

Flood Resistant Design and Construction

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Full document details: ASCE 24-14 2014

American Society of Civil Engineers

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Published by the American Society of Civil Engineers



Documents

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Library of Congress Cataloging-in-Publication Data

Flood resistant design and construction.

pages cm

“ASCE/SEI 24-14.”

ISBN 978-0-7844-1379-1 (print : alk. paper)—ISBN 978-0-7844-7872-1 (ebook)

1. Structural design—Standards. 2. Flood damage prevention—United States.

3. Building, Stormproof—United States. I. American Society of Civil Engineers.

TA658.2.F56 2015

624.1'76—dc23

2014035187

Published by American Society of Civil Engineers

1801 Alexander Bell Drive

Reston, Virginia, 20191-4382

www.asce.org/bookstore | ascelibrary.org

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Errata: Errata, if any, can be found at <http://dx.doi.org/10.1061/9780784413791>.

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ISBN 978-0-7844-1379-1 (print)

ISBN 978-0-7844-7872-1 (PDF)

Manufactured in the United States of America.

22 21 20 19 18 17 16 15

1 2 3 4 5



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ASCE STANDARDS

In 2006, the Board of Direction approved the revision to the ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by the Society. All such standards are developed by a consensus standards process managed by the Society's Codes and Standards Committee (CSC). The consensus process includes balloting by a balanced standards committee made up of Society members and nonmembers, balloting by the membership of the Society as a whole, and balloting by the public. All standards are updated or reaffirmed by the same process at intervals not exceeding five years.

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PREFACE

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The 2014 edition has a number of significant technical revisions from the 2005 edition, including

1. Defines Flood Design Class rather than using Risk/Occupancy Classification assigned under ASCE 7 and requires each building or structure governed by the standard to be assigned to Flood Design Class 1, 2, 3, or 4. Uses the assigned Flood Design Class to apply elevation requirements specified in Chapters 2, 4, 5, 6, and 7. Flood Design Class 4 buildings and facilities are equivalent to Occupancy Category/Risk Category IV buildings, which ASCE 7 identifies as essential facilities.
2. Adds definitions for Mixed Use and Residential Portions of Mixed Use in commentary to clarify limitations on use of dry floodproofing measures.
3. Changes the Coastal A Zone determination requirement from the designer's responsibility to one depending on either: (1) delineation of a Limit of Moderate Wave Action (LiMWA) on a Flood Insurance Rate Map, or (2) designation by the Authority Having Jurisdiction.
4. Separates specifications for flood openings from the installation requirements. Requires the presence of louvers, blades, screens, faceplates, or other covers and devices to be accounted for in determining net open area for non-engineered openings and in determining the performance of engineered openings. Revises coefficient of discharge table for engineered flood openings. Adds commentary regarding selection of coefficient of discharge and for grouping or stacking of flood openings.
5. For Flood Design Class 4 buildings, requires the minimum lowest floor elevation (or floodproofing level of protection) to be the higher of the Base Flood Elevation plus freeboard specified in Chapters 2, 4, and 6, the Design Flood Elevation, or the 500-year flood elevation. The 500-year flood elevation requirement is new.
6. Clarifies text pertaining to alluvial fan high risk flood hazard areas.
7. In Coastal High Hazard Areas (V Zone) and Coastal A Zones (if delineated),
 - a. Makes explicit that designs must account for local scour and erosion
 - b. Provides for shallow foundations in Coastal A Zones under certain circumstances
 - c. Requires flood openings in breakaway walls
 - d. Eliminates orientation of the lowest horizontal structural member as a factor to determine elevation for lowest floors, equipment, and flood damage-resistant materials
 - e. Requires exterior doors at the top of stairways that are located inside enclosed areas with breakaway walls
 - f. Consolidates requirements for all nonstructural concrete slabs
 - g. Allows substantial improvement of existing buildings seaward of the reach of mean high tide in V zones (makes ASCE 24 consistent with National Flood Insurance Program and Coastal A Zones).
8. Updates flood damage-resistant material requirements.
9. Clarifies emergency escape and rescue opening requirements for dry floodproofed buildings.
10. Clarifies requirements for garages, carports, and accessory storage structures. Adds new section for multistory parking structures.
11. Consolidates requirements for tanks and more clearly distinguishes between requirements based on flood hazard area.

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ACKNOWLEDGMENTS

The American Society of Civil Engineers (ASCE) acknowledges the work of the Flood Resistant Design and Construction Standard Committee of the Codes and Standards Activities Division of the Structural Engineering Institute. This group comprises individuals from many backgrounds including consulting engineering, research, construction, education, government, design, and private practice.

This standard was prepared through the consensus standards process by balloting in compliance with procedures of ASCE's Codes and Standards Activities Committee. Those individuals who served on the ASCE 24-14 Standard Committee include

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ASCE would like to thank each member of the committee for his or her dedication and hard work during completion of ASCE 24-14.

ASCE would like to acknowledge the long-standing contributions of previous Committee Chair, Harry B. Thomas, and of those current members who have served the committee since the development of the 1998 edition: William L. Coulbourne, Shou-Shan Fan, Christopher P. Jones, Joseph J. Messersmith, Jr., and Kimberly Paarlberg.

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UNIT CONVERSIONS

Measurement	S.I. Units	Customary Units
Abbreviations	m = meter (S.I. base unit of length) cm = centimeter km = kilometer ha = hectare L = liter (S.I. base unit of volume) mL = milliliter kg = kilogram (S.I. base unit of mass) g = gram N = Newton ($\text{m}\cdot\text{kg}\cdot\text{s}^{-2}$) Pa = Pascal (N/m^2) kPa = kilopascal J = Joule W = watt kW = kilowatt s = second (S.I. base unit of time) min = minute h = hour day °C = degrees Celsius ppm = parts per million	yd = yard in. = inch mi = mile acre gal = gallon qt = quart lb = pound oz = ounce lbf = pound-force (lb/ft) psi = pounds per square inch atm = atmosphere ft-lbf = feet per pound-force Btu = British thermal unit hp = horsepower s = second min = minute h = hour day °F = degrees Fahrenheit ppm = parts per million
Length	1 m = 3.2808 ft = 1.0936 yd 1 cm = 0.3937 in. 1 km = 0.6214 mile	1 ft = 0.333 yd = 0.3048 m 1 in. = 2.54 cm 1 mile = 0.869 nautical mile = 1.6093 km
Area	1 m ² = 10.7643 ft ² 1 km ² = 0.3861 mi ² 1 ha = 2.4710 acre	1 ft ² = 0.0929 m ² 1 mi ² = 2.59 km ² 1 acre = 43,560 ft ² = 0.4047 ha
Volume	1 L = 0.2642 gal 1 ml = 1 cm ³	1 gal = 4 qt = 3.7854 L 1 ft ³ = 7.481 gal = 28.32 L
Mass	1 g = 0.0353 oz 1 kg = 2.2046 lb	1 oz = 28.3495 g 1 lb = 0.4536 kg
Force	1 N = 0.2248 lb/ft	1 lbf = 4.4482 N
Density	1 kg/m ³ = 0.2048 lb/ft ³ 1 kg/m ³ = 6.2427 lb/ft ³	1 lb/ft ³ = 4.882 kg/m ³ 1 lb/ft ³ = 16.018 kg/m ³
Pressure	1 kPa = 0.145 psi	1 psi = 6.8948 kPa 1 atm = 14.7 psi = 101.35 kPa
Energy and Power	1 J = 1.00 W·s = 0.7376 ft-lbf 1 kJ = 0.2778 W·h = 0.948 Btu 1 W = 0.7376 ft-lbf/s = 3.4122 Btu/h 1 kW = 1,3410 hp	1 ft-lbf = 1.3558 J 1 Btu = 1.0551 kJ 1 ft-lbf/s = 1.3558 W 1 hp = 550 ft-lb/s = 0.7457 kW
Flow	1 L/s = 15.85 gal/min = 2.119 ft ³ /min	1 gal/min = 0.1337 ft ³ /min = 0.0631 L/s
Concentration	mg/L = ppm _m (in dilute solutions)	
Temperature	°C = (°F - 32) × 5/9	°F = (°C × 9/5) + 32
Fundamental Constants and Relationships	Acceleration of gravity Density of freshwater (at 4 °C) = Density of saltwater (at 15 °C, 35 ppt) = Specific weight of freshwater (15 °C) = Specific weight of saltwater Weight of freshwater Weight of saltwater	32.2 ft/s ² = 9.81 m/s ² 1,000 kg/m ³ = 1 g/cm ³ 1,025 kg/m ³ = 1.025 g/cm ³ 62.4 lb/ft ³ = 9,810 N/m ³ 64.0 lb/ft ³ = 10,062 N/m ³ 1 gal = 8.345 lb = 3.7854 kg 1 gal = 8.559 lb = 3.8825 kg

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CHAPTER 1 GENERAL

1.1 SCOPE

This standard provides minimum requirements for flood resistant design and construction of structures that are subject to building code requirements and that are located, in whole or in part, in Flood Hazard Areas. This standard applies to the following: (1) new construction, including subsequent work to such structures, and (2) work classified as substantial improvement of an existing structure that is not an historic structure (see Fig. 1-1).

The general provisions of this section shall apply to all new construction and substantial improvements in flood hazard areas. In addition to the requirements of this section (see Fig. 1-2):

1. Chapter 2 shall apply to all new construction and substantial improvements in Flood Hazard Areas and High Risk Flood Hazard Areas except those that are identified as Coastal High Hazard Areas and Coastal A Zones;
2. Chapter 3 shall apply to all new construction and substantial improvements in High Risk Flood Hazard Areas;
3. Chapter 4 shall apply to all new construction and substantial improvements in Coastal High Hazard Areas and Coastal A Zones; and
4. Chapters 5, 6, 7, 8, and 9 shall apply to all new construction and substantial improvements.

1.2 DEFINITIONS

The following definitions apply to the provisions of the entire standard (italicized words in a definition mean the words are defined in this section):

500-Year Flood Elevation—Elevation of flooding having a 0.2% chance of being equaled or exceeded in any given year.

Accessory Storage Structure—A *structure* designed and used only for storage that is customarily accessory to and incidental to that of dwellings.

Alluvial Fan—Fan-shaped deposits of sediment eroded from steep slopes and *watersheds* and deposited on valley floors.

Alluvial Fan Flooding—Type of flood hazard that occurs only on *alluvial fans*. Alluvial fan flooding is considered hazardous when designated as a *flood hazard area* on a community's *flood hazard map* or otherwise legally designated.

Apex—Highest point on an *alluvial fan* or similar landform, where the flow is last confined. The apex generally corresponds to the location where the *watershed* erosion ceases and fan sediment deposition commences.

Attendant Utilities and Equipment—Utilities, mechanical, electrical, fuel gas, plumbing, HVAC, and related equipment, as well as services associated with new construction and *substantial improvements*.

Authority Having Jurisdiction—Organization, community, political subdivision, office, or agency that has adopted this standard under due legislative authority.

Base Flood—Flood having a 1% chance of being equaled or exceeded in any given year.

Base Flood Elevation (BFE)—Elevation of flooding, including *wave height*, having a 1% chance of being equaled or exceeded in any given year.

Basement—That portion of a *structure* having its lowest floor below ground level on all sides.

Breakaway Wall—Any type of wall subject to flooding that is not required to provide structural support to a building or other *structure* and that is designed and constructed such that, under *base flood* or lesser flood conditions, it will collapse under specific lateral loads in such a way that (1) it allows the free passage of floodwaters, and (2) it does not damage the structure or supporting foundation system.

Bulkhead—Wall or *structure* to retain or prevent sliding or *erosion* of the land; sometimes used to protect against *wave action*.

Channel—Natural or artificial waterway that periodically or continuously contains moving water.

Coastal A Zone (CAZ)—Area within a *special flood hazard area*, landward of a *V Zone* or landward of an open coast without mapped *V Zones*. In a Coastal A Zone, the principal source of flooding must be astronomical tides, storm surges, seiches, or tsunamis, not riverine flooding. During the *base flood* conditions, the potential for breaking *wave heights* shall be greater than or equal to 1.5 ft. The inland limit of the Coastal A Zone is (1) the *Limit of Moderate Wave Action* if delineated on a *FIRM*, or (2) designated by the *authority having jurisdiction*.

Coastal High Hazard Area (CHHA)—Area within a *special flood hazard area* extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area that is subject to *high velocity wave action* from storms or seismic sources. This area is designated on *FIRMs* as velocity zones V, VO, VE, or V1-30.

Community—Any state or area or political subdivision thereof, or any Indian tribe or authorized tribal organization, or Alaska native village or authorized native organization, which has the authority to adopt and enforce this standard for areas within its jurisdiction.

Datum—The vertical reference on which maps are drawn, including but not limited to the North American Vertical Datum of 1988 (NAVD) and the National Geodetic Vertical Datum of 1929 (NGVD).

Debris Flow—Mass movement of sediment, including boulders, organic materials, and other debris; debris flows typically move in surges and are characterized by a steep frontal wave.

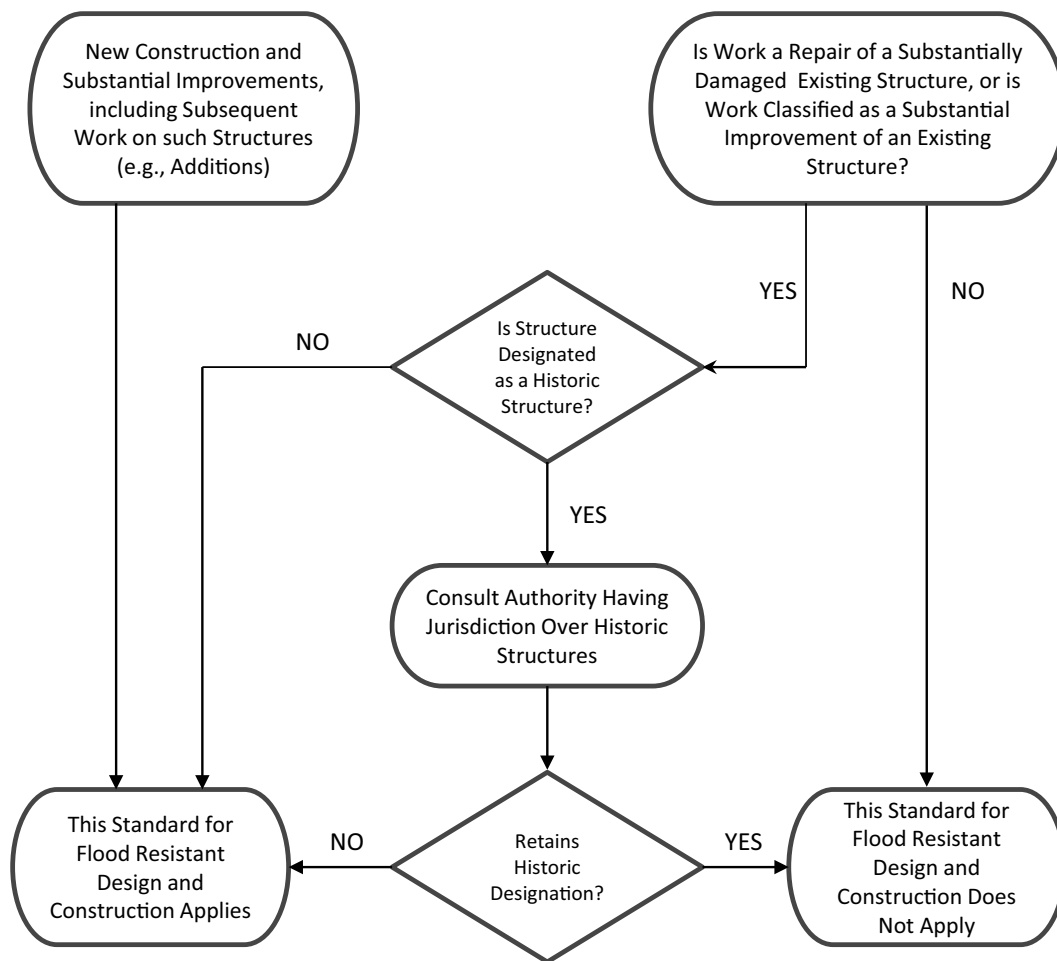


Fig. 1-1. Illustration of application of this standard.

Debris Impact Loads—Loads on a *structure* caused by flood-borne debris striking the structure, or a portion thereof; often it is sudden in nature and large in magnitude.

Design Flood—The flood associated with the greater of the following two areas: (1) area within a *floodplain* subject to a 1% or greater chance of flooding in any year, or (2) area designated as a *flood hazard area* on a *community's flood hazard map* or otherwise legally designated.

Design Flood Elevation (DFE)—Elevation of the *design flood*, including *wave height*, relative to the *datum* specified on the community's *flood hazard map*.

Dry Floodproofing—A combination of measures that results in a *structure*, including the *attendant utilities and equipment*, being watertight with all elements *substantially impermeable* and with structural components having the capacity to resist flood loads.

Enclosed Area or Enclosure—Confined area below the *DFE*, formed by walls on all sides of the enclosed space.

Eroded Ground Elevation—Elevation of ground following *erosion*.

Erodible Soil—Soil subject to wearing away, shifting, and movement due to the effects of wind, water, or other geological processes during a flood or storm or over a period of years.

Erosion—Wearing away of the land surface by detachment and movement of soil and rock fragments during a flood or storm or over a period of years, through the action of wind, water, or other geological processes.

Erosion Analysis—Analysis of the *erosion* potential of soil or strata to include the effects of *flooding* or storm surge, moving water, *wave* action, and the interaction of water and structural components.

Essential Facility—Buildings and other *structures* that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow, or earthquakes.

Existing Structure—Any *structure* for which the *start of construction* commenced before the effective date of the first *floodplain* management code, ordinance, or standard adopted by the *authority having jurisdiction*.

Fill—Material such as soil, gravel, or crushed stone that is placed in an area to increase ground elevations (see *Structural Fill*).

Flash Flood—*Flood* that crests in a short length of time and is often characterized by *high velocity flow*; it often results from heavy rainfall over a localized area, which overflows a confined water course. A flood whose waters rise from within banks to 3 ft or more above banks in less than 2 hours shall be considered a flash flood.

Flood or Flooding—General and temporary condition of partial or complete inundation of normally dry land from (1) the overflow of inland or tidal waters, or (2) the unusual and rapid accumulation of runoff or surface waters from any source.

Flood Control Structure—Barrier designed and constructed to keep water away from or out of a specified area (see *Flood Protective Works*).

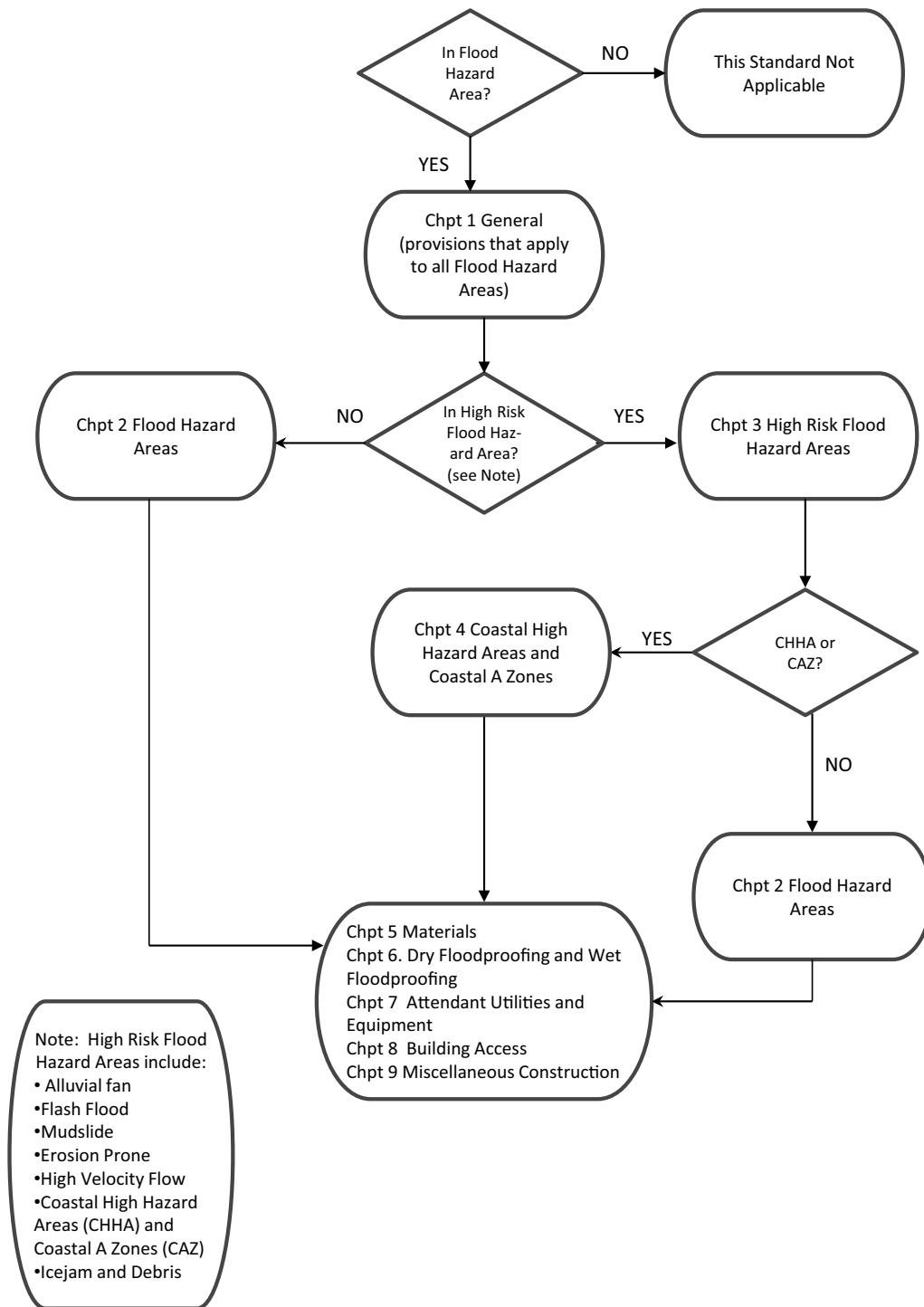


Fig. 1-2. Application of chapters.

Flood Damage-Resistant Material—Any construction material capable of withstanding direct and *prolonged contact with floodwaters* without sustaining any damage that requires more than cosmetic repair.

Flood Design Class—A classification of buildings and other structures for determination of flood loads and conditions, and determination of minimum elevation requirements on the basis of risk associated with unacceptable performance.

Flood Hazard Area—Area subject to *flooding* during the *design flood*.

Flood Hazard Map—Map delineating *flood hazard areas* adopted by the *authority having jurisdiction*.

Flood Hazard Study—Study that serves as the technical basis for a *flood hazard map*.

Flood Insurance Rate Map (FIRM)—Official map of a *community* on which the Federal Emergency Management Agency

(FEMA) has delineated both *special flood hazard areas* and the risk premium zones applicable to the community.

Flood Protective Works—Barriers designed and constructed to keep water away from or out of a specified area (see *Flood Control Structure*; *Floodwall*).

Flood-Related Erosion—Collapse, subsidence, or wearing away of land as a result of the action of *flooding*, including the effects of storm surge, moving water, and *wave* action.

Floodplain—Any land area, including watercourse, susceptible to partial or complete inundation by water from any source.

Floodproofing—Any combination of structural or nonstructural adjustments, changes, or actions that reduce or eliminate flood damage to a *structure*, contents, and *attendant utilities and equipment*.

Floodwall—Constructed barrier used to contain, control, or divert the flow of water so as to reduce the frequency of *flooding* in a specific area.

Floodway—Channel and that portion of the *floodplain* reserved to convey the base flood without cumulatively increasing the water surface elevation more than a designated height.

Footing—Enlarged base of a foundation, wall, pier, or column designed to spread the load of the *structure* so that it does not exceed the soil-bearing capacity.

Footprint—Horizontal extent of a *structure*.

Functionally Dependent—A use which cannot perform its intended purpose unless it is located or carried out in close proximity to water. The term includes only docking facilities, port facilities that are necessary for the loading and unloading of cargo or passengers, and ship building and ship repair facilities, but does not include long-term storage or related manufacturing facilities.

High Risk Flood Hazard Area—*Flood hazard area* where one or more of the following hazards are known to occur: *alluvial fan flooding*, *flash floods*, *mudslides*, *ice jams*, *high velocity flows*, *high velocity wave action*, breaking wave heights greater than or equal to 1.5 ft (*Coastal High Hazard Area* and *Coastal A Zone*), or *erosion*.

High Velocity Flow—During *design flood* or lesser conditions, water movement adjacent to *structures* or foundations with flow velocities greater than 10 ft/s.

High Velocity Wave Action—Condition where *wave heights* are greater than or equal to 3.0 ft or where *wave runup elevations* reach 3.0 ft or more above grade.

Highest Adjacent Grade—Highest elevation of the natural ground surface prior to construction next to the proposed foundation of a *structure*.

Historic Structure—Any *structure* that meets one of the following criteria: (1) listed individually in the National Register of Historic Places; (2) certified by the Secretary of the Interior as meeting the requirements for individual listing in the National Register; (3) certified or preliminary determination by the Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary of the Interior to qualify as a registered historic district; (4) individually listed on a state inventory of historic places, in states with historic preservation programs that have been approved by the Secretary of the Interior; or (5) individually listed on a local inventory of historic places in *communities* with historic programs certified by an approved state program or by the Secretary of the Interior.

Human Intervention—Required presence and active involvement of people to implement a *floodproofing* measure prior to the onset of *flooding*.

Hydrodynamic Loads—Loads imposed on an object by water flowing against and around it.

Hydrostatic Loads—Loads imposed on an object by a standing mass of water.

Ice Jam—Accumulation of floating ice fragments that causes the bridging or damming of a channel or stream.

Impact Loads—Loads that result from debris, ice, or any object transported by floodwaters striking against *structures* or parts thereof.

Levee—Artificial barrier, usually an earthen embankment, used to contain, control, or divert the flow of water so as to reduce the frequency of *flooding* in a specific area.

Limit of Moderate Wave Action (LiMWA)—Line shown on *FIRMs* to indicate the inland limit of the 1.5-ft breaking wave height during the base *flood*.

Local Scour—During flood conditions, the removal of material from a localized portion of the channel cross section or land surface due to an abrupt change in flow direction or velocity around an object or structural element.

Lowest Floor—Lowest floor of the lowest enclosed area, including *basement*; however, an unfinished or flood-resistant enclosure used solely for parking of vehicles, building access, or storage shall not be considered the lowest floor provided such enclosure is built as specified in this standard.

Mangrove Stand—Assemblage of mangrove trees containing one or more of the following species: black mangrove, red mangrove, white mangrove, or buttonwood.

Mud Flood—Hyperconcentrated sediment flow with a sediment concentration less than 45% by volume. Characterized by distinct fluid properties in deformation, particle setting, wave motion, and spreading on a horizontal surface. A mud flood is a turbulent *flood* phenomenon.

Mudflow—Hyperconcentrated sediment flow with a sediment concentration in excess of 45% by volume, characterized by plastic deformation, cohesive characteristics, and lack of *wave* motion and spreading on a horizontal surface. A mudflow is a viscous flow.

Mudslide—General category of hyperconcentrated sediment flows including *mudflows*, *mud floods*, and *debris flows*.

New Construction—Structures for which the *start of construction* commenced on or after the effective date of the first *floodplain* management code, regulation, ordinance, or standard adopted by the *authority having jurisdiction*, including any subsequent improvements to such structures. New construction includes work determined to be *substantial improvement*.

Nonerrodible Soil—Soil not subject to wearing away or movement due to the effects of wind, water, or other agents during a flood or storm or a period of years.

Nonresidential—Any building or *structure* or portion thereof that is not classified *residential*.

Obstruction—Any object or structural component attached to a *structure* below the *DFE* that can cause an increase in *flood* elevation, deflect floodwaters, or transfer flood loads to any *structure*.

Pile—Structural element that is embedded in soils by drilling, driving, or jetting, so that axial loads in the member are supported through skin friction or end bearing with the soil or rock and lateral loads in the member are supported through side bearing with the soil or rock.

Prolonged Contact with Floodwaters—Partial or total inundation by floodwaters for 72 h or more.

Rapid Drawdown—Rapid lowering of flood elevation at a rate equal to or exceeding 5 ft/h.

Rapid Rise—Rapid increase in flood elevation at a rate equal to or exceeding 5 ft/h.

Residential—(1) Buildings and structures and portions thereof where people live or that are used for sleeping purposes

on a transient or nontransient basis; (2) *structures* including but not limited to one- and two-family dwellings, townhouses, condominiums, multifamily dwellings, apartments, congregate residences, boarding houses, lodging houses, rooming houses, hotels, motels, apartment buildings, convents, monasteries, dormitories, fraternity houses, sorority houses, vacation time-share properties; and (3) institutional facilities where people are cared for or live on a 24-h basis in a supervised environment, including but not limited to board and care facilities, assisted living facilities, halfway houses, group homes, congregate care facilities, social rehabilitation facilities, alcohol and drug centers, convalescent facilities, hospitals, nursing homes, mental hospitals, detoxification facilities, prisons, jails, reformatories, detention centers, correctional centers, and pre-release centers.

Sand Dune—Natural or artificial ridges or mounds of sand landward of a beach.

Seawall—Wall separating land and water areas, primarily designed to prevent *erosion* and other damage due to *wave* action.

Shear Wall—Load bearing or nonload-bearing wall that transfers, by in-plane lateral forces, lateral loads acting on a *structure* to its foundation.

Shield—Removable or permanent substantially impermeable protective cover for an opening in a *structure* below the DFE, used in *dry floodproofing* the *structure*.

Special Flood Hazard Area—Land in the *floodplain* subject to a 1% or greater chance of *flooding* in any given year; area delineated on the *Flood Insurance Rate Map* as Zone A, AE, A1-30, A99, AR, AO, AH, V, VO, VE, or V1-30.

Start of Construction—Date the construction permit was issued for *new construction*, provided that actual start of construction commenced within 180 days of the permit date. The actual start means either the first placement of permanent construction of a *structure* on a site, such as the pouring of a slab or *footing*, the installation of *piles*, the construction of columns, or any other work beyond the stage of excavation; or the placement of a manufactured home. Permanent construction does not include land preparation, such as clearing, grading, or filling; nor does it include excavation for a *basement*, *footings*, piers, or foundation or the erection of temporary forms; nor does it include the installation of accessory structures, such as garages or sheds not occupied as dwelling units or not part of the main structure. For *substantial improvement*, the actual start of construction means the first alteration of any wall, ceiling, floor, or other structural part of a *structure*, whether or not that alteration affects the external dimensions of the *structure*.

Stem Walls—Masonry or concrete perimeter walls backfilled with compacted soil or gravel to support a floor slab or floor system.

Stillwater Depth—Vertical distance between the ground and the *stillwater elevation*.

Stillwater Elevation—Elevation that the surface of the water would assume in the absence of waves referenced to a *datum*.

Storage Tank—Closed vessel used to store gases or liquids.

Structural Fill—*Fill* placed and compacted to a specified density to provide structural support or protection to a *structure*.

Structure—Any building or other *structure*, including gas and liquid *storage tanks*.

Substantial Damage—Damage of any origin sustained by a *structure*, whereby the cost of restoration to its predamage condition equals or exceeds 50% of its predamage market value, or equals or exceeds a smaller percentage established by the *authority having jurisdiction*.

Substantial Improvement—Any reconstruction, rehabilitation, addition, or other improvement to a *structure*, the cost of which equals or exceeds 50% of its preimprovement market value, or equals or exceeds a smaller percentage established by the *authority having jurisdiction*. This term includes structures that have incurred *substantial damage*, regardless of the actual repair work performed.

Substantially Impermeable—Use of *flood damage-resistant materials* and techniques for *dry floodproofing* portions of a *structure*, which result in a space free of through cracks, openings, or other channels that permit unobstructed passage of water and seepage during flooding, and which result in a maximum accumulation of 4 in. of water depth in such space during a period of 24 h.

V Zone—Velocity Zones V, VO, VE, or V1-30 (See *Coastal High Hazard Area*).

Watershed—Topographically defined area drained by a river or stream, or by a system of connecting rivers and streams such that all outflow is discharged through a single outlet.

Wave—Ridge, deformation, or undulation of the water surface.

Wave Height—Vertical distance between the crest and the trough of a *wave*.

Wave Loads—Loads imparted on a *structure* caused by *waves* striking the *structure* or a portion thereof.

Wave Runup—Rush of *wave* water running up a slope or *structure*.

Wave Runup Elevation—Elevation, usually referenced to a *datum*, reached by *wave runup*.

Wet Floodproofing—*Floodproofing* method that relies on the use of *flood damage-resistant materials* and construction techniques in areas of a *structure* that are below the elevation required by this standard by intentionally allowing those areas to flood (see *Floodproofing*).

1.3 IDENTIFICATION OF FLOOD HAZARD AREAS

This standard shall apply to the larger of (1) those lands within a floodplain subject to a 1% or greater chance of flooding in any year (i.e., the area subject to flooding during the base flood event); and (2) those lands designated as a flood hazard area on a community's flood hazard map, or otherwise legally designated.

The flood associated with the governing definition listed here shall be termed the design flood. Design and construction requirements for new construction and substantial improvements shall be dictated by conditions during the design flood.

1.4 IDENTIFICATION OF FLOOD-PRONE STRUCTURES

1.4.1 General A determination shall be made as to whether or not a structure lies, in whole or in part, within a flood hazard area following review of flood hazard maps, studies available in the public domain, and other information available from the authority having jurisdiction.

1.4.2 Consideration for Flood Protective Works Dams, levees, floodwalls, diversions, channels, flood control structures, and other flood protective works shall not be considered to provide protection for structures during the design flood, unless those works are shown on the flood hazard map as providing protection during design flood conditions.

Design of structures behind levees and floodwalls shall consider the adequacy of drainage of rainfall, runoff, and other waters behind the levees and floodwalls.

New construction adjacent to flood protective works shall not (1) damage, endanger, or otherwise harm the flood protective works, (2) be in conflict with maintenance and repair operations of the entity responsible for the flood protective works, or (3) significantly increase the potential for trapping of rainfall, runoff, and other waters behind the flood protective works.

1.4.3 Assignment of Flood Design Class to Buildings and Structures For the purpose of applying this standard, each building and structure shall be assigned a Flood Design Class based on the risk to human life, health, and welfare associated with damage or failure due to flooding, and by nature of their occupancy or use, according to Table 1-1. Each building or other structure shall be assigned to the highest applicable Flood Design Class or Classes.

1.4.3.1 Multiple Flood Design Classes Where buildings or other structures are divided into portions with independent structural systems, the Flood Design Class assignment for each portion shall be permitted to be determined independently.

Where building systems, such as required egress, HVAC, or electrical power, for a portion with a higher Flood Design Class pass through or depend on other portions of the building or other structure having a lower Flood Design Class, those portions shall be assigned to the higher Flood Design Class.

1.5 BASIC DESIGN AND CONSTRUCTION REQUIREMENTS

1.5.1 General New construction and substantial improvements shall be designed, constructed, connected, and anchored to resist flotation, collapse, or permanent lateral movement resulting from the action of hydrostatic, hydrodynamic, wind, and other loads during design flood, or lesser, conditions in accordance with requirements of this standard if specified, or if not specified in this standard then in accordance with requirements approved by the authority having jurisdiction. Design shall include the loads and load combinations described in Section 1.6.

Design and construction in flood hazard areas shall account for each of the following in accordance with this standard:

1. Elevation of the structure,
2. Foundation types and site-specific geotechnical factors,
3. Resistance of structures to damage up to and during the design flood,
4. Obstructions or enclosures below elevated structures,
5. Structural members and connections required to resist design loads,
6. Use of flood damage-resistant materials,
7. Floodproofing,
8. Utilities,
9. Means of egress, and
10. Adverse impacts to other structures and property.

1.5.2 Elevation Requirements New construction and substantial improvements shall have the lowest floors (including basements) elevated to or above the DFE in conformance with the requirements of the chapter applicable to the specific flood hazard area.

Enclosed areas that are used solely for parking of vehicles, building access, or storage are not the lowest floor and shall be allowed below the DFE, provided the enclosed areas meet the requirements for enclosed areas applicable to the specific Flood Hazard Area. Structures that are used solely for parking of vehicles, building access, or storage shall be allowed below the DFE, provided the structures meet the requirements of Section 9.4.

Nonresidential structures and nonresidential portions of mixed-use structures shall be allowed to have the lowest floor (including basements) below the DFE, provided the structures meet the dry floodproofing requirements in Chapter 6.

1.5.3 Foundation Requirements Foundations of structures shall be designed and constructed to support the structures during design flood conditions and shall provide the required support to prevent flotation, collapse, or permanent lateral movement under the load combinations specified in Section 1.6.2. Any part of the foundation that is below the minimum elevations specified by Table 2-1 or Table 4-1, as applicable, and that provides structural support to the structure shall meet applicable foundation requirements in this standard.

1.5.3.1 Geotechnical Considerations Foundation design shall be based on the geotechnical characteristics of the soils and strata below the structure and on interactions between the soils and strata and the foundation. Foundation design shall account for instability and decreased structural capacity associated with soil consolidation, expansion, or movement; erosion and local scour; liquefaction; and subsidence, as applicable.

Geotechnical information necessary to complete the foundation design shall be obtained through geotechnical investigations of the site or from existing available data, such as investigations conducted at nearby project sites, regional studies conducted by government agencies, or other reliable sources.

1.5.3.2 Foundation Depth The foundation shall extend to a depth based on geotechnical considerations to provide the support described in Sections 1.5.3 and 1.5.3.1, taking into account the erosion and local scour of the supporting soil based on an erosion analysis.

1.5.3.3 Foundation Walls and Wall Footings Foundation walls extending below the minimum elevations specified by Table 2-1 or Table 4-1, as applicable, and foundation wall footings shall be designed and constructed to account for (1) hydrostatic, hydrodynamic, flood-borne debris impact, soil, wind, and other lateral loads acting during design flood conditions, and (2) buoyancy, dead load, live load, and other vertical loads acting during design flood conditions.

Foundation walls, foundation wall footings, and connections between the elevated building and the foundation walls, and between the foundation walls and the foundation wall footings, shall have the strength and stability to resist applied loads and to transfer applied loads to the underlying soils.

1.5.3.4 Piers, Posts, Columns, or Piles Piers, posts, columns, or piles used to elevate a structure above the DFE in flood hazard areas shall comply with all applicable foundation requirements of this standard. In Coastal High Hazard Areas and Coastal A Zones, piers, posts, columns, or piles used to elevate a structure shall be designed and constructed in accordance with Chapter 4. Connections between footings, mat, or raft foundations and piers, posts, and columns shall meet all applicable requirements of this standard.

1.5.4 Use of Fill Fill shall be designed to be stable under conditions of flooding, including rapid rise and rapid drawdown of floodwaters, prolonged inundation, and flood-related erosion and scour. Use of fill in flood hazard areas other than High Risk Flood Hazard Areas shall be in accordance with Section 2.4. Use of fill in Coastal High Hazard Areas and Coastal A Zones shall be in accordance with Section 4.5.4.

1.5.5 Anchorage and Connections The structure, including anchorage and connections, shall be designed to resist effects of

Table 1-1 Flood Design Class of Buildings and Structures

Use or Occupancy of Buildings and Structures	Flood Design Class
Buildings and structures that normally are unoccupied and pose minimal risk to the public or minimal disruption to the community should they be damaged or fail due to flooding. Flood Design Class 1 includes (1) temporary structures that are in place for less than 180 days, (2) accessory storage buildings and minor storage facilities (does not include commercial storage facilities), (3) small structures used for parking of vehicles, and (4) certain agricultural structures. ^a	1
Buildings and structures that pose a moderate risk to the public or moderate disruption to the community should they be damaged or fail due to flooding, except those listed as Flood Design Classes 1, 3, and 4. Flood Design Class 2 includes the vast majority of buildings and structures that are not specifically assigned another Flood Design Class, including most residential, commercial, and industrial buildings.	2
Buildings and structures that pose a high risk to the public or significant disruption to the community should they be damaged, be unable to perform their intended functions after flooding, or fail due to flooding. Flood Design Class 3 includes (1) buildings and structures in which a large number of persons may assemble in one place, such as theaters, lecture halls, concert halls, and religious institutions with large areas used for worship; (2) museums; (3) community centers and other recreational facilities; (4) athletic facilities with seating for spectators; (5) elementary schools, secondary schools, and buildings with college or adult education classrooms; (6) jails, correctional facilities, and detention facilities; (7) healthcare facilities not having surgery or emergency treatment capabilities; (8) care facilities where residents have limited mobility or ability, including nursing homes but not including care facilities for five or fewer persons; (9) preschool and child care facilities not located in one- and two-family dwellings; (10) buildings and structures associated with power generating stations, water and sewage treatment plants, telecommunication facilities, and other utilities which, if their operations were interrupted by a flood, would cause significant disruption in day-to-day life or significant economic losses in a community; and (11) buildings and other structures not included in Flood Design Class 4 (including but not limited to facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released. ^b	3
Buildings and structures that contain essential facilities and services necessary for emergency response and recovery, or that pose a substantial risk to the community at large in the event of failure, disruption of function, or damage by flooding. Flood Design Class 4 includes (1) hospitals and health care facilities having surgery or emergency treatment facilities; (2) fire, rescue, ambulance, and police stations and emergency vehicle garages; (3) designated emergency shelters; (4) designated emergency preparedness, communication, and operation centers and other facilities required for emergency response; (5) power generating stations and other public utility facilities required in emergencies; (6) critical aviation facilities such as control towers, air traffic control centers, and hangars for aircraft used in emergency response; (7) ancillary structures such as communication towers, electrical substations, fuel or water storage tanks, or other structures necessary to allow continued functioning of a Flood Design Class 4 facility during and after an emergency; and (8) buildings and other structures (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, or hazardous waste) containing sufficient quantities of highly toxic substances where the quantity of the material exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released. ^b	4

^a Certain agricultural structures may be exempt from some of the provisions of this standard; see Section C1.4.3.

^b Buildings and other structures containing toxic, highly toxic, or explosive substances shall be eligible for assignment to a lower Flood Design Class if it can be demonstrated to the satisfaction of the authority having jurisdiction by a hazard assessment as described in Section 1.5.3 of *Minimum Design Loads for Buildings and Other Structures* that a release of the substances is commensurate with the risk associated with that Flood Design Class.

vertical loads, including uplift and lateral loads in accordance with the load combinations specified in Section 1.6.2.

Stringers or beams shall be attached to the substructure or directly to piles, columns, piers, and walls with bolted or welded connections such that a continuous load path is maintained.

Washers shall be used under all nuts and bolt heads bearing directly on wood. All nuts, bolts, and washers shall be corrosion resistant. Notches at the tops of timber posts and piles shall not exceed 50% of the cross section of the post or pile.

Adequate anchorage shall be provided for storage tanks, sealed conduits and pipes, lined pits, sumps, and all other similar structures that are subject to flotation or lateral movement during the design flood.

1.6 LOADS IN FLOOD HAZARD AREAS

1.6.1 General Design of structures within flood hazard areas shall be governed by the loading provisions of ASCE 7 *Minimum Design Loads for Buildings and Other Structures* (ASCE/SEI 2010).

Design and construction of structures located in flood hazard areas shall consider all flood-related loads and conditions, including the following: hydrostatic loads, hydrodynamic loads, wave action; debris impact; rapid rise and rapid drawdown of floodwaters; prolonged inundation; alluvial fan flooding; wave-induced and flood-related erosion and local scour; deposition of sediments; ice flows and ice jams; and mudslides in accordance with requirements of this standard if specified, or if not specified in this standard then in accordance with requirements approved by the authority having jurisdiction. Design considerations shall be documented and shall take into account the applicable flood-related loads and conditions, and load combinations that will act on the foundation and the structure.

1.6.2 Combination of Loads Flood loads shall be combined with other loads as specified in ASCE 7 *Minimum Design Loads for Buildings and Other Structures* (ASCE/SEI 2010), either by using the allowable stress design method load combinations or by using the strength design method load combinations.

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CHAPTER 2

BASIC REQUIREMENTS FOR FLOOD HAZARD AREAS THAT ARE NOT IDENTIFIED AS COASTAL HIGH HAZARD AREAS AND COASTAL A ZONES

2.1 SCOPE

The requirements of this section shall apply to new construction and substantial improvements in Flood Hazard Areas, including High Risk Flood Hazard Areas that are not identified as Coastal High Hazard Areas and Coastal A Zones.

2.2 DEVELOPMENT IN FLOODWAYS

Structures and fill shall not be constructed or placed in floodways unless it is demonstrated that those structures and fill will not (1) increase the flood level during occurrence of the base flood discharge, and (2) reduce the conveyance of the floodway.

If the design flood elevation has been determined and a floodway has not been designated, structures and fill shall not be constructed or placed unless it has been demonstrated that the cumulative effect of proposed structures and fill, combined with all other existing and anticipated development, will not increase the base flood elevation more than 1 ft.

2.3 ELEVATION REQUIREMENTS

Structures shall have the lowest floor (including basements) elevated in conformance with the minimum elevation requirements of Table 2-1. Enclosed areas used solely for parking of vehicles, building access, or storage and that comply with Section 2.7 are allowed below elevated buildings. Elevation requirements for other building components are found in Chapters 5, 6, and 7.

Exception: Nonresidential structures with the lowest floor (including basement) below the minimum elevation specified in Table 2-1 and nonresidential portions of mixed-use structures with the lowest floor (including basement) below the minimum elevation specified by Table 2-1 shall be allowed in conformance with the dry floodproofing requirements of Section 6.2.

2.4 USE OF FILL

Fill shall not be placed in floodways unless in compliance with the requirements of Section 2.2.

2.4.1 Structural Fill Structural fill shall not be used unless design and construction of the structural fill accounts for (1) consolidation of the underlying soil under the weight of the fill and the structure, (2) differential settlement due to variations in fill composition and characteristics, and (3) slope stability and erosion control during conditions of the design flood.

Fill used for structural support or protection shall be suitable for its intended use. Structural fill used to support or protect a structure shall be placed in lifts of not more than 12-in. loose thickness, with each lift compacted to at least 95% of its maximum standard proctor density (ASTM 2012f) or 90% of its

maximum modified proctor density (ASTM 2012e), unless otherwise required by the building code or specified in a geotechnical investigation report or a soils engineering report prepared by a qualified registered design professional and approved by the authority having jurisdiction.

The side slopes of structural fill shall be no steeper than 1 on 1.5 (vertical/horizontal). Structural fill, including side slopes, shall be protected from erosion under flood conditions up to and including the design flood.

2.5 SLABS-ON-GRADE AND FOOTINGS

2.5.1 Use of Slabs-on-Grade Use of slabs-on-grade is acceptable if the slabs are constructed on structural fill that is placed in conformance with Section 2.4 or constructed on undisturbed soil of adequate bearing capacity. The top of the slab shall be at or above the elevation specified in Table 2-1. If turned down to act as footings, the bottom of the turned-down edges of the slab shall be installed at or below the depth of expected local scour and erosion.

Reinforcement shall be sufficient to prevent breakup of the slab during design flood conditions, even if the soil under the slab is undermined by erosion. Slabs-on-grade constructed on structural fill shall be placed so that there is no loss of supporting soil during the design flood conditions.

Slabs that conform to Section 9.3 shall be permitted.

Exception: Slabs located under elevated buildings and used as parking slabs or floors of enclosed areas that comply with Section 2.7 shall be permitted.

2.5.2 Footing Design Footings shall support the structure during design flood conditions, including prolonged inundation and local scour and erosion if expected during design flood conditions to prevent flotation, collapse, and lateral movement.

Footings that are intended also to act as grade beams shall comply with the provisions of Section 4.5.10.

2.6 FOUNDATION WALLS

Foundation walls that form enclosed areas shall be designed to meet the requirements of this section.

Masonry walls shall be designed and constructed in accordance with the requirements of ACI 530/ASCE 5/TMS 402, *Building Code Requirements and Specifications for Masonry Structures and Related Commentaries* (ACI 2013). The empirical design of masonry contained in Chapter 5 of ACI 530/ASCE 5/TMS 402, *Building Code Requirements and Specifications for Masonry Structures and Related Commentaries* (ACI 2013) is not permitted to be used.

Concrete shall be designed and constructed in accordance with the requirements of ACI 318, *Building Code Requirements for Structural Concrete and Commentary* (ACI 2014).

Table 2-1 Minimum Elevation of the Top of Lowest Floor—Flood Hazard Areas Other Than Coastal High Hazard Areas,^a Coastal A Zones,^a and High Risk Flood Hazard Areas^a

Flood Design Class ^b	Minimum Elevation, Relative to Base Flood Elevation (BFE) or Design Flood Elevation (DFE)
1 ^c	DFE
2 ^d	BFE + 1 ft or DFE, whichever is higher
3 ^d	BFE + 1 ft or DFE, whichever is higher
4 ^d	BFE + 2 ft or DFE, or 500-year flood elevation, whichever is higher

^aMinimum elevations shown in Table 2-1 do not apply to Coastal High Hazard Areas and Coastal A Zones (see Table 4-1). Minimum elevations shown in Table 2-1 apply to other high risk flood hazard areas unless specific elevation requirements are given in Chapter 3 of this standard.

^bSee Table 1-1 for Flood Design Class descriptions.

^cFlood Design Class 1 structures shall be allowed below the minimum elevation if the structure meets the wet floodproofing requirements of Section 6.3.

^dFor nonresidential buildings and nonresidential portions of mixed-use buildings, the lowest floor shall be allowed below the minimum elevation if the structure meets the dry floodproofing requirements of Section 6.2.

2.7 ENCLOSURES BELOW THE DESIGN FLOOD ELEVATION

Enclosed areas that are used solely for parking of vehicles, building access, or storage shall be permitted below the DFE, provided the enclosed areas meet the requirements of this section.

2.7.1 Required Openings in Foundation Walls and Walls of Enclosures Foundation walls and exterior walls that form enclosures below the DFE that do not meet the dry-floodproofing requirements of Section 6.2 shall contain openings to allow for automatic entry and exit of floodwaters during design flood conditions. Openings shall meet the requirements of Section 2.7.2 and Section 2.7.3.

2.7.1.1 Openings in Breakaway Walls Openings to allow for the automatic entry and exit of floodwaters during design flood conditions shall be installed in breakaway walls in all flood hazard areas. Openings shall meet the requirements of Section 2.7.2 and be installed in accordance with Section 2.7.3.

2.7.2 Design of Openings Openings shall meet the non-engineered opening requirements of Section 2.7.2.1 or the engineered opening requirements of Section 2.7.2.2. Installation of all openings shall meet the requirements of Section 2.7.3.

2.7.2.1 Non-Engineered Openings Non-engineered openings shall meet the following criteria: (1) The total net open area of all openings shall be at least 1 sq in. for each sq ft of enclosed area, where the enclosed area is measured on the exterior of the enclosure walls; (2) openings shall not be less than 3 in. in any direction in the plane of the wall; and (3) the presence of louvers, blades, screens, and faceplates or other covers and devices shall not block or impede the automatic flow of floodwaters into and out of the enclosed areas and shall be accounted for in the determination of the net open area.

2.7.2.2 Engineered Openings Engineered openings shall meet the following criteria:

1. Each individual opening shall be designed to allow automatic entry and exit of floodwaters during design flood or lesser flood conditions;
2. The performance of engineering openings shall account for the presence of louvers, blades, screens, grilles, faceplates, or other covers and devices;

Table 2-2 Flood Opening Coefficient of Discharge^a

Opening Shape and Condition	c
All shapes, partially obstructed during design flood ^b	0.20
Circular, unobstructed during design flood	0.60
Rectangular, long axis horizontal, short axis vertical, unobstructed during design flood	0.40 ^c
Square, unobstructed during design flood	0.35
Rectangular, short axis horizontal, long axis vertical, unobstructed during design flood	0.25 ^d
Other shapes, unobstructed during design flood	0.30

^aDifferent coefficients of discharge shall be permitted: (1) where a designer has performed detailed, opening-specific calculations, a coefficient of discharge up to 10% different than given in Table 2-2 shall be permitted; or (2) where laboratory testing or numerical modeling of flow through the opening has been conducted, the resulting coefficient of discharge shall be permitted. In no case shall a coefficient of discharge >0.60 be permitted.

^bOpenings shall be classified as partially obstructed if louvers, blades, screens, grilles, faceplates, or other covers or devices are present during the design flood.

^cWhen the horizontal dimension is twice or more the vertical dimension, use 0.4; as the dimensions approach a square, interpolate from 0.4 to 0.35.

^dWhen the horizontal dimension is half or less the vertical dimension, use 0.25; as the dimensions approach a square, interpolate from 0.25 to 0.35.

3. Openings shall not be less than 3 in. in any direction in the plane of the wall;
4. The performance of engineered openings shall ensure that the difference between the exterior and interior floodwater levels shall not exceed 1 ft;
5. In the absence of reliable data on the rates of rise and fall, assume a minimum rate of rise and fall of 5 ft/h; where an analysis indicates the rates of rise and fall are greater than 5 ft/h, the total net area of the required openings shall be increased to account for the higher rates of rise and fall; where an analysis indicates the rates of rise and fall are less than 5 ft/h, the total net area of the required openings shall remain the same or shall be decreased to account for the lower rates of rise and fall; and
6. The minimum total net area of the required openings in enclosure walls shall be calculated using the equation

$$A_o = 0.033 (1/c)(R)(A_e)$$

where

A_o = the total net area of openings required (in.²)

0.033 = coefficient (in.² · h/ft³) corresponding to a factor of safety of 5.0

c = opening coefficient of discharge given in Table 2-2

R = worst case rate of rise and fall (ft/h)

A_e = the total enclosed area (ft²).

2.7.3 Installation of Openings Installation of openings shall meet the following criteria:

1. Each enclosed area shall have a minimum of two openings,
2. Openings shall be in at least two walls of each enclosed area,
3. The bottom of each opening shall be no more than 1 ft above the higher of the final interior grade or floor and the finished exterior grade immediately under each opening, and
4. Openings meeting requirements of Section 2.7.2.1 or Section 2.7.2.2 that are installed in doors and windows are permitted.

CHAPTER 3

HIGH RISK FLOOD HAZARD AREAS

3.1 SCOPE

The requirements of Chapter 3 shall apply to new construction and substantial improvements in High Risk Flood Hazard Areas subject to one or more of the following hazards: alluvial fan flooding, flash floods, mudslides, erosion, high-velocity flows, high-velocity wave action, breaking wave heights greater than or equal to 1.5 ft (Coastal High Hazard Area and Coastal A Zone) and damage-causing ice or debris. In addition to the requirements of Chapter 3, the basic requirements of Chapter 2 shall apply to High Risk Flood Hazard Areas other than Coastal High Hazard Areas and Coastal A Zones.

3.2 ALLUVIAL FAN AREAS

New construction and substantial improvements shall not be constructed at the apex of an alluvial fan, in the fan's meandering flow paths, or in areas of the fan that have characteristics and evidence that the natural processes that form alluvial fans are active on the fan's surface, including braided channels, erratic flow paths, and sediment transport. Construction in other areas of the alluvial fan shall meet the following requirements:

1. The elevation of the lowest floor shall be a minimum of 1 ft above the highest adjacent grade, or higher, if required on a community's flood hazard map;
2. Foundations shall be designed and constructed to resist scour caused by the actual flow velocity but not less than 5 ft/s. Determination of actual flow velocities shall be based on a review of a community's flood hazard map and flood hazard study or on hydraulic calculations; and
3. Design and construction shall resist all load combinations specified in Section 1.6.2.

3.2.1 Protective Works in Active Alluvial Fan Areas New construction and substantial improvements shall not be allowed in active alluvial fan areas that have characteristics and evidence that the natural processes that form alluvial fans are active on the fan's surface unless protective works (whole alluvial fan flood damage reduction project) have been designed and constructed (1) to safely pass the design flood at the apex, within the capacity of the constructed channel(s), (2) such that it does not divert flood flows and debris toward other structures nor increase flood velocities and depths elsewhere on the alluvial fan, and (3) such construction satisfies the requirements of Section 1.4.2, and a maintenance and operations plan for the protective works is provided.

3.3 FLASH FLOOD AREAS

New construction and substantial improvements shall not be constructed in areas subject to flash flooding equal to or less than design flood conditions.

Areas suspected of being subject to flash floods shall be investigated to obtain historical information on past events. The investigation shall also include analysis of historic rainfall and runoff data for the watershed. Results of such analyses shall be documented in an engineering report, which defines the methodology and data used to conclude whether the area in question has the potential for flash flooding.

3.3.1 Protective Works in Flash Flood Areas New construction and substantial improvements shall not be constructed in areas subject to flash floods unless protective works have been determined to provide protection during the design flood event, where such construction satisfies the requirements of Section 1.4.2, and where a maintenance and operations plan for the protective works has been provided.

3.4 MUDSLIDE AREAS

New construction and substantial improvements shall not be constructed in areas subject to mudslides during periods of rainfall and runoff. Areas suspected of being subject to inundation by mudslides shall be investigated to obtain historical information on past flood events. The investigation also shall include analysis of the source area for potential overland or channel erosion, bank failure, hillslope failure, and rainfall/runoff potential. Results of such analyses shall be documented in an engineering report, which defines the methodology and data used to conclude whether the area in question has potential for future mudslides.

3.4.1 Protective Works in Mudslide Areas New construction and substantial improvements shall not be constructed in areas subject to mudslides unless protective works have been determined to provide protection during the design flood event, such construction satisfies the requirements of Section 1.4.2, and a maintenance and operations plan for the protective works has been provided.

3.5 EROSION-PRONE AREAS

New construction and substantial improvements shall not be constructed within flood hazard areas subject to erosion from