
CHAPTER 7

Floodplain Management

7.1 INTRODUCTION

WATER QUALITY MANAGEMENT, GREEN INFRASTRUCTURE & FLOOD MANAGEMENT

Water quality protection and floodplain management work hand-in-hand to manage stormwater drainage in communities across Texas. By using smart development design techniques, low impact development practices, limited impervious cover, open channel drainage systems, rainwater harvesting, and water quality treatment measures, frequent storm runoff rates and volumes can be reduced to background conditions. Measures, labeled as green infrastructure, that maximize the use of natural systems, vegetation, and soils can require less maintenance than conventional stormwater drainage systems and improve appearance. At the same time, these systems can be more resilient than conventional methods using structural approaches.

By reducing stormwater runoff and protecting floodplains, green infrastructure can help manage both localized and riverine floods. In areas impacted by localized flooding, green infrastructure practices absorb rainfall, preventing water from overwhelming pipe networks and pooling in streets or low-lying areas. Green infrastructure practices that enhance infiltration include rain gardens, bioswales, and permeable pavements. In areas impacted by riverine flooding, green infrastructure, open space preservation, and floodplain management can all complement gray infrastructure approaches. These practices reduce the volume of stormwater that flows into streams and rivers, protect the natural function of floodplains, and reduce damage to infrastructure and property.

FLOODPLAIN PROGRAMS

The Texas Floodplain Management Association (TFMA) and Texas Water Development Board (TWDB) provide information and guidance to help citizens and communities understand what floodplain management is and why floodplain development is regulated.

Communities regulate the floodplain to:

- Protect people and property
- Save tax dollars
- Ensure that Federal flood insurance and disaster assistance is available
- Reduce future flood losses
- Reduce liability

Floods have been, and continue to be, the most destructive natural disaster in terms of economic loss to the citizens of Texas with a total coverage of about \$156 billion. More than 12% of the State's land area is subject to flooding. Since 1978, Texas flood insurance policy holders have filed over 251,569 flood loss claims totaling \$5.8 billion in claim payments (as of 2015). Even though that represents many insurance payments, most flood-prone Texans do not have flood insurance.

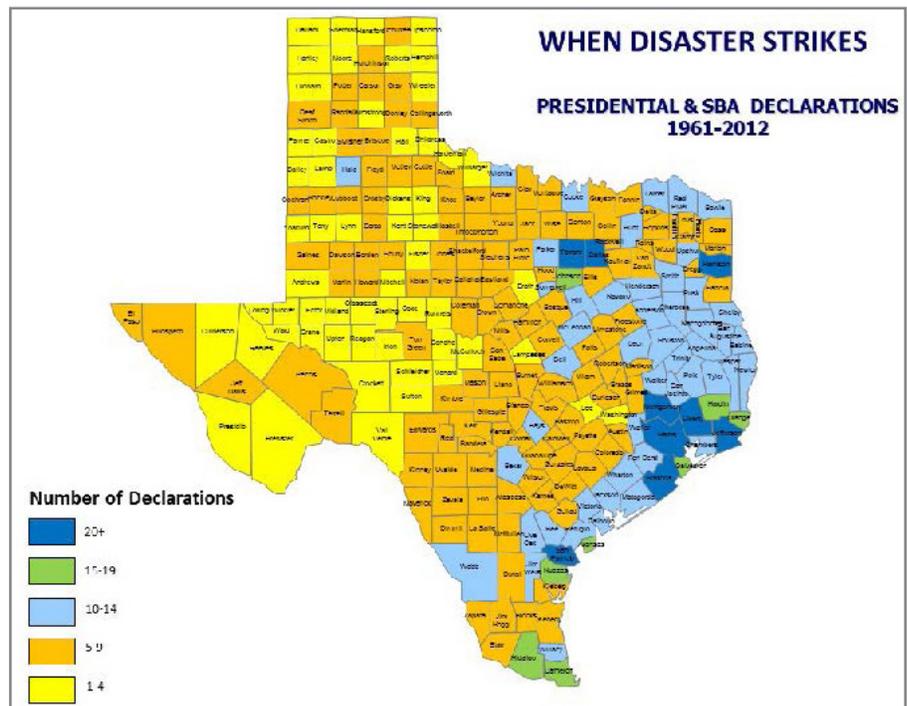


Figure 7-1: Presidential Disaster Area Declarations (1961-2012)
source: TWDB.

7.2 NATIONAL FLOOD INSURANCE PROGRAM

The National Flood Insurance Program (NFIP) was created by Congress in 1968 to protect lives and property and to reduce the financial burden of providing disaster assistance. The NFIP is administered by the Federal Emergency Management Agency (FEMA).

Nationwide, over 22,000 communities participate in the NFIP, including many in Texas. The NFIP is based on a mutual agreement between the Federal Government and communities. Communities that participate agree to regulate floodplain development according to certain criteria and standards. The partnership involves:

- **Flood Hazard Maps:** FEMA prepares maps that are used by communities, insurance agents, and others.
- **Flood Insurance:** Property owners in participating communities are eligible to purchase federal flood insurance for buildings and contents.
- **Regulations:** Communities must agree to adopt and enforce floodplain management regulations so that development, including buildings, is undertaken in ways that reduce exposure to flooding.

NFIP Flood Insurance is not available to residents of communities that do not participate in the NFIP. It is also not available for structures built or substantially improved in the Coastal Barrier Resources Act (CBRA) after their designation date, even though the structure may be in a participating community.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP) COMMUNITY RATING SYSTEM (CRS)

The NFIP's CRS program gives "extra credit" to communities in the form of reduced flood insurance rates. **Thus, property owners that live in a community participating in the CRS program receive a discount on their annual flood premium.** Communities must apply to the CRS and commit to implement and certify activities that contribute to reduced flood risk and promote safety. The [CRS Fact Sheet](#) provides a program summary and contact information for a community to get started.

The Community Rating System recognizes and encourages community floodplain management activities that exceed the minimum NFIP standards. Depending upon the level of participation, flood insurance premium rates for policyholders can be reduced up to 45%. Besides the benefit of reduced insurance rates, CRS floodplain management activities enhance public safety, reduce damages to property and public infrastructure, avoid economic disruption and losses, reduce human suffering, and protect the environment. Technical assistance on designing and implementing some activities is available at no charge to communities that participate.

Participating in the CRS provides an incentive to maintaining and improving a community's floodplain management program over the years. Implementing some CRS activities can help projects qualify for certain other Federal assistance programs. The CRS provides credit under 19 public information and floodplain management activities described in the [CRS Coordinator's Manual](#). Examples of action that a community can take to reduce the flood insurance cost include:

- Preserve open space in the floodplain, such as in the form of parks.
- Enforce higher floodplain development standards for safer development through zoning, stormwater, subdivision, and floodplain damage protection ordinances.
- Develop hazard mitigation plans.
- Obtain floodplain grants to buy, elevate, or floodproof houses and businesses in the floodplain.
- Maintain drainage systems.
- Monitor flood conditions and issue warnings during storm events.
- Inform residents about flood hazards, flood insurance, and methods to reduce flood damage.

A community that already performs some of these activities can apply to the CRS program for approval and provide flood insurance reduction benefits to its residents.

The [CRS Brochure](#) provides insight into program specifics and how a community can participate to improve floodplain protection, reduce flood insurance rates, and receive technical assistance at no charge.

Nearly 3.6 million policyholders in 1,444 communities participate in the CRS by implementing local mitigation, floodplain management, and outreach activities that exceed the minimum NFIP requirements.

FLOOD MAPS AND FLOOD ZONES

FEMA prepares Flood Insurance Rate Maps (FIRMs) to show areas that are at high risk of flooding. Since the 1970s, many versions and updates to maps have been produced.

- **“Old format” maps** may include flood zones (like B, C, A1-30) that are not being included in map updates. The maps were only available in hard copy and were often accompanied with Flood Hazard Boundary Maps.
- **“New format” maps** have been produced in order to simplify map zone designations and make map items easier to identify. See Figure 7-2.
- **Flood zones** are geographic areas that FEMA has defined according to varying levels of flood risk. These zones are depicted on a community’s Flood Hazard Boundary Map (FHBM) or FIRM and Digital FIRMs (DFIRMs) if the DFIRM is available. Each zone reflects the severity or type of flooding in the area.
- **High Risk Areas** include all A and V Zones, or the area located within the 1% annual chance floodplain (100-year floodplain) identified as a Special Flood Hazard Areas on Flood Insurance Rate Maps. Flood insurance is available to all property owners and renters. Lenders require mandatory purchase of flood insurance.
- **Moderate to Low Risk Areas** include Zone B (moderate), C and X (low) – are areas located outside the one-percent annual chance floodplain. This includes areas protected from flood by certified levees and where area is higher than base flood elevation. Lower-cost flood insurance is available to all property owners and renters. Mandatory Flood insurance purchase requirements do not apply.
- **Undetermined Risk Areas** includes Zone D, which encompass unstudied areas of undetermined but possible flood hazards. Base flood elevations not available. Flood insurance is available to all property owners and renters. Mandatory flood insurance purchase requirements do not apply.

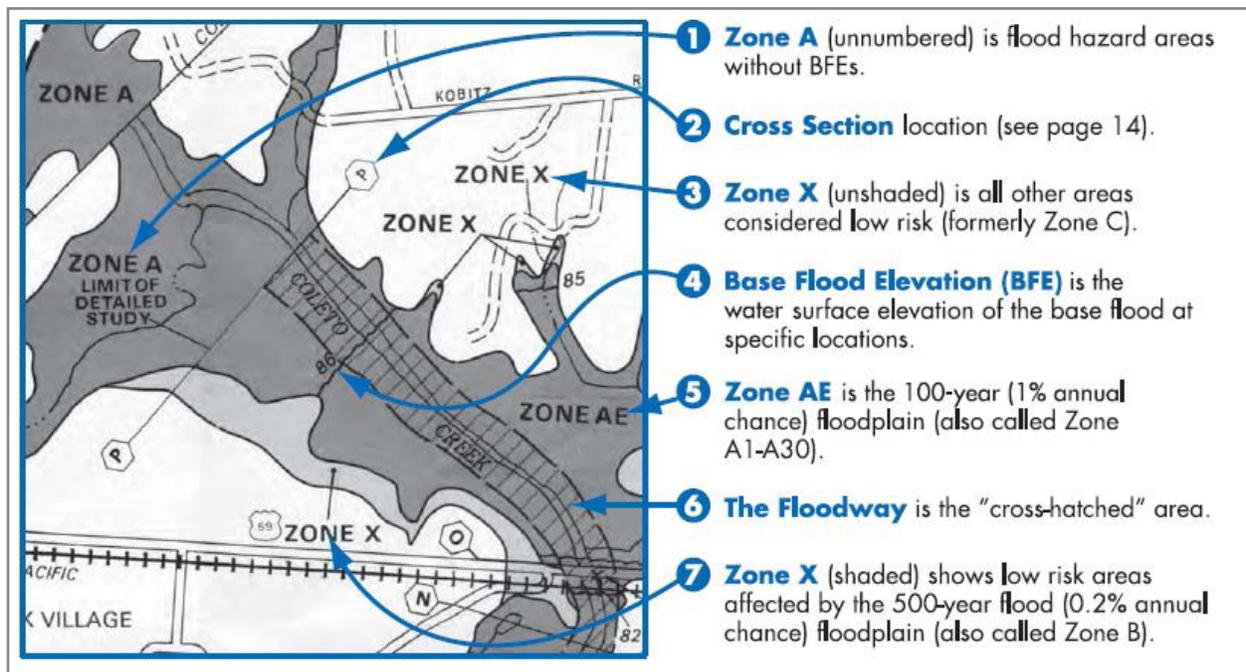


Figure 7-2: Riverine Flood Insurance Rate Map Format

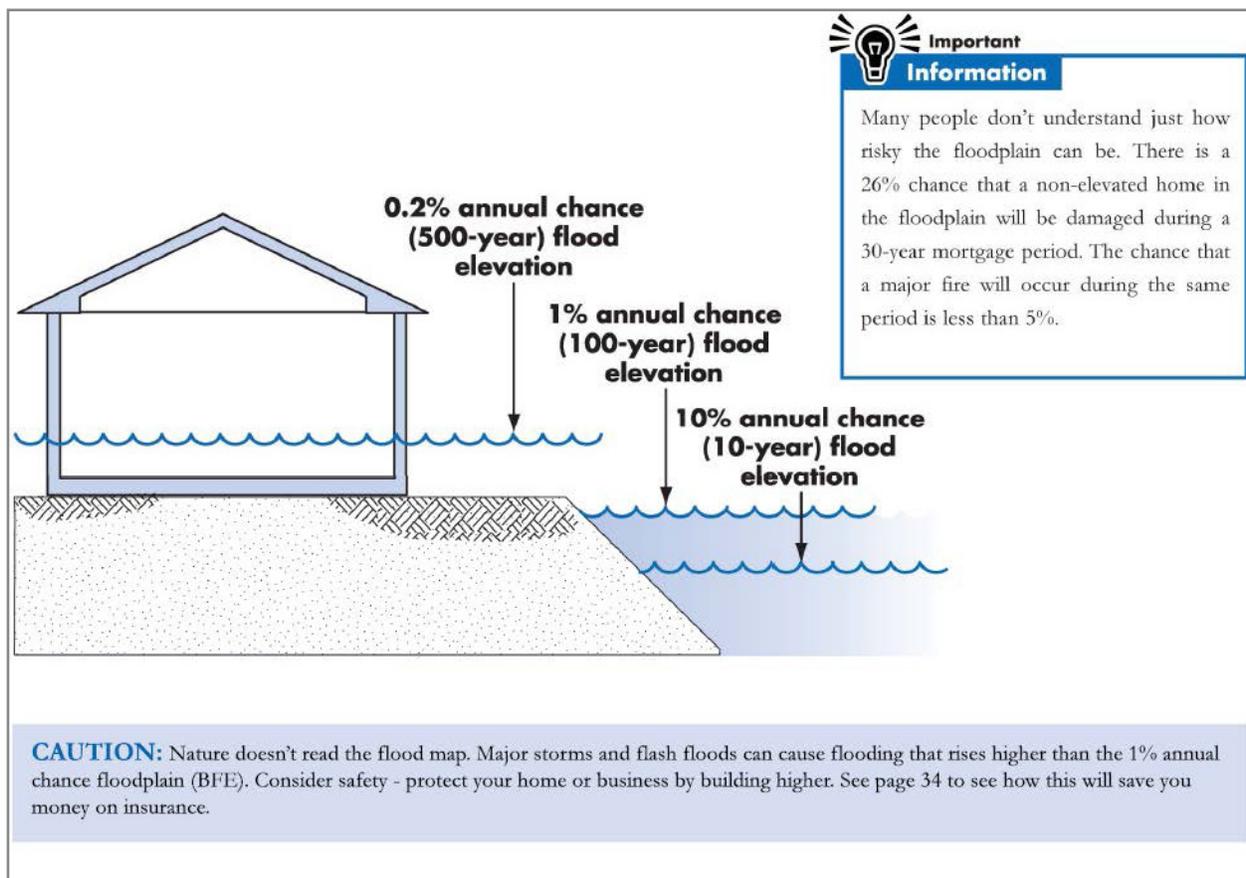


Figure 7-3: Floodplain Risk

7.3 RIVERINE FLOODPLAIN

For floodplains with Base Flood Elevations, check the Flood Insurance Study to find the Flood Profile which shows water surface elevations for different frequency floods.

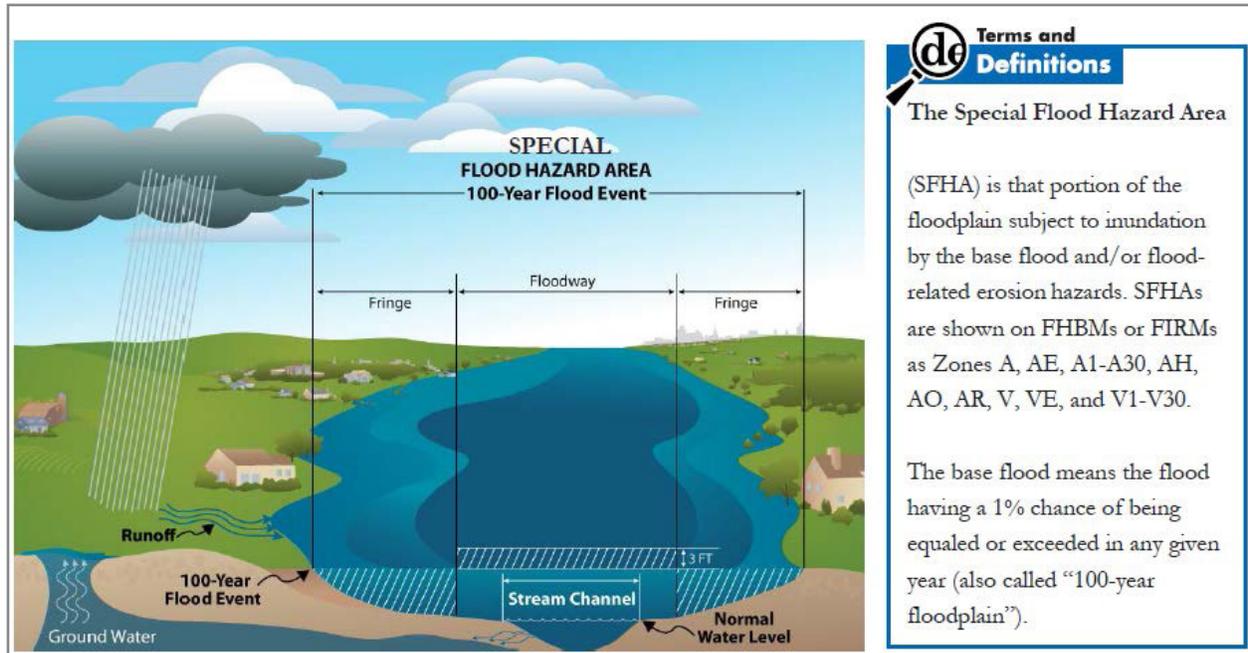


Figure 7-4: Riverine Floodplain Illustration

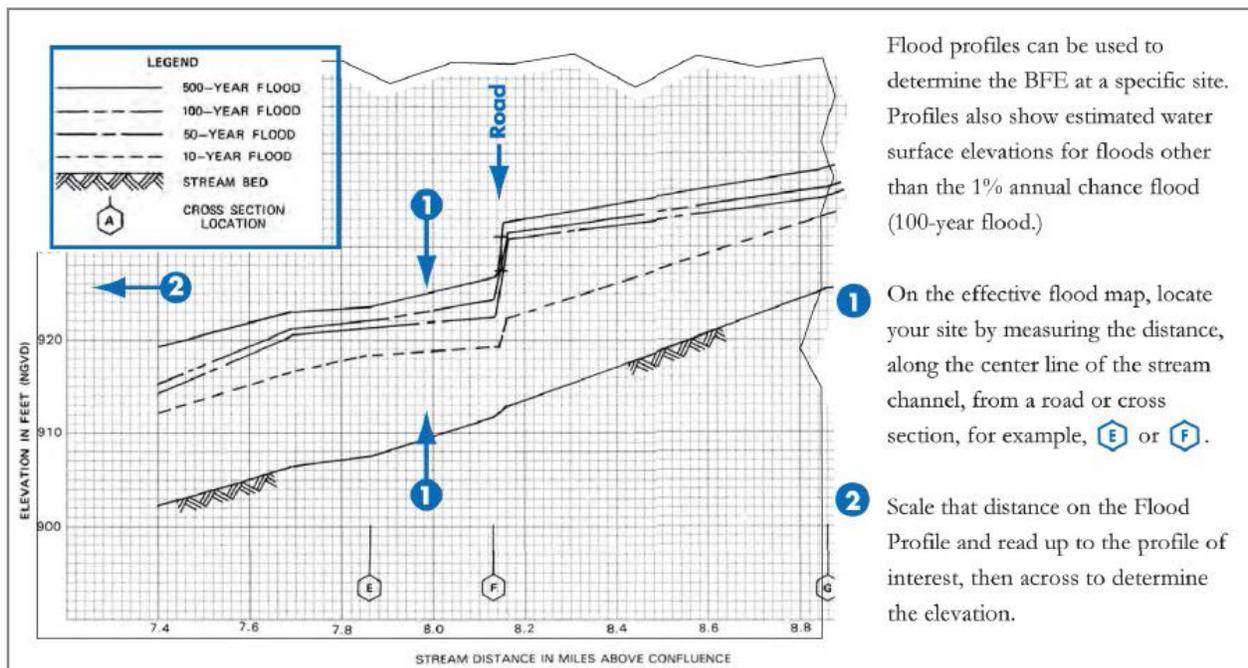
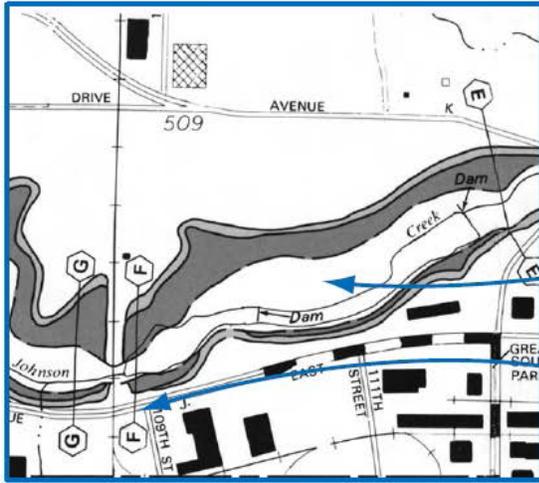


Figure 7-5: Riverine Flood Profile

FEMA prepares Floodway maps as companions to many FIRMs. Check to see if your project will be in the Floodway because additional engineering may be required.



Important Information

Initial floodplain maps were flood hazard boundary maps accompanied with separate floodway maps.

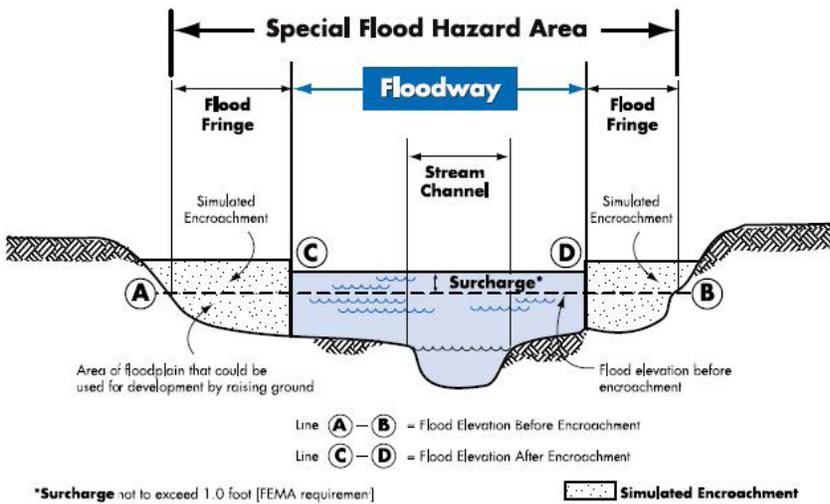
Floodway maps do not show flood zones or BFEs. Check the companion FIRM and FIS for that information.

1 **The Floodway** is the "white" area along the waterway.

2 **Cross Section** location, where ground surveys determined the shape of the land and how constrictions such as bridges and culverts affect the flow of floodwater.

Figure 7-6: The Riverine Flood Boundary

For any proposed floodway development, before a local floodplain permit can be issued, the applicant must provide evidence that "no rise" will occur. You will need a qualified registered engineer to make sure your proposed project won't increase flooding on other properties.



Terms and Definitions

The Floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to pass the base flood discharge without increasing flood depths.

Computer models of the floodplain are used to simulate "encroachment" or fill in the flood fringe in order to predict where and how much the base flood elevation would increase if the floodplain is allowed to be filled.

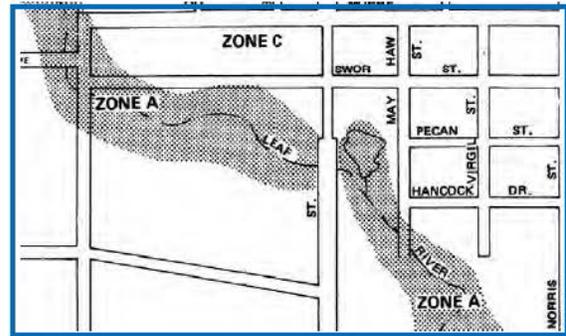
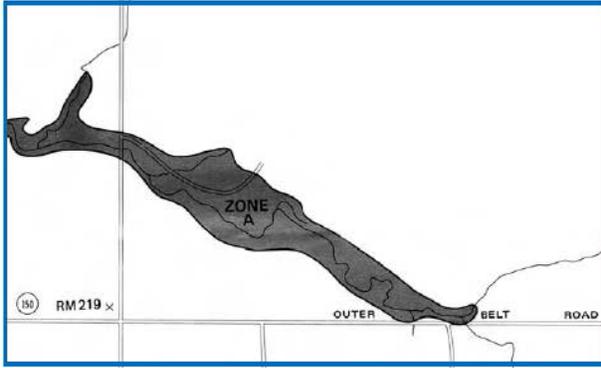
Figure 7-7: Understanding the Floodway

Some floodplains are delineated using approximate methods and therefore do not have specified base flood elevations (BFE). If you need help determining the BFE, check with your community permit office and/or FEMA.

FEMA publication *Managing Floodplain Development in Approximate Zone A Areas* (FEMA 265) is useful for engineers and community officials.

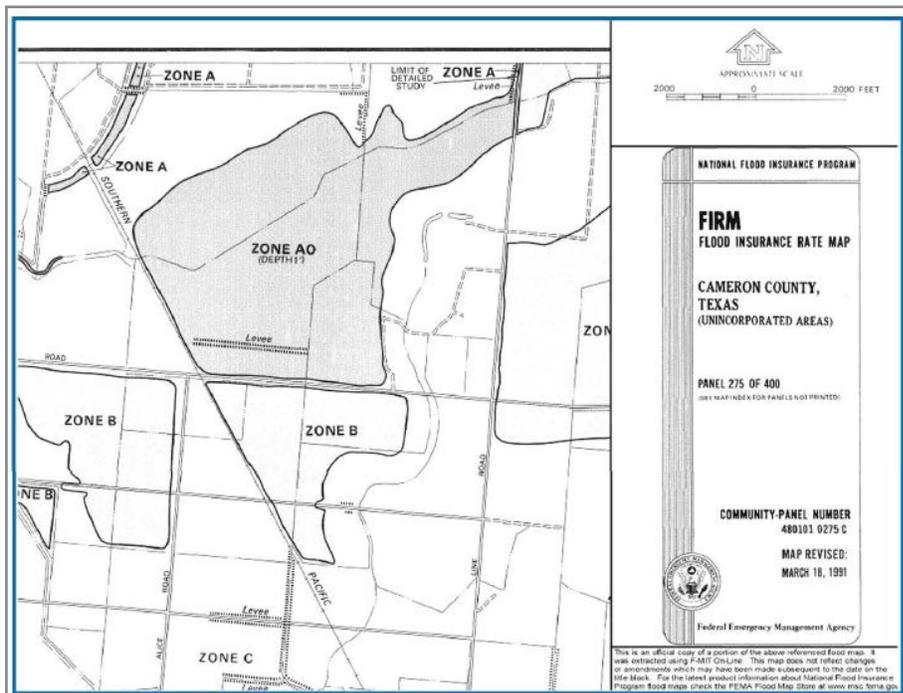
Terms and Definitions

An Approximate or Unnumbered A Zone is a special flood hazard area where BFE information is not provided.



Topographic maps can be used to estimate the Base Flood Elevation if the FIRM shows approximate or unnumbered A Zones.

Figure 7-8: Approximate Flood Zones and Unnumbered A Zones



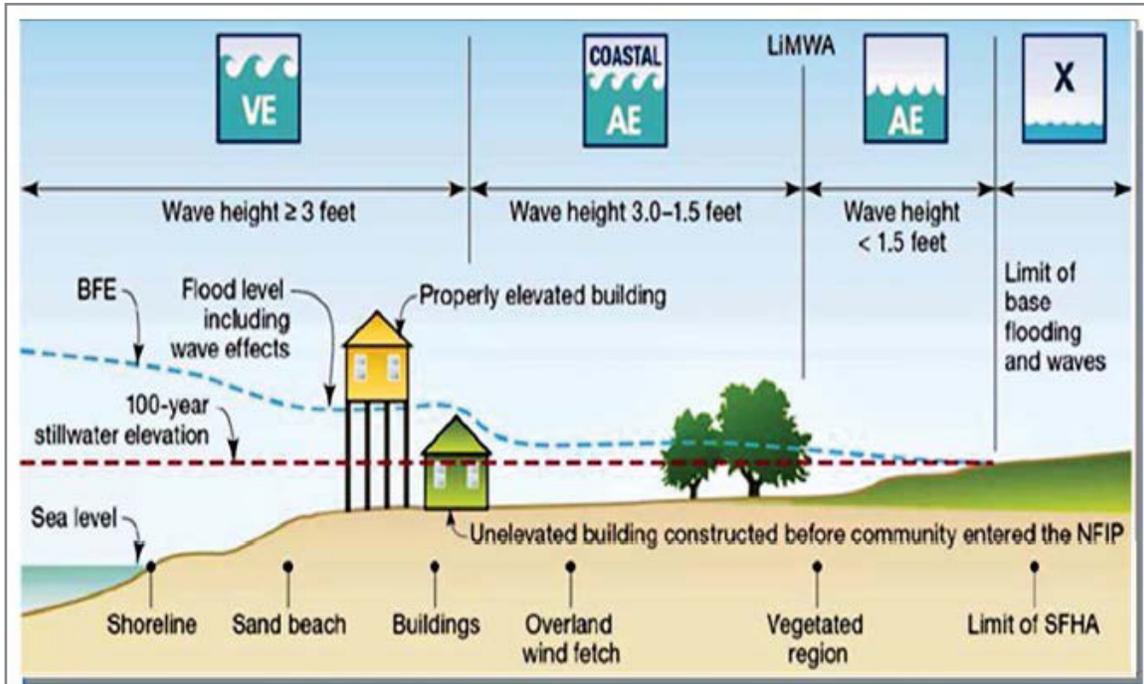
These are areas with a 1% annual chance of a shallow flood (1-3 feet of flood depth) each year.

Zone AH areas usually flood from ponding in which water is generally not moving across the land.

Zone AO areas usually flood from sheet flow in which water moves across land where there is no defined channel.

Figure 7-9: Areas of Shallow Flooding

7.4 COASTAL FLOODING

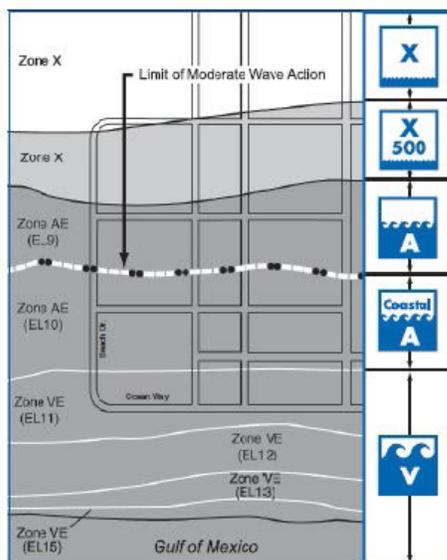


Terms and Definitions

The Coastal High Hazard Area (V Zone) is the Special Flood Hazard Area 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. The area is designated on the FIRM as Zone V1-V30, VE, or V.

The term Coastal A Zone means the portion of the SFHA landward of the V Zone or landward of a shoreline that does not have a mapped V Zone. The principal sources of flooding are associated with astronomical tides, storm surges, seiches or tsunamis. Coastal A Zones may be subject to wave effects, velocity flows, erosion, scour, or combinations of these forces and may be treated as V Zones.

Figure 7-10: Coastal Flooding Illustration



For illustration purposes only. Some FIRMs published after 2009

Figure 7-11: The Coastal A Zone

- Post-flood evaluations and laboratory tests confirm that breaking waves as small as 1.5 feet high cause damage to walls and scour around foundations.
- The Limit of Moderate Wave Action (LiMWA) may be shown on revised FIRMs.
- LiMWA conditions are found inland of Zone V and along shorelines without Zone V.
- LiMWA conditions occur where stillwater depths are between 2 and 4 feet, which can support 1.5 to 3-foot waves.
- Scour and erosion should be considered in LiMWA if soils are sandy and erodible.
- Federal flood insurance in LiMWAs is rated using Zone A rates (lower than Zone V rates).

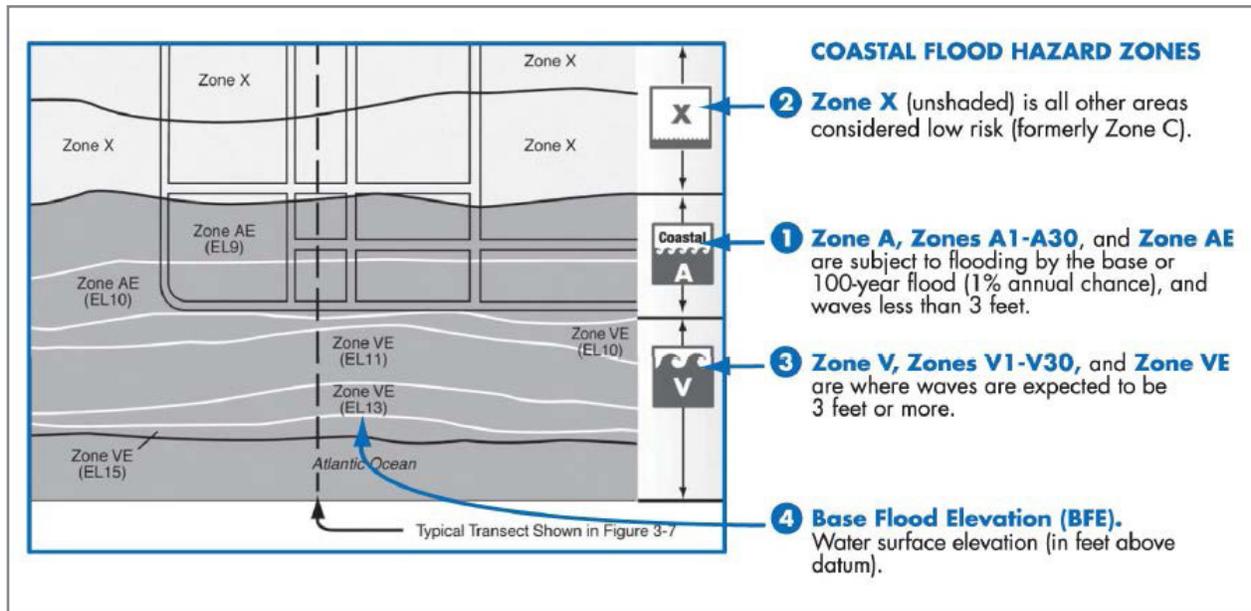
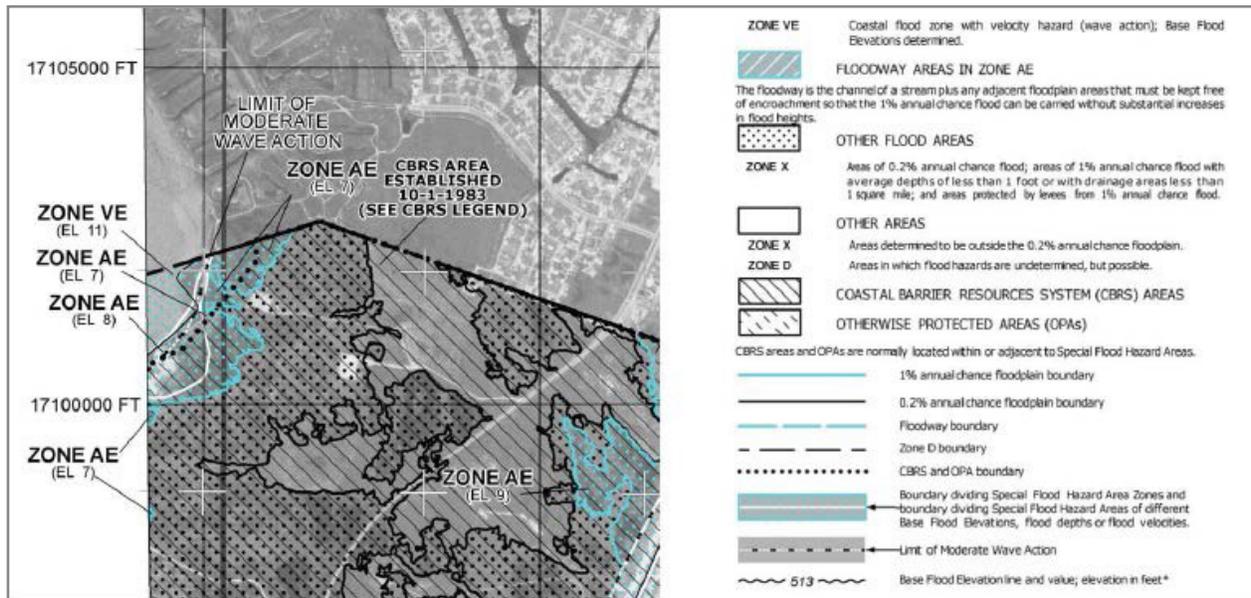


Figure 7-12: Coastal Flood Insurance Rate Map



In areas designated as a Coastal Barrier Resource System (CBRS) or an Otherwise Protected Area (OPA), NFIP insurance is not available for new or Substantially Improved structures built on or after the designation date.

Figure 7-13: Coastal Barriers Resource System (CBRS) Areas

7.5 FEMA FLOODPLAIN MAP MODIFICATIONS

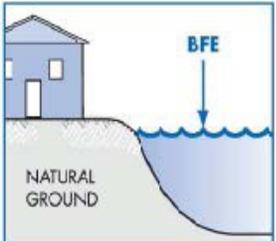
Most changes to FIRMs are made by Letter of Map Change (LOMC) – a letter which reflects an official revision to an effective NFIP map.

1. **Letter of Map Amendment (LOMA)** is an official amendment to an effective FIRM that may be issued when a property owner provides additional technical information from a licensed land surveyor or engineer, such as ground elevation relative to the BFE, SFHA, and the building. Lenders may waive the flood insurance requirements if the LOMA documents that a building is on ground above mapped floodplain.
2. **Electronic Letter of Map Amendment (eLOMA)** is a web-based application to submit simple LOMAs to FEMA.
3. **Letter of Map Revision (LOMR)** is an official revision to an effective FIRM that may be issued to change flood insurance risk zones, special flood hazard area and floodway delineations, BFEs and/or other map features. Lenders may waive the insurance requirement if the approved map revision shows buildings to be outside the SFHA.
4. **Letter of Map Revision Based on Fill (LOMR-F)** is an official revision to an effective FIRM that is issued to document FEMA's determination that a structure or parcel of land has been elevated by fill above the BFE, and therefore is no longer in the SFHA. Lenders may waive the insurance requirement if the LOMR-F shows that a building on fill is above the BFE.
5. **Physical Map Revision (PMR)** may be issued for major floodplain changes that require engineering analyses, such as bridges, culverts, channel changes, flood control measures, and large fills that change the BFE or Floodway. Physical map revisions are also issued when a new study updates or improves the FIRM.

Requests for map revisions must be coordinated through your community.

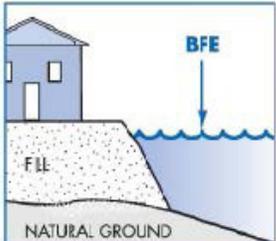
Flood Map Revisions: LOMA and LOMR-F

The most accurate information available is used to make flood maps, including topographic base maps and detailed engineering methods or methods of approximation. FEMA issues map revisions if technical data are submitted to support the changes.



Letter of Map Amendment (LOMA) is an official amendment to an effective FIRM that may be issued when a property owner provides additional technical information from a registered land surveyor or engineer, such as ground elevation relative to the BFE.

Lenders may waive the flood insurance requirement if the LOMA removes a building site from the SFHA because natural ground at the site is above the BFE.



Letter of Map Revision Based on Fill (LOMR-F) is an official revision to an effective FIRM that is issued to document FEMA's determination that a structure or parcel of land has been elevated by fill above the BFE, and therefore is no longer in the SFHA. Lenders may waive the insurance requirement if the LOMR-F removes a building site from the SFHA.

Check online at www.fema.gov/letter-map-amendment-letter-map-revision-based-fill-process for more about map revisions for different user groups (homeowners, floodplain managers, surveyors, engineers and insurance professionals). Also learn about eLOMA, a web-based application for surveyors and engineers to submit applications for simple LOMAs and FEMA.

Figure 7-14: Floodplain Map Revisions

Flood Map Revisions: CLOMR and LOMR

- **Conditional Letter of Map Revision (CLOMR)** is a letter commenting on whether a proposed project, if built as shown on the submitted documentation, would meet the standards for a map revision. Communities may require this evidence prior to issuing a permit, and the Certificate of Occupancy/Compliance should be withheld until receipt of the final LOMR based on “as-built” documentation and certification.
- **Letter of Map Revision (LOMR)** is an official revision to an effective FIRM that may be issued to change flood insurance risk zones, special flood hazard areas and floodway boundary delineations, BFEs and/or other map features. Lenders may waive the insurance requirement if the approved map revision shows buildings to be outside of the SFHA.



To download the forms used to submit map revisions, go to www.fema.gov/library, click on “Search by Resource Title,” and search on “MT-EZ”, “MT-1”, and “MT-2”.

Figure 7-15: CLOMR and LOMR Flood Map RevisionsResource System (CBRS) Areas

7.6 FLOODPLAIN FILL

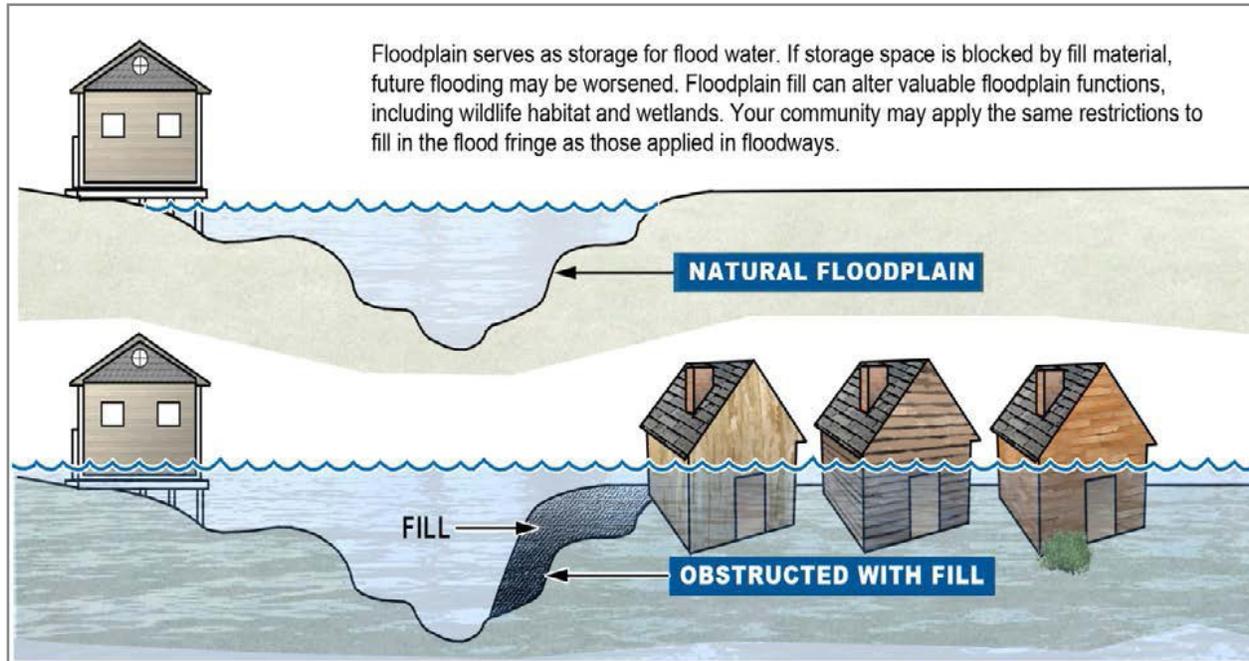


Figure 7-16: Floodplain Fill Can Make Things Worse

Make sure that floodplain fill projects do not harm neighbors. Floodway fill is only allowed if an engineering evaluation demonstrates that no net-rise in the floodplain level will occur. Floodways can be dangerous because water may flow at a fast rate.

CODE OF FEDERAL REGULATIONS - 44 CFR 60.3 D(3): ENCROACHMENT (FILL)

Prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in flood levels within the community during the occurrence of the base flood discharge.

7.7. FLOODPLAIN PROTECTION MEASURES

IS YOUR BUILDING SITE ABOVE THE BASE FLOOD ELEVATION?

If your land is shown on the floodplain map as being in the regulatory floodplain, but your building site is higher than the BFE, get a licensed land surveyor or a registered professional engineer to prepare an Elevation Certificate (EC). Submit the EC along with a Letter of Map Amendment to FEMA to verify that your property is above the BFE. If approved, it could remove the mandatory federal requirement to purchase flood insurance if you have a federally backed mortgage.

FREEBOARD: BUILD ABOVE THE BASE FLOOD ELEVATION (BFE)

Want to save some money and have peace of mind at the same time? Add Freeboard to build higher than the minimum elevation requirement. Freeboard is a factor of safety, usually one, two or even three feet above the BFE. Freeboard tends to compensate for the many unknown factors that could contribute to flood heights greater than the BFE.

Annual Flood Insurance Cost If you have:

- a post-FIRM structure
- in an AE Zone
- with \$250,000 structural coverage (maximum)
- with \$100,000 contents (maximum)

The approximate annual cost for flood insurance:

- +3 ft. \$500
- +2 ft. \$550
- +1 ft. \$700
- BFE \$1,100
- -1 ft. \$5,000
- -2 ft. expensive (submit for rate)

This is hypothetical and flood insurance premiums change annually, however, it illustrates the value in building above the Base Flood Elevation.

While building owners will save insurance money if they elevate above the BFE, the cost of insurance can more than double if a building is only one foot below the BFE.

In this case, the community may be able to grant a variance, however, the owner will most likely be required to buy insurance.

7.8. FLOODPLAIN MANAGEMENT DESIGN PROCESS GUIDE

The following section outlines the design approach to minimize floodplain damage to new development.

DRAINAGE AND FLOODPLAIN MANAGEMENT PRACTICES

1. Build outside the floodplain and floodway to the maximum extent practical, if floodplain development is proposed, apply the guidance in this Chapter to maximize safety, avoid community impacts, and minimize risk.
2. Minimize flow path alteration in the development design process to attempt to maintain the existing time of concentration.
3. The owner or developer of a site is responsible for conveyance of all existing stormwater flow through the property, even for storm events up to the 100-year storm. Design of on-site conveyance systems including channel, culvert, and drainage easements shall account for future anticipated upstream development.
4. Easements shall be dedicated to the public drainage system to convey the design storm from the upstream contributing drainage area through the property. Maintenance access shall be provided to all drainage improvements including stormwater detention basins or other structural BMPs.
5. Open channels are the preferred conveyance system and shall be designed with 4:1 side slopes where practicable with established vegetation.
6. Develop drainage standards for storm drain systems, culverts, and channels and require the design engineer to apply appropriate hydrologic and hydraulic modeling techniques to demonstrate compliance. Examples include:
 - Five-year design storm for storm drain systems such that the hydraulic grade line is below the top of curb or contained within the channel when the drainage area is less than 200 acres.
 - Twenty-five or 100-year design storm for cross culverts with a contributing drainage area greater than 100 acres such that the hydraulic grade line is below the top of road. Recommend the inclusion of freeboard of at least one foot as cross culverts are prone to debris blockage during large storm events.
7. Require that new development does not increase peak flow rates or floodplain elevations on adjacent or downstream property owners. This can be accomplished by requiring that the developed site peak flow rates remain equal to or less than the existing land use peak flow rates.
 - Common practices include the demonstration that peak flow rates are not increased by development for the 2-, 10-, 25-, and 100-year storms through detention basins, low impact development, and on-site measures.

Drainage Criteria Manual resources to guide proper hydrologic and hydraulic design include:

- [City of Corpus Christi](#)
- [Aransas County](#)
- [Harris County Flood Control District – Hydrology and Hydraulics Guidance Manual](#)

The Harris County Flood Control District also provides numerous other guidance documents relating to drainage, low impact development design, slope protection, detention basins, and other measures including CAD standards. These guidance documents can be found [here](#).

7.9. FLOODPLAIN PERMIT REVIEW GUIDE

Permits can be issued by the local government floodplain administrator. The permit reviewer has to check many things. Some of the key items are:

- Is the site in the mapped floodplain?
- Is the site in the mapped floodway?
- Have other local, State and federal permits been obtained (septic, water quality, wetland)?
- Is the site reasonably safe from flooding?
- Does the site plan show the BFE, development location and the floodplain delineation?
- Is substantial improvement of an older building proposed?
- Is an addition proposed?
- Will new buildings and utilities be elevated properly?
- Will manufactured homes be properly elevated and anchored?
- Do the plans show an appropriate and safe foundation?
- Will an Elevation Certificate be required?

The Community Floodplain Administrator may seek resources or [Floodplain Planning \(FPP\) Grants](#) from the TWDB. This agency is a resource and can help in the funding of floodplain mapping/protection planning and the development of mitigation projects/programs to create a more safe and resilient community in the Texas coastal region.