89th Congress, 1st Session - - - - - - - - - House Document No. 167

MORGAN CITY AND VICINITY, LOUISIANA

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED MAY 28, 1964, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON AN INTERIM HURRICANE SURVEY OF MORGAN CITY AND VICINITY, LOUISIANA, AUTHORIZED BY PUBLIC LAW 71, EIGHTY-FOURTH CONGRESS, APPROVED JUNE 15, 1955

MAY 11, 1965.—Referred to the Committee on Public Works and ordered to be printed with nineteen illustrations

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U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1965

47-840 O

CONTENTS

ILLUSTRATIONS ACCOMPANYING THE REPORT OF THE DISTRICT ENGINEER

(Only Plate 2 printed)

Plate No.:

1. General Map.
2. Plans of Protection.
3. Morgan City Levees—Plan, Profiles, and Sections.
4. Bayou Ramos Drainage Structure.
5. Franklin and Vicinity Levees—Plan, Profiles, and Sections.
6. Franklin Canal Floodgate.
7. Yellow Bayou Drainage Structure.

APPENDIXES ACCOMPANYING THE REPORT OF THE DISTRICT ENGINEER

(Only Appendix E not printed)

LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 20310

IN REPLY REFER TO:

May 1, 1965

Honorable John W. McCormack

Speaker of the House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 28 May 1964, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on an interim hurricane survey of Morgan City and Vicinity, Louisiana, authorized by Public Law 71, Eighty-fourth Congress, approved 15 June 1955.

The views of the State of Louisiana, and the Departments of the Interior, Agriculture and Commerce are set forth in the inclosed communications.

The Bureau of the Budget advises that there is no objection to the submission of the proposed report to the Congress; however, it states that no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation. A copy of the letter from the Bureau of the Budget is inclosed.

Sincerely yours,

1 Incl

STEPHEN AILES
Secretary of the Army

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
BUREAU OF THE BUDGET
WASHINGTON, D.C. 20503

April 21, 1965

Honorable Stephen Ailes
Secretary of the Army
Washington, D. C. 20310

Dear Mr. Secretary:

Mr. Harry C. McPherson's letter of July 21, 1964, submitted the proposed report of the Chief of Engineers on Morgan City and Vicinity, Louisiana, in partial response to Public Law 71, 84th Congress, approved June 15, 1955, with a view of providing improvements to prevent loss of human life and damages to property from flooding caused by hurricanes.

I am authorized by the Director of the Bureau of the Budget to advise you that there would be no objection to the submission of the proposed report to the Congress. No commitment, however, can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation.

Sincerely yours,

Carl H. Schwartz, Jr.
Chief, Resources and
Civil Works Division

COMMENTS OF THE STATE OF LOUISIANA

State of Louisiana

CLAUDE KIRKPATRICK
DIRECTOR

DEPARTMENT OF PUBLIC WORKS
BATON ROUGE 4

May 1, 1964

Lieutenant General W. K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Wilson:

The Department of Public Works has reviewed the copy of the proposed report of the Chief of Engineers, together with the reports of the Board of Engineers for Rivers and Harbors, and of the District and Division Engineers, on an interim hurricane survey of Morgan City and Vicinity, Louisiana.

This Department concurs in the views and recommendations made in the report of the Chief of Engineers. However, we believe that additional protection will probably be needed at a later date.

We appreciate the privilege afforded us to review and comment upon the report.

Sincerely yours,

Claude Kirkpatrick

CLAUDE KIRKPATRICK
Director

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

May 15, 1964

Dear General Wilson:

This is in reply to your letter of March 20, 1964, requesting our comments on an interim hurricane survey of Morgan City and Vicinity, Louisiana.

The Fish and Wildlife Service advises that hurricane protection and improvements proposed for Franklin and vicinity would have little effect on fish or wildlife resources. Levee construction at Morgan City would expand existing high water protection and facilitate eventual drainage and urbanization of a 1,100-acre wooded swamp area adjoining Morgan City on the northeast. Fish and wildlife resources of this area ultimately may be eliminated as a result of improvements in local drainage works. The project does not afford opportunities for fish and wildlife conservation.

The Regional Director, Southeast Regional Office, Federal Building, P. O. Box 10008, Richmond, Virginia 23240, should be kept advised as to progress on the project in order to program and initiate such surveys, salvage, and preservation of historical and archeological evidence as may exist in accordance with provisions of the Act of June 27, 1960 (74 Stat. 220).

We appreciate the opportunity of presenting our comments.

Sincerely yours,

Robert W. Nelson

Deputy Assistant Secretary of the Interior

Lt. General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

x

COMMENTS OF THE DEPARTMENT OF AGRICULTURE

DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D.C.

May 20, 1964

The Honorable
The Secretary of the Army

Dear Mr. Secretary:

This is in reply to the Chief of Engineers' letter of March 20, 1964, transmitting for our review and comment his proposed report on an interim hurricane survey of Morgan City and Vicinity, Louisiana.

The report recommends certain works of improvement for hurricane protection for the Morgan City and Franklin, Louisiana, areas. Since the proposed improvements will not affect projects or programs of the Department of Agriculture, this Department has no comments to offer.

Thank you for providing this report for our review.

Sincerely yours,

John A. Baker

John A. Baker
Assistant Secretary

COMMENTS OF THE DEPARTMENT OF COMMERCE

THE UNDER SECRETARY OF COMMERCE
FOR TRANSPORTATION
WASHINGTON 25, D. C.

15 May 1964

Lieutenant General W. K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington, D. C. 20315

Dear General Wilson:

This is in further reply to your letter of 20 March 1964 transmitting for our information and comment copies of your proposed report, together with the reports of the Board of Engineers for Rivers and Harbors, and of the District and Division Engineers, on an interim hurricane survey of Morgan City and Vicinity, Louisiana. Comments by the Department of Commerce follow:

The Coast and Geodetic Survey notes that horizontal and vertical control have been established in the project area and are considered adequate to meet the engineering requirements of the project. If additional control is required for the project, the Survey requests that it be given advance notice so that cost estimates can be furnished.

The Bureau of Public Roads review of the report indicates that a certain amount of highway relocation will be required in the construction of this project and that the performance of the highway reconstruction involved has been made a part of the local contribution to the project. In view of this requirement, it is necessary that the local interests be advised that Federal-aid highway funds cannot be used in the financing of this highway reconstruction.

The Weather Bureau had no comments for inclusion in the Department's report.

We appreciate the opportunity to comment on this report.

Sincerely yours,

Clarence D. Martin, Jr.

MORGAN CITY AND VICINITY, LOUISIANA

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

IN REPLY REFER TO

ENGCW-PD

28 May 1964

SUBJECT: Morgan City and Vicinity, Louisiana

TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on a survey of Morgan City and Vicinity, Louisiana, in partial response to Public Law 71, Eighty-fourth Congress, first session, with a view of providing improvements to prevent loss of human life and damages to property from flooding caused by hurricanes. My report includes the reports of the District and Division Engineers and the Board of Engineers for Rivers and Harbors.

2. The reporting officers recommend construction of levees, floodgates, and drainage structures for the Morgan City and for the Franklin, Louisiana, areas. The total cost of the recommended plan is estimated to be $4,449,000, of which $3,049,000 is the Federal cost for construction and $1,400,000 is the non-Federal cost for lands and damages, relocations, and a cash contribution presently estimated at $248,000. Construction would be contingent upon certain requirements of local cooperation. The annual charges are $162,700 and the average annual benefits are $411,300. The benefit-cost ratio is 2.5.

3. The Board of Engineers for Rivers and Harbors concurs generally in the findings of the reporting officers and recommends the proposed improvements, provided that certain requirements of local cooperation are met, and that the improvements either at Morgan City or at Franklin and vicinity may be undertaken independently of the other whenever funds therefor are available and the prescribed local cooperation has been provided.

4. I concur in the views and recommendations of the Board.

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

ENGBR(12 Nov 63) 2nd Ind
SUBJECT: Morgan City and Vicinity, Louisiana

Board of Engineers for Rivers and Harbors, Washington, D. C. 20315
18 February 1964

TO: Chief of Engineers, Department of the Army

1. The study area is in south-central Louisiana and consists mainly of low coastal marshes and ridges of higher alluvial lands along several bayous and the lower Atchafalaya River. Approximately 45,000 persons reside in the study area. The occurrence of severe hurricanes in the vicinity creates serious hazards to human life and causes severe damages to property. The more thickly populated portion of the area is protected from headwater flooding from the lower Atchafalaya River and tributaries by a system of levees and appurtenant structures. Some of the existing levees are of sufficient height to protect against the floodwaters of hurricane tides while remaining areas are flooded and suffer extensive damages to property and hazards to human life. Many damaging storms have been experienced in the area. Hurricane "Audrey", in June 1957, caused overtopping of several existing levees in the area, and severe damages were experienced.

2. Due to differences in location and topographic and economic features, four independent areas were studied. The major portion of the town of Morgan City is designated as subarea A while a small portion of the town along Bayou Boeuf is designated as subarea B. Patterson and vicinity, Franklin and vicinity, and Lower Bayou Sale are the other areas designated for study. Patterson and vicinity has ample existing protection. A preliminary study indicated that damages in the Lower Bayou Sale area were entirely too low to warrant construction of improvements. Average annual hurricane damages are $74,400 and $5,200 for Morgan City subareas A and B, respectively, and $72,600 for Franklin and vicinity.

3. Local interests desire improvements to existing protective structures and construction of new levees, and have expressed willingness to cooperate and participate in the construction of improvements.

4. The District Engineer finds justification for construction of new levees to protect subareas A and B of Morgan City, and for levee improvement and new construction to protect Franklin and vicinity. Based on May 1963 prices and a 100-year period of analysis, his estimates of first costs for the proposed improvements, average annual benefits and charges, and benefit-cost ratios for plans of protection recommended are given in Table 1, following. He apportions the cost

between Federal and non-Federal interests in accordance with the action of Congress on hurricane projects authorized in the Flood Control Act of 1958. On this basis, local interests would bear not less than 30 percent of the total project cost, to include the cost of lands, rights-of-way, and relocations and the remainder in cash or equivalent work. For the proposed improvements at Morgan City, the estimated cost of lands, rights-of-way, and relocations exceed 30 percent of the total project cost, and no additional contribution will be required. For the proposed work at Franklin and vicinity, the additional contribution is estimated at $248,000. Subject to conditions of local cooperation, the District Engineer recommends adoption of hurricane protective improvement plans and related works as described in his report. The Division Engineer concurs.

TABLE 1

Item	Morgan City: Subarea A	Morgan City: Subarea B	Franklin and vicinity
First costs			
Federal			
Amount	$ 944,000	$ 45,000	$2,060,000
(Percent)	(66.2)	(56.3)	(70.0)
Non-Federal			
Amount	482,000	35,000	883,000
(Percent)	(33.8)	(43.7)	(30.0)
Total	$1,426,000	$ 80,000	$2,943,000
Annual charges			
Federal			
Interest and amortization	$ 30,800	$ 1,400	$ 65,200
Non-Federal			
Interest and amortization	23,400	1,800	29,800
OM&R	1,100	200	9,000
Total	$ 55,300	$ 3,400	$ 104,000
Annual benefits			
Present	$ 62,000	$ 4,300	$ 59,300
Future	171,300	800	113,600
Total	$ 233,300	$ 5,100	$ 172,900
Benefit-cost ratio	4.2	1.5	1.7

5. The Division Engineer issued a public notice stating the recommendations of the reporting officers and affording interested parties an opportunity to present additional information to the Board. No communications have been received.

Views and Recommendations of the Board of Engineers for Rivers and Harbors.

6. Views.--The Board of Engineers for Rivers and Harbors concurs in general in the views and recommendations of the reporting officers. The improvements recommended are economically justified and the requirements of local cooperation are appropriate. The Board concurs in the view that hurricane preparedness committees should be organized in the area to prepare plans for dissemination of hurricane information, for use of refuge shelters, and to direct evacuation and rescue work when necessary.

7. Recommendations.--Accordingly, the Board recommends authorization for construction of improvements for the prevention of hurricane tidal damages and loss of life at Morgan City and vicinity, Louisiana, to consist of:

Morgan City. - Construction of approximately 5.6 miles of new levees along the shore of Lake Palourde and the west bank of Bayou Ramos and approximately 0.5 mile of new levee from the railroad embankment in the vicinity of Wyandotte to tie in with the Bayou Boeuf lock levee, and construction of three gravity drainage structures; and

Franklin and vicinity. - Enlargement of approximately 21.6 miles of back levee and construction of approximately 3.1 miles of new levees to effect a complete closure of the area to be protected, construction of one floodgate and five gravity drainage structures, and alteration of existing drainage facilities where necessary;

all generally in accordance with the plans of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at estimated costs to the United States for new work as follows:

Area	Cost
Morgan City	
Subarea A	$ 944,000
Subarea B	45,000
Franklin and vicinity	2,060,000

Provided that, prior to construction, local interests give assurances satisfactory to the Secretary of the Army that they will:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the project;

b. Accomplish, without cost to the United States, alterations as required to roads, pipelines, cables, wharves, drainage structures, and any other facilities for the construction of the project;

c. Hold and save the United States free from damages due to the construction works;

d. Contribute in cash or equivalent work, as estimated below, not less than 30 percent of the total project cost, said 30 percent to include the fair market value of lands and relocations required under subparagraphs a and b above, and the remainder in cash or equivalent work specifically undertaken as an integral part of the project after authorization and in accordance with approved construction schedules, the final determinations to be made after construction is completed:

Area	Total contribution	Lands and relocations	Cash or equivalent work
Morgan City			
Subarea A	$482,000	$482,000	None
Subarea B	35,000	35,000	None
Franklin and vicinity	883,000	635,000	$248,000

e. Provide all interior drainage and pumping plants required for reclamation and development of the protected areas;

f. Maintain and operate the project after completion, including levees, drainage structures, and drainage ditches or canals, in accordance with regulations prescribed by the Secretary of the Army; and

g. Prevent encroachments on existing ponding areas unless substitute storage capacity or equivalent pumping capacity is provided promptly, without cost to the United States;

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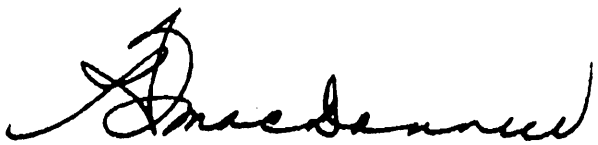
And provided further, that the improvements either at Morgan City or at Franklin and vicinity may be undertaken independently of the other whenever funds therefor are available and the prescribed local cooperation has been provided.

FOR THE BOARD:



R. G. MacDONNELL
Major General, USA
Chairman

REPORT OF THE DISTRICT ENGINEER

HURRICANE STUDY
INTERIM SURVEY REPORT
MORGAN CITY, LOUISIANA AND VICINITY

SYLLABUS

The study area is located in south central Louisiana and consists mainly of low coastal marshes and ridges of higher alluvial lands, one to several miles inland, adjacent to Bayous Teche, Sale, and Boeuf, and the Atchafalaya River. Hurricanes approaching on critical paths will cause severe flooding to developments within areas having inadequate protective systems. As a result of the flooding, residences and industrial and commercial establishments suffer damage, business activities are disrupted, lives are endangered, and hazards to health are created. Protection against these threats to life and damage to property has been requested by local interests.

Plans considered for protection of the study area consist of raising the heights of existing levees where necessary and constructing new levees. Included in the plans studied are construction of a floodgate and drainage structures, and modification of pumping stations and gravity drainage structures. Relocations also will be required of oil and gas pipelines and road crossings over levees.

Due to differences in location, topography, and economic features, it was necessary to divide the study area into four independent areas. The Morgan City area has two subareas, A and B. Subarea A includes the major portion of Morgan City located to the north of the Southern Pacific Railroad, while subarea B includes a small area located below the railroad along Bayou Boeuf and between the Atchafalaya River and the Bayou Boeuf lock. Patterson and vicinity is the protected area between the Atchafalaya River and Wax Lake Outlet. Franklin and vicinity is the protected area between Wax Lake Outlet and the Charenton Drainage Canal. Lower Bayou Sale is a leveed area located along the Bayou Sale Ridge south of the Gulf Intracoastal Waterway.

The plan of protection for Morgan City, subarea A, provides for construction of 5.6 miles of levee and two flap-gated gravity drainage structures. The estimated first cost of the work is $1,426,000, of which $944,000 is Federal. Annual economic costs are estimated at $55,300. Benefits are estimated at $233,300 indicating a benefit-cost ratio of 4.2 to 1.

The protective plan for subarea B of Morgan City provides for construction of 0.5 mile of levee and a flap-gated gravity drainage structure. Estimated first cost for the work is $80,000, of which

$45,000 is Federal. Annual economic costs are estimated at $3,400 and benefits $5,100. The benefit-cost ratio is indicated at 1.5 to 1.

Improvements planned for Franklin and vicinity consist of increasing the height of 21.6 miles of levee, construction of 3.1 miles of new levee, construction of 1 floodgate, alteration of 5 pumping stations and 11 gravity drainage culverts, and construction of 5 drainage structures. Existing oil and gas pipelines and roads will be ramped over the improved levee. The estimated first cost for this work is $2,943,000, of which $2,060,000 is Federal. Annual economic costs are estimated at $104,000 and benefits at $172,900, indicating a benefit-cost ratio of 1.7 to 1.

The remaining areas, Patterson and vicinity and Lower Bayou Sale, were not studied in detail. Early in the study, it was determined that the Patterson area had protective works of sufficient height to prevent damages from design hurricane tides. Preliminary analysis of construction cost and benefit studies for Lower Bayou Sale indicated that the benefit-to-cost ratio was entirely too low to warrant further study. Similarly, the industrial and agricultural area along Bayou Boeuf is situated on high ground, and a favorable benefit-cost ratio is not evident for this location. In addition, construction of protective structures along the bayou is impracticable at this time.

For each plan of protection, local interests would be required to provide all lands, easements, rights-of-way, and relocations without cost to the United States; maintain and operate the project after completion; hold and save the United States free from damages due to the construction works; give assurances that encroachment on the existing ponding areas will be prevented unless substitute storage capacity or equivalent pumping capacity is provided; and contribute in cash or equivalent work specifically undertaken as an integral part of the project after authorization and in accordance with approved construction schedules 30 percent of the total cost, said 30 percent now estimated at $883,000 for Franklin and vicinity. The above amount is to include the fair market value of lands and relocations estimated at $635,000. The estimated fair market value of lands and relocations for subareas A and B of Morgan City exceeds the minimum 30 percent of the total cost requirement of local interests. Therefore, the values of lands and relocations now estimated at $482,000 and $35,000 for subareas A and B, respectively, are the required contributions of local interests.

Additional protection from hurricane tides can be afforded to residents of low-lying coastal communities by the establishment of building codes and zoning regulations, provision of adequate shelters of refuge, and organization of hurricane preparedness committees to formulate plans for effective preventive measures, evacuation, and rescue work.

GLOSSARY

ASTRONOMICAL TIDE - See PREDICTED NORMAL TIDE.

ATMOSPHERIC PRESSURE ANOMALY - The difference between atmospheric pressure at any point within the hurricane and normal pressure at the periphery of the hurricane.

BUILDUP - The increase, in feet, over that from other causes, of water surface elevation in a body of water resulting from:

1. Convergence in depth or width
2. Construction of a barrier
3. Ponding

CENTRAL PRESSURE - The minimum atmospheric pressure within the hurricane at any specific time.

FETCH - The continuous area of water over which the wind blows in essentially a constant direction. Often used synonymously with FETCH LENGTH.

FETCH LENGTH - The horizontal distance over which the wind from a fixed direction may have unobstructed contact with the water surface.

HURRICANE - A cyclonic storm, usually of tropical origin, containing winds of 75 miles per hour or more.

a. DESIGN HURRICANE - That hurricane selected by the reporting office as a basis for design of the proposed plan of improvement.

b. STANDARD PROJECT HURRICANE - A hurricane that may be expected from the most severe combination of meteorological conditions that are considered characteristic of the region involved.

c. PROBABLE MAXIMUM HURRICANE - The hurricane that may be expected from the most severe combination of meteorological conditions that are reasonably possible in the region.

d. MODERATE HURRICANE - A hurricane that may be expected from a combination of meteorological conditions that are frequently experienced in the region.

e. TRANSPOSED HURRICANE - A storm transferred from actually observed location to another location for the purpose of study, with appropriate changes in storm characteristics.

HURRICANE PATH (OR TRACK) - The line connecting successive locations of central pressure of the hurricane.

HURRICANE SPEED - The rate of forward movement.

HURRICANE SURGE - The mass of water causing an increase in elevation of the water surface at the time of a hurricane.

HURRICANE SURGE HEIGHT - The elevation of the still water level at a given point resulting from hurricane surge action. It may be the result of one or more of the following components:

1. Predicted normal tide
2. Pressure setup
3. Setup due to winds over the continental shelf
4. Buildup

In inland lakes, hurricane surge height is the average lake level and does not include local wind setup.

HURRICANE TIDE - The elevation of the still water level at a given point during a hurricane. In inland lakes it is the sum of hurricane surge height and additional local wind setup.

ISOVEL - Line drawn through locations having the same wind velocity at a given time.

KNOT - A velocity equal to one nautical mile (6,080 feet) per hour, or about 1.15 statute miles per hour.

LANDFALL - The arrival of a hurricane center at the coastline.

OVERTOPPING - The amount of water passing over the top of a structure as a result of wave runup or surge action.

PONDING - The storage behind a water-retaining structure of water from interior runoff or from overtopping of a structure.

PREDICTED NORMAL TIDE - The periodic rising and falling of the water that results from gravitational attraction of the moon and sun acting upon the rotating earth.

PRESSURE SETUP - The conversion of atmospheric pressure anomaly to equivalent height of water and adjusted for its dynamic effects as a part of the total hurricane surge.

RANGE - A narrow fetch over which the hurricane surge height is computed.

RUNUP - The vertical elevation above still water level to which water rises on the face of a structure as a result of wave action.

SETDOWN - The decrease in water surface elevation behind a water-retaining barrier or at a windward shore due to wind action.

SETUP - The vertical rise in the still water level, above that which would occur without wind action, caused by wind stresses on the surface of the water.

SIGNIFICANT WAVE - A statistical term denoting waves having the average height and period of the highest one-third waves of a given wave train.

STILL WATER LEVEL - The elevation of the water surface if all wave action were to cease.

STORM SURGE - Same as HURRICANE SURGE, except that it may be caused by storms not of hurricane characteristics as well as by hurricanes.

WAVE HEIGHT - The vertical distance between the crest and the preceding trough. (Referenced to significant waves in this report.)

WAVE SETUP - The superelevation of the water surface above the hurricane tide height due to wave action alone.

WAVE TRAIN - A series of waves from the same direction.

WIND SETUP - Same as SETUP.

WIND TIDE LEVEL - Same as STILL WATER LEVEL.

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
Foot of Prytania Street
New Orleans, Louisiana

LMNGH 12 November 1963

SUBJECT: Interim Survey Report on Hurricane Study of Morgan City, Louisiana and Vicinity

THRU: Division Engineer
U. S. Army Engineer Division
Lower Mississippi Valley

TO: Chief of Engineers

SECTION I - AUTHORIZATION, PURPOSE, AND SCOPE

1. AUTHORITY

This report is submitted in response to Public Law 71, 84th Congress, 1st Session, approved 15 June 1955:

"BE IT ENACTED BY THE SENATE AND HOUSE OF REPRESENTATIVES OF THE UNITED STATES OF AMERICA IN CONGRESS ASSEMBLED, That:

"In view of the severe damage to the coastal and tidal areas of the eastern and southern United States from the occurrence of hurricanes, particularly the hurricanes of August 31, 1954, and September 11, 1954, in the New England, New York, and New Jersey coastal and tidal areas, and the hurricane of October 15, 1954 in the coastal and tidal areas extending south to South Carolina, and in view of the damages caused by other hurricanes in the past, the Secretary of the Army, in cooperation with the Secretary of Commerce and other Federal agencies concerned with hurricanes, is hereby authorized and directed to cause an examination and survey to be made of the eastern and southern seaboard of the United States with respect to hurricanes, with particular reference to areas where severe damages have occurred.

"Sec. 2. Such survey, to be made under the direction of the Chief of Engineers, shall include the securing of data on the behavior and frequency of hurricanes, and the determination of methods of forecasting their paths and improving warning services, and of possible means of preventing loss of human lives and damages to property, with due consideration of the economics of proposed breakwaters, seawalls, dikes, dams, and other structures, warning services, or other measures which might be required.

"Sec. 3. There are hereby authorized to be appropriated such sums as may be necessary to carry out the provisions of this Act."

2. PURPOSE AND EXTENT OF INVESTIGATION

a. The authorizing legislation prescribes a hurricane study for the eastern and southern seaboards of the United States. In order to facilitate the study, the Louisiana coast within the limits of the U. S. Army Engineer District, New Orleans, was divided into six independent study areas. The study area covered by this interim report, designated "Morgan City, Louisiana and Vicinity," is one of these areas and is shown on plate 1. The purpose of this report is to present plans and recommendations for protection of life and property against hurricane flooding within this area. Sufficient field work has been performed to provide a sound basis for engineering and economic considerations required to define economic justification and degree of Federal participation. Investigations were curtailed when solutions appeared impracticable.

b. Basic data were available for the study from surveys and studies made in connection with previous reports and existing projects in the area. These data consisted of topographic maps and aerial photographs, topographic and geological surveys, soil borings, construction drawings, hurricane damage survey reports, census reports, development planning reports and records of hurricane damages from newspapers, periodicals, miscellaneous reports, and U. S. Weather Bureau files. Details and descriptions of experienced hurricane characteristics and damages are given in supplement 1.* Additional data required for the study were obtained from field surveys, appraisal studies to determine damages for selected surge heights, and research of technical bulletins, reports, and publications. Details and descriptions of procedures employed and their development are given in appendix A.

c. The following agencies and organizations were consulted during the course of the study: U. S. Department of Commerce,

*Available at the U. S. Army Engineer District, New Orleans, New Orleans, Louisiana

Weather Bureau; U. S. Department of the Interior, Fish and Wildlife Service and Bureau of Mines; U. S. Department of Agriculture, Soil Conservation Service; and State of Louisiana, Department of Public Works and Department of Wild Life and Fisheries.

d. The District Engineer made a reconnaissance of the area during the preparation of this report.

3. PRIOR REPORTS

The prior reports in the area under investigation have been concerned with flood control and navigation on the lower Atchafalaya River. Pertinent reports are as follows:

a. House Document No. 90, 70th Congress, 1st Session, submitted 8 December 1927, is the basis of the Mississippi River and Tributaries flood control project adopted by the Flood Control Act of 15 May 1928. As amended, the general plan includes among other things construction of levees in the Atchafalaya Basin terminating with the levees at and below Morgan City and west of Berwick.

b. House Committee Document No. 1, 74th Congress, submitted 12 February 1935, as adopted by the Flood Control Act of 15 June 1936, recommended with respect to this area the construction of the Wax Lake Outlet west of Berwick.

c. Senate Document No. 53, 82nd Congress, submitted 26 July 1951, and adopted by the Flood Control Act of 3 September 1954 provides for a 12- by 125-foot waterway from the Mississippi River via Old and Atchafalaya Rivers to Morgan City, La.

d. House Document No. 566, 87th Congress, 2d Session, submitted 11 September 1962, recommended the following improvements of the G.I.W.W.*

(1) A channel 16 by 150 feet from the Mississippi River to the Atchafalaya River including a bypass around Houma, La.

(2) A channel 16 by 200 feet from the Atchafalaya River to the Sabine River.

e. House Document No. 583, 87th Congress, 2d Session, submitted 24 September 1962, recommended that no further studies be made for the "Atchafalaya River, Morgan City to the Gulf of Mexico, La."

*Gulf Intracoastal Waterway

SECTION II - DESCRIPTION

4. DESCRIPTION

a. Location and extent. The study area, as shown on plate 1, is located in south central Louisiana in the vicinity of Morgan City. It includes the land south of Grand Lake, Six Mile Lake, and Lake Palourde extending from about 8 miles east of Morgan City westward to the Charenton Drainage and Navigation Canal.

b. Topography. The major portion of the study area is marshland having an average elevation of 1.5 feet m.s.l.* Higher ridges ranging up to 2 miles wide border Bayou Teche, the Lower Atchafalaya River, and Bayou Sale. These ridges range in elevation from about 5 feet to as much as 15 feet. The lower Atchafalaya River and Wax Lake Outlet, the principal outlets for the Atchafalaya Basin Floodway traverse the area. The G.I.W.W. crosses the area in an east-west direction. Numerous bayous and artificial canals excavated for drainage purposes or for access to oil developments exist throughout the area.

c. Geology. The area included in this study is located on the deltaic plain of the Mississippi River, near its western boundary. It is a region of extremely low relief. Specifically, the area is located on ancient deltas of the Mississippi River formed during the Sale, Cypremort, and Teche stages. The principal physiographic features include natural levees along ancient courses and distributaries of the Mississippi River; a low-lying lake and backswamp area to the north of the Teche Ridge; marshlands and numerous bays to the south of the Teche Ridge; a shell reef zone at the southern extremity of the area; and a few beach ridges along the shores of the bays. Generally, in the central and eastern parts of the study area foundation conditions and available fill material are extremely poor, and settlement and stability of structures are serious problems. A detailed description of the geology of the area is covered in appendix B.

d. Tides. The tide along this portion of the Louisiana coast is diurnal and has a normal range of approximately 1.6 feet. Storm and hurricane tides have produced elevations up to 10 feet, while northerly storms during the winter depress the gulf level as much as 3 feet below m.s.l. During low water periods on the Atchafalaya River, generally September through November, the effect of tide extends approximately 35 miles above Morgan City. Location and description of gages and their periods of record are given in appendix A. Maps showing areas flooded and maximum

*Mean sea level, the datum to which all elevations in this report are referenced, unless otherwise indicated.

water surface elevations that have been experienced in the study area are contained in supplement 1 and appendix A.

e. Flood protection and drainage systems. Flood protection in the study area, with the exception of the levee on the Lake Palourde side of Morgan City which was constructed by local interests, is a feature of the Mississippi River and Tributaries flood control project. Four independent areas within the study area are protected by levees, with gravity drainage structures and pumping stations as necessary. Locations of the areas are shown on plate 2. These are described briefly in the following paragraphs.

(1) Morgan City. Morgan City is located along the shores of Berwick Bay and the north bank of the G.I.W.W. It is protected by the Federal levee and floodwall system fronting Berwick Bay and Bayou Boeuf (G.I.W.W.) which protects against Atchafalaya Basin floodwaters and by the local back levee on the Lake Palourde side to the north and east. Project grade of the front levee and floodwall varies in elevation between 13.0 and 16.0 feet, and for the back levee is 6.0 feet. Six pumping stations with a combined capacity of 857 c.f.s., two constructed at Federal cost and four built by local interests, remove local runoff.

(2) Patterson and vicinity. This area is located between Six Mile Lake and the G.I.W.W. and extends from Berwick Bay to Wax Lake Outlet. It is completely encircled by the Federal levee and floodwall system which affords protection from Atchafalaya Basin floodwaters. The protective system varies from 11 feet to 18 feet in elevation. The drainage system consists of the Wax Lake East pumping station, capacity 1,000 c.f.s., and a gravity drainage structure on the G.I.W.W. and necessary canals and drainage structures, including an inverted siphon under Bayou Teche near the East Calumet Floodgate, to tie the entire area to the main outlet facilities.

(3) Franklin and vicinity. This area is located between Grand Lake and the G.I.W.W. and extends from Wax Lake Outlet to the Charenton Drainage and Navigation Canal. The protective system consists of the Federal flood control levees, the several elements on the gulf side of which tie in to high ground along Bayou Teche. Project grade elevations of the gulf side levees range from 11 feet near Wax Lake Outlet to 6 feet at Bayou Sale and beyond, and from 16 to 22 feet for the floodway side levee. Major drainage for the area is handled by numerous canals, 14 gravity drainage structures, and 6 pumping stations (total capacity 2218 c.f.s.), 4 of which are completed. One additional pumping station is under construction and construction of another one has been advertised for bids.

(4) Lower Bayou Sale. This area, bordering along the Bayou Sale Ridge between the G.I.W.W. and the town of Gordy, is protected against Atchafalaya Basin floodflow by the Federal levee system. Project grade ranges between 6.0 and 7.0 feet. The upper portion of the area is drained by the Ellerslie pumping station which has a design capacity of 134 c.f.s., and by two gravity drainage structures. The lower part of the area is presently drained by two gravity drainage structures. A pumping station with a capacity of 230 c.f.s. is under construction in the vicinity of Gordy.

f. Maps. Reference is made to U. S. Army Corps of Engineers quadrangles Bayou Sale, Jeanerette, Foster, Belle Isle, Point Au Fer, Morgan City, and Lake Decade, scale 1:62,500; and U. S. Coast and Geodetic Survey chart No. 1116, scale 1:458,596; and the maps attached to this report.

5. ECONOMIC DEVELOPMENT

a. Population. The population of the study area was about 41,500, 28,900, 25,700, and 24,300 in 1960, 1950, 1940, and 1930, respectively. The incorporated towns and their 1960 populations are Morgan City (13,540), Franklin (8,673), Berwick (3,880), and Patterson (2,923). The 1960 population within the areas protected by levees are as follows:

Area	Population
Morgan City	12,540*
Patterson and vicinity	9,700
Franklin and vicinity	14,790
Lower Bayou Sale	170
Total	37,200

*The population of the three communities to the east of the Morgan City corporate limits was 2,175 in 1960.

b. Industry. Industries within the study area include ship and boat building and repairing, steel fabricating, lumber and wood products manufacture, sugar mills, a sugar refinery, carbon black manufacture, petroleum refining, processing of shells for lime and other uses, seafood freezers and cold storage, seafood processing, ice manufacture, marble and granite processing, hand and edge tool manufacture, and extensive servicing facilities for the petroleum industry.

c. Mineral production. Numerous oil and gas fields have been developed throughout the coastal area and in the contiguous offshore areas of the Gulf of Mexico. The subject area contains

nine producing fields and numerous single well fields. Much of the area is traversed by oil and gas pipelines leading from producing fields to refineries and centers of population in Louisiana and to the eastern seaboard. Salt has been placed in production recently at Belle Isle. Shell deposits are mined near the coastline.

d. Fisheries and fur animals. Shrimp, oysters, and crabs abound in the coastal waters and commercial fishing is a profitable industry. Many fur pelts, principally muskrat and nutria, are taken from the coastal marsh. A total of 254 trawl boats was registered in St. Mary Parish in 1959 and in the 1958-1959 season, 175 trapping licenses were issued.

e. Agriculture. Sugar cane is the principal crop and accounts for a major part of the farm income. Small acreages of corn and rice are grown. Considerable acreage of soybeans is plowed under for improvement of soil. Many acres of pasture are devoted to the production of beef cattle.

f. Land transportation. The area is served by U. S. Highway 90 along Bayou Teche and many state and parish all-weather roads. An alternative route for U. S. Highway 90 extending from Morgan City westward across the area is under construction. Rail service is provided by the main line of the Southern Pacific.

g. Air transportation. Small commercial air transport is available at the Harry P. Williams Memorial Airport located to the west of Patterson.

h. Navigation. The area is traversed in an east-west direction by the G.I.W.W. (authorized 16 by 200 feet west of Atchafalaya River and 16 by 150 feet east thereof). The 20- by 200-foot channel, Atchafalaya River, Morgan City to the Gulf (now maintained to 16-foot depth) provides an outlet to the Gulf, and the 12- by 125-foot Atchafalaya River provides for navigation from Morgan City to the Mississippi River via Old River. The area is served also by numerous improved waterways and natural streams navigable by shallow draft vessels, including Bayou Teche, Franklin Canal, Charenton Canal, and Wax Lake Outlet.

i. Utilities. Electric power, telephone service, and natural gas are available to essentially all of the populated parts of the area.

j. Recreation. Both fresh and salt water fishing attract many to the area. Waterfowl hunting is available through much of the marsh area. Boating is popular on Lake Palourde and on the many streams and channels.

k. Forestry. Approximately one-third of the land area is wooded. These stands of timber serve the wood-using industries within the study area.

6. CLIMATOLOGY

a. Climate. The climate of this area is greatly influenced by its proximity to the Gulf of Mexico. Southerly winds from the gulf moderate the climate, giving it a semitropical marine character. Heavy precipitation in this region results from such climatic phenomena as tropical hurricanes moving northward over the area; intensive convective storms; and frontal storms resulting from the reaction of moist maritime and cold polar air masses.

b. Temperature. The average annual temperature of this area is 69.3 degrees Fahrenheit. The coldest month is January with a mean temperature of 55.8 degrees. July and August, the hottest months, have a mean temperature of 82.1 degrees. The normal length of frost-free growing period is approximately 8-1/2 months.

c. Precipitation. The average annual precipitation, based on the latest U. S. Weather Bureau normals from two stations, Franklin and Morgan City, is 64.4 inches. Snowfall is very infrequent.

d. Records. Detailed temperature, precipitation, stage, and discharge records are shown in appendix A.

7. HURRICANES OF RECORD

a. Historical hurricanes. This area has experienced many severe storms as well as numerous lesser storms. Because of the characteristic flatness and low elevation of the land and its proximity to the Gulf of Mexico, water from adjacent bays is easily driven over the marshlands toward the inhabited areas. Before 1893, there were no official U. S. Weather Bureau meteorological records and the early historical accounts are limited because of the sparse development of the area.

(1) The first recorded storm of consequence to the area occurred in 1879. The major damage sustained was to crops along the bayous and in the vicinity of Franklin. Other storms in 1892, 1893, 1897, 1905, and 1912 struck the area, but very little factual information is available.

(2) A severe storm occurred in September 1909. The center of this disturbance passed midway between New Orleans and Morgan City and created tides from 5 to 10 feet above normal in southeastern Terrebonne Parish and 2.8 feet at Morgan City. Twenty-three people were drowned south of Morgan City, and heavy property damage

was incurred at Patterson, Franklin, and Berwick. Heavy rains that continued for 18 hours added to the already serious tide problem.

(3) The violent storm of 5-24 August 1915 passed inland just west of Galveston, Texas. Though the center was more than 100 miles west of the Louisiana coast, above normal tides of 2.5 feet at Morgan City, 4 feet at Patterson, and 9 feet at Point Au Fer were experienced. The August 1918 storm caused a tide of 3 feet at Morgan City. The small diameter storm of 13-17 October 1923 produced a tide of 3.6 feet at Morgan City.

(4) The storm of 21-27 August 1926 passed just east of Morgan City. Tides rose 3 to 6 feet above the marshes and overflowed into Morgan City where a tide of 4.3 feet occurred. Many small boats were sunk and crops throughout the area were damaged severely from the inundation of salt water. Heavy property damage was incurred in Franklin, Morgan City, and Patterson. One death occurred at Patterson.

(5) The 4-21 June 1934 hurricane passed inland west of Morgan City. Water rose to 3 feet above normal at Morgan City where two lives were lost. Patterson, Berwick, and the Bayou Sale region were near the storm path, but only minor damage was reported. The hurricane of August 1940 caused a tide of 3.2 feet at Morgan City and flooded the highway in the vicinity of Berwick.

(6) Hurricane "Audrey," 25-28 June 1957, caused the highest recorded stages in the area. The highest stage registered at Ricohoc was 8.4; at Morgan City, 8.4; near North Bend, 7.4; and 8.0 feet near the Southern end of the Avoca Island Cutoff. The Bayou Sale levees were topped and the inclosed area was inundated. Flooding also occurred in the vicinity of Franklin where levees under construction were only partially complete. Heavy tidal damage was sustained in the unprotected areas along the waterfronts of Morgan City and Berwick.

(7) The storm of 8-11 August 1957, "Bertha," was not of hurricane intensity and did little damage. A stage of 6.4 feet was recorded at Morgan City. The tropical storm "Esther," 16-19 September 1957, caused tides of 2 feet at Morgan City, but no damage was reported.

(8) The center of the very intense hurricane "Carla," 4-14 September 1961, moved inland at Galveston, Texas. This hurricane, having a very large diameter, produced maximum stages of 4.5 feet at Morgan City, 4.6 feet at Ricohoc, 4.3 feet near Franklin, and 5.4 feet in the vicinity of Gordy.

(9) Other storms in 1920 and 1956 caused minor damage, and storms in 1931, 1932, 1937, 1941, 1942, 1943, 1946, and 1959 resulted in unassessed damages to the area.

b. Hurricane frequency. Damaging floods caused by hurricane tides have been experienced in the study area. Because of the sparsity of observed maximum high water elevations, it is not possible to compute accurate stage-frequency relationships. A synthetic method for computing stage-frequencies was derived by relating central pressure frequencies and stages that were computed for selected hurricane tracks. Hurricane frequencies for other study areas were computed using both the observed data and synthetic methods, and the results obtained by both methods were in close agreement. This verification permitted application of the synthetic method of estimating hurricane stage-frequencies to this study area. A detailed discussion of methods used in the computation of hurricane stage frequencies is presented in appendix A.

8. HURRICANE CHARACTERISTICS

a. General description. A hurricane is a well-developed cyclonic storm, usually of tropical origin. The term "hurricane" meaning "big wind" is thought to be of Carib Indian origin and it applies to cyclonic storms that have hurricane characteristics and occur in the North Atlantic Ocean, Gulf of Mexico, Caribbean Sea, Eastern Pacific, and Southern Pacific Oceans. Storms having similar characteristics but occurring in other locations are named typhoons, baguios, or willy-willies. The South Atlantic Ocean is excluded because its generally cool temperatures prevent hurricane formation. Hurricane characteristics are violent winds, tremendous waves and surges, and torrential rainfall. Size and duration vary with each hurricane but generally they extend over thousands of square miles, reach a height of 30,000 feet or more, and last from 9 to 12 days.

b. Origins and tracks. Hurricanes apparently originate exclusively in the shifting zone of equatorial calms called the "doldrums" which lie between the two trade wind systems. However, since all hurricanes cannot be traced to a point of genesis, it is possible that they may originate elsewhere. Cyclonic storms are not likely to develop when the doldrums belt is within 6° of the equator because there the deflecting effect of the earth's rotation, which is an important factor in cyclonic formation, is at a minimum. Other conditions necessary for cyclonic formation are light variable winds, warm moist air, an ocean surface temperature in excess of 80° F., and a moderately low pressure area. However, these conditions may produce a cyclone and yet not increase in severity so as to produce a hurricane. It has been observed that a continuation of stormy weather for 2 to 10 days, a continued lowering of barometric pressure in the storm center, and perhaps well-developed circulation in the upper level of air above the storm may be important steps towards hurricane development. Some of the hurricanes which affect the Atlantic and gulf coasts develop in the eastern North Atlantic Ocean off the coast of Africa near the Cape Verde

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Islands; others may develop in the western Caribbean Sea when that body of water is influenced by an extension of the Pacific doldrums. Early in the hurricane season, June and July, there is a tendency for the storms to develop in the western Caribbean; while late in the season, September and October, storms are more likely to develop in the Atlantic. While still in the initial stages of development, the storms are affected by the trade winds and begin to move toward the west or northwest. In the vicinity of 30° North latitude, they recurve and begin to move in a northeasterly direction at an accelerated speed. This is only a very general path that hurricanes follow and actually there are many deviations, for hurricanes have been known to circle back and cross over their earlier paths.

c. Barometric pressures and winds. Normal barometric pressures in the tropics are about 30 inches of mercury whereas the pressures recorded in hurricane centers normally range between 29 and 27 inches. The pressure system of a hurricane appears on a weather map as a low pressure area encircled by lines called isobars which connect points of equal barometric pressure. The isobars have a circular pattern near the center of the storm but become asymmetric towards the periphery. The wind system of a hurricane follows a circular pattern also, with the wind direction deflecting about 30° inward towards the center of the storm. At the storm's outer limits, the winds are light to moderate; at about 30 miles from the center, they reach a maximum velocity of about 100 m.p.h.* with gusts as high as 150 m.p.h.; and at the center, they are relatively calm. This calm area which ranges between 7 and 20 miles in diameter is called the "eye" of the storm and here the sky is sometimes clear, while from all sides is heard the roar of the hurricane winds. The point of lowest barometric pressure is located in the vicinity of or within the eye. The lowest recorded barometric pressure for hurricanes occurring along the gulf coast was 26.35 inches.

d. Surge. The hurricane surge which inundates low coastal lands is the most destructive of the hurricane characteristics. It alone accounts for three-fourths of the lives lost from hurricanes. It is the product of meteorological, beach, and shore conditions. In the initial stage of development, it reaches a height of about 3 feet in the open sea from the combined effects of high velocity winds and a lowered barometric pressure. Simultaneously, at shore, the water level slowly begins to rise. As the hurricane approaches and the surge develops under the influence of a gently rising ocean floor and a favorable or indented shore contour, the shoreline water level rises more rapidly. A higher surge will be produced if the hurricane path is perpendicular to shore, the velocity of forward movement is slow, or the

*Wind velocities represent a 5-minute average.

storm's diameter is very large. Maximum surge heights experienced along the gulf and Atlantic coast range between 10 and 16 feet.

e. Waves. The waves generated by hurricane winds cause a great deal of damage to ships and shore structures. At sea, the waves are high and turbulent particularly in the right front quadrant and the eye of the storm. The pyramidal shaped waves in the eye have been observed to reach heights of 45 feet or more. Near shore, wave heights which have diminished some since origin begin to increase again because of the slowing and therefore building effect of the shallow water. Further, breaking waves can run up and overtop shore structures whose crowns are higher than the wave heights. But the force expended when they break is the most damaging to the shore structures. Some waves which are generated in midocean, travel away from the point of origin faster than the storm advances, and arrive at the shore 2 to 3 days ahead of the full fury of the storm.

f. Rainfall. The rainfall accompanying a hurricane usually is heavy and sometimes torrential. However, its distribution during the passage of a hurricane is not uniform. The rain may begin long before the storm's arrival. Prior to the passage of the eye, rainfall generally reaches its maximum rate, and after the eye has passed, it ceases almost entirely. Rainfall is particularly heavy in the right front quadrant. Some hurricanes, however, are accompanied by little or no rainfall over considerable lengths of their paths.

9. STANDARD PROJECT HURRICANE

A standard project hurricane (SPH) is one that may be expected from the most severe combination of meteorological conditions that are considered reasonably characteristic of the region. The SPH that is characteristic for the Louisiana coast was developed in cooperation with the U. S. Weather Bureau and corresponds to one having a frequency of once in 100 years. This frequency is adjusted for application to the individual study area. A detailed coverage of derivation procedures and frequency computations may be found in appendix A. The specific SPH for the study area has a central pressure index (CPI) of 27.6 inches, maximum wind velocity of 100 m.p.h. at a radius of 30 nautical miles, and a forward speed ranging between 5 and 15 knots. However, each location in the study area requires a particular critical path necessary to produce SPH effects. The occurrence of an SPH for any location in the study area would produce maximum surge heights of 10.8 feet along the G.I.W.W. from Morgan City to Bayou Sale, 13.0 feet in the vicinity of Gordy, and 11.7 feet in the vicinity of Todd. Maximum surge contours for the occurrence of an SPH are shown in appendix A.

10. PROBABLE MAXIMUM HURRICANE

The probable maximum hurricane (PMH) is one that may be expected from the most severe combination of critical meteorological conditions that are reasonably possible for the region. It has an infinite recurrence period. The specific PMH for the study area has a CPI of 26.9 inches, maximum wind velocity of 115 m.p.h. at a radius of 30 nautical miles, and a forward speed ranging from 5 to 35 knots. Critical hurricane paths are identical to the ones used for the SPH. The occurrence of a hurricane with PMH characteristics would produce maximum surge heights of 13.3 feet along the G.I.W.W. from Morgan City to Bayou Sale, 15.5 feet in the vicinity of Gordy, and 14.2 feet in the vicinity of Todd. Maximum surge contours for the occurrence of a PMH are shown in appendix A.

11. EXTENT AND CHARACTER OF FLOODED AREA

a. The standard project hurricane would cause flooding within the general study area of approximately 243,500 acres, of which about 24,100 acres are improved lands, 2,700 acres are idle cleared lands along Bayou Boeuf east of Morgan City, and the remaining 216,700 acres are wooded swamp and marsh. Patterson and vicinity is adequately protected by the existing levee system. Urban communities, residences, farm structures, commercial and industrial developments, public buildings, and roads occupy about 7,140 acres, and about 16,950 acres are devoted to agricultural use. The land area subject to flooding within areas protected by existing levees, designated as Morgan City, Franklin and vicinity, and Lower Bayou Sale described in paragraph 4.e., aggregates 37,024 acres and is composed of 5,244 acres occupied by improvements, 18,910 acres in agriculture, and 14,830 acres of wooded swamp and marsh. Some 27,500 residents, about two-thirds of the population of the study area, are located within these leveed areas. About 3,300 residents are located along Bayou Boeuf to the east of Morgan City, and about 1,000 residents on the riverside of the floodwalls and levees near Morgan City. Eighty percent of the improvements within areas subject to overflow, except for the oilfield facilities scattered through the marsh, are located within the leveed areas. The remaining improvements are located east of Morgan City along Bayou Boeuf and on the riverside of the floodwalls and levees near Morgan City and Berwick. Sugar cane is the principal source of agricultural income within the overflow area. Normally about 64 percent is planted in sugar cane, 7 percent is in pasture, and 29 percent is fallow land.

b. The total land area and the areas of land by category of use that are subject to overflow within the leveed areas, and the value of improvements thereon are as follows:

Areas subject to flooding (in acres)

Area	Total	Occupied by improvements	Agricultural land	Wooded swamp and marsh	Estimated value - residences, commercial, industrial and public buildings
Morgan City	1,794	1,364	-	430	$24,063,000
Franklin and vicinity	31,970	3,440	14,800	13,730	10,570,000
Lower Bayou Sale	3,260	440	2,150	670	165,000
Totals	37,024	5,244	16,950	14,830	$34,798,000

c. The value of residential, commercial, and industrial developments located outside of existing levees is estimated at $6,673,000. This includes improvements along Bayou Boeuf east of Morgan City and along the waterfronts of Morgan City and Berwick, but is exclusive of the value of oilfield equipment scattered throughout the marsh area.

12. HURRICANE FLOOD DAMAGES

a. Flood damage surveys. Flood damage surveys were made in this region following the occurrences of hurricane "Audrey" on 27 June 1957 and hurricane "Carla" on 9-14 September 1961. Hurricane "Audrey" caused flooding of all of the marshland to depths up to about 6 feet. The levee inclosing the lower Bayou Sale area was overtopped and the entire area was flooded. Flooding occurred in the Franklin and vicinity area from near Todd to North Bend west of the Bayou Sale Ridge and in a small sector of Franklin where construction of the levee had not been completed. The maximum stage occurred in the Atchafalaya River at Morgan City. Extensive flooding resulted to commercial and industrial establishments and homes located on the riverside of the floodwalls at Morgan City and Berwick. Flood damage from hurricane "Carla" was small. Flooding occurred over the marsh and to some extent over the ground around houses south of Franklin where the levee system was incomplete. Information on damage from tidal flooding in prior hurricanes is sparse and would not be useful in estimating damages under the present state of development because of changed physical and economic conditions. In order to establish stage-damage relationships in the several areas, an appraisal survey was made of all improvements likely to be damaged by floodwaters, and of economic activities that would be affected. These data were correlated with data collected in this region and in similar areas in recent damage surveys

to establish damage values for various theoretical tide flood heights. In this manner, stage-damage curves were developed. Details are contained in appendix C.

b. Experienced damages. Hurricane "Audrey" caused a flood damage of $923,000 in the study area. Damage from hurricane "Carla" was estimated at $10,000.

c. Average annual damages. Average annual losses from tidal overflow were calculated by individual areas and by smaller division within these areas where certain structural features form natural boundaries. These losses were derived by correlating stage-damage, stage-frequency, and damage-probability relationships. Details of estimates of average annual damages are contained in appendix C. Average annual flood losses in the various areas, based on price levels of May 1963 on noncrop features, seasonal average 1962 on crops, and present development are as follows:

AVERAGE ANNUAL DAMAGE

Locality	Noncrop	Crop	Total
Morgan City	$ 69,400	$ -	$ 69,400
Franklin and vicinity	69,300	3,300	72,600
Lower Bayou Sale	7,200	1,200	8,400
Remainder of study area outside of existing levees	86,000	-	86,000
TOTAL	$231,900	$4,500	$236,400

13. EXISTING CORPS OF ENGINEERS' PROJECTS

a. The Mississippi River and Tributaries flood control project, authorized by the Flood Control Act of 15 May 1928 and amendments, provides for construction of levees and appurtenant control structures for protection against floodwaters of the Mississippi River and Atchafalaya Basin. Authorized improvements pertinent to the study area include the lower portions of the East and West Atchafalaya Basin protection levees; the Wax Lake Outlet guide levees; and the levees south of Morgan City and west of Berwick, including gravity drainage and pumping stations (as shown on plate 2). Additional information on this project is contained in the Annual Reports of the Chief of Engineers, U.S. Army, on Civil Works Activities.

b. The following additional Corps of Engineers' projects within the study area are described in appendix E:

(1) Flood Control, Mississippi River and Tributaries, Atchafalaya Basin Floodway, Atchafalaya River, La. (Navigation).

(2) Atchafalaya River, Morgan City to the Gulf of Mexico.

(3) Gulf Intracoastal Waterway between Apalachee Bay, Fla., and the Mexican Border, including the alternate route, Morgan City to Port Allen.

(4) Bayou Teche, La.

14. IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

a. Federal. No other Federal improvements are known to exist within the study area.

b. Non-Federal.

(1) Local interests constructed the Morgan City back levee near the east city limits to protect against flooding from Lake Palourde, and installed four pumping stations for removal of runoff. The cost for these projects is not available.

(2) Franklin Canal, constructed by local interests, extends from the G.I.W.W. to the city of Franklin. The canal provides for navigation between Franklin and the G.I.W.W. After its completion, the U. S. Army Corps of Engineers negotiated for a 300-foot right-of-way along the canal and assumed the responsibility for maintenance work. In addition to providing for navigation, the canal serves as an escape route for a large percentage of rainfall-runoff in the area. The total construction cost of the canal is not available.

SECTION III - PROBLEMS UNDER INVESTIGATION

15. IMPROVEMENTS DESIRED

a. Public hearings. Public hearings were held at New Orleans, Morgan City, and Lake Charles, Louisiana, on 13, 15, and 20 March 1956, respectively. The hearings were attended by about 50 representatives of business, transportation and industrial interests, civic organizations, and Federal, state, and local agencies. The State of Louisiana, Department of Public Works, and local interests requested that maximum consideration be given to protective works required to safeguard lives and to protect property from hurricane damages, and to the development of an adequate warning system, and indicated that they would actively support the studies as they progressed. Specific suggestions as to type of protection desired were not proposed. Supplement 2* is a transcript of the public hearings.

*Available at the U. S. Army Engineer District, New Orleans, New Orleans, Louisiana.

b. Additional proposals by local interests.

(1) Additional requests for studies of protection measures were received in letters from the Department of Public Works, representatives of local governmental agencies, and residents of the study area. Loss of life and damage to property during past hurricane experiences and the inundation of the developed areas by abnormally high wind tides were offered as justification for the desired improvements. The Department of Public Works requested that an investigation be made to determine the maximum stages which could be produced by a hurricane in the study area and the means by which the damages could be prevented. Several oil companies requested that additional navigation channels be maintained to a depth of at least 12 feet to provide access to safe harbors during hurricanes.

(2) Local interests from Morgan City presented a plan of protection for the Morgan City-Tiger Island area consisting of a new back levee along Lake Palourde and Bayou Ramos, including necessary drainage facilities and a pumping plant. The new levee with a proposed grade of 7 feet would extend from the Atchafalaya Basin Protection Levee to the Southern Pacific Railroad.

(3) Local interests also presented a plan for protection of Avoca Island consisting of a levee along Bayou Chene, from the existing levee along the Atchafalaya River to and across the G.I.W.W. at Bayou Black Settlement, thence north to the Southern Pacific Railroad. A floodgate at Bayou Penchant and a barge-type closure for hurricane emergencies at the G.I.W.W. were proposed. This system would provide protection for the southeastern portion of Morgan City as well as for Avoca Island.

16. HURRICANE FLOOD PROBLEMS, RELATED PROBLEMS, AND SOLUTIONS CONSIDERED

a. Hurricane flood problems. Hurricanes from the southeast, south, and southwest that approach the coastline within the limits of the problem area can cause flooding and damage to the developed sections by overtopping existing protective works. The 1957 hurricane, "Audrey," caused the highest recorded stages in the area, 8.4 feet at Ricohoc and Morgan City and 7.4 feet near North Bend. Bayou Sale levees were overtopped and the inclosed area inundated and some flooding occurred in the vicinity of Franklin. Stages attending a standard project hurricane would overtop the existing protective works except in the Patterson and vicinity area and impound water in the developed areas. This inundation would cause damage to private and public property, interrupt traffic on transcontinental railroad and highway routes, create serious hazards to life and health, disrupt business and community life, and require excessive expenditure of public and private funds for evacuation and subsequent rehabilitation of local residents.

b. Protective measures considered.

(1) General. Preliminary study of the flood problem indicated that the nature and extent of the flooding and damages to be anticipated were such as to limit detailed consideration of protection at this time to the higher, more developed and inhabited portions of the study area, particularly those areas within and adjacent to the protection levee system of the Mississippi River and Tributaries projects in the lower Atchafalaya Basin. These portions are, for the most part, inadequately protected against hurricane tides by the existing levee system. The marsh and low woodland areas outside of the existing protective works suffer a low degree of damage. The existing development and use of these areas create little need or desire for protection and protection is not economically justified at this time. No detailed studies for areas of this type were undertaken.

(2) Protective structures.

(a) The most practical protection that can be provided for residents of the study area is to raise existing levees to the required height, construct new levees where necessary to offer adequate hurricane protection, and install necessary drainage facilities and floodgates.

(b) The high embankment of the Southern Pacific Railroad effectively separates Morgan City into two segments. Two plans were considered for protection of the Morgan City, subarea A, north of the Southern Pacific Railroad. One consisted of raising the existing back levee. The other provided for a new back levee along Lake Palourde and Bayou Ramos together with two new drainage structures. The latter plan would provide the larger protected area that is needed for near future growth of the city. Protection of the subarea B south of the railroad requires construction of a new levee extending from the Southern Pacific Railroad near Wyandotte to Bayou Boeuf near the lock and tying in to the existing levee system. No feasible protection can be provided for the area between the Southern Pacific Railroad and Bayou Boeuf and east of Bayou Boeuf lock. Most of the buildings in this latter area are constructed on spoil or piles. Therefore, little damage would be experienced.

(c) The State of Louisiana, Department of Public Works, recommended a plan consisting of a levee around the lower side of Avoca Island, crossing the G.I.W.W. west of Bayou Black Settlement, and continuing north to the Southern Pacific Railroad embankment; a floodgate at Bayou Penchant consisting of twelve 60-inch diameter flap and lift gates; and a barge-type barrier for closure of a 20- by 350-foot channel at the G.I.W.W. The area that would be protected by this plan will experience only a small

amount of flooding from the overland surge. The expansive marsh and timbered areas retard and minimize the effects of flooding. Benefits that would be derived are not sufficient to economically justify the construction of protective works for the area at this time. Accordingly, a detailed study was not made.

(d) Preliminary study of the Patterson and vicinity area revealed that the existing protective works would prevent overtopping of any consequence. A few miles of the existing levee lack the required freeboard above maximum surge but the deficiencies are less than 0.5 foot. Hence, the protection is considered adequate and no improvement is necessary.

(e) Raising the east and west levees in the lower Bayou Sale area, including modification of existing drainage facilities, was considered. An increase in levee height of about 8 feet was required to protect against the SPH. The excessive length of levee involved in terms of the area to be protected, the great increase in height and cost of the levee, and the limited development in the area at this time indicated that protection cannot be economically justified. Hence, no detailed study of the area was undertaken.

(f) A detailed study of the Franklin and vicinity area was necessary to develop a feasible overall plan for moderate levee raising with minimum interference with existing drainage facilities and local navigation arteries. Only the area south of Bayou Teche is vulnerable to SPH flooding. The area north of the Teche was found to be adequately protected by the existing protective levee system.

(3) Hurricane warning and flood evacuation measures.

(a) Experience in the recent past indicates that inhabitants of the low areas along the Louisiana coast are not fully responsive to warnings issued by the U. S. Weather Bureau on an approaching hurricane. Some leave promptly, some prefer to remain, and others elect to evacuate after such action is no longer feasible. This last group creates the major problem and usually suffers greatest mortality. Hurricane warnings are considered adequate but action is necessary at the local or state level to implement these warnings and coordinate timely evacuation while such action still is feasible. In order to avoid a catastrophe, state and local authorities should coordinate their efforts to establish adequate emergency flood evacuation measures. The hurricane warning system materially aids in preventing loss of life and damage to movable property for the residents of low-lying coastal communities. However, in order to take maximum advantage of such warnings, the populace of the vulnerable communities must be made fully cognizant of advance hurricane

preparedness planning. For these measures to be effectively accomplished, residents should be advised of the inherent danger of indecision after evacuation warnings have been issued. Also, authorities should be informed of the potential stages along the coastline when a hurricane threatens the area, thereby helping to determine the approximate number of hours left before roads become flooded.

(b) Highways traversing the problem area serve as evacuation routes for the populace prior to the time of occurrence of maximum hurricane tides. These highways have minimum elevations ranging from 5 to 6 feet, and the majority are located some distance inland from open waters. Ample time is available for safe and orderly evacuation to higher ground should the populace of low-lying areas heed warnings of the authorities.

(4) Zoning regulations and building codes. Public buildings, including schools, churches, and courthouses located outside of protected areas should be designed with upper floor elevations above the height of hurricane surges, and of adequate structural stability to withstand wind and wave forces to be anticipated. Building codes should require sturdy structures in places where buildings and homes are subject to destruction by hurricane surges, and zoning regulations should restrict construction in critical flood areas. Provision for the future construction of havens of refuge, therefore, is dependent upon the enactment of legislation by state and local authorities prescribing zoning regulations and building codes.

SECTION IV - PROPOSED SOLUTIONS AND PROJECT FORMULATION

17. PLANS OF PROTECTION

a. General. Protection against hurricane flooding is proposed for two of the areas as shown on plate 2. The most effective protective plan for Morgan City consists of a new levee along Lake Palourde and Bayou Ramos, coupled with the new levee extending from the Southern Pacific Railroad near Wyandotte to Bayou Boeuf near the lock. The existing levees in the Franklin and vicinity area will be raised and extended.

b. Design hurricane. Areas to be protected are highly developed for residential, commercial, and industrial use, or have immediate potential for such development. Because of the serious threat to human life and property involved, the design of the protective plan must be based on the standard project hurricane described in paragraph 9. Additional details relative to the design hurricane are covered in appendix A.

c. Design elevations. Maximum hurricane tide elevations, as shown in the following tabulation, were computed for the design hurricane. These levels were used to establish the final levee grades. A levee grade approximately 1 foot above the hurricane tide elevation was considered generally adequate in view of the great distance from the open waters of the gulf and the dense growth of timber in areas adjacent to the levees. Additional details are furnished in appendix A.

DESIGN HURRICANE TIDE HEIGHTS

Area	Elevation (feet m.s.l.)
Morgan City (along south shore of Lake Palourde)	6.7
Morgan City (vicinity of Bayou Boeuf lock)	8.0
Franklin and vicinity	10.8-12.5

d. Description of the plans.

(1) Morgan City. The plan provides for the construction of a new levee 5.6 miles in length along Lake Palourde and Bayou Ramos from the Atchafalaya Basin Protection Levee to the Southern Pacific Railroad for protection of subarea A north of the railroad and a new levee 0.5 mile in length from the railroad near Wyandotte to the protection levee at Bayou Boeuf lock for protection of subarea B. The lakeside levee will have a crown width of 10 feet and a net grade of 8.0 feet, except for the segment close to the lake which will be 9.0 feet. The new levee near the lock will have a crown width of 10 feet and a net grade of 9.0 feet. The plan, profiles, and typical sections of the two levees are shown on plate 3. Interceptor drainage ditches will be excavated landward of the proposed levees, and three gravity drainage structures will be provided at locations shown on plate 3. The Lake Palourde drainage structure will consist of approach and exit channels and a vertical concrete wall with six circular openings 60 inches in diameter. Each opening will be provided with a flap gate. This structure will be adequate to dispose of the local runoff combined with the pumped drainage from the present leveed area. Bayou Ramos drainage structure, shown on plate 4, will consist of two 48-inch diameter corrugated metal culverts. A single corrugated metal culvert 48 inches in diameter is used for the Bayou Boeuf drainage structure. All culverts will be equipped with flap gates. Additional details pertaining to the hydraulic design of the structures are presented in appendix A. The railroad embankment is utilized in the plan to connect the two new protection levees. This embankment has a net grade of approximately 12 feet, and is considered adequate in type of material, height, and section to withstand the short duration hurricane tide which is about 2 feet above natural ground elevations on the south side. The occurrence of a severe hurricane will necessitate minor sandbagging of two railroad embankment culverts. Alterations to one road, 0.25 mile of powerline, and 0.25 mile of telephone line will be required.

(2) Franklin and vicinity. The plan provides for the raising of 21.6 miles of the existing levee and construction of two sections of new levee. One section, 2.0 miles in length, is located in the vicinity of Todd. This levee is required to provide protection to improved lands that are not protected by levees at this time. The other section, 1.1 miles in length, is located along the Charenton Drainage Canal and extends to high ground to prevent flanking. The net grade of the levee varies between 12.0 and 14.0 feet depending on the distance from the surge reference line. The portion of the levee east of the Bayou Sale Ridge has a net grade of 12.0 feet. Consideration will be given to using material from the G.I.W.W. to raise this portion of levee. The crown width between the ridge and the pumping station is 16.0 feet to permit the construction of a road to the pumping station. Crown widths at other locations are 10 feet. The net grade of the levee slopes downward from 14.0 feet at the G.I.W.W. to 12.5 feet at the Yellow Bayou Drainage Canal, continues at 12.5 feet from this point to the Charenton Drainage Canal, and then slopes downward to 12.0 feet in the vicinity of U. S. Highway 90. Plan, profiles, and typical sections of the levee are shown on plate 5. The floodgate required at Franklin Canal will be of the sector gate type designed for small boat passage. The structure, shown on plate 6, is 56 feet wide with a sill elevation of -9.0 feet. Five gravity drainage structures, locations as shown on plate 2, are required for this area. The Yellow Bayou drainage structure, shown on plate 7, is located in the Yellow Bayou Drainage Canal and consists of a concrete wall with four 60-inch round openings equipped with flap gates. The Hanson Canal drainage structure consists of two 60-inch corrugated metal culverts equipped with flap gates. The three drainage structures at Todd, upper, middle, and lower, are flap-gated corrugated metal culverts. These culverts are 48, 54, and 36 inches in diameter, respectively. Additional details concerning the hydraulic design of the structures are presented in appendix A. Other features include the modification of 3 existing pumping stations and 2 under construction, alteration of 11 flap-gated corrugated metal culverts, and relocation of 18 pipeline crossings. A levee crossing is required for Louisiana Highway 317.

e. Construction. The levees will be constructed in one or two lifts. A 1-year interval will be allowed between lifts to allow for proper consolidation of materials. Stripping of the levee foundations will not be required since no advantage is to be gained by the removal of surface organic materials. Adequate allowances have been made for levee shrinkage and settlement during and after construction in the computation of fill quantities. Typical levee sections of the proposed plans are shown on plates 3 and 5.

f. Method of operation and maintenance. The drainage structures will operate automatically, allowing flow from the protected areas to escape to the surrounding marshes when stages within the

levee system are higher than outside stages. The flap gates will close and prevent inflow when reverse heads exist. The Franklin Canal floodgate will remain in an open position at all times that normal stages are experienced in the canal to permit uninterrupted navigation. Closure of the gates will be effected only upon announcement by the U. S. Weather Bureau of the approach of a hurricane or tropical disturbance on a path that might cause the rise of gulf tides in the general vicinity of the project area. The physical operation and maintenance of all project features will be the responsibility of local interests.

18. OTHER DESIRABLE IMPROVEMENTS

a. Hurricane preparedness plans. Each coastal community should organize a permanent committee of local and parish officials essentially in accordance with the recommendations in the U. S. Weather Bureau report, National Hurricane Research Project, Report No. 28, March 1959. The committee should establish and maintain a continual preparedness plan; direct a public educational program on the hazards of hurricanes and desirable protective measures; maintain preparations for a hurricane emergency; and direct evacuation when authorized, and rescue work when necessary. The committee would utilize and coordinate the resources and efforts of local, state, and Federal agencies.

b. Refuge shelters. An inventory of and plans for use of buildings as shelters of refuge should be incorporated in the preparedness plan. The data should be reviewed periodically and revised when necessary to insure the availability of all suitable shelters, such as courthouses, schools, churches, and other suitable buildings. All public buildings to be constructed in the future should be designed to withstand anticipated wind and tide forces, with upper floor grades of sufficient elevation to serve as an emergency shelter in addition to its principal purpose. Agreements with owners for use of nonpublic buildings should be incorporated in the preparedness plan in advance of any required emergency use.

c. Zoning regulations and building codes. Appropriate building codes and zoning regulations for communities having none should be formulated, and codes and regulations in effect should be reviewed and desirable revisions recommended. This would be one of the important functions of the preparedness committee.

SECTION V - ECONOMIC ANALYSIS

19. ESTIMATES OF FIRST COST

The estimated first cost of the plans of protection, based on May 1963 prices, is summarized in the following tables. Detailed estimates are given in appendix D.

MORGAN CITY, SUBAREA A

Class. No.	Item	Federal	Non-Federal	Total
	Lands*	$ -	$470,000	$ 470,000
	Relocations*	-	12,000	12,000
11	Levees*	728,000	-	728,000
	Drainage structures*	107,000	-	107,000
30	Engineering and design	66,000	-	66,000
31	Supervision and administration	43,000	-	43,000
	Subtotal	$944,000	$482,000	$1,426,000
	Cash contribution	None	None	
	FIRST COST	$944,000	$482,000	$1,426,000

(Cost estimate is exclusive of preauthorization cost of $17,000)

MORGAN CITY, SUBAREA B

	Lands*	$ -	$ 35,000	$ 35,000
11	Levees*	32,000	-	32,000
	Drainage structures*	7,000	-	7,000
30	Engineering and design	4,000	-	4,000
31	Supervision and administration	2,000	-	2,000
	Subtotal	$ 45,000	$ 35,000	$ 80,000
	Cash contribution	None	None	
	FIRST COST	$ 45,000	$ 35,000	$ 80,000

(Cost estimate is exclusive of preauthorization cost of $5,000)

FRANKLIN AND VICINITY

	Lands*	$ -	$ 97,000	$ 97,000
	Relocations*	-	538,000	538,000
11	Levees*	1,143,000	-	1,143,000
	Floodgate*	661,000	-	661,000
	Drainage structures*	218,000	-	218,000
30	Engineering and design	146,000	-	146,000
31	Supervision and administration	140,000	-	140,000
	Subtotal	$2,308,000	$635,000	$2,943,000
	Cash contribution	-248,000	248,000	
	FIRST COST	$2,060,000	$883,000	$2,943,000

(Cost estimate is exclusive of preauthorization cost of $25,000)

*Includes contingencies

20. ESTIMATES OF ANNUAL CHARGES

The estimated annual economic costs of the plans of protection are based on an interest rate of 3 percent for both Federal and non-Federal costs, and on an economic life of 100 years.

MORGAN CITY, SUBAREA A

Item	Federal	Non-Federal	Total
Interest	$ 29,200	$ 14,900	$ 44,100
Amortization	1,600	800	2,400
Maintenance	-	1,000	1,000
Replacements	-	100	100
Economic loss on land	-	7,700	7,700
TOTAL	$ 30,800	$ 24,500	$ 55,300

MORGAN CITY, SUBAREA B

Interest	$ 1,300	$ 1,000	$ 2,300
Amortization	100	100	200
Maintenance	-	150	150
Replacements	-	50	50
Economic loss on land	-	700	700
TOTAL	$ 1,400	$ 2,000	$ 3,400

FRANKLIN AND VICINITY

Interest	$ 61,800	$ 26,500	$ 88,300
Amortization	3,400	1,400	4,800
Maintenance and operation	-	8,100	8,100
Replacements	-	900	900
Economic loss on land	-	1,900	1,900
TOTAL	$ 65,200	$ 38,800	$104,000

21. ESTIMATES OF BENEFITS

a. Benefits which have been evaluated for the several areas consist of flood damage prevention under the existing state of development, under future conditions of growth and development expected without the proposed projects, and land enhancement expected to accrue to the land as a result of the proposed construction. No land enhancement is expected to accrue in those areas where existing levees and other barriers, such as railroad and highway embankments, provide a high degree of protection. However, where new levee construction will enclose additional areas, land

enhancement is expected to result from the construction. The projects are designed to protect against standard project hurricane tide heights. Annual damages, with the projects in place, would be the annual damages resulting from hurricanes of less return frequency than the SPH. Depths of flooding from rainfall were assumed to be the same for all hurricane occurrences since damage from this cause would not be preventable. Consequently, the effect of rainfall was eliminated from all damage calculations.

b. Flood damages and flood damages prevented. The estimated annual flood damage in the project areas under present conditions and under conditions with the proposed projects in place, the average annual damage prevented under the present state of development, and the annual damage prevented as adjusted for future growth are shown in the following tabulation. Price levels are May 1963 on noncrop features and seasonal average 1962 on crops. Detailed estimates of benefits are outlined in appendix C.

Area	Av. annual damage under present conditions	Av. annual damage with project	Av. annual damage prevented	Av. annual damage prevented as adjusted for future development
Morgan City				
Subarea A	$74,400	$12,400	$62,000	$173,900
Subarea B	5,200	900	4,300	5,100
Franklin & vicinity	72,600	13,300	59,300	172,900

c. Enhancement - Morgan City, subarea A. Protection will be afforded to an area of 1,128 acres of wooded swampland between the new levee along Lake Palourde and the existing Morgan City back levee. The plan will include gravity drainage facilities to provide for drainage intercepted by the new levee. Development of the area to its full potential will be contingent on local interests providing adequate pumping facilities as needed in the future. The present appraised value (1963) as determined by qualified real estate appraisers after consultation with local real estate firms and examinations of the lands to be protected is $1,128,000. Considering the rate of development taking place in Morgan City, it is probable that sale of these lands to developers for residential and commercial use would be accomplished in 25 years. The value is estimated to be enhanced during that period to $2,820,000, exclusive of enhancement that will result from drainage and other improvements by local interests. The annual value of the enhancement based on the increased value of $1,692,000 at a 5 percent interest rate is $84,600. The discounted annual value of the enhancement on this basis is $59,400 ($84,600 x 0.702).

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d. Average annual benefits from the hurricane protection plans are as follows:

Area	Benefits		
	Flood damage prevented	Enhancement	Total
Morgan City			
Subarea A	$173,900	$59,400	$233,300
Subarea B	5,100	-	5,100
Franklin and vicinity	172,900	-	172,900

e. Intangible benefits include the protection of human life, the prevention of hazards to health arising from pollution, and improvement of sanitary facilities and water supplies in the area.

22. ECONOMIC JUSTIFICATION

A comparision of the estimated average annual benefits and annual economic costs of the three plans of hurricane protection is as follows:

Area	Av. annual benefit	Av. annual cost	Benefit-cost ratio
Morgan City			
Subarea A	$233,300	$55,300	4.2 to 1
Subarea B	5,100	3,400	1.5 to 1
Franklin and vicinity	172,900	104,000	1.7 to 1

SECTION VI - COORDINATION AND LOCAL COOPERATION

23. PROPOSED LOCAL COOPERATION

It is proposed that the following local cooperation be prescribed for each of the proposed plans of protection:

a. Provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the project;

b. Accomplish without expense to the United States alterations as required to roads, pipelines, drainage structures, wharves, and any other facilities necessary for the construction of the project;

c. Hold and save the United States free from damages due to the construction works;

d. Contribute in cash or equivalent work not less than 30 percent of the total project cost, said 30 percent to include the fair market value of lands and relocations required under subparagraphs a. and b. above, and the remainder in cash or equivalent work. The contribution will be made during the construction period. The values of total contribution, fair value of lands and relocations, and cash contribution listed below, are estimates only, the final determination to be made after construction is completed:

Area	Total contribution	Lands and relocations	Cash contribution
Morgan City			
Subarea A	$482,000	$482,000	None
Subarea B	35,000	35,000	None
Franklin and vicinity	883,000	635,000	$248,000

e. Provide all interior drainage and pumping plants required for reclamation and development of the protected areas;

f. Maintain and operate the project after completion including levees, drainage structures, floodgates, and drainage ditches or canals, in accordance with regulations prescribed by the Secretary of the Army.

g. Provide assurances that encroachment on existing ponding areas will be prevented unless substitute storage capacity or equivalent pumping capacity is provided promptly, without cost to the United States.

24. APPORTIONMENT OF COSTS AMONG INTERESTS

The apportionment of costs of the proposed plans of protection is based on the cost-sharing formula adopted in the Flood Control Act of 1958 for the Narragansett Bay, New Bedford, and Texas City projects. This Act specifies that first costs, including the costs of lands, easements, rights-of-way, and relocations, but excluding the cost of preauthorization studies, shall be apportioned at least 30 percent to non-Federal interests and not to exceed 70 percent to the Federal government. Lands, easements, rights-of-way, and relocations shall be provided by non-Federal interests without cost to the United States and will be credited to the local contribution. Maintenance and operation costs of all levees, floodgate, and drainage facilities shall be the responsibility of non-Federal interests. On this basis, the apportionment of first costs of the two proposed plans found to be economically justified are as follows:

MORGAN CITY, SUBAREA A

Item	First cost	Federal	Non-Federal
Construction	$ 944,000	70%	30%
Lands, damages, and relocations	482,000		
TOTAL	$1,426,000	$998,000*	$428,000
Less cost of lands, damages, and relocations			482,000
Cash contribution			None

*Non-Federal costs for lands, etc., are in excess of 30 percent of total project costs, therefore, the Federal government will provide the total construction costs of $944,000.

MORGAN CITY, SUBAREA B

Construction	$ 45,000	70%	30%
Lands, damages, and relocations	35,000		
TOTAL	$ 80,000	$ 56,000*	$ 24,000
Less cost of lands, damages, and relocations			35,000
Cash contribution			None

*Non-Federal costs for lands, etc., are in excess of 30 percent of total project costs, therefore, the Federal government will provide the total construction costs of $45,000.

FRANKLIN AND VICINITY

Construction	$2,308,000	70%	30%
Lands, damages, and relocations	635,000		
TOTAL	$2,943,000	$2,060,000	$883,000
Less cost of lands, damages, and relocations			635,000
Cash contribution			$248,000

25. COORDINATION WITH OTHER AGENCIES

This study has been coordinated with Federal, state, and local agencies that are concerned with hurricane problems, or that are responsible for the protection of public and private property or fish and wildlife resources. They have been consulted during the course of the study to obtain technical data, pertinent information, or cooperation where mutual responsibilities were involved. The participation of these agencies and a summary of their views are stated below.

a. U. S. Department of Commerce. The Weather Bureau furnished technical information regarding intensity, frequency, and duration of synthetic hurricanes and expanded data related to historic hurricanes which were necessary for verification of procedures. Descriptions of these data are included in appendix A.

b. U. S. Department of the Interior. The Fish and Wildlife Service findings indicate that since the plan of protection consists essentially of raising existing levees that surround developed areas, the fish and wildlife resources would be subject to only minor effects from the proposed construction. The Service makes no recommendations for modification of the plan. Appendix F contains the views of the Fish and Wildlife Service.

c. U. S. Department of Agriculture. The Soil Conservation Service was consulted during the study and requested to furnish views and comments on the plans of protection. The Service stated that the proposed works would not adversely affect agricultural lands.

d. State of Louisiana.

(1) The Department of Public Works was consulted throughout the development phase of the study. The Department recommended the plans described in paragraphs 15.b.(2) and 15.b.(3).

(2) The Wild Life and Fisheries Commission has been requested to furnish its views and comments relative to the project. Although no reply has been received from the Commission, the U. S. Fish and Wildlife Service has stated that the Commission concurs with the findings of the Service that are presented in appendix F.

e. Assurances of cooperation. The St. Mary Parish Police Jury has concurred in the suitability of the plans of protection and stated that assurances will be provided when required, see appendix H.

SECTION VII - RESULTS OF INVESTIGATION

26. DISCUSSION

a. The problem.

(1) The portion of the Louisiana coastal area covered by this report is subject to flooding by hurricane surges from the Gulf of Mexico and connecting water areas. The surges from the gulf move over the low marshes into inland areas, and coincident with heavy rainfall, move across Lake Palourde from a northeasterly direction toward the rear of the town of Morgan City. The surges also overtop existing protective works in the lower Bayou Sale and the Franklin and vicinity areas. As a result, hazards to human life are created and widespread destruction of homes and business establishments is experienced. Industrial and commercial activities are interrupted, crops are destroyed, the residents are subjected to severe hardships, and health hazards are created.

(2) Although some high stages have been recorded in the past for some locations in the study area, it is only due to the fortuitous distribution of hurricanes that the remaining locations have been spared more loss of life and greater damage to property. Analyses of observed and potential tides confirm that practically the entire study area is subject to tides substantially equivalent to those that have caused heavy loss of life and damage to property in the past to communities located in close proximity to the study area.

(3) Protection of the vast tidewater marsh and swamp lands generally located south of existing protective levees is impracticable. These areas are sparsely inhabited and preliminary analyses indicated that provision of protective works is not warranted. The ridge of Bayou Boeuf east of Morgan City is not flooded by moderate hurricanes, and existing developments are of such nature and extent as not to warrant protection at this time.

b. Selection of plans.

(1) The plans selected as the most practicable and economically justified for protection of the study area consist principally of levee and gravity drainage construction for the Morgan City area and levee enlargement and floodgate and gravity drainage construction for the Franklin and vicinity area. Some modification of existing pumping stations and gravity drainage is required.

(2) Further protection of human life and property can be afforded by the more widespread dissemination of information relative to potential hurricane tide elevations and extent of probable

flooding through organization of a hurricane preparedness committee in each community. Such a committee would establish a continual preparedness plan, conduct public educational programs, formulate plans for use of buildings as hurricane shelters, recommend desirable zoning regulations and building codes, and direct evacuation and rescue work when necessary.

c. Effects on other interests. The proposed protection plans will have negligible effect on other interests in the area. Fish and wildlife values will undergo little change since only a small additional area will be inclosed. The project will in no way hamper business and industrial operations or agricultural activities.

d. Costs and benefits.

(1) Estimated average annual benefits and annual economic costs for each of the protection plans are as follows:

Area	Annual benefits	Annual charges	Benefit-cost ratio
Morgan City			
Subarea A	$233,300	$ 55,300	4.2 to 1
Subarea B	5,100	3,400	1.5 to 1
Franklin and vicinity	172,900	104,000	1.7 to 1

(2) Local interests will contribute not less than 30 percent of the total cost of the proposed plans of protection for each separate project. This contribution will include the fair value of lands, easements, rights-of-way, and relocations, and the remainder in cash, except where the value of lands and relocations exceeds the 30 percent contribution. In this case, no cash contribution is required. Total estimated first costs of each economically justified protection plan and apportionment of costs between the United States and local interests are as follows:

Area	First cost	Federal	Non-Federal	Lands, damages, and relocations	Cash contribution
Morgan City					
Subarea A	$1,426,000	$ 944,000	$482,000	$482,000	None
Subarea B	80,000	45,000	35,000	35,000	None
Franklin and vicinity	2,943,000	2,060,000(a)	883,000(b)	635,000	248,000

(a) 70 percent of first cost.
(b) 30 percent of first cost.

(3) Additional information on recommended and alternative projects called for by Senate Resolution 148, 85th Congress, adopted 28 January 1958, is contained in the attachment to this report.

SECTION VIII - CONCLUSIONS

27. CONCLUSIONS

a. The plan of protection found most suitable for protection against hurricane tide damages consists of new levee construction for the Morgan City area and raising the existing levees of the Franklin and vicinity area. Alterations to drainage, road, and pumping station facilities will be made where necessary. The plans for the two areas are economically justified. The existing protective works for the Patterson and vicinity area are adequate. Additional protection for the lower Bayou Sale area is not economically justified at this time. The Federal first costs for construction of the recommended work should be provided over a period of 2 years for the Morgan City area and 1 year for the Franklin and vicinity area.

b. Local hurricane preparedness committees should be organized to develop a hurricane preparedness plan, to keep the populace informed as to the potential hazards of hurricanes, to plan for maximum utilization of shelters of refuge, and to direct evacuation and rescue work when necessary. Zoning regulations and building codes for construction of public buildings should be established and enforced where not presently in effect. Shelters of refuge should be provided within protected areas for residents of adjacent nonprotected areas. Shelters of refuge also should be provided in exposed areas for those unable to comply with advance storm warnings. All of these measures will be undertaken by local interests at no cost to the United States.

SECTION IX - RECOMMENDATIONS

28. RECOMMENDATIONS

a. It is recommended that hurricane protection projects be adopted for the Morgan City and for the Franklin and vicinity areas. The plans would provide:

(1) Morgan City. Construction of approximately 5.6 miles of new levees along the shore of Lake Palourde and the west bank of Bayou Ramos and approximately 0.5 mile of new levee from the railroad embankment in the vicinity of Wyandotte to tie in with the Bayou Boeuf lock levee, and construction of three gravity drainage structures.

(2) Franklin and vicinity. Enlargement of approximately 21.6 miles of back levee and construction of approximately 3.1 miles of new levees to effect a complete closure of the area to be protected, construction of one floodgate and five gravity drainage structures, and alteration of existing drainage facilities where necessary.

b. The proposed plans shall be generally in accordance with the plans of improvement described herein and shown on the accompanying plates and with such modification thereof as in the discretion of the Chief of Engineers may be advisable, at estimated costs to the United States for new work as follows:

Area	Cost
Morgan City	
Subarea A	$ 944,000
Subarea B	45,000
Franklin and vicinity	2,060,000

c. Construction of the project shall be subject to the condition that local interests give assurances satisfactory to the Secretary of the Army that they will:

(1) Provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the project;

(2) Accomplish, without expense to the United States, alterations as required to roads, pipelines, cables, wharves, drainage structures, and any other facilities for the construction of the project;

(3) Hold and save the United States free from damages due to the construction works;

(4) Contribute in cash or equivalent work not less than 30 percent of the total project cost, said 30 percent to include the fair market value of lands and relocations required under subparagraphs (1) and (2) above, and the remainder in cash or equivalent work specifically undertaken as an integral part of the project after authorization and in accordance with approved construction schedules. The contribution will be made during the construction period. The values of total contributions, fair value of lands and relocations, and cash contributions listed below are estimates only, the final determinations to be made after construction is completed:

Area	Total contribution	Lands and relocations	Cash contribution
Morgan City			
Subarea A	$482,000	$482,000	None
Subarea B	35,000	35,000	None
Franklin and vicinity	883,000	635,000	$248,000

(5) Provide all interior drainage and pumping plants required for reclamation and development of the protected areas;

(6) Maintain and operate the project after completion, including levees, drainage structures, and drainage ditches or canals, in accordance with regulations prescribed by the Secretary of the Army; and

(7) Prevent encroachments on existing ponding areas unless substitute storage capacity or equivalent pumping capacity is provided promptly, without cost to the United States.

Edward B. Jennings

EDWARD B. JENNINGS
Colonel, CE
District Engineer

Incl
Plates 1-7
Appendixes A-H
Attachment

[First endorsement]

LMVGN (NOD rpt 12 Nov 63)
SUBJECT: Interim Survey Report on Hurricane Study of Morgan City, Louisiana and Vicinity

U. S. Army Engr Div, Lower Mississippi Valley, Vicksburg, Miss., 13 Dec 63

TO: Chief of Engineers

I concur in the findings and recommendations of the District Engineer.

Ellsworth I. Davis

Incl
nc

ELLSWORTH I. DAVIS
Major General, USA
Division Engineer

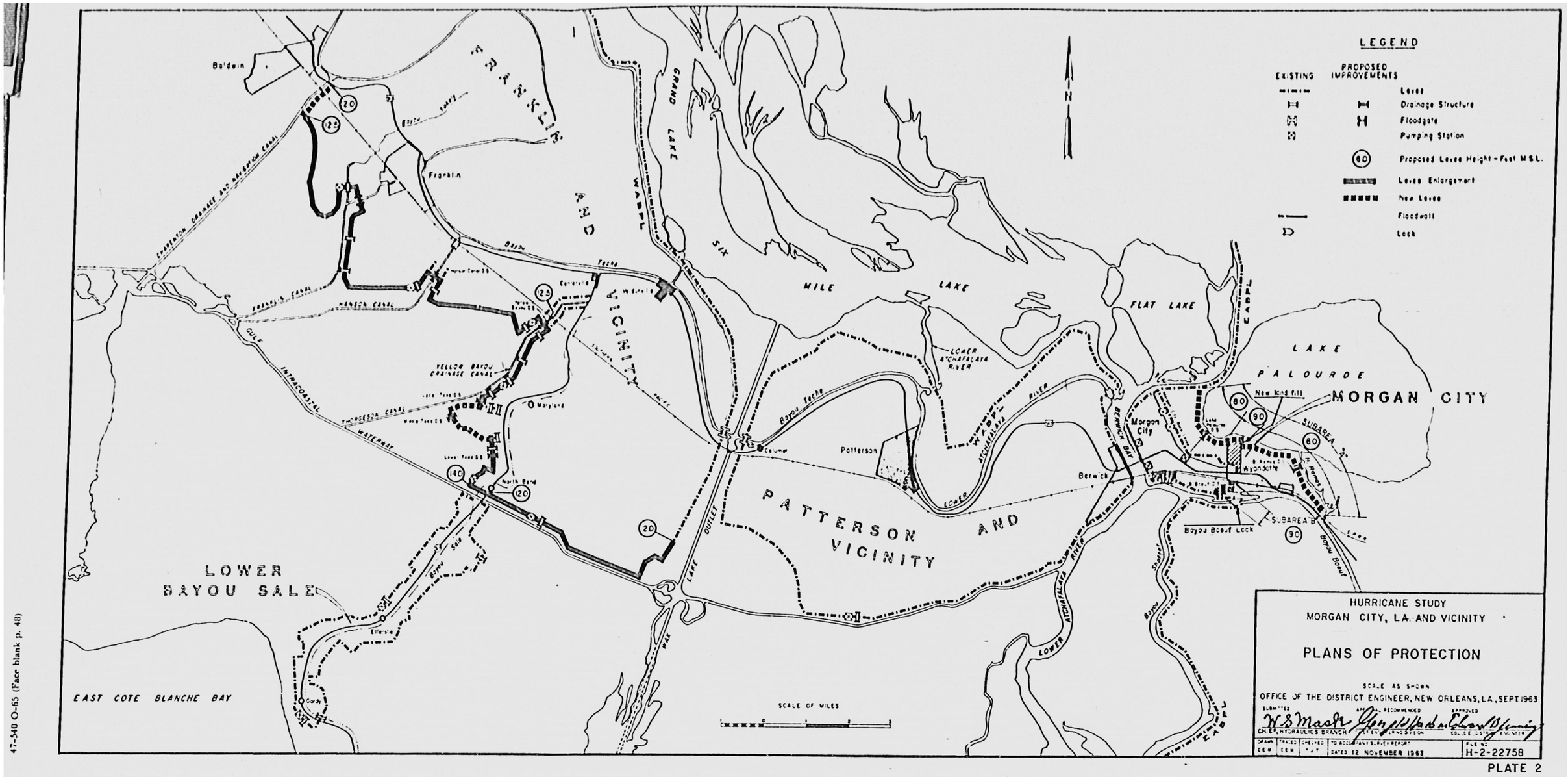

PLATE 2

APPENDIX A

HYDROLOGY AND HYDRAULICS

SECTION I - ANALYSES

A-1 CLIMATOLOGY

TABLE A-1

TEMPERATURE DATA (DEGREES FAHRENHEIT)

Station*	Years of record	Temperature				
		Annual average	Summer average	Winter average	Highest recorded	Lowest recorded
Franklin	68	69.0	81.4	56.5	104	8
Morgan City	41	69.5	81.8	57.0	101	12

TABLE A-2

NORMAL MONTHLY PRECIPITATION (INCHES)
(Average of Franklin and Morgan City stations)

Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
4.46	4.90	4.78	4.55	5.00	5.60	8.52	7.41	6.31	3.28	4.18	5.40

*See plate A-1 for location.

TABLE A-3

LOCATIONS AND RECORDS OF GAGING STATIONS

Location	Map symbol*	Year established	Years of record	Stages in feet m.s.l. Maximum	Date	Minimum	Date	
Bayou Teche Calumet Floodgate West	N-59A	1951	11	4.1	4/29/53	-2.4	12/ 6/54	
Bayou Teche Calumet Floodgate East	N-59B	1951	11	4.4	4/29/53	-2.3	12/23/53	
Bayou Sale, Luke's Landing	N-77B	1957	6	6.0	6/27/57	-3.7	4/ 9/57	
Berwick Lock West	N-117A	1955	8	3.3	5/30/59	-2.0	1/ 8/56	
Bayou Boeuf Lock West	N-104	1954	8	8.4	6/27/57	-2.0	11/ 8/59	
Bayou Boeuf Lock East	N-104	1954	8	2.8	6/29/57	-0.8	1/ 4/56	opened
							11/22/56	closed
Bayou Ramos, Ramos, La.	-	1935	27(a)	4.8	3/ 9/50	-1.0	2/ 3/40	
Bayou Boeuf, Amelia, La.	N-60G	1932	30(b)	4.5	3/ 8/50	-0.8	11/ 4/39,	1/14/56
Charenton Drainage Canal at S.P.R.R.	T-T	1941	21	5.1	6/27/57	-1.8	1/17/48	
Charenton Drainage Canal at Mud Lake	N-146	1939	21	9.7	6/27/57	-2.7	3/ 8/40	
Eugene Island (U.S.C.& G.S.) (not shown on map)		1939	24	6.8	6/27/57	-3.5	1/25/40	
GIWW (sta.2445+00) North Bend, La.	N-77A	1950-1958	9	7.0	6/27/57	-2.7	12/23/53	
Lower Atchafalaya River Dike F.W.S.	N-57	1945-1955	10	7.1	3/ 8/50	-2.2	12/ 6/54	
Lower Atchafalaya River at Sweet Bay Lake	N-61A	1947	16	8.0	11/ 6/59	-1.8	12/ 6/54	
Lower Atchafalaya River, Morgan City	N-56	1905	58	8.5	6/27/57	-5.4	8/25/26	
Grand Lake at Myette Point	LOA-NN	1941	12(a)	10.5	3/ 8/50	0.7	1/ 8/54	
Six Mile Lake, Verdunville	N-55	1933	30	9.0	6/27/59	-2.2	10/18/48	
Wax Lake Outlet at Calumet	N-59	1942	21	8.3	6/27/57	-2.8	10/18/48	
Wax Lake West Cont.Str.North (LS)	N-108	1955	8	2.1	6/27/57	-2.2	11/ 6/59	
Wax Lake West Cont.Str.South (FWS)	N-109	1955	8	7.4	6/27/57	-2.3	1/11/56	
Wax Lake East Cont.Str.North (LS)	N-106	1955	8	2.2	5/ 3/57	-2.0	11/ 6/59	
Wax Lake East Cont.Str.South (FWS)	N-107	1955	8	8.5	6/27/57	-2.1	1/11/56	

(a) Intermittent readings throughout period.
(b) Intermittent readings, 23 years.
* See plate A-1 for location.

TABLE A-4

LOCATIONS AND RECORDS OF DISCHARGE STATIONS

Location	Map symbol*	Maximum observed discharge c.f.s.	Date	Minimum observed discharge c.f.s.	Date
Charenton Drainage Canal - Baldwin, La.	T-T	18,335	31 Apr 1953	-3,850	17 Sep 1954
Myette Point Cut at Myette Point	LOA-NN	65,200	26 May 1961	23,600	2 July 1959
Six Mile and Grand Lakes near Verdunville, La.	LOA-OO	172,267	21 May 1958	125,000	27 Apr 1960
Wax Lake Outlet at Calumet	LOA-II	132,000	2, 13 Mar 1950	0	30 Oct 1953
Bayou Shaffer above Bayou Boeuf	LOA-B	52,360	7 May 1935	32,714	3 July 1933
Bayou Shaffer below Bayou Boeuf	LOA-C	59,407	28 Feb 1949	35,522	9 Mar 1933
Bayou Boeuf Jct. with Bayou Shaffer	LOA-JJ	10,063	14 Feb 1949	-4,596	28 Mar 1949
Lower Atchafalaya River at Morgan City	LOA-A	702,686	7 June 1927	-83,700	1 Sep 1936

*See plate A-1 for location.

A-2 DESCRIPTION AND VERIFICATION OF PROCEDURES

a. Hurricane memorandums. The Hydrometeorological Section (HMS), U. S. Weather Bureau, has cooperated in the development of hurricane criteria for experienced and potential hurricanes in the study area. The HMS memorandums provided isovel patterns, hurricane paths, pressure profiles, rainfall estimates, frequency data, and various other parameters required for the hydraulic computations. A reevaluation of historic meteorologic and hydrologic data was the basis for memorandums relative to experienced hurricanes. Those relative to potential hurricanes were developed through the use of generalized estimates of hurricane parameters based on the most recent research and concepts of hurricane theory. Memorandums applicable to the study area are listed in the attached bibliography.

b. Surges.

(1) Maximum hurricane surge heights along the gulf shores were determined from computations made for ranges extending from the shores out to the continental shelf by use of a general wind tide formula based on the steady state conception of water superelevation (1) (2) (3)*. In order to reach agreement between the computed maximum surge heights and the observed high water marks, it was necessary to introduce a surge adjustment factor or calibration coefficient into the general equation, which in its modified form, was as follows:

$$S = 1.165 \times 10^{-3} \frac{V^2 F N Z}{D} \cos \theta$$

where S = wind setup in feet
V = windspeed in m.p.h.
F = fetch length in statute miles
D = average depth of fetch in feet
θ = angle between direction of wind and the fetch
N = planform factor, assumed equal to unity
Z = surge adjustment factor

(2) Hurricane surges at the shore were determined by summation of incremental wind setups along a range above the water surface elevation at the gulf end of the range. A combination of the setup due to atmospheric pressure anomaly and the predicted normal tide was used to determine the initial elevation at the gulf end of the range. Typical tidal cycles for the study area are shown on plate A-2. Due to the variation in pressure setup between the shoreward end and gulfward end of the range, an adjustment was made at the former to compensate for the difference. This procedure for determining surge

*Numbers in parentheses indicate reference in bibliography.

heights at the coastline was developed for the Mississippi gulf coast, where reliable data were available at several locations for more than one severe hurricane, and is used for the entire coastal Louisiana region. Due to dissimilar shoreline configurations different factors were required at different locations, but identical factors were used at each location for every hurricane. The value of the factor is apparently a function of the distance from the shoreline to deep water and varies inversely with this distance. Comparative computed surge heights and observed high water marks for the 1915 and 1947 hurricanes at the locations used to verify the respective procedures are shown in table A-5. All elevations in this appendix are in feet and are referred to mean sea level (m.s.l.).

TABLE A-5

HURRICANE SURGE HEIGHTS

Location	Surge adjustment factor (Z)	1915		1947	
		Observed	Computed	Observed	Computed
		feet m.s.l.		feet m.s.l.	
Long Point, La.	0.21	9.8	9.6	10.0	10.1
Bay St. Louis, Miss.	0.46	11.8	11.8	15.2	15.1
Gulfport, Miss.	0.60	10.2(a)	9.9	14.1	14.3
Biloxi, Miss.	0.65	10.1(a)	9.8	12.2(a)	12.6

(a) Average of several high water marks.

(3) In those areas where the coastline is characterized by a coastal bay separated from the gulf by an offshore barrier island or shoal, it is necessary to inject an additional step in the normal procedure to verify experienced hurricane tides. The incremental step computation was completed to the gulf shore of the island and the water surface elevation transposed to the inland bay side of the island from where the incremental computations were continued using a new surge adjustment factor which was considered representative of the shallower depths within the bay. This procedure resulted in a satisfactory verification of hurricane tides along other portions of the Louisiana coast.

(4) The incremental step computation was used to check elevations experienced during hurricane "Audrey" 25-28 June 1957. Records of elevations from other hurricane occurrences are lacking in the area. Surge adjustment factors of 0.60 in open water and 0.25 in the Atchafalaya Bay were used to verify maximum surge heights. Isovel patterns for hurricane "Audrey" (4) are shown on plate A-3.

47-540 O-65—5

(5) Marshlands that fringe the coastline in certain locations are inundated for considerable distances inland by hurricane surges that approach the shores. The limit of overland surge penetration is dependent upon the height of the surge and the duration of high stages at the coast. The surge height at the coastline depends primarily on the direction and intensity of winds and the hurricane velocity of translation. Numerous bays and marshes are prevalent in the area, and also influence the surge heights at the coastline. The routing of these surges overland by conventional methods was complicated by the undefinable effect of high wind speeds on flow, such that the procedures yielded questionable results when applied to different experienced hurricanes in a given location. Attempts to correlate hurricane translation speeds, surge hydrographs at the coastline, and surge heights at inland locations also yielded inconsistent and therefore unusable relationships. The study of available observed high water marks at the coastline and inland indicates a fairly consistent simple relation between the maximum surge height and the distance inland from the coast, as shown on plate A-4. This relationship exists independently of the speed of hurricane translation, wind speeds, or directions. The data indicate that the weighted mean decrease in surge heights inland is at the rate of 1.0 foot per 2.75 miles. This relationship remains true even in the western portion of Louisiana where relatively high chenieres, or wooded ridges, parallel the coast. Efforts to establish time lags between crest surge heights at the coast and at inland locations were unsuccessful because of inadequate basic data.

(6) For the purpose of surge routing procedures, the coastline is defined as the locus of points where the maximum surge heights would be observed along fetches normal to the general coast. This synthetic coastline has been designated the surge reference line (SRL) and is shown on plate A-1. In order to determine maximum surge heights at inland locations, it was necessary to compute maximum surge heights at the SRL, and then adjust these computed elevations by application of the average slope of maximum surge height inland (1 foot/2.75 miles) to the location of interest. Sufficient reliable hurricane stages were not available for positive verification of the procedure within the area. However, the procedure has given satisfactory results in this area and has verified the observed data in other areas of study.

(7) Maximum surge height contours were developed in the area for probable maximum (PMH), standard project (SPH), and moderate (Mod H) hurricanes. These contours are shown on plates A-5, A-6, and A-7, respectively. The contours represent maximum surge heights that would be experienced for the simultaneous occurrence of hurricanes in each of these three categories for storm paths most critical for every location. Similar contours representing simultaneous occurrence of maximum observed surge heights are shown on plate A-8.

c. Wind tides. The effect of strong hurricane winds blowing over shallow inclosed bodies of water is to drive large quantities of water ahead of the winds. Wind tide levels (WTL's) in Lake Palourde, located northeast of Morgan City, are needed to determine stage-damage curves and design levee heights.

(1) The still water level in the lake rises during the passage of a hurricane. Determination of the maximum still water level is necessary to accurately compute WTL's. Lake Palourde is situated in such a way that the volume of incoming flow from the gulf cannot be measured because the water flows over broad areas of ungaged marshland. Records of stages prior to construction of the Atchafalaya Basin protection levees, as shown on plate A-1, do not reflect present lake conditions. Since the construction of the Atchafalaya Basin project, the highest average elevation experienced in Lake Palourde is 3.0 feet. Extensive marshlands on two sides of the lake allow the rising lake water to overflow its banks resulting in an almost unlimited storage area. Therefore, it was assumed that an average elevation of 3.5 feet would not be exceeded for even the most critical and severe storm.

(2) To compute wind tide, the lake is divided into three zones that are roughly parallel to wind directions. A nodal line is designated perpendicular to the zones and setup is calculated for the leeward segment and setdown for the windward segment. The average windspeed and average depth in each segment were determined from isovel and hydrographic charts for each computation. The storm isovel patterns were furnished by the U. S. Weather Bureau (5). The computation of setup or setdown along each segment was based on the segmental integration method (3) and was calculated by the use of the step method formulas (6) that were modified as follows:

$$\text{Setup} = d_t \left(\sqrt{\frac{0.00266\, u^2\, FN}{d_t^2} + 1} - 1 \right)$$

$$\text{Setdown} = d_t \left(1 - \sqrt{1 - \frac{0.00266\, u^2\, FN}{d_t^2}} \right)$$

Where: setup or setdown in feet is measured above or below mean water level (m.w.l.) of the surge in the lake.

d_t = average depth of fetch in feet below m.w.l.
u = windspeed in m.p.h. over fetch.
F = fetch length in miles, node to shoreline.
N = planform factor, equal generally to unity.

Graphs were constructed from the above formulas to determine setup and setdown quickly about the nodal elevation for storms of varied

frequencies. Volumes of water along the zones, represented by the setup and setdown with respect to a nodal elevation, were determined and the water surface profiles adjusted until setup and setdown volumes for the lake balanced within 5 percent. Then setup elevations were added to the still water level to yield the WTL.

(3) Observed wind tide elevations at the existing back protection levee of Morgan City are not available. Therefore, the method of WTL computation could not be verified by comparing observed and computed data. However, the above-described method has been used successfully for Lake Pontchartrain farther east of Lake Palourde. Observed data were available for this lake and the method verified. Maximum WTL's at the existing Morgan City back levee that would be experienced during occurrences of PMH, SPH, and Mod H are 8.0, 7.2, and 6.4 feet, respectively.

d. Wave runup. In order to determine the heights above WTL or surge to which protective works must be constructed to prevent overtopping by waves, computation of maximum runup was necessary. For the purposes of this study, wave runup was considered to be the ultimate height to which water in a wave ascended on the slope of a protective structure. Its height is measured vertically. Maximum waves and runup usually occur at the time when WTL or surge is at a maximum. Wave heights and periods were determined from forecast curves developed by Bretschneider (6). Runup was calculated by interpolation of model study data developed by Saville (7) (8) (9) relating relative runup (R/H_O'), wave steepness H_O'/T^2), relative depth (d/H_O'), and structure slope.

A-3 FREQUENCY ESTIMATES

a. Procedure.

(1) Accounts of inundation by hurricane surges do not appear in the earliest records of the study area. Information on stages is available only for the larger towns or more thickly populated locations. After about 1900, when systematic records of hurricane damages were assembled by the U. S. Weather Bureau, more details relative to flooding along the isolated coastline and vicinity are available. However, until recent years, no attempt has been made to determine accurately the maximum height of stages experienced during hurricanes. The only exception is that after the September 1915 hurricane, a thorough survey was made by Charles W. Okey, Senior Drainage Engineer, Office of Public Roads and Rural Engineering, U. S. Department of Agriculture. In this survey, he covered the affected coastal areas which were between central Mississippi and central Texas. His report (10) is the only comprehensive record of reliable stages in the study area prior to hurricane "Audrey" of June 1957.

(2) The lack of additional data has made the establishment of dependable stage-frequency relationships impracticable. Records indicate that there is no locality along the Louisiana coast which is more prone to hurricane attack than other localities. The U. S. Weather Bureau has made a generalized study of hurricane frequencies and presented the results in a memorandum (11). In a 400-mile zone along the central gulf coast from Cameron, La., to Pensacola, Fla. (Zone B), frequencies for hurricane central pressure indexes (CPI) presented in the report, shown on plate A-9, reflect the probability of hurricane recurrence in the mid-gulf coastal area. Hurricane characteristics with critical tracks and CPI's representative of the PMH, SPH, and Mod H were then developed in cooperation with the U. S. Weather Bureau. The CPI's used were 26.9, 27.6, and 28.3 inches for these three hurricanes, respectively. The SPH's described in HMS hurricane memorandums (12) (13) (14) (15) were the basis of development of the PMH's and the Mod H's used in the study. Representative hurricane paths and wind patterns for the SPH critical to the surge reference line and the rear of Morgan City are shown on plates A-10 and A-11, respectively. The conversion of SPH to PMH is described in a HMS memorandum (16). Wind patterns for these two hurricanes are identical except that wind speeds are 14 percent greater for the latter.

(3) Conversion of SPH wind fields for use as the Mod H was accomplished in the following manner. A Mod H was assumed to have a CPI with a Zone B probability of 10 percent. Maximum gradient winds (V_{gx}) were derived for the SPH and Mod H CPI's in accordance with procedure recommended by the U. S. Weather Bureau (11) (17). An adjustment coefficient equal to the ratio of V_{gx} of the Mod H to V_{gx} of the SPH was then used to convert SPH wind velocities to Mod H velocities. Thus, Mod H winds were 83 percent of SPH winds for any given hurricane path. It was necessary to use additional synthetic hurricanes of moderate intensity to define in more detail the stage-frequency relationship. When this was required, moderate hurricanes having CPI's of 27.8 and 29.0 inches were used. These hurricanes were of 2 and 40 percent probability, and wind speeds were 96.6 and 59.8 percent of SPH winds, respectively.

(4) Hurricane surges were then computed for the theoretical hurricanes in accordance with procedures described in par. A-2b. Isovels were rotated and paths transposed within allowable limits as necessary to produce maximum elevations at the surge reference line from gulf surges and from Lake Palourde to the rear of Morgan City. Representative bottom and surge profiles for the PMH, SPH, and Mod H for hurricanes critical to the surge reference line are shown on plate A-12. Contours of maximum surge heights that would be experienced in the study area for a simultaneous occurrence of hurricanes of SPH characteristics for every location in the area are shown on plate A-6. Plate A-5 shows contours of maximum surge heights of PMH's for an identical situation.

(5) A synthetic stage-frequency curve was developed by correlating stages and frequencies for corresponding CPI's, using a procedure developed for the Lake Pontchartrain study area (18). Stages for pertinent locations in the area that would accompany the PMH, SPH (design hurricane), and Mod H are shown in table A-6.

TABLE A-6

COMPARATIVE SURGE HEIGHTS

Location	PMH	SPH (Des H)	Mod H
Surge reference line	15.5	13.0	10.5
Morgan City			
Berwick Bay	13.3	10.8	8.3
Lake Palourde	7.7	6.7	6.3
Patterson and vicinity	13.3	10.8	8.3
Franklin and vicinity	13.7	11.2	8.7
Lower Bayou Sale	15.5	13.0	10.5

The probability value used for a given CPI represents frequency of occurrence from any direction in a 400-mile zone along the central gulf coast. In order to establish frequencies for the locality under study, it was assumed that hurricanes critical to the locality would pass through a 50-mile subzone along the coast. Thus, the number of occurrences in the 50-mile subzone would be 12.5 percent of the number of occurrences in the 400-mile zone, provided that all hurricanes traveled in a direction normal to the coast. A hurricane whose track is perpendicular to the coast ordinarily will cause extremely high tides and inundation for a distance of about 50 miles along the coast. However, the usual hurricane track is oblique to the shoreline, as shown in table 2 of HMS memorandum (11). The average projection along the coast of this 50-mile swath for the azimuth of 42 Zone B hurricanes is 80 miles. Since this is 1.6 times the width of the normal 50-mile strip affected by a hurricane, the probability of occurrence of any hurricane in the 50-mile subzone would be 1.6 times the 12.5 percent, or 20 percent of the probabilities for the entire midgulf Zone B. Therefore, 20 percent of the frequencies of hurricanes for Zone B, midgulf, shown in figure 4 of HMS memorandum HUR 2-4 (11), was used to represent the frequencies of hurricanes in the critical 50-mile subzone for each study locality.

(6) The azimuths of tracks observed in the vicinity of landfall were divided into quadrants corresponding to the four cardinal points. In Zone B, 24 tracks were from the south, 14 from the east, 3 from the west, and 1 from the north. Hurricanes with tracks having major components from the southeast, south, and southwest generate critical or near-critical surges for the study area. Hurricanes having tracks approaching between azimuths of 120° and 240° were selected and used to develop a curve representing a synthetic probability of stages for hurricanes approaching from these directions. Thirty-four Zone B hurricane tracks are evident between the azimuths selected, and therefore, 80 percent of the frequencies of hurricanes in the critical 50-mile subzone was used for probabilities.

(7) Due to the absence of a sufficient number of recorded hurricane induced stages in the area, it was necessary to employ the synthetic method for computing hurricane stage-frequencies. In a prior Hurricane Study Interim Survey Report, "Mississippi River Delta at and below New Orleans, La.," (19) separate frequencies were computed using both the observed and synthetic methods. In the final analysis, the synthetic frequency curve was superimposed over the plotted observed frequency points and the close relation between the two indicated satisfactory verification of the synthetic procedure.

(8) Table A-7 illustrates the synthetic frequency computation for surges from the gulf at the surge reference line for the area between the Atchafalaya River and Lower Bayou Sale. Computations for other locations in the study area are similar in nature except for variation in surge heights.

b. Relationships. Based on the above-described procedures, stage-frequency relationships were established under existing conditions for flooding from Gulf of Mexico hurricane surges and from flooding by surges from Lake Palourde for the rear of Morgan City. Stage-frequency curves are shown on plate A-13.

TABLE A-7

STAGE-FREQUENCY COMPUTATION

SURGE REFERENCE LINE
(Atchafalaya River to Lower Bayou Sale)

	ZONE B (400 miles)		SUBZONE (50 miles)		
	Probability		Probability all tracks (42)	Stage	Probability tracks between 120° - 240° (34)
CPI					
		occ/100	occ/100		occ/100
in.	years	years	years	feet m.s.l.	years
(1)	(2)	(3)	(4)	(5)	(6)
29.0	2.5	40	8.0	6.5	6.40
28.3	10.0	10	2.0	10.5	1.60
27.8	50.0	2	0.4	12.5	0.32
27.6	100.0	1	0.2	13.0	0.16

Col. 4 - 20 percent of Col. 3.
Col. 6 - 80 percent of Col. 4.

A-4 DESIGN HURRICANE

a. Characteristics. The characteristics of the design hurricane (Des H) for the proposed plans of protection are identical to the standard project hurricane described in detail in paragraph 9. However, due to transposition of the regional SPH to the smaller study area, the Des H would have a probability of recurrence of once in several hundred years in the study area. The path of the Des H was located successively to produce maximum hurricane tides along the entire length of the proposed protective works. The Des H is a theoretical hurricane, but actual disturbances of similar intensity have been known to occur.

b. Normal predicted tides. The mean tide in the study area is 0.3 foot m.s.l.; the mean tidal range is 1.6 feet. The difference in height of hurricane tides for occurrence of the Des H at high or low tide was only a few tenths of a foot. In determining the elevation of design surges, it was assumed that mean normal predicted tide occurs at the critical period for surges.

c. Design rainfall. Hurricanes usually are accompanied by intense rainfalls. The mean 24-hour maximum point precipitation depth is 9.4 inches, based on data available on over 50 gulf region hurricanes (20) (21). Complete precipitation records, including but not limited to hurricane induced rainfall, indicate maximum

24-hour point depths of 21 inches for a standard project rainfall and 40 inches for the probable maximum rainfall. Estimates of point precipitation depths likely to be experienced with a standard project hurricane are 14 inches for moderately high and between 8.6 and 9.8 inches for moderate rainfalls. A moderate hurricane rainfall of 9.4 inches in 24 hours, based on the observed average volume, was used in the determination of residual damages for hurricanes, both under present conditions and after construction of the project.

d. Design tide. The hurricane tide is the maximum still water surface elevation experienced at a given location during the passage of a hurricane. It reflects the combined effects of the hurricane surge, and where applicable, the overland flow of the surge, and wind tide. Design hurricane tides were computed to reflect conditions with existing and proposed protective works or improvements in place, using the procedures described in paragraphs A-2 b. and c.

e. Design waves and runup. Hurricane surges and tides usually are accompanied by violent wave action at the coastline in unprotected bays, and in inland lakes close to the hurricane path. As the surge moves inland over marshlands and natural ridges, the waves deteriorate rapidly, and wave heights are attenuated by marsh grasses and woodland. In summer and fall, when hurricanes are most likely to occur, the marsh grasses reach heights of from 2 to 4 feet above ground. Therefore, effective depths used in forecasting wave heights and computing runup on levees located along marshland were considered equal to the difference in elevations between surge height or WTL and the top of the marsh grass (22). Then wave heights were computed using the procedures described in paragraph A-2 d. Only one small section of the proposed protective works back of Morgan City is vulnerable to wave action. Since this section is fronted by a large berm, an allowance of only 1.5 feet was necessary to protect against waves. The remainder of the proposed protective works in the study area is fronted by thick timber growths which minimize the effects of wave action. These levees were designed to include an allowance of 1 foot above surge height.

f. Design flood levels. Delineation of areas flooded and determination of flood levels attributed to the combined effects of rainfall and hurricane tide were necessary for economic analysis.

(1) Morgan City. The area north of the S.P.R.R. and between Berwick Bay and Lake Palourde would be flooded to an elevation of 7.2 feet during an occurrence of the design hurricane under existing protection. The floodwaters would be the result of the wind tide level in Lake Palourde. The area between the S.P.R.R. and Bayou Boeuf would be flooded to an elevation of 7.5 feet under

the above conditions. Water flooding this area would move inland from the south and the east of the Bayou Boeuf lock.

(2) Franklin and vicinity. The area between Bayous Sale and Teche, Wax Lake Outlet and the G.I.W.W. would be flooded to an elevation of 9.9 feet. The remainder of the area would be flooded to 11.2 feet.

g. Streamflow coincident with hurricane surge flooding. Maximum headwater flow in the Atchafalaya Basin usually occurs prior to the hurricane season. However, should high basin flow and a hurricane occur simultaneously, the resultant water surface elevation would be approximately the same as without the high headwater flow. The hurricane surge is generated to specific heights which are determined mainly by the velocity and direction of the winds and water depth. The formula in paragraph A-2 b.(1) shows that the incremental setup of the hurricane surge varies inversely with the water depth. Therefore, if headwater flow has increased the depth before or during the arrival of the hurricane surge, the incremental setup will be smaller. The water surface elevation upstream from the hurricane surge admittedly would be higher because of the retardation effect the surge would have on the headwater flow. Existing levee grades of the Atchafalaya Basin protective system are of sufficient heights to withstand the effects of a combination of high headwater flow and hurricane surge. The probability is remote of maximum headwater flow and maximum hurricane surge occurring at the same time.

SECTION II - HYDRAULIC DESIGN INTERIOR DRAINAGE

A-5 MORGAN CITY

a. General. The proposed levees will intercept pumped outflow from approximately 1,200 acres of the leveed portion of Morgan City plus the surface runoff from 2,000 acres of mostly unimproved land. The combined pumping capacity involved is 625 c.f.s. Ground surface elevations in the area range from about 8 feet to less than 1 foot.

b. Description of rectified drainage plan. The features of the plan for providing for the drainage intercepted by the proposed levees are shown on plate 2. It is proposed to collect all runoff in drainage ditches excavated immediately landward of the proposed levees. Three separate gravity structures will be provided. The Lake Palourde drainage structure will consist of approach and exit channels and a vertical concrete wall with 6 circular openings 60 inches in diameter with invert at elevation -5.0 feet. Each opening will be provided with an automatic flap gate to prevent ingress of tides. This structure will dispose of the total pumped outflow

plus the surface runoff from 820 acres of undeveloped land. The Bayou Ramos drainage structure will drain 1080 acres and consists of two 48-inch round corrugated metal pipe culverts with invert at -4.0 feet. Automatic flap gates will be provided for each culvert. The Bayou Boeuf structure will drain 100 acres and consists of a single, flap-gated corrugated metal culvert 48 inches in diameter with invert at -2 feet. Existing pumping station outfalls will be enlarged where required to limit velocities to 1 foot per second.

c. Design criteria. Criteria used for determining the sizes of the three drainage structures are listed below. Capacities for all pipe culverts are based on an entrance loss of 0.3 of the velocity head and a friction loss evaluated by the Manning Formula with a roughness coefficient of 0.021. The capacity of the wall-type structure is based on an entrance loss of 0.5 of the velocity head, with friction loss assumed to be zero. Coefficients thus computed are 0.82 and 0.64 for the Lake Palourde structure, and the Bayou Ramos and Bayou Boeuf structures, respectively.

(1) Lake Palourde drainage structure. This structure was designed to dispose of the combined daily outflow of the existing pumping stations (625 c.f.s.) plus 3 inches of runoff from the remainder of the area served by it in 1 day under a 1-foot head. This criterion was used in computing drainage structure sizes for areas west of Berwick, La., whose drainage was intercepted by construction of the West Atchafalaya Basin Protection Levee and has proven completely satisfactory.

(2) Bayou Ramos drainage structure. This structure was designed to provide for the removal of 3 inches of runoff in 1 day under a 1-foot head.

(3) Bayou Boeuf drainage structure. Because the area served by this structure is flat and without unimproved areas suitable for ponding, a more generaous design was considered warranted. Accordingly, the structure is designed to remove 6 inches of runoff in 1 day under a 1-foot head.

A-6 FRANKLIN AND VICINITY

a. General. The proposed levee will intercept the existing drainage of approximately 1,620 acres of cleared land tributary to Yellow Bayou Canal, 765 acres tributary to Hanson Canal, and 520 acres of land, hereafter called the Todd area, located between North Bend and Maryland. Drainage from these adjacent areas will be partially affected since part of the drainage from them presently moves through the Todd area. The hurricane levee system also crosses the Franklin Canal, which serves as the outfall for the Bayou Yokely pumping station. Inasmuch as this canal is navigable,

a navigation gate will be provided which will adequately serve the drainage requirements as well. All areas intercepted are parts of the alluvial ridges of Bayous Teche and Sale. Ground surface elevations vary from in excess of 10 feet to about 1 foot. Considerable portions of the towns of Centerville and Verdunville are included in the intercepted area tributary to Yellow Bayou Canal, and little unimproved land is available for ponding in this area. Similarly, the intercepted area tributary to Hanson Canal lacks substantial unimproved area for ponding. The Todd area includes adequate unimproved area suitable for ponding.

b. Description of rectified drainage plan.

(1) Area tributary to Yellow Bayou Canal. The drainage intercepted by the proposed levee will be provided for by construction of the Yellow Bayou drainage structure through the levee consisting of approach and exit channels and a concrete wall with four 60-inch round openings equipped with automatic flap gates. Opening inverts will be at -5 feet.

(2) Area tributary to Hanson Canal. Intercepted drainage will be provided for by the Hanson Canal drainage structure in the levee consisting of two 60-inch round corrugated metal pipes equipped with automatic flap gates. Invert will be at elevation -5 feet.

(3) Todd area. The proposed levee will inclose an area of approximately 520 acres lying between the Maryland and North Bend areas, and additionally, will intercept the outflow of one 36-inch round corrugated metal pipe and one 48-inch round corrugated metal pipe in the Maryland area, and one 36-inch round corrugated metal culvert in the North Bend area. These three pipes will be plugged. To accommodate drainage from the areas served by these pipes, the upper Todd drainage structure, a single 48-inch round corrugated metal pipe with invert at -4 feet, will be installed in the Maryland area, and the lower Todd drainage structure, a single 36-inch round corrugated metal pipe with invert at -1 foot, will be installed in the North Bend area. Both pipes will be equipped with automatic flap gates. The newly inclosed Todd area will be served by the middle Todd drainage structure, a single flap-gated 54-inch round corrugated metal pipe with invert at -4.5 feet.

c. Design criteria.

(1) Areas tributary to Yellow Bayou and Hanson Canals. In these areas, which have little unimproved land suitable for ponding, the outlets were designed to discharge 6 inches of runoff per day under a 1-foot head. The capacity of the Yellow Bayou Canal outlet was based on an entrance loss of 0.5 times the velocity head

with friction loss assumed to be zero. The capacity of the Hanson Canal outlet was based on an entrance loss of 0.3 times the velocity head with a friction loss evaluated by the Manning Formula with a roughness coefficient of 0.021. The discharge coefficients thus computed are 0.82 and 0.63, respectively.

(2) Todd area. The drainage outlet was designed to discharge 3 inches of runoff per day under a 1-foot head. The discharge coefficient, computed similarly to that for the Hanson Canal outlet, is 0.58.

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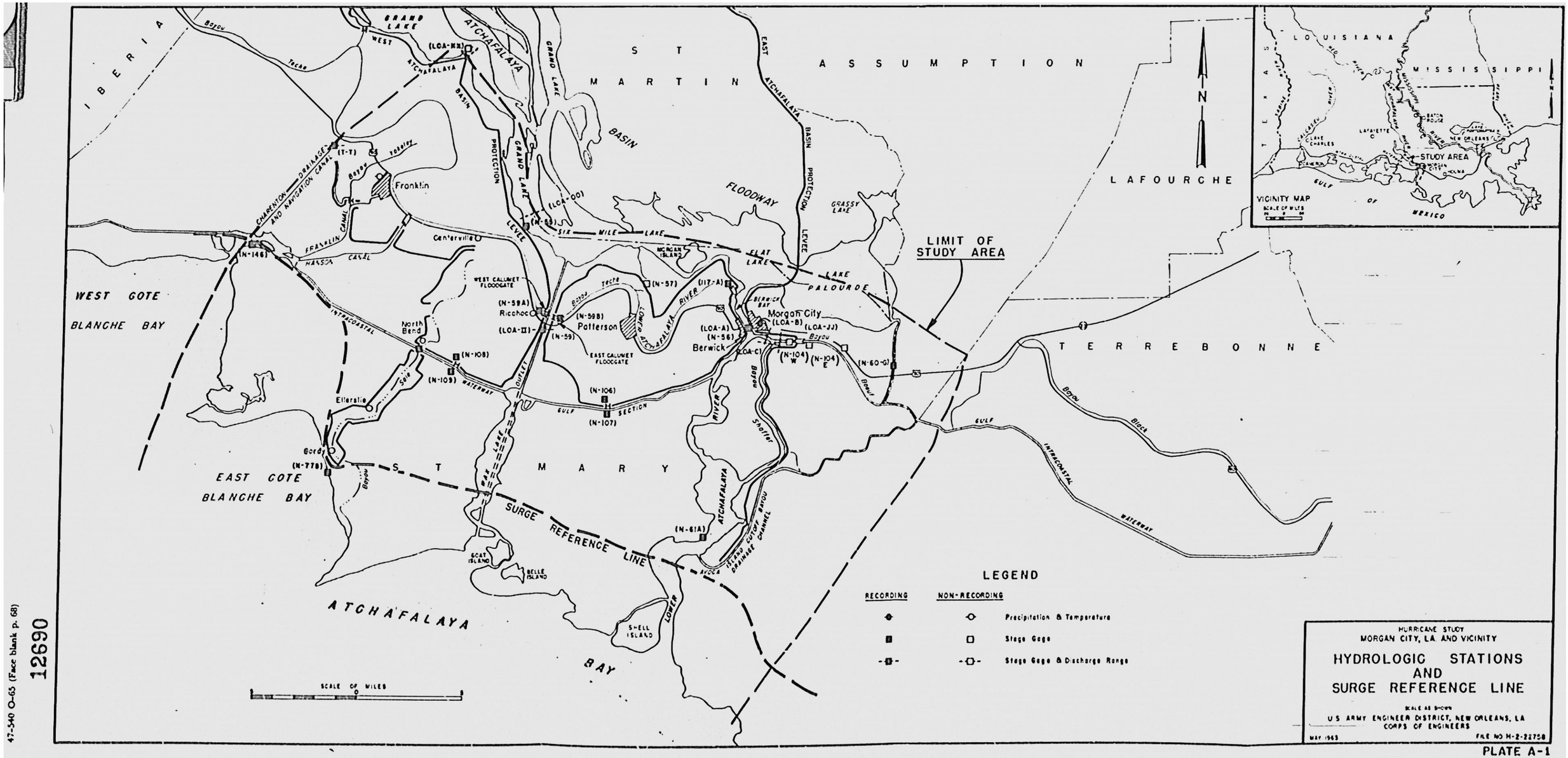
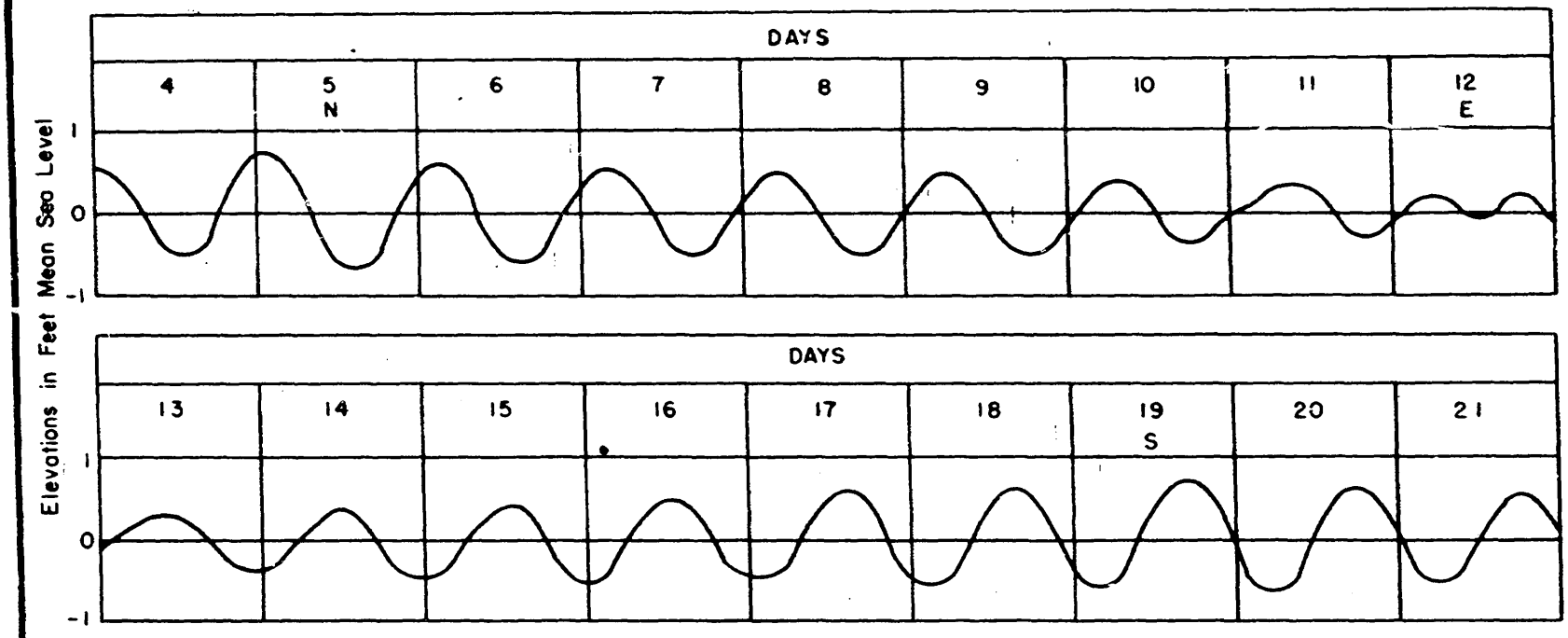


PLATE A-1



LEGEND

E, moon on the equator
N, S, moon farthest north or south of the equator

HURRICANE STUDY

MORGAN CITY, LA. AND VICINITY

TYPICAL TIDAL CYCLES

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

MARCH 1963 FILE NO. H-2-22758

PLATE A-2

PLATE A-2

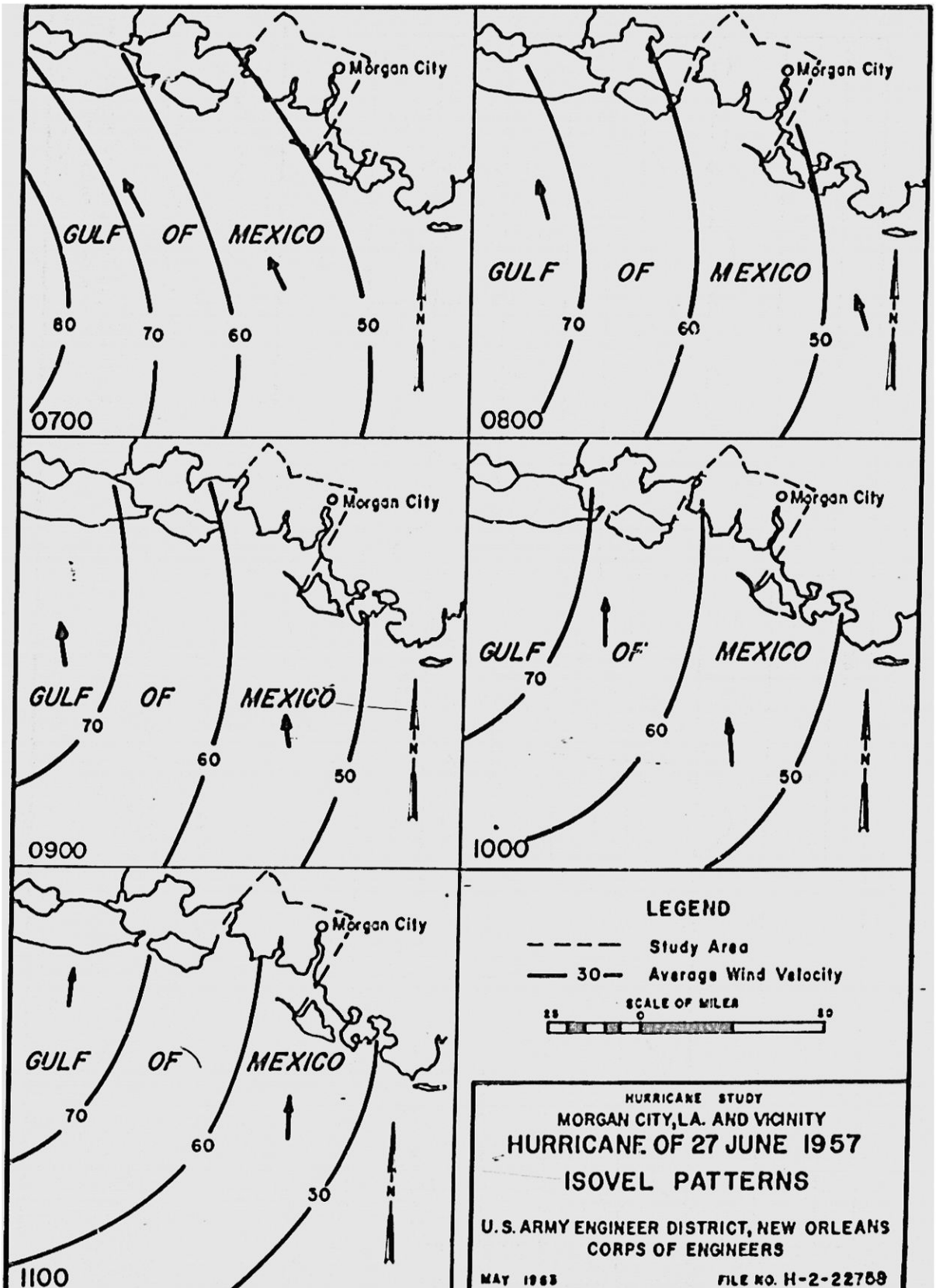
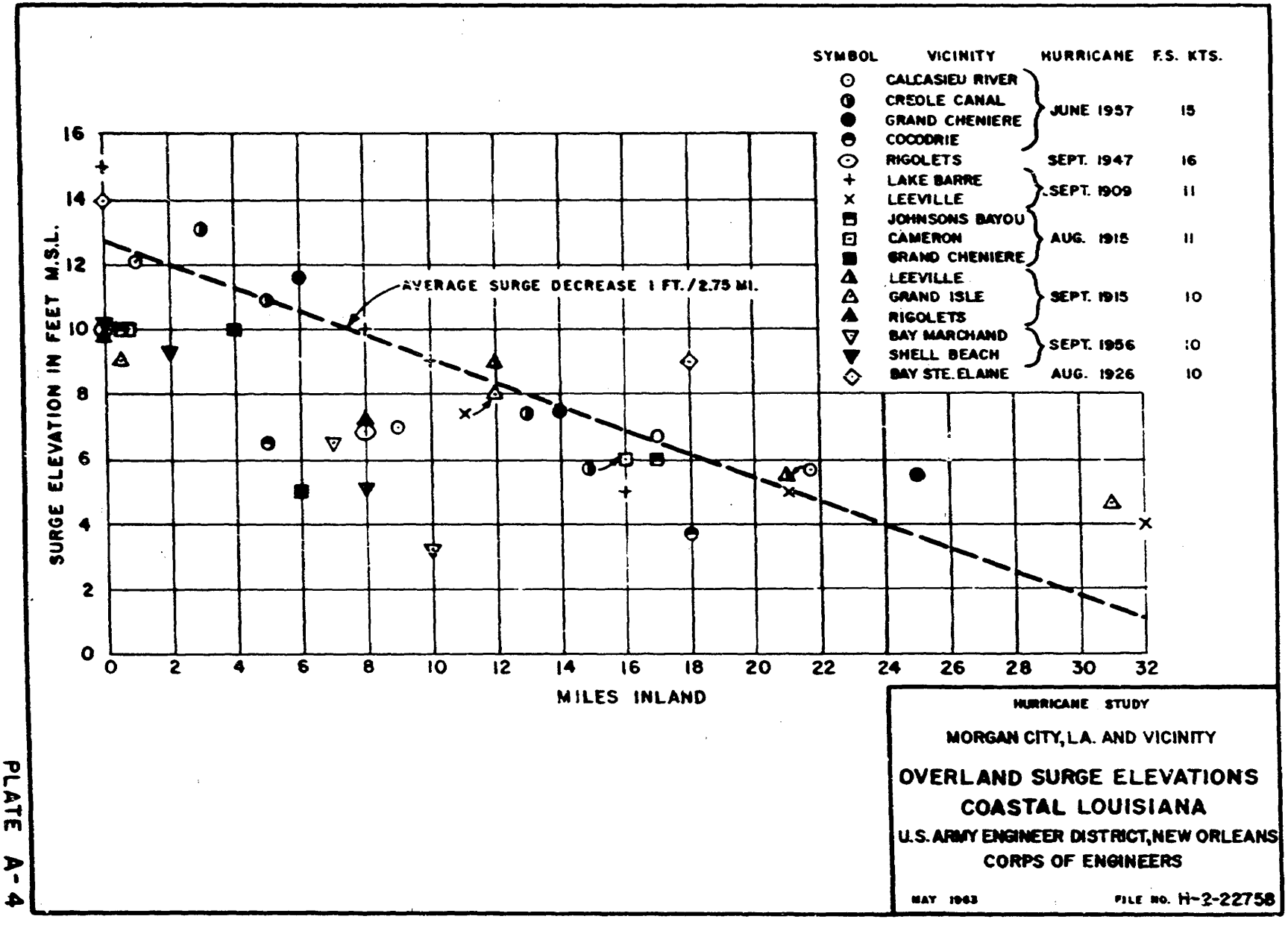

Morgan City
GULF OF MEXICO
80
70
60
50
0700
Morgan City
GULF OF MEXICO
70
60
50
0800
Morgan City
GULF OF MEXICO
70
60
50
0900
Morgan City
GULF OF MEXICO
70
60
50
1000
Morgan City
GULF OF MEXICO
70
60
30
1100
LEGEND
Study Area
30 Average Wind Velocity
SCALE OF MILES
25 0 50
HURRICANE STUDY
MORGAN CITY, LA. AND VICINITY
HURRICANE OF 27 JUNE 1957
ISOVEL PATTERNS
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MAY 1963
FILE NO. H-2-22758

PLATE A-3



HURRICANE STUDY

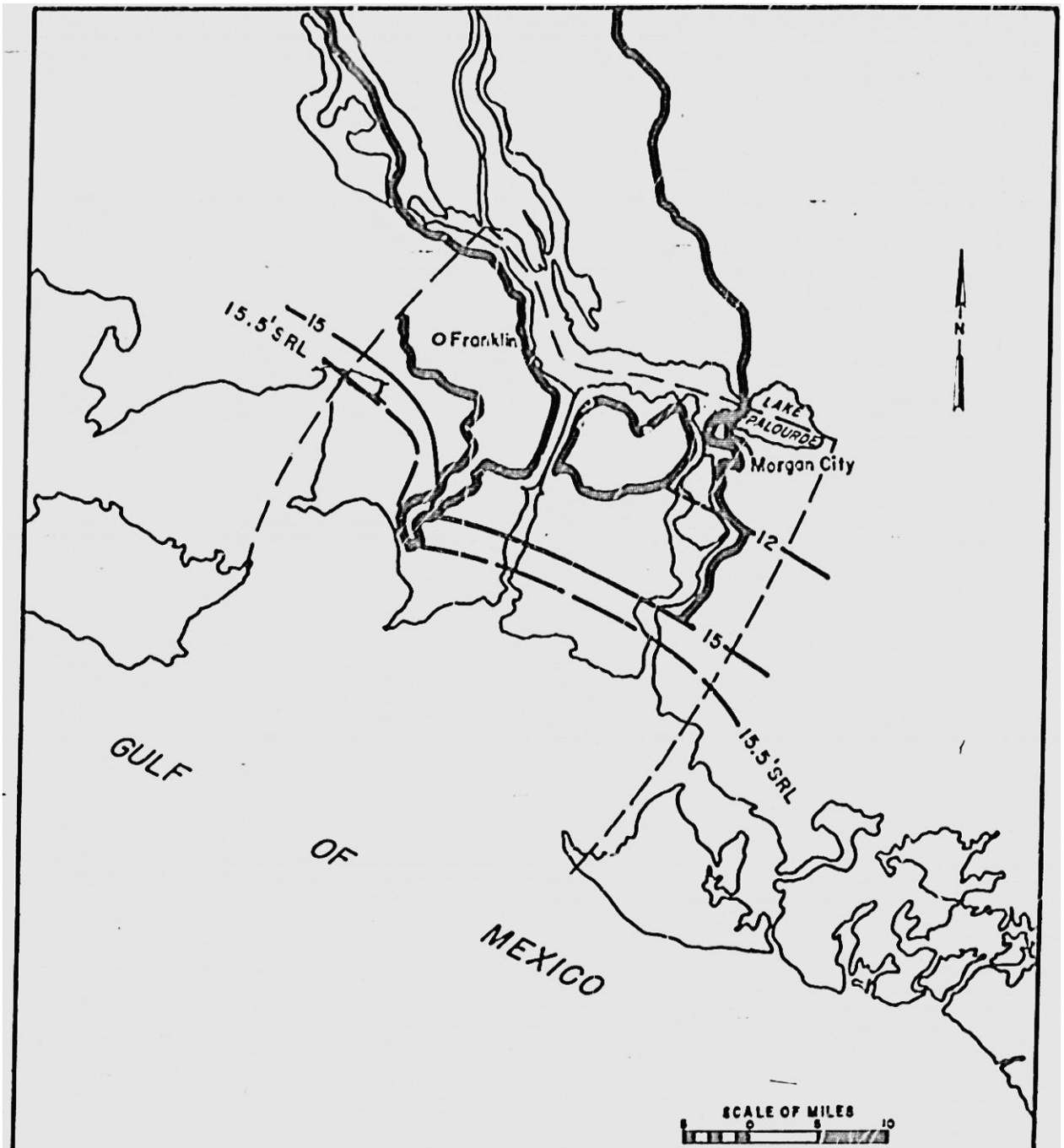
MORGAN CITY, LA. AND VICINITY

OVERLAND SURGE ELEVATIONS COASTAL LOUISIANA

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

MAY 1963 FILE NO. H-2-22758

PLATE A-4



LEGEND

- Existing Levees
- Study area limits
- 12 Isoline of maximum water
- SRL – Surge reference line

HURRICANE STUDY

MORGAN CITY, LA. AND VICINITY

MAXIMUM SURGE CONTOURS PROBABLE MAXIMUM HURRICANE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

MAY 1963 FILE NO. H-2-22758

PLATE A-5

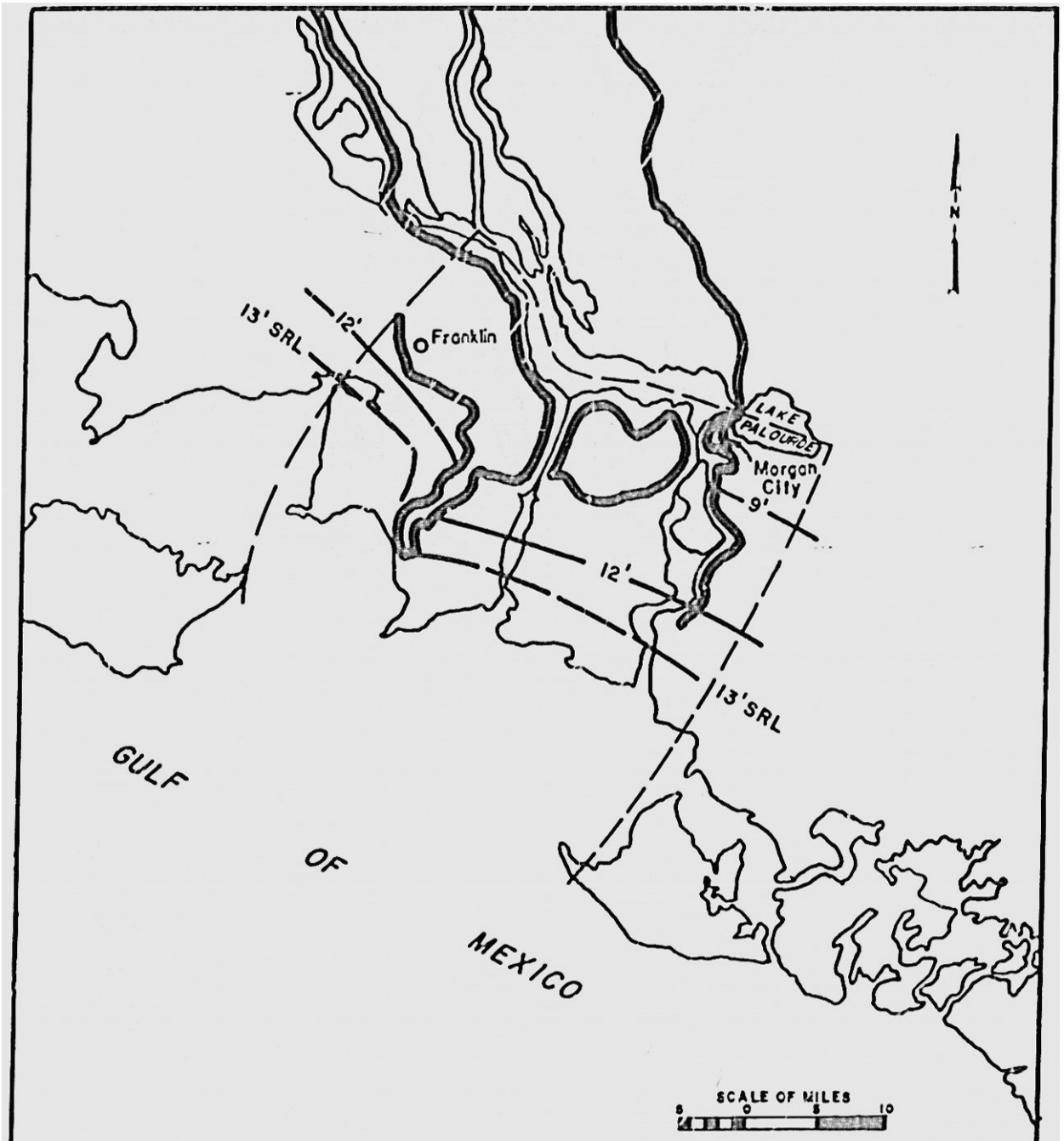
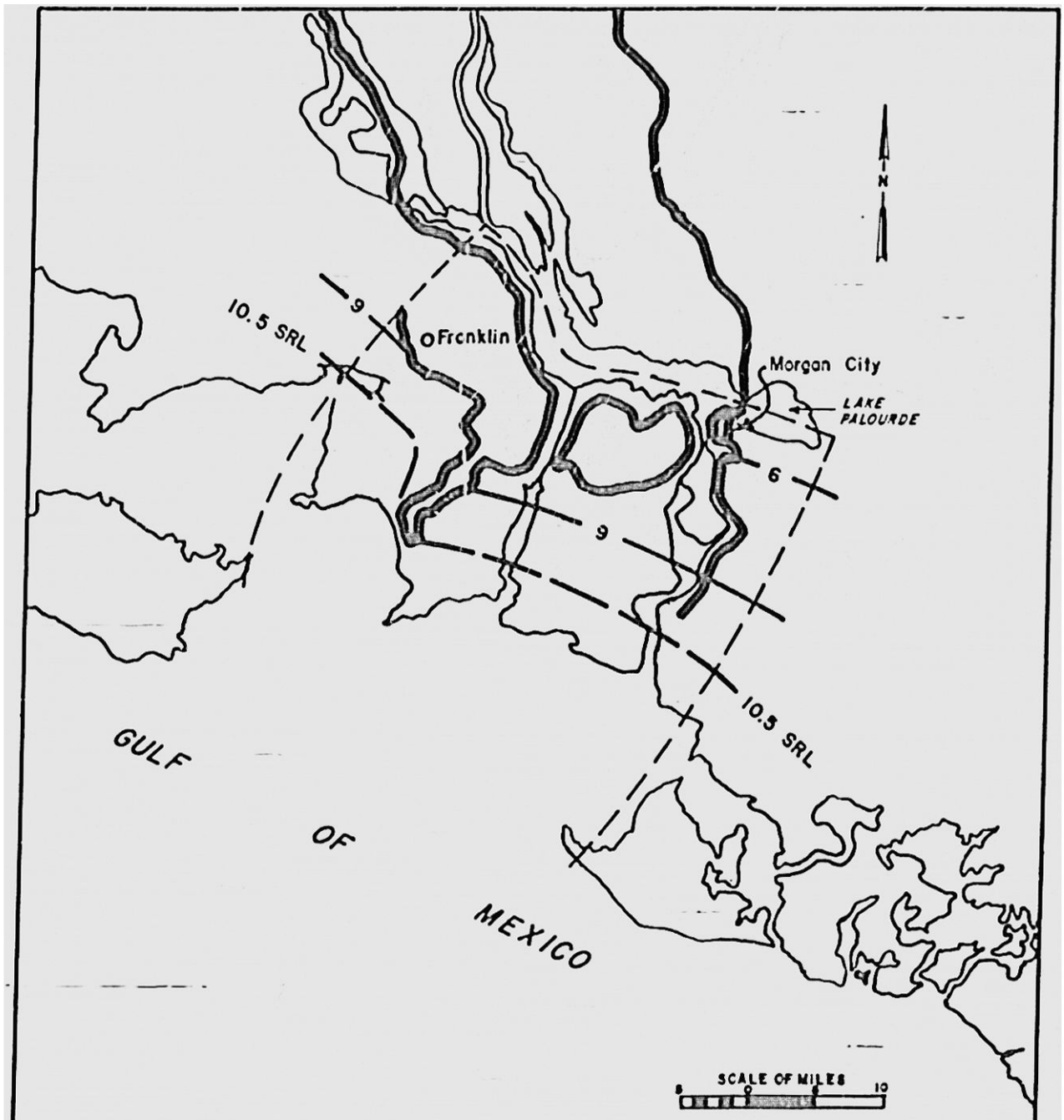

N
13' SRL
12'
Franklin
LAKE PALOURDE
Morgan City
9'
12'
13' SRL
GULF
OF
MEXICO
SCALE OF MILES
8 0 5 10
LEGEND
Existing Levees
Study area limits
12 Isoline of maximum water
SRL - Surge reference line
HURRICANE STUDY
MORGAN CITY, LA. AND VICINITY
MAXIMUM SURGE CONTOURS
STANDARD PROJECT HURRICANE
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MAY 1963
FILE NO. H-2-22758

PLATE A-6



LEGEND

- Existing Levees
- Study area limits
- 9 — Isoline of maximum water
- SRL - Surge reference line

HURRICANE STUDY

MORGAN CITY, LA. AND VICINITY

MAXIMUM SURGE CONTOURS MODERATE HURRICANE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

MAY 1963 FILE NO. H-2-22758

PLATE A-7

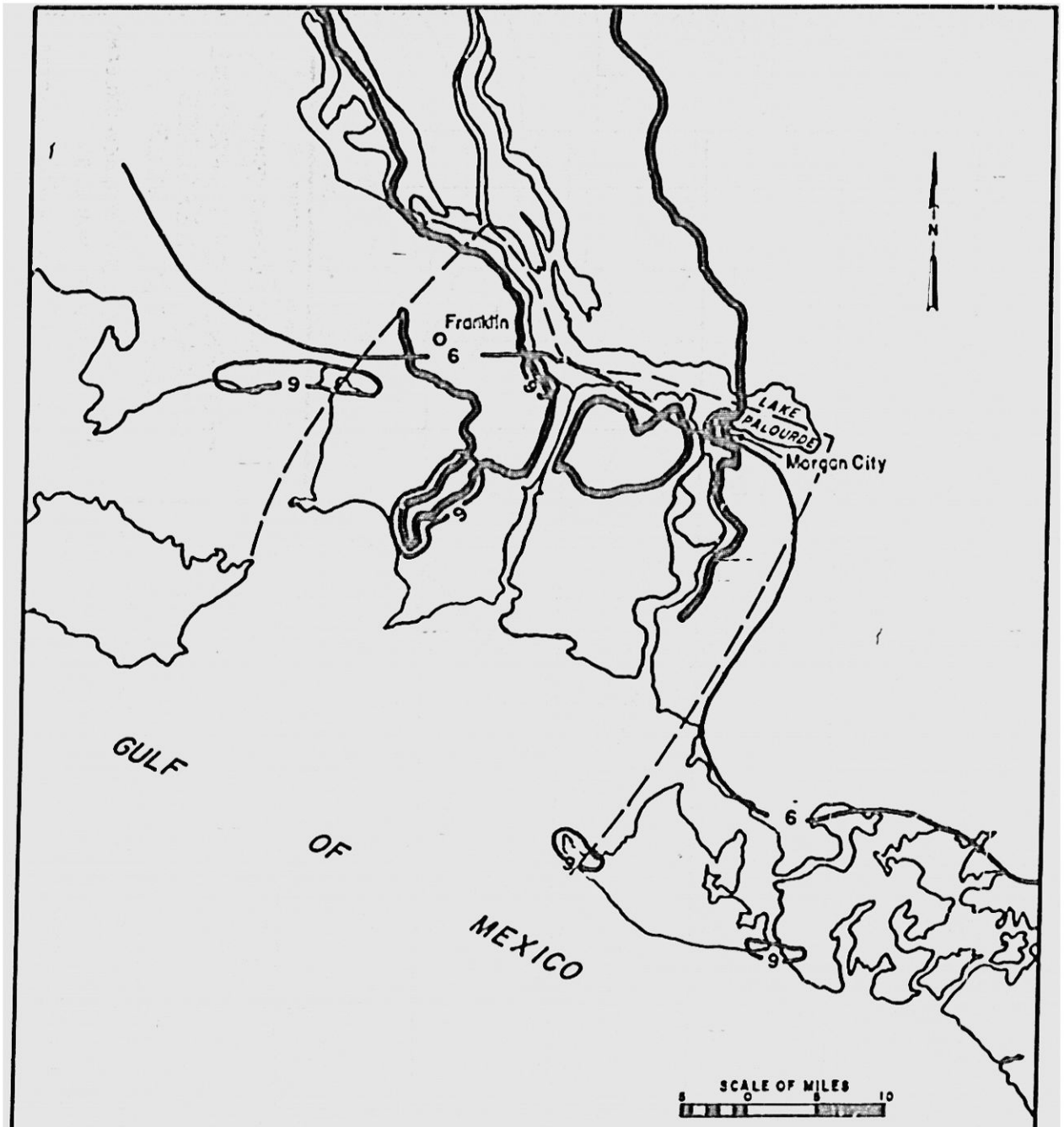

N
Franklin
6
9
9
9
LAKE PALOURDE
Morgan City
GULF
OF
MEXICO
6
9
9
SCALE OF MILES
5 0 5 10
LEGEND
Existing Levees
Study area limits
9
Isoline of maximum water surface elevations
HURRICANE STUDY
MORGAN CITY, LA. AND VICINITY
MAXIMUM SURGE CONTOURS OBSERVED
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MAY 1963
FILE NO H-2-22758

PLATE A-8

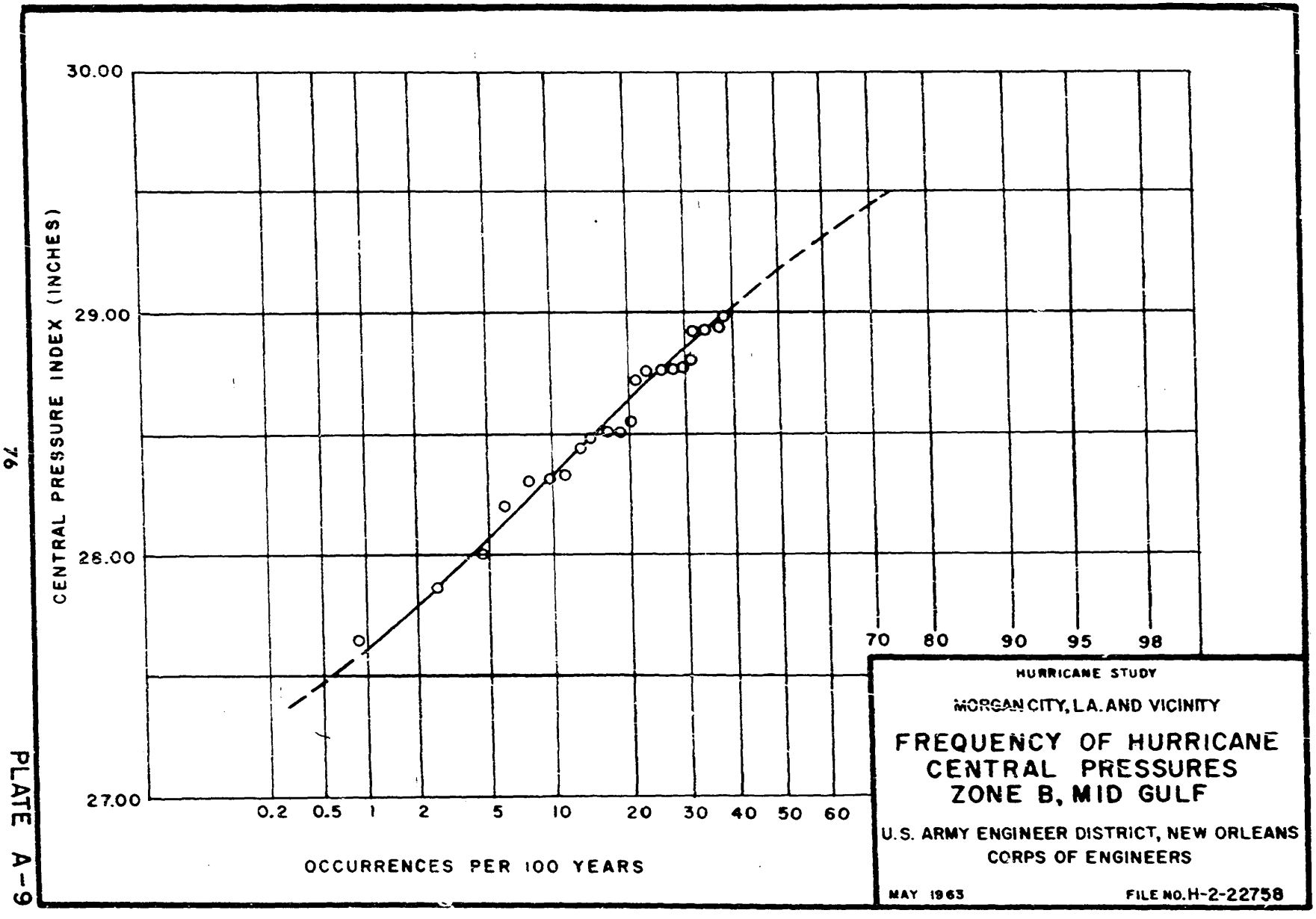
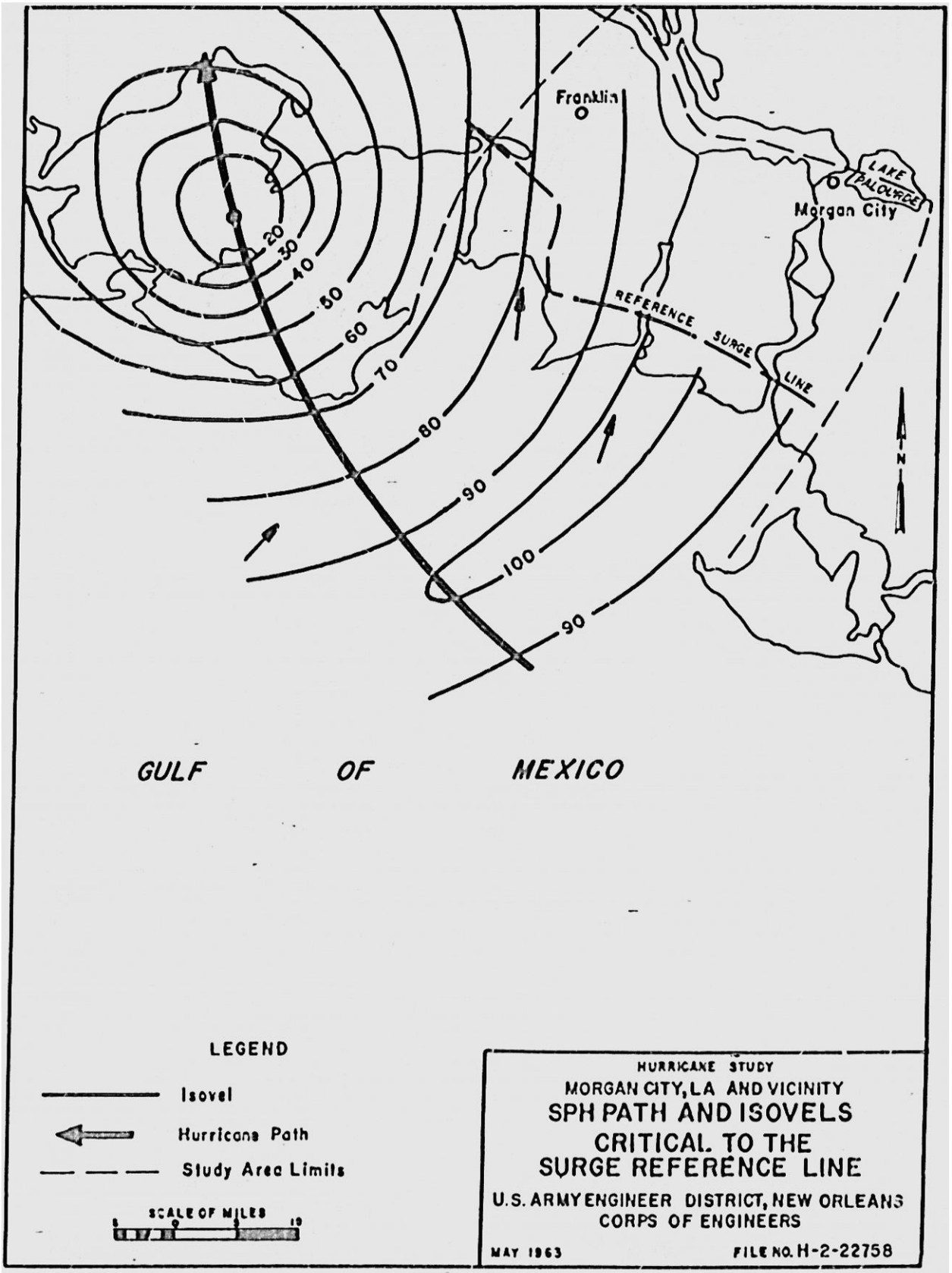

30.00
29.00
28.00
27.00
CENTRAL PRESSURE INDEX (INCHES)
0.2
0.5
1
2
5
10
20
30
40
50
60
70
80
90
95
98
OCCURRENCES PER 100 YEARS
HURRICANE STUDY
MORGAN CITY, LA. AND VICINITY
FREQUENCY OF HURRICANE CENTRAL PRESSURES ZONE B, MID GULF
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MAY 1963
FILE NO. H-2-22758

PLATE A-9



HURRICANE STUDY

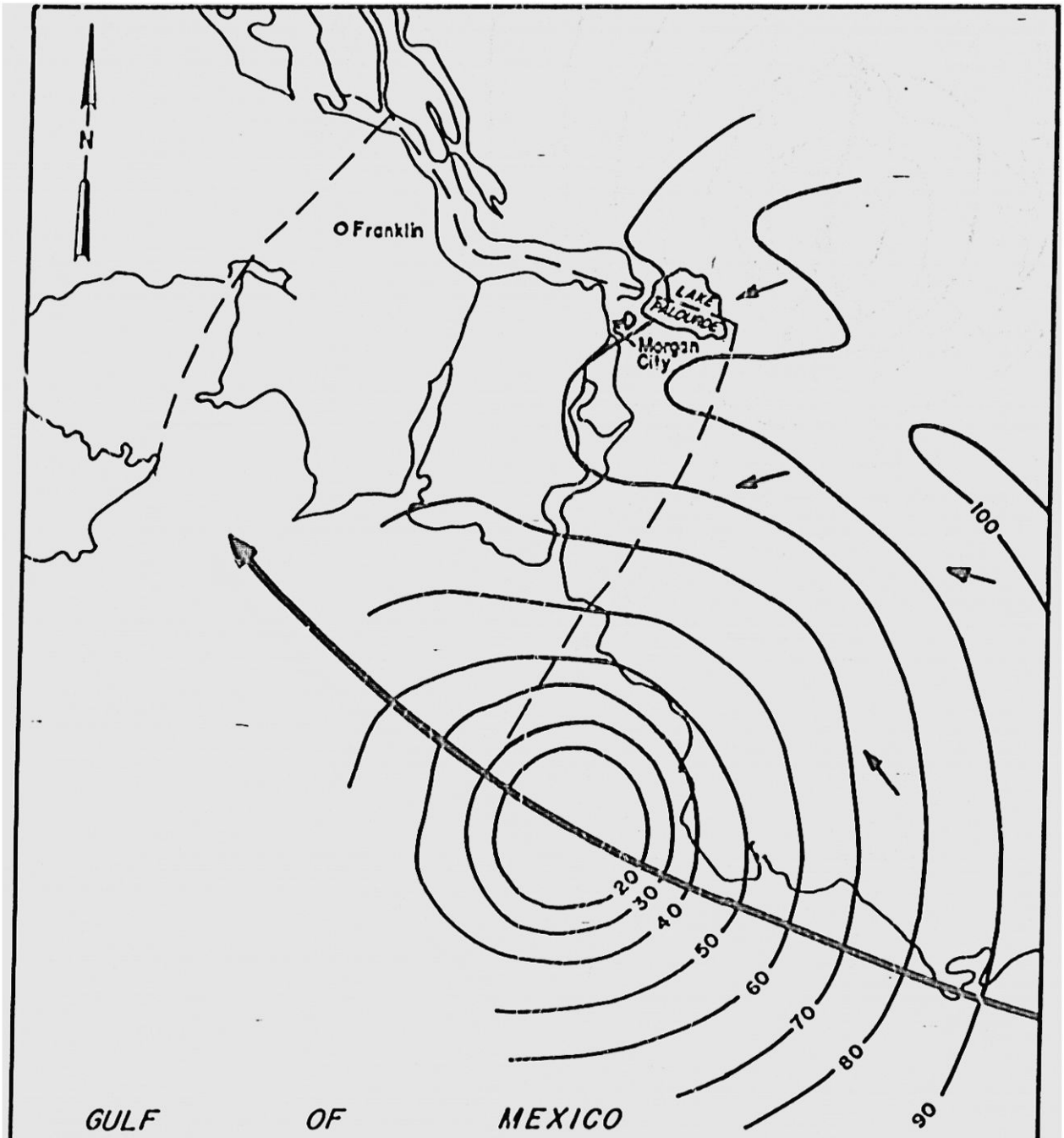
MORGAN CITY, LA AND VICINITY

SPH PATH AND ISOVELS CRITICAL TO THE SURGE REFERENCE LINE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

MAY 1963 FILE NO. H-2-22758

PLATE A-10



LEGEND

60 Isovel

Hurricane Path

Study Area Limits

SCALE OF MILES
5 0 5 10

HURRICANE STUDY
MORGAN CITY, LA. AND VICINITY
SPH PATH AND ISOVELS
CRITICAL TO
LAKE PALOURDE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS

MAY 1963 FILE NO. H-2-22758

PLATE A-11

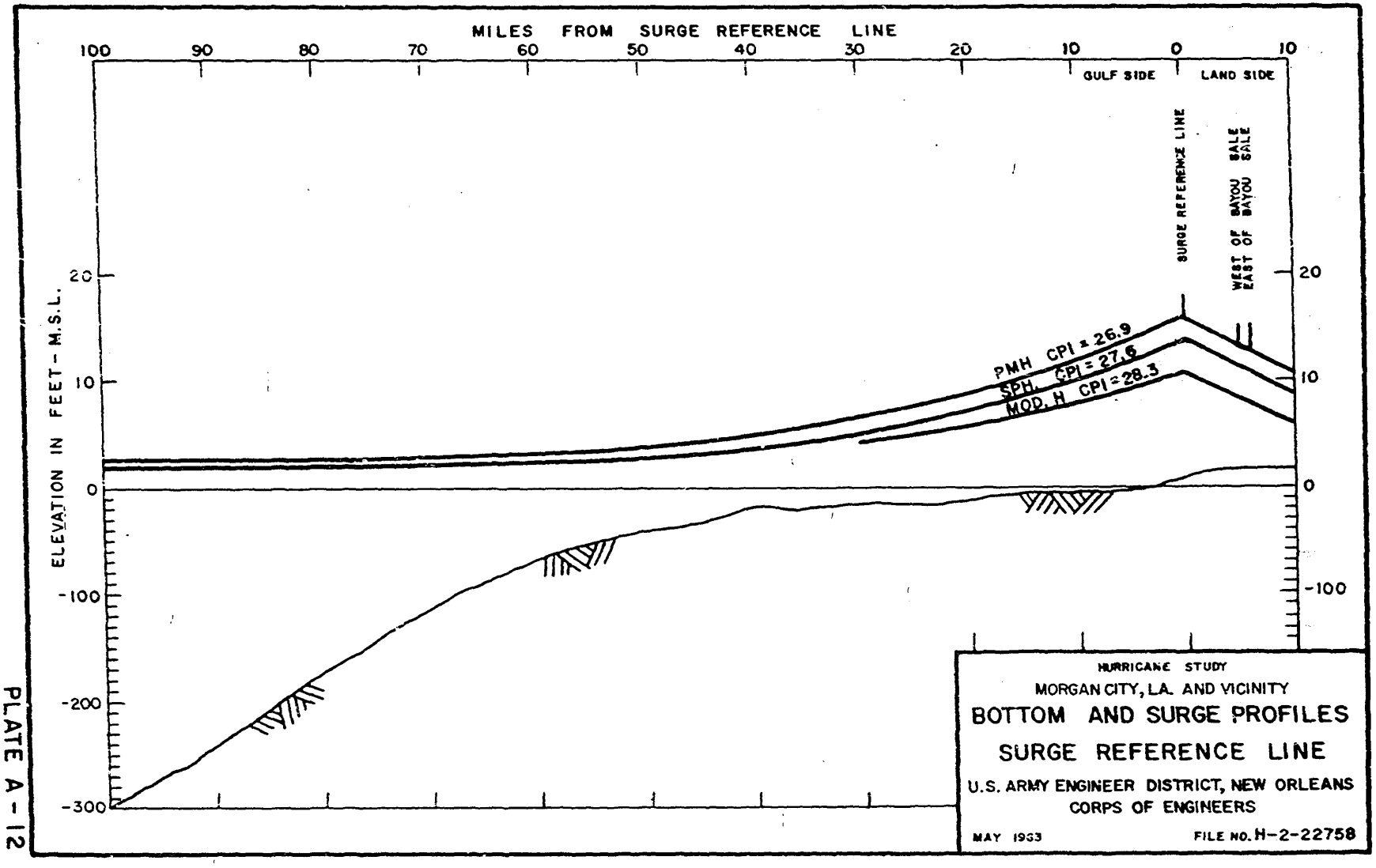

MILES FROM SURGE REFERENCE LINE
100
90
80
70
60
50
40
30
20
10
0
10
GULF SIDE
LAND SIDE
SURGE REFERENCE LINE
WEST OF BAYOU SALE
EAST OF BAYOU SALE
ELEVATION IN FEET - M.S.L.
20
10
0
-100
-200
-300
PMH CPI = 26.9
SPH CPI = 27.6
MOD. H CPI = 28.3
HURRICANE STUDY
MORGAN CITY, LA. AND VICINITY
BOTTOM AND SURGE PROFILES
SURGE REFERENCE LINE
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MAY 1963
FILE NO. H-2-22758

PLATE A - 12

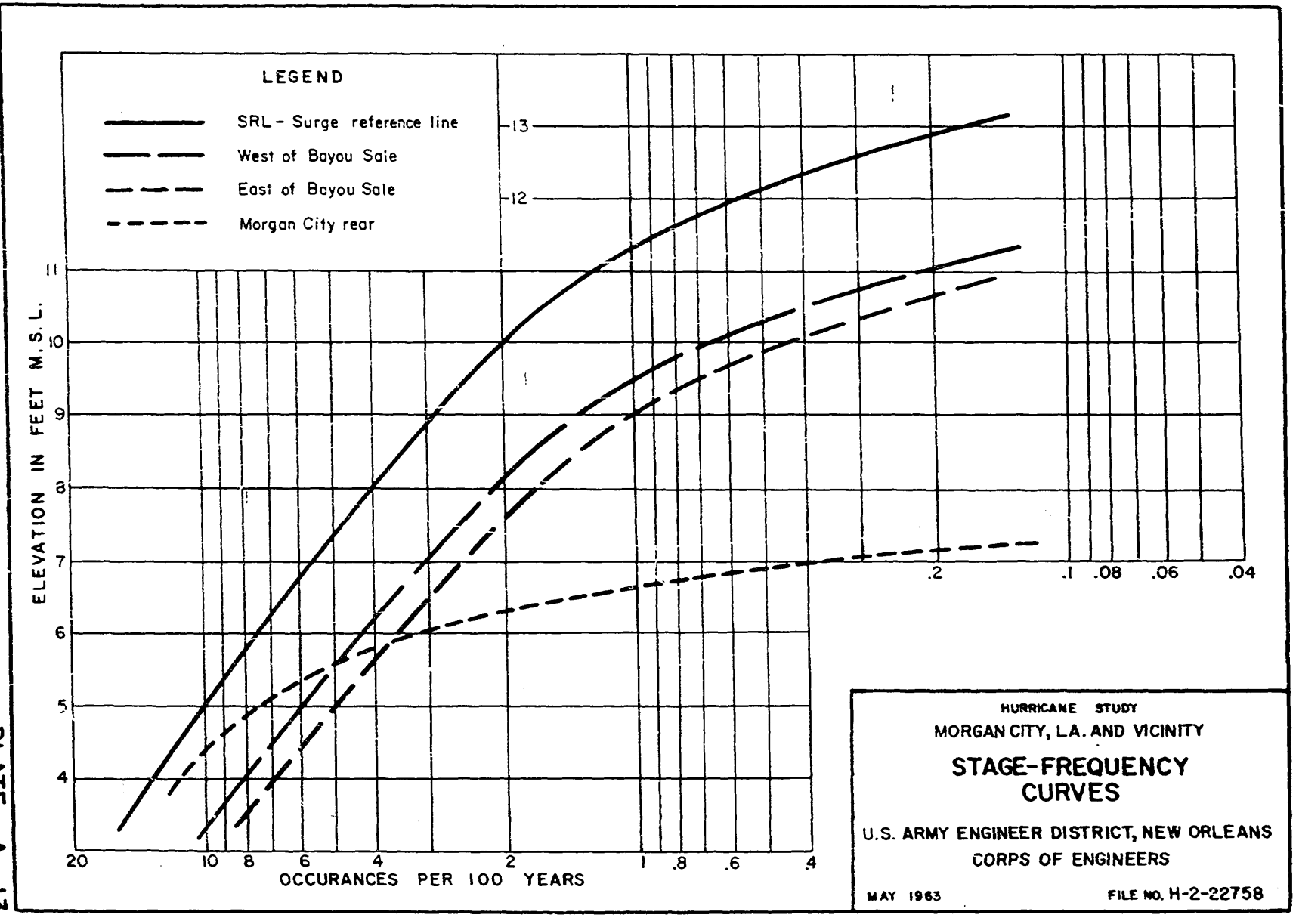

LEGEND
SRL - Surge reference line
West of Bayou Sale
East of Bayou Sale
Morgan City rear
ELEVATION IN FEET M.S.L.
OCCURANCES PER 100 YEARS
20
10
8
6
4
2
1
.8
.6
.4
.2
.1
.08
.06
.04
13
12
11
10
9
8
7
6
5
4
HURRICANE STUDY
MORGAN CITY, LA. AND VICINITY
STAGE-FREQUENCY CURVES
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
MAY 1963
FILE NO. H-2-22758

PLATE A-13

APPENDIX B

GEOLOGY

B-1 SUBSURFACE INVESTIGATION

No borings were made in conjunction with this survey. However, sufficient boring data is available from other projects, as well as geologic information, for interpretation of the physiography, subsurface, and foundation conditions of the area.

B-2 SUBSURFACE CONDITIONS

a. The subsurface, as shown by the map on plate B-1 and by the generalized sections on plate B-2, consists of Recent deposits except on the south side of the Teche ridge in the vicinity of Franklin, and at Belle Isle, where Pleistocene deposits comprise the subsurface. The Recent deposits vary in depth from zero near the northwest boundary of the study area to approximately 250 feet in the northeast section. These Recent deposits are underlain by Pleistocene (Prairie Formation) soils. Physiographic features and their relation to the proposed plans of protection are shown on plate B-3.

b. A surface stratum in the Recent consists generally of very soft peat and organic clay with local zones of silt and sand. This layer varies in depth from zero in the northwest corner and adjacent to the natural levee ridges, to about 30 feet in the marshlands remote from the natural levees. Along the ancient distributary courses, the natural levees and channel fillings are predominantly silts, sands, and lean clays. Underlying the marsh and channel filling deposits is a stratum of clay containing layers and zones of silts and sands. West of Wax Lake Outlet, the clay stratum lies directly on top of the Pleistocene. East of Wax Lake Outlet, the clay stratum is underlain by a stratum of sand which thickens eastward.

c. The beaches around the bays consist of ridges, 2 to 3 feet high. They are composed of shells and shell fragments interbedded with thin clay layers and organic layers, and are underlain by marsh deposit.

d. The Point Au Fer reef zone, located in the southern extremity of the area, extends to a depth of about 14 feet below m.s.l. It consists generally of well cemented oyster and clam shells.

e. The lake area north of Bayou Teche consists predominantly of backswamp deposits comprised of soft clays with isolated silt and fine sand lenses, and layers of wood. These backswamp deposits extend in depth for approximately 125 to 135 feet and are underlain by a thick stratum of sand.

B-3 EROSION

Wave action and subsidence have been the dominant factors in the study area since the Mississippi River abandoned the area and occupied its present course. Erosion by wave action has resulted in a retreat of the shoreline. At present, sediments carried down the Atchafalaya River are filling the lake area to the north of the Teche ridge. After the lake area becomes filled, appreciable sediments from the Atchafalaya will be transported through Wax Lake Outlet and the Lower Atchafalaya River and deposited in Atchafalaya Bay. These sediments will compensate for the material being lost by wave action and eventually will cause the shoreline to advance.

B-4 REGIONAL SUBSIDENCE

The area under study is located near the central axis of the Gulf Coast Geosyncline. Since the close of the Tertiary period, the Quaternary Sediments in the area have been subjected to downwarping and consolidation. At present, the rate of subsidence has been estimated to be about 1 or 2 feet per century. This rate of subsidence decreases inland.

B-5 FOUNDATION CONDITIONS

The best foundation conditions are found on the natural levee and beach ridges and in the northwest section where the Pleistocene (Prairie Formation) outcrops or is near the surface. As a general rule, the soil conditions become progressively worse with increasing distance away from the ridges and the Pleistocene outcrop. Sections A-A' and B-B' on plate B-2 show the generalized soil conditions in the subsurface.

B-6 MINERAL RESOURCES

Shell for construction purpose is available from the shell reef and from dredging on the bay bottoms. Oil and gas are produced within the study area, particularly in the northeast and southwest sections. However, this production will not be affected adversely by the project.

B-7 CONCLUSIONS

Levees can be constructed over both the natural levee ridges and the marsh surface. Generally, levees on the natural levee ridges can be constructed in one lift. However, the levees in the marsh areas will have to be constructed in two lifts because of poor subsurface conditions. The settlement of the levees constructed over the marsh will be much greater than that of the levees constructed over the ridges. Because of this, the levees should be located, insofar as is practical, on or near the ridges.

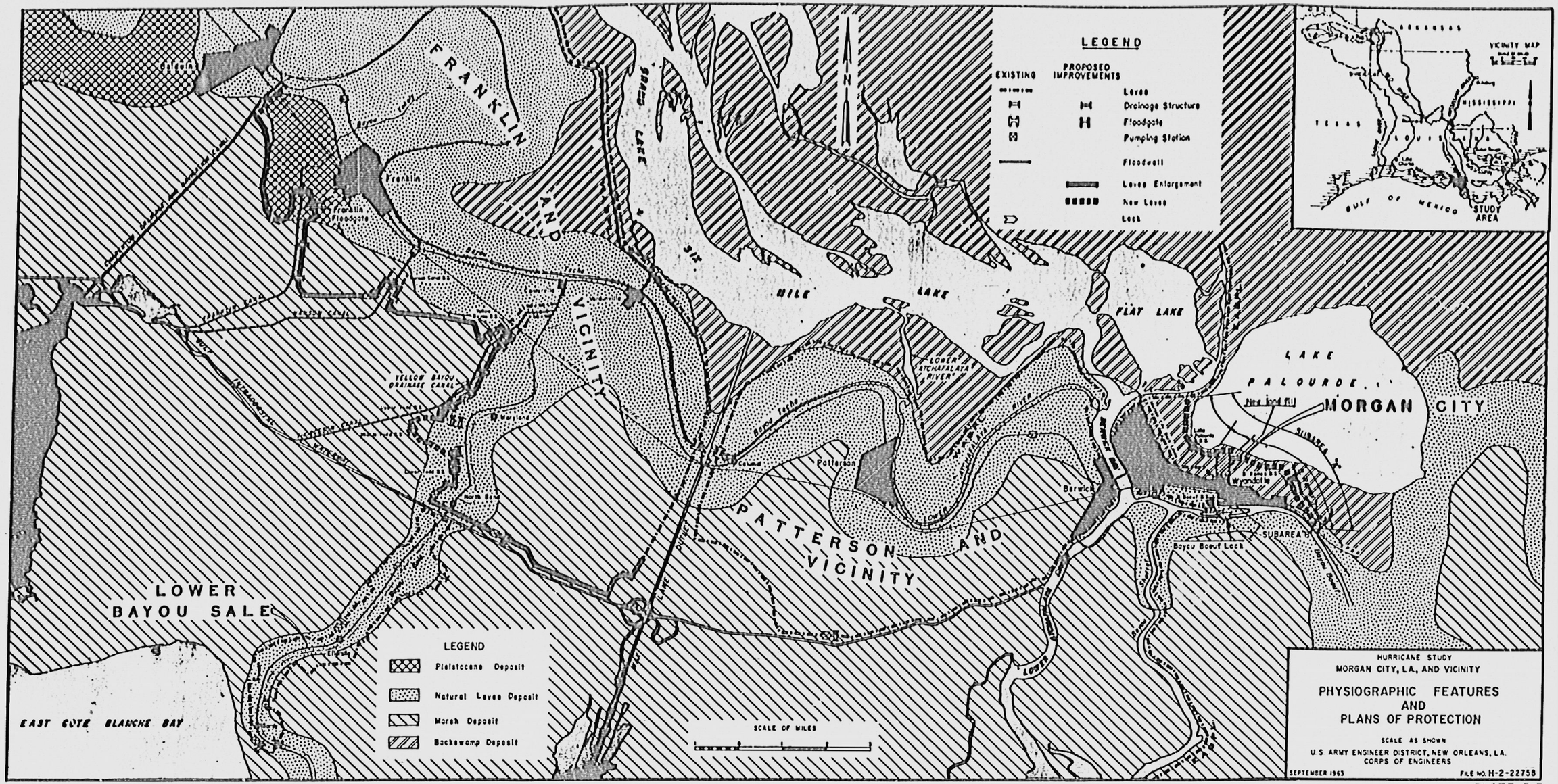


PLATE B-3

APPENDIX C

FLOOD LOSSES AND BENEFITS

C-1 MEASUREMENT OF FLOOD DAMAGES

a. Very little of the improved lands has been severely flooded during recent times, therefore, in order to have a basis for determining the feasibility of the proposals for hurricane flood protection, an appraisal survey was made of the improvements likely to be damaged by floodwaters and economic activities that would be affected within the study area. Tabulations were made of all residences, out-buildings, commercial, industrial, church and public buildings, and other improvements by type of construction, type of business, elevations of floor, and estimated replacement value. Damage relationships between building values and depth of flooding over floors were established from a large amount of data accumulated in damage surveys made following recent hurricanes in this region and in other flood damage surveys. These relationships were then used in estimating physical damages that would result to buildings, furnishings, and equipment from selected flood stages. Other physical damages considered included loss of stock on hand in retail and wholesale trade, damage to crops, and utilities. Non-physical losses evaluated included loss of net profit and salaries in wholesale, retail, and manufacturing trades, utilities, selected services, and miscellaneous services, evacuation and extra subsistence cost of residents moved to points of safety and costs of debris removal. Agricultural losses were based on the assumption that hurricane occurrences would be in the month of September. The majority of hurricanes has occurred in this month.

b. As a basis for the economic analysis, stage-damage curves were constructed for the numerous independent areas within the study area. These curves were based on data obtained as described in paragraph C-1 a.

C-2 ANNUAL LOSSES AND BENEFITS

a. Average annual flood damages. Average annual damages were obtained by combining stage-damage curves with stage-frequency curves to obtain damage-probability curves. The area under the damage-probability curve represents the average annual damage. Stage-damage, stage-frequency, and damage-probability curves for Morgan City subarea A, reach 1, which are typical of the curves used in the study, are shown on plates C-1, C-2, and C-3. This reach is bounded by the existing back levee, Atchafalaya Basin levee, Morgan City floodwall, and the Southern Pacific Railroad.

The average annual damages, based on present development and May 1963 price levels on noncrop features and 1962 seasonal average prices on crop features, are as follows:

Area	Average annual damage		
	Noncrop	Crop	Total
Morgan City			
Subarea A			
Reach 1*	$ 64,200	$ -	$ 64,200
Reach 2*	6,100	-	6,100
Reach 3*	4,100	-	4,100
Reach 4*	-	-	-
Subarea B	5,200	-	5,200
Area along Bayou Boeuf east of Morgan City	5,800	-	5,800
Franklin and vicinity	69,300	3,300	72,600
Lower Bayou Sale	7,200	1,200	8,400
Remainder of study area	70,000	-	70,000
Study area total	$231,900	$ 4,500	$236,400

*1 Portion of Morgan City bounded by back levee, Atchafalaya Basin levee, Morgan City floodwall, and Southern Pacific Railroad embankment.
2 Area bounded by new land fill, Morgan City back levee, Southern Pacific Railroad embankment, Bayou Ramos, and Lake Palourde.
3 Area bounded by Morgan City back levee, new land fill, Lake Palourde, and Atchafalaya Basin levee.
4 New land fill located near Wyandotte and extending from Morgan City back levee to shore of Lake Palourde.

b. Average annual damage prevention benefits. The average annual benefits from flood damage prevented is the average annual damage without the proposed projects less the average annual damage remaining with the proposed projects in place. The projects are designed to protect against flooding from the standard project hurricane (SPH). The residual damages consist of damages resulting from hurricane occurrences less frequent than the SPH. Damage resulting from flooding from rainfall would not be preventable and has been eliminated from damage estimates. The average annual flood damage under present conditions, with the proposed projects in place,

and the average annual damage prevented, in the several areas are as follows:

Area	Av. ann. damage present conditions			Av. ann. damage with prop. projects in place			Av. ann. damage prevented
	Noncrop	Crop	Total	Noncrop	Crop	Total	
Morgan City Subarea A							
Reach 1*	$ 64,200	-	$64,200	$11,500	-	$11,500	$52,700
Reach 2*	6,100	-	6,100	700	-	700	5,400
Reach 3*	4,100	-	4,100	200	-	200	3,900
Reach 4*	-	-	-	-	-	-	-
TOTAL	$ 74,400	-	$74,400	$12,400	-	$12,400	$62,000
Subarea B	$ 5,200	-	$ 5,200	$ 900	-	$ 900	$ 4,300
Area along Bayou Boeuf east of Morgan City	$ 5,800	-	$ 5,800	No protection proposed.			
Franklin and vicinity	$ 69,300	$3,300	$72,600	$12,800	$500	$13,300	$59,300
Lower Bayou Sale	$ 7,200	$1,200	$ 8,400	No protection recommended.			
Remainder of study area	$ 70,000	-	$70,000	No protection proposed.			
TOTAL	$231,900	$4,500	$236,400				

*See footnote on page 84

c. Adjustment of average annual damage prevention benefits to account for future growth. Analysis of the growth trend of Morgan City indicates a population of about 30,000 within the next 50 years and about 43,000 within 100 years. This growth indicates that the unoccupied lands suitable for development without additional flood protection would be developed for residential, commercial, and other uses within a period of about 50 years. This would indicate that a substantial area of additional land will need to be provided with protection to accommodate the future growth. The growth trend in Franklin and vicinity indicates a population of about 20,000 within 50 years and about 30,000 within 100 years. It is probable that a substantial part of the growth will occur on the high lands along the banks of Bayou Teche above the limits of hurricane tidal

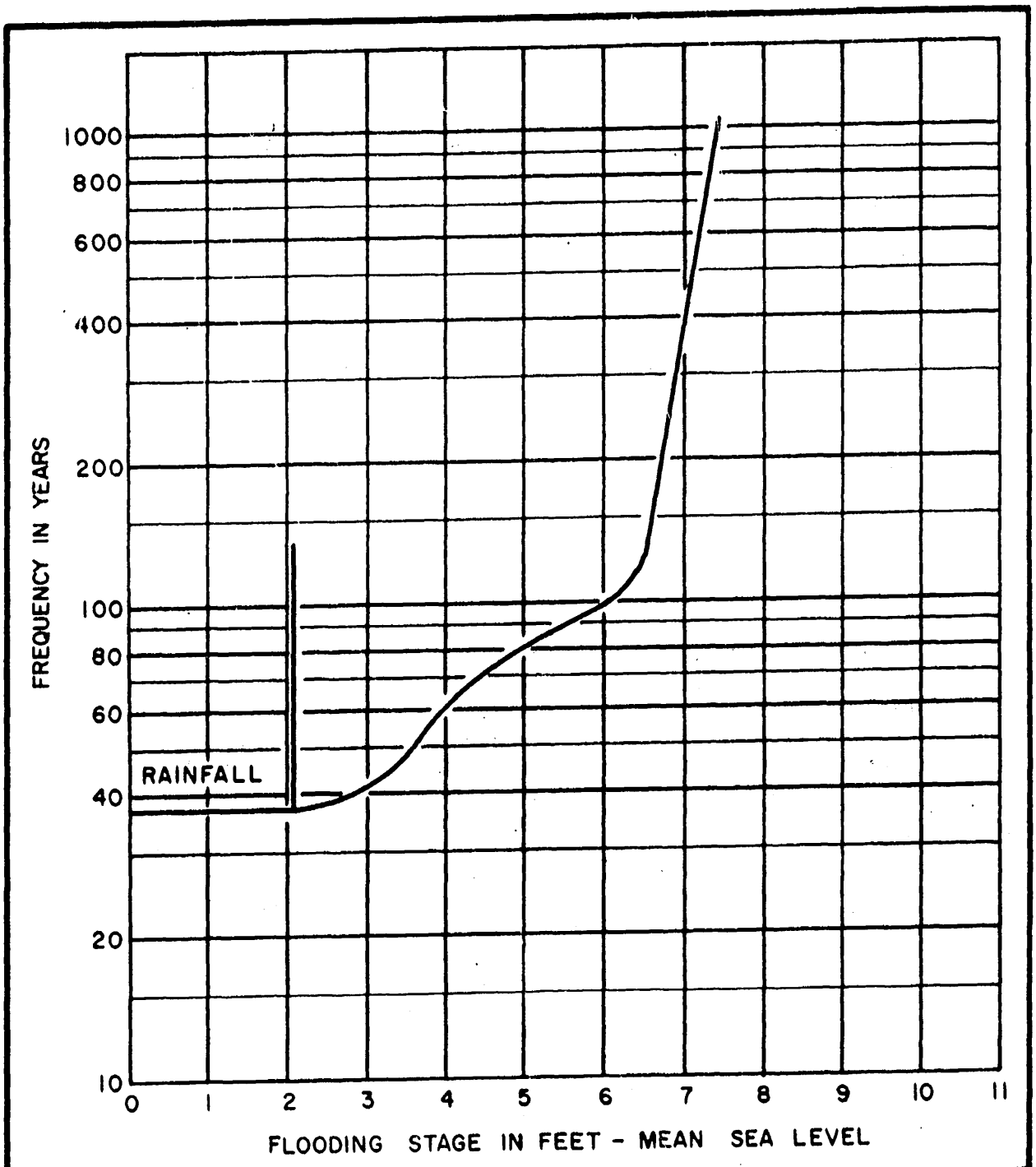
47-540 O-65—7

flooding. A new bridge is being constructed over Bayou Teche at Franklin which will provide access to attractive residential areas on the north bank of the bayou. It has been assumed that approximately one-half of the future growth will occur in areas subject to overflow. It was assumed that future improvements constructed in these areas would be similar to those in adjoining developed areas within overflow limits. It is indicated that within the Morgan City area future development likely to occur without additional flood protection would consist mainly of house construction with some additional construction of shopping centers, schools, and churches in reaches 1 and 4 with a value of about $41,000,000, and in reach 2 and subarea B future expansion of commercial and industrial construction in excess of $1,000,000 is indicated. Within the vicinity of Franklin, it is probable that future development will consist mainly of house construction which is estimated at $45,000,000. Future development of commercial, industrial, and public buildings in the Franklin area would probably take place near the main highway along Bayou Teche outside the limits of overflow. Benefits from reduction of overflow on agricultural land were based on the present land use. Sugar cane is the principal source of income from these lands and occupies about 64 percent of the land. About 7 percent is used for pasture and 29 percent remains fallow each season. No significant future change in land use is indicated. The loss of agricultural land will result from urban growth in and near Franklin; however, this loss will probably be recovered by conversion of woodland and a reduction in fallow land. The effect on agricultural benefits would be small. Stage-damage relationships were established in the future growth areas and annual damages were estimated on the basis of full development, reduced by annual residual damages and then discounted to annual equivalent values based on a project life of 100 years and an interest rate of 3 percent. The estimated average annual damages prevented on future development and the total average annual damage prevented are outlined in the following tabulation:

Area	Ann. damage prevented on future development (full dev.)	Est. years req'd. for dev.	Discount factor	Discounted ann. damage prevented	Annual damage prev. on existing dev.	Total annual damage prevented
Morgan City Subarea A						
Reach 1*	$178,100	50	0.504	$ 89,800	$52,700	$142,500
Reach 2*	1,400	25	0.702	1,000	5,400	6,400
Reach 3*	None	-	-	-	3,900	3,900
Reach 4*	28,000	20	0.753	21,100	None	21,100
TOTAL	$207,500			$111,900	$62,000	$173,900
Subarea B	$ 1,100	25	0.702	$ 800	$ 4,300	$ 5,100
Franklin and vicinity	$394,500	100	0.288	$113,600	$59,300	$172,900

*See footnote on page 84

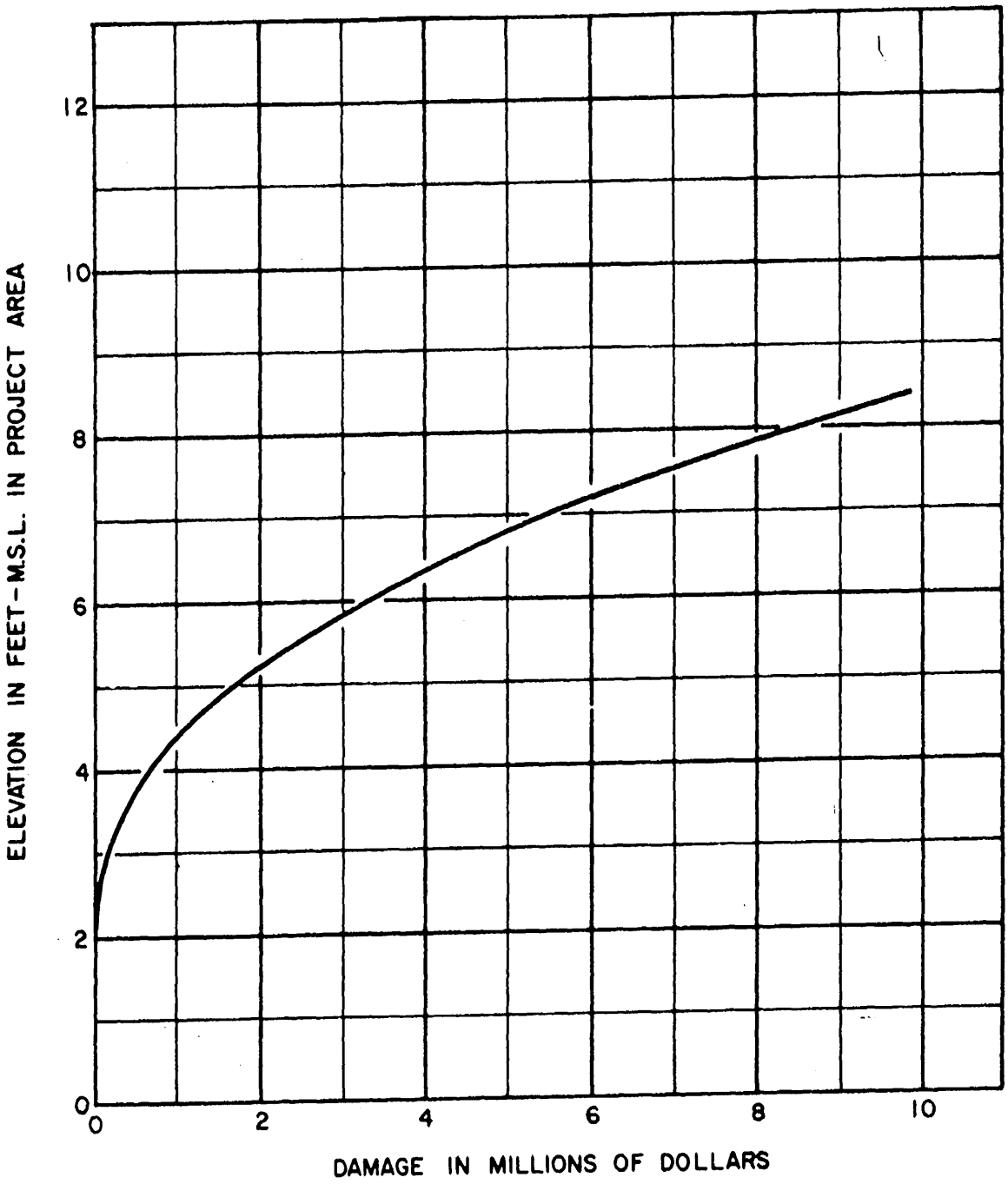
d. Enhancement benefits. Protection will be provided by the proposed Morgan City back levee to 1,128 acres of wooded swampland. The plan will include gravity drainage facilities to provide for drainage intercepted by the new levee. Upon completion of the proposed levee, construction of drainage improvements and development of these lands for residential and commercial use can be accomplished by local and private interests. The present (1963) appraised value, as determined by qualified real estate appraisers after consultation with local real estate firms and examination of the lands to be protected, is $1,128,000. It is estimated that by providing flood protection the lands will have an enhanced value of $2,820,000. These values are based on uniform values of $1,000 and $1,500 per acre throughout the area. This enhanced value is exclusive of enhancement that would result from drainage and other improvements. Pumping facilities will be required before full development of the area can take place. These facilities are to be provided by local interests and neither their cost nor benefits have been included in this evaluation. The annual value of the enhancement based on the increased value of $1,692,000 at a 5 percent interest rate is $84,600. In consideration of the rate of growth and land transactions in the vicinity, it is probable that sale of these lands to developers would be accomplished within 25 years. The discounted annual value of the enhancement on this basis is $59,400 ($84,600 x 0.702).



HURRICANE STUDY
MORGAN CITY, LA., AND VICINITY
MORGAN CITY-SUBAREA A
REACH 1
STAGE-FREQUENCY

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
SEPTEMBER 1963 FILE NO. H-2-22758

PLATE C-1



HURRICANE STUDY
MORGAN CITY, LA., AND VICINITY
MORGAN CITY-SUBAREA A
REACH I
STAGE-DAMAGE

U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
SEPTEMBER 1963 FILE NO. H-2-22758

PLATE C-2

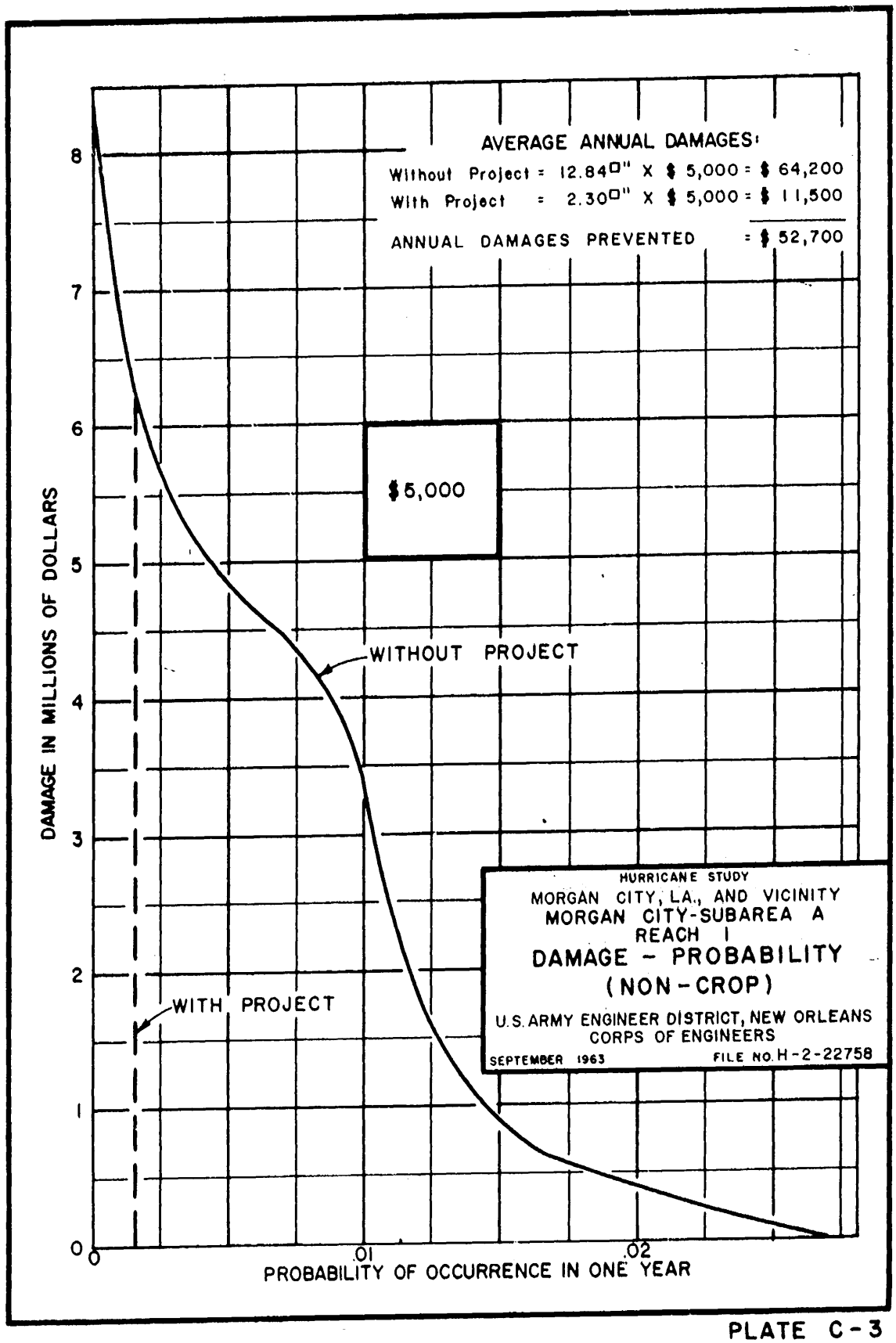

AVERAGE ANNUAL DAMAGES:
Without Project = 12.84□" X $ 5,000 = $ 64,200
With Project = 2.30□" X $ 5,000 = $ 11,500
ANNUAL DAMAGES PREVENTED = $ 52,700
$5,000
WITHOUT PROJECT
WITH PROJECT
DAMAGE IN MILLIONS OF DOLLARS
PROBABILITY OF OCCURRENCE IN ONE YEAR
0
1
2
3
4
5
6
7
8
.01
.02
HURRICANE STUDY
MORGAN CITY, LA., AND VICINITY
MORGAN CITY-SUBAREA A
REACH I
DAMAGE - PROBABILITY
(NON-CROP)
U.S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
SEPTEMBER 1963
FILE NO. H-2-22758

PLATE C-3

APPENDIX D

COST ESTIMATES
(Based on May 1963 prices)

TABLE D-1
MORGAN CITY, SUBAREA A

FIRST COST
LEVEE, LAND, AND RELOCATIONS

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEE AND FLOODWALLS				
	Levee, cast	720,000	cu.yd.	$ 0.75	$ 540,000
	Levee, haul	22,525	cu.yd.	1.50	33,788
	Seeding	52.5	acre	60.00	3,150
	Subtotal				$ 576,938
	Contingencies				151,062
	Subtotal				$ 728,000
30	Engineering and design				57,000
31	Supervision and administration				37,000
	Subtotal levee and floodwalls				$ 822,000
	LAND				
	Levee and borrow	318	acre	variable	$ 350,000
	Contingencies				35,000
	Market value				$ 385,000
	Severance				84,200
	Acquisition				800
	TOTAL LAND				$ 470,000
	RELOCATIONS				
	Alteration of road			lump sum	$ 4,500
	Powerline	0.25	mile	$10,000.00	2,500
	Telephone line	0.25	mile	10,000.00	2,500
	Subtotal				$ 9,500
	Contingencies				2,500
	TOTAL RELOCATIONS				$ 12,000

TABLE D-2
MORGAN CITY, SUBAREA A

FIRST COST
LAKE PALOURDE DRAINAGE STRUCTURE

Class No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Excavation, structure	2,200	cu.yd.	$ 1.50	$ 3,300
	Excavation, channel	27,200	cu.yd.	0.50	13,600
	Timber piling	2,400	lin.ft.	2.50	6,000
	Sheet piling MA-22	600	sq.ft.	3.50	2,100
	Sheet piling Z-38	4,500	sq.ft.	6.00	27,000
	Concrete	100	cu.yd.	80.00	8,000
	Steel, reinforcement	13,800	lb.	0.15	2,070
	Portland cement	140	bbl.	6.00	840
	Backfill	800	cu.yd.	2.00	1,600
	Riprap	245	ton	12.00	2,940
	Filter under riprap	70	cu.yd.	6.00	420
	Flap gate, 60 in.	6	each	1,500.00	9,000
	Subtotal				$ 76,870
	Contingencies				19,130
	Subtotal				$ 96,000
30	Engineering and design				8,000
31	Supervision and administration				5,000
	Subtotal levees and floodwalls				$109,000

TABLE D-3
MORGAN CITY, SUBAREA A

FIRST COST
BAYOU RAMOS DRAINAGE STRUCTURE

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Excavation, structure	520	cu.yd.	$ 1.50	$ 780
	Excavation, channel	320	cu.yd.	1.00	320
	Pipe, corr. metal, 48 in.	212	lin.ft.	25.00	5,300
	Flap gate, 48 in.	2	each	750.00	1,500
	Riprap	40	ton	15.00	600
	Filter under riprap	12	cu.yd.	6.00	72
	Backfill	300	cu.yd.	2.00	600
	Subtotal				$ 9,172
	Contingencies				1,828
	Subtotal				$ 11,000
30	Engineering and design				1,000
31	Supervision and administration				1,000
	Subtotal levees and floodwalls				$ 13,000

TABLE D-4
MORGAN CITY, SUBAREA A

SUMMARY OF ESTIMATES OF FIRST COST

Class No.	Item	Cost
11	LEVEE AND FLOODWALLS	
	Levee construction	$ 728,000
	Drainage structures (2)	107,000
	Subtotal	$ 835,000*
30	Engineering and design	66,000
31	Supervision and administration	43,000
	Subtotal	$ 109,000
	TOTAL LEVEE AND FLOODWALLS	$ 944,000
	Lands and damages	$ 469,200*
	Acquisition cost	800
	Subtotal	$ 470,000
	Relocations	12,000*
	FIRST COST	$1,426,000

(Cost estimate is exclusive of preauthorization cost of $17,000.)

*Includes contingencies.

TABLE D-5
MORGAN CITY, SUBAREA A

ESTIMATE OF APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS

1. Project first cost

Construction	$ 944,000
Lands, damages, and relocations	482,000
TOTAL	$1,426,000

2. Apportionment of cost

	Federal 70%	Non-Federal 30%
	$998,000*	$ 428,000
Less lands, damages, and relocations		482,000
Cash contribution		None

*Non-Federal costs for lands, etc., are in excess of 30 percent of total project costs, therefore, the Federal government will provide the total construction costs of $944,000.

TABLE D-6
MORGAN CITY, SUBAREA A

ESTIMATE OF ANNUAL ECONOMIC COST

Summary of project costs	Federal	Non-Federal	Total
Construction	$944,000	$ -	$ 944,000
Lands, damages, and relocations	-	482,000	482,000
FIRST COST	$944,000	$482,000	$1,426,000
Interest during constr. (2 yrs.)	28,300	14,500	42,800
TOTAL PROJECT INVESTMENT	$972,300	$496,500	$1,468,800
Annual economic costs			
Interest (3%)	$ 29,200	$ 14,900	$ 44,100
Amortization (100 yrs.)	1,600	800	2,400
Maintenance*	-	1,000	1,000
Replacements**	-	100	100
Economic loss on land (Market value $385,000 @ .02)	-	7,700	7,700
TOTAL	$ 30,800	$ 24,500	$ 55,300

*Annual maintenance consists of the following:

Maintenance of drainage structures (2) Job	$ 300
Levee grass cutting 50 ac. @ $14	700
Total	$1,000

**Annual equivalent cost of replacement:
Replacement of pipes in structure No. 2 in 50 yrs.
($10,100 x .22811 x .03165 = $73) (Rounded $100)

TABLE D-7
MORGAN CITY, SUBAREA B

FIRST COST
LEVEE AND LAND

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Levee, haul	16,800	cu.yd.	$ 1.50	$ 25,200
	Seeding		job	lump sum	200
	Subtotal				$ 25,400
	Contingencies				6,600
	Subtotal				$ 32,000
30	Engineering and design				3,000
31	Supervision and administration				1,700
	Subtotal levees and floodwalls				$ 36,700
	LAND				
	Levee	7.5	acre	variable	$ 32,000
	Contingencies				2,900
	Market value				$ 34,900
	Acquisition cost				100
	TOTAL LAND				$ 35,000

TABLE D-8
MORGAN CITY, SUBAREA B

FIRST COST
BAYOU BOEUF DRAINAGE STRUCTURE

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Excavation, structure	540	cu.yd.	$ 1.50	$ 810
	Excavation, channel	1,680	cu.yd.	0.80	1,344
	Pipe, corr. metal, 48 in.	80	lin.ft.	25.00	2,000
	Flap gate, 48 in.	1	each	750.00	750
	Backfill	315	cu.yd.	2.00	630
	Subtotal				$ 5,534
	Contingencies				1,466
	Subtotal				$ 7,000
30	Engineering and design				1,000
31	Supervision and administration				300
	Subtotal levees and floodwalls				$ 8,300

TABLE D-9
MORGAN CITY, SUBAREA B

SUMMARY OF ESTIMATES OF FIRST COST

Class. No.	Item	Cost
11	LEVEES AND FLOODWALLS	
	Levee construction	$ 32,000
	Drainage structure	7,000
	Subtotal	$ 39,000*
30	Engineering and design	4,000
31	Supervision and administration	2,000
	Subtotal	$ 6,000
	TOTAL LEVEES AND FLOODWALLS	$ 45,000
	Lands and damages	$ 34,900*
	Acquisition cost	100
	Subtotal	$ 35,000
	FIRST COST	$ 80,000

(Cost estimate is exclusive of preauthorization cost of $5,000.)
*Includes contingencies.

TABLE D-10
MORGAN CITY, SUBAREA B

ESTIMATE OF APPORTIONMENT OF COSTS BETWEEN FEDERAL AND NON-FEDERAL INTERESTS

1. Project first cost

Construction	$ 45,000
Lands and damages	35,000
TOTAL	$ 80,000

2. Apportionment of cost

	Federal 70%	Non-Federal 30%
	$56,000*	$ 24,000
Less lands and damages		35,000
Cash contribution		None

*Non-Federal costs for lands, etc., are in excess of 30 percent of total project costs, therefore, the Federal government will provide the total construction costs of $45,000.

TABLE D-11
MORGAN CITY, SUBAREA B

ESTIMATE OF ANNUAL ECONOMIC COST

Summary of project costs	Federal	Non-Federal	Total
Construction	$ 45,000	$ -	$ 45,000
Lands and damages	-	35,000	35,000
FIRST COST	$ 45,000	$ 35,000	$ 80,000
Annual economic costs			
Interest (3%)	$ 1,300	$ 1,000	$ 2,300
Amortization (100 yrs.)	100	100	200
Maintenance*	-	150	150
Replacements**	-	50	50
Economic loss on land (Market value $34,900 @ .02)	-	700	700
TOTAL	$ 1,400	$ 2,000	$ 3,400

*Annual maintenance consists of the following:

Maintenance of drainage structure	Job	$ 100
Levee grass cutting 3.5 ac. @ $14		50
	Total	$ 150

**Annual equivalent cost of replacement:
Replacement of pipes in drainage structure in 50 yrs.
($5,500 x .22811 x .03165 = $40) (Rounded $50.)

TABLE D-12
FRANKLIN AND VICINITY

FIRST COST
LEVEES, LAND, AND RELOCATIONS

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Levee, cast	2,307,434	cu.yd.	$ 0.35	$ 807,602
	Levee, haul	110,410	cu.yd.	1.50	165,615
	Seeding	176	acre	60.00	10,560
	Subtotal				$ 983,777
	Contingencies				159,223
	Subtotal				$1,143,000
30	Engineering and design				82,000
31	Supervision and administration				80,000
	Subtotal levees and floodwalls				$1,305,000
	LAND				
	Levee and borrow	449.7	acre	variable	$ 84,840
	Contingencies				8,560
	Market value				$ 93,400
	Improvements				800
	Acquisition cost				2,800
	TOTAL LAND				$ 97,000
	RELOCATIONS				
	Modification of outlet pipes of pumping plants and drainage culvert pipes:				
	Bayou Yokely pumping plant			lump sum	$ 71,000
	Franklin pumping plant & 1-60" culv.pipe			lump sum	45,000
	Centerville pumping plant & 3-60" " pipes			lump sum	59,000
	Maryland pumping plant & 1-60" " pipe			lump sum	49,000
	North Bend pumping plant			lump sum	45,000
	Five 60" and one 36" culv. pipes			lump sum	28,000
	Subtotal				$ 297,000
	Four 4" pipelines	515	lin.ft.	$ 21.00	10,815
	Three 6" pipelines	340	lin.ft.	31.50	10,710
	Two 8" pipelines	210	lin.ft.	42.00	8,820
	Two 20" pipelines	215	lin.ft.	106.75	22,951
	Two 22" pipelines	215	lin.ft.	117.25	25,209
	Two 24" pipelines	170	lin.ft.	127.75	21,717
	One 30" pipeline	85	lin.ft.	159.25	13,536
	Two 36" pipelines	260	lin.ft.	190.75	49,595
	Alteration State Hwy.317	180	lin.ft.	9.50	1,710
	Road on Wax L. West levee	2,370	cu.yd.	2.00	4,740
	Subtotal				$ 169,803
	Contingencies				42,197
	Subtotal				$ 212,000
	Engineering and design				15,000
	Supervision and administration				14,000
	Subtotal				$ 241,000
	TOTAL RELOCATIONS				$ 538,000

TABLE D-13
FRANKLIN AND VICINITY

FIRST COST
FRANKLIN CANAL FLOODGATE

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Earth cofferdams	6,700	cu.yd.	$ 2.00	$ 13,400
	Dewatering	1	job	lump sum	56,000
	Excavation, structure	9,200	cu.yd.	1.00	9,200
	Timber piling	15,300	lin.ft.	2.50	38,250
	Stabilization slab, concrete	130	cu.yd.	30.00	3,900
	Concrete in base slab	1,250	cu.yd.	40.00	50,000
	Conc.in wall,bridge,etc.	1,000	cu.yd.	60.00	60,000
	Portland cement	3,280	bbl.	5.00	16,400
	Steel, reinforcement	337,500	lb.	0.15	50,625
	Metal work, misc.	17,000	lb.	0.45	7,650
	Wall armor and armor plate	5,500	lb.	0.35	1,925
	Sheet piling, MA-22	1,700	sq.ft.	3.50	5,950
	Floodwall	70	lin.ft.	180.00	12,600
	Control houses	2	each	8,000.00	16,000
	Handrail	450	lin.ft.	8.00	3,600
	Timber guidewalls	400	lin.ft.	140.00	56,000
	Riprap	925	ton	12.00	11,100
	Filter under riprap	500	cu.yd.	6.00	3,000
	Sector gate	152,000	lb.	0.50	76,000
	Operating machinery and electrical work	1	job		30,000
	Backfill	4,400	cu.yd.	1.50	6,600
	Subtotal				$528,200
	Contingencies				132,800
	Subtotal				$661,000
30	Engineering and design				48,000
31	Supervision and administration				45,000
	Subtotal levees and floodwalls				$754,000

TABLE D-14
FRANKLIN AND VICINITY

FIRST COST
HANSON CANAL DRAINAGE STRUCTURE

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Earth cofferdams	6,500	cu.yd.	$ 2.00	$ 13,000
	Pipe, corr. metal, 60 in.	510	lin.ft.	45.00	22,950
	Flap gate, 60 in.	2	each	1,000.00	2,000
	Backfill	4,200	cu.yd.	2.00	8,400
	Riprap	350	ton	12.00	4,200
	Filter	115	cu.yd.	6.00	690
	Dewatering	1	job	lump sum	2,000
	Subtotal				$ 53,240
	Contingencies				12,760
	Subtotal				$ 66,000
30	Engineering and design				5,000
31	Supervision and administration				6,000
	Subtotal levees and floodwalls				$ 77,000

TABLE D-15
FRANKLIN AND VICINITY

FIRST COST
YELLOW BAYOU DRAINAGE STRUCTURE

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Excavation, structure	2,500	cu.yd.	$ 1.50	$ 3,750
	Timber piling	2,500	lin.ft.	2.50	6,250
	Steel sheet piling, MA-22	470	sq.ft.	3.50	1,645
	Floodwall	150	lin.ft.	300.00	45,000
	Concrete in stab. slab	10	cu.yd.	30.00	300
	Concrete in structure	150	cu.yd.	80.00	12,000
	Portland cement	210	bbl.	6.00	1,260
	Steel, reinforcement	21,000	lb.	0.15	3,150
	Backfill on floodwall	2,100	cu.yd.	2.00	4,200
	Riprap	195	ton	12.00	2,340
	Filter under riprap	60	cu.yd.	6.00	360
	Flap gate, 60"	4	each	1,500.00	6,000
	Excavation channel	3,800	cu.yd.	0.50	1,900
	Subtotal				$ 88,155
	Contingencies				21,845
	Subtotal				$110,000
30	Engineering and design				8,000
31	Supervision and administration				6,000
	Subtotal levees and floodwalls				$124,000

TABLE D-16
FRANKLIN AND VICINITY

FIRST COST
UPPER TODD DRAINAGE STRUCTURE

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Excavation, structure	1,500	cu.yd.	$ 1.50	$ 2,250
	Pipe, corr. metal, 48 in.	250	lin.ft.	25.00	6,250
	Flap gate, 48 in.	1	each	750.00	750
	Backfill	900	cu.yd.	2.00	1,800
	Subtotal				$ 11,050
	Contingencies				2,950
	Subtotal				$ 14,000
30	Engineering and design				1,000
31	Supervision and administration				1,200
	Subtotal levees and floodwalls				$ 16,200

TABLE D-17
FRANKLIN AND VICINITY

FIRST COST
MIDDLE TODD DRAINAGE STRUCTURE

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Excavation, structure	1,600	cu.yd.	$ 1.50	$ 2,400
	Pipe, corr. metal, 54 in.	250	lin.ft.	30.00	7,500
	Flap gate, 54 in.	1	each	900.00	900
	Backfill	1,200	cu.yd.	2.00	2,400
	Subtotal				$ 13,200
	Contingencies				3,800
	Subtotal				$ 17,000
30	Engineering and design				1,000
31	Supervision and administration				1,200
	Subtotal levees and floodwalls				$ 19,200

47-540 O-65—8

TABLE D-18
FRANKLIN AND VICINITY

FIRST COST
LOWER TODD DRAINAGE STRUCTURE

Class. No.	Item	Quantity	Unit	Unit price	Cost
11	LEVEES AND FLOODWALLS				
	Excavation, structure	1,200	cu.yd.	$ 1.50	$ 1,800
	Pipe, corr. metal., 36 in.	250	lin.ft.	20.00	5,000
	Flap gate, 36 in.	1	each	600.00	600
	Backfill	700	cu.yd.	2.00	1,400
	Subtotal				$ 8,800
	Contingencies				2,200
	Subtotal				$ 11,000
30	Engineering and design				1,000
31	Supervision and administration				600
	Subtotal levees and floodwalls				$ 12,600

TABLE D-19
FRANKLIN AND VICINITY

SUMMARY OF ESTIMATES OF FIRST COST

Class. No.	Item	Cost
11	LEVEES AND FLOODWALLS	
	Levee construction	$1,143,000
	Floodgate (1)	661,000
	Drainage structures (5)	218,000
	Subtotal	$2,022,000*
30	Engineering and design	146,000
31	Supervision and administration	140,000
	Subtotal	$ 286,000
	TOTAL LEVEES AND FLOODWALLS	$2,308,000
	Lands and damages	$ 94,200*
	Acquisition cost	2,800
	Subtotal	$ 97,000
	Relocations	538,000*
	FIRST COST	$2,943,000

(Cost estimate is exclusive of preauthorization cost of $25,000)
*Includes contingencies.

TABLE D-20
FRANKLIN AND VICINITY

ESTIMATE OF APPORTIONMENT OF COSTS BETWEEN
FEDERAL AND NON-FEDERAL INTERESTS

1. Project first cost

Construction	$2,308,000
Lands, damages, and relocations	635,000
TOTAL	$2,943,000

2. Apportionment of cost

	Federal 70%	Non-Federal 30%
	$2,060,000	$ 883,000
Less lands, damages, and relocations		-635,000
Cash contribution		$ 248,000

TABLE D-21
FRANKLIN AND VICINITY

ESTIMATE OF ANNUAL ECONOMIC COST

Summary of project costs	Federal	Non-Federal	Total
Construction	$2,308,000	$ -	$2,308,000
Lands, damages, and relocations	-	635,000	635,000
Subtotal	$2,308,000	$ 635,000	$2,943,000
Less cash contribution	-248,000	248,000	-
FIRST COST	$2,060,000	$ 883,000	$2,943,000
Annual economic costs			
Interest (3%)	$ 61,800	$ 26,500	$ 88,300
Amortization (100 yrs.)	3,400	1,400	4,800
Maintenance and operation*	-	8,100	8,100
Replacements**	-	900	900
Economic loss on land (Market value $93,400 @ .02)	-	1,900	1,900
TOTAL	$ 65,200	$ 38,800	$ 104,000

*Annual maintenance and operation consists of the following:

Maintenance and operation of floodgate (1)	Job	$5,000
Maintenance of drainage structures (5)	Job	700
Levee grass cutting 171 ac. @ $14		2,400
	Total	$8,100

**Annual equivalent cost of replacements:
Replacement of operating machinery in Franklin Canal floodgate at $44,000 in 50 yrs. ($44,000 x .22811 x .03165 = $300) and replacement of pipes in four drainage structures in 50 yrs. ($81,600 x .22811 x .03165 = $600).

APPENDIX F

REPORT OF FISH AND WILDLIFE SERVICE

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
PEACHTREE-SEVENTH BUILDING
ATLANTA 23, GEORGIA

April 19, 1963

CE-LM-po

District Engineer
U. S. Army, Corps of Engineers
New Orleans, Louisiana

Dear Sir:

The Bureau of Sport Fisheries and Wildlife, in cooperation with the Louisiana Wild Life and Fisheries Commission, has reviewed the proposed plans for protection in Hurricane Study Area IV, Louisiana, and submits this report pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). Studies for hurricane protection in this area are authorized by Public Law 71, 84th Congress, approved June 15, 1955.

Hurricane Study Area IV extends from the vicinity of Franklin, Louisiana, easterly to the vicinity of Morgan City, Louisiana, and southward from the southern limits of the Atchafalaya Floodway to the coast. Within the study area are the natural outlet of Atchafalaya River, the dredged Wax Lake Outlet, and the lower end of Bayou Teche (see attached plate).

Your plan of protection under study would provide for increasing the grade elevation of several existing ring levee systems. New levee construction for hurricane protection is not contemplated. As an alternate to enlargement of levees bordering stream channels extending into the protected area in the vicinity of Franklin, you are considering the feasibility of incorporating gated control structures at three locations. These gated structures would remain open except during the time of flood occurrences in the vicinity.

Virtually all high ground within the protected area has been cleared and is in urban, industrial or agricultural usage. Fish and wildlife resources that are present occur in the remaining wetlands enclosed by the existing levees. The more valuable fish and wildlife habitat is outside the protected area and is an expression of the natural water-marsh complex.

Examination of the project as proposed indicates that construction would have little effect on fish and wildlife resources. Enlargement of

existing levees should not affect fish and wildlife habitat; nor should the installation of floodgates significantly alter the habitat from that existing with the present levee system.

The Bureau, therefore, has no recommendations regarding construction of the project as described. However, should major changes or alterations in project plans be considered, the Bureau requests the opportunity for further review in the interest of fish and wildlife conservation.

The Regional Director of the Bureau of Commercial Fisheries, St. Petersburg Beach, Florida, and the Director of the Louisiana Wild Life and Fisheries Commission have reviewed this report and the letter of concurrence from Louisiana is attached.

Sincerely yours,

Walter A. Gresh
Regional Director

Enclosures 2

State of Louisiana

WILD LIFE AND FISHERIES COMMISSION
400 ROYAL STREET
NEW ORLEANS 16

L. D. YOUNG, JR.
DIRECTOR

April 10, 1963

Mr. W. L. Towns, Chief
Division of Technical Services
U. S. Fish & Wildlife Service
Bureau of Sport Fisheries & Wildlife
Peachtree-Seventh Building
Atlanta 23, Georgia

Dear Mr. Towns:

Reference is made to your letter of April 1, 1963 and enclosed proposed report concerning the Hurricane Study Area IV, Louisiana, Project.

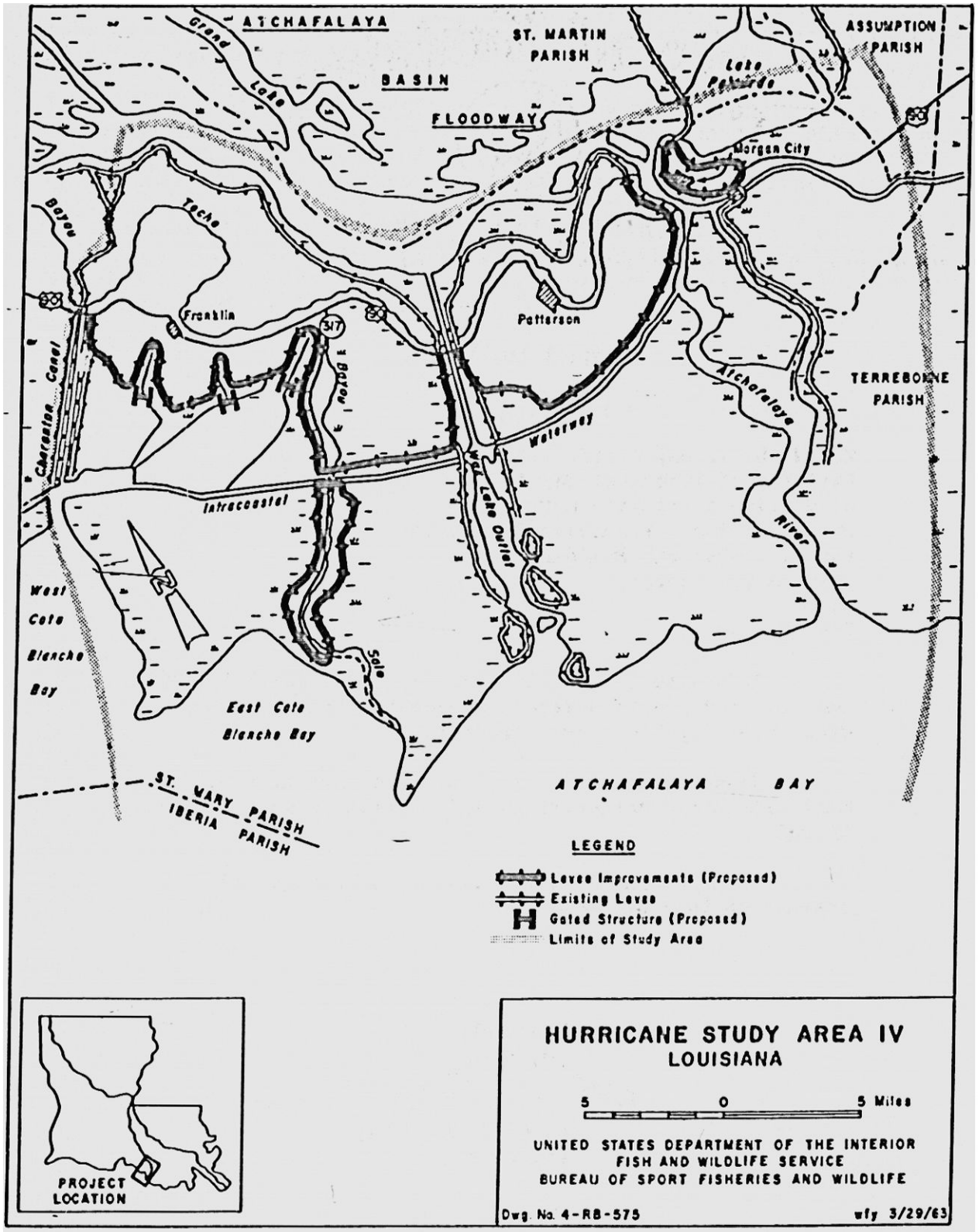
We have reviewed this report and are in agreement with the considerations and contents described therein.

We appreciate the opportunity to review and comment on this project report.

Sincerely,

L. D. Young, Jr.,
Director

LDYJr/al.


ATCHAFALAYA
BASIN
FLOODWAY
Grand Lake
ST. MARTIN PARISH
Lake Palourde
ASSUMPTION PARISH
Morgan City
Bayou Teche
Franklin
Patterson
Charenton Canal
Bayou Sale
Waterway
Intracoastal
Lake Outlet
Atchafalaya River
TERREBONNE PARISH
West Cote Blanche Bay
East Cote Blanche Bay
Sale
ATCHAFALAYA BAY
ST. MARY PARISH
IBERIA PARISH
LEGEND
Levee Improvements (Proposed)
Existing Levee
Gated Structure (Proposed)
Limits of Study Area
PROJECT LOCATION
HURRICANE STUDY AREA IV
LOUISIANA
5 0 5 Miles
UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Dwg. No. 4-RB-575
wfy 3/29/63

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
PEACHTREE-SEVENTH BUILDING
ATLANTA 23, GEORGIA

July 31, 1963

CE-LM-po

District Engineer
U. S. Army Engineer District,
New Orleans
P. O. Box 60267
New Orleans 60, Louisiana

Dear Sir:

In response to your letters of June 5 and July 1, 1963, the additional proposals for protection in Hurricane Study Area No. IV in the vicinity of Morgan City, Louisiana, have been considered.

Unlike the original proposals for hurricane protection, which are not expected to significantly affect fish and wildlife, the additional plans are expected to have a detrimental effect on these resources. The inclusion of wetlands north of Morgan City within the protection levee will permit development of this area, resulting in loss of wildlife habitat. If interchange of waters in the Avoca Island area is restricted, a substantial reduction in habitat quality could result.

We are finalizing a report which will more fully express our views on the above points. Release of this report will probably not be possible until after September 1, 1963, so we are transmitting this letter for your use in the interim.

The map provided with your letter of February 8, 1963, shows a levee improvement to be considered around Morgan City. The map provided with your letter of June 5, 1963, shows an existing levee and three pumping stations to the northeast of Morgan City in approximately the same location as the considered improvement shown on the February 8 map. Have these features now been constructed?

Sincerely yours,

W. L. Towns
Acting Regional Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
Peachtree-Seventh Building
ATLANTA 23, GEORGIA

COPY

October 23, 1963

CE-LM-at

District Engineer
U. S. Army, Corps of Engineers
New Orleans, Louisiana

Dear Sir:

Your letters of June 5 and July 1, 1963, have brought to our attention two proposals under consideration as possible modifications to plans for Hurricane Study Area IV, Morgan City, Louisiana and Vicinity. Our views on these modifications, submitted in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), have been prepared in cooperation with the Louisiana Wild Life and Fisheries Commission.

The modified plans, which have been presented by local interests, would provide for construction of new levees and drainage structures in lieu of the existing back protective levee system to prevent flooding of the Morgan City area by high stages in Lake Palourde and hurricane surges from the south.

You advise that the proposed levees and structures would be located as follows:

1. Tiger Island area - this new levee intended to prevent flooding of the Morgan City area from high stages in Lake Palourde, would be located approximately 1,000 feet landward of Lake Palourde, extending southeasterly from the East Atchafalaya Basin Protection Levee, then paralleling Bayou Ramos on its west bank to the Southern Pacific Railroad embankment. In order to complete the protective system, a short stretch of levee would be constructed from the Bayou Boeuf Lock Levee to the railroad embankment. Installation of three flap-gated structures would prevent interception of existing gravity drainage.

2. Avoca Island - this levee, intended to prevent hurricane surges from the south, would be located along the south side of Avoca Island extending easterly from the existing

Bayou Shaffer levee, and generally paralleling Bayou Chene to its juncture with the Intracoastal Waterway. The levee then would continue northward across swampland to the Southern Pacific Railroad embankment. A barge-type barrier would provide for closure of the 20' x 350' Bayou Chene-Intracoastal Waterway during hurricane emergencies. Drainage for the Avoca Island area would require construction of a structure equipped with 12 flap and lift gates near Bayou Penchant.

The Bureau provided you a letter, dated April 19, 1963, relative to your original plans for Hurricane Study Area IV. The project as proposed at that time would have had no significant effect on fish and wildlife resources. With the planned modifications, however, the project could have major impact on fish and wildlife habitat. Additional wetlands have been incorporated in the protected areas and drainage facilities proposed. With the incorporation of these drainage facilities, the scope of project capability now exceeds that of hurricane protection.

Fish and wildlife resources of the two "islands" which would be incorporated in the protected area, are of high value. Sport fishing and hunting provide some 21,000 recreational days annually. The total dollar value of fish and wildlife resources, including the commercial harvest, is estimated to be $48,000 annually, of which $44,000 is assignable to Avoca Island and the remainder, $4,000, to Tiger Island.

Because of the wetland nature of the fish and wildlife habitat, drainage would be particularly damaging. Expansion of Morgan City would eventually eliminate the Tiger Island swamp, causing complete fish and wildlife losses in that area. At Avoca Island drainage and obstruction of water exchange also could have serious adverse effects. Changes in the wetland habitat could very well eliminate 50 percent of the wildlife values and reduce productivity of fishery habitat by a third.

Mitigation of losses which would accrue from the modified project could be accomplished most effectively by further modification in project design in the Avoca Island area. The planned levee paralleling Bayou Chene along the south side of Avoca Island should be relocated as shown on the attached plate to follow the toe of the Bayou Boeuf Ridge along the north side of Avoca Island. If the levee were so located, hurricane protection for Morgan City and the higher lands along Bayou Boeuf could be accomplished without major loss of fish and wildlife resources.

A levee extending from Bayou Boeuf Lock southeastward to the proposed emergency closure barrier in the Intracoastal Waterway on Bayou Chene would be about the same length as one along the south side of the island, and would very likely require less costly drainage structures.

The Bureau, therefore, recommends that hurricane protection in the Avoca Island area, if you find such works are feasible and needed, should provide for levee alignment generally as described above and shown on the attached plate.

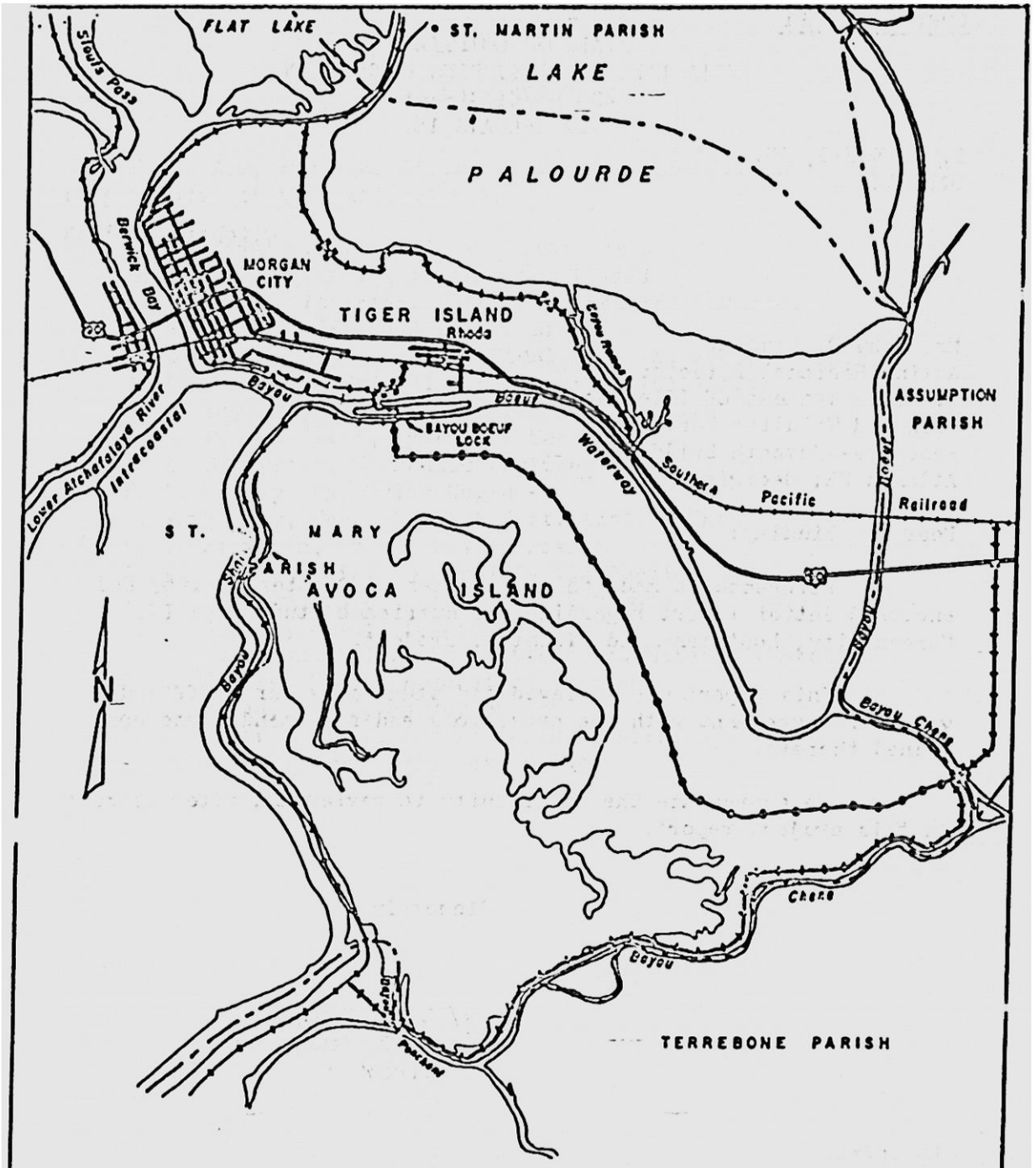
This report has been reviewed and concurred in by the Louisiana Wild Life and Fisheries Commission and their letter of comment is attached.

The Bureau appreciates this opportunity of further comment on the project, and requests that we be advised of any action you propose to take.

Sincerely yours,

/s/ W. L. Towns
W. L. Towns
Acting Regional Director

Attachments 2


FLAT LAKE
ST. MARTIN PARISH
LAKE
PALOURDE
Sluice Pass
Berwick Bay
MORGAN CITY
TIGER ISLAND
Rhoda
Bayou
BSFW
BAYOU BOEUF LOCK
Lower Atchafalaya River
Intracoastal
Waterway
Southern Pacific Railroad
ASSUMPTION PARISH
ST. MARY PARISH
AVOCA ISLAND
Bayou
Chene
TERREBONE PARISH
LEGEND
Levee, existing
Levee, proposed - USCE
Levee relocation, proposed - BSFW
Water control structure, proposed - USCE
HURRICANE STUDY AREA IV
MORGAN CITY and VICINITY, LA.
1 0 1 2 Miles
UNITED STATES DEPARTMENT OF THE INTERIOR
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife
Base Map, USCE
Dwg. No. 4-RB-605

COPY OF A COPY

STATE OF LOUISIANA
WILD LIFE AND FISHERIES COMMISSION
400 Royal Street
NEW ORLEANS 16

L. D. YOUNG, JR.
Director

October 14, 1963

Mr. John D. Findlay
Acting Regional Director
U. S. Department of Interior
Fish and Wildlife Service
Peachtree-Seventh Building
Atlanta 23, Georgia

Dear Mr. Findlay:

Reference is made to your letter of October 9, 1963 and enclosed letter report regarding the Hurricane Study Area IV, Morgan City, Louisiana and Vicinity, Project.

This report was reviewed and studied by our staff and we are in agreement with the provisions and recommendations contained therein.

We appreciate the opportunity to review and offer comment on this project report.

Sincerely,

/s/ L. D. Young, Jr.
L. D. Young, Jr.,
Director

LDYJr/sl.

APPENDIX G

PERSONNEL

U. S. Army Engineer District, New Orleans, personnel directly responsible for this project were:

E. B. Jennings, Colonel, CE, District Engineer
G. H. Hudson, Chief, Engineering Division
J. C. Baehr, Assistant Chief, Engineering Division
W. S. Mask, Chief, Hydraulics Branch
W. B. Seale, Acting Chief, Tidal Section, Project Engineer
A. P. Gautreau, Hydraulic Engineering Technician
M. S. Boyd, Hydraulic Engineering Technician
G. A. Price, Chief, Hydrology Section
R. L. Sylvester, Hydraulic Engineer
F. M. Chatry, Hydraulic Engineer
C. W. Miller, Head, Project Justification Unit
R. J. Franklin, Chief, Design Branch
A. F. Jacobi, Chief, General Design Section
W. I. Freeman, Chief, Government Estimate Section
W. E. Sommer, Chief, Levees Section
H. A. Huesmann, Chief, Foundations and Materials Branch
S. E. Worley, Chief, Foundation Section
M. W. Bland, Chief, Survey Branch
A. M. McNeil, Chief, Service Branch, Drafting
J. O. Ecuyer, Appraiser, Real Estate

47-540 O-65—9

APPENDIX H

ASSURANCES BY LOCAL INTERESTS

POLICE JURY
ST. MARY PARISH
Franklin, Louisiana

COPY OF A COPY

October 28, 1963

Director
State of Louisiana
Department of Public Works
Baton Rouge, Louisiana

Dear Sir:

Enclosed please find resolution adopted in regular session on October 9, 1963, approving the hurricane study entitled, "Morgan City, Louisiana and Vicinity," made by the U. S. Corps of Engineers.

We would appreciate your help in planning and the construction of said proposal for hurricane protection for this area.

Yours very truly,

/s/ Robert E. Miller, Jr.
ROBERT E. MILLER, JR.
Parish Engineer

REMJ/CD

COPY OF A COPY

RESOLUTION

WHEREAS, the Corps of Engineers has recently completed a hurricane study entitled, "Morgan City, Louisiana and Vicinity," as authorized by Public Law 71, 84th Congress, and,

WHEREAS, it is now necessary to have the proposed plan or study approved by the State and local agencies and,

WHEREAS, the proposed study as planned will definitely be of great benefit to this Parish in the future for hurricane protection in the low lying areas and,

NOW THEREFORE BE IT RESOLVED, that the hurricane study entitled "Morgan City, Louisiana and Vicinity," is hereby approved by the St. Mary Parish Police Jury and recommend that steps be taken to carry out the proposed plan and that construction be initiated in the very near future.

* * * * * * * * * * * * * * *

I, May Belle B. Hiemstra, Secretary of the Police Jury of St. Mary Parish, Louisiana, do hereby certify that the foregoing is a true and correct copy of the resolution adopted by the Police Jury of St. Mary Parish in regular session on October 9, 1963, at which meeting a quorum was present.

GIVEN UNDER MY OFFICIAL Signature and seal of office this 28th day of October, 1963.

/s/ May Belle B. Hiemstra
SECRETARY, POLICE JURY OF
ST. MARY PARISH, LOUISIANA

ATTACHMENT
HURRICANE STUDY
MORGAN CITY, LOUISIANA AND VICINITY

INFORMATION CALLED FOR BY
SENATE RESOLUTION 148, 85TH CONGRESS
ADOPTED 28 JANUARY 1958

1. PROJECT DESCRIPTION AND ECONOMIC LIFE

a. Description of the plans of protection.

(1) Morgan City. The proposed plan of protection for this area provides for the construction of a new levee 5.6 miles in length along Lake Palourde and Bayou Ramos, a new levee 0.5 mile in length from the railroad near Wyandotte to Bayou Boeuf lock, and construction of necessary gravity drainage structures.

(2) Franklin and vicinity. The proposed plan of protection for this area provides for the raising of 21.6 miles of the existing levee, construction of 3.1 miles of new levee to effect a complete closure of the area to be protected, construction of a floodgate, and replacement, modification, and construction of drainage facilities.

b. Economic life. The costs and benefits of the above-described improvements are based on an economic life of 100 years.

2. PROJECT COSTS

The following tables give the estimated first costs for the proposed projects, based on May 1963 prices, and annual economic costs based on economic lives of 100 and 50 years:

a. First cost.

(1) Morgan City, subarea A.

Item	Federal	Non-Federal	Total
Levees*	$ 728,000	$ -	$ 728,000
Drainage structures*	107,000	-	107,000
Lands*		470,000	470,000
Relocations*		12,000	12,000
Engineering and design	66,000	-	66,000
Supervision and administration	43,000	-	43,000
Subtotal	$ 944,000	$482,000	$1,426,000
Cash contribution	None	None	
FIRST COST	$ 944,000	$482,000	$1,426,000

(2) Morgan City, subarea B.

Levees*	$ 32,000	$ -	$ 32,000
Drainage structure*	7,000	-	7,000
Lands*		35,000	35,000
Engineering and design	4,000	-	4,000
Supervision and administration	2,000	-	2,000
Subtotal	$ 45,000	$ 35,000	$ 80,000
Cash contribution	None	None	
FIRST COST	$ 45,000	$ 35,000	$ 80,000

(3) Franklin and vicinity.

Levees*	$1,143,000	$ -	$1,143,000
Floodgates*	661,000	-	661,000
Drainage structures*	218,000	-	218,000
Lands*		97,000	97,000
Relocations*		538,000	538,000
Engineering and design	146,000	-	146,000
Supervision and administration	140,000	-	140,000
Subtotal	$2,308,000	$635,000	$2,308,000
Cash contribution	-248,000	248,000	
FIRST COST	$2,060,000	$883,000	$2,943,000

*Includes contingencies.

b. Annual economic costs.

(1) Morgan City, subarea A. (100-year economic life)

Interest	$ 29,200	$ 14,900	$ 44,100
Amortization	1,600	800	2,400
Maintenance		1,000	1,000
Replacements		100	100
Economic loss on land		7,700	7,700
TOTAL	$ 30,800	$ 24,500	$ 55,300

(50-year economic life)

Item	Federal	Non-Federal	Total
Interest	$ 29,200	$ 14,900	$ 44,100
Amortization	8,600	4,400	13,000
Maintenance		1,000	1,000
Economic loss on land		7,700	7,700
TOTAL	$ 37,800	$ 28,000	$ 65,800

(2) Morgan City, subarea B.
(100-year economic life)

Interest	$ 1,300	$ 1,000	$ 2,300
Amortization	100	100	200
Maintenance		150	150
Replacements		50	50
Economic loss on land		700	700
TOTAL	$ 1,400	$ 2,000	$ 3,400

(50-year economic life)

Interest	$ 1,300	$ 1,000	$ 2,300
Amortization	400	300	700
Maintenance		150	150
Economic loss on land		700	700
TOTAL	$ 1,700	$ 2,150	$ 3,850

(3) Franklin and vicinity.
(100-year economic life)

Interest	$ 61,800	$ 26,500	$ 88,300
Amortization	3,400	1,400	4,800
Maintenance and operation		8,100	8,100
Replacements		900	900
Economic loss on land		1,900	1,900
TOTAL	$ 65,200	$ 38,800	$104,000

(50-year economic life)

Interest	$ 61,800	$ 26,500	$ 88,300
Amortization	18,300	7,800	26,100
Maintenance and operation		8,100	8,100
Economic loss on land		1,900	1,900
TOTAL	$ 80,100	$ 44,300	$124,400

3. BENEFIT-COST RATIOS

a. Tangible benefits which would accrue to the proposed projects, based on 100-year and 50-year economic lives, and the resulting benefit-cost ratios are estimated to be as follows:

(1) Morgan City, subarea A.

	100-year life	50-year life
Average annual flood damage prevented	$173,900	$152,000
Enhancement	59,400	53,600
TOTAL	$233,300	$205,600

(2) Morgan City, subarea B.

Average annual flood damage prevented	$ 5,100	$ 5,000

(3) Franklin and vicinity.

Average annual flood damage prevented	$172,900	$136,600

b. The benefit-cost ratios of the proposed plans of improvement, based on 100-year and 50-year economic lives, are:

Plan	Econ. life	Annual econ. cost	Annual benefits	Benefit-cost ratio
Morgan City, subarea A	100 yrs.	$ 55,300	$233,300	4.2 to 1
" " " "	50 yrs.	65,800	205,600	3.1 to 1
Morgan City, subarea B	100 yrs.	3,400	5,100	1.5 to 1
" " " "	50 yrs.	3,850	5,000	1.3 to 1
Franklin and vicinity	100 yrs.	104,000	172,900	1.7 to 1
" " "	50 yrs.	124,400	136,600	1.1 to 1

4. INTANGIBLE PROJECT EFFECTS

a. The protection plans for the Morgan City and the Franklin and vicinity areas may afford some additional benefits which cannot be evaluated in monetary terms. The economic value of the proposed project was based on the reduction of hurricane flood damage and enhancement of the area. Control of flooding may result in prevention of loss of life, prevention of disease arising from polluted floodwaters, and elimination of worry among residents concerning unpredictable flooding.

b. The U. S. Fish and Wildlife Service reports that construction of the proposed project would have little effect on fish and wildlife resources. The views of this agency and a letter of concurrence from the State of Louisiana, Wild Life and Fisheries Commission, are in appendix E of the report.

5. PHYSICAL FEASIBILITY AND COST OF PROVIDING FOR FUTURE NEEDS

The levee and appurtenant work designs will accommodate the present needs for flood control in each of the separate areas, as well as in the foreseeable future.

6. ALLOCATION OF COSTS

Allocation of costs is not involved.

7. APPORTIONMENT OF COSTS

First costs, excluding preauthorization studies, are usually apportioned at 30 percent to local interests and 70 percent to the Federal government. However, all lands, rights-of-way, and relocations are to be provided by non-Federal interests and will be credited to the local contribution. Maintenance and operation will be the responsibility of local interests. The estimated value of lands, rights-of-way, and relocations for subareas A and B, Morgan City, exceeds the minimum 30 percent of the total cost requirement of local interests. Therefore, the values of lands, rights-of-way, and relocations now estimated at $482,000 and $35,000 for subareas A and B, respectively, are the required contributions of local interests. The 30 percent contribution required of local interests for Franklin and vicinity is estimated at $883,000 which includes the fair market value of lands and relocations estimated at $635,000. The cash contribution by local interests for this portion of the project is estimated at $248,000. Details of cost computations are shown in appendix D of the report.

8. EXTENT OF INTEREST IN PROJECT

Three public hearings were held for the purpose of securing information on problems caused by hurricane flooding and obtaining views of local interests relative to their solution. During the hearings, the State of Louisiana, Department of Public Works, requested that maximum consideration be given to protective works to safeguard lives and property from damages and the development of an adequate warning system. Additional requests for studies of protective measures were received from representatives of local governmental agencies and residents of the study area. The plans of protection proposed for Morgan City provide primarily for construction of new levees along an alignment which will provide additional protected areas necessary for the expansion and growth of the city.

The plan of protection for Franklin and vicinity provides for improvement of existing levee grades. Findings of the investigations of willingness and ability of local interests to meet the prescribed requirements of local cooperation are discussed in paragraph 25.d. of the report.

9. REPAYMENT SCHEDULES

Repayment schedules are not involved.

10. EFFECT OF PROJECT ON STATE AND LOCAL GOVERNMENTS

a. The increase in the value of lands benefiting from the project will offset the value of lands required for the construction of the improvements. Therefore, no loss in tax revenue will be experienced.

b. The non-Federal first cost for construction of the projects and chargeable to the local government for a 100-year project life for the plans of protection is as follows:

	Lands, rights-of-way, and relocations	Cost contribution	Total
Morgan City			
Subarea A	$482,000	$ -	$482,000
Subarea B	35,000	-	35,000
Franklin and vicinity	635,000	248,000	883,000

c. More detailed information concerning costs is furnished in appendix D of the report.

11. ALTERNATIVE PROJECTS

Consideration was made of an alternative plan which would provide for improving the grade elevation of the existing Morgan City back levee. This plan would not provide any additional area for expansion of the city and was not recommended. The benefit-cost ratio of the plan, based on economic life of 100 years, is approximately 4.0 to 1.