



## Executive Summary

On September 28, 1998, Hurricane Georges made landfall in the Ocean Springs/Biloxi, Mississippi area. Over the next 30 hours, the storm moved slowly north and east, causing heavy damage along the Gulf Coast in Alabama, Florida, and Mississippi. Preliminary data from National Weather Service (NWS) reports indicate that maximum sustained winds ranged from 46-mph at Pensacola, Florida to as high as 91-mph with peak gusts up to 107-mph at Sombrero Key in the Florida Keys.

Storm surges over the area ranged from more than 5 feet in Pensacola, Florida to 9 feet in Pascagoula, Mississippi. According to the NWS, the Town of Munson, Florida, in Santa Rosa County, received the highest recorded level of rainfall with more than 38 inches. Elsewhere in the Gulf Coast area, total rainfall ranged from 8 to 26 inches.

Hurricane Georges caused extensive erosion to the Gulf Coast. Many coastal barrier islands, including Dauphin Island and the Chandeleur Islands, were completely overwashed in areas, and vertical beach loss and considerable shoreline retreat occurred. High tides and rain washed out major highways and flooded beachfront homes in many areas of Alabama, Florida, and Mississippi.

On October 2, 1998, the Federal Emergency Management Agency (FEMA) Mitigation Directorate deployed a Building Performance Assessment Team (BPAT) to the Gulf Coast to assess damages caused by Hurricane Georges. The team included FEMA Headquarters and Regional Office engineers, planners, and a coastal geologist; consulting engineers; floodplain management specialists; and a forensic engineer.

The BPAT's mission was to assess the performance of buildings in the Gulf Coast area and make recommendations for improving building performance in future hurricanes. The assessment included areas of the Gulf Coast from Pensacola Beach, Florida, to Gulfport, Mississippi (including Mobile Bay, Alabama). In addition, a supplemental assessment of manufactured home performance was conducted in the Florida Keys. The assessment also included inland areas along major streams and rivers that experienced flooding. The BPAT process is intended to provide guidance to state and local governments on post-hurricane reconstruction and new construction with the goal of enhancing future building design and construction.

In conducting this assessment, the BPAT focused on:

- The success and effectiveness of flood and wind hazard mitigation initiatives undertaken prior to Hurricane Georges, including acquisition and removal of structures located in floodprone areas, elevation of floodprone buildings, installation of storm shutters, and high wind roofing systems;
- Siting and other planning issues that contributed to building success, damage, or failure;

- Floodplain management issues, including repetitive loss structures and floodplain mapping; and
- The impact of the hurricane on the shoreline/beach system.

An aerial survey and on-the-ground site investigations were conducted to observe building conditions in selected areas affected by the storm. One- and two-family, one- to three-story wood-frame structures elevated on pilings were the primary building types assessed in coastal areas, although some slab-on-grade structures were included. In riverine areas, one-family wood-frame structures were the primary structures inspected. Foundation types included piles, perimeter wall/crawl space, and slab-on-grade. Several public and commercial buildings in coastal and riverine areas were also evaluated, including a hospital, convention center, fire houses, municipal buildings, schools, and casinos.

The Gulf Coast region experienced the loss of several vertical feet of beach sand and sustained considerable shoreline damage as a result of Hurricane Georges. By far, the most severe flood damage the BPAT observed was a result of coastal surge along the Alabama Gulf Coast, specifically Dauphin Island, the eastern and western shores of Mobile Bay, and the Fort Morgan/Gulf Shores areas. Building damage was concentrated on the front row of houses. Houses set back and properly elevated on deep pilings suffered little damage. Hundreds of inland residential structures in Alabama, Florida, and Mississippi were also inundated with water by riverine flooding.

Hurricane Georges did not cause significant wind-related structural damage along the Gulf Coast. Buildings along the open coast suffered minor wind damage, including loss of sections of composition roof shingles and siding. While limited structural damage was observed, many homes that sustained roof damage were susceptible to further interior damage from rainfall. Wind damage in inland areas included damage to trees and signs. The most severe inland wind damage occurred to signs, roofs, and trees in the Pascagoula, Mississippi area.

The BPAT findings are summarized below:

- Engineered structures constructed in accordance with current building codes, such as the Standard Building Code (SBC), National Flood Insurance Program (NFIP) compliant local floodplain management requirements, and additional state and local standards performed well;
- Communities that recognized and required buildings be designed and constructed for the actual hazards present in their area, sustained reduced damages;
- Manufactured homes with reinforced concrete or reinforced masonry piers and proper anchoring performed well;
- Specialized building materials such as siding and roof shingles designed for higher wind speeds performed well; and
- Publicly financed flood mitigation programs and planning activities clearly had a positive impact on the communities where they were implemented.

The BPAT concluded that several factors contributed to the building damages observed in the Gulf Coast area:

- Riverine flooding in many areas exceeded the 100-year flood level;
- Inadequate pile embedment depths on coastal structures;
- Inadequately elevated and protected on-site utility systems;

- Inadequate designs for frangible concrete slabs below elevated buildings in coastal areas subject to wave action;
- Impact from waterborne debris on coastal structures;
- Siting of houses that did not consider localized impacts of coastal erosion and scour;
- Corrosion of hurricane straps on coastal structures;
- Site-built attachments to manufactured homes; and
- Improperly installed manufactured home anchors.

The BPAT developed recommendations for reducing future hurricane damage. The recommendations address areas of concern, including: continuing development of flood mitigation programs and planning; mitigating residual flood risk; increasing the pile embedment depth for coastal structures; improving the installation of utilities to include greater attention to the potential effects of riverine and coastal flooding; proper design of below-building concrete slabs; mitigating waterborne debris impact; protecting metal structural components from corrosion; improving attachment design and anchoring for awnings, decks, and porches on manufactured homes; and proper use and installation of manufactured home anchors.