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.

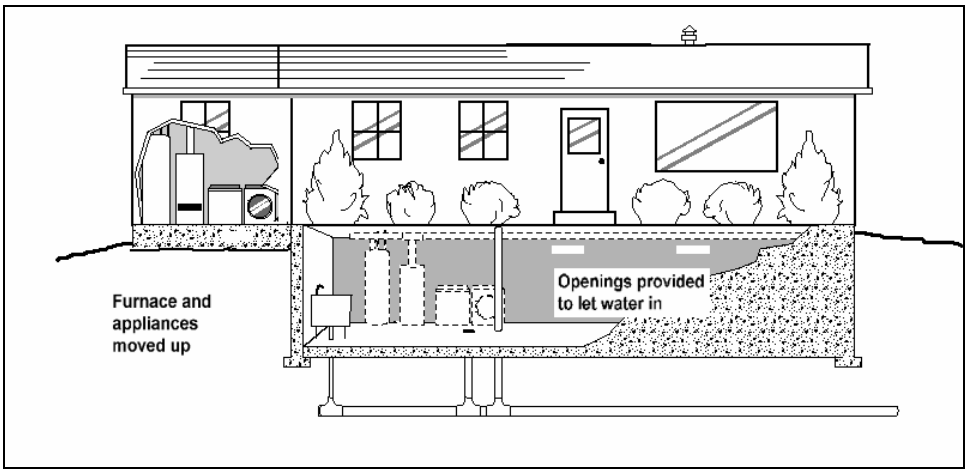

Figure 6-1. Wet floodproofed basement

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).

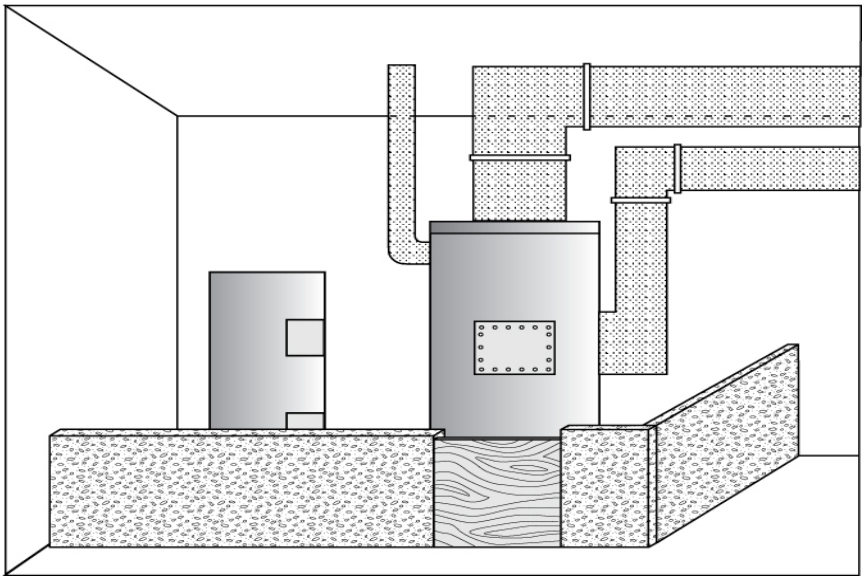

Figure 6-2. Small floodwall constructed to protect a furnace and hot water heater. A gate is installed for access.

(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).

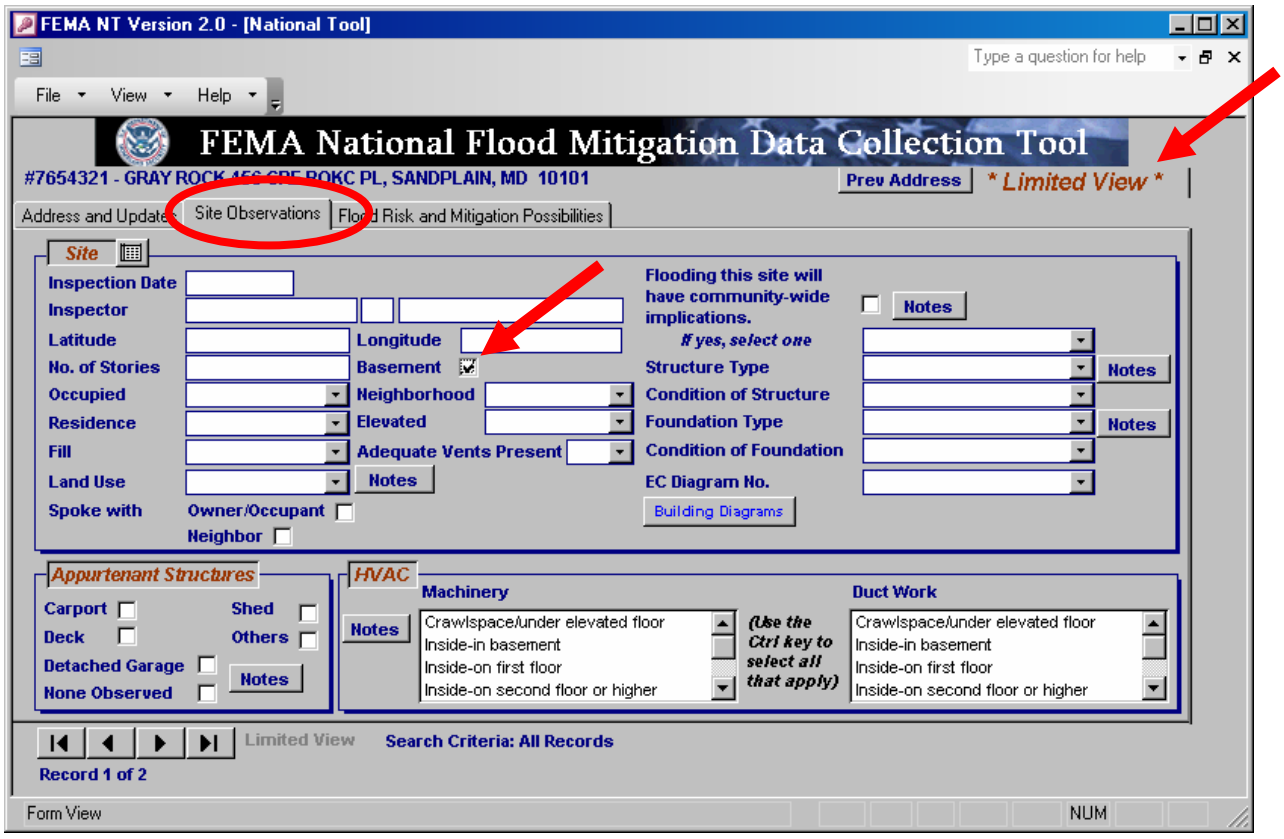

Figure 6-3. *Site Observations* tab - Basement

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).

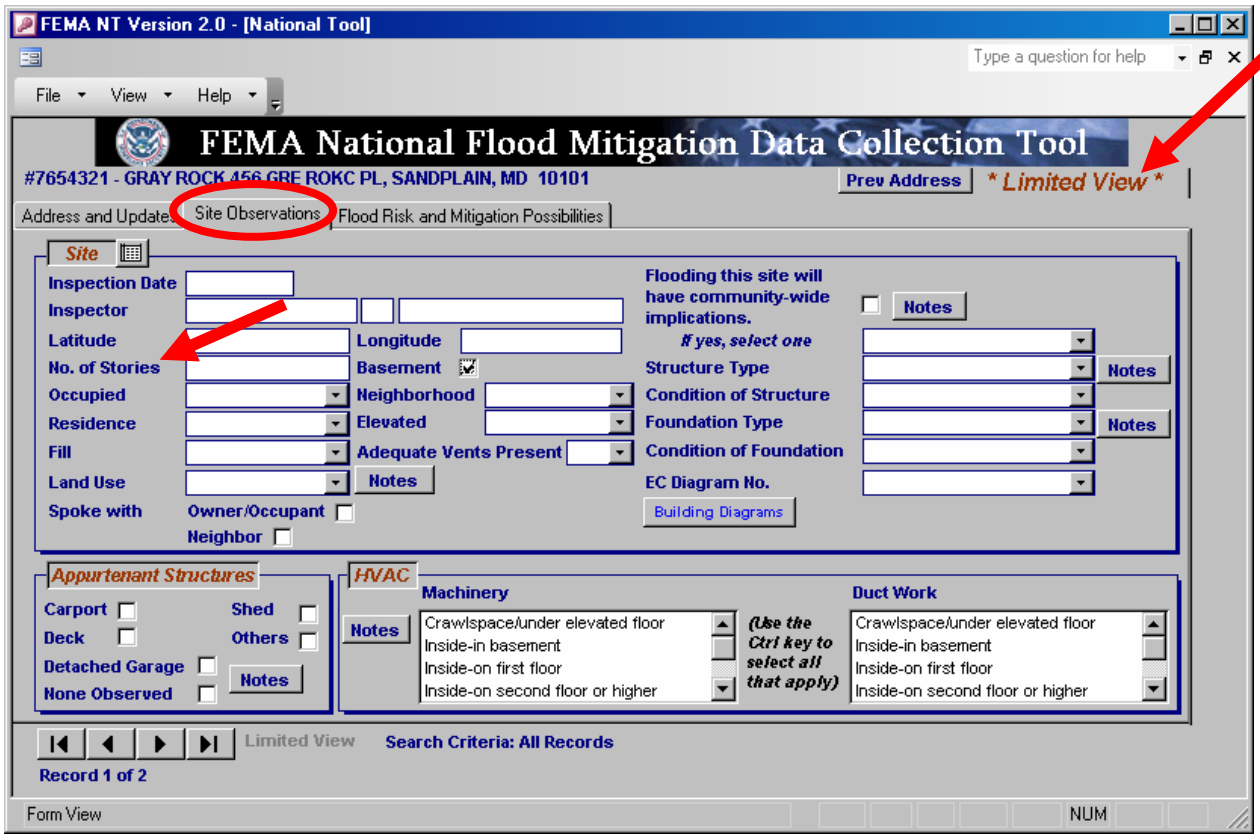

Figure 6-4. *Site Observations* tab - No. of Stories

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).

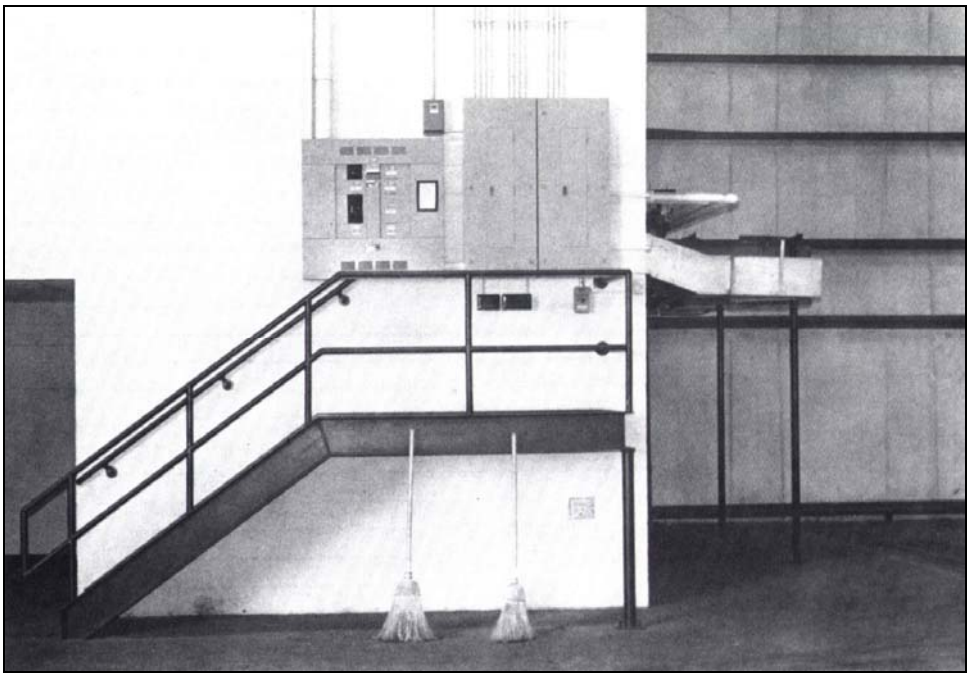

Figure 6-5. Electrical utilities elevated for protection against flooding

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).

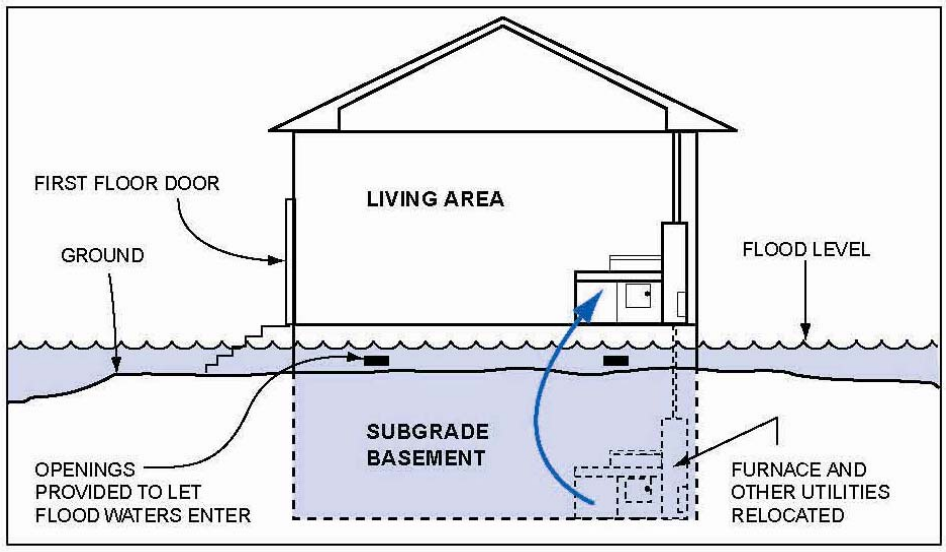

Figure 6-6. Wet floodproofing with a wet floodproofed subgrade basement

(Source: FEMA 312)

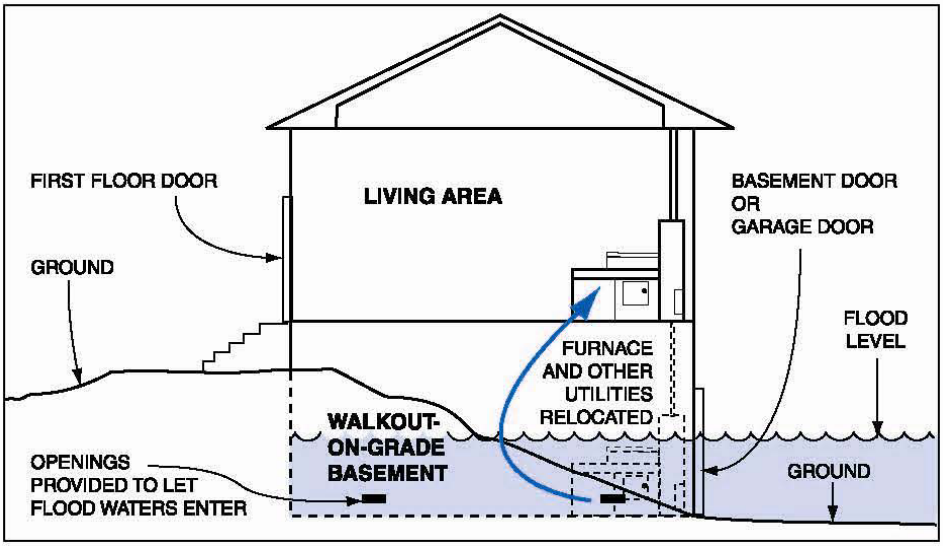

Figure 6-7. A structure with a wet floodproofed walkout-on-grade basement

(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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