2 Site Observations

2.1 Assessment Team Approach

On September 12, 1996, the FEMA Mitigation Directorate deployed a BPAT to coastal North Carolina to assess damage caused by Hurricane Fran. The team was composed of FEMA Headquarters and regional office engineers, a State representative, a consulting structural engineer, a consulting specialist in coastal construction and shoreline erosion, a consulting coastal engineer, the Chief Underwriter of the NFIP, and an engineer from the Insurance Institute for Property Loss Reduction. (See Appendix B for a list of team members.) Some members of the BPAT also represented the American Society of Civil Engineers (ASCE) Committee on Flood-Resistant Design and Construction.

The mission of the BPAT was to assess the performance of buildings on the barrier islands most directly affected by Hurricane Fran and to make recommendations for improving building performance in future events. Better performance of building systems can be expected when the causes of observed failures are determined and repair and reconstruction are undertaken in accordance with recognized standards of design and construction. The immediate goal of the BPAT process is to provide guidance to State and local governments for post-hurricane reconstruction. In addition, the BPAT's findings can enhance future coastal design and construction.

The BPAT made its assessments by conducting site investigations to observe the condition of buildings in selected areas affected by the storm. The scope of the BPAT process did not include recording the numbers of buildings damaged by the hurricane, determining the frequency of specific types of damage, or collecting other data that could serve as the basis of statistical analyses. Collectively, the team did invest over 600 hours of effort conducting site investigations, inspecting damages, and preparing documentation. Documentation of observations made during ground-level and aerial surveys included field notes and photographs.

On Friday, September 13, 1996, the BPAT conducted an aerial survey along the North Carolina coast from Wrightsville Beach (in the south) to Emerald Isle (in the north). Ensuing ground observations were made in the area extending from Kure Beach (in the south) to North Topsail Beach (in the north). Figure 2-1 shows the areas where the aerial surveys and ground observations were made. Other communities in the studied area include Carolina Beach, Wrightsville Beach, Topsail Beach, and Surf City. Documentation of observations made during the ground and aerial surveys included field notes and photographs.

The BPAT assessed the performance of primary structural systems of buildings, i.e., systems that support the building against lateral and vertical loads experienced during a hurricane; building extensions, such as decks, porches, and roof overhangs; nonstructural building components such as breakaway walls and below-building concrete slabs; and on-site building support utilities such as electrical, water, and sewage services. The team focused its efforts on primary structural systems. It is extremely important to note, however, that damage to other portions of buildings often contributed to the damage incurred by the primary structural systems.

The building types observed were primarily one- and two-family, one- to three- story, wood-frame structures elevated on wood pilings. Other types of construction observed included one- and two- family wood-frame, slab-on-grade houses, manufactured homes and permanently installed recreation vehicles (RVs) on dry-stack masonry foundations, and a small number of

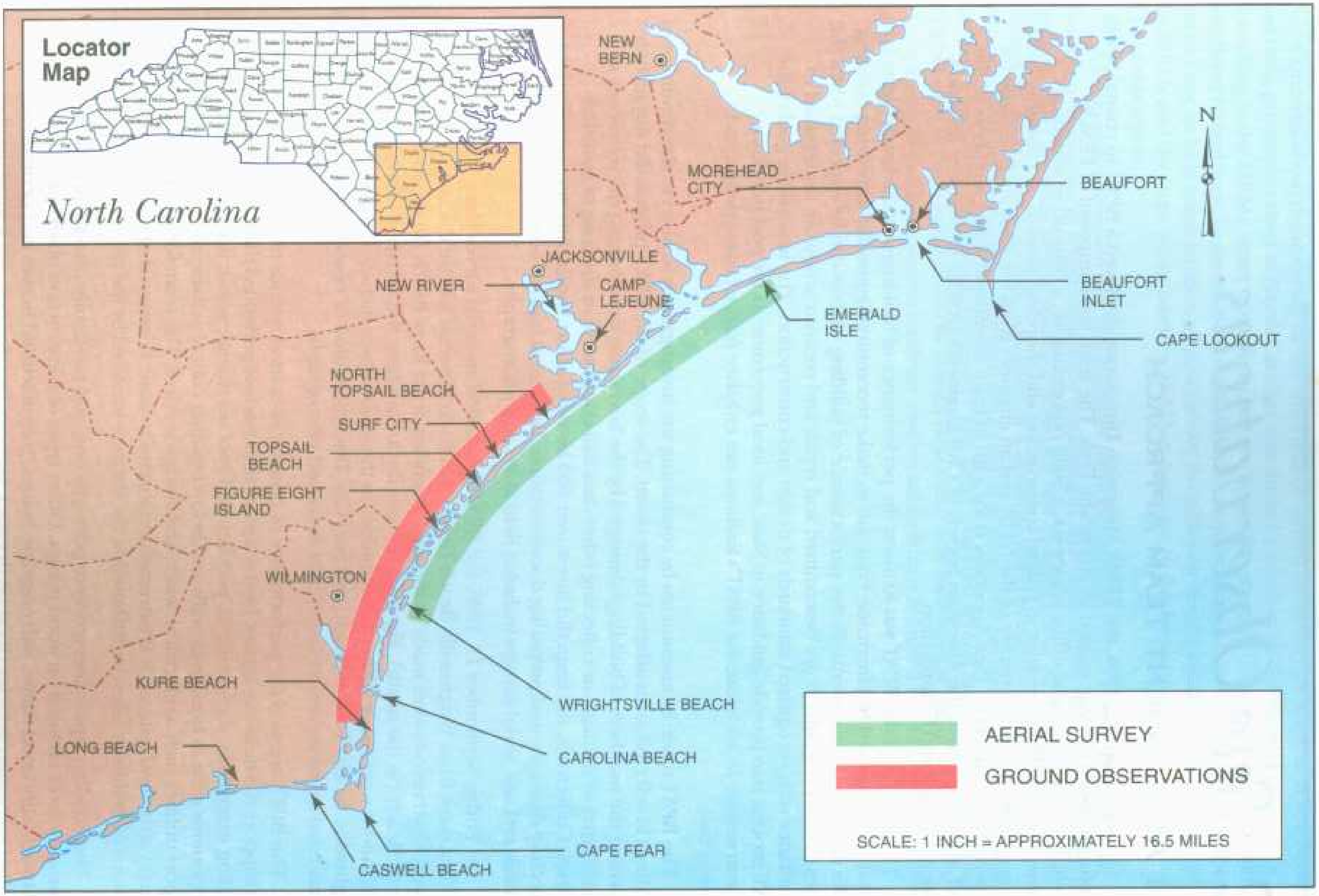

Figure 2-1 *Areas of BPAT aerial survey and ground observations.*

wood-frame structures elevated on solid perimeter masonry walls. In general, wood-frame structures elevated on piling foundations outperformed all other types of foundations (e.g., masonry pier, solid perimeter masonry wall [crawl space], slab-on-grade) in resisting flood effects, including velocity flow, storm surge, breaking waves, debris impact, erosion, and scour. The team also observed two commercial structures: a hotel in which dry floodproofing measures helped protect the structure from flood damage and a large oceanfront engineered concrete building that performed well.

2.2 Erosion and Scour

Oceanfront Residential Buildings

Coastal areas from Cape Fear to Cape Lookout experienced significant erosion and scour. In many locations, especially from Topsail Beach to North Topsail Beach, localized frontal dunes were eroded and the beach profile was lowered 2 to 3 feet. Erosion beneath oceanfront homes averaged 4 to 6 vertical feet (see Figure 2-2). In addition, erosion and localized scour at vertical foundation members was observed to have occurred.

A cursory study of localized scour was performed during the site investigation. Sand surrounding pilings was excavated to identify the maximum localized scour that occurred. From changes in sand color, texture, and bedding, the team determined that, in general, localized scour occurred to a depth of approximately 1 to 1.5 times the diameter or width of the piling (see Figure 2-3). The depth of scour around 8-inch-diameter round pilings and 8-inch x 8-inch square pilings supporting oceanfront structures was measured to be approximately 10 to 11 inches.

Figure 2-2 *Erosion resulted in significant loss of supporting sand, averaging 4 to 6 feet, under oceanfront buildings.*

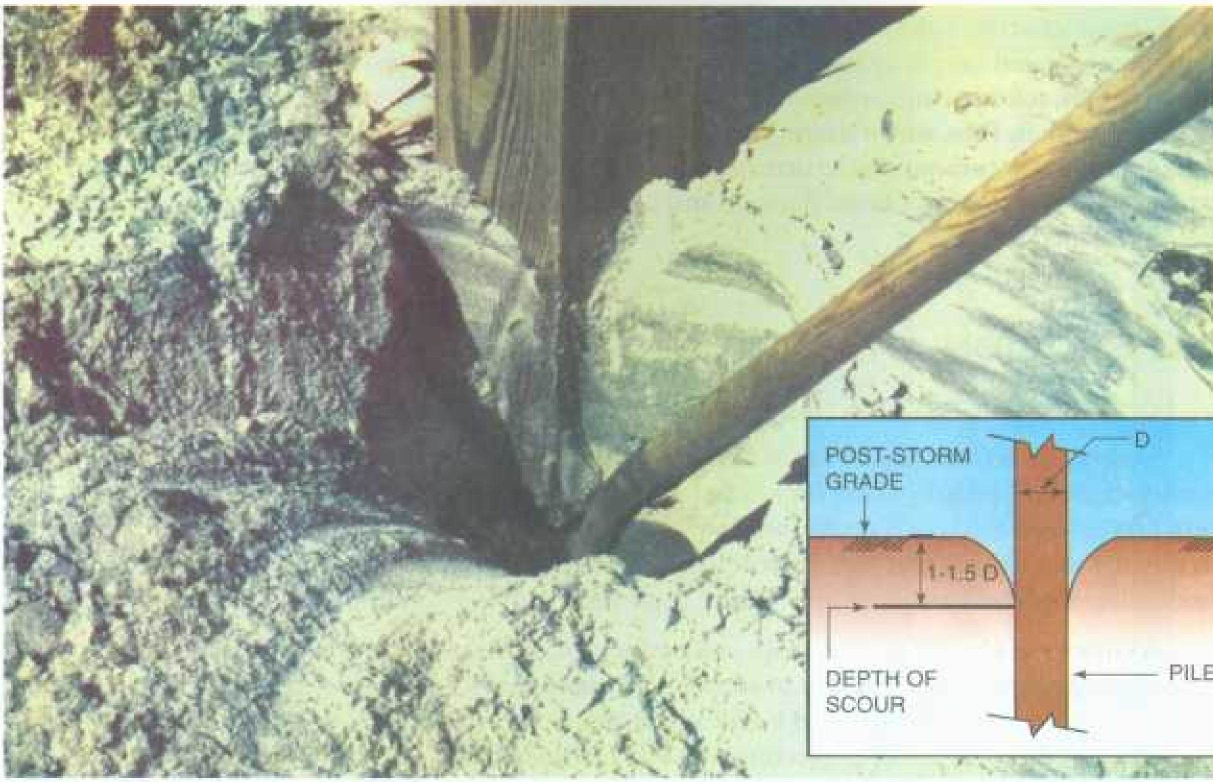

Figure 2-3 Determination of localized scour from changes in sand color, texture, and bedding.

Erosion and scour were commonly observed to total 5 to 7 vertical feet at oceanfront homes in the area from Topsail Beach to North Topsail Beach. This erosion and scour, added to the long-term erosion rate of an average 1 to 2 feet a year, left many homes unable to withstand the loads imposed by flood and wind forces acting simultaneously (see Figure 2-4).

Landward Residential Buildings

No evidence of general erosion was observed in the areas around landward structures, but evidence of localized scour around pilings and other obstructions was plentiful (see Figures 2-5 and 2-6). In general, scour did not result in the failure of the piling foundations of landward structures. However, scour around the vertical members supporting air conditioner platforms and building extensions such as decks, porches, and roof overhangs occasionally decreased the ability of the vertical members to withstand flood forces and led to their collapse.

Figure 2-4 *Loss of the frontal dune and the resulting erosion and scour left many coastal houses unable to resist wind and flood loads acting simultaneously.*

Figure 2-5 *Overwash of barrier islands generated high-velocity flows that caused extensive scour adjacent to large objects.*