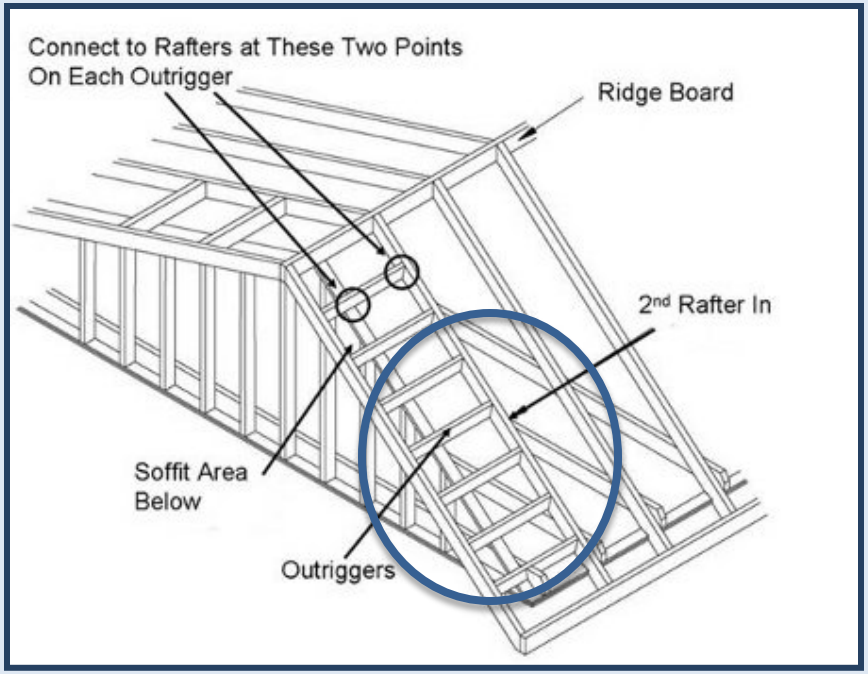
Strengthening Gable End Overhangs

Gable end overhangs can be very vulnerable in high wind areas, potentially exposing the interior of your structure.

Using outriggers is the best method to ensure a secure gable end overhang, however you must adequately attach each outrigger.



*** Courtesy of Florida Division of Emergency Management***

For more information on strengthening gable end overhangs check out Florida's Hurricane Retrofit Guide!

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Roof Mounted Structures

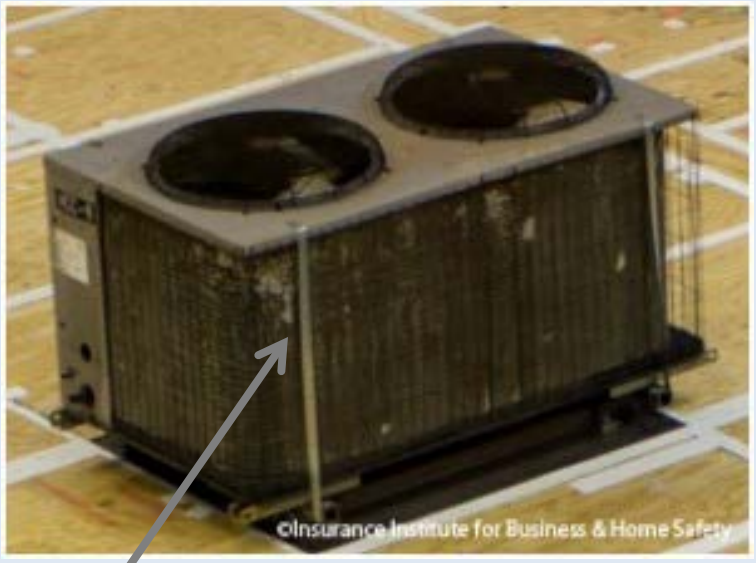
Roof mounted structures are particularly vulnerable to high winds

If damaged, the holes can provide direct access to the interior – vulnerable to precipitation

*** Can turn into wind-borne debris ***

*** Courtesy of FEMA**

Securing Roof Mounted Structures



Anchoring HVAC units and other structures helps prevent air borne debris and holes in the roofing.

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Flood-Proofing Retrofits

- Accommodating Flood Waters
  - Elevate Structure
  - Breakaway Walls
  - Flood Vents
  - Elevate Utilities
  - Install Backup Generator
- Excluding Flood Waters
  - Build out of Impervious Materials
  - Install Backflow Valve to Prevent Sewage Backup

- Click here to locate what flood zone your structure may fall in
- To view the FM Global Emergency Flood checklist click here

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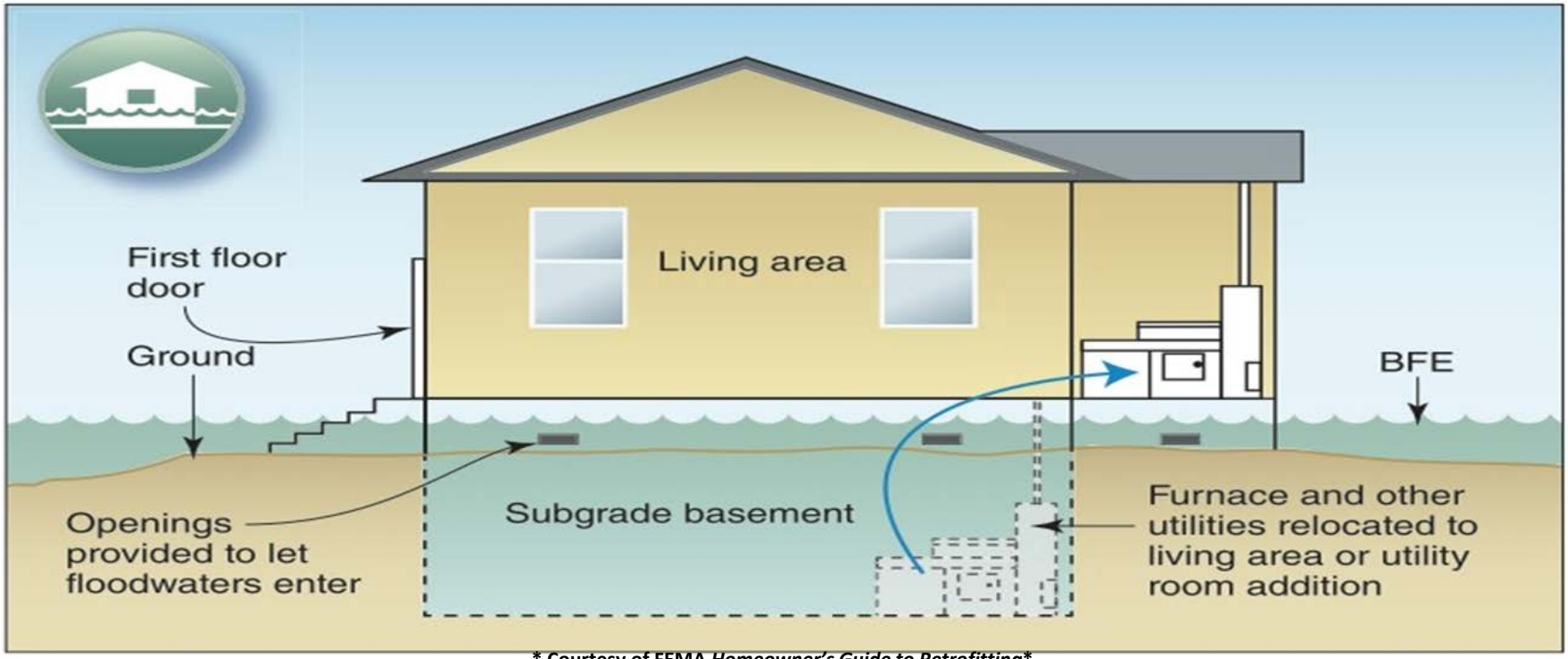
Accommodating Flood Waters

Methods for allowing flood water to enter and exit a structure while minimizing damage are commonly used to accommodate flood waters. Examples: Elevating a structure, installing flood vents and raising utilities and electrical system components.



*** Courtesy of FEMA *Homeowner's Guide to Retrofitting**

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Elevating Structures

Elevating allows for flood waters to freely flow under the structure, helping to minimize damage.

*** Courtesy of RI CRMC***

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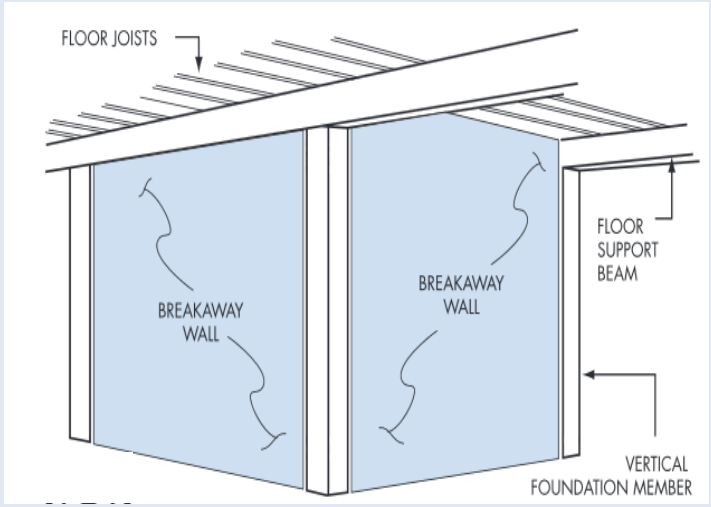
Breakaway Walls



*** Courtesy of RI Emergency Management Agency***

Breakaway walls prevent collapse of entire structure by allowing storm surge to flow underneath an elevated structure

*** Courtesy of Janet Freedman, RI CRMC***

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Flood Vents

* Courtesy of City of Key West, Florida*

Can be as simple as a hole left in the wall or a block turned sideways ***or*** *a well engineered automatic vent that opens with the water pressure*

* Courtesy of Maryland Department of Environment*

Keep the pressure exerted by floodwaters from collapsing the walls of a structure

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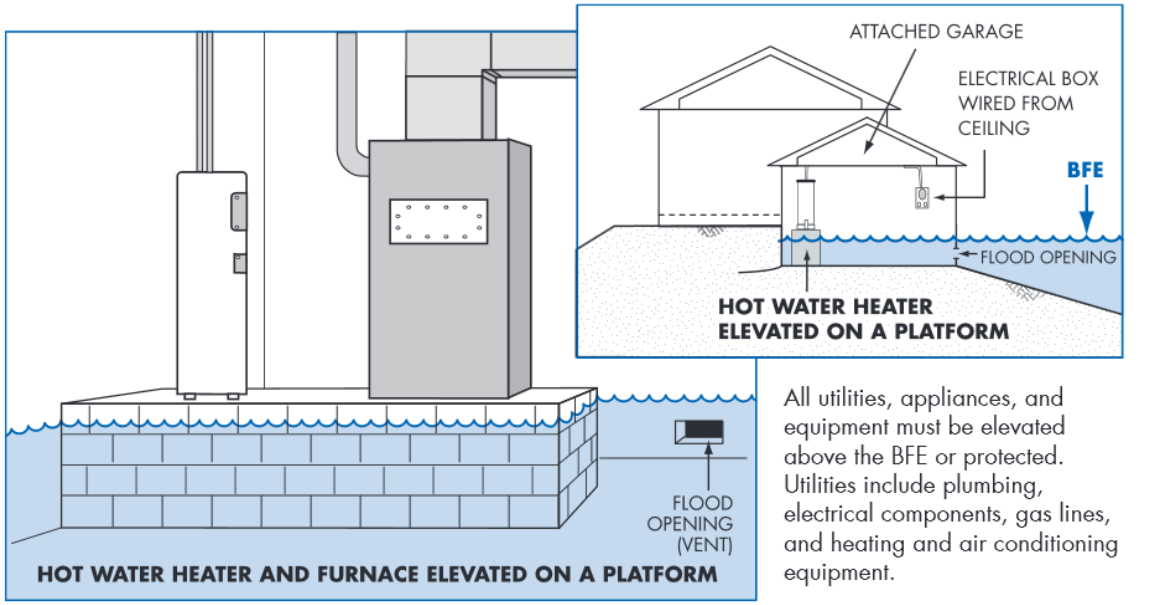
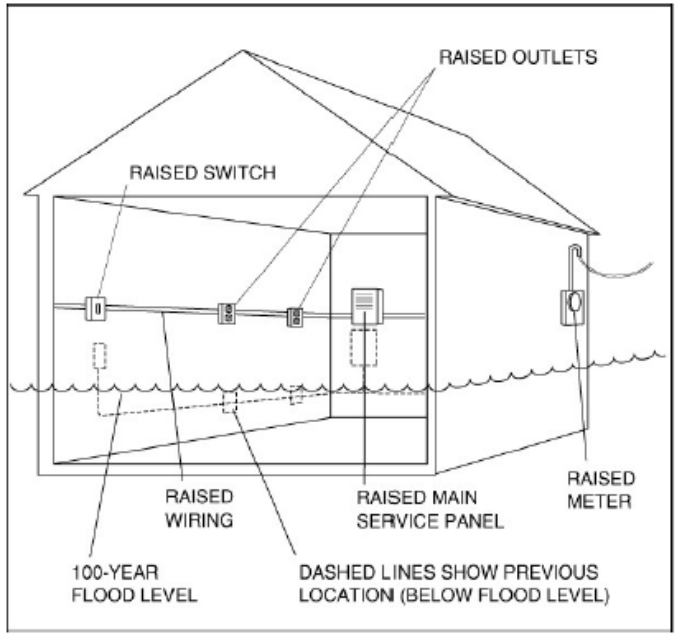
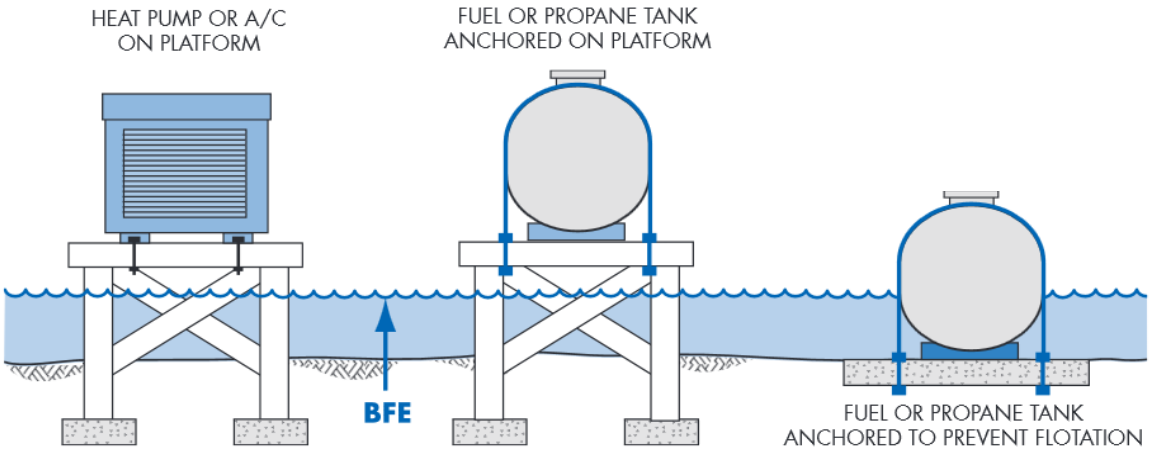
Elevate Utilities



All utilities, appliances, and equipment must be elevated above the BFE or protected. Utilities include plumbing, electrical components, gas lines, and heating and air conditioning equipment.





Whether inside an attached garage or outside the building, all utilities, appliances and equipment must be elevated above the BFE or protected against flood damage. Utilities include plumbing, electrical components, gas lines, fuel tanks, and heating and air conditioning equipment.

For information on raising electrical system components provided by FEMA, click here

* Courtesy of RI Emergency Management Agency*

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Install Backup Generator

*** Courtesy of US Fish and Wildlife Service***

Backup generators help to minimize downtime after a storm event. It is highly encouraged to install the generator on higher ground or elevate it to prevent inundation from floodwaters.

https://www.disastersafety.org/disastersafety/commercial-generators-for-your-business/

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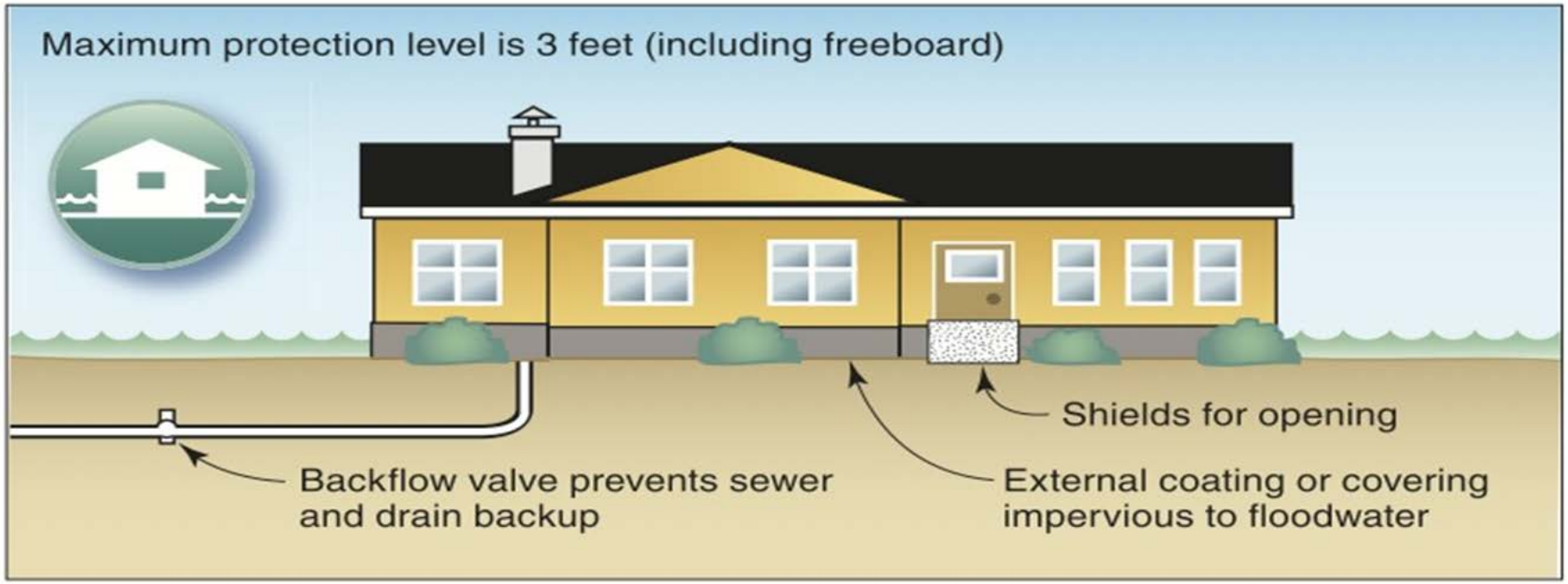
Excluding Flood Waters

This figure shows a structure dry flood-proofing by using impervious construction material, shields for openings and a backflow valve to prevent sewage backup



*** Courtesy of FEMA *Homeowner's Guide to Retrofitting****

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Installing Flood Gates

Temporary flood resistant walls can exclude floodwaters before a storm event

*** Courtesy of Rising Sun Mills, Providence***

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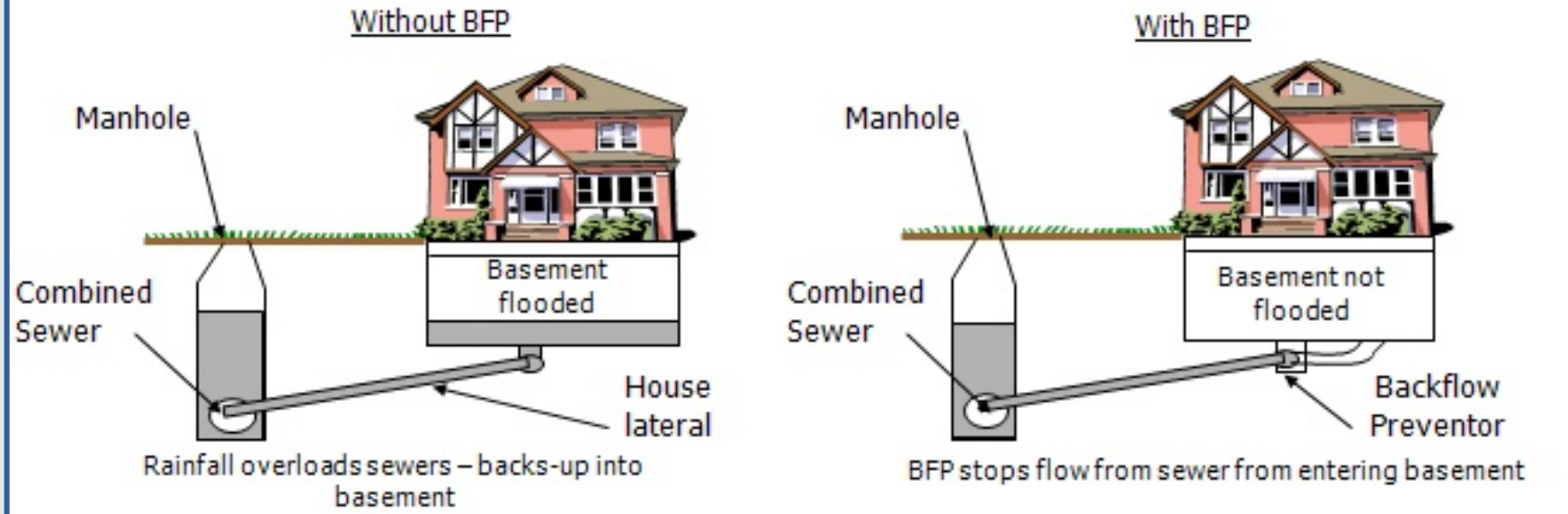
Backflow Valves



*** Courtesy of District of Columbia Water and Sewer Authority***

To ensure sewage backup does not enter your building, installing a backflow valve is highly recommended. In certain places it may be required based off of the elevation of structure.

For more information on installing backflow valves click here

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Stormwater Management

- Rain Gardens
- Rain Barrels and Cisterns
- Green Parking Designs
- Permeable Pavers
- Vegetated Roofs
- Tree Grates

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Rain Gardens

- A depressed area with porous backfill (material used to refill an excavation) under a vegetated surface
- Often have an underdrain to encourage filtration and infiltration, especially in clayey soils
- Provide groundwater recharge, pollutant removal, and runoff detention
- Effective solution in parking lots or urban areas where green space is limited.
- Can be installed in dividers of parking lots and between road ways

Rain Garden Bristol, RI, Photo credit: Janet Freedman, CRMC

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Rain Barrels and Cisterns

Photo credit: CT Department of Environmental Protection and the Environmental Protection Agency

- Harvest rainwater for reuse
- Placed outside a building at roof downspouts to store rooftop runoff for later reuse in lawn and garden watering
- Cisterns store rainwater in significantly larger volumes in manufactured tanks or underground storage areas.
  - Rainwater collected in cisterns may also be used in non-potable water applications such as toilet flushing.
- Can be implemented without the use of pumping devices by relying on gravity flow instead
- Low-cost water conservation devices that reduce runoff volume and, for very small storm events, delay and reduce the peak runoff flow rates
- Can provide a source of chemically untreated “soft water” for gardens and compost, free of most sediment and dissolved salts

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Green Parking Designs

- Refers to several techniques that, applied together, reduce the contribution of parking lots to total impervious cover. Techniques include:
  - ❑ Minimizing the dimensions of parking lot spaces
  - ❑ Utilizing alternative pavers in overflow parking areas
  - ❑ Using bioretention areas to treat stormwater

*** Courtesy of EPA Green Parking Lot Resource Guide***

Green Parking Design: Examples

The raingarden in Bloedel Donovan Park helps protect the water quality in nearby Lake Whatcom, and recharge groundwater supplies.

Strategically sloped vegetated strips are a better option than conventional grassy parking islands for collecting and filtering runoff.

*** Courtesy of EPA Green Parking Lot Resource Guide***

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Permeable Pavers

- Promote groundwater recharge
- Permeable interlocking concrete pavements (PICP) are concrete block pavers that create voids on the corners of the pavers
- Concrete grid paver (CGP) systems are composed of concrete blocks made porous by eliminating finer particles in the concrete which creates voids inside the blocks;
  - The blocks are arranged to create voids between blocks.
- Plastic turf reinforcing grids (PTRG) are plastic grids that add structural support to the topsoil and reduce compaction to maintain permeability.
  - Grass is encouraged to grow in PTRG, so the roots will help improve permeability due to their root channels.

Examples of Permeable Pavers

* Courtesy of Pam Rubinoff, CRC/ RI Sea Grant*

Can make a great alternative for parking lots as well as walkways

* Courtesy of James Houle, UNH Stormwater Center*

Maintenance is required to reduce clogging of pavers. If clogging occurs, street sweeping can often fix the problem.

For more information on pavers click here

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Vegetated Roofs

- Consist of an impermeable roof membrane overlaid with a lightweight planting mix with a high infiltration rate and vegetated with plants
  - Tolerant of: heat, drought, and periodic inundations.
- Reduce runoff volume/frequency & improve runoff water quality
- Can reduce the effects of atmospheric pollution, reduce energy costs, and create an attractive environment
- Have reduced replacement and maintenance costs and longer life cycles compared to traditional roofs
- Options for high wind areas to reduced vulnerability of plants and soils using mesh grates

Examples of Vegetated Roofs

Save the Bay Center, RI

*** Courtesy Wenley Ferguson, Save the Bay***

A green roof in Ipswich, Massachusetts

*** Courtesy of U.S. Environmental Protection Agency***

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Tree Grates

- Allows for planting of trees in urban areas
- The grate protects the base of the tree, while allowing people to walk over it and rainwater to be absorbed
- Helps to manage stormwater and reduce runoff

*** Courtesy of James Houle, UNH Stormwater Center***

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Preparedness and Planning

- Business Continuity Planning
- Post-Disaster Plans
- Insurance

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Business Continuity Planning

- Helps businesses of any size reduce impact from disasters and reduce closure time

- These toolkits will help you:
  - ❑ Identify the business activities that are essential for continued operation during a disruption;
  - ❑ Deal with risks your organization faces; and
  - ❑ Create an easy-to-use recovery plan tailored to your business, giving you confidence if the worst occurs.

- ❑ Planning Resources:
  - ❑ Ready.gov Business Continuity Planning Guides click here
  - ❑ Open for Business ® (OFB –EZ) click here

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Post-Disaster Plans

- The US Small Business Administration (SBA) provides a guide to developing post-disaster recovery plans, to visit click here
- For another services that you can buy called Agility Recovery click here

*** Courtesy of Teresa Crean, URI Coastal Resources Center & RI Sea Grant***

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Insurance

- Things to keep in mind about your insurance:
  - Know what is covered by your policy
  - Understand the claims process
  - Take pre-storm photos of inventory and business assets for insurance claim submissions

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Preparing Your Employees

- Have a comprehensive plan
  - ❑ Ensure employees and staff are personally prepared, allowing them to be on call if needed
  - ❑ Ensure employees and staff are aware of the contingency plan and their personal responsibilities

* Courtesy of Pam Rubinoff, URI Coastal Resources Center & RI Sea Grant*

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Additional Resources

www.beachsamp.org

Contact Information:
Tel: (401) 874-6626
beachSAMP@etal.uri.edu

- 2012 IBC Flood Resistant Provisions
- 2014 R.I. Hazard Mitigation Plan
- FEMA Building Code Resources
- FEMA Coastal Construction Manual
- FEMA Flood Zones
- IBHS FORTIFIED Program
- IBHS Hurricane Standards
- IBHS Roof Information
- National Flood Insurance Program (NFIP)
- R.I. Coastal Resources Management Council (CRMC)
- R.I. CMRC Hurricane Preparedness Guide
- R.I. Hurricane Evacuation Maps
- R.I. Inundation Surfaces (Sea level Rise viewer)
- RIEMA Flood Insurance Information
- U.S. Army Corps of Engineers Hurricane Inundation Maps

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