

## **Appendix D**

### **406 Hazard Mitigation Measures for Large Projects**

#### Infrastructure Systems

##### Drainage, Crossings, and Bridges:

- Drainage structures – When drainage structures are destroyed, replacing the structure with multiple structures or a larger structure. However, structures need to be considered with regard to a total drainage system and should not be replaced without a watershed hydrology study.
- Low span bridges – Demolish/replace damaged low span bridges or other crossings that act to collect debris, increase flooding, and/or can be severely damaged.
- Low-water crossings – Where traffic counts are low, replacing bridges with carefully placed low-water crossings.
- Debris traps – Installing traps upstream of a culvert to prevent culverts from becoming clogged by vegetation.
- Erosion Control Measures – Gabion baskets, riprap, sheetpiling, and geotextile fabric installation to control erosion.
- Headwalls and wing walls – Installation to control erosion.
- Restraining cables on bridges – Installation of cables to restrain a bridge from being washed off piers or abutments.

#### Sanitary and Storm Sewer Systems

- Access covers – When feasible, access covers can be elevated to the hydraulic grade line. There are a number of devices that prevent infiltration into access holes.

##### Sewer lines:

- Repair, lining or encasement of damaged sections to prevent infiltration or structural collapse.
- Relocating sections of damaged sewer lines to avoid damage from slip-out on roads or to avoid damage to lines crossing a stream or drainage area.

Pump stations:

- Equipment or controls in a pump station that are subject to damage from the 100-year flood can be elevated. Pump station buildings can be dry floodproofed.
- Installation of camlocks, transfer switches, and electrical panels to ease the hook-up of portable emergency generators.

Wastewater Treatment Plants

- Elevation of equipment and controls that can be elevated easily.
- Dry or wet floodproofing of buildings.

Potable Water

Well systems:

- Reduction of infiltration and subsequent contamination of the aquifer. Methods include casing the well or raising the elevation of the well head.
- Elevation of controls, mechanical equipment, or electrical service associated with use of the well to protect them from flood damage.
- Raw water intakes – Strengthening to prevent damage from erosion, scour and flood debris.

Water treatment plants:

- Elevation of equipment and controls that can be elevated easily.
- Dry floodproofing.

Electric Power Distribution

- Pad-mounted transformers – elevating above the base flood elevation, or lowering them or burying them in non-flood, high-wind areas.
- Using multiple poles to support transformers.
- Burying lines.

- Anchoring or otherwise protecting fuel tanks from movement in a disaster.
- Replacing damaged poles with higher-class pole, or with a different material pole such as replacing wood poles with spun concrete poles.
- Adding guy wire or other additional support to power lines.
- Removing large diameter communication lines from power poles.
- Providing looped distribution service or other redundancies in the electrical service to critical facilities.

#### *Above Ground Storage Tanks*

- Strengthening or stiffening base connections.

#### *Underground Pipelines*

- Installation of shut-off valves (based on accepted practice) so that damaged sections of pipeline can be isolated.

### **Buildings—General**

#### *General Effects of Flood Damage*

- Buildings substantially damaged under NFIP regulations – Repair, dry floodproofing, or elevation so they are protected to meet minimum NFIP regulations. If the building is replaced, rather than repaired, no Section 406 hazard mitigation funding is appropriate.
- Buildings not substantially damaged under NFIP regulations – If technically feasible, dry floodproofing. Electrical panels, machinery rooms, emergency generators can be elevated above the BFE or dry floodproofed. If dry floodproofing is not feasible, these buildings should be wet floodproofed.

#### *Roofs*

Because the failure of a roof covering can lead to extensive damage to contents and operation, damaged roofing should never be replaced with the same material unless the cause of failure has been identified and corrected.

Roof-mounted equipment should be attached to a foundation that will resist expected wind forces.

- Low slope roofs – Replacement of the entire roof with a roof covering with a secondary membrane and a fully adhered roof covering that is not subject to

progressive failure, such as a modified bitumen. Mechanically fastened insulation or membranes are not acceptable.

- Curbing and flashing – Single membrane and built up roofs can be susceptible to progressive failure from flashing and curbing failure. These items should be inspected and repaired or replaced. National Roofing Contractors can provide technical advice.
- Ballasted roof systems – Roof systems with gravel or other small ballast should be replaced with ballast of sufficient weight that it does not become airborne causing increased damages.
- Hurricane clips – Hurricane clips may be recommended for use in high-wind areas.

### Shutters

In areas subject to hurricane winds, shutters are appropriate in the following areas:

- All windows on critical facilities such as hospitals.
- The lower floors of buildings with windows most likely to be struck by debris.
- Windows of buildings with very high value contents that can be damaged by water (such as libraries and document centers).
- Windows of buildings subject to debris from nearby ballasted roofs, metal buildings, manufactured homes or other structures likely to fail and result in debris.

### Anchoring

- Anchoring of mechanical and electrical equipment in critical facilities.

### Flexible Piping

- Installation of flexible piping at pipe/conduit connections to equipment to accommodate expected movement in an earthquake.

### Bracing

- Bracing of overhead pipes and electrical lines to meet seismic loads.
- Bracing interior walls and partitions that could collapse, preventing safe exit from the building.

- Bracing parapets, anchoring veneer or cladding, and bracing other non-structural elements that could collapse and cause injury or block safe exit of a building during an earthquake.

*Replacement of Glass*

- Replacement of glass (with break-resistant material) in mullions to prevent breakage and fallout in the event of building movement.