

# FLOOD INSURANCE STUDY



## PLAQUEMINES PARISH, LOUISIANA UNINCORPORATED AREAS

**Community  
Name**

Plaquemines Parish  
Unincorporated Areas

**Community  
Number**

220139



**Federal Emergency Management Agency**

FLOOD INSURANCE STUDY NUMBER

22075CV00A

**NOTICE TO  
FLOOD INSURANCE STUDY USERS**

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Selected Flood Insurance Rate Map panels for the community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed as follows:

Old Zone	New Zone
A1 through A30	AE
V1 through V30	VE
B	X
C	X

This preliminary revised Flood Insurance Study contains only profiles added or revised as part of the restudy. These profiles are presented in a reduced scale to minimize reproduction costs. All profiles will be included and printed at full scale in the final published report.

Part or all of this Flood Insurance Study may be revised and republished at any time. In addition, part of this Flood Insurance Study may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the Flood Insurance Study. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current Flood Insurance Study components.

## TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION .....	1
1.1 Purpose of Study.....	1
1.2 Authority and Acknowledgments .....	1
1.3 Coordination .....	1
2.0 AREA STUDIED.....	2
2.1 Scope of Study.....	2
2.2 Community Description .....	2
2.3 Principal Flood Problems .....	3
2.4 Flood Protection Measures .....	4
3.0 ENGINEERING METHODS .....	4
3.1 Hydrologic Analyses .....	4
3.2 Hydraulic Analyses .....	6
3.3 Coastal Analysis .....	6
3.3.1 Storm Surge Analysis and Modeling.....	6
3.3.2 Statistical Analysis .....	8
3.3.3 Stillwater Elevation .....	9
3.3.4 Wave Height Analysis.....	9
3.4 Vertical Datum .....	14
4.0 FLOODPLAIN MANAGEMENT APPLICATIONS .....	14
4.1 Floodplain Boundaries.....	15
4.2 Floodways.....	15
5.0 INSURANCE APPLICATION.....	16
6.0 FLOOD INSURANCE RATE MAP .....	17
7.0 OTHER STUDIES.....	17
8.0 LOCATION OF DATA.....	17
9.0 BIBLIOGRAPHY AND REFERENCES .....	18



Transect 32	Panels 64P – 65P
Transect 33	Panels 66P – 67P
Transect 34	Panels 68P – 69P
Transect 35	Panels 70P – 71P
Transect 36A	Panels 72P – 73P
Transect 36B	Panels 74P – 75P

EXHIBIT 3 – FLOOD INSURANCE RATE MAPS

**FLOOD INSURANCE STUDY  
PLAQUEMINES PARISH UNINCORPORATED AREAS**

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Plaquemines Parish, including the unincorporated areas of the Parish (referred to collectively herein as Plaquemines Parish), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence, and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS report are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for the original study was performed by the U.S. Army Corps of Engineers, New Orleans District (USACE-MVN) for the Federal Emergency Management Agency (FEMA), under Interagency Agreement No. H-7-76, Project Order No. 9. That study was completed in August 1979.

The hydrologic and hydraulic analyses for the September 1990 revision was performed by Prescott Follett & Associates, Inc. for the lower portion of Plaquemines Parish, south of the Empire Lateral Levee. The work for that study was completed in July 1989.

The hydrologic and hydraulic analyses for the September 1993 study represented a revision to the original study performed by the USACE-MVN for FEMA, under Interagency Agreement No. H-7-76, and included the wave height analysis in areas subject to coastal surge inundation performed by Bernard Johnson Incorporated in 1984.

The hydrologic and hydraulic analyses for this study were performed by USACE-MVN for FEMA, under Interagency Agreement No. 05-06-A047S. This study was completed in April 2008.

1.3 Coordination

An initial Consultation Coordination Officer (CCO) meeting was held on April 18, 1975, and attended by representatives of FEMA, USACE-MVN and the Parish to determine the flooding sources to be studied by detailed methods.

The results of that study were reviewed at a final CCO meeting held on May 5, 1982 and attended by representatives of FEMA, the Parish and the study contractor.

For this revision, the initial CCO meeting was held in November 2004, and was attended by representatives of FEMA, USACE-MVN, the Parish and the study contractor to determine the flooding sources to be studied by detailed methods.

The results of this study were reviewed at the final CCO meeting held on \_\_\_\_\_, and attended by representatives of FEMA, the USACE-MVN, the Parish and the study contractor. All problems raised at that meeting have been addressed in this study.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This FIS report covers the entire geographic area of Plaquemines Parish. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and representatives of the Parish.

### 2.2 Community Description

Plaquemines Parish is located in southeastern Louisiana, southeast of the City of New Orleans. The Parish lies along both banks of the Mississippi from Orleans Parish in the north to the Gulf of Mexico, the southern boundary. Plaquemines Parish is also bordered by Jefferson Parish to the west, St. Bernard Parish to the east, and Orleans Parish to the north. The total land area of the Parish is approximately 1,986 square miles. The population was 26,757 in 2000 and had decreased to 22,512 (estimated) or approximately 15.9 percent in 2006, after Hurricane Katrina (Reference 1).

The economy of the area is predominantly agricultural and industrial. The principal crops consist of oranges and tomatoes. Industries are related to offshore oil exploration and production and to the excellent port facilities afforded by the Mississippi River. State Routes 23 and 39 are the major arteries paralleling the Mississippi River on the west and east banks, respectively. Many other state and Parish roads supplement land transportation within the Parish. Railroad service is provided on the west bank by the New Orleans and Lower Coast Railroad. Many streams and bays (both natural and man-made) traverse Plaquemines Parish; many of these are navigable. The Mississippi River is the major waterway in the Parish and much of the economy and culture of the area is derived from it.

Natural ground in the area varies in elevation from 10 feet along the alluvial banks of the Mississippi River in the northern portion of the Parish, to several feet below sea level in the lower portions of some pumped areas. Vegetation varies from urban and agricultural varieties along the alluvial banks and protected areas to heavily wooded swamp and open

marsh classes covering the largest portions of the land area within the Parish. Soil conditions are sedimentary types ranging from consolidated clays on the higher alluvial banks to clays and silts in various degrees of liquification in open marsh areas.

The climate of the area is subtropical and is strongly influenced by the Gulf of Mexico. Extremes of temperature are seldom experienced and the average temperatures range from 83 degrees Fahrenheit (°F) in the summer to 56 °F in winter. The average annual precipitation is approximately 60 inches; the heaviest rainfall occurs between June and September and the least during the December-January period.

### 2.3 Principal Flood Problems

The low-lying areas of Plaquemines Parish are subject to periodic flooding from a variety of sources. Flooding results from intense rainfall in the general area, abnormally high tides in the Gulf of Mexico, hurricanes or lesser tropical disturbances and/or combinations of the various events. In the northern portion of Plaquemines Parish, the predominant flooding source is rainfall runoff. Pumping facilities within protected areas are unable to discharge runoff from severe storms expeditiously. The problem is further aggravated by subsidence that usually occurs in pumped areas that were formerly wetlands.

Areas in the southern portion of the Parish also experience flooding from runoff ponding described above; however, the greatest threat to southern Plaquemines Parish, due to its precarious location on the Mississippi River delta, is that of hurricane surge inundation. As hurricanes approach coastal Louisiana from any direction, large volumes of water are propelled inland over the low marshlands and into many bayous and canals. Hurricane protection levees, in combination with the Mississippi River levees, provide protection for the pumped areas from hurricanes having recurrence intervals of 10 years or less. During severe hurricanes, overtopping of the hurricane protection levees and the Mississippi River levees in its most exposed reaches can occur, producing severe flooding. The Mississippi River itself is forced out of its banks in these southern areas during hurricane conditions. Many severe storms have been experienced in the areas east and west of the Mississippi River. Flooding to various depths occurred on one or both sides of the river during storms of 1856, 1860, 1886, 1887, 1893, 1901, 1906, 1909, 1915, 1916, 1917, 1926, 1940, 1947, 1948, 1956, 1961, 1964, 1965 and 1969. Hurricane Betsy, in September 1965, produced what at that time was the highest recorded tide in the area. Other storms prior to Katrina and Rita significantly impacting the Parish were Carmen (1974), Bob (1979), Danny and Juan (both 1985), Andrew (1992), Frances and George (both 1998).

Prior to Hurricanes Katrina and Rita, there were records of tides experienced at key locations of 15.7 feet at Bohemia; 15.2 feet in the Mississippi River at West Pointe a la Hache; 13.6 feet at Ostrica lock; 10.4 feet at Empire; 7.7 feet at Buras; 8.8 feet at Venice; 6.6 feet at the head of Southwest Pass; and 11.7 feet at Yscloskey. Hurricane Camille, which occurred in August 1969, inundated the areas that had previously been protected on the west side of the Mississippi River from Port Sulphur to Venice, and caused almost total destruction to facilities located south of the latitude of Port Sulphur. Some of the flood stages caused by Hurricane Camille were at: Ostrica, 15.9 feet; Empire, 9.5 feet; Bohemia, 11.0 feet; West Pointe a la Hache, 11.8 feet; Yscloskey, 8.0 feet; Buras, 13.4 feet; Southwest Pass, 12.0 feet; and Venice, 9.1 feet (References 2, 3, 4, 5, and 6).

## 2.4 Flood Protection Measures

Plaquemines Parish operates and maintains drainage pumps at 16 locations within the Parish. These drainage areas are bounded by Mississippi River levees on the river side, and hurricane protection levees on the Gulf side.

Non-federal levees were generally constructed of spoil from canals used for conveyance to the pumps. These measures can not be considered as providing protection from flooding due to the low-intensity rain storms and high stages that sometimes occur in the swamps or marsh areas.

Several Federal projects were constructed to provide hurricane protection to the Parish. The hurricane protection project, Reach C, enclosed the area adjacent to the Mississippi River on the east bank from Phoenix to Bohemia (Reference 7). On the west bank of the river, the hurricane protection projects, Reaches B1 and B2, were constructed to protect the area from Tropical Bend to Venice, with a levee designed to exclude hurricane surges from the west (References 8 and 9). Those two projects were completed from Empire to Venice. The enlargement of the Empire Lateral Levee, which lies to the north of the Daullut Canal, was also completed. Other Federal projects authorized for Plaquemines Parish were the hurricane protection project for Reach A, City Price to Tropical Bend, and the East Bank Barrier project, a levee from river mile 10 to 44 on the east alluvial bank of the Mississippi River that would break hurricane surge waves enough to prevent overtopping of the west bank Mississippi River levees (References 10 and 11). None of these projects are considered to provide protection to the Parish post Hurricanes Katrina and Rita.

## 3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

### 3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting the community.

In the original study, topographic information for the Parish was collected to determine drainage areas and storage characteristics. Rainfall depth, frequency, and duration data were obtained from the National Weather Service (NWS); information for hypothetical storms of 10-, 50-, 1-, and 0.2-percent-annual-chance recurrence intervals, and time distributions were developed for each hypothetical storm (Reference 12). Precipitation records are available at several locations in the Parish for varying periods of record (Reference 13).

No rainfall runoff monitoring is performed in the vicinity; consequently, synthetic unit hydrographs were developed. Runoff hydrographs were developed using a computerized model (Reference 14).

In areas containing forced drainage, pump information was gathered and pumped routings were performed to determine peak flood elevations for this type of flooding. The discharge range at Tarbert Landing, river mile 306.3 above Head of Passes on the Mississippi River, was the principal source of data for defining discharge-frequency relationships. Data from this station, reflecting present conditions for the river below this point, have been collected since 1932. Below Bonnet Carre Spillway, a frequency of one in 7 years was assigned to the Mississippi River and Tributaries (MR&T) project flood of 1,250,000 cubic feet per second (cfs) by using these data. The 10-, 50-, and 1-percent-annual-chance floods will not produce discharges and associated stages of greater magnitude than 1,250,000 cfs at Plaquemines Parish, because they are limited by the use of the Bonnet Carre Spillway. The project was designed for floods in excess of the 1-percent-annual-chance event. The determination of maximum wave crest elevations associated with the 1-percent-annual-chance event was approached by the method recommended by the National Academy of Sciences (Reference 15).

The peak discharge-drainage area relationship for the Mississippi River is shown in Table 1, Summary of Discharges.

**TABLE 1 - SUMMARY OF DISCHARGES**

FLOODING SOURCE <sup>1</sup>	DRAINAGE AREA (acres)	PEAK DISCHARGE (cfs)			
		10-PERCENT ANNUAL CHANCE FLOOD	2-PERCENT ANNUAL CHANCE FLOOD	1-PERCENT ANNUAL CHANCE FLOOD	0.2-PERCENT ANNUAL CHANCE FLOOD
Mississippi River River Miles 10-82	Not Determined	1,250,000	1,250,000	1,250,000	Not Determined

<sup>1</sup> River miles refers to distance above Head of Passes

## 3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the Flood Insurance Rate Map (FIRM) represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

In the original study, hurricane surge flooding in lower Plaquemines Parish was investigated using results presented in the Type-5 Flood Insurance Study for the Louisiana Gulf Coast and other USACE-MVN project studies for Plaquemines Parish (References 6, 7, 8, 9, 10, and 11). Comparison of the inland hurricane surge profiles with hurricane protection levees and Mississippi River levees provided a determination that the 2-, 1-, and 0.2-percent-annual-chance flood events would produce flooding by overtopping in most of the drainage areas. Overtopping for the 1-percent-annual-chance flood event or greater hurricane in most areas would cause flooding up to the levee crest quite rapidly. In the lower drainage areas on the west bank, hurricane overtopping can occur on the Mississippi River levee or the hurricane protection levee.

Headwater floods on the Mississippi River are confined by a levee system constructed and maintained by the Federal Government to protect the area from riverine floods in excess of 1-percent-annual-chance flood. For this reason, riverine flooding was not considered to be a threat to Plaquemines Parish. On the lower reaches of the river, and a portion of the middle reach in the Parish, hurricane tides supersede headwater flooding.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles and Transects (Exhibits 1 and 2). For stream segments for which a floodway was computed (Section 4.2), selected cross-section locations are also shown on the FIRM.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles and Transects (Exhibits 1 and 2) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

## 3.3 Coastal Analysis

For this revision, the hydraulic characteristics of flooding from possible sources were analyzed to provide estimates of flood elevations for selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown in the coastal data tables and flood profiles in the FIS report.

### 3.3.1 Storm Surge Analysis and Modeling

For areas subject to tidal inundation, the 10-, 2-, 1-, and 0.2-percent-annual-chance Stillwater

elevations and delineations were taken directly from a detailed storm surge study documented in the Technical Study Data Notebook (TSDN) for this new Louisiana coastal flood hazard study.

The Advanced Circulation model for Coastal Ocean Hydrodynamics (ADCIRC) developed by the USACE-MVN was applied to predict the stillwater elevations or storm surge levels for coastal Louisiana. The ADCIRC model uses an unstructured grid and is a finite-element long wave model. It has the capability to simulate tidal circulation and storm surge propagation over large areas and is able to provide highly detailed resolution in the areas of interest including shorelines, open coasts and inland bays. It solves the three dimensional equations of motion, including tidal potential, Coriolis acceleration, and nonlinear terms of the governing equations. The model is formulated from the depth averaged shallow water equations for conservation of mass and momentum which result in the generalized wave continuity equation.

Near-shore waves are required to calculate wave runup and overtopping on structures, and the wave momentum (radiation stress) contribution to elevated water levels (wave setup). The numerical model STWAVE was used to generate and transform waves to the shore. STWAVE is a finite-difference model that calculates wave spectra on a rectangular grid. The model outputs zero-moment wave height, peak wave period ( $T_p$ ), and mean wave direction at all grid points and two-dimensional spectra at selected grid points. STWAVE includes an option to input spatially variable wind and surge field. The surge significantly alters the wave transformation and generation for the hurricane simulations in shallow areas flooded.

The STWAVE model was applied on several grids for the southern Louisiana area. The input for each grid includes the bathymetry (interpolated from the ADCIRC domain), surge fields (interpolated from ADCIRC surge fields), and wind (interpolated from the ADCIRC wind fields, which apply land effects to the wind fields input to the surge model). The wind applied in the STWAVE is spatially and temporally variable for all domains. The STWAVE model was run at 30-minute intervals.

An existing ADCIRC grid mesh developed by the USACE-MVN was refined along the shoreline of Louisiana and surrounding areas using bathymetric and topographic data from various sources. Bathymetric data consisted of ETOPO5 and Digital Nautical chart databases in the offshore regions. In the nearshore areas, bathymetric data came from regional bathymetric surveys conducted by the USACE-MVN. The topographic portion of the ADCIRC mesh was populated with topographic light detection and ranging (LIDAR) from several sources. In addition, subgrid sized features such as roads and levees were captured in the grid and modeled as weirs. Further details about the terrain data and how it was processed can be found in the TSDN.

The completed ADCIRC grid mesh forming the finite element model has over 2,200,000 grid nodes. The NOAA high definition vector shoreline was used to define the change between water and land elements. The grid includes other features, such as islands, roads, bridges, open water, bays, and rivers. Field reconnaissance detailed the significant drainage and road features, and documentation of coastal structures in the form of seawalls, bulkheads, and

harbors. The National Land Cover Dataset was used to define Manning's n values for bottom roughness USACE-MVNfficients input at each node to the mesh. A directional surface wind roughness value was also applied. Further details about the ADCIRC mesh creation and grid development process can be found in the TSDN.

Predicted tidal cycles were used to calibrate the ADCIRC model and refine the grid. Tidal boundary conditions were obtained from a total of 40 NOAA tide gauges. Seven tidal constituents were used (K1, O1, Q1, M2, S2, N2, and K2). The simulated water-surface elevation time series was compared to measured tides from tide gauge stations for over a 30-day period. Model validation, which tests its ability to reproduce historical events, was performed against Hurricanes Katrina (2005), Rita (2005), and Andrew (1993). Simulated water levels for each event were compared to observed water levels from NOAA tidal gauges, as well as available high water marks. Further details about the model calibration and validation can be found in the TSDN.

Production runs were carried out with STWAVE and ADCIRC on a set of hypothetical storm tracks and storm parameters in order to obtain the maximum water levels for input to the statistical analysis. The hypothetical (synthetic) population of storms was divided into two groups, one for hurricanes of Saffir-Simpson scale Category 3 and 4 strength or "greater storms" and another set for hurricanes of Category 2 strength or "lesser storms." A total of 304 individual storms with different tracks and various combinations of the storm parameters were chosen for the production runs of synthetic hurricane simulations. Each storm was run for at least 3 days of simulation and did not include tidal forcing. Wind and pressure fields obtained from the Planetary Boundary Layer model and wave radiation stress from the STWAVE model were input into the ADCIRC model for each production storm. All stillwater results for this study include the effects of wave setup. The maximum water-surface elevation was output at every wetted ADCIRC grid point in a specific storm. This resulted in more than 1,000,000 locations where statistical methods were applied to obtain return periods of the stillwater elevation. A Triangular Irregular Network (TIN) was created to represent the stillwater surface based on the density of the output points from the ADCIRC. Further details about the production run process can be found in the TSDN.

### 3.3.2 Statistical Analysis

The Joint Probability Method (JPM) was used to develop the stillwater frequency curves for the 10-, 2-, 1-, and 0.2-percent-annual-chance stillwater elevations. The JPM approach is a simulation methodology that relies on the development of statistical distributions of key hurricane input variables such as central pressure, radius to maximum wind speed, maximum wind speed, translation speed, track heading, etc., and sampling from these distributions to develop model hurricanes. The resulting simulation results in a family of modeled storms that preserve the relationships between the various input model components, but provides a means to model the effects and probabilities of storms that historically have not occurred. The JPM approach was modified for this coastal study based on updated statistical methods developed by FEMA and the USACE-MVN for Mississippi and Louisiana.

Due to the excessive number of simulations required for the traditional JPM method, the Joint Probability Method-Optimum Sampling (JPM-OS) was utilized to determine the stillwater elevations associated with tropical events. JPM-OS is a modification of the JPM method

developed cooperatively by FEMA and the USACE-MVN for Mississippi and Louisiana coastal flood studies that were being performed simultaneously, and is intended to minimize the number of synthetic storms that are needed as input to the ADCIRC model. The methodology entails sampling from a distribution of model storm parameters (e.g., central pressure, radius to maximum wind speed, maximum wind speed, translation speed, and track heading) whose statistical properties are consistent with historical storms impacting the region, but whose detailed tracks differ. The methodology inherently assumes that the hurricane climatology over the past 60 to 65 years (back to 1940) is representative of the past and future hurricanes likely to occur along the Louisiana coast.

### 3.3.3 Stillwater Elevation

The results of the ADCIRC model, as described above, provided stillwater elevations, including wave setup effects that are statistically analyzed to produce probability curves. The JPM-OS is applied to obtain the return periods associated with tropical storm events.

The approach involves assigning statistical weights to each of the simulated storms and generating the flood hazard curves using these statistical weights. The statistical weights are chosen so that the effective probability distributions associated with the selected greater and lesser storm populations reproduced the modeled statistical distributions derived from all historical storms.

Stillwater elevations for each Louisiana coastal Parish, obtained using the ADCIRC and JPM-OS models, are provided for JPM and ADCIRC grid node locations for the 10-, 2-, 1-, or 0.2-percent-annual-chance return period stillwater elevations in the TSDN.

### 3.3.4 Wave Height Analysis

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The USACE-MVN has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones. The 3-foot wave has been established as the minimum size wave capable of causing major damage to conventional wood frame and brick veneer structures.

Figure 1 shows a profile for a typical transect and illustrates the effects of energy dissipation and regeneration of wave as it moves inland. This figure shows the wave crest elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Figure 1 also illustrates the relationship between the local stillwater elevations, the ground profile, and the location of the V/A boundary. This inland limit of the coastal high hazard area is delineated to ensure that adequate insurance rates apply and appropriate construction standards are imposed, should local agencies permit building in this coastal high hazard area.

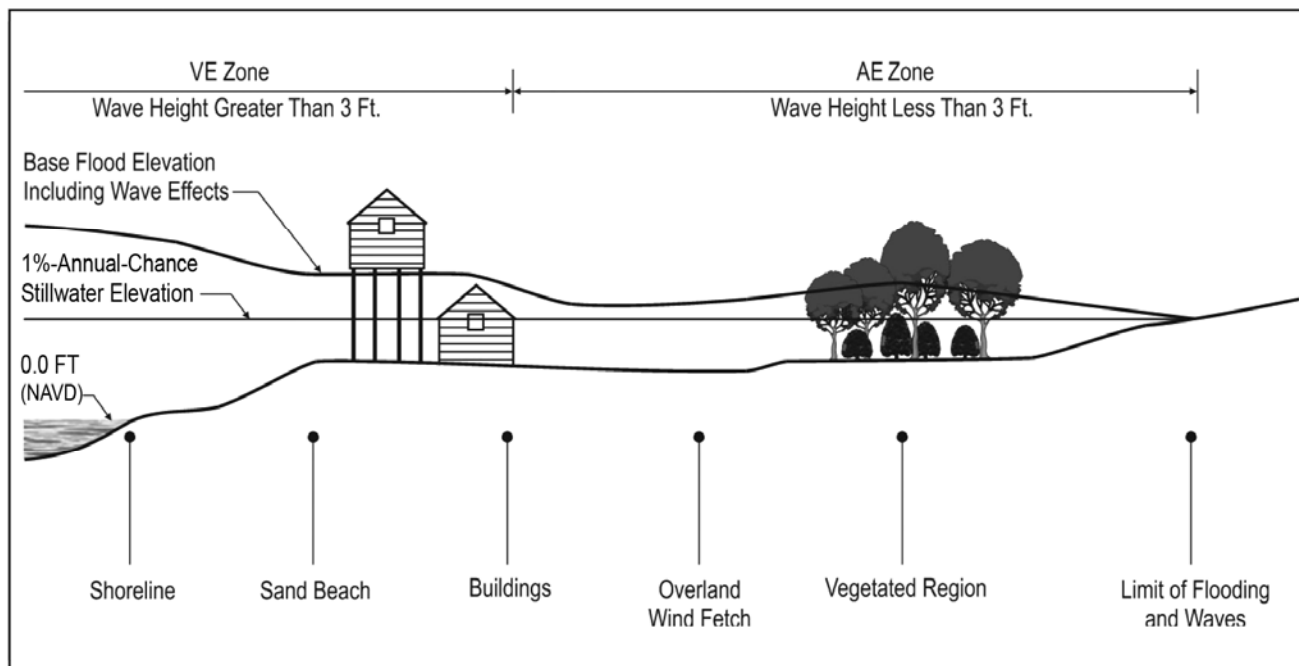


FIGURE 1 - TRANSECT SCHEMATIC

For Plaquemines Parish, the primary flood source is the Gulf of Mexico. All transects originate from the Gulf shoreline and end at the Mississippi River levee. The area bordering St. Bernard Parish to the east could also be subject to floods from the Lake Borgne. Transects addressing floods from Lake Borgne originate in (and are extended from) St. Bernard Parish. WHAFIS wave height analysis for those extended transects were performed and included in St. Bernard Parish. For areas with crossing transects, the higher water surface elevation was mapped. The initial wave heights representing 1- and 0.2-percent-annual-chance flood events were determined based on depth-limited breaker heights, which is 78% of the stillwater depth under the corresponding surge conditions. Wave periods were extracted from STWAVE modeling results.

The wave transects for this study were developed considering the physical and cultural characteristics of the land so that they would closely represent physical conditions in their locality. Transects were spaced dense enough to represent the hydraulic conditions and to capture hydraulic changes. In areas having more uniform characteristics, transects were spaced at relatively larger intervals. Transects are also located in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects. Transects are shown on the respective FIRM panels for the Parish.

The topographic information applied to transect profiles was based on ADCIRC grid bathymetry and LIDAR data collected by the State of Louisiana and FEMA between 2003 and 2005. The vertical datum for topographic/bathymetry data is the NAVD88.

The Louisiana GAP Analysis (Reference 23), developed by the USGS, served as the primary source for the spatial distribution of vegetative cover. Aerial imagery and field reconnaissance were performed to verify the Louisiana GAP Analysis data. Aerial photos and images down-

loaded from the Atlas website were applied to verify features such as buildings, levees, forested vegetation, and marsh grass for input to the wave height models.

No storm-induced erosion analysis was performed. Primary frontal dune erosion was not applicable for this Parish.

Wave height calculation used in this study follows the methodology described in Appendix D of the October 2006 FEMA Guidelines and Specifications for Flood Hazard Mapping Partners. WHAFIS 4.0 was applied to calculate overland wave height propagation and establish base flood elevations. In addition to the 1-percent-annual chance event, the 0.2 percent-annual-chance event was also modeled with WHAFIS 4.0. The 0.2-percent-annual-chance wave height results are not included on the FIRMs but are provided in wave transect profiles in the FIS.

Stillwater elevations are applied to each ground station along each transect and input to WHAFIS. The stillwater elevations were obtained from the ADCIRC storm surge study, using the stillwater TIN generated by the USACE-MVN. Wave setup was not calculated separately because wave setup was included in the base stillwater elevations from the storm surge analysis.

Levees and embankment structures not meeting FEMA's free board requirements were removed in the WHAFIS wave height analysis. For the remaining levees, if there is high ground in front of those levees and the surge did not reach those levees, then no wave runup analysis is performed. Otherwise, the van der Meer Method described in the 2003 version of the Coastal Engineering Manual (CEM) was used in calculating wave runup over sloped levees. Wave characteristics and stillwater elevations were obtained from the WHAFIS wave height analysis and USACE-MVN's storm surge analysis (without wave setup). This data is summarized in Table 2, Coastal Data Table. The FIRM panel shows a Base Flood Elevation (BFE) along the levee that includes wave runup.

**Table 2. COASTAL DATA TABLE**

Community Name	Transect	Description	Latitude & Longitude at Start of WHAFIS Transect (NAD83)		Starting Stillwater Elevations (feet NAVD 88) Range of Stillwater Elevations (feet NAVD 88)				Zone Designation and BFE (feet NAVD88)
					10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	
Plaquemines	1	Begins at Gulf shoreline near western Parish boundary, traversing south to north to Mississippi River.	29.4706	89.9361	5.4 Range Not Available	6.3 Range Not Available	8.7 8.7-9.5	12.1 12.1-13.9	AE 9-11 VE 11-14
Plaquemines	2	Located to the east of transect 1, traversing south to north to Mississippi River.	29.3046	89.8745	5.1	7.5	9.5 6.3-10.6	12.1 8.4-15.2	AE 7-13 VE 10-16
Plaquemines	3	Located to the east of transect 2, traversing south to north to Mississippi River.	29.3263	89.8320	4.9	7.3	8.8 6.8-10.8	11.3 9.1-15.5	AE 8-13 VE 9-16
Plaquemines	4	Located to the east of transect 3, traversing south to north to Mississippi River.	29.3124	89.8045	5.1	7.4	9.1 6.9-11.6	11.4 9.0-15.7	AE 8-14 VE 9-16
Plaquemines	5	Located to the east of transect 4, traversing south to north to Mississippi River.	29.3067	89.7489	5.1	7.6	9.5 7.5-11.6	11.7 9.8-15.3	AE 9-14 VE 10-15
Plaquemines	6	Located to the east of transect 5, traversing south to north to Mississippi River.	29.2935	89.6840	4.5	7.2	9.2 8.7-11.8	11.2 10.9-15.8	AE 10-13 VE 11-16
Plaquemines	7	Located to the east of transect 6, traversing south to north to Mississippi River.	29.2460	89.4838	4.1	6.9	8.6 8.4-12.5	11.5 11.5-17.6	AE 10-14 VE 11-16
Plaquemines	8	Located to the east of transect 7, traversing south to north to Mississippi River.	29.1967	89.4500	4.6	7.1	8.5 8.4-11.0	11.0 11.0-15.5	AE 10-13 VE 11-15
Plaquemines	9	Located to the east of transect 8, traversing south to north to Mississippi River.	29.2207	89.3728	5.8	8.6	10.0 9.4-11.3	12.5 12.5-14.3	AE 10-12 VE 12-15
Plaquemines	10	Located to the south of transect 9, traversing southwest to northeast to Mississippi River.	28.9375	89.3990	5.1	6.2	6.8 6.8-9.6	8.5 8.5-11.9	AE 8-11 VE 10-19
Plaquemines	11	Located to the east of transect 10, traversing southeast to northwest to Mississippi River.	28.9953	89.1491	3.9	6.1	6.9 6.9-9.5	8.7 8.7-11.8	AE 8-11 VE 9-15
Plaquemines	12	Located to the east of transect 11, traversing southeast to northwest to Mississippi River.	29.1133	89.0565	5.3	7.1	8.9 8.9-9.8	10.9 10.9-11.9	AE 11-12 VE 11-14
Plaquemines	13	Located to the north of transect 12, traversing southeast to northwest to Mississippi River.	29.1729	89.0527	4.9	7.5	9.1 9.1-10.4	11.2 11.2-12.9	AE 11-12 VE 11-15
Plaquemines	14	Located to the north of transect 13, traversing southeast to northwest to Mississippi River.	29.2329	89.1255	5.2	8.3	10.0	12.4	AE 12-15
							10.0-12.6	12.4-15.9	VE 12-19

**Table 2. COASTAL DATA TABLE (Cont.)**

Community Name	Transect	Description	Latitude & Longitude at Start of WHAFIS Transect (NAD83)		Starting Stillwater Elevations (feet NAVD 88) Range of Stillwater Elevations (feet NAVD 88)				Zone Designation and BFE (feet NAVD88)
					10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance	
Plaquemines	15	Located to the north of transect 14, traversing east to west to Mississippi River.	29.3030	89.2781	5.4	9.7	11.9 11.9-13.2	14.7 14.7-16.5	AE 14-15 VE 15-18
Plaquemines	16	Located to the north of transect 15, traversing east to west to Mississippi River.	29.3415	89.3265	6.1	10.4	12.9 12.9-13.8	15.9 15.9-17.1	AE 15-16 VE 15-20
Plaquemines	17	Located to the west of transect 16, traversing northeast to southwest to Mississippi River.	29.3856	89.3986	7.2	11.4	13.9 13.9-14.6	17.1 17.1-17.9	AE 16-17 VE 17-21
Plaquemines	18	Located to the west of transect 17, traversing northeast to southwest to Mississippi River.	29.3989	89.4670	7.8	12.1	14.8 14.8-15.9	18.2 18.2-19.4	AE 17-18 VE 17-22
Plaquemines	19	Located to the west of transect 18, traversing northeast to southwest to Mississippi River.	29.4456	89.5464	8.8	12.9	15.6 15.6-17.1	19.0 19.0-20.5	AE 18-19 VE 18-23
Plaquemines	20	Located to the west of transect 19, traversing northeast to southwest to Mississippi River.	29.4923	89.5955	8.9	12.8	15.4 15.4-16.5	18.9 18.9-19.9	AE 17-18 VE 18-23
Plaquemines	21	Located to the west of transect 20, traversing northeast to southwest to Mississippi River.	29.5148	89.6554	9.4	13.2	16.1 16.1-17.1	19.4 19.4-20.4	AE 17-19 VE 18-24
Plaquemines	22	Located to the north of transect 21, traversing northeast to southwest to Mississippi River.	29.5465	89.6822	9.6	13.5	16.2 16.2-17.1	19.5 19.4-20.3	AE 17-19 VE 19-24
Plaquemines	23	Located to the north of transect 22, traversing northeast to southwest to Mississippi River.	29.5774	89.7121	9.8	13.7	16.1 16.1-17.3	19.3 19.3-20.3	AE 18-19 VE 18-24
Plaquemines	24	Located to the north of transect 23, traversing east to west to Mississippi River.	29.6196	89.6901	9.7	13.4	15.6 11.3-16.1	18.9 16.0-19.6	VE 11-18 VE 15-24
Plaquemines	25	Located to the north of transect 24, traversing east to west to Mississippi River.	29.6350	89.6740	9.6	13.0	15.4 15.0-17.2	18.7 18.5-20.6	AE 16-19 VE 17-23
Plaquemines	26	Located to the north of transect 25, traversing southeast to northwest to Mississippi River.	29.6340	89.6649	9.6	13.0	15.3 14.8-17.4	18.6 13.4-21.5	AE 17-19 VE 17-23
Plaquemines	27	Located to the north of transect 26, traversing southeast to northwest to Mississippi River.	29.6540	89.6604	9.4	12.9	15.0 14.8-8.01	18.4 18.3-22.5	AE 17-19 VE 17-23
Plaquemines	28	Located to the north of transect 27, traversing southeast to northwest to Mississippi River.	29.6788	89.6325	9.1	12.5	14.9 14.8-18.2	18.3 18.3-22.3	AE 15-20 VE 17-23

### 3.4 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD), many FIS reports and FIRMs are now prepared using NAVD as the referenced vertical datum.

Flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. Some of the data used in this revision were taken from the prior effective FIS reports and FIRMs and adjusted to NAVD88. The datum conversion factor from NGVD to NAVD in Plaquemines Parish is -0.11 foot.

For additional information regarding conversion between the NGVD and NAVD, visit the National Geodetic Survey website at [www.ngs.noaa.gov](http://www.ngs.noaa.gov), or contact the National Geodetic Survey at the following address:

Vertical Network Branch, N/CG13  
National Geodetic Survey, NOAA  
Silver Spring Metro Center 3  
1315 East-West Highway  
Silver Spring, Maryland 20910  
(301) 713-3191

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

To obtain current elevation, description, and/or location information for benchmarks shown on this map, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their website at [www.ngs.noaa.gov](http://www.ngs.noaa.gov).

## 4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1- and 0.2-percent-annual-chance floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

## 4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:6000, with a contour interval of 2 feet (Reference 25).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards Zones A, AE, V, and VE, and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations, but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM.

## 4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation (WSEL) of the base flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2, Floodway Schematic.

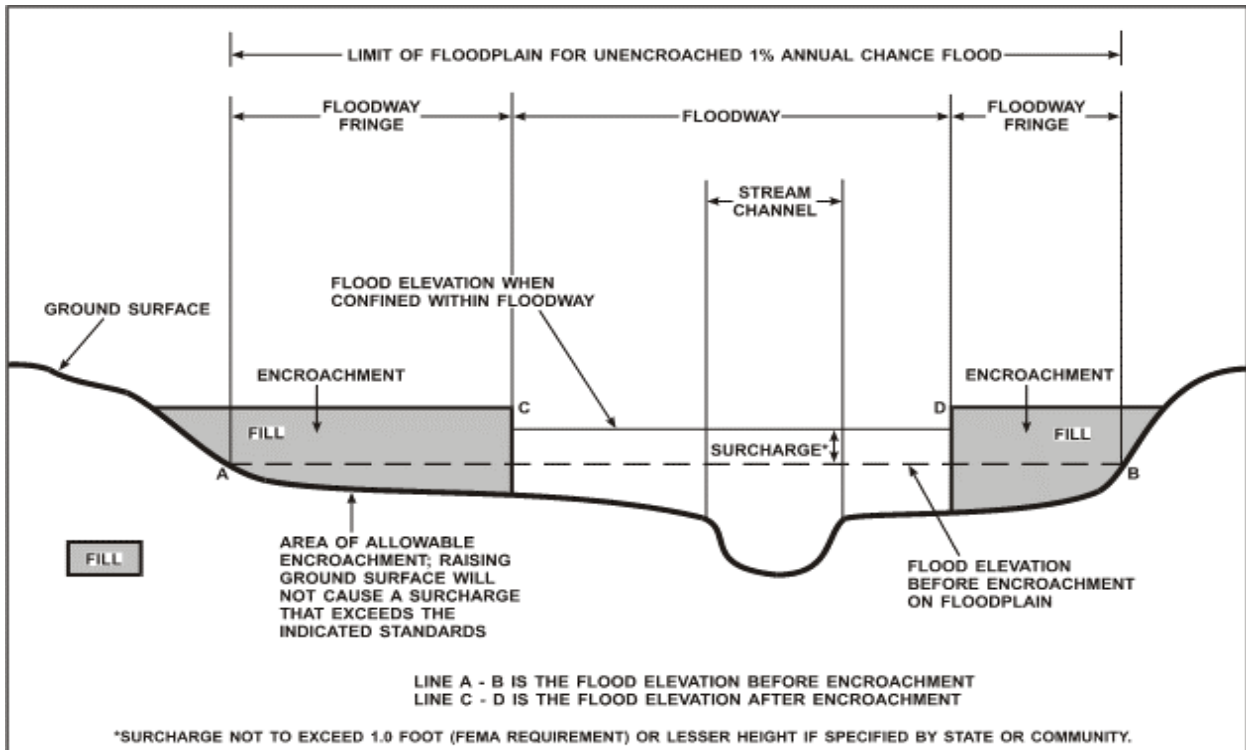


FIGURE 2 – FLOODWAY SCHEMATIC

No floodways were computed for Plaquemines Parish because no new analysis of applicable flooding sources was done.

## 5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

### Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base (1-percent-annual-chance) flood elevations (BFEs) or depths are shown within this zone.

### Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS report by detailed methods. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

### Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs are shown within this zone.

## Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

## Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile (sq. mi.), and areas protected from the base flood by levees. No BFEs or depths are shown within this zone.

## 6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The parishwide FIRM presents flooding information for the entire geographic area of Plaquemines Parish.

## 7.0 OTHER STUDIES

Flood Insurance Studies are ongoing for St. Bernard, Jefferson and Orleans Parishes (Reference 30). The results of this study are in complete agreement with the results of these studies.

This FIS report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

## 8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, FEMA Region VI, 800 North Loop 288, Denton, Texas 76209.

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