

Elevating Floodprone Buildings Above Minimum NFIP Requirements



FEMA

IOWA FLOODS OF 2016 RECOVERY ADVISORY

RA1, April 2017

Purpose and Intended Audience

Flooding in Iowa in the fall of 2016 extended beyond mapped Special Flood Hazard Areas (SFHA) and exceeded base flood elevations (BFEs) by several feet in some areas, though the flooding was not as widespread as the Midwest Floods of 2008. Lessons learned from those floods were incorporated into mitigation efforts since that time and successfully guided the repair and reconstruction efforts and design of new buildings to reduce susceptibility to future flood damage.

This Recovery Advisory reviews how Flood Insurance Rate Maps (FIRMs) and BFEs are established and provides guidance on elevating buildings above minimum NFIP requirements to minimize flood damage. The intended audience for this advisory is primarily homeowners and designers, but it may be helpful to anyone involved in selecting lowest floor elevations for new construction and reconstruction of buildings in areas with riverine flooding across Iowa and other Midwest states.

Key Issues:

1. Elevating to the BFE does not provide complete protection against flooding. Storms more severe than the base flood can and do occur as was seen in 2008 and 2016 in Iowa.
2. FIRMs are only as accurate as the topography, and technical information used, and the technical analyses used to create them. FIRMs are a snapshot in time and may become outdated as physical conditions, climate, and engineering methods change.
3. Once flood levels exceed the lowest floor of a building, the extent of damage increases dramatically. Incorporating freeboard into elevation of buildings can reduce this damage.
4. Design and construction practices can minimize damage to buildings, particularly by elevating the building higher than the minimum required elevation (Figure 1).

Terminology

Flood Insurance Rate Map (FIRM): A map produced by FEMA to show flood hazard areas and risk premium zones. The SFHA and BFE are both shown on FIRMs.

Special Flood Hazard Area (SFHA): Land areas subject to a 1 percent or greater chance of flooding in any given year. These areas are indicated on FIRMs as Zone AE, A1-A30, A99, AR, AO, AH, V, VO, VE, or V1-30. Mapped zones outside of the SFHA are Zone X (shaded or unshaded) or Zone B/Zone C on older FIRMs.

Base Flood Elevation (BFE): Elevation of flooding, including wave height, having a 1 percent chance of being equaled or exceeded in any given year (also known as “base flood” and “100-year flood”). The BFE is the basis of insurance and floodplain management requirements and is shown on FIRMs.



Figure 1: This home along the banks of the Cedar River has been raised so that flood waters no longer reach the main floor during flooding events. The lower area is used as a parking area and has flood damage resistant construction materials (Cedar Falls, Iowa)

This Recovery Advisory Addresses:

- FIRMS, Flood Insurance Studies (FIS), and flood risk
- Building Damage when flood levels rise above the lowest floor
- Height above the BFE that a building should be elevated
- Effect of building elevation on flood insurance premiums
- Additional design considerations for mitigating flood damage, inside and outside mapped flood hazard zones

FIRMS, FISs, and Flood Risk

Constructing a building to the minimum National Flood Insurance Program (NFIP) requirements – or constructing a building outside the SFHA – is no guarantee that the building will not be damaged by flooding. In order to make informed decisions during repair and reconstruction, owners, designers, and communities should understand the following:

- FIRMs are based on modeling of the best available topographic, hydraulic, and climate conditions data at the time of the FIS. However, there are inherent uncertainties in the modeling and analysis of BFEs and flood hazard zones. Some FIRMs, particularly older FIRMs, may no longer accurately reflect the river alignment, land characteristics, and actual risk during a base flood event.
- The BFE is the flood level with a 1-percent-annual chance of occurrence. The BFE is based on model studies of both historical and hypothetical storms.
- Floods can and do exceed the BFE and extend beyond the SFHA. In some recent storms (Midwest Floods of 2008, 2013, and 2016), flood levels exceeded the BFE by several feet in some areas and extended far beyond the SFHA shown on the FIRM. Figure 2 shows a comparison of the mapped SFHA at the time of the 2016 flood in Cedar Rapids.

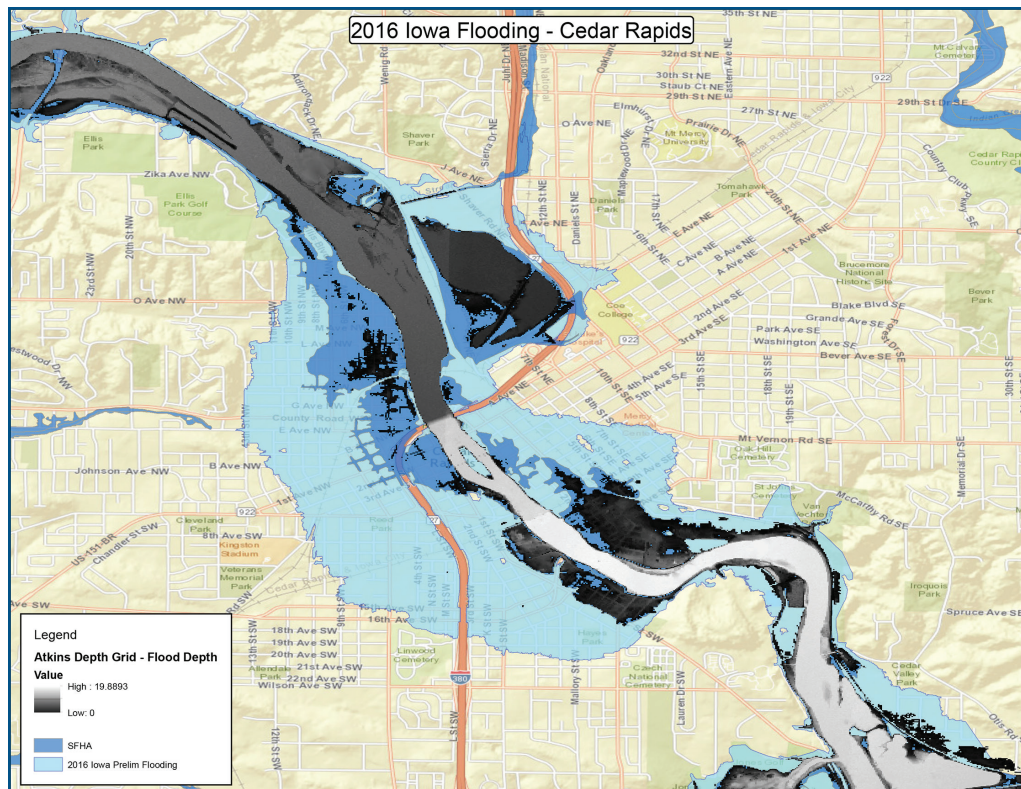


Figure 2: The areas in light blue show the extent of the 2016 Iowa flooding as compared to the SFHA shown in dark blue. This indicates inundation far beyond the 100-year flood hazard area.

Sources of Flood Hazard Information – How to determine your flood risk

FIRMs and FIS. FIRMs delineate flood hazard zones (e.g., Zone VE, Zone AE), which reflect the nature of the flood conditions expected during the base flood. FIRMs show BFEs associated with a flood that has a 1-percent-annual chance of occurrence (Figure 3). FIRMs also show Zone X areas that are outside the SFHA but which are subject to flooding with a 0.2-percent-annual chance of occurrence (500-year flood). Note, the FIRM shown in Figure 3 is reflective of the older FEMA maps. Newer FEMA maps are referred to as Digital FIRMs, or D-FIRMS, and provide a more modern map background with digital imagery. These D-FIRMS also show the floodway and SFHA boundaries.

FIRMs are issued after an FIS is completed, and are then adopted by communities that regulate floodplain development. The FIS are prepared using the specified models and the physical, hydraulic, and climate conditions in effect at the time. The resulting FIRMs are drawn using the FIS data. FIRMs and the corresponding FIS are thus a “snapshot” of flood risk at a certain time, and can become outdated as topographic or hydraulic or climate conditions change, or as engineering methods and models improve.

Many FIRMs produced after approximately 2005 are based on FEMA’s current computer models and engineering procedures. BFEs and flood hazard zones on FIRMs that are dated many years before this may understate actual flood risk. In such cases, elevating buildings above the BFE and extending flood-resistant construction practices outside the mapped SFHA is recommended. Attention should also be paid to the models identified in the FIS and the dates the models were run to develop the flood hazard information to produce the FIRM. The FEMA mapping program is constantly evolving, data collection with high-resolution imagery and updates to the engineering standards for the FEMA models may have been accomplished after the preparation of the most recent FIRM. During these updates some, but not all rivers and streams may have been restudied and identifying those specific tributaries is important when understanding when to recommend elevating above the mapped BFE. The date of the technical studies should be verified for any referenced FIRM by reviewing the associated FIS.

It is critical for building owners, operators, designers, and others to understand that FIRMs do not account for future impacts related to:

- Multiple severe storms occurring over a short period of time
- Topographic and bathymetric changes, watershed development, changes to the drainage characteristics of the drainage basin such as addition drain tiles, and addition of impervious surfaces that affect drainage and/or flooding
- Degradation or settlement of levees, and floodwalls
- Changes in storm climatology (frequency and severity)

These future conditions can be addressed through building siting decisions in concert with design considerations and mitigation actions described in subsequent sections of this advisory.

Probability of Flood Levels exceeding the BFE

FIRMs depict the regulatory limits of flooding, flood elevations, and flood hazard zones for the 1-percent-annual chance (100-year) flood event. Buildings constructed to the elevations shown on a FIRM offer protection only to the BFE. Some storms result in flood levels that exceed the BFE. The blue line in Figure 4 shows the probability of a flood event that will result in floodwaters above the 100-year flood level. As shown on the figure, there is an 18 percent chance the 100-year flood level will be exceeded in a 20-year period, a 26 percent chance it will be exceeded in a 30-year period, and a 51 percent chance it will be exceeded in a 70-year period (typical useful life of a home). Therefore, a building elevated to the BFE has a significant chance of being flooded during its useful life and elevating above the BFE reduces this chance and can also reduce flood insurance premiums for the building. Likewise, buildings sited just outside the SFHA (beyond the

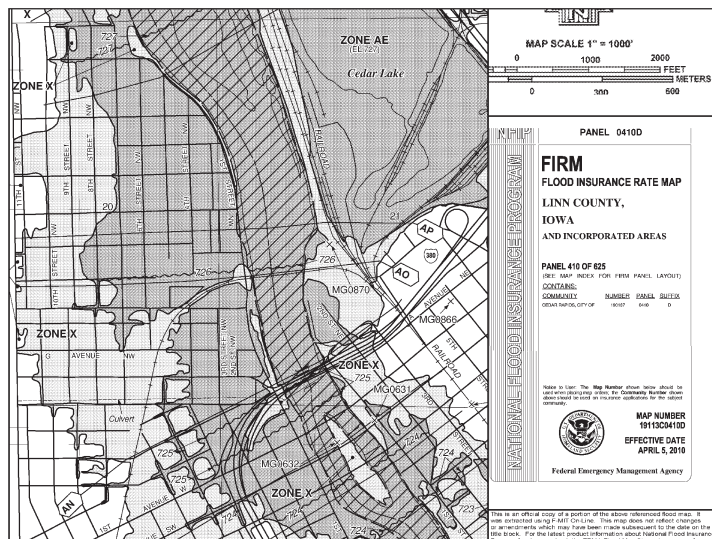


Figure 3: A FIRM panel for Cedar Rapids Iowa showing flood hazard zones and BFEs.

100-year flood hazard area, but especially those within the 500-year flood hazard area) still have a significant chance of being flooded over their useful life.

Building Damage when Flood Levels Rise above the Lowest Floor

Buildings are designed to resist most environmental hazards (wind, seismic, snow, etc.), but are generally designed to avoid flooding by elevating the building above the anticipated flood elevation. The reason for this difference in design approach is because of the sudden onset of damage when a flood exceeds the lowest floor elevation of a building as seen in Figure 5 – building elements and contents get wet, and moving water imparts large structural loads on the building.

How High Above BFE

To comply with the NFIP, new buildings, buildings with Substantial Damage undergoing reconstruction, and buildings undergoing Substantial Improvements must be elevated so that their lowest floor is at or above the BFE. Some States and communities require elevation above the BFE; this is known as adding freeboard. Adding freeboard or regulating to a flood elevation more severe than the base flood results in a higher building elevation. This is often known as the design flood elevation (DFE).

FEMA recommends the addition of at least 1 or 2 feet of freeboard to account for uncertainties, future development, and floods higher than the base flood. While the addition of freeboard is not an NFIP minimum requirement, **it does result in significantly lower flood insurance rates due to reduced flood risk.**

The amount of freeboard to be added depends on a number of factors. Before selecting a freeboard value, building owners and designers should decide whether a freeboard mandated by a State or community is sufficient to protect a particular building or if additional freeboard is needed.

Required Design Considerations

The selection of appropriate freeboard amounts must include consideration of locally adopted requirements, as well as the importance of the building to the community during and after a hazard event.

Building Codes and Floodplain Management Regulations. Building codes may contain freeboard requirements or reference other documents with freeboard requirements. The International Building Code (IBC), which serves as the basis for the Iowa State building code, requires buildings to be designed and constructed in accordance with the American Society of Civil Engineers' Standard for Flood Resistant Design and Construction (ASCE 24). ASCE 24 requires between 0 and 3 feet of freeboard above the BFE, depending on the flood hazard zone and the importance of the building.

Further, the State of Iowa adopted freeboard in its residential construction requirements through incorporation of the International Residential Code into its local floodplain ordinances, which specifies a minimum of 1 foot of freeboard above the BFE. In Iowa, new residential buildings, buildings with Substantial Damage undergoing

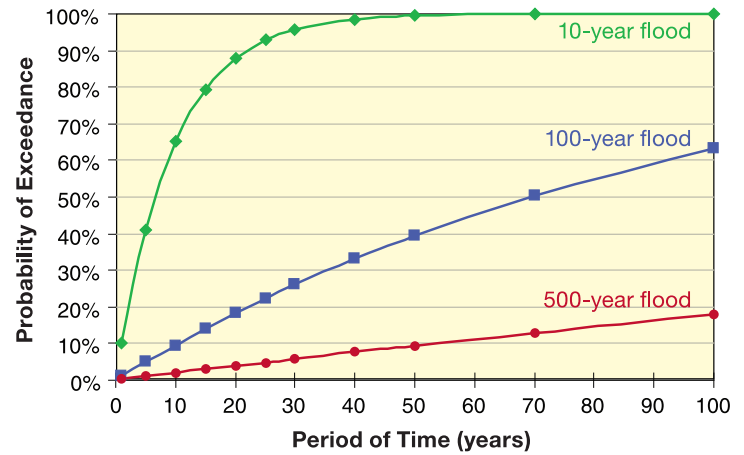


Figure 4: Probability of a flood exceeding the 10-year (10-percent-annual chance), 100-year (1-percent-annual chance), and 500-year (0.2-percent-annual chance) flood level during a given period of time.

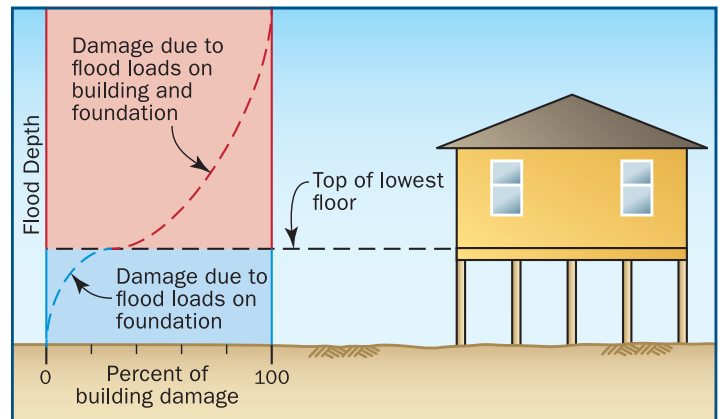


Figure 5: The graph above illustrates how increases in flood depths increase the value of the DDF. The DDF is a relationship between the flood depth and the finished floor elevation of the building and not the elevation of the adjacent ground.

reconstruction, and buildings undergoing Substantial Improvements must be elevated so that their lowest floor is at or above the DFE.

The State of Iowa has mandated a minimum 1-foot freeboard above the BFE to help protect communities against flood damages and assist in reducing flood insurance rates. Some communities within the State of Iowa have exceeded these minimum requirements and have set their DFE at an elevation higher than the BFE + 1 foot. For example, the City of Cedar Falls requires the use of a 1-foot freeboard above the 500-year flood elevation as their DFE, and the City of Palo requires the use of 2 feet of freeboard above the 100-year flood elevation as their DFE. Building officials with Linn County also recommend exceeding the minimum state/county requirements of 1 foot of freeboard above the BFE because experience with recent damaging floods has shown the extra effort has been worth the protection it provides against damages from future floods.

Importance of a Building to the Community. Certain buildings and facilities (e.g., police, fire, emergency operations centers, and hospitals) are deemed critical or essential to a community and must remain partly or fully operational during and after severe flood events. In some cases, the community may determine that other buildings and facilities (such as schools, community centers, transportation, and utilities) are critical or essential for their community and should be capable of carrying out operations immediately after a severe storm. The recommendations in this advisory can also be applied to those buildings and facilities. To maintain needed functionality, these essential buildings and facilities should be elevated or protected to a higher elevation than most commercial and residential buildings. Building codes and ASCE 24 acknowledge this need and require additional freeboard. FEMA recommends that essential facilities be elevated or protected to the higher of: the code-mandated elevation, the community-mandated elevation, the flood of record or the 500-year flood elevation. Communities may wish to use the flood of record as the elevation/protection level for essential facilities.

Terminology

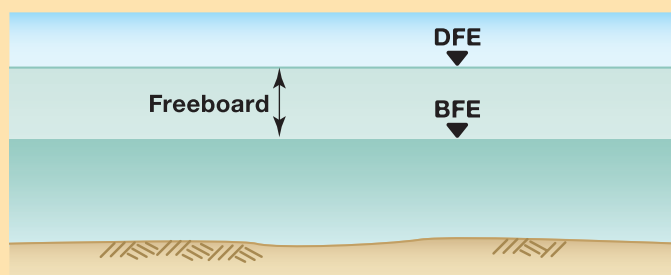
Substantial Damage: Defined by the NFIP as “damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.”

Substantial Improvement: Defined by the NFIP as “any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the ‘start of construction’ of the improvement. This term includes structures that have incurred ‘Substantial Damage,’ regardless of the actual repair work performed.”

Refer to FEMA P-758, *Substantial Improvement/Substantial Damage Desk Reference (2010b)* for more information. Homeowners should consult a local building official to determine whether their local codes and regulations have more restrictive definitions.

Freeboard: The vertical height the lowest floor is above the BFE, usually expressed in feet.

Design Flood Elevation (DFE): Regulatory flood elevation adopted by a local community. If a community regulates to minimum NFIP requirements, the DFE is identical to the BFE. Typically, the DFE is the BFE plus any freeboard adopted by the community.



For more information on category classification requirements, see Occupancy Category Table 1-1 ASCE 7-05 and Risk Category Table 1.5-1 in ASCE 7-10, as well as the guidance in FEMA 543, *Design Guide for Improving Critical Facility Safety from Flooding and High Winds*, January 2007. Note: ASCE 7-05 and ASCE 7-10 use different category classifications; also, check for any modifications made by your State or local jurisdictions.

Building owners and designers should consult with building officials and floodplain managers regarding appropriate freeboard levels above the BFE.

Recommended Considerations

In addition to required design considerations, FEMA recommends review of available FIRMs and FIS information; evaluation of possible future conditions; and consideration of building owner risk tolerance when determining appropriate freeboard amounts.

Building Owner Tolerance for Damage, Displacement, and Downtime. Many building owners do not want to go through the disruption and damage sustained during a flooding event again. Reducing the probability of future occurrences will necessitate using either large freeboard amounts when repairing rebuilding buildings and equipment or construction of tall flood barriers (where permitted). Freeboard and other flood-resistant design and construction practices should be incorporated to the maximum extent feasible.

Age of the Effective Flood Analysis. See subsection on FIRMs and FISs.

Future Conditions. Because FIRMs reflect conditions at the time of the FIS, owners, designers, and communities may wish to consider future conditions (subsidence, dredging, drainage basin changes including large scale drain tile installation, increased storm frequency/intensity, and levee settlement and failure) when deciding how high to elevate a building.

Effect of Building Elevation on NFIP Flood Insurance Premiums

NFIP flood insurance premiums are affected by the elevation of the building in relationship to the BFE. As part of design considerations, building owners should be aware of three things:

- Flood insurance premiums drop significantly as freeboard increases, provided equipment is not located below the BFE and any enclosed space is compliant with NFIP requirements (e.g., flood openings in Zone AE, etc.).
- The 2012 NFIP reauthorization legislation (called the Biggert-Waters Flood Insurance Reform Act of 2012, hereafter called “Biggert-Waters”) eliminated flood insurance premium subsidies and “grandfathering” for many existing buildings that are – or may be in the future – below the BFE (for more detail, see the text box on page 7 titled “Biggert-Waters impact on flood insurance premiums”).
- The Homeowner Flood Insurance Affordability Act of 2014 (HFIAA 2014) rolled back many of the provisions of Biggert-Waters, notably reinstating the “grandfathering” of re-mapped structures. It also set a minimum and maximum for the rate of premium increases until structures reach their full-risk rates.

Flood Premiums and Freeboard

According to the flood insurance premium rate tables in FEMA’s Flood Insurance Manual, premium savings can be substantial when freeboard is added to building design (FEMA 2013a). These savings can be enough to repay the added cost of elevating higher in just a few years’ time (AIR 2006, FEMA 2008).

- Adding 1 foot of freeboard above the BFE can save an owner approximately 25% to 40% in annual flood insurance premiums, depending on the flood hazard zone and building characteristics.
- Adding 4 feet of freeboard can save approximately 50% to 65% in annual flood insurance premiums in some flood zones.

Biggert-Waters Flood Insurance Reform Act of 2012

On July 6, 2012 Biggert-Waters took effect, significantly changing the NFIP and how flood insurance premium rates will be determined in the future (FEMA 2012). Changes affected how buildings are rated to reflect actual flood risk and eliminate grandfathering and flood insurance premium subsidies for many buildings.

Of importance to property owners, some buildings constructed in compliance with current BFEs and flood hazard zones may be subject to significantly higher flood insurance premiums in the future if revised FIRMs show higher BFEs and increased flood risk. For more information, please see FEMA’s *Flood Insurance Reform Act of 2012: Impact of changes to the NFIP* (FEMA 2013b).

Effect of Biggert-Waters and HFIAA 2014 on Flood Insurance Premiums

According to *Changes in the Flood Insurance Program: Preliminary Considerations for Rebuilding (FEMA 2012)*:

Under the law, flood insurance premium rates on many properties in special flood hazard areas will increase. The new rates will reflect the full flood risk of an insured building and some insurance subsidies and discounts will be phased out and eventually eliminated.

Rates on almost all buildings that are, or will be, in special flood hazard areas will be revised over time to reflect full flood risks. Based on various conditions set forth in the law, subsidies and grandfathered rates will be eliminated for most properties in the future.

Subsidies will be phased out for the following types of properties: non-primary residences, severe repetitive loss properties, business properties, and properties that have incurred flood-related damages where claims payments exceed the fair market value of the property.

Policy rates will also increase based on one or all of the following circumstances:

- *After a change of ownership;*
- *After there is a lapse in insurance coverage;*
- *When a new or revised flood insurance rate map is issued; or*
- *If there is substantial damage or improvement to a building.*

HFIAA 2014 softens many of these provisions by both rolling back grandfathering and capping the rate of premium increases to, at most, 18% in any given year. Particular exclusions from these rollbacks, however, were buildings that include:

- *Pre-firm business properties insured with subsidized rates;*
- *Pre-firm non-primary residences insured with subsidized rates;*
- *Repetitive Loss Properties insured with subsidized rates;*
- *Pre-firm Buildings that have been substantially damaged or improved*

These properties are allowed to have up to 25% increases in a given year, until they reach full-risk premiums.

Homeowner Flood Insurance Affordability Act of 2014

Due to concerns of the Biggert-Waters premiums increase, Congress decided to enact a more gradual shift towards actuarial insurance rates. In 2014, Congress passed the Homeowner Flood Insurance Affordability Act (HFIAA) as a way to control and phase in cost changes. HFIAA suggests, though does not provide any mandate, that “affordable” premiums are ones that do not exceed 1% of a property’s insurance coverage. To encourage this affordability, the law re-established “grandfathering” of properties in newly mapped risk zones and established minimums and maximums on premiums increases. Under the revisions, premium increases are mandated at no less than 5% and no more than 18% in a given year, until individual policies reach full-risk rates. As close to 80% of pre-Biggert Waters policyholders are subsidized, the reduced increases slow the migration of the NFIP program to financial solvency. This may encourage further premium “reforms” in the future, as program viable remains uncertain.

Additional Design Considerations for Mitigating Flood Damage Inside and Outside Mapped Flood Hazard Zones

In addition to the design considerations described in other sections of this advisory, the following recommendations can help building owners minimize damage in the event that flood levels rise above the BFE.

Elevate Bottom of Lowest Floor above BFE

In all areas where flooding is anticipated, inside and outside the mapped SFHA, elevate the lowest floor so that the bottom of the lowest horizontal structural member is above the BFE.

Even though the NFIP and some building codes allow the top of the lowest floor to be set equal to the BFE in Zone A, the top of the floor should be set above the BFE. Otherwise, the floor systems, floor coverings, floor insulation, lower walls, and utilities contained therein will incur flood damage during the base flood. In addition to structural damage, inundation may lead to costly repairs from mold or floodwater contamination.

Elevating the Utilities

Buildings that are located in areas that have flooding should consider elevation of the electric meter and service as well as the main structure. In the event that a NFIP compliant home is undamaged due to sufficient elevation, this will allow these electrical components to remain undamaged as well and provide for a quicker return to the building after a flood. Coordination with service providers will be needed to move electric meters and service and should be consulted about proper procedure for doing so.

Design Loads

In Zones A and X, design loads and conditions (hydrostatic loads, hydrodynamic loads, floating debris loads, and erosion and scour) should be calculated using 100-year or 500-year flood conditions. Loads can be based on freeboard levels if desired, but freeboard is usually used as a factor of safety against inundation, not for design load calculations.

Use Flood Damage Resistant Materials

Flood damage-resistant building materials and methods should be used not only below the lowest floor, but also for wall construction and floor finishes sitting directly on the lowest floor. For example, consider using drainable, dryable interior wall assemblies similar to those illustrated in Figure 6. This allows interior walls to be opened up and dried after a flood that rises above the lowest floor, or after water wicks up the wall. Walls should be designed and constructed to accommodate flooding without damage (LSU 2012). To prevent wicking and limit flood damage, building owners can use the following flood damage-resistant methods and materials:

- Construct walls with pressure-treated wood framing and with horizontal gaps in the wallboard (a chair rail can be used to conceal the gap)
- Elevate electrical outlets, wiring, and circuit panels to a location above the horizontal gap
- Install rigid or closed-cell insulation in lower portions of walls
- Below the horizontal gaps, use non-paper-faced gypsum wallboard, concrete board, or a removable wainscot; use a water-resistant drywall primer and finish with latex paint
- Use water-resistant flooring with waterproof, marine-grade adhesive

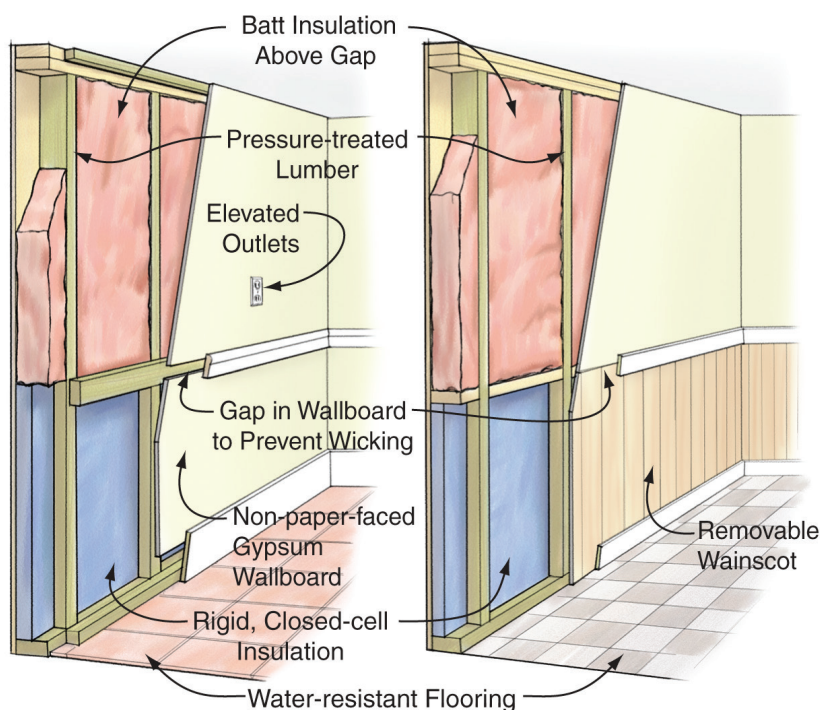


Figure 6: Wet floodproofing techniques for interior wall construction; details may vary depending on wall construction (Source: LSU, 2012)

Resources and Useful Links

The following resources describe numerous mitigation options with sufficient detail to complete an elevation mitigation project.

The FEMA Region VII Web page provides useful information and links for disaster survivors and recovering communities including available FEMA assistance and recovery initiatives. Please refer to <https://www.fema.gov/region-vii-ia-ks-mo-ne>.

- FEMA NFIP Technical Bulletins. Available from <https://www.fema.gov/media-library/collections/4>.
- AIR (American Institutes for Research). 2006. *Evaluation of the National Flood Insurance Program's Building Standards*. Available at <https://www.fema.gov/media-library/assets/documents/9585>.
- ASCE (American Society of Civil Engineers). 2014. *Standard for Flood Resistant Design and Construction*. ASCE 24-14.
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- FEMA P-348. 2017. *Protecting Building Utility Systems from Flood Damage*. Washington, DC. Available at <http://www.fema.gov/media-library/assets/documents/3729>.
- FEMA P-312. 2014. *Homeowner's Guide to Retrofitting*. Washington, DC. Available at <http://www.fema.gov/media-library/assets/documents/480>.
- FEMA P-259. 2012. *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures*. Washington, DC. Available at <http://www.fema.gov/media-library/assets/documents/3001>.
- FEMA 086-0-33. 2012. *National Flood Insurance Program Elevation Certificate and Instructions*. Washington, DC. Available at <http://www.fema.gov/media-library/assets/documents/160>.
- FEMA. 2013. *National Flood Insurance Program Flood Insurance Manual*. Washington, DC. Available at <https://www.fema.gov/flood-insurance-manual>.

For more information, see the FEMA Building Science Frequently Asked Questions Web site at <http://www.fema.gov/frequently-asked-questions>.

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