Infrastructure Retrofit Technical Review

This job aid supplement covers the requirements associated with the technical reviews for infrastructure retrofit projects funded by Hazard Mitigation Assistance. FEMA will also conduct an Environmental Planning and Historic Preservation review of each project. Refer to the Infrastructure Retrofit: 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 job aid to help communities applying for Hazard Mitigation Assistance grants to 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 Environmental Planning and Historic Preservation (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 Supplement 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.

In addition to these documents, local drainage and stormwater requirements will need to be followed when designing the project, and all applicable codes and standards should be given in an accompanying engineering report.

It is recommended that the grant applicant consult a professional engineer to assist in preparing the application, as many of the documentation requirements are technical in nature. An engineer will be required for design and implementation. For complex flood risk reduction projects, applicants may want to consider Advanced Assistance or a phased project approach. Initial funds may be obtained to produce detailed designs of the project (Advanced Assistance or Phase 1) for further FEMA review and approval prior to construction (Phase 2). Refer to HMA Guidance, Part VIII, A.12 and A.13 for additional guidance.

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.

FEMA

Additional Resources

- Hazard Mitigation Assistance Guidance (HMA Guidance)
- Hazard Mitigation Assistance Guidance Addendum
- Benefit-Cost Analysis Reference Guide and Supplement to the Benefit-Cost Analysis Reference Guide
- Hazard Mitigation Assistance Application Development
- Hazard Mitigation Field Book for Roadway Infrastructure

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

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 Site Photographs
- ☐ STEP 8: Determine if Project Location is in a Floodplain
- ☐ STEP 9: Document the Before-Mitigation Risk
- ☐ STEP 10: Document the After-Mitigation Risk and Define the Level of Protection
- ☐ STEP 11: Cost-Effectiveness Analysis
- ☐ STEP 12: Environmental and Historic Preservation Considerations

Important Terms

Average Daily Traffic Count: The daily average of cars that are detoured around the project area due to loss of function of the road or bridge.

Critical Infrastructure: Systems or assets, whether physical or virtual, whose incapacity or destruction would have a debilitating impact on the economic security of an organization, community or nation.

Electrical Infrastructure: Systems or assets that support the generation, transmission and distribution of electricity to the public.

Infrastructure: Structures that improve living conditions and commerce, including roads, bridges, sewers, water and energy systems.

Loss of Service/Loss of Function Benefits: For public facilities, critical facilities, utilities and infrastructure like roads and bridges, there is an economic value associated with keeping them in place and operable during a

hazard event. The economic value is expressed in a value per day and is calculated as if that service is lost for a certain period.

Potable Water Infrastructure: Systems or assets that support the collection, treatment, and transmission of potable water to the public.

Roadway Infrastructure: Systems or assets that support the movement of automobiles. This can include roadways and drainage crossings such as bridges and culvers.

Wastewater Infrastructure: Systems or assets that support the collection, transmission and treatment of public wastewater.

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 addressing the major components of an infrastructure retrofit project. Data collected in these steps will provide reviewers with the necessary information to determine whether a project is feasible and effective. The feasibility of a project is demonstrated through conformance with accepted engineering practices, established codes, standards, modeling techniques or best practices.

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 structures to be mitigated and the proposed mitigation action, a description of 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:

- HMA Guidance Part IV, Section H: Scoping Narrative: Scope of Work, Schedule, and Cost Estimate
- Addendum to the HMA Guidance, Part F: Supplemental Guidance
- HMA Application Development

Approach: A design professional should be consulted when developing the SOW for the mitigation project. The following items are recommended for inclusion in the SOW (specific details and documentation required to support the narrative will be documented in the subsequent steps):

- Provide a detailed narrative of the risk being mitigated, and any historic events in the project area, if available. Infrastructure retrofit projects may address risk from any natural hazard. Clearly identify which natural hazard the infrastructure retrofit project will be addressing. It is possible that the project will address multiple hazards (each should be clearly identified).
- Describe the existing conditions of the project area, including existing infrastructure that is impacted from the natural hazard(s).

- Describe the structures and infrastructure that will benefit from the project.
- Explain the proposed mitigation activity, including the mechanism for the mitigation (e.g., increasing culvert capacity, undergrounding of an electrical line, fixing roadway misalignment), specifying the deliverables, identifying the tasks/steps required to complete the proposed activity and defining the tasks to be accomplished in clear, concise and meaningful terms. All cost elements must match the tasks and provide sufficient detail for FEMA to determine whether the application is eligible. The scoping narrative will become part of the conditions of the award.
- Describe construction activities, such as:
  - Site access, storage, staging and security
  - Site preparation
  - Temporary construction, such as a cofferdam to allow dewatering of a streambed
  - Earthwork, including importation and disposal of fill
  - Installation of the underground infrastructure during construction, such as streets that must be excavated, so that subsurface components can be installed
  - Description of the flood zone in which work is expected to be completed; if work within the floodplain or floodway is anticipated, including staging area, provide documentation that all local flood regulations are being met
- Verify the project will be constructed in accordance with the latest edition of codes and standards (including a description of the codes and standards to be followed).
- Describe all permitting requirements:
  - Statement that the project will be designed in accordance with all applicable codes and standards and National Flood Insurance Program (NFIP) requirements
- Describe how the project will reduce risk and damages and specify the level of protection and how it will be achieved. The narrative should state how all parts of the project are necessary and contribute to lowering the risk of hazard-related damages.
- For infrastructure retrofit addressing flood hazard, provide documentation demonstrating that the project will not have negative impacts upstream or downstream of the project. The proposed project should not cause an increase in flood risk or increase the potential for other damages (such as bank erosion) to any areas outside the project limits.
- Mitigation project alternatives are required as part of the application development. Document at least two alternatives that were considered during the planning or design phase. Clearly indicate which alternative is the preferred mitigation alternative 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 verifying an efficient EHP review process.

STEP 2: Provide Structure-Specific Details

Description: It is necessary to demonstrate that a project is feasible and effective at reducing risk. As part of this demonstration, provide detailed information about each structure in the project. For infrastructure retrofit projects, there are numerous types of potential structures that require specific details. These structures may include, but are not limited to, those provided in **Table 1**.

References: For some infrastructure details, a design professional should be consulted. Documentation for most of the required details can be found in as-built drawings, design drawings, tax assessor records, aerial photo assessments, parcel databases or building permit information.

Table 1. Structures based on infrastructure type.

Infrastructure Type	Potential Structures
Electric Power	▪ Generation Facilities (e.g., coal/lignite/biomass-fired steam plant, nuclear steam plant, natural gas/oil-fired steam plant, combustible turbine, solar-powered devices, wind turbines) ▪ Transmission (e.g., overhead and underground transmission) ▪ Distribution (e.g., overhead and underground distribution)
Roadway	▪ Roads ▪ Bridges ▪ Culverts ▪ Other related drainage infrastructure
Potable Water	▪ Source structures ▪ Treatment facilities ▪ Water storage structures ▪ Pumping stations ▪ Piping and appurtenances (for transmission and distribution)
Wastewater	▪ Gravity sewers ▪ Manholes ▪ Pumping stations ▪ Force mains ▪ Treatment facilities

Approach: Provide all pertinent information about the existing structure(s); for multiple structures, this information must be provided, with supporting documentation, for each. Describe the existing conditions of the project area, including existing drainage structures, if any, and structures and infrastructure impacted by flooding.

- Date structure was built
- Date(s) of any upgrades or additions

- Structure type (e.g., non-residential, electrical utility, wastewater treatment plant, critical infrastructure, bridge)
- Structure use (e.g., agricultural, hospital, grade school, college/university, emergency response, industrial, general services)
- Construction type (e.g., wood frame, masonry, concrete, manufactured housing, steel-frame)
- Existing condition (narrative with a qualitative assessment of the structure condition)
- Foundation type
- Structure-specific information as it related to the associated hazard (e.g., existing ring wall elevations for a clarifier that will be protected from the flood hazard)
- Structure systems (e.g., electrical, mechanical, conveyance, fuel, life-safety, data, communications)
- Building replacement value (BRV) based on the cost per square foot to replace the building with a functionally equivalent building based on the current cost of labor and materials. The BRV is different from the current market value of the structure. The BCA Tool may estimate the BRV based on structure details; however, additional sources can be used to document the BRV, including a letter from a construction or contracting firm or local building inspector, a photocopy of pages from a standard reference manual (e.g., RSMeans) or tax records (if the source is an assessor).

STEP 3: Provide Available Technical Data

Description: It is necessary to demonstrate that a project is feasible and will be effective at reducing risk. Provide engineering or design plans; these may be conceptual (e.g., sketches or schematics) with the project application. This information can be further developed following the grant award and should be accounted for in the scoping narrative, schedule and cost estimate if not available during application development.

Since infrastructure retrofit projects may include electric power, roads/bridges, potable water or wastewater, it is recommended that information outlining the appropriate consensus-based codes, specifications and standards the project is intended to comply with be included in the SOW. This information will establish the minimum acceptable criteria for design, construction and maintenance of infrastructure facilities.

References: The FEMA Disaster Recovery Reform Act Section 1235(b) Consensus-Based Codes, Specifications, and Standards for Public Assistance Frequently Asked Questions document, Quick Reference section, provides a list of organizations and associated codes and standards that should be incorporated when developing the scope of work for infrastructure retrofit projects.

Approach: Project plans should comply with the applicable codes, standards and minimum construction requirements. Providing project plans and specifications will allow reviewers to determine the technical feasibility for the proposed mitigation project and check the validity of the cost estimate against the drawings and specifications. Clearly document how the scope solves the identified hazard risk or is a **functional portion of a solution**. Documentation should indicate that the final design drawings and specifications will be signed and sealed by a design professional licensed in the state or jurisdiction where the project is located prior to beginning construction.

A project represents a **functional portion of a solution** if it produces quantifiable benefits shown through an approved BCA methodology.

Potential Sources: When preparing the technical data, refer to the following organizations, as appropriate:

- **Electric power infrastructure** may include generation facilities, transmission and distribution. Organizations that have applicable codes and standards that incorporate the latest hazard-resistant concepts for electric power infrastructure include the U.S. Department of Agriculture Rural Electric Service (RUS), International Code Council (ICC), American Society of Civil Engineers (ASCE), Institute of Electrical and Electronics Engineers (IEEE) and National Fire Protection Association (NFPA).
- **Roadway infrastructure** may include roads, bridges, culverts and drainage. Organizations that have applicable codes and standards pertaining to geotechnical issues, design parameters, material usage, installation, construction and natural hazard-resistant concepts include the American Association of State Highway and Transportation Officials (AASHTO), American Concrete Institute (ACI), American Welding Society (AWS), American Institute of Steel Construction (AISC) and American Society of Civil Engineers (ASCE).
- **Potable water infrastructure** may include source structures, treatment facilities, finished water storage structures, and piping and appurtenances. Organizations that have applicable codes and standards pertaining to design parameters, chemical usage, construction, installation, electrical, energy conservation, automation, instrumentation, controls, rehabilitation and natural hazard-resistant concepts include the Great Lakes – Upper Mississippi River, Board of Provincial Public Health and Environmental Managers (GLUMRB), American Water Works Association (AWWA), National Fire Protection Association (NFPA), ASTM International, National Standards Foundation (NSF), American Society of Civil Engineering (ASCE), Water Environment Federation (WEF) and International Code Council (ICC).
- **Wastewater infrastructure** may include gravity sewers, manholes, pumping stations, force mains and treatment facilities. Organizations that have applicable codes and standards pertaining to design parameters, material usage, construction, installation, electrical, energy conservation, automation, instrumentation, controls, rehabilitation and natural-resistant concepts include the Great Lakes – Upper Mississippi River, Board of Provincial Public Health and Environmental Managers (GLUMRB), National Fire Protection Association (NFPA), ASTM International, American Society of Civil Engineers (ASCE), Water Environment Federation (WEF) and International Code Council (ICC).

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: Verify 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 those that are necessary and reasonable for the proper and efficient performance and administration of the federal award. All costs included in the application should be reviewed to verify they are necessary, reasonable and allocable consistent with the provisions of 2 Code of Federal Regulations, Part 200. Include sufficient detail so that FEMA can determine whether costs are reasonable based on proposed activities and 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: HMA Guidance Part IV, Section H: Scoping Narrative: Scope of Work, Schedule, and Cost Estimate

Approach: Applications must include detailed, line-item costs in the project cost estimates for each mitigation item provided in the SOW. Well-documented project cost estimates contain quantities, unit costs and a source for each unit cost. Lump sum cost estimates are not acceptable. The assistance of a design professional or contractor may be required to help develop the project cost. Provide line-item costs using the recommended line items below, where applicable.

Allowable costs are those that are necessary and reasonable for the proper and efficient performance and administration of the federal award. They must 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
- Permitting and/or legal fees
- Project planning and design activities, including construction verification
- All construction activities that are required for project completion
- Debris disposal and erosion control
- Costs related to complying with local utility requirements
- Costs for repair of lawns, landscaping, sidewalks, or driveways if damaged by retrofits

It is also important to verify that an annual maintenance cost is determined using appropriate methods. The annual maintenance cost is necessary to address those costs associated with maintaining the effectiveness of the mitigation measures. Although the costs will not be funded by FEMA, they are required to be included in the BCA.

STEP 5A: Provide Maintenance Costs

Description: Maintenance costs should reflect the costs associated with mitigation being maintained for the entire project useful life (PUL). Maintenance costs will vary, depending on the project type.

Potential Sources: Project-specific maintenance costs may be obtained from the design professional.

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 1** 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, hazard source, map scale and location information. For any maps provided, verify that a scale bar is shown and the map if clearly labeled to identify the project boundaries.

- Clear delineation of areas disturbed to construct the project, including potential off-site areas such as spoils disposal locations
- Full description of the geographical location(s) of the project boundaries
- Topographic data with vertical datum clearly shown
- Latitude and longitude for the project location. If the project involves multiple, discontinuous locations, provide enough coordinates to delineate the entire project boundary (e.g., four corners). Include coordinates for any properties that are affected by the mitigation project. It may be helpful to show the latitude and longitude coordinates on a map. The latitude and longitude should be taken at the center of the property. That latitude and longitude can be provided in either decimal degrees (e.g., 27.9807, -82.5340) or degrees, minutes and seconds (e.g., 27° 58' 50.5'' N, 82° 32' 2.4'' W).

Potential Sources: Maps from previously developed reports, official site survey, assessor maps, and topographic maps with markups obtained from the design professional or planner, maps created using a web-based service such as Google Maps

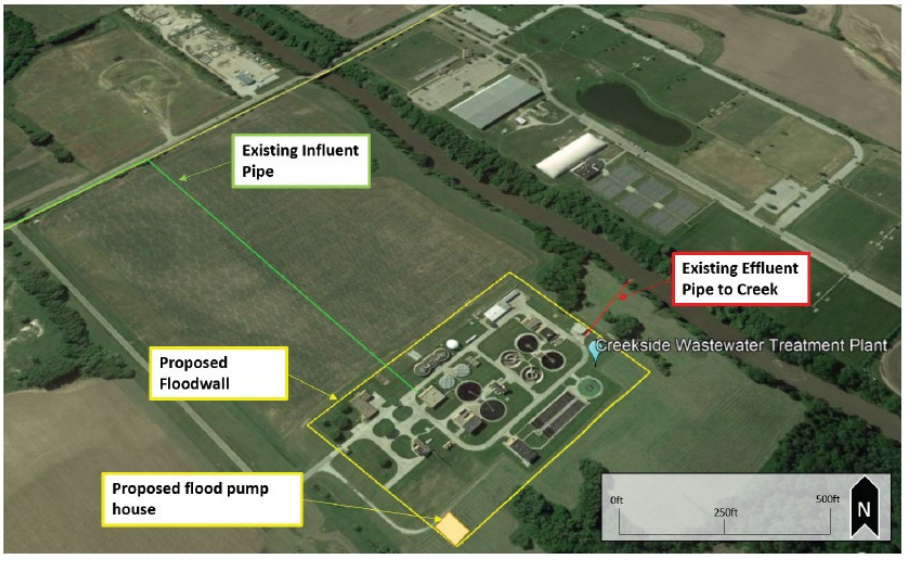

Figure 1. Example of a project site map. Map clearly shows the infrastructure (wastewater treatment facility) and the location of the proposed mitigation measures. The map includes a north arrow and a scale.

STEP 7: Provide Site Photographs

Description: Provide photographs of the proposed project area and the impacted infrastructure. For example, if the project will be undergrounding utilities, take photographs of the existing overhead utilities, as well as the location where the utilities will be underground. Show all directions to the surrounding area. Provide photographs with as much detail as possible to support the description of the proposed project.

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

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

STEP 8: Determine if Project Location is in a Floodplain

Description: Provide a Flood Insurance Rate Map (FIRM) showing the project location. Include a description of the flood zone in which the existing structure(s) are located and whether the site is in a regulatory floodway.

References: To identify flood risk, refer to FEMA's Flood Map Service Center and FEMA's How to Find Your FIRM and Make a FIRMette.

Approach: If a FIRM is available for the project area, provide a copy of the map with the project location(s) and structure(s) footprint outlined on the map, as shown in **Figure 2**.

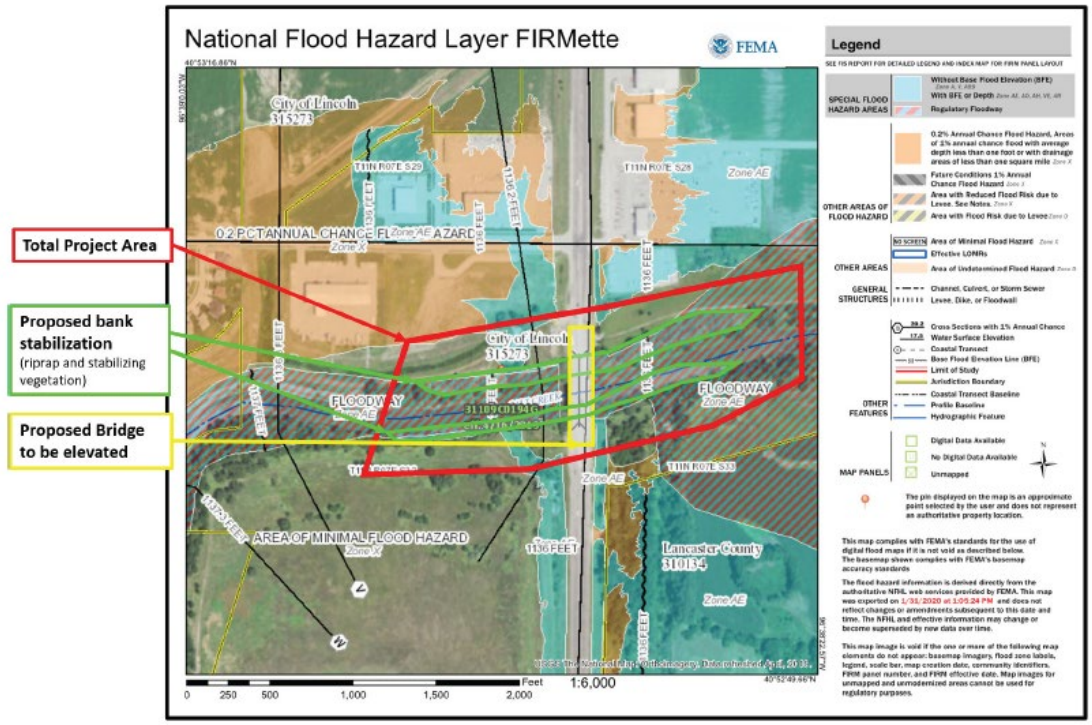

Figure 2. FEMA FIRMette with an infrastructure (bridge) retrofit project boundary identified. The total area where work is to be completed is identified, as well as work within the channel.

STEP 9: Document the Before-Mitigation Risk

Description: Documenting the before-mitigation risk is a crucial part of understanding what needs to be done to mitigate the project. It is critical to define the risk from all natural hazards. Since infrastructure retrofit projects can protect against multiple risks, an engineering analysis will be necessary to demonstrate what the risk is and how it will be mitigated. If the proposed solution has not been studies in detail, it is possible the project will need to be phased (eligible for HMGP and Building Resilient Infrastructure and Communities [BRIC] projects only), thus allowing for development of an engineering report to ensure feasibility and effectiveness. Other hazard-specific job aids were created to help identify the before-mitigation risk.

Reference: To identify before-mitigation risks, refer to the hazard-specific Job Aids on FEMA's HMA webpage.

Approach: One of the following steps should be taken to document existing before-mitigation risk:

1. Provide detailed documentation in the form of an engineering report that is sealed by a design professional. For some infrastructure, a technical report may be sufficient (e.g., electrical power transmission and distribution report). Reports should clearly identify the pre-project conditions and include any calculations used to determine pre-project conditions. If these calculations were completed using modeling software, the report, documenting all model inputs and outputs, should be provided.
2. If a detailed analysis is not available, clearly define the before-mitigation risk the project will protect against and any engineering calculations supporting this analysis. If no engineering analysis is available, it is possible the project will need to be phased (eligible for HMGP projects only), allowing for development of an engineering study to ensure before-mitigation risk is accurate.

STEP 10: Document the After-Mitigation Risk and Define the Level of Protection

Description: Documenting after-mitigation risk (also referred to as residual risk) is critical to understanding the project's effectiveness. It is important to clearly state the level of protection in the scoping narrative.

References: To identify after-mitigation risks, refer to the hazard-specific Job Aids on FEMA's HMA webpage.

Approach: One of the following steps should be taken to document existing after-mitigation risk:

1. Provide detailed documentation in the form of an engineering report that is sealed by a design professional. Reports should clearly identify the proposed project conditions and include any calculations used to determine after-mitigation conditions. If these calculations were completed using modeling software, the report, documenting all model inputs and outputs, should be provided.
2. If detailed analysis is not available, clearly define the level of protection the project provides and any engineering calculations supporting the design. If this is the best available data, it is possible the project will need to be phased (eligible for HMGP projects only), thus allowing for development of an engineering study to ensure after-mitigation risk is accurate.

Example: A project proposes to increase the level of protection provided by seismically retrofitting the underground water transmission lines up to an 8.0 magnitude earthquake, which corresponds to a 300-year recurrence interval. Potential damages to the waterline during a 6.0 magnitude earthquake, which corresponds to a 50-year event, will be eliminated.

STEP 11: Cost-Effectiveness Analysis

Description: Cost-effectiveness of an infrastructure project must be demonstrated to obtain FEMA funding. A benefit-cost analysis (BCA) is a quantitative procedure that assesses the cost-effectiveness of a hazard mitigation measure over the project useful life (PUL) by comparing the potential avoided damages (benefits) associated with the mitigation measure to the cost of a project in current dollars.

This section provides guidance on the following:

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

FEMA will only consider applications that use a FEMA-approved methodology to demonstrate cost-effectiveness. FEMA provides BCA software 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 considered cost-effective. FEMA requires the use of the BCA Tool to verify that calculations are consistent with Office of Management and Budget Circular A-94 Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. The BCA must be performed using the most current version of the BCA Tool. Benefits may include avoided damages, loss of function and displacement. In the case of infrastructure projects these may include:

- Avoided physical damage to the structures, roads, bridges and utilities
- Avoided life safety damages (injuries or casualties)
- Avoided volunteer labor time that typically supports cleanup and repair work
- Avoided loss of income or net revenue
- Avoided loss of public services (for public properties)
- Avoided loss of life or delay in essential services (critical services)
- Avoided loss of service (for utilities)
- Avoided loss of function (for roads and bridges)
- Avoided mental stress and loss of productivity

It is important to note that there are several benefits that could be counted for a project, and any or all benefits can be included in a BCA when analyzing cost-effectiveness. The approaches outlined in **Step 11A** and **Step 11B** of this supplement are focused primarily on avoided damage and loss of service/function. It is recommended that the applicant start on a BCA using these types of benefits, as they are typically the largest benefits for infrastructure retrofit projects.

If the BCR does not exceed 1.0, or is slightly over 1.0, after following **Step 11A**, move to **Step 11B** to find additional methods for calculating potential benefits for the project.

An infrastructure retrofit project can reduce risk to several facilities, including roads, bridges and utilities. The approach to the BCA depends on the infrastructure being protected and the data available.

- If data for historic damages, or professional expected damages is available, the BCA Tool provides DFA module (**Step 11A**) to evaluate any type of infrastructure.
- Combination of historic and estimated damages can be used when evaluated structures and other infrastructure together.
- Refer to other hazard-specific job aids for guidance on how to use the BCA program to model damages if applicable for your project.

This supplement only provides a recommended approach to documenting cost-effectiveness. For detailed guidance on using the FEMA BCA Tool, refer to the FEMA BCA Reference Guide and FEMA Supplement to the BCA Reference Guide. For additional questions, contact the BCA Helpline at ***bchelpline@fema.dhs.gov*** or at ***855-540-6744***. Provide a .pdf of the BCA report and an export of the BCA .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. Typically for infrastructure retrofit projects, the DFA module will be used to evaluate the BCA. This can be done by using historical damages or professional expected damages.

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

STEP 11A: 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 used when the user has hazard data for historical damages or professional expected damages.

References: FEMA's Benefit-Cost Analysis Reference Guide, Supplement to the Benefit-Cost Analysis Reference Guide, 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 historical damages (such as physical damages or loss of function) or professional expected damages (estimated damages that have not yet occurred or that occurred but not to the extent possible) from at least one known frequency event. If recurrence intervals are not known and there are historical damage data from at least three events, 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. An example is shown in **Table 2**.

- **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 event, the 50-year event) can be entered into the DFA module to perform a BCA.
- **After-mitigation:** Damages for the same scenario events should result in reduced damages due to the mitigation project. The after-mitigation damages should be estimated based on the level of protection provided by the project (e.g., the proposed mitigation provides a level of protection up to the 10-year event, but damages will be expected to occur in an event greater than the level of protection).

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

Recurrence Interval	Before Mitigation Damages		After Mitigation Damages	
	Physical Damages	**Loss of Function**	**Physical Damages**	**Loss of Function**
10-year	$25,000	$175,000	$0	$0
50-year	$50,000	$250,000	$5,000	$10,000
100-year	$1,500,000	$3,000,000	$75,000	$150,000

To verify the information entered in the BCA software, the following supporting information should be provided:

1. Project useful life (PUL) – FEMA-approved values can be found in the BCA Reference Guide or within the BCA Help Content of the BCA Tool.
2. Project cost – refer to **Step 5**
3. Annual maintenance cost associated with maintaining the effectiveness of the components installed as part of the mitigation project
4. Calculations detailing the events frequency analysis and explaining how recurrence intervals were determined (this is not needed if there were more than three damage events – the BCA Tool will then calculate the recurrence interval)
5. Engineering calculations, studies or designs to document the project's level of protection
6. For loss of function, provide basis for determining the BCA Toolkit input parameters. Guidance for documenting loss of function is discussed in **Step 11B**.

Potential Sources:

- Insurance claims, receipts from repair of flooding, wind, or seismic damages, FEMA Public Assistance projects, BureauNet data, documentation of lost service from a utility provider, Public Works department
- Results of models developed and certified by a design professional

STEP 11B: 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. Does the project prevent loss of service to a utility? If yes, see explanation for Loss of Service to Utilities below.

2. Does the project prevent the closure of a roadway? If yes, see explanation for Loss of Service to Roads and Bridges below.
3. Are residential structures impacted? If so, how many residents live in the structure? If this information is not readily available, use averages from Census data related to the municipality or county. Avoided mental stress and loss of productivity could be included if the BCR is already over 0.75.
4. Does the project eliminate or reduce the need for volunteer labor?
5. Does the project change or enhance the land use of the project area to create beneficial environmental space? For example, if a property is acquired, then a new green space is created.

LOSS OF SERVICE TO UTILITIES

Description: The BCA Tool will account for the loss of service for utilities such as electricity, potable water, wastewater service and other utility services. Under each utility type, specific information is required to determine the monetary damages incurred if the utility loses function because of a natural hazard. The following is a list of information that will allow the loss of service to be calculated.

References: Supporting documentation for loss of function calculations can be obtained from the entity, agency or company providing the utility service. The documentation should be in the form of a letter from the utility on their letterhead.

Approach: To calculate loss of service for utilities, provide the following information:

- Number of customers supported by the utility
- Value of unit of service ($/person/day)
    - Standard values for electrical, potable water and wastewater were determined by FEMA and no additional documentation is needed. Users who want to override a FEMA standard value with a higher value must provide (a) the reason the FEMA standard value is not valid for the proposed mitigation project, and (b) supporting documentation for the user-entered utility loss of function value that exceeds the FEMA standard value.
    - If “Other” is selected as the type of service, documentation is required that shows the economic value of the service in terms of dollars per person per day. In these cases, the value of the service is typically determined by the utility company and documentation is provided to the user.
- Duration that the service was lost during a past event, or a prediction of the duration of loss of service due to a future event

LOSS OF SERVICE TO ROADS AND BRIDGES

Description: The BCA Tool will account for the loss of service for roadways and/or bridges. The total economic loss is calculated by the increased time and distance of the detour needed when the service of a road or bridge is lost. Significant economic benefits can accrue, especially for well-traveled roads with limited or no detour routes available.

Resources: Supporting documentation for loss of function calculations can be obtained from the state, county, parish, borough, township or other local departments of transportation or public work agencies, or highway

engineers. The documentation should be dated and signed, be provided on the letterhead of the estimated official and include the assumptions used in determining the information.

Approach: To calculate loss of service for roads and bridges, provide the following information:

- Estimated number of one-way traffic trips per day. The number of cars that are detoured around the project area due to loss of function of the road or bridge.
  - Estimates of daily one-way traffic trips can be obtained in writing from the relevant entity or person competent to determine the traffic count
  - Additional time per one-way trip (minutes)
  - Additional travel time (in hours and minutes) required for detours that affect daily one-way trips is the detour distance (in miles) divided by the speed limit (in mph) for the detour route. This can also be determined through an online mapping service.
  - Additional detour times may be projected to be higher because of reduced speed limits from increased traffic due to the detour
  - If the roadway or bridge is the only means of ingress/egress for a community, set the additional travel time per one-way trip equal to 12 hours.
- Number of additional miles
  - This information can be obtained by using online mapping services, scaling the distance on a highway map or by driving the detour route and using the vehicle odometer. Speed limit data can be obtained by a field visit.
  - If the roadway or bridge is the only means of ingress/egress for a community, set the number of additional miles equal to 0.
- Federal rate
  - Standard mileage rates used to calculate the costs of operating an automobile are issued by the Internal Revenue Service (IRS) and are typically updated annually, although the IRS has updated the mileage rate twice per year if the cost of oil has greatly fluctuated. The current mileage rate can be found by searching for the standard mileage rate on the IRS website.

STEP 12: Environmental and Historic Preservation Considerations

Description: Environmental and historical preservation compliance will need to be considered as part of the application process for infrastructure retrofit projects. The assistance of a licensed design professional, architect, or contractor may be required to help obtain the necessary information about EHP compliance. Refer to the EHP Supplement Job Aids.

Resources

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

PROGRAM AUTHORITIES

- 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 Guidance
- Benefit-Cost Analysis Reference Guide and Supplement to the Benefit-Cost Analysis Reference Guide

TECHNICAL GUIDANCE AND STANDARDS

- FEMA Disaster Recovery Reform Act Section 1235(b) Consensus-Based Codes, Specifications, and Standards for Public Assistance Frequently Asked Questions (Quick Reference section provides a list of suggested codes and standards for potable water, wastewater, roadways, and electrical infrastructure projects)

ADDITIONAL TOOLS AND RESOURCES

- FEMA's How to Find Your FIRM and Make a FIRMette
- FEMA's Map Service Center
- FEMA's Benefit-Cost Analysis (BCA) Tool
- Cost Estimating Principles for Hazard Mitigation Assistance Applications
- FEMA's National Flood Hazard Layer
- Hazard Mitigation Assistance Application Development (Scope of Work Examples)
- Hazard Mitigation Assistance Application Development (Engineering Case Studies)
- EHP Review Supplements
- FEMA Hazard Mitigation Assistance Job Aids