Selecting Appropriate Mitigation Measures for Floodprone Structures

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About the Cover

The house pictured on the cover, located in Michigan, was elevated approximately five feet. The basement was abandoned, filled, and the house placed upon a new extended wall foundation with a crawlspace. Twelve hydrostatic vent openings were installed to allow any floodwater to enter the crawlspace. The deck and wrap-around porch was added at the owner's expense to improve the overall aesthetics of the site. The project was completed utilizing Flood Mitigation Assistance Funds for 75 percent of the project's cost. The community paid 12.5 percent of the cost and the home owner the remaining 12.5 percent. Total cost of the elevation project was $49,140, completed in 2001.

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CHAPTER 1 − INTRODUCTION

1.1 Intended Users and Purpose of This Manual

The intended users of this manual are State and local officials with the responsibility to reduce or eliminate risk of property damage and human suffering due to flooding. These officials carry out this responsibility by:

- Assessing risks;
- Developing priorities and strategies to address these risks through what are commonly referred to as "mitigation plans" or area analyses; and
- Working with other community officials and property owners to implement projects that reduce or eliminate the identified risks, also referred to as "mitigation projects."

The purpose of this manual is to assist State and local officials with the last of the three tasks listed above.

CAUTION

This guidance document is provided for assisting in the development of mitigation projects for floodprone structures only. It is not implied that following this guidance will result in the Federal Emergency Management Agency (FEMA) funding the mitigation project in part or in whole. Meeting the requirements of the guidance and/or regulations under each of FEMA's respective mitigation programs is the only way to ensure a mitigation project is eligible for funding under FEMA's grant programs.

This manual provides guidance on how to interpret data collected with the National Flood Mitigation Data Collection Tool (NFMDCT) (also referred to as the "National Tool" or "NT" in this manual) and other sources to develop detailed proposals for flood mitigation projects.

This manual assumes that the community has already completed the mitigation planning process, and that specific structures and/or areas considered high priority for mitigation (due to recurrent, significant flooding) have been identified and local officials are looking to identify specific mitigation measures to meet these priorities. In addition, this manual identifies technical issues associated with many mitigation techniques and references other documents that provide more detailed structure analyses, assessments, and technical guidance.

What is the NT?

As part of ongoing efforts by FEMA to reduce the impact of flooding on people and property, the NT was developed for use by Federal, State, and local mitigation officials to gather information about floodprone properties, including repetitive loss (RL) properties. One of the primary intended uses for the data is determining appropriate mitigation measures for these properties that are both feasible and cost-effective.

The NT software (FEMA 497 CD) may be obtained free of charge by contacting the FEMA Distribution Center at 1-800-480-2520. The *National Flood Mitigation Data Collection Tool User's Manual* (FEMA 497) may be downloaded from FEMA's website at http://www.fema.gov/plan/prevent/floodplain/data_tool.shtm.

1.2 Organization of This Manual

To develop detailed proposals for mitigation projects, there are three "steps" recommended in the decision-making process:

1. **Initial screening using NT**: Analyzing data gathered using NT to narrow the available options for mitigation measures (see Section 3.3 for a description of this step);
2. **Evaluating the mitigation measures:** Using information from NT and other sources to evaluate the options remaining after the initial screening (see Section 3.5 for a description of this step); and
3. **Working with property owners:** Meeting and working with owners of floodprone properties to identify the option preferred by all interested parties and then working to implement it as a fundable mitigation project (see Chapter 11 for a description of this step).

This manual is designed to support such efforts by providing technical guidance on the most appropriate protection measures on an individual basis. It follows a standard process of data collection, evaluation, and decision-making:

- A review of the community's flood problems identifies which areas or buildings should be addressed. This review is often done during preparation of a hazard mitigation plan or area analysis (see Section 1.3 for more information).
- The buildings are visited and data are collected and recorded, preferably using the NFMDCT (also referred to as the "National Tool" or "NT" in this manual). This is described in Chapter 2.
- An analysis of the data identifies the most appropriate mitigation measures, as shown in Chapter 3.
- The most appropriate measures are reviewed in more detail in Chapters 4 through 10.

- The results are reviewed with property owners, who select which measures to pursue (Chapter 11).
- Funds are sought and projects are implemented.

Appendix A contains a sample information packet. Blank worksheets are contained in Appendix B. Appendix C presents information on cost estimating. Determining cost-effectiveness is discussed in Appendix D. Appendix E describes hazard mitigation assistance programs. The FEMA Regional Offices are presented in Appendix F. Appendix G is a listing of State and Tribal Historic Preservation Offices. National Flood Insurance Program (NFIP) State Coordinating Agencies and State Hazard Mitigation Officers are listed in Appendix H. Appendices I and J contain the glossary and list of acronyms, respectively. Appendix K contains the references for the document.

1.3 Available Resources

FEMA 386-1, *Getting Started: Building Support for Mitigation Planning.*

FEMA 386-2, *Understanding Your Risks: Identifying Hazards and Estimating Losses.*

FEMA 386-3, *Developing the Mitigation Plan: Identifying Mitigation Actions and Implementing Strategies.*

FEMA 386-4, *Bringing the Plan to Life: Implementing the Hazard Mitigation Plan.*

FEMA 511, *Reducing Damage from Localized Flooding.*

FEMA Community Rating System (CRS). *Example Plans.*

Schwab, et al. *Planning for Post-Disaster Recovery and Redevelopment. American Planning Association (APA) Planning Advisory Service Report Number 483/484.*

USACE, *Local Floodproofing Programs.*

44 Code of Federal Regulations (CFR), Part 201, Mitigation Planning. See http://www.fema.gov/plan/mitplanning/interim_final_rules.shtm

FEMA Mitigation Planning "How-To" Guides. See http://www.fema.gov/plan/mitplanning/planning_resources.shtm#1

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CHAPTER 2 – THE NATIONAL TOOL (NT)

FEMA's National Tool (NT) software was developed to help catalog floodprone structures and to determine potentially appropriate mitigation measures. It is explained in detail in the *National Flood Mitigation Data Collection Tool Guide* (FEMA 497). This chapter provides an overview of how the National Tool works.

The ultimate goal of the NT is to provide a standardized, systematic approach to collecting and interpreting property data and mitigation project development. While the focus of the NT is on data collection for repetitive loss (RL) properties, it can also be used to gather information related to flood risk, building construction, and building value for any structure.

2.1 Starting Data

The NT is designed to encourage a comprehensive sweep for information pertinent to each structure. Data fields within the NT require information from a variety of sources, including the National Flood Insurance Program (NFIP) policy information; community building, tax, and historical flood records; and field reconnaissance. However, the NT can be used with cursory or limited data or with lots of detailed data, if available.

It is best to start using the NT already populated with readily available flood insurance data on each property. BureauNet is a database maintained by the NFIP's Bureau and Statistical Agent and access is available through FEMA. The community can ask the FEMA Regional Office (see Appendix F) or the NFIP State Coordinating Agency (see Appendix H) to provide "drill down" summaries of flood insurance and claims information. The drill downs contain such information as:

- Dates of claims
- Value of claims paid
- Property's insured status
- Property address
- Current policy holder's name
- Last claimant's name
- Mitigated status
- Mitigation actions and funding sources (where applicable)

This information can be used to identify general areas of repetitive flooding, locate clusters of floodprone structures, and determine which structures have incurred the most frequent or severe losses. These data can be used to prioritize further investigations and field data collection efforts.

The data will be provided in a Microsoft Excel spreadsheet format that can then be uploaded into the NT through the Utilities function. For additional information about how to import data into the NT, see the *National Flood Mitigation Data Collection Tool Guide* (FEMA 497).

2.2 NT Contents

The NT is initially populated with NFIP data. Data fields within the NT require supplemental information collected from several sources. The NT is organized into two basic sections:

- **Limited Data View** ("Limited Data"). This view enables the user to enter data from a brief visual inspection of the property; limited communication with the property owner, occupant, or neighbor; and basic flood risk data from the Flood Insurance Rate Map (FIRM) or Flood Insurance Study (FIS).
- **Detailed Data View** ("Detailed Data"). This view is suitable when a more thorough inspection of the property and its surroundings is conducted as well as when local or State officials are contacted for structure-specific information and coordination of on-site data collection efforts.

2.2.1 Limited Data View

The Limited Data View includes three main subsections or "tabs."

Address and Updates (Figure 2-1)

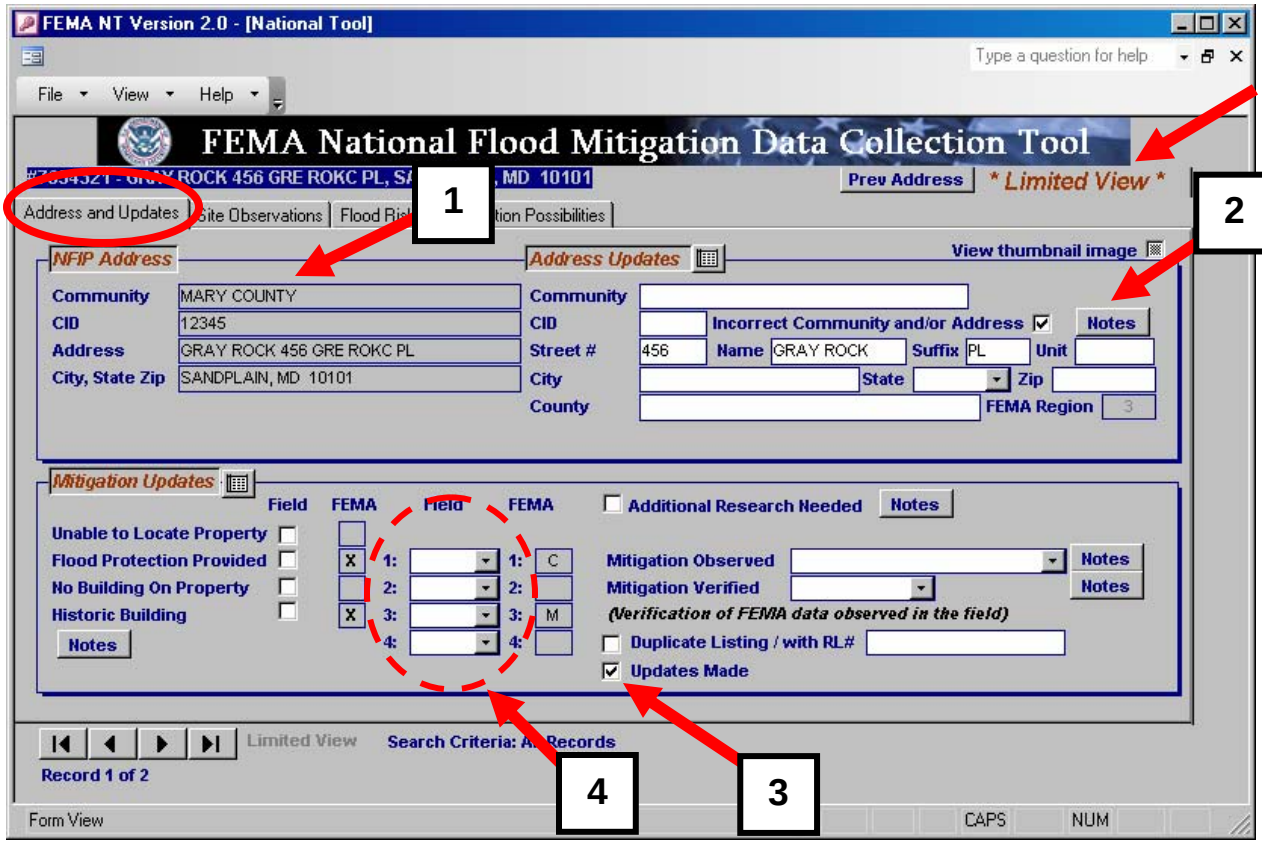

Figure 2-1. *Address and Updates* tab

1. The "grayed out" boxes for the *NFIP Address* are imported from the BureauNet Data and represent information that cannot be manipulated by the user. The correct location

information is important in writing and executing all legal documents, such as contracts and agreements.

2. Changes made to any part of the address (e.g., incorrect spelling) should be noted by checking the box for *Incorrect Community and/or Address*.
3. Updates of any nature are denoted by checking the *Updates Made* box.
4. Mitigation measures observed on the site can be recorded in the *Field* menus. A drop down menu lists potential options to choose from. Past mitigation efforts should be studied closely to determine what has or has not worked in the past. This will help in avoiding future inappropriate or ineffective mitigation approaches.

Site Observations (Figure 2-2)

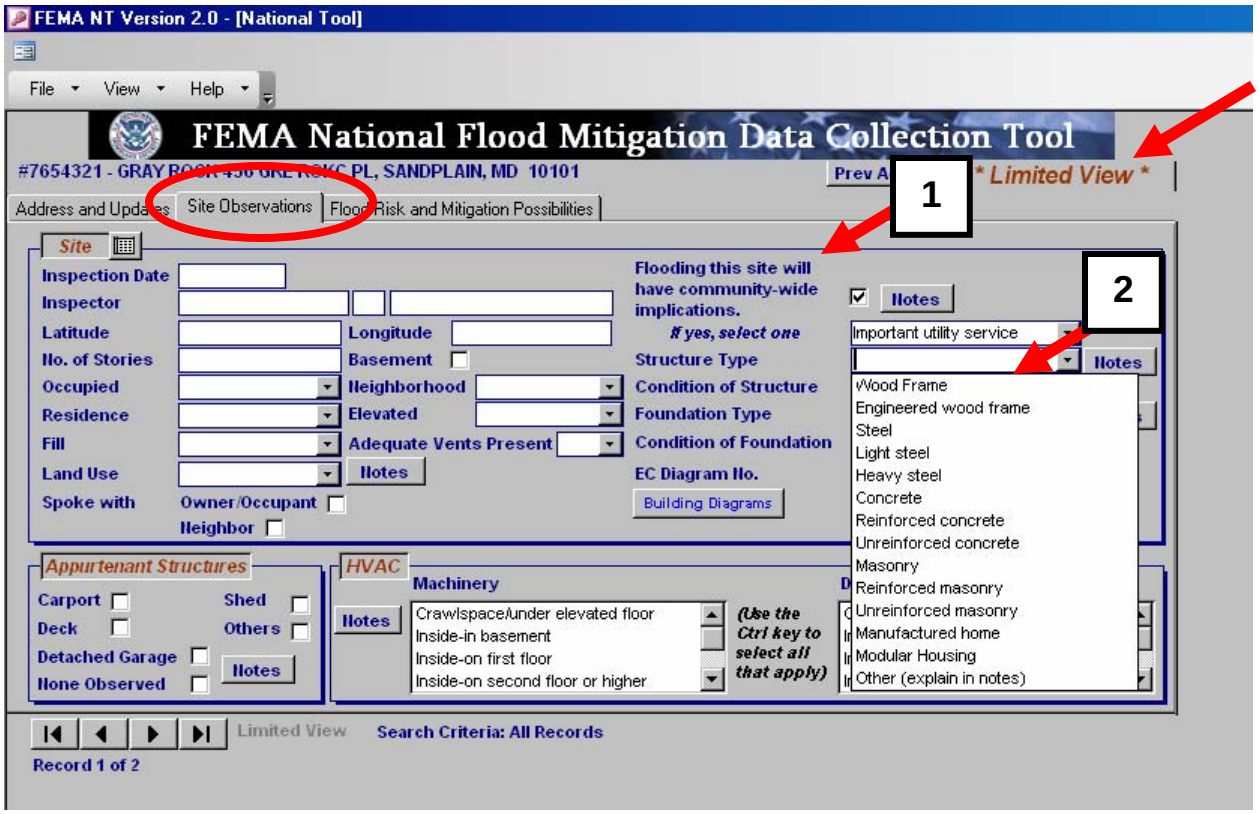

Figure 2-2. *Site Observations* tab

The *Site Observations* tab contains some of the information regarding the physical characteristics of the building to be mitigated. It may need to be supplemented by detailed investigation, but will greatly facilitate the initial decision-making process regarding suitability and type of mitigation measure to select.

1. Checking the *Flooding this site will have community-wide implications* box indicates whether or not flooding will have a critical impact on the community.

2. Additional drop down menus on the Site Observations tab include *Structure Type, Condition of Structure, Foundation Type,* and *Condition of Foundation*. The particular menu shown is for *Structure Type.*

Flood Risk and Mitigation Possibilities (Figure 2-3)

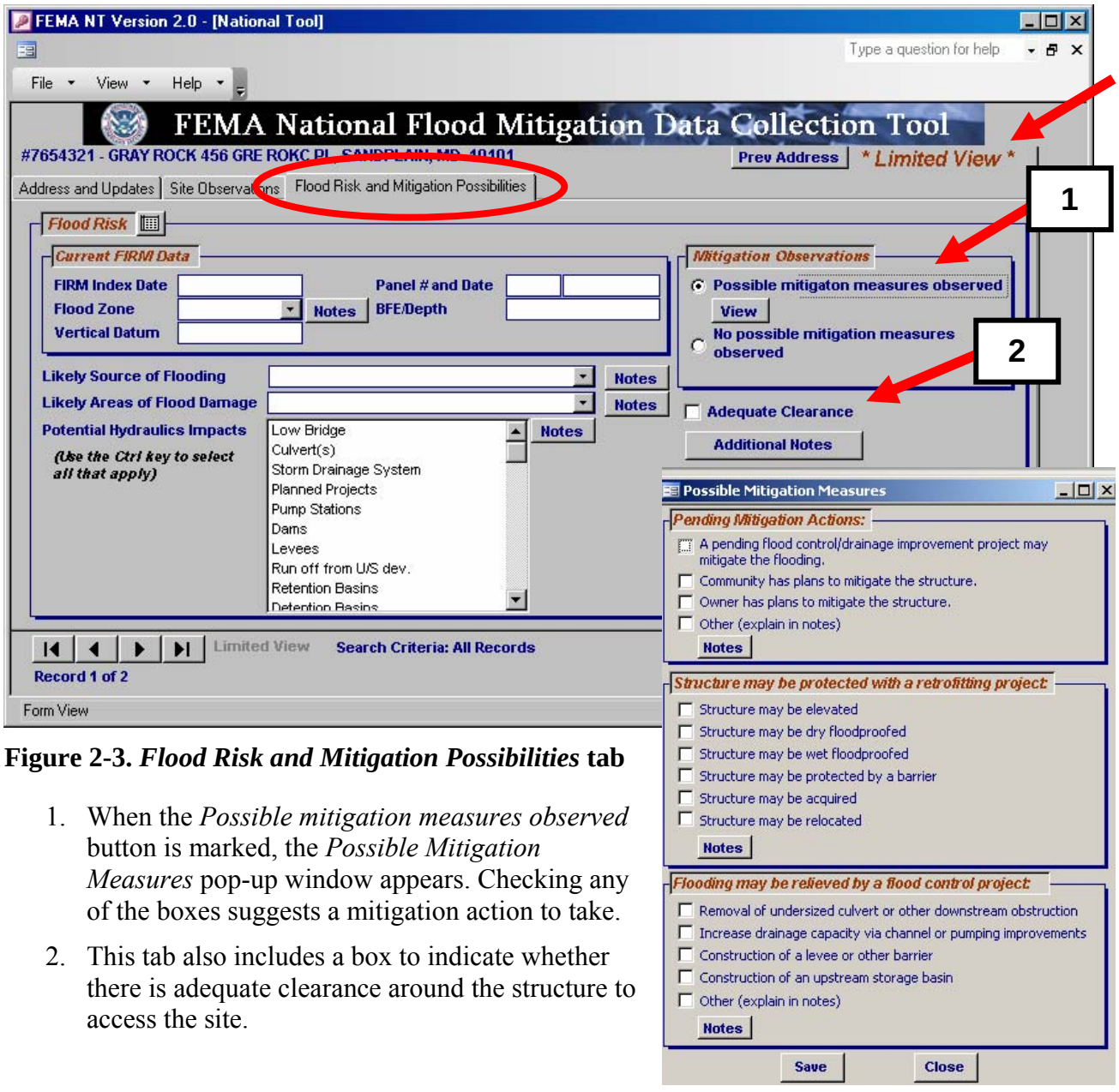

Figure 2-3. *Flood Risk and Mitigation Possibilities* tab

1. When the *Possible mitigation measures observed* button is marked, the *Possible Mitigation Measures* pop-up window appears. Checking any of the boxes suggests a mitigation action to take.
2. This tab also includes a box to indicate whether there is adequate clearance around the structure to access the site.

2.2.2 Detailed Data View

The Detailed Data View includes four main subsections or "tabs."

Additional Site Information (Figure 2-4)

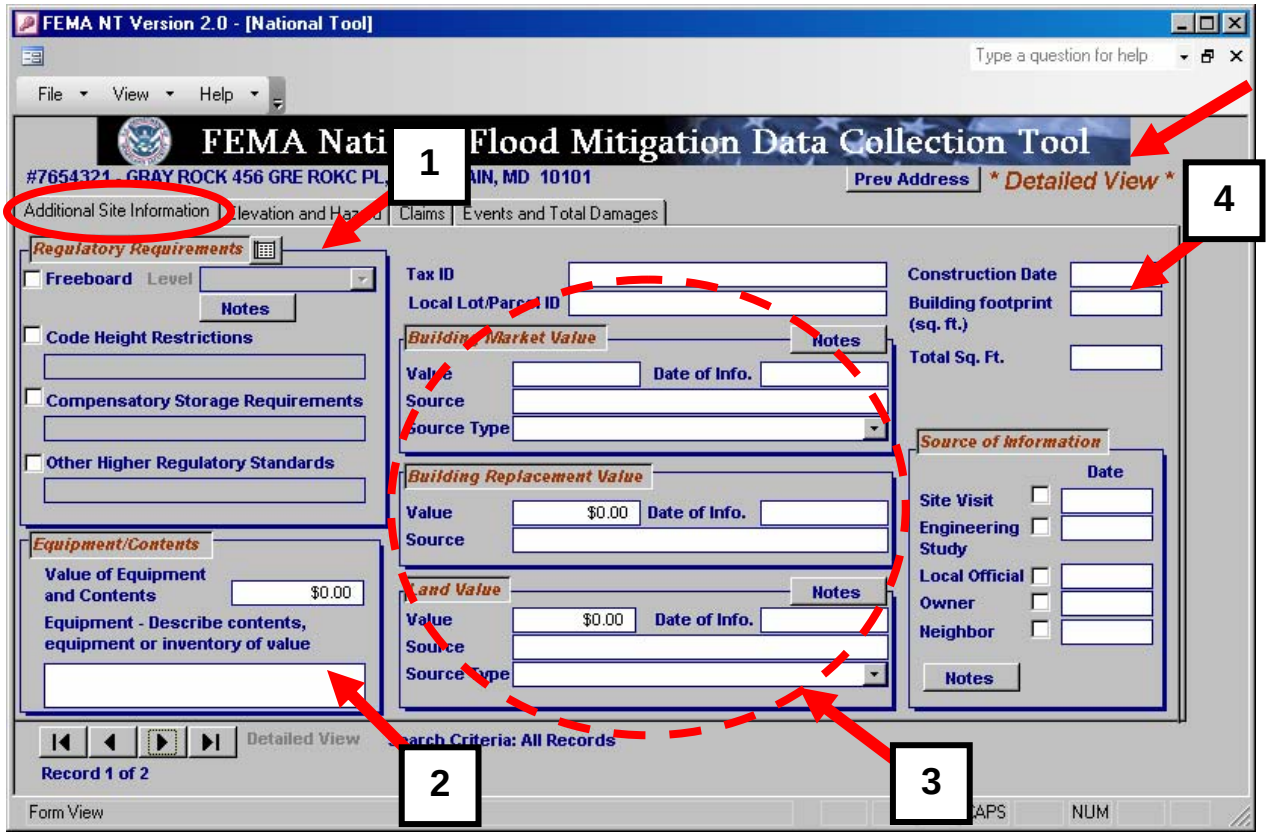

Figure 2-4. *Additional Site Information* tab

1. *Regulatory Requirements* has information on local regulatory requirements related to floodplain management. The local regulatory codes will include relevant requirements, including more restrictive requirements related to freeboard, height restrictions, or storage requirements.
2. *Equipment/Contents* is available if specialized equipment such as machinery or high dollar contents that might be found at a manufacturing or retail site are present. The information will accompany other costs in assessing the benefit/cost ratio (BCR) of a project.
3. *Building Market Value, Building Replacement Value*, and *Land Value* information is generally obtained from the county tax assessor. This information will be of primary importance in determining if substantial improvement requirements are applicable and is essential in the benefit/cost process.
4. *Building footprint*. This information will be useful in confirming property values and in indicating the potential mitigation alternatives.

Elevation and Hazard (Figure 2-5)

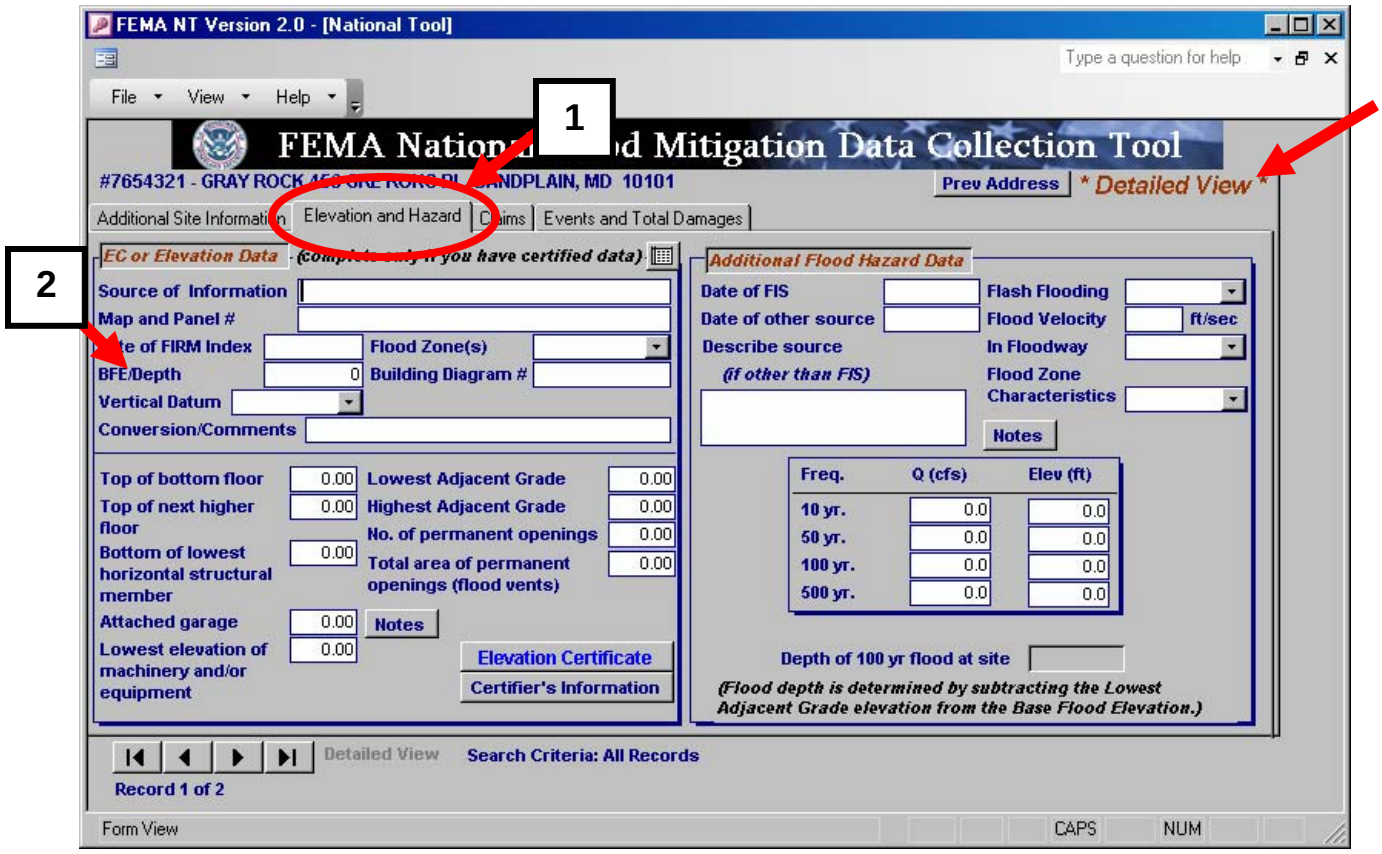

Figure 2-5. *Elevation and Hazard* tab

1. The *Elevation and Hazard* tab contains the required elevation data. The data listed for collection in the *EC or Elevation Data* section is the same information collected in Sections B and C of a FEMA Elevation Certificate. This section contains additional information that was previously collected by an engineer, surveyor, or qualified local official from the FIRM or FIS, as well as surveyed building elevations.
2. See Sections 2.3.1 through 2.3.4 for sources of base flood elevation data.

Claims (Figure 2-6)

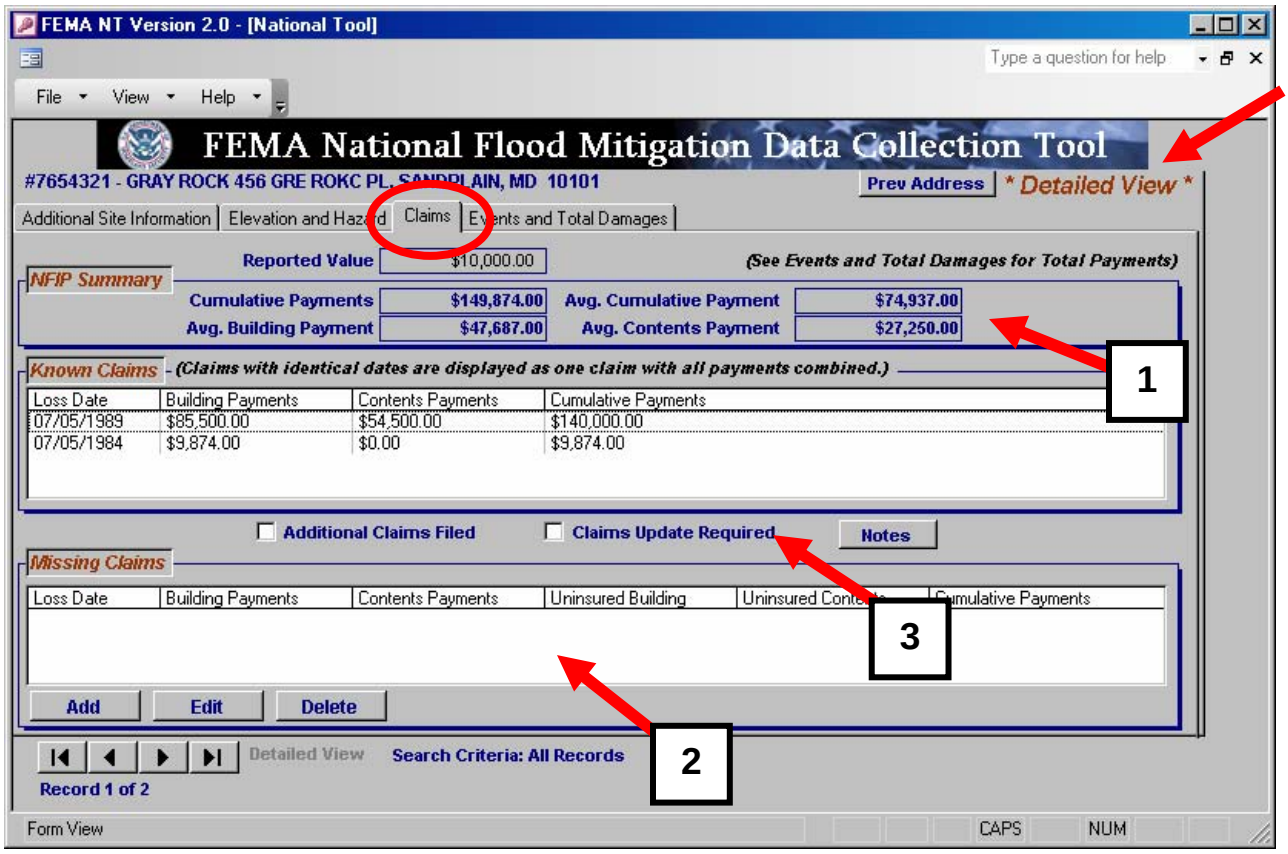

Figure 2-6. *Claims* tab

1. The *Known Claims* in the *NFIP Summary* section on the Claims tab includes a summary of past NFIP claims data on the structure.
2. The *Missing Claims* section provides an opportunity to add additional or missing claims.
3. Checking the *Claims Update Required* box signifies that added claims should be captured as part of the official record for the property.

Events and Total Damages (Figure 2-7)

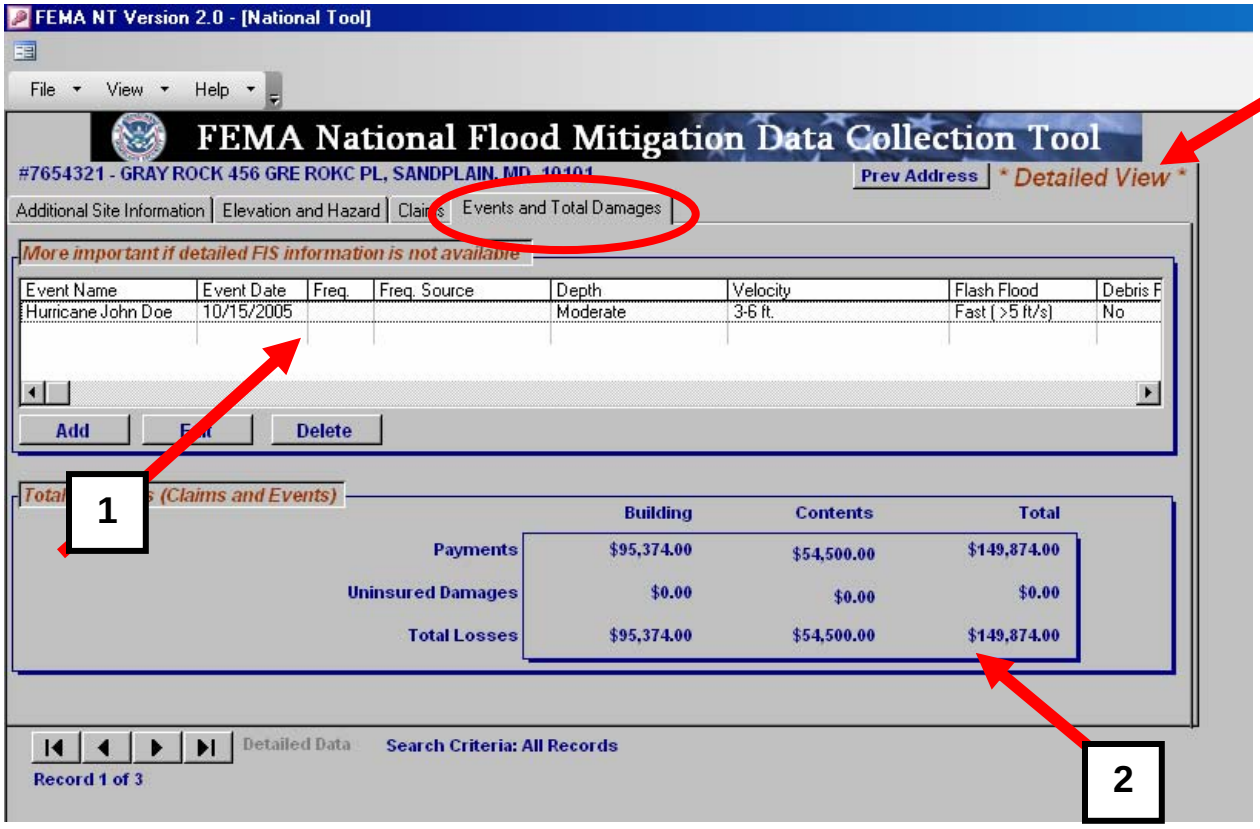

Figure 2-7. *Events and Total Damages* tab

1. Information about specific uninsured flood events by name and date, including data about frequency, source, depth, velocity, damages, etc., can be entered and viewed in the area designated.
2. The *Events and Total Damages* tab also contains the summary and totals for past events and claims made under the NFIP. The claims and damage information is used to assist in the development of benefit/cost ratios necessary to select the appropriate mitigation measures.

2.3 Additional Sources of Information

Other sources of information identified in this subsection are either related to obtaining BureauNet data or provide supplemental information to manually enter into the NT. The additional sources include the following:

- Flood Insurance Studies (FIS)
- Community Information System (CIS)
- FEMA Regional Offices
- Other Federal agencies
- State, regional, and local agencies

2.3.1 Flood Insurance Studies

A detailed FIS provides the data and maps needed for both the flood insurance and floodplain management aspects of the NFIP. The FIS presents compiled flood risk data for specific watercourses, lakes, and coastal flood-hazard areas within a community. It delineates flood-hazard areas, designates flood risk zones, and establishes Base Flood Elevations (BFEs). An FIS thereby serves as the basis for determining flood insurance rates, regulating floodplain development, and carrying out other floodplain management measures. FISs and FIRMs can be viewed and ordered online at http://store.msc.fema.gov.

The FIS consists of three components:

- The FIS report
- The Flood Insurance Rate Map (FIRM)
- The Flood Boundary and Floodway Map (FBFM, or Floodway Map, included in studies prepared before 1985)

The FIS report includes the following:

- A narrative that appraises the community's flood history, and describes the purpose of the study, historic floods, and the area and streams studied
- Maps of the study area often with photographs of historic floods
- Tables summarizing various study data
- Computed flood profiles of the 10-, 50-, 100-, and 500-year floods for the stream reaches studied

The FIRMs and FBFMs are essential parts of the FIS that portray the following:

- Floodplain boundaries
- BFE and cross-section locations (for detailed study areas)
- Delineation of floodways, where applicable
- Designation of flood risk zones such as A and V Zones

CAUTION

FIRMs may not provide flood elevations or a floodway designation for floodplains in undeveloped areas. If the data are not available from a community's FIS or FIRMs, the community may need to investigate the possible existence of more recent or more detailed flood studies conducted by other agencies. If no reasonable floodplain information is available, a qualified engineer should review available data and determine if a new study should be conducted. This is especially important if a history of flood problems is not reflected on the FIRM or if the site is in a small watershed that has experienced an increase of recent development.

Some communities' FIS and FIRMs can be several years old. They will not reflect recent developments and may have been generated using older, less accurate mapping techniques. Map modernization work is in progress, including the development of up-to-date flood hazard data for areas across the U.S. and the creation of maps and data in digital format such as the Digital Flood Insurance Rate Map (DFIRM).

2.3.2 FEMA Regional Offices

FEMA has divided the United States and outlying territories into 10 regions (see Appendix F for contact information or http://www.fema.gov/about/contact/regions.shtm). Each office serves several states and territories with regional staff who work directly with their constituents to plan for disasters, develop mitigation programs, and respond when major disasters occur. Each of the 10 FEMA regions has a Risk Insurance and Risk Reduction Branch to handle flood insurance and community mitigation issues. A designated RL Coordinator is available in each region to coordinate RL activities (see Appendix F).

2.3.3 Other Federal Agencies

Other Federal agencies that may have information about past flooding events, damages incurred, and areas of repetitive flooding include the following:

- U.S. Army Corps of Engineers (USACE) Floodplain Information Reports
- National Oceanographic and Atmospheric Administration (NOAA)
- U.S. Geological Survey (USGS) Water Resources Investigations
- Natural Resources Conservation Service (NRCS) Watershed Studies
- Federal Highway Administration (FHWA) Floodplain Studies
- Tennessee Valley Authority (TVA) Floodplain Studies

U.S. Army Corps of Engineers (USACE). The USACE focuses on public works and engineering missions, and works with FEMA and other Federal agencies to respond to disasters, including flooding. They also advise communities, industries, and property owners about protection measures, including flood damage prevention measures. The USACE has eight divisions composed of several district offices across the country

(http://www.usace.army.mil/divdistmap.html). The USACE can provide information on pending and completed flood protection projects, level of protection provided, and post completion flood events.

National Oceanographic and Atmospheric Administration (NOAA). The National Climatic Data Center (NCDC) keeps records of historic storm events, including flooding. The database can be accessed online at http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms. Data provided include the date and extent of the storm as well as the overall value of damage. A description of the storm is also sometimes available and can provide specific detail about damage. NOAA's Flooding Page (http://www.noaa.gov/floods.html) includes a link to NOAA's Hydrologic Information Center, which monitors not only river/stream flow conditions but also other conditions such as soil moisture, snow, and longer-term meteorological outlooks. The National Hurricane Center (NHC) Tropical Prediction Center website (http://www.nhc.noaa.gov/) has information from real-time updates to forecasts and historical background information on hurricane-related flooding.

United States Geological Survey (USGS). The USGS operates and maintains a network of approximately 7,000 stream gauges. Historical records and real-time data are available for many of these gauges, which are valuable tools in helping to quantify floods. The USGS uses this information to produce publications documenting flood events. Such publications include descriptions of the events and detail the cause of flooding, damage caused, storm frequency, and other pertinent information.

Natural Resources Conservation Service (NRCS). Under the Watershed Protection and Flood Prevention Act (Public Law [P.L.] 83-566), the NRCS conducts watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance. As watershed boundary Geographic Information Systems (GIS) coverage is completed, statewide and national data layers will be made available publicly via the Geospatial Data Gateway at http://datagateway.nrcs.usda.gov/.

Federal Highway Administration (FHWA). The FHWA conducts hydraulics and hydrologic (H+H) research and analyses, develops H+H modeling software, and prepares environmental impact statements and environmental assessments for projects related to transportation, which can be accessed online at http://www.fhwa.dot.gov/engineering/hydraulics/index.cfm. The data from the FHWA are for areas near bridges.

Tennessee Valley Authority (TVA). The TVA divides the Tennessee River watershed into 12 divisions, each overseen by a TVA Watershed Team. Information about unregulated stream flows at sites across the Tennessee Valley, and watershed maps, environmental reviews, and environmental reports can be found at http://www.tva.gov. The TVA also maintains stream gauges and manages river forecasters who track storms, predict stream flows and flood heights, and calculate runoff amounts.

2.3.4 State, Regional, and Local Agencies

A number of State, regional, and local government agencies have information that can be used to supplement the data entries of NT (see Table 2-1). This information includes delineations of

specific areas and/or structures that have been flooded in the past and the extent of damage for each structure.

Table 2-1. State, Regional, and Local Sources for Information about Flood Events

State Agencies (Departments or Divisions)	Regional Agencies and Organizations	Local Agencies
▪ Emergency Management ▪ Environmental Conservation and Protection ▪ Floodplain Management ▪ Geologic Surveys ▪ Homeland Security ▪ Natural Resources ▪ Transportation ▪ Water Resources	▪ Emergency Management ▪ Flood Control Districts ▪ Levee Improvement Districts ▪ Regional Planning and/or Economic Development Commissions ▪ River Basin Commissions	▪ Emergency Management Agencies and Coordinators ▪ Local Planning Commissions ▪ Municipal Utilities ▪ Public Works

CHAPTER 3 – SELECTING MITIGATION MEASURES

3.1 Introduction

The remainder of this document focuses on the process of selecting appropriate mitigation measures. This process includes the following steps:

1. **Initial screening using NT.** Conduct an initial screening using NT and determine appropriate mitigation measures by answering questions regarding flooding and structure characteristics (use **Worksheet A, Technical Considerations Scorecard**).
2. **Evaluate appropriate mitigation measures.** Based on information provided in Chapters 4 through 10, record rankings of each mitigation measure (use **Worksheet B, Appropriate Mitigation Measures**).

This process is designed to assist State and local officials in discussing which mitigation measures are the most appropriate to pursue with the individual property owners and other community officials who may need to make or support decisions. The initial results of the selection process may not always identify a single best option for any particular situation. However, it will narrow the options and document the selection process for all participants. It is assumed that structures and/or areas of interest within the community have been identified based on past flooding and a comprehensive mitigation planning process.

Hazard Mitigation Planning - For information on the mitigation planning process refer to the FEMA Mitigation Planning "How-To" Guides which are based on 44 CFR, Part 201 – Mitigation Planning (see Section 1.3). FEMA publication 511 provides an overview of how to conduct an area analysis to determine whether a neighborhood-level approach, such as drainage improvements, relocation, or acquisition, would resolve the flood problem (see Chapter 7, Area Analysis in FEMA 511, *Reducing Damage from Localized Flooding*).

This chapter includes the following:

- **Section 3.2, Mitigation Measures Overview,** provides a brief overview of seven categories of mitigation measures. Additional information on each mitigation measure is located in Chapters 4 through 10 with appropriate references for detailed information.
- **Section 3.3, Initial Screening Using the NT,** describes the initial screening process for identifying appropriate mitigation measures using data that are collected in the NT. Completed examples of worksheets are included in Appendix A.
- **Section 3.4, Hazard and Structure Characteristics,** includes information on the questions used in the initial screening process. This subsection describes how to obtain the data needed to answer the question and provides references for additional information. A screenshot from the NT illustrates where this information is located.
- **Section 3.5, Evaluating the Mitigation Measures,** describes how to further evaluate the identified mitigation measures following the initial screening process.

3.2 Mitigation Measures Overview

This subsection introduces seven categories of flood mitigation measures designed to protect properties from flooding. These mitigation measures are further discussed in Chapters 4 through 10.

3.2.1 Drainage Improvements (see also Chapter 4)

The drainage system moves surface water through channels to a receiving body of water. The system itself contains several conveyance systems that carry water away and may contain storage facilities to store excess water until it can be removed. Examples of improvements to regional or local drainage systems include modifying a culvert, stream, or river channel to provide a greater carrying capacity to move floodwaters off areas where damage occurs.

3.2.2 Barriers (see also Chapter 5)

Examples of barriers include building a floodwall or levee around a structure or a group of structures to hold back floodwaters. Levees are usually embankments of compacted soil, and floodwalls are usually built of concrete or masonry or a combination of both. Levees require more space than a floodwall since the sides of a levee are sloped to provide stability and resist erosion. An alternative to a permanent barrier is a temporary one, such as large water-filled tubes or bladders, metal walls lined with impermeable materials that act as floodwalls**,** and expandable gates that block floodwaters from entering structures through openings such as doors and windows.

3.2.3 Wet Floodproofing (see also Chapter 6)

Wet floodproofing a structure involves making uninhabited portions of the structure resistant to flood damage and allowing water to enter during flooding. Damage to a structure is reduced since water is allowed to enter and balances the hydrostatic pressure on both sides of the walls and floors.

3.2.4 Dry Floodproofing (see also Chapter 7)

Dry floodproofing involves sealing structures to prevent floodwaters from entering. A structure can be dry floodproofed using waterproof coatings or impermeable membranes to prevent seepage of floodwater through the walls, installing watertight shields over doors or windows, and installing sewer backup prevention measures.

3.2.5 Elevation (see also Chapter 8)

Elevating a structure consists of raising the lowest floor to or above the flood level. This can be done by elevating the entire structure, including the floor, or by leaving the structure in its existing position and constructing a new, elevated floor within the structure. The method used depends on the construction type, foundation type, and flooding conditions.

3.2.6 Relocation (see also Chapter 9)

Relocating a structure includes moving the structure out of the floodplain to higher ground where it will not be exposed to flooding. The process involved in relocating a structure includes raising the structure and placing it on a wheeled vehicle to be moved to a new location.

3.2.7 Acquisition (see also Chapter 10)

Acquisition involves buying and tearing down a structure. The property owners would then move to another property that is located outside of the floodplain. A new building meeting all building and flood protection code requirements can be built on the lot or the lot can remain as open space.

3.3 Initial Screening Using the NT

The steps listed below describe how to fill out **Worksheet A, Technical Considerations Scorecard.** Appendix A includes a completed sample packet. For blank versions of this worksheet, see Appendix B.

1. Use **Worksheet A, Technical Considerations Scorecard,** to record responses to the nine questions under the first column (titled "Question").

   For background information on each question, see Section 3.4, Hazard and Structure Characteristics. This subsection also discusses how to obtain the data needed to answer these questions as well as where this information, once collected, is located in the NT.

2. Based on the responses selected in the Response column of Worksheet A, for each row with a check mark in the "Response" column, check all boxes that are <u>not</u> blacked out.

   Repeat this step for each question. Include any notes or comments in the far right-hand column of Worksheet A.

3. Place an "X" in the row (titled "Appropriate Mitigation Measures") of Worksheet A under the column of any mitigation measure that does not include a black box in any selected response row.

   For example, a response of manufactured home to Question #1 will exclude the selection of wet floodproofing and dry floodproofing in the Appropriate Mitigation Measures row. In the sample packet in Appendix A, the response of "Deep" to Question #6 eliminates the mitigation measures of drainage improvements, wet floodproofing, and dry floodproofing from consideration as appropriate.

Worksheet A: Technical Considerations Scorecard

Date Prepared: _____ Date Property Visited: _____
Property Owner Name: _____
Property Address: _____
Repetitive Loss Property Locator Number: _____
Prepared by: _____

Legend
- Mitigation measure is not appropriate.
- Mitigation measure may be appropriate and requires additional consideration.
- Mitigation measure is appropriate.

NT Reference indicates where the information may be found in the National Tool.

Instructions to complete Worksheet A: Technical Considerations Scorecard

1. For each of the questions, based on the property information, put a check mark in the appropriate box in the "Response" column.
2. For the row with a check mark in the "Response" column, check all boxes that are not blacked out.
3. After completing the questions, review each of the mitigation measures columns. Select the "Appropriate Mitigation Measures" box only for those columns that do not have any blacked out boxes in the selected response row.

Question	Response	Drainage Improvements	Barriers	Wet Floodproofing	Dry Floodproofing	Elevation	Relocation	Acquisition	Comments
1. What is the structure type? *NT Reference - Limited Data View, Site Observations* tab	☐ Wood Frame/ Metal/ Other	☐	☐	☐	☐	☐	☐	☐	
	☐ Concrete/ Masonry/ Brick Faced	☐	☐	☐	☐	☐	☐	☐	
	☐ Manufactured Home	☐	☐	■	■	☐	☐	☐	
2. What is the condition of the structure? *NT Reference - Limited Data View, Site Observations* tab	☐ Good	☐	☐	☐	☐	☐	☐	☐	
	☐ Fair	☐	☐	☐	☐	☐	☐	☐	
	☐ Poor	☐	☐	■	■	■	■	☐	
3. What is the foundation type? *NT Reference - Limited Data View, Site Observations* tab Diagram numbers refer to Elevation Certificate found in the NT.	☐ Slab-on-grade (Diagram 1, 3, 6, or 7)	☐	☐	☐	☐	☐	☐	☐	
	☐ Basement/ Split level (Diagram 2 or 4)	☐	☐	☐	☐	☐	☐	☐	
	☐ Piers, Posts, Columns, or Crawlspace (Diagram 5 or 8)	☐	☐	☐	■	☐	☐	☐	

Question	Response	Drainage Improvements	Barriers	Wet Floodproofing	Dry Floodproofing	Elevation	Relocation	Acquisition	Comments
4. What is the number of stories? *NT Reference - Limited Data View, Site Observations* tab	☐ 1-2	☐	☐	☐	☐	☐	☐	☐	
	☐ 3 or more	☐	☐	☐	☐	☐	☐	☐	
5. What is the building footprint? *NT Reference - Detailed Data View, Additional Site Information* tab	☐ < 2,500 sq ft	☐	☐	☐	☐	☐	☐	☐	
	☐ > 2,500 sq ft	☐	☐	☐	☐	☐	☐	☐	
6. What is the flood protection depth? *NT Reference - Detailed Data View, Elevation and Hazard* tab	☐ Deep (> 6ft)		☐			☐	☐	☐	
	☐ Moderate (3 to 6 ft)	☐	☐	☐		☐	☐	☐	
	☐ Shallow (<3 ft)	☐	☐	☐	☐	☐	☐	☐	
7. Does flash flooding occur at the project site? *NT Reference - Detailed Data View, Elevation and Hazard* tab	☐ Yes	☐	☐	☐	☐	☐	☐	☐	
	☐ No	☐	☐	☐	☐	☐	☐	☐	
8. What is the flood velocity? *NT Reference - Detailed Data View, Elevation and Hazard* tab	☐ Fast (>5 fps)	☐	☐	☐	☐	☐	☐	☐	
	☐ Slow/Moderate (<5 fps)	☐	☐	☐	☐	☐	☐	☐	
9. Is the structure located in the floodway? *NT Reference - Detailed Data View, Elevation and Hazard* tab	☐ Yes	☐	☐	☐	☐	☐	☐	☐	
	☐ No	☐	☐	☐	☐	☐	☐	☐	
Appropriate Mitigation Measures		☐	☐	☐	☐	☐	☐	☐	

fps = feet per second
ft = feet
sq ft = square feet

3.4 Hazard and Structure Characteristics

3.4.1 Question #1. What is the structure type?

What are the most common structure types? The most often used structure types include wood frame, metal, concrete, masonry, manufactured home, or a combination of two or more of these types. Definitions of these terms are included in the Glossary in Appendix I.

What is the significance of the structure type? The structure type influences the considerations that will need to be addressed.

- Dry floodproofing may not be an appropriate mitigation measure for a wood-frame or metal structure since they are difficult to make watertight.
- Solid masonry, stone walls, or wood-frame construction with a brick veneer may not be appropriate for elevation or relocation projects since these structures will need significant support during the lifting process, which may be expensive.
- If the construction type is a manufactured home, wet and dry floodproofing are not appropriate mitigation measures because virtually any depth of flooding causes significant and irreparable damage.

Where is structure type information located in NT? The structure type can be found under Limited Data View on the *Site Observations* tab (Figure 3-1).

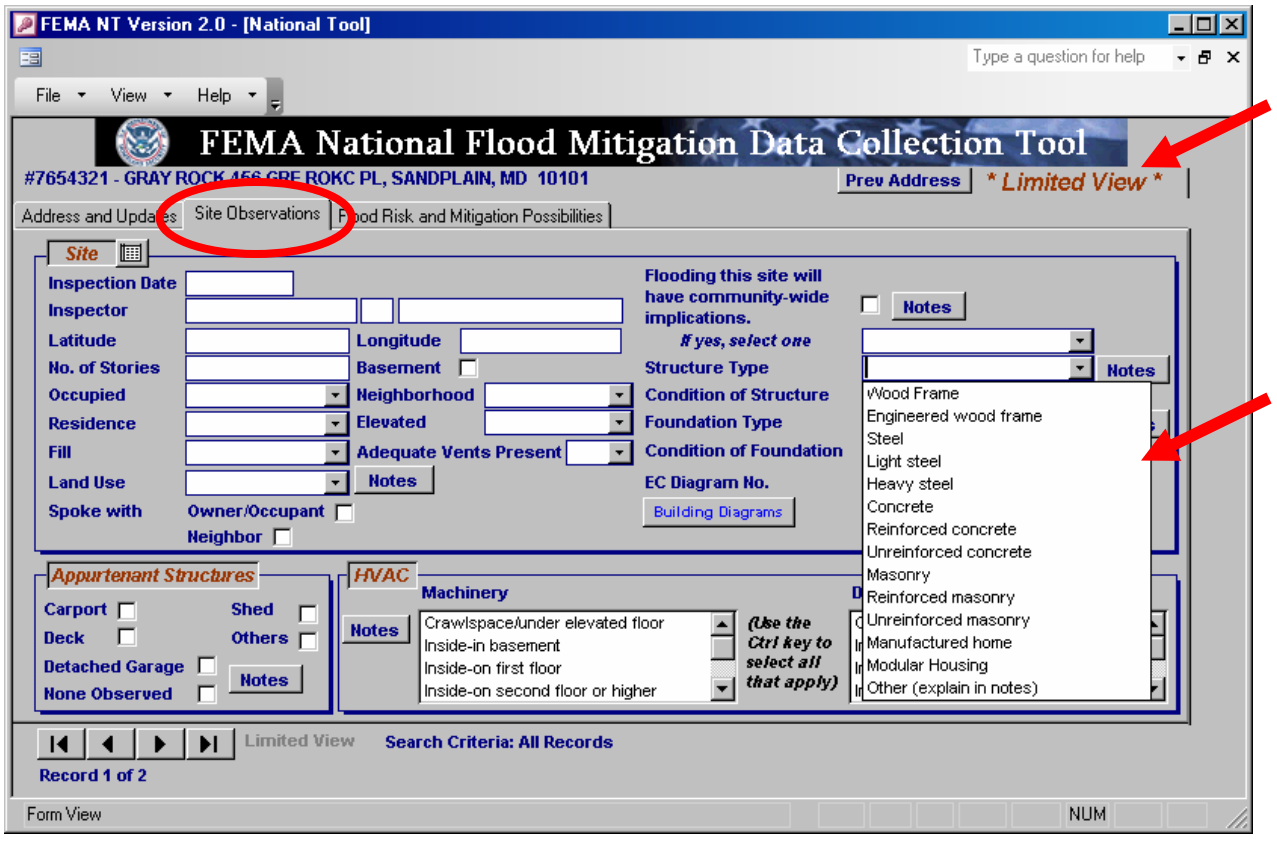

Figure 3-1. *Site Observations* tab - Structure Type menu

Where to find additional information:

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures***.** See Chapter III, Parameters of Retrofitting (page III-31).

FEMA 497. *National Flood Mitigation Data Collection Tool Guide*. See Chapter 6, Data Collection with the NT 6.2.2.1 – Site for additional information on structure types (page 6-13).

3.4.2 Question #2. What is the condition of the structure?

How is the condition of the structure determined? This information is based on the level of repair needed and may be obtained by a site visit. It is recommended that the local building official be consulted for the condition of the structure. An explanation of the terms (Good, Fair, and Poor) can be found in FEMA 497, *National Flood Mitigation Data Collection Tool Guide***.**

The condition of the structure will have implications for selecting an appropriate mitigation measure:

- For a structure in fair condition, wet and dry floodproofing, elevation, and relocation may not be appropriate mitigation measures unless it is determined that the structure is sound enough to undergo the mitigation measure.
- Wet and dry floodproofing, elevation, and relocation are not appropriate mitigation measures for structures in poor condition since these projects may not be technically feasible or cost-effective.

Where is structure condition information located in NT? An assessment of the structure condition can be found on the *Site Observations* tab in Limited Data View (Figure 3-2).

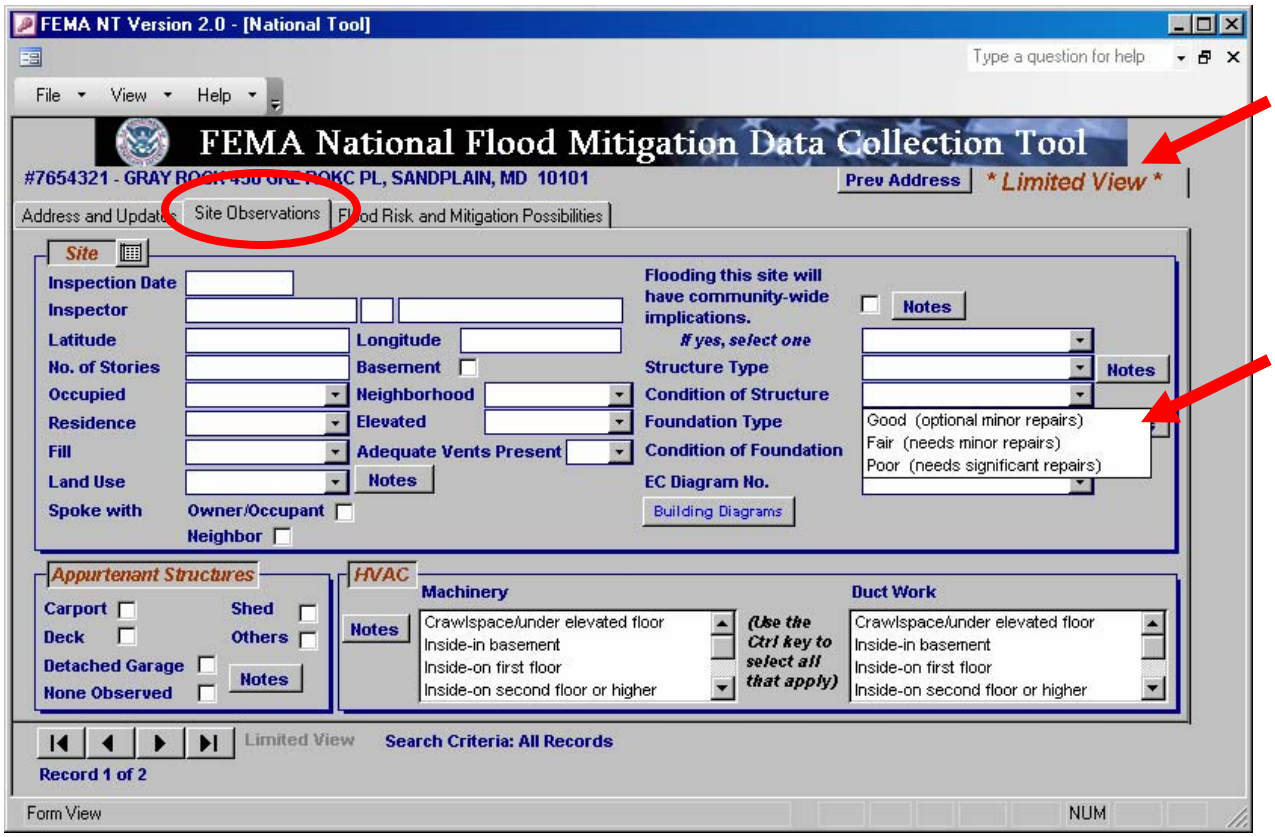

Figure 3-2. *Site Observations* tab - Condition of Structure drop down menu

Where to find additional information

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. See Chapter III, Parameters of Retrofitting (pages III-32 to III-34).

FEMA 497. *National Flood Mitigation Data Collection Tool Guide***.** See Chapter 6, Data Collection with the NT 6.2.2.1 – Site for additional information on the condition of the structure (pages 6-13 to 6-14).

3.4.3 Question #3. What is the foundation type?

What types of foundations are most common? The main types of foundations are slab-on-grade; basement; elevated on piers, posts, piles, columns, or shear walls; and crawlspaces. Each type has specific considerations that can affect a mitigation project:

- Slab-on-grade structures are more difficult to elevate or relocate than structures on basement or crawlspace foundations, if the slab is attached.
- Elevating structures on basement foundations involves elevating or relocating utility system components usually found in basements, such as furnaces and hot water heaters. In addition, if the structure is substantially damaged or is being substantially improved, the basement may need to be filled in to meet local floodplain regulations. Basement

walls are subject to hydrostatic pressure and buoyancy forces, which may make barriers and dry floodproofing inappropriate mitigation measures.

- Structures with piers, posts, piles, columns, shear walls, or crawlspaces should not be dry floodproofed since the floors are not watertight and flotation will cause damage to the foundation.

Where is foundation information located in the NT? The type and condition of the foundation can be found on the *Site Observations* tab in the Limited Data View (Figure 3-3).

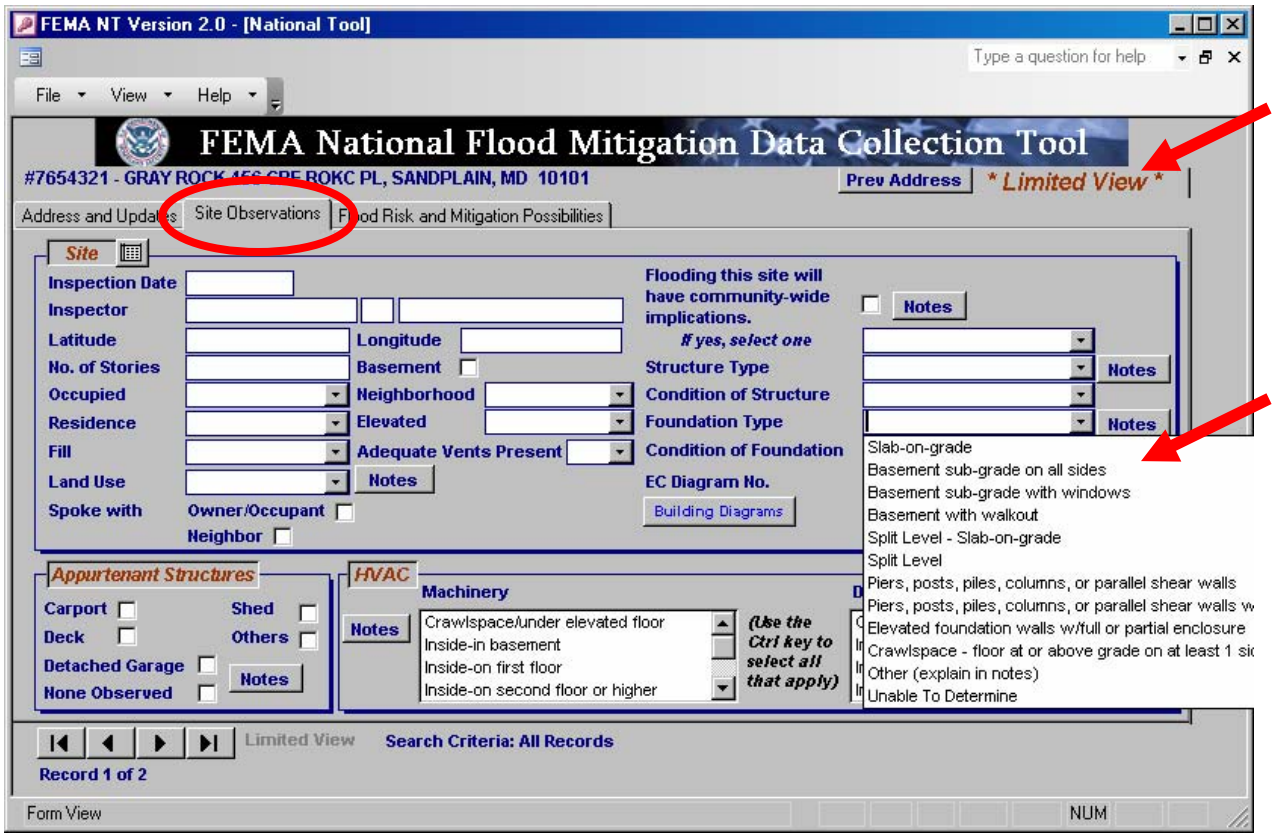

Figure 3-3. *Site Observations* tab - Foundation Type menu

Where to find additional information:

FEMA 85. *Manufactured Homes in Flood Hazard Areas: A Multi-Hazard Foundation and Installation Guide*. See Chapter 9, Foundation Systems.

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. See Chapter III, Parameters of Retrofitting (pages III-28 to III-29).

FEMA 497. *National Flood Mitigation Data Collection Tool Guide*. See Chapter 6, Data Collection with the NT 6.2.2.1 – Site for additional information on foundation types (page 6-14).

3.4.4 Question #4. What is the number of stories?

Why is the number of stories in a structure important? Multi-story structures are difficult to elevate and relocate. One consideration is that moving overhead power lines along the route may cause the cost of the mitigation measure to increase and thereby reduce the cost-effectiveness. It is also technically more difficult to elevate or relocate a larger structure than a smaller more compact structure.

Where is number of stories information located in NT? The number of stories for the structure may be identified on the *Site Observations* tab in the Limited Data View (Figure 3-4).

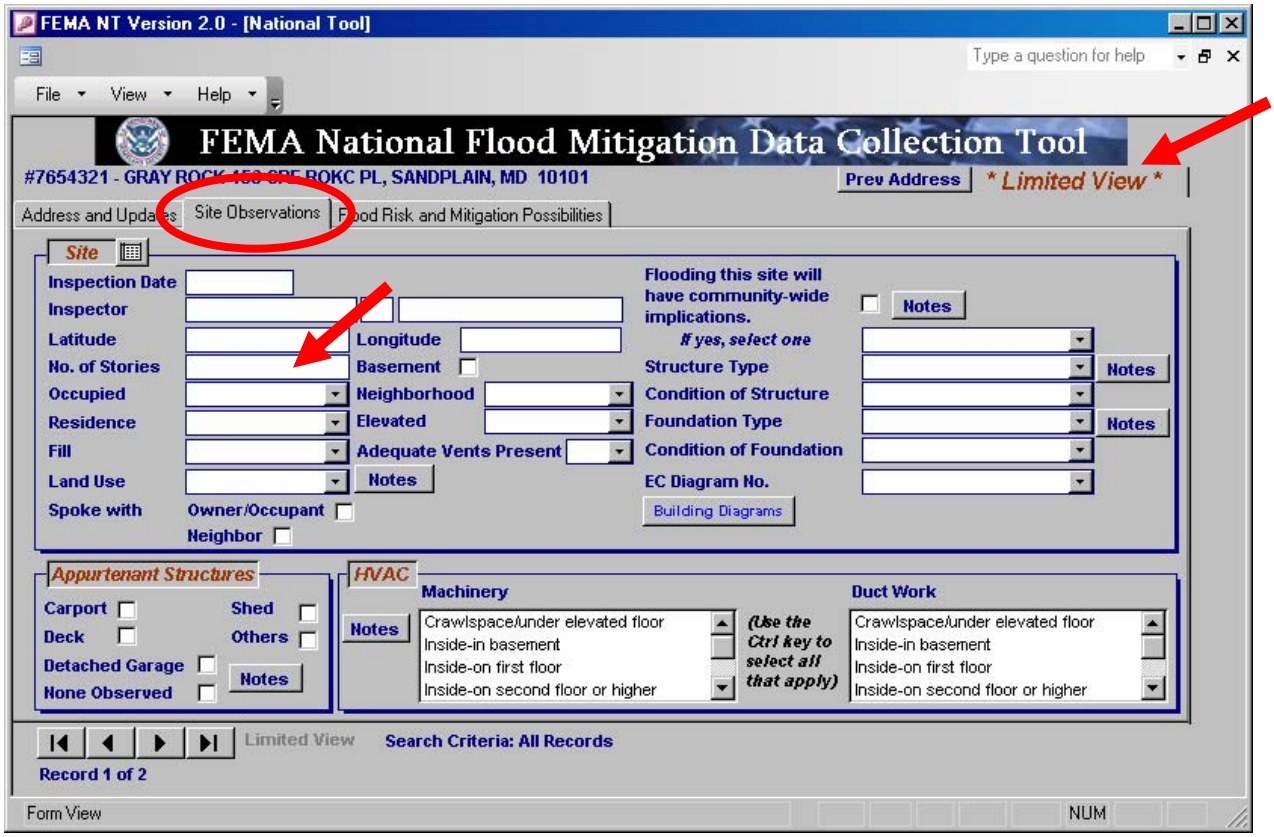

Figure 3-4. *Site Observations* tab - Number of Stories

Where to find additional information:

FEMA 497. *National Flood Mitigation Data Collection Tool Guide*. See Chapter 6, Data Collection with the NT 6.2.2.1 – Site (page 6-11).

3.4.5 Question #5. What is the building footprint?

Why is footprint an important issue? Larger, heavier, more complex shaped buildings are more difficult and expensive to elevate or relocate. While large buildings are not necessarily a different type of construction, they do present a significant challenge to the elevation or relocation contractor, primarily because of their weight or configuration. They may include a rambling, ranch-style house; a multi-storied house or commercial building; or a very large and heavy masonry, concrete, or stone building. Rambling construction can be handled by cutting the building into two or more pieces and elevating each piece individually. Once elevated, the individual sections are rejoined and cosmetically corrected to disguise the fact the building was cut.

Where is structure size information located in NT? The building footprint area or square feet of the structure can be found on the *Additional Site Information* tab in the Detailed Data View (Figure 3-5).

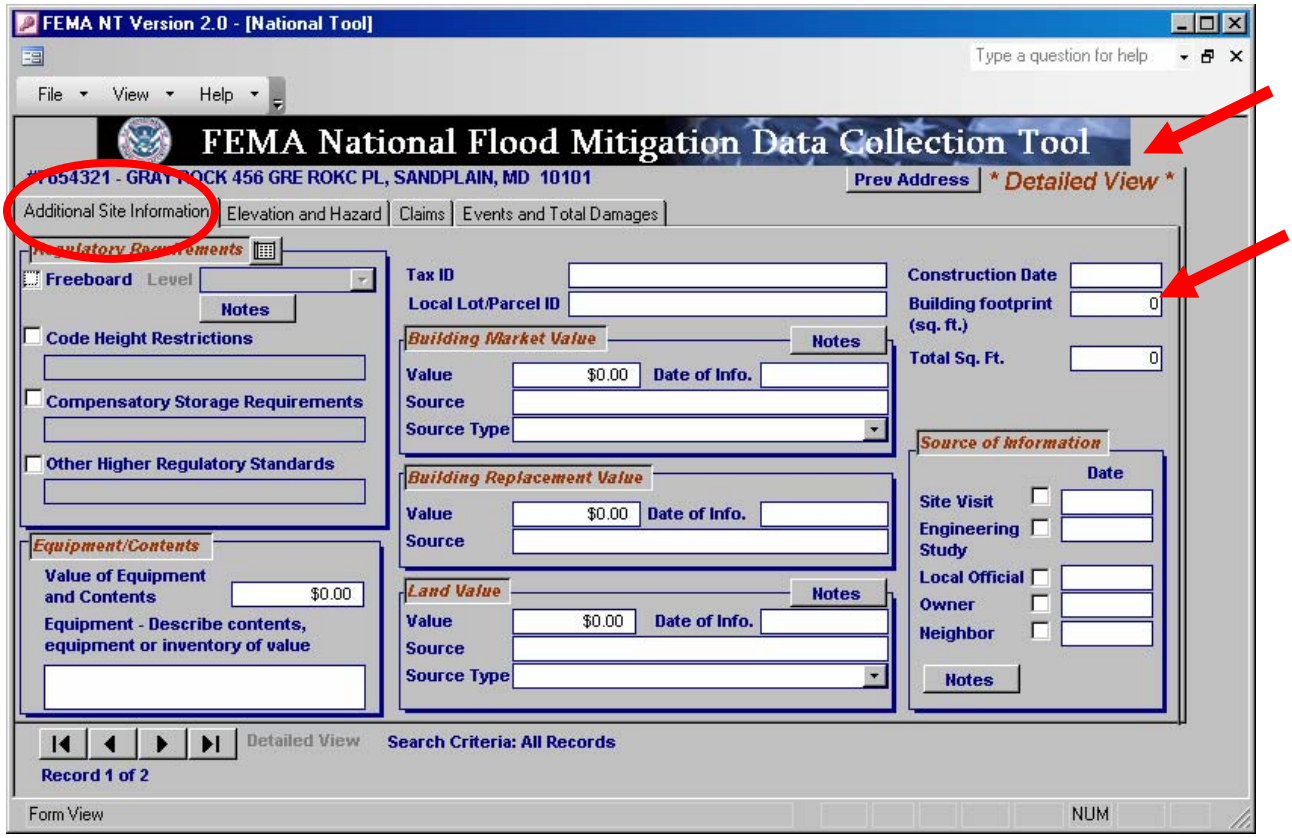

Figure 3-5. *Additional Site Information* tab - Building footprint

Where to find additional information:

FEMA 497. *National Flood Mitigation Data Collection Tool Guide*. See Chapter 6, Data Collection with the NT 6.3.1 - *Additional Site Information* tab (page 6-18).

3.4.6 Question #6. What is the flood protection depth?

What is flood protection depth? Flood protection depth is the depth above the lowest adjacent grade to which a mitigation measure is designed. It is the flood protection elevation (or flood protection level) minus the elevation of the lowest adjacent grade. "Flood protection elevation" is used in other FEMA mitigation publications, including FEMA 259. It is usually the BFE plus 1 or more feet of freeboard. Floodwaters, even when they are not moving, exert pressure on structural components such as walls and concrete floor slabs. This hydrostatic pressure is caused by the weight of the water and increases as the depth of the water rises.

Flood Protection Depth Example. If the base flood elevation is 480 feet above sea level and the lowest adjacent grade is 475 feet above sea level and the community wants to have the margin of protection of a 1-foot freeboard, the flood protection depth is (480 + 1) -475 = 6 feet.

Flood protection depth may be a higher level, especially if a recent flood was higher than the base flood. If protecting to the BFE proves infeasible, the designer may want to use a lower flood protection level, such as the depth of the repetitive flooding. For example, if the building is a large masonry industrial building on a slab foundation, elevation may be infeasible. Dry floodproofing to 3 feet may be the only feasible approach, so the flood protection depth would be 3 feet, even though the base flood depth may be 4 or more feet above lowest adjacent grade.

How does flood depth affect a structure? Floodwater, including water-saturated soil, pushes in on walls and up on floors, posing a special hazard for basement walls. Because pressure increases with the depth of the water, the pressure on basement walls is greater than the pressure on the walls of the upper floor. This pressure is made even greater by the weight of the saturated soil that surrounds the basement. Drainage improvements will not be technically feasible for structures that experience deep flooding. Dry floodproofing is not an appropriate mitigation measure for flooding that exceeds 3 feet due to the hydrostatic pressure on the structure.

How is flood depth calculated? Flood depth is the difference between the water surface elevation and the grade elevation of the flooded area. Ground elevations are established by topographic surveys and BFEs are included on FIRM panels where a detailed study has been performed and should be estimated using the flood profile in the corresponding FIS.

Guidance provided in FEMA 265, *Managing Floodplain Development in Approximate Zone A Areas,* suggests other methods to determine the BFE and appropriate Design Flood Elevation (DFE). One method involves extrapolating existing BFE data by using the flood profile from a FIS for a site that is within 500 feet upstream of a detailed studied portion of a stream and the floodplain and channel bottom slope characteristics are fairly similar. FEMA 265 also provides information on QUICK-2, which is a computer program developed by FEMA that may be used to compute BFEs. This software program is available on the FEMA website at http://www.fema.gov/plan/prevent/fhm/frm_soft.shtm.

Where is depth of flooding information located in NT? The depth of flooding may be identified in the NT on the *Elevation and Hazard* tab in the Detailed Data View in the "Depth of 100 yr flood at site" box (Figure 3-6, number 3). When the BFE (Figure 3-6, number 1) and Lowest Adjacent Grade (Figure 3-6, number 2) are entered in the *EC or Elevation Data* section,

the flood depth of 100-year flood (Figure 3-6, number 3) at the project site is calculated automatically by the NT. The Lowest Adjacent Grade is subtracted from the BFE to determine flood depth. Both the BFE and Lowest Adjacent Grade information can be found on a FEMA Elevation Certificate. Freeboard requirements are included in the Additional Site Information Tab (Figure 3-7, number 1). The drop down box includes options for the amount of freeboard required.

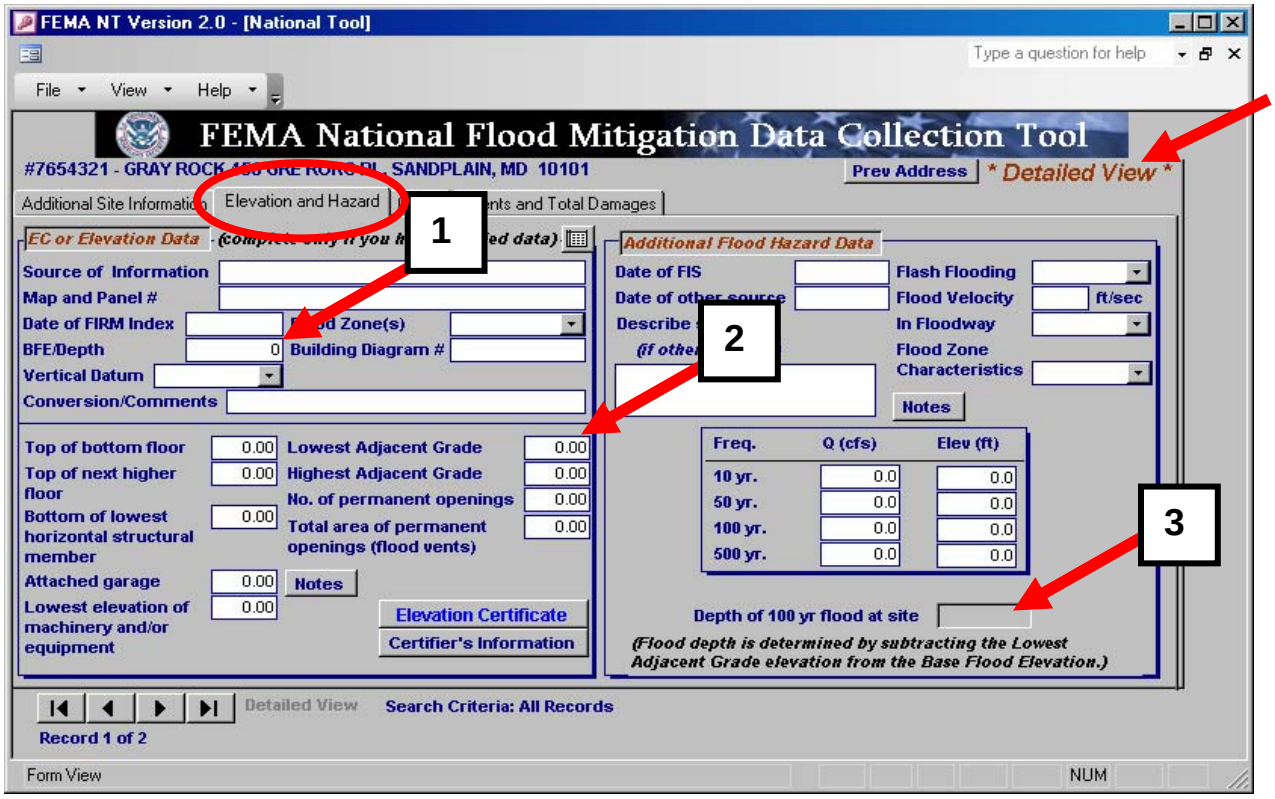

Figure 3-6. *Elevation and Hazard* tab - Flood Depth

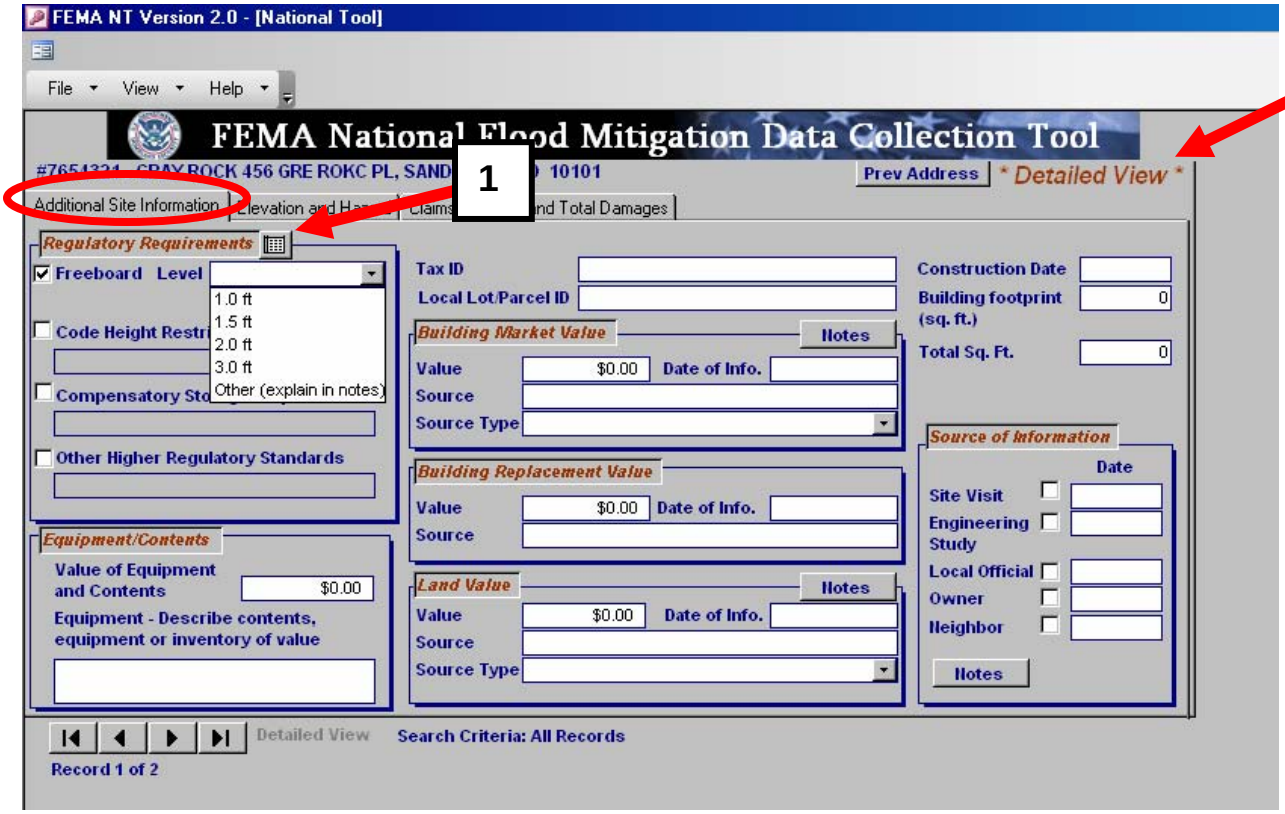

Figure 3-7. *Additional Site Information* tab - Regulatory Requirements

Where to find additional information:

FEMA 85. *Manufactured Homes in Flood Hazard Areas: A Multi-Hazard Foundation and Installation Guide.* See Chapter 5, Natural Hazards – Design Considerations 5.2.2 Flood Elevation and Depth (pages 5-18 to 5-20).

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. See Chapter III, Parameters of Retrofitting (pages III-21 to III-23).

FEMA 265. *Managing Floodplain Development in Approximate Zone A Areas*.

FEMA 480. *National Flood Insurance Program (NFIP) Floodplain Management Requirements: A Study Guide and Desk Reference for Local Officials*. See Unit 4 – Using NFIP Studies and Maps for instruction on how to use the FIRM and FIS to determine the BFE.

FEMA 497. *National Flood Mitigation Data Collection Tool Guide*. See Chapter 6, Data Collection with the NT 6.3.2.2-Additional Flood Hazard Data (page 6-24).

FEMA 499. *Home Builder's Guide to Coastal Construction.* Technical Fact Sheet No. 4 Lowest Floor Elevation.

3.4.7 Question #7. Does flash flooding occur at the project site?

Why is flash flooding important? Flash flooding determines the amount of warning time prior to an impending flood. With adequate warning, property owners can be better prepared to protect themselves and their property. For example, property owners in the floodplains of large rivers such as the Mississippi and Missouri may know days in advance that flooding is occurring upstream and will eventually reach their property. Conversely, the warning time may be very short on small streams or drainageways where flooding from an intense thunderstorm may begin only minutes after the rainfall begins. With adequate warning, property owners can be better prepared to implement actions designed to protect themselves and their property. Mitigation measures that require human intervention to operate such as barriers, and wet and dry floodproofing may not be appropriate mitigation measures without adequate warning time.

How is flash flooding determined? Information on whether the structure is subject to flash flooding may be obtained from the FIS. In addition, surrounding and upstream terrain is a good indicator of the likelihood of flash flooding.

Where is flash flooding information located in NT? To identify whether the structure is in an area that experiences flash flooding and thereby has a short warning time, the Additional Flood Hazard Data section of the *Elevation and Hazard* tab in Detailed Data View would be reviewed (Figure 3-8).

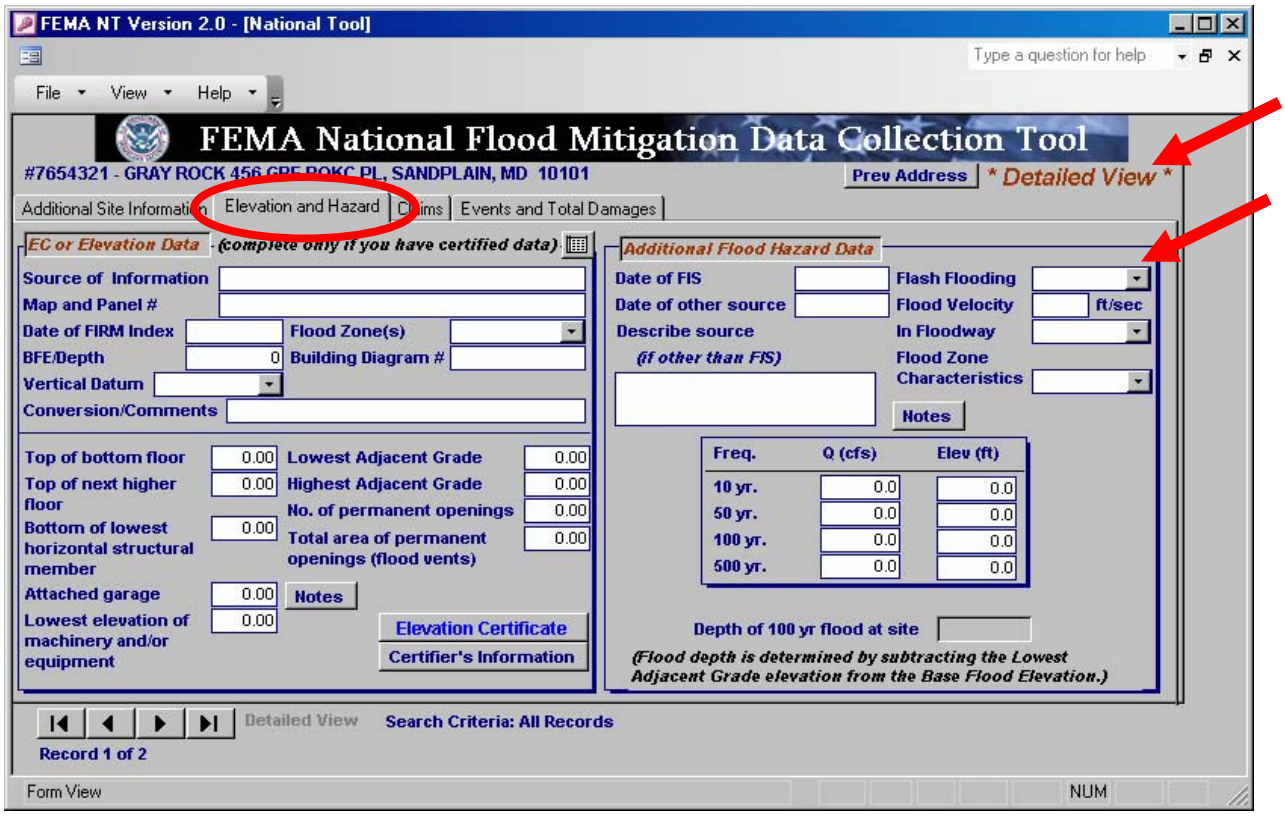

Figure 3-8. *Elevation and Hazard* tab - Flash Flooding

Where to find additional information:

FEMA 85. *Manufactured Homes in Flood Hazard Areas: A Multi-Hazard Foundation and Installation Guide.* See Chapter 5, Natural Hazards – Flood Characteristics 5.2.1 Frequency, Duration and Rate of Rise (pages 5-16 to 5-18).

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures.* See Chapter III, Parameters of Retrofitting (page III-25).

FEMA 497. *National Flood Mitigation Data Collection Tool Guide*. See Chapter 6, Data Collection with the NT 6.3.2.2 – Additional Flood Hazard Data (page 6-23).

FEMA 511. *Reducing Damage from Localized Flooding.* See Chapter 6, Warning and Emergency Services.

3.4.8 Question #8. What is the flood velocity?

What is flood velocity? Flood velocity is the speed at which floodwaters move. It is usually measured in feet per second (fps). Flow velocities during riverine floods can easily reach 5 to 10 fps, and in some situations may even be greater; 10 fps is roughly equivalent to 7 miles per hour.

What affects flood velocity? The velocity of floodwaters depends on factors such as the slope of the stream channel and floodplain and surface roughness. Floodwaters generally move faster along streams in steep mountainous areas than streams in flatter areas. Flood velocity also depends on surface roughness. For example, water will flow more swiftly over impervious surfaces, such as parking lots, roads, and other paved surfaces, than over ground covered with large rocks, trees, dense vegetation, or other obstacles.

Flood velocities in the floodplain are usually higher nearer the stream channel than at the outermost fringes of the floodplain where water may flow very slowly or not at all. Even with only a few feet of flooding depth, floodwaters with velocities as low as 1 or 2 fps can exert tremendous forces on a building.

There are several reasons why flow velocity is important. The pressure on the structure caused by flowing water, known as "hydrodynamic pressure," pushes harder on walls than still water. Hydrodynamic forces are caused by water moving around an object and consist of frontal pressure against the structure, drag forces along the sides, and negative forces on the downstream side. In addition, flowing water can cause erosion and scour. Erosion removes soil that lowers the ground surface across an area. Scour is the removal of soil around objects that obstruct flow, such as foundation walls. Both erosion and scour can weaken a structure by removing supporting soil and undermining the foundation. In general, the greater the flow velocity and the larger the structure, the greater the extent and depth of the erosion and scour will be. The impact, drag, and suction from fast-moving water may move a building from its foundation or otherwise cause structural damage or failure. Any mitigation measure that is implemented in an area that experiences high flood velocity (5 fps or greater) will need to factor this technical consideration into its design.

How is flood velocity calculated? The mean flood velocity in the floodway can be obtained from the community's Flood Insurance Study. Mean floodway velocities can be obtained from the FIS by matching the cross-section on the FIRM with the cross-section in the FIS Floodway Data Table. The floodway's mean velocity usually overestimates the flood velocity within the flood fringe, which is the portion of the floodplain lying outside of the floodway. In general, floodwaters move slower as they extend outward from the floodway. However, the floodway velocities can be used as a general measure to determine cross-section locations within the floodplain where floodwaters will move relatively faster or slower, and provide an upper limit for velocities in the flood fringe.

Unfortunately, there is usually no definitive source of information to determine potential flood velocities in the vicinity of specific buildings. Hydraulic computer models or hand computations based on existing floodplain studies may provide flood velocities in the channel and overbank areas. Where current analysis data are not available, historical information from past flood events is probably the most reliable source. The property owner should consider special precautions if velocities exceed 5 fps or if there is a history of higher velocities during previous local floods.

The estimation of design flood velocities in coastal flood hazard areas is subject to considerable uncertainty. There is little reliable historical information concerning the velocity of floodwaters during coastal flood events. Floodwaters can approach a site from many different directions and the flow velocities can vary from close to zero to high velocities during a flood event. FEMA 55 provides a formula to calculate the design flood velocity in coastal areas (see FEMA 55, *Coastal Construction Manual,* page 11-10).

Where is velocity of flooding information located in the NT? The velocity of flooding may be identified in the NT on the *Elevation and Hazard* tab in the Detailed Data View (Figure 3-9).

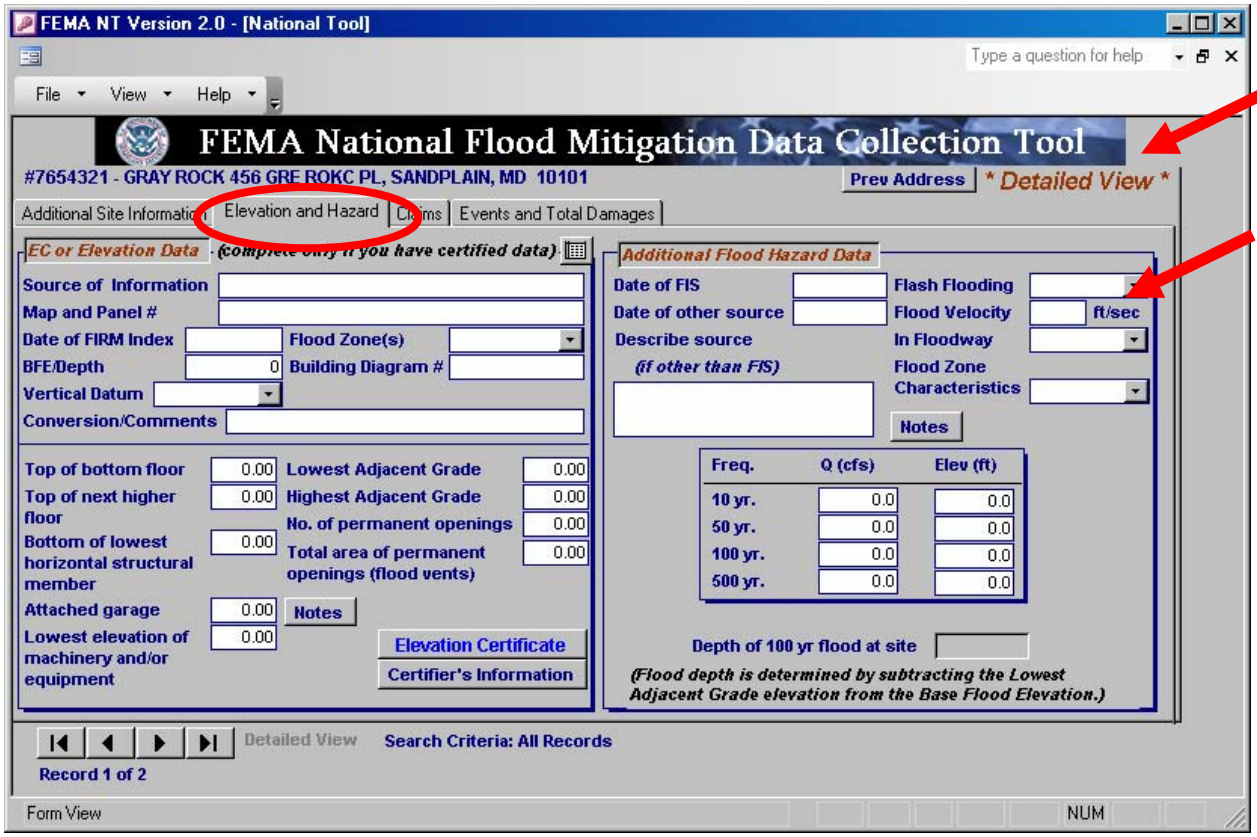

Figure 3-9. *Elevation and Hazard* tab - Flood Velocity

Where to find additional information:

FEMA 55. *Coastal Construction Manual.* See Chapter 11, Determining Site-Specific Loads, Subsection 11.6.6 Design Flood Velocity (V) for a description of how to estimate the velocity of floodwaters during coastal flood events (pages 11-9 to 11-11).

FEMA 85. *Manufactured Homes in Flood Hazard Areas: A Multi-Hazard Foundation and Installation Guide.* See Chapter 5, Natural Hazards – Design Considerations 5.2.4 Hydrodynamic Forces (pages 5-22 to 5-24). Section 10.3.1 Velocity Data in Chapter 10, Pre-engineered Foundations, includes tools and sources of information that are available to provide an estimate of the floodwater velocity. They include hydraulic modeling, documented historic information, alternate methodologies for estimating velocities, knowledge of past flooding, and site indicators.

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. See Chapter III, Parameters of Retrofitting (page III-24).

FEMA 312. *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House from Flooding.* See Chapter 2, Introduction to Retrofitting – Flow Velocity (pages 13 to 15).

FEMA 497. *National Flood Mitigation Data Collection Tool Guide*. See Chapter 6, Data Collection with the NT 6.3.2.2-Additional Flood Hazard Data (page 6-23).

FEMA 511. *Reducing Damage from Localized Flooding.* See Chapter 10, Retrofitting – Design Parameters (page 10-17).

3.4.9 Question #9. Is the structure located in the floodway?

What is a floodway? The floodplain associated with the base flood (or the 100-year flood) is known as the Special Flood Hazard Area (SFHA). Within the SFHA of a riverine system is the floodway, which is where water is likely to be deepest and fastest. It is the area of the floodplain that should be reserved and kept free of obstructions to allow floodwaters to move downstream. Requirements are included in 44CFR 60.3 (d)(3) for proposed development in regulatory floodways. This requirement applies to all types of development where a floodway has been delineated. Delineated floodways are most often found in A1-30, AH, and AE-Zones; however, there may be information available for approximate A Zones as well.

In floodway areas, encroachments, which include fill, new construction, substantial improvements, and other development, are not permitted if they result in any increase in the BFE. In general, very little development is permitted in the floodway since even minor encroachments lead to an increase in the BFE. Therefore, any mitigation measure, except demolition where the property is removed from the floodway, must meet NFIP, State, and local floodplain requirements regarding encroachment of the floodway conveyance area.

How is a floodway identified? Whether the structure is located in the floodway will be determined based on the Flood Insurance Rate Map. The floodway delineation, as depicted on the legend of the FIRM, will indicate whether the property is within or outside the floodway. A FIRM may be requested through the FEMA Map Service Center via the web at http://store.msc.fema.gov.

Where is floodway information located in NT? Structures located in the floodway can be identified in the NT by viewing the *Elevation and Hazard* tab in the Detailed Data View (Figure 3-10).

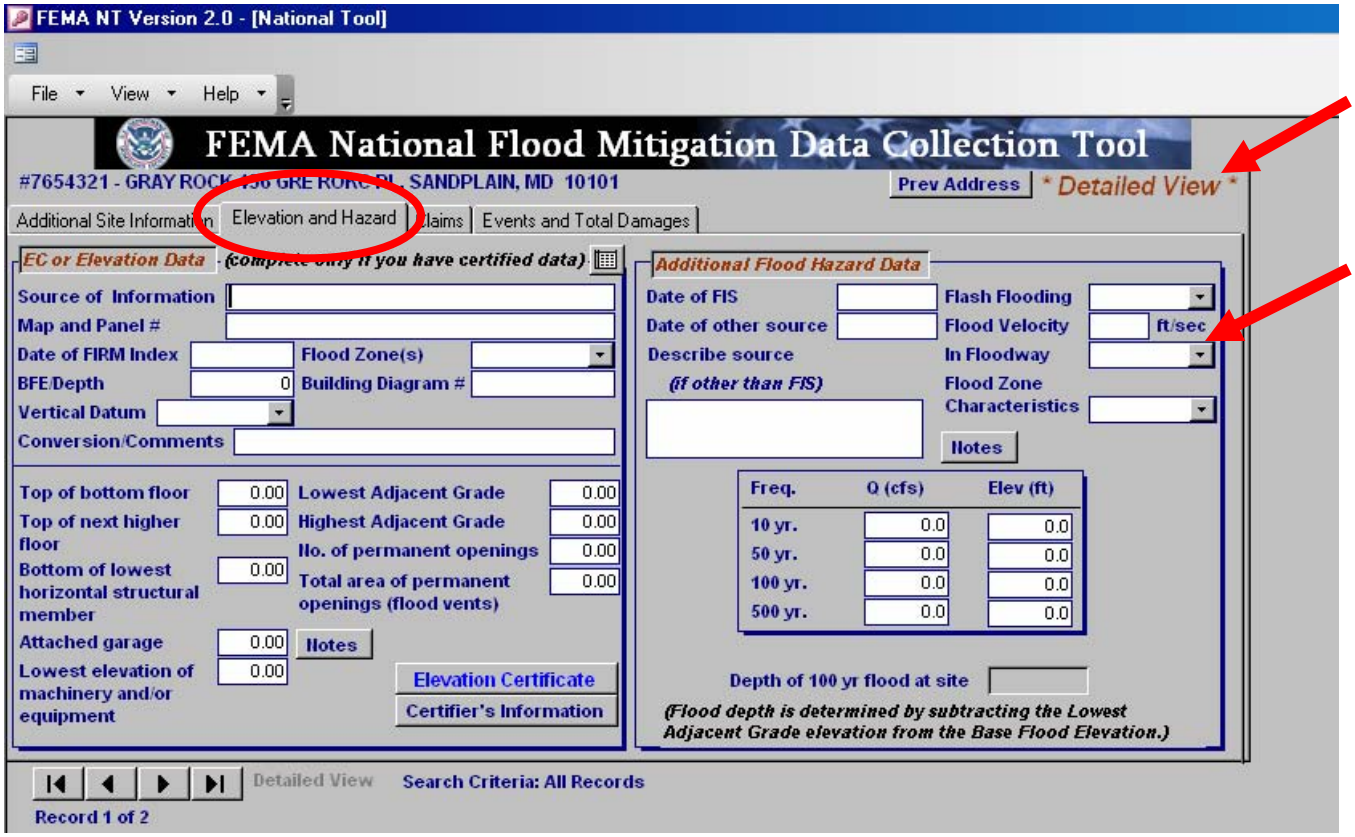

Figure 3-10. *Elevation and Hazard* tab - Floodway

Where to find additional information:

FEMA 85. *Manufactured Homes in Flood Hazard Areas: A Multi-Hazard Foundation and Installation Guide.* See Chapter 3, Regulatory Requirements for information on the regulatory requirements for development in the floodway (page 3-9). See Chapter 5, Natural Hazards – Design Considerations for a step by step description of how to use the FEMA Map Center website to access both the FIRM and FIS for a particular property (pages 5-1 to 5-16).

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. See Chapter III, Parameters of Retrofitting (page III-26).

FEMA 480. *National Flood Insurance Program (NFIP) Floodplain Management Requirements: A Study Guide and Desk Reference for Local Officials.* See Unit 4 – Using NFIP Studies and Maps.

FEMA 497. *National Flood Mitigation Data Collection Tool Guide*. See Chapter 6, Data Collection with the NT 6.3.2.2 – Additional Flood Hazard Data (page 6-23).

FEMA 499. *Home Builder's Guide to Coastal Construction.* Technical Fact Sheet No. 3 Using a Flood Insurance Rate Map (FIRM).

3.5 Evaluating the Mitigation Measures

After completing **Worksheet A, the Technical Considerations Scorecard**, the next step is to evaluate the remaining appropriate mitigation measures to confirm applicability and to develop a recommendation for the property owners to consider. This information is recorded on **Worksheet B, Appropriate Mitigation Measures**. A sample of a completed Worksheet B is included in Appendix A.

The steps in evaluating the remaining mitigation measures include the following:

1. From Worksheet A, list each of the remaining mitigation measures with an "X" in the Appropriate Mitigation Measures row into the far left column (titled "Mitigation Measures") of **Worksheet B, Appropriate Mitigation Measures**.
2. Assign a relative ranking of High, Moderate, or Low for each consideration column based on the mitigation measures listed.
3. Check the appropriate box (High, Moderate, or Low) under each of the decision factors.
4. Add up the scores for each row of mitigation measures and record it in the Total Score column of Worksheet B. The mitigation measure with the LOWEST score is the measure that is most appropriate.
5. Record additional information regarding the decision factors for the mitigation measures in the Notes column.

The scores for the Technical Considerations and Relative Costs column are weighted higher (twice the value) than the other two columns. This means the result of these considerations have a greater influence on the outcome since these considerations are more significant in selecting an appropriate mitigation measure.

The information contained in Chapters 4 through 10 is structured in the following manner to assist in the comparative evaluation process:

- **Technical Considerations** provide other factors to determine whether the mitigation measure addresses the project objectives.
- **Relative Costs** identify the associated costs of the mitigation measures and include a determination of cost-effectiveness.
- **Additional Considerations** include Human Intervention, Annual Maintenance, and other factors in the decision-making process.

Worksheet B: Appropriate Mitigation Measures

Date Prepared:___________________ Date Property Visited:_____________
Property Owner Name: ____
Property Address:____
Repetitive Loss Property Locator Number:_________________________________
Prepared by: ____

Instructions to complete Worksheet B: Appropriate Mitigation Measures

1. List the mitigation measures from the "Appropriate Mitigation Measures" row from Worksheet A, Technical Considerations Scorecard (all checked boxes in last row of Worksheet A).
2. Using information from Chapters 4 through 10 of FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures,* rank each measure as High, Moderate, or Low. See "Tips to Rank Mitigation Measures" on next page for additional information.
3. Check the appropriate box (High, Moderate, or Low) under each of the decision factors.
4. Total the points for each mitigation measure. **The LOWEST total points indicates the most appropriate mitigation measure(s).**
5. Include notes describing how the determination was made for a particular ranking.

*NOTE: Since Technical Considerations and Relative Costs are more significant in selecting appropriate mitigation measure(s), they are weighted higher than Human Intervention and Annual Maintenance.

Decision Factors – LOWEST score is most appropriate – See Reverse for Notes					
Mitigation Measures	**Technical Considerations***	**Relative Costs***	**Human Intervention**	**Annual Maintenance**	**Total Score**
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts

Tips to Rank Mitigation Measures (Worksheet B Cont.)

Technical Considerations

Use the responses in Worksheet A, Technical Considerations Scorecard, to determine a ranking of High, Moderate, or Low for each mitigation measure.

- If there are no grayed out boxes checked for a mitigation measure, the technical consideration ranking is Low.
- If there are 1 or 2 grayed out boxes checked for a mitigation measure, the technical consideration score is Moderate.
- If there are 3 or more grayed out boxes checked for a mitigation measure, the technical consideration score is High.

List any considerations in the implementation process that could be a limiting factor or clear constraint in the Notes section.

Relative Costs

Rank each of the mitigation measures based on the estimated cost to address the flood risk and the likelihood of cost-effectiveness. Chapters 4 through 10 include information to rank each mitigation measure based on FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding*, and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. Low cost indicates Low ranking and high cost indicates High ranking.

Need for Human Intervention

This reflects the need for human intervention to operate the mitigation measure and the warning time to conduct the required activity. Generally, the more "passive" the system (i.e., requiring the least human interaction), the more reliable the system will be over time, thereby resulting in a Low ranking. Mitigation measures that require human intervention, such as barriers and dry floodproofing, receive a High ranking..

Need for Annual Maintenance

This reflects the level of effort of annual maintenance required by each mitigation measure. Similar to human intevention, less annual maintenance results in a Low ranking.

NOTE: If two or more mitigation measures tie with the lowest score, other decision factors should be considered in determining the most appropriate mitigation measure(s). These considerations include, but are not limited to aesthetics; access to site; housing of occupants during the project; compliance with all applicable codes, ordinances, and regulations; historic preservation concerns; and availability of contractors.

The other decision factors should be listed in the Comments section of Worksheet C.

NOTES:

Mitigation Measures	Technical Considerations

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CHAPTER 4 – DRAINAGE IMPROVEMENTS

4.1 Introduction

Depending on the specific characteristics of a particular watershed, one method to lessen the impacts of flooding is to modify the stream or river channel. Modifying the channel attempts to provide a greater carrying capacity for moving floodwaters away from areas where damage occurs. Methods of drainage improvements include overflow channels, channel straightening, restrictive crossing replacements, and rainfall/runoff storage. Table 4-1 presents a summary of advantages and disadvantages for using drainage improvements as a mitigation measure.

CAUTION

Drainage improvements may help one area but create new problems in another. Whenever drainage improvements are considered as a flood mitigation measure, the effects upstream and downstream from the proposed improvements need to be considered.

Table 4-1. Considerations for Using Drainage Improvement

Advantages	Disadvantages
▪ Can increase a stream's carrying capacity through overflow channels, channel straightening, restrictive crossing replacements, or rainfall/runoff storage. ▪ Minor projects may be fundable under FEMA mitigation grant programs.	▪ May help one area but create new problems upstream or downstream of the proposed improvements. ▪ Channel straightening increases the capacity to accumulate and carry sediment, thereby potentially adversely affecting the surrounding areas and the stream system's equilibrium. ▪ There can be difficulty in setting culverts of a sufficient size in a stream to convey the 100-year flood discharge, unless weir flow over the road surface is considered.

For a detailed discussion of drainage improvements, see FEMA 511, *Reducing Damage from Localized Flooding,* Chapter 8. Additional references are included in Section 4.5, Available Resources.

4.2 Technical Considerations

4.2.1 Depth of Flood

The drainage improvement project is built to a certain flood protection level that may be exceeded by a larger flood event and thereby cause more damage to the structure than might have occurred without the project.

4.2.2 Adverse Impact Downstream

A drainage improvement project, such as a channelized stream, can worsen flooding problems downstream because water is transported at a faster rate. Since the stream now has the capacity to carry more water, it will also have an increased capacity to accumulate and carry sediment. The additional sediment load may come from accelerated bank or stream bottom erosion.

4.3 Relative Costs

The relative cost ranking is based on the combination of the estimated costs for the drainage improvement project and a determination of cost-effectiveness.

4.3.1 Estimated Cost

The cost of a drainage improvement project will vary, depending on materials used and the size and scope of the project. In order to determine the relative cost of a drainage improvement project, examples of cost estimating items that may need to be considered include the following:

- Type of equipment needed for the job, such as the size of backhoe needed to excavate the trench.
- Depending on the depth and width of an excavation trench, shoring might be needed. If shoring is needed, amount of material needed for shoring.
- Removal of excavated material. For example, the estimated quantity and distance from the nearest dump site and if there are fees associated with dumping the excavated material.
- Supplies, such as length of pipe and number and type of pipe fittings needed

Appendix C, Cost Estimating, provides guidance and references for conducting a more detailed cost estimate. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*. A blank preliminary cost estimating worksheet (Worksheet D) is provided in Appendix B, Blank Worksheets.

4.3.2 Determination of Cost-Effectiveness

A component of the relative cost scoring is to include a determination of cost-effectiveness. Table D-1 in Appendix D, Determining Cost-Effectiveness, provides a quick screening for the cost-effectiveness of a project. The attributes included in the table are frequency of flood, level of damage, project cost, project benefits, and criticality (impact or loss of function). For example, if the frequency is the 10-year flood, the project will have a very high likelihood of cost-effectiveness.

Based on the combination of the estimated cost of the project and the likelihood of cost-effectiveness, a relative cost ranking will be assigned on Worksheet B, Appropriate Mitigation Measures. If the likelihood of cost-effectiveness is low, the ranking of relative cost will be either moderate or high, based on the estimated cost of the project. However, if the estimated cost is low and the likelihood of cost-effectiveness is very high or high, the relative cost ranking will be low.

4.4 Additional Considerations

4.4.1 Annual Maintenance

A regular program of drainage system maintenance can detect and resolve problems before they become large obstructions and create flooding themselves. Examples of the work involved in maintaining the drainage system include the following:

- Enacting formal procedures to maintaining the public drainage system, the Community Rating System (CRS) provides credit for enacting these procedures (see text box at right);
- Involving citizens in the maintenance process through organized "stream teams" or by training homeowner associations;
- Enacting regulations against dumping; and
- Informing the public about the importance of yard maintenance, keeping the drainage system free of obstructions, and notifying public officials about problems.

Through Activity 540 (Drainage System Maintenance), the CRS encourages and provides credit for the following:

- A formal program that inspects the drainage system, removes debris and corrects drainage problem sites
- Stream dumping regulations
- A capital improvements plan to eliminate or correct problem sites

4.5 Available Resources

ASFPM. *No Adverse Impact: A Toolkit for Common Sense Floodplain Management.* http://www.floods.org/NoAdverseImpact/NAI_Toolkit_2003.pdf

FEMA. *Promoting Mitigation in Louisiana: Performance Analysis.* *http://*www.fema.gov/pdf/casestudys/performance.pdf

FEMA NFIP/CRS. *CRS Credit for Drainage System Maintenance.* http://www.training.fema.gov/emiweb/CRS/m7s5main.htm

FEMA 511. *Reducing Damage from Localized Flooding.* See Chapter 8, Drainage Improvements.

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CHAPTER 5 – BARRIERS

5.1 Introduction

Levees and floodwalls are types of flood protection barriers. A levee is typically a compacted earthen structure; a floodwall is an engineered structure usually built of concrete, masonry, or a combination of both (Figure 5-1). Barriers can be built to protect a single structure or multiple structures as regional facilities.

CAUTION

Levees and floodwalls may not be used to bring a substantially damaged or substantially improved structure into compliance with the community's floodplain management ordinance or law.

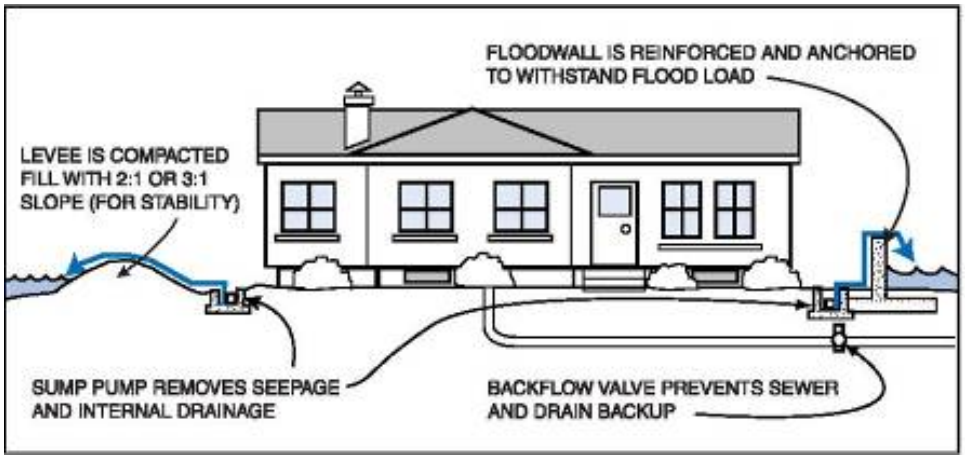

Figure 5-1. Structure protected by levee (on left) and floodwall (on right)

(Source: FEMA 312)

Table 5-1 includes a summary of advantages and disadvantages for using barriers as a mitigation measure.

Table 5-1. Considerations for Using Barriers

Advantages	Disadvantages
▪ Floodwaters cannot reach the structure(s) in the protected area and therefore will not cause damage through inundation, hydrodynamic pressure, erosion, scour, or debris impact. ▪ The structure and the area around it will be protected from inundation, and no significant changes to the structure will be required.	▪ Barriers may not be used to bring a substantially damaged or substantially improved structure into compliance with the community's floodplain management ordinance or law. ▪ Cost may be prohibitive, as a large area may be required for construction. ▪ Periodic maintenance is required. ▪ Local drainage can be affected, possibly creating or worsening flood problems for others.

Types of barriers include levees, berms, floodwalls, and temporary barriers.

5.1.1 Levees

Levees are embankments or structures constructed of compacted earthen materials and differ from berms in size. Construction of a levee begins with excavating and inspecting the cutoff trench. Its initial purpose is to give the designer a better look at the subsurface soil conditions, so that the presence of roots, utility lines, and animal burrows, or changes in soil conditions are considered during the design process. The interior of the levee is composed of an impermeable core, usually clay. The lifts of impervious clay fill are placed in 6-inch layers and with each lift being compacted to the density specified by the designer of the levee (Figure 5-2). Like large floodwalls, levee design should be accomplished by a licensed engineer.

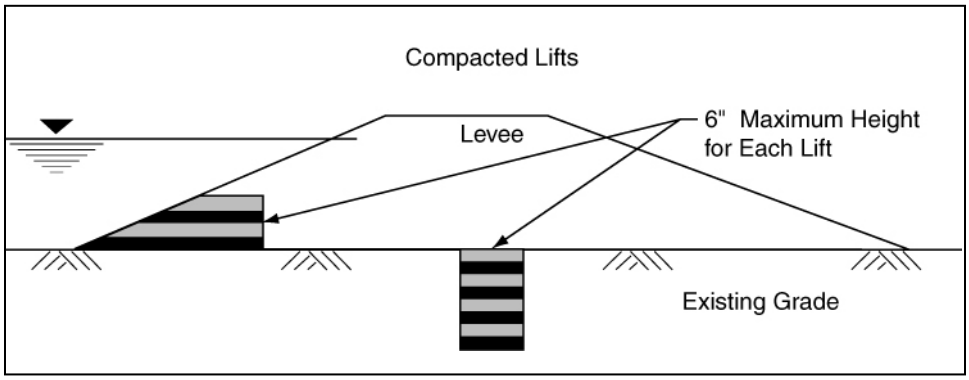

Figure 5-2. Levee construction

(Source: FEMA 259)

5.1.2 Berms

Berms can be utilized to completely encircle a building. However, they require a lot of room and a large quantity of earthen fill. Unless the fill is readily available nearby, hauling it to the site may prove to be cost-prohibitive. One way to decrease this expenditure is to incorporate the berm into existing high ground.

5.1.3 Floodwalls

A floodwall is an engineered structure made of reinforced concrete or reinforced concrete block and varies anywhere from 1 foot to over 20 feet in height. A floodwall can surround a structure or, depending on flood depths, site topography, and design preferences, can protect isolated openings such as doors, windows, and basement entrances, including entry doors and garage doors. When built with decorative bricks or blocks or as part of garden areas, floodwalls can become attractive architectural or landscaping features. But they can also be built solely for utility, usually at a much lower cost.

Since a floodwall is made of concrete or masonry rather than compacted earth, it is more resistant to erosion than a levee and requires less space than a levee that provides the same level of protection. But floodwalls are often more expensive. As a result, floodwalls are normally considered only for sites where there is not enough room for a levee or where high flow

velocities may erode a levee. Also, some property owners prefer floodwalls because they can be more aesthetically pleasing and allow for the preservation of existing site features, such as landscaping and trees (Figure 5-3).

Figure 5-3. Structure protected by a floodwall with landscaping features

5.1.4 Temporary Barriers

There are several types of temporary barriers available to address many of the flooding problems typically encountered. They work with the same principles as permanent barriers such as floodwalls or levees, but can be removed, stored, and reused in subsequent flood events. Most of these barriers are meant to take the place of sandbag floodwalls and may also be used to reinforce existing permanent barriers such as levees or berms (Figures 5-4 and 5-5).

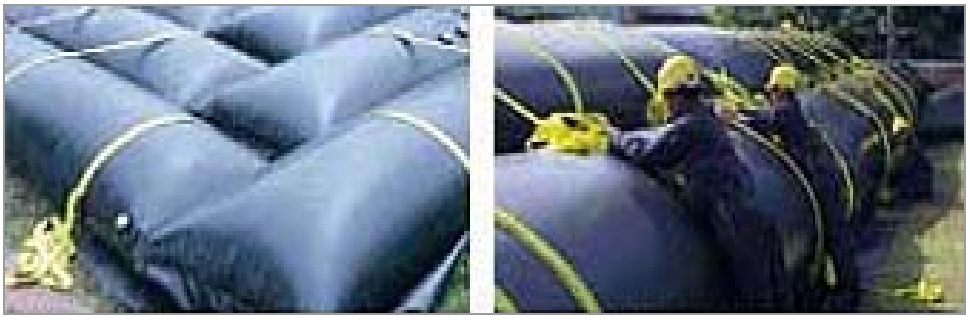

Figure 5-4. Water-filled temporary barriers deployed and anchored in place. Installation designed for a 3-tiered placement, protecting to approximately 7 feet in depth.

(Source: FloodMaster Barriers, Inc.)

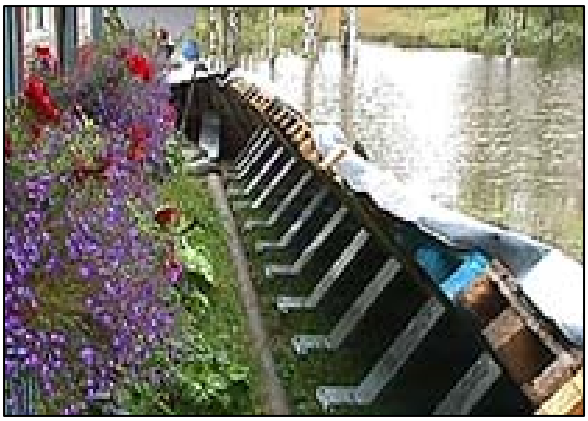

Figure 5-5. Metal supports for floodwall installed for deployment. Floodwall deployed with impermeable membrane.

(Source: FloodMaster Barriers, Inc.)

These products are designed so that they can be utilized numerous times. Additionally, a joint program between the Federal Government and an internationally recognized certification laboratory will begin in the fall of 2006 to test and certify temporary, emergency measures for flood protection products.

5.2 Technical Considerations

5.2.1 Height of Barrier

When barriers are built to protect a single structure, they are referred to as "residential," "individual," "on-site," or "local" levees and floodwalls. The practical, cost-effective heights of these levees and floodwalls are usually limited to 6 feet and 4 feet, respectively. These limits are the result of the following considerations:

- The higher the levee or floodwall, the greater the depth of water that builds behind it and the greater the water pressure exerted on the barrier. Levees and floodwalls must be designed and constructed to withstand the increased pressures. Meeting this need for additional strength greatly increases the cost of the levee or floodwall, usually beyond what an individual property owner can afford.
- Because taller levees and floodwalls must be stronger, they must also be more massive, so they usually require more space than is likely to be available on an individual lot. This is especially true of levees.
- Local zoning and building codes may also restrict use, size, and location.

If the flood depth at the project site is above the practical height limits, an alternative mitigation method, such as elevation, should be considered. The levee or floodwall can always be overtopped by a flood higher than expected regardless of the height of the barrier. Overtopping is a greater concern for a levee than a floodwall since a small amount of overtopping can cause erosion at the top of the levee and cause it to fail.

5.2.2 Structure with Basement Foundation

Special design considerations are necessary when levees or floodwalls are built to protect a structure with a basement. Even though the surface water is kept from coming into contact with the structure, the soil below the levee or floodwall and around the structure can become saturated, especially during floods of long duration. The resulting pressure on basement walls and floors can cause them to crack, buckle, or even collapse. An analysis by a qualified soils engineer can help locate a floodwall or barrier a sufficient distance from the structure to lessen or alleviate this pressure.

5.2.3 Soil Conditions

The type of soils encountered may have a significant impact on the choice of barriers as a flood protection option. This is true regardless of whether the choice is a permanent barrier or a temporary barrier. The following soil-related considerations must be taken into account:

- **Bearing capacity.** All of the permanent barriers and many of the temporary barriers are very heavy. If the soil is of the type that has low bearing capacity characteristics, the barrier may either fail structurally or begin to sink, losing its design protection height.
- **Permeability.** Barriers will ideally be deployed on tight, impermeable soils. If the soils are permeable, such as sand or sandy loam, geotechnical steps will need to be taken to counteract the seepage of water under or through the barriers. This may include an impervious core to a levee or a deeper cut-off trench filled with impermeable clay soil.

5.2.4 Duration of Flooding

Eventually, all barriers will have seepage or leakage through the barrier if they are exposed to floodwaters for an extended period of time. If the duration of flooding is relatively short (less than 1 day) and depth of flooding is relatively low (less than 1 foot), many barriers will at least slow down the effects of inundation. Longer exposure will require barriers that are better engineered and more carefully constructed or deployed. Likewise, deeper flood depths will also need to be considered due to the extremely high forces exerted on the barriers by the weight of the floodwaters.

5.3 Relative Costs

The relative cost ranking is based on the combination of the estimated costs for the barrier project and a determination of cost-effectiveness.

5.3.1 Estimated Cost

The costs for a barrier project, such as floodwalls and levees, are generally inexpensive. The costs for levee construction can vary greatly, depending on the distance between the construction site and the source of the fill dirt used to build the levee. The greater the distance that fill dirt must be hauled, the greater the cost.

Examples of cost estimating items that may need to be considered include the following:

- Field investigation to collect data and to develop a plan of action
- Design of the barrier
- Design of the drainage systems
- Design for architecture details
- Construction

To estimate the relative cost of a barrier project, examples of general cost estimates have been provided below and are included in FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding* and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*.

The figures in Table 5-2 are example cost estimate numbers developed for a study for the St. Louis Metropolitan Sewer District. These numbers were generated using the U.S. Army Corps of Engineers' publication, *Flood Proofing - How to Evaluate Your Options,* and updated to 2002 and adjusted for the St. Louis area. It is important to note that the cost estimate numbers are location and time dependent.

Table 5-2. General Estimates of the Unit Costs for Typical Barrier Projects

Levee/Berm	
2 feet above ground	$60/linear foot
4 feet above ground	$106/ linear foot
6 feet above ground	$170/ linear foot
Floodwalls	
2 feet above ground	$92/linear foot
4 feet above ground	$140/linear foot
6 feet above ground	$195/linear foot

Appendix C, Cost Estimating, provides guidance and references for conducting a more detailed cost estimate. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*. A blank preliminary cost estimating worksheet (Worksheet D) is provided in Appendix B.

5.3.2 Determination of Cost-Effectiveness

A component of the relative cost scoring is to include a determination of cost-effectiveness. Table D-1 in Appendix D, Determining Cost-Effectiveness, provides a quick screening for the cost-effectiveness of a project. The attributes included in the table are frequency of flood, level of damage, project cost, project benefits, and criticality (impact or loss of function). For

example, if the frequency is the 10-year flood, the project will have a very high likelihood of cost-effectiveness.

Based on the combination of the estimated cost of the project and the likelihood of cost-effectiveness, a relative cost ranking will be assigned on Worksheet B, Appropriate Mitigation Measures. If the likelihood of cost-effectiveness is low, the ranking of relative cost will be either moderate or high, based on the estimated cost of the project. However, if the estimated cost is low and the likelihood of cost-effectiveness is very high or high, the relative cost ranking will be low.

5.4 Additional Considerations

5.4.1 Human Intervention

As described in Section 5.4.4, openings in the barrier will need to be closed prior to a flood event. Putting the closure mechanisms in place require human intervention. The barrier will not protect the structure from flooding unless the property owner is willing and able to operate all closures before the floodwaters arrive.

5.4.2 Annual Maintenance

A barrier requires periodic inspections and maintenance to address any necessary repairs. Otherwise, small problems, such as cracks, loss of vegetation, and erosion and scour, can quickly become large problems during a flood event. The barrier should be inspected at a minimum each spring and fall, before each impending flood, and after each flood event. To facilitate maintenance and the mowing of grass, the side slopes of most berms should not be steeper than 1-foot vertically to 4-feet horizontally. A driveway should probably not be steeper than a 1 to 3 slope. Trees and large shrubs should not be located on barriers. When they die, their roots decay, leaving routes for water to pass through, causing the barrier to fail.

5.4.3 Housing of Occupants

Although the building can be used during construction of the barrier, the building should not be occupied during a flood event. Levees and floodwalls may give the property owner a false sense of security. Every flood is different and the one that exceeds the height of the barrier could occur at any time. If water overtops the barrier, the protected area will fill rapidly and evacuation should occur well before this happens.

5.4.4 Access to Structure

Access to the structure may be difficult. Openings will need to be created or provided for driveways, sidewalks, and other entrances. These openings must be closed prior to the flood event occurring, as floodwaters can rise rapidly enough to prevent an opening from being closed. Examples of these closure mechanisms for floodwalls include shields similar to the ones used in dry floodproofing or prefabricated panels and permanently mounted, hinged, or sliding flood gates and prefabricated stop logs or panels for levee openings. Unless the gates remain in the closed position at all times, human intervention is required to close an entry point to prevent rising floodwaters from entering the structure (Figure 5-6).

Figure 5-6. The City of Boulder, Colorado, installed a "pop up" closure to this floodwall at a City office building subject to flash floods. The closure floats up into place automatically when the site is flooded.

5.4.5 Interior Drainage

Interior drainage must be taken into account and provided for since building a barrier that keeps floodwater out of the protected area also will keep water in. Drains and sump pumps should be installed to remove water collected inside the barrier. In addition, caution must be taken to ensure that local drainage patterns in the area are not disrupted. As shown in Figure 5-7, an interior drainage system, including a sump pump, must be installed in the area protected by a levee or floodwall.

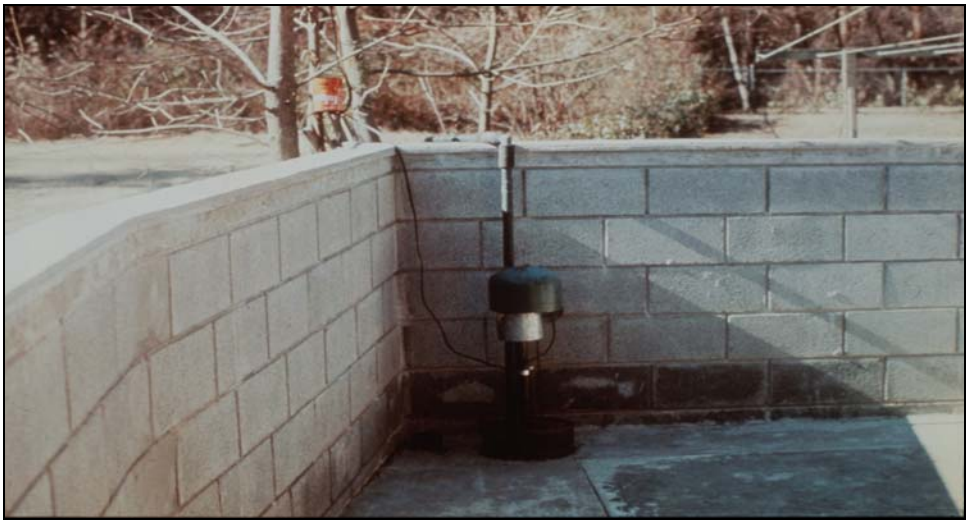

Figure 5-7. Small patio floodwall with sump pump

5.5 Available Resources

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures.* See Chapters VI-F, Floodwalls and VI-L: Levees.

FEMA 312. *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House from Flooding.* See Chapter 3, An Overview of the Retrofitting Methods and Chapter 7, Other Methods – Levees and Floodwalls.

FEMA 511. *Reducing Damage from Localized Flooding*. See Chapter 10, Retrofitting.

The Louisiana State University (LSU) Extension Center website (http://www.louisianafloods.org) lists many retrofitting publications, provides advice on floodproofing methods and flood insurance, and links to online shopping for retrofitting products and contractors.

USACE. *Flood Proofing - How to Evaluate Your Options.*

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CHAPTER 6 – WET FLOODPROOFING

6.1 Introduction

Wet floodproofing a structure consists of modifying the uninhabited portions (such as a crawlspace or an unfinished basement) to allow floodwaters to enter and exit (Figure 6-1). This ensures equal hydrostatic pressure on the interior and exterior of the structure and its supports. Equalized pressures will reduce the likelihood of wall failures and structural damage. However, wet floodproofing is practical in only a limited number of situations. Table 6-1 includes a summary of the advantages and disadvantages in using wet floodproofing.

CAUTION

Wet floodproofing does not reduce flood insurance premium rates on residential structures. Premium rates can only be reduced through elevation of the residential structure above the Base Flood Elevation. Non-residential structures can reduce flood insurance premium rates through other forms of floodproofing.

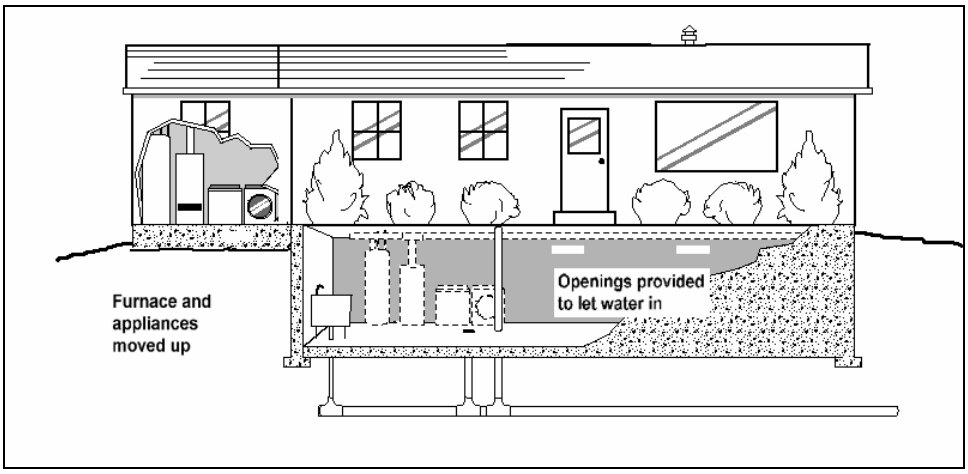

Figure 6-1. Wet floodproofed basement

Table 6-1. Considerations for Using Wet Floodproofing

Advantages	Disadvantages
▪ Wet floodproofing measures are often less costly than other mitigation measures. ▪ Allows internal and external hydrostatic pressures to equalize, lessening the loads on walls and floors.	▪ May be used to bring a substantially damaged or substantially improved structure into compliance with the community's floodplain management ordinance or law only if the enclosed areas of the structure below the BFE are above grade on at least one side and used solely for parking, storage, or building access. (When in communities that allow buildings constructed on below grade crawlspaces, see FEMA Technical Bulletin 11-01, *Crawlspace Construction for Buildings Located in Special Flood Hazard Areas*.) ▪ Extensive cleanup may be necessary if the structure becomes wet inside and possibly contaminated by sewage, chemicals, and other materials borne by floodwaters. ▪ Pumping floodwaters out of a basement too soon after a flood may lead to structural damage. ▪ Periodic maintenance may be required. ▪ Does not minimize the potential damage from high-velocity flood flow and wave action.

6.2 Technical Considerations

6.2.1 Construction Materials

Because wet floodproofing allows floodwaters to enter the structure, all construction and finishing materials that may be under water must be resistant to flood damage. For this reason, wet floodproofing is practical only for non-living spaces, such as a basement as defined by NFIP regulations, a walkout-on-grade basement, crawlspace, or garage. Wet floodproofing is not practical for most slab-on-grade structures that have the living space at or near ground level. Whether or not wet floodproofing is appropriate depends on the flood conditions, the design and construction of the structure, and whether the structure has been substantially damaged or is being substantially improved. However, many industrial or commercial structures could benefit greatly from wet floodproofing techniques.

Flood-Resistant Construction Materials. As found during the inspection of structures in New Orleans, LA, following Hurricane Katrina (2005), construction materials were subjected to deterioration and mold because of the extreme heat and humidity from the long-term moisture conditions.

6.2.2 Basement Areas (as defined by NFIP regulations)

Wet floodproofing is appropriate if all valuable contents have been or can readily be relocated to a flood-free space above the flood protection level and hydrostatic vent openings have been installed. If basement utilities cannot be relocated to a higher level, they can be protected by being placed in a watertight room or enclosure made of impermeable material such as concrete (Figure 6-2).

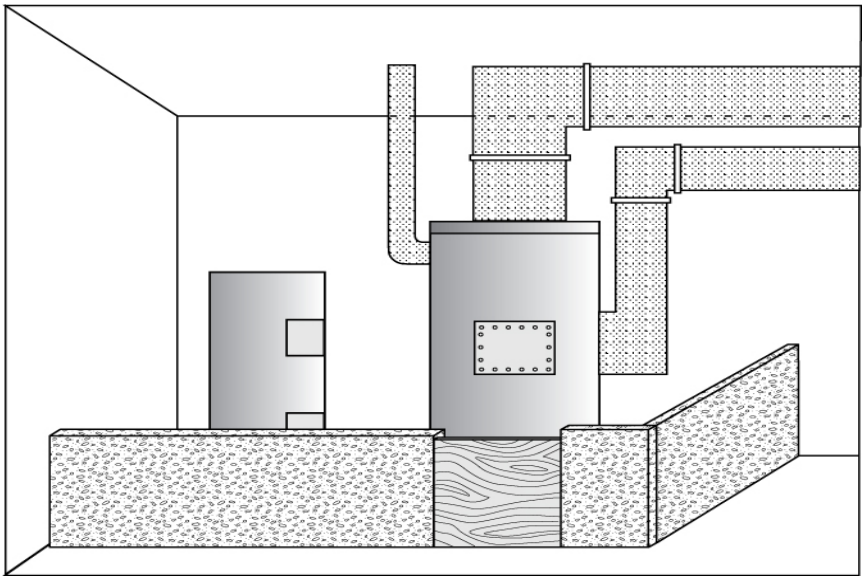

Figure 6-2. Small floodwall constructed to protect a furnace and hot water heater. A gate is installed for access.

(Source: FEMA 259)

The *Site Observations* tab in the NT provides a check box to mark whether the structure has a basement (Figure 6-3).

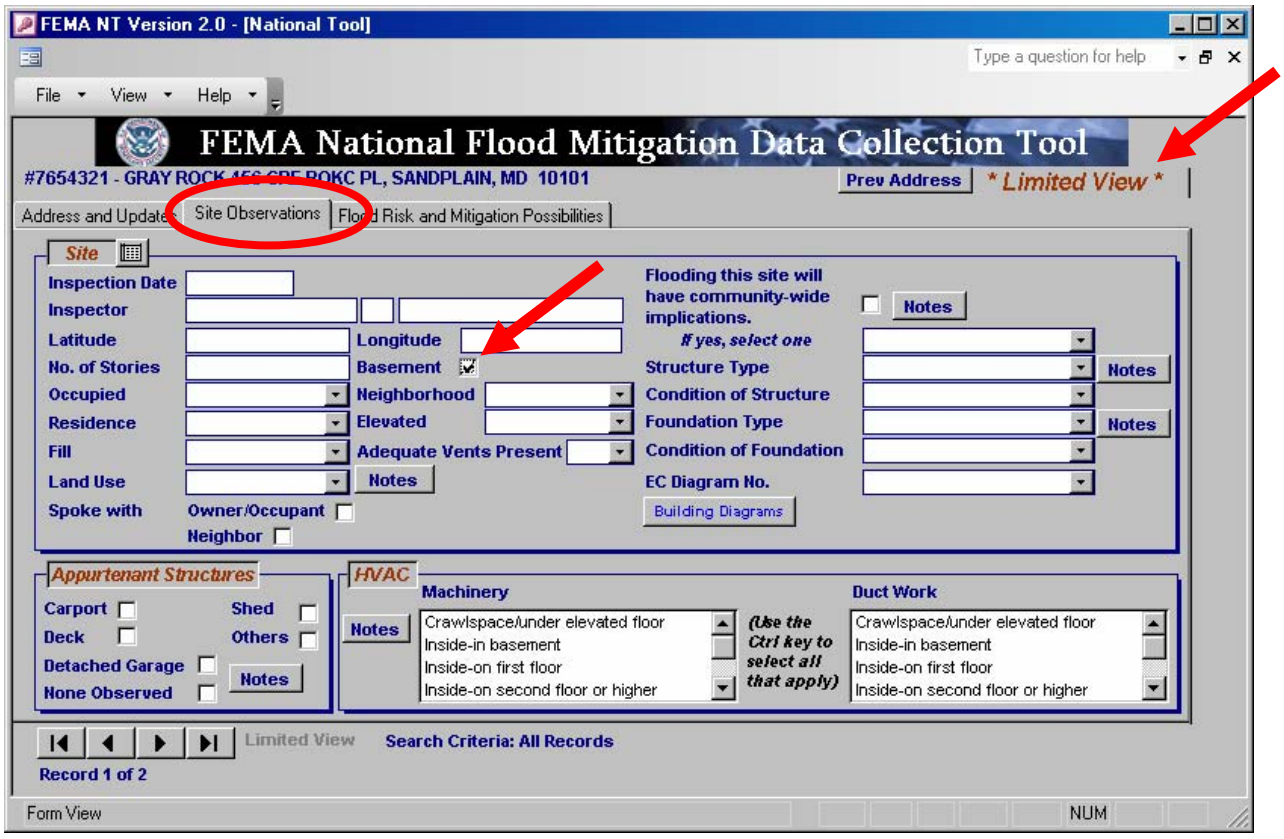

Figure 6-3. *Site Observations* tab - Basement

6.2.3 Duration of Flooding

If the duration of the flood is longer than 1 day, wet floodproofing is not a reasonable approach to protecting a structure. As was evident following the flooding along the Gulf Coast after Hurricane Katrina in 2005, long periods of inundation and wet conditions led to damage to some of the structural components of buildings and extreme damage to the contents. The structural integrity of some building components was affected by long exposure to floodwaters and the very high moisture content of the atmosphere within the buildings led to conditions very favorable to the growth of mold and mildew. Wooden structural members began to warp and lose their ability to act as the design was intended. Plywood began to delaminate and chip board or fiber board began to deteriorate. The sooner the floodwaters were removed from the buildings and the sooner they were dried, the less damage that was experienced.

6.2.4 Location of Utilities

Any electrical outlets should be relocated or elevated to higher areas on the wall above the flood protection elevation, as there is a danger of not being unable to shut off the electrical panel before the basement floods. Relocation of utilities also includes the electrical service panel and the heating, ventilation, and air conditioning (HVAC) ductwork. If ductwork becomes inundated with floodwaters, the following can occur:

> **Reference.** For additional information, refer to FEMA 348, *Protecting Building Utilities from Flood Damage*.

- The flooded ducts may be pulled from their supports after the floodwaters recede because of the increased weight of the water inside the ducts.
- The receded floodwaters leave silt and contaminants in the ductwork that can become recirculated throughout the structure if the ducts are not removed and thoroughly cleaned.

6.2.5 Non-Residential Structures, Garages, etc.

Non-residential structures (particularly manufacturing warehouses or distribution centers) are suited for wet floodproofing. With multi-level structures, merchandise and contents can be moved to the upper floors above the flood protection level. The *Site Observations* tab of the NT provides an area to record the number of stories of the structure (Figure 6-4).

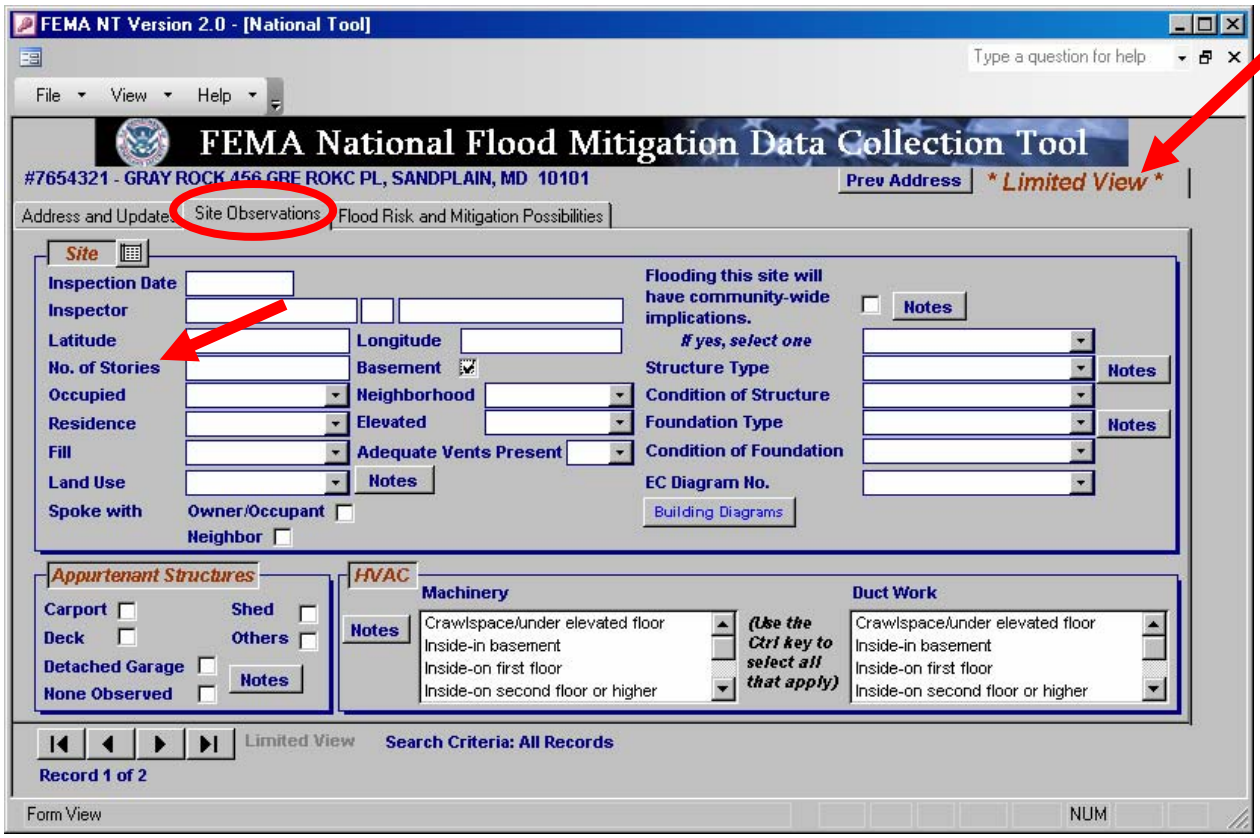

Figure 6-4. *Site Observations* tab - No. of Stories

In lieu of an upper story to relocate contents, tractor trailers can be used for storing and moving contents to a flood-free location. Rental companies that cater to the need for temporary storage are a quick solution for transient relocation and storage of commercial equipment/residential belongings. Relocation can be made easier if the machines have quick-disconnect fittings and are mounted in such a way as to facilitate lifting with forklifts. If physical relocation is not feasible, elevation is the next best option. For example, electrical motors, generators, heating/air conditioning units, and electric service panels are suited for elevation (Figure 6-5).

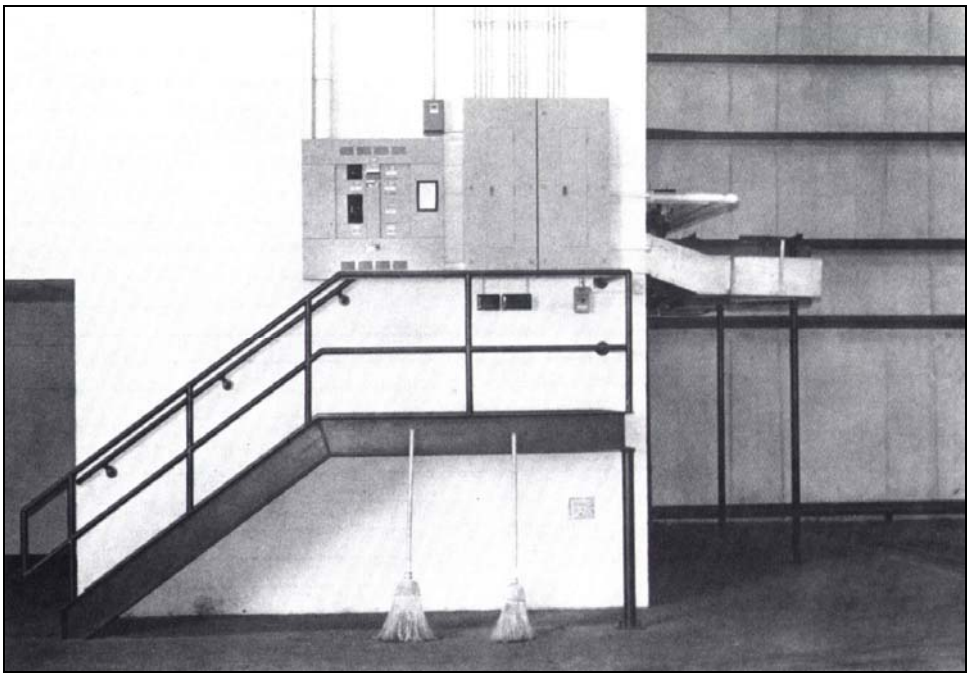

Figure 6-5. Electrical utilities elevated for protection against flooding

6.3 Relative Costs

The relative cost ranking is based on the combination of the estimated costs for the wet floodproofing project and a determination of cost-effectiveness.

6.3.1 Estimated Cost

Wet floodproofing is generally less expensive than the other mitigation measures described in this manual. Any action undertaken to reduce the number of items that are exposed to flood damage is considered a wet floodproofing measure.

Examples of cost estimating items that may need to be considered include the following:

- Design
- Construction
- Relocation of utility systems (electrical, HVAC, fuel supply and storage, water and sewer) that may be flooded.

To estimate the relative cost of a wet floodproofing project, examples of general cost estimates are included in FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding* and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*.

Appendix C, Cost Estimating, provides guidance and references for conducting a more detailed cost estimate. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*. A blank preliminary cost estimating worksheet (Worksheet D) is provided in Appendix B.

6.3.2 Determination of Cost-Effectiveness

A component of the relative cost scoring is to include a determination of cost-effectiveness. Table D-1 in Appendix D, Determining Cost-Effectiveness, provides a quick screening tool for the cost-effectiveness of a project. The attributes included in the table are frequency of flood, level of damage, project cost, project benefits, and criticality (impact or loss of function). For example, if the frequency is the 10-year flood, the project will have a very high likelihood of cost-effectiveness.

Based on the combination of the estimated cost of the project and the likelihood of cost-effectiveness, a relative cost ranking will be assigned on Worksheet B, Appropriate Mitigation Measures. If the likelihood of cost-effectiveness is low, the ranking of relative cost will be either moderate or high, based on the estimated cost of the project. However, if the estimated cost is low and the likelihood of cost-effectiveness is very high or high, the relative cost ranking will be low.

6.4 Additional Considerations

6.4.1 Human Intervention

In most cases, human intervention is required to implement a wet floodproofing project. To reduce the level of human intervention, the interior finish can be changed to improve resistance to flood damage, gypsum wallboard can be removed, and impervious paints can be applied to the floors and walls.

6.4.2 Annual Maintenance

Annual maintenance is required after implementing a wet floodproofing mitigation measure. Several considerations to facilitate a successful maintenance schedule include:

- Check the floodwater access vents/openings to ensure they are easily opened and unobstructed to allow floodwater to enter the structure as planned.
- Check the condition of impervious painted surfaces.
- Check the serviceability of pumps and pipes or hoses used for draining the structure.
- Verify that electrical service panels have been relocated to an area above expected flooding.
- Make any necessary repairs/replacement of damaged or worn components of the wet floodproofing system.
- Check to ensure that any fuel tanks are securely strapped to the walls or set on concrete footings that are anchored to the floor and securely fastened.

6.4.3 Substantial Improvement or Substantial Damage Requirements

If wet floodproofing is used on a structure that is substantially improved or substantially damaged, the community's floodplain management ordinance or law will not allow the property owner to have a basement, as defined under the NFIP. The NFIP regulations define a basement as "any area of the structure having its floor below subgrade on all sides." If the structure has such a basement, it is required to be filled in as part of any wet floodproofing project (Figure 6-6). The NFIP definition

of basement does not include what is typically referred to as a "walkout" basement, whose floor would be at or above grade on at least one side (Figure 6-7).

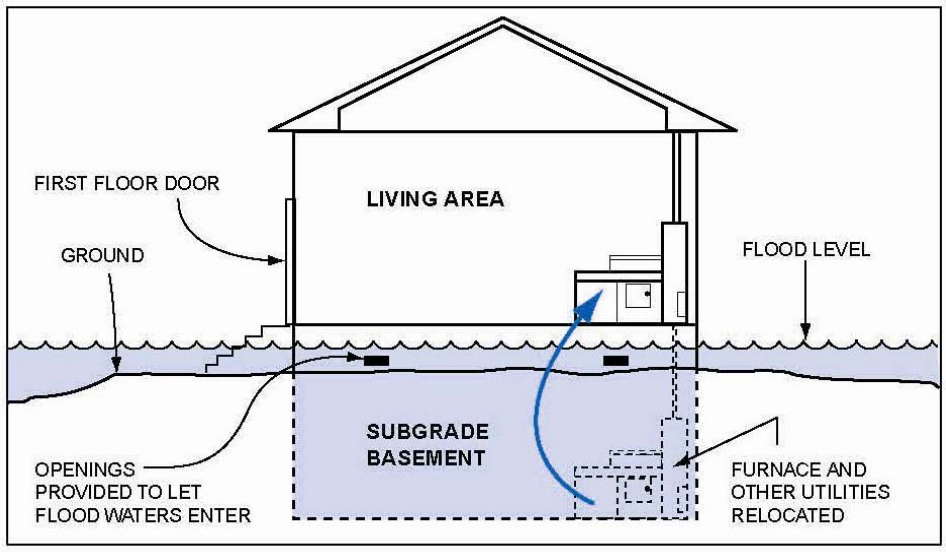

Figure 6-6. Wet floodproofing with a wet floodproofed subgrade basement

(Source: FEMA 312)

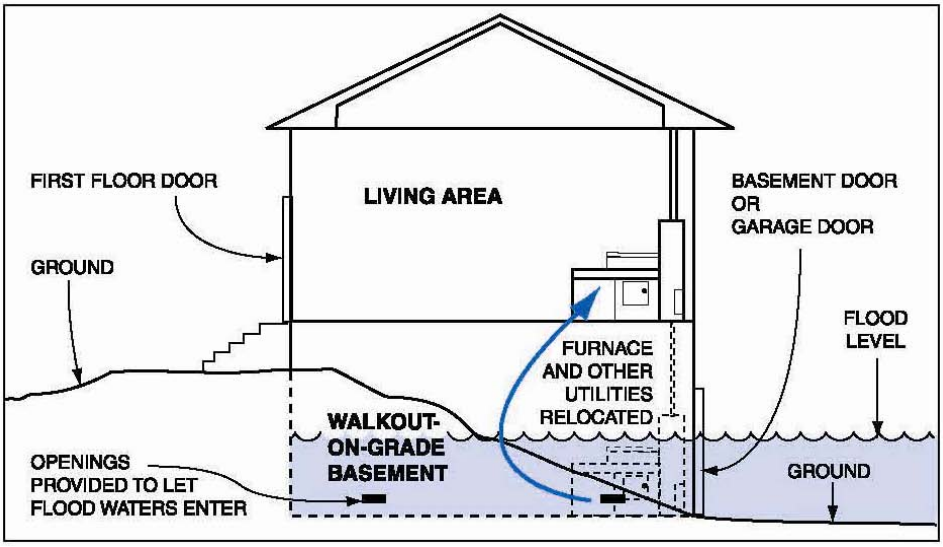

Figure 6-7. A structure with a wet floodproofed walkout-on-grade basement

(Source: FEMA 312)

Wet floodproofing is allowed to bring a substantially damaged or substantially improved structure into compliance with NFIP regulations in limited situations. Should a structure be substantially damaged or proposed to be substantially improved, it will need to meet all requirements of the NFIP and the local building code. Thus, a residential structure will normally be required to be constructed above the 100-year flood level and a non-residential structure either elevated or floodproofed to the 100-year level.

A community's floodplain management ordinance or law might restrict wet floodproofing to garages and enclosed areas below the BFE that are above grade on at least one side and used solely for parking, storage, or structure access (if the structure has been substantially damaged or is being substantially improved). For more information, refer to FEMA Technical Bulletin 7-93, *Wet Floodproofing Requirements for Structures Located in Special Flood Hazard Areas* and FEMA Technical Bulletin 11-01, *Crawlspace Construction for Buildings Located in Special Flood Hazard Areas*.

6.4.4 Post-Flood Concerns

These concerns revolve around emptying a flooded basement to prevent contaminating the structure and potable water:

- **Hydrostatic pressure.** Water should not be pumped out of the basement area or enclosed crawlspace until the water outside has receded. Doing so will cause a pressure differential on the walls and could result in basement wall failure.
- **Well water testing.** If the well and the area surrounding the well are submerged under the floodwaters, the well must be tested by a licensed sanitarian before any water can be disinfected and consumed. The sanitarian can advise the property owner on how to accomplish this or contract for the service.

6.5 Available Resources

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. See Chapters VI-W, Wet Floodproofing.

FEMA 312. *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House from Flooding.* See Chapter 3, An Overview of the Retrofitting Methods and Chapter 6, Wet Floodproofing.

FEMA 348. *Protecting Building Utilities from Flood Damage*. See Chapter 4, Existing Buildings.

FEMA 511. *Reducing Damage from Localized Flooding*. See Chapter 10, Retrofitting.

FEMA TB 7-93. *Wet Floodproofing Requirements for Structures Located in Special Flood Hazard Areas.*

FEMA TB 11-01, *Crawlspace Construction for Buildings Located in Special Flood Hazard Areas*

The Louisiana State University (LSU) Extension Center website (http://www.louisianafloods.org) lists many retrofitting publications, provides advice on floodproofing methods and flood insurance, and links to online shopping for retrofitting products and contractors.

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CHAPTER 7 – DRY FLOODPROOFING

7.1 Introduction

A dry floodproofed structure is made watertight below the level that needs flood protection to prevent floodwaters from entering. Making the structure watertight requires sealing the walls with waterproof coatings, impermeable membranes, or a supplemental layer of masonry or concrete (Figure 7-1).

CAUTION

Dry floodproofing may not be used to bring a substantially damaged or substantially improved residential structure into compliance with the community's floodplain management ordinance or law.

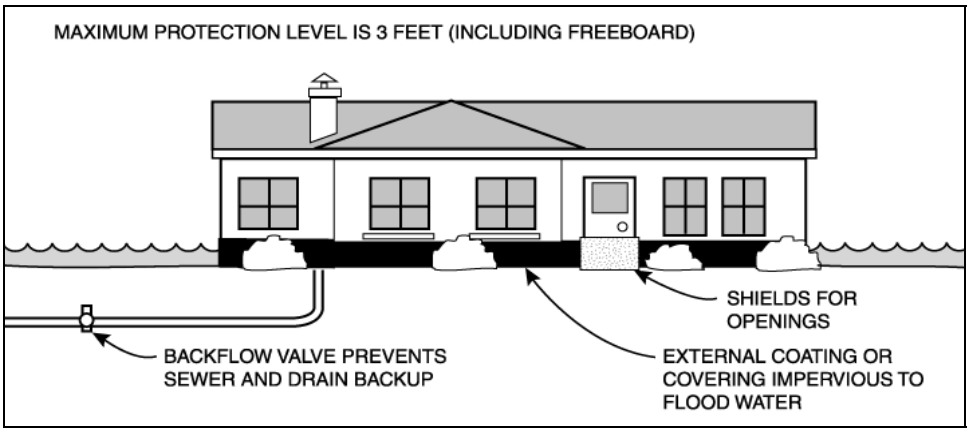

Figure 7-1. A typical dry floodproofed structure

(Source: FEMA 312)

Table 7-1 includes a summary of advantages and disadvantages for using dry floodproofing as a mitigation measure.

Table 7-1. Considerations for Using Dry Floodproofing

Advantages	Disadvantages
▪ Dry floodproofing is less costly than other retrofitting methods. ▪ Does not require the additional land that may be needed for levees and floodwalls. ▪ May be fundable under FEMA mitigation grant programs.	▪ May not be used to bring a substantially damaged or substantially improved residential structure into compliance with the community's floodplain management ordinance or law. ▪ Dry floodproofing requires human intervention and adequate warning to install protective measures. ▪ Does not minimize the potential damage from high-velocity flood flow and wave action. ▪ Ongoing maintenance is required. ▪ Flood shields may not be aesthetically pleasing.

Dry floodproofing a structure includes the following:

- Using waterproof membranes or other sealants to prevent water from entering the structure through the walls
- Installing watertight shields over windows and doors
- Installing measures to prevent sewer backup

7.1.1 Waterproof Membranes

Installing heavy plastic sheeting or waterproof membrane along a wall's exterior surface is an effective means of waterproofing (Figure 7-2). The waterproof membrane can be installed relatively quickly; however, it does require human intervention. The membrane is unsightly and cannot remain in place indefinitely. Furthermore, the plastic will deteriorate with continued exposure to solar radiation.

Figure 7-2. Photograph of membrane providing flood protection

(Source: U.S. Army Corps of Engineers)

7.1.2 Closures

In conjunction with a waterproof membrane, openings in the walls need to be closed, either with temporary closures or permanently sealed shut (Figure 7-3).

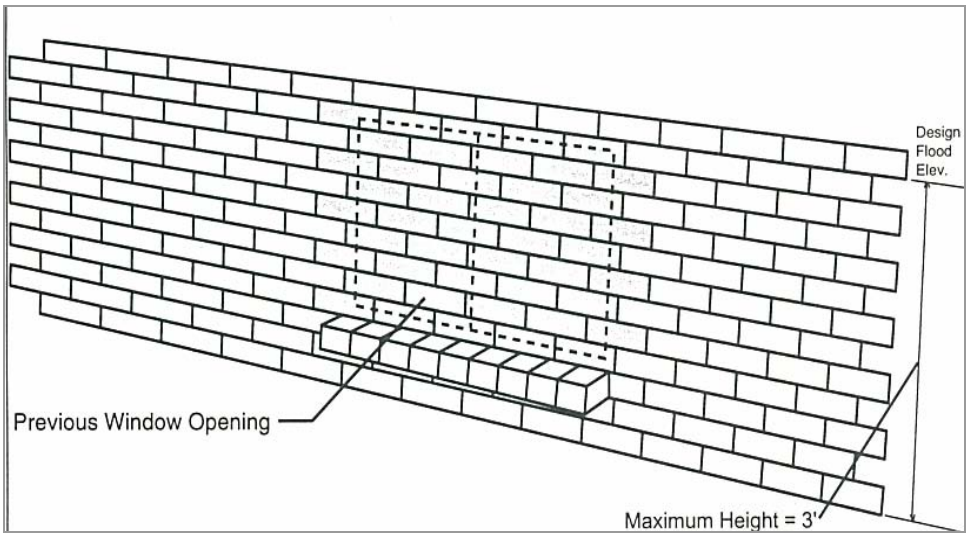

Figure 7-3. Permanently sealed opening

(Source: FEMA 259)

Low window openings at ground level can either have a pre-sized closure fitted over their surface or have a low wall constructed around the opening to a height above the flood protection elevation (Figure 7-4).

Figure 7-4. Low wall construction

Various closure systems can be manufactured to fit the individual openings, providing a way for it to be quickly closed and have a watertight seal. These types of closures can either be stored in a readily accessible location or permanently remain in place. Many of these closures have rubberized seals and other components that will require periodic care and maintenance (Figure 7-5).

Figure 7-5. Small patio gate

(Source: W.A. Wilson Consulting Services)

7.1.3 Sewer Backup Protection

Backup of sanitary sewers into a structure is a major concern due to the health hazards. Even after floodwaters have receded, contents and belongings that have been exposed to sewage are severely contaminated and can be nearly impossible to clean. The five main approaches to protect a structure against sewer backup are floor drain plugs, floor drain standpipes, overhead sewers, backup valves, and grinder pumps. For a detailed discussion of sewer backup protection, see FEMA 511, *Reducing Damage from Localized Flooding,* Chapter 10 (pages 10-9 to 10-11) and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures,* Section VI-D.

7.2 Technical Considerations

The flood characteristics that affect the success of dry floodproofing are flood depth, flood duration, flow velocity, amount of warning time, and floodborne debris.

7.2.1 Flood Depth

The depth of the floodwaters affects the hydrostatic pressure that is exerted on walls and floors. Because water is prevented from entering a dry floodproofed structure, the exterior pressure on walls and floors is not counteracted from the opposite side as it is in a wet floodproofed structure. The ability of walls to withstand the hydrostatic pressures depends partly on how the walls are constructed:

- Typical masonry and masonry veneer walls, without reinforcement, can usually withstand the pressure exerted by water up to about 3 feet deep.
- In flood depths exceeding 3 feet, unreinforced masonry and masonry veneer walls are much more likely to crack or collapse. An advantage of masonry and masonry veneer

walls is that their exterior surfaces are resistant to damage by moisture and can be made watertight relatively easily with sealants.

- Typical frame walls are likely to fail at lower flood depths, are more difficult to make watertight, and are more vulnerable to damage from moisture.

7.2.2 Structures with Basements

If a structure has a basement, the walls and floors must be specifically designed to resist hydrostatic pressure. Otherwise the risks associated with dry floodproofing a basement are high. Figure 7-6 illustrates how hydrostatic pressure operates on a structure during a flood. Structure "a" has no basement and the forces acting upon the structure are relatively small. However, for structure "b," the forces are significantly greater due to the presence of a basement.

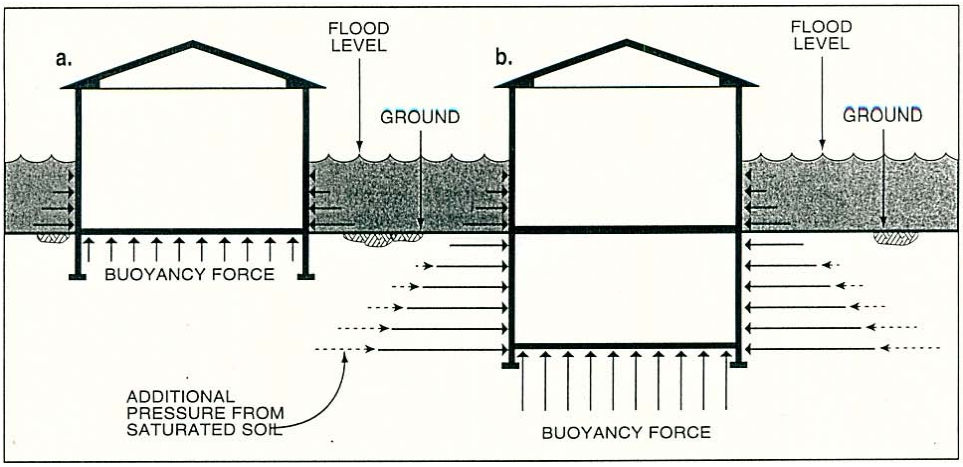

Figure 7-6. Hydrostatic pressures on a structure

(Source: FEMA 312)

7.2.3 Flood Duration

The longer a structure is exposed to floodwaters, the more likely it is that structural systems and floodproofing measures will begin to leak or fail. Most sealing systems will begin to allow some amount of seepage after prolonged periods of exposure to water. If the structure is in an area where high floodwaters can remain for days, a different retrofitting method should be used.

7.2.4 Flow Velocity

A seemingly "low" flow velocity of 1 or 2 feet per second can exert tremendous forces on a structure with only a few feet of flooding. Structures can be easily moved off of their foundations, which results in the total loss of the structure. Walls are easily damaged and subject to collapse by moving water.

7.2.5 Warning Time

Since dry floodproofing is often best suited for flooding conditions that last for a relatively short period of time, warning time and the time it takes to deploy the various components of a dry floodproofing system must be considered. Streams that are at flood levels for a short period of time generally reach flood levels quickly, thus the warning and preparation time is limited.

Incorporating any type of flood warning system into the project design will enhance its ability to perform properly.

7.2.6 Floodborne Debris

The impact forces from debris in the moving water, such as trees, can compound the hydrodynamic forces of the moving floodwaters.

7.3 Relative Costs

The relative cost ranking is based on the combination of the estimated costs for the dry floodproofing project and a determination of cost-effectiveness.

7.3.1 Estimated Cost

Dry floodproofing a structure is generally an inexpensive mitigation measure. The costs for dry floodproofing a structure will depend on the following factors: the size of the structure, the height of the Flood Protection Elevation (FPE), types of sealant and shield materials used, number of plumbing lines that have to be protected by check valves, and number of openings that have to be covered by shields.

Examples of cost estimating items that may need to be considered include the following:

- Analysis to determine the effective dry floodproofing method and design of the dry floodproofing method
- Dry floodproofing method selected, including:
    - Watertight shields for doors and windows
    - Reinforcing walls to withstand floodwater pressures and impact forces generated by floating debris
    - Drainage collection systems and sump pumps to control the interior water level, collect seepage, and reduce hydrostatic pressure on slab and walls
    - Membranes and/or other sealants to reduce seepage of floodwater through walls and wall penetrations
    - Anchoring the structure to resist flotation, collapse, and lateral movement
- Construction

To estimate the relative cost of a dry floodproofing project, examples of general cost estimates have been provided below and are included in FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways To Protect Your House From Flooding* and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*.

The figures in Table 7-2 are example cost estimate numbers used in a study for the St. Louis Metropolitan Sewer District. These numbers were generated using the U.S. Army Corps of

Engineers' publication, *Flood Proofing - How to Evaluate Your Options,* and updated to 2002 and adjusted for the St. Louis area. It is important to note that the cost estimate numbers are location and time dependent.

Table 7-2. General Estimates of the Unit Costs for Typical Dry Floodproofing Projects

Dry Floodproofing	
Waterproofing a concrete block or brick-faced wall by applying a polyethylene sheet or other impervious material and covering with a facing material such as brick.	$3.50/square foot
Acrylic latex wall coating	$3.00/ square foot
Caulking/sealant − a high performance electrometric "urethane" sealant is recommended.	$2.50/linear foot
Bentonite grout (below grade waterproofing, 6 feet deep)	$20/linear foot

Appendix C, Cost Estimating, provides guidance and references for conducting a more detailed cost estimate. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*. A blank preliminary cost estimating worksheet (Worksheet D) is provided in Appendix B.

7.3.2 Determination of Cost-Effectiveness

A component of the relative cost scoring is to include a determination of cost-effectiveness. Table D-1 in Appendix D, Determining Cost-Effectiveness, provides a quick screening for the cost-effectiveness of a project. The attributes included in the table are frequency of flood, level of damage, project cost, project benefits, and criticality (impact or loss of function). For example, if the frequency is the 10-year flood, the project will have a very high likelihood of cost-effectiveness.

Based on the combination of the estimated cost of the project and the likelihood of cost-effectiveness, a relative cost ranking will be assigned on Worksheet B, Appropriate Mitigation Measures. If the likelihood of cost-effectiveness is low, the ranking of relative cost will be either moderate or high, based on the estimated cost of the project. However, if the estimated cost is low and the likelihood of cost-effectiveness is very high or high, the relative cost ranking will be low.

7.4 Additional Considerations

Most floodproofing projects use more than one technique; this is especially true in dry floodproofing. A good dry floodproofing project can be enhanced through the use of small flood barriers or modifications to the structure's foundation drainage system. The small flood barriers will move the floodwaters away from the structure, thereby reducing the forces exerted on the subsurface portions of the structure. Additional considerations for using dry floodproofing are human intervention, annual maintenance, non-residential buildings, and structures without basements.

7.4.1 Human Intervention

Property owners must be able to install all flood shields and physically perform the activities required for the successful operation of the dry floodproofing system before floodwaters arrive.

7.4.2 Annual Maintenance

The components must be inspected and maintained on a regular basis. Because dry floodproofing has window and door closures as part of the system, closures must be available and in good condition. Some considerations to facilitate a successful maintenance schedule are as follows:

- Develop an inventory and location list of all flood shields and closures.
- Develop an inspection plan to ensure flood shields and closures fit properly.
- Check walls, floors, and floodproof coatings for cracks and potential leaks.

7.5 Available Resources

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. See Chapters VI-D, Dry Floodproofing.

FEMA 312. *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House from Flooding.* See Chapter 3, An Overview of the Retrofitting Methods and Chapter 7, Other Methods – Dry Floodproofing.

FEMA 511. *Reducing Damage from Localized Flooding*. See Chapter 10, Retrofitting.

The Louisiana State University (LSU) Extension Center website (http://www.louisianafloods.org) lists many retrofitting publications, provides advice on floodproofing methods, and flood insurance and links to online shopping for retrofitting products and contractors.

R.S. Means *Contractor's Pricing Guide.*

USACE. *Flood Proofing - How to Evaluate Your Options.*

CHAPTER 8 – ELEVATION

8.1 Introduction

Elevating a structure to prevent floodwaters from reaching living areas is an effective and one of the most common mitigation methods. The goal of the elevation process is to raise the lowest floor to or above the required level of protection. This can be done by elevating the entire structure, including the floor (Figures 8-1 and 8-2), or by leaving the structure in its existing position and constructing a new, elevated floor within it.

Figure 8-1. Residence before elevation

Figure 8-2. Residence shown in Figure 8-1 now elevated 5 feet

Table 8-1 includes a summary of advantages and disadvantages for using elevation as a mitigation measure.

Table 8-1. Considerations for Using Elevation

Advantages	Disadvantages
▪ Elevating to or above the BFE allows a substantially damaged or substantially improved house to be brought into compliance with the community's floodplain management ordinance or law. ▪ Often reduces flood insurance premiums. ▪ Techniques are well-known, and qualified contractors are often readily available. ▪ May be fundable under FEMA mitigation grant programs.	▪ Cost may be prohibitive. Additional costs are likely if the structure must be brought into compliance with current code requirements for plumbing, electrical, and energy systems. ▪ The appearance of the structure and access to it may be adversely affected.

For a detailed discussion of the techniques to elevate a structure, see FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding*, Chapter 5 or FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*, Chapter VI-E. Additional references are included in Section 8.5, Available Resources. The three most common elevation techniques are:

- Elevating on open foundations
- Elevating on continuous foundation walls
- Elevating by extending the walls or by moving the living space to an upper floor

8.2 Technical Considerations

8.2.1 Structure Type

Concrete, masonry, or brick faced structures require special attention to ensure that the structure is not damaged during the elevation process. For a structure with wood-frame construction, with a brick veneer, the brick could be removed and then reapplied once the elevation process is complete.

8.2.2 Foundation Type

There are four main types of structure foundations. In order of increasing difficulty to elevate, they are:

- Crawlspaces
- Piers, Posts, Piles, Columns, and Shear Walls
- Basements
- Slabs-on-Grade

8.2.2.1 Crawlspaces. A building on this type of foundation is the easiest to work with on an elevation project. There is usually room for the contractor to move lifting beams under the building and to deploy the lifting jacks. The building is lifted to the desired height, the new foundation is constructed up to the correct elevation to bring the lowest floor to the flood protection level, and the building is then lowered onto the new foundation and connected. Once the utilities are reconnected, the residents may reoccupy the home or business.

8.2.2.2 Piers, Posts, Piles, Columns, and Shear Walls. This type of construction is often found in buildings within a coastal floodplain, allowing floodwater to pass under the building and around the piles or posts. To elevate this type of construction, the building is often raised and moved to one side while new piles or posts are either poured or driven into the ground. The building is then moved back onto the site and lowered onto the new foundation supports.

8.2.2.3 Basements. This type of construction can be difficult to work with on an elevation project because anytime NFIP regulations are employed to bring a residence into compliance, the existing basement will need to be abandoned and filled. The NFIP requires the lowest floor to be above the BFE: a pre-existing basement is considered the lowest floor, therefore the basement must be filled and new foundation footings and walls constructed to the proper flood protection elevation. The physical elevation of the building is also more difficult because the support structures for the lifting beams must be constructed outside of the basement's footprint in order to begin the lifting process.

8.2.2.4 Slabs-on-Grade. This type of construction is very difficult to elevate. Depending upon the slab construction (with or without stiffeners), support beams must be placed close together to ensure the slab is not broken. The area underneath the slab must be excavated to insert the lifting equipment and disconnect utilities. If the slab is not adquately reinforced with reinforcing steel, the slab may crack when lifted. This approach is discussed in detail in USACE's *Raising and Moving the Slab-on-Grade House with Slab Attached.*

The alternatives to excavating under the slab (e.g., cut openings in the walls for the lifting beams, detach the walls from the slab, and lift the building without the slab) require that a new floor is constructed on the elevated foundation, the building is placed upon the new floor, and the holes through the walls are repaired.

8.2.3 Structure Size

Large rambling structures, buildings constructed of extremely heavy materials, and multi-story structures require special attention before they are elevated.

8.2.4 Utility Modifications

All utilities must be disconnected before the structure is elevated and reconnected on its new foundation. Underground utilities need to be protected from the lifting equipment and site excavations. Some utilities that service a structure may need modification once the elevation project is complete. For instance, the electrical service mast may need to be relocated or raised after a structure is elevated to keep the wires off the roof of the structure or away from other hazards. FEMA 348, *Protecting Building Utilities from Flood Damage,* provides additional information on utility modifications.

8.2.5 Other Hazards

Although elevating a structure can help protect it from floodwaters, other natural hazards need to be considered before choosing this method; in particular, earthquake, wind, and hydrostatic and hydrodynamic forces. For example, elevation causes a structure to become "top heavy" and, therefore, more susceptible to the overturning forces of earthquakes. Because the walls and roof of this structure are higher and more exposed, it can be more susceptible to wind forces. Likewise, both closed and open elevated foundations can fail as a result of damage caused by erosion and the impact of debris carried by floodwaters. If portions of the original foundation are used to support new walls, other foundation members, or a new second story, they must be capable of safely carrying the additional loads imposed by the new construction along with the expected flood, wind, and earthquake forces. Constructing or elevating a structure in accordance with applicable building codes will address most if not all of these issues.

8.2.6 Vents

For all elevation projects, vents in the enclosed areas below the BFE are required. Most building codes will require vents for air circulation; additionally, vents are needed to relieve hydrostatic pressure. FEMA's Technical Bulletin 1-93 details the NFIP criteria for the placement of vents in the foundation walls. Although some building codes may be more stringent, the most common requirement is to provide 1 square inch of vent opening for every square foot of enclosed space. The bottom of the vents must be no higher than 1 foot above the outside grade (Figures 8-3 and 8-4). Inside and outside ground elevations should be essentially equal and the vents must be installed in two or more walls. If the openings in the vents are covered with bars or screening to keep pests from entering the crawlspace, the cross-sectional area of the bars or screening must be deducted from the vent opening area.

Figure 8-3. New foundation with vents

(Source: W. A. Wilson Consulting Services)

Figure 8-4. New foundation with vents

(Source: W. A. Wilson Consulting Services)

8.3 Relative Costs

The relative cost ranking is based on the combination of the estimated costs for the elevation project and a determination of cost-effectiveness.

8.3.1 Estimated Cost

The cost of elevating a structure is generally in the middle range compared to the costs of implementing other mitigation measures. Basic costs for elevating structures on open and closed foundations include constructing a foundation, elevating utilities, and adding or extending staircases.

ICC Coverage. The cost of elevating a substantially damaged structure may be an eligible flood insurance claim under Increased Cost of Compliance (ICC) coverage (see FEMA 301, *NFIP's Increased Cost of Compliance Coverage Guidance for State and Local Officials,* for additional information).

In some instances, slab-on-grade structures are raised without the slab attached. Although this method of elevation may be less expensive than raising the structure with the slab, it involves detaching the structure from the slab and requires alterations to the interior and exterior walls. Therefore, raising the structure without the slab is most often done when the structure has experienced substantial damage, yet remains structurally sound.

The cost of elevating by extending walls and abandoning an existing lower level depends on whether the structure has an existing upper level that can be used for living space. If an upper level is available, abandoning the lower floor would involve primarily elevating or relocating utilities, adding openings in the lower-level walls, and ensuring that all construction materials are flood-resistant.

Examples of cost estimating items that may need to be considered include the following:

- Preparation of the structure for elevation
- Elevation of the structure, including cost of steel beams, jacks, etc.
- Construction of the new, elevated foundation
- Secure the structure to the new foundation
- Replacement or reconstruction of items removed from the structure prior to elevation

To estimate the relative cost of a elevation project, examples of general cost estimates have been provided below and are included in FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways To Protect Your House From Flooding* and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*.

The figures in Table 8-2 are example cost estimate numbers used in a study for the St. Louis Metropolitan Sewer District. These numbers were generated using the U.S. Army Corps of Engineers' publication, *Flood Proofing - How to Evaluate Your Options,* and updated to 2002 and adjusted for the St. Louis area. It is important to note that the cost estimate numbers are location and time dependent.

Table 8-2. General Estimates of the Unit Costs for Typical Elevation Projects

Elevation	
Wood-frame building on piles, posts, or columns	$36/square foot
Wood frame on concrete or block foundation walls	$32/square foot
Brick walls	$43/square foot
Slab-on-grade	$45/square foot

Appendix C, Cost Estimating, provides guidance and references for conducting a more detailed cost estimate. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*. A blank preliminary cost estimating worksheet (Worksheet D) is provided in Appendix B.

8.3.2 Determination of Cost-Effectiveness

A component of the relative cost scoring is to include a determination of cost-effectiveness. Table D-1 in Appendix D, Determining Cost-Effectiveness, provides a quick screening for the cost-effectiveness of a project. The attributes included in the table are frequency of flood, level of damage, project cost, project benefits, and criticality (impact or loss of function). For example, if the frequency is the 10-year flood, the project will have a very high likelihood of cost-effectiveness.

Based on the combination of the estimated cost of the project and the likelihood of cost-effectiveness, a relative cost ranking will be assigned on Worksheet B, Appropriate Mitigation Measures. If the likelihood of cost-effectiveness is low, the ranking of relative cost will be either moderate or high, based on the estimated cost of the project. However, if the estimated cost is low and the likelihood of cost-effectiveness is very high or high, the relative cost ranking will be low.

8.4 Additional Considerations

8.4.1 Substantial Damage/Improvement

If the structure being elevated has been substantially damaged or is being substantially improved, the local floodplain management ordinance or law will generally restrict the structure from having a basement (as defined under the NFIP) if the structure is located within the mapped 100-year floodplain. For areas removed from the SFHA by the placement of fill, see FEMA Technical Bulletin 10-01, *Ensuring That Structures Built on Fill In or Near Special Flood Hazard Areas are Reasonably Safe from Flooding*.

The NFIP regulations define a basement as "any area of the building having its floor sub-grade on all sides." If the structure has a basement, it must be filled in as part of any elevation project. The NFIP definition of basement does not include what is typically referred to as a "walkout-on-grade" basement, whose floor would be at or above grade on at least one side. Additional information on substantial damage requirements is included in FEMA 213, *Answers to Questions About Substantially Damaged Buildings.*

FEMA Technical Bulletin 11-01, *Crawlspace Construction for Buildings Located in Special Flood Hazard Areas,* provides guidance on crawlspace construction and supports a policy decision to permit crawlspaces to be built up to 2 feet below the lowest adjacent exterior grade (LAG), provided that other considerations are met. Previously, these below grade crawlspaces were considered basements under NFIP regulations.

8.4.2 Access to the Structure by the Lifting Crew

Elevating a structure requires specialized heavy equipment and materials, ranging from large front-end loaders to long steel beams. Therefore, there must be enough room on the site from obstructions such as trees, adjacent structures, and utilities. The proximity of adjacent neighbors may also require obtaining agreements or temporary easements from them. Any repairs from damage to their property must be covered in a pre-construction agreement and completed promptly. The *Flood Risk and Mitigation Possibilities* tab in NT provides a check box to indicate whether adequate clearance exists at the site (Figure 8-5).

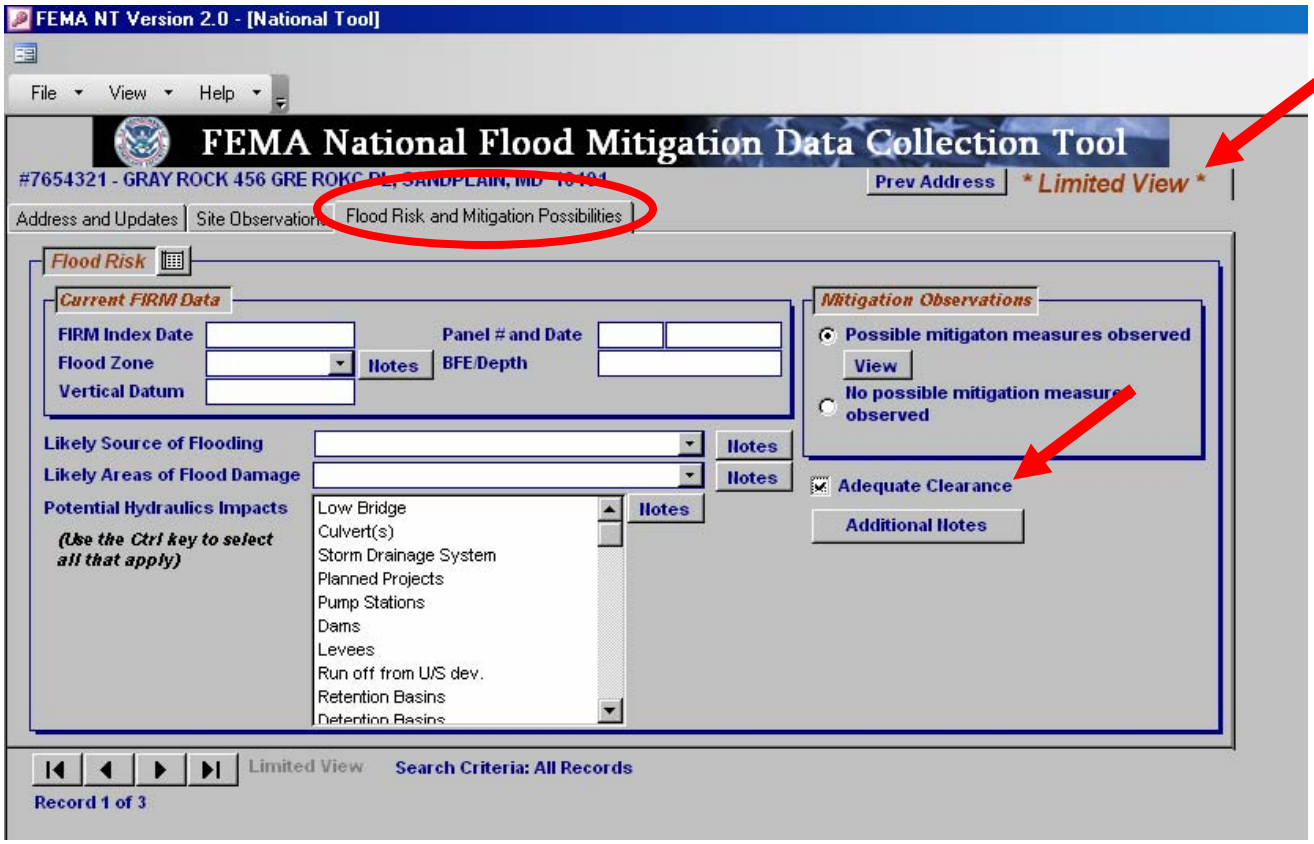

Figure 8-5. *Flood Risk and Mitigation Possibilities* tab - Adequate Clearance

8.4.3 Access to the Structure Following Elevation

An elevated structure is harder to access due to the height. If the structure is a residence, the age and physical condition of the occupants must be taken into consideration. Ramps, stairs and elevators can been used for entryways on many elevated residences (Figure 8-6). Refer to the Americans with Disabilities Act (ADA) and FEMA Technical Bulletin 4-93, *Elevator Installation for Buildings Located in Special Flood Hazard Areas in Accordance with the National Flood Insurance Program,* for additional information.

Figure 8-6. Elevator provides access to elevated structure

8.4.4 Codes and Ordinances

The local building code and the community's floodplain ordinance must be followed. The *Additional Site Information* tab should list any pertinent regulatory requirements or standards (Figure 8-7):

- Floodplain location requirements
- Local and state permits
- Design wind speeds and seismic loadings
- Snow loads
- Frost depths
- Height restrictions
- Restrictions on size or types of foundations
- Lowest floor requirements
- Heat duct elevation requirements
- Foundation venting requirements
- ADA requirements

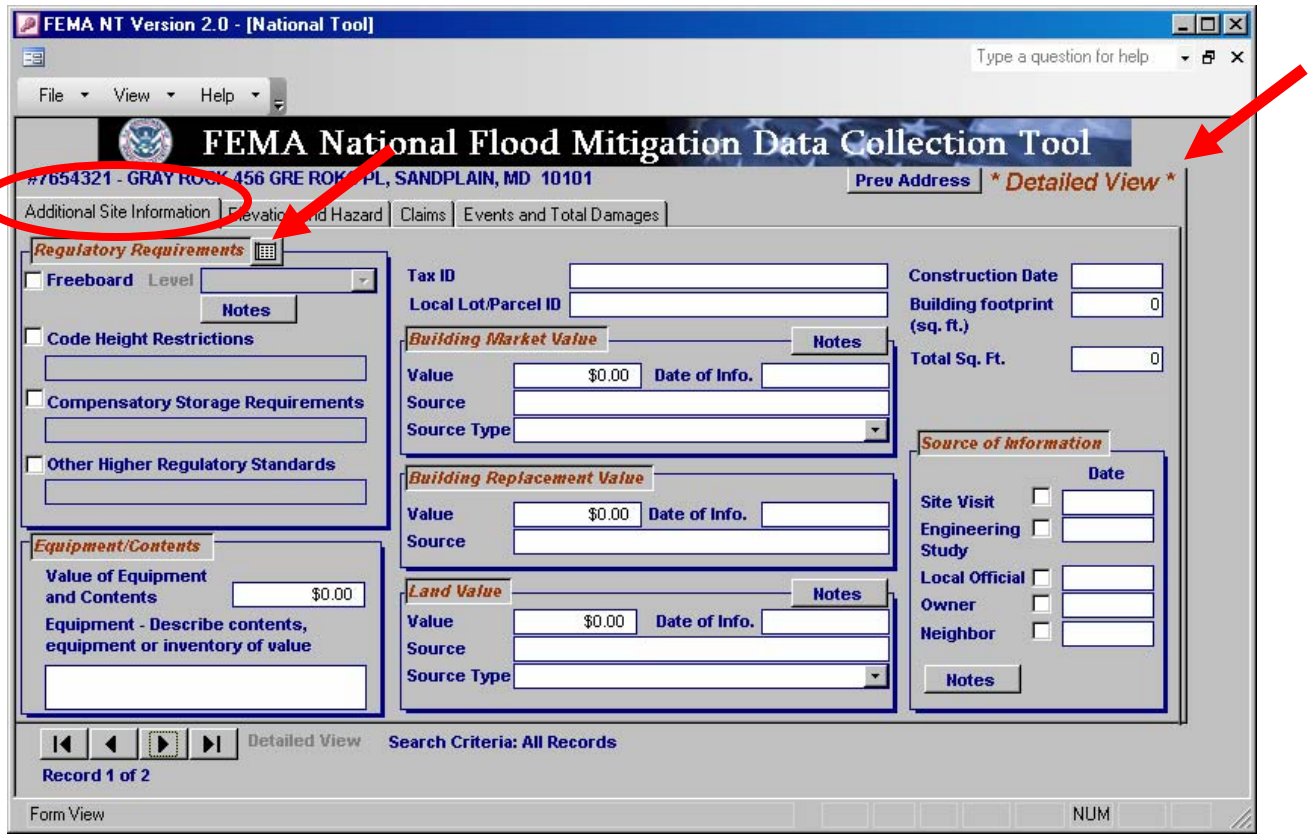

Figure 8-7. *Additional Site Information* tab - Regulatory Requirements

8.4.5 Historic Preservation

Structures placed on or designated as eligible for the National Register of Historic Buildings have historic value to the nation and are protected by legislation. As such, structural modifications to them, even for the purpose of protecting them from flooding, may be limted or not allowed. This is particularly true for changes that affect the exterior of the structure. Many communities have local historic preservation commissions and State Historic Preservation Officers (SHPOs) that can identify historic buildings and historic districts or neighborhoods (see Appendix G for a list of SHPOs).

8.4.6 Housing of Occupants

During the elevation process, the occupants of a residential structure will need to be temporarily relocated. Most elevation projects will result in the residents being relocated for 1 to 3 months.

8.4.7 Aesthetics

The visual aspect of an elevated structure is vitally important to both the property owner and the neighborhood, especially for residential structures. If the proposed project is perceived to be an "eyesore," it can be difficult to convince the property owners to proceed with the project, despite being protected from flooding. Additionally, a neighborhood eyesore can lead to criticism of the project itself and possible non-participation in future mitigation initiatives. Small cosmetic changes can greatly improve the looks of an elevated structure, such as:

- Landscaping and shrubbery
- Fill placed along the foundation wall, giving the appearance of the structure being located on a small knoll
- Extending siding down over the foundation walls

Figures 8-8 and 8-9 illustrate the contrast between a structure without cosmetic improvements and a structure with improvements.

Figure 8-8. House elevated 8 feet, but lacking landscaping, producing a stark look

Figure 8-9. House elevated over 5 feet with retaining wall, porch, and landscaping

8.5 Available Resources

FEMA 85. *Manufactured Homes in Flood Hazard Areas: A Multi-Hazard Foundation and Installation Guide*. See Chapter 8, Methods for Mitigating Flood Hazards 8.1 Elevation

FEMA 213. *Answers to Questions About Substantially Damaged Buildings*.

FEMA 259. Engineering Principles and Practices of Retrofitting Floodprone Residential Structures. See Chapter VI-E, Elevation.

FEMA 301, *NFIP's Increased Cost of Compliance Coverage Guidance for State and Local Officials.*

FEMA 312. *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House from Flooding.* See Chapter 3, An Overview of the Retrofitting Methods and Chapter 5, Elevating Your House.

FEMA 347. *Above the Flood: Elevating Your Floodprone House*.

FEMA 348. *Protecting Building Utilities from Flood Damage*. See Chapter 4, Existing Buildings.

FEMA 511. *Reducing Damage from Localized Flooding*. See Chapter 10, Retrofitting.

FEMA Technical Bulletin 1-93. *Openings in Foundation Walls for Buildings Located in Special Flood Hazard Areas*.

FEMA Technical Bulletin 4-93. *Elevator Installation for Buildings Located in Special Flood Hazard Areas in Accordance with the National Flood Insurance Program.*

FEMA Technical Bulletin 10-01 *Ensuring that Structures Built on Fill In or Near Special Flood Hazard Areas are Reasonably Safe from Flooding.*

FEMA Technical Bulletin 11-01. *Crawlspace Construction for Buildings Located in Special Flood Hazard Areas: National Flood Insurance Program Interim Guidance*.

The Louisiana State University (LSU) Extension Center website (http://www.louisianafloods.org) lists many retrofitting publications, provides advice on floodproofing methods and flood insurance, and links to online shopping for retrofitting products and contractors.

USACE. *Flood Proofing - How to Evaluate Your Options.*

USACE. *Raising and Moving the Slab-on-Grade House with Slab Attached.*

R.S. Means'. *Contractor's Pricing Guide*.

CHAPTER 9 – RELOCATION

9.1 Introduction

Relocation involves lifting and placing a structure on a wheeled vehicle to transport it to the new site outside the SFHA (Figure 9-1). This method is one of the most effective mitigation measures. If space permits, it may be possible to move the structure to another location on the same piece of property.

Figure 9-1. Structure placed on a wheeled vehicle for relocation to a new site

Relocation is most appropriate in areas where the flood conditions are characterized by one or more of the following:

- Deep water
- Short warning time (flash flooding)
- High flow velocity
- Wave action
- Significant quantity of debris in floodwaters

Table 9-1 includes a summary of advantages and disadvantages for using relocation as a mitigation measure.

Table 9-1. Considerations for Using Relocation

Advantages	Disadvantages
▪ Removes flood problem since the structure is relocated out of the floodprone area. ▪ Allows a substantially damaged or substantially improved structure to be brought into compliance with a community's floodplain management ordinance. ▪ May be fundable under FEMA mitigation grant programs.	▪ Cost may be prohibitive. ▪ Additional costs are likely if the structure must be brought into compliance with current code requirements for plumbing, electrical, and energy systems.

For a detailed discussion of the relocation process, see FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding*, Chapter 7 or FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*, Chapter VI-R. Additional references are included in Section 9.5, Available Resources.

9.2 Technical Considerations

Technical considerations for a relocation project include structure type, condition, and size.

9.2.1 Structure Type

Structures that are easiest to elevate, such as a single-story wood-frame structure over a crawlspace or basement foundation with a simple rectangular shape, are also the easiest to relocate. Concrete, masonry, or brick faced structures require special attention to ensure that the structure is not damaged during the process. For a structure with wood-frame construction, with a brick veneer, the brick could be removed and then reapplied once the relocation process is complete.

9.2.2 Structure Condition

Structures best suited for relocation are those in good condition. All structural members and their connections must be able to withstand the stresses imposed when the structure is lifted and moved. A structure that is in poor condition, especially one that has been damaged by repeated or severe flooding, may need so much structural repair and bracing that relocation would not be practical.

Prior to beginning, a thorough analysis of both the existing site and structure and the new site must be made. The examination of the structure should be done by a licensed structural engineer, with particular attention given to the building's floor support system (i.e., joists, plates, and flooring) to ensure that it will remain intact. If these components are not in good structural condition, the structure may not be a good candidate for relocation.

9.2.3 Structure Size

Large rambling structures, buildings constructed of extremely heavy materials, and multi-story structures require special attention before they are relocated.

9.3 Relative Costs

The relative cost ranking is based on the combination of the estimated costs for the relocation project and a determination of cost-effectiveness.

9.3.1 Estimated Cost

Relocation is a relatively expensive mitigation measure. In order to determine the estimated cost of a relocation project, contact one or more house movers. Provide basic data on the structure, such as wall and foundation type and size, and information on the distance to the new site. The movers should be able to provide a general cost estimate.

Examples of cost estimating items that may need to be considered include the following:

- Analysis of existing site and structure
- Site selection and analysis and design of the new location (i.e., adequacy of the new location for the structure, utility connections, permits, etc.)
- Analysis and preparation of the moving route, including items such as the width of the road, obtaining approval and permits, and route preparation
- Preparation of the structure prior to the move, such as disconnecting utilities, preparing the structure for the lift, and separating the structure from its foundation
- Moving the structure to the new location
- Preparation of the new site
- Construction of the foundation at the new location
- Connection of the structure to the new foundation
- Restoration of the old site

To estimate the relative cost of a relocation project, examples of general cost estimates are included in FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding* and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*.

Appendix C, Cost Estimating, provides guidance and references for conducting a more detailed cost estimate. Additional cost estimates can be obtained from R.S. Means' *Contractor's Pricing Guide*. A blank preliminary cost estimating worksheet (Worksheet D) is provided in Appendix B.

9.3.2 Determination of Cost-Effectiveness

A component of the relative cost scoring is to include a determination of cost-effectiveness. Table D-1 in Appendix D, Determining Cost-Effectiveness, provides a quick screening for the cost-effectiveness of a project. The attributes included in the table are frequency of flood, level of damage, project cost, project benefits, and criticality (impact or loss of function). For example, if the frequency is the 10-year flood, the project will have a very high likelihood of cost-effectiveness.

Based on the combination of the estimated cost of the project and the likelihood of cost-effectiveness, a relative cost ranking will be assigned on Worksheet B, Appropriate Mitigation Measures. If the likelihood of cost-effectiveness is low, the ranking of relative cost will be either moderate or high, based on the estimated cost of the project. However, if the estimated cost is low and the likelihood of cost-effectiveness is very high or high, the relative cost ranking will be low.

9.4 Additional Considerations

9.4.1 Annual Maintenance

The ownership of the original site may be transferred to the local community, which then has the maintenance and security responsibilities associated with the vacated site. If several relocation projects are undertaken within the same community, the result may create an undesirable patchwork of empty lots for the community to maintain.

9.4.2 Moving a Structure Between the Old and New Sites

Analysis and preparation of the moving route is accomplished by the contractor. Permits for a move and the new site will likely be required from the local government. If the move entails more than one community, a moving permit from each community will be required. On the day of the move, any obstructions need to be temporarily removed or positioned out of the way: power lines are either disconnected or simply lifted above the moving structure; fire hydrants close to the street may need to be disconnected and temporarily removed; and roads checked for possible obstructions to the passage of the structure. Narrow roads, restrictive load capacities on roads and bridges, and low clearances under bridges and power lines can make it necessary to find an alternative route. When no practical alternatives are available, the moving contractor may have to cut the structure into sections, move them separately, and reassemble the structure at the new site.

9.4.3 Access to Site

The Adequate Clearance box in the *Flood Risk and Mitigation Possibilities* tab in NT indicates whether there is sufficient clearance to permit equipment access to the site (Figure 9-2). The box should be checked if the structure is clear by approximately 20 feet on each side.

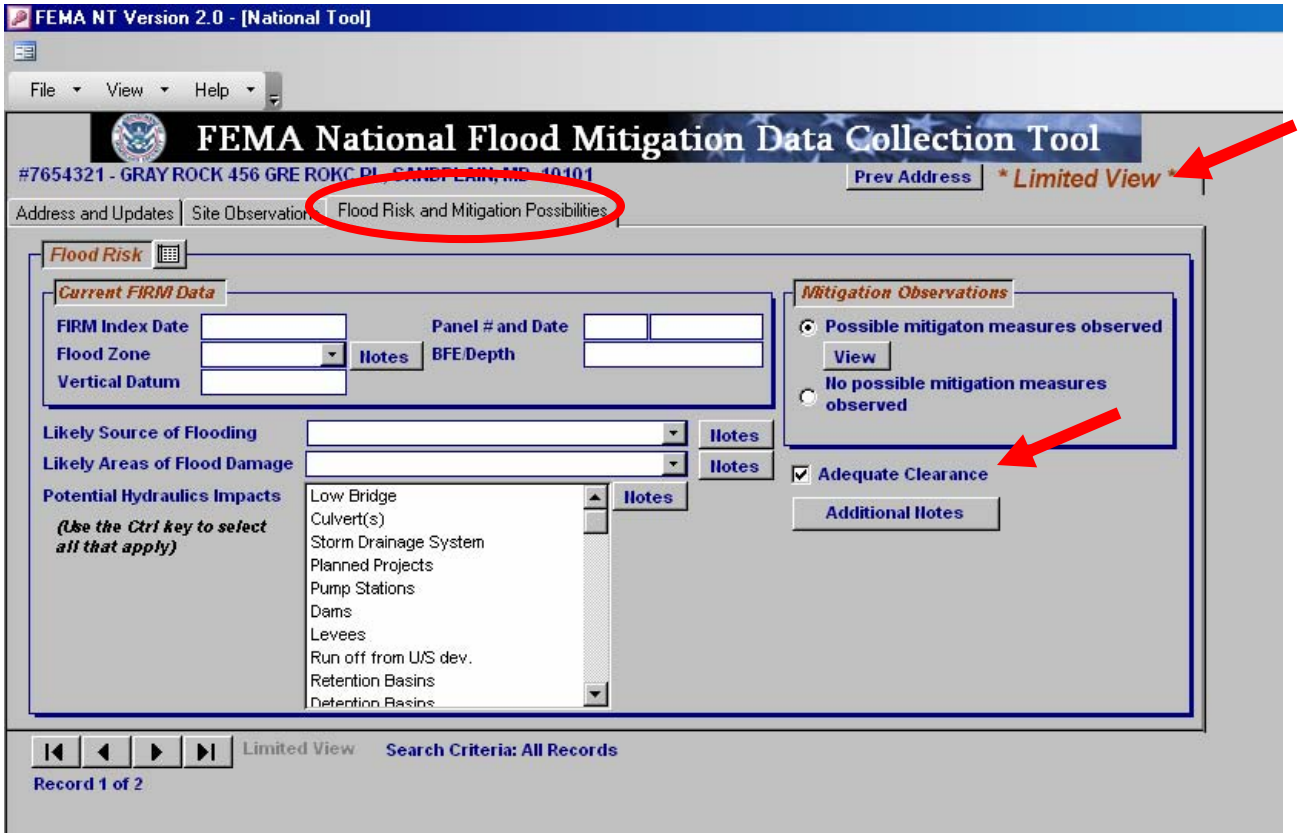

Figure 9-2. *Flood Risk and Mitigation Possibilities* tab - Adequate Clearance

9.4.4 Housing of Occupants

Relocation is a disruptive mitigation method for the occupants of the structure. Before the structure can be lifted, all utility systems must be disconnected. The structure becomes uninhabitable at this point, and the property owner will not be able to move back in until the structure has been placed at the new site and all utility systems have been reconnected. Until then, the property owner will need to find temporary lodging and a place to store furniture and other belongings.

9.5 Available Resources

FEMA 85. *Manufactured Homes in Flood Hazard Areas: A Multi-Hazard Foundation and Installation Guide*. See Chapter 8, Methods for Mitigating Flood Hazards 8.3 Relocation.

FEMA 259. *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. See Chapter VI-R, Relocation.

FEMA 312. *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House from Flooding.* See Chapter 3, An Overview of the Retrofitting Methods and Chapter 7, Other Methods - Relocation.

FEMA 511. *Reducing Damage from Localized Flooding*. See Chapter 9, Redevelopment.

The Louisiana State University (LSU) Extension Center website (http://www.louisianafloods.org) lists many retrofitting publications, provides advice on floodproofing methods and flood insurance, and links to online shopping for retrofitting products and contractors.

R.S. Means' *Contractor's Pricing Guide.*

CHAPTER 10 – ACQUISITION

10.1 Introduction

Acquiring and demolishing or simply demolishing a floodprone structure is the most successful means of ensuring that a structure will not accumulate additional losses from future flood events (Figure 10-1). There are two options for what to do with the site after the structure is gone:

1. The property site can be purchased by a government agency or appropriate organization that, after demolishing the structure, will keep the land in an open space use in perpetuity.
2. If the lot remains in private ownership after the building is demolished, a new structure can be built on the lot, provided it is constructed to meet all local building and flood protection code requirements.

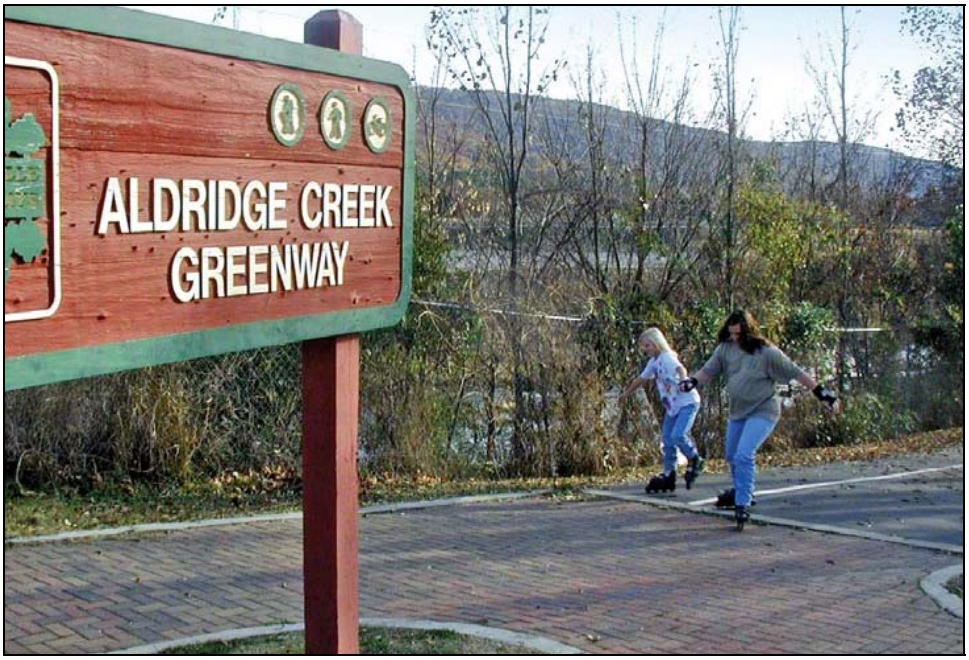

Figure 10-1. The Aldridge Creek Greenway in Huntsville, AL, is expanded as floodprone homes are acquired and cleared.

(Source: FEMA 511)

Table 10-1 includes a summary of advantages and disadvantages for using acquisition as a mitigation measure.

Table 10-1. Considerations for Using Acquisition

Advantages	Disadvantages
• Permanently removes problem since the structure no longer exists. • Allows a substantially damaged or substantially improved structure to be brought into compliance with the community's floodplain management ordinance or law. • Expands open space and enhances natural and beneficial uses. • May be fundable under FEMA mitigation grant programs.	• Cost may be prohibitive. • Resistance may be encountered by local communities due to loss of tax base, maintenance of empty lots, and liability for injuries on empty, community-owned lots.

10.2 Technical Considerations

Property acquisition is a complex process. The procedures for property title transfer from a private owner to the government are detailed and extensive. Every precaution is made to protect the private property owner's and renter's rights and to ensure they are fully aware of all aspects of the transaction. The acquisition process involves the following: disconnect and cap utility lines, tear the structure down, remove debris, restore old site and building, or buying a new structure. First the utility company must turn off all services to the structure and the demolition contractor will then disconnect the utility lines. If another structure will not be built on the site, the contractor will cap the lines permanently or remove them according to the requirements of the utility company. The structure is then relocated, salvaged or demolished, and debris removed as required by Federal, State, and local regulations. Site restoration includes demolishing and removing any paved surfaces, grading the property, and stabilizing the site.

Eligibility Requirements. In order for a community to qualify for FEMA grants for acquisition projects, three basic requirements must first be met:

1. The local community must inform the property owners interested in the acquisition program that the community will not use its condemnation authority to purchase their property and that participation in the program is strictly voluntary.
2. The subsequent deed to the property to be acquired will be amended such that the landowner will be restricted from receiving any further Federal disaster assistance grants, the property shall remain in open space in perpetuity, and the property will be retained in ownership by a public entity.
3. Any replacement housing or relocated structures will be located outside of the 100-year floodplain.

10.3 Relative Costs

The relative cost ranking is based on the combination of the estimated costs for the acquisition project and a determination of cost-effectiveness.

10.3.1 Estimated Cost

Acquisition is a relatively expensive mitigation measure. The cost of tearing a structure down can vary widely, depending on the amount of debris, whether it must be hauled to a licensed disposal site, and if a dumping fee is required. The major costs associated with the acquisition method are for purchasing the structure and land. Examples of cost estimating items that may need to be considered include the following:

- Purchase of structure and land
- Demolition
- Debris removal, which includes any landfill processing fees
- Grading and stabilizing the property site
- Permits and plan review

10.3.2 Determination of Cost-Effectiveness

A component of the relative cost scoring is to include a determination of cost-effectiveness. Table D-1 in Appendix D, Determining Cost-Effectiveness, provides a quick screening for the cost-effectiveness of a project. The attributes included in the table are frequency of flood, level of damage, project cost, project benefits, and criticality (impact or loss of function). For example, if the frequency is the 10-year flood, the project will have a very high likelihood of cost-effectiveness. Conversely, if the frequency is the 50 to 100-year flood, the likelihood of cost-effectiveness is low.

Based on the combination of the estimated cost of the project and the likelihood of cost-effectiveness, a relative cost ranking will be assigned on Worksheet B, Appropriate Mitigation Measures. If the likelihood of cost-effectiveness is low, the ranking of relative cost will be either moderate or high, based on the estimated cost of the project. However, if the estimated cost is low and the likelihood of cost-effectiveness is very high or high, the relative cost ranking will be low.

10.4 Additional Considerations

10.4.1 Historic Preservation

A community may not acquire, relocate or floodproof any structure prior to FEMA satisfying its compliance review required by Section 106 of the National Historic Preservation Act. Typically, the community must submit photographs of each property under consideration along with a description of the anticipated flood mitigation project. If FEMA determines, in consultation with the State Historic Preservation Office (SHPO) or Tribal Historic Preservation Office (THPO), that the property is listed or eligible for listing on the National Register of Historic Places (historic properties), FEMA must determine the effect of the proposed mitigation project on the identified property or properties. Historic properties include buildings, sites, structures, objects, and districts. If FEMA, in consultation with the SHPO/THPO and any other consulting parties, determine that the proposed project will adversely affect the historic property and properties, FEMA, the SHPO/THPO, and other consulting parties must agree on measures to avoid,

alleviate, minimize, or otherwise compensate for the adverse effect(s). These treatment measures are outlined in either a Memorandum of Agreement or Programmatic Agreement.

Early coordination between the applicant and the SHPO/THPO is helpful in understanding the historic significance of a particular area and avoiding potential adverse effects. A list of SHPOs/THPOs can be found through the National Park Service's web page and is included in Appendix G. Keep in mind though that FEMA is still required to formally identify and evaluate historic properties as part of the Section 106 review process. In many States, FEMA has negotiated programmatic agreements with the SHPO and state emergency management agency to exclude routine activities from further review, accelerate time periods for consultation between FEMA and the SHPO, and provide for other procedures to minimize delays during disaster recovery. These agreements often are extended to cover flood mitigation projects that occur during non-disaster periods, particularly for repetitive loss and substantially damaged structures. For example, most agreements allow for the administrative action of property acquisition to proceed before Section 106 review is initiated.

Properties identified as historic may be marked on the *Address and Updates* tab on the Limited View (Figure 10-2). An example of a historic structure is included in Figure 10-3.

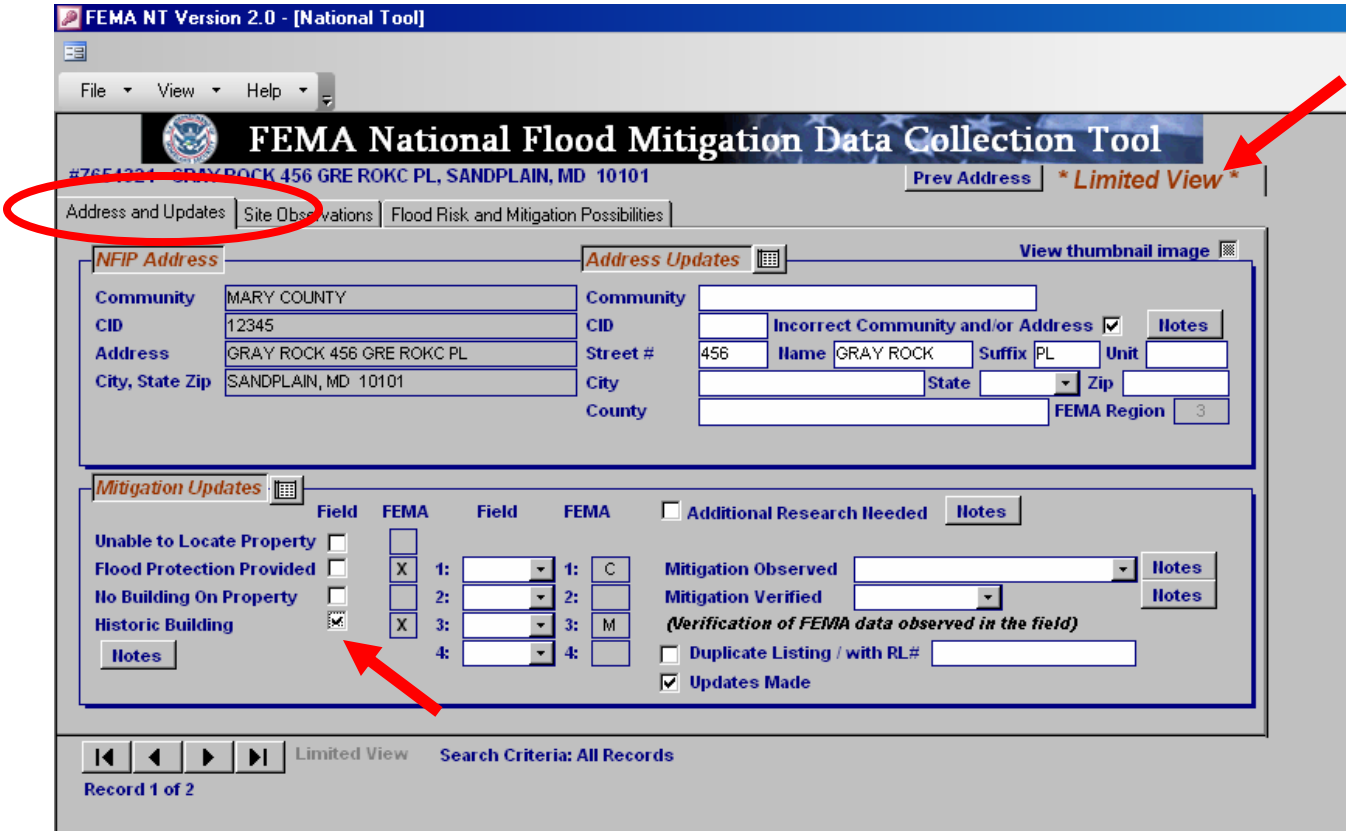

Figure 10-2. *Address and Updates* Tab - Historic Building Check

Figure 10-3. Historic Structure

10.4.2 Hazardous Materials

Existing owners must certify that the property is free of hazardous materials and contaminants or that the site has been cleaned to Federal standards. The sellers of any suspected agricultural/commercial properties must indemnify FEMA (if FEMA funding is involved), the State, and local governments from liability resulting from contamination of the site. If there is still suspicion regarding the acceptability of the site for the acquisition program, an environmental assessment may be required. Using FEMA funds to purchase contaminated properties is prohibited.

A review of a property's past uses must ensure that no hazardous materials are likely to be encountered. Research may need to be done to identify previous uses of the site as well. For example, a commercial site that is currently used as an office or retail space may have been used as a dry cleaner or screen printer shop, both of which are known for hazardous materials issues, especially when located in a floodprone area.

The *Site Observations* tab indicates whether the structure is currently used for commercial or industrial purposes, where the presence of hazardous materials could be a concern (Figure 10-4, number 1). In addition, the *Site Observations* tab contains a checkbox to indicate if flooding at this site will have community-wide implications (Figure 10-4, numbers 2a and 2b), with "contains hazardous materials" as one of the choices if this is true.

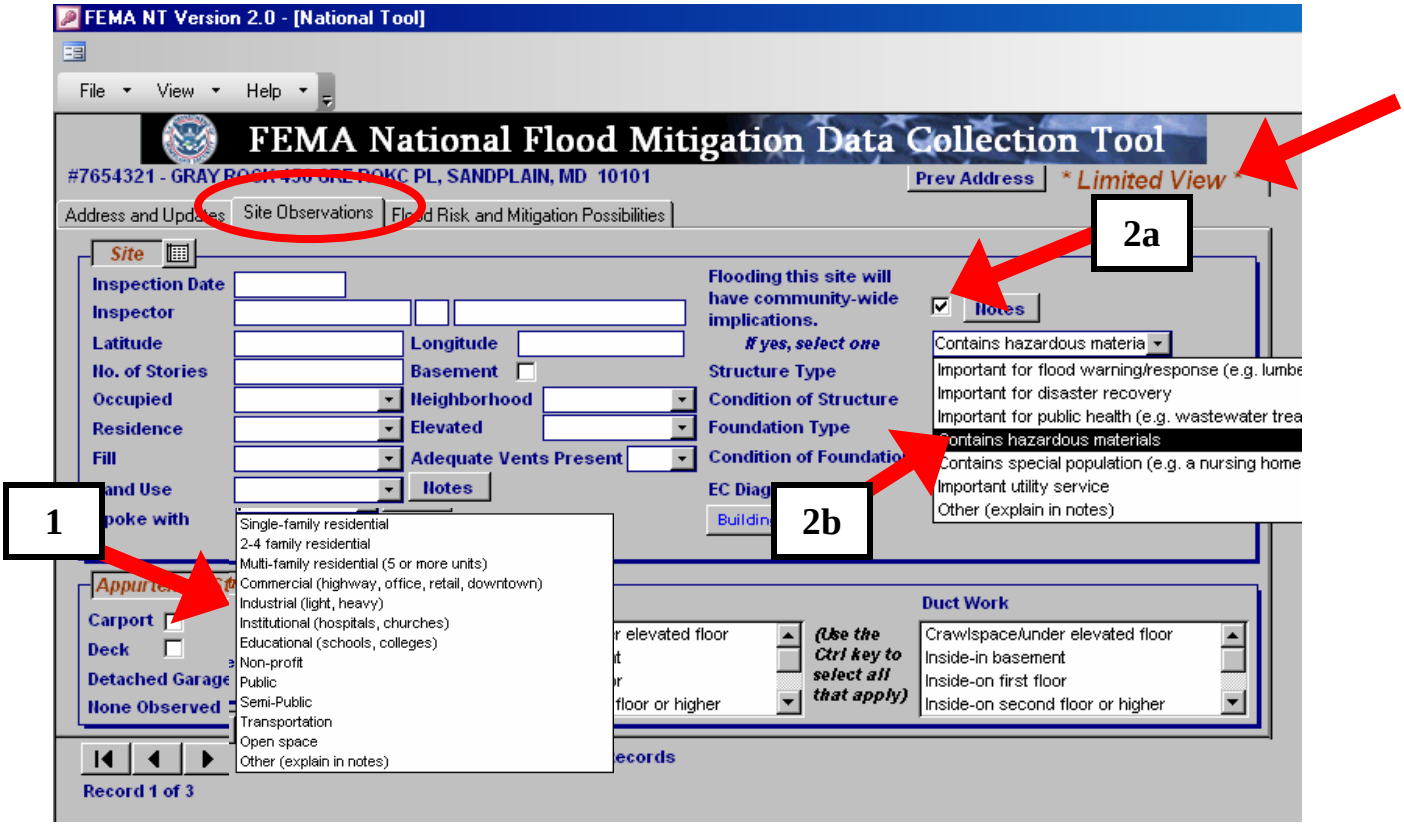

Figure 10-4. *Site Observations* tab - Hazardous materials site indicators

10.5 Available Resources

FEMA 312. *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House from Flooding.* See Chapter 3, An Overview of the Retrofitting Methods and Chapter 7, Other Methods - Demolition.

FEMA 317. *Property Acquisition Handbook for Local Communities.*

FEMA 511. *Reducing Damage from Localized Flooding*. See Chapter 9, Redevelopment.

The Louisiana State University (LSU) Extension Center website (http://www.louisianafloods.org) lists many retrofitting publications, provides advice on floodproofing methods and flood insurance, and links to online shopping for retrofitting products and contractors.

CHAPTER 11 – WORKING WITH PROPERTY OWNERS

11.1 Introduction

The evaluation process in Chapter 3 outlined steps designed to identify some of the mitigation approaches appropriate for further consideration. This section provides recommendations on how to work with the property owners who will be affected by the proposed mitigation measures.

11.2 Presenting Appropriate Mitigation Measures

There are several options for how to present the results of the selection process to the property owners and other decision-makers. The options include:

- Package the results of the evaluation process (as described in Chapter 3) and meet with the property owners to discuss the process, the findings, and their preferences. The information provided in Chapters 4 through 10 for each mitigation measure may be used as a reference for any mitigation measures that were identified as appropriate during the evaluation process.
- Prepare a recommendation for a specific mitigation measure along with the appropriate justification. It is strongly recommended that all work is shown and copies of all the worksheets are provided to the property owners.

The following documentation should be used to prepare for the initial meetings with the property owners:

- NT Basic Report
- Technical Considerations Scorecard (see Worksheet A)
- Appropriate Mitigation Measures (see Worksheet B)
- Initial Consultation with Property Owner (see Worksheet C)

During the meeting, the following issues should be discussed between the State or local officials and the property owner:

- The property owner should be aware that there is no guarantee the project will be funded.
- The property owner should be aware of what the project will look like after completion.
- The property owner should be aware of their responsibilities concerning operations and maintenance and determine if they are capable of fulfilling them.
- Cost-sharing is an option. This issue is addressed in Appendix E, Hazard Mitigation Assistance Programs.

At the end of the meeting, the State or local officials should have a preliminary idea of the property owners' interest in any of the mitigation measures. There may be concerns that will need to be addressed.

Worksheet C: Initial Consultation with Property Owner

Date Prepared: _____ Consultation Date: _____
Property Owner Name: _____
Property Address: _____
Repetitive Loss Property Locator Number: _____
Prepared by: _____

Instructions to complete Worksheet C: Initial Consultation with Property Owner

1. Record recommended mitigation measures (mitigation measure(s) with lowest score from Worksheet B) and include any comments for the discussion with the property owner.
2. Record property owner's response to recommended mitigation measure(s).
3. If an appropriate mitigation measure has been agreed upon, record it under "Property Owner Preferred Mitigation Measure(s)". A detailed cost estimate and/or benefit/cost analysis will be necessary to ensure the preferred mitigation measure is appropriate. The cost analysis and additional required actions are recorded under "Action Items for Follow Up."

Recommended Mitigation Measure(s)

☐ Drainage Improvements
☐ Barriers
☐ Dry Floodproofing
☐ Wet Floodproofing
☐ Elevation
☐ Relocation
☐ Acquisition

Comments

_____
_____
_____
_____

Response from Property Owner

_____
_____
_____

Property Owner Preferred Mitigation Measure(s)

_____

Action Items for Follow Up

_____
_____
_____

11.3 Addressing Property Owner Concerns

Not all property owners will accept the proposed measure that is presented to them, regardless of how the risk to natural hazards can be overcome. The results of the process in Worksheets A and B should be discussed with the property owner to explain how the decision was made to recommend a particular mitigation measure or measures. Typical property owner concerns are included in a report titled, *Implementing Floodplain Land Acquisition Programs in Urban Localities.* See Section 11.5 for information on accessing this report.

11.3.1 Evaluation Process

The concerns of the property owner regarding the proposed mitigation measure should be taken into consideration and addressed by using the following:

- **Show all work**. By demonstrating the decision-making process of how certain mitigation measures were eliminated from consideration, the property owner will be able to gain an understanding of the steps involved and the rationale used to select or eliminate from consideration a specific mitigation measure.
- **Solicit feedback.** The property owner can provide additional information that may be necessary to determine if alternative measures are more suitable for acceptance.
- **Address concerns.** The property owner may have an objection to a particular mitigation measure for a variety of reasons: cost, aesthetics, or displacement. Working closely with the property owner and demonstrating the range of options available allows the property owner to determine which of the remaining mitigation measures will best suit their needs.

11.3.2 Property Owners' Preference

There are four main areas of concern that influence the property owner's preference for a particular mitigation measure:

- How they will be affected by the mitigation project
- How secure they will be from future flood damage
- Their responsibilities to the project, including maintenance
- The appearance of the property

Mitigation project concerns include:

- The cost of the project to the property owner
- Administration of the contract with the contractor
- Additions or modifications to the structure during the project
- Vacating the property during the project and for how long

Security concerns include:

- Degree of safety from flooding as a result of the mitigation project
- Occupying the structure during a flood event

It is important to convey to the property owner that only acquisition and demolition will provide total security from any future flood event. A project can fail if the flood exceeds the project's design level, the owner did not adequately maintain the project, or the property owner did not properly implement the measure during a flood event (e.g., did not install a closure or was not home when the structure was flooded). Although the project is designed to reduce damage to the structure, the property owner will still need to take safety and health precautions during a flood. If the building is flooded, it should not be occupied, especially if the floodwater is deep or fast.

The property owner's responsibility concerns include project maintenance and how much the property owner can remodel the structure in the future. The property owner is ultimately responsible for the maintenance of the mitigation measures and needs to be aware that the project will only work if he or she assumes this responsibility.

Appearance concerns are most often the issue that stalls many potential mitigation projects, particularly elevation. Property owners will regard any change to the appearance of their home with a very critical eye. If the property owner is subject to criticism (or perceives that they will be) since the project may be an eyesore, he or she will not be willing a participant in the floodproofing project. It would be beneficial to provide the property owner with before and after photographs of similar mitigation projects completed in an aesthetically pleasing manner.

11.3.3 FEMA Buyout Study Findings

There may be situations in which the only appropriate mitigation measure is an acquisition project. The property owner may not be receptive to this alternative. FEMA and the National Science Foundation (NSF) commissioned a study in 2003 to examine why property owners did or did not participate in an acquisition (also known as a buyout) program. The findings are included in the report, *Implementing Floodplain Land Acquisition Programs in Urban Localities.*

According to the results in the buyout study, the key factors that influenced a homeowner's decision to participate in a buyout program included the perception of risk, neighborhood attachment, and buyout factors, including timing, communication, trust, and pressure.

Perception of risk. While the buyout staff defined "risk" in terms of the probability of future flooding, the residents and other agencies perceived risk as financial debt, affordable housing, and losing social networks. Community officials and buyout staff perceived themselves as sympathetic to residents' concerns; however, many residents reported that they felt pressured to participate in the buyout program.

Neighborhood attachment. Many residents considered their neighborhood to be as important, if not more important, than the probability of future flooding in deciding whether or not to participate in a buyout program. Residents stated that their neighborhood provided a sense of

community and home, and access to familiar resources such as transportation, shopping, employment, recreation, and places of worship.

Buyout factors. Residents and buyout staff reported several factors that contributed to the difficulties during the buyout process: lengthy delays before settlement, miscommunication, lack of trust in buyout staff, and a feeling of pressure to participate in buyout program.

11.4 Next Steps

Finally, one of two steps remains for follow-up:

1. **The property owner accepts the proposed mitigation measure**. Both the community official and the property owner explore options for accomplishing this mitigation measure. A design professional should be consulted to determine the exact cost of the mitigation measure and how then to proceed with construction. Applicable hazard mitigation assistance programs (see Appendix E) should be researched to determine which ones might provide funding opportunities for the mitigation project. A benefit/cost analysis should be conducted to determine whether the project is eligible for FEMA funding.

2. **The property owner rejects the proposed mitigation measure based on personal preference, cost, or other reasons.**

    a. Record the property owner's concerns regarding the proposed mitigation measure on Worksheet C, Initial Consultation with Property Owner.

    b. Review Worksheet B with the property owner to determine whether other appropriate mitigation measures might warrant additional consideration. The process described in Section 3.5, Evaluating the Mitigation Measures, should be followed to determine whether any of the available mitigation measures preferred by the property owner are appropriate for the flood risk and construction characteristics of the structure.

11.5 Available Resources

Fraser et al. *Implementing Floodplain Land Acquisition Programs in Urban Localities*. Report prepared for the Federal Emergency Management Agency (FEMA) and the National Science Foundation (NSF). http://www.unc.edu/~fraser18/publications/Floddplain%20Project%20Report.Final.pdf

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Selecting Appropriate Mitigation Measures for Floodprone Structures

Information Packet

This information packet includes the following documents:

- Technical Considerations Scorecard (Worksheet A)
- Appropriate Mitigation Measures (Worksheet B)
- Initial Consultation with Property Owner (Worksheet C)
- Preliminary Cost Estimating Worksheet (Worksheet D)
- NT Basic Report

Date Prepared: July 24, 2006 Date Property Visited: July 13, 2006

Property Owner Name: Janet Wilson

Property Address: 19000 Main Street, Roanoke, VA 20202-6689

Repetitive Loss Property Locator Number: 1234567

Prepared by: Bryant Shea

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Worksheet A: Technical Considerations Scorecard

Date Prepared: July 24, 2006 Date Property Visited: July 13, 2006
Property Owner Name: Janet Wilson
Property Address: 19000 Main Street, Roanoke, VA 20202-6689
Repetitive Loss Property Locator Number: 1234567
Prepared by: Bryant Shea

Legend
- Mitigation measure is not appropriate.
- Mitigation measure may be appropriate and requires additional consideration.
- Mitigation measure is appropriate.

NT Reference indicates where the information may be found in the National Tool.

Instructions to complete Worksheet A: Technical Considerations Scorecard

1. For each of the questions, based on the property information, put a check mark in the appropriate box in the "Response" column.
2. For the row with a check mark in the "Response" column, check all boxes that are not blacked out.
3. After completing the questions, review each of the mitigation measures columns. Select the "Appropriate Mitigation Measures" box only for those columns that do not have any blacked out boxes in the selected response row.

Question	Response	Drainage Improvements	Barriers	Wet Floodproofing	Dry Floodproofing	Elevation	Relocation	Acquisition	Comments
1. What is the structure type? *NT Reference - Limited Data View, Site Observations* tab	☐ Wood Frame/ Metal/ Other	☐	☐	☐		☐	☐	☐	
	☒ Concrete/ Masonry/ Brick Faced	☒	☒	☒	☒	☒	☒	☒	Could be expensive, requires bracing
	☐ Manufactured Home	☐	☐			☐	☐	☐	
2. What is the condition of the structure? *NT Reference - Limited Data View, Site Observations* tab	☒ Good	☒	☒	☒	☒	☒	☒	☒	
	☐ Fair	☐	☐	☐	☐	☐	☐	☐	
	☐ Poor	☐	☐					☐	
3. What is the foundation type? *NT Reference - Limited Data View, Site Observations* tab Diagram numbers refer to Elevation Certificate found in the NT.	☐ Slab-on-grade (Diagram 1, 3, 6, or 7)	☐	☐	☐	☐	☐	☐	☐	
	☒ Basement/ Split level (Diagram 2 or 4)	☒	☒	☒	☒	☒	☒	☒	Pressure could cause foundation damage
	☐ Piers, Posts, Columns, or Crawlspace (Diagram 5 or 8)	☐	☐	☐		☐	☐	☐	

Question	Response	Drainage Improvements	Barriers	Wet Floodproofing	Dry Floodproofing	Elevation	Relocation	Acquisition	Comments
4. What is the number of stories? *NT Reference - Limited Data View, Site Observations* tab	☒ 1-2	☒	☒	☒	☒	☒	☒	☒	Structure has two stories
	☐ 3 or more	☐	☐	☐	☐	☐	☐	☐	
5. What is the building footprint? *NT Reference - Detailed Data View, Additional Site Information* tab	☒ < 2,500 sq ft	☒	☒	☒	☒	☒	☒	☒	Building footprint is 2,000 sq ft.
	☐ > 2,500 sq ft	☐	☐	☐	☐	☐	☐	☐	
6. What is the flood protection depth? *NT Reference - Detailed Data View, Elevation and Hazard* tab	☒ Deep (> 6ft)		☒			☒	☒	☒	Depth of 100 yr flood is 7 ft, plus 1 ft freeboard
	☐ Moderate (3 to 6 ft)	☐	☐	☐		☐	☐	☐	
	☐ Shallow (<3 ft)	☐	☐	☐	☐	☐	☐	☐	
7. Does flash flooding occur at the project site? *NT Reference - Detailed Data View, Elevation and Hazard* tab	☒ Yes	☒	☒	☒	☒	☒	☒	☒	Source is NOAA website
	☐ No	☐	☐	☐	☐	☐	☐	☐	
8. What is the flood velocity? *NT Reference - Detailed Data View, Elevation and Hazard* tab	☒ Fast (>5 fps)	☒	☒	☒	☒	☒	☒	☒	
	☐ Slow/Moderate (<5 fps)	☐	☐	☐	☐	☐	☐	☐	
9. Is the structure located in the floodway? *NT Reference - Detailed Data View, Elevation and Hazard* tab	☐ Yes	☐	☐	☐	☐	☐	☐	☐	
	☒ No	☒	☒	☒	☒	☒	☒	☒	
Appropriate Mitigation Measures		☐	☒	☐	☐	☒	☒	☒	

fps = feet per second

ft = feet

sq ft = square feet

Worksheet B: Appropriate Mitigation Measures

Date Prepared: July 24, 2006 Date Property Visited: July 13, 2006
Property Owner Name: Janet Wilson
Property Address: 19000 Main Street, Roanoke VA 20202-6689
Repetitive Loss Property Locator Number: 1234567
Prepared by: Bryant Shea

Instructions to complete Worksheet B: Appropriate Mitigation Measures

1. List the mitigation measures from the "Appropriate Mitigation Measures" row from Worksheet A, Technical Considerations Scorecard (all checked boxes in last row of Worksheet A).
2. Using information from Chapters 4 through 10 of FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures,* rank each measure as High, Moderate, or Low. See "Tips to Rank Mitigation Measures" on the next page for additional information.
3. Check the appropriate box (High, Moderate, or Low) under each of the decision factors.
4. Total the points for each mitigation measure. **The LOWEST total points indicates the most appropriate mitigation measure(s).**
5. Include notes describing how the determination was made for a particular ranking.

*NOTE: Since Technical Considerations and Relative Costs are more significant in selecting appropriate mitigation measure(s), they are weighted higher than Human Intervention and Annual Maintenance.

Decision Factors – LOWEST score is most appropriate – See Reverse for Notes

Mitigation Measures	Technical Considerations*	Relative Costs*	Human Intervention	Annual Maintenance	Total Score
Barriers	H ☒ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☒ (2 pts)	H ☒ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☒ (2 pts) L ☐ (1 pts)	13 pts
Elevation	H ☒ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☒ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☒ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☒ (1 pts)	12 pts
Relocation	H ☐ (6 pts) M ☒ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☒ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☒ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☒ (1 pts)	10 pts
Acquisition	H ☐ (6 pts) M ☐ (4 pts) L ☒ (2 pts)	H ☐ (6 pts) M ☒ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☒ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☒ (1 pts)	8 pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts

Tips to Rank Mitigation Measures (Worksheet B Cont.)

Technical Considerations

Use the responses in Worksheet A, Technical Considerations Scorecard, to determine a ranking of High, Moderate, or Low for each mitigation measure.

- If there are no grayed out boxes checked for a mitigation measure, the technical consideration ranking is Low.
- If there are 1 or 2 grayed out boxes checked for a mitigation measure, the technical consideration score is Moderate.
- If there are 3 or more grayed out boxes checked for a mitigation measure, the technical consideration score is High.

List any considerations in the implementation process that could be a limiting factor or clear constraint in the Notes section.

Relative Costs

Rank each of the mitigation measures based on the estimated cost to address the flood risk and the likelihood of cost-effectiveness. Chapters 4 through 10 and Appendix D include information to rank each mitigation measure based on FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding*, and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. Low relative cost indicates Low ranking and high relative cost indicates High ranking.

Need for Human Intervention

This reflects the need for human intervention to operate the mitigation measure and the warning time to conduct the required activity. Generally, the more "passive" the system (i.e., requiring the least human interaction), the more reliable the system will be over time, thereby resulting in a Low ranking. Mitigation measures that require human intervention, such as barriers and dry floodproofing, receive a High ranking,.

Need for Annual Maintenance

This reflects the level of effort of annual maintenance required by each mitigation measure. Similar to human intevention, less annual maintenance results in a Low ranking.

NOTE: If two or more mitigation measures tie with the lowest score, other decision factors should be considered in determining the most appropriate mitigation measure(s). These considerations include, but are not limited to aesthetics; access to site; housing of occupants during the project; compliance with all applicable codes, ordinances, and regulations; historic preservation concerns; and availability of contractors.

The other decision factors should be listed in the Comments section of Worksheet C.

NOTES:

Mitigation Measures	Technical Considerations
Barriers	Technical considerations include depth and velocity of flood and flash flooding (see Worksheet A). Estimated cost of constructing a floodwall or levee will be low and the likelihood of cost-effectiveness is High for small barrier – relative cost ranking is Low (approximately $25,000 for a 4-foot levee and $35,000 for a 4-foot floodwall based on FEMA 312). Human intervention is High since the property owner must be able to install flood gates as a flood event occurs and adequate warning time must be provided. Flash flooding occurs at the project site, therefore barriers will be ranked as High for human intervention. Annual maintenance is required by the property owner to check the barrier for leaks and will be Moderate.
Elevation	Technical considerations include structure type (masonry), foundation type (basement), and flood velocity (> 5 fps) (see Worksheet A). Estimated cost to elevate 8 feet to BFE is Moderate (approximately $83,000) based on the estimate from FEMA 312 and the likelihood of cost-effectiveness is Moderate – relative cost ranking is Moderate. Little or no human intervention is required once the structure has been elevated and is therefore ranked Low. Annual maintenance of an elevated structure will be minimal; ranking is set as Low.
Relocation	Technical considerations include structure type (masonry) (see Worksheet A). Relative cost to relocate a masonry structure on a basement foundation to a site less than 5 miles away on the same type of foundation is Moderate (approximately $128,000) and the likelihood of cost-effectiveness is Moderate – relative cost ranking is Moderate. Human intervention is not required once the structure has been relocated from the floodprone site. Low ranking. Annual maintenance for a relocated or acquired property includes maintenance of the abandoned site by the community, ranking is Low.
Acquisition	Technical considerations – none. Low ranking (see Worksheet A). Estimated cost is High (see Worksheet D for sample cost estimate) and the likelihood of cost-effectiveness is High – relative cost ranking is moderate. Human intervention is not required once the structure has been acquired. Low ranking. Annual maintenance for a relocated or acquired property includes maintenance of the abandoned site by the community, ranking is Low.

Worksheet C: Initial Consultation with Property Owner

Date Prepared: July 24, 2006 Consultation Date: August 1, 2006
Property Owner Name: Janet Wilson
Property Address: 19000 Main Street, Roanoke, VA 20202-6689
Repetitive Loss Property Locator Number: 1234567
Prepared by: Bryant Shea

Instructions to complete Worksheet C: Initial Consultation with Property Owner

1. Record recommended mitigation measure(s) with the lowest score from Worksheet B and include any comments for the discussion with the property owner.
2. Record property owner's response to recommended mitigation measure(s).
3. If an appropriate mitigation measure has been agreed upon, record it under "Property Owner Preferred Mitigation Measure(s)". A detailed cost estimate and/or benefit/cost analysis (BCA) will be necessary to ensure the preferred mitigation measure is appropriate. The cost analysis and additional required actions are recorded under "Action Items for Follow-Up."

Recommended Mitigation Measure(s)

- ☐ Drainage Improvements
- ☐ Barriers
- ☐ Dry Floodproofing
- ☐ Wet Floodproofing
- ☐ Elevation
- ☐ Relocation
- ☒ Acquisition

Comments

Acquisition is the recommended mitigation measure. Elevation and relocation are alternate mitigation measures. In order to select the most appropriate mitigation measure, the following decision factors should be discussed with the property owner: aesthetic concerns, housing of occupants during the project, compliance with all applicable codes, regulations and ordinances, and access to the site.

Response from Property Owner

Property Owner Preferred Mitigation Measure(s)

Action Items for Follow-Up

1. Develop detailed cost estimate for each preferred mitigation measure
2. Conduct BCA
3. Determine funding sources

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.Worksheet D: Preliminary Cost Estimating Worksheet

Date Prepared: July 24, 2006 Date Property Visited: July 13, 2006
Property Owner Name: Janet Wilson
Property Address: 19000 Main Street, Roanoke VA 20202-6689
Repetitive Loss Property Locator Number: 1234567
Prepared by: Bryant Shea

Mitigation Measure: Acquisition and demolition of 19000 Main Street

Cost Component	Unit	Unit Cost	Quantity	Total
Acquisition of Structure		$275,000	1	$275,000
Acquisition of Land		$149,000	1	$149,000
Certified Real Estate Appraisal		$500	1	$500
Disconnect Utilities		$500	1	$500
Surveying		$1,000	1	$1,000
Title Search, Deed Preparation, Attorney Fees, Permits and Plan Review Costs		$1,100	1	$1,100
Installation of Erosion Controls		$600	1	$600
Demolition		$7,000	1	$7,000
Grading and Restabilization		$1,500	1	$1,500
Uniform Relocation Assistance (URA)		$6,500	1	$6,500
Other (Environmental Report, Advertising)		$1,000	1	$1,000
Subtotal Retrofitting Measure(s)				$443,700
Contractor's Profit (10%)				$44,370
Design Fee (10%)				
Loss of Income (optional)				
Displacement Expenses (optional)				
Contingency				
Subtotal Other Costs				$44,370
Total Costs				$488,070

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Basic Report

Property Locator / Rep Loss # 1234567

Community Name/CID # ROANOKE COUNTY * #510090
Address: 19000 MAIN STREET , ROANOKE, VA 20202-6689
Latitude: **Longitude**

Tax ID:
Local Lot/Parcel ID:
Foundation Type:
Basement with walkout

Pre or Post FIRM: Pre
Date of Construction: 1/1/1982
Total Sq. Ft.: 3100
No. of Stories: 2

Condition of Foundation: Good (optional minor repairs)
Structure Type: Unreinforced masonry
EC Diagram No
2. Basement
Condition of Structure: Good (optional minor repairs)
Bldg Mkt Value: $275,000.00 **Land Value:** $149,000.00
Currently Occupied: Yes **Occupancy:** SINGLE FMLY
Residence: **Land Use:** Single-family residential
Flood Zone: AE A1-30
Top of Bottom Floor: 100.00 ft. **BFE/Depth** 107
Top of Next Higher Flr: 107.00 ft.
Lowest Adjacent Grade: 100.00 ft.
Bottom of Lowest Horizontal Structural Member:
Likely Source of Flooding:
Stre rce of riverine fl g

tes:

Likely Areas of Damag
W r in areas belo rade-l ding is a bile split le or has ish a below grade
N seme

Potential Hydraulics Impacts:

Notes:

Mitigation Observations

☑ **Possible mitigaton measures observed**
Pendi Actions:

No

Struct may be protected wit retrofitting projec
Structu ay be: elevated; prote by a barrier acqu relocated

Notes:

Flooding may be relieved by a flood control project:

Notes:

Most Recent Claims and Summary

Current Insured's Name: JANET WILSON
Name of Last Claimant: MICHAEL S JOHNSON

No. of Claims per BureauNet: 4

Total Payments Made:	Building	Contents	Total
	$118,833.00	$23,489.00	$142,322.00

Date	Building	Contents	Total
2/10/1988	$5,731.00	$0.00	$5,731.00
1/18/1993	$19,472.00	$2,591.00	$22,063.00
6/25/1996	$37,138.00	$9,304.00	$46,442.00
7/22/1999	$56,492.00	$11,594.00	$68,086.00

Mitigation Updates

	Field	*FEMA*	*Field*	*FEMA*
Unable to Locate Property	☐	☐		
Flood Protection Provided	☐	☐	1	1
No Building on Property	☐	☐	2	2
Historic Building	☐	☐	3	3
Notes:			4	4

☐ **Additional Research Needed**
Notes:

Mitigation Observed:
Notes:

Mitigation Verified:
Notes:

☐ **Updates Made** ☐ **Duplicate Listing / with RL #:**

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Selecting Appropriate Mitigation Measures for Floodprone Structures

Information Packet

This information packet includes the following documents:

- Technical Considerations Scorecard (Worksheet A)
- Appropriate Mitigation Measures (Worksheet B)
- Initial Consultation with Property Owner (Worksheet C)
- Preliminary Cost Estimating Worksheet (Worksheet D)
- NT Basic Report

Date Prepared: _____ Date Property Visited: _____

Property Owner Name: _____

Property Address: _____

Repetitive Loss Property Locator Number: _____

Prepared by: _____

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Worksheet A: Technical Considerations Scorecard

Date Prepared: _____ Date Property Visited:_____
Property Owner Name: _____
Property Address: _____
Repetitive Loss Property Locator Number: _____
Prepared by: _____

Legend
- Mitigation measure is not appropriate.
- Mitigation measure may be appropriate and requires additional consideration.
- Mitigation measure is appropriate.

NT Reference indicates where the information may be found in the National Tool.

Instructions to complete Worksheet A: Technical Considerations Scorecard

1. For each of the questions, based on the property information, put a check mark in the appropriate box in the "Response" column.
2. For the row with a check mark in the "Response" column, check all boxes that are not blacked out.
3. After completing the questions, review each of the mitigation measures columns. Select the "Appropriate Mitigation Measures" box only for those columns that do not have any blacked out boxes in the selected response row.

Question	Response	Drainage Improvements	Barriers	Wet Floodproofing	Dry Floodproofing	Elevation	Relocation	Acquisition	Comments
1. What is the structure type? *NT Reference - Limited Data View, Site Observations tab*	☐ Wood Frame/ Metal/ Other	☐	☐	☐	☐	☐	☐	☐	
	☐ Concrete/ Masonry/ Brick Faced	☐	☐	☐	☐	☐	☐	☐	
	☐ Manufactured Home	☐	☐			☐	☐	☐	
2. What is the condition of the structure? *NT Reference - Limited Data View, Site Observations tab*	☐ Good	☐	☐	☐	☐	☐	☐	☐	
	☐ Fair	☐	☐	☐	☐	☐	☐	☐	
	☐ Poor	☐	☐					☐	
3. What is the foundation type? *NT Reference - Limited Data View, Site Observations tab* Diagram numbers refer to Elevation Certificate found in the NT.	☐ Slab-on-grade (Diagram 1, 3, 6 or 7)	☐	☐	☐	☐	☐	☐	☐	
	☐ Basement/ Split level (Diagram 2 or 4)	☐	☐	☐	☐	☐	☐	☐	
	☐ Piers, Posts, Columns, or Crawlspace (Diagram 5 or 8)	☐	☐	☐		☐	☐	☐	

Question	Response	Drainage Improvements	Barriers	Wet Floodproofing	Dry Floodproofing	Elevation	Relocation	Acquisition	Comments
4. What is the number of stories? *NT Reference - Limited Data View, Site Observations tab*	☐ 1-2	☐	☐	☐	☐	☐	☐	☐	
	☐ 3 or more	☐	☐	☐	☐	☐	☐	☐	
5. What is the building footprint? *NT Reference - Detailed Data View, Additional Site Information tab*	☐ < 2,500 sq ft	☐	☐	☐	☐	☐	☐	☐	
	☐ > 2,500 sq ft	☐	☐	☐	☐	☐	☐	☐	
6. What is the flood protection depth? *NT Reference - Detailed Data View, Elevation and Hazard tab*	☐ Deep (> 6ft)		☐			☐	☐	☐	
	☐ Moderate (3 to 6 ft)	☐	☐	☐		☐	☐	☐	
	☐ Shallow (<3 ft)	☐	☐	☐	☐	☐	☐	☐	
7. Does flash flooding occur at the project site? *NT Reference - Detailed Data View, Elevation and Hazard tab*	☐ Yes	☐	☐	☐	☐	☐	☐	☐	
	☐ No	☐	☐	☐	☐	☐	☐	☐	
8. What is the flood velocity? *NT Reference - Detailed Data View, Elevation and Hazard tab*	☐ Fast (>5fps)	☐	☐	☐	☐	☐	☐	☐	
	☐ Slow/Moderate (<5 fps)	☐	☐	☐	☐	☐	☐	☐	
9. Is the structure located in the floodway? *NT Reference - Detailed Data View, Elevation and Hazard tab*	☐ Yes	☐	☐	☐	☐	☐	☐	☐	
	☐ No	☐	☐	☐	☐	☐	☐	☐	
Appropriate Mitigation Measures		☐	☐	☐	☐	☐	☐	☐	

fps = feet per second

ft = feet

sq ft = square feet

Worksheet B: Appropriate Mitigation Measures

Date Prepared:___________________ Date Property Visited:________________
Property Owner Name: ____
Property Address:____
Repetitive Loss Property Locator Number:_________________________
Prepared by: ____

Instructions to complete Worksheet B: Appropriate Mitigation Measures

1. List the mitigation measures from the "Appropriate Mitigation Measures" row from Worksheet A, Technical Considerations Scorecard, (all checked boxes in last row of Worksheet A)
2. Using information from Chapters Four through 10 of FEMA 551, *Selecting Appropriate Mitigation Measures for Floodprone Structures,* rank each measure as High, Moderate or Low. See "Tips to Rank Mitigation Measures" on next page for additional information.
3. Check the appropriate box (High, Moderate or Low) under each of the decision factors.
4. Total the points for each mitigation measure. **The LOWEST total points indicates the most appropriate mitigation measure(s).**
5. Include notes describing how the determination was made for a particular ranking.

*NOTE: Since Technical Considerations and Relative Costs are more significant in selecting appropriate mitigation measure(s), they are weighted higher than Human Intervention and Annual Maintenance.

Decision Factors – LOWEST score is most appropriate – See Reverse for Notes					
Mitigation Measures	**Technical Considerations***	**Relative Costs***	**Human Intervention**	**Annual Maintenance**	**Total Score**
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts
__________	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (6 pts) M ☐ (4 pts) L ☐ (2 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	H ☐ (3 pts) M ☐ (2 pts) L ☐ (1 pts)	__ pts

Tips to Rank Mitigation Measures (Worksheet B Cont.)

Technical Considerations

Use the responses in Worksheet A, Technical Considerations Scorecard, to determine a ranking of High, Moderate, or Low for each mitigation measure.

- If there are no grayed out boxes checked for a mitigation measure, the technical consideration ranking is Low.
- If there are 1 or 2 grayed out boxes checked for a mitigation measure, the technical consideration score is Moderate.
- If there are 3 or more grayed out boxes checked for a mitigation measure, the technical consideration score is High.

List any considerations in the implementation process that could be a limiting factor or clear constraint in the Notes section.

Relative Costs

Rank each of the mitigation measures based on the estimated cost to address the flood risk and the likelihood of cost-effectiveness. Chapters 4 through 10 include information to rank each mitigation measure based on FEMA 312, *Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding*, and FEMA 259, *Engineering Principles and Practices of Retrofitting Floodprone Residential Structures*. Low cost indicates Low ranking and high cost indicates High ranking.

Need for Human Intervention

This reflects the need for human intervention to operate the mitigation measure and the warning time to conduct the required activity. Generally, the more "passive" the system (i.e., requiring the least human interaction), the more reliable the system will be over time, thereby resulting in a Low ranking. Mitigation measures that require human intervention, such as barriers and dry floodproofing, receive a High ranking,.

Need for Annual Maintenance

This reflects the level of effort of annual maintenance required by each mitigation measure. Similar to human intevention, less annual maintenance results in a Low ranking.

NOTE: If two or more mitigation measures tie with the lowest score, other decision factors should be considered in determining the most appropriate mitigation measure(s). These considerations include, but are not limited to aesthetics; access to site; housing of occupants during the project; compliance with all applicable codes, ordinances, and regulations; historic preservation concerns; and availability of contractors.

The other decision factors should be listed in the Comments section of Worksheet C.

NOTES:

Mitigation Measures	Technical Considerations

Worksheet C: Initial Consultation with Property Owner

Date Prepared: _____ Consultation Date: _____
Property Owner Name: _____
Property Address: _____
Repetitive Loss Property Locator Number: _____
Prepared by: _____

Instructions to complete Worksheet C: Initial Consultation with Property Owner

1. Record recommended mitigation measure(s) with the lowest score from Worksheet B and include any comments for the discussion with the property owner.
2. Record property owner's response to recommended mitigation measure(s).
3. If an appropriate mitigation measure has been agreed upon, record it under "Property Owner Preferred Mitigation Measure(s)". A detailed cost estimate and/or benefit/cost analysis (BCA) will be necessary to ensure the preferred mitigation measure is appropriate. The cost analysis and additional required actions are recorded under "Action Items for Follow-Up."

Recommended Mitigation Measure(s)

☐ Drainage Improvements
☐ Barriers
☐ Dry Floodproofing
☐ Wet Floodproofing
☐ Elevation
☐ Relocation
☐ Acquisition

Comments

_____
_____
_____
_____

Response from Property Owner

_____
_____
_____
_____

Property Owner Preferred Mitigation Measure(s)

_____

Action Items for Follow-Up

_____
_____
_____

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Worksheet D: Preliminary Cost Estimating Worksheet

Date Prepared: _____ Date Property Visited:_____
Property Owner Name: _____
Property Address:_____
Repetitive Loss Property Locator Number:_____
Prepared by: _____

Mitigation Measure: _____

Cost Component	Unit	Unit Cost	Quantity	Total
Subtotal Retrofitting Measure(s)				
Contractor's Profit (10%)				
Design Fee (10%)				
Loss of Income (optional)				
Displacement Expenses (optional)				
Contingency				
Subtotal Other Costs				
Total Costs				

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APPENDIX C – COST ESTIMATING

C.1 Introduction

A cost estimate for each property's selected mitigation measure should be developed to make a decision on the most appropriate mitigation measure. The cost estimate describes all anticipated costs associated with the proposed mitigation measure and represents the approximate price of the proposed activity. The cost estimate should typically reflect the activities described in the scope of work prepared for the activity and be prepared with adequate documentation.

The cost estimate documentation should include the following:

- Detailed information for all project costs, including materials, labor, equipment, and subcontract costs, in addition to maintenance costs over the useful life of the project
- The source of the estimate (e.g., documented local cost, previous similar projects, bids from qualified professionals, published national or local cost-estimating guides, etc.) and documentation supporting each source
- Other related construction, demolition, relocation, maintenance, environmental, and/or historic preservation costs (i.e., survey, permitting, site preparation, and material disposal)
- Base year of all cost estimates provided
- Anticipated date of construction
- Potential impacts to estimated costs resulting from any delay to the anticipated start of construction

NOTE: Some situations will require more complicated comparisons (e.g., comparing the cost of implementing a regional solution barriers or drainage improvements - with the cost of mitigation measures on a structure by structure basis). In this case, it is recommended that accurate cost estimates be performed so that a comprehensive decision can be made.

C.2 Options to Creating a Cost Estimate

The following options should be used to develop preliminary cost estimates for each appropriate mitigation measure. These options are listed in order of increasing cost and level of effort based on the reliability and level of detail of the cost estimate. For example, the first option is the least expensive way to conduct a cost estimate; however, it only provides an approximate cost of the project.

- **Determine costs for similar projects in the area**. Consulting with contractors and building permit officials may yield a list of similar projects in the area. Verify that site and structure conditions are similar before using these costs.
- **Determine costs for similar projects per staff at the State Hazard Mitigation Office or FEMA Regional Office**. State and Federal level staff are involved with a number of

mitigation projects funded by Federal programs (see Appendix E, Hazard Mitigation Assistance Programs) and may be able to provide cost information for similar projects. As with the first option, ensure that the projects are similar in nature.

- **Conduct Preliminary Cost Estimates using assistance from local community agency staff,** if available.
- **Conduct Preliminary Cost Estimates using qualified consultants.**

One of these methods may identify the appropriate mitigation measure. However, if this is not the case, it may be necessary to perform some level of benefit/cost analysis (BCA) to comparatively evaluate mitigation measures (see Appendix D, Determining Cost-Effectiveness).

C.3 Process to Develop a Cost Estimate

Table C-1. Steps to Develop a Cost Estimate

	Step	Task
1.	**Break out the work into smaller tasks**	Smaller tasks can be quantified in terms of materials and/or labor requirements. This can be organized by using a tool such as the *Preliminary Cost Estimating Worksheet* in Appendix B.
2.	**Estimate the quantities of materials and labor**	For example, tasks required to elevate a structure include: ▪ Design, engineering, and permitting ▪ Mobilization ▪ Site preparation (including establishing access, disconnecting utilities) ▪ Excavation ▪ Demolition and hauling ▪ Jacking and cribbing ▪ Masonry or cast-in-place concrete ▪ Carpentry ▪ Utility hook-ups ▪ Site restoration and landscaping
3.	**Determine the unit cost for materials and labor for each task**	Use a resource such as the *RS Means Building Construction Data* or *Marshall and Swift* (see also Subsection C.4, Available Resources)
4.	**Record costs on the Preliminary Cost Estimating Worksheet**	
5.	**Compute cost per task and the total cost estimate**	

For each of the five steps, there are associated labor, material, and equipment costs. Indirect costs required to complete a project can include administrative costs. These costs are allowable under FEMA hazard mitigation assistance grants and can be a significant determination factor in

selecting the preferred mitigation activity. For example, relocation costs for residents involving temporary displacement or moving to another structure should be included in the cost estimate. The relative cost of replacement housing in the area should be considered, particularly where acquisition is the preferred alternative. Also remember the contractor needs to earn a profit. Thus an estimate of cost should include a profit-factor of about 10 to 15 percent of the total estimated cost.

As much detail as possible must be included when preparing a construction cost estimate. Pertinent details for a construction cost estimate can include the amount of dirt to be removed (in cubic feet), weight of steel to be purchased (in tons), amount and type of lumber needed (in linear feet), and type and quantity of concrete needed (in cubic yards).

C.4 Available Resources

Detailed construction cost estimating appears to be a time-consuming task. However, there are two reliable estimating handbooks to help streamline the process.

The RS Means' *Building Construction Cost Data* is an industry standard. It covers every aspect of construction pricing needed to prepare detailed project estimates, including the following:

- Unit costs (lists construction items from site work to finish work)
- References (includes backup information on how the costs are developed and what they include)
- Unit costs for thousands of residential building components
- Location cost adjustment factors
- Daily productivities and standard crews
- Overhead and profit guidance

Additional information on RS Means products and order forms may be found on the website: http://www.rsmeans.com/.

The Marshall & Swift's *Residential Cost Handbook* provides an in-depth description of the costs involved in different types of residential structures, including site-built and modular housing. With six classifications for building quality, ranging from low to excellent, this extensive handbook helps eliminate the guesswork of construction quality with corresponding descriptions and photographs. The *Residential Cost Handbook* and additional resources are found on the Marshall & Swift website (http://www.marshallswift.com/).

NOTE: RS Means and Marshall & Swift also produce cost estimating handbooks for other types of construction (e.g., heavy construction of dams).

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APPENDIX D – DETERMINING COST-EFFECTIVENESS

D.1 Introduction

At its most basic level, benefit/cost analysis (BCA) determines whether the cost of investing in a mitigation project today (the "cost") will result in sufficiently reduced damage in the future (the "benefits") to justify spending money on the project. If the benefit is greater than the cost, then the project is cost-effective; if the benefit is less than the cost, then the project is not cost-effective. Thus, the benefit/cost ratio (BCR) should have a value of 1.0 or greater.

A BCA is conducted in the same way for each type of hazard mitigation project; the difference is in the types of data used in the calculations. Refer to the document *What is a Benefit*, located on FEMA's Mitigation BCA Toolkit (currently Version 3.0), for additional information.

Why should a BCA be conducted?
A determination of cost-effectiveness is required by FEMA if a proposed project is to be considered for Federal funding. If the proposed project is determined to be cost-effective (i.e., has a BCR of 1.0 or greater), funding from FEMA's grant programs, such as the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance Program (FMA), Pre-Disaster Mitigation Program (PDM), Repetitive Flood Claims (RFC) Program, and others could be used to reduce the cost of the project to the property owner. For additional information on these programs and others that fund eligible projects, refer to Appendix E, Hazard Mitigation Assistance Programs.

D.2 Process to Assess Cost-Effectiveness

There are two different methods for assessing cost-effectiveness: 1) a quick screening to determine whether the project is likely to be cost-effective and 2) a BCA using software available through FEMA.

Quick Screening to Determine Cost Effectiveness

With some experience, a community official can look at key project data, before doing any analysis, and determine whether the project is likely to be cost-effective. Table D-1 shows how to quickly screen a project for cost-effectiveness based on these attributes, as well as the damages expected from various types of floods. In Table D-1, the damages refer to losses to structures or residences, contents of these structures, displacement costs (temporary housing), and the loss of critical public services and infrastructure (e.g., hospitals, electricity, schools, roads, bridges, etc.). The more frequent the flood, the more damage can be expected, and the more cost-effective the project is likely to be, as it protects against those damages. It is important to understand that "quick screening" will not yield a conclusive cost-effectiveness determination and should be used only as a preliminary indicator of the appropriateness of the project.

Table D-1. Quick Screening to Determine the Likelihood of Cost-Effectiveness

	Likelihood of Cost-Effectiveness			
Attribute	Very High	High	Moderate	Low
Frequency of Flood	10-year flood	10- to 25-year flood	25- to 50-year flood	50- to 100-year flood
Level of Damage	Very high damage	High damage	Limited damage	Minor damage
Project Cost	Low relative to damages	Moderately-low relative to damages	Close to cost of damages in frequent floods	High relative to damages in frequent floods
Project Benefits	Very high	High	Moderate	Low
Criticality (impact or loss of function)	Very high, broad damages to community	High damages to key facility; community	Moderate loss of certain functions limited impact	Little or no loss of functions; minor impact

(Source: *How to Determine Cost-Effectiveness of Hazard Mitigation Projects*, Chapter 3 from FEMA's Mitigation BCA Toolkit Version 2.0)

Benefit/Cost Analysis

FEMA's Mitigation Benefit/Cost Toolkit includes BCA modules, which address both riverine and coastal flooding. The riverine software includes three levels of BCA: Very Limited Data Module, Limited Data Module, and Full Data Module. These modules are described in detail in *How to Determine Cost-Effectiveness of Hazard Mitigation Projects* (also referred to as the "Yellow Book") located on FEMA's Mitigation BCA Toolkit. The toolkit itself may be obtained free of charge by contacting the BC Helpline at 1-(866) 222-3580 or bchelpline@dhs.gov.

The procedures required by FEMA for performing a BCA are specific and well defined. Without previous experience with FEMA-compliant BCAs, there are two options:

- **Get training**. FEMA offers extensive training opportunities through the Emergency Management Institute (EMI). Contact the State Hazard Mitigation Office or FEMA Regional Office for information on how to obtain training.
- **Get help**. Consultants with BCA experience are effective, especially with more complicated projects.

APPENDIX E – HAZARD MITIGATION ASSISTANCE PROGRAMS

NOTE: By the end of FY 2007, FEMA will offer five hazard mitigation assistance programs as described below. All five programs have unique statutory authorities, program requirements, and triggers for funding. All of the programs have the common goal of providing funds to States, Territories, Tribal governments, and communities to reduce the loss of life and property from future natural hazard events. These programs as described below are subject to revision. Check with the FEMA Regional Office for the latest information (http://www.fema.gov/about/contact/regions/).

NOTE: The mitigation reconstruction project entails demolishing the floodprone house and then reconstructing a new elevated, code-compliant house on the same site. These projects are most often justified through application of the following criteria:

- When the cost of a standard elevation or acquisition project approximates or exceeds the cost to construct a new structure, or
- When a standard elevation or acquisition project is not possible or feasible due to the condition of the structure or some other structural impairment.

CAUTION

If a mitigation reconstruction method is selected, FEMA grant program funding may not be available. In instances where traditional mitigation options are not programmatically feasible, check with the State Hazard Mitigation Officer to determine if funding may be available for the mitigation measure selected before proceeding.

E.1 Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) was created in 1988 by Section 404 of the Robert S. Stafford Disaster Relief and Emergency Assistance Act, as amended (amendments include the Hazard Mitigation and Relocation Assistance Act of 1993, the Disaster Mitigation Act of 2000, and the Post Katrina Emergency Management Reform Act of 2006). The HMGP assists States, Territories, Tribal governments, and communities in implementing long-term hazard mitigation measures for all hazard types following a major disaster declaration. A key purpose of the HMGP is to ensure that the opportunity to take critical mitigation measures to protect life and property from future disasters is not lost during the recovery and reconstruction process following a disaster.

The program's objectives are to:

- Significantly reduce or permanently eliminate future risk to lives and property from severe hazards
- Provide funds to implement projects previously identified in State, Tribal, or local hazard mitigation plans

- Enable mitigation measures to be implemented during the immediate recovery from a disaster

HMGP funds can be made available based on a percentage of the estimated Federal funds to be spent on the Public and Individual Assistance programs (minus administrative expenses) for each disaster. These grant funds may be used to fund up to 75 percent of the eligible project costs. The non-Federal match does not need to be in cash; in-kind services or materials may be used.

Eligible mitigation measures under the HMGP include acquisition or relocation of floodprone structures, elevation of floodprone structures, seismic rehabilitation of existing structures, constructing "safe rooms" inside schools or other buildings in tornado-prone areas, and strengthening of existing structures against hurricane force winds. Additionally, up to 7 percent of HMGP funds, available from any disaster, may be used to develop State and/or local mitigation plans.

The State, as grantee, is responsible for administering the HMGP. Communities develop HMGP project applications and apply for funds through the State. The State notifies potential applicants of the availability of funding, defines a project selection process, ranks and prioritizes projects for funding, and forwards projects to FEMA for approval. The applicant, or subgrantee, carries out approved projects. The State, local government, or the property owner must provide a 25 percent match, which can be from a combination of cash and in-kind sources.

In response to flood hazards, FEMA's primary emphasis is on nonstructural hazard mitigation measures. Nonstructural measures include the acquisition and demolition, relocation, elevation, and floodproofing of flood-damaged or floodprone properties.

For more information on the HMGP, contact the State Hazard Mitigation Office or the FEMA Regional Office. Detailed information about managing the program can be found in FEMA's *HMGP Desk Reference* (FEMA 345) at http://www.fema.gov/government/grant/hmgp/index.shtm. To order a copy, call 1-(800)480-2520.

E.2 Flood Mitigation Assistance Program

The Flood Mitigation Assistance (FMA) program provides funding to assist States and communities to accomplish flood mitigation planning and implement measures to reduce future flood damages to structures insured under the National Flood Insurance Program (NFIP). This program was created as part of the National Flood Insurance Reform Act of 1994 (42 United States Code [USC] 4101).

The FMA program provides annual funding for planning and project grants. Eligible activities for planning grants include conducting local planning meeting to obtain citizen input; contracting for engineering or planning technical assistance; surveying structures at risk of flooding; and assessing repetitive losses. Only projects for mitigation activities specified in an approved flood mitigation plan are eligible for project grants. For example, a community may determine in its plan that acquisition of structures would be the preferred alternative for floodway areas, while elevation may be a more appropriate solution in other areas of the floodplain.

The purpose of FMA project grants is to assist States and communities in implementing flood mitigation projects to reduce the risk of flood damage to NFIP-insured structures. Eligible types of projects include:

- Elevation of residential structures and elevation or dry floodproofing of non-residential structures in accordance with 44 Code of Federal Regulations (CFR) §60.3.
- Acquisition of structures and underlying real property.
- Relocation of structures from acquired or deed restricted real property to sites not prone to flood hazards.
- Dry floodproofing of non-residential structures.
- Demolition of structures on acquired or deed restricted real property.
- Beach nourishment activities that focus on facilitating natural dune replenishment through the planting of native dune vegetation and/or the installation of sand fencing. Placement of sand on beach is not eligible.
- Minor physical flood control projects that do not duplicate the flood-prevention activities of other Federal agencies that address localized flood problem areas such as stabilization of stream banks, modification of existing culverts, or creation of small stormwater retention basins. Major structural flood control structures, such as levees, dams, and seawalls are not eligible.

Any State agency, participating NFIP community (including tribal governments), or qualified local organization is eligible to participate in the FMA program. Communities that are suspended or on probation from the NFIP are not eligible. Individuals wishing to participate in the FMA program should contact their community officials.

A project must, at a minimum, be:

- Cost-effective
- Cost beneficial to the NFIP
- Technically feasible
- Physically located in a participating NFIP community, or must reduce future flood damages in an NFIP community

A project must also conform to:

- The minimum standards of the NFIP floodplain management regulations
- The applicant's flood mitigation plan
- All applicable laws and regulations, such as Federal and State environmental standards or local building codes

FEMA distributes funds to States, which in turn provide funds to communities. The State serves as the grantee and program administrator for the FMA. The State:

- Sets mitigation priorities
- Provides technical assistance to communities applying for FMA funds

- Evaluates grant applications based on minimum eligibility criteria and State priorities
- Awards planning grants
- Works with FEMA to approve projects and awards funds to communities
- Ensures that all community applicants are aware of their grant management responsibilities

For more information on how to apply for a FMA grant, contact the State FMA Point of Contact (POC) or call the nearest FEMA Regional Office for the name of the State's POC. A list of FEMA Regional Offices and contact information are included in Appendix F and are available from http://www.fema.gov/about/contact/regions/. Additional information on the FMA program may be found at the FEMA website at http://www.fema.gov/government/grant/fma/index.shtm.

E.3 Pre-Disaster Mitigation Program

The Pre-Disaster Mitigation (PDM) program was authorized by Section 203 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (the Stafford Act), 42 U.S.C., as amended by Section 102 of the Disaster Mitigation Act of 2000 (DMA 2000).

Funding is provided to assist States, Tribes, and communities in implementing cost-effective hazard mitigation activities that complement a comprehensive mitigation program and reduce injuries, loss of life, damage, and destruction of property. FEMA provides PDM grants to states which, in turn, provide sub-grants to local governments for mitigation activities such as planning and the implementation of projects identified through the evaluation of natural hazards.

Only the State emergency management agencies or a similar office (i.e., the office that has emergency management responsibility) of the State as well as federally recognized Indian tribal governments are eligible to apply to FEMA for assistance as applicants under this program.

Guidance materials for all Hazard Mitigation Assistance programs such as model scopes of work, Benefit/Cost Analysis Guidelines, and engineering case studies are currently available on the FEMA webpage at http://www.fema.gov/government/grant/pdm/index.shtm or from the FEMA Regional Office.

E.4 Repetitive Flood Claims Program

The Repetitive Flood Claims (RFC) grant program provides funding to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have had one or more claim payments for flood damages, through mitigation activities that are in the best interest of the National Flood Insurance Fund (NFIF). RFC funds may only mitigate structures that are located within a State or community that can not meet the requirements of the FMA program for either cost share or capacity to manage the activities.

The RFC program was authorized by Section 1323 of the Act, 42 U.S.C. 4030, as amended by the Flood Insurance Reform Act (FIRA) of 2004, Public Law 108-264.

The RFC program provides funding up to $10 million a year with up to 100 percent Federal funding (no non-Federal match requirement). Current eligible activities include the acquisition of

severe repetitive loss (SRL) properties and non-residential properties that meet the same claim thresholds as defined SRL properties. Planning grants are not available under the RFC. There is currently no local plan requirement for participation.

A project must, at a minimum, be:

- Cost-effective
- Cost beneficial to the NFIP
- Technically feasible
- Physically located in a participating NFIP community
- Insured under the NFIP

A project must also conform to:

- The minimum standards of the NFIP floodplain management regulations
- All applicable laws and regulations, such as Federal and State environmental standards or local building codes

Any State agency, participating NFIP community (including Tribal governments), or qualified local organization is eligible to participate in the RFC program. Communities that are suspended or on probation from the NFIP are not eligible. Individuals wishing to participate in the RFC program should contact their community officials. Only those States or communities that can not meet the requirements of the FMA program for either cost share or capacity to manage the activities are eligible to apply under the RFC program.

Guidance materials and application forms, such as grant administrative forms, project sub-applications, and management costs sub-applications (for Grantees), are available at any FEMA Regional Office or on the FEMA web page: http://www.fema.gov/government/grant/rfc/index.shtm.

E.5 Severe Repetitive Loss Program

The Severe Repetitive Loss (SRL) program provides funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss properties and the associated drain on the NFIF from such properties. See Appendix I – Glossary, for a definition of SRL properties.

The SRL program was authorized by Section 1361A of the Act, 42 U.S.C. 4102a, as amended by the Flood Insurance Reform Act (FIRA) of 2004, Public Law 108-264.

FEMA is currently developing regulations for the SRL program. The FEMA web page http://www.fema.gov/government/grant/srl/index.shtm will be updated with information on the availability of funds, application periods, and other program requirements periodically.

The SRL program currently provides funding up to $40 million annually until 2009 with 75 percent Federal funding (minimum 25 percent non-Federal match requirement). A reduced match (10 percent non-Federal funding) is allowed for States with approved State mitigation plans meeting the hazard mitigation planning requirements under Section 322 of the Robert T. Stafford

Disaster Relief and Emergency Assistance Act (42 USC 5165) that specifies how the State reduces the number of severe repetitive loss properties.

Allocations to eligible applicants (States, Territories, and Tribal governments) will be based on the number of severe repetitive loss properties in each State or Territory. A set-aside amount of 10 percent is reserved for communities that receive little or no assistance under the allocation formula.

Current eligible activities include:

- Acquisition, structure demolition, or structure relocation with the property deed restricted for open space uses in perpetuity
- Elevation of structures
- Floodproofing of structures
- Minor physical localized flood control projects
- Mitigation and reconstruction

E.6 Additional Information

- Contact information for State Emergency Management Directors through the National Emergency Management Agency, http://www.nemaweb.org/State_Contacts/index.cfm
- Contact information for State Hazard Mitigation Officers through the State Offices and Agencies of Emergency Management, http://www.fema.gov/about/contact/statedr.shtm
- Public Assistance (PA) Program, http://www.fema.gov/government/grant/pa/index.shtm

The objective of FEMA's PA Grant Program is to provide assistance to States, local governments, and certain non-profit organizations to alleviate suffering and hardship resulting from major disasters or emergencies declared by the President.

Through the PA Program, FEMA provides supplemental Federal disaster grant assistance for the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain Private Non-Profit (PNP) organizations.

The Federal share of assistance is not less than 75 percent of the eligible cost for emergency measures and permanent restoration. The grantee (usually the State) determines how the non-Federal share (up to 25 percent) is split with the subgrantees (eligible applicants).

- Individual Assistance Programs,

  http://www.fema.gov/media/fact_sheets/individual-assistance.shtm

When the President declares a disaster and authorizes providing Individual Assistance, FEMA's Individuals and Households Program (IHP) can help homeowners and renters affected by the disaster with housing needs and necessary expenses.

To be considered for IHP housing assistance, the affected home must be the individual's primary residence and it must be located in the disaster area designated for Individual Assistance. To be considered for IHP assistance for necessary expenses or serious needs, the loss must have occurred in the disaster area designated for Individual Assistance. An individual or a pre-disaster member of the household must be a United States citizen, a non-citizen national, or a qualified alien.

When a disaster is declared and Individual Assistance is authorized, affected individuals are directed to register with FEMA and to make sure that the information they provide is complete and correct.

Disaster assistance is money or direct assistance to individuals, families, and businesses in an area whose property has been damaged or destroyed and whose losses are not covered by insurance. It is meant to help you with critical expenses that cannot be covered in other ways. This assistance is not intended to restore your damaged property to its condition before the disaster.

While some housing assistance funds are available through FEMA's IHP, most disaster assistance from the Federal Government is in the form of loans administered by the Small Business Administration (SBA).

E.7 Housing Needs

- **Temporary Housing** (a place to live for a limited period of time). Money is available to rent a different place to live, or a government provided housing unit when rental properties are not available.

- **Repair.** Money is available to homeowners to repair damage from the disaster to their primary residence that is not covered by insurance. The goal is to make the damaged home safe, sanitary, and functional.

- **Replacement.** Money is available to homeowners to replace their home destroyed in the disaster that is not covered by insurance. The goal is to help the homeowner with the cost of replacing his or her destroyed home.

- **Permanent Housing Construction.** Direct assistance or money for the construction of a home. This type of help only occurs in insular areas or remote locations specified by FEMA, where no other type of housing assistance is possible.

Money is available for necessary expenses and serious needs caused by the disaster. This includes:

- Disaster-related medical and dental costs.
- Disaster-related funeral and burial costs.
- Clothing; household items (room furnishings, appliances); tools (specialized or protective clothing and equipment) required for your job; necessary educational materials (computers, school books, supplies).
- Fuels for primary heat source (heating oil, gas, firewood).
- Clean-up items (wet/dry vacuum, air purifier, and dehumidifier).
- Disaster damaged vehicle.
- Moving and storage expenses related to the disaster (moving and storing property to avoid additional disaster damage while disaster-related repairs are being made to the home).
- Other necessary expenses or serious needs as determined by FEMA.
- Other expenses that are authorized by law.

Moving and storage expenses related to the disaster (moving and storing property to avoid additional disaster damage while disaster-related repairs are being made to the home).

- Other necessary expenses or serious needs as determined by FEMA.
- Other expenses that are authorized by law.

- U.S. Small Business Administration (SBA), http://www.sba.gov
  http://www.fema.gov/assistance/process/sba_assistance.shtm

The SBA was created in 1953 as an independent agency of the Federal Government to aid, counsel, assist and protect the interests of small business concerns; preserve free competitive enterprise; and maintain and strengthen the overall economy of our nation.

The SBA provides various types of loans for businesses of all sizes and homeowners and renters in the event of a disaster. This includes physical disaster loans, economic injury loans, military reservists' loans, and home and personal property loans. These loans help people recover from disasters and rebuild their lives by providing affordable, timely, and accessible financial assistance to homeowners, renters, and businesses.

APPENDIX F – FEMA REGIONAL OFFICES

http://www.fema.gov/about/contact/regions.shtm

Location	FEMA
Region I: (CT, MA, ME, NH, RI, VT)	FEMA 99 High Street, 6th Floor Boston, MA 02110 (617) 956-7559
Region II: (NJ, NY)	26 Federal Plaza, Suite 1311 New York, NY 10278-0002 (212) 680-3600
Caribbean Office (PR, VI)	*Mailing address*: FEMA Caribbean Division P.O. Box 70105 San Juan PR 00936-0105 (787) 296-3500 *Physical address*: New San Juan Office Building 159 Calle Chardon Avenue Sixth Floor Hato Rey, PR 00918

Region III: (DC, DE, MD, PA, VA, WV)	One Independence Mall, 6th Floor 615 Chestnut Street Philadelphia, PA 19106-4404 (215) 931-5608
Region IV: (AL, FL, GA, KY, MS, NC, SC, TN)	Koger Center - Rutgers Building 3003 Chamblee-Tucker Road, Room 270 Atlanta, GA 30341 (770) 220-5200
Region V: (IL, IN, MI, MN, OH, WI)	536 S. Clark Street 6th Floor Chicago, IL 60605 (312) 408-5500
Region VI: (AR, LA, NM, OK, TX)	Federal Regional Center 800 North Loop 288 Denton, TX 76201-3698 (940) 898-5399
Region VII: (IA, KS, MO, NE)	Suite 300 9221 Ward Parkway Kansas City, MO 64114-3372 (816) 283-7002
Region VIII: (CO, MT, ND, SD, UT, WY)	Building 710 Denver Federal Center P.O. Box 25267 Denver, CO 80225-0267 (303) 235-4800
Region IX: (AZ, CA, HI, NV, Guam, American Samoa, Mariana Islands)	1111 Broadway, Suite 1200 Oakland, CA 94607-4052 (510) 627-7100
Region X: (AK, ID, OR, WA)	Federal Regional Center 130 228th Street, S.W. Bothell, WA 98021-9796 (425) 487-4600

Regional Repetitive Loss Coordinators

As of June 9, 2006

Region	Contact Name	Contact Phone #	Backup Contact	Supervisor
I	Daisy Sweeney*	(617) 832-4788		Mike Goetz
II	Pat Griggs	(212) 680-3625	Scott Duell* (212) 680-3630	Mary Colvin
III	Dave Odegard	(215) 931-5506		Gene Gruber
IV	David L. Thomas II	(770) 220-5457	Robert Durrin (770) 220-5428	Brad Loar
V	Eric Kuklewski	(312) 408-5230		Terry Fell
VI	Mark Price	(940) 898-5359	Ross Richardson (940) 898-5143	Frank Pagano
VII	Joe Chandler	(816) 283-7071	Georgia Wright	Kathy Strange
VIII	Bonnie Heddin*	(303) 235-4739		Robert Ives
IX	Mike Hornick*	(510) 627-7260		Michael Shore
X	Denise Atkinson	(425) 487-4677	Bruce Knipe	Mark Carey

* Region's FMA coordinator

Headquarters Contact

Errol Garren (202) 646-3678

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APPENDIX G – STATE AND TRIBAL HISTORIC PRESERVATION OFFICES

The following contact information is subject to change. For a current list of State Historic Preservation Offices, see http://www.ncshpo.org/stateinfolist/FullList.htm
For a complete list of Tribal Historic Preservation Offices, see http://www.cr.nps.gov/hps/tribal/thpo.htm

State Historic Preservation Offices

Alabama

Col. John Neubauer, Executive Director & SHPO
Alabama Historical Commission
468 South Perry Street
Montgomery, AL 36130-0900
(334) 242-3184, Fax (334) 240-3477

Alaska

Judith Bittner, SHPO
Alaska DNR, Office of History & Archaeology
550 West 7th Avenue
Suite 1310
Anchorage, AK 99501-3565
(907)269-8721, Fax (907)269-8908
judy_bittner@dnr.state.ak.us

American Samoa

John Enright, HPO
Executive Offices of the Governor
AS Government/Historic Preservation Office
Pago Pago, American Samoa 96799
(684) 699-2316, Fax (684) 699-2276
enright@samoatelco.com

Arizona

James W. Garrison, SHPO
Arizona State Parks
1300 West Washington
Phoenix, AZ 85007
(602) 542-4174, Fax (602) 542-4180
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Arkansas

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Department of Arkansas Heritage
323 Center Street
Suite 1500
Little Rock, AR 72201
(501) 324-9150, Fax (501) 324-9154
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California

Milford Wayne Donaldson, SHPO
Office of Historic Preservation
Department of Parks & Recreation
P.O. Box 942896
Sacramento, CA 94296-0001
(916) 653-6624, Fax: (916) 653-9824
mwdonaldson@parks.ca.gov

Colorado

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Colorado Historical Society
1300 Broadway
Denver, CO 80203
(303) 866-3355, Fax (303) 866-4464

Connecticut

Jennifer Aniskovich, Executive Director
Connecticut Commission on Culture and Tourism
755 Main Street
One Financial Plaza
Hartford, CT 06103
(860) 566-4770, Fax (860) 566-5078
janiskovich@ctarts.org

Delaware

Timothy A. Slavin, SHPO
Division of Historical and Cultural Affairs
21 The Green
Dover, DE 19901
(302) 739-5313, Fax (302) 739-6711
timothy.slavin@state.de.us

District of Columbia

SHPO
Historic Preservation Office
801 North Capitol Street, NE.
3rd Floor
Washington, DC 20002
(202) 442-8800, Fax (202) 741-5246

Florida

Frederick Gaske, SHPO & Division Director
Division of Historical Resources,
Department of State
500 South Bronough Street
Room 305
Tallahassee, FL 32399-0250
(850) 245-6300
fgaske@dos.state.fl.us

Bureau of Historic Preservation
(800) 847-7278
(850) 245-6333, Fax: (850) 245-6437

Georgia

Noel A. Holcomb, SHPO
Historic Preservation Division/DNR
34 Peachtree Street NW
Suite 1600
Atlanta, GA 30303-2316
(404) 656-2840, Fax: (404) 651-8739

Guam

Lynda B. Aguon, SHPO
Guam Historic Preservation Office
Department of Parks & Recreation
490 Chalan Palasyo
Agana Heights, Guam 96910
(671) 475-6294/6295/6272
Fax: (671) 477-2822
laguon@mail.gov.gu

Hawaii

Peter T. Young, SHPO
Department of Land & Natural Resources
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(808) 548-6550, Fax (808) 587-0018

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Idaho State Historical Society
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kpeterson@ishs.idaho.gov

Illinois

William L. Wheeler, SHPO
Associate Director
Illinois Historic Preservation Agency
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Springfield, IL 62701-1512
(217) 785-4512, Fax (217) 524-7525

Indiana

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Indiana Government Center South
Room W256
Indianapolis, IN 46204
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Iowa

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State Historical Society of Iowa
Capitol Complex
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Des Moines, IA 50319
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Fax: (785) 272-8682
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Kentucky Heritage Council
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Louisiana

Pamela A. Breaux, SHPO
Department of Culture, Recreation & Tourism
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Baton Rouge, LA 70804
(225) 342-8200, Fax (225) 342-8173

Maine

Earle G. Shettleworth, Jr., SHPO
Maine Historic Preservation Commission
55 Capitol Street
Station 65
Augusta, ME 04333
(207) 287-2132, Fax (207)287-2335
earle.shettleworth@maine.gov

Marshall Islands, Republic of the

Lenest Lanki, HPO
Secretary of Interior and Outer Islands Affairs
P.O. Box #1454
Majuro Atoll, MH 96960
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Fax (011) 692-625-5353

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Maryland Historical Trust
100 Community Place
3rd Floor
Crownsville, MD 21032-2023
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RLittle@mdp.state.md.us

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Massachusetts Historical Commission
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Michigan

Brian D. Conway, SHPO
Michigan Historical Center
702 West Kalamazoo Street
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Lansing, MI 48909-8240
(517) 373-1630, Fax (517) 335-0348
conwaybd@michigan.gov

Micronesia, Federated States of

Rufino Mauricio, FSM HPO
Office of Administrative Services
Division of Archives and Historic Preservation
FSM National Government
P.O. Box PS 70
Palikir, Pohnpei, FM 96941
(011) 691-320-2343
Fax: (011) 691-320-5634
hpo@mail.fm

Minnesota

Dr. Nina Archabal, SHPO
Minnesota Historical Society
345 Kellogg Boulevard West
St. Paul, MN 55102-1906
(651) 296-2747, Fax (651) 296-1004

Mississippi

H.T. Holmes, SHPO
Mississippi Department of Archives & History
P.O. Box 571
Jackson, MS 39205-0571
(601) 576-6850

Missouri

Doyle Childers, SHPO
State Department of Natural Resources
(573) 751-4732, Fax (573) 751-7627

Montana

Dr. Mark F. Baumler, SHPO
State Historic Preservation Office
1410 8th Avenue
P.O. Box 201202
Helena, MT 59620-1202
(406) 444-7719, Fax:(406) 444-6575
swilmoth@mt.gov

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Michael Smith, Director and SHPO
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Lincoln, NE 68501
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Ronald James, SHPO
Historic Preservation Office
100 North Stewart Street
Capitol Complex
Carson City, NV 89701-4285
(775) 684-3440, Fax (775) 684-3442

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James McConaha, SHPO & Director
New Hampshire Division of Historical Resources
19 Pillsbury Street
2nd Floor
Concord, NH 03301-3570
(603) 271-6435, Fax:(603) 271-3433
TDD: (800)735-2964
James.McConaha@dcr.nh.gov

New Jersey

Bradley M. Campbell, SHPO
Department of Environmental Protection
401 East State Street
P.O. Box 402
Trenton, NJ 08625
(609) 292-2885, Fax (609) 292-7695

New Mexico

Katherine (Kak) Slick, SHPO
Historic Preservation Division
Bataan Memorial Building
407 Galisteo Street
Suite 236
Santa Fe, NM 87501
(505) 827-6320, Fax: (505) 827-6338
katherine.slick@state.nm.us

New York

Bernadette Castro, SHPO
Parks, Recreation & Historic Preservation
Agency Building #1
Empire State Plaza
Albany, NY 12238
(518) 474-0443

North Carolina

Dr. Jeffrey J. Crow SHPO
Division of Archives & History
4610 Mail Service Center
Raleigh, NC 27699-4610
(919) 807-7280, Fax: (919) 733-8807
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Northern Mariana Islands, Commonwealth of

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State Historic Preservation Office
Oklahoma Historical Society
Oklahoma History Center
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Oklahoma City, OK 73105-7914
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Oregon

Tim Wood, SHPO
Oregon Parks & Recreation Department
725 Summer Street, NE.
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Salem, OR 97301

Palau, Republic of

Victoria N. Kanai, HPO
Ministry of Community & Cultural Affairs
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(011) 680-488-2489
Fax: (011) 680-488-2657

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Pennsylvania Historical and Museum Commission
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Puerto Rico, Commonwealth of

Aida Belen Rivera Ruiz, SHPO
State Historic Preservation Office
P.O. Box 9066581
San Juan, PR 00906-6581
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Rhode Island Historic Preservation & Heritage Commission
Old State House
150 Benefit Street
Providence, RI 02903
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Texas

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Texas Historical Commission
P.O. Box 12276
Austin, TX 78711-2276
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Utah

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Utah State Historical Society
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Vermont

Jane Lendway, SHPO
Vermont Division for Historic Preservation
National Life Building, Drawer 20
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Virgin Islands

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Department of Historic Resources
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Washington

Dr. Allyson Brooks, SHPO
Office of Archeology & Historic Preservation
P.O. Box 48343
Olympia, WA 98504-8343
(360) 586-3065

1063 South Capitol Way
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Olympia, WA 98501
(360) 586-3064, Fax:(360) 586-3067
allyson.brooks@dahp.wa.gov

West Virginia

Randall Reid-Smith, SHPO
West Virginia Division of Culture & History
Historic Preservation Office
1900 Kanawha Boulevard East
Charleston, WV 25305-0300
(304) 558-0220, Fax:(304) 558-2779

Wisconsin

Dr. Michael E. Stevens, SHPO
Wisconsin Historical Society
816 State Street
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Wyoming

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Tribal Historic Preservation Offices

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Bad River Band of Lake Superior Chippewa Indians
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Leland Chavez
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Catawba Indian Nation
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Albert LeBeau
Tribal Historic Preservation Officer
Cheyenne River Sioux Tribe
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Eagle Butte, SD 57625
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Alvin Windy Boy
THPO
Chippewa Cree Tribe of the Rocky Boy's Reservation
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Box Elder, MT 59521
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awindyboy@earthlink.net

Terry Cole
Tribal Preservation Officer
Choctaw Nation of Oklahoma
P. O. Drawer 1210
Durant, OK 74702-1210
(580) 924-8280

Quanah Matheson
THPO
Coeur d'Alene Tribe
P.O. Box 408
Plummer, ID 83851
(208) 686-0675

Marcia Pablo
Tribal Preservation Officer
Confederated Salish and Kootenai Tribes of the Flathead Indian Nation
Tribal Preservation Office
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Pablo, MT 59855
(406) 675-2700
skthpo@ronan.net

Kate Valdez
THPO
Confederated Tribes and Bands of Yakama Nation
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Camille Pleasants
Acting Tribal Preservation Officer
Confederated Tribes of the Colville Reservation
Archaeology and History Department
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Carey Miller
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Confederated Tribes of the Warm Springs Reservation in Oregon
Department of Cultural Resources
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Russell Townsend
Tribal Historic Preservation Officer
Eastern Band of Cherokee Indians
Cultural Resources Department
Qualla Boundary P.O. Box 455
Cherokee, NC 28719
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Ray Martell
THPO
Elk Valley Rancheria
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Loretta Jackson
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Summer Sky Cohen
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Keweenaw Bay Indian Community
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Chippewa Indians of Wisconsin
Tribal Historic Preservation Office
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Kelly Jackson -Golly
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Lac du Flambeau Band of Lake Superior
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giiwegiizhigookway Martin
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Lac Vieux Desert Band of Lake Superior
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Gina Papasodora
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Janine Bowechop
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APPENDIX H – NFIP STATE COORDINATING AGENCIES AND STATE HAZARD MITIGATION OFFICERS

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APPENDIX I – GLOSSARY

A Zones	A Zones are areas within the Special Flood Hazard Area identified on FIRMs as an area that has a 1 percent or greater annual chance of flooding. The A Zone may be identified on a FIRM with one of the following designations: AE, A1-30, AO, AH, or A. These areas include riverine floodplains, lacustrine (lake) floodplains, and coastal floodplains landward of V Zones.
Approximate A Zones	Areas not studied by detailed hydrologic/hydraulic methods. These areas are shown on a FIRM as "unnumbered A zones" and "approximate 100-year flood zones" on the Flood Boundary and Floodway Map (FBFM).
Base Flood Elevation (BFE)	The water surface elevation resulting from the base flood, (i.e., a flood that has a 1 percent chance of equaling or exceeding that level in any given year [100-year flood]).
Construction Type	
Concrete	Walls constructed of concrete block
Frame	Walls constructed of wood or light gauge metal studs, with wood, vinyl, or aluminum siding
Masonry	Walls constructed of brick
Manufactured home	Prefabricated frame structure constructed on a transportable frame
Disaster Mitigation Act of 2000 (DMA 2000)	The impetus for states and communities to undertake natural hazard mitigation planning was given a significant boost on October 30, 2000, when the President signed the Disaster Mitigation Act of 2000 (Public Law 106-390). To maintain eligibility for pre- and post-disaster grant funds, communities need to have a mitigation plan approved by FEMA that identifies risks from natural hazards and includes a strategy to address these problems.
Dry floodproofing	Measures that eliminate or reduce the potential for flood damage by keeping floodwaters out of the structure. Examples include installation of watertight shields for doors and windows, reinforcement of walls to withstand the hydrostatic and hydrodynamic pressures and debris impact, and use of sealants to reduce seepage of floodwaters through walls.

Elevation Datum	Elevation datum, or datum plane, is an arbitrary surface that serves as a common reference for the elevations of points above or below it. Elevations are expressed in terms of feet, meters, or other units of measure and are identified as negative or positive depending on whether they are above or below the datum plane. Three common elevation datum are mean sea level (msl), National Geodetic Vertical Datum (NGVD), and North American Vertical Datum (NAVD).
Erosion	The removal of soil that lowers the ground surface elevation across an area.
Flash flood	A flood that rises and falls very quickly and is usually characterized by high flow velocities. Flash floods often result from intense rainfall over a small area and can also occur in highly urbanized areas where pavements and other impervious improvements increase the volume and speed of runoff.
Flood fringe	The portion of the floodplain that lies beyond the floodway and serves as a temporary storage area for floodwaters during a flood. This section receives waters that are generally shallower and of lower velocities than those of the floodway.
Flood Hazard Boundary Map (FHBM)	An official map of a community published by FEMA that delineates the approximate boundary of the floodplain. An FHBM is generally the initial map provided to the community and is usually eventually superseded by a FIRM.
Flood Insurance Rate Map (FIRM)	An official map of a community, on which the Federal Emergency Management Agency has delineated both the special hazard areas and the risk premium zones applicable to the community. The map shows the extent of the base floodplain and may also display the extent of the floodway, as well as other relevant information such as Base Flood Elevations.
Flood Insurance Study (FIS)	An engineering study developed in conjunction with the FIRM. The FIS, also known as a flood elevation study, frequently contains a narrative of the flood history of a community and discusses the engineering methods used to develop the FIRM. The study also contains flood profiles for studied flooding sources and is used to provide accurate Base Flood Elevations for some areas.
Floodplain	Any land area susceptible to being inundated by the 1 % flood.
Floodplain Management Regulations	Regulations for development and land use within floodprone areas. Floodplain management regulations in communities that participate in the National Flood Insurance Program must be compliant with the NFIP requirements described in 44 CFR 60.3.

Flood Protection Elevation (FPE)	Elevation of the highest flood, including freeboard that a retrofitting method is intended to protect against.
Floodway	The channel of a river or other watercourse and that portion of the adjacent floodplain that must remain open to permit passage of the base flood without cumulatively increasing the water surface elevation more than a designated height (usually 1 foot).
Foundation Type	
Basement	Any area of the building having its floor subgrade (below ground level) on all sides.
Crawlspace	Low space below the first floor of a house, where there has not been excavation deep enough for a basement, but where there is often access for pipes, ducts, and utilities.
Pier	An upright support member of a building with a height limited to a maximum of three times its least lateral dimension. It is designed and constructed to function as an independent structural element in supporting and transmitting building and environmental loads to the ground.
Pile	An upright support member of a building, usually long and slender in shape, driven or jetted into the ground by mechanical means and primarily supported by friction between the pile and the surrounding earth.
Post or Column	Upright support units for a building, set in pre-dug holes and backfilled with compacted material. Posts are usually made of wood and columns are usually of concrete or masonry construction.
Slab-on-grade	A structural design where the first floor sits directly on a poured concrete slab, which sits directly on the ground.
Freeboard	An additional amount of height above the Base Flood Elevation used as a factor of safety (e.g., 2 feet above the Base Flood) in determining the level at which a structure's lowest floor must be elevated or floodproofed to be in accordance with state or local community floodplain management regulations.
Hazard Mitigation	Any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event.
Hydraulics	Hydraulics is used to determine how a quantity of water will flow through a channel or floodplain. Hydraulic analysis combines: • Flood hydrology, or discharges,

	• Cross-section data on how much area there is to carry the flood, and • Stream characteristics such as roughness, slope, locations, and sizes of structures.
Hydrodynamic Loads	Forces imposed on an object, such as a structure, by water moving around it. Among these loads are positive frontal pressure against the structure, drag effect along the sides and negative pressure on the downstream side.
Hydrology	Hydrology deals with the distribution and circulation of water in the atmosphere, on land surfaces, and underground, and is used to determine flood flow frequencies. A hydrologic analysis determines the amount of rainfall that will stay in a watershed and the rate at which the remaining amount of rainfall will reach the stream.
Hydrostatic Loads	Forces imposed on a surface, such as a wall or floor slab, by a standing mass of water. The water pressure increases with the square of the water depth.
Increased Cost of Compliance (ICC)	NFIP flood insurance coverage for expenses that a property owner must incur, above and beyond the cost to repair the physical damage the structure actually sustained from a flooding event, to comply with mitigation requirements of state or local floodplain management ordinance or laws. Acceptable mitigation measures are elevation, floodproofing, relocation, demolition, or any combination thereof (*Flood Insurance Manual*, May 2003 [revised May 2004]).
Levee	Manmade structures, usually an earthern embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water to provide protection from temporary flooding.
Map Modernization	Efforts being made by FEMA to update flood maps for the Nation to digital format and streamline FEMA's responses to requests to revise them.
Market Value	The value of a structure based on the estimated price it would be sold by a willing seller to a willing buyer in the current real estate market.
Mitigation	Any sustained action taken to reduce or eliminate long-term risk to life and property from a hazard event.
Mitigation Planning	Hazard mitigation planning is the process of figuring out how to reduce or eliminate the loss of life and property damage resulting from natural hazards like floods, earthquakes, and tornadoes**.**

National Flood Insurance Program (NFIP)	Established in 1968 to help flood victims recover from the effects of flooding (Pub. L. 90-448, 42 U.S.C. 4001 et seq.), the NFIP is administered by FEMA. The NFIP is a government program that provides public benefits that go beyond what private sector insurance could achieve. Those who are at risk pay toward their own recovery so the financial burden is shifted away from disaster assistance programs funded by the general taxpayer. Flood insurance premium payments go into the National Flood Insurance Fund (NFIF), which in turn is used to pay claims resulting from flood damages. Those individuals with a flood insurance policy can receive the resources needed to clean and repair or replace their damaged property. The concept of the NFIP is that flood insurance is made available in communities that regulate development in flood-hazard areas. In return for adoption and enforcement of the minimum NFIP regulations, the NFIP insures existing buildings with "subsidized" rates (i.e., flood insurance premium rates below the true risk based cost of the insurance coverage). The program has proven successful in reducing flood losses, especially to buildings constructed after communities began enforcing their regulations. It is estimated that over $1 billion in damage is avoided each year because of the NFIP. The program has also saved disaster assistance programs billions of dollars. For additional information on the NFIP, see the NFIP website address, http://www.fema.gov/business/nfip/index.shtm.
Post-FIRM structure	For insurance rating purposes, a post-FIRM building was constructed or substantially improved after December 31, 1974, or after the effective date of the initial Flood Insurance Rate Map of a community, whichever is later. A post-FIRM building in a participating community is required to meet the National Flood Insurance Program's minimum Regular Program flood protection standards.
Pre-FIRM structure	For insurance rating purposes, a pre-FIRM building was constructed or substantially improved on or before December 31, 1974, or before the effective date of the initial Flood Insurance Rate Map of the community, whichever is later. Most pre-FIRM buildings were constructed without taking the flood hazard into account.
Repetitive Loss Properties	Repetitive Loss Properties are properties where two or more claims of more than $1,000 have been paid by the NFIP in any consecutive 10-year period since 1978.

Scour	The removal of soil around objects that obstruct flow, such as foundation walls.
Severe Repetitive Loss Properties	Severe repetitive loss properties are defined in the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 as insured repetitive loss properties that have received multiple flood insurance claims: 1. Single-family properties. In the case of a property consisting of one to four residences, such term means a property that: a. Is covered under a contract for flood insurance made available under this title; and b. Has incurred flood-related damage: i. For which four or more separate claims payments have been made under flood insurance coverage under this title, with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or ii. For which at least two separate claims payments have been made under such coverage, with the cumulative amount of such claims exceeding the value of the property. 2. Multifamily properties. In the case of a property consisting of five or more residences, such term shall have such meaning as the Director shall by regulation provide.
Special Flood Hazard Area (SFHA)	An area within a floodplain having a 1 percent or greater chance of flood occurrence in any given year (100-year floodplain); represented on Flood Insurance Rate Maps by shaded areas with zone designations that include the letter A or V.
Substantial Damage (SD)	Substantial Damage is defined as damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damage conditions would equal or exceed 50 percent of the market value of the structure before the damage occurred.
Substantial Improvement (SI)	Substantial Improvement is any reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before to the "start of construction" of the improvement. This term includes structures that have incurred "substantial" damage, regardless of the actual repair work performed.

V Zones	V Zones are areas identified on FIRMs as Zones VE, V1-30, or V. These areas, also known as Coastal High Hazard Areas, are areas along the coast that have a 1 percent or greater annual chance of flooding from storm surge and waves greater than 3 feet in height, as well as being subject to significant wind forces.
Wet floodproofing	Permanent or contingent measures applied to a structure and/or its contents that prevent or provide resistance to damage from flooding by allowing floodwaters to enter the structure. Such measures include the design of openings for intentional flooding of enclosed areas below the DFE, use of flood-resistant building materials below the DFE, and protection of the structure and its contents (including utilities).

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APPENDIX J – ACRONYMS

ADA	Americans with Disabilities Act
APA	American Planning Association
BCA	Benefit/Cost Analysis
BCR	Benefit/Cost Ratio
BFE	Base Flood Elevation
CFR	Code of Federal Regulations
CIS	Community Information System
CR	Claims Representative
CRS	Community Rating System
CSB	Community Status Book
DFE	Design Flood Elevation
DFIRM	Digital Flood Insurance Rate Map
DHS	Department of Homeland Security
DMA 2000	Disaster Mitigation Act of 2000
EC	Elevation Certificate
EMI	Emergency Management Institute
FBFM	Flood Boundary and Floodway Map
FEMA	Federal Emergency Management Agency
FHBM	Flood Hazard Boundary Map
FHWA	Federal Highway Administration
FIRA	Flood Insurance Reform Act
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FPE	Flood Protection Elevation
fps	feet per second
ft	feet

FY	Fiscal Year
GIS	Geographic Information Systems
H+H	hydraulics and hydrologic
HMGP	Hazard Mitigation Grant Program
HUD	Department of Housing and Urban Development
HVAC	heating, ventilation, and air conditioning systems
ICC	Increased Cost of Compliance
IHP	Individuals and Households Program
LAG	lowest adjacent exterior grade
LSU	Louisiana State University
msl	mean sea level
NAVD	North American Vertical Datum
NCDC	National Climatic Data Center
NFIF	National Flood Insurance Fund
NFIP	National Flood Insurance Program
NFIRA	National Flood Insurance Reform Act
NFMDCT	National Flood Mitigation Data Collection Tool ("National Tool")
NGVD	National Geodetic Vertical Datum
NHC	National Hurricane Center
NOAA	National Oceanographic and Atmospheric Administration
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
NSF	National Science Foundation
NT	National Tool (see also NFMDCT)
PA	Public Assistance
PDM	Pre-Disaster Mitigation
PNP	Private Non-Profit
POC	Point of Contact
RFC	Repetitive Flood Claims

RL	Repetitive Loss
SBA	Small Business Administration
SD	Substantial Damage
SFHA	Special Flood Hazard Area
SFIP	Standard Flood Insurance Policy
SHMO	State Hazard Mitigation Officer
SHPO	State Historic Preservation Office
SI	Substantial Improvement
sq ft	square feet
SRL	Severe Repetitive Loss
THPO	Tribal Historical Preservation Office
TVA	Tennessee Valley Authority
URA	Uniform Relocation Assistance
USACE	U.S. Army Corps of Engineers
USC	United States Code
USGS	U.S. Geological Survey
WYO	Write-Your-Own

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APPENDIX K – REFERENCES

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FEMA 55	*Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing and Maintaining Residential Buildings in Coastal Areas Volume I, II and III.* (June 2000) http://www.fema.gov/rebuild/mat/fema55.shtm
FEMA 85	*Manufactured Homes in Flood Hazard Areas: A Multi-Hazard Foundation and Installation Guide*. (August 2005) http://www.fema.gov/hazard/flood/pubs/lib85.shtm
FEMA 102	*Floodproofing Non-Residential Structures*. (May 1986) http://www.fema.gov/library/viewRecord.do?id=1413
FEMA 114	*Design Manual for Retrofitting Floodprone Residential Structures* (1986) http://www.fema.gov/library/viewRecord.do?id=1414
FEMA 213	*Answers to Questions About Substantially Damaged Buildings.* (May 1991) http://www.fema.gov/hazard/flood/pubs/lib213.shtm
FEMA 234	*Repairing Your Flooded Home*. (August 1992) http://www.redcross.org/static/file_cont333_lang0_150.pdf
FEMA 259	*Engineering Principles and Practices of Retrofitting Floodprone Residential Structures* (June 2001) http://www.fema.gov/hazard/flood/pubs/lib259.shtm
FEMA 265	*Managing Floodplain Development in Approximate Zone A Areas*. (July 1995) http://www.fema.gov/library/viewRecord.do?id=1526

FEMA 301	*National Flood Insurance Program's Increased Cost of Compliance Coverage Guidance for State and Local Officials.* (September 2003) http://www.fema.gov/business/nfip/icc.shtm http://www.fema.gov/library/viewRecord.do?id=1532
FEMA 312	*Homeowner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding* (June 1998) http://www.fema.gov/rebuild/mat/rfit.shtm
FEMA 317	*Property Acquisition Handbook for Local Communities* (October 1998) http://www.fema.gov/government/grant/resources/acqhandbook.shtm
FEMA 345	*Hazard Mitigation Grant Program Desk Reference* (October 1999) http://www.fema.gov/government/grant/hmgp/index.shtm http://www.fema.gov/library/viewRecord.do?id=1472
FEMA 347	*Above the Flood: Elevating Your Floodprone House* (May 2000) http://www.fema.gov/rebuild/recover/fema347.shtm
FEMA 348	*Protecting Building Utilities from Flood Damage* (November 1999) http://www.fema.gov/hazard/flood/pubs/pbuffd.shtm
FEMA 386-1	*Getting Started: Building Support for Mitigation Planning* (September 2002) http://www.fema.gov/plan/mitplanning/howto1.shtm
FEMA 386-2	*Understanding Your Risks: Identifying Hazards and Estimating Losses* (August 2001) http://www.fema.gov/plan/mitplanning/howto2.shtm
FEMA 386-3	*Developing the Mitigation Plan: Identifying Mitigation Actions and Implementing Strategies* (April 2003) http://www.fema.gov/plan/mitplanning/howto3.shtm
FEMA 386-4	*Bringing the Plan to Life: Implementing the Hazard Mitigation Plan* (August 2003) http://www.fema.gov/plan/mitplanning/howto4.shtm
FEMA 386-6	*Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning* (May 2005) http://www.fema.gov/plan/mitplanning/howto6.shtm
FEMA 386-7	*Integrating Manmade Hazards Into Mitigation Planning*. (September 2003) http://www.fema.gov/plan/mitplanning/howto7.shtm

FEMA 386-8	*Multi-Jurisdictional Mitigation Planning* (August 2006) http://www.fema.gov/plan/mitplanning/howto8.shtm
FEMA 480	*National Flood Insurance Program (NFIP) Floodplain Management Requirements: A Study Guide and Desk Reference for Local Officials* (February 2005) http://www.floods.org/Certification/FEMA_480_TOC.asp
FEMA 497	*National Flood Mitigation Data Collection Tool Guide* (May 2005) http://www.fema.gov/plan/prevent/floodplain/data_tool.shtm
FEMA 499	*Home Builder's Guide to Coastal Construction Technical Fact Sheet Series* (August 2005) http://www.fema.gov/rebuild/mat/mat_fema499.shtm
FEMA 511	*Reducing Damage from Localized Flooding* (June 2005) http://www.fema.gov/hazard/flood/pubs/flood-damage.shtm
FEMA 550	*Recommended Residential Construction for the Gulf Coast: Building on Strong and Safe Foundations* (July 2006) http://www.fema.gov/library/viewRecord.do?id=1853
FEMA TB 1-93	*Openings in Foundation Walls for Buildings Located in Special Flood Hazard Area* http://www.fema.gov/fima/techbul or http://www.fema.gov/pdf/fima/job2.pdf
FEMA TB 4-93	*Elevator Installation for Buildings Located in Special Flood Hazard Areas in Accordance with the National Flood Insurance Program* http://www.fema.gov/fima/techbul or http://www.fema.gov/pdf/fima/job8.pdf
FEMA TB 7-93	*Wet Floodproofing Requirements for Structures Located in Special Flood Hazard Areas* http://www.fema.gov/fima/techbul or http://www.fema.gov/pdf/fima/job14.pdf
FEMA TB 10-01	*Ensuring That Structures Built on Fill In or Near Special Flood Hazard Areas Are Reasonably Safe from Flooding* http://www.fema.gov/fima/techbul or http://www.fema.gov/pdf/fima/tb1001.pdf

FEMA **TB 11-01**	*Crawlspace Construction for Buildings Located in Special Flood Hazard Areas: National Flood Insurance Program Interim Guidance.* http://www.fema.gov/fima/techbul or http://www.fema.gov/pdf/fima/tb1101.pdf

USACE Publications

To obtain copies of these publications, visit the USACE National Floodproofing Committee website http://www.usace.army.mil/inet/functions/cw/cecwp/NFPC/nfpc.htm or write to the following address:

U.S. Army Corps of Engineers
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Attn.: CEIM-IM-PD
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Hyattsville, MD 20781-1102

USACE	*Flood Proofing - How to Evaluate Your Options* (July 1993) http://www.usace.army.mil/cw/cecw-p/NFPC/fphow/ace8toc.htm
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Websites

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Association of State Floodplain Managers	http://www.floods.org/home/default.aspwww.floods.org
FEMA	http://www.fema.gov/
FEMA Map Service Center	http://store.msc.fema.gov
FEMA National Flood Insurance Program (NFIP)	http://www.fema.gov/business/nfip/
FEMA NFIP Answers to Questions About the NFIP	http://www.fema.gov/business/nfip/qanda.shtm
FEMA Planning Resource Center	http://www.fema.gov/plan/mitplanning/index.shtm
FEMA Region Offices	http://www.fema.gov/about/contact/regions.shtm

Federal Highway Administration (FHWA) Hydraulics Engineering	http://www.fhwa.dot.gov/engineering/hydraulics/index.cfm
Louisiana State University's (LSU) Extension Center	http://www.louisianafloods.org
National Climatic Data Center – Storm Events	http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms
National Conference of State Historic Preservation Officers	http://www.ncshpo.org/stateinfolist/FullList.htm
National Hurricane Center – Tropical Prediction Center	http://www.nhc.noaa.gov
National Oceanographic and Atmospheric Administration – Flooding Page	http://www.noaa.gov/floods.html
National Park Service Tribal Historic Preservation Officers	http://www.cr.nps.gov/hps/tribal/thpo.htm
Tennessee Valley Authority	http://www.tva.gov
U.S. Army Corps of Engineers (USACE) Divisions and Districts	http://www.usace.army.mil/divdistmap.html
USACE National Flood Proofing Committee	http://www.usace.army.mil/cw/cecw-p/NFPC/nfpc.htm
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