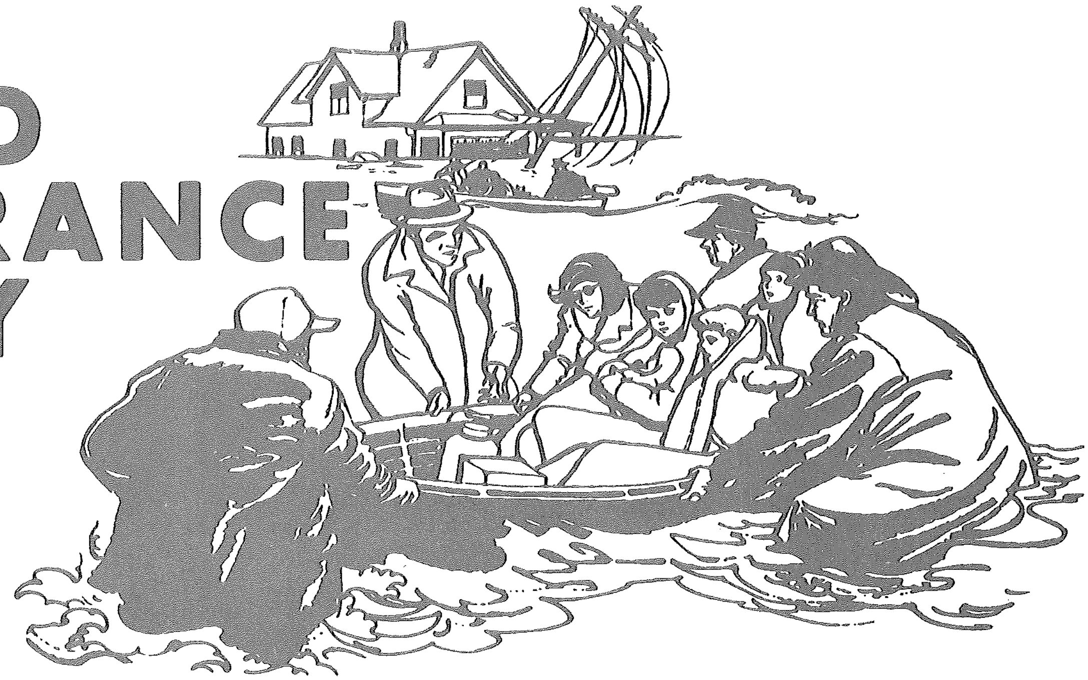
FLOOD INSURANCE STUDY



CITY OF

LEAGUE CITY, TEXAS

GALVESTON AND HARRIS COUNTIES

REVISED: SEPTEMBER 22,1999

Federal Emergency Management Agency

COMMUNITY NUMBER - 485488

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.

This publication incorporates revisions to the original Flood Insurance Study. These revisions are presented in Section 9.0.

TABLE OF CONTENTS

		Page
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	4
	2.3 Principal Flood Problems	5
	2.4 Flood Protection Measures	7
3.0	ENGINEERING METHODS	7
	3.1 Hydrologic Analyses	7
	3.2 Hydraulic Analyses	10
	3.3 Wave Height Analysis	11
	3.4 Effects of Land Subsidence	15
4.0	FLOODPLAIN MANAGEMENT APPLICATIONS	19
	4.1 Flood Boundaries	20
	4.2 Floodways	20
	4.3 Base Flood Elevations	25
	4.4 Velocity Zones	25
5.0	INSURANCE APPLICATION	25
	5.1 Reach Determinations	26
	5.2 Flood Hazard Factors	26
	5.3 Flood Insurance Zones	28
	5.4 Flood Insurance Rate Map Description	28
6.0	OTHER STUDIES	29
7.0	LOCATION OF DATA	29
8.0	BIBLIOGRAPHY AND REFERENCES	29
9.0	REVISION DESCRIPTIONS	34
	9.1 First Revision	34

TABLE OF CONTENTS (Cont'd)

Page

FIGURES

Figure 1 - Vicinity Map 3
Figure 2 - Transect Location Map 13
Figure 3 - Typical Transect Schematic 14
Figure 4 - Land Subsidence Schematic - Riverine Flooding 16
Figure 5 - Land Subsidence Schematic - Hurricane/Tidal Surge Flooding . . . 18
Figure 6 - Floodway Schematic 24

TABLES

Table 1 - Parameter Values for Surge Elevation Computations 9
Table 2 - Summary of Discharges 8, 10
Table 3 - Floodway Data 21-23
Table 4 - Coastal Flood Insurance Zone Data 27

EXHIBITS

Exhibit 1 - Flood Profiles

Clear Creek	Panels 01P-02P
Benson Bayou	Panel 03P
Magnolia Creek	Panel 04P
Unnamed Tributary of Clear Creek	Panel 05P
Dickinson Bayou	Panels 06P-07P
Bordens Gully	Panel 08P
Magnolia Bayou	Panel 09P

PUBLISHED SEPARATELY

Flood Insurance Rate Map Index
Flood Insurance Rate Map

FLOOD INSURANCE STUDY
CITY OF LEAGUE CITY, GALVESTON COUNTY, TEXAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of League City, Galveston County, Texas, 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 assist the community in their efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program 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 Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses in this study represent a revision of the original analyses prepared by Tetra Tech, Inc., for the Federal Emergency Management Agency (FEMA), under Contract No. H-4788. The work for the original study was completed in July 1981. The hydrologic and hydraulic analyses for Bordens Gully and Magnolia Bayou in this revision were prepared by Van Sickle, Michelson & Klein, Inc. The work for this revision was completed in July 1988.

1.3 Coordination

The following were contacted for coordination in the development of the original study: the City of League City, Galveston County, Clear Lake Area Chamber of Commerce, Houston-Galveston Area Council, the National Oceanic and Atmospheric Administration (NOAA), the Texas Highway Department, the Texas State Department of Water Resources, the Galveston District of the U. S. Army Corps of Engineers (COE), the U. S. Geological Survey (USGS), and the Soil Conservation Service (SCS).

On June 3, 1982, the results of the original study were reviewed at a final Consultation and Coordination Officer's (CCO) meeting held with representatives of Tetra Tech, Inc. (the study contractor), the city, and FEMA.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of League City, Galveston County, Texas. The area of study is shown on the Vicinity Map (Figure 1).

The detailed analyses in the original study included coastline flooding due to hurricane-induced storm surge. Both the open coastal surge and its inland propagation were studied; in addition, the added effects of wave heights was considered.

The following flooding sources were studied by detailed methods: Clear Creek, from a point approximately 4.55 miles upstream of its confluence with Galveston Bay to the corporate limits; Benson Bayou, from the downstream corporate limits to State Route 3; Magnolia Creek, from its confluence with Clear Creek to a point approximately 100 feet upstream of an unnamed road; Unnamed Tributary of Clear Creek, from its confluence with Clear Creek to a point approximately 1,200 feet upstream of Colonial Court North; Dickinson Bayou, from Algoa Friendswood Road to the upstream corporate limits; Magnolia Bayou, from the downstream corporate limits to a point approximately 3,200 feet upstream of FM 646; Bordens Gully, from the downstream corporate limits to a point approximately 2,900 feet upstream of FM 646; and the entire shoreline of Galveston Bay/Clear Lake within the community.

In this revision, Magnolia Bayou and Bordens Gully were restudied by detailed methods to incorporate updated topographic information and updated hydrologic and hydraulic analyses. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

All or portions of the following flooding sources were studied by approximate methods: Unnamed Tributary of Clear Creek, Magnolia Creek, Dickinson Bayou, and Bordens Gully. 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 the City of League City.

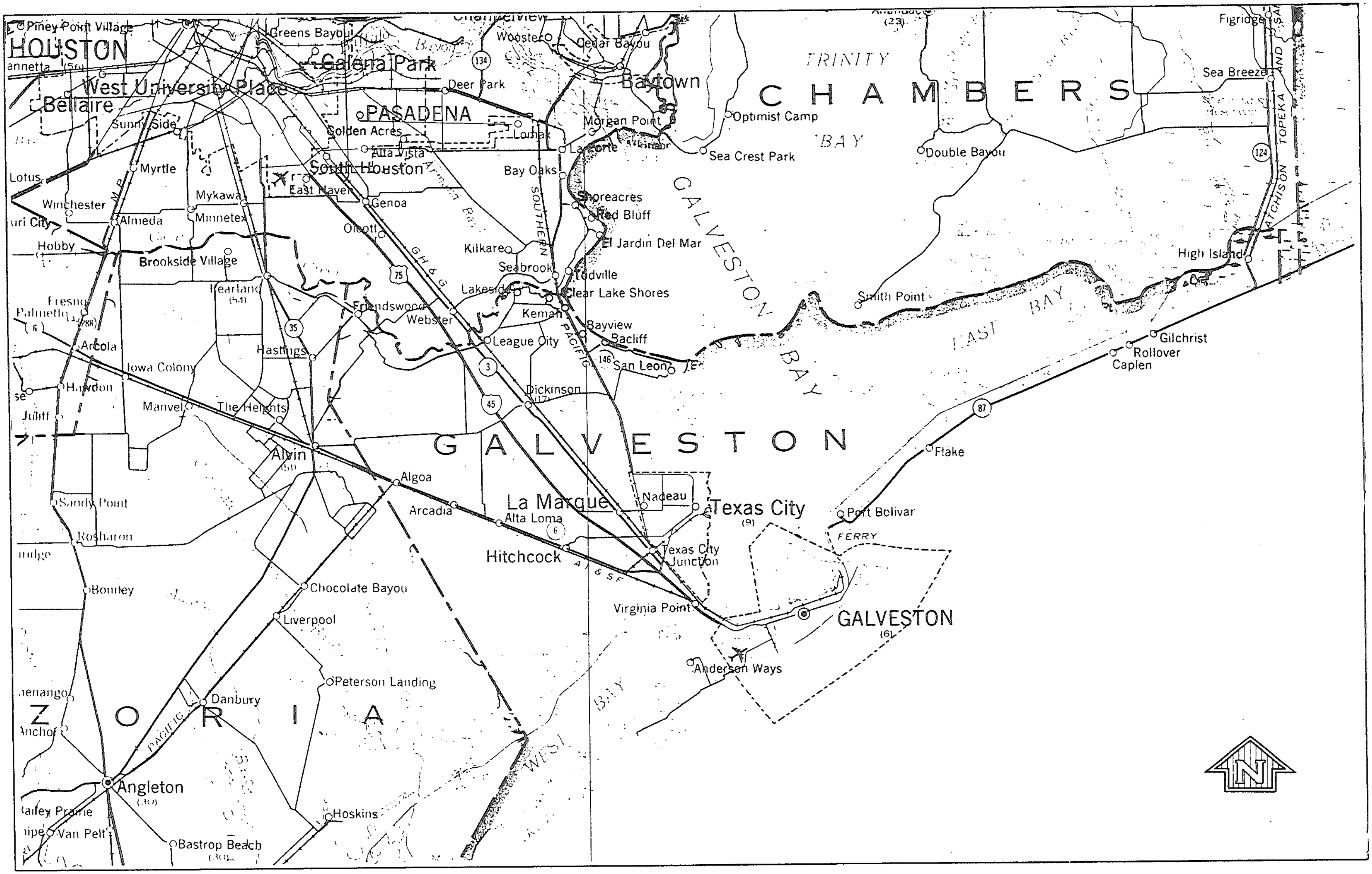


FIGURE 1	FEDERAL EMERGENCY MANAGEMENT AGENCY CITY OF LEAGUE CITY, TX (GALVESTON AND HARRIS COS.)	APPROXIMATE SCALE 8 0 8 16 24 MILES VICINITY MAP

Minimum barometric pressure at Texas City was 29.26 inches. Hurricane Carla caused maximum tide levels of 9.3 feet above mean sea level (msl) in the Gulf at Galveston, and water-surface elevations along the western shore of Galveston Bay reached approximately 14 feet msl. During the four-day period from September 9-12, recorded rainfall at Galveston was 15.32 inches, and at Crabb, 9.26. Water levels in homes in the League City area reached 2 to 3 feet.

July 24-27, 1979 (Tropical Storm Claudette)

Tropical Storm Claudette, an upper air low pressure cell, originated in the Atlantic Ocean near Puerto Rico and moved towards the west, into the Gulf of Mexico. It brought gale-force winds and heavy rainfall to many parts of southeastern Texas, causing severe flooding along streams and coastal areas. Within a 48-hour period, League City received 24.9 inches of rainfall. Estimated tides were between four and five feet in Galveston Bay and its upper reaches. League City was severely affected by the storm, and approximately 2,000 residents in the low-lying areas between Interstate Route 45 (Gulf Freeway) and Galveston Bay were evacuated. Clear Creek, normally 100 to 150 feet wide where it flows under the Gulf Freeway, was more than one mile wide on July 26. The creek inundated the Freeway with water two feet deep. League City sustained over six million dollars in damage to approximately 200 structures. Almost all areas of the city, and all new subdivisions, were flooded, as was the main sewer plant. On July 28, President Carter declared six counties, including Galveston County, to be major disaster areas.

September 19, 1979

Heavy rain from this storm caused Clear Creek to overflow its banks, and many subdivisions in League City were evacuated. In areas such as Bayridge and Glen Cove, many streets became impassable.

June 4 and 5, 1981

On June 4, a tropical depression formed over the western Gulf of Mexico. Thunderstorms spawned by the depression brought heavy rains over southeast Texas on June 5, then moved eastward into the Gulf of Mexico and Louisiana. The ground throughout southeast Texas had already been saturated by recent rains, thereby increasing the flooding from this storm. Many communities suffered extensive flood damage. The heaviest rainfall and most of the flooding was reported in communities near the coast, including: Galveston, Texas City, Baytown, Pasadena, Bay City, Wharton, Liberty, and Pearland. The western end of Galveston Island recorded nine inches of rainfall; Dickinson recorded seven inches; Alvin recorded 3.92 inches; Alta

Loma recorded 5.65 inches; and Hitchcock recorded 7.38 inches. In Baytown, where nine inches of rainfall was reported, most arterial roads were inundated on June 5. Minor flooding was reported in League City.

2.4 Flood Protection Measures

To alleviate flooding along Clear Creek, plans are being considered for both enlargement and rectification of the existing channel, and for the opening of a diversion channel at the mouth of Clear Lake. Since these flood protection measures are still in the planning stages, they have not bee considered in this study.

Nonstructural flood protection measures in League City consist of a flood ordinance that places controls on the types of development and related activities permissible in the city.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail 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 are 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 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, 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 the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Flood magnitudes and frequency values for areas subject to flooding from Clear Creek were available from the Galveston District of the COE (Reference 4). For Bordens Gully and Magnolia Bayou in this revision, flood-frequency discharge values were determined using the COE HEC-1 computer program (Reference 17).

The determination of inundation caused by passage of a hurricane storm surge was approached by the Joint Probability Method (Reference 18). The storm populations were described by probability distributions of five parameters that influence surge heights. These were central pressure depression (which measures the intensity of the storm), radius to maximum winds, forward speed of the storm, shoreline crossing point, and crossing angle. These characteristics were described statistically, based on an analysis of observed storms in the vicinity of Galveston County. Primary sources of data for this analysis were the National Weather Service, the National Hurricane Research Project, and the Mariners Weather Log (References 19, 20, 21, 22, and 23). A summary of the parameters used for the Galveston County area is presented in Table 1.

Maximum wave crest elevations associated with the 10- and 100-year events were determined using the National Academy of Sciences method (Reference 24).

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 2, "Summary of Discharges."

TABLE 2 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs)			
		10-YEAR	50-YEAR	100-YEAR	500-YEAR
CLEAR CREEK					
At mouth	257.50	26,396	38,823	44,753	58,000
At confluence of Magnolia Bayou	138.73	13,478	19,099	22,212	28,500
BENSON BAYOU					
At corporate limits	3.2	1,215	1,550	1,670	2,000
MAGNOLIA CREEK					
At mouth	4.1	1,060	1,450	1,660	2,650
UNNAMED TRIBUTARY OF CLEAR CREEK					
At mouth	3.1	890	1,220	1,390	2,150

CENTRAL PRESSURE DEPRESSION (Millibars)	5	15	25	35	45	55	65	75	85	95	105
PROBABILITY: ENTERING EXITING PARALLEL	0.16	0.16	0.17	0.10	0.14	0.07	0.08	0.07	0.02	0.02	0.01
STORM RADIUS (Nautical Miles)			20					35			
PROBABILITY			0.8					0.2			
FORWARD SPEED (Knots)			8		14			20			
PROBABILITY: ENTERING EXITING PARALLEL			0.63		0.28			0.09			
CROSSING ANGLE (Degrees)			21		-24			-69			
PROBABILITY			0.29		0.28			0.43			
FREQUENCY OF OCCURRENCE	1.99×10^{-3} storms/nautical miles/years										

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX

(GALVESTON CO.)

TABLE 1

PARAMETER VALUES FOR SURGE ELEVATION COMPUTATIONS

TABLE 2 - SUMMARY OF DISCHARGES - continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
BORDENS GULLY					
At a point approximately 1,250 feet upstream of corporate limits	1.8	710	850	1,080	1,400
MAGNOLIA BAYOU					
At a point approximately 1,650 feet upstream of corporate limits	5.5	1,830	2,760	2,600	3,380

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.

For areas subject to flooding directly from the Gulf of Mexico/Galveston Bay/Trinity Bay, the standard coastal surge model was used to simulate the coastal surge generated by any chosen storm (that is, any combination of the five storm parameters defined previously). Performing such simulations for a large number of storms, each of known total probability, permits the establishment of the frequency distribution of surge height as a function of coastal location. These distributions incorporate the large scale surge behavior but do not include an analysis of the added effects associated with much finer scale wave phenomena such as wave heights, setup, or runup. The astronomic tide for the region is then statistically combined with the computed storm surge to yield recurrence intervals of total water level (Reference 25).

This model uses a grid pattern approximating the geographic features of the study area and the adjoining areas. Subsidence prior to 1975 was considered in this study (Reference 26). Surges were computed using grids of five nautical miles for the open coast computations and 1.5 miles for the Galveston Bay computations.

Data for the model grid systems and for the wave height calculations were obtained from USGS quadrangle sheets, a topographic map of the Clear Lake area, NOAA nautical charts, and from aerial photographs (References 27, 28, 29, 30, 31, 32, 33, and 34).

For the streams studied by detailed methods in the original study and in this revision, water-surface elevations of floods of the selected recurrence intervals were computed using the COE HEC-2 step-backwater computer program (References 35 and 36). Starting water-surface elevations for Benson Bayou, Magnolia Creek, and Unnamed Tributary of Clear Creek were set equal to normal depth. Cross sectional data for Magnolia Creek and Unnamed Tributary of Clear Creek were obtained from the Galveston District of the COE. Cross sectional data for Benson Bayou were obtained from field surveys and USGS topographic maps (Reference 27). For Bordens Gully and Magnolia Bayou in this revision, starting water-surface elevations were determined from the backwater elevation of Dickinson Bayou. Cross sectional data used in this revision were obtained from field surveys; elevations were adjusted to the 1984 vertical datum due to subsidence. Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals. Flood profiles for Clear Creek were obtained from the Galveston District of the COE (Reference 4).

Channel roughness factors (Manning's "n") used in the hydraulic computations were chosen by engineering judgment based on field observations, aerial photographs of the streams and floodplain areas, and USGS Water Supply Paper 1849 (Reference 37). For the streams studied by detailed methods, the channel "n" values ranged from 0.020 to 0.080, and overbank "n" values ranged from 0.080 to 0.150.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), 1984 adjustment. Elevation reference marks used in this study are shown on the maps.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

3.3 Wave Height Analysis

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 24). This method is based on three major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions such as sand dunes, dikes and seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures described in Reference 24. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Wave heights were computed along transects (cross section lines) that were located along the coastal areas, as illustrated in Figure 2, in accordance with the Users Manual for Wave Height Analysis (Reference 38). The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

The transects were continued inland until the wave was dissipated or until flooding from another source with equal or greater elevation was reached. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The stillwater elevations for the 100-year flood were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transects. Areas with a wave component three feet or greater were designated as velocity zones. Other areas subject to wave action were designated as A Zones with base flood elevations adjusted to include wave crest elevations.

Figure 3 is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave elevations being diminished by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual wave conditions in the City of League City may not necessarily include all the situations illustrated in Figure 3.

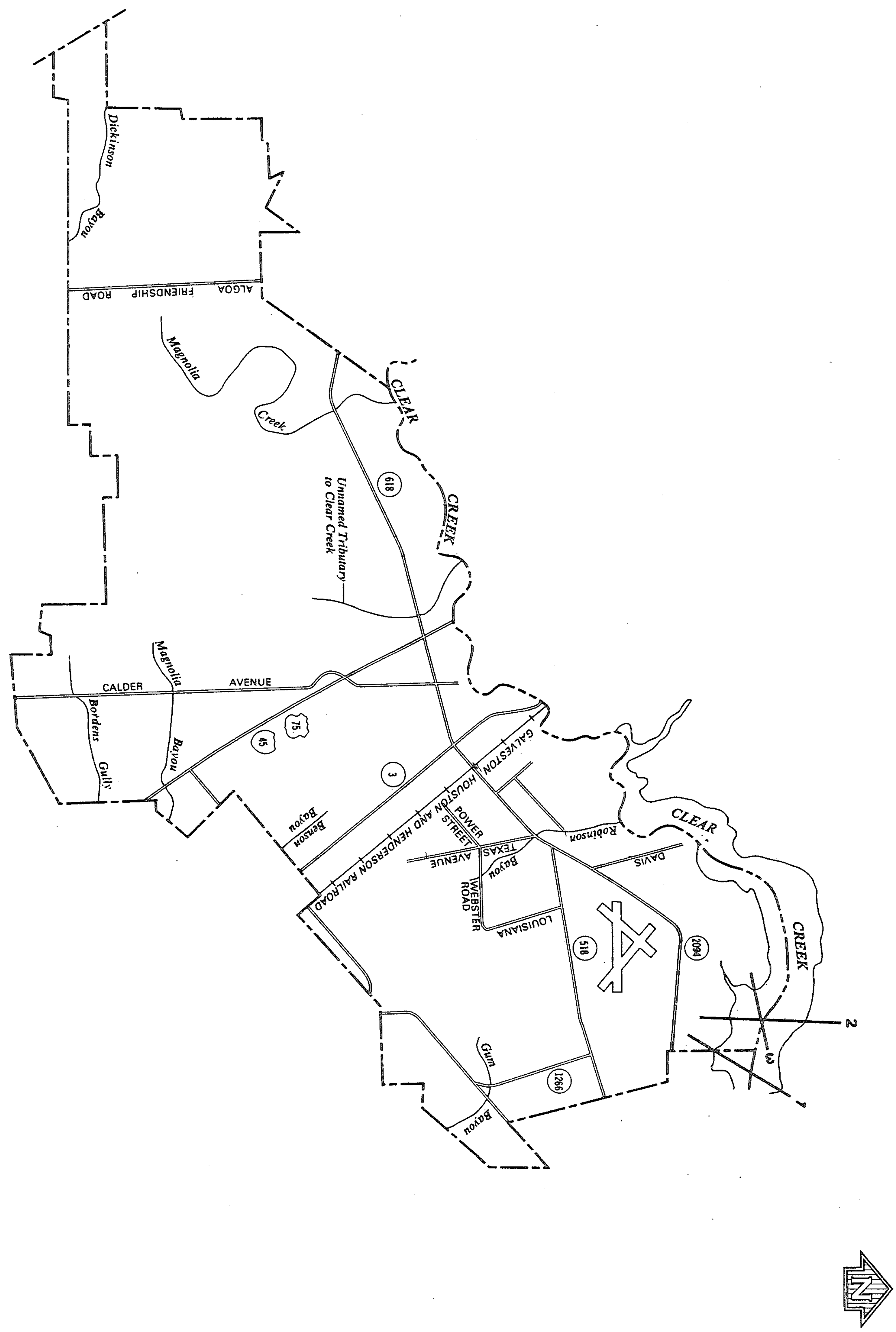


FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON AND HARRIS COS.)

TRANSECT LOCATION MAP

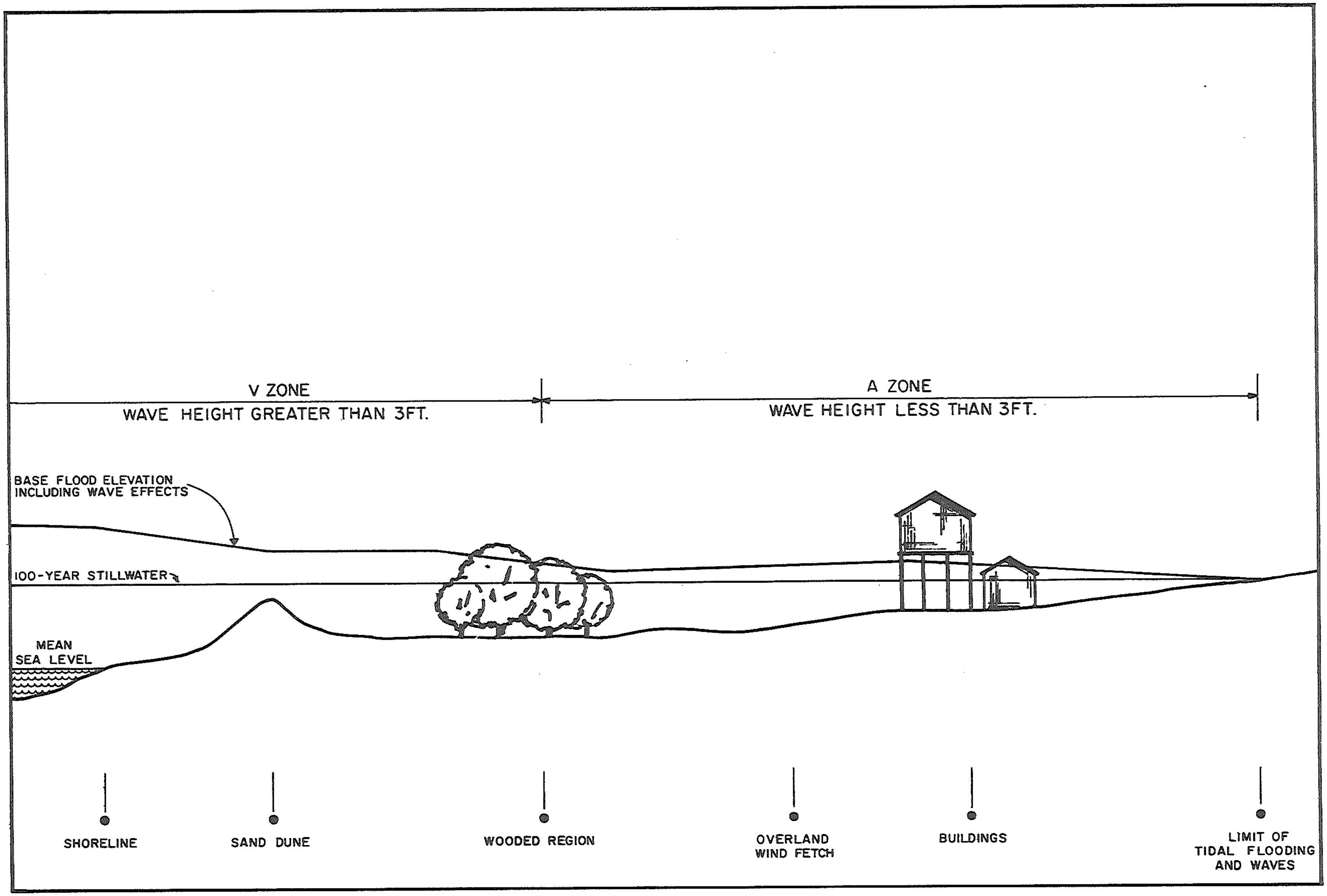


FIGURE 3
TYPICAL TRANSECT SCHEMATIC

3.4 Effects of Land Subsidence

Base flood elevations shown on the Flood Insurance Rate Map and in this report were developed using benchmarks referenced to the NGVD. The City of League City is affected by land subsidence. Land subsidence is the lowering of the ground as a result of water, oil, and gas extraction, as well as other phenomena such as soil compaction, decomposition of organic material, and tectonic movement. Due to the presence of land subsidence in the City of League City, some or all of the benchmarks used to develop the base flood elevations on the Flood Insurance Rate Map have subsided. Periodically, the National Geodetic Survey relevels some benchmarks to determine new elevations above the NGVD; however, not all benchmarks are releveled each time. A relatively extensive releveling was conducted in 1973, and less extensive relevelings were performed in 1978, 1987, and 1995.

The prevalence of land subsidence in the study area complicates the determination of the amount a given property lies above or below the base flood elevation. Complicating factors include determining which benchmark releveling to use to determine a property elevation and possible changes in flood hazards as a result of subsidence. Changes in flood hazards, caused by changed hydrologic and hydraulic conditions, could include increases or decreases in (1) depths of flooding, (2) the amount of land inundated, and (3) the intensity of wave action in coastal areas. The nature and extent of possible flood-hazard changes are different depending on the type of flooding (riverine, coastal, or combined riverine and coastal) present.

The need for more definitive information became evident as local governmental entities moved forward in planning for water-supply, drainage and flood-control, and ground-water regulation. To respond to the need for better information, a study was undertaken by the local entities primarily responsible for water supply and subsidence and flood control in the Houston metropolitan area - Fort Bend County Drainage District, Harris County Flood Control District (HCFCD), Harris-Galveston Coastal Subsidence District (H-GCSD), and the City of Houston. The study, dated December 1986, is entitled "A Study of the Relationship Between Subsidence and Flooding." The effects of subsidence on flooding and the different methods used to account for land subsidence for each type of flooding (riverine, coastal, and combined riverine and coastal) are discussed below.

<u>Riverine Flooding</u> (inland flooding not associated with coastal flooding)

Subsidence within inland watersheds has little or no effect on flood depths when the entire watershed, including all hydraulic structures, subsides uniformly. However, differential subsidence (the presence of differing amounts of subsidence within a watershed) can cause changes in stream-channel slope and stream-valley geometry, which can result in changes in flood depths. Where stream-channel slopes are steepened (where there is more subsidence downstream than upstream), flood discharges usually increase and hydraulic efficiency, as measured by the amount of discharge for a given flood depth, increases. In this situation, the depth of flow usually decreases. The opposite is generally true where stream-channel slopes are flattened.

Other effects of land subsidence can include changes in cross-section floodplain geometry and changes in drainage-basin boundaries. Changes in cross-section geometry can affect conveyance, overbank storage, and flow diversions and result in localized changes in flood hazards. Changes in drainage basin boundaries affect the size of the drainage area and can result in changes in discharges and flood depths in the altered basins.

The City of League City is affected by relatively wide-scale, uniform subsidence with minor differential subsidence within individual watersheds. Flood depths remain relatively constant and base flood elevations generally subside as the ground subsides (see Figure 4). The local effects of subsidence may be adequately addressed, in the short term, by assuming that base flood elevations subside by the same amount the ground subsides. For floodplain management (setting lowest-floor elevations and regulating construction in the floodplain) and flood insurance (determining the amount the lowest floor of a structure lies above or below the base flood elevation) purposes, the effects of subsidence can be accounted for by *determining ground and structure elevations using benchmark elevations with the same relevel date as the benchmarks used to develop the base flood elevations on the Flood Insurance Rate Map.* No adjustment is necessary to the base flood elevations on the Flood Insurance Rate Map.

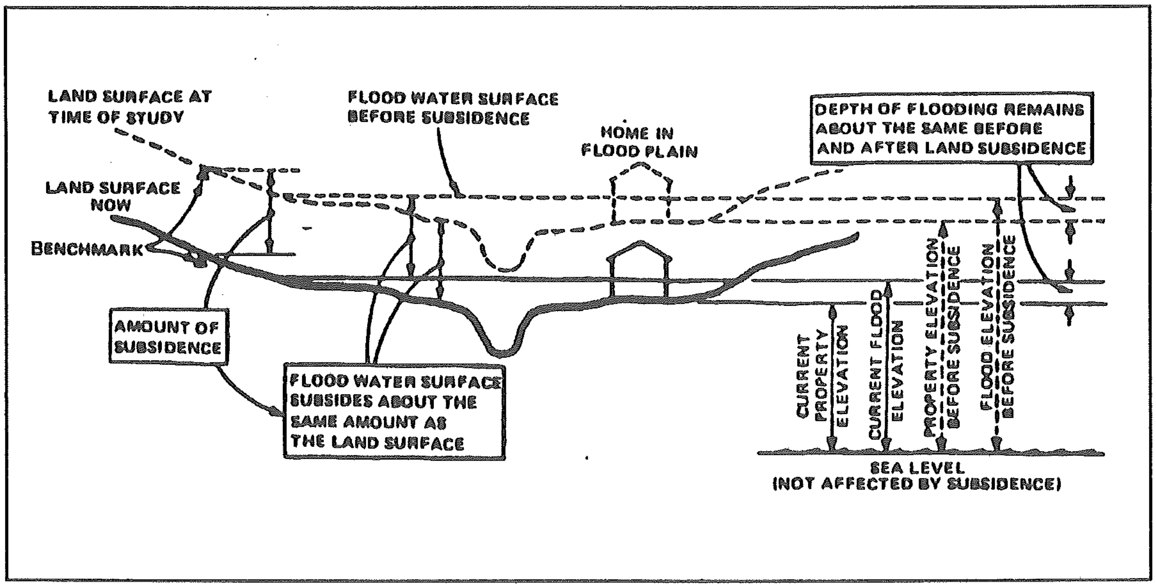


Figure 4. Land Subsidence Schematic - Riverine Flooding

The data for Clear Creek shown on the Flood Insurance Rate Map and in this report are referenced to the 1973 benchmark releveling.

The location and description of Elevation Reference Marks (ERMs) are provided on the Flood Insurance Rate Map to assist in determining ground and structure elevations. These ERMs are either permanent benchmarks established by other Federal, state, or local agencies or reference marks established in the field during the time the Flood Insurance Study was conducted. The local city or county engineering or permitting department should be contacted to verify the compatibility of ERMs and benchmark elevations for use with the base flood elevations on the Flood Insurance Rate Map. (Note: More recent relevelings of ERMs or other benchmarks may be used with the base flood elevations on the Flood Insurance Rate Map; however, this may result in: 1) an underestimation of the amount a structure or property is above the base flood elevation, 2) an overestimation of the amount a structure is below the base flood elevation, or 3) problems tying in a revised hydraulic analysis to the Flood Insurance Study profile upstream and downstream of the revised reach.)

When reviewing development permit applications for new construction in areas subject to ongoing subsidence, and using the ERM elevations on the Flood Insurance Rate Map or other benchmarks with the same relevel date as the base flood elevations, consideration should be given to setting the lowest-floor elevation above the base flood elevation by an amount associated with potential increases in flood depths as a result of past and future subsidence. In the absence of site-specific engineering data, elevating a structure by an additional 1.5 feet above the base flood elevation is recommended at this time. This recommendation is based on information on potential increases in flood depths due to worst-case scenarios of predicted future differential subsidence as discussed in the report entitled "A Study of the Relationship Between Subsidence and Flooding" (HCFCD, et al., December 1986). Alternatively, the elevations of more recent releveling of benchmarks, including the 1995 releveling, could be used for ground surveying in setting lowest-floor elevations with the base flood elevations shown on the Flood Insurance Rate Map.

In watersheds where minor differential subsidence can be considered negligible in the short term, greater differentials in subsidence may occur over time and uniform subsidence assumptions may no longer be appropriate. Additionally, local conditions may produce changes in ground elevations that cannot always be predicted. As a result, more uncertainty is introduced with respect to potential changes in flood depth. The useful life of a Flood Insurance Study is limited and the Flood Insurance Study must eventually be updated. When an entire watershed, or large portions of a watershed, are restudied and the effects of differential subsidence may be significant, it may be appropriate to relevel benchmark elevations at that time or use the most recently releveled benchmark elevations. The new or more recent benchmark elevations should be used for developing new topography and new cross-section data for hydrologic and hydraulic models.

When two streams with base flood elevations based on different releveling dates confluence, the backwater projected onto the tributary is at a different releveling date than the tributary riverine profile. When reviewing development permit applications for new construction in areas subject to ongoing subsidence, consideration should be given to setting the lowest-floor elevation above the base flood elevation by an amount associated with the potential increases in flood depths as a result of past and future subsidence. It is recommended that the elevations of the more recent releveling of benchmarks be used for ground surveying in setting lowest-floor elevations with the base flood elevations shown on the Flood Insurance Rate Map.

Coastal Flooding

In areas subject to coastal flooding, storm-surge elevations generally are not affected as the ground subsides. The changes in topography due to subsidence are minor compared to the overall size of the Gulf of Mexico and Galveston Bay, where storm surges are generated. However, as a result of subsidence, increases in flood depths and flooding of additional inland areas may occur. Base flood elevations may increase due to increased wave heights resulting from increased flood depths, and the A/V-zone boundary may be located farther inland than shown on the Flood Insurance Rate Map. For floodplain management and flood insurance purposes, increases in base flood elevations usually can be disregarded in the short term, and increases in flood depth must be taken into account by comparing the base flood elevation on the Flood Insurance Rate Map with current (at that time) and accurate (true elevation above NGVD within the limits of surveying accuracy) ground and structure elevations (see Figure 5).

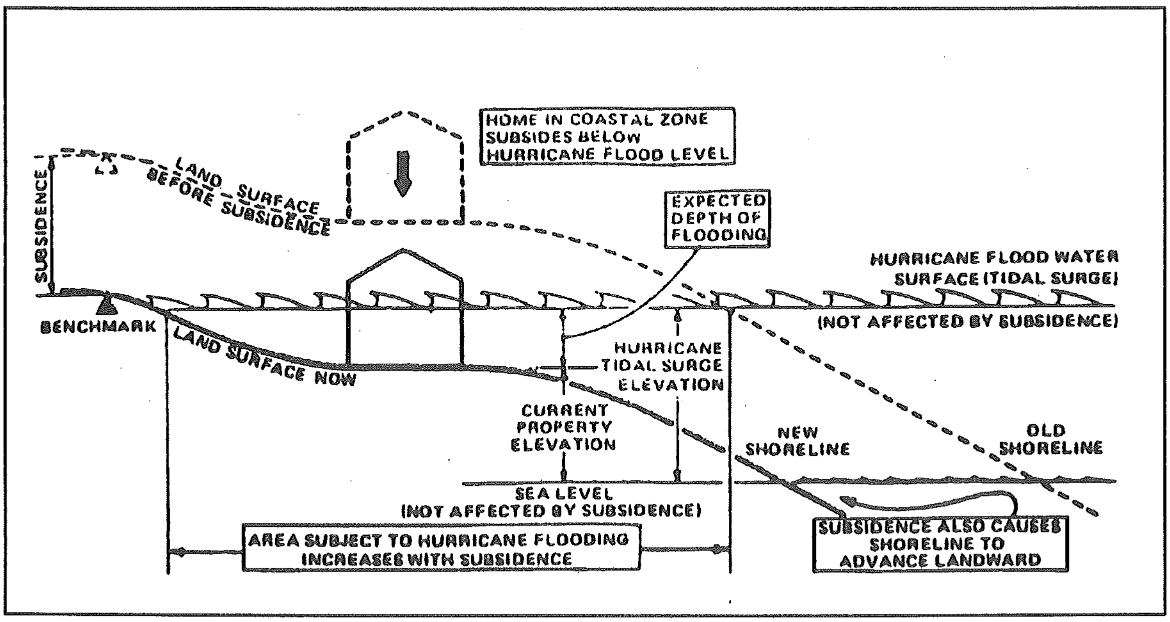


Figure 5. Land Subsidence Schematic - Hurricane/Tidal Surge Flooding

Because coastal base flood elevations generally are not affected by subsidence, the relevel date of benchmarks used to develop onshore topography is not an important factor in determining base flood elevations. However, using the elevation of ERMs on the Flood Insurance Rate Map is not sufficient for floodplain management and flood insurance purposes if an area has experienced significant subsidence (0.5 foot or more) since the relevel date of the ERM. Current and accurate ground and structure elevations above the NGVD must be obtained by field surveys or other appropriate methods. Using outdated ERMs would result in (1) setting the lowest-floor elevations below the base flood elevation, and (2) an improper determination of the amount an existing structure lies above or below the base flood elevation. The error introduced is the same as the amount the land has subsided since the relevel date of the ERM used.

When reviewing development permit applications for construction in areas subject to ongoing subsidence, a community should consider setting the lowest-floor elevation above the base flood elevation by an amount equal to expected future subsidence plus any expected increase in wave heights. In addition, a community should consider the potential flood risks when regulating construction in non-Special Flood Hazard Areas that are adjacent to coastal flood zones and may be susceptible to coastal flood inundation due to subsidence. Requirements in these non-Special Flood Hazard Areas should include setting the lowest-floor elevation at or above the base flood elevation shown in the adjacent coastal flood zone.

Combined Riverine and Coastal

Certain areas are affected by both riverine and coastal flooding. These areas are identified on the Flood Profiles and in the Floodway Data Table in this report as Combined Probability or Combined Flooding areas. As subsidence occurs in these areas, the depth of riverine flooding tends to remain constant, while the depth of coastal flooding increases. For floodplain management and flood insurance purposes, criteria used in coastal areas should be applied in areas of combined riverine and coastal flooding.

Information regarding the location and amount of subsidence is available from the H-GCSD in Friendswood, Texas, and the Fort Bend Subsidence District in Richmond, Texas. Subsidence information is available for periods of record including 1906-1943, 1943-1964, 1964-1973, 1973-1978, 1978-1987, and 1987-1995. In areas affected by subsidence, benchmarks that have been installed with the foundation of the benchmark deep in the ground on a nonsubsiding subterranean layer may provide stable benchmark elevations even though the surrounding ground is subsiding. Information concerning the location and stability of these benchmarks may be obtained from the H-GCSD.

FEMA Form 81-31 (May 1993), "Elevation Certificate and Instructions," is used to provide elevation information necessary to ensure compliance with applicable community floodplain management ordinances, to determine the proper insurance premium rate, and to support a request for a FEMA Letter of Map Change. The instructions for completing Item 4, Section C, of the Elevation Certificate and Instructions in part state: "In areas experiencing ground subsidence, the most recently adjusted reference mark elevations must be used for reference level elevation determinations." The information in this report supersedes the instructions for Item 4, Section C, of the Elevation Certificate and Instructions for the City of League City.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study produces maps designed to assist communities in developing floodplain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps and aerial photographs (Reference 27, 28, 34, 39, 40, and 41).

For the flooding sources studied by approximate methods, the 100-year floodplain boundaries were delineated using the previously printed Flood Insurance Study for the City of League City (Reference 39).

The 100- and 500-year floodplain boundaries are shown on the Flood Boundary and Floodway Map (Exhibit 2). In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year 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.

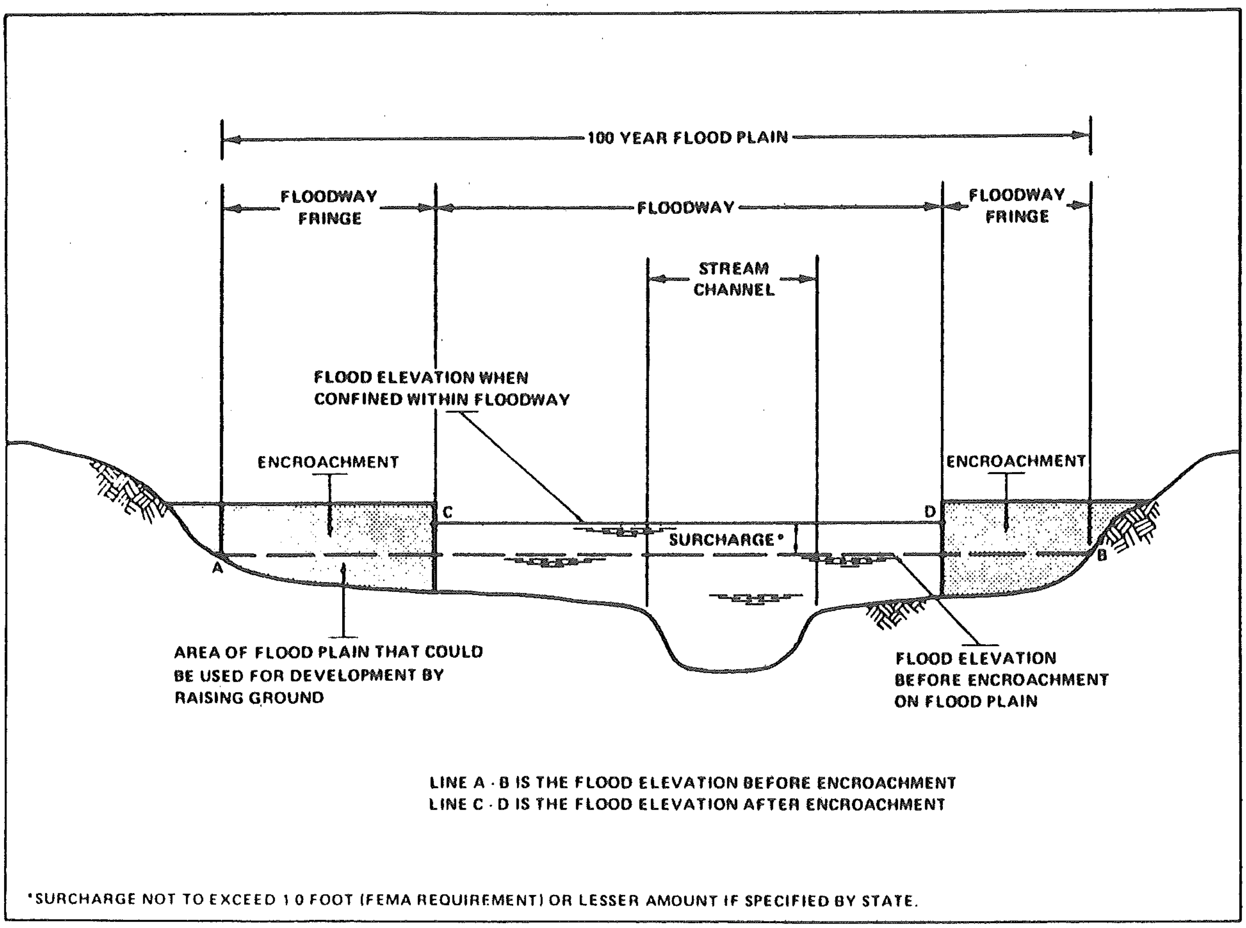
4.2 Floodways

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 National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year 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 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as a minimum standard that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the floodplain. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 3).

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and 100-year 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 of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 6.



FLOODWAY SCHEMATIC Figure 6

4.3 Base Flood Elevations

Areas within the communities studied by detailed engineering methods have base flood elevations established in A and V Zones. These are the elevations of the base (100-year) flood relative to NGVD. In coastal areas affected by wave action, base flood elevations are generally maximum at the normal open shoreline. These elevations generally decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in base flood elevations have been shown in one-foot increments on the FIRM. However, where the scale did not permit, two- or three-foot increments were sometimes used. Base flood elevations shown in the wave action areas represent the average elevation within the zone. These elevations vary from 11 to 14 feet NGVD in the incorporated area of League City and are shown on the FIRM. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is above the base flood elevation in A and V Zones.

4.4 Velocity Zones

The COE has established the three-foot breaking wave as the criterion for identifying coastal high hazard zones (Reference 42). This was based on a study of wave action effects on structures. This criterion has been adopted by FEMA for the determination of V Zones. Because of the additional hazards associated with high-energy waves, the NFIP regulations require much more stringent floodplain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in V Zones are higher than those in A Zones with similar numerical designations.

The location of the V Zone is determined by the three-foot breaking wave as discussed above. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the V Zone to be established. The V Zone generally extends inland to the point where the 100-year flood depth is insufficient to support a three-foot breaking wave.

5.0 INSURANCE APPLICATION

To establish actuarial insurance rates, data from the engineering study must be transformed into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source studied in detail in the City of League City.

5.1 Reach Determinations

Reaches are defined as sections of floodplain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

The locations of the reaches determined for the flooding sources of the City of League City are shown on the Flood Profiles (Exhibit 1) and summarized in Table 4.

Reaches are defined as sections of floodplain that have relatively the same flood hazard. In tidal areas, reaches are limited to the distance for which the 100-year flood elevation does not vary more than 1.0 foot. Using these criteria, one reach was required for the flooding sources of the City of League City. The location of this reach is shown on the Flood Insurance Rate Map and summarized in Table 5.

In areas where a wave height analysis was performed, reaches were determined for areas of the coastline, represented by a transect or group of transects, which have the same physical characteristics.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one- half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[2]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD - 1973 RELEVELING)	WITHOUT FLOODWAY (FEET NGVD - 1973 RELEVELING)	WITH FLOODWAY (FEET NGVD - 1973 RELEVELING)	INCREASE (FEET NGVD - 1973 RELEVELING)
Clear Creek								
A[1]	24,328	2,582/562[3]	18,883	1.4	11.4	7.4[4]	7.4[4]	0.0
B[1]	27,654	2,707/752[3]	27,713	0.9	11.4	7.5[4]	7.5[4]	0.0
C[1]	31,825	348/158[3]	4,775	5.3	11.4	8.2[4]	8.5[4]	0.3
D[1]	32,934	1,827/177[3]	11,394	2.2	11.4	8.3[4]	9.1[4]	0.8
E[1]	35,841	1,063/658[3]	8,857	2.8	11.4	8.7[4]	9.4[4]	0.7
F[1]	37,476	913/598[3]	14,052	1.8	11.4	9.3[4]	10.1[4]	0.8
G[1]	39,113	925/512[3]	11,380	2.2	11.4	9.4[4]	10.2[4]	0.8
H[1]	40,591	1,225/455[3]	11,576	2.2	11.4	9.6[4]	10.4[4]	0.8
I[1]	41,489	1,125/799[3]	14,305	1.8	11.4	9.6[4]	10.5[4]	0.9
J[1]	44,023	1,696/1,559[3]	4,996	5.0	11.4	9.8[4]	10.7[4]	0.9
K[1]	45,684	475/205[3]	6,500	3.9	11.4	10.7[4]	11.3[4]	0.6
L[1]	46,318	1,170/820[3]	13,110	1.9	11.4	10.8[4]	11.8[4]	1.0
M[1]	47,374	1,290/520[3]	14,996	1.7	11.4	11.0[4]	12.0[4]	1.0
N[1]	49,539	748/346[3]	8,241	3.0	11.4	11.2[4]	12.2[4]	1.0
O[1]	50,648	945/400[3]	11,199	2.2	11.4	11.4	12.4	1.0
P[1]	52,285	1,355/479[3]	15,689	1.6	11.6	11.6	12.6	1.0
Q[1]	54,157	337/86[3]	5,136	4.7	12.0	12.0	12.9	0.9
R[1]	56,005	887/814[3]	11,317	2.1	12.9	12.9	13.8	0.9
S[1]	58,011	1,115/740[3]	13,842	1.7	13.4	13.4	14.4	1.0
T	60,123	1,081	15,215	1.5	13.8	13.8	14.8	1.0
U	61,654	933	12,570	1.8	14.0	14.0	15.0	1.0
V	62,868	1,353	14,919	1.6	14.2	14.2	15.2	1.0
W	64,716	852	12,158	1.9	14.5	14.5	15.5	1.0
X	66,089	1,025	12,369	1.9	14.7	14.7	15.7	1.0
Y	68,201	1,275	15,510	1.5	15.0	15.0	16.0	1.0
Z	70,894	781	10,619	2.1	15.4	15.4	16.3	0.9
AA	73,798	853/793[3]	9,822	2.3	16.1	16.1	17.0	0.9

[1]Cross section located in combined flooding zone [2]Feet above confluence with Galveston Bay [3]Width/width within corporate boundary
[4]Elevation computed without consideration of flooding effects from Galveston Bay

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON CO.)

FLOODWAY DATA

CLEAR CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET NGVD)
Benson Bayou								
A	9,800	73	492	3.4	15.4	15.4	16.1	0.7
B	14,150	420	1,417	1.2	17.8	17.8	18.4	0.6
Magnolia Creek								
A	150	45	299	5.5	15.5	7.4[2]	8.4[2]	1.0
B	2,550	83	443	3.7	15.5	11.9[2]	12.6[2]	0.7
C	3,600	50	318	5.2	15.5	13.8[2]	14.2[2]	0.4
D	4,000	50	355	4.7	15.5	14.5[2]	14.9[2]	0.4
E	6,400	43	267	6.2	19.5	19.5	20.2	0.7
F	7,730	50	300	4.6	22.9	22.9	23.4	0.5
G	9,301	560	960	1.4	26.7	26.7	27.5	0.8
Unnamed Tributary of Clear Creek								
A	0	80	623	2.2	13.8	4.8[2]	5.8[2]	1.0
B	900	80	597	2.3	13.8	5.1[2]	6.0[2]	0.9
C	1,340	44	241	5.8	13.8	5.1[2]	6.0[2]	0.9

[1]Feet above mouth [2]Elevation computed without consideration of flooding effects from Clear Creek

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON CO.)

FLOODWAY DATA

BENSON BAYOU - MAGNOLIA CREEK - UNNAMED TRIBUTARY OF CLEAR CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Dickinson Bayou								
A-X[1]								
Y	69,579[2]	259/70[3]	3,047	1.9	15.0	15.0	16.0	1.0
Z[1]	75,652[2]	294	2,837	2.1	18.4	18.4	19.4	1.0
AA[1]	79,000[2]	723	4,645	1.3	20.0	20.0	21.0	1.0
AB[1]	81,400[2]	964	5,396	1.1	20.9	20.9	21.9	1.0
AC[1]	84,000[2]	449	3,489	1.7	22.1	22.1	23.1	1.0
AD[1]	85,750[2]	982	5,787	1.0	22.8	22.8	23.8	1.0
AE[1]	87,800[2]	820	4,838	1.2	23.7	23.7	24.7	1.0
AF[1]	89,500[2]	1,039	5,005	1.2	24.7	24.7	25.7	1.0
AG	91,600[2]	1,080	5,141	1.2	25.8	25.8	26.8	1.0
AH	92,100[2]	654	2,404	2.5	26.5	26.5	27.5	1.0
AI	94,700[2]	1,386	6,319	0.9	28.6	28.6	29.6	1.0
AJ	98,326[2]	1,337	7,964	0.7	30.2	30.2	31.2	1.0
AK	99,626[2]	900	4,840	1.2	30.7	30.7	31.7	1.0
Bordens Gully								
A	8,532[4]	120	651	1.6	15.4	15.4	15.8	0.4
B	11,450[4]	107	500	1.5	16.1	16.1	16.6	0.5
Magnolia Bayou								
A	9,317[4]	102	874	3.0	14.9	14.9	15.2	0.3
B	9,586[4]	93	710	3.7	15.4	15.4	15.5	0.1
C	11,826[4]	116	869	2.6	17.1	17.1	18.1	1.0

[1]Cross sections located outside corporate boundary [2]Feet above mouth [3]Width/width within corporate boundary
[4]Feet upstream of confluence with Dickinson Bayou

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON CO.)

FLOODWAY DATA

DICKINSON BAYOU - BORDENS GULLY - MAGNOLIA BAYOU

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER-SURFACE ELEVATION			
CROSS SECTION	DISTANCE	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE
Dickinson Bayou								
A-X[1]								
Y	69,579[2]	259/70[3]	3,047	1.9	15.0	15.0	16.0	1.0
Z[1]	75,652[2]	294	2,837	2.1	18.4	18.4	19.4	1.0
AA[1]	79,000[2]	723	4,645	1.3	20.0	20.0	21.0	1.0
AB[1]	81,400[2]	964	5,396	1.1	20.9	20.9	21.9	1.0
AC[1]	84,000[2]	449	3,489	1.7	22.1	22.1	23.1	1.0
AD[1]	85,750[2]	982	5,787	1.0	22.8	22.8	23.8	1.0
AE[1]	87,800[2]	820	4,838	1.2	23.7	23.7	24.7	1.0
AF[1]	89,500[2]	1,039	5,005	1.2	24.7	24.7	25.7	1.0
AG	91,600[2]	1,080	5,141	1.2	25.8	25.8	26.8	1.0
AH	92,100[2]	654	2,404	2.5	26.5	26.5	27.5	1.0
AI	94,700[2]	1,386	6,319	0.9	28.6	28.6	29.6	1.0
AJ	98,326[2]	1,337	7,964	0.7	30.2	30.2	31.2	1.0
AK	99,626[2]	900	4,840	1.2	30.7	30.7	31.7	1.0
Bordens Gully								
A	8,532[4]	120	651	1.6	15.4	15.4	15.8	0.4
B	11,450[4]	107	500	1.5	16.1	16.1	16.6	0.5
Magnolia Bayou								
A	9,317[4]	102	874	3.0	14.9	14.9	15.2	0.3
B	9,586[4]	93	710	3.7	15.4	15.4	15.5	0.1
C	11,826[4]	116	869	2.6	17.1	17.1	18.1	1.0

[1]Cross sections located outside corporate boundary [2]Feet above mouth [3]Width/width within corporate boundary
[4]Feet upstream of confluence with Dickinson Bayou

TABLE 3

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON CO.)

FLOODWAY DATA

DICKINSON BAYOU - BORDENS GULLY - MAGNOLIA BAYOU elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

Because it is based on more up-to-date analyses, this study supersedes the previously printed Flood Insurance Study for the City of League City (Reference 39).

Flood Insurance Studies are currently being prepared for Harris County and incorporated areas, Brazoria County and incorporated areas, and the unincorporated areas of Galveston County (References 43, 44, and 45). The results of those studies will be in exact agreement with the results of this study.

Flood Insurance Studies have been prepared for the Cities of Clear Lake Shores, Kemah, and Friendswood (References 46, 47, and 48).

Land-surface subsidence investigations have been performed for Texas, and the Galveston District COE has prepared a National Shoreline Study (References 8, 9, 49, and 50). Previous 100-year hurricane surge elevations were determined for the Gulf Coastal Engineering Research Center in 1969, and by the Galveston District of the COE in 1979 (References 51 and 52).

7.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA, Mitigation Division, Federal Regional Center, Room 206, 800 North Loop 288, Denton, Texas 76201-3698.

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9.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original Flood Insurance Study was printed. Future revisions may be made that do not result in the republishing of the Flood Insurance Study report. To assure that any user is aware of all revisions, it is advisable to contact the community repository of flood-hazard data located at the City Engineering Building, 300 West Walker, League City, Texas.

9.1 First Revision

This study was revised to incorporate updated hydrologic and hydraulic information to reflect existing watershed conditions along the entire reach of Clear Creek.

The hydrologic analysis was completed using the U. S. Army Corps of Engineers (USACE) HEC-1 computer program (Reference 53). The revised HEC-1 analysis, dated August 1991, was included in a report entitled "Clear Creek Regional Flood Control Plan, Hydraulic Baseline Report" (Reference 54).

The discharges increased compared to the previously determined discharges as a result of the updated watershed conditions. A summary of the revised drainage area-peak discharge relationship for Clear Creek is shown in Table 2, "Summary of Discharges."

The revised hydraulic analysis, dated October 28, 1991, was prepared through the use of the USACE HEC-2 computer program (Reference 55). Cross sections for the backwater analyses were obtained from field surveys, highway plans, and aerial photographs. Roughness coefficients (Manning's "n" values) used in the hydraulic computations were chosen by engineering judgment and based on field observations of the stream and floodplain areas.

Floodplain boundaries were delineated using USGS topographic maps at a scale of 1:24,000, with a contour interval of 5 feet (Reference 27).

Elevations along Clear Creek are referenced to the NGVD, 1973 adjustment.

As part of this revision, the format of the map panels has changed. Previously, flood-hazard information was shown on both the Flood Insurance Rate Map and Flood Boundary and Floodway Map. In the new format, all base flood elevations, cross sections, zone designations, and floodplain and floodway boundary delineations are shown on the Flood Insurance Rate Map and the Flood Boundary and Floodway Map has been eliminated. Some of the flood insurance zone designations were changed to reflect the new format. Areas previously shown as numbered Zone A were changed to Zone AE. Areas previously shown as Zone B were changed to Zone X (shaded). Areas previously shown as Zone C were changed to Zone X (unshaded). In addition, all Flood Insurance Zone Data Tables were removed from the Flood Insurance Study report and all zone designations and reach determinations were removed from the profile panels.

Table 3, "Floodway Data," and Exhibit 1, "Flood Profiles," were also revised to reflect changes as a result of the restudy.

This restudy also incorporates the results of a Letter of Map Revision (LOMR) dated December 4, 1990. The basis for the LOMR was a channelization project along Unnamed Tributary of Clear Creek that contains the 100-year flood from approximately 700 feet upstream of State Route 518 to Highlands Boulevard.

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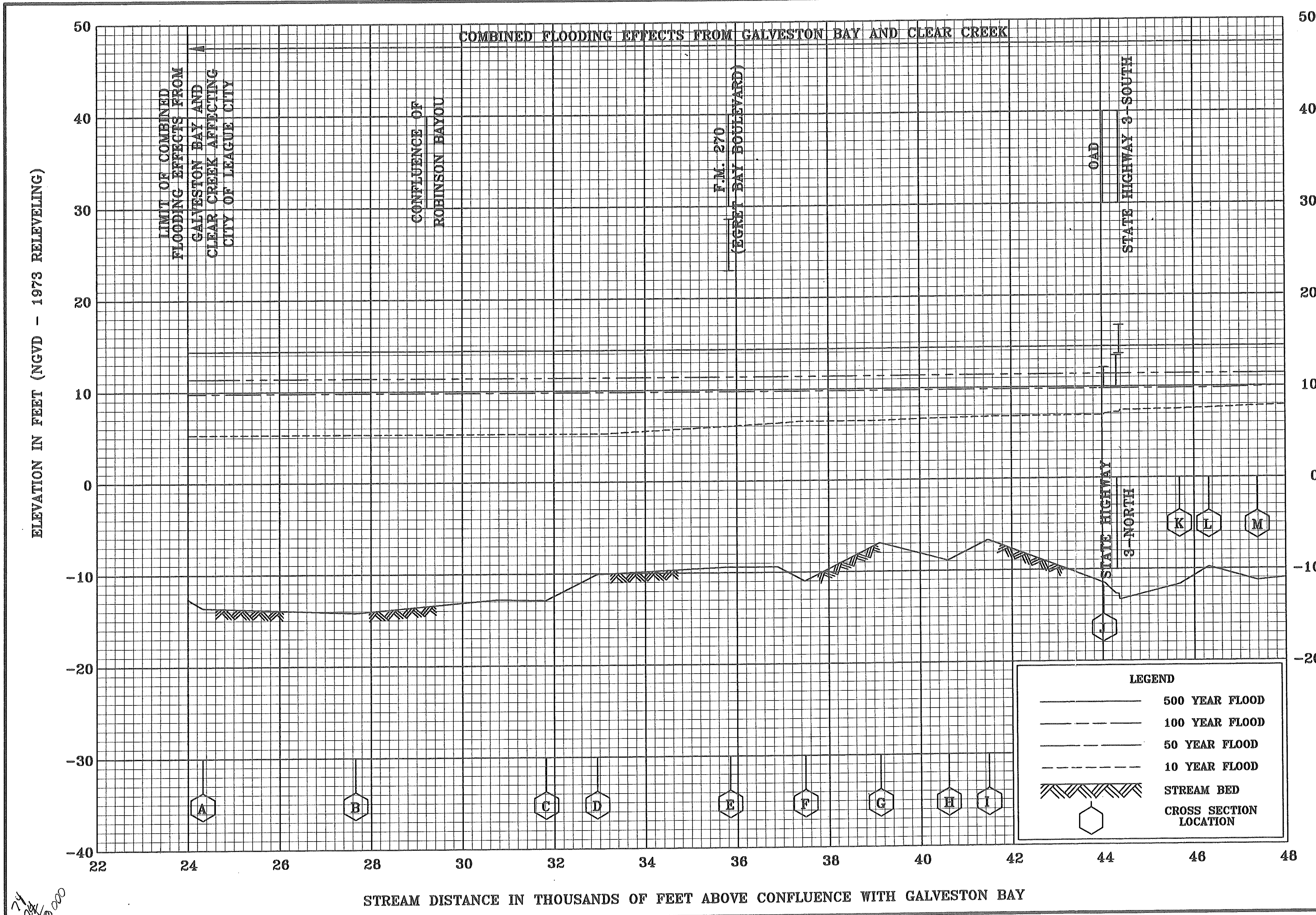


FLOOD PROFILES

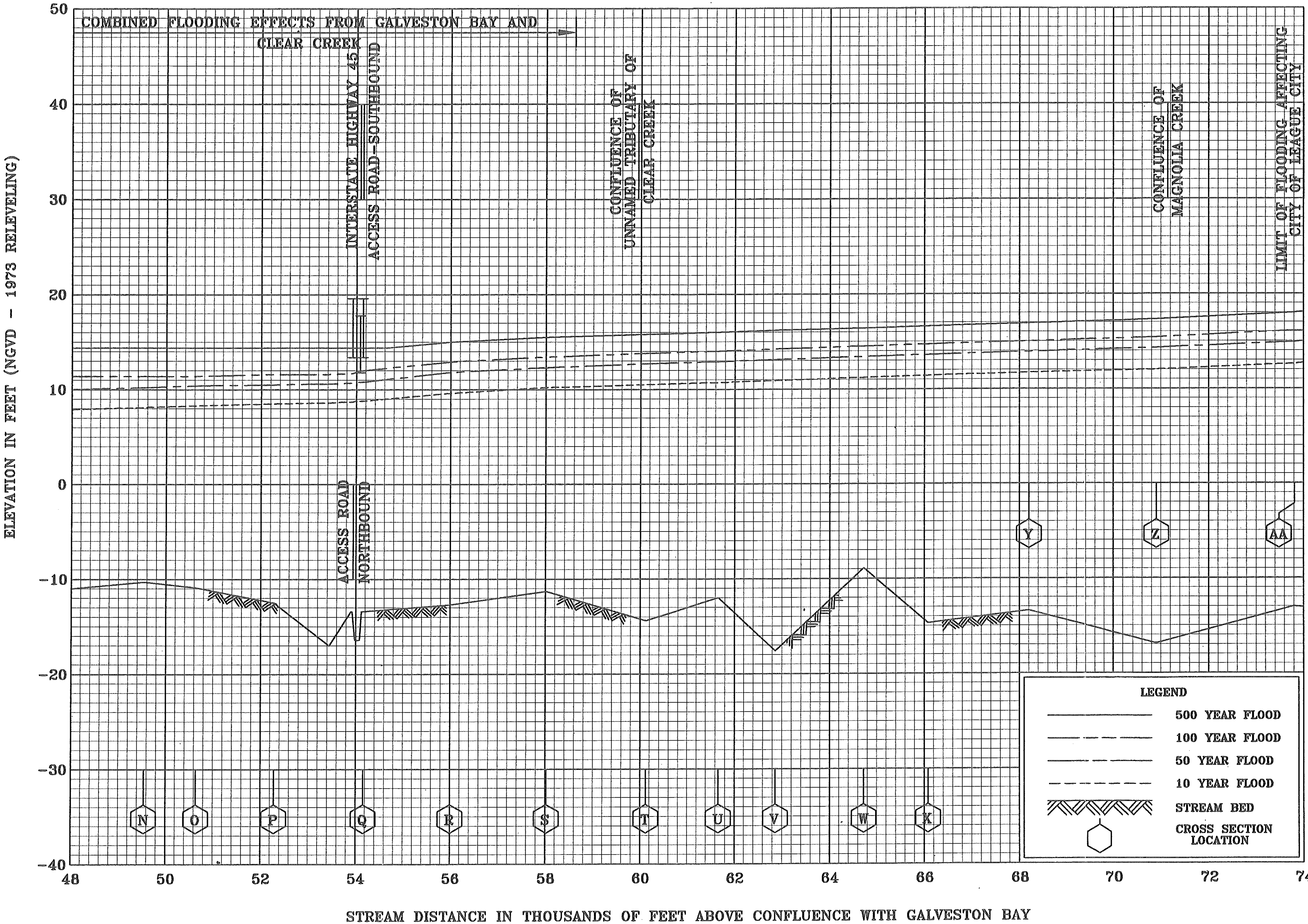
CLEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX

(GALVESTON AND HARRIS COS.)

01P



FEDERAL EMERGENCY MANAGEMENT AGENCY

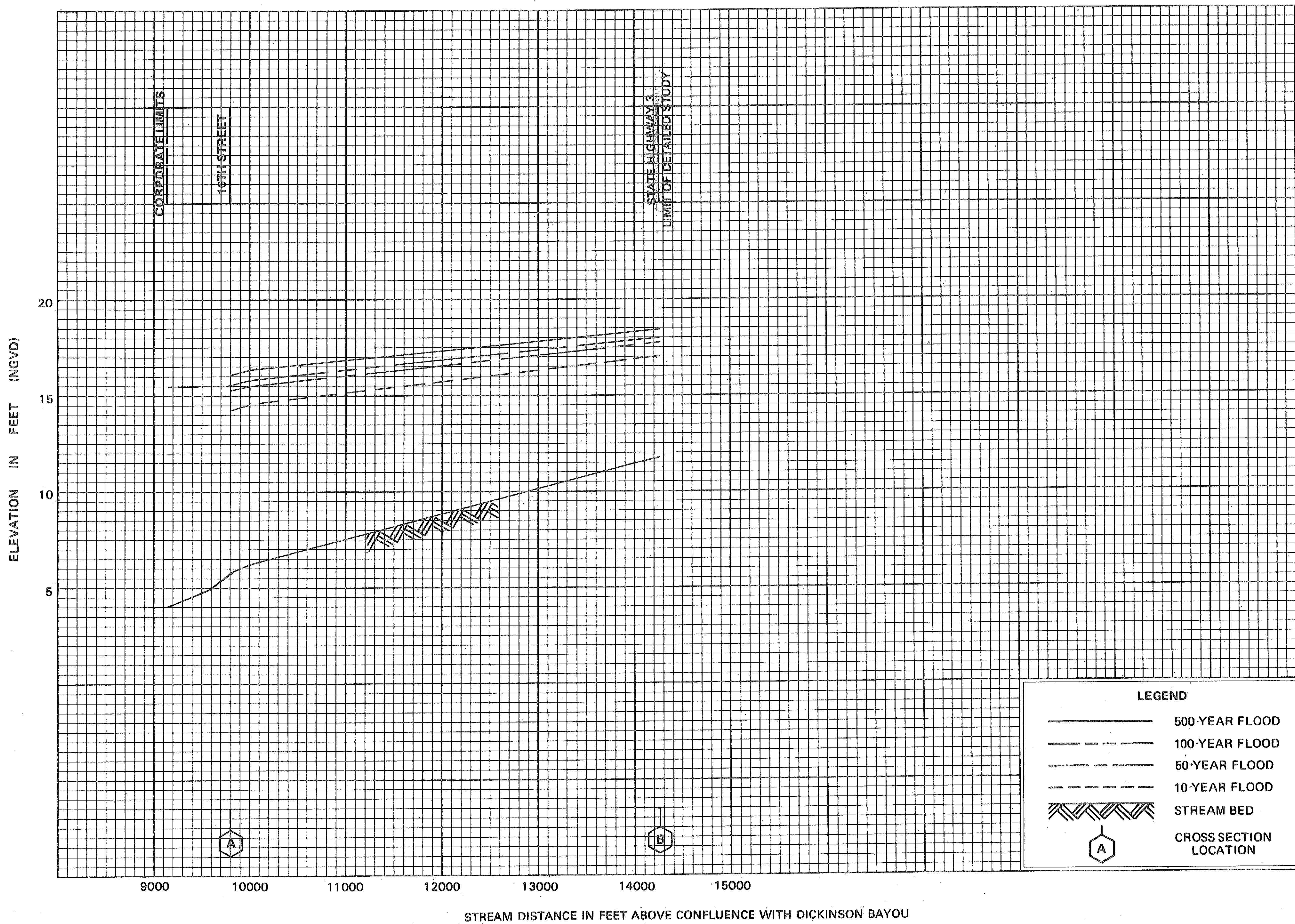
CITY OF LEAGUE CITY, TX

(GALVESTON AND HARRIS COS.)

FLOOD PROFILES

CLEAR CREEK

02P



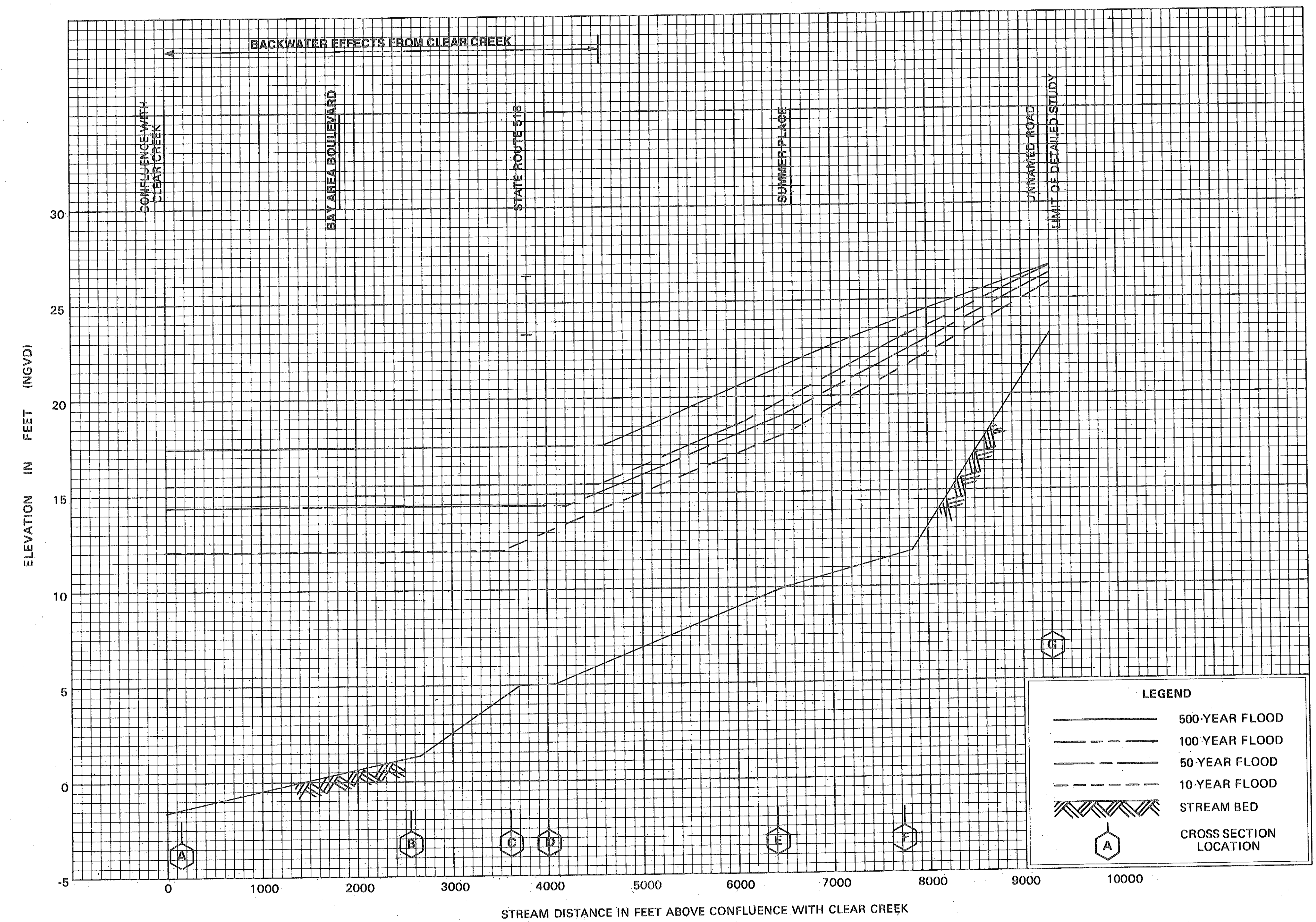
FLOOD PROFILES

BENSON BAYOU

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON AND HARRIS COS.)

03P



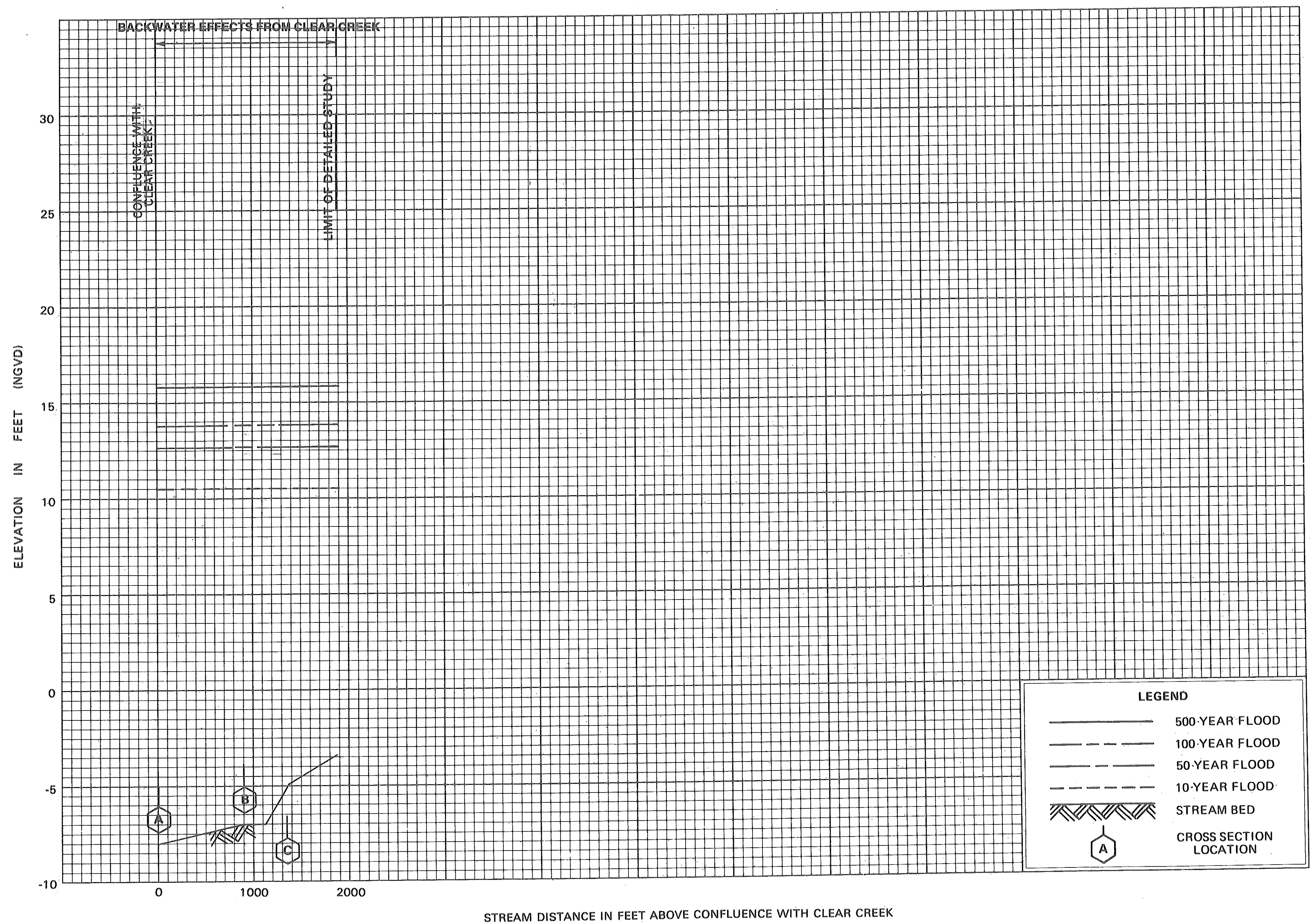
FLOOD PROFILES

MAGNOLIA CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON AND HARRIS COS.)

04P



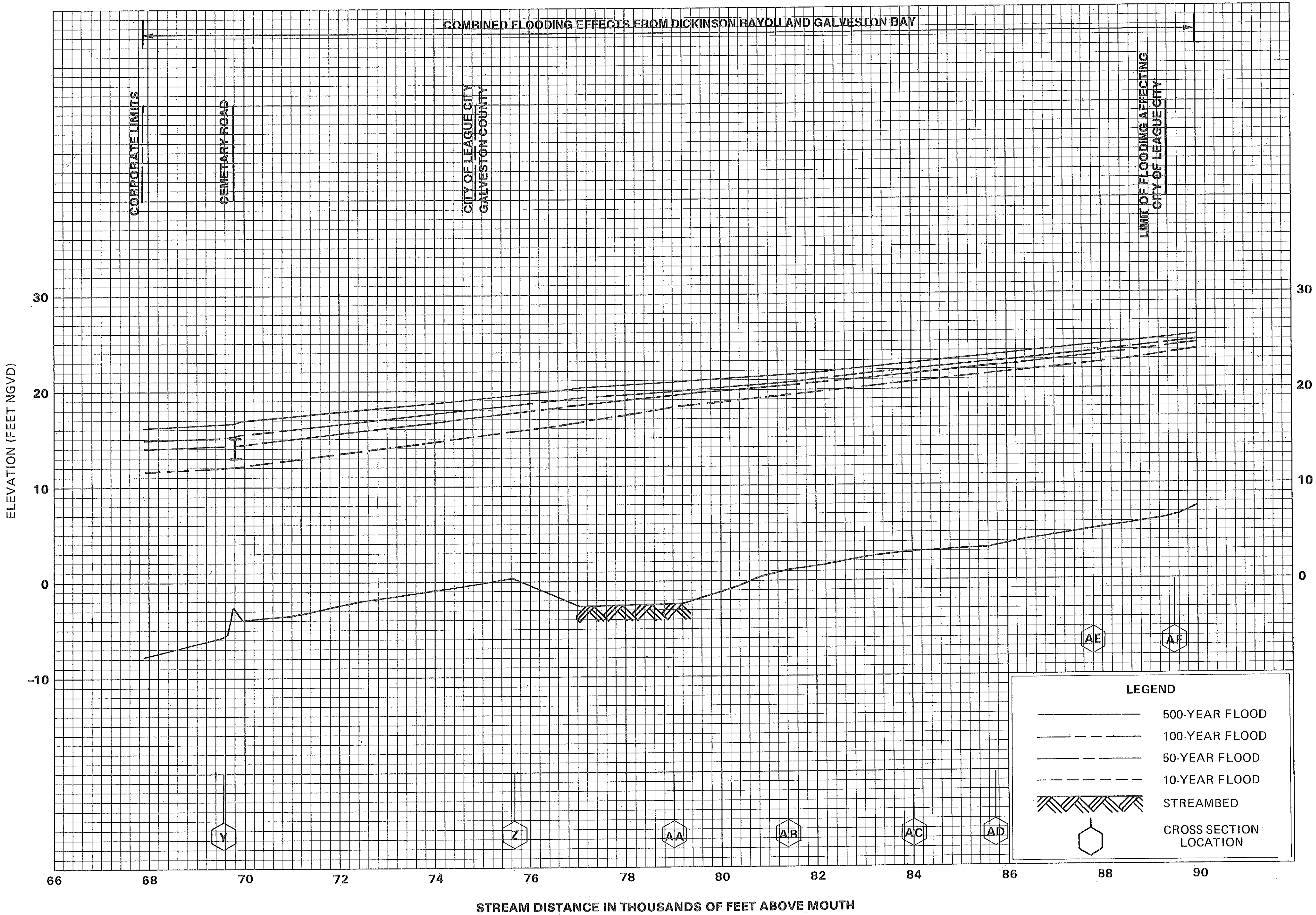
FLOOD PROFILES

UNNAMED TRIBUTARY OF CLEAR CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON AND HARRIS COS.)

05P



FLOOD PROFILES

DICKINSON BAYOU

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON AND HARRIS COS.)

06P

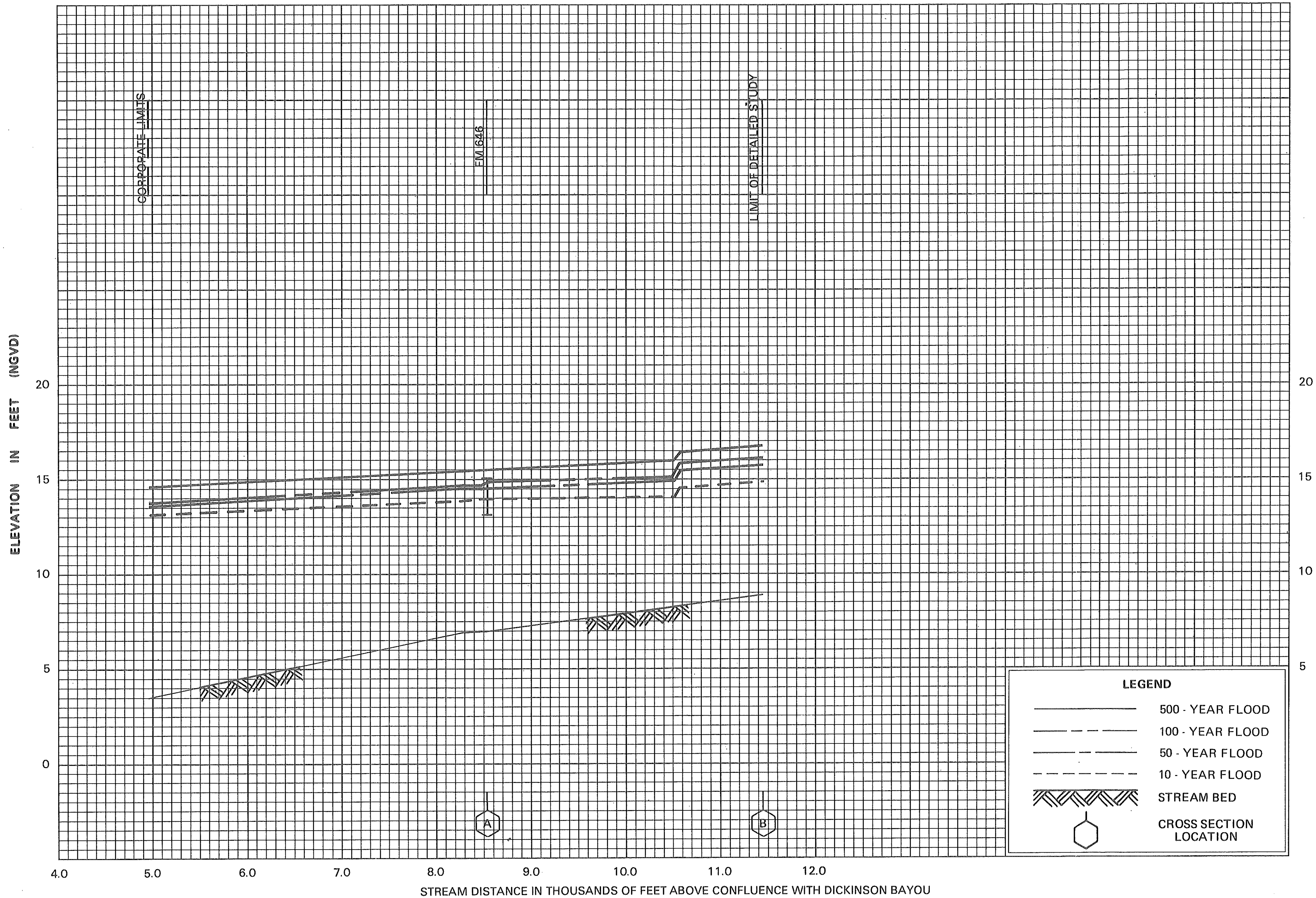
FLOOD PROFILES

DICKINSON BAYOU

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON AND HARRIS COS.)

07P



FLOOD PROFILES

BORDENS GULLY

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON AND HARRIS COS.)

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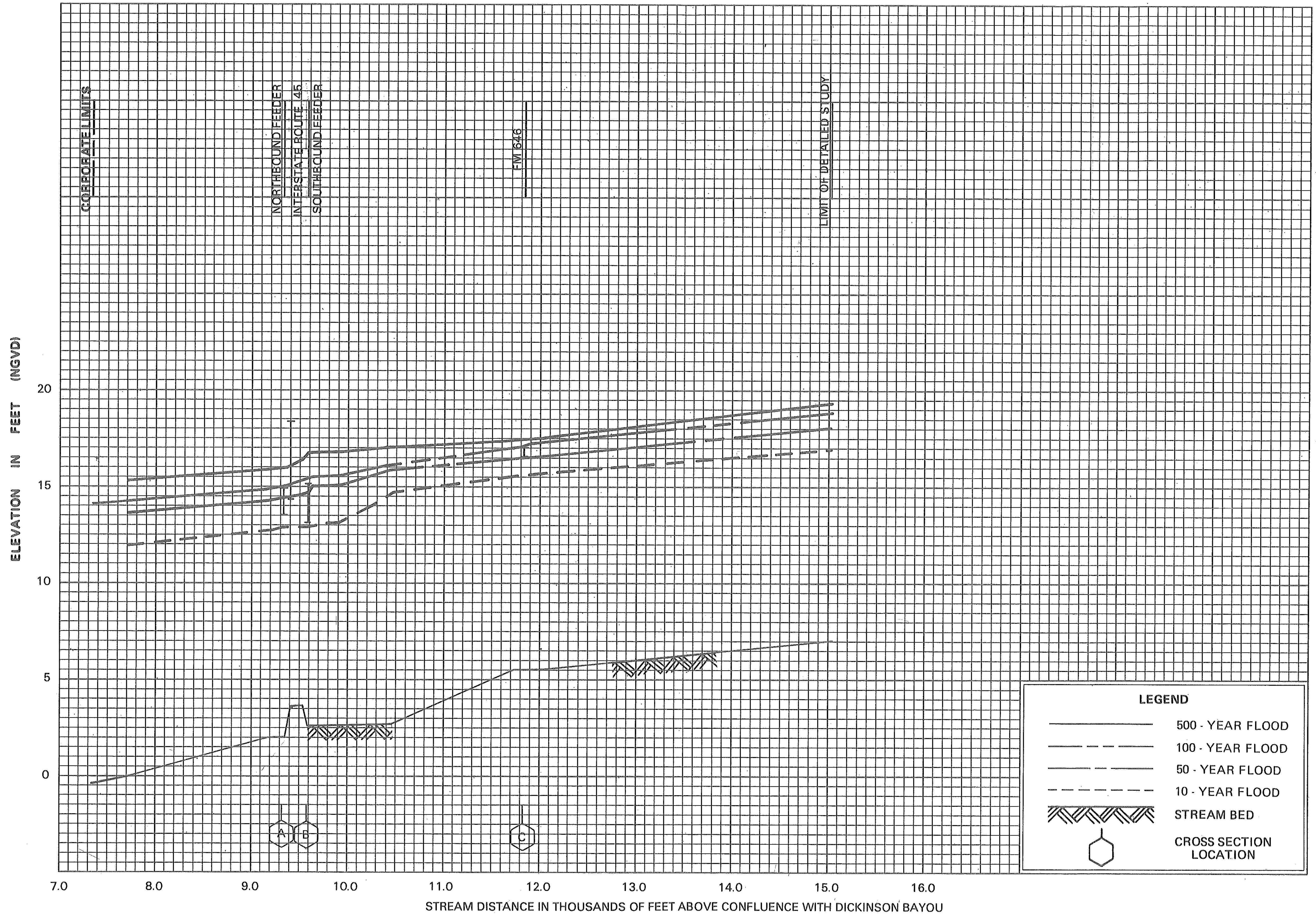

FLOOD PROFILES

MAGNOLIA BAYOU

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF LEAGUE CITY, TX
(GALVESTON AND HARRIS COS.)

09P