Appendix B: Biltmore Village Emergency Flood Response Plan

Permanent Flood Proofing Measures

1.0 General

The responsibility for flood proofing, including the detailed planning, the purchasing of flood proofing materials and the implementation of flood proofing, lies solely with the owner or tenant of each structure. In order to offer as many options as possible to the stakeholders in Biltmore Village, this document includes both temporary (Appendix A) and permanent (this Appendix B) flood proofing measures. This appendix provides information and recommendations on permanent flood proofing; structure-specific information and flood proofing guidance are presented at the end of this appendix.

Permanent flood proofing measures are those which are implemented once yet provide protection against flood events for many years in the future. Each structure owner should weigh the costs associated with implementing temporary flood proofing measures numerous times as opposed to the long-term security and peace of mind that can come with implementing permanent measures. It is recommended that each owner transition to more permanent flood prevention measures as soon as reasonably possible.

It should be noted that the Federal Emergency Management Agency (FEMA) which regulates the National Flood Insurance Program considers flood proofing to be a viable option to paying for flood insurance. FEMA requires that a structure be protected up to the 100-year level of protection. However, some municipalities have more strict regulations. The municipality's more strict regulations would govern over the less strict national regulations.

Permanent mitigation measures for existing flood-prone buildings include: 1) removing such buildings from the flood plain, 2) relocating them from the flood plain, 3) water proofing them with permanent materials to keep flood waters out (dry flood proofing), 4) modifying them so that flood waters entering will not cause damage (wet flood proofing), 5) raising them above a design flood level (elevating), and 6) constructing berms, levees or floodwalls to protect individual buildings. The characteristics of each individual building, the characteristics of the site and characteristics of the flood all determine whether a structure can be flood proofed and what flood proofing measure is most efficient. Except for removal/relocation, the different mitigation methods will provide protection up to a design depth of flooding. Once the design flood level for flood proofing is exceeded, significant flood damages can occur. The different mitigation methods for buildings are discussed in the following sections.

2.0 Permanent Mitigation Methods

2.1 Acquisition and Removal of Flood-Prone Buildings

This measure is often referred to as a buy-out. A government agency offers owners to purchase their flood-prone buildings on a strictly voluntary basis. Flood-prone buildings that are acquired may either be moved out of the flood plain or demolished and the site cleared. In either case, all future flood damages to the building are eliminated. The cleared land can be used as part of a community park or recreation area or for some other function that is compatible with flooding. According to federal regulation, the sites of the buildings acquired with federal funds must become permanent open space for future flood flows.

2.2 Relocation

In relocation, the owner moves a building to a location outside the flood hazard area. This differs from a buy-out in that the building remains in private ownership, even if a government agency provides financial assistance with the relocation. Standard house-moving techniques are used for this method. Relocation is the ultimate option for the property owner who worries about flooding and wishes to be free of flood damages.

2.3 Dry Flood Proofing

Permanent dry flood proofing involves sealing the walls of buildings with waterproofing compounds, impermeable sheeting or other permanent materials and using water-tight closures on doorways and other openings to prevent floodwaters from entering. Check valves are fitted on sewer lines to prevent backup and flooding through the sewers. Generally, dry flood proofing should only be used on buildings constructed of reinforced concrete, concrete block or brick veneer on a wood frame. A general rendition of how dry flood proofing works is shown in Figure B-1. Dry flood proofing is not recommended for buildings with basements or for flood depths greater than three feet because of the danger of structural failure to a building from the hydrostatic forces. It is recommended that the owner have the structure evaluated by a contractor or certified professional prior to placing a substantial hydrostatic load on the building. The Corps also recommends the installation of sump pumps and one way valves for all structures in Biltmore Village. A real world example of dry flood proofing is shown in Figure B-2. The Corps recommends that any unneeded openings in a structure such as doors and windows be removed because any opening will require a closure structure, an example of which is shown in Figure B-3.

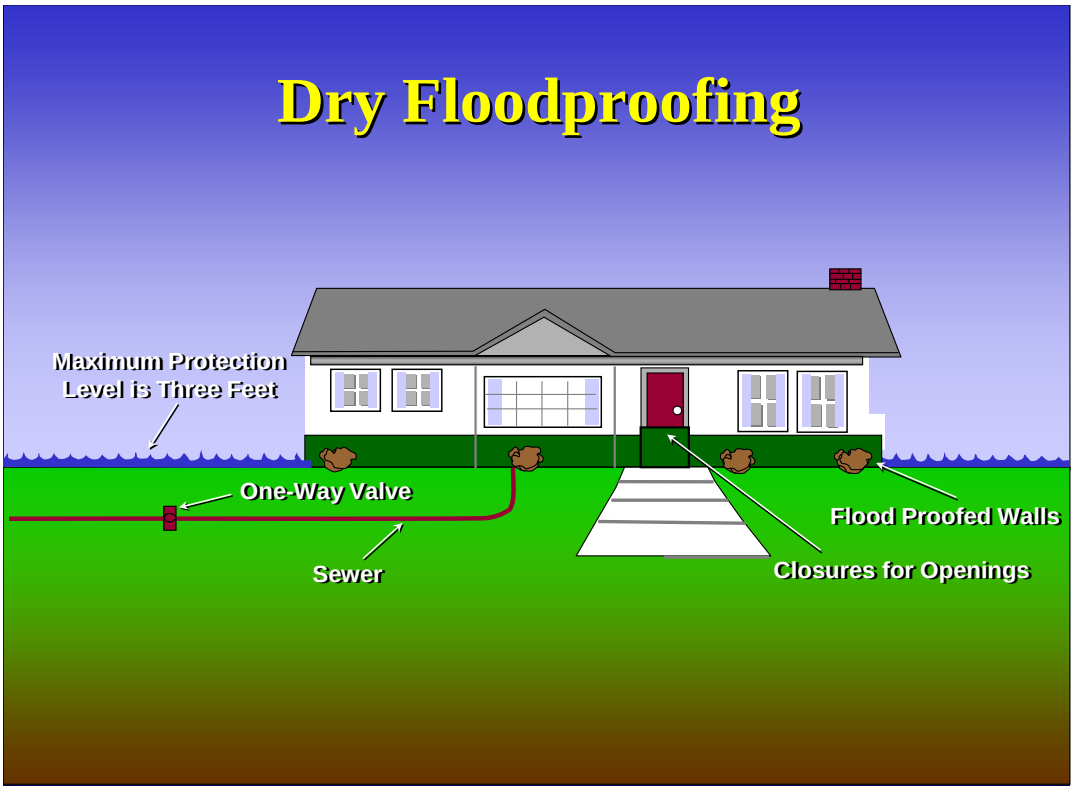

Figure B-1. Computer rendition of how dry flood proofing is implemented.

Figure B-2. Typical Dry Flood Proofing Example

During Construction. Notice the black flood proofing material behind the brick veneer.

After Construction. The fact that this structure has been retrofitted with flood proofing is barely noticeable.

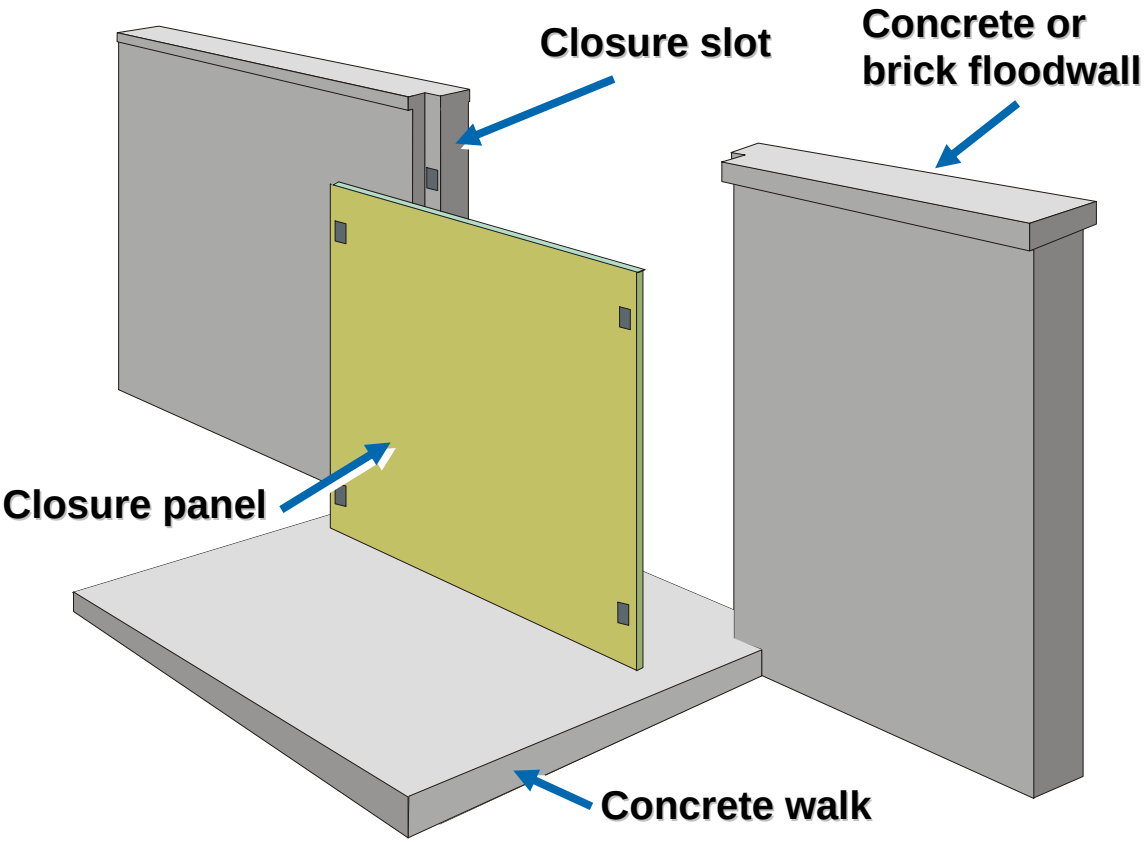

Figure B-3. Example of a closure structure

2.4 Wet Flood Proofing

Wet flood proofing allows a building to flood inside while ensuring that there is minimal damage to the building and its contents. Wet flood proofing is suitable for buildings with basements that have floor elevations above the design flood level. In wet flood proofing, flood vents are installed in the basement or foundation walls to allow floodwaters into the building. The interior flooding allows the hydrostatic forces inside and outside the foundation to equalize and eliminates the chance for structural damage. When a building is modified for wet flood proofing, vulnerable fixtures such as furnaces, water heaters and electric service panels are relocated above the design flood level. If sufficient warning time is available, the area below the design flood level can be used for storage, provided the owner plans to remove those items to higher floors before flooding begins.

2.5 Elevation

Elevation involves raising buildings in place so that the lowest floor is above the design flood level. Almost any structurally sound building can be raised. Buildings can be elevated on an open foundation or a closed foundation. Elevating a building on an open foundation involves raising it onto piers, post or piles (See Figure B-4). Elevating a building on a closed foundation involves raising it onto extended foundation walls (See Figure B-5) or onto compacted fill (See Figure B-6).

Figure B-4. Example of a house raised on an open foundation.

Figure B-5. Example of a house raised on a closed foundation.

Figure B-6. Example of a house raised on fill.

2.6 Berms, Levees and Floodwalls

Berms, levees or floodwalls are considered nonstructural measures when they are used to protect individual buildings. They are freestanding flood barriers that are located away from the building being protected and may completely surround the building or protect only a low side of the property. Unlike other flood proofing measures, a well-designed and constructed berm, levee or floodwall results in no damaging flood forces on the protected building and there is no need to make structural alterations to the building. An example of how these can be used to protect a structure is shown in Figure B-7.

While it is possible to design floodwalls and levees to resist large depths and flood forces, such as those associated with major flood protection projects, levees and floodwalls for individual buildings are generally of a height of 6 feet or less. This height restriction is usually necessary because of cost, limited space or esthetic concerns, or because the owner decides not to obtain the more rigorous design analysis required for greater height.

Berms and levees are typically constructed of compacted fill taken from locally available soils. Most types of soils are suitable for constructing levees. The best soils are those that have high clay content and therefore are highly impervious. Impervious soils minimize seepage problems either through or under the levee.

Floodwalls are constructed of stronger materials than levees and take up less space. Floodwalls may be constructed of a variety of materials such as poured concrete, concrete block or brick. Timber can be used in some applications as well as steel sheet pile. For large flood depths, floodwalls must resist the hydrostatic forces that could cause the floodwall to fail by tipping over.

Where it is necessary to have openings in a levee or floodwall for access to the protected building, water-tight closures must be provided to block the openings during floods. Sufficient warning time must be available before a flood to install the closures.

A sump pump should be incorporated into the design of a protective levee or floodwall to remove precipitation from within the protected area as well as any floodwater that may seep in. Sewers or drains into the protected area should be equipped with closure valves to prevent a backup of floodwater.

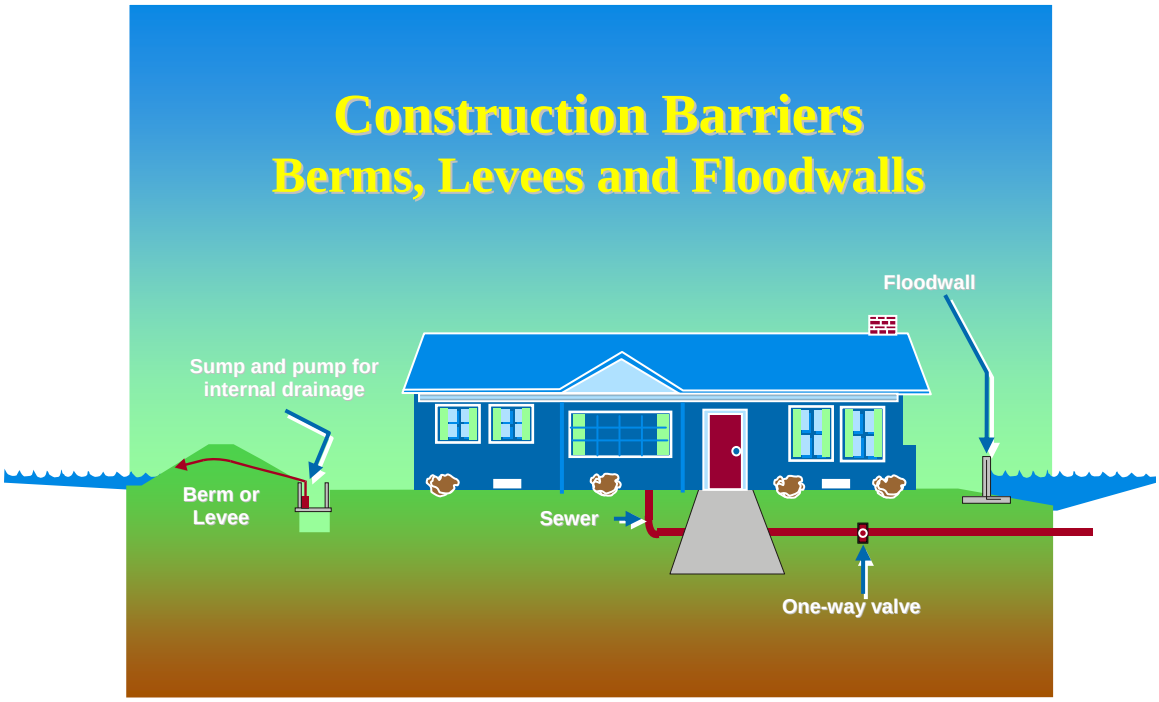

Figure B-7. Example of how berms, levees and floodwalls can be used to protect a structure

3.0 General Recommendations for Biltmore Village

The recommendations for the structures in Biltmore Village vary greatly. In many cases, the structure owners of structures can utilize one or a combination of the methods presented above to provide protection against flooding. The goal of the Corps of Engineers was to provide in this document guidance for protection up to the 100-year flood for all structures, but due to the great depth of 100-year flood waters in the lowest lying areas of Biltmore Village, protection up to the 100-year level for all structures is not feasible for all structures. Only structures in the study area that had first floor elevations below the 100-year level were considered in this study. Owners of structures already above the 100-year level can still implement flood proofing measures to protect up to an even higher level. The diversity of structures in this study will provide a good example for anyone wishing to permanently flood proof their structure.

4.0 Site Maps and Structure Sheets

Please use the following site maps to locate a structure of interest in the study area; structures are denoted by a unique number. Then, refer to the sheet(s) for that structure. The sheets typically contain building photos and the following data: 1) elevation of the lowest ground surface adjacent to the building, 2) first floor elevation, 3) current flood data, including the flood water elevations for various flood event frequencies, relative to the lowest ground and the first floor (negative numbers indicate that the water is below the ground or first floor; positive numbers indicate flooding), and 4) suggested permanent

flood proofing measures. Note that NAVD is the North American Vertical Datum, the vertical control datum established for vertical control surveying in the U.S.

Note that some structures are indicated on the maps but are not included in the recommendations. These include the Hill Partners mixed-use development on Brook Street (structure numbers 32-35) and the Bohemian Hotel (numbers 38 and 41), both of which are new projects which, by design, should already be protected to at least the 100-year flood elevation. Also, some structures are not identified by number on the master map but are identified on maps A1-3, B1-3 and C1-3.