VOLUNTEER GUIDE
FLOOD HAZARD GUIDANCE

FLASH®
FEDERAL ALLIANCE FOR SAFE HOMES

Developed by the Federal Alliance for Safe Homes (FLASH)®
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1.0 INTRODUCTION
KNOW THE FLOOD RISK

This Flood Hazard Guidance provides volunteer construction managers with information concerning the impacts of flooding on residential structures and most importantly methods to mitigate the damage caused by flooding. It is understood that by the time the volunteer teams begin rework of the home, all insurance and other recovery issues are being addressed by a case manager. Therefore, this guidance is primarily tailored for members of volunteer and service groups that rebuild/repair residential homes during the long-term recovery phase of a disaster. This guide is not intended to be used by volunteers not affiliated with a nationally recognized organization and working within the long-term recovery phase of the disaster.

NOTE

This Flood Hazard Guidance does not replace controlled engineering data. Volunteer group members should always consult with the construction coordinator/leader when questions arise or when further explanation is required.

Figure 1.1 Flooded Roadways and Property

1.1 FLOOD BASICS

A flood is a general and temporary condition of partial or complete inundation of normally dry land areas from one of the following four sources:

- The overflow of inland or tidal waters.
- The unusual and rapid accumulation or runoff of surface waters from any source.
- Mudflows, which are primarily caused by floods, as defined above, and are akin to a river of liquid and flowing mud on the surface of normally dry land area, as when earth is carried by a current of water and deposited along the path of the current.
- The collapse or cave-in of land along the shore of a lake or other body of water because of erosion or undermining caused by waves or currents of water exceeding the normal cyclical levels which results in flood, as defined above.

Figure 1.2 Roadway Flood Damage Due to Erosion or Undermining

1.2 TWO TYPES OF FLOODING

There are two fundamental types of flooding: riverine and ocean flooding.

1. RIVERINE FLOODING

Riverine flooding occurs when rivers and streams overflow their banks due to extensive rainfall. When the amount of water being carried by a river or stream exceeds the capacity of its channel, the water overflows onto the adjacent land. The land that is most likely to be flooded is commonly referred to as the floodplain.

2. COASTAL FLOODING

Coastal flooding affects areas where beachfront properties are particularly vulnerable. Areas around bays and adjacent to streams that empty into bays near the coast are at risk. Coastal flooding is caused by tropical storms and hurricanes due to the high winds and reduced atmospheric pressure associated with these storms. Reduced atmospheric pressure causes the level of the ocean to rise, moving the water further inland. This rise in the elevation of the ocean in localized areas is referred to as storm surge.

1.3 AN OVERVIEW OF NATIONAL FLOOD INSURANCE PROGRAM

This guidance is not intended to make the reader an expert on the National Flood Insurance (NFIP) program. It is intended to provide a basic understanding of the program in order to initiate the discussion regarding flood mitigation with the homeowner.

The National Flood Insurance Program (NFIP) makes federally backed flood insurance available to homeowners in communities that adopt and enforce floodplain management ordinances or laws that meet a set of minimum design requirements. The insurance premiums set by the NFIP are based on the risk of flood to the buildings within a community.

Recommending and identifying affordable mitigation following a flooding event requires an understanding of Base Flood Elevation (BFE). BFE refers to the elevation associated with the “100-year flood” level, or a flood with a 1 percent chance of occurrence in any given year. The location of the “100-year flood” level line forms the basis for the NFIP flood insurance rates and regulatory floodplain management.

Elevating an existing residential structure is well beyond the capabilities and scope typically provided by volunteer repair/rebuilding groups. Therefore, it is important to understand what types of mitigation the NFIP will recognize prior to performing any of the measures outlined in this guide.

Figure 1.3 Elevating a Home above BFE

1.3.1 DETERMINING FLOOD RISK

Floods can endanger both life and property, so evaluating flood risk is the first step in determining appropriate construction enhancements to reduce flood damage. It is vital to know the areas where flood hazards are known to exist for proper evaluation of risk to a home.

A Flood Insurance Rate Map (FIRM) is the official map of a community upon which FEMA delineates both the Special Flood Hazard Areas and the Flood Risk Premium Zones applicable to that community. FIRMs are usually available at local municipal offices, libraries, map dealers, or insurance agent's offices, as well as online at msc.fema.gov.

1.3.2 SPECIAL FLOOD HAZARD AREAS

In addition to determining the BFE of an area, FIRMs are also used to determine the flood zone classification for a particular area. The flood zone refers to a classification system of the characteristics of a flood that can be expected in the area. According to FEMA and the NFIP, any building located in either an "A" or a "V" zone is considered to be in a Special Flood Hazard Area (SFHA).

"A" zones are defined as special flood hazard areas with a 1 percent annual chance (100-year) of flooding. Within this classification are several sub zone classifications as shown in Table No. 1.

A	Special Flood Hazard Areas where no depth or BFE is shown.
A#	Special Flood Hazard Areas where the FIRM shows a BFE (old format).
AE	Special Flood Hazard Areas where BFEs are provided. The AE Zone delineation replaces A# zones on new FIRMS.
AO	Special Flood Hazard Areas with sheet flow, ponding, or shallow water flooding base flood depths 1 to 3 feet.
AH	A shallow flooding Special Hazard Area, usually in the form of a pond with an average depth of 1 to 3 feet, BFEs derived from detailed analysis are shown.
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam).
A99	Areas that will be protected by a Federal flood control system where construction has reached specified legal requirements.

Table 1.1 "A" Zone Flood Designations

"V" zones are defined as areas with ground elevations below the BFE with waves expected to be greater than three feet high during the 100-year flood. "V" zones are considered to be subject to coastal high hazard flooding. Within the classification are several sub zones as defined by Table 1.2.

V	Special Flood Hazard Areas where no BFE is shown.
V#	Numbered zone in Special Flood Hazard Areas where the FIRM shows a BFE (old format).
VE	Special Flood Hazard Areas where BFEs are provided. The VE Zone delineation replaces V# zones on new FIRMS.

Table 1.2 "V" Zone Flood Designations

2.0 MITIGATION ASSESSMENT

An assessment of the home prior to rebuilding or repair will assist with determining which flood mitigation techniques can be employed. For example, raising electrical panels and connection boxes when the whole home should be elevated would add unnecessary cost and time to the project. The assessment table below will guide the construction manager through the process of inspecting the home for possible inclusion of flood mitigation techniques.

If during the inspection, the construction manager identifies any of the areas on the checklist as needing to be retrofitted to avoid future flood damage, refer to the referenced mitigation section in Chapter 3 to ensure flood mitigation techniques are included as part of the rebuilding/repair process.

MITIGATION ASSESSMENT TABLE

Information Request	Rebuilt/Repaired	Mitigation Information Section
Section A – Home Information		
Date		
Owner's Name		
Property Address		
Construction Manager's Name		
Contact Phone		
Section B – General Building Information		
Complete rebuild/repair		
Number of stories		
Type of Flood Zone		Section 1.0
Base Flood Elevation		Section 1.0
Section C – Foundation Type		
Basement (subgrade)		
Walk-out Basement		
Crawlspace		
Slab-on-grade		
Piers		
Posts/Columns		
Piles		
Section D – Lowest Floor Elevation		
A: Lowest floor elevation (ft)		
B: Base Flood Elevation (ft)		
A-B=		Section 3.1.1 Elevation

Information Request	Rebuilt/Repaired	Mitigation Information Section
Section E – Appliances/Utilities		
Interior Utilities below BFE » Furnace » Ductwork » Hot Water Heater » Electrical Panel » Electrical Outlets » Electrical Switches » Baseboard Heaters » Sump Pumps » Fuel Tanks » Other		Section 3.1.1 Elevation of Utilities
Exterior Utilities below BFE » Compressor » Electric Meter » Fuel Tank » Septic Tank » Well » Gas Meter » Other		Section 3.1.1 Elevation of Utilities or Section 3.1.3 Dry Floodproofing
Appliances below BFE » Refrigerator » Freezer » Washer » Dryer » Other		Section 3.1.1 Elevation of Utilities

3.0 IMPLEMENTING FLOOD MITIGATION TECHNIQUES

If elevating a residential structure above BFE is not an option, then a series of other flood mitigation methods can be considered. These post-flooding mitigation methods are effective in minimizing damage and costs from the impact of future flooding events. Many FEMA publications provide excellent resources for information for flood mitigation particularly, FEMA P-312, *Homeowners Guide to Retrofitting, Six Ways to Protect Your Home From Flooding* and FEMA P-805, *Protecting Your Home and Property From Flood Damage.*

The mitigation methods described in this document are considered reasonable or low cost yet the return on the investment in these mitigation efforts can be significant. In addition, the mitigation efforts proposed are usually well within the capabilities of most volunteer organizations.

NOTE

- **Certain repairs are not permitted for "substantially damaged" buildings located in A or V zones or the regulatory floodplain. ("Substantial damage" is usually determined after an inspection of the building by a qualified inspector).**
- **Repairs may require a building permit before construction can begin.**
- **Volunteer group members should always consult with the construction coordinator/leader when questions arise or when further explanation is required.**

3.1 MITIGATION CRITERIA

Post-flooding mitigation actions will primarily fall into one of three criteria. Each of these criteria, shown below, has specific guidance for implementation.

- Elevation
- Wet Floodproofing
- Dry Floodproofing

3.1.1 ELEVATION

Elevating an entire structure above BFE is not an option many volunteer groups can perform. This mitigation action requires significant time, permitting, equipment, labor and money. However, this should be considered first since it is the second most effective method of reducing future flood damage with removing the home entirely from the floodplain being the most effective. Only after making the decision that the structure cannot be elevated, should the other floodproofing methods described in this guide be employed.

ADVANTAGES	DISADVANTAGES
• Elevation to or above the BFE allows a substantially improved or substantially damaged home to be brought into compliance with a community's floodplain management ordinance or law. • Elevation reduces the flood risk to the home and its contents. • Except where a lower enclosed area is used for storage, elevation eliminates the need to move vulnerable contents to areas above the water level during flooding. • Elevation often reduces flood insurance premiums. • Elevation techniques are well known, and qualified contractors are often readily available. • Elevation does not require the additional land that may be needed for the construction of levees or floodwalls. • Elevation reduces the physical, financial, and emotional strain that accompanies floods.	• Cost may be high. • Appearance of the home may be affected. • Access to the home may be affected. • The home must not be occupied during a flood. • Unless special measures are taken, elevation is not appropriate in areas with high-velocity flows, waves, fast-moving ice or debris flow, or erosion. • Additional costs are likely if the home must be brought into compliance with current code requirements for plumbing, electrical, and energy systems.

Table 3.1 Advantages and Disadvantages of Elevating a Structure above BFE

Elevating Electrical Systems

PERSONNEL WARNINGS

- The combination of floodwater and energized electrical systems can produce potentially deadly electrical shock hazards.
- Do not enter a flooded or wet building if the power is on.
- Electrical power must remain de-energized until the electrical system has been evaluated and determined safe for operation by authorized personnel—usually the building official or building inspector and/or service provider.

MITIGATION WARNING

- Raising the electrical panel and connection boxes above flood levels may protect it from water damage. However, it does not automatically make it safe to have the electrical service turned on during flooding.

PROFESSIONAL NOTE

- Repair of electrical systems shall be covered by a Building Permit and be performed by or under the specific instructions of a licensed electrician or authorized local building officials as is determined on a case-by-case basis. Volunteer group members should always consult with the construction coordinator/ leader prior to beginning any work on electrical systems.

An undamaged operating electrical system after a flood will help expedite cleanup and repairs, and allow the occupants to return to their homes with shorter delays. The surest way to protect the electrical system is to keep it from getting wet. When rebuilding or repairing a home after a flood by wet floodproofing, move all wiring, switches, and outlets at least one foot above the BFE.

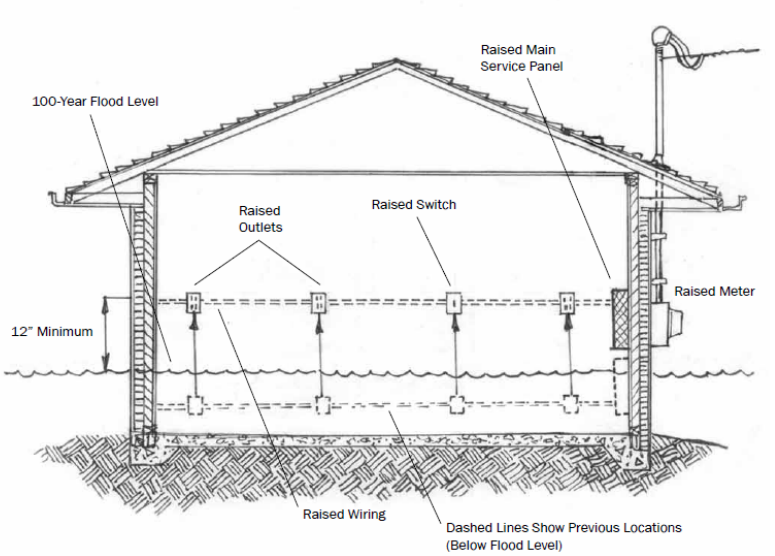


Figure 3.1 Electrical System Elevation

Electrical system components may be easily damaged by floodwater. Even if they are under water for only short periods, they will most likely have to be replaced. Another problem created by floods is the potential for short circuits and resultant fires.

Run wires overhead above BFE. If wires have to run in the areas that could get wet, use appropriately rated wire. No wire should be terminated in the flood zone (below BFE) and all connections should be in approved junction boxes. If a wire has to terminate below BFE it should be specially marked in the panel box and the power turned off at the time of a flood warning.

In an existing house, the elevation of the electrical system will require the removal of some interior wall sheathing (drywall, for example). When elevating electrical panels and outlets:

- The main electric panel (fuses or circuit breakers) should be at least 12" above the BFE for the home. The panel board height is regulated by code, and all electrical work should be supervised or completed by a licensed electrician.
- Elevate electric service lines (at the point they enter the home) at least 12" above BFE and /or as directed by the local building official/service provider.
- Elevate all electric outlets, switches, light sockets, baseboard heaters, and wiring at least 12" above BFE for the home.
- In areas that could get wet, connect all receptacles to a ground fault interrupter (GFI) circuit or outlets to avoid the risk of shock or electrocution.

Appliances, Water Heaters, Air Conditioning Units, and Furnaces

Figure 3.2 Water Heater and Furnace Damaged from Hurricane Sandy.
Source Feb 2013, Hurricane Sandy Recovery Advisory No. 3

For protection against shallow floodwaters, appliances, such as washers and dryers, can be elevated on masonry or pressure-treated lumber at least 12" above BFE. Other options include moving the washer and dryer to a higher floor, or building a concrete or masonry floodwall at least 12" above BFE around the appliances.

The cost of a floodwall will depend on the construction materials used and the wall's height and length.

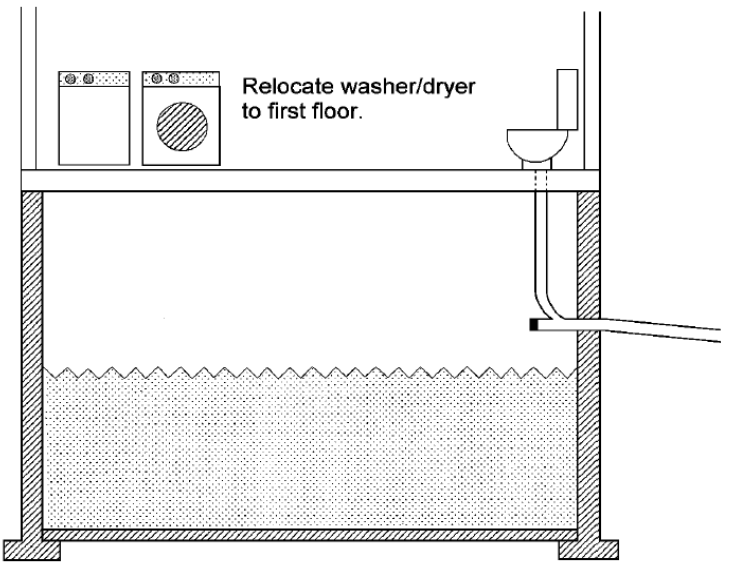


Figure 3.3 Elevating Appliances From Basement to First Floor at Least One Foot Above the BFE.

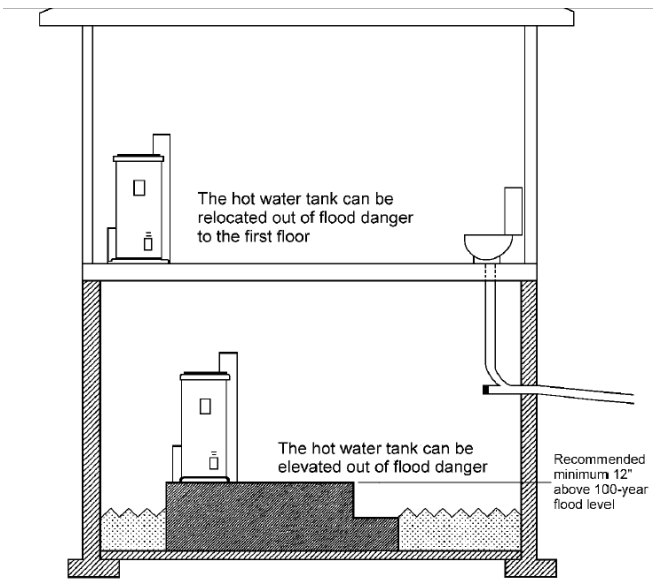


**Figure 3.4 Elevating Hot Water Heaters Above the BFE or a Higher Floor.
Be Sure to Check the Code Requirements in Your Jurisdiction.**

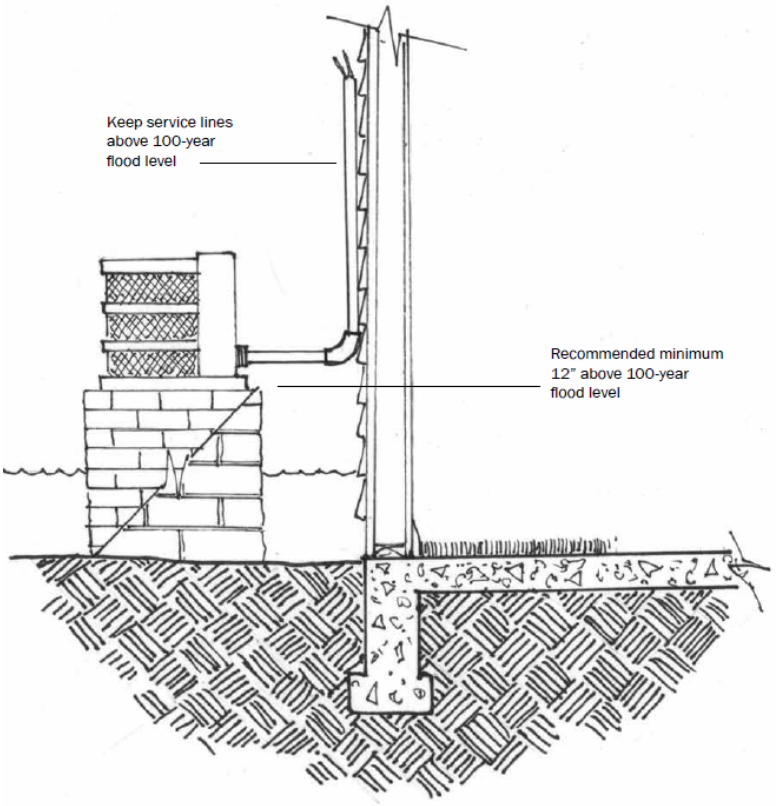


Figure 3.5 Elevated Air Conditioning Unit on Masonry Block

Air conditioning units and furnaces can be placed on masonry blocks or concrete at least 12" above BFE, moved inside a floodwall, or moved to a higher floor.

As a cost saving measure, exterior AC units can be elevated onto pressure treated lumber platforms, but be forewarned, unless designed to do so, these platforms may be ineffective in resisting coastal storm surge.

When relocating or raising the furnace or heating unit and the existing ductwork is below BFE (e.g. inside a slab or crawlspace beneath the home) it should be relocated so that it distributes heat from at least one foot above BFE. If you locate the furnace on an upper floor or attic, it may require the installation of a "downdraft" furnace, which is slightly different from a standard model. If you are replacing the furnace, ask the supplier for information on a downdraft system.

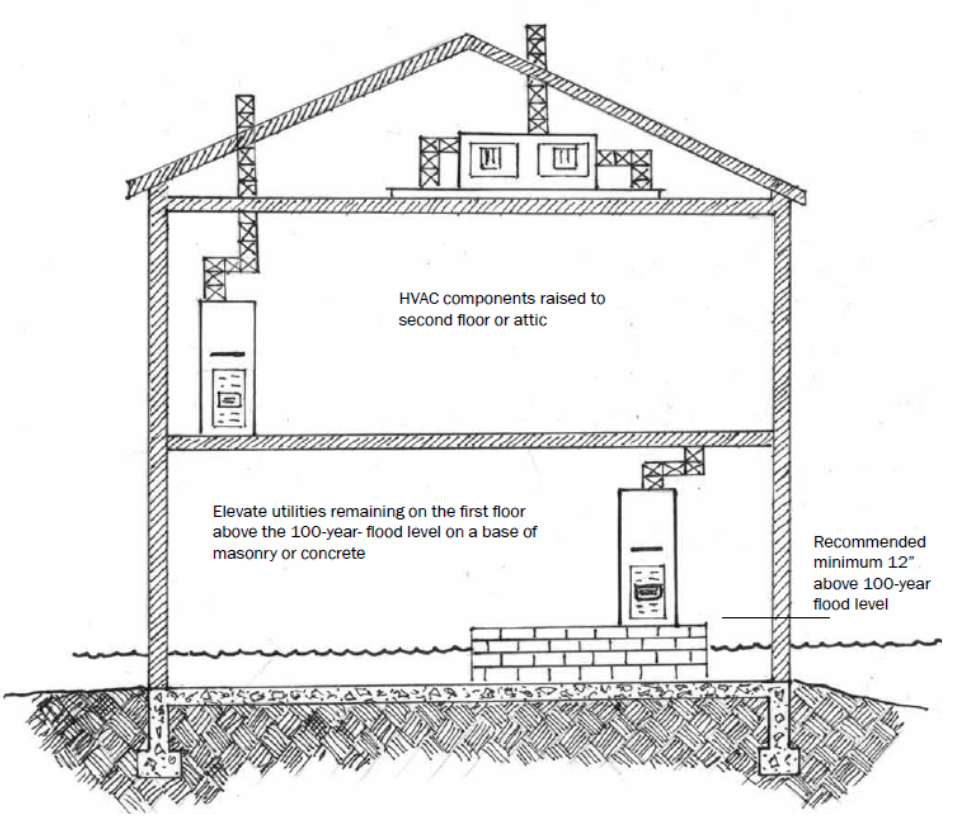


Figure 3.6 Elevating a Furnace or Heating Plant

Another option for a furnace that operates horizontally is to suspend it from the ceiling structure. The ceiling structure should be evaluated by qualified professionals (architect or professional engineer) to verify if the existing structure is strong enough to hold the weight.

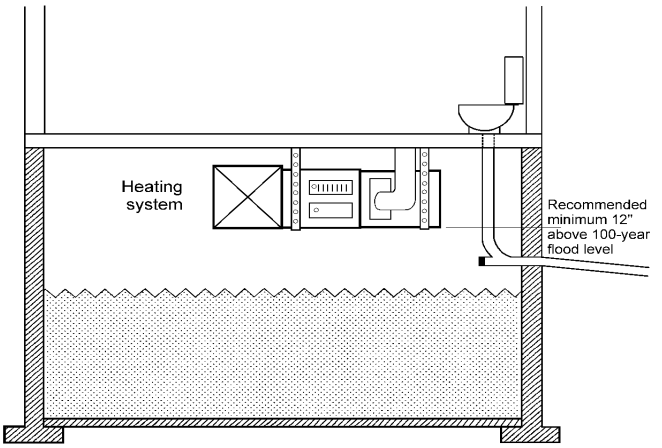


Figure 3.7 Horizontal Furnace Installed on Ceiling Joists

Anchoring Fuel Tanks

Unanchored fuel tanks can tip over or float and escaping fuel may result in hazardous spills and fires. To prevent this, anchor the fuel tank securely to the ground using suitable ground anchors or to a concrete slab using non-corrosive metal structural supports and fasteners. The type of anchorage, including slab dimensions, will vary depending on the size of the tank and soil conditions at the house. Advise the homeowner to keep the fuel tank topped off to increase the tank's weight and to reduce its tendency to float.

PROFESSIONAL NOTES

- Check with fuel tank manufacturer for recommendations on anchoring.
- Be sure all work done conforms to state and local building codes.
- For rented fuel tanks, check with the fuel supplier/owner of the tank before making any modifications to the tank.

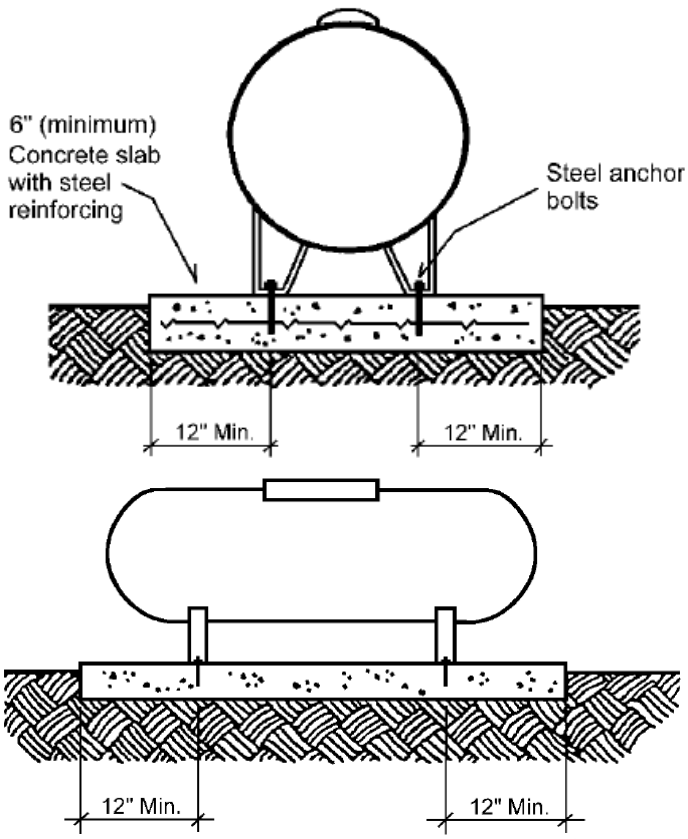


Figure 3.8 Anchoring Fuel Tanks

3.1.2 WET FLOODPROOFING

Wet floodproofing is a mitigation action where one could consider it as using water to fight water or water to fight damage from flooding.

Wet floodproofing allows water to enter a home in a way that minimizes damage to the structure and its contents. Wet floodproofing techniques make uninhabited parts of a home resistant to flood damage when water is allowed to enter during flooding. Wet floodproofing is often less costly than other retrofits. In addition, wet floodproofing can have little effect on the appearance of the house. It is important to note that wet floodproofing cannot be used in V zones as described by the National Flood Insurance Program.

Wet floodproofing protects a home from the effects of hydrostatic pressure (pressure of the water) but not from other flood hazards, such as the hydrodynamic force (pressure) of flowing water, erosion and scour. Erosion refers to a general removal of the ground surface over a wide area due to water flow. Scour refers to a localized loss of soil, often around a foundation element, saturation of building materials, damage to contents, the impact flood borne debris, and damage from flood borne contaminants.

ADVANTAGES AND DISADVANTAGES OF WET FLOODPROOFING

ADVANTAGES	DISADVANTAGES
• Small efforts provide protection • Usually less costly than other mitigation actions • Requires no additional land or space • Little to no effect on the appearance of a home	• Exposes the interior of the home to flood waters and may require extensive cleanup later • May leave a home uninhabitable after a flood • Does not prevent damage from high velocity flows • May cause structural damage if water is pumped out of structure too soon following flood

Table 3.2 – Advantages and Disadvantages of Wet Floodproofing

Structure Flood Vents

Selection of flood vents and their location within the structure requires careful consideration and is best left to qualified design professionals. FEMA Technical Bulletin 1-93, *Openings in Foundation Walls and Walls of Enclosures*, provides specific guidance for the installation of flood vents.

Flood vents are designed to allow water inside the building thus reducing the difference in hydrostatic pressure on walls when the interior (or exterior) floodwater level is higher than the opposite side.

Failure to reduce the difference in hydrostatic pressure may cause significant foundation and structural damage. By reducing the difference in hydrostatic pressure these large loads can be reduced to almost zero.

Figure 3.9 Structural Damage from Trapped Floodwaters

Figure 3.9 shows a residence where flood vents were not properly sized and inadequate numbers of flood vents were installed. This failure created large a differential pressure on the foundation wall causing the wall to fail significantly damaging the home.

Engineered and Non-Engineered Flood Vents

Flood vents predominantly fall into two categories: Engineered and Non-Engineered.

As with windows and doors, true flood vents are engineered to go into openings in the building structure. By their design, construction, and installation, flood vents are designed to provide relief from significant buildup of hydrostatic pressure caused by flooding. They are engineered to handle specific volumes of floodwater at specific flow rates. Certified engineered flood vents are commercially available from several manufacturers.

Non-Engineered flood vents are existing openings usually used as foundation air vents. They are designed to allow the movement of air, not floodwater.

Figure 3.10, Foundation Air Vent Clogged with Debris

Some air vents are equipped with insect screens, which are prone to becoming clogged with debris, especially vegetative matter like leaves and grass clippings. Clearing these screens of obstructions is an ideal function for volunteer groups.

Engineered and Non-Engineered Flood Vent Installation Requirements

To satisfy the National Flood Insurance Program, the following requirements for installation apply regardless of whether engineered flood vents or non-engineered flood vents are used:

- Each enclosed area must have a minimum of two openings; if there are multiple enclosed areas, each area must have at least two openings in its exterior walls.
- The bottom of each opening must be no more than 1 foot above the higher of the interior or exterior grade immediately under the opening, and any screens, grates, grilles, fixed louvers, or other covers or devices must not block or impede the automatic flow of floodwaters into and out of the enclosed area.

It is important to note that FEMA has determined that certain measures are not acceptable as flood vents, including:

- Standard foundation air ventilation devices that can be closed manually, because they do not allow for the automatic entry and exit of floodwaters unless closing mechanism is permanently disabled in the open position.
- Standard foundation air ventilation devices that have detachable solid covers that are intended to be manually installed over the opening in cold weather, because they do not allow for the automatic entry and exit of floodwaters when the cover is in place.
- Standard foundation air ventilation devices that are designed to open and close based on temperature (unless they also are designed to allow for the automatic entry and exit of floodwaters).
- Windows below the BFE, because the automatic entry and exit of floodwaters cannot be satisfied by the expectation that windows will break under rising floodwaters.
- Garage doors without flood vent openings installed in them, because human intervention is required to open the doors when flooding is expected. Gaps between the garage door and the doorjamb or walls do not count towards the net open area requirement.
- Standard exterior doors without flood vent openings installed in them.

3.1.3 DRY FLOODPROOFING

Dry floodproofing WITHIN Special Flood Hazard Areas (SFHA) is prohibited by the NFIP for all new and substantially improved structures.

Dry floodproofing refers to the elimination or minimization of the potential for flood damage by implementing waterproofing features designed to keep floodwaters completely outside of a structure.

In dry floodproofing, the portion of a structure that is below the BFE (walls and other exterior components) is sealed to make it watertight and impermeable to floodwaters. Such watertight impervious membrane sealant systems can include wall coatings, waterproofing compounds, impermeable sheeting, and supplemental impermeable wall systems, such as cast-in-place concrete. Doors, windows, sewer and water lines, and vents are closed with permanent or removable shields or valves.

The expected duration of flooding is critical when deciding which sealant systems to use because seepage can increase the longer the floodwaters are present, potentially rendering the floodproofing ineffective. Waterproofing compounds, sheeting, or sheathing may fail or deteriorate if exposed to floodwaters for extended periods.

Sealant systems are also subject to damage (puncture) in areas that experience water flow of significant velocity or debris flow.

ADVANTAGES AND DISADVANTAGES OF DRY FLOODPROOFING

ADVANTAGES	DISADVANTAGES
• Reduces the flood risk to the structure and contents if the design flood level is not exceeded • May be less costly than other retrofitting measures • Does not require the extra land that may be needed for floodwalls or reduced levees • Reduces the physical, financial, and emotional strains that accompany flood events • Retains the structure in its present environment and may avoid significant changes in appearance	• Does not satisfy the NFIP requirement for bringing substantially damaged or improved residential structures into compliance • Requires ongoing maintenance • Does not reduce flood insurance premiums for residential structures • Usually requires human intervention and adequate warning time for installation of protective measures • May not provide protection if measures fail or the flood event exceeds the design parameters of the measure • May result in more damage than flooding if design loads are exceeded, walls collapse, floors buckle, or the building floats • Does not eliminate the need to evacuate during floods • May adversely affect the appearance of the building if shields are not aesthetically pleasing • May not reduce damage to the exterior of the building and other property

Table 3.3 – Advantages and Disadvantages of Dry Floodproofing

Dry floodproofing is also not recommended for structures with a basement. In a flood event, these types of structures can be susceptible to significant lateral (horizontal) and uplift (buoyancy) forces. Dry floodproofing may not be appropriate for a wood-frame superstructure; however, in some instances, buildings constructed of concrete block or faced with brick veneer may be considered for dry floodproofing retrofits. When compared to masonry construction, wood-frame superstructure with siding will often fail at much lower water depths from the hydrostatic forces caused by the floodwaters.

Installing an Exterior Floodwall

An exterior floodwall can protect a window well or stairwell against low level flooding. Constructed of concrete or masonry, the walls should be supported by and securely tied into a footing so they will not be undercut by scouring. Understanding the particular flood situation and soil conditions is important for properly evaluating if a floodwall is the right solution for the homeowner. Floodwalls are usually not effective when the ground becomes saturated.

Construct a watertight floodwall around the perimeter of the opening. A qualified design professional should design the wall and anchoring system. The basic requirements are that the wall should not exceed three feet in height and must be constructed of steel reinforced poured concrete or steel reinforced concrete masonry units to prevent failure under flood conditions.

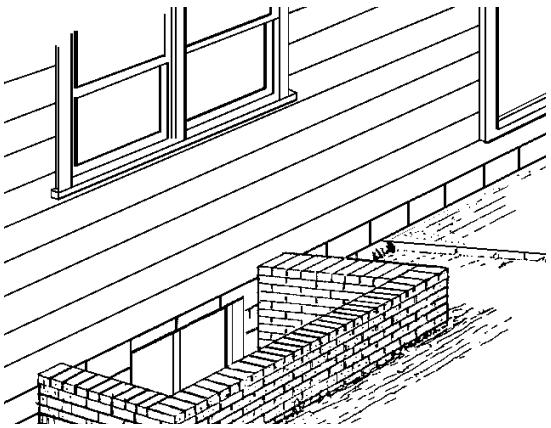


Figure 3.11 An Exterior Floodwall at a Window Well

Install a proper footing and anchor the floodwall to existing walls. Install a watertight, spring-loaded steel access door and watertight gaskets on sides and bottom of frame at any necessary opening. Be sure all work conforms to state and local building codes.

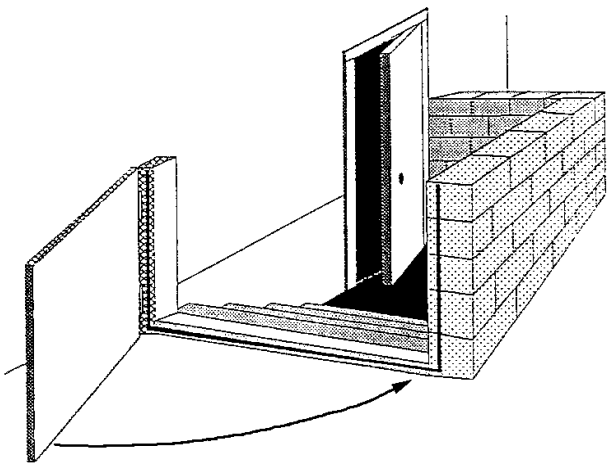
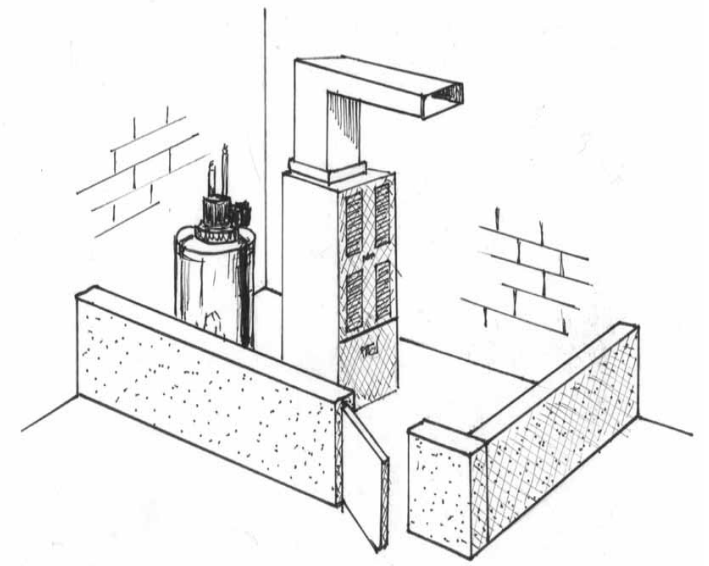


Figure 3.12 An Exterior Floodwall at a Stairwell

Installing an Interior Floodwall

An interior floodwall can protect against low level flooding inside the home. The wall must enclose the utilities and be at least one foot above BFE. To resist the pressure of the floodwaters, construct the wall of either steel reinforced concrete blocks or steel reinforced poured concrete. Connect the new wall to the existing basement wall and floor with properly embedded reinforcing steel. For best protection, do not install gates, which open into the enclosure. Designs should be provided by a qualified design professional architect or professional engineer.



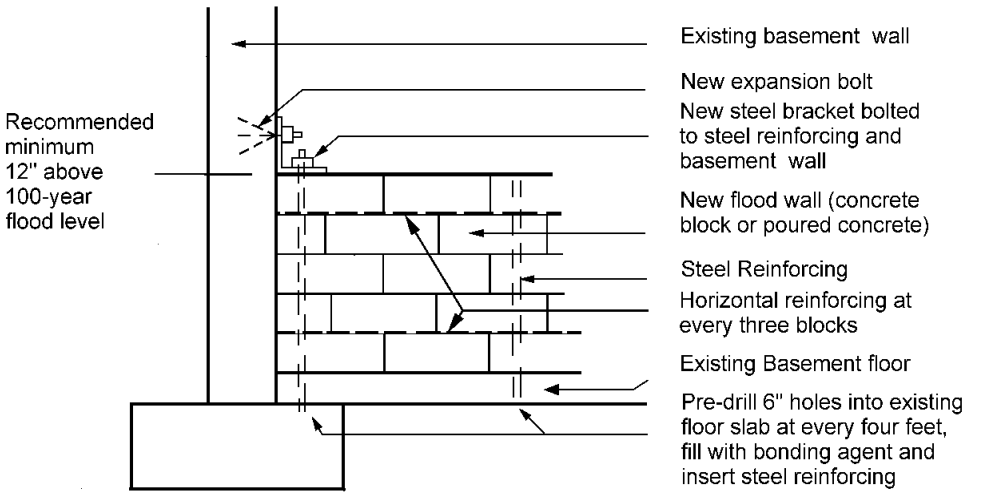


Figure 3.13 Installing an Interior Floodwall

Sealing Openings in Walls

If it is possible for a home to be flooded by flowing waters entering through windows, doors, or other openings, you can temporarily seal those openings to keep out the water.

Make or purchase metal or wooden shields to fit the openings. Secure the shields to the openings with bolts or slide them into special positioning channels. Seal the shields to the opening with a special rubber gasket or a bead of caulking to make them watertight. In addition, sandbags can be stacked in doorways or window wells and vents to make the openings water-resistant. Designs should be provided by a qualified design professional architect or professional engineer.

PROFESSIONAL NOTE

Shield height generally should not exceed 1 ½ feet above ground level. Exterior water deeper than 1 ½ feet could push the walls in if there is no water inside to push back with equal force.

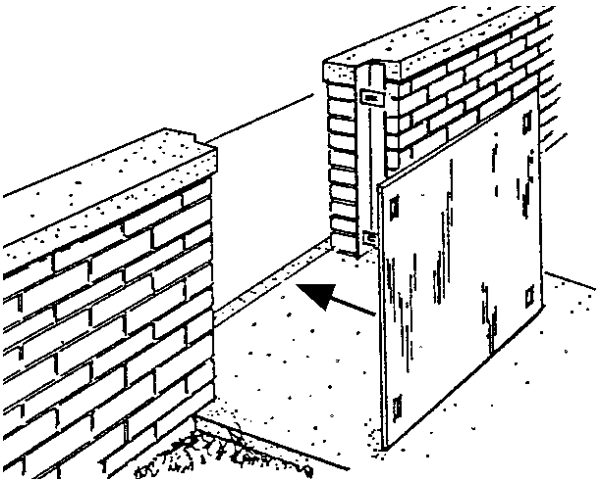


Figure 3.14 Bolt-On Flood Shield

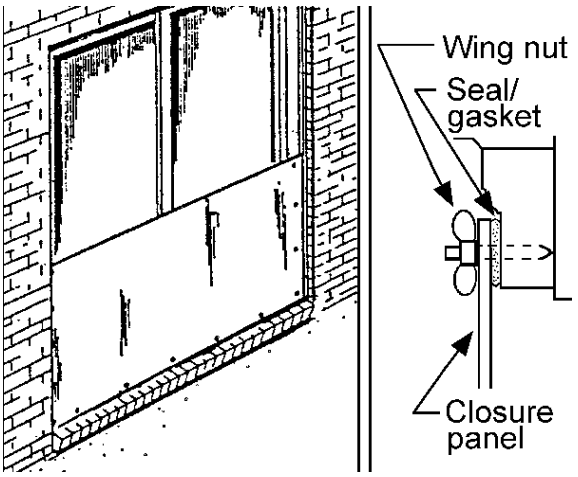


Figure 3.15 Removable Window Cover

Installing a Floor Drain Plug

Sewage systems can allow floodwater to backflow into the home. If the sanitary system's lowest opening in the house is the floor drain, the easiest way to stop sewer line backup is to plug the floor drain. Commercial plugs are available that can be placed in the floor drain below the grate. Bolts on metal end pieces are tightened, causing a rubber gasket to expand and seal the plug in the pipe.

A plug not only stops water from entering the house but it prevents it from leaving the house as well. Because of this, it may be best to put the plug in place only when a flood is expected, such as during heavy rains.

You may install a plug with a float to close the plug when water backs up into the pipe. The float allows water to drain out of the floor drain. A float plug permanently installed will not interfere with the floor drain's normal operation.

PROFESSIONAL NOTES

- Float plugs may be blocked open by even small amounts of debris.
- Floor drain plugs do not stop backup from coming out of the next lowest opening, for example a laundry tub or basement toilet.
- In older houses, the sewer lines under the basement floor may be clay tile. A buildup of water pressure can damage the sewer lines. Therefore, using a drain plug may not be the best option.

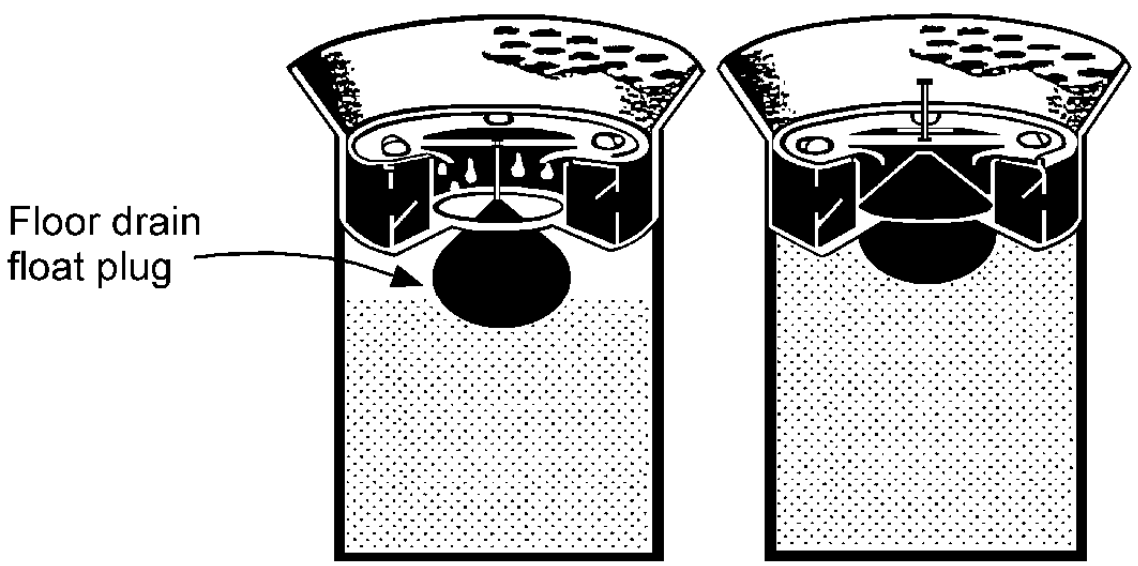


Figure 3.16 Floor Drain Float Plug

3.2. POST-FLOODING IMMEDIATE ACTIONS

Before beginning post-flooding mitigation efforts, it is important to practice patience in allowing ample time for drying. Rule of thumb is if it takes a week for visible moisture to disappear, it will take at least another week for unseen parts to dry.

Here are some affordable post-flooding actions, which are well suited for volunteer groups:

Walls

Wash and disinfect the studs and sills with clean water and common household disinfectant if the wallboard and insulation were removed. If rebuilding, consider metal studs and sills, as they are less prone to damage from water. Pressure-treated wood resists mildew and wood-eating insects but may swell when soaked. Warning: Some pressure-treated wood should not be used inside the house. The chemicals that these woods are treated with may contaminate the floodwater and cause an even more hazardous situation.

Wallboard

Remove the trim, molding and wallboard up to 2 feet above the water line. Remember, cutting and removing wallboard in 4-foot sections allows for easier replacement. In addition, all insulation and nails must be removed from the wall studs.

Floors

Oriented Strand Board (OSB) or plywood often fall apart when wet for lengthy periods. Floor joists and some wood floors regain their shape when naturally dried. Use screws or screw nails on floors and stairs to minimize warping. Completely dry subflooring before laying new flooring or carpeting. Re-nail, then sand or place a new underlayment for a new floor.

Paints

Completely dry the surface before painting. This may take several weeks, but paint will most likely peel if applied over a damp surface. Coat concrete surfaces with penetrating sealer for easier future cleanup. Coat water-stained areas with shellac or commercial stain killer first or the stains will bleed through the paint. Waterproofing paints do not keep out floodwaters.

Windows and Doors

When appropriate, replace flood-damaged windows with vinyl or metal framed windows. Hollow core or polystyrene foam filled metal doors are water-resistant. Metal in both windows and doors may rust slightly but that is easily repaired.

3.3 WATER-RESISTANT BUILDING MATERIALS

The NFIP regulations require the use of construction materials that are resistant to flood damage.

All construction below the BFE is susceptible to flooding and must consist of flood damage-resistant building materials. The table below provides a list of flood-resistant materials along with the mitigation value for each specific material.

FEMA Technical Bulletin No. 2, Flood Damage – *Resistant Materials Requirements* provides additional information.

BUILDING MATERIALS TO CONSIDER WHEN FLOODPROOFING	
MATERIAL	**MITIGATION VALUE**
Marine Plywood	Marine Plywood is the most water-resistant plywood. It can be used for floor and exterior-wall sheathing applications.
Exterior-Grade Plywood	Exterior-grade plywood is meant to resist low-level moisture and humidity. It is not meant to be used in water saturation conditions.
Greenboard	Manufacturers do not consider greenboard (moisture-resistant dry wall) to be a floodproofing material. It can be submerged for several hours without extensive deterioration and it is only slightly more expensive than normal plasterboard.
Rigid (closed cell) Insulation	Rigid insulation will not deform or lose its insulative properties when it gets wet. It can be dried out and reinstalled in wall or floor cavities instead of fiberglass insulation.
Synthetic Baseboards	Synthetic baseboards are water-resistant and should be used instead of wood baseboards.
Galvanized Nails	Galvanized nails will not rust after being in floodwaters. Use galvanized nails at all locations up to 3-ft above BFE.
Metal Doors and Frames	Metal doors and frames will not warp if saturated. They may rust in spots, but this can be sanded out and repainted. Use at all doorways, especially exterior.
Metal and Vinyl Windows	Metal and vinyl windows will not warp if saturated.
Sheet Vinyl Flooring or Tile	Sheet vinyl flooring or tile adheres to marine or pressure-treated plywood underlayment with waterproof adhesive.

Indoor/Outdoor Carpet	Carpet should only be installed with a synthetic carpet pad and not permanently fastened down.
Galvanized Drywall Screws	Galvanized drywall screws will not rust and allow for easy removal and reassembly of interior walls.
Brick/Concrete	Brick/concrete is not damaged by water saturation, but must be used in conjunction with a waterproof membrane.
Plastic Wood	Plastic wood, made of recycled materials, is waterproof and dimensionally stable. Be sure to check the local building codes for acceptable uses.

Table 3.4 Water Resistant Building Materials

Building Materials to Avoid When Floodproofing

- Fiberglass or cellulose insulation
- Cork or corkboard
- Gasoline, motor oil, pesticide, lye, drain clear, other chemicals
- Linoleum
- Particle Board, plywood, chipboard, fiberboard, paperboard, strawboard, Masonite paneling
- Wallboard, plasterboard, drywall, gypsum
- Wallpaper

4.0 SOURCES

The following sources were used to develop this Guide:

- FEMA P-312, *Homeowners Guide to Retrofitting, Six Ways to Protect Your Home From Flooding*
- FEMA P-805, *Protecting Your Home and Property From Flood Damage*
- FEMA Technical Bulletin No. 2, Flood Damage – *Resistant Materials Requirements*
- Federal Alliance for Safe Homes – Blueprint for Safety Manual

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