


Chapter 1: Introduction

Table of Contents

Page

| | |
|----------------------------|-----|
| Introduction | 1-1 |
| 1.1 Background | 1-1 |
| 1.2 Purpose | 1-1 |
| 1.3 Organization | 1-3 |
| 1.4 Using the Manual | 1-6 |

Figures

| | | |
|------------|--|-----|
| Figure 1-1 | General process flowchart for coastal construction. | 1-4 |
| Figure 1-2 | Example of chapter summary table. | 1-8 |

Introduction

1.1 Background

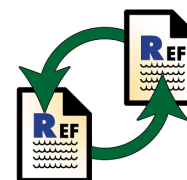
The Federal Emergency Management Agency (FEMA) first published the *Coastal Construction Manual* (FEMA-55) in 1981. The manual was updated in 1986 and has provided guidance to public officials, designers, architects, engineers, and contractors for over a decade. In that time, however, construction practices and materials have changed, and more information on hazards and building performance has been developed. There has also been an explosion in coastal development, leading to greater numbers of structures at risk. Many of the residential buildings being constructed today are larger and more valuable than those of the past, leading to the potential for larger economic losses when disasters strike. The increase in coastal development has also brought about greater use of sites located in areas where the risk is higher, such as lots closer to the ocean, lots on high bluffs subject to erosion, or lots artificially created on fill deposits.

Regulatory requirements have also expanded over the past decade. More communities require compliance with model building codes. More states and communities, in implementing the Coastal Zone Management Act, have instituted construction setbacks and coastal resource protection programs. More jurisdictions require geotechnical studies and certifications from design professionals for construction along the coastline. Finally, more communities participate in the **National Flood Insurance Program** (NFIP), which requires, among other things, that plans for new buildings constructed in a **Coastal High Hazard Area** be certified by a design professional.

Investigations conducted by FEMA and other organizations after major coastal disasters have consistently shown that properly sited, well-designed, and well-constructed coastal residential buildings generally perform well. This updated *Coastal Construction Manual*—prepared by FEMA with assistance from other agencies, organizations, and professionals involved in coastal construction and regulation—is intended to help the designer, contractor, and community official identify and evaluate practices that will improve the quality of construction and reduce the economic losses associated with coastal disasters.

1.2 Purpose

This manual provides guidance for the design and construction of coastal residential buildings that will be more resistant to the damaging effects of natural hazards. The focus is on new residential buildings—principally detached single-family, attached single-family (townhouses), and low-rise (three-story or less) multi-family buildings. Discussions, examples, and



CROSS-REFERENCE

The **National Flood Insurance Program** is discussed in Chapter 6, Section 6.4. **Coastal High Hazard Area** (or V zone) is explained on page 1-6 of this Chapter. Both terms are also defined in Appendix B, in Volume III of this manual.

example problems are provided for buildings located in or near coastal flood hazard areas, in a variety of coastal environments and subject to high winds, flooding, seismic activity, erosion, and other hazards.

This manual will be of assistance to all persons involved in the design and construction of one- to three-story residential buildings in coastal areas of the United States and its territories. Contractors, designers, architects, engineers, and building officials can apply the information presented in this manual as they strive to site and construct disaster-resistant housing.

One objective of this manual is to highlight the many tasks and decisions that must be made before actual construction begins. These tasks include, but may not be limited to, the following:

- evaluating the suitability of coastal lands for residential construction
- planning for development of raw land, and for infill or redevelopment of previously developed land
- identifying regulatory, environmental, and other constraints on construction or development
- evaluating site-specific hazards and loads at a building site
- evaluating techniques to mitigate hazards and reduce loads
- identifying risk, insurance, and financial implications of siting, design, and construction decisions

A second objective of this manual is to identify the best design and construction practices that can be used to build disaster-resistant structures. As a result, the manual will at times recommend and advocate techniques that exceed the minimum requirements of model building codes, design and construction standards, or Federal, state, and local regulations. However, the authors of the manual are aware of the implications of such recommendations, and make them on the basis of a careful review of building practices and subsequent building performance.

The construction and design techniques included in this manual are based on a comprehensive evaluation of:

- coastal residential buildings, both existing and under construction,
- siting, design, and construction practices employed along the U.S. coastlines,
- various building, floodplain management, and other codes and standards applicable to coastal construction, and
- the performance of coastal buildings, based on post-disaster field investigations.

The manual first provides a history of coastal disasters in the United States, an overview of the U.S. coastal environment, and fundamental considerations for constructing a building in a coastal region. The manual provides information on every step in the process of constructing a home, from evaluating potential sites, to selecting a site, to locating, designing, and constructing the building, to insuring and maintaining the building (see Figure 1-1). Flowcharts, checklists, maps, formulas, and details are provided throughout the manual to help the reader understand the entire process. In addition, example problems are presented to demonstrate decisions and calculations designers must make to reduce the potential for damage to the building from natural hazard events.

The manual also includes numerous examples of siting, design, and construction practices—both good and bad—to illustrate the results and ramifications of those practices. The intent is twofold: (1) to highlight the benefits of practices that have been employed successfully by communities, designers, or contractors, and (2) to warn against practices that have resulted in otherwise avoidable damage or loss of coastal residential buildings.

1.3 Organization

Because of its size, the manual is divided into three volumes, with 14 chapters and appendixes as follows:

Volume I

Chapter 1– Introduction. This chapter describes the purpose of the manual, provides an overview of the manual’s contents and organization, and explains how icons and summary tables are used throughout the manual to guide and advise the reader.

Chapter 2 – Historical Perspective. This chapter provides short summaries of selected coastal flood events, including findings of post-event evaluations, and it documents the causes and types of damage associated with storms and tsunamis ranging from the 1900 hurricane that struck Galveston, Texas, to Hurricane Georges, which struck Puerto Rico and the U.S. Gulf coast in September 1998.

Chapter 3 – Coastal Environment. This chapter provides an introduction to coastal processes, coastal geomorphology, and coastal hazards. Regional variations for the Great Lakes, north Atlantic, middle Atlantic, south Atlantic, Gulf of Mexico, Pacific, Alaska, Hawaii, and U.S. territories are discussed.

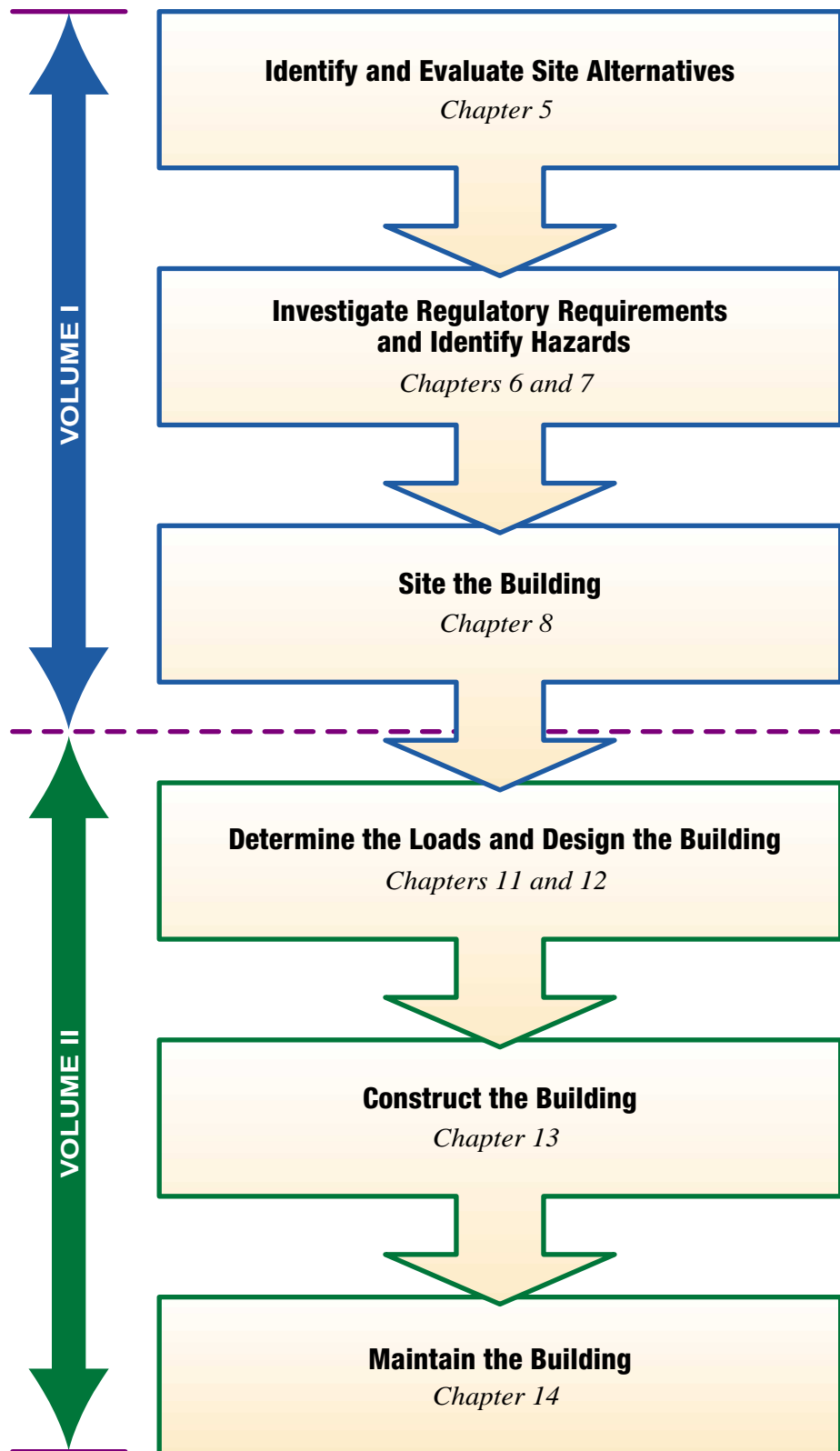
Chapter 4 – Fundamentals. This chapter provides an overview of acceptable levels of risk; tradeoffs in decisions concerning siting, design, construction, and maintenance; and cost and insurance implications that need to be considered in coastal construction.

Figure 1-1
General process flowchart for coastal construction.



NOTE

The chapters not listed in Figure 1-1 provide general information that supports the process illustrated in the figure. See pages 1-3, 1-5, and 1-6 for descriptions of all chapters in the manual.



Chapter 5 – Identifying and Evaluating Site Alternatives. Detailed discussions of the coastal construction process begin in this chapter, which presents information on which to base the selection of a site for a coastal residential building.

Chapter 6 – Investigating Regulatory Requirements. This chapter presents an overview of building codes and Federal, state, and local regulations, including the NFIP, Coastal Barrier Resources Act, and Coastal Zone Management programs, which may affect construction on a coastal building site.

Chapter 7 – Identifying Hazards. This chapter provides information about hazards that will influence the design and construction of a coastal building, including coastal storms, erosion, tsunamis, and earthquakes, and their effects.

Chapter 8 – Siting. This chapter describes the factors that should be considered in the selection of building sites, including small parcels within already developed areas, large parcels of undeveloped land, and redevelopment sites. Also provided is guidance that will assist designers and contractors in determining how a building should be placed on a site.

Chapter 9 – Financial and Insurance Implications. This chapter includes explanations of short-term and lifecycle costs associated with alternative decisions regarding siting, design, and construction. Included is a discussion of different types of hazard insurance and the effects that decisions regarding where and how to build have on insurance purchase requirements and rates, including premium discounts.

Volume II

Chapter 10 – Introduction to Volume II.

Chapter 11 – Determining Site-Specific Loads. This chapter provides information on calculating site-specific loads, including loads from high winds, flooding, seismic events, and tsunamis, as well as combinations of more than one load.

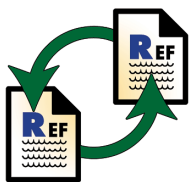
Chapter 12 – Designing the Building. This chapter provides designers and builders with information needed to design each part of a building to withstand the expected loads. Topics covered include structural failure modes, load paths, building systems, application of loads, structural connections, the building envelope, utilities, and appurtenant structures.

Chapter 13 – Constructing the Building. This chapter provides information needed to properly construct a building in a coastal area. Information is provided on ways to avoid common construction mistakes that may lessen the ability of a building to withstand a natural disaster.

Chapter 14 – Maintaining the Building. This chapter explains special maintenance concerns for new and existing buildings in coastal areas. Methods to reduce damage from corrosion, rot, fatigue, and weathering are provided along with descriptions of building elements that require frequent maintenance.

Volume III

Volume III contains the appendixes referred to in Volumes I and II.



CROSS-REFERENCE

Flood Insurance Rate Maps (FIRMs) are discussed in Chapters 3 and 6 of this manual.



DEFINITION

Under the NFIP, **freeboard** is a factor of safety, usually expressed in feet above flood level, that is applied for the purposes of floodplain management. Freeboard tends to compensate for the many unknown factors that could contribute to flood heights greater than those calculated for a selected flood, such as the base flood.

1.4 Using the Manual

As discussed in Chapter 3 of this manual, the NFIP flood insurance zone designations shown on **Flood Insurance Rate Maps (FIRMs)** issued by FEMA indicate the nature and magnitude of the flood hazard in a given area. As explained in Chapter 6, communities who participate in the NFIP use these insurance zone designations to regulate construction in identified **Special Flood Hazard Areas (SFHAs)** – areas subject to inundation by a flood that has a 1-percent probability of being equaled or exceeded in any given year (also referred to as the base flood). The flood elevation associated with the SFHA is termed the **Base Flood Elevation (BFE)**.

This manual uses the term BFE when it discusses NFIP elevation requirements, but introduces the term **Design Flood Elevation (DFE)** to account for situations where communities choose to enforce floodplain management requirements more stringent than those of the NFIP. For example, many communities require **freeboard** above the BFE, and some regulate to more severe flood conditions. Where a community chooses to exceed NFIP minimum requirements, the DFE will be higher than the BFE. Where a community's requirements are the same as the NFIP requirements, the DFE and BFE will be identical.

Currently, the NFIP uses two categories of zones to differentiate between flood hazards in SFHAs: **V zones** and **A zones**. These zones are described below (and in greater detail in Chapter 6). Also described below is a third zone defined specifically for this manual: **Coastal A zone**.



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 V zone is also referred to

as the **Coastal High Hazard Area**. As explained in Chapter 6, the minimum NFIP regulatory requirements regarding construction in V zones are more stringent than those regarding A-zone construction. V-zone requirements account for the additional hazards associated with high-velocity wave action, such as the impact of waves and waterborne debris and the effects of severe scour and erosion.



Coastal A zone – The portion of the SFHA landward of a V zone or landward of an open coast without mapped V zones (e.g., the shorelines of the Great Lakes), in which the principal sources of flooding are astronomical tides, storm surges, seiches, or tsunamis, not riverine sources. Like the flood forces in V zones, those in coastal A zones are highly correlated with coastal winds or coastal seismic activity. Coastal A zones may therefore be subject to wave effects, velocity flows, erosion, scour, or combinations of these forces. The forces in coastal A zones are not as severe as those in V zones but are still capable of damaging or destroying buildings on inadequate foundations.



Non-Coastal A zone – Portions of the SFHA in which the principal source of flooding is runoff from rainfall, snowmelt, or a combination of both. In (non-coastal) A zones, flood waters may move slowly or rapidly, but waves are usually not a significant threat to buildings. However, in extreme cases (e.g., 1993 Midwest floods), long fetches and high winds have generated damaging waves in non-coastal A zones. Designers in non-coastal A zones subject to waves may wish to employ some of the methods described in this manual.



X zone – Areas where the flood hazard is less than that in the SFHA. Shaded X zones shown on recent FIRMs (B zones on older FIRMs) designate areas subject to inundation by the flood with a 0.2-percent annual probability of being equaled or exceeded (the 500-year flood). Unshaded X zones (C zones on older FIRMs) designate areas where the annual exceedance probability of flooding is less than 0.2 percent.

The flood hazard zone icons shown above are used as visual guides throughout this manual to help readers find information specific to their needs. To use the icons effectively, readers must determine whether the property or building site in question is in a V zone, coastal A zone, or non-coastal A zone. Chapter 3 of this manual provides information readers will need to make such a determination.



NOTE

The coastal A zone classification is used by ASCE 7-98 (*Minimum Design Loads for Buildings and Other Structures*), in the determination of both flood loads and design load combinations.



NOTE

Although the NFIP regulations do not differentiate between coastal and non-coastal A zones, this manual recommends that buildings in coastal A zones be designed and constructed to be more resistant to flood forces—including wave effects, velocity flows, erosion, and scour—than buildings in non-coastal A zones (see Section 6.5 in Chapter 6).















WARNING

Areas outside the SFHA can still be subject to flooding and erosion. Designers should not ignore potential flooding and erosion hazards in areas labeled Zone X, Zone B, or Zone C.

These icons also appear in the summary table (see Figure 1-2) presented in Chapter 6. As shown by the example in Figure 1-2, the table summarizes zone-based differences among regulatory requirements and technical recommendations for buildings in V, coastal A, and non-coastal A zones. The table also provides cross-references that enable readers to quickly find more detailed information in the body of the text.

Figure 1-2
Example of chapter summary table.

| |  |  |  |
|--|--|---|--|
| | V Zone | Coastal A Zone | A Zone |
| | Guidance  | Guidance  | Guidance  |
| <p>This column lists specific topics addressed in Chapter 6, such as foundation design, the use of fill, enclosures below the BFE, the use of space below the BFE, and certification requirements.</p> |  |  |  |
| |  |  |  |
| <p>The columns for V, coastal A, and non-coastal A zones present specific guidance regarding regulatory requirements and technical recommendations.</p> | | | |

The cross-reference columns list pages, sections, and chapters of this manual that provide detailed information about the topics in question.

Additional icons appear in the margins of pages throughout the manual. These icons call out notes, warnings, definitions, cross-references, cost considerations, formulas, and example problems:



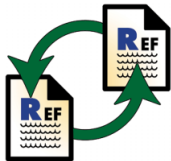
Note – Notes contain supplemental information that readers may find helpful, including things to consider when undertaking a coastal construction project, suggestions that can expedite the project, and the titles and sources of other publications related to coastal construction. Full references for publications are presented at the end of each chapter of the manual.



Warning – Warnings present critical information that will help readers avoid mistakes that could result in dangerous conditions, violations of community ordinances or laws, and, possibly, delays and higher costs in a coastal construction project. All readers should be sure to heed these warnings. Any questions about the meanings of warnings in this manual should be directed to the appropriate state or local officials.



Definition – The meanings of selected technical and other special terms are presented in the page margins where appropriate. Definitions are also provided in Appendix B, in Volume III.



Cross-Reference – Cross-references point the reader to related information—including technical discussions, regulatory information, formulas, tables, and figures—that supplements or further explains issues of interest.



Cost Considerations – Cost consideration notes discuss issues that can affect short-term and lifecycle costs associated with a coastal residential construction project.



Formula – Chapter 11 includes formulas for calculating loads imposed by forces associated with natural hazard events. Chapter 12 presents formulas used in the design of building components intended to withstand the loads imposed by design events. Each formula is presented in a box that separates it from the body of the text.



Example Problem – In Chapter 11, Example Problems demonstrate the calculation of flood, wind, and seismic loads on a coastal residential building.



NOTE

Many technical and regulatory terms used in this manual may not be familiar to some readers. Definitions of those terms are presented in the margins of pages and in Appendix B, in Volume III.

Every effort has been made to make this manual as comprehensive as possible. However, no single manual can anticipate every situation or need that may arise in a coastal construction project. Readers who have questions that are not addressed herein should consult local officials. Information is also available from the Mitigation Division of the appropriate FEMA Regional Office (see Appendix C, in Volume III), the State NFIP Coordinating Agency (see Appendix D, in Volume III), and the State Coastal Zone Management Agency (see Appendix E, in Volume III).