Impact

A regulatory impact analysis must accompany every economically significant federal rule or regulation. The Office of Policy Development and Research performs this analysis for all U.S. Department of Housing and Urban Development rules. An impact analysis is a forecast of the annual benefits and costs accruing to all parties, including the taxpayers, from a given regulation. Modeling these benefits and costs involves use of past research findings, application of economic principles, empirical investigation, and professional judgment.

Reducing the Flood Hazard Exposure of HUD-Assisted Properties

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Background

Following the extensive flood damage caused by Hurricane Sandy, Executive Order 13690[1] directed federal agencies to reduce risk associated with floodplain development. In response, the Mitigation Framework Leadership Group (MitFLG), which coordinates flood mitigation efforts across Federal agencies, studied evidence on past and predicted sea level changes and riverine flooding and established the Federal Flood Risk Management Standard (FFRMS).[2] The new standard requires that buildings be constructed with at least 2 feet of freeboard[3] above base flood elevation (BFE), or BFE+2. Critical actions, such as construction or substantial rehabilitation of hospitals and assisted living facilities, should be constructed with at least 3 feet of freeboard above

[1] "Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input."

[2] "Revised Guidelines for Implementing Executive Order 11988, Floodplain Management, and Executive Order 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input."

[3] Freeboard is defined by FEMA in 44 CFR 59.1 as "a factor of safety usually expressed in feet above a flood level for purposes of floodplain management. 'Freeboard' tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed."

BFE (BFE+3) or to the 0.2 percent annual chance (500-year) floodplain,[4] whichever is higher. Finally, nonresidential structures that are not critical actions, including multifamily structures without residential units below BFE+2, may be floodproofed instead of elevating to the new standard. The U.S. Department of Housing and Urban Development (HUD) proposed the adoption of this standard.[5]

Impetus for Policy Change

HUD's previous standard, which did not require elevation beyond BFE, was insufficient for two reasons. First, the rise in sea level and riverine flooding is slowly increasing the BFE. According to U.S. Global Change Research Program (2014), the global sea level has risen about 8 inches since reliable recordkeeping began in 1880 and is expected to rise another 1 to 4 feet by 2100. The frequency of inland and riverine floods is also increasing. IPCC (2013) also confirmed that the sea level is expected to continue rising throughout the 21st century.

Second, flood maps drawn by the U.S. Federal Emergency Management Agency (FEMA) are updated infrequently and therefore do not indicate the true BFE at the time of construction for much of the country. Thus, many buildings are inadvertently constructed with the lowest floor below the 1-percent annual chance (100-year) flood plain. Requiring an additional 2 feet of elevation would offset these deficiencies.

The proposed floodplain standard not only addresses the rising sea level and flood map deficiencies; it also addresses inefficiencies created by federal disaster assistance and the provision of flood insurance. Federal flood insurance suffers from a market failure of information in which homeowners do not understand the true flood risk and therefore do not take actions, particularly maintaining active flood insurance policies, to reduce this risk. Flood insurance, similar to other types of insurance, also suffers from problems arising from asymmetric information and moral hazard. Many sellers and developers know the risk of flood damage, but buyers or—in the case of multifamily buildings—renters do not always know the risk. Moral hazard occurs as policyholders decrease flood mitigation efforts, knowing that flood insurance will cover the costs of flood damage. This section explains the inefficiencies inherent in the provision of federal disaster assistance and the market for flood insurance.

Market Failure

Many homeowners lack information and understanding regarding the risks of locating in the floodplain, resulting in inefficient pricing whereby house and land prices do not reflect the true flood risk, leading to overdevelopment in the floodplain and underinsured homes. Numerous studies indicate that many homeowners are either not fully aware of the risk of a flood occurring or that they discount the cost of a flood if it occurs. In some cases, owners simply underestimate the risk of flooding. Rosenbaum (2005) noted that many studies find homeowners underestimate the risk of floods, and even when informed few owners react to offset the risk. For example, Chivers and

[4] As defined in 24 CFR§55.2(b)(3)(i), "critical action" means any activity for which even a slight chance of flooding would be too great, because such flooding might result in loss of life, injury to persons, or damage to property. Applicable critical actions include but are not limited to HUD-insured hospitals and assisted care facilities.

[5] 81 FR 74967. October 28, 2016.

Flores (2002) surveyed homebuyers in Boulder, Colorado, and found a market failure of information in which homeowners did not fully understand the flood risks or cost of insuring against the risk when purchasing their homes. Michel-Kerjan (2010: p.179) also noted that, despite the occurrence of floods or natural disasters, homeowners take no action to fortify their homes, likely due to "a lack of accurate knowledge about risk; budget constraints; and myopia." This effect is evident through the actions of homeowners. Michel-Kerjan, Lemoyne de Forges, and Kunreuther (2012) found that homeowners allowed their flood policies to lapse typically after 2 to 4 years, even for federally backed mortgages, which require flood insurance.[6] This lapse occurs despite the "one bite rule," which prohibits parties from applying for flood disaster assistance a second time unless flood insurance has been maintained.[7]

This market failure is also found empirically in the price of homes in floodplains. In an efficient market, in which the flood risk is fully known, the sales prices of residential properties in the floodplain should reflect this risk, selling for a lower price than identical homes located outside of the floodplain. Further, the occurrence of a 1-percent annual chance (100-year) flood should not affect house prices. However, several studies, including Muckleston (1983), Holway and Burby (1990), and Tobin and Montz (1997), found that residential property values in the floodplain do not incorporate this risk. Chivers and Flores (2002) concluded that, despite the notification of flood risk per National Flood Insurance Program (NFIP) regulations, this risk is only incorporated after a flood has occurred. If house prices do not reflect full flood risks, then more settlement would occur in floodplains than if the market were efficient.

Evidence suggests, however, that home prices do include the flood risk discount in some markets. Kousky (2010) examined the response of home prices in St. Louis County, Missouri, following the Great Flood of 1993. Prior to the flood, she found a flood risk discount between 3.2 and 4.5 percent for homes in the 1-percent annual chance (100-year) floodplain, but no such discount for homes in the 0.2-percent annual chance (500-year) floodplain. Home prices did not change in response to the flood in the 1-percent annual chance (100-year) floodplain. Prices did decline, however, by 2.6 percent in the 0.2 percent annual chance (500-year) floodplain. Since NFIP requires homebuyer notification of flood risk in the 1-percent annual chance floodplain but not the 0.2-percent annual chance floodplain, this finding indicates that home prices reflected the risk in the former, but the flood event provided new information to owners in the latter. This implies that not all markets are priced inefficiently, and owners in these markets more fully internalize the costs related to flooding.

[6] For loans made by federally regulated lenders, lenders are responsible for enforcing the flood insurance requirement. However, as explained by Michel-Kerjan, Lemoyne de Forges, and Kunreuther (2012), some banks do not ensure the policies remain in force.

[7] Under section 582 of the National Flood Insurance Reform Act of 1994 (42 U.S.C. 5154a), HUD disaster assistance that is made available in a special flood hazard area may not be used to make a payment (including any loan assistance payment) to a person for repair, replacement, or restoration for flood damage to any personal, residential, or commercial property if (1) the person had previously received federal flood disaster assistance conditioned on obtaining and maintaining flood insurance, and (2) the person failed to obtain and maintain flood insurance.

Asymmetric Information

Asymmetric information about the precautionary behavior of an insured household allows homeowners and property managers to reduce flood mitigation efforts. Flood insurance policies are priced at an actuarially fair rate to reflect the risk of damage based on location, elevation, and other structural characteristics. However, insurers do not observe the behavior of individuals, who may act riskier or safer than the insurer expects. For riskier individuals, additional flood risk is transferred to the insurer. As explained by Stiglitz (1983: p.6), "the more and better insurance that is provided against some contingency, the less incentive individuals have to avoid the insured event, because the less they bear the full consequences of their actions." The inability to adjust rates for individual risk allows some owners and developers to act riskier without bearing the full cost of their actions.

Moral Hazard

In the absence of disaster assistance and federal flood insurance, owners would bear the full cost of locating in a floodplain. The federal government, however, has a long history of providing disaster assistance and relief to individuals affected by flooding, which has allowed individuals to avoid the full cost of flooding. In order to reduce the cost of this assistance and ensure landowners assume more of the inherent flood risk, Congress created NFIP in 1968. A government-run insurance program was necessitated to resolve market failures caused by information asymmetries. Although Congress initially limited FEMA's ability to charge actuarial rates, allowing owners to bear only part of the cost, recent statutory changes require FEMA to phase out these subsidies.

The financial damage imposed upon a household by a severe flood can be extensive, and the potential severity underlying the loss should lead households to guard against this risk through insurance, preventative measures, or both. Households can reduce their vulnerability by living in less risky areas and by investing in floodproofing. However, many private citizens do not appear to take precautions that would be in their own best interest. As an example, Moore (2016) found that approximately 2,100 properties across the United States that are enrolled in NFIP have been flooded and subsequently rebuilt more than 10 times since 1978. An outlier in Louisiana flooded 40 times. Some of the residents of these homes may have been able to reduce their losses through flood mitigation.

In addition, many homeowners implicitly expect disaster assistance in the event of severe flooding, even if they are perfectly informed of flood risks (Burby, 2006; Kunreuther and Michel-Kerjan, 2010). This expectation leads to the underprovision of flood mitigation, encourages underinsurance, and increases the liability to the federal government.

Two studies (Browne et al., 2015; Cordes and Yezer, 1998) studied flood insurance specifically. Cordes and Yezer (1998) estimated a model of development in 42 beach communities from Florida to New York across three decades and found strong evidence of induced development during the emergency phase of a community's participation in NFIP. After controlling for various demand factors, storm damage and shore protection projects, the authors found that building permits were 50 percent higher in the emergency phase of participating NFIP communities. Development during

the regular phase of the program, however, was unchanged. The large effect found by Cordes and Yezer contrasts with the marginal impact concluded by the U.S. Government Accountability Office but is not inconsistent with the positive influence. Cordes and Yezer found that initial approval of a community for NFIP appears to be the driving factor of development, underscoring the importance of having national standards in place before any further development surges. The findings of these studies illustrate the excessive risk sharing of the government and the corresponding need for development standards.

Browne et al. (2015) studied the effect of NFIP in coastal and noncoastal Florida communities from 1975 to 1998 during the regular phase of these communities' NFIP participation. Estimating a model of development similar to the one employed by Cordes and Yezer, except at the county level, the authors found that NFIP participation increased development in noncoastal counties by 55 to 60 percent but decreased development in coastal counties by the same amount, despite the higher risk associated with coastal areas. The authors believe this may result from the higher costs of regulations in coastal communities. However, if the coastal development occurred earlier than otherwise planned in communities that participated in an emergency phase of the program, as indicated by Cordes and Yezer, it is not surprising to find that the development during the regular phase was lower. In addition, estimating the model at the county level, rather than the community level, may bias the results toward areas out of the floodplain or near the edge, where the flood risk is lower but more stringent building codes still apply.

Analysis

HUD's assistance in floodplains generally consists of only noncritical actions, assisting or insuring the new construction or substantial improvement of single-family and multifamily properties. Because HUD does not routinely insure or fund critical actions, such as mortgage insurance of hospitals and assisted-living facilities, in flood zones, this analysis focuses on the impact to noncritical actions in a typical production year. Developers receiving HUD assistance who are not currently building to the proposed standard of BFE+2 can meet the proposed standards either by elevating the lowest floor of the structure or by floodproofing to the new standard and limiting the first floor to nonresidential uses. Alternatively, developers could choose to locate outside of the floodplain and the affected horizontal expansion or reduce substantial improvement projects to less than 50 percent of the market or predisaster value of the structure, which would no longer classify the project as "substantial."

The proposed standards will increase the construction cost of HUD's assisted and insured new construction and substantially improved properties located in the 1-percent annual chance floodplain. This amends HUD's current standard, which requires elevation to at least the BFE. Thus, the elevation standards are not new, but rather revised to an increased height.[8] Therefore, the costs of the new standard increase the marginal cost of construction for the affected properties.

[8] The determination of whether a property is located in the floodplain is made using FEMA's flood maps, as HUD already requires. The determination of whether a property is located in the horizontal expansion can be determined by comparing the property's elevation, using Google Earth or topographic maps, for example, and the height of BFE identified in FEMA's flood maps.

Developers of new single-family and multifamily structures are expected to meet the new standard by elevating the lowest floor.[9] Owners of existing single-family homes undergoing substantial improvement would also likely meet the standard through elevation due to the relatively low cost. Although the cost of elevating multifamily apartment buildings could be prohibitive, most of HUD's assisted and insured multifamily properties located in the floodplain are lowrise, garden-style buildings. Thus, HUD also expects these properties to elevate. However, for larger buildings, developers of substantially improved multifamily structures would likely choose to meet the new standard by floodproofing and excluding residential units below the new standard from the building's first occupied floor.

Twenty states, plus the District of Columbia and Puerto Rico, already require elevation exceeding HUD's current standard of BFE+0.[10] A further four states—Indiana, Montana, New York, and Wisconsin—already require residential structures elevated with a minimum of BFE+2. Thus, the cost of compliance in these states would be less than in those that have no minimum elevation requirements in the floodplain. In addition, its likely that some of the HUD-assisted properties in the remaining states, which do not impose elevation above BFE, do in fact build to a higher elevation than HUD's minimum standards. To the extent that such building occurs, the effect of this rule would be less than the following estimate.

The costs of floodproofing for a substantial improvement project are greater than for new construction because an existing structure has less flexibility for modification. The economic benefit of elevation—that is, the avoided damage—will be the same whether newly built or rehabilitated (see exhibit 3 in the Costs of Rule section). Because a rehabilitation project brings the level of housing capital to the same level of newly built housing, the cost of restoring a building is the same for newly built or redeveloped housing. Thus, we would expect the net benefit of floodproofing to be greater for new construction because the cost is lower.

Exhibit 1 shows the estimated number of single-family and multifamily properties that would be affected by the standard proposed at their current state elevation standards. During Federal Housing Administration (FHA) insurance year 2012, 116 newly constructed and 821 substantially rehabilitated single-family properties were located in flood zones of states that require less than 2 feet of freeboard. Geocodable information, which is required to determine location in floodplains, is available for HUD's largest production programs, including public housing and properties financed with FHA multifamily insurance. Geocoded information for multifamily properties receiving funds

[9] Alternatively, a developer could choose to locate outside of the floodplain. Doing so would likely not change revenue since many of HUD's multifamily programs set income and rent limits by metropolitan area. In addition, Holway and Burby (1990) found that land values decrease $74 per 1,000 square feet in response to elevation requirements of 1 foot. For a typical FHA-insured home of 1,800 square feet on a lot between three and four times the house size, the decrease in land value, before the developer purchases the land, would total approximately $400 to $500. This amount is within in the range of increased costs of elevation. Thus, the change in location is unlikely to result in different costs to the developer and therefore the developer is unlikely to choose an alternate location.

[10] Arizona, Colorado, Georgia, Illinois, Iowa, Kansas, Maryland, Maine, Michigan, Minnesota, North Dakota, Nebraska, New Jersey, Oregon, Puerto Rico, and Rhode Island require BFE+1. The District of Columbia and Pennsylvania require BFE+1.5. Indiana, Montana, New York, and Wisconsin require BFE+2. See www.floods.org/ace-files/documentlibrary/FloodRiskMngmtStandard/States_with_freeboard_and_CRS_Communities_with_Freeboard_in_Other_states_2-27-15.pdf.

Exhibit 1

Annual Average Number of FHA-Insured Single-Family and HUD-Assisted Multifamily Properties Located in 1-Percent Annual Chance Floodplain

State Construction Standard	FHA-Insured Single-Family Properties		HUD-Assisted Multifamily Properties			
			New Construction		Substantial Rehabilitation	
	New Construction	Substantial Rehabilitation	Properties	Units	Properties	Units
No standard specified	101	581	117	1,725	3	117
Coastal states	95	552	117	1,725	3	117
Inland states	6	29	0	0	0	0
BFE +1 foot	15	220	46	366	7	128
Coastal states	11	147	46	366	7	128
Inland states	4	73	0	0	0	0
BFE +1.5 feet	0	20	0	0	0	0
Coastal states	0	20	0	0	0	0
Inland states	0	0	0	0	0	0
All properties	232	1,622	163	2,091	10	245

BFE = base flood elevation. FHA = Federal Housing Administration. HUD = U.S. Department of Housing and Urban Development.

from one of HUD's grant programs, such as the Community Development Block Grant (CDBG)[11] and HOME programs, is available only for properties that also received low-income housing tax credits. Annual production averages for these programs rely on production years 2011 through 2013, which are the most recent available. Overall, approximately 163 newly constructed and 10 substantially rehabilitated multifamily properties each year were located in the 1-percent annual chance (100-year) floodplain of states that require less than 2 feet of freeboard.

Costs of Rule

The estimated costs of elevating newly constructed single-family and multifamily structures are shown in exhibit 2. HUD estimates the construction cost of elevating for new construction projects based on findings from two engineering studies conducted for FEMA.[12] These studies examine the construction cost of elevation for new residential structures in Coastal A Zones, V Zones, and A Zones for various foundation types, building sizes, elevation levels of the lowest floor, and flood conditions. The term *Coastal A Zone* is used to differentiate areas that are subject to breaking waves up to 3 feet and conditions similar to, but less severe than, V Zones. Base flood conditions in A Zones resemble those in riverine areas. Thus, although these studies focus on coastal areas, the results are equally applicable to riverine areas.

[11] Nonresidential actions funded by CDBG that are located in the floodplain are subject to an eight-step environmental review process but not elevation requirements. Thus, expanding the affected area beyond the 1-percent annual change floodplain to include horizontal expansion would subject more CDBG projects to the review process. The cost of compliance for these projects, however, would be negligible.

[12] See Jones et al. (2006) and updated in FEMA (2013).

Exhibit 2

Cost of Elevation for Newly Constructed HUD-Assisted and HUD-Insured Properties in 1-Percent Annual Chance Flood Zone

State Construction Standard	New Construction		Cost of Freeboard		Increase in Construction Costs Per Property		Aggregate Increase in Construction Costs	
	Properties (#)	Units (#)	Minimum (%)	Maximum (%)	Minimum ($)	Maximum ($)	Minimum ($)	Maximum ($)
Single-family								
No standard specified	101	NA						
Coastal states	95	NA	0.30	4.80	317	5,074	30,125	481,992
Inland states	6	NA	0.30	4.50	317	4,757	1,903	28,539
BFE +1 foot	15	NA						
Coastal states	11	NA	0.20	3.90	211	4,122	2,325	45,345
Inland states	4	NA	0.20	2.30	211	2,431	846	9,724
BFE +1.5 feet	0	NA						
Coastal states	0	NA	0.10	1.95	106	2,061	0	0
Inland states	0	NA	0.10	1.15	106	1,216	0	0
All properties	116	NA					35,198	565,601
Multifamily								
No standard specified	117	1,725	0.30	4.80	4,423	70,769	517,500	8,280,000
BFE +1 foot	46	366	0.20	3.90	1,591	31,030	73,200	1,427,400
BFE +1.5 feet	0	0	0.10	1.95	0	0	0	0
All properties	163	2,091					590,700	9,707,400
Increase due to horizontal expansion							99,238	1,630,843
Overall total							689,938	11,338,243

BFE = base flood elevation. HUD = U.S. Department of Housing and Urban Development. NA = not applicable.

Based on these findings, the construction cost of increasing the base of a new residential structure 2 additional feet of vertical elevation varies from 0.3 to 4.8 percent of the base building cost. The increased cost as a percentage of construction cost is highest in Coastal A Zones, although the cost range is generally similar across the three flood zones. Although HUD's geocoding identifies whether buildings are located in the 1-percent annual chance floodplain, details are not available on which flood zone the building is located. Thus, for coastal states, HUD applies the full cost range across the three flood zones. For inland states, HUD applies only the A Zone cost.

Based on the median mortgage amount for FHA-insured properties in the 1-percent annual chance (100-year) flood zone, the estimated average cost of construction for FHA-insured single-family properties totals approximately $105,700 for newly constructed homes. Construction costs of new multifamily properties average approximately $100,000 per unit. Applying the previously discussed construction cost range, the cost of elevating a single-family home an additional 2 feet would add as much as $5,074 to the total cost of construction. The additional cost per multifamily property, based on a weighted average of HUD-assisted and HUD-insured properties located in the floodplain, for an additional 2 feet of elevation would cost up to $70,769 per property. These costs should generally be considered a maximum because most HUD-assisted or HUD-insured substantial improvement projects already involve elevation to the current standard, BFE+0. Thus,

the cost of elevating a structure an additional 2 feet would be marginal compared with the initial cost of elevation to the floodplain level. The aggregate increased costs of construction for newly constructed FHA-insured properties would range from $0.035 million to $0.566 million for single-family properties and from $0.591 million to $9.707 million for multifamily properties.

Adding 2 feet of freeboard would extend the floodplain and the area impacted by this rule horizontally, except in the case of the FHA single-family mortgage insurance program for one- to four-unit properties. The distance of this horizontal expansion depends on the topography of local jurisdictions. Based on available data from 20 coastal counties in six states,[13] FEMA estimates that the horizontal expansion from the additional 2 feet of freeboard would increase the area of the floodplain, and thus the affected area, by 16.8 percent on average across the country. For purposes of this analysis, HUD assumes that the number of affected properties would also increase by this percentage. This estimate, however, likely overestimates the impact because HUD's assisted and insured properties are not evenly distributed across space, and the counties in the sample are more concentrated in higher-flood-risk areas than HUD's stock. Furthermore, none of these counties includes riverine floodplains, which would likely have a smaller extension. Also, less than 1 percent of HUD-assisted multifamily properties and less than 2 percent of single-family properties that are in the floodplain are in these counties. Including the 16.8-percent increase from horizontal expansion, the aggregate increased construction cost for multifamily properties ranges from $0.690 million to $11.338 million.

Substantial improvement projects require a more involved process of lifting the structure and extending the foundation. The cost of elevating single-family homes depends on factors such as the foundation type, but costs of elevation generally range from $7,682 to $22,022 per foot that the house is elevated.[14] Owners of multifamily properties could choose to either elevate or floodproof and use any floor below the standard for nonresidential purposes. Because virtually all HUD-assisted and HUD-insured multifamily properties are two-story, garden-style apartments, HUD expects these properties to opt for elevating. Based on the elevation of larger structures noted in ASFPM (2002), HUD estimates that the cost of elevating small multifamily buildings ranges from $4,097 to $11,745 per unit per foot of elevation. These costs should be considered a maximum because most HUD-assisted or HUD-insured substantial improvement projects already involve elevation to the current standard, BFE+0. Thus, the cost of elevating a structure as much as an additional 2 feet would be marginal compared with the initial cost of elevation to the floodplain level.

As stated previously, HUD expects multifamily properties to meet the standard by raising the building base elevation rather than by eliminating residential units on the first floor. Choosing the latter, however, could lead to lost revenue either because fewer units are produced or because of the higher construction costs of adding a floor to maintain the same number of units. Alternatively, some developers may choose to locate outside of the floodplain and construct the same number of units. Revenue would likely remain the same in this case, because many of HUD's multifamily programs set rent limits by metropolitan area. Any change in rent, however, would be offset by

[13] The counties included in the horizontal expansion calculation are San Francisco County, California; Flagler and Nassau Counties, Florida; Charlton, Chatham, Douglas, Effingham, and Forsyth Counties, Georgia; Beaufort, Brunswick, Carteret, Craven, Hyde, New Hanover, Onslow, Pamlico, and Pender Counties, North Carolina; Colleton and Horry Counties, South Carolina; and Grays Harbor County, Washington.

[14] See ASFPM (2002). Estimates are adjusted for inflation.

further decreased flood insurance premiums and avoided damage. Furthermore, this change would affect only properties at the margin with viable alternatives to locating inside and outside the flood zone. HUD does not have an estimate for the number of properties that may choose this option.

Exhibit 3 shows the cost of elevating substantially rehabilitated, HUD-insured single-family homes and HUD-assisted multifamily properties. In FHA insurance year 2012, HUD insured 581 single-family properties in the 1-percent annual chance floodplain in states that do not require elevation above the BFE. Another 220 homes were insured in states that require construction to at least BFE+1 and 20 homes in states that require at least BFE+1.5. The aggregate increased construction cost for these single-family homes to meet the proposed standard ranges from $10.693 million to $30.655 million.

HUD assists far fewer substantial improvement projects of multifamily properties in the floodplain. Annually, only 10 properties containing 245 units are typically assisted in the floodplain. Most of these properties, comprising slightly more than one-half of the units, are in states that require construction to at least BFE+1. Overall, the aggregate costs of the proposed standard ranges from $1.483 million to $4.252 million, and from $1.732 million to $4.966 million if including horizontal expansion.

Exhibit 3

Cost of Elevation for HUD-Assisted and HUD-Insured Substantial Improvement Properties in the 1-Percent Annual Chance Flood Zone

State Construction Standard	New Construction		Cost of Freeboard per Unit		Aggregate Increase in Construction Costs	
	Properties (#)	Units (#)	Minimum ($)	Maximum ($)	Minimum ($)	Maximum ($)
Single-family						
No standard specified	581	NA				
Coastal states	552	NA	15,365	44,045	8,481,396	24,312,824
Inland states	29	NA	15,365	44,045	445,581	1,277,304
BFE +1 foot	220	NA				
Coastal states	147	NA	7,682	22,022	1,129,316	3,237,305
Inland states	73	NA	7,682	22,022	560,817	1,607,641
BFE +1.5 feet	20	NA				
Coastal states	20	NA	3,841	11,011	76,824	220,225
Inland states	0	NA	3,841	11,011	0	0
All properties	1,622	NA			10,693,934	30,655,300
Multifamily						
No standard specified	3	117	8,195	23,491	958,766	2,748,406
BFE +1 foot	7	128	4,097	11,745	524,453	1,503,402
BFE +1.5 feet	0	0	2,049	5,873	0	0
All properties	10	245			1,483,220	4,251,808
Increase due to horizontal expansion					249,181	714,304
Overall total					1,732,401	4,966,112

BFE = base flood elevation. HUD = U.S. Department of Housing and Urban Development. NA = not applicable.

Benefits of Rule

The standard proposed in this rule that requires that buildings be constructed with at least 2 feet of freeboard above BFE is intended to protect HUD-assisted and HUD-insured structures and the owners and tenants in these units. Thus, the benefits of the rule include reduced building damage and decreased costs to tenants temporarily displaced due to flooding, the latter of which includes avoiding search costs for temporary replacement housing and lost wages. The annual reduction in insurance premiums provides an adequate measure of the reduction in expected damages, assuming that NFIP rates are calculated to maintain a nonnegative balance. In this case, the premiums for catastrophic insurance would be slightly higher than, but similar to, the expected value of the claim to pay for administrative costs. It is not clear whether NFIP will operate without deficits or need for appropriations after the most recent reforms[15] (GAO, 2014). If the reduction in the insurance premium is not equivalent to the change in the risk-adjusted expected cost of claim (higher or lower), then a transfer to or from the insured will come from or go to the insurer.

Flood insurance premiums vary based on a variety of factors, such as the structure's height above BFE. Estimation of the expected reduction in damage for both new construction and substantial improvement projects, measured by the reduction in premiums, rely on the engineering studies discussed previously, which examine the effect of freeboard on new residential buildings in floodplains. As previously mentioned, although the studies focus on coastal areas, they separately model the effects in the Coastal A Zone and the A Zone. Flood conditions in the A Zone are subject to stillwater flooding and have a low threshold for wave damage. Therefore, the results of these studies are equally applicable to riverine areas. Similarly, HUD also applies findings to both new construction and substantial improvement projects because substantial improvement increases the value of the structure, with all else equal, to be near the new construction value.

FEMA (2013) estimated that the average annual premium savings as a percentage of construction cost ranges from 0.24 to 0.87 percent. The savings are greatest in the V Zone (0.87 percent) compared with the Coastal A (0.24 percent) and A (0.26 percent) Zones. Exhibit 4 shows the aggregate savings for a range of BFE levels, based on a typical production year for FHA-insured single-family properties, and exhibit 5 shows the same for HUD-assisted multifamily properties. These estimates reflect compliance with the minimum standard of 2 feet of freeboard. On learning of the benefits related to elevation, owners may choose to elevate to a level higher than the minimum required or take other precautions to minimize the flood risk.

For single-family properties, moving to the BFE+2 standard will decrease NFIP premiums in aggregate by a minimum of $142,987 ($28,687 + $114,300) and a maximum of $453,231 ($95,088 + $3,587,144) annually. Assuming a 30-year useful life, the aggregate discounted savings range from $1.717 million to $9.150 million, assuming a 3-percent discount rate, and $1.208 million to $6.018 million, assuming a 7-percent discount rate.

[15] The Biggert Waters Flood Insurance Reform Act of 2012 (Pub. L. 112–141, 126 Stat. 916. July 6, 2012) included provisions requiring FEMA to charge actuarial rates in order to allow the agency to repay the $24 billion loaned from the U.S. Treasury. The Homeowner Flood Insurance Affordability Act of 2014 (Pub. L. 113–89, 128 Stat. 1020. March 21, 2014), however, restricted the amount premiums could increase, slowing FEMA's ability to charge full risk rates and repay the loan.

Exhibit 4

Avoided Damage to FHA-Insured Single-Family Properties in 1-Percent Annual Chance Floodplain

State Construction Standard	Number of Properties		Average Premium Savings[a] (%)	Per Property Annual Savings ($)		Aggregate Annual Savings ($)		Discounted Savings[b] ($)	
	New Construction	Substantial Rehabilitation		New Construction	Substantial Rehabilitation	New Construction	Substantial Rehabilitation	3%	7%
Miniumum estimated savings									
No standard specified									
Coastal states	95	552	0.24	254	150	24,100	82,800	1,283,707	903,408
Inland states	6	29	0.26	275	163	1,649	4,713	76,391	53,760
BFE +1 foot									
Coastal states	11	147	0.18	190	113	2,093	16,538	223,723	157,445
Inland states	4	73	0.20	211	125	846	9,125	119,732	84,261
BFE +1.5 feet									
Coastal states	0	20	0.09	95	56	0	1,125	13,510	9,507
Inland states	0	0	0.10	106	63	0	0	0	0
All properties	116	801				28,687	114,300	1,717,064	1,208,382
Maxiumum estimated savings									
No standard specified									
Coastal states	95	552	0.87	920	544	87,361	300,150	7,823,249	5,145,245
Inland states	6	29	0.26	275	163	1,649	4,713	128,427	84,465
BFE +1 foot									
Coastal states	11	147	0.45	476	281	5,232	41,344	940,295	618,420
Inland states	4	73	0.20	211	125	846	9,125	201,291	132,386
BFE +1.5 feet									
Coastal states	0	20	0.23	238	141	0	2,813	56,780	37,343
Inland states	0	0	0.10	106	63	0	0	0	0
All properties	116	801				95,088	358,144	9,150,043	6,017,860

BFE = base flood elevation. HUD = U.S. Department of Housing and Urban Development.

[a] *Decrease in annual flood insurance premiums as percentage of construction costs.*

[b] *Discounted annual insurance premium savings based on 30-year useful life of buildings.*

Exhibit 5

Avoided Damage to HUD-Assisted Multifamily Properties Located in 1-Percent Annual Chance Floodplain

State Construction Standard	Number of Properties		Substantial Rehabilitation		Average Premium Savings[a] (%)	Per Property Annual Savings ($)		Aggregate Annual Savings ($)		Discounted Savings[b] ($)	
	Properties	Units	Properties	Units		New Construction	Substantial Rehabilitation	New Construction	Substantial Rehabilitation	3%	7%
Miniumum estimated savings											
No standard specified	117	1,725	3	117	0.24	3,538	4,212	414,000	12,636	8,613,122	5,664,734
BFE +1 foot	46	366	7	128	0.18	1,432	1,481	65,880	10,368	1,539,329	1,012,396
BFE +1.5 feet	0	0	0	0	0.09	0	0	0	0	0	0
All properties	163	2,091	10	245				479,880	23,004	10,152,451	6,677,130
Including horizontal expansion										11,858,063	7,798,888
Maxiumum estimated savings											
No standard specified	117	1,725	3	117	0.87	12,827	15,269	1,500,750	45,806	31,222,565	20,534,660
BFE +1 foot	46	366	7	128	0.45	3,580	3,703	164,700	25,920	3,848,323	2,530,990
BFE +1.5 feet	0	0	0	0	0.23	0	0	0	0	0	0
All properties	47	1,000	117	5,499,000				1,665,450	71,726	35,070,889	23,065,650
Including horizontal expansion										40,962,798	26,940,679

BFE = base flood elevation. HUD = U.S. Department of Housing and Urban Development.

[a] *Decrease in annual flood insurance premiums as percentage of construction costs.*

[b] *Discounted annual insurance premium savings based on 30-year useful life of buildings.*

NFIP premiums for multifamily properties will decrease in aggregate from $0.503 million ($0.480 million + $0.023 million) to $1.737 million ($1.665 million + $0.071 million) annually. Over a 30-year structure life, the aggregate discounted savings ranges from $10.152 million to $35.071 million, assuming a 3-percent discount rate, and $6.677 million to $23.066 million, assuming a 7-percent discount rate.

In addition to savings on insurance premiums, homeowners and tenants would also accrue significant benefits by avoiding the costs of moving from a flooded property. The family cost of moving a two-bedroom apartment costs approximately $800 plus lost wages. According to the American Moving and Storage Association (Williams 2014), an average in-state move costs $1,170, based on an average move weight of 7,100 pounds, or approximately $0.16 per pound. Based on a review of typical apartment weights, the median estimate for a two-bedroom apartment is 5,000 pounds.[16] Thus, the cost of moving a two-bedroom apartment is approximately $800 ($0.16 x 5,000). Using the national median hourly wage reported by the U.S. Bureau of Labor Statistics of $16.71, if affected households' wage earners are unable to work for a cumulative 40 hours each, due to time spent doing flood-related apartment searching and moving, a family would lose $668. Moving costs and lost wages combined would cost each tenant an estimated $1,468.

Homeowners and tenants living in the 100-year floodplain face a 1-percent chance each year that a flood will occur and that they will need to temporarily relocate. Increasing the base elevation by 2 feet would place the building, on average, at the 250-year floodplain, which has a 0.4-percent probability of experiencing a flood each year. Based on the weighted average of FHA-insured and HUD-assisted multifamily properties located in the floodplain each year—based on current state and local standards—this rule decreases the annual risk by 0.67 percent. The expected value of decreased owner and tenant costs is $9.88 per household ($1,468 x 0.67 percent). The discounted 30-year value of these avoided costs is $199 per household, assuming a 3-percent discount rate, and $131 per household, assuming a 7-percent discount rate. Aggregating over the combined 3,273 units (both single-family and multifamily), the total benefit to owners and tenants is $0.643 million, assuming a 3-percent discount rate, and $0.423 million, assuming a 7-percent discount rate. Including horizontal expansion, the benefits increase to $0.751 million using a 3-percent discount rate and $0.494 using a 7-percent discount rate.

Exhibit 6 summarizes the expected benefits generated from the proposed standard of 2 feet of freeboard. Overall, the maximum valued benefits of this rule, including horizontal expansion (where applicable) and higher estimates of damage avoided, total $50.657 million, assuming a 3-percent discount rate, and $33.317 million, assuming a 7-percent discount rate.

In addition to the benefits discussed previously, tenants experience unvalued benefits of avoiding temporary relocation. Being forced to relocate on short notice creates considerable stress and uncertainty for families. Furthermore, some families may not be able to find affordable housing in their immediate area and could be forced to move farther away, sometimes out of state. Long-distance moves remove a family from their local social network and add additional stress not only on adults, but also on children who may be required to enroll in different schools.

[16] Average apartment weights are calculated from a range of industry estimates, including www.citytocitymoving.us, www.movers.com, and www.movingcompanies.us.

Exhibit 6

Valued Benefits of BFE+2 Standard

Benefits	Excluding Horizontal Expansion Discount Rate ($)		Including Horizontal Expansion Discount Rate ($)	
	3%	7%	3%	7%
Avoided damage				
Minimum	11,869,515	7,885,512	13,575,126	9,007,270
Maximum	44,220,932	29,083,510	50,112,841	32,958,539
Avoided tenant costs	642,599	422,629	750,555	493,630
Total				
Minimum	12,335,648	8,192,082	14,119,571	9,365,343
Maximum	44,687,065	29,390,080	50,657,285	33,316,613

BFE = base flood elevation.

Coastal Versus Inland States

As explained previously, one concern about the applicability of the study (Jones et al., 2006) on which HUD's analysis relies is that the data were collected from coastal states, where costs and damage due to flooding may differ from inland states. Thus, it is important to consider how using data from coastal states may affect our estimates. Coastal states will possess A Zones, Coastal A Zones, and V Zones; however, inland states will possess only A Zones.[17]

The Coastal A Zone distinction was developed to encourage more effective flood mitigation. A FEMA (2005: p.1) study of damage during Hurricane Katrina found that "typical A Zone construction techniques … are subject to damage when exposed to less than 3-foot breaking waves, which is the current threshold for V Zone conditions." Higher standards, roughly equivalent to V Zone standards, are recommended but not required for A Zones in coastal areas. The Coastal A Zone is not shown on Flood Insurance Rate Maps because the federally mandated design standards are the same for all A Zones.

A more recent report (FEMA, 2009: p.1) after Hurricane Ike defined the Coastal A Zone as one that is "landward of a V Zone, or landward of an open coast without mapped V Zones." The Coastal A Zone's source of flooding ranges from "astronomical tides, storm surges, seiches or tsunamis, not riverine flooding." According to the report, "communities, designers, and owners, will have to determine whether a site lies within a Coastal A Zone" (FEMA, 2009: p.2). Without any geographic data, it is difficult to analyze the frequency of development in Coastal A Zones.

A Zones in coastal areas (as opposed to Coastal A Zones) are characterized as "areas with shallow flooding only, where potential for damaging waves and erosion is low" (FEMA, 2005: p.1). This definition is identical whether the zone is inland or near a coast. Fortunately, the FEMA report differentiates between A Zones and Coastal A Zones so that the increase in compliance costs can be calculated for properties in A Zones of inland states as well as those in coastal states.

In a typical production year, all HUD-assisted new construction in flood zones occurs in coastal states, and nearly 60 percent of HUD-assisted single-family development in flood zones occurs in

[17] HUD recognizes that flooding in inland states with major rivers may be more severe than in some coastal states.

coastal states. According to FEMA (2013), the cost of adding 2 feet of freeboard (BFE+2) is lower in A Zones than in Coastal A Zones (0.3 to 4.5 percent of construction cost for A Zones compared with 0.7 to 4.8 percent for Coastal A Zones). The maximum cost in V Zones of BFE+2 is 3.6 percent of total construction cost. The benefits may be different as well. Although A Zones and Coastal A Zones are expected to experience similar insurance savings as a percentage of the cost of construction, development in V Zones may experience significantly greater benefits. Thus, both the costs and benefits of the rule could be lower in inland areas, which have only A Zones.

Deaths Prevented and Health-Related Benefits

Although the purpose and expected impact of this rule is the protection of HUD investments and the uninterrupted provision of affordable housing, it is reasonable to expect that building to higher construction standards would prevent injuries or deaths related to tenant evacuation during or soon after a dangerous flood. According to National Weather Service data (NWS n.d.a, n.d.b), from 1995 to 2015, 82 deaths occurred per year due to flash and river floods. A large portion of these deaths occurred in vehicles as drivers tried to cross flooded roads or hydroplaned. In 2015, 176 deaths occurred due to floods, and 64 percent of these involved a vehicle. In contrast, 11 deaths, or 6.3 percent, occurred within an individual's permanent home. Since 1995, flooding was involved in 76 deaths in permanent homes and 35 deaths in mobile homes, making up 4.4 and 2.0 percent of total flood-related deaths in that time period, respectively. Of these flood-related deaths, 373, or 21.7 percent, were of elderly people (those over the age of 60).

Ashley and Ashley (2008) found that between 1959 and 2005, 4,586 flood-related fatalities occurred in the contiguous United States. On average, approximately 97.6 flood-related fatalities occurred per year, with a median value for reported deaths of 81. Most of these flood-related fatalities occurred due to flash floods, followed by traditional floods and tropical systems. Fewer than 200 of the 4,586 flood-related deaths occurred in a permanent structure, although this report did not distinguish between residential and nonresidential structures. This report also noted that people between the ages of 10 and 29 and people older than age 60 were more vulnerable to floods. However, the data used for this study, from the National CDs of Environmental Information Storm Events database, contained unknown ages for 63 percent of the fatalities.

Rappaport (2014) examined the fatalities that occurred in the United States from Atlantic tropical cyclones and found that, between 1963 and 2012, approximately 2,544 people died in the United States due to tropical cyclones, equating to roughly 50 deaths per year on average.[18] Roughly 90 percent of these deaths occurred in water-related incidents like drowning, 49 percent were caused by storm surge, and 27 percent were caused by freshwater floods and mudslides. In an overview of deaths caused by Hurricane Katrina, the report noted than many died due to drowning and entrapment in attics in the home.

Aside from decreasing deaths, the higher standards proposed in this rule will also decrease the incidence of mold. The additional 2 feet of freeboard will prevent water damage from a 1-percent annual chance flood. As FEMA, the Centers for Disease Control and Prevention (CDC), and other

[18] Atlantic tropical cyclones affect only coastal areas in the Eastern United States.

federal agencies have noted (CDC, n.d.; Hurricane Sandy Rebuilding Task Force, 2015), mold after flooding can cause a number of health issues to residents. Children, elderly people, pregnant women, and people with respiratory conditions such as asthma are at high risk for adverse health effects from mold.

The CDC also notes that floodwater can bring harmful contaminants into a home. For example, contaminated water can contain bacteria that cause infectious diseases and diarrhea. Also, floods can wash chemicals; displaced insects, reptiles, and other animals; and sharp objects into a home. Residents also face electrical hazards from downed power lines and flooded electrical equipment; if not property ventilated, diesel- and gasoline-powered generators can cause carbon monoxide poisoning. Floods can also cause indirect impacts, such as destruction of infrastructure that could help provide medicine, food, public services, or other needed supplies in an emergency.

Summary of Benefits, Transfers, and Costs

HUD proposed new elevation standards for its funded and assisted residential properties, due to the increased sea level and frequency of riverine flooding. The new standard also addresses issues that affect the insurance industry, including a market failure of information, asymmetric information on occupant flood mitigation efforts, and the moral hazard associated with insured properties and the assumption of governmental disaster relief. Increasing the required minimum elevation of HUD-assisted structures located in and around the floodplain will prevent or reduce damage caused by flooding and avoid relocation costs to tenants associated with temporary moves when HUD-assisted structures sustain flood damage and are temporarily uninhabitable. These benefits, which are realized throughout the life of HUD-assisted structures, are offset only by the one-time increase in construction costs.

As explained previously, HUD estimates that requiring developers to construct or floodproof HUD-funded and HUD-insured properties to BFE+2 will increase construction costs by $12.803 million to $47.525 million total. Benefits of the increased standard include avoided damage to buildings, as measured by decreased insurance premiums, and avoided costs associated with tenants being displaced. These benefits occur annually over the life of the structures. Over a 30-year period, the present value of aggregate benefits total between $12.336 million to $50.657 million, assuming a 3-percent discount rate, and between $8.192 million to $33.317 million, assuming a 7-percent discount rate.

These estimates are based on the annual production of HUD-assisted and HUD-insured structures in the floodplain and accounts for the 20 states, plus the District of Columbia and Puerto Rico, with existing freeboard requirements. The cost of compliance and expected benefits are lower in these states than in states that have no minimum elevation requirements above the BFE. HUD's analysis does not consider benefits due to further coastal sea level or riverine rise. Further increase in the sea level rise or inland and riverine flooding would increase the benefits of this rule.

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