Guidance for Applying ASCE 24 Engineering Standards to HMA Flood Retrofitting and Reconstruction Projects

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FEMA

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1 Introduction

This document was prepared by the Federal Emergency Management Agency (FEMA) to assist local governments, designers, and property owners. It identifies key design and construction requirements in the American Society of Civil Engineers (ASCE) Structural Engineering Institute's ASCE/SEI 24-05, *Flood-Resistant Design and Construction* (ASCE 24) that apply to HMA flood mitigation grant projects. This document is in no way intended to be used in place of ASCE 24 but rather as a companion to the standard. Designers, local officials, and others who want to apply the standard still need to refer to the standard for complete requirements.

This document addresses the full range of structures—residential and nonresidential—that are eligible for project assistance consideration under FEMA's Hazard Mitigation Assistance (HMA) program and provides guidance on how ASCE 24 should be applied to structure elevation, dry floodproofing, and mitigation reconstruction projects in flood hazard areas. Table 1-1 presents a summary of permitted and not permitted residential and nonresidential mitigation projects per the National Flood Insurance Program (NFIP), ASCE 24, and HMA policies. In this document, "HMA Policy" refers to the existing HMA guidance, and "HMA 24-05 Policy" refers to FP 203-074-1, *Minimum Design Standards for HMA Projects in Flood Hazard Areas* (FIMA 2013).

The guidance in this document does not advocate construction in the floodplain; rather, it is intended to reduce hazard risk for situations in which there is no practicable alternative. The emphasis of this document is on mitigation if construction in the floodplain is not avoidable, although the best way to greatly reduce (if not eliminate) flood risk is to relocate a structure out of the floodplain.

In this draft guidance document, the term "must" is used in the context of the ASCE 24 design standard to indicate compliance to applicable criteria within ASCE 24.

1.1 Unified HMA Program

FEMA's HMA Program provides assistance for mitigation activities that reduce damages and protect life and property from future damages. An important part of such mitigation activities involves ensuring that each project meets FEMA's requirements, which include adhering to project-related design standards. In accordance with the HMA policy FP 203-074-1, "FEMA will use ASCE 24-05, *Flood Resistant Design and Construction* or its equivalent as the minimum design criteria for all Hazard Mitigation Assistance (HMA) mitigation reconstruction, structure elevation, and dry floodproofing projects in flood hazard areas."

More detailed information on FEMA HMA Programs can be found at http://www.fema.gov/hazard-mitigation-assistance.

FEMA's HMA Program administers several programs that provide assistance for hazard mitigation projects. These grant programs are authorized under the Robert T. Stafford Disaster

Table 1-1. Eligible and Ineligible Project Types per the NFIP, ASCE 24, and HMA Policies

Flood Hazard	Regulatory Framework	Project and Building Type					
		Elevation		Dry Floodproofing		Mitigation Reconstruction	
		Residential	Nonresidential	Residential	Nonresidential	Residential	Nonresidential
Floodway[1]	NFIP	E	E	E (if SI/SD then I)[2]	E	E	E
	HMA-G	E (if SI/SD then I)	E (if SI/SD then I)	I[2]	E	I	I
	HMA w/ASCE 24	E (if SI/SD then I)	E (if SI/SD then I)	I[2]	I[3]	I	I
Zone A	NFIP	E	E	E (if SI/SD then I)[2]	E	E	E
	HMA-G	E	E	I[2]	E	E*	E*
	HMA w/ASCE 24	E	E	I[2]	I[3]	E*	E*
Coastal A Zone	NFIP	E	E	E (if SI/SD then I)[2]	E	E	E
	HMA-G	E	E	I[2]	E	E*	E*
	HMA w/ASCE 24	E	E	I[2]	I	E*	E*
Zone V	NFIP	E	E	I	I	E	E
	HMA-G	E	E	I	I	I	I
	HMA w/ASCE 24	E	E	I	I	I	I
Other High-Risk Areas	NFIP	—	—	—	—	—	—
	HMA-G	—	—	—	—	—	—
	HMA w/ASCE 24	E (if SI/SD then I)	E (if SI/SD then I)	I	I	I	I

HMA-G = General HMA Policy

HMA w/ASCE 24 = provisions being added to HMA policy with the integration of the ASCE 24 Standard.

E=eligible

E*= eligible in FMA only

I = Ineligible

SI/SD = Substantial Improvement/Damage

— = Other High-Risk Areas is a term used in ASCE 24

Other High-Risk Areas = Alluvial fans, flash flood areas, mudslide areas, erosion-prone areas, ice jam and debris area, high-velocity flow areas and areas subject to wave action, high-velocity wave action, breaking wave heights greater than or equal to 1.5 feet, and erosion (ASCE 24-05)

1. Development in the floodway is only permitted if it can be demonstrated that it will not result in an increase in the flood level or reduce the conveyance of the floodway for the base flood.
2. Residential structures determined to be historic buildings may be dry floodproofed and are not subject to the SI/SD restriction.
3. Ineligible where flood velocities exceed 5 feet/second.

Relief and Emergency Assistance Act (Stafford Act) or the National Flood Insurance Act. All mitigation projects must be cost effective and technically feasible. They must also meet environmental planning and historic preservation requirements in accordance with HMA Program requirements as well as all other applicable Federal statutes. FEMA requires that these grant programs also comply with applicable local, State, or national building codes, standards, and regulations. States, Territories, federally recognized Indian Tribal governments, and communities are eligible for assistance provided by HMA Programs in both the pre- and post-disaster time frames. These programs include the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation Program (PDM), and the Flood Mitigation Assistance Program (FMA).

Information on the background of the aforementioned programs, assistance, the award process and administration, applicant and project eligibility, how to complete and submit an application, application review, and program-specific guidance has been combined in a single document: *Hazard Mitigation Assistance Unified Guidance (HMA Unified Guidance)*. Although the latest edition of this document was published in 2013, it is updated regularly and users should refer to the most recent edition (see Appendix E). See Table 1-2 for a list of eligible projects by program.

Table 1-2. Eligible Flood Mitigation Activities Organized by HMA Program for Project Types Addressed in HMA Policy FP 203-074-1 "Minimum Design Standards for HMA Projects in Flood Hazard Areas"

Eligible Activities	HMA Program		
	HMGP	PDM	FMA
Structure Elevation	✓	✓	✓
Dry Floodproofing of Historic Residential Structures	✓	✓	✓
Dry Floodproofing of Nonresidential Structures	✓	✓	✓
Mitigation Reconstruction	X	X	✓

Source: FEMA (2013)

1.2 ASCE 24 and the National Flood Insurance Program

ASCE 24 provides minimum requirements for the flood-resistant design and construction of structures in flood hazard areas. The provisions of ASCE 24 are consistent with NFIP performance requirements and are intended to meet or exceed NFIP regulations. Buildings designed according to ASCE 24 will be more resistant to flood loads and flood damage than buildings designed and constructed solely in accordance with NFIP minimum requirements. This is because ASCE 24 offers additional specificity and requirements that both strengthen and complement the NFIP requirements. ASCE 24 is applicable to buildings situated in Special Flood Hazard Areas (SFHAs) or in lands designated by the authority having jurisdiction as flood hazard areas, whichever associated flood regulations are more restrictive. ASCE 24 includes an overview of how to identify flood hazard areas and flood-prone buildings, and requirements for:

- General design and construction in flood hazard areas (Zone A, Zone V, and Coastal A Zones);
- Construction in other high-risk flood hazard areas (e.g., alluvial fans, flash flood areas, mudslide areas);
- Building elevation;
- Use of flood-resistant materials;
- Dry and wet floodproofing;
- Protecting utilities from flood damage; and
- Protecting miscellaneous construction (e.g., decks, porches, garages) from flood damage.

ASCE 24 differs from the NFIP minimum requirements in three fundamental ways:

(1) ASCE 24 provides more specific performance requirements than the NFIP,

(2) ASCE 24 requires new construction to meet higher standards than the NFIP, and

(3) ASCE standards are developed by a consensus process that includes balloting by a committee and a public review.

For example, ASCE 24 requires freeboard above the base flood elevation (BFE) for many (not all) buildings, and buildings in Coastal A Zones (wave heights between 1.5 and 3 feet) must meet the same design and construction requirements as buildings in Zone V (wave heights $\geq$ 3 feet). For the purposes of this document, the ASCE 24 zone convention is adopted—when the term "Zone A" is used, it does not include Coastal A Zones.

ASCE 24 was written to apply to the construction of new buildings and to Substantially Improved/Damaged existing buildings that are not historic structures (see Section 6 of this document). As a result, mitigation projects that do not constitute new construction (i.e., new buildings) or Substantial Improvements, such as some elevation and dry floodproofing projects, may not be required to comply with every provision of

High-risk flood hazard areas can be identified using community flood hazard maps, historical information on past flood events, and analyses of relevant community data. Details on how to identify each specific area are included in ASCE 24-05 Section 3.0, and further information on their application to HMA projects is included in Section 5.1 of this document.

Definitions

"Substantial damage" is damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damage condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

"Substantial improvement" is any repair, reconstruction, rehabilitation, addition, or improvement of a building, the cost of which equals or exceeds 50 percent of the market value of the building before the improvement or repair is started (certain historic structures may be excluded).

Zone A in coastal areas is divided by the Limit of Moderate Wave Action (LiMWA). The LiMWA is the 1.5-foot wave height line mapped on flood insurance rate maps. The area between the LiMWA and the Zone V limit is known as the Coastal A Zone for building code and standard purposes. Because the 1.5 feet breaking wave can potentially cause foundation failure, communities are encouraged to adopt, within the LiMWA zone, building construction standards applicable for Zone V.

ASCE 24. This is because project designers may not have all the information required to fully apply ASCE 24, and/or the original structure may not have been designed in accordance with the loads and conditions specified by ASCE 24.

Although complete compliance with ASCE 24 is preferred, certain provisions of ASCE 24 must be met completely, and the intent of the remaining provisions must be met. Elevation and dry floodproofing projects that meet this level of compliance will be "deemed-to-comply" with ASCE 24. Appendix A, "Deemed-to-Comply Table," summarizes the provisions of ASCE 24 and what constitutes a "deemed-to-comply" project approach.

In ASCE 24, structures are classified according to Table 1-3. These classifications are referenced throughout the standard, and requirements specific to each structure type are provided.

Table 1-3. ASCE/SEI 24-05 Table 1.1 Classification of Structures for Flood-Resistant Design and Construction (Classification same as ASCE 7, *Minimum Design Loads for Buildings and Other Structures*)

Nature of Occupancy	Category
Buildings and other structures that present a low hazard to human life in the event of failure including, but not limited to: • Agricultural facilities[1] • Certain temporary facilities • Minor storage facilities[2]	I
All buildings and other structures except those listed in Categories I, III, and IV	II
Buildings and other structures that present a substantial hazard to human life in the event of failure including, but not limited to: • Buildings and other structures where more than 300 people congregate in one area • Buildings and other structures with day-care facilities with capacity greater than 150 • Buildings and other structures with elementary school or secondary school facilities with capacity greater than 250 • Buildings and other structures with a capacity greater than 500 for colleges or adult education facilities • Health care facilities with a capacity of 50 or more resident patients but not having surgery or emergency treatment facilities • Jails and detention facilities • Power generating stations and other public utility facilities not included in Category IV Buildings and other structures not included in Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing sufficient quantities of hazardous materials considered to be dangerous to the public if released. Buildings and other structures containing hazardous materials shall be eligible for classification as Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2[3] that a release of the hazardous material does not pose a threat to the public.	III

Nature of Occupancy	Category
Buildings and other structures designated as essential facilities including, but not limited to: • Hospitals and other health care facilities having surgery or emergency treatment facilities • Fire, rescue, ambulance, and police stations and emergency vehicle garages • Designated earthquake, hurricane, or other emergency shelters • Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response • Power generating stations and other public utility facilities required in an emergency • Ancillary structures (including, but not limited to, communication towers, fuel storage tanks, cooling towers, electrical substation structures, fire water storage tanks or other structures housing or supporting water, or other fire-suppression material or equipment) required for operation of Category IV structures during an emergency • Aviation control towers, air traffic control centers, and emergency aircraft hangars • Water storage facilities and pump structures required to maintain water pressure for fire suppression • Buildings and other structures having critical national defense functions Buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing extremely hazardous materials where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction. Buildings and other structures containing extremely hazardous materials shall be eligible for classification as Category II structures if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.2[3] that a release of the extremely hazardous material does not pose a threat to the public. This reduced classification shall not be permitted if the buildings or other structures also function as essential facilities.	IV

1. Certain agricultural structures may be exempt from some of the provisions of ASCE/SEI 24-05; see Section C1.4.3 of ASCE/SEI 24-05.
2. For the purposes of ASCE/SEI 24-05, minor storage facilities do not include commercial storage facilities.
3. Section 1.5.2 reference is made to ASCE Standard 7-05, not ASCE/SEI 24-05.

1.3 ASCE 24 and Its Applicability to HMA Flood Projects

Per FEMA's HMA Policy FP 203-074-1, ASCE 24 will be used as the minimum design criteria for HMA grants for structure elevation, mitigation reconstruction, and dry floodproofing projects (FIMA 2013). Structure elevation and dry floodproofing projects can use the "deemed-to-comply" approach, which summarizes the provisions in ASCE 24 as they apply to these types of HMA projects (see Appendix A). Because buildings designed according to ASCE 24 will be more resistant to flood loads and flood damage than buildings designed and constructed solely in accordance with NFIP minimum requirements, applying the ASCE 24 standard to HMA funded projects will help to protect the HMA investment.

For all flood mitigation projects, whether they are federally supported or not, FEMA encourages the use of ASCE 24 to the extent practicable. During the application development for flood mitigation projects, a statement verifying that the requirements of ASCE 24 will be incorporated into the project design (also known as an affirmative certification statement) will aid the review process for HMA projects. Section 7.1.3 provides a sample affirmative certification statement. This statement is required to be included in applications for mitigation reconstruction, elevation,

and dry floodproofing projects in order to be "deemed to comply." Deemed-to-comply provisions cannot be applied to any new construction on structures or systems during alterations where ASCE 24 provisions can be implemented.

1.4 Preliminary Codes, Standards, and Ordinances Considerations

HMA grant projects are required to comply with applicable State and local laws, standards, and ordinances, as well as with Federal laws, regulations, and statutes, including participation in the NFIP. State and local laws, standards, and ordinances often exceed the requirements of Federal regulations and, therefore, should be considered early during project development. Even if a project is technically feasible and cost effective, if implementing the project violates a local ordinance, the project will be ineligible for Federal assistance. For HMA supported mitigation reconstruction, elevation, and dry floodproofing projects in flood hazard areas, the application of ASCE 24 is required in addition to the NFIP requirements, Title 44 of the Code of Federal Regulations (CFR) Part 9 minimization standards, and applicable local and State standards, codes, and/or ordinances. For HMA grant projects outside of the SFHA and that would not otherwise be subject to ASCE 24 (e.g., structure elevation or dry floodproofing projects), FEMA encourages the use of ASCE 24 to the extent practicable. ASCE 24 establishes minimum requirements for flood-resistant design and construction of structures that are subject to building code requirements and that are located, in whole or in part, in flood hazard areas.

All new buildings or structures within flood hazard areas and that fall under the purview of the 2006 or newer *International Building Code* (IBC) must be designed and constructed in accordance with ASCE 24. Similarly, buildings and structures located in floodways and that are governed by the 2006 or newer *International Residential Code* (IRC) must be designed and constructed in accordance with ASCE 24. Additionally, buildings and structures located in Coastal High Hazard Areas (Zone V) and Coastal A Zones, where delineated, may follow the provisions of ASCE 24, subject to the limitations of the IRC and any limitations of ASCE 24.

Modern building codes contain provisions for existing buildings that can trigger additional requirements depending on the work being done. If the project will involve significant work to structural elements or large portions of a building, the adopted building code may require additional portions of the building to be brought into compliance with current code requirements. This should not be confused with local floodplain development regulations, which may be separate from the building code. The work done as part of a flood retrofit project must comply with the adopted building code, local floodplain development regulations, and ASCE 24. Provisions for work on existing buildings are covered in the 2012 IRC, 2012 IBC, and 2012 *International Existing Building Code* (IEBC). Alterations, repairs, renovations, and relocations are covered through these provisions. For more information on code compliance, see Section 7.4.1.

It is also important to be aware of the permitting process within a local jurisdiction at the outset of a flood mitigation project. Permit requirements may vary from jurisdiction to jurisdiction, depending on the local regulations, including floodplain development regulations and adopted

building code. If no building code has been adopted for a community that participates in the NFIP, permits are still required for development in SFHAs per NFIP regulations. Similarly, if HMA assistance is being requested, the project is subject to HMA requirements and, thus, the provisions of ASCE 24 as outlined in this document. For more information on permitting and community-specific requirements, see Section 7.4.2.

1.5 Organization of This Guidance

Chapter 1: Introduction

Introduction to FEMA's Unified HMA grant programs, and the applicability of ASCE 24 to the HMA Program.

Chapter 2: ASCE 24 Requirements for Building Elevation Mitigation Projects

Information on ASCE 24 requirements for both riverine and coastal elevation mitigation projects, including design flood elevation (DFE) by structure category, foundation types and siting, enclosures below the DFE, and building materials and utilities.

Chapter 3: ASCE 24 Requirements for Dry Floodproofing Mitigation Projects

Dry floodproofing methods, the pros and cons of each method, dry floodproofing utilities, and requirements for dry floodproofing historic residential buildings versus nonresidential buildings.

Chapter 4: ASCE 24 Requirements for Mitigation Reconstruction

Requirements for new construction, including siting, utilities, and HMA restrictions for mitigation reconstruction.

Chapter 5: High-Risk Flood Hazard Areas

How to apply ASCE 24 standards in high-risk flood hazard areas and for mitigation projects (other than elevation, dry floodproofing, and mitigation reconstruction) when substantially improving a building in an SFHA.

Chapter 6: Historic Properties

How historic properties are treated under HMA and factors that affect the ability to apply ASCE 24 to reduce flood damage to historic properties.

Chapter 7: Project Implementation

The process of implementing the HMA grant programs from programmatic considerations to closeout.

Appendix A: Deemed-to-Comply Table

Provides a table that summarizes the provisions of ASCE 24 and what constitutes a "deemed-to-comply" project approach.

Appendix B: Benefit-Cost Considerations

Provides basic guidance on using the FEMA Benefit-Cost Analysis (BCA) Tool (Version 4.5.5) (2009) to complete a BCA for the mitigation project types covered in this publication.

Appendix C: Methodology for Evaluating Risks

An optional tool that can be used to evaluate the risks of the flood hazard in the project area.

Appendix D: Checklists for Mitigation Projects: Development, Grant Applications, Implementation, and Closeout

Checklists available as optional tools to guide the applicant through the grant application process and project development, implementation, and closeout.

Appendix E: References, Resources, and Links

Lists references, resources, and links useful for flood mitigation projects.

Appendix F: Acronyms and Abbreviations

Lists acronyms and abbreviations used throughout the document.

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2 ASCE 24 Requirements for Building Elevation Mitigation Projects

Structure elevation involves physically raising an existing superstructure to a height at or above the BFE, as shown in Figure 2-1. The height to which a structure is raised depends on several factors, including the building type and its location within the flood zone. Traditionally, HMA guidance for elevation projects specifies that, at a minimum, projects should be designed to satisfy the requirements in the NFIP standards (44 CFR Part 60) by complying with local codes and standards communities use to enforce their floodplain development regulations. ASCE 24 incorporates stricter requirements than the NFIP standards, several of which can be applied to structure elevation projects.

Figure 2-1. Building elevated on piles (Source: FEMA 2012a)

ASCE 24 HMA Policy Impact for Elevation Projects

Elevation projects are permitted in all flood hazard zones; however, in high-risk flood hazard areas, such as alluvial fan areas, if the elevation project is a Substantial Improvement to a home, or if a home is Substantially Damaged, then the project must adhere to Section 3 of this standard. See Table 1-1 for more details. Although non-Substantial Improvement/Damage elevation projects are technically permitted in high-risk flood hazard areas, as part of the FEMA HMA assistance review process (the Part 9 or environmental and historic preservation [EHP] review in particular), the agency would evaluate the risk and impacts for this type of project and try to avoid them. In all cases, the HMA project must still comply with all regulations outlined in 44 CFR Part 9.

This section offers guidance for designing and implementing building elevation mitigation projects in accordance with ASCE 24 based on the location of the project site (Zone A or Coastal High Hazard Area and Coastal A Zone).This section highlights the key provisions in ASCE 24 that apply to elevation projects. Elevation project types covered in this section include elevation on continuous foundation walls; elevation on open foundations, such as piles, piers, posts, or columns; and elevation on fill. Per HMA general guidance, any activity that results in the construction of new living space at or above the BFE will only be considered when consistent with the Mitigation Reconstruction requirements (see Section 4 of this document). Relevant ASCE 24 design considerations for each of the applicable project types are addressed in Sections 2.1 and 2.2 of this document.

According to the NFIP regulations, in general, a structure's lowest floor must be either elevated or floodproofed to the BFE. However, States and communities may set higher elevation standards than what is required by the NFIP, often by including freeboard requirements (freeboard is a measure of safety usually expressed in feet above a flood level). Similar to the

requirements that may be set in communities, ASCE 24 also requires elevating many types of structures to an elevation higher than the BFE. For any elevation project, the greater of the two elevations must be followed (either the DFE required by the community or the minimum elevation requirements from ASCE 24). The concepts of BFE, DFE, and freeboard are illustrated in Figure 2-2.

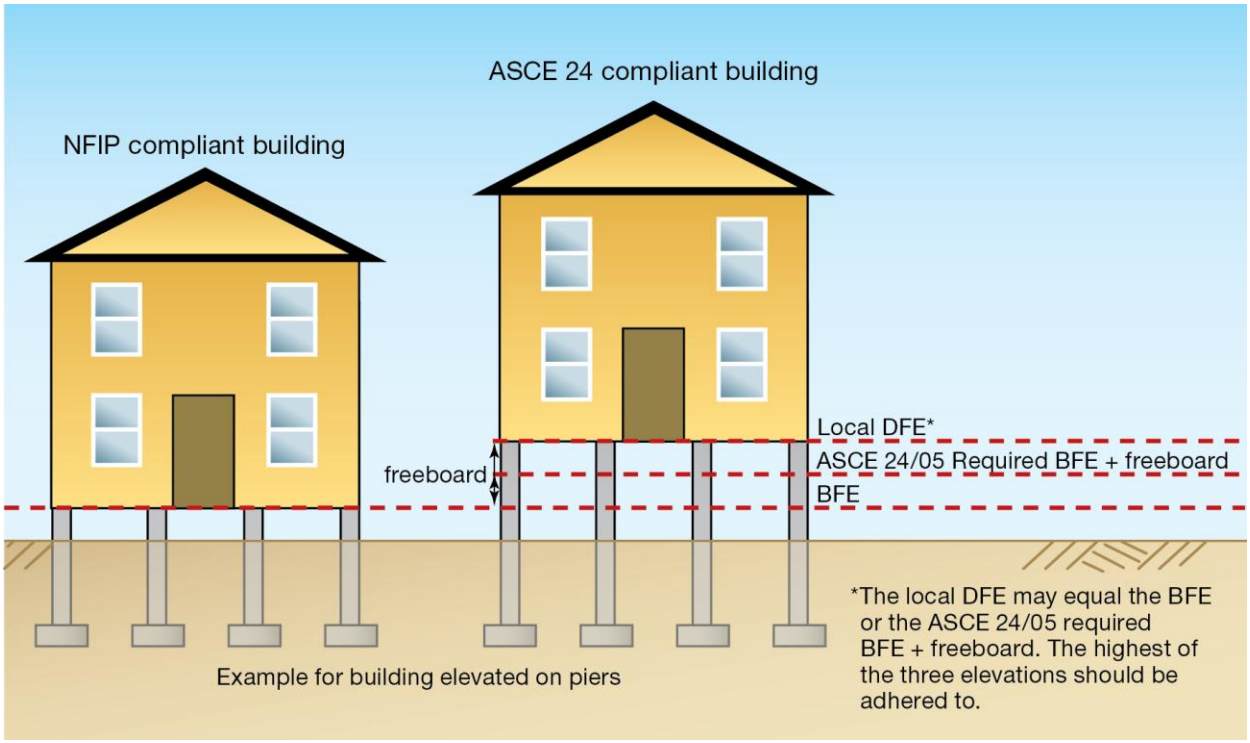

Figure 2-2. Building satisfying NFIP minimum requirements compared with building satisfying ASCE 24 requirements

2.1 Requirements for Zone A

The requirements described in this section apply to elevation projects in flood hazard areas that are not identified as Coastal High Hazard Areas or Coastal A Zones. This includes areas delineated on the Flood Insurance Rate Map (FIRM) as Zone A, AE, A1–30, A99, AR, AO, and AH. For this guidance, the term "Zone A" refers to all A zones except Coastal A Zones.

In Zone A, structures may be elevated on one of four foundation types, including elevating the structure on piles; elevating on piers, posts, or columns; elevating on continuous foundation walls; or elevating on fill (Figure 2-3).

The type of existing foundation may determine how the elevated project is constructed and whether part or all of the existing foundation can be reused in the mitigation project. For example, if the existing structure has a continuous wall crawl space foundation, the foundation walls might be vertically extended to the necessary elevation.

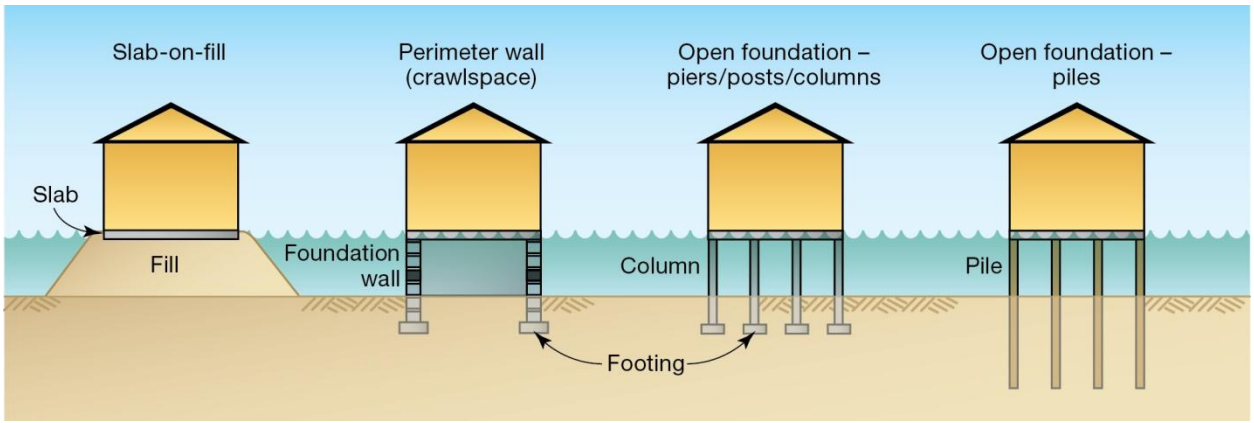

Figure 2-3. Allowable foundation types in Zone A (Source: FEMA 2012c)

Pertinent ASCE 24 provisions are identified and their application to elevation mitigation projects is explained in the following sections.

2.1.1 Design Flood Elevation

All elevation projects must have the lowest floor (including basements) elevated to or above the height specified in Table 2-1. The DFE is determined by the community requirements, which may either be the BFE or some higher elevation as set by the community.

Table 2-1. Minimum Elevation of the Top of Lowest Floor Relative to BFE or DFE—Flood Hazard Areas Other Than Coastal High Hazard Areas and Coastal A Zones

Structure Category[1]	Minimum Elevation of Lowest Floor
I	DFE
II	BFE + 1 ft or DFE, whichever is higher
III	BFE + 1 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher

1. See Table 1-3 in this document for structure category descriptions.
BFE = base flood elevation
DFE = design flood elevation
ft = feet
Source: ASCE 24-05, Table 2-1

For guidance on selecting the appropriate structure category, see Section 1.2 of this document. Figure 2-4 shows the lowest floor elevation requirement for structures in Zone A. Any area below the lowest floor must be used solely for parking, building access, or storage. Section 2.1.3 includes additional detail regarding requirements for enclosures below the lowest floor. The exception to these requirements is dry floodproofed nonresidential buildings where the lowest floor is permitted below the elevation specified in Table 2-1 because the lowest floor will be beneath the level of the dry floodproofing protection. See Section 3 for applicable dry floodproofing considerations.

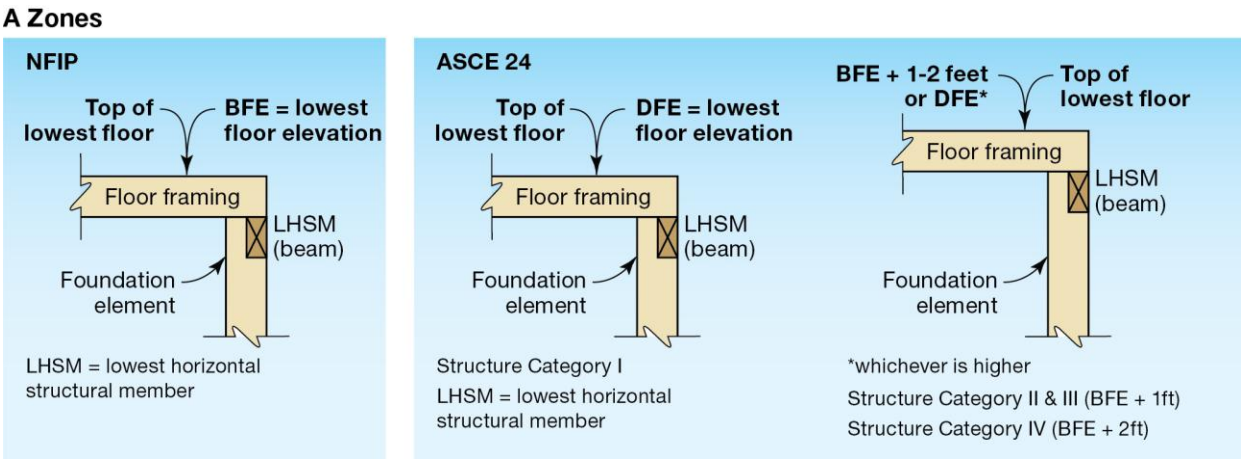

Figure 2-4. Lowest floor elevation requirements in Zone A

2.1.2 Foundation Design Requirements

In accordance with ASCE 24, foundations of structures must be designed, constructed, connected, and anchored to resist flotation, collapse, or permanent lateral movement under design loads and load combinations. This applies for any foundation type being used to support an elevated structure, including slab-on-grade; piles, posts, piers, or columns; and continuous walls. The superstructure is not subject to the provisions of ASCE 24. Design loads and load combinations for foundation elements must be in accordance with the applicable building code requirements or the requirements as shown in ASCE 24, whichever is more restrictive. ASCE 24 specifies that loads must be in accordance with ASCE 7, *Minimum Design Loads for Buildings and Other Structures*.

In structure elevation projects where portions of the existing foundation will be used, the designer must verify, to the extent possible, that the existing foundation elements will be capable of resisting the design loads and conditions applied to the foundation. One example of using existing foundation elements may include slab separation where the slab is used as the spread footing for piers in cases where removal of the slab would be expensive or could disturb consolidated soil underneath. A second example is the elevation of a building by extending an existing solid perimeter foundation wall; CMU may be added to the existing wall to extend it upwards. However, depending on the structure and potential environmental loads, new larger footings may be necessary or reinforcement of the existing footings and wall might be needed for structural stability. Design loads must be applied to the mitigated or new sections of the foundation. This would include any loads placed directly on the foundation as well as loads transferred to the foundation from the superstructure such as uplift from wind. Any new beams required for the foundation must comply with ASCE 24 loading requirements and must be designed to create a load path between the existing structure and the new elements.

Similarly, in structure elevation projects where the existing foundation will be removed and replaced with a new foundation, the provisions in ASCE 24 apply only to the foundation design

and connection of the existing structure to the new foundation. Building elements located above the foundation are not subject to the provisions of ASCE 24.

2.1.2.1 Slab-on-Grade

For elevation mitigation projects where a slab on grade foundation will be constructed to support the structure, ASCE 24-05 Section 2.4 specifies that the slab must be placed on structural fill or undisturbed soil with adequate bearing capacity. The design and construction of the fill must account for consolidation of the underlying soil, differential settlement, and slope stability and erosion control. ASCE 24 includes specific guidance for compaction and side slopes. The top of any slab-on-grade foundation must be at or above the elevation specified in Table 2-1, and if the slab has been turned down to act as footings, it must be designed to resist damage from scour and erosion during a flooding event. In addition, the slab must not break up during design flood conditions, and must be placed such that no supporting soil is lost during the design flood.

In the case where an existing home is supported on a slab-on-grade foundation, the two possible elevation methods are to separate the home from the slab and raise the home or to keep the home and slab intact and raise them both. In either situation, the ASCE 24 requirements apply as described in this and the following sections for the new foundation type. In addition, if raising the slab with the home, the new foundation system must include an elevated support structure to accommodate the load of both the slab and the home.

2.1.2.2 Piers, Posts, Columns, or Piles

When elevating on piles, posts, piers, or columns in Zone A, it is important to consider the depth of the foundation; its resistance to erosion, scour, and any effects of debris impact associated with higher velocity floodwaters; and its ability to satisfy the foundation performance requirement (designed, constructed, connected, and anchored to resist flotation, collapse, or permanent lateral movement under design loads and load combinations).

Often, when a structure is elevated on piles, posts, or piers, infill walls or breakaway walls are installed around the perimeter of the foundation. ASCE 24 includes specific requirements for enclosures below the DFE, which are described in section 2.1.3 of this document.

2.1.2.3 Continuous Foundation Walls

In structure elevation projects, solid perimeter walls are often vertical extensions of existing walls. Adequate connection to the existing foundation and the elevated superstructure are necessary. When continuous foundation walls enclose areas below the lowest floor, it is important to consider the design of flood openings to allow for the automatic entry and exit of floodwaters. Further details on openings in continuous foundation walls are provided at the end of Section 2.1.3.

2.1.3 Enclosures Below the Design Flood Elevation

In accordance with ASCE 24, enclosures below the DFE can only be used for parking, building access, and storage. There are no ASCE 24 restrictions on the size of the enclosure area;

however, designers should be aware that the size may affect flood insurance premiums. ASCE 24 has specific requirements for the size, number, location, and spacing of openings in any walls that form an enclosure below the lowest floor of a structure situated in Zone A. Openings may be engineered or non-engineered, but must prevent an imbalance of hydrostatic pressure (equivalent to no more than 1 foot of variation in the water surface elevation inside and outside the enclosed area). Breakaway wall enclosures in Zone A must have openings to allow for the automatic entry and exit of floodwaters during design flood conditions, just as solid foundation walls must. The design guidance provided in ASCE 24 will satisfy the elevation design standards of *HMA Unified Guidance, Part IX Additional Project Guidance,* section titled "Eligible Design Standards." FEMA Technical Bulletin 1 (TB-1), *Openings in Foundation Walls and Walls of Enclosures* (2008d); FEMA TB-5, *Free-of-Obstruction Requirements* (2008b); and FEMA TB-9, *Design and Construction Guidance for Breakaway Walls Below Elevated Coastal Buildings* (2008a), offer additional related guidance on enclosures below the DFE.

2.1.4 Building Materials

Any portions of elevated buildings that remain below the minimum elevation specified in Table 2-2 for flood hazard areas must be constructed with materials capable of resisting damage, deterioration, corrosion, and decay from direct and prolonged contact with floodwaters; for non-coastal flood hazard areas, prolonged contact equates to partial or total inundation by floodwaters for 72 hours. Except for breakaway walls (which must fail under base flood or lesser flood conditions, but also be able to resist wind loads), materials and components must have the capacity to resist all flood-related and other loads, and must be in accordance with the applicable building code requirements or the requirements in ASCE 24, whichever are more stringent. If no building code is in place, the latest version of ASCE 24 should be used.

Table 2-2. Minimum Elevation, Relative to BFE for DFE, Below Which Flood Damage-Resistant Materials Must Be Used in Zone A

Structure Category[1]	Flood Hazard Areas
I	DFE
II	BFE + 1 ft or DFE, whichever is higher
III	BFE + 1 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher

1. See Table 1-3 in this document for structure category descriptions.

BFE = base flood elevation

DFE = design flood elevation

ft = feet

Source: ASCE 24-05, Table 5-1

ASCE 24-05 Section 5.2 provides specific requirements for metal connectors and fasteners, structural steel, concrete, masonry, wood and timber, and finishing materials. For elevation mitigation projects where a portion of the existing foundation will remain and be reused, the

building materials requirements apply only to the new sections of the foundation. If the foundation has been replaced in the mitigation project, then the material requirements apply to the entire foundation. Similarly, if the mitigation falls under Substantial Improvement/Damage requirements, the material requirements apply to all areas of the building that remains below the minimum elevation specified by ASCE 24 (Table 2-2 of this document).

2.1.5 Utilities

ASCE 24-05 Section 7 includes requirements for electrical service; plumbing systems; mechanical systems; heating, ventilation, and air-conditioning systems; and elevators. According to ASCE 24, to avoid flood damage, utilities and attendant equipment in SFHAs must be elevated above the minimum elevations in Table 2-3, and must be anchored to resist damage from high wind. ASCE 24-05 Section 7 provides specific utility requirements and allows some utility connections to be below the DFE, including some buried systems and connections extending from the ground upwards. These portions of utilities must be designed, constructed, and installed to prevent the entry of floodwater into the system or its components.

Additionally, utility systems and components can be protected by enclosing the systems within structures that are dry floodproofed per the guidance in ASCE 24-05 Section 6.

Table 2-3. Minimum Elevation of Utilities and Attendant Equipment Relative to BFE or DFE in Zone A

Structure Category[1]	Flood Hazard Areas
I	DFE
II	BFE + 1 ft or DFE, whichever is higher
III	BFE + 1 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher

1. See Table 1-3 in this document for structure category descriptions.

BFE = base flood elevation

DFE = design flood elevation

ft = feet

Source: ASCE 24-05, Table 7-1

The ASCE 24 guidance requires that utilities be elevated to a greater height than specified by the NFIP.

2.2 Requirements in Coastal High Hazard Areas and Coastal A Zones

The requirements described in this section apply to elevation projects in Coastal High Hazard Areas and Coastal A Zones. This includes areas delineated on the FIRM as velocity Zones V, VO, VE, V1–30, and Coastal A Zones (between the limit of moderate wave action and the Zone V limit, or as otherwise specified by the community).

In accordance with ASCE 24, structures within a Zone V or Coastal A Zone may only be elevated on open foundations consisting of piers, posts or columns, or piles (Figure 2-5).

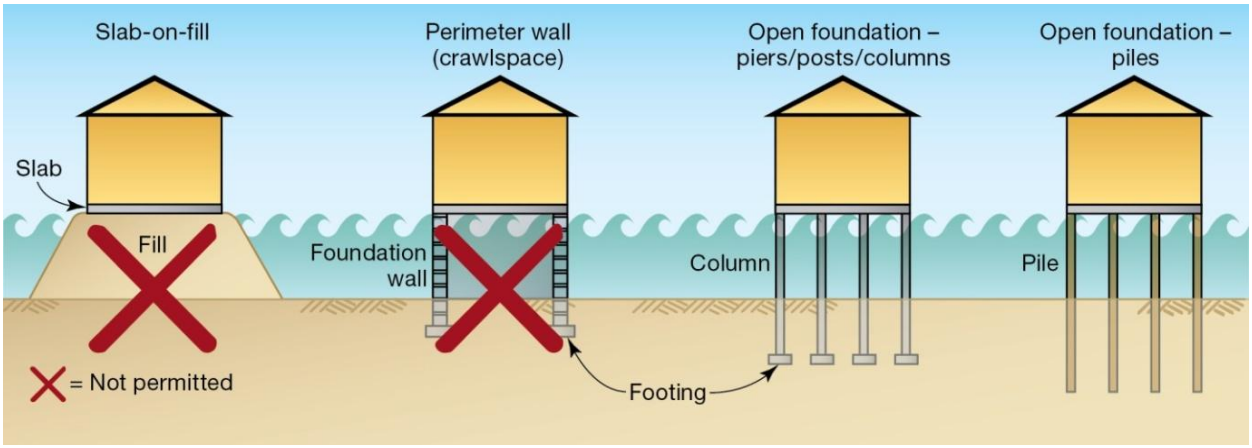

Figure 2-5. Foundation requirements in Coastal High Hazard Areas and Coastal A Zones (Source: FEMA 2012c)

Unlike the NFIP, which does not differentiate between Zone A and Coastal A Zone design and construction requirements, ASCE 24 prohibits elevation structurally supported by or on fill and elevation on continuous foundation walls in Coastal A Zones. ASCE 24 allows for the placement of nonstructural fill under and around a structure for dune construction or reconstruction if the fill will not result in wave runup, ramping, or deflection of floodwaters that cause damage to structures.

2.2.1 Design Flood Elevation

All elevation projects must have the bottom of the lowest horizontal structural member of the lowest floor at or above the elevations specified in Table 2-4. The DFE is determined by the community requirements, which may either be the BFE or some higher elevation. Figure 2-6 shows the lowest floor elevation requirements for Coastal High Hazard Areas (Coastal Zone V) and Coastal A Zones.

For guidance on selecting the appropriate structure category, see Table 1-3 of this document. Any area below the DFE must be used solely for parking, building access, or storage. Section 2.2.3 includes additional detail regarding requirements for enclosures below the DFE.

Table 2-4. Minimum Elevation of Bottom of Lowest Supporting Horizontal Structural Member of Lowest Floor Relative to BFE or DFE—Coastal High Hazard Areas and Coastal A Zones

Structure Category[1]	Member Orientation Relative to the Direction of Wave Approach	
	Parallel[2]	Perpendicular[2]
I	DFE	DFE
II	DFE	BFE + 1 ft or DFE, whichever is higher
III	BFE + 1 ft or DFE, whichever is higher	BFE + 2 ft or DFE, whichever is higher
IV	BFE + 1 ft or DFE, whichever is higher	BFE + 2 ft or DFE, whichever is higher

Source: ASCE 24-05, Table 4-1

1. See Table 1-3 for structure category descriptions.
2. Orientation of lowest horizontal structural member relative to the general direction of wave approach: parallel shall mean less than or equal to +20 degrees from the direction of approach; perpendicular shall mean greater than +20 degrees from the direction of approach.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

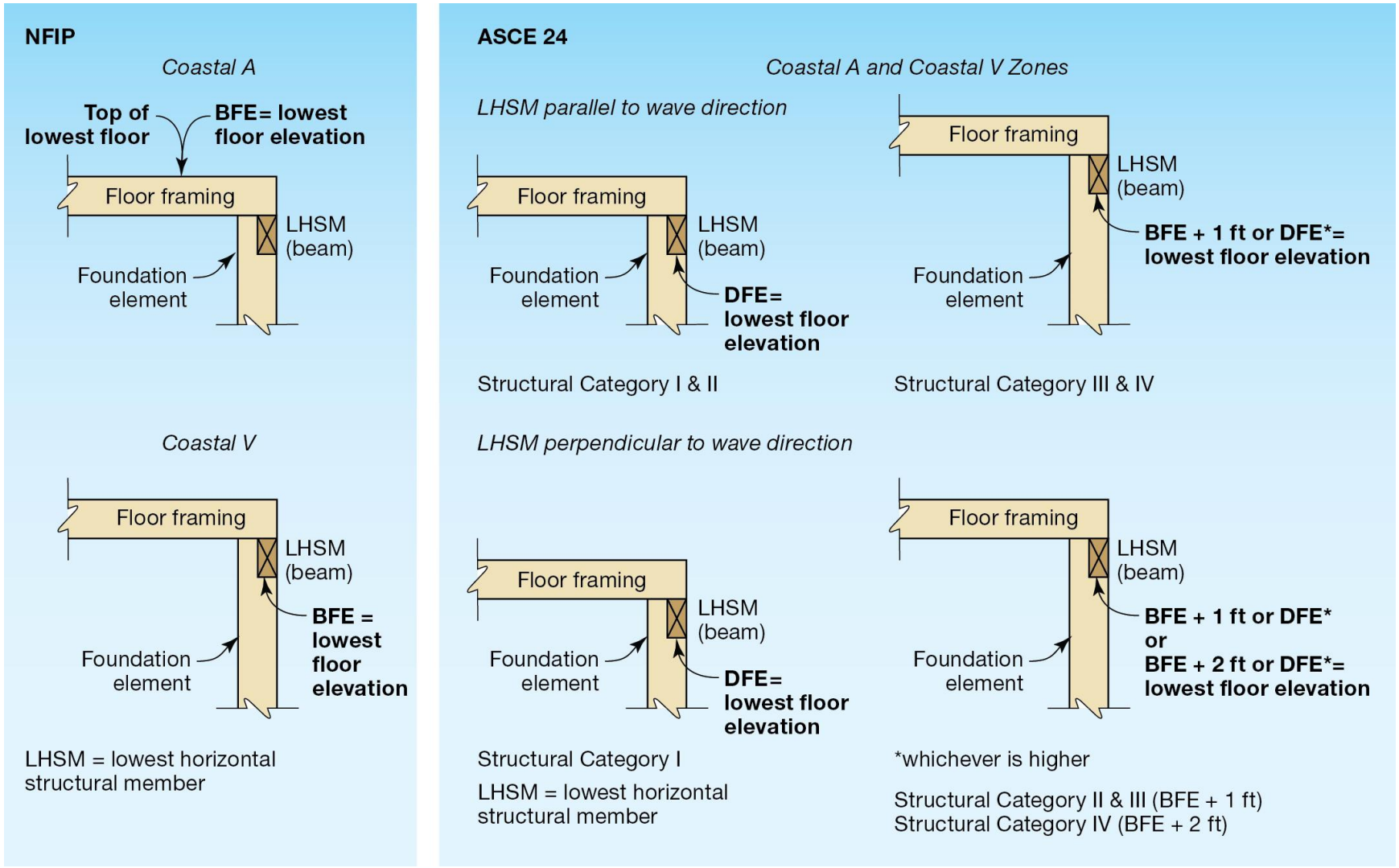

Figure 2-6. Lowest floor elevation requirements for Coastal High Hazard Areas (Zone V) and Coastal A Zones (Source: FEMA 2012c) Foundation Design Requirements

In accordance with the requirements in ASCE 24, foundations must be designed to minimize forces acting on that system, and must be free of obstructions that will either transfer flood forces to the structure or restrict the free passage of flood waters and waves during design flood conditions. Buildings in Coastal High Hazard Areas and Coastal A Zones must be elevated on and anchored to piles, columns, or, where permitted, walls serving as shear walls. Shear walls are not continuous foundation walls around the perimeter of a structure. Permitted shear walls must be oriented parallel to the direction of wave approach, and must be staggered so as not to form a continuous wall or enclosed area. Foundations must be designed and constructed to withstand design loads and load combinations, including the effects of erosion, scour, wind, waves, currents, and flood-borne debris. The resistance of existing foundations to design loads and conditions must be evaluated or meet the deemed-to-comply approach (see Appendix A). Fill must not be used for structural support. Minor quantities of nonstructural fill for landscaping and site drainage purposes are permitted.

In structure elevation projects where portions of the existing foundation will be used, loads and conditions must be applied to the foundation (existing and new portions). This would include any loads placed directly on the foundation as well as loads transferred to the foundation from the superstructure, such as uplift from wind. The entire foundation, both new and existing, must comply with ASCE 24 loading requirements and beams must be designed to create a load path between the existing structure and the new elements.

In structure elevation projects where the existing foundation will be removed and replaced with a new foundation, the provisions in ASCE 24 apply only to the foundation. The superstructure is not subject to the provisions of ASCE 24.

2.2.1.1 Piles

ASCE 24-05 specifies that all foundations on erodible soils must be constructed on pile foundations unless doing so is not feasible, in which case the provisions in Section 4.5.1 must be met. Detailed design guidance is provided in ASCE 24-05 Sections 4.5.5 and 4.5.6 for elevating a structure in a Coastal High Hazard Area or Coastal A Zone on piles.

2.2.1.2 Piers, Posts, or Columns

ASCE 24-05 Section 4.5.7 provides detailed design guidance for elevating a structure in a Coastal High Hazard Area or Coastal A Zone on posts, piers, or columns. If elevating on an existing spread footing, mat, or raft foundation, columns must be connected and extend upward from the spread footing, mat, or raft foundation to a point at or above the DFE. In addition, the top of the spread footing, mat, or raft foundation must be below the eroded ground elevation, per ASCE 24-05 guidance in Section 4.5.1.

2.2.2 Enclosures Below the Design Flood Elevation

In accordance with the NFIP and ASCE 24 guidance, any enclosed areas below the DFE must only be used for parking, building access, or storage, and will not be finished or used for any other purpose. In addition, any breakaway walls, lattice-work, or screening installed below the

DFE must be designed and constructed such that under base flood or lesser flood conditions, they will collapse in such a way that (1) allows the free passage of floodwaters and (2) does not damage the structure, supporting foundation system, or adjacent structures.

There are no restrictions on the size of the enclosure area; however, designers should be aware that the presence and size of an enclosed area may affect flood insurance premiums. Specifically, flood premiums in Zone V will increase significantly if a compliant breakaway enclosure is constructed (the building will be rated as "with obstruction"); even higher premiums will be assessed for Zone V structures with enclosed areas that are 300 square feet or more in size (including stairwells and elevator enclosures), even if enclosed by compliant breakaway walls. An insurance agent should be contacted to determine flood premiums for elevation projects that include enclosures.

In accordance with ASCE 24, breakaway walls in Coastal A Zones must have openings to allow for the automatic entry and exit of floodwaters during design flood conditions. Openings may be engineered or non-engineered, but must prevent an imbalance of hydrostatic pressure (equivalent to no more than 1 foot of variation in the water surface elevation inside and outside the enclosed area). The design of the openings for breakaway walls in Coastal A Zones must follow the requirements in ASCE 24-05 Section 4.6.2. FEMA TB-5, *Free-of-Obstruction Requirements* (2008b), and FEMA TB-9, *Design and Construction Guidance for Breakaway Walls Below Elevated Coastal Buildings* (2008a), offer related guidance regarding enclosures below the DFE.

2.2.3 Building Materials

Any portions of elevated buildings that lie below the minimum elevation specified in Table 2-5 for Coastal High Hazard Areas and Coastal A Zones must be constructed with materials capable of resisting damage, deterioration, corrosion, and decay; for Coastal High Hazard Areas and Coastal A Zones, prolonged contact equates to partial or total inundation by floodwaters for 12 hours per ASCE 24-05. In general, the materials must have the capacity to resist all flood-related and other loads. Breakaway walls must fail under base flood loads but must resist design wind and seismic loads. For elevation mitigation projects, building materials should be in accordance with the applicable building code requirements or the requirements as shown in ASCE 24, whichever is more stringent. If no building code is in place, the latest version of ASCE 24 should be used.

ASCE 24-05 Section 5.2 provides specific requirements for metal connectors and fasteners, structural steel, concrete, masonry, wood and timber, and finishing materials. For elevation mitigation projects in which a portion of the existing foundation remains, the building materials requirements apply only to the new sections of the foundation. If the foundation has been replaced in the mitigation project, then the material requirements apply to the entire foundation. Similarly, if the mitigation triggers Substantial Improvement/Damage requirements, the material requirements apply to all areas of the building that remain below the minimum elevation specified by ASCE 24 (Table 2-5).

Table 2-5. Minimum Elevation, Relative to BFE for DFE, Below Which Flood Damage-Resistant Materials Must Be Used in Coastal High Hazard Areas and Coastal A Zones

Structure Category[1]	Coastal High Hazard Areas and Coastal A Zones	
	Orientation Parallel[2]	Orientation Perpendicular[2]
I	DFE	DFE
II	BFE + 1 ft or DFE, whichever is higher	BFE + 2 ft or DFE, whichever is higher
III	BFE + 2 ft or DFE, whichever is higher	BFE + 3 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher	BFE + 3 ft or DFE, whichever is higher

Source: ASCE 24-05, Table 5-1

1. See Table 1-3 in this document for structure category descriptions.
2. Orientation of lowest horizontal structural member relative to the general direction of wave approach: parallel shall mean less than or equal to +20 degrees from the direction of approach; perpendicular shall mean greater than +20 degrees from the direction of approach.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

2.2.4 Utilities

ASCE 24-05 Section 7 includes requirements for electrical service; plumbing systems; mechanical systems; heating, ventilation, and air-conditioning systems; and elevators. To avoid flood damage, utilities and attendant equipment in Coastal High Hazard Areas and Coastal A Zones must be elevated above the minimum elevations in Table 2-6 and must be anchored to resist damage from high wind. The minimum elevations specified in ASCE 24 for utility elevation are higher than those required by the NFIP. In addition to the above-mentioned requirements, in Coastal High Hazard Areas and Coastal A Zones, ASCE 24 requires that utilities be capable of resisting anticipated flood loads, wave loads, and erosion and scour expected in design flood conditions.

ASCE 24-05 Section 7 provides specific utility requirements and allows some utility connections to be below the DFE, including connections extending from the ground upwards. These portions of utilities must be designed, constructed, and installed to prevent the entry of floodwater into the system or its components. ASCE 24-05 Section 7 includes requirements for electrical service; plumbing systems; mechanical systems; heating, ventilation, and air-conditioning systems; and elevators.

Table 2-6. Minimum Elevation of Utilities and Attendant Equipment Relative to BFE or DFE in Coastal High Hazard Areas and Coastal A Zones

Structure Category[1]	Coastal High Hazard Areas and Coastal A Zones	
	Orientation Parallel[2]	Orientation Perpendicular[2]
I	DFE	DFE
II	BFE + 1 ft or DFE, whichever is higher	BFE + 2 ft or DFE, whichever is higher
III	BFE + 2 ft or DFE, whichever is higher	BFE + 3 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher	BFE + 3 ft or DFE, whichever is higher

Source: ASCE 24-05, Table 7-1

1. See Table 1-3 in this document for structure category descriptions.
2. Orientation of lowest horizontal structural member relative to the general direction of wave approach: parallel shall mean less than or equal to +20 degrees from the direction of approach; perpendicular shall mean greater than +20 degrees from the direction of approach.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

3 ASCE 24 Requirements for Dry Floodproofing Mitigation Projects

Dry floodproofing is a mitigation measure that renders the exterior walls and floor of an enclosure ***substantially impermeable*** to the passage of floodwaters. FEMA dry floodproofing guidance is generally intended for short-term flooding of 12 to 24 hours in duration and in many cases depths of up to 2 to 3 feet. Although dry floodproofing for residential and small nonresidential buildings is generally recommended only where flood depths do not exceed 2 to 3 feet, large nonresidential buildings sometimes may be dry floodproofed up to an entire story in height. Often building components need to be strengthened to withstand flood forces and may require significant retrofits to properly incorporate dry floodproofing measures.

Dry floodproofing reduces—but does not eliminate—the potential for flood damage by reducing the probability that the structure interior will be inundated with flood water. Extreme flooding events can overtop the upper limit of the floodproofing and quickly flood the building to the height of the floodproofing.

ASCE 24 HMA Policy Impact

Based on HMA policy and ASCE 24 requirements, dry floodproofing projects are typically limited to nonresidential buildings in Zone A where flood velocities are less than or equal to 5 feet/second. Depending on the structure category, the ASCE 24 minimum elevation standards, which determine the design elevation for dry floodproofing, exceed NFIP requirements by at least 1 to 2 feet.

Definition

Substantially impermeable means the accumulation of no more than 4 inches of water depth in a 24-hour period if there are no devices to provide for removal of water. Sump pumps are required to control seepage (USACE 1995).

The *HMA Unified Guidance* restricts the use of dry floodproofing to two building types—nonresidential buildings and historic residential buildings. In the introduction of ASCE 24-05, Figure 1-1 states that historic buildings are not covered by the standard (unless work causes the building to lose its historic designation), and Section 6 states that the dry floodproofing of residential buildings is prohibited and restricts its use to nonresidential buildings in certain flood zones. The intent of this section of the *Guidance for Applying ASCE 24 Engineering Standards to HMA Flood Retrofitting and Reconstruction Projects* is to better define the use of ASCE 24 for dry floodproofing projects. Because strict compliance with ASCE 24 can be difficult with an existing structure, the dry floodproofing provisions should be applied as follows (see Appendix A):

- **Nonresidential Buildings:** Apply ASCE 24 to all areas to be dry floodproofed and to utilities and sanitary systems that may be affected by being outside of the dry floodproofed area. This applies to all nonresidential buildings and mixed use buildings in which the lowest floor is used for nonresidential purposes.
- **Mixed Use Buildings:** Although ASCE 24 allows for a portion of a building to be considered nonresidential (such as the lowest floor), for flood insurance rating purposes, mixed use buildings are treated as follows:

- They are considered "2-4 Family" if they contain 2 to 4 residential units and incidental occupancies are limited to less than 25 percent of floor space.
- They are considered "other residential" if incidental uses are limited to less than 25 percent of total floor space and there are at least 4 apartment units.
- They are considered non-residential if they have some apartment units and 25 percent or more of floor space is dedicated to incidental use.
- The building type may restrict the potential mitigation options as HMA grant programs do not fund dry floodproofing for residential buildings.

- **Historic Residential Buildings:** For historic residential buildings that are not currently occupied and will not be occupied in a residential capacity, an attempt should be made to adhere to the provisions of ASCE 24 as closely as possible without compromising the historic designation of the building. For historic residential buildings that are currently or will be occupied in a residential capacity, ASCE 24 provisions for dry floodproofing should be adhered to, including any requirements associated with adding a means of egress from the dry floodproofed area. This is intended to improve protection to residents. If strict adherence to ASCE 24's dry floodproofing provisions is too restrictive to preserve the historic designation of a building, other mitigation measures should be considered.

3.1 General Requirements

ASCE 24 specifically states that it only applies within the flood hazard area, but for the purposes of dry floodproofing projects, it should be adhered to as a best practice for all buildings subject to flooding, even if they are located outside the NFIP's SFHA or the community's flood hazard area. The building site must be evaluated because ASCE 24 restricts the use of dry floodproofing to nonresidential structures and nonresidential areas of mixed use structures and to areas located outside the following:

- High-risk flood hazard areas (e.g., alluvial fan flooding, flash flooding, mudslides, ice jams, floodway)
- Zone V
- Coastal A Zone
- Areas where design flood velocities adjacent to the structure are greater than 5 feet per second

If the building is behind a protective work, such as a levee, floodwall, or other flood protective measure, the provisions of ASCE 24-05 Section 1.4.2 must be met. Specifically, the flood protective measure will not be considered to provide protection for the building during a design event unless the flood protection measure is shown to provide protection on a flood map or it has been recognized by the authority having jurisdiction as providing flood protection during a design event.

Table 3-1 provides a comparison of ASCE 24 and NFIP dry floodproofing requirements; the latter can be found in FEMA TB-3, *Non-Residential Floodproofing – Requirements and Certification for Buildings Located in Special Flood Hazard Areas* (1993).

If the site and building use requirements are met, ASCE 24 stipulates the minimum floodproofing elevation; however, more restrictive local floodplain ordinances may require higher elevation criteria be met. Table 3-2 establishes the minimum lowest elevation of floodproofing based on the structure category.

In addition to the minimum elevation of floodproofing, design process considerations should include the duration of the flood, the rate of rise and fall of floodwaters, floodwater temperatures, and potential flood-borne contaminants and debris. Flood velocities should be determined to evaluate whether dry floodproofing is an appropriate mitigation approach and to evaluate site conditions, such as the potential for soil and fill material to erode and scour. A site evaluation may also dictate the values above the minimum requirements be selected for the flood-borne debris calculations. In addition to meeting loading and siting requirements, the building elements should be designed to meet the criteria described below in Sections 3.2 through 3.8.

Table 3-1. Comparison of ASCE 24 and NFIP Dry Floodproofing Requirements

Dry Floodproofing	NFIP/Technical Bulletin 3	ASCE 24
Zone A, Nonresidential buildings, Nonresidential mixed use buildings**	P	P
Coastal High Hazard Area (Zone V, VE, or V1–V30), Floodway	NP	NP
Coastal A Zone	NS	NP
Areas where flood velocities are > 5 ft/second	P	NP
Minimum elevation of floodproofing	BFE (NFIP minimum) and BFE + 1 ft (Technical Bulletin 3)*	BFE + 1 ft or 2 ft (depending on Structure Category) or DFE, whichever is greater
Flood Emergency Operations Plan, Inspection and Maintenance Plan, Warning time, etc.	R	R

*Although the NFIP only requires floodproofing to base flood elevation (BFE), the Floodproofing Certificate shown in Technical Bulletin 3 notes that 1 foot of freeboard above the BFE as a minimum elevation is required to satisfy flood insurance requirements. Failure to include the 1 foot of freeboard will result in significant increases in flood insurance premiums.

**See Section 3 Introduction for what classifies as nonresidential mixed use.

BFE = base flood elevation
DFE = design flood elevation
ft = feet
NP = Not Permitted
NS = Not Specified
P = Permitted
R = Required

Table 3-2. Minimum Elevation of Floodproofing Relative to the BFE or DFE (based on ASCE 24 Table 6-1)

Structure Category[1]	Minimum Elevation of Lowest Floor
I	BFE + 1 ft or DFE, whichever is higher
II	BFE + 1 ft or DFE, whichever is higher
III	BFE + 1 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher

Source: ASCE 24, Table 6-1

1. See Table 1-3 for structure category descriptions.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

3.2 Foundation

The foundation for a retrofitted building must be assessed to determine whether it is capable of resisting the additional loads that will be imposed by dry floodproofing the building. The evaluation of the foundation must consider the building load path. Building components, included into the dry floodproofing measures and load path must be able to resist the loads outlined in Section 1.6 of ASCE 24-05. Flood loads include, but aren't limited to, hydrostatic loads, such as buoyancy against the slab and lateral loads against the foundation and attached walls, hydrodynamic loads, and debris impact loads. Wall-to-foundation connections and the foundation-to-ground connections are common areas, which may require additional construction detailing beyond what is normally shown on construction plans. In addition to resisting the specified loads, foundation elements associated with the dry floodproofed area must also be designed to be watertight below the floodproofed design elevation and deemed to be substantially impermeable.

3.3 Walls, Floors, and Opening Protection

Walls, floors, and openings must be designed and constructed or retrofitted to resist design flood loads and load combinations. The walls and floors must also be substantially impermeable to the passage of floodwaters. This can be accomplished with an impermeable wall/floor system and/or an exterior sealant system. Internal drainage systems, which incorporate underdrain lines and sump pumps, are often incorporated for redundancy. Opening protection often consists of flood shields (see Figure 3-1). These flood shields must be designed to resist all flood loads, waterproof, and installable within the flood warning time, which is discussed in Section 6.2.3 of ASCE 24-05.

Figure 3-1. Types of flood shields (Source: FEMA 2012b)

Dry floodproofing a historic building can be challenging because historic buildings may have several potential points of penetration in the walls and floor system, connections between floor systems and walls can be difficult or impossible to retrofit, and wall systems may have weaknesses that are difficult to retrofit or upgrade. Also, because historic buildings were likely constructed with gravity as a primary loading consideration, they may not be designed to withstand the additional lateral flood loads that will be imposed as a result of dry floodproofing and could be subject to catastrophic wall system failure.

3.4 Utilities

Section 7 of ASCE 24-05 outlines the minimum requirements for utilities and attendant equipment such as, but not limited to, electrical, plumbing, and mechanical (heating and air-conditioning) systems, and elevators. Utility lines or systems within the floodproofed area will be protected by the dry floodproofing, but utilities and sanitary systems outside of the floodproofed area and within the SFHA must be elevated to the minimum elevation for utilities

and attendant equipment as shown in ASCE 24-05 Table 7-1 (Table 2-3 of this document). Utility systems outside of the floodproofed area and below the minimum required elevation must be:

- Designed to resist all flood loads;
- Constructed of flood damage-resistant materials;
- Designed to minimize flood damage;
- Impermeable to floodwaters; and
- Able to resist the intrusion from floodwaters during an event.

With respect to a sanitary system, verifying that the existing system will not leak into floodwaters or experience damage during a flood event is important. If there is potential for the sanitary system to leak or become damaged during a flood event, it must be modified to avoid these issues. More information on minimum requirements can be found in 44 CFR Section 60.3, and design information can be found in FEMA 348, *Protecting Utilities from Flood Damage* (1999).

3.5 Materials

Section 5 of ASCE 24-05 defines the material considerations for a dry floodproofing project. All materials considered to be flood damage-resistant, must have sufficient strength, rigidity, and durability to adequately resist flood-related and other loads. Although not explicitly defined in the section, materials generally fall into two categories: those that are directly exposed to floodwaters and those that are exposed to windblown rain and salt spray. Directly exposed materials must be resistant to direct contact with the floodwaters and potential flood-borne contaminants. All the materials, both those with direct exposure and those that will be protected, must be resistant to moisture from precipitation and wind-driven water.

These requirements focus on metal components such as fasteners, angles, and straps. Because concrete is a primary construction material for foundations and many nonresidential wall systems, the mix must be designed for the corrosivity associated with a coastal environment. Requirements for concrete cover over reinforcing steel must also be observed for any concrete building elements. Wood and timber elements must be designed using the *National Design Specification for Wood Construction* (ANSI/AF&PA 2005) and must be decay-resistant or pressure treated with a preservative to resist deterioration and decay due to insects, fungi, and flood-borne organisms. Interior finishes must also meet the requirements of a flood damage-resistant material.

3.6 Sump Pumps

Although most dry floodproofing projects incorporate the use of sump pumps, ASCE 24 clearly states that their use must only be for small leaks and vapor seepage and that sump pumps are not allowed to be used as a means to achieve the “substantially impermeable” requirement. The dry floodproofed area must be designed to be substantially impermeable in the absence of a sump

pump, and the sump pump system must be sized and designed to address leakage. Sump pumps also require a backup source of electricity to ensure continued operation during a power outage, per TB-3, *Non-Residential Floodproofing — Requirements and Certification for Buildings Located in Special Flood Hazard Areas* (1993). Additional guidance on the design of sump pumps and internal drainage systems can be found in FEMA P-936, *Floodproofing Non-Residential Structures* (2012b), and FEMA P-259, *Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures* (2012a).

3.7 Egress

ASCE 24 requires that one door or primary exit be located above the minimum lowest elevation of floodproofing and connected to the dry floodproofed areas. This is intended as an emergency provision and not to encourage occupants to stay in the building during a flood event. Although this may require retrofitting interior partitions or creating an opening in an exterior wall, this should not result in a significant alteration for most nonresidential buildings. This provision may be difficult to meet for some historic buildings without potentially compromising the historic designation of the building. However, significant precautions should be taken to ensure that all occupants are out of the building well before the arrival of floodwaters.

3.8 Human Intervention

Ideally, dry floodproofing projects use passive measures, i.e., measures that do not require the installation of protective sealants around the building or opening protection in the form of flood shields. If floodproofing measures such as flood shields are incorporated into the design, the requirements and minimum warning times specified in ASCE 24 must be met; either the community must operate a flood warning system and implement an emergency plan that provides adequate time for notification, travel, installation/activation of measures, and evacuation or there must be a minimum 12-hour warning time. Additionally, ASCE 24 requires a plan that outlines conditions for use, evacuation procedures, storage locations for flood shields, installation procedures, practice and maintenance schedules, and testing procedures for devices such as pumps be posted in at least two locations in the building. The plan must be approved by the authority having jurisdiction and should also be supplied to FEMA as part of the grant documentation. Although ASCE 24-05 Commentary C6.2.3 provides a reference for development of an automated flood warning system, more current resources are available at the National Weather Service Automated Flood Warning Systems Web site (http://afws.erh.noaa.gov/afws/national.php). Dry floodproofed buildings that require active measures such as the installation of protective sealants or flood shields in the event of a flood may result in increase in flood insurance premiums.

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4 ASCE 24 Requirements for Mitigation Reconstruction

Mitigation reconstruction involves constructing a building on the same site where an existing building has been partially or completely demolished or destroyed. All activities that result in the construction of a new building at or above the BFE must meet NFIP and HMA general policy requirements and are only eligible for assistance under the FMA program. All mitigation reconstruction projects must result in the construction of code-compliant and hazard-resistant buildings on elevated foundation systems; mitigation reconstruction projects must be designed and constructed to the minimum standard as established by the requirements of the latest edition of the International Codes. Mitigation reconstruction projects cannot be combined with other activity types within the same project grant subapplication.

Mitigation Reconstruction Is New Construction

Because mitigation reconstruction is essentially new construction (and demolition of the existing building), ASCE 24 is more readily applicable to this project type than building elevation or dry floodproofing. Current FEMA regulations and HMA policy do not allow new construction in the floodway nor in Zone V. Per the new HMA flood mitigation policy applying ASCE 24 to mitigation projects, the siting requirements of Section 3 of ASCE 24-05 apply to new construction.

Project development activities for a mitigation reconstruction project must include a determination of the size of the pre-existing structure and the location of the structure with respect to the surrounding flood hazard areas. HMA general policy states that the square footage of the resulting structure must be no more than 10 percent greater than that of the original structure. Mitigation reconstruction is only permitted for structures outside of the regulatory floodway or Coastal High Hazard Area (Zone V) as identified by the existing best available flood hazard data. Though this allows construction in the floodplain with appropriate mitigation measures, the more effective way to reduce (and possibly eliminate) flood risk is to relocate the property outside the floodplain.

Because mitigation reconstruction projects qualify as new construction, the requirements in ASCE 24 must be met in their entirety. However, this section only discusses selected ASCE 24 design and construction requirements.

4.1 Requirements for Zone A

The requirements described in this section apply to mitigation reconstruction projects in flood hazard areas delineated on the FIRM as Zone A, AE, A1–30, A99, AR, AO, AH. See Section 4.2 of this document for areas identified as Coastal A Zones. For areas designated as Coastal High Hazard Areas (Zone V), mitigation reconstruction grants are not permitted.

4.1.1 Design Flood Elevation

For mitigation reconstruction, all structures must have the lowest floor (including basements) elevated to or above the elevations shown in Table 4-1.

Table 4-1. Minimum Elevation of the Top of Lowest Floor Relative to BFE or DFE

Structure Category[1]	Minimum Elevation of Lowest Floor
I	DFE
II	BFE + 1 ft or DFE, whichever is higher
III	BFE + 1 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher

Source: ASCE 24-05, Table 2-1.

1. See Section 1, Table 1-3 in this document for structure category descriptions.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

4.1.2 General Design Requirements

All new construction must be designed and constructed to the loading provisions of ASCE 7, *Minimum Design Loads for Building and Other Structures*. Sections 1.5 and 1.6 of ASCE 24-05 describe basic design requirement and design loads for new construction. If the community's building code has more restrictive provisions than those found in ASCE 24 or ASCE 7, they must be used.

4.1.3 Foundation Design Requirements

Mitigation reconstruction projects may include the design and construction of one of multiple foundation types, including slab on grade, piles, posts, piers, columns, or continuous foundation walls. Regardless of the foundation type, they must be designed, constructed, connected, and anchored to resist flotation, collapse, or permanent lateral movement under design loads and load combinations. Foundations must be designed according to the requirements of ASCE 24 in their entirety.

4.1.3.1 Slab-on-Grade

If the mitigation reconstruction project is designed with a slab-on-grade foundation, the slab must be installed on structural fill or undisturbed soil with adequate bearing capacity, as specified in Section 2.4 of ASCE 24-05. The design and construction of the fill must account for consolidation of the underlying soil, differential settlement, and slope stability and erosion control. ASCE 24 includes specific guidance for compaction and side slopes. The top of the slab must be at or above the elevation shown in Table 4-1 of this document. Reinforcement must be used to prevent failure of the slab during design conditions, even if the slab is undermined by erosion. The slab-on-grade foundation installed on structural fill must be placed so that there is no loss of supporting soil during the design flood conditions.

4.1.3.2 Piers, Posts, Columns, or Piles

When constructing a new building on piers, posts, columns, or piles, the applicable requirements in ASCE 24-05 Section 1.5 must be followed.

Often, when a structure is elevated on piles, posts, or piers, infill walls or breakaway walls are installed around the perimeter of the foundation, enclosing the area underneath the structure. ASCE 24-05 includes specific requirements for enclosures below the DFE, which are described in Section 2.6.

4.1.3.3 Continuous Foundation Walls

When constructing a new building on continuous foundation walls, the applicable requirements in ASCE 24-05 Section 1.5 must be followed. Design considerations specific to foundation walls and standards for masonry walls and concrete are specified in ACI 530-11/ASCE 5-11/TMS 402, *Building Code Requirements and Specifications for Masonry Structures* (ACI/ASCE/TMS 2011), and ACI 318, *Building Code Requirements for Structural Concrete* (ACI 2008).

4.1.4 Enclosures Below the Design Flood Elevation

Enclosures below the DFE must meet the requirements of ASCE 24-05 Section 2.6.

Enclosures below the DFE that exceed 300 square feet will result in significantly increased insurance premiums.

4.1.5 Building Materials

Buildings must be constructed with flood damage-resistant materials below the DFE. ASCE 24 provides specific minimum elevation requirements for flood damage-resistant materials, which are shown in Table 4-2 below. A flood damage-resistant material is any construction material capable of withstanding direct and prolonged contact with floodwaters without sustaining any damage that requires more than cosmetic repair. ASCE 24-05 Section 5.2 provides specific requirements for metal connectors and fasteners, structural steel, concrete, masonry, wood and timber, and finishing materials. Section 2.1.4 of this document provides additional information about building materials for Zone A.

Table 4-2. Minimum Elevation, Below Which Flood Damage-Resistant Materials Must Be Used

Structure Category[1]	Minimum Elevation of Lowest Floor
I	DFE
II	BFE + 1 ft or DFE, whichever is higher
III	BFE + 1 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher

Source: ASCE 24-05, Table 5-1

1. See Section 1, Table 1-3 in this document for structure category descriptions.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

4.1.6 Utilities

ASCE 24 requires that utilities and attendant equipment be elevated to or above elevations provided in Section 7 of the standard, unless the utility is designed, constructed, and installed to prevent floodwaters, including any backflow through the system, from entering or accumulating within the components. Electrical services; plumbing systems; mechanical, heating, ventilation, and air-conditioning systems; and elevators must be taken under consideration when meeting the utility requirements of ASCE 24. Utility elevation requirements are provided in the Table 4-3.

Table 4-3. Minimum Elevation of Utilities and Attendant Equipment Relative to the BFE or DFE

Structure Category[1]	Minimum Elevation of Lowest Floor
I	DFE
II	BFE + 1 ft or DFE, whichever is higher
III	BFE + 1 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher

Source: ASCE 24-05, Table 7-1

1. See Section 1, Table 1-3 in this document for structure category descriptions.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

4.2 Requirements in Coastal A Zones

HMA policy allows and supports new construction in Coastal A Zones. Designs for mitigation reconstruction projects in Coastal A Zones must account for hazards such as wave forces striking the foundation and underside of the elevated building, as well as erosion and scour.

4.2.1 Design Flood Elevation

For Coastal A Zone mitigation reconstruction projects, all structures must have the bottom of the lowest horizontal structural member of the lowest floor at or above the elevations provided in Table 4-4.

The required height of the bottom of the lowest horizontal structural member supporting the lowest floor in Coastal A Zones is determined by the orientation of the lowest horizontal structural member relative to the direction of the wave approach. Piles, pile caps, footings, mat or raft foundations, grade beams, columns, and shear walls must be designed in accordance with Section 4.5 of ASCE 24-05. Enclosed areas below the DFE are permitted, provided they are used solely for parking, building access, and storage and they meet the requirements of Section 4.6 in ASCE 24-05.

Table 4-4. Minimum Elevation of Bottom of Lowest Supporting Horizontal Structural Member of Lowest Floor Relative to BFE or DFE

Structure Category[1]	Minimum Elevation of Lowest Floor	
	Parallel[2]	Perpendicular[2]
I	DFE	DFE
II	DFE	BFE + 1 ft or DFE, whichever is higher
III	BFE + 1 ft or DFE, whichever is higher	BFE + 2 ft or DFE, whichever is higher
IV	BFE + 1 ft or DFE, whichever is higher	BFE + 2 ft or DFE, whichever is higher

Source: ASCE 24-05, Table 4-1

1. See Table 1-3 in this document for structure category descriptions.
2. Orientation of lowest horizontal structural member relative to the general direction of wave approach: parallel shall mean less than or equal to +20 degrees from the direction of approach; perpendicular shall mean greater than +20 degrees from the direction of approach.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

4.2.2 General Design Requirements

As noted in Section 4.1.2 of this document, all new construction within flood hazard areas must be designed and constructed to the loading provisions of ASCE 7, *Minimum Design Loads for Building and Other Structures*, flood loads must be combined with other loads as specified in ASCE 7, and ASCE 24-05 Sections 1.5 and 1.6 describe basic design requirements and design loads for new construction.

4.2.3 Foundation Design Requirements

For construction in Coastal A Zones, foundation systems must meet Zone V requirements, i.e., they must be free of obstructions and attachments that will either transfer flood forces to the structure or restrict the free passage of flood waters and waves during design flood conditions. Post, pier, column, and pile foundation systems are permitted. Shear walls are permissible if they are oriented parallel to the direction of wave approach and do not create an enclosed area. Section 4.5 of ASCE 24-05 provides additional specific foundation design requirements for foundations in Coastal A Zones.

4.2.3.1 Piles

Sections 4.5.5 and 4.5.6 of ASCE 24-05 detail considerations and design requirements for pile foundation systems. All foundation systems constructed in erodible soils must be founded on piles.

4.2.3.2 Piers, Posts, or Columns

Section 4.5.7 of ASCE 24-05 provides specific design considerations and requirements for posts, piers, and columns in Coastal A Zones. These include spacing, embedment, and anchoring requirements. Size requirements for wood posts are also provided as well as references to ACI 530-11/ASCE 5-11/TMS 402, *Building Code Requirements and Specifications for Masonry Structures* (ACI/ASCE/TMS 2011), and ACI 318, *Building Code Requirements for Structural Concrete* (ACI 2008), for masonry and concrete columns.

4.2.4 Enclosures Below the Design Flood Elevation

Enclosures must meet the requirements of ASCE 24-05 Section 4.6. Although both ASCE 24 and the NFIP require the use of flood openings in breakaway wall enclosures in Coastal A Zones.

4.2.5 Building Materials

Mitigation reconstruction projects must be constructed with flood damage-resistant materials below the elevations specified in Table 4-5. In coastal areas, where saltwater is prevalent, corrosion has shown to significantly reduce the strength and effectiveness of structural and nonstructural materials, including connectors and fasteners in as little time as a few years. Materials permitted to be used in mitigation reconstruction projects in Coastal A Zones must meet the requirements of ASCE 24-05 Section 5.

Table 4-5. Minimum Elevation, Relative to the BFE or DFE, Below Which Flood-Damage-Resistant Materials Must Be Used

Structure Category[1]	Minimum Elevation of Lowest Floor	
	DFE	DFE
	BFE + 1 ft or DFE, whichever is higher	BFE + 2 ft or DFE, whichever is higher
	BFE + 2 ft or DFE, whichever is higher	BFE + 3 ft or DFE, whichever is higher
	BFE + 2 ft or DFE, whichever is higher	BFE + 3 ft or DFE, whichever is higher

Source: ASCE 24-05, Table 5-1

1. See Table 1-3 in this document for structure category descriptions.
2. Orientation of lowest horizontal structural member relative to the general direction of wave approach: parallel shall mean less than or equal to +20 degrees from the direction of approach; perpendicular shall mean greater than +20 degrees from the direction of approach.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

4.2.6 Utilities

ASCE 24 requires that utilities and attendant equipment be elevated to or above the elevation stipulated for the bottom of the lowest supporting horizontal structural member of the lowest floor unless the utility is designed, constructed, and installed to prevent floodwaters, including any backflow through the system, from entering or accumulating within the components. Electrical services; plumbing systems; mechanical, heating, ventilation, and air-conditioning systems; and elevators must be taken into consideration when meeting the utility requirements of ASCE 24. Utility DFEs for Coastal A Zones are provided in Table 4-6. Utility elevations are subject to the orientation of the lowest horizontal structural member of the lowest floor relative to the direction of the wave approach.

Table 4-6. Minimum Elevation of Utilities and Attendant Equipment Relative to the BFE or DFE

Structure Category[1]	Minimum Elevation of Lowest Floor	
	Parallel[2]	Perpendicular[2]
I	DFE	DFE
II	BFE + 1 ft or DFE, whichever is higher	BFE + 2 ft or DFE, whichever is higher
III	BFE + 2 ft or DFE, whichever is higher	BFE + 3 ft or DFE, whichever is higher
IV	BFE + 2 ft or DFE, whichever is higher	BFE + 3 ft or DFE, whichever is higher

Source: ASCE 24-05, Table 7-1

1. See Table 1-3 in this document for structure category descriptions.
2. Orientation of lowest horizontal structural member relative to the general direction of wave approach: parallel shall mean less than or equal to +20 degrees from the direction of approach; perpendicular shall mean greater than +20 degrees from the direction of approach.

BFE = base flood elevation
DFE = design flood elevation
ft = feet

5 High-Risk Flood Hazard Areas

In addition to the requirements outlined in the three previous sections, some other provisions may need to be considered for mitigation projects, depending on their location and occupancy. Also, while structure elevation, dry floodproofing, and mitigation reconstruction are the focus of this document, other mitigation projects could be affected by the requirements of ASCE 24.

5.1 HMA Policies and Assistance

For properties located in the floodway, no new construction or Substantial Improvement will be supported under HMA unless the subject building is functionally dependent on its location for its use or it facilitates open space use. Moreover, no projects involving new construction in the Coastal High Hazard Area will be supported.

5.2 ASCE 24 Requirements

Section 3 of ASCE 24-05 contains requirements for a variety of high-risk areas, some of which are mapped and some of which are not: alluvial fan flooding areas, flash flood areas, mudslide areas, erosion-prone areas, high-velocity flow areas, wave action areas (Coastal High Hazard Area and Coastal A Zone), and ice jam and debris areas. Wave action areas are covered in detail in Section 4 of ASCE 24-05 and are excluded from additional requirements contained in Section 3.

In instances where high risk areas are known to exist but where associated hazards have not been mapped, ASCE 24 may require additional investigations and studies, at a minimum, before construction. These investigations and studies should utilize available historic data and must produce an engineering report addressing the site-specific high-risk hazard(s). FEMA will coordinate with the applicant to determine the most effective approach to mitigation consistent with ASCE 24.

ASCE 24-05 Section 3 requirements include siting requirements not typically found in building codes or NFIP regulations. Mitigation reconstruction projects and other HMA projects constituting a Substantial Improvement are subject to the high-risk area siting requirements in ASCE 24.

ASCE 24 siting requirements prohibit construction in many of these high-risk flood hazard areas unless:

- The construction is in an area where protective works have been determined to provide protection during the design flood event;
- The protective works meet the requirements of Section 1.4.2 of ASCE 24-05; and
- A maintenance and operations plan has been provided for the protective works.

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6 Historic Properties

A historic property is a resource (i.e., building, structure, site, object, or district) that is listed in or eligible for listing in the National Register of Historic Places (NRHP) or listed on a State or local inventory of historic places. The application of ASCE 24 to mitigation projects involving historic properties is strongly encouraged to the extent practicable—meaning capable of being done within existing constraints—without compromising the qualities and characteristics that make the resource eligible for listing in the NRHP or similar State and local inventories, also referred to as historic integrity. While FEMA encourages the retention of historic integrity, it is not a requirement that must be met to receive assistance under the HMA grant programs. In some instances, proceeding with a mitigation project that causes a loss of historic integrity, but provides a higher level of protection for the resource, may be more beneficial than maintaining its historic integrity and providing a lower level of protection. If the former course is taken, the requirements of ASCE 24 apply as outlined elsewhere in this document. If a mitigation project results in the loss of historic integrity, FEMA will coordinate and consult with the applicant, subapplicant, State Historic Preservation Office (SHPO), and any other interested parties, which could include local, State, and/or national historic preservation organizations, to design an appropriate course of action to resolve the adverse effect. Interested parties will be identified in relation to the scale of the project and the scope of Federal involvement.

6.1 HMA Programs and Historic Properties

The HMA grant program requires a historic preservation review process that addresses potential effects of mitigation projects on historic properties in compliance with the National Historic Preservation Act of 1966. The historic preservation review process involves four steps: 1) initiation, 2) identification of historic properties, 3) assessment of effects on historic properties, and 4) resolution of adverse effects on historic properties. The HMA EHP process is a collaborative process between FEMA, the SHPO, and the applicant and/or subapplicant, and other interested parties (if applicable). Prior to obligating grant assistance, FEMA must reach concurrence with the SHPO and other historic preservation stakeholders, including Tribal entities if applicable, on the identification of historic properties in the project area and the effects of the project on these properties.

As defined in 36 CFR Section 800.16, "the area of potential effects means the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist. The area of potential effects is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking." Direct effects can include the elevation of the property, while indirect effects can be visual, audible, or atmospheric changes that could affect the character and setting of the property or surrounding properties. The property subject to the proposed mitigation activity will be reviewed and both direct and indirect effects will be taken into consideration in determining whether the project will result in an adverse effect. As defined in 36 CFR Section 800.5, an adverse effect is found when an undertaking may alter, directly or indirectly, any of the

characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanships, feeling, or association. Adverse effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance, or be cumulative. If adverse effects will result, FEMA, in cooperation with the Applicant and subapplicant, consults with the historic preservation stakeholders on ways to avoid, minimize, or mitigate (treat) adverse effects to historic properties. Completion of the historic preservation review process for adverse effects to historic properties can take time and should be considered in developing the scope of work.

The subapplicant should contact the SHPO, or the local government representative responsible for managing historic properties, early in the development phase of the project to identify historic properties and evaluate whether the proposed work has the potential to adversely affect those properties. FEMA EHP coordination early in the development phase of the project is encouraged to help establish whether the scope of work has the potential to adversely affect historic properties. The subapplicant should develop the scope of work (preferred) to avoid or minimize adverse effects on historic properties. However, in cases where adverse effects cannot be minimized or avoided, project eligibility will be determined on a case-by-case basis as an adverse effect does not automatically make a project ineligible for FEMA funding. In many cases, an adverse effect is not avoidable and the historic preservation review process outlined above will allow for treatment measures to be developed to resolve the adverse effect. These treatment measures can include, but are not limited to, a written history of the neighborhood, architectural and photographic documentation, an educational installation and/or historical marker. Proper treatment measures will be determined among all consulting parties in a Memorandum of Agreement that will outline the particular roles and responsibilities of each party in resolving the adverse effect.

Often, the treatment measures developed to resolve an adverse effect can be very beneficial to the community. One such example involves the town of Belle Haven, NC, where repetitive flooding became an issue for many of the towns properties located in an NRHP-listed historic district. Rather than relocating to higher ground or demolishing and rebuilding, 379 properties were elevated in place. With assistance from the North Carolina SHPO, the community developed plans for an elevation project that would best preserve the historic character of the district. As part of the plan, guidance was drafted for preserving porches, railings, balusters, and steps and for replacing old materials with appropriate new materials where necessary. Although the initial elevation of the buildings resulted in an adverse effect, many beneficial steps were taken to minimize the effect and, as a result, Belhaven Historic District was able to maintain its NRHP status. As part of the treatment measures developed for this project, large-format archival photographs were taken of each building that would be affected. Additional treatment measures included a recording of oral histories; a compilation of written memories; a historical documentary on video and for posting on the internet; the conservation of historic artifacts, documents, home movies, and historical photographs as part of a documented archival

collection; and museum exhibits that document and explain the importance of local historic events to regional and national history.

6.2 Avoiding Adverse Effects When Applying ASCE 24 to Historic Properties

Three primary categories of flood mitigation are addressed by this document: structure elevation, dry floodproofing, and mitigation reconstruction. Structure elevation and dry floodproofing can usually be done in a manner that avoids or minimizes adverse effects to historic properties such that historic integrity is retained. Mitigation reconstruction of a historic property or within a historic district will almost always result in an adverse effect (loss of the historic designation).

The following general concepts should help avoid adverse effects to historic properties:

- Retain and preserve the historic character (materials, features, spaces, etc.);
- Repair historic materials and features, rather than replace them;
- Where replacement of historic materials and features must occur, replacement materials and features should be "in kind," meaning they should have the same look, feel, and physical properties (e.g., design, color, texture, materials, visual qualities); and
- Minimize the visual impact of the alterations to the extent possible.

For more information, see the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (NPS 2001), available online at http://www.nps.gov/history/hps/tps/standguide/.

6.2.1 Structure Elevation

If done properly, taking into consideration the historic characteristics of the resource and the properties around it, elevation can usually be done without adversely affecting historic properties. Consultation with a contractor or architect experienced working with historic buildings should be done early during project planning. Aspects of the project design that must be carefully considered in avoiding adverse effects include:

- Building height, scale, mass, and proportions;
- Architectural character (design elements, features, materials);
- Building footprint, orientation, and location;
- Landscape;
- Archaeology;
- Site elevation and topography; and
- Adjoining historic properties/historic district.

An experienced contractor or architect will be familiar with the aspects of a historic building that are important to retain, and will have ideas for approaches to mitigation while preserving the historic character of the property and adjacent historic district (if applicable). Figure 6-1 shows an example of a historic building that was elevated.

Figure 6-1. Elevated historic buildings

Section 2 of this document describes how to apply ASCE 24 requirements to elevation projects. These requirements should be applied to the extent practicable for historic properties.

6.2.2 Dry Floodproofing

Where elevation of a historic building is neither possible nor desirable, such as in an urban historic district where buildings are very close together or attached, dry floodproofing may be the preferred mitigation measure. FEMA P-467-2, *National Flood Insurance Program (NFIP) Floodplain Management Bulletin, Historic Structures* (2008c), offers guidance specific to historic buildings.

If carried out in a manner that is sensitive to the character-defining features of the historic building, dry floodproofing does not have to result in an adverse effect:

- Where measures are undertaken to stabilize and reinforce the historic building against movement or impact from water or debris, emphasis should be on preserving the existing structural system (i.e., reinforcing structural elements rather than replacing them) and minimizing visibility of the mitigation measures, especially on the exterior.
- Where membranes and sealants are used to prevent water intrusion into the building, they should be selected and applied in a manner that does not damage the historic materials. Historic buildings are usually constructed of naturally "breathable" and porous materials, such as wood, brick, stone, tile, stucco, and plaster. These materials permit the intrusion of water, but they also permit its evaporation over time. Although sealants prohibit water intrusion from the outside, they can trap moisture inside the building elements, eventually

resulting in degradation of the historic material. Depending on the chemical composition of sealants, they may break down historic materials, leading to erosion, cracking/spalling, or rot. The appearance of the sealant is also important: adverse effects are best avoided when the sealant does not alter the appearance of the historic building (e.g., color, texture).

- The installation and relocation of mechanical systems should be carried out in a manner that minimizes their visibility (e.g., at the rear of the building rather than the front) and physical impact on historic fabric (e.g., use an existing penetration in a wall rather than cutting a new one).

FEMA requires that dry floodproofing be implemented with an appropriate design by a registered Professional Engineer or architect. For work on historic buildings, the engineer or architect should also have experience with historic buildings and materials. Figure 6-2 shows an example of dry floodproofing for historic buildings.

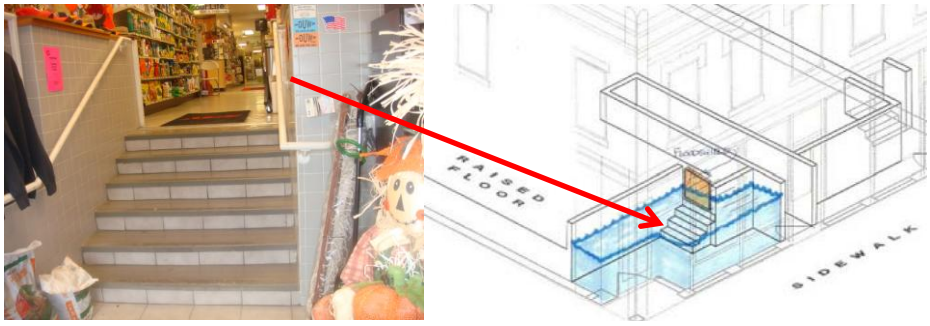

Figure 6-2. The entrance of the historic building leads into a tiled vestibule with a stairway leading to the elevated first floor retail space. Before a flood event, the owners remove display items in the vestibule and slide a flood shield into place protecting the elevated area from floodwaters. All building materials in the vestibule are flood damage-resistant. (Darlington, WI)

Section 3 in this document describes ASCE 24 applicability to dry floodproofing projects. These requirements should be applied to the extent practicable for historic properties.

6.2.3 Mitigation Reconstruction

Demolition of an existing historic building and reconstruction, even if the new building looks the same as the historic building, will be an adverse effect and should be the last resort for the owner of a historic property. Mitigation reconstruction should only be considered if elevation, dry floodproofing, and wholesale relocation to a parcel outside the flood hazard area are shown to be infeasible. If mitigation reconstruction is conducted in a historic district or adjacent to another historic property, adverse effects on the district or adjacent property should be considered during project evaluation. Adverse effects to nearby historic properties or a historic district can be avoided by designing new construction in a manner that is consistent with the historic surroundings. Aspects of the project design that should be considered include:

- Building height, scale, mass, and proportions;

- Architectural character (design elements, features, materials);
- Building footprint, orientation, and location; and
- Landscape.

Section 4 of this document describes ASCE 24 applicability to mitigation reconstruction projects. These requirements should be applied to the extent practicable for historic properties.

6.3 National Flood Insurance Program Considerations

The NFIP gives special consideration to the unique value of our Nation's most significant resources—historic buildings, landmarks, and sites. Under the NFIP, "historic structure" is defined as any structure that is:

> *(a) Listed individually in the National Register of Historic Places (a listing maintained by the Department of the Interior) or preliminary determined by the Secretary of the Interior as meeting the requirements for individual listing on the National Register;*
>
> *(b) Certified or preliminarily determined as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district;*
>
> *(c) Individually listed on a state inventory of historic places in states with historic preservation programs which have been approved by the Secretary of the Interior; or*
>
> *(d) Individually listed on a local inventory of historic places in communities with historic preservation programs that have been certified either:*
>
> *(1) By an approved state program as determined by the Secretary of the Interior or*
>
> *(2) Directly by the Secretary of the Interior in states without approved programs* (44 CFR Section 59.1).

Two floodplain management provisions provide regulatory relief for historic structures. Communities have a choice of adopting one or the other, but not both.

(1) The Substantial Improvement definition excludes historic structures from the elevation and dry floodproofing (nonresidential) requirements of the NFIP.

> *Any alteration of a "historic structure," provided that the alteration will not preclude the structure's continued designation as a "historic structure"* (44 CFR Section 59.1).

The exemption also applies to structures that have been Substantially Damaged.

(2) The other NFIP provision that provides relief for historic structures is the variance criteria at 44 CFR Section 60.6(a), which states:

> *Variances may be issued for the repair or rehabilitation of historic structures upon a determination that the proposed repair or rehabilitation will not preclude the structure's continued designated as a "historic structure" and the variance is the minimum necessary to preserve the historic character and design of the structure.*

Under the variance criteria, communities can place more conservative conditions to make the building more flood resistant and minimize flood damage, but such conditions should not affect the historic character and design of the building.

If plans to Substantially Improve a historic structure or repair a Substantially Damaged historic structure, as defined by the NFIP at 44 CFR Section 59.1, would result in loss of its designation as a historic structure, the structure would be required to meet NFIP floodplain management regulations (44 CFR Section 60.3) for elevation to the BFE for residential structures and elevation and dry floodproofing to the BFE for nonresidential structures. This determination needs to be made in advance of the local official issuing a permit. This provides an incentive to the property owner to maintain the structure's historic designation rather than alter the structure in such a way that it loses its designation as a historic structure as defined by the NFIP.

NFIP floodplain management requirements pertaining to floodways could apply to historic structures. As an example, an addition, or any portion thereof, to a historic structure that expands the square footage of the structure beyond the footprint into the floodway must comply with the regulatory floodway criteria at 44 CFR Section 60.3(c)(10) and (d)(3). Additions can obstruct flood flow and increase flood stages under 44 CFR Section 60.3 (d)(3).

Obtaining flood insurance is important to ensuring that historic structures can be repaired and restored after a flood event. Property owners of historic structures are encouraged to purchase flood insurance. Disaster assistance will not take care of all financial needs if a historic structure is damaged by flooding. If a residential or nonresidential historic structure is elevated, it should be elevated to or above the BFE to get a lower insurance rate. If a nonresidential building is dry floodproofed, it must be dry floodproofed 1 foot above the BFE to receive a rate equivalent to a building with its lowest floor elevated to the BFE. The NFIP allows only elevation of residential buildings (not dry floodproofing) to meet new construction and Substantial Improvement/Damage provisions. In some cases, dry floodproofing of residential historic structures may be the only option for minimizing damages. However, the insurance rating procedures do not recognize dry floodproofing for residential buildings so the rate will not be discounted.

Increased Cost of Compliance (ICC) coverage is not available to a historic structure that is exempt from the floodplain management requirements if a historic structure is Substantially Damaged by flood. ICC coverage provides for the payment of a claim for the cost to comply with State or community floodplain management laws or ordinances after a direct physical loss by flood. When a building covered by a flood insurance policy is declared Substantially Damaged or repetitively damaged by a State or community, ICC will pay up to $30,000 for the cost to elevate, floodproof, demolish, or relocate the building. If a variance is granted, but the

community places conditions on the variance such that the historic structure must comply with the floodplain management requirements in the State or community's floodplain management regulations, ICC will be available if the structure is declared Substantially Damaged or repetitively damaged.

See FEMA P-467-2, *National Flood Insurance Program (NFIP) Floodplain Management Bulletin, Historic Structures* (2008c), for a more complete explanation of how the NFIP treats historic structures and suggested ways of minimizing flood damages to historic structures.

6.4 Effects of Applying Requirements to the Extent Practicable

As mentioned in Section 6.1 of this document, the application of ASCE 24 requirements for mitigation projects involving historic properties is strongly encouraged to the extent practicable. The test of what is practicable depends on the situation and includes consideration of all pertinent factors, such as environment, cost, and technology. Some of the more common constraints encountered in applying ASCE 24 to historic properties are presented below.

- Legal Constraints – The city or county in which the property is located may have special requirements for work done to historic properties or within historic districts. In these cases, the project may be reviewed by historic preservation staff and a design review board to determine whether the proposed scope of work is appropriate for a historic property. If the scope of work is determined not to be appropriate for a historic property, then a permit or certificate of appropriateness may not be issued for the work, and revisions to the project may be necessary to receive concurrence.

  In more limited cases, a second party (usually a non-profit organization) may hold a preservation easement on a historic property that gives them the right to review and approve changes made to the property. If there is an easement on the historic property, the Applicant/subapplicant may have to revise the scope of work to receive approval from the easement holder.

  A city or county's zoning ordinance may limit what can be done on a historic property. For example, there may be height restrictions, floor area ratio and lot occupancy limits, and setback requirements that affect the Applicant/subapplicant's ability to meet ASCE 24. Similarly, deed restrictions and homeowners' associations may present additional constraints.

- Environmental Constraints – Nature and physical constraints, including the presence of hazardous materials common in historic buildings that require special treatment or controlled removal, such as asbestos pipes or siding and lead paint, may affect the Applicant/subapplicant's ability to meet ASCE 24.

- Financial Constraints – Doing work on a historic building will be more expensive than on a non-historic building. Designing a project so that it is compatible with the character-defining features of a historic property requires special considerations: consultation with an architect or contractor with experience with historic buildings may be needed; and

traditional building materials, such as wood, brick, stone, clay tile, slate, glass, and plaster may cost more to purchase and may require more special expertise to install than the readily available and cheaper synthetic alternatives (e.g., vinyl, aluminum, oriented strand board, asphalt, concrete, drywall, laminate).

6.5 When Adverse Effects Are Unavoidable

When a project will adversely affect historic properties—either the building itself or adjacent resources—assistance may be delayed while FEMA completes the EHP review process described in Section 6.1. The subapplicant *must* wait for FEMA to complete this EHP review process *before* commencing work on the project, or the project is no longer eligible. The most important thing that a subapplicant can do to assist FEMA in the timely completion of the EHP review is to document that alternatives that would avoid or minimize adverse effects on historic properties have been considered. Documentation of considered alternatives can include:

- Copies of e-mails with your contractor/architect/engineer in which the pros and cons of various options are presented;
- Copies of earlier concept sketches/drawings and estimates;
- Notes of conversations or correspondence with the SHPO, county or local officials, or other interested parties about the project, indicating opinions, concerns, and constraints; and
- Copies of correspondence related to any other permitting that must be coordinated for your project.

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7 Flood Mitigation Project Implementation

This section provides guidance on how to implement flood mitigation projects subject to the ASCE 24 standard with a focus on FEMA HMA Program requirements and processes. Code compliance and local permitting as they relate to flood mitigation projects are also discussed.

7.1 HMA Project Implementation

As discussed in Section 1.1 of this document, there are currently three assistance programs under FEMA's HMA Program: the HMGP, the PDM Program, and the FMA Program. Table 1-2 in Section 1 indicates the mitigation project types that are eligible for assistance under each of these programs.

Figure 7.1 shows the HMA grant cycle, indicating local, State, and FEMA responsibilities during the five stages of the grant cycle.

7.1.1 Stage 1. Mitigation Planning

A State, Tribal, or Local Multi-Hazard Mitigation Plan is a prerequisite for all project grants, unless exempted by 44 CFR 206.434 (b)(2). The State, Tribal, or Local Multi-Hazard Mitigation Plan lays out the process for identifying the risks of a community and the actions that will help reduce those risks. Requirements and procedures for State, Tribal, and Local Mitigation Plans are found in 44 CFR 201. Flood mitigation projects proposed for FEMA assistance under these programs must be consistent with the State, Tribal, or Local mitigation plan. The mitigation planning process requires public participation and identification of measures to reduce risks and is, therefore, a good opportunity for property owners to address concerns about flood hazards. More information is available on the FEMA Web site at http://www.fema.gov/hazard-mitigation-planning-overview.

According to 44 CFR 206.434 (b)(2), a Regional Director may grant an exception to this requirement in extraordinary circumstances, such as in a small impoverished community when justification is provided. In these cases, a plan will be completed within 12 months of the award of the project grant. If a plan is not provided within this timeframe, the project grant will be terminated, and any costs incurred after notice of grant's termination will not be reimbursed by FEMA.

7.1.2 Stage 2. Program Assistance

HMA Programs enable hazard mitigation measures to be implemented before, during, and after disasters. The provision of assistance for projects depends on the availability of appropriation funding or is based on disaster recovery expenditures, as well as any directive or restriction made with respect to such funds. HMGP must be requested by a State and assistance depends on the provision of Federal assistance for disaster recovery following a Presidential disaster declaration in that State; PDM assistance may be authorized annually by Congress; and the FMA Program is supported through the National Flood Insurance Fund but is still subject to appropriation. Once

the application period is open, the State notifies the local governments of the availability of assistance and relays information on the application process, project requirements, and eligibility criteria for the local government. Table 7-1 shows the cost-share requirements for each program. Property owners should work with their local government to express their interest in participating in a flood mitigation project; the local government can then submit a subapplication to the State and request HMA assistance. In general, the community applying for the grant must be participating in the NFIP. Table 7-2 shows the eligible subapplicants for each program.

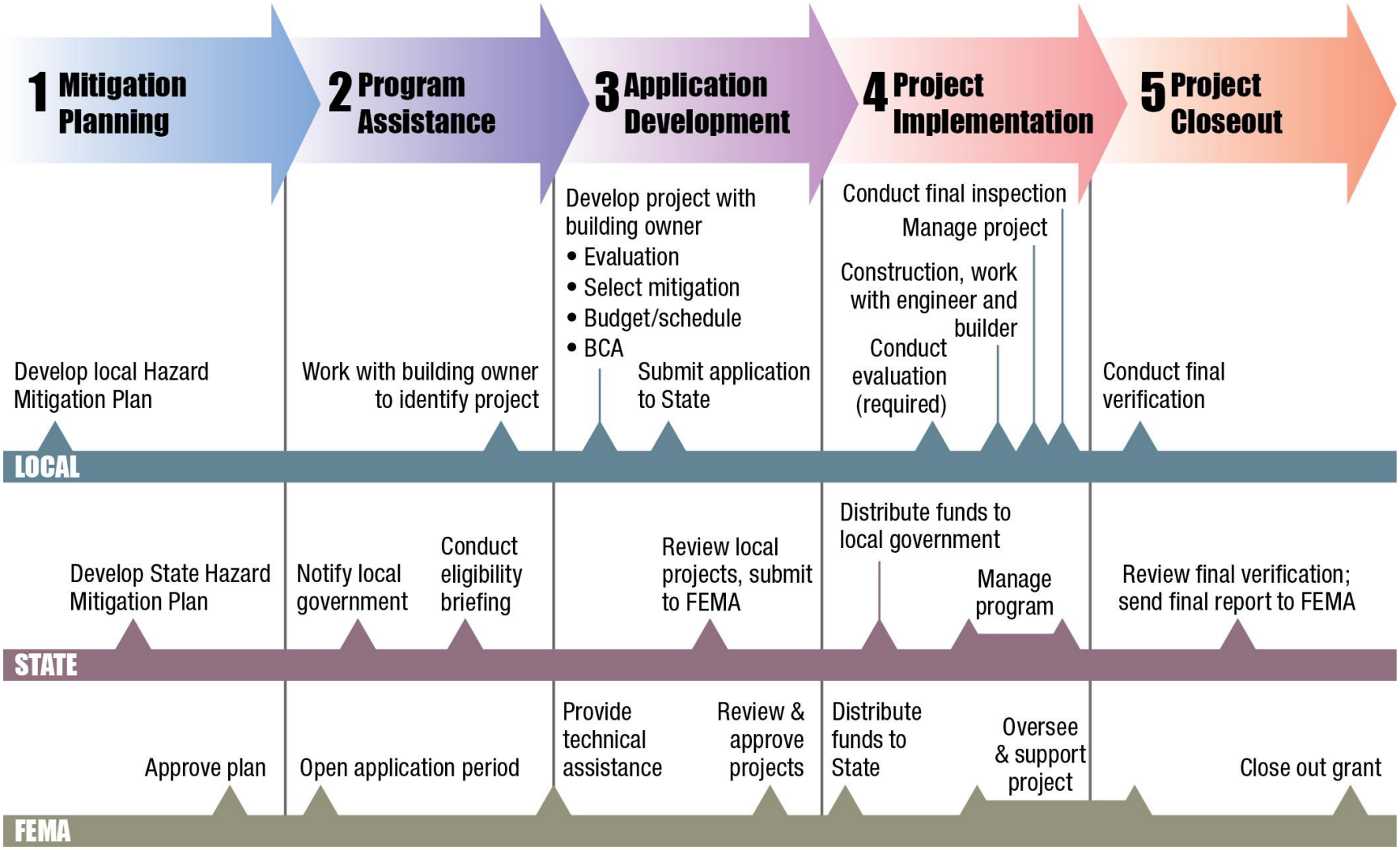

Figure 7-1. HMA grants cycle process showing roles and responsibilities of each stakeholder

Table 7-1. HMA Program Cost-Share Requirements

Program	Subcategory	Mitigation Activity Grant (Percent of Federal/ Non-Federal Share)[1]
HMGP	—	75/25
PDM	—	75/25
	Subgrantee is small impoverished community	90/10
	Tribal Grantee is small impoverished community	90/10
FMA	Insured property and planning grant	75/25
	Repetitive loss property with State repetitive loss strategy and with repetitive loss strategy in mitigation plan	90/10
	Severe repetitive loss property with State repetitive loss strategy in mitigation plan	100/0

1. Ratios were applicable as of May 2013. Please refer to the current fiscal year's *Hazard Mitigation Assistance Unified Guidance* (also called *HMA Unified Guidance*) for relevant ratios when referencing this table. The current fiscal year's *HMA Unified Guidance* can be found at http://www.fema.gov/media-library/assets/documents/33634?id=7851

Table 7-2. Eligible Subapplicants

Subapplicant	HMGP	PDM	FMA
State agencies	✓	✓	✓
Tribal governments	✓	✓	✓
Local governments/communities	✓	✓	✓
Private nonprofit organizations	✓	X	X

7.1.3 Stage 3. Application Development

Individuals and businesses are not eligible to apply for HMA assistance, so property owners must work with their local governments to develop a complete project subapplication on their behalf; however, local governments may not want to develop an application. Local governments may submit a retrofit project for a single structure as an individual subapplication or combine it with other structures as part of an aggregate subapplication (subject to program restrictions). Aggregating benefit and cost values is allowed for multiple structures if they are all vulnerable to damage as a result of similar hazard conditions. Users of this document should refer to the most

applicable version of the *HMA Unified Guidance* for information on aggregating projects in an application.

Key project elements necessary for flood mitigation applications include:

- Identify the property (address, age, first floor elevation, flood hazard, and other characteristics) to be mitigated.
- Identify key project personnel and roles, such as design professional and contractor.
- Select an eligible project (see Appendix C, "Methodology for Evaluating Risks").
- Ensure the project is consistent with the Mitigation Plan.
- Have a professional inspect the structure to verify that the project can be implemented (if possible; if not done at this stage, it must be done during Stage 4, Project Implementation). See *Initial Inspection and Data Collection Worksheet* from Appendix D, "Checklists for Mitigation Projects."
- Include design parameters illustrating that ASCE 24 requirements will be incorporated into the project design or provide an affirmative certification statement. An example of an acceptable affirmative certification statement is:

  > The Applicant affirms that the proposed scope of work will be implemented in conformance with the design criteria outlined in the ASCE 24-05, *Flood Resistant Design and Construction*, standard if this application is approved for HMA.
  >
  > The Applicant understands that prior to project closeout, verification and design documentation and/or certification must be submitted to FEMA to demonstrate that conformance with accepted engineering practices, established codes, standards, modeling techniques, or best practices, including adherence to ASCE 24-05 minimum design and construction requirements has been met.
  >
  > The Applicant understands that failure to implement this project, if approved,

What qualifies as design documentation and/or certification?

- ✓ A statement or affidavit from a design professional involved in evaluating the building and developing the design to meet ASCE 24 "deemed to comply" requirements
- ✓ A "template" design that meets ASCE 24, developed by the contractor and with the help of a designer, based on the existing foundation type, soil, condition of the building, etc. that could be used anytime these conditions are the same
- ✓ A statement or affidavit from a local official with technical competency certifying that the design meets the spirit of ASCE 24

in conformance with ASCE 24-05 will constitute a breach of the terms and conditions of the Grant Award Agreement and may result in a recoupment of Federal assistance.

The last two statements are more likely to appear in the grant agreement; however, to establish clear understanding of the grant requirements, ideally they will be included in the application as well.

- Develop a project cost estimate and work schedule (see *Develop Cost Estimate* from Appendix D).
- Conduct a BCA using FEMA's BCA software (refer to Section 7.2 and Appendix B, "Benefit-Cost Considerations"); if the benefit-cost ratio (BCR) is 1.0 or more, the project is cost effective. FEMA requires a BCR of 1.0 or greater for funding (see *BCA Input Resources* from Appendix D).
- Ensure that properties located in designated SFHAs will obtain and maintain flood insurance and that this condition will be recorded on the property deed.
- Identify the appropriate agency consultation letters and responses (may include correspondence from SHPO, U.S. Army Corps of Engineers, Natural Resources Conservation Service, floodplain administrators, State coastal management agencies, State environmental quality departments, State wildlife departments, and U.S. Fish and Wildlife Service, etc.).
- Include a signed environmental justice statement.

The local government submits the subapplication to the State (see *Application Development Resources* in Appendix D for additional resources and information). The State then reviews the projects, selects projects based on the State's priorities, coordinates and resolves issues with the subapplicant's project application before submitting applications to FEMA for review. FEMA reviews the projects for eligibility, completeness, engineering feasibility, cost effectiveness, and EHP documentation. The review process helps to determine whether the Applicant and subapplicant have demonstrated that all hazard mitigation activities are in compliance with all relevant statutes, regulations, and program requirements, including other applicable Federal, State, Indian Tribal, and local laws, implementing regulations, and Executive Orders (EOs), which are detailed in the most applicable version of the *HMA Unified Guidance*. Once FEMA approves and awards the project, the grant funds are distributed by the State to the local governments, who will distribute it to individuals, as appropriate. No construction activities should begin until after the money has been awarded because HMA assistance is not available for activities initiated or completed prior to award or final approval.

7.1.4 Stage 4. Project Implementation

Once the State has awarded the funds to the local government, the next stage in the process is project implementation. HMA projects have to be completed within a specific amount of time

called a period of performance, which is usually not more than 36 months. The homeowner or local government should secure the professional services of a contractor or an engineer at this stage to develop a detailed construction plan. If the scope of work or cost estimate changes as a result, consult the most applicable version of the *HMA Unified Guidance* for direction on how to revise the scope of work prior to construction.

During the period of performance, the local government must maintain a record of work and expenditures for the quarterly reports that the State submits to FEMA. The basic steps for implementing an HMA mitigation flood retrofit project are as follows:

1. Have a professional inspect the structure to verify that the project can be implemented (unless already completed during Stage 3, Application Development). See *Initial Inspection and Data Collection Worksheet* from Appendix D.
2. Finalize selection of viable project (unless already completed during Stage 3, Application Development).
3. Secure professional services to complete the approved project. See *Design Checklists* from Appendix D for important design considerations for the design professional.
4. Complete installation of the approved hazard mitigation. See *Pre-Construction and Walk-Through Checklist* and *Construction Checklist and Compliance Checks* from Appendix D for inspection items and compliance checks that should occur prior to and during construction.
5. Inspect the completed hazard mitigation elements and verify other program requirements. See *Final Walk-Through Checklist and Punch-List Items* from Appendix D.

7.1.5 Stage 5. Project Closeout

Once the project has been completed, a professional should conduct a final verification to ensure that the project was implemented as intended. This will facilitate project closeout documentation and confirm that the building provides the desired level of protection. In addition, the State will verify that the work was completed in accordance with the approved scope of work, including any conditions placed on the scope of work, and closeout procedures. If the building is located in an SFHA, the local government must provide documentation of flood insurance for the structure and a copy of the recorded deed amendment. A *Project Closeout Checklist* is provided in Appendix D. Although completion of this checklist is not mandatory, it is a useful tool to ensure the completion of closeout tasks.

The local government / subapplicant should reconcile/adjust subgrant costs, ensure that non-Federal share costs are documented, and ensure that all costs submitted are eligible according to the FEMA-approved scope of work. If there are remaining funds, the local government / subapplicant should return unobligated funds to FEMA.

The local government / subapplicant should also provide the State/Tribal government with site photos and applicable supporting documentation to ensure that the project was completed in

compliance with the scope of work. In addition, the Grantee may conduct a final site visit prior to project closeout. Supporting documentation that is needed from the subgrantee includes but is not limited to copies of all applicable permits and inspections, documented expenditures consistent with the approved SF-424, *Application for Federal Assistance*, FEMA Form 20-18, *Report on Government Property*, cost-share records including cash and in-kind services provided by the community, and latitude/longitude coordinates for each mitigated structure with an accuracy of +/- 20 meters. Complete grant closeout records must be on file for at least 3 years from the submission date of the last expenditure report.

Although closeout requirements typically apply to all three project types addressed in this guidance, some are unique to specific mitigation projects as shown in Table 7-3. Additionally, the most applicable version of the *HMA Unified Guidance* should be referenced to ensure all closeout requirements are addressed.

Table 7-3. Closeout Requirements Unique to Elevation, Mitigation Reconstruction, and Dry Floodproofing

Structure Elevation	Dry Floodproofing	Mitigation Reconstruction
Final elevation certificate to verify the first floor elevation height meets the requirements of ASCE 24-05. A copy of the recorded deed amendment for each property. Certification by an engineer, floodplain manager, or senior local official that the completed structure elevation is in compliance with local ordinances and NFIP regulations, including all applicable NFIP Technical Bulletins. Verification and design documentation and/or certification to demonstrate adherence to ASCE 24-05 minimum design and construction requirements that have been "deemed to comply" for structure elevation. A front, rear, and side photograph of the final elevated structure. Verification of flood insurance for each structure. A Certificate of Occupancy for each structure in the project to certify that the structure is code compliant.	*Historic Buildings* Assurances and supporting documentation that all required environmental mitigation conditions have been met. Photographs of the mitigated structure as required under environmental conditions. Dry floodproofing certificate showing the elevation of the floodproofing measure must be provided. *Nonresidential Buildings* A dry floodproofing certificate showing the elevation of the floodproofing measure, as well as photographs of a representative sample of mitigation elements of the structure (e.g., shields on doors). Verification and design documentation and/or certification to demonstrate adherence to ASCE 24-05 minimum design and construction requirements that have been "deemed to comply" for dry floodproofing.	A certificate of occupancy issued by the local government when the project is complete to ensure all required permits were obtained and building code requirements, including requirements of ASCE 24-05, were observed. A certification from a building official or licensed design professional verifying that the structure was designed and constructed to the minimum standard of the 2006 International Codes. Verification that final square footage is within 10 percent of original structure square footage at the time of closeout. Verification of insurance for each structure. Verification and design documentation and/or certification to demonstrate adherence to ASCE 24-05 minimum design and construction requirements.

7.2 Cost Effectiveness

Risk is a critical element when evaluating the cost effectiveness of a proposed mitigation project. The two components of risk are magnitude of potential loss and probability of loss. Most flood mitigation projects help reduce the risk of flood damage. The greater the effectiveness of the project in reducing or eliminating the risk of high-probability flooding, the more likely the

project will be cost effective. If the project has marginal increases in cost, the impact to the BCR, or cost effectiveness of the project, will be negligible. Often times, increases in project costs result in a reduction of flood risk (i.e., elevating a home 2 feet above the BFE instead of just to the BFE).

The FEMA BCA Tool is used to determine the cost effectiveness of proposed mitigation projects submitted for assistance under FEMA's HMA grant programs. FEMA developed the software to assist in complying with the most applicable version of the *HMA Unified Guidance* and Stafford Act requirements, which state that FEMA can only support cost-effective mitigation activities.

The software is used to estimate the magnitude of potential loss caused by a natural disaster (flood, hurricane, tornado, earthquake, or wildfire) with and without the proposed mitigation. For flood events, loss is estimated using depth-damage functions, which are used to predict inundation impacts to the building, contents, and use of the building. Depth-damage functions relate flood depths to predicted percentages of damage to a building.

The probability of loss is based on the flood recurrence interval, which is typically based on flood hazard data from a FEMA Flood Insurance Study and/or hydrologic and hydraulic study. When flood hazard data are either unavailable or limited, the recurrence interval may need to be based on the Unknown Frequency Calculator, which is built into the Damage Frequency Assessment module of the FEMA BCA Tool.

Projects that are eligible for funding under the HMA programs must be cost effective, i.e., have a BCR equal to or greater than 1.0. A FEMA memorandum, released on August 15th, 2013, provides a methodology to streamline the benefit cost analysis for certain mitigation project types. This methodology was based on FEMA's Risk Reduction Division analysis of 11,000 acquisition and elevation projects. FEMA has determined that the average benefits for each type of project are $276,000 and $175,000, respectively (2013 dollars). Therefore, FEMA has determined that the acquisition or elevation of a structure located in a 100-year floodplain (as delineated on the FIRM or based on best available data) that costs less than or equal to the average benefit listed above is considered cost effective. For projects that contain multiple structures, the average cost of all structures in the project must meet the stated criterion. There is no need for applicants to conduct a separate BCA for a structure that meets this criterion.

For structures identified in a riverine SFHA on the current effective FIRM and declared Substantially Damaged as a result of the impacts of flooding by a local authority having such jurisdiction, property acquisition and structure demolition or relocation are considered cost effective and a BCA is not required to be submitted for the structure.

For more information about conducting a BCA for elevation, dry floodproofing, and mitigation reconstruction projects, refer to Appendix B.

7.3 Environmental Considerations

Because HMA Programs are supported with Federal dollars, projects must comply with 44 CFR Parts 9 and 10, and with all applicable EHP laws, implementing regulations, and EOs. In addition

to the National Historic Preservation Act, addressed in Section 6 of this document, these include, but are not limited to:

- The National Environmental Policy Act (NEPA)
- The Endangered Species Act
- The Clean Air Act
- The Clean Water Act
- EO 11988 (Floodplain Management)
- EO 11990 (Protection of Wetlands)
- EO 12898 (Environmental Justice)

The HMA grant program includes an EHP review process that addresses potential impacts of mitigation projects on environmental resources.

Three primary categories of flood mitigation are addressed by ASCE 24: building elevation, dry floodproofing, and mitigation reconstruction. The following sections describe the potential for environmental impacts associated with each of these types of mitigation.

7.3.1 Structure Elevation

Typically, this type of mitigation will have minimal impacts to the environment. The appropriate level of NEPA review for building elevation is generally a Categorical Exclusion (44 CFR Section 10.8(d)(2)(XV)). However, there may be special circumstances in which project location, including proximity to sensitive environmental resources, triggers additional NEPA compliance. In addition, environmental impacts related to viewsheds, water quality, and hazardous wastes are possible. These are discussed in the following sections.

7.3.1.1 Viewsheds

If done properly, taking into consideration its surroundings, elevation can be done without adversely affecting the aesthetic character of the community. Aspects of the project design that must be carefully considered to avoid aesthetic impacts are highlighted in Section 6.2.1 of this document.

7.3.1.2 Water Quality

As with all construction sites, temporary impacts to water quality may occur as a result of the operation of heavy equipment, disturbance of soils, placement of rock or soil in water sources, and dewatering of water sources during construction activities. The Grantee/subgrantee should develop and implement an erosion and sedimentation control plan that includes one or more of the following:

- Silt fences, hay bales, and similar measures to prevent soils from entering water bodies

- Revegetating disturbed soils to provide stability
- Runoff filtration during construction and after construction activities are complete
- Stabilizing or maintaining soil stockpiles to prevent/control/reduce soil laden runoff to waterways

7.3.1.3 Hazardous Wastes

Construction activities may disturb hazardous materials present at the site of an action. These may include asbestos; lead-based paint; fluorescent and high-intensity discharge light bulbs; polychlorinated biphenyls (PCBs) or a PCB replacement chemical (bis(2-ethylhexyl)phthalate [DEHP]) in the starter, capacitors, and ballasts for lights; and aboveground storage tanks (ASTs) or underground storage tanks (USTs). The subgrantee should conduct a site assessment (such as a Phase I Environmental Site Assessment) to determine whether such materials are present. The subgrantee must comply with local, State, and Federal regulations for the removal, handling, transport, and disposal of hazardous wastes or materials, or for removing ASTs or USTs. The subgrantee must coordinate with the appropriate local, State, or Federal regulatory agency. Non-compliance with EHP laws can jeopardize potential assistance.

7.3.2 Dry Floodproofing

In cases where elevation of a structure is not possible or desirable, such as in an urban setting where buildings are very close together or attached, dry floodproofing may be the preferred method for flood mitigation. If the structure is historic, refer to Section 6.2.2 of this document. For non-historic structures, environmental impacts would be negligible. The appropriate level of NEPA review for dry floodproofing is generally a Categorical Exclusion (44 CFR Section 10.8(d)(2)(XV)). However, there may also be special circumstances in which project location, including proximity to sensitive environmental resources, triggers additional NEPA compliance. One potential environmental impact relates to hazardous wastes (for details refer to Section 7.3.1.3, Hazardous Wastes, above).

7.3.3 Mitigation Reconstruction

Demolition of an existing structure followed by new construction on the same site has the potential for a number of environmental impacts related to air quality, hazardous wastes, water quality, plant and animal species, environmental justice, floodplains, and wetlands. The appropriate level of NEPA review for mitigation reconstruction may be a Categorical Exclusion (44 CFR Section 10.8(d)(2)(XVI)) if all the conditions are met. However, there may also be special circumstances in which project location, including proximity to sensitive environmental resources, triggers additional NEPA compliance. If neither satisfies all conditions, an Environmental Assessment is required.

7.3.3.1 Air Quality

Based on the type of facility and the setting of the relocation, air quality impacts may result from increasing traffic or altering traffic patterns, increasing utility use, or introducing new activities with the potential to affect air quality.

7.3.3.2 Hazardous Wastes

For mitigation reconstruction, one potential environmental impact relates to hazardous wastes (for details refer to Section 7.3.1.3, Hazardous Wastes, above).

7.3.3.3 Water Quality

As with all construction sites, temporary impacts to water quality may occur as a result of the operation of heavy equipment, disturbance of soils, placement of rock or soil in water sources, and dewatering of water sources during construction activities. The Grantee/subgrantee should develop and implement an erosion and sedimentation control plan that includes one or more of the following:

- Silt fences, hay bales, and similar measures to prevent soils from entering water bodies
- Revegetating disturbed soils to provide stability
- Runoff filtration after construction activities are complete
- Maintaining soil stockpiles adjacent to waterways

7.3.3.4 Plant and Animal Species

Except for actions affecting riparian habitat or waterways, actions that involve modification or construction within or immediately adjacent to the footprint of an existing facility would not substantially disturb the biology of the area of the action. This assumes that the facility would not substantially increase in size, existing access routes are used, and staging areas are returned to original conditions.

Actions undertaken on a previously undisturbed site may adversely affect biological resources. Vegetation would be removed and displacement or mortality of individual wildlife may occur. The subgrantee should minimize impacts to biological resources through proper siting and design and by ensuring that no threatened or endangered species, or their critical habitat, are present on the site. Except for staging areas on hardened surfaces, the subgrantee should reseed or sod staging areas with native vegetation.

7.3.4 Executive Order 11988 Floodplain Management and 44 CFR Part 9

All activities supported by HMA programs must conform to 44 CFR Part 9 and EO 11988, which discourages building in a floodplain and particularly Coastal High Hazard Areas unless there are no alternatives. Critical facilities, which may include hospitals, fire stations, police stations, storage of critical records, and similar facilities, should not be located in a floodplain if at all

possible. If a critical facility must be located in a floodplain, it should be provided a higher level of protection so that it can continue to function and provide services after a flood.

7.3.5 Executive Order 11990 Protection of Wetlands and the Clean Water Act

Actions that affect wetlands and other waters of the United States or navigable waters of the United States require coordination with the U.S. Army Corps of Engineers to ensure compliance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbor Act. The subgrantee is responsible for applying for and obtaining required Section 404 and Section 10 permits. Further, the subgrantee is responsible for obtaining a water quality certification from the appropriate State agency for any project subject to Section 404 permitting.

7.4 Code Compliance and Permitting

Retrofitting existing buildings can be a complicated process. Building configurations, material types, construction methods, and local codes and ordinances can all differ widely. This section discusses these issues so that the owner, local government, contractor, and design professional can consider how such concepts may apply to their project and what potential issues may need to be addressed over the course of the project. Code compliance and local permitting and inspection requirements are addressed in this section.

7.4.1 Code Compliance Check

Modern building codes contain provisions for existing buildings to ensure that renovations, alterations, repairs, and relocations of space are completed in a manner that does not compromise the structural integrity of the building. Although a flood retrofit project should improve the structural integrity of a home rather than reduce it, every retrofit project should still undergo a code compliance check to verify that the project does not trigger provisions for existing buildings. Code compliance checks should be done during project planning to avoid disruptions during the implementation of the project.

As with new construction, individual retrofit measures and the measures that are part of a flood retrofit project should comply with the effective building code adopted by the community, local floodplain development regulations, and ASCE 24. This guidance does not intend for any retrofit measures to be performed that would result in a conflict with the building code as it applies to the retrofitting of buildings.

One type of provision that is prevalent in existing building codes is for buildings undergoing extensive repairs or improvements. Buildings that experience damage or undergo improvements may trigger the Substantial Improvement/Damage provisions in either the building code or, if located in an SFHA, the local floodplain development regulations. The resulting code compliance checks are generally triggered when work to repair damage or work to improve a building is considered to be Substantial Improvement/Damage. More information on Substantial Improvement/Damage can be found in FEMA P-758, *Substantial Improvement/Substantial Damage Desk Reference* (2010a).

The 2012 IRC, IBC, and IEBC describe various categories to classify work on existing buildings. For flood mitigation projects on residential and nonresidential structures, alterations and repairs are typically the most applicable categories. The 2012 IRC provides provisions for existing residential buildings in Appendix J. The 2012 IBC covers provisions for existing nonresidential buildings in Chapter 34. If adopted by the authority having jurisdiction, the 2012 IEBC provides further, more detailed requirements and guidance for work on existing buildings (both residential and nonresidential). With respect to alterations, various levels of alterations can be triggered; higher levels correspond to greater amounts of work being done to the structure. In some cases, these provisions can trigger additional work that may need to be done to the structure or portions of the structure to meet certain building code requirements. State-specific codes and older codes may have different requirements; therefore, the provisions of the applicable building code should be carefully checked before the project is implemented.

Additional information on these provisions, and the type of work they can apply to, can be found in FEMA 499, *Home Builder's Guide to Coastal Construction,* Technical Fact Sheet No. 9.1. (2010b).

7.4.2 Permitting and Inspections

Building owners should ensure that their retrofit projects are properly permitted through their local building department and that inspections required by the local building department are carried out. Permitting and inspection procedures in SFHAs are usually more involved than those not in SFHAs, and if unanticipated, can complicate a mitigation project. For instance, in addition to meeting all of the Federal, State, and local requirements, the design plans and specifications may need to be sealed by a licensed design professional. Additional documentation may be necessary. These requirements can vary with each community and, depending on the specific flood hazard, should be considered as early as possible in the process of developing a flood mitigation project.

Homeowners should be aware that retrofit actions may trigger the requirement for code verification; additionally, those elements of the home affected by the retrofit may be required to be brought up to the current building code as discussed in Section 7.2.1. These elements may include the structural, electrical, mechanical, or plumbing systems, or the method by which the structure provides fire protection. If there is a local building department, inspections may be required throughout the process in addition to a final inspection. If there is no building department or building codes are not being enforced, proper documentation must still be maintained for the mitigation project.

Although the permitting process may vary between jurisdictions, several factors should remain constant for communities that participate in the NFIP and, thus, enforce local floodplain development regulations. If a building is located in an SFHA, a permit is required for all proposed construction and other development.

In addition to NFIP requirements, both the 2012 IRC and IBC require permits for construction and development. Section 105.1 in the 2012 IBC and Section R105.1 in the 2012 IRC state:

> Any owner or authorized agent who intends to construct, enlarge, alter, repair, move, demolish, or change the occupancy of a building or structure, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical or plumbing system, the installation of which is regulated by this code, or to cause any such work to be done, shall first make application to the building official and obtain the required permit.

The requirement for a permit in both the building code and NFIP regulations means that owners, contractors, design professionals, and officials must be aware of both requirements. Although the model International Codes contain the NFIP provisions, many communities use a separate local ordinance for their floodplain development regulations and multiple permits may be required depending on the community's enforcement of one or more requirements. For example, a building official may require a permit for construction of a residential building per IRC requirements. However if that building is located in a floodplain, the floodplain administrator may also require a permit for construction in an SFHA per the NFIP. In some cases, these roles (building official and floodplain administrator) may be given to one official, but in other cases there may be multiple officials with varying requirements. The design professional must be aware of the requirements that apply to a specific site so that the most restrictive applicable requirements are met.

The 2012 IBC requires buildings constructed in flood hazard areas to be in accordance with ASCE 24 (see Section 1612.4 of the 2012 IBC), while the 2012 IRC references ASCE 24 only for buildings and structures constructed in floodways (see Section R322.1 of the 2012 IRC). Although communities that do not have an effective building code but participate in the NFIP do not have to obtain a permit for construction and development per the building code, they must still obtain a permit if they are developing or constructing in an SFHA, per NFIP requirements. Communities with no building code may have local ordinances that also require a permit and provide more restrictive requirements than the minimum NFIP requirements. Without a building code, the authority having jurisdiction may have difficulty enforcing the provisions of ASCE 24, as they will be less familiar with those requirements. A floodplain administrator may not have the same level of building expertise that a building official would have, because their primary duties typically deal with floodplain development rather than building design and construction. In such cases, local floodplain administrators may need to rely on affidavits or certifications from licensed professional designers to ensure compliance with ASCE 24.

Permitting provides an important form of oversight to ensure that buildings are being properly designed and constructed, which becomes even more crucial when a building or structure is located in an SFHA. Communities that do not participate in the NFIP cannot receive Federal assistance for flood mitigation projects located in a floodplain.

Figure 7-2 illustrates the permitting process. Several steps must be taken before a building permit can be issued. After a zoning review and verification that the application meets the NFIP and local ordinances for development, an application should undergo a building code review. Verification of Substantial Improvement, BFE and lowest floor elevation, and impacts on the

floodway should be considered. Once a building permit has been issued, the Applicant may begin construction. The site should be inspected both during and after construction to verify that NFIP regulations and local ordinance requirements have been followed. After final inspection, an elevation certificate should be provided, and the final record should be logged with the authority having jurisdiction.

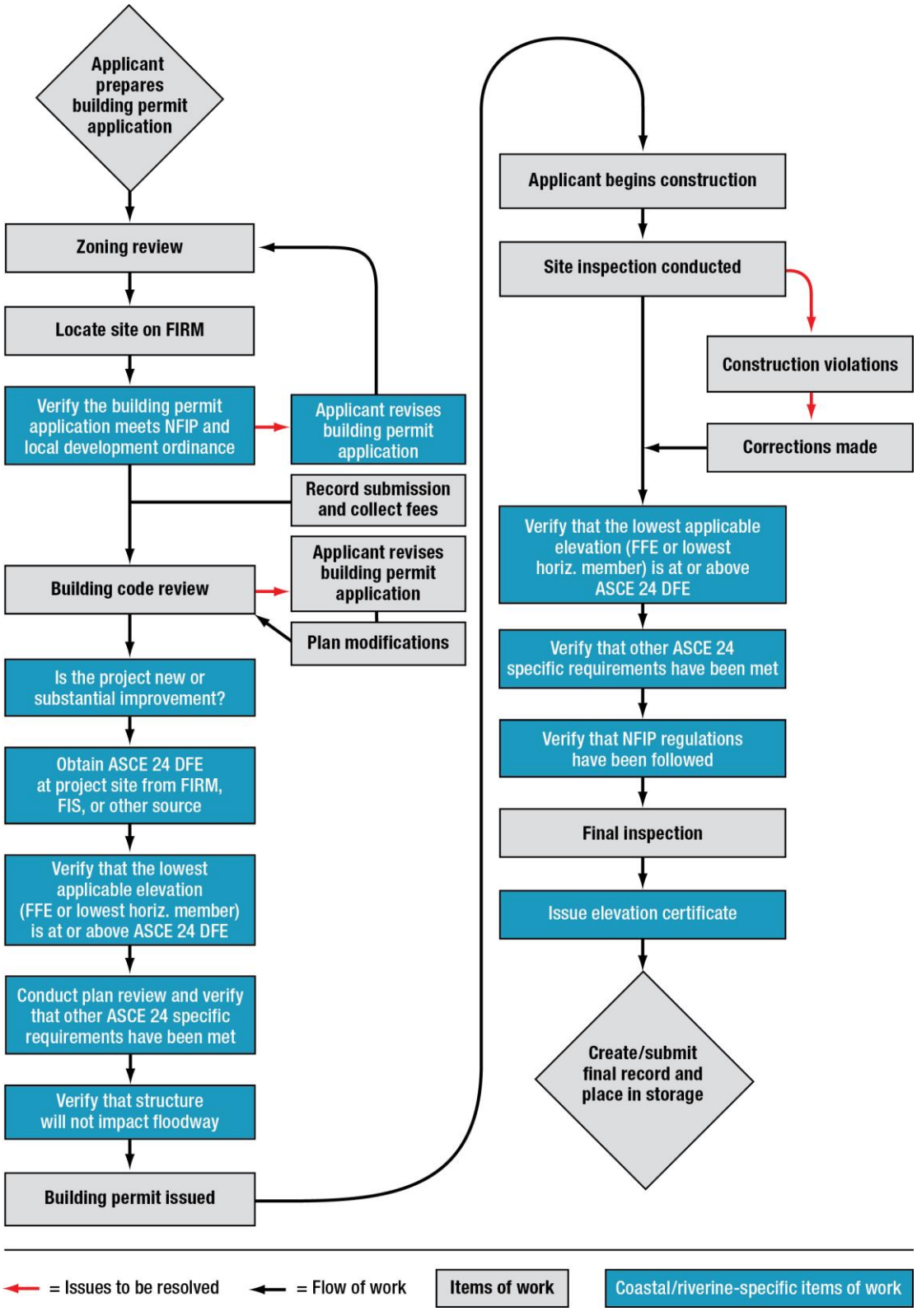

Figure 7-2. Overview of the permitting process*

*This process is not standard to all communities.

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A Deemed-to-Comply Table

Table A-1. Deemed-to-Comply Table

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
1.0	General		
1.1	Scope	This standard applies to new and substantially improved/damaged structures in flood hazard areas that are subject to building code requirements	New construction and substantial improvements shall meet the requirements of ASCE 24-05. Mitigation reconstruction projects shall meet the requirements of ASCE 24-05. For all other projects, ASCE 24-05 shall apply only to the mitigated portions of those projects.
1.3	Identification of Flood Hazard Areas	This standard applies to the larger of: 1) Special Flood Hazard Area (SFHA) and 2) lands designated by the authority having jurisdiction (AHJ) as flood hazard areas.	Must comply with ASCE 24-05 requirements.
1.4	Identification of Floodprone Structures	Determine whether a structure lies in whole or in part in flood hazard area; classify structures; don't allow new structures to damage or compromise flood protective works (1.4.2).	Determine whether an existing structure lies in whole or in part in flood hazard area; if so, this standard will apply as indicated throughout this summary. Structures shall be classified by ASCE 24-05 Table 1-1, and applicable provisions shall be applied. Mitigation projects shall not damage, endanger, or harm protective works, or interfere with maintenance and repairs of such works.
1.5	Basic Design and Construction Requirements	Designed, constructed, connected, and anchored to resist flotation collapse or permanent lateral movement during design loads and load combinations.	Must comply with ASCE 24-05 requirements.
1.6	Loads in Flood Hazard Areas	Loads and load combinations shall be in accordance with ASCE 7-02.	Design loads and load combinations for mitigated structural elements shall be in accordance with the applicable building code requirements or the requirements as shown in ASCE 24-05, whichever is more stringent, or the latest version of ASCE 7 if no building code is in effect.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
2.0	Basic Requirements for Flood Hazard Areas not Identified as Coastal High Hazard Areas or Coastal A Zones		
2.1	Scope	This section provides requirements for new construction and substantial improvements in A zones (not including Coastal A Zone).	Section 2 shall apply to the mitigated portions of an existing structure.
2.2	Development in Floodways	Structures and fill shall not be placed in floodways unless it can be demonstrated that the flood level will not be increased and the conveyance will not be reduced more than the allowable amounts.	Section 2.2 shall apply only to mitigation projects allowed within the floodway.
2.3	Elevation Requirements	Table 2-1: Design flood elevation (DFE) or base flood elevation (BFE) + freeboard, whichever is higher.	Mitigated structures shall be elevated to the elevation specified in ASCE 24-05 Table 2-1.
2.4	Use of Fill	Placement of structural fill shall account for consolidation and settlement of underlying soil due to weight of fill and structure. Fill shall be placed in lifts and compacted. Fill shall be stable and protected from scour and erosion, if needed.	Placement of structural fill shall account for consolidation and settlement of underlying soil due to weight of fill and structure. Fill shall be placed in lifts and compacted. Fill shall be stable and protected from scour and erosion, if needed. With respect to undisturbed areas, field observations and testing shall be permitted to be used to evaluate compliance with this requirement, provided such efforts ascertain whether settlement has occurred or is occurring, whether settlement has caused or is likely to cause structural problems, and whether proposed mitigation measures are likely to cause or exacerbate settlement to the point where the mitigated structure will sustain structural damage.
2.5	Slabs-on-Grade and Footings	Slabs shall be placed on structural fill or undisturbed soil with adequate bearing capacity. Top of slab shall be at or above elevation per Table 2-1. Bottom of turned down footings of slabs shall be below the depth of expected scour. Slabs shall be reinforced to prevent breakup if undermined. Slabs on structural fill shall suffer no loss of supporting soil during design flood. Footings shall support the structure (and prevent flotation, collapse, lateral movement) during design flood conditions. Slabs under elevated buildings shall not have turned down edges.	Slabs, footings, and underlying soil shall support the structure during design flood conditions such that the structure is not subject to flotation collapse or lateral movement. Existing slabs, footings, and underlying soil shall be evaluated using field observations and testing to a reasonable standard of care to verify that during design flood conditions they will not lead to structure floatation, collapse, or lateral movement.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
2.0	Basic Requirements for Flood Hazard Areas not Identified as Coastal High Hazard Areas or Coastal A Zones		
2.6	Enclosures Below the DFE	Enclosed areas below the DFE shall be used solely for parking, building access, or storage. Walls of enclosed areas, including breakaway walls, shall be equipped with openings to provide for automatic entry and exit of floodwaters. Openings shall meet the non-engineered or engineered opening requirements.	Must comply with ASCE 24-05 requirements.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
3.0	High Risk Flood Hazard Areas		
3.1	Scope	Section 3 shall apply to new construction and substantial improvements in high risk flood hazard areas.	Section 3 applies to new construction and substantial improvement/substantial damage unless a waiver is granted by FIMA.
3.2	Alluvial Fan Areas	Structures shall not be allowed in alluvial fan areas unless a whole fan flood damage reduction project exists, and such project has an operations and maintenance plan. Structures shall not be constructed at the apex of the fan or in the fan's meandering flow paths. Where permitted: 1) structures shall have the lowest floor at least 1.0 foot above the highest adjacent grade (higher, if required by the community), 2) foundations shall be designed to resist scour and flood loads for design flow velocities, or 5 feet/second, whichever is higher.	The ASCE 24-05 provision applies to new construction and substantial improvement/substantial damage unless a waiver is granted by FIMA.
3.3	Flash Flood Areas	Structures shall not be constructed in areas subject to flash flooding unless protective works have been determined to provide protection during a design flood event. Protective works must have an operations and maintenance plan. Areas suspected of being susceptible to flash floods shall be investigated and an engineering report shall be produced.	The ASCE 24-05 provision applies to new construction and substantial improvement/substantial damage unless a waiver is granted by FIMA.
3.4	Mudslide Areas	Structures shall not be constructed in areas subject to mudslides unless protective works have been determined to provide protection during a design flood event. Protective works must have an operations and maintenance plan. Areas suspected of being susceptible to mudslides shall be investigated and an engineering report shall be produced.	The ASCE 24-05 provision applies to new construction and substantial improvement/substantial damage unless a waiver is granted by FIMA.
3.5	Erosion-Prone Areas	Structures shall not be constructed in areas subject to erosion unless protective works have been determined to provide protection during a design flood event. Protective works must have an operations and maintenance plan. Erosion-prone areas shall be determined by analysis and such analyses shall be documented in an engineering report.	The ASCE 24-05 provision applies to new construction and substantial improvement/substantial damage unless a waiver is granted by FIMA.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
3.0	High Risk Flood Hazard Areas		
3.6	High Velocity Flow Areas	Structures shall not be constructed in areas subject to high velocity flow unless protective works have been determined to provide protection during a design flood event. Protective works must have an operations and maintenance plan. High velocity flow areas shall be determined by analysis and such analyses shall be documented in an engineering report. Section 1.2 defines High Velocity Flow as flow velocity greater than 10 feet/second adjacent to a structure or foundation during a design flood or lesser conditions.	The ASCE 24-05 provision applies to new construction and substantial improvement/substantial damage unless a waiver is granted by FIMA.
3.7	Areas Subject to Wave Action	Structures constructed in Coastal High Hazard Areas and Coastal A Zones shall meet the requirements of Section 4. Structures shall not be constructed in other areas subject to high velocity wave action (defined in Sec. 1.2 as 3.0 feet wave height or runup depth) unless they meet the requirements of Section 4.	Must comply with ASCE 24-05 requirements.
3.8	Ice Jam Debris Areas	Structures shall not be constructed in areas subject to transportation of damage-causing ice or debris unless protective works have been determined to provide protection during a design flood event. Protective works must have an operations and maintenance plan. Ice jam and debris areas shall be determined by analysis and such analyses shall be documented in an engineering report.	The ASCE 24-05 provision applies to new construction and substantial improvement/substantial damage unless a waiver is granted by FIMA.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
4.0	Coastal High Hazard Areas and Coastal A Zones		
4.1	Scope	Section 4 shall apply to new construction and substantial improvements in Coastal High Hazard Areas and Coastal A Zones. For the purposes of this standard, Coastal High Hazard Area shall mean those locations designated as V zones on the flood hazard map, or areas where 3 feet wave heights or runup depths will occur during the base flood. For the purposes of this standard, Coastal A Zone shall mean those locations where the stillwater depth and wave conditions will yield a wave height equal to or greater than 1.5 feet during the base flood.	Section 4 shall apply to the mitigated portions of an existing structure.
4.2	Genera	Design shall account for lateral and vertical wave loads, other flood loads, and scour and erosion.	Design shall account for lateral and vertical wave loads, other flood loads, and scour and erosion.
4.3	Siting	Structures shall be sited landward of the reach of mean high tide and shoreline construction setbacks, and shall not alter sand dunes or mangrove stands if those alterations reduce the wave and flow dissipation characteristics.	Mitigation projects shall not be allowed for or result in a building that is seaward of the reach of mean high tide. Mitigation projects shall not cause the wave or flow dissipation characteristics of sand dunes or mangrove stands to be reduced.
4.4	Elevation Requ ments	The bottom of the lowest horizontal structural member of the lowest floor shall be at or above the elevation specified in Table 4-1.	The bottom of the lowest horizontal structural member of the lowest floor shall be at or above the elevation specified in Table 4-1.
4.5	Foundation Requirements	Structures shall be elevated on and anchored to piles, columns, or where permitted, walls serving as shear walls. Foundations shall be free of obstructions. Permitted shear walls shall be oriented parallel to the direction of wave approach, and shall be staggered so as not to form a continuous wall or enclosed area. Spread footing, mat, or raft foundations shall not be permitted unless the top is below the eroded ground elevation, or unless subsurface nonerodible conditions prevent the use of deeply embedded piles or columns (footings, mats, and rafts shall be anchored to the nonerodible strata). Foundations shall be designed and constructed to withstand design loads and load combinations, including the effects of erosion and scour. Fill shall not be used for structural support. Nonstructural fill for landscaping and site drainage purposes shall be permitted. Grade beams shall be permitted but shall be designed to perform their intended function when undermined by scour and erosion. Bracing shall	Structures shall be elevated on and anchored to piles, columns, or where permitted, walls serving as shear walls. Foundations shall be free of obstructions. Permitted shear walls shall be oriented parallel to the direction of wave approach, and shall be staggered so as not to form a continuous wall or enclosed area. Spread footing, mat, or raft foundations shall not be permitted unless the top is below the eroded ground elevation, or unless subsurface nonerodible conditions prevent the use of deeply embedded piles or columns (footings, mats, and rafts shall be anchored to the nonerodible strata). Foundations shall be designed and constructed to withstand design loads and load combinations, including the effects of erosion and scour. Fill shall not be used for structural support. Nonstructural fill for landscaping and site drainage purposes shall be permitted. Grade beams shall be permitted but shall be designed to perform their intended function when undermined by scour and erosion. Bracing shall

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
4.0	Coastal High Hazard Areas and Coastal A Zones		
		be designed to minimize flood loads. The structure shall be designed to withstand any flood loads transferred from grade beams and bracing.	be designed to minimize flood loads. The structure shall be designed to withstand any flood loads transferred from grade beams and bracing. To the extent possible, designers should evaluate existing foundation elements that will be part of the new, elevated foundation to determine whether they can support the design loads as described in ASCE 24 and ASCE 7.
4.6	Enclosed Areas Below the DFE	Enclosed areas shall be used solely for parking, building access, and storage. Walls of enclosures shall be designed and constructed to break away without adversely affecting the main structure, and without producing debris capable of causing damage to structures. Enclosure walls in Coastal A Zones shall be equipped with openings that allow for the automatic entry and exit of floodwaters.	Enclosed areas shall be used solely for parking, building access, and storage. Walls of enclosures shall be designed and constructed to break away without adversely affecting the main structure, and without producing debris capable of causing damage to structures. Enclosure walls in Coastal A Zones shall be equipped with openings that allow for the automatic entry and exit of floodwaters.
4.7	Erosion Control Structures	Erosion control structures shall not be connected to the building foundation or other parts of the building. Erosion control structures shall not focus or increase flood forces or erosion impacts on any structure.	Mitigation projects shall not be permitted where an erosion control structure is connected to a building or its foundation, or where the erosion control structure will cause damaging flow diversion, or wave runup or reflection, or erosion impacts to the building.
4.8	Decks, Concrete Pads and Patios	Decks, pads, and patios are permitted below the DFE provided they are structurally independent of the primary structure foundation, and do not adversely affect adjacent structures through flow deflection or debris. Decks, pads, and patios shall be of breakaway construction, and shall not produce damage-causing debris. Concrete pads shall have a maximum thickness of 4 inches and not be reinforced.	Decks, concrete pads, and patios will be retrofitted only if they pose a potential threat to the main structure or are attached to the structure. Efforts will be made to minimize the work necessary to retrofit these portions of the structure to make the deck, pad, or patio such that they no longer pose a threat to the building.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
5.0	Materials		
5.1	General	New construction and substantial improvements shall be constructed with flood-damage-resistant materials below the elevation specified in Table 5-1. Unless designed to break away, materials shall have the strength, rigidity, and durability to withstand floods and other loads. Materials shall be capable of resisting damage, deterioration, corrosion, and decay.	Mitigated portions of an existing structure shall utilize flood-damage-resistant materials below the elevation specified in Table 5-1, and shall use materials capable of resisting damage, deterioration, corrosion, and decay.
5.2	Specific Material Requirements for Flood Hazard Areas	ASCE 24-05 contains specific requirements or cites reference standards for: metal connectors and fasteners, structural steel, concrete, masonry, wood and timber, and finishes.	Material specific specifications shall be in accordance with the applicable building code requirements or the requirements as shown in ASCE 24-05, whichever is more stringent, or the latest version of the specification if no building code is in effect.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
6.0	Dry and Wet Floodproofing		
6.1	Scope	Section 6 addresses floodproofing for new construction and substantial improvements. Floodproofing shall take into consideration flood loads and load combinations, the nature of flood-related hazards, flood warning time and access, structure occupancy and use, and functional dependence.	Section 6 shall apply to mitigation projects.
6.2	Dry Floodproofing	Dry floodproofing shall render a structure substantially impermeable to the passage of floodwater below the elevation specified in Table 6-1. Dry floodproofing shall be limited to non-residential structures and non-residential portions of mixed-use structures. Dry floodproofing shall be limited to structures where flow velocities adjacent to the structure are less than or equal to 5 feet/second. Where human intervention is necessary, dry floodproofing shall be limited to situations where at least 12 hours of flood warning time is provided, or where a community warning and evacuation plan provides sufficient time to activate/install the floodproofing and evacuate floodproofing staff. Where removable shields are included in the dry floodproofing, a flood emergency plan approved by the AHJ is required.	Must comply with ASCE 24 requirements.
6.3	Wet Floodproofing	Wet floodproofing shall be accomplished using flood-damage-resistant materials and techniques. Wet floodproofing of enclosed spaces below the elevation in Table 6-1 shall be limited to Category 1 structures; enclosures used for parking building access or storage in any category building; functionally dependent structures; and agricultural buildings not classified as Category 1, that cannot be located elsewhere, and that are used solely for agricultural purposes.	Must comply with ASCE 24 requirements.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
7.0	Utilities		
7.1	General	Utilities and equipment shall not be permitted below the elevations in Table 7-1, unless in dry-floodproofed spaces or specifically permitted by this section, and unless designed, constructed, and installed to prevent floodwaters from entering or accumulating within the components. Utilities and equipment shall be anchored to resist flood forces. Utilities and equipment shall not be mounted on, or pass through, or be located along breakaway walls. Supports for elevated exterior platforms for utilities and equipment shall be capable of resisting flood loads including effects of erosion and scour.	Section 7 shall apply to all building utilities and equipment that are replaced during a mitigation project. Provisions related to underground lines do not apply unless the underground lines are affected or disturbed during the construction of the mitigation project.
7.2	Electrical Service	If electrical service is below the minimum flood elevation, it must be waterproof or conform to National Fire Protection Association (NFPA) 70, National Electrical Code. All electrical components below the minimum elevation must be designed to resist flood forces. Electrical components must be secured to the structure and not a breakaway wall or enclosures. Everything must be sealed to prevent water intrusion.	Section 7 shall apply to all building utilities and equipment that are replaced during a mitigation project. Provisions related to underground lines do not apply unless the underground lines are affected or disturbed during the construction of the mitigation project.
7.3	Plumbing Systems	If plumbing equipment is below the minimum flood elevation, it must be waterproof. All plumbing components below the minimum elevation must be designed to resist flood forces. Plumbing components must be secured to the structure and not a breakaway wall or enclosures. Backflow devices are required for lines that extend below the DFE. Everything must be sealed to prevent floodwater intrusion or loss of sewage into floodwaters. Underground lines must be designed to address scour and erosion. Storage tanks must be anchored to resist flood forces. Sanitary systems must be designed to operate during flood conditions and subsequent days following the flood event.	Section 7.2 shall apply to all building utilities and equipment that are replaced during a mitigation project. Backflow prevention valves should be installed for all mitigation projects and tanks should be properly anchored for all mitigation projects.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
7.0	Utilities		
7.4	Mechanical, HVAC Systems	Mechanical systems should be located above the DFE, if any is below the minimum flood elevation, it must be waterproofed. All mechanical components below the minimum elevation must be designed to resist flood forces. Mechanical components must be secured to the structure, located on the landward side of the structure, and not secured to breakaway walls or enclosures. Everything must be sealed to prevent water intrusion. Fuel lines must include an automatic float shutoff valve when floodwaters rise above the supply line elevation.	Section 7 shall apply to all building utilities and equipment that are replaced during a mitigation project. Provisions related to underground lines do not apply unless the underground lines are affected or disturbed during the construction of the mitigation project.
7.5	Elevators	All elevator components must be above the DFE. If anything is located below that, it must be made of flood-damage-resistant materials and capable of resisting physical damages due to a flood. Electrical controls must be located above the DFE. Drainage must be detailed for elevator pits below the DFE. The cab must be fitted such that it cannot descend below floodwaters.	Section 7 shall apply to all building utilities and equipment that are replaced during a mitigation project. Provisions related to underground lines do not apply unless the underground lines are affected or disturbed during the construction of the mitigation project.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
8.0	Building Access		
8.1	General	Stairways and ramps located below the Minimum Lowest Floor Elevation must be constructed of flood-damage-resistant materials and be designed to resist flood-related loads and to minimize the transfer of flood loads to the structure and structure foundation or to breakaway during design flood conditions without causing damage to the structure, including the foundation. Enclosures must comply with other enclosure provisions in ASCE 24.	Section 8 shall apply to mitigation projects.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
9.0	Miscellaneous Construction		
9.1	General	Structures must comply with loads in Section 1.6 and be elevated as per Section 2.3 and 4.4, using materials that conform to Section 5, and all associated utilities must conform to Section 7.	Items not directly related to the mitigation project will not be required to meet the ASCE 24-05 provisions requirements.
9.2	Decks, Porches and Patios	In flood hazard areas other than Coastal High Hazard Areas, Coastal A Zones, and other high risk flood hazard areas, decks, porches, and patios that are structurally connected must act as a continuation of the structure and meet loading requirements, and those below the DFE must also meet the opening requirements. Those not structurally connected to a structure designed below the Minimum Lowest Floor Elevation shall conform to the foundation requirements of Section 1.5.3 and enclosed walls shall conform to the requirements for openings as stated in Section 2.6. In V Zones and Coastal A Zones (and other high risk flood areas), decks, porches, and patios that are structurally connected to the structure must act as a continuation of the structure and be located above the DFE. Those not structurally connected to a structure and below the Minimum Lowest Horizontal Structural Member Elevation shall be designed in accordance with Section 4.8 and enclosed walls shall conform to the breakaway wall requirements in Section 4.6.	In some instances, decks, porches, and patios that cannot be successfully retrofitted may need to be detached from the structure. The level of retrofitting necessary will be to a threshold necessary to ensure that during a design flood condition the deck, porch, or patio does not cause damage to the main structure or its foundation.
9.3	Garages	In flood hazard areas other than Coastal High Hazard Areas, Coastal A Zones, and other high risk flood hazard areas, carports and garages that are structurally connected must act as a continuation of the structure and meet loading requirements, and those below the DFE must also meet the opening requirements and at least two sides must be above grade (floodproofing provisions apply to nonresidential structures). Those not structurally connected to a structure designed below the DFE shall conform to the foundation requirements of Section 1.5.3 and enclosed walls shall conform to the requirements for openings as stated in Section 2.6. In V Zones and Coastal A Zones (and other high risk flood areas), carports and garages that are structurally connected to	In some instances, garages and carports that cannot be successfully retrofitted may need to be detached from the structure. The level of retrofitting necessary will be to a threshold necessary to ensure that during a design flood condition the garage or carport does not cause damage to the main structure or its foundation.

Section	Title	Summary of ASCE 24-05 Provision	ASCE 24-05 Provision as applied to HMA
9.0	Miscellaneous Construction		
		the structure must act as a continuation of the structure, those areas below the DFE must be constructed with breakaway walls in conformance to the requirements of Section 4, and all sides must be above grade. Those not structurally connected to a structure and below the DFE shall be designed in accordance with Section 4 and enclosed walls shall conform to the breakaway wall requirements in Section 4.6.	
9.4	Chimneys and Fireplaces	In flood hazard areas other than Coastal High Hazard Areas, Coastal A Zones, and other high risk flood hazard areas, chimneys that extend below the DFE must be designed to be vertically supported and independent of the structure, and must be designed to withstand all flood-related loads. In V Zones and Coastal A Zones, they must be supported by an open foundation designed to meet all loading requirements	All fireplace and chimney foundations will be retrofitted to resist flood loads and wind loads (and other loading), but where it is not possible to make the chimney or fireplace structurally independent, it will be allowed to remain structurally attached.
9.5	Pools	Pools must resist all flood load requirements. If attached to the structure, the pool must act as a continuation of the structure. In V Zones or Coastal A Zones, if the pool is attached to the structure, it must be above the DFE and be elevated per Section 4.4 or be designed to break away during flooding without producing damaging debris.	May cause significant cost increases for pools attached to the structure. These are ineligible costs for a HMA project, so pool requirements are the responsibility of the homeowner and must be funded by the homeowner.
9.6	Storage Tanks	Tanks must be designed to be consistent with Section 7 and be anchored to resist all flood loads. The tank must also be designed to prevent the release of its contents during a flood condition. It must be anchored to resist up to 1.5 times its buoyancy load when empty during a design flood event.	May not impact many projects since this section refers to tanks independent of the structure.

B Benefit-Cost Considerations

B.1 Introduction

The purpose of this appendix is to provide basic guidance on using the Federal Emergency Management (FEMA) Benefit-Cost Analysis (BCA) Tool (Version 4.5.5) (2009) to complete a BCA for the three primary mitigation project types covered in this publication:

- Structure elevation
- Dry floodproofing
- Mitigation reconstruction

B.2 Elevation

The Flood module in the BCA Tool is typically used to complete a BCA for an elevation project. The Flood module relies on flood hazard data, building characteristics (size, occupancy type, replacement value, etc.), depth-damage function (DDF), and the increase in building elevation to estimate before- and after-mitigation damages. It is important to reflect the total elevation amount in the BCA as well as the project cost. The elevation amount should be the increase in building elevation necessary for the building to be at or above the design flood elevation (DFE). The DFE is the regulatory flood elevation adopted by a local community or provided by ASCE 24, whichever is greater. Typically, the DFE is the base flood elevation (BFE) plus any freeboard adopted by the community. The BFE is defined as the flood elevation, including wave height, having a 1-percent chance of being equaled or exceeded in any given year and the minimum elevation requirement under the National Flood Insurance Program (NFIP).

As a general rule of thumb, elevation projects for buildings situated at or below the 10-percent-annual-chance flood elevation (or 10-year flood) are most likely cost effective, those below the 4-percent-annual-chance flood elevation (or 25-year flood) are likely cost effective, and those above the 4-percent-annual-chance flood elevation are not likely cost effective.

In addition to traditional elevation projects where an entire building is elevated, the BCA Tool can also be used to evaluate the cost effectiveness of elevating utilities or other critical components of a building. Buildings that are already above the required DFE may have utilities in locations such as a basement that are subject flooding. In these cases, it is maybe cost effective to elevate a water heater; electrical panel; heating, ventilation, and air conditioning (HVAC) system; and/or other building component so that the building remains serviceable during frequent flood events. The Flood module in the BCA Tool can be used to analyze this type of project by appropriately adjusting the DDF. The project cost should be limited to the scope of elevating the utility (versus the entire building). Depending on the frequency of flooding, these projects are typically cost effective because they are relatively inexpensive (especially if the utilities are continuously damaged by flooding).

See section B.8 for FEMA's policy to streamline the BCA process for elevation type mitigation projects.

B.3 Dry Floodproofing

Determining the cost effectiveness of a floodproofing project can be done using either the Flood module or the Damage Frequency Assessment (DFA) module, which are both part of the BCA Tool. The Flood module relies on flood hazard data, building characteristics, and DDFs, and the DFA module relies on historical or expected damage along with a recurrence interval associated with the damage. The DFA module is used more often for floodproofing because it generally requires less data collection and may better represent the complexity of some floodproofing projects. Damages in the DFA are often estimated by applying a DDF (see Section 2.1.4.7, Using the BCA Full Data Flood Module to Maximize Benefits in the DFA Module, in the FEMA *Supplement to the Benefit-Cost Analysis Reference Guide* [2011]).

Loss of function is the direct economic impact that occurs when physical damage is severe enough to interrupt the function or normal use of a building. These types of damages are often overlooked in floodproofing project BCAs and can make up the largest percentage of net benefits for mitigation projects, especially for nonresidential buildings.

Typically, loss of function damage is calculated using the annual net income of a business or the annual operating budget for a public service (e.g., school, library) to estimate a value of service per day for the function of the building. The value of service per day is multiplied by the estimated number of days a building is expected to be closed based on the depth of flooding (the estimated number of days is typically included in a DDF and varies by building and occupancy type). It is important to consider whether displacement benefits are already being accounted for in the BCA; if so, displacement and loss of function cannot both be included in the BCA if the function or service is being provided at a temporary facility (an exception is if partial displacement and loss of function are combined).

B.4 Mitigation Reconstruction

The cost effectiveness of a mitigation reconstruction project can be determined using the BCA Tool's Flood module. Similar to an elevation project, flood hazard data, building characteristics (size, occupancy type, replacement value, etc.), DDF, and before- and after-mitigation elevation data are required in order for the Flood module to estimate damages. Just like an elevation project BCA, the elevation amount should be the building elevation necessary for it to be at or above the DFE. Because some of the building characteristics (size) and DDF (one-story versus two-story) are changed by reconstruction, the user will need to enter the building as two separate structures and compare the present value of benefits for each structure to determine the net benefit associated with the mitigation reconstruction project.

A common mistake made when analyzing mitigation reconstruction projects is to consider only the cost difference associated with reconstructing the building to the DFE versus the existing first

floor elevation. However, the total project cost must include all documented costs, including the cost to demolish the existing building and the total reconstruction cost.

It is important to evaluate cost effectiveness and maximize the extent of elevation during reconstruction to reduce flood damage resulting from future conditions, such as sea level rise, erosion, and development impacts. In 2006, the American Institutes for Research prepared a study that assessed the cost of adding freeboard at the time of construction. The *Evaluation of the National Flood Insurance Program's Building Standards* (AIR 2006) found the additional costs are modest compared to the benefit. In addition, the study found that property owners who incorporate freeboard recover their investment through flood insurance premium discounts in just a few years (3 to 8 years, depending on flood zone and building characteristics). Although insurance premium reductions are not eligible benefits for a FEMA BCA, they should be considered an additional benefit to the building owner.

One additional consideration for reconstruction projects is the benefits associated with other hazards (wind and seismic). A reconstructed building will be built to the latest building codes. Depending on the age of the existing building, the reconstructed building maybe less vulnerable to wind and seismic loads. These benefits can be captured using the Wind and Seismic modules in the BCA Tool.

B.5 Data Requirements for Use of the FEMA BCA Tool

The following table illustrates common data requirements for each project type by BCA Tool module.

Table B-1. BCA Data Requirements by Project Type and Tool Module

CATEGORY	DESCRIPTION	Elevation		Dry Floodproofing		Mitigation Reconstruction	
		Flood	DFA	Flood	DFA	Flood	DFA
Scope of Work	Problem description, proposed solution, description of existing conditions, work schedule	R	R	R	R	R	R
Project Useful Life	Estimated number of years the mitigation will be effective	R	R	R	R	R	R
Project Cost	Labor, materials, engineering and design, project management, construction engineering and inspection, permitting, estimated annual maintenance costs, etc.	R	R	R	R	R	R
Flood Hazard Data	Flood Insurance Study or hydrologic and hydraulic study data indicating the source of flooding; 10-, 50-, 100-, and 500-year flood hazard data	R	U	R	U	R	U
Building Size	Enclosed square footage	R	U	R	U	R	U
Building Type	Number of stories, wood vs. masonry, etc.	R	P	R	P	R	P

CATEGORY	DESCRIPTION	Elevation		Dry Floodproofing		Mitigation Reconstruction	
		Flood	DFA	Flood	DFA	Flood	DFA
Occupancy Type	Residential, retail, hotel, restaurant, hospital, medical office, religious facilities, schools, office, apartment, industrial, warehouse, etc.	R	P	R	P	R	P
First Floor Elevation	The elevation based on a FEMA Elevation Certificate or other accepted source documentation indicating the first floor elevation or lowest horizontal structural member	R	P	R	P	R	P
Building Replacement Value	Cost per square foot to build a comparable building	R	P	R	P	R	P
Contents Value	Description of contents, their value, and how the value was assessed	R	P	R	P	R	P
Displacement Costs	Cost of displacement while damage is repaired	R	P	R	P	R	P
Type & Value of service	Type of service(s) provided (e.g., residential government, library, education, medical, shelter, administrative, warehouse/storage)	R	R	R	R	R	R
Estimated Damages	Explanation of how pre- and post-mitigation damages were estimated as well as an explanation of project level of effectiveness	U	R	U	R	U	R
Recurrence Interval of Estimated Damages	Explanation of how probability of loss was estimated	U	R	U	R	U	R

R/Green – Required

P/Yellow – Possibly needed/situation dependent

U/Red – Normally unnecessary

B.6 Other Considerations

In addition to these considerations, the FEMA *Supplement to the Benefit-Cost Analysis Reference Guide* (2011) provides the following guidance that can help you complete a BCA for all three project types.

- DFA Module
    - Determining Recurrence Intervals (Section 2.1.2) – Provides direction on how to use stream gage data to help estimate the recurrence interval of a storm event. This can be of assistance when there are historic damages without a known recurrence interval.

  - Using National Flood Insurance Program (NFIP) BureauNet Data (Section 2.1.4) – Provides guidance on retrieving flood insurance policy claims data from a Web-based database that contains information on all NFIP claims since 1978. This can be helpful when flood hazard data or a building elevation is unavailable to help estimate damages based on flood depths; historical damages are used instead.

- Flood Module
  - Counting Damages for Finished or Unfinished Basements (Section 2.2.1) – Provides assistance with properly adjusting DDFs for residential buildings with finished basements. Appropriately applying DDFs is important to properly estimating damages when mitigating a building with a basement.

For large-scale projects where multiple buildings are being mitigated, it is important to consider combining the benefits and costs associated with all the buildings. The BCA Tool and the *Hazard Mitigation Assistance Unified Guidance* (FEMA 2010a) allow for calculating an aggregate benefit-cost ratio (BCR) for projects that address multiple structures. An aggregate BCR is calculated by dividing the total net present value of benefits for each structure by the total project cost estimate. Aggregation of benefit and cost values is allowed if the structures are vulnerable to damage as a result of similar hazard conditions. A key factor in analyzing projects with multiple buildings is to consider the likelihood of any buildings dropping out throughout HMA project implementation process (see figure 7-1). In some cases, high-risk buildings dropping out can jeopardize the cost effectiveness of the entire project.

B.7 The Greatest Savings To the Fund

FEMA also allows the use of the Greatest Savings To the Fund (GSTF) data and methodology to demonstrate cost effectiveness for Severe Repetitive Loss properties included in mitigation projects. Subapplicants are not required to use this methodology when submitting projects for funding, and may use the current applicable BCA version methodology. The GSTF approach measures the expected savings of a mitigation project over a specific time period, such as 30 years. This methodology is based on the actual insurance claims paid on a structure. In this approach, the total expected future insurance claim payments and loss adjustment expenses (expected dollars paid out of the National Flood Insurance Fund [NFIF], assuming the property is not mitigated) are reduced by the total expected future insurance premiums available for paying claims (expected dollars paid into the NFIF, assuming the property is not mitigated) to derive the savings to the fund from the proposed mitigation. Similar to the more traditional methods of BCA, the savings to the fund (benefit) and project cost are then compared to determine the cost effectiveness of the mitigation activity.

B.8 FEMA Policy for Streamlining BCA

Projects that are eligible for funding under the HMA programs must be cost effective, i.e., have a BCR equal to or greater than 1.0. A FEMA memorandum, released on August 15th, 2013,

provides a methodology to streamline the benefit cost analysis for certain mitigation project types. This methodology was based on FEMA's Risk Reduction Division analysis of 11,000 acquisition and elevation projects. FEMA has determined that the average benefits for each type of project are $276,000 and $175,000, respectively (2013 dollars). Therefore, FEMA has determined that the acquisition or elevation of a structure located in a 100-year floodplain (as delineated on the FIRM or based on best available data) that costs less than or equal to the average benefit listed above is considered cost effective. For projects that contain multiple structures, the average cost of all structures in the project must meet the stated criterion. There is no need for applicants to conduct a separate BCA for a structure that meets this criterion.

C Mitigation Measure Selection Worksheet

A number of site- and building-specific factors influence the selection of a mitigation measure for an existing building. The Mitigation Measure Selection Worksheet has been developed to simplify the process of selecting a mitigation option and is an optional tool. It asks users to answer a list of questions and, based on the answers, provides possible mitigation options, along with any additional items to consider. The questions account for National Flood Insurance Program (NFIP) regulations and guidance, existing codes and standards, and engineering requirements. They also help to identify any potential cost increases or engineering challenges associated with a given project.

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D Checklists for Mitigation Projects: Development, Grant Applications, Implementation, and Closeout

Checklists are provided as an optional tool to guide the applicant through the grant application process and project development, implementation, and closeout. A flowchart represents the project and grant application "life cycle," presenting various steps in the process for which these optional checklists are available to facilitate data collection and compilation.

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Resources

FEMA Hazard Mitigation Assistance (HMA) Programs	
Benefit-Cost Analysis	http://www.fema.gov/benefit-cost-analysis
Benefit-Cost Analysis Helpline	http://www.bcahelpline.com
Environmental Planning and Historic Preservation	http://www.fema.gov/environmental-planning-and-historic-preservation-program
Flood Mitigation Assistance Program	http://www.fema.gov/flood-mitigation-assistance-program
Hazard Mitigation Assistance Overview	http://www.fema.gov/hazard-mitigation-assistance
Hazard Mitigation Assistance Helpline	Telephone: (866) 222-3580 E-mail: hmagrantshelpline@dhs.gov
Hazard Mitigation Assistance policies	http://www.fema.gov/hazard-mitigation-assistance-policy
Hazard Mitigation Grant Program	http://www.fema.gov/hazard-mitigation-grant-program
Increased Cost of Compliance coverage	http://www.fema.gov/national-flood-insurance-program-2/increased-cost-compliance-coverage
Pre-Disaster Mitigation Program	http://www.fema.gov/pre-disaster-mitigation-grant-program
FEMA Building Science Publications and Other Resources	
Community Rating System	http://www.fema.gov/national-flood-insurance-program-community-rating-system
Community Rating System Resource Center	http://training.fema.gov/EMIWeb/CRS/
FEMA Building Science Branch	http://www.fema.gov/building-science
FEMA Library	http://www.fema.gov/resource-document-library
FEMA P-787, *Catalog of FEMA Flood and Wind Publications, and Training Courses*	http://www.fema.gov/media-library/assets/documents/12909
Flood Insurance Studies	http://www.fema.gov/floodplain-management/flood-insurance-study
Flood Insurance Rate Maps	http://www.fema.gov/floodplain-management/flood-insurance-rate-map-firm
Information and Guidance on Building Safer	http://www.fema.gov/safer-stronger-protected-homes-communities
Map Service Center	http://msc.fema.gov/
Mitigation	http://www.fema.gov/what-mitigation
Mitigation Assessment Team Reports	http://www.fema.gov/fema-mitigation-assessment-team-reports
Mitigation Planning	http://www.fema.gov/hazard-mitigation-planning-overview
National Flood Insurance Program	http://www.fema.gov/national-flood-insurance-program
National Flood Insurance Program Technical Bulletins	http://www.fema.gov/national-flood-insurance-program-2/nfip-technical-bulletins
National Preparedness Directorate National Training and Education	http://www.training.fema.gov/

Building Codes and Standards	
The Aluminum Association	http://www.aluminum.org
American Concrete Institute	http://www.concrete.org
American Institute of Steel Construction	http://www.aisc.org
American Society of Civil Engineers Publications	http://www.pubs.asce.org/
American Society for Testing and Materials	http://www.astm.org
The Engineered Wood Association	http://www.apawood.org
International Code Council: Codes and Standards	http://www.iccsafe.org/cs/
National Fire Protection Association	http://www.nfpa.org
Other Resources	
Flood Mitigation News	http://www.floodmitigation.com/
International Association of Structural Movers	www.iasm.org
National Oceanic and Atmospheric Administration's National Weather Service	http://www.nws.noaa.gov/
National Park Service Secretary of the Interior's Standards for the Treatment of Historic Properties	http://www.nps.gov/history/hps/tps/standguide/
Natural Resource Conservation Service	http://www.nrcs.usda.gov/programs/
Natural Resource Conservation Service Soils website	http://soils.usda.gov/
Natural Resource Conservation Service Technical Resource Library	http://www.nrcs.usda.gov/technical/
National Trust for Historic Preservation	http://www.preservationnation.org/resources/technical-assistance/disaster-recovery/preparing-for-floods.html
National Weather Service	http://www.nws.noaa.gov/
National Weather Service Automated Flood Warning Systems	http://afws.erh.noaa.gov/afws/national.php
National Weather Service Precipitation Frequency Studies	http://www.nws.noaa.gov/oh/hdsc/currentpf.htm
U.S. Army Corps of Engineers Library	http://www.publications.usace.army.mil/
U.S. Department of Housing and Urban Development	http://portal.hud.gov/portal/page/portal/HUD

State and Regional Contacts	
Association of State Floodplain Managers	http://www.floods.org/
Federal Emergency Management Agency	http://www.fema.gov/fire-management-assistance-grants-regional-contacts
National Flood Insurance Program	http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-regional-offices
State Hazard Mitigation Officers	http://www.fema.gov/state-hazard-mitigation-officers
State Historic Preservation Offices	http://www.nps.gov/nr/shpolist.htm
U.S. Army Corps of Engineers	http://www.usace.army.mil/

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F Acronyms and Abbreviations

A

AHJ	authority having jurisdiction
ASCE	American Society of Civil Engineers
AST	above ground storage tank

B

BCA	Benefit-Cost Analysis
BCR	benefit-cost ratio
BFE	base flood elevation

C

CFR	Code of Federal Regulations

D

DDF	depth-damage function
DEHP	bis(2-ethylhexyl)phthalate
DFA	Damage Frequency Assessment
DFE	design flood elevation

E

EHP	environmental and historic preservation
EO	Executive order

F

FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance Program
ft	feet

G

GSTF	Greatest Savings To the Fund

H

HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HVAC	heating, ventilation, and air conditioning

I

IBC	International Building Code
ICC	Increased Cost of Compliance
IEBC	International Existing Building Code
IRC	International Residential Code for One- and Two-Family Dwellings

L

LHSM	lowest horizontal structural member
LiMWA	Limit of Moderate Wave Action

N

NEPA	National Environmental Protection Act
NFIF	National Flood Insurance Fund
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NRHP	National Register of Historic Places

P

PCB	polychlorinated biphenyl
PDM	Pre-Disaster Mitigation Program

S

SFHA	Special Flood Hazard Area
SHPO	State Historic Preservation Officer

T

TB	Technical Bulletin

U

UST	underground storage tank