Elevation Technical Review

This job aid supplement covers the requirements associated with the technical reviews for elevation projects funded by Hazard Mitigation Assistance. FEMA will also conduct an Environmental Planning and Historic Preservation review of each project. Refer to the Elevation: Information Required for Environmental Review Job Aid.

This Technical Review Supplement provides additional information, examples and potential sources of documentation for items listed in the Elevation Job Aid to help communities applying for Hazard Mitigation Assistance grants comply with application requirements.

- All Hazard Mitigation Assistance (HMA) applications must comply with the requirements outlined in the HMA Guidance.
- According to the guidance, in addition to a general programmatic review, an EHP review and a technical review will be performed by FEMA for each proposed project.
- The technical review will verify that a project demonstrates feasibility, effectiveness and cost-effectiveness. This document is intended for technical reviews of applications only.
- For assistance completing EHP compliance reviews, see the EHP Supplemental Job Aids.

Introduction

The following provides a review of the information that should be provided with the grant application, including recommended documentation and a list of supplementary information, to assist FEMA when conducting technical reviews of the project application. Technical resources are identified throughout this supplement to provide clarifying information on specific project application components. The final section provides a comprehensive list of resources identified throughout this supplement.

The project-specific guidance in this supplement does not provide all the information necessary to apply for funding through an HMA program and must be read in conjunction with all other relevant guidance documents.

Additional Resources

- Hazard Mitigation Assistance Guidance (HMA Guidance), Part E
- Benefit-Cost Analysis Reference Guide and Supplement to the Benefit-Cost Analysis Reference Guide
- Hazard Mitigation Assistance Application Development
- Scope of Work Development for Structural Elevation
- Sample Engineering Case Study for Structural Elevation

A list of all resources referenced is provided on the last page of the supplement.

FEMA

Summary of Steps

- ☐ STEP 1: Provide a Scope of Work
- ☐ STEP 2: Provide Structure-Specific Details
- ☐ STEP 3: Provide Available Technical Data
- ☐ STEP 4: Provide a Project Schedule
- ☐ STEP 5: Provide a Project Cost Estimate
- ☐ STEP 6: Provide a Project Site Map
- ☐ STEP 7: Provide Property Location Information
- ☐ STEP 8: Provide Lowest Floor Elevation
- ☐ STEP 9: Provide Structure Photographs
- ☐ STEP 10: Document the Before-Mitigation Flood Risk
- ☐ STEP 11: Cost-Effectiveness Analysis
- ☐ STEP 12: Environmental and Historic Preservation Considerations

Important Terms

ASCE/SEI 24-14 (American Society of Civil Engineers/Structural Engineering Institute – Minimum Design Standards and Other Structures, 2016 Edition): This standard provides minimum requirements for design and construction of structures located in flood hazard areas and subject to building code requirements.

Base Flood Elevation (BFE): The elevation shown on the Flood Insurance Rate Map (FIRM) for Zones AE, AH, A1-A30, AR, AR/A, AR/AE, AR/A1-A30, AR/AH, AR/AO, V1-V30 and VE that indicates the water surface elevation resulting from a flood that has a 1% change of equaling or exceeding that level in any given year.

Elevated Building: A building that has no basement and a lowest floor that is elevated to or above the base flood elevation (BFE) by foundation walls, shear walls, posts, piers, pilings or columns.

Federal Flood Risk Management Standards (FFRMS): A federal policy (FEMA Interim Policy FP-206-21-003) that sets forth the elevation requirements for projects in the special flood hazard area.

Flood Insurance Rate Map (FIRM): The official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community.

Flood Insurance Study (FIS): A compilation and presentation of flood risk data for specific watercourses, lakes and coastal flood hazard areas within a community. When a flood study is completed for the National Flood Insurance Program (NFIP), the information and maps are assembled into an FIS. The FIS report contains detailed flood elevation data in flood profiles and data tables.

Lowest Floor: The lowest floor of the lowest enclosed area (including basement). An unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access or storage in an area other than a

basement area is not considered a building's lowest floor, provided that such enclosure is not built to render the structure in violation of the applicable non-elevation design requirements of 44 CFR Part 60.3.

Lowest Floor Elevation (LFE): The elevation of the top of the lowest finished floor in a building.

Special Flood Hazard Area (SFHA): The land in the floodplain within a community subject to a 1% or greater chance of flooding in any given year. Also, an area having special flood, mudflow, or flood-related erosion hazards and appearing on a Flood Hazard Boundary Map or a FIRM as Zone A, AO, A1-A30, AE, A99, AH, AR, AR/A, AR/AE, AR/AH, AR/AO, AR/A1-A30, V1-V30, VE or V.

Technical Review Components

To complete a successful project application, a minimum amount of technical information is required for review. The following is a step-by-step approach to addressing the major components of an elevation project. Data collected in these steps will provide reviewers with the necessary information to determine whether a project is feasible and effective.

The data requirements in the following steps should be compiled in an attachment to the project application. If the project impacts multiple structures, this information must be provided for each.

STEP 1: Provide a Scope of Work

Description: Provide a project narrative clearly identifying the proposed mitigation action and structures to be mitigated, describing the proposed activities and a clear explanation of how the project will mitigate risk. The SOW should include key milestones and coincide with the design information, project schedule and cost estimate.

References: When preparing a SOW, refer to the following:

- For guidance, see HMA Guidance Part IV, Section H: Scoping Narrative: Scope of Work, Schedule, and Cost Estimate; and Addendum to the HMA Guidance, Part A: Property Acquisition and Structure Demolition or Relocation for Open Space.
- For an example narrative for an Elevation Project, see the HMA Application Development – Mitigation Project Subapplication Scope of Work Examples and Sample Engineering Case Study for Elevation.

Approach: The following items should be included in the SOW:

- Provide a detailed narrative of the flood risk being mitigated, including flood event history in the project area, if available.
- Mitigation project alternatives are required as part of application development. Document at least two alternatives that were considered as part of the planning or design phase. Clearly indicate which alternative is the preferred mitigation project and discuss why it is the most practical, effective and environmentally sound alternative. One alternative is often considered the "no-action alternative" and reflects conditions expected to exist if a mitigation project is not completed. This is a key step to ensure an efficient EHP review process. For additional guidance, see the Elevation EHP Review.

- Clearly explain the proposed mitigation activity, specifying the deliverables, identifying the tasks required to complete the proposed activity and defining the tasks to be accomplished in clear, concise and meaningful terms. All cost elements must match tasks and provide sufficient detail for FEMA to determine whether the application is eligible. The scoping narrative (including SOW) will become part of the conditions of the award.
- Describe the existing conditions of the structure(s) to be elevated. Specific details and documentation to support the narrative are described in **Step 2**.
- Define the level of protection (i.e., the number of feet the lowest floor elevation of the structure is being raised above the BFE). The first floor must be raised to 2 feet above the BFE or to the elevation specified in local ordinances, if higher.
    - Example: If the BFE at a given property is 14 feet, the existing LFE is 10 feet and the proposed mitigation will raise the LFE to 2 feet above the BFE (for a final LFE of 16 feet), then the number of feet the lowest floor elevation of the structure is being raised above the BFE would be 2 feet.
- A description of the elevation method and the steps required to implement the mitigation activity, including the following:
    - Mechanism for elevation (e.g., continuous foundation walls; elevation on open foundations, such as piles, piers, posts or columns; elevating on fill).
    - Description of activities needed to elevate utilities, if known. (This information may be further developed during the design phase).
    - Debris disposal and erosion control, if necessary.
- Verify that the project will be constructed to the appropriate codes and standards by including all the following:
    - A statement that the proposed project will be designed and constructed to meet the requirements of ASCE 24-14. For more information, refer to Addendum to the HMA Guidance, Part F.3: Use of ASCE 24-14 as Minimum Design Requirements for Certain Flood Risk Reduction Activities.
    - A statement that the proposed project will be designed in compliance with the Federal Flood Risk Management Standard (FFRMS). Requires the elevation of the lowest floor or floodproofing level to be a minimum of BFE + 2 feet.
    - A statement that the project will be designed in compliance with the NFIP standards in 44 Code of Federal Regulations (CFR) Part 60.
    - A description of any additional building code standards that will be followed.

STEP 2: Provide Structure-Specific Details

Description: Provide detailed information about each structure included in the project.

Approach: Provide the following information about the structure. If there are multiple structures, this information must be provided and documented for each.

- Date structure was built

- Building type (e.g., one story residential, apartment, police station, hospital, mobile home)
- Structure information, including the size of the house, number of stories, existence of attached garage and description of outbuildings, if present
- Describe the construction type (e.g., wood frame, masonry, concrete) and existing condition
- Describe the foundation (see **Figure 1**)

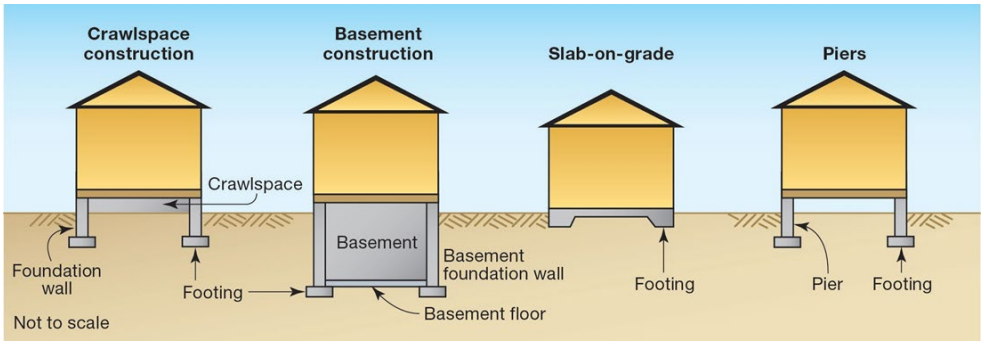
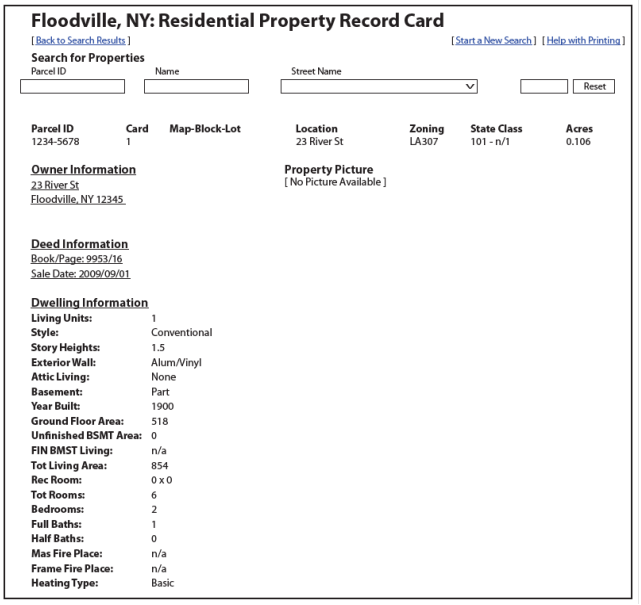


Figure 1. The four foundation types represented in this figure are crawlspace construction, basement construction, slab-on-grade and piers.

Potential Sources: Structure information may be verified through city or county property records or from building permit information. This information can often be found from publicly available websites such as tax assessor website. Some cities and counties have parcel databases with this information. Alternatively, online mapping programs with measuring features and high- quality aerial photographs may be used to estimate the size of the structure.

Example: One-story residential building, slab-on-grade, without a basement, no outbuildings, built in 1900; see the attached Residential Property Record Card for documentation (**Figure 2**).



Floodville, NY: Residential Property Record Card

[Back to Search Results] [Start a New Search] [Help with Printing]

Search for Properties

Parcel ID | Name | Street Name | Reset

Parcel ID	Card	Map-Block-Lot	Location	Zoning	State Class	Acres
1234-5678	1		23 River St	LA307	101 - n/1	0.106

Owner Information
23 River St
Floodville, NY 12345

Property Picture
[No Picture Available]

Deed Information
Book/Page: 9953/16
Sale Date: 2009/09/01

Dwelling Information

Living Units:	1
Style:	Conventional
Story Heights:	1.5
Exterior Wall:	Alum/Vinyl
Attic Living:	None
Basement:	Part
Year Built:	1900
Ground Floor Area:	518
Unfinished BSMT Area:	0
FIN BMST Living:	n/a
Tot Living Area:	854
Rec Room:	0 x 0
Tot Rooms:	6
Bedrooms:	2
Full Baths:	1
Half Baths:	0
Mas Fire Place:	n/a
Frame Fire Place:	n/a
Heating Type:	Basic

Figure 2. An example of a Residential Property Record Card that can be used for documentation of the structure's details.

STEP 3: Provide Available Technical Data

Description: It is necessary to demonstrate that a project is feasible and will be effective at reducing risk. Engineering or design plans may be conceptual in nature at the time of project application and can be developed following award and should be accounted for in the SOW, schedule and cost estimate if not available during application development.

References: When preparing the technical data, refer to the following, as appropriate:

- ASCE 24-14, Flood Resistant Design and Construction (or latest edition)
- FEMA P-55, Coastal Construction Manual, Fourth Edition (2011)
- FEMA P-259, Engineering Principles and Practices of Retrofitting Floodprone Structures (2012)
- FEMA P-312, Homeowner's Guide to Retrofitting, Third Edition (2014)
- FEMA P-499, Home Builders Guide to Coastal Construction Technical Fact Sheet Series (2010)
- FEMA P-500, Recommended Residential Construction for Coastal Areas: Building on Strong and Safe Foundations, Second Edition (2009)

Approach: In addition to verifying that the project will meet the required codes and standards in the narrative (**Step 1**), provide any available information to support the following:

- Demonstrate that it is feasible to meet the aforementioned standards:
  - Buildings proposed for elevation must be structurally sound and capable of being elevated safely.
  - Proposed foundations must be designed to properly address all loads and be appropriately connected to the floor structure above.
  - Foundation construction shall be capable of accommodating all loads and of transmitting the resulting loads to the supporting soil. A geotechnical engineer should be consulted when any unusual or unknown soil condition is encountered. Frequently, designs are prepared on a presumed bearing capacity; however, if there is quantifiable data created by accepted soil science methodologies indicating expansive, compressible, shifting or other questionable soil characteristics are likely to be present, then a soil test should be conducted to derive the actional bearing capacity (measures the ability of soils to support gravity loads without soil shear failure or excessive settlement). Another critical geotechnical consideration is localized scour. In some locations, soil at or below the ground surface can be susceptible to localized scour, and the foundation must be designed to account for these estimated scour depths.

STEP 4: Provide a Project Schedule

Description: Include a detailed project schedule for all tasks identified in the project cost estimate and SOW. The schedule identifies major milestones with start and end dates for each activity. Project schedules must show completion of all activities (including construction period) within the period of performance (POP) allowed by the relevant HMA program. Sufficient details must be provided so FEMA can determine whether the proposed activities can be accomplished within the POP.

References: HMA Guidance Part VI, Section D.4: Program Period of Performance; and Part IV, Section H: Scoping Narrative: Scope of Work, Schedule, and Cost Estimate

Approach: Ensure that the information in the schedule supports the SOW and aligns with the project cost estimate.

STEP 5: Provide a Project Cost Estimate

Description: Include a detailed line-item cost estimate for all tasks identified in the project schedule and SOW. Allowable costs are costs that are necessary and reasonable for the proper and efficient performance and administration of the federal award. All costs included in the sub-application should be reviewed to ensure they are necessary, reasonable and allocable consistent with the provisions of 2 CFR Part 200. Include sufficient detail so that FEMA can determine whether costs are reasonable based on proposed activities and the level of effort. Costs incurred prior to award may be considered pre-award costs and may be eligible for reimbursement. Eligibility may depend on the date they occurred and the grant program. Refer to HMA guidance and the Notice of Funding Opportunity for specifics.

Reference: For more detailed information on eligible and ineligible costs for elevation projects, refer to Addendum to the HMA Guidance Parts E.4.2 and E.4.3.

Approach: Ensure that the information in the cost estimate supports the SOW and aligns with the schedule. Source materials used to support the cost estimate should be referenced.

Allowable costs are costs that are necessary and reasonable for the proper and efficient performance and administration of the federal award and may include, but are not limited to:

- Engineering services for design, structural feasibility analysis and cost estimate preparation
- Project administration and construction management
- Surveying and inspection
- Soil sampling
- Completion of Elevation Certificate, title search, and deed recording fees
- Permitting and/or legal fees
- Building on a foundation to the proposed BFE
- All construction activities required for elevation
- Disconnecting and reconnecting utilities, extending lines and pipes as necessary and elevating all utilities and service equipment
- Debris disposal and erosion control
- Costs for repair of lawns, landscaping, sidewalks and driveways if damaged by elevation activities
- Construction of new stairs, landings and railings to access the elevated living space per minimum code or local ordinance
- Construction of Americans with Disabilities Act-compliant access facilities or ramps when an owner or member of the owner's family has a permanent disability and a physician's written certification
- Filling basements with compacted clean fill

STEP 6: Provide Project Site Map

Description: Provide a map showing the project location. If the project includes multiple structures, show the project boundaries, including staging area. **Figure 3** provides an example of a project site map.

Reference: Supplement to the Benefit-Cost Analysis Reference Guide Section 5: Available Technology Aids

Approach: Provide a map showing the project location, including structures, flooding source, map scale and location information. For any maps provided, ensure that a scale bar is shown, and the map is clearly labeled to identify the project boundaries.

Potential Sources: Official site survey, assessor maps, and topographic maps obtained from the project engineer or planner, maps created using a web-based service such as Google Maps. Flood maps can be downloaded at FEMA's Flood Map Service Center.

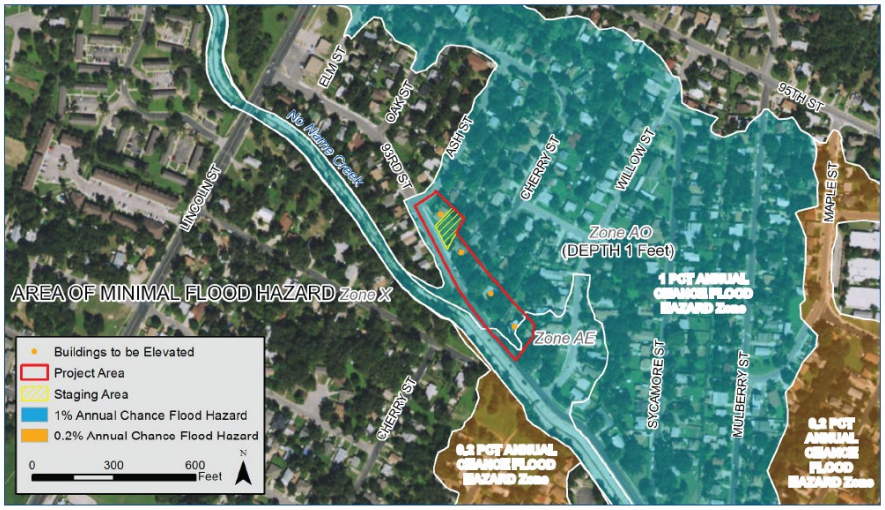


Figure 3. Example of a project site map. Map clearly shows the buildings to be elevated, the project area, the staging area, the flood zones and flood source, and the base flood elevation for the project site. The map includes a north arrow and a scale.

STEP 7: Provide Property Location Information: Address and Latitude and Longitude

Description: Provide property address(es) of each structure involved in the mitigation project. For projects with multiple properties, tables containing all relevant information by property can be helpful.

PROPERTY ADDRESS

Approach: Provide property address(es) of each structure involved in the mitigation project. This includes street name and number; city, county or parish; state; and zip code. A post office box number is not an acceptable address. If the address provided does not clearly match up with the structure(s) to be acquired, provide pictures or a site map with the structure(s) footprint(s) clearly identified.

Potential Sources: Property owner, local building inspector, tax assessor records, deed to the property, engineering plans

Example: 456 River Road, Martinsburg, Berkeley County, WV 25409

LATITUDE AND LONGITUDE

Approach: Provide the latitude and longitude of each structure involved in the mitigation project. The latitude and longitude should be taken at the center of the property. The latitude and longitude can be provided in either decimal degrees (e.g., 27.9807, -82.5340) or degrees, minutes and seconds (27° 58' 50.5'' N, 82° 32' 2.4'' W).

If your global positioning system (GPS) or mapping application provides degrees, minutes and seconds, you will need to convert this into decimal degrees to enter it into FEMA Grant Outcome (GO) (Building Resilient Infrastructure and Communities and Flood Mitigation Assistance applications only). Several free tools are available on the Internet for this conversion. Enter "coordinate converter" into a search engine to find one of these tools.

Potential Sources:

- GPS device
- Free online map tools or search engines that generate latitude and longitude when an address is supplied

Example: 27.9807, -82.5340 or 27° 58' 50.5'' N, 82° 32' 2.4'' W

STEP 8: Provide Lowest Floor Elevation

Description: The risk to the structure from flooding is based on the existing elevation of the building, the lowest point of entry of water into the structure, and the location of contents (typically on the lowest finished floor of the structure).

Approach: Based on the foundation type, determine the LFE (Zone A, Riverine Flooding) or lowest horizontal member (Zone V, Coastal Flooding) of each structure included in the project.

STEP 9: Provide Structure Photographs

Description: Provide photographs of the property, or properties, and structure(s) that are proposed to be acquired/elevated (for example, see **Figure 4**).

Approach: Provide photographs of all sides of the structure showing the foundation and entrances.

- For each photograph, provide a descriptive caption explaining what the photo shows, the direction it was taken (e.g., "looking east" or "east side of building, looking west"), side of the structure shown (e.g., front, back) and other relevant details.
- When a structure has multiple levels, it is important to provide photographs that provide different views of the structure.

- For structures that are raised (or partially raised) owing to surrounding ground level changes or other circumstances, it is important to provide photographs of different sides and angles of the building so that the correct building diagram is chosen for determining the LFE.

Potential Sources: Use a cell phone, tablet or camera to take clear, good quality photos for inclusion in the application.

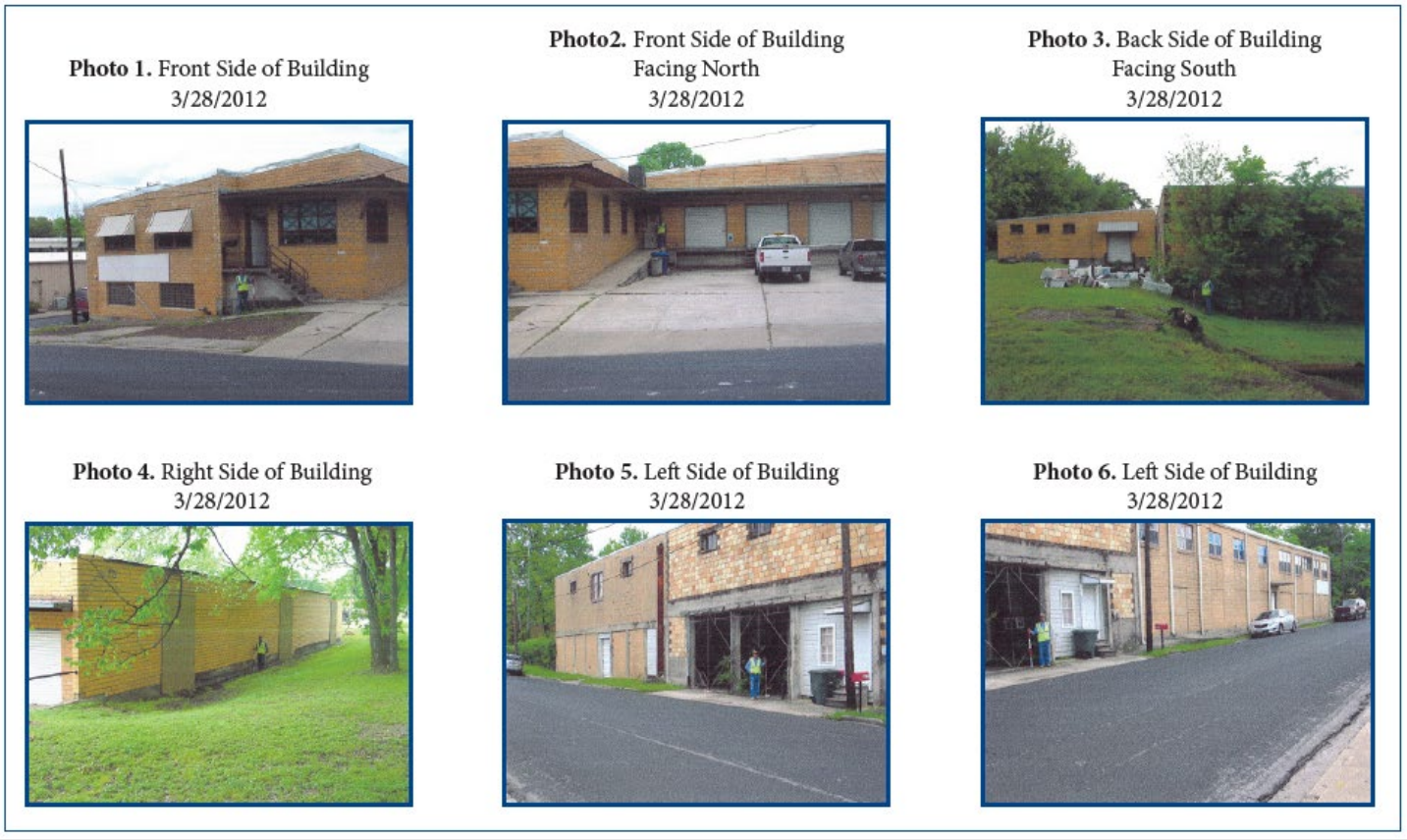


Figure 4. Photos showing the structure to be acquired. Photos include all sides of the building from different cardinal directions.

STEP 10: Document Before-Mitigation Flood Risk

Description: There are two ways to demonstrate the risk of flooding to a hazard-prone structure: 1) using engineering analysis to estimate the risk or 2) using historical information to demonstrate the risk. In many flood-prone areas, FEMA has performed an engineering analysis of the risk that can be found in an FIS and accompanying FIRM. In some areas, it may be possible that an engineering professional has performed an independent study of the flood risk and has prepared an engineering report documenting the results. If the area has not been studied in detail, flood risk can be demonstrated through documentation of a flood event history.

References: FEMA's How to Find Your FIRM and Make a FIRMette; and FEMA's Flood Map Service Center

Approach: The following steps should be taken to document flood risk:

1. If an FIS and FIRM are available for the project area, provide a copy of the map with the project location and impacted structure(s) footprint(s) outlined on the map and a copy of the associated information in the FIS. Ensure that the flood zone in which the structure is located is clear. Note whether the structure is in the SFHA (the 100-year floodplain) and if located in a regulatory floodway.

   Note that if an FIS and FIRM exist for the project area, this documentation should be provided whether or not an independent flood analysis or historical flood information was used to assess the project.

2. If an independent engineering study exists and is being used to assess the flood risk for the project, provide a copy of the professional certified report. The report should include hydrologic and hydraulic (H&H) calculations used to determine flood elevations for four events with varying flood recurrence intervals such as the 10-year, 50-year, 100-year and other interval. If these calculations were completed using modeling software, the engineering report should document all model inputs and outputs. Inundation maps are also recommended to support the analysis and document which structures are at risk.

3. If detailed flood analysis is not available, provide a list of historical flood events along with the following information:

   - Specific date of each flood event
   - Measured or estimated high water marks from the event in the vicinity of the project area, if available
   - Size of the event (flood recurrence interval such as the 10-year, 50-year, 100-year or other), if known. See Supplement to the Benefit-Cost Analysis Reference Guide Section 2.1.2: Determining Recurrence Intervals.
   - A list of physical damages to the structures, contents and infrastructure (broken out by each of these components, if possible). Actual insurance claims may be available through the homeowner or BureauNet if the structures are flood-insured. See Supplement to the Benefit-Cost Analysis Reference Guide.
   - Number of volunteer hours spent at the project site to assist in repair/recovery activities such as damaged material removal, if any
   - Length of loss of function to structures, public services, utilities, roads or bridges
   - Depth-damage functions (that is, percent damage of the building replacement value at each flood depth) for the structures to be elevated, if available

STEP 11: Cost-Effectiveness Analysis

Description: Cost-effectiveness of an elevation project must be demonstrated to obtain FEMA funding. FEMA has provided an approach to demonstrating cost-effectiveness based on pre-calculated benefits which require minimal documentation if certain requirements are met. If it is not possible to meet those requirements, a benefit-cost analysis (BCA) is required to assess the cost-effectiveness of the project.

This section provides guidance on the following:

- **Step 11A:** Pre-Calculated Benefits for Elevation Projects in Special Flood Hazard Area (SFHA)
- **Step 11B:** Benefit-Cost Analysis Tool – Modeled Damages

- **Step 11C:** Benefit-Cost Analysis Tool – Historical or Professional Expected Damages
- **Step 11D:** Additional Benefits for a Benefit-Cost Analysis

All BCA inputs must be justified and documented. When appropriate FEMA standard values are used, it should be clearly stated.

A BCA is a quantitative procedure that assesses the cost-effectiveness of a hazard mitigation measure over the useful life of the project by comparing the potential avoided damages (benefits) associated with the mitigation measure to the cost of a project in current dollars. **Figure 5** and **Table 1** help illustrate this concept.

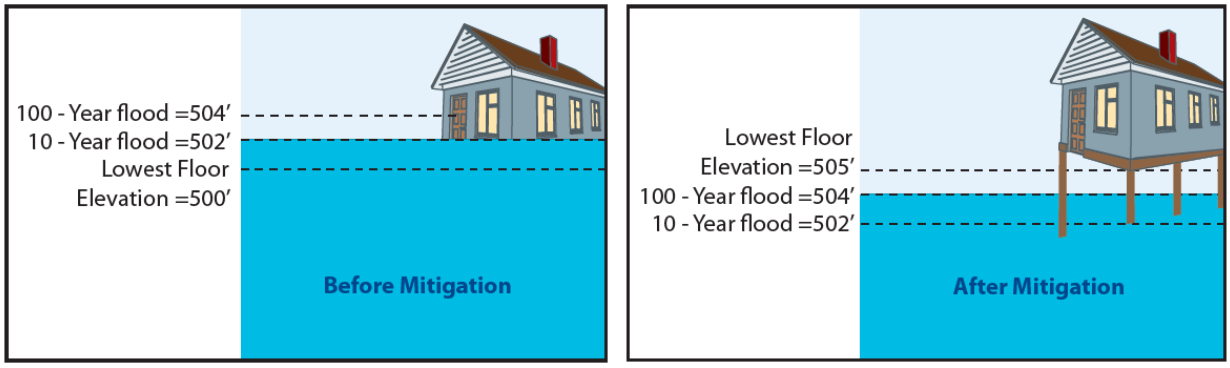


Figure 5. Before and after mitigation elevation.

Table 1. Comparison of mitigation benefits.

Recurrence Interval	Expected Damages Before-Mitigation	Expected Damages After-Mitigation – Elevating Structure FFE 4 ft	Damages Avoided (Benefits)
10-year flood	$1,981	$0	$1,981
100-year interval	$17,121	$1,000	$16,121

Before-mitigation, the structure's Lowest Floor Elevation is at 500 feet. At this location, the 10-year flood event is estimated to be 502 feet, causing an estimated $1,981 in damages to the structure, and the 100-year flood event is estimated to be 504 feet, causing an estimated $17,121 damages to the structure. After Mitigation, the structure's Lowest Floor Elevation is at 505 feet. The 10-year flood event now causes $0 in expected damages and the 100-year flood event causes $1,000 in expected damages to the structure

FEMA will only consider applications that use a FEMA-approved methodology to demonstrate cost-effectiveness. FEMA provides a BCA Tool that allows applicants to calculate a project Benefit-Cost Ratio (BCR). The BCR is a calculation of the project benefits divided by the project costs. Projects for which benefits exceed costs (a BCR of 1.0 or greater) are generally considered cost-effective. Benefits may include avoided damage, loss of function and displacement. In the case of elevation projects, these include:

- Avoided physical damage to the building and contents
- Avoided displacement costs – the costs required to move to and reside in a temporary location while repairs are performed on the building

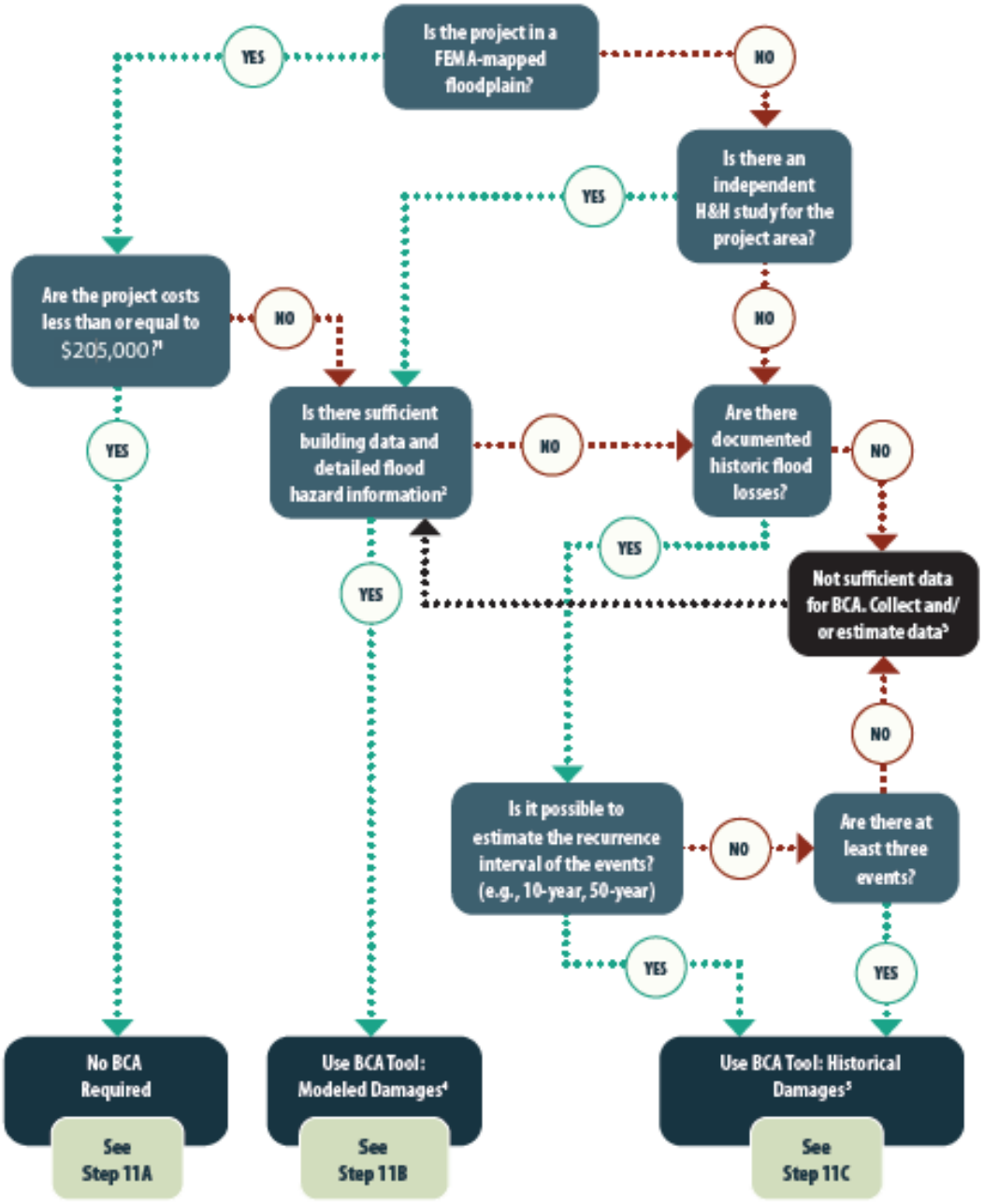
- Avoided mental stress and lost productivity (for residential properties)
- Avoided loss of net revenue (for commercial properties)
- Avoided loss of public services (for public properties)
- Avoided volunteer labor time that typically supports cleanup and repair work

It is important to note that there are several benefits that could be counted for a project, and any or all the benefits can be included in a BCA when analyzing cost-effectiveness. The approaches outlined in **Step 11B** and **Step 11C** of this supplement are focused primarily on avoiding physical damage (building and contents). It is recommended that the applicant start a BCA using these types of benefits as they are typically the largest benefits for elevation projects. If the BCR does not exceed 1.0 or is only slightly over 1.0 after following **Step 11B** or **Step 11C**, move to **Step 11D** to find additional methods of calculating potential benefits for the project.

This supplement only provides a recommended approach to documenting cost-effectiveness. For detailed guidance on using the FEMA BCA Tool, refer to FEMA BCA Reference Guide and FEMA Supplement to the BCA Reference Guide. For additional questions, contact the BC Helpline at ***dchelpline@dhs.gov*** or at ***1-855-540-6744***. If the FEMA BCA Tool is used, provide a .pdf of the BCA report and an export of the BCS as a .zip file.

Approach: There are several methods to evaluate cost-effectiveness. The method used will depend on the data collected in the previous steps of this supplement. Use the flow chart below to analyze the data available for the project site and determine the recommended approach.

The FEMA BCA Tool includes embedded Help Content. Click on the information button within the tool to access the Help Content.



NOTES

1. For projects that contain multiple structures, the average cost of all structures in the project must meet the stated criterion. Additionally, the specific geographic location of structures can greatly increase project costs, and the benefits identified may be adjusted using locality multipliers that are included in industry-accepted cost and pricing guides for construction. Refer to HMA Guidance Part IV, I.7.
2. Described in **Step 8** (Approach 1 or 2), an elevation project must have information on 4 events. Building information must include LFE.
3. Review the BCA Reference Guide and Supplement prior to data collection to ensure that sufficient and relevant data for a BCA is collected for before-mitigation and after-mitigation conditions. Note that at least one known-frequency event, or three unknown-frequency events are required for historic flood losses. Once data is collected, return to process flow to determine the appropriate BCA approach.
4. For projects with multiple structures, consider using the Professional Expected Damages DFA module.
5. Consider using Greatest Savings to the Fund (GSTF) (Refer to HMA Guidance Part IV, I.5).

Figure 6. Flowchart for Determining the Appropriate BCA Frequency and Damage Relationship.

STEP 11A: Pre-Calculated Benefits for Elevation Projects in Special Flood Hazard Area

Description: For elevation projects located in the SFHA, HMA Guidance Part IV, Section 1.7 describes the pre-calculated benefits that may be used to demonstrate cost-effectiveness for elevation projects, including the specific documentation required.

The elevation of a structure located in the 100-year floodplain for which costs are equal to or less than $205,000 is cost-effective. For projects that contain multiple structures, the average cost of all structures in the project must meet the stated criterion (e.g., if there are 10 structures, the total project cost must be less than $2,050,000 [10 x $205,000]).

Additionally, the specific geographic location of structures can greatly increase elevation costs, and the benefits identified may be adjusted using locality multipliers that are included in industry-accepted cost and pricing guides for construction.

If cost-effectiveness is met through pre-calculated benefits, no further cost-effectiveness analysis is required.

Approach: Ensure that documentation requested under **Step 1** through **Step 10** of this supplement is provided. A BCA is not required. Ensure that the flood maps provided clearly identify the structures as located in the SFHA.

STEP 11B: Benefit-Cost Analysis Tool – Modeled Damages

Description: The BCA Tool can utilize modeled damages to analyze proposed mitigation projects by comparing estimated flood elevations for various flood events to the structure's LFE. The BCA Tool then uses the depth of each scenario flood event above (or below in some instances) structure's LFE and established depth-damage curves to estimate damages to the building based on a percentage of the Building Replacement Value (BRV). Additionally, it uses the same depth-damage curves to estimate damage to building contents, displacement from the buildings, and loss of use of the building. Using modeled damages is recommended for BCAs when users have detailed flood hazard information and structural data (using **Step 10**, Methods 1 or 2).

References: FEMA's Benefit-Cost Analysis Reference Guide, Supplement to the Benefit-Cost Analysis Reference Guide, and FEMA BCA Tool (including Help Content within the tool)

Approach: The following describes the essential flood hazard and structural data required to estimate avoided physical damages using Modeled Damages in the BCA Tool. If **Step 1** through **Step 10** of this supplement were followed and all data gathered, there should be minimal additional data collection needed to complete the modeled damages BCA:

1. Structural information:
   - Building information (**Step 2**)
   - Lowest Floor Elevation (LFE)
2. Project useful life
3. Building Replacement Value (BRV)

4. Annual maintenance cost associated with maintaining the effectiveness of the components installed as part of the elevation project
5. Flood Hazard Information – **Step 10** (Method 1 or 2)

Table 2. Flood hazard information.

Coastal Projects	Riverine Projects
Ground surface elevation	Stream bed elevation
BFE or 100-year elevation with wave action	Flood elevations for the 10-, 50-, 100- and 500-year recurrence intervals (RIs) (alternative recurrence intervals are acceptable when using H&H studies)
Stillwater elevation (for the 10-, 50-, 100- 500-year RI). Alternative RIs are acceptable when using a non-FEMA H&H study	Flood discharge rates for the 10-, 50-, 100- and 500-year RIs (riverine flood hazard analysis only, alternative RIs are acceptable when using H&H study)

Note that while the information listed above is required to calculate avoided building damages, using modeled damages will use FEMA standard values to automatically calculate avoided loss to contents and avoided displacement costs (the costs required to move and stay in a temporary location while repairs are performed on the structure). If additional benefits are to be calculated, go to **Step 11D**.

TIP: Data are entered for each structure individually in the BCA Tool. To reduce data entry time, consider first entering data in the Flood Project Import Template found under the Import/Export button and then importing into the BCA software.

STEP 11C: Benefit-Cost Analysis Tool – Historical or Professional Expected Damages

Description: The BCA Tool Damage Frequency Assessment (DFA) module calculates project benefits and costs for proposed mitigation projects for any hazard. The DFA module compares user-entered damages/losses and the frequency that they occur in the before-mitigation scenario versus the after-mitigation scenario to calculate benefits based on avoided damages. The DFA module is recommended when the user has data for historical damages (**Step 10**, Method 3) or professional expected damages (**Step 10**, Method 2).

References: FEMA's Benefit-Cost Analysis Reference Guide, Supplement to the Benefit-Cost Analysis Reference Guide, and FEMA BCA Tool (including Help Content within the tool)

Approach: The DFA module calculates project benefits for proposed hazard mitigation projects based on either documented historic damages or professional expected damages from at least one known-frequency event. If recurrence intervals are not known and there are historical damage data from at least three events of unknown frequency, the DFA module can estimate a recurrence interval; otherwise, additional data collection or analysis will be needed. The calculation compares before- and after-mitigation conditions and an example is shown in **Table 3**:

- **Before-mitigation:** Based on existing conditions at the site. To demonstrate the current risk, actual historical damages or professionally expected damages for certain severity events (e.g., the 10-year flood, the 50-year flood) can be entered in the DFA module to perform a BCA.

- **After-mitigation:** The same scenario flood events should result in reduced damages due to the mitigation project. The post-project damages should be estimated based on the level of protection provided by the project. For example, for a project that elevates a home above the 100-year flood elevation, it could be assumed that there would no longer be damages to the home below the 100-year level of protection.

Table 3. Before- and after-mitigation estimated damages.

	Before Mitigation Damages		After Mitigation Damages	
Recurrence Interval	**Building**	**Contents**	**Building**	**Contents**
10-year	$500	$250	$0	$0
100-year	$7,500	$3,750	$0	$0
500-year	$75,000	$12,000	$5,000	$7,500

For an elevation project, the DFA module is most typically utilized when there is no detailed H&H analysis for the project area and the risk to the project site is demonstrated through past flood damages to the structure. Information regarding each of the scenario events was described in **Step 10** of this supplement. For each damage event, the corresponding recurrence interval information is needed. If recurrence intervals are not available, the BCA Tool will calculate a recurrence interval when historical damage data from at least three events are provided.

Potential Sources:

- Insurance claims, receipts from repair of flood damages, FEMA Public Assistance Worksheets, BureauNet data, documentation of loss of service from a utility provider, Public Works Department
- Property owner affidavit, estimated from damage functions

FEMA also allows for the use of the Greatest Savings to Fund (GSTF) data and methodology to demonstrate cost- effectiveness. The GSTF calculation measures the expected savings of a mitigation project over the project useful life. Using past NFIP claims, the total expected future insurance claims can be projected. GSTF is calculated by subtracting total expected future insurance premiums from expected future claim payments.

STEP 11D: Additional Benefits for a Benefit-Cost Analysis

Description: There are several benefits that could be counted for a project. Any or all the benefits can be used to demonstrate that a project is cost-effective, or, in other words, has a BCR greater than 1.0. Once the initial BCA information is collected and a preliminary analysis is performed, additional benefits may be analyzed if needed.

Approach: Answer the following questions:

1. Is the building residential? If yes, how many residents reside in each building? If not readily available, use averages from Census data related to the municipality or county.
2. Does the building include any rental property for which the owner receives rental income?
3. Is there a business run out of the building or home?
4. Are there any non-critical governmental services provided from the building such as a permit office or library?
5. Are there any critical services provided by the building such as police, fire or medical services?
6. Does the project eliminate or reduce the need for volunteer labor?
7. Do you have a BCR greater than 0.75? If so, environmental benefits could be considered.
8. Does the project prevent loss of service to a utility?

STEP 12: Environmental and Historic Preservation Considerations

Environmental and historic preservation compliance will need to be considered as part of the application process. Please refer to Elevation EHP Review.

Resources

Below is a list of resources identified throughout this supplement. Not all these resources are necessary for every elevation project but are provided to ease in identification of source material.

PROGRAM AUTHORITIES

- The National Flood Insurance Act of 1968, As Amended, 42 U.S.C. 4001 et seq.
- The Robert T. Stafford Disaster Relief and Emergency Assistance Act, As Amended, 42 U.S.C. 4001 et seq.
- 44 Code of Federal Regulations, Part 206, Subpart N
- 2 Code of Federal Regulations, Part 200

PROGRAM GUIDANCE

- FEMA Hazard Mitigation Assistance Guidance and Addendum to the Hazard Mitigation Assistance Unified Guidance, Part E
- Benefit-Cost Analysis Reference Guide and Supplement to the Benefit-Cost Analysis Reference Guide

TECHNICAL GUIDANCE AND STANDARDS

- American Society of Civil Engineer (ASCE) Structural Engineering Institute's ASCE/SEI 24-14, Flood Resistant Design and Construction (or latest version)
- FEMA P-55, Coastal Construction Manual, 4th Edition, August 2011 (or latest version)
- FEMA P-259, Engineering Principles and Practices of Retrofitting Floodprone Residential Structures, 3rd Edition, January 2012 (or latest version)

- FEMA P-312, Homeowners Guide to Retrofitting, 3rd Edition, June 2014 (or latest version)
- FEMA P-499, Home Builder's Guide to Coastal Construction Technical Fact Sheet Series, December 2010 (or latest version)
- FEMA P-550, Recommended Residential Construction for Coastal Areas Building on Strong and Safe Foundations, 2009 (or latest version)

ADDITIONAL TOOLS AND RESOURCES

- FEMA's How to Find Your FIRM and Make a FIRMette
- FEMA's Map Service Center
- Benefit-Cost Analysis (BCA) Tool
- Cost Estimating Principles for Hazard Mitigation Assistance Applications