

## Selecting Floodproofing Techniques – Financial Considerations

Floodproofing costs money. Generally, a higher level of flood protection costs more. Prior to selecting a floodproofing method, it is necessary to evaluate the benefits of a proposed project and the anticipated cost of achieving those benefits. The following information can be used as general guidance for evaluating floodproofing options.<sup>1</sup>

### Benefits

Floodproofing is principally a means for **reducing damages from future floods**. This includes the cost of repairing the building and its utility systems, repair or replacement of damaged contents, the time and expense for cleanup, the cost of housing during periods when the structure cannot be occupied, and loss of income if flood cleanup and repairs require time off from work. The tables on the following page can be used to estimate potential damages to buildings and contents based on the depth of flooding. The history of previous damages can also help with this assessment. Keep in mind that the damages from frequent events may be prevented numerous times over the life of the building. Because no floodproofing project can prevent all potential flood damages, the expected project benefit is the difference between the expected damages without the project and the expected damages if the project is implemented.

Additional benefits of floodproofing include:

- **Increased safety:** Floodproofing reduces health and safety impacts associated with reentry into a flooded structure. Relocation away from the flood hazard area precludes the need to evacuate and is thus even safer.
- **Reduced flood insurance premiums:** The cost of flood insurance for buildings that do not comply with floodplain development standards (at the time of construction) is generally quite high. Actuarial rates are based on the height of the first floor (or dry floodproofing of non-residential buildings) relative to the height of the 100-year flood. A project that brings a building into compliance and/or increases the level of protection can significantly reduce the annual cost of flood insurance.
- **Increased resale value.**
- **Intangible benefits** result from reducing the annoyance, inconvenience, and stress associated with preparation for and recovery from flood events.



### Project Costs

General information about construction costs for retrofitting projects is provided on the following pages. These values are only appropriate for preliminary planning purposes. Once a floodproofing method has been selected and the project is designed, a more accurate cost estimate can be developed. Make sure that the detailed cost estimate includes all of the project elements, such as temporary housing during construction, landscaping, and annual maintenance expenses.

<sup>1</sup> Additional information for assessing the financial benefits of a floodproofing project is provided in *Chapter V: Benefit / Cost Analysis and Alternative Selection*, in FEMA 259, *Engineering Principles and Practices of Retrofitting Flood-Prone Residential Structures* (2001) at <http://www.fema.gov/library/viewRecord.do?id=1645>.

### Depth-Damage Tables

The following tables can be used to estimate the damage that may be sustained each time a building is flooded, based on the depth of flooding relative to the top of the first floor (excluding the basement, which is defined as any portion of the building with its floor below grade on all sides).

Flood Depth	Building Damage Percent by Building Type (based on Building Replacement Value)						
	1 Story without Basement	2 or More Stories without Basement	Split Level without Basement	1 Story with Basement	2 or More Stories with Basement	Split Level with Basement	Mobile Home*
-2	0.0	0.0	0.0	13.8	10.2	10.4	0.0
-1	2.5	3.0	6.4	19.4	13.9	14.2	0.0
0	13.4	9.3	7.2	25.5	17.9	18.5	8.0
1	23.3	15.2	9.4	32.0	22.3	23.2	44.0
2	32.1	20.9	12.9	38.7	27.0	28.2	63.0
3	40.1	26.3	17.4	45.5	31.9	33.4	73.0
4	47.1	31.4	22.8	52.2	36.9	38.6	78.0
5	53.2	36.2	28.9	58.6	41.9	43.8	80.0
6	58.6	40.7	35.5	64.5	46.9	48.8	81.0
7	63.2	44.9	42.3	69.8	51.8	53.5	82.0
8	67.2	48.8	49.2	74.2	56.4	57.8	82.0
9	70.5	52.4	56.1	77.7	60.8	61.6	82.0
10	73.2	55.7	62.6	80.1	64.8	64.8	82.0
11	75.4	58.7	68.6	81.1	68.4	67.2	82.0
12	77.2	61.4	73.9	81.1	71.4	68.8	82.0
13	78.5	63.8	78.4	81.1	73.7	69.3	82.0
14	79.5	65.9	81.7	81.1	75.4	69.3	82.0
15	80.2	67.7	83.8	81.1	76.4	69.3	82.0

Source: "Default Building Depth-Damage Functions: Residential Buildings" from FEMA Retrofitting Flood-Prone Residential Buildings Training (January 2009).

Flood Depth	Contents Damage Percent by Building Type (based on total value of contents)					
	1 Story without Basement	2 Story without Basement	Split Level without Basement	1 or 2 Story with Basement	Split Level with Basement	Mobile Home
-2	0	0	0	6	5	0
-1	0	0	0	12	8	0
0	14	8	5	17	9	12
1	21	14	14	23	24	66
2	33	20	20	30	29	90
3	41	27	38	35	33	90
4	44	30	41	42	41	90
5	45	33	42	50	48	90
6	60	36	50	57	53	90
7	65	39	51	66	54	90
8	66	44	62	74	66	90
>8	68	50	65	77	72	90

Source: FEMA 259, *Engineering Principles and Practices of Retrofitting Flood-Prone Residential Structures* (2001).

## Floodproofing Cost Estimates

The following cost estimates are for preliminary planning purposes only. They are based on nationwide averages and published in 2001.<sup>2</sup>

### Elevation:

- 2-foot raise: Wood frame building with basement or crawlspace – \$18 per square foot
- Wood frame building with slab-on-grade foundation – \$50 per square foot
- Masonry building with basement or crawlspace – \$37 per square foot
- Masonry building with slab-on-grade foundation – \$50 per square foot
- 3- to 8-foot raise – add \$0.80 per square foot for each additional foot of elevation
- Above 8 feet – add \$1.05 per square foot
- Wood frame with brick veneer on walls – add 10 percent

These costs include foundation, existing utilities, and miscellaneous items. Large buildings (3 or more stories and those with footprints more than 2,500 square feet) and those with complex shapes are technically more difficult to elevate and may thus be more costly.

Displacement costs – Additional expenses will be incurred to remove and store contents and for temporary living quarters during construction, which may last 2 to 3 weeks.

### Relocation:

- Relocation costs: Wood frame building with basement – \$34 per square foot
- Wood frame building with crawlspace – \$29 per square foot
- Wood frame building with slab-on-grade foundation – \$54 per square foot
- Masonry building with basement – \$52 per square foot
- Masonry building with crawlspace – \$34 per square foot
- Masonry building with slab-on-grade foundation – \$65 per square foot
- Wood frame with brick veneer on walls – add 10 percent
- Restoration of old site: \$12 per square foot of building footprint

These costs include off-site relocation (less than 5 miles) and new site development for a 1,000 square foot building. Extrapolation of this unit cost to larger buildings may result in artificially high estimates because the costs of relocation do not increase proportionally with building size. However, if the building has 3 or more stories, a footprint greater than 2,500 square feet, or a complex shape, technical challenges may result in increased costs.

Displacement costs – Additional expenses will be incurred to remove and store contents and for temporary living quarters during construction, which may last 3 to 4 weeks.



<sup>2</sup> Source: FEMA 259, *Engineering Principles and Practices of Retrofitting Flood-Prone Residential Structures* (2001).

### Dry Floodproofing

Sprayed-on cement (above grade) – \$3.50 per square foot  
 Waterproof membrane (above grade) – \$1.17 per square foot  
 Asphalt (2 coats below grade; not including cost of excavation) – \$1.17 per square foot  
 Perimeter drainage – \$33 per linear foot  
 Plumbing check valve – \$660 lump sum  
 Sump pump (with backup battery) – \$1,060 lump sum  
 Metal flood shield – \$77 per square foot  
 Wood flood shield – \$24 per square foot  
 Sprayed-on cement (above grade) – \$3.50 per square foot

### Wet Floodproofing

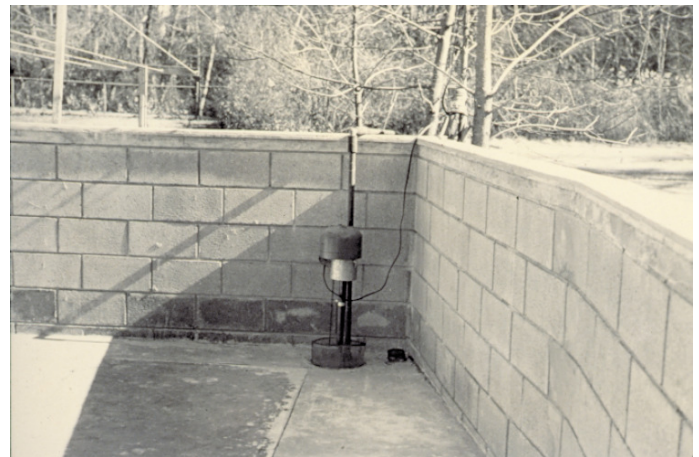
Unfinished basement: 2 feet height (above basement floor) – \$1.80 per square foot of house footprint  
 4 feet height (above basement floor) – \$3.70 per square foot of house footprint  
 8 feet height (above basement floor) – \$10.60 per square foot of house footprint  
 Crawlspace: 2 feet height (above lowest adjacent grade) – \$1.40 per square foot of house footprint  
 4 feet height (above lowest adjacent grade) – \$3.45 per square foot of house footprint

### Floodwalls and Levees

Floodwalls: 2 feet above ground level – \$90 per linear foot  
 4 feet above ground level – \$132 per linear foot  
 Levees: 2 feet above ground level – \$39 per linear foot  
 4 feet above ground level – \$73 per linear foot  
 6 feet above ground level – \$122 per linear foot

Interior drainage – \$4,500 lump sum  
 Closures – \$77 per square foot  
 Riprap – \$33 per cubic yard  
 Seeding of disturbed areas – \$0.05 per square foot

Floodwall costs are based upon typical foundation depth of 30 inches. Levee costs are based upon typical foundation depth of one foot, 5-foot top width, and 1:3 side slopes. Levee costs include seeding and stabilization.



### Additional Costs

- Compliance with building codes – These estimates do not include additional expenditures that may be required to bring the building into compliance with building codes.
- Professional or architectural design – 10% of estimated costs
- Contractors' profit – 10% of estimated costs
- Contingency to account for unknown or unusual conditions
- Annual maintenance expenses – Levees, floodwalls, dry floodproofing, and wet floodproofing projects all require ongoing maintenance.

### **Additional Information**

- **FEMA's Benefit-Cost Analysis** methodology and tools can be used to evaluate the cost effectiveness of proposed retrofitting projects (<http://www.fema.gov/government/grant/bca.shtm>).