



# *Floodplain Management Regulations and Building Codes and Standards*

**F**loodplain management regulations, and building codes and standards, are adopted and enforced to regulate construction in at-risk areas. The floodplain regulations applicable to the affected areas are discussed in Section 2.1. Section 2.2 discusses the building codes and standards used to regulate construction in Alabama and Florida. The building code requirements specific to floods are discussed in Subsections 2.2.1 (Alabama) and 2.2.2 (Florida). Subsections 2.2.3 and 2.2.4 discuss the Alabama and Florida building code requirements specific to wind, respectively.

## **2.1 Floodplain Management Regulations**

**A**ll of the communities visited by the MAT participate in the NFIP and have adopted floodplain management regulations that meet or exceed minimum NFIP requirements. Up until 2000, these requirements generally were contained only in community floodplain management ordinances. Starting in 2000, however, flood-resistant provisions and floodplain management requirements began to be incorporated into model building codes (e.g., the International Building Code [IBC], the International Residential Code [IRC], and the National Fire Protection Association [NFPA] 5000).

Thus, if a community in Alabama has adopted a recent edition of these codes (without amending the code to remove the flood provisions), it will have two avenues for enforcing flood-resistant design and construction requirements – the floodplain management ordinance and the building code (see Figure 2-1). More details are contained in Sec. 2.2.1 of this report.

### How Floodplain Regulations Influence Building Design Alabama

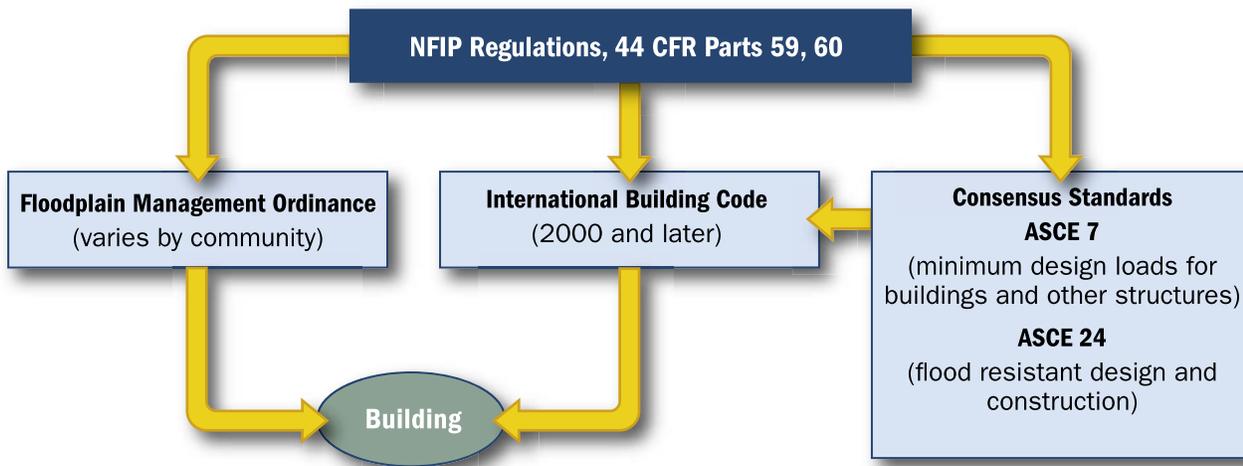


Figure 2-1. Floodplain Management Regulations and Building Design, Alabama

This is not the case in Florida, where the Florida Building Code (FBC) is in place. Chapter 31 of the FBC specifically defers floodplain management issues to the community floodplain management ordinance. However, a companion set of design requirements for coastal construction seaward of Florida's Coastal Construction Control Line (CCCL) has been placed in Chapter 31 of the FBC (see Figure 2-2). Many of the CCCL requirements are similar in nature to NFIP requirements (e.g., pile foundations, elevation above the 100-year wave crest elevation, etc.). More details are contained in Sec. 2.2.2 of this report.

### How Floodplain Regulations Influence Building Design Florida

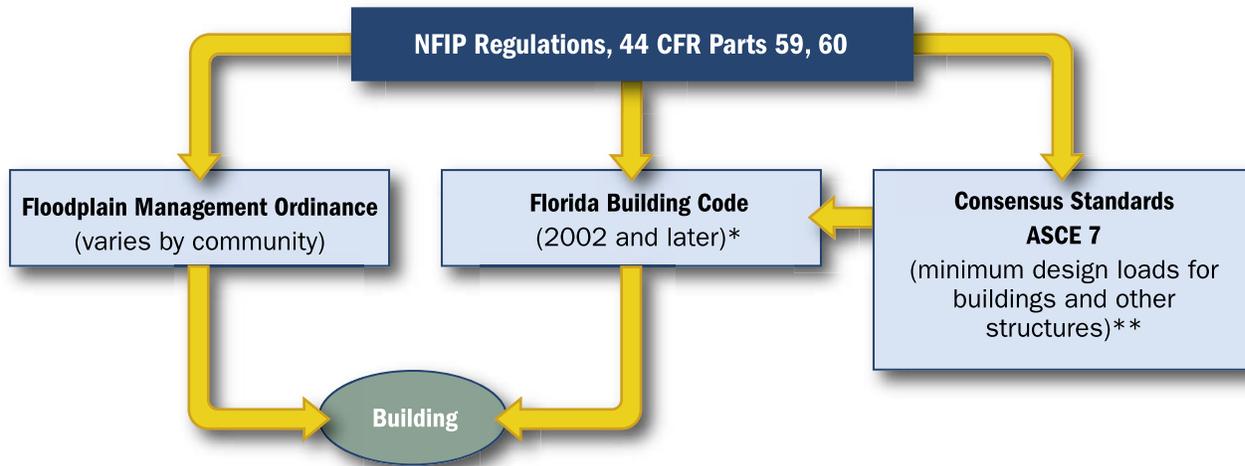


Figure 2-2. Floodplain Management Regulations and Building Design, Florida

\* Ch. 31 defers to Floodplain Management Ordinance, contains CCCL requirements

\*\* Flood loads only via load combination, FBC Ch. 16

#### 2.1.1 Flood Studies, Flood Maps, and Floodplain Management Regulations

FEMA provides participating communities with a Flood Insurance Rate Map (FIRM) and Flood Insurance Study (FIS). Several areas of flood hazard are commonly identified on the FIRM. One of these areas is the Special Flood Hazard Area (SFHA), which is defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood. SFHAs labeled as Zone AE have been studied by detailed methods and show Base Flood Elevations (BFEs). SFHAs labeled as Zone VE are along coasts and are subject to additional hazards due to storm-induced velocity wave action. BFEs derived from detailed hydraulic analyses are shown within these zones. (Zone VE is used on new and revised maps in place of Zones VI-V30.) Mandatory flood insurance purchase requirements apply in all SFHAs.<sup>1</sup>

<sup>1</sup> Note: The term “Zone A” is used in this report to represent those flood hazard zones identified on the FIRMs as A1-30, AE, and AO, and “Zone V” is used to represent those flood hazard zones identified on the FIRMs as Zone V1-30 and VE. Where used in this report, these terms are not intended to describe approximate or unnumbered zones (i.e., zones without BFEs). Approximate and unnumbered zones will be identified specifically as such. Further, when the term “BFE” is used in conjunction with “Zone A” in this report, it should be taken to mean the BFE for Zones A1-30 and AE, and the depth number shown on the FIRM for Zone AO.

## DESCRIPTION OF FLOOD ZONES

**Zones X, B, and C.** These zones identify areas outside of the SFHA. Zone B and shaded Zone X identify areas subject to inundation by the flood that has a 0.2-percent probability of being equaled or exceeded during any given year. This flood is often referred to as the 500-year flood. Zone C and unshaded Zone X identify areas above the level of the 500-year flood. The NFIP has no minimum design and construction requirements for buildings in Zones X, B, and C.

**V Zone.** The portion of the SFHA that extends from offshore to the inland limit of a primary frontal dune along an open coast, and any other area subject to high-velocity wave action from storms or seismic sources. The FIRMs use Zones VE and V1-30 to designate these Coastal High Hazard Areas. These SFHAs are subjected to inundation during the flood that has a 1-percent chance of being equaled or exceeded during any given year. This flood is referred to as the 100-year flood.

**A Zone.** The portion of the SFHA not mapped as a V Zone. Although FIRMs depict A Zones in both riverine and coastal floodplains (as Zones A, AE, A1-30, and AO), the flood hazards and flood forces acting on buildings in those different floodplains can be quite different. In coastal areas, A Zones are subject to wave heights less than 3 feet and wave runup depths less than 3 feet. Flood forces in A Zones in coastal areas are not as severe as in V Zones, but are still capable of damaging or destroying buildings on shallow foundations. For this reason, different design and construction standards are recommended (by the MAT and others) in coastal A Zones.

For NFIP flood zone definitions, refer to 44 CFR 64.3.

The zone designation and the BFE are critical factors in determining what requirements apply to a building and, as a result, how it is built. For example, the NFIP minimum requirements for buildings built in Zone VE (Coastal High Hazard Areas) are: 1) the building must be elevated on pile, post, pier, or column foundations, 2) the building must be adequately anchored to the foundation, 3) the building must have the bottom of the lowest horizontal structural member at or above the BFE, and 4) the building design and method of construction must be certified by a design professional. The area below the BFE must be free of obstructions; if enclosed, the enclosure must be made of lightweight wood lattice, insect screening, or breakaway walls.

In the Zone AE, the NFIP requires that the top of the lowest floor of a building must be at or above the BFE; however, there are no standards for foundations other than the general performance standard that the building be anchored to resist floatation, collapse, and lateral movement. In an A Zone, non-residential buildings can be flood-proofed with their walls made substantially impermeable to the passage of floodwater.

For buildings built in Zones B, C, and X (areas of moderate or minimal hazard from the principal source of flood in the area), there are no NFIP build-

ing requirements, even for buildings built on barrier islands, because these buildings are outside of the SFHA.

Many of the buildings on shallow foundations that failed in Hurricane Ivan were built in areas that were designated as Zone B, C, or X at the time of construction. These areas were exposed to V-Zone conditions during Hurricane Ivan as a result of long-term erosion or the erosion that occurred during the storm.

### 2.1.2 Higher Regulatory Standards

One of the goals of the MAT was to investigate building failures in mapped Zones AE, B, C, and X. The MAT determined that some of the communities visited have adopted more stringent design and construction requirements for these zones (e.g., Santa Rosa Island Authority), and that structural damage to newer buildings in these communities was generally less than in communities that have not adopted higher standards.

The MAT also observed a large number of buildings in all flood hazard zones (VE, AE, B, C, X) that were constructed (voluntarily) to higher than required elevations with pile foundations. These structures generally sustained far less flood damage than nearby structures constructed to the minimum NFIP requirements. This was especially true in Zone AE, where buildings were constructed several feet above the BFE on pilings, thus reinforcing the benefits of using V-Zone design and construction techniques in the coastal A Zone.<sup>2</sup>

### 2.1.3 Relating Observed Flood Damages to the FIRMs

FEMA's methodologies for mapping have evolved over the years due to improvements in our understanding of coastal processes and the development of new technologies. Over a 30-year period, there have been at least four generations of FIRMs in the area affected by Hurricane Ivan. As methodologies have evolved, BFEs have gone up or down, and Zones VE, Zones AE, and Zones X have expanded or contracted. The differences in damages between adjacent buildings are due to differences in how the buildings were constructed (i.e., building elevations), and some of this can be explained by the flood hazard zone and BFE that were in effect at the time the buildings were constructed.

FEMA recently announced an update of the coastal flood hazard mapping guidelines. The guidelines will promote more accurate flood studies by incorporating consistent methodologies and improved technological processes. Guidelines are being developed first for the Pacific Coast, with the Atlantic and Gulf Coasts to follow.

The MAT determined that the area flooded by Ivan exceeded the SFHA shown on the effective FIRMs for many communities, from Gulf Shores, Alabama, to Okaloosa County, Florida, which is reflected in Table 1-2 and based on the current FIRMs and the High Water Marks

<sup>2</sup> As a working definition, consider the coastal A Zone to be that area near the shoreline with exposure to breaking wave heights between 1.5 and 3.0 feet. Another way to identify the coastal A Zone is to identify areas near the shoreline and exposed to waves, where base flood stillwater depths are between approximately 2 feet and 4 feet, or where the ground lies between 3 feet and 6 feet below the BFE.

(HWMs) as shown in Figures 1-7 through 1-17. The coastal FIRM changes over the years likely resulted in variations in lowest floor elevations and construction practices since most buildings tend to be constructed to the minimum regulatory requirements.

During its investigations, the MAT researched the flood hazard mapping for two locations in Baldwin County, Alabama; three locations in Escambia County, Florida; and one location in Santa Rosa County, Florida. The results of some of this research (for one location in Baldwin County and the location in Santa Rosa County) are provided in Sec. 2.1.3.1 and 2.1.3.2, respectively.

### 2.1.3.1 Baldwin County, Alabama

The effective FIRM and FIS for Baldwin County are in countywide format and are dated June 17, 2002. Table 2-1 shows the 2002 Baldwin County 100-year stillwater elevations and BFEs along the Gulf of Mexico shoreline near Orange Beach and Gulf Shores.

Table 2-1. Baldwin County Stillwater Elevations and BFEs (2002)

Flooding Source	FIS Stillwater Elevations (feet*)	BFEs (feet*)
Gulf of Mexico	9.3 – 10	10 - 15**

\* Elevations are referenced to NAVD 1988

\*\* Includes wave setup of 2.2 feet

The MAT conducted a series of comparisons to assess flood map changes that occurred with the various map revisions (see Figure 2-3 for a typical comparison). These changes are significant because they would have influenced building construction while the maps were in place. Three sets of maps were compared: the Baldwin County Flood Hazard Boundary Map (FHBM) from October 1983 (based on the NOAA tide gauge frequency study); the January 1985 FIRM that was based on the TTSURGE joint probability analyses; and the latest FIRM, dated June 2002.

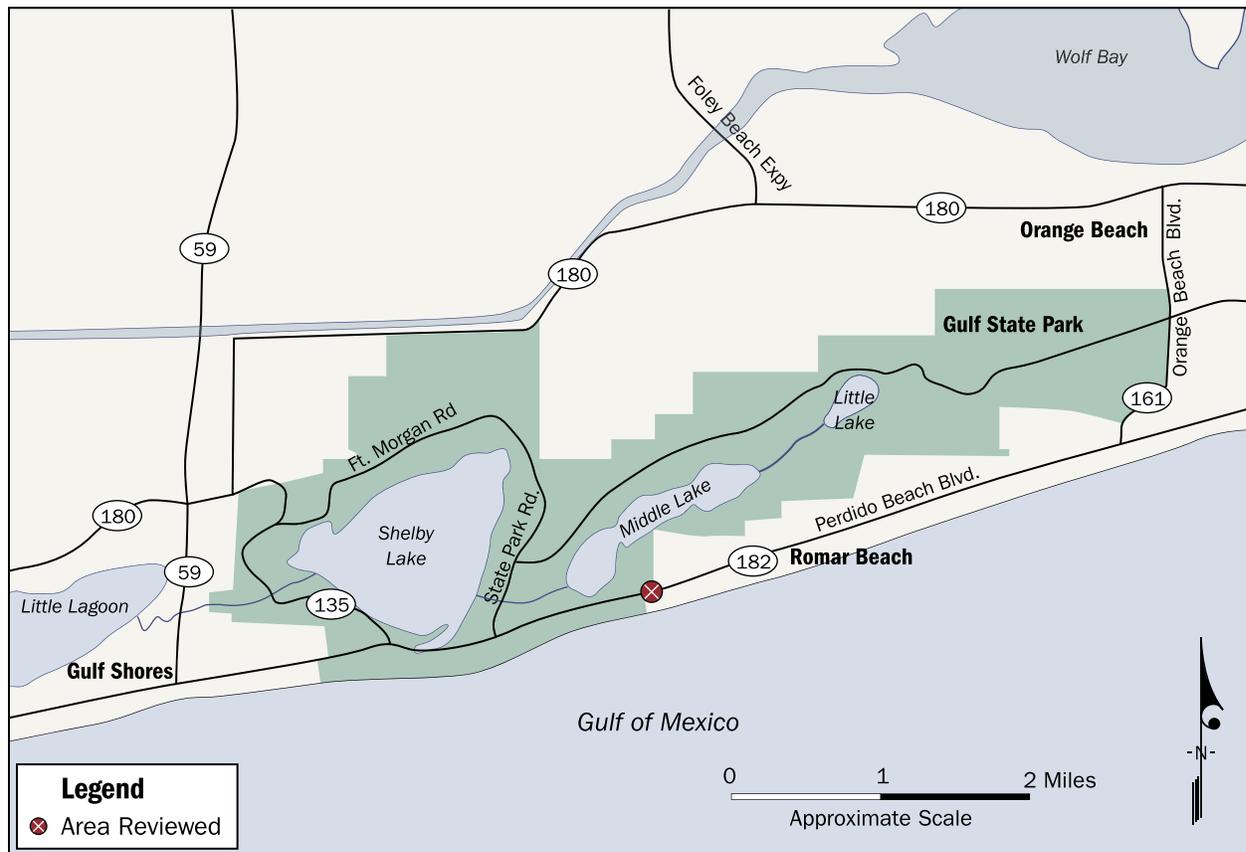
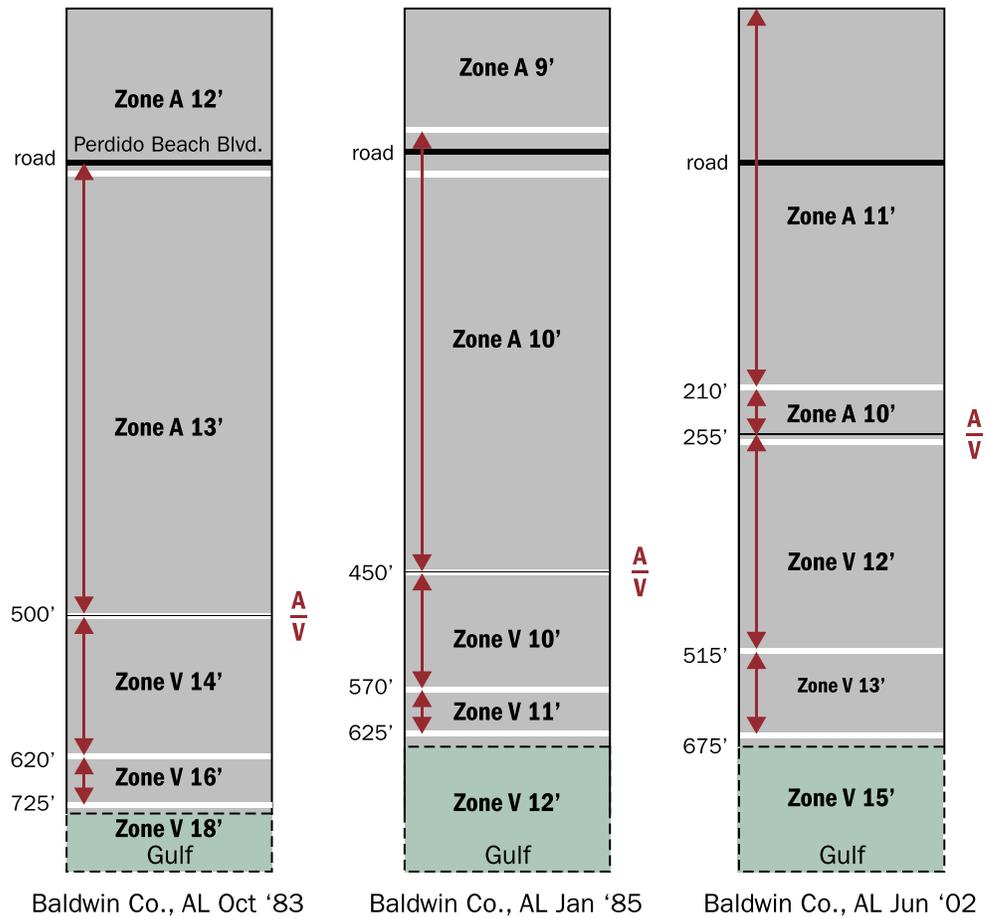


Figure 2-3. Baldwin County location near the State Park/Orange Beach boundary (see red dot) where the historical FIRMs (1983, 1985, 2002) were reviewed.

During the 2002 revision, wave setup of 2.2 feet was added along the open coast barrier islands, and the primary frontal dune was included as a V-Zone mapping criterion. Differences between the 2002 and the previous (1985) FIRM include: 1) BFEs on the barrier islands generally increased 2 to 3 feet and 2) the V-Zone width increased approximately 200 to 250 feet. The 2002 revisions outside the barrier islands were primarily to reflect updated topographic information (the BFEs did not change significantly in these areas).

One of the areas the MAT researched in Baldwin County is located at the west end of Orange Beach at the State Park boundary (see red dot in Figure 2-3). This area is located on FIRM panel 01003C0819 K of the current maps. The flood zone boundaries were measured from the centerline of Perdido Beach Boulevard on the 1983, 1985, and 2002 FIRMs at this location. Figure 2-4 illustrates the flood zone changes here, plus the decreasing and then increasing BFEs over time.

Figure 2-4. Comparison of FIRMs over time, at the State Park boundary, west end of Orange Beach (Orange Beach, Baldwin County, Alabama)



Figures 2-5, 2-6, and 2-7 illustrate the nature of flood and erosion damage at this location during Ivan. While the ages of the destroyed and surviving buildings are not known, most were likely built after Hurricane Frederic in 1979. A review of the damage and the FIRMs also indicates the following:

- Houses built to the 1985 BFEs and foundation requirements were generally at a disadvantage compared to those houses built to the 1983 and 2002 requirements.
- The surviving houses in Figure 2-5 were all built on pilings, even though it appears NFIP regulations did not require construction on pilings at those locations (the houses are within approximately 250 feet from the road, where all the FIRMs show Zone A).
- The surviving houses were all near the rear and middle of the beach where wave effects would have been reduced somewhat. None of the houses on the front row in this area survived.

- The surviving houses in Figure 2-5 were likely built with the lowest floor above the BFEs shown on the FIRMs. The CHWM figures in Chapter 1 show Ivan stillwater elevations of approximately 12 to 14 feet NAVD in the area, and wave heights could have been several feet higher yet (the highest BFE within 600 feet of the road was 14 feet NAVD between 1983 and 1985).



Figure 2-5. Ivan damage at the west boundary of Orange Beach. Houses are missing from piles and piles are broken near the ground level. (See Figures 2-6 and 2-7 for ground photos.) (Orange Beach/State Park boundary)



Figure 2-6. Ground photo of the same area as Figure 2-5. At this location, all houses seaward of the blue house (circled) were destroyed by Ivan. Some houses (arrow designates the left house in Figure 2-5) washed landward largely intact. Other houses were completely destroyed. The likely cause was pile breakage due to inadequate pile size and/or insufficient elevation of the houses, combined with large lateral (flood and wind) loads acting on the houses.

**Figure 2-7.** Building on the right side of Figure 2-5 survived, although it sustained destruction of the lower enclosed area and suffered extensive internal damage due to wind (soffit loss, window breakage, rainfall penetration).



MAT examination of larger buildings in Orange Beach (see section 3.1.2) confirmed these general findings: elevation above the BFE on an adequate pile foundation was the key to buildings successfully resisting flood forces during Ivan.

### 2.1.3.2 Santa Rosa County, Florida

The effective FIRM and FIS for the unincorporated areas of Santa Rosa County, Florida, are dated July 17, 2002. The most recent coastal revision was first reflected on the January 19, 2000, FIS and FIRM. For this revision, updated coastal flooding analyses were prepared for the open coast shorelines of the Gulf of Mexico, Santa Rosa Sound, and Pensacola Bay up to U.S. Route 90. The revision incorporated primary frontal dune analysis, updated wave action, and provided a new shoreline and the effects of coastal erosion. Wave setup of 2.5 feet was added to the open coast stillwater elevation. The July 17, 2002, FIS and FIRM were produced to reflect changes in community boundaries; there was no revised flooding analysis provided as part of this revision.

Table 2-2 presents stillwater elevations from the Santa Rosa County FIS dated July 17, 2002.

Table 2-2. Santa Rosa County Stillwater Elevations

Flooding Source	FIS Stillwater Elevations (feet*)	BFEs (feet*)
Gulf of Mexico	10.5**	11-16
Pensacola Bay	4.9 – 5.7	5-8
Santa Rosa Sound	8.0	8-12

\* Elevations are referenced to NGVD 1929.

\*\* Includes wave setup of 2.5 feet.

The MAT conducted a detailed comparison to assess flood hazard zone changes over time in Santa Rosa County, Florida, along Bay Street in the Oriole Beach area (see Figure 2-8). The zero station for this comparison was taken at the centerline of the intersection of Bay Street and Harrison Avenue. The MAT used two sets of maps: the Santa Rosa County FIRM dated November 1985 and the FIRM dated January 2000, the latter of which reflects the same flood hazards shown on the current effective FIS dated July 17, 2002. Figure 2-9 shows how the flood zones and BFEs changed between the 1985 and 2000 FIRMs. The major changes are an increase in BFEs seaward of Bay Street of up to 3 feet and an inland expansion of the SFHA of approximately 1,500 feet (with BFEs of 8 and 9 feet in the newly mapped inland areas).

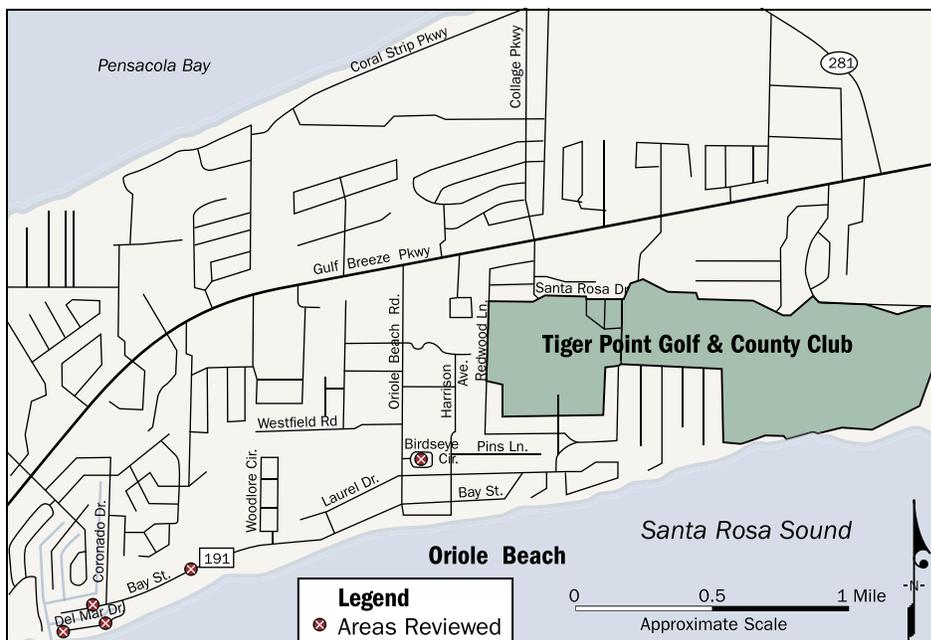


Figure 2-8. Santa Rosa County locations where historical FIRMs were reviewed. The easternmost dot (just northwest of Bay Street and Harrison Avenue) shows the reviewed Santa Rosa County location, and the other dots reflect building locations discussed later in this section.

**Figure 2-9.**  
**Santa Rosa County:**  
**Comparison of FIRMs**  
**at the centerline of the**  
**intersection of Bay Street**  
**and Harrison Avenue**

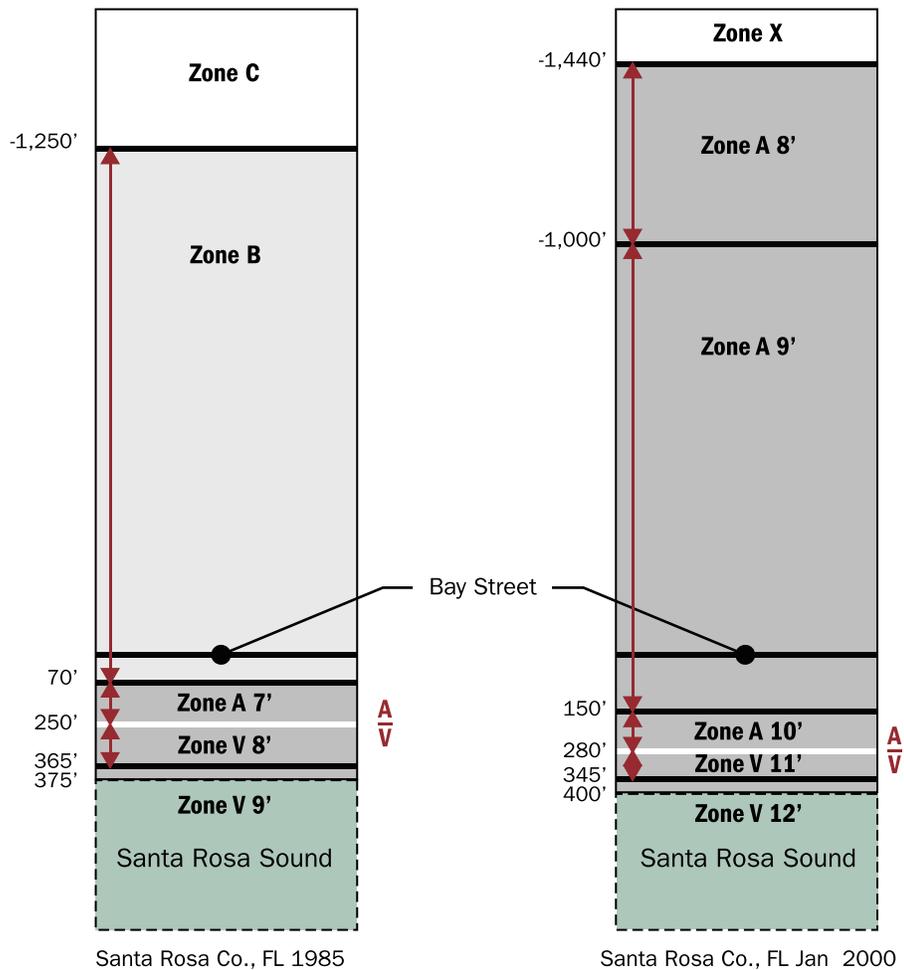


Figure 2-10 shows some of the houses in the newly mapped area. These buildings are on ground estimated at +/- 7 feet NGVD, approximately 700 feet north of Bay Street (1,000 feet from Santa Rosa Sound) and within 1,000 feet of Harrison Avenue. The FIRMs in Figure 2-9 show the changes that have occurred in the vicinity. The houses were constructed in flood hazard Zone B, outside the SFHA shown on the 1985 FIRMs, but had 2 to 4 feet of water inside as a result of Hurricane Ivan. Some property owners said their lenders had not notified them when the flood maps changed, and they had not purchased flood insurance.

Many houses constructed along the west end of Bay Street (approximately 1 mile west of Harrison Avenue) were older, pre-FIRM houses, and were likely built on land with grade elevations of 5 to 6 feet NGVD. These houses were later mapped by the 1985 FIRM as Zone B or Zone AE with a BFE of 7 feet NGVD and by the 2000 FIRM as Zone AE with a BFE of 9 feet NGVD. Figure 2-11 shows a typical house along the west end of Bay Street that was damaged heavily during Ivan. The house

was most likely in Zone B at the time of construction (but is currently mapped as Zone AE elevation 9 feet NGVD). The figure shows significant damage due to storm surge and wave and floating debris impacts, which are typical of V-Zone conditions. The HWM (stillwater) in this area was approximately 11 feet, as shown on Figure 1-12. Based on FEMA's current flood hazard mapping methodology, the 11-foot stillwater elevation and a ground elevation of approximately 6 feet would yield a wave crest elevation of approximately 13 to 14 feet NGVD during Ivan. The house shown in Figure 2-11 undoubtedly experienced V-Zone conditions during Ivan.



**Figure 2-10.** Typical houses at Birdseye Circle, which had 2 to 4 feet of flooding inside the houses. This area was mapped as being outside the SFHA on the 1985 FIRM, which likely governed the construction standards that were followed when the house was built.



**Figure 2-11.** Typical damage to houses along Bay Street that were impacted by surge and wave effects from Santa Rosa Sound. This house on the west end and south side of Bay Street was constructed with a slab-on-grade foundation. The house was either pre-FIRM or constructed in Zone B (1985 FIRM) and is currently mapped as Zone AE with a BFE of 9 feet. The house undoubtedly experienced V-Zone conditions. (Santa Rosa County)

Figure 2-12 is an aerial photograph showing houses along Bay Street (above the canal) that were impacted by storm surge, waves, and floodborne debris. These houses were likely constructed in Zone B, according to the 1985 FIRM; however, many were likely built prior to the 1985 FIRM. Although the surge and wave impacts from Hurricane Ivan in the area produced V-Zone conditions, the current FIRM shows these houses in Zone AE with a BFE of 9 feet.

Figure 2-12 also shows houses constructed along Santa Rosa Sound that experienced different levels of damages based on the elevations of their lowest floors. The white house on the bottom right was constructed above the BFE on a pile foundation and higher than other nearby houses, which were constructed on a slab or stem wall foundation. The lower houses were severely damaged by storm surge, waves, and debris impacts. The white house and other nearby pile-supported houses along this shoreline appear to have been constructed several feet above the BFE, which prevented significant flood damages; based on elevation certificates, two of the pile-supported houses in this area were constructed to an elevation of 15 feet, over 5 feet above the minimum elevation requirement.

**Figure 2-12.** Aerial view of houses along Bay Street (above the canal) and Santa Rosa Sound that were heavily damaged by storm surge and wave impacts. The circled house is the same house shown in Figure 2-11. The house on the lower left is the same house shown in the background of Figure 2-13. Houses elevated above the BFE on pilings (see arrow) sustained far less flood damage than houses at lower elevations.





Figure 2-13. The house in the foreground was constructed on piles and had minimal flood damage during Ivan, although it lost a pile support for the deck. The house in the background (see arrow) was constructed at much lower level and sustained significant flood damage throughout the first floor. The damaged house is also shown on the left side of Figure 2-12.

Figures 2-14 and 2-15 show a house on Santa Rosa Sound that was heavily damaged by waves and floodborne debris. The house was likely constructed when the area was mapped as Zone B, but the effective FIRM shows the house in Zone AE with a 10-foot BFE. Like the other nearby houses, this house undoubtedly experienced V-Zone conditions during Ivan. Had this house been elevated on a substantial pile foundation, as was the house west of the canal entrance (see arrow) or the white house in Figure 2-12, the flood damage would probably have been minimal.



Figure 2-14. The house on the right (circled), which is at the west end of Del Mar Drive, south of Bay Street, along the Santa Rosa Sound, was heavily damaged by storm surge and wave and debris impacts. The same house is shown in Figure 2-15. The effective FIRM shows the house in a Zone AE with a BFE of 10 feet. Note minimal flood damage occurred to the newer, pile-elevated house west of the canal entrance (arrow).

**Figure 2-15.**  
This house, located on Santa Rosa Sound and circled in Figure 2-14, was severely damaged by surge, wave, and debris impacts. The large timber that washed into the house reportedly originated across the Sound in Pensacola Beach



These examples point out several important points:

- The changes in flood hazard zones and BFEs over time likely contributed to the reduction of flood damage experienced by newer houses, but given a storm like Ivan with flood levels above the BFE, the new maps alone could not ensure building survival.
- Elevating newer houses on pilings several feet above the BFE was also central to the success of these buildings. Elevating the lowest floor above the BFE (freeboard) contributed greatly to the reduction in flood damage, especially in areas shown as Zone AE on the effective FIRM that experienced V-Zone conditions during Ivan.

## 2.2 Building Codes and Standards

**A**labama adopts building codes on a statewide basis only for state-owned buildings, such as schools. Local jurisdictions determine the adoption of building codes for private buildings. All Alabama jurisdictions have traditionally adopted editions of the Standard Building Code (SBC) published by the Southern Building Code Congress International. The City and County of Mobile had adopted the 2000 International Building Code (IBC) on May 15, 2001 (City of Mobile) and in 2000 (County of Mobile).<sup>3</sup> The City of Orange Beach adopted the 2003 IBC in the summer of 2004. The City of Gulf Shores adopted the 2003 IBC as an emergency measure after Hurricane Ivan to improve the quality of the reconstruction. Most other affected Alabama communities such as those in unincorporated Baldwin County were still enforcing the 1997 or 1999 SBC at the time of Hurricane Ivan.

In the Florida Panhandle, the SBC – with local amendments – was used to regulate construction until early 2002. By March 2002, the FBC 2001 Edition had been adopted statewide. The FBC, administered by the Florida Building Commission, governs the design and construction of residential and non-residential (commercial, industrial, critical/essential, etc.) buildings in Florida. In December 2004, the Florida Building Commission completed the 2004 Edition of the FBC. The 2004 Edition replaces the 2001 Edition and will be adopted statewide by administrative rule in the fall of 2005.

### 2.2.1 Flood Requirements in Building Codes and Standards

#### – Alabama

Flood-resistant construction requirements in coastal Alabama are located in the building codes (IBC, IRC), which themselves reference community floodplain management ordinances and consensus standards with flood requirements (i.e., Minimum Design Loads for Buildings and Other Structures published by the American Society of Civil Engineers 7 (ASCE 7) and Flood-Resistant Design and Construction (ASCE 24)). One additional program affects coastal construction in Alabama: the CCCL, which acts as a seaward limit for construction. Details for each are provided below.

<sup>3</sup> The International Code Council (ICC) was formed to bring together the three model code groups and their respective codes – ICBO (*Uniform Building Code*), BOCA (*National Building Code*), and SBCCI (*Standard Building Code*) - under a unifying code body in support of common code development. In 2000, the ICC developed a family of codes, including the *International Building Code (IBC)* and the *International Residential Code for One- and Two-Family Dwellings (IRC)*.

### 2.2.1.1 Flood Provisions in the IBC (2003)

The IBC is applied to multi-family buildings (with a few exceptions, which are governed by the IRC), and to non-residential buildings. Most of the mandatory flood provisions are contained in *Section 1612 (Flood Loads)*, but others also occur in the Code related to lowest floor elevation inspection, flood resistance materials, accessibility, ventilation, and elevators.

### 2.2.1.2 Flood Provisions in the IRC (2003)

The IRC applies to one- and two-family dwellings and to some townhouses. Most of the mandatory flood provisions are contained in *Section R323 (Flood-Resistant Construction)*, but others also occur in the Code related to utilities, design, and floodplain construction.

### 2.2.1.3 Flood Requirements in ASCE 7

Design loads used by the IBC (2003) are taken from ASCE 7 (2002). The following sections of ASCE 7 deal with flood:

- Section 2.3 (Load Combinations, including different load combinations for V Zones and coastal A Zones)
- Section 5.3 (Flood Loads, which covers hydrostatic, hydrodynamic, and wave and impact loads; and which specifies load criteria for breakaway walls)

Flood design loads, per se, are not specified by the IRC (2003) since it is a prescriptive code. The IRC refers the designer to the local jurisdiction for flood requirements. The IRC makes use of environmental hazard maps (wind, seismic, snow, etc.), which are largely consistent with ASCE 7 hazard maps.

### 2.2.1.4 Flood Requirements in ASCE 24

ASCE 24 is a standard devoted entirely to flood-resistant design and construction. It is referenced by Section 1612 of the IBC (2003), which states: “The design and construction of buildings and structures in flood hazard areas, including areas subject to high velocity wave action, shall be in accordance with ASCE 24.”

The IRC does not reference ASCE 24; thus, communities would have to reference ASCE 24 directly for its provisions to apply to small residential buildings. However, Section R323 of the IRC states that buildings in floodways shall be designed in accordance with the IBC, thereby mandating use of ASCE 24 for buildings in floodways.

The 1998 edition of ASCE 24 was the first edition produced and, by default, was the edition referenced by the 2003 IBC. However, a new edition of ASCE 24 (2005 edition) is forthcoming, and the 2005 edition has some significant changes to the earlier edition. The 2005 edition of ASCE 24 will be referenced by the 2006 edition of the IBC.

### 2.2.1.5 Coastal Construction Control Line (Alabama)

In addition to the NFIP and building code requirements, buildings constructed along the Gulf shoreline may also be subject to CCCL regulations (Alabama Administrative Code, Division 335-8) administered by the Alabama Department of Environmental Management (ADEM), Coastal Area Management Program, except in the City of Gulf Shores, which administers the CCCL within its jurisdiction. The CCCL was established in the mid-1980s and has not been revised since that time.

In Alabama, the CCCL is a line of prohibition, seaward of which no construction (including substantial improvement of an existing structure) or excavation is allowed. Any proposed building on a parcel intersected by the CCCL must obtain a permit from ADEM (or approval from Gulf Shores). CCCL variances may be obtained in some instances where the property owner can demonstrate that enforcement of the CCCL provisions would constitute a taking. CCCL coordinates and maps are available from ADEM and Gulf Shores.

When construction on a parcel intersected by the CCCL involves commercial or multi-family structures (e.g., a hotel, motel, or condominium), the permitting is more involved than for a single-family or duplex-type structure. Commercial and multi-family CCCL permits require an Environmental Impact and Natural Hazards Study that includes:

- A wave study that addresses the flood hazard and erosion potential using eroded beach profiles for pre- and post-developed conditions,
- Location and delineation of velocity zones, and
- Analysis of the project's potential to significantly increase the likelihood that damage will occur from floods, hurricanes, or storms.

Commercial and multi-family CCCL permits also require a Beach and Dune Enhancement Plan that includes provisions for dune walkovers, sand fencing, and vegetation and dune maintenance.

Bulkheads, retaining walls, or similar structures are not permitted on parcels intersected by the CCCL unless it can be demonstrated that: 1) the bulkhead or retaining wall is landward of the CCCL and it is necessary to protect and ensure the structural integrity of an existing or previously permitted structure, and 2) there are no other feasible non-structural alternatives.

## 2.2.2 Flood Requirements in Building Codes and Standards

### – Florida

Flood-resistant construction requirements in coastal Florida are located primarily in community floodplain management ordinances and in Chapter 31 of the FBC (for buildings seaward of the Florida CCCL).

#### 2.2.2.1 Flood Provisions in the FBC (2004 Edition)

Major flood provisions contained in the 2004 Edition of the FBC address siting requirements for nursing homes, hospitals, educational facilities, and shelters as well as general flood-resistant design requirements. Section 1605.2.2 of the FBC states that flood loads shall be determined by the provisions of ASCE 7. There is no reference in the FBC to ASCE 24.

The Florida Building Code – Residential Volume (2004) is a new document that is also under development at this time. Like the FBC, Section R301.2.4 of the residential volume defers most matters related to flood-resistant construction to the community floodplain management ordinance.

#### 2.2.2.2 Coastal Construction Control Line (Florida)

The CCCL is established by the Florida Department of Environmental Protection (FDEP) and describes the landward boundary of “that portion of the beach-dune system which is subject to severe fluctuations based on a 100-year storm surge, storm waves, or other predictable weather event” (Florida Statutes, Ch. 161). As a practical matter, the state defines the CCCL position as being one of the following:

- the landward limit of storm-induced erosion (where upland elevations are substantially greater than the 100-year still water level)
- the landward limit of a 3.0 foot wave propagating at the 100-year stillwater level (where upland elevations are low and profile inundation occurs)

- at the landward limit of overwash (in instances where the profile is not inundated but where wave overtopping and sediment deposition occur), or
- at the landward toe of the coastal barrier dune structure impacted by, but not destroyed by, erosion accompanying the 100-year stillwater level and storm waves.

The Florida CCCL is generally situated farther landward than the Alabama CCCL, and unlike the Alabama CCCL, the Florida CCCL is a line of jurisdiction (not prohibition), seaward of which a permit is required from the FDEP and seaward of which special provisions of Section 3109 of the FBC apply. The CCCL permit from FDEP addresses building siting and beach/dune protection issues, while Section 3109 of the FBC addresses building design and construction requirements. The Florida CCCL has been re-established and moved over the years, unlike the Alabama CCCL.

Building requirements seaward of the Florida CCCL are in many ways similar to NFIP V-Zone requirements: elevation above the 100-year wave crest on a pile foundation; design for simultaneous flood and wind loads, including the effects of storm-induced erosion; aside from the foundation, construction below the lowest floor must be frangible (i.e., breakaway); etc. However, the State has established its own 100-year wave crest elevations, which, in most cases, are higher than FEMA's BFEs along beachfront areas.

A comparison of NFIP flood hazard zones and the CCCL in Florida shows that the CCCL lies landward of the V-Zone boundary in some locations and seaward in others. In areas where the CCCL is seaward of the V-Zone boundary, the higher of the BFE and the state's wave crest elevation will govern (subject to local freeboard requirements).

In the areas where the CCCL is more landward than the V-Zone boundary, CCCL provisions will generally control design and construction in any A Zones seaward of the CCCL (again, subject to higher standards imposed by a community). There may be some inconsistencies, however, about which designers should consult building officials and floodplain managers (concerning, for example, whether flood openings are required in CCCL-mandated breakaway walls in mapped A Zones seaward of the CCCL).

## 2.2.3 Wind Requirements in Building Codes and Standards

### – Alabama

In Alabama, the 1997 and the 1999 SBC was the code in effect for most impacted counties. The exceptions are the City and County of Mobile; they adopted the 2000 IBC/IRC on May 15, 2001 (City of Mobile) and in 2000 (County of Mobile).

#### 2.2.3.1 Comparing Design Wind Speeds

Current codes and standards (the FBC, the IBC, and ASCE 7) standardize the wind speed measure as the 3-second peak gust. This differs from the fastest-mile wind speed measure that was previously used by the SBC and ASCE 7 and the wind speed measure of 1-minute sustained that is used in the Saffir-Simpson Hurricane Scale presented in Chapter 1.

The IBC specifies higher wind speeds for coastal Alabama than any of the previous editions of the SBC. Baldwin County, Alabama, is approximately 75 miles long in the north-south direction perpendicular to the Gulf of Mexico coast line. Mobile County is similar at 65 miles long. Therefore, there is great variation in the design wind speeds from the coastal, southern end of the counties to the inland, northern end. At the time of Hurricane Frederic in 1979, the SBC design wind speeds were fastest-mile speeds varying from 110 mph at the coast to 90 mph inland, the equivalent of 3-second peak gust speeds are 130 mph at the coast to 105 mph inland. The 1985 SBC modified the required speeds to match those in American National Standards Institute (ANSI) A58.1 -1982, the predecessor to the ASCE *Minimum Load Standard for Buildings and Other Structures* (ASCE 7). For Baldwin and Mobile Counties, that range of speeds was 85 to 100 mph fastest-mile, or 100 to 120 mph measured as a 3-second peak gust. The wind speed map remained unchanged for all the subsequent editions of SBC, including the last edition in 1999. The maps used by the 2003 IBC are taken directly from ASCE 7-02. The 3-second peak gust wind speeds for Baldwin and Mobile Counties are 115 mph (north end) to 150 mph (at the coast) as shown in Figure 2-16. Table 2-3 contains a summary of the design wind speeds for the counties in Alabama visited by the MAT. Table 2-4 (in the next section) presents a summary of the design wind pressure on wall and roof areas for a typical residence in Gulf Shores. Exposure B is assumed for the IBC calculations. In instances where Exposure C design coefficients are applicable, the tabulated pressures would be approximately 30 percent higher than these values. SBC loads were based on Exposure B, but no differentiation was made for more open sites.

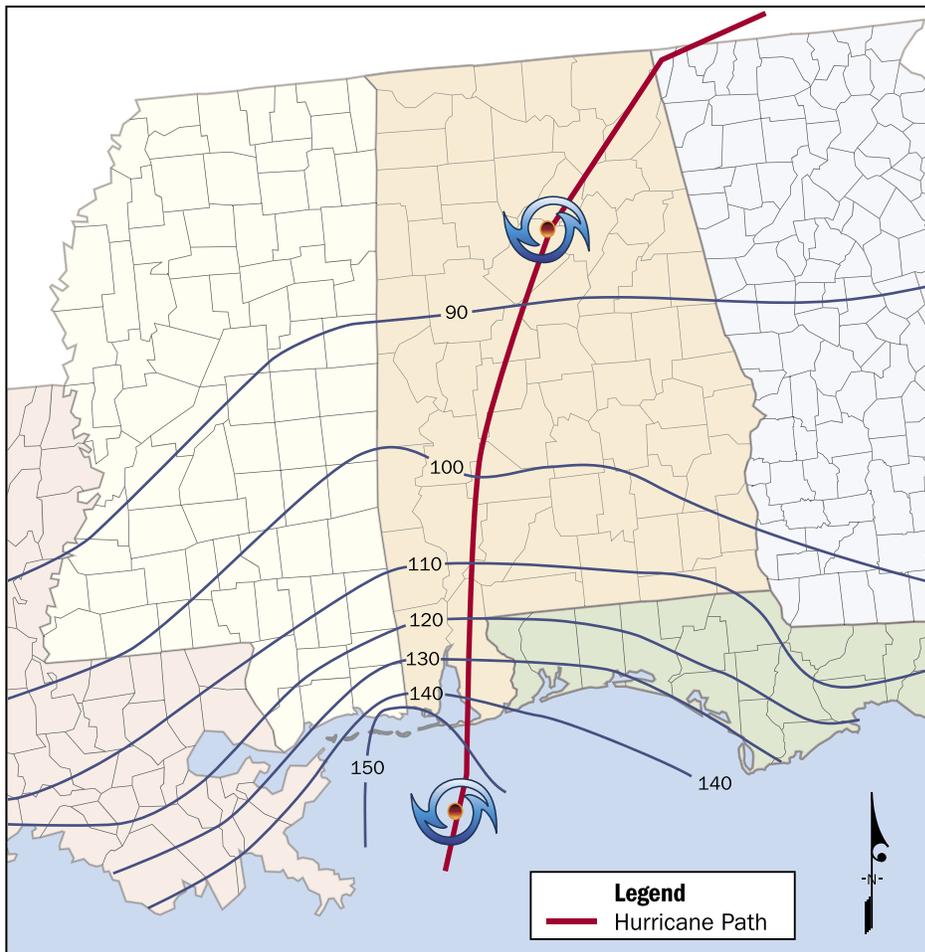


Figure 2-16. Design Wind Speeds from IBC 2003 and ASCE 7-98 and 02

Table 2-3. Basic Design 3-Second Gust Wind Speeds (For Baldwin and Mobile Counties, Alabama)

County	Standard Building Code 1979 Edition*	Standard Building Code 1997 Edition*	International Building Code 2003 Edition and ASCE 7-98 and later
<b>Baldwin</b>	105-130 mph	100-115 mph	114-150 mph
<b>Mobile</b>	105-130 mph	100-115 mph	117-150 mph

\* Code wind speeds reported as fastest-mile wind speeds in the SBC were converted to 3-second gust for comparison.

Where a range is given, the lower values correspond to the edge of the county farthest from the coast, and the higher values correspond to the coastal value or the edge of the county closest to the coast.

### 2.2.3.2 Comparing Design Wind Pressures

The methodology required for calculating wind loads in the 2003 IBC is that prescribed in Chapter 6 of ASCE 7-02. Using ASCE 7 for determination of wind loads ensures designers are using state-of-the-art methodology in wind-load analysis to calculate wind loads. The ASCE 7-02 provisions provide the same loads as ASCE 7-98 for the cases discussed previously. In addition to the improved load computations provided by ASCE 7, the IBC also has requirements for windborne debris protection of glazing, and improved component and cladding requirements, particularly for roof coverings and accessories. It is evident that the design wind pressures have been increasing for components and cladding with each new code development over the last 25 years. This increase was due to observed failures and damage to buildings (similar to MAT observations in Gulf Shores and Orange Beach) at these exterior building systems when subjected to a design level wind event such as Hurricane Ivan.

For example, the required pressure for corner zones of roofs has increased more than 3 fold over that period. Corner zones did not even exist in the 1979 SBC. The 1979 SBC did not prescribe higher loads at roof perimeters or corners, or at wall corners. These increases are a reflection of the findings of both wind tunnel research full-scale measurements and post-storm investigations. The pressures have increased most dramatically on the parts of buildings that consistently experienced wind-induced damage. In addition, wind speeds in this region of the Gulf Coast increased as a result of new modeling of the hurricane threat.

Table 2-4. Typical Single-Family Residence in Gulf Shores, Alabama

Description	Standard Building Code 1979 Edition	Standard Building Code 1997 Edition	International Building Code 2003 Edition - Also ASCE 7-98 and later	Maximum Recorded Wind Speed for Hurricane Ivan using IBC Factors
<b>Basic Wind Design Speed</b>	110 mph	97 mph	145 mph	
<b>Equivalent Wind Speed (3-second gust)</b>	130 mph	115 mph	145 mph	124 mph
<b>Wind Design Pressures on Exterior Walls</b>	(psf)	(psf)	(psf)	(psf)
<b>As Main Frame</b>				
Edge	20/-18	21/-18	32/-28	24/-21
Middle	20/-18	15/-13	23/-20	17/-15
Net Edge	33	32	46	34
Net Middle	33	21	31	23
<b>As C &amp; C</b>				
Middle	27/-27	25/-25	38/-42	28/-31
Corner	27/-27	25/-29	38/-51	28/-38
<b>Wind Design Pressures on Roof (4 in 12 slope)</b>	(psf)	(psf)	(psf)	(psf)
<b>As Main Frame</b>				
Windward Edge	-25	-26	-40	-30
Leeward Edge	-19	-19	-28	-21
Windward Middle	-25	-19	-28	-21
Leeward Middle	-19	-14	-22	-16
<b>As C &amp; C</b>				
Middle	-23	15/-23	22/-35	16/-26
Corner	-23	15/-52	22/-73	16/-54

- 1 The pressure calculations under each code for both main frame and components and cladding were calculated using building design coefficients in wind zones that provide the maximum wind pressure for any area on that building surface.
- 2 Positive value pressures indicate pressures acting inward toward building surfaces. Negative value pressures indicate pressures acting outward from building surfaces.
3. Pressures calculated from the 1979 and 1997 SBC were calculated using their appropriate fastest-mile wind speed and design methods in the code that were in effect at the time. The 3-second peak gust wind speed is shown for comparative purposes only and was not used in the calculation of the design wind pressures.

psf = pounds per square foot

net edge = the net pressure contributing to the shear force for the wall edge strips; equal to the sum of the external pressures from edge wall Zones 1E and 4E (see ASCE 7 Figure 6-4; internal pressures cancel).

Net middle = the net pressure contributing to the shear force for the interior wall zone; equal to the sum of the external pressures from wall Zones 1 and 4 (see ASCE Figure 6-4; internal pressures cancel).

## 2.2.4 Wind Requirements in Building Codes and Standards – Florida

Both the SBC and the FBC 2001 specify higher wind speeds for areas that are closer to the ocean or gulf and lower wind speeds for the inland areas. However, the methodology required for calculating wind loads in the FBC is that prescribed in Chapter 6 of ASCE 7 (with exceptions). The acceptance of ASCE 7-98 as the methodology for calculating design wind pressures was an important step for the Florida Building Commission. Using ASCE 7 for determination of wind loads ensures designers use state-of-the-art methodology in wind load analysis to calculate wind loads. The use of ASCE 7 also provided Florida with an opportunity to align with the IBC and IRC (basis for the FBC 2004 Edition), both of which also incorporate the methodologies of ASCE 7 for load determination. However, it is important to note that the legislative statutes governing construction in Florida restrict use of ASCE 7 to the 1998 Edition and, thus, do not incorporate the updates included in the 2002 Edition of ASCE 7. The FBC 2001 Edition also instituted improved design requirements for components and cladding (such as roof coverings) and debris impact criteria that were not previously required by the SBC.

In addition to the FBC, there are legislative statutes in Florida that affect design and construction. These statutes are found in Chapters 553.71 and 2000-141 of the *Laws of Florida* and are presented here to assist in understanding the design and construction process in the Florida Panhandle. Discussions regarding the use of these statutes as part of the design and construction process are presented in Chapters 7 and 8.

First, regarding wind loads, the Florida Legislature mandated several items. One such mandate relates to the wind load provisions of ASCE 7-98 as implemented by the IBC:

- (3) For areas of the state not within the high velocity hurricane zone, the commission shall adopt, pursuant to s. 553.73, Florida Statutes, the wind protection requirements of the American Society of Civil Engineers, Standard 7, 1998 edition as implemented by the IBC, 2000 edition, and as modified by the commission in its February 15, 2000, adoption of the Florida Building Code for rule adoption by reference in Rule 9B-3.047, Florida Administrative Code. [Section 109(3), Ch. 2000-141, *Laws of Florida*.]

Next, the Florida Legislature modified the windborne debris regions of ASCE 7-98 as follows:

- (3) For areas of the state not within the high velocity hurricane zone, the commission shall adopt, pursuant to s. 553.73, Florida Statutes, the wind protection requirements of the American Society of Civil Engineers, Standard 7, 1998 edition as implemented by the IBC, 2000 edition, and as modified by the commission in its February 15, 2000, adoption of the Florida Building Code for rule adoption by reference in Rule 9B-3.047, Florida Administrative Code. However, from the eastern border of Franklin County to the Florida-Alabama line, only land within 1 mile of the coast shall be subject to the windborne-debris requirements adopted by the commission. The exact location of wind speed lines shall be established by local ordinance, using recognized physical landmarks such as major roads, canals, rivers, and lake shores, wherever possible. Buildings constructed in the windborne debris region must be either designed for internal pressures that may result inside a building when a window or door is broken or a hole is created in its walls or roof by large debris, or be designed with protected openings. Except in the high velocity hurricane zone, local governments may not prohibit the option of designing buildings to resist internal pressures. [Section 109(3), Ch. 2000-141, *Laws of Florida*]

Lastly, the Florida Legislature modified the definition of Exposure C as follows:

- (10) "Exposure category C" means, except in the high velocity hurricane zone, that area which lies within 1,500 feet of the coastal construction control line, or within 1,500 feet of the mean high tide line, whichever is less. On barrier islands, exposure category C shall be applicable in the coastal building zone set forth in s. 161.55(5). [Ch. 553.71(10), F.S.]

However, it is important to note that the combination of the wind load determination process of ASCE 7, the new requirements for components and cladding, and the debris impact criteria for glazing provided immediate construction successes during Hurricane Ivan. Most newer houses and commercial buildings near the coast designed and constructed to the design wind requirements in the FBC 2001 Edition performed well and sustained only minimal damage during this

hurricane event. These results are in contrast to the damages observed in the older building stock, which often ranged from roof covering and cladding damage, to roof structural failures, to partial structural collapse of the primary load-bearing system.

Santa Rosa, Escambia, and Okaloosa Counties experienced the heaviest damage during Hurricane Ivan. Many of the existing buildings and structures in these counties were built under the 1997 edition of the SBC. In these counties, like other areas in the state, the FBC 2001 Edition is now the applicable building code; exceptions to debris impact requirements should be noted.

The SBC, FBC, IBC, and ASCE 7 codes and standards in hurricane-prone areas differ significantly in four areas:

1. The wind speed measure and the design wind speed
2. How and where pressures are calculated on a building
3. Requirements for debris impact protection
4. The FBC defines building exposure categories as Exposure B except for areas within 1,500 feet of the coast

These differences, which will affect the performance of buildings, are discussed in the following subsections, respectively.

#### **2.2.4.1 Comparing Design Wind Speeds**

Current codes and standards (the FBC, the IBC, and ASCE 7) standardized the wind speed measure as the 3-second peak gust. This differs from the fastest-mile wind speed measure that was previously used by the SBC and ASCE 7 and the wind speed measure of 1-minute sustained that is used in the Saffir-Simpson Hurricane Scale presented in Chapter 1. Figure 2-17 shows the FBC 2001 wind speed and windborne debris region map. Table 2-5 presents the design wind speeds (in 3-second gusts) for the heavily impacted counties from Hurricane Ivan using three different codes. The wind speeds shown in Table 2-5 are the nominal design, 3-second peak gust wind speeds at 33 feet above ground for Exposure C category (open terrain). The SBC used fastest-mile wind speeds; the FBC 2001 Edition uses the 3-second peak gust wind speed. To facilitate comparison with the FBC, the MAT converted fastest-mile wind speeds provided in the older editions of the SBC Code into 3-second peak gust wind speeds.

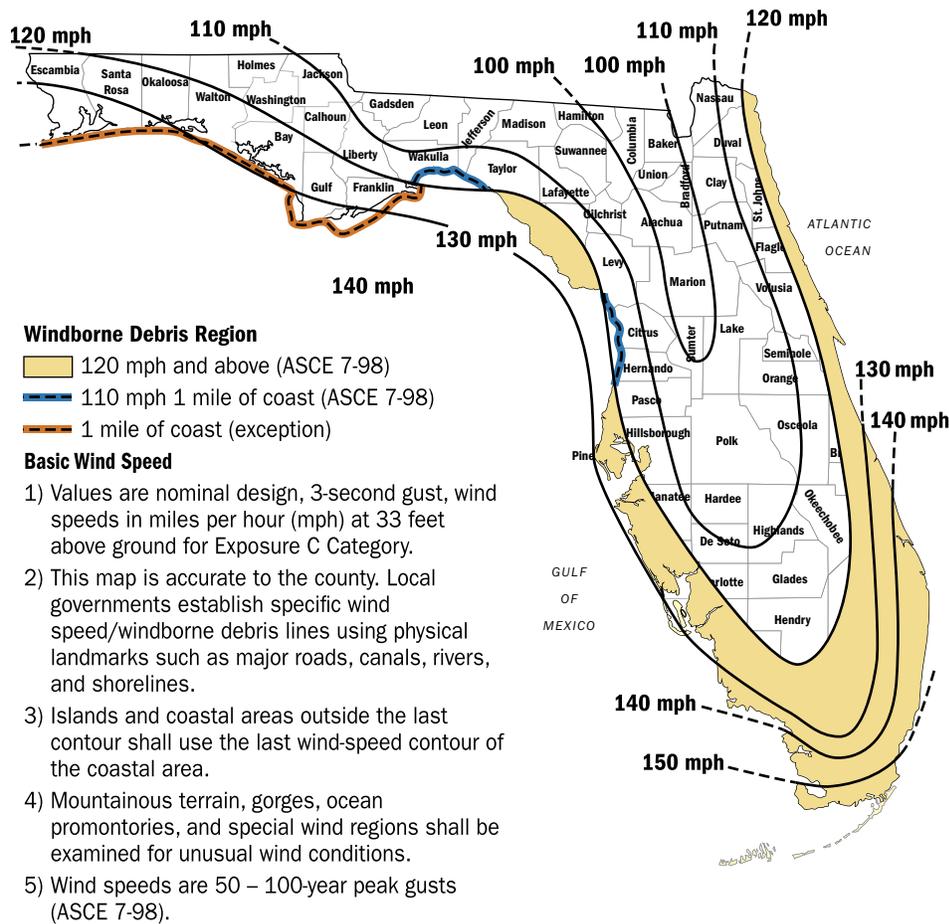


Figure 2-17. Wind speed and windborne debris region map (Courtesy of the Florida Building Commission, 2001)

Table 2-5. Basic Design 3-Second Gust Wind Speeds (Ranges for Each County)

County	Standard Building Code 1979 Edition*	Standard Building Code 1997 Edition*	Florida Building Code 2001 Edition and ASCE 7-98 and later Editions
<b>Escambia</b>	105-130 mph	105-112 mph	120-140 mph
<b>Santa Rosa</b>	105-130 mph	105-112 mph	120-140 mph
<b>Okaloosa</b>	105-130 mph	105-112 mph	116-134 mph

\* Code wind speeds reported as fastest-mile wind speeds in the SBC were converted to 3-second gust for comparison.

Where a range is given, the lower values correspond to the edge of the county farthest from the coast, and the higher values correspond to the coastal value or the edge of the county closest to the coast.

#### 2.2.4.2 Comparing Calculated Wind Pressures

The wind pressures used for design of buildings in the Florida Panhandle have changed significantly from the design pressures from 25 years ago. The 2001 FBC uses the wind speed map from ASCE 7-98, as shown in Figure 2-16. This map prescribes a design wind speed of between 130 and 140 mph for the affected coastal areas. By comparison, Ivan's estimated wind speeds were almost 20 percent below the design wind speeds required by the current code.

From Table 2-6, the buildings in the Pensacola area constructed to the older SBC codes experienced a design level or near design level event. As such, pressures on the main structural systems were at or near design loads. An analysis of the wind pressures resulting from the actual speeds shows an even greater disparity between the code-prescribed design pressures and the pressures predicted from the actual recorded wind speeds for components and cladding systems. As seen in Table 2-6, the resulting pressures are 25 percent to 40 percent below the code pressures.

Table 2-6. Wind Pressures on a Single-Family Residence in Pensacola, Florida

Description	Standard Building Code 1979 Edition	Standard Building Code 1997 Edition	International Building Code 2001 Edition - Also ASCE 7-98 (and later editions)	Maximum Recorded Wind Speed in Florida from Hurricane Ivan using IBC Factors
<b>Basic Wind Design Speed</b>	105 mph	95 mph	135 mph	
<b>Equivalent Wind Speed (3-second gust)</b>	130 mph	110 mph	135 mph	119 mph
<b>Wind Design Pressures on Exterior Walls</b>	(psf)	(psf)	(psf)	(psf)
<b>As Main Frame</b>				
Edge	18/-16	20/-17	28/-25	22/-19
Middle	18/-16	14/-13	20/-18	15/-14
Net Edge	30	31	40	31
Net Middle	30	20	27	21
<b>As C &amp; C</b>				
Middle	25/-25	24/-24	33/-36	25/-28
Corner	25/-25	24/-28	33/-34	25/-34
<b>Wind Design Pressures on Roof (4 in 12 slope)</b>	(psf)	(psf)	(psf)	(psf)
<b>As Main Frame</b>				
Windward Edge	-23	-25	-35	-27
Leeward Edge	-17	-18	-25	-19
Windward Middle	-25	-18	-25	-14
Leeward Middle	-17	-14	-19	
<b>As C &amp; C</b>				
Middle	-21	14/-22	19/-30	14/-24
Corner	-21	14/-50	19/-63	14/-49

- 1 The pressure calculations under each code for both main frame and components and cladding were calculated using building design coefficients in wind zones that provide the maximum wind pressure for any area on that building surface.
- 2 Positive value pressures indicate pressures acting inward toward building surfaces. Negative value pressures indicate pressures acting outward from building surfaces.
3. Pressures calculated from the 1979 and 1997 SBC were calculated using their appropriate fastest-mile wind speed and design methods in the code that were in effect at the time. The 3-second peak gust wind speed is shown for comparative purposes only and was not used in the calculation of the design wind pressures.

psf = pounds per square foot

net edge = the net pressure contributing to the shear force for the wall edge strips; equal to the sum of the external pressures from edge wall Zones 1E and 4E (see ASCE 7 Figure 6-4; internal pressures cancel).

Net middle = the net pressure contributing to the shear force for the interior wall zone; equal to the sum of the external pressures from wall Zones 1 and 4 (see ASCE Figure 6-4; internal pressures cancel).

### 2.2.4.3 Comparing Debris Impact Requirements

The FBC instituted statewide debris impact requirements related to design wind speeds. Prior to the FBC, the South Florida Building Code (with county provisions) identified debris impact requirements affecting the design of buildings for portions of Florida. However, the SBC, which was enforced in the portions of the state not using the South Florida Building Code, did not have debris impact requirements, and, therefore, buildings constructed prior to the adoption of the 2001 FBC were not required to protect openings against windborne debris. For new construction, Section 1606.1.5 of the FBC 2001 Edition defines the windborne debris impact regions as:

1. Areas where the basic wind speed is 120 mph (53 meters per second [m/s]) or greater, except from the eastern border of Franklin County to the Florida-Alabama line where the region includes areas only within 1 mile of the coast.
2. Areas within one mile (1.6 kilometers) of the coastal mean high water line where the basic wind speed is 110 mph (49 m/s) or greater.

Figure 2-17, in combination with the definitions above, depicts the windborne debris impact regions. Different criteria for requiring protection of openings against damage from windborne debris apply for new buildings constructed to the 2001 FBC in coastal Florida counties affected by Hurricane Ivan. Whereas a building within the 120-mph wind contour (or higher) triggers compliance with the statewide criteria for protecting openings, in the Florida Panhandle, only new buildings constructed within one mile of the coast are required to have opening protection. The FBC provides clear guidance on design requirements in the windborne debris regions. Buildings in these regions are required to protect glazed openings (windows and doors) to ensure that the building envelope remains “enclosed.” To achieve the requirement of an “enclosed building,” shutters, laminated glass, or other opening protection systems are required to be installed. Protection measures are required to resist large or small debris (missiles) depending upon their height on the exterior of a building above grade. An exemption is provided for residential construction in the Florida statutes allowing unprotected glazing and openings if the building was designed and constructed as a partially enclosed building. A building designed to resist the effects of internal pressurization accounts for higher pressures that occur when wind enters a building or structure. This exemption implies that wind and rain may enter the building increasing internal wind pressure substantially, yet the structural design is sufficient to prevent failure of the main wind-force resisting

system. This method of high-wind design may result in substantial interior damage from the wind and rain that enter the building since openings are not protected. Additional guidance on the windborne debris region and the debris impact requirements is provided in FBC Section 1606.1.4.

Given the potential for extreme wind and water damage to buildings and building contents when the envelope is breached (as confirmed by 2004 post-hurricane investigations), building codes have begun to restrict the use of the partially enclosed design option. The 2004 supplement to the IBC removes this option; thus, building openings must be protected or glazed with impact-resistant glazing. A similar change to the IRC has been approved in committee, and the next edition (2006) is expected to eliminate the partially enclosed design option for buildings governed by the IRC.

#### **2.2.4.4 High-Wind Elements of the Code**

The FBC 2001 Edition has special and stringent requirements for HVHZ areas. Sections 1611-1616 in the FBC define wind and debris requirements of HVHZs. Only Dade and Broward Counties are included in the HVHZ areas.

The HVHZs affect the design and construction of buildings by requiring higher design wind speeds for the entire building and by requiring the design of specific building components, attachments, and equipment for the design wind speed. The difference in design pressure is often substantial and results in a much stronger main structure and higher component design values for buildings. Many other requirements (e.g., mandatory exposure category, allowable stress increase, requirements for windborne debris, inspections during construction, product approval requirements, etc.) make HVHZ design and construction substantially stronger than in other areas of the state. Buildings built according to HVHZ requirements have much more capacity to withstand hurricanes and provide additional protection of property.

Observations related to specific examples of damage observed and the sections of the HVHZ criteria that would help resist the types of damage noted by the MAT are presented in Chapter 5.