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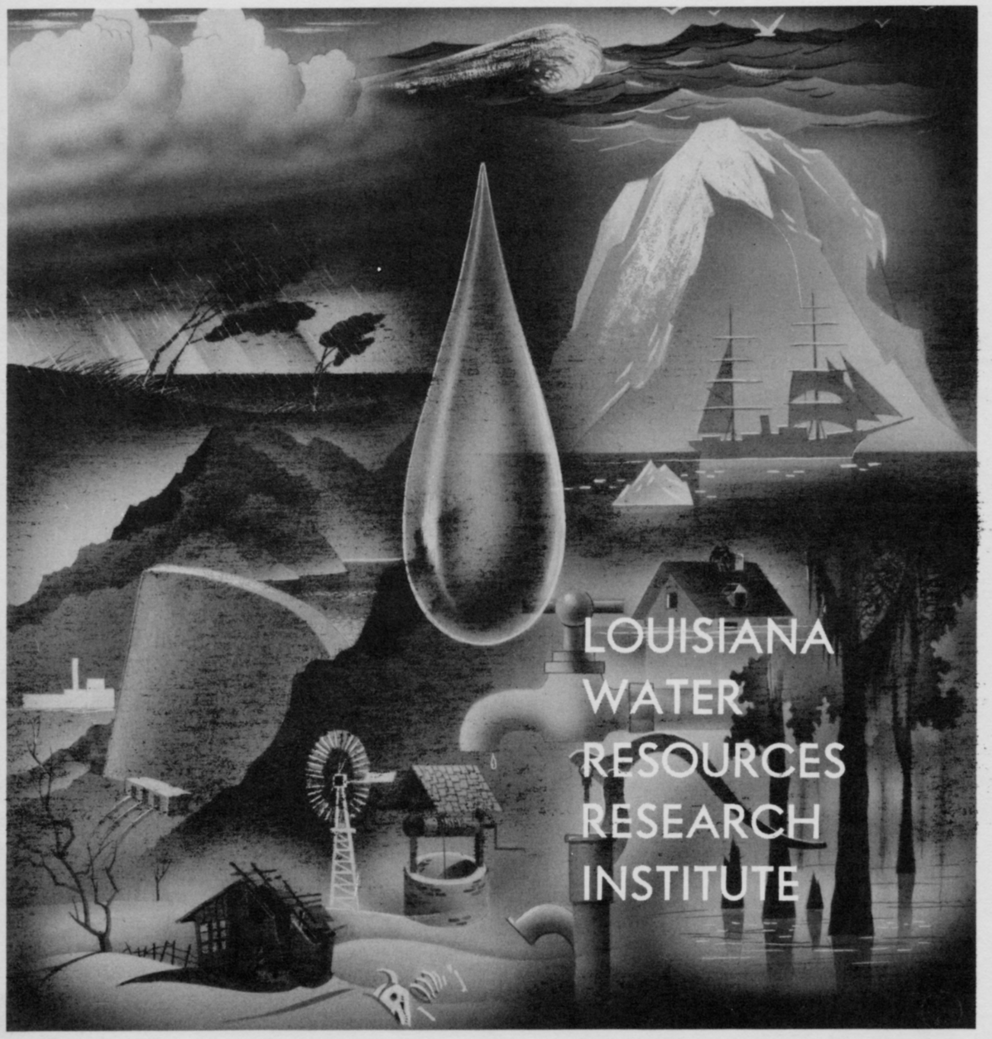

The Flood Control Capabilities of the Atchafalaya Basin Floodway

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THE FLOOD CONTROL CAPABILITIES
OF THE
ATCHAFALAYA BASIN FLOODWAY

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APRIL 1967

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EDITORIAL NOTE

This publication is the first of a series which will, it is hoped, increase the readership of selected graduate level papers on the subject of water resources. In this broad field, problems involving humanity (its present or future wealth and welfare) spring up to confuse--and mistakes, to snare--the planner, the designer, and the constructor. Consequently, the papers will be published to stimulate thinking, to warn of danger, to criticize, and to evaluate.

Since the spring of 1967, when this bulletin was first printed, the importance of the basin to the future of Louisiana became publicized during the squalls fronting the universal acknowledgment of our present ecological plight. Although the author only touches on the subject of conservation and the U.S. Corps of Engineers has revised certain parts of the overall plan, the report remains a basic reference on the floodway. The supply of copies from the first printing is now exhausted. Foreseeing continued requests, the Institute has reprinted the bulletin with minor corrections.

Mr. Hebert originally submitted this paper to Louisiana State University as partial fulfillment of the requirements for the Master of Science degree. His major professor was Raphael G. Kazmann, Associate Professor of Civil Engineering and Associate Director of the Louisiana Water Resources Research Institute.

Even though this report has been edited for clarity and general readability, the ideas and style remain those of the author and do not necessarily reflect any official point of view adopted by Louisiana State University.

Special thanks are due to Mrs. Sarah Pickell, former Technical Librarian, Louisiana Department of Public Works, and others who made available much valuable material for the figures. The U. S. Corps of Engineers, New Orleans District, kindly furnished the photographs used for the illustrations.

Charles W. Hill
Research Associate

ABSTRACT

The history of past flood control efforts and plans in the lower Mississippi River Valley is presented, in view of the geological history of the Lower Mississippi River and Atchafalaya Basin. A hydrologic evaluation of these plans and the effects of engineering works built to implement them has revealed shortcomings in both plans and works.

Many of the previous projects, instead of being systematic efforts, have been piecemeal construction to solve immediate problems. The East and the West Atchafalaya Basin Protection Levees have gross deficiencies in grade between Krotz Springs and Morgan City. The present discharge capacity of the Atchafalaya Floodway is found to be only about two-thirds of that needed to carry the design flood safely. Funds have not been appropriated to complete the proposed project in the planned ten-year period.

An examination of the existing hydrologic conditions has revealed that, unless an accelerated program is developed, the planned capability of the Atchafalaya Floodway will never materialize. Even if funds are made immediately available, many engineering and political problems will have to be resolved before the floodway can provide south Louisiana with adequate flood protection.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

The Atchafalaya Basin Floodway and the Mississippi River together drain 1¼ million square miles from thirty-one of the United States and two Canadian provinces. The flow through this drainage system ranges from 100,000 cubic feet per second at low water to approximately 2,500,000 cubic feet per second for the largest flood on record, with an average annual volume of 470 million acre-feet.

The Mississippi River Commission was created in 1879 by Congress to consider methods to improve navigation and present plans to protect the Mississippi River Valley from floods. Before 1927, the set policy had been the building of levees along the Mississippi River with sufficient heights to prevent flooding. In 1927 the largest flood ever recorded came down the lower Mississippi River, causing over 40 breaks in the Mississippi River levees and resulting in hundreds of millions of dollars in damages. This disaster convinced the Commission that its "levee only" policy for flood protection was a failure.

The Flood Control Act of 1928, based on the Jadwin Plan (Jadwin was then Chief of Engineers of the U. S. Army), provided for the control of the maximum probable flood in the Mississippi River Basin with protection against a design project flood of 3,000,000 cubic feet per second, a discharge 20 percent greater than that of the 1927 flood. The new concept in this plan was the utilization of the Atchafalaya Basin as a floodway or relief outlet.

Diversion of about one-half of the total discharge from the Mississippi River to the Atchafalaya Basin Floodway was a basic feature of the new plan. The ultimate flow in the Atchafalaya River was to be about 650,000 cubic feet per second. Two artificial floodways, the Morganza and West Atchafalaya, were to discharge a total of 850,000 cubic feet per second. These outlets would carry 600,000 cubic feet per second and 250,000 cubic feet per second respectively. The floodways, one on each side of the Atchafalaya River, would be enclosed by protection levees (sometimes referred to as "guide levees") and the river levees. These are shown in Figure 1.

An improved levee system along the lower Mississippi River was also proposed to pass safely 1,500,000 cubic feet per second. Upstream from New Orleans, the Bonnet Carre Spillway would reduce the flow of the Mississippi River above New Orleans by 250,000 cubic feet per second. The remaining flow, 1,250,000 million cubic feet per second, would pass New Orleans en route to the Gulf of Mexico.

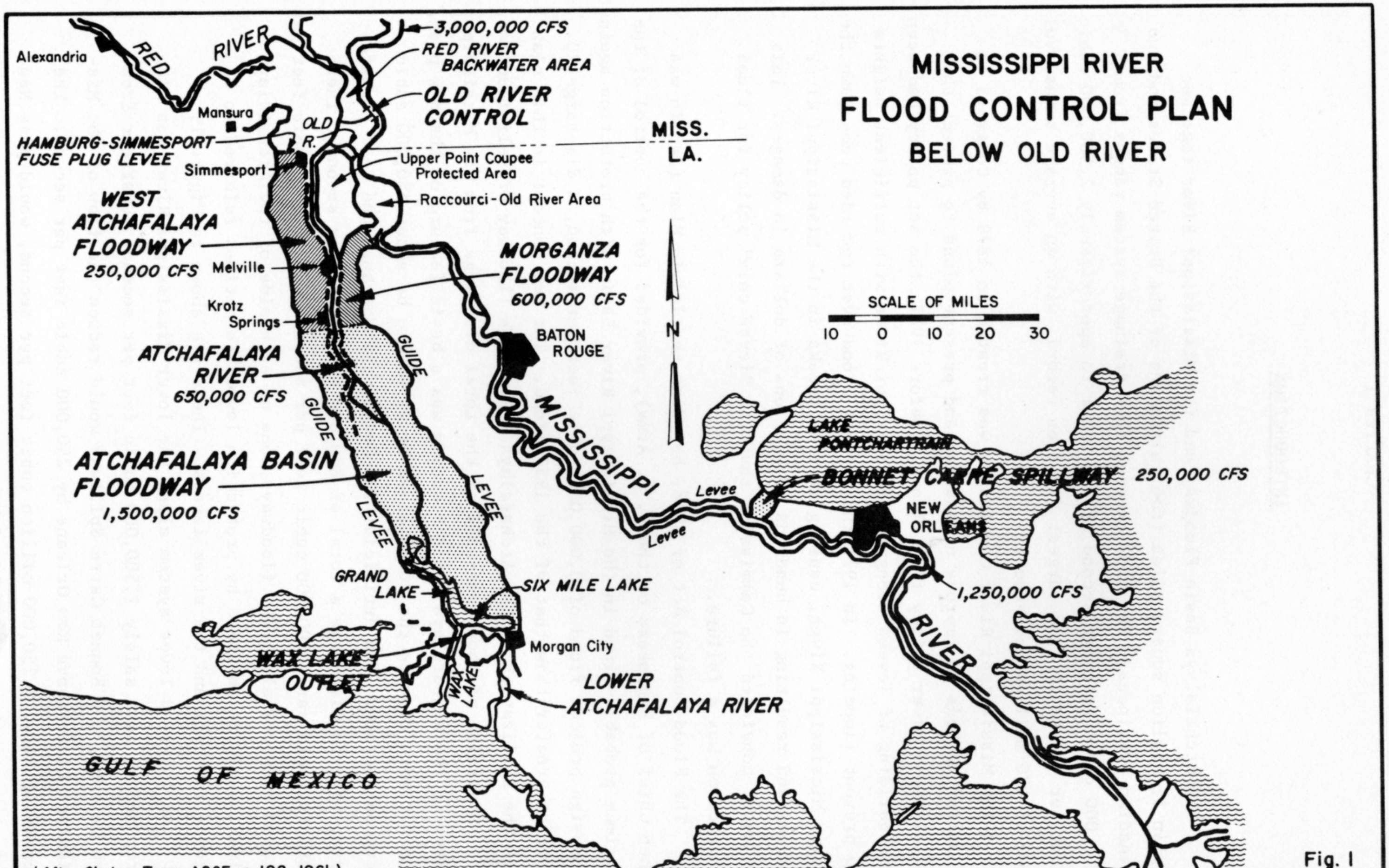

MISSISSIPPI RIVER
FLOOD CONTROL PLAN
BELOW OLD RIVER
Alexandria
RED RIVER
3,000,000 CFS
RED RIVER BACKWATER AREA
OLD RIVER CONTROL
Mansura
OLD R.
HAMBURG-SIMMESPORT FUSE PLUG LEVEE
Simmesport
MISS.
LA.
Upper Point Coupee Protected Area
Raccourci-Old River Area
WEST ATCHAFALAYA FLOODWAY
250,000 CFS
Melville
MORGANZA FLOODWAY
600,000 CFS
Krotz Springs
SCALE OF MILES
10 0 10 20 30
N
ATCHAFALAYA RIVER
650,000 CFS
GUIDE
BATON ROUGE
MISSISSIPPI
GUIDE
LEVEE
ATCHAFALAYA BASIN FLOODWAY
1,500,000 CFS
LEVEE
Levee
Levee
LAKE PONTCHARTRAIN
BONNET CARRE SPILLWAY
250,000 CFS
NEW ORLEANS
GRAND LAKE
SIX MILE LAKE
1,250,000 CFS
WAX LAKE OUTLET
Morgan City
WAX LAKE
LOWER ATCHAFALAYA RIVER
RIVER
GULF OF MEXICO
(After Chatry, Trans. ASCE, p. 108, 1961)

Fig. 1

Since 1928, in accord with this plan, the Corps of Engineers has constructed various flood control works. The continuous levee system along the Mississippi River and the Bonnet Carre Spillway have been completed. In the Atchafalaya Basin Floodway, levee construction and channel dredging have been undertaken to raise its capacity to the design discharge of 1,500,000 cubic feet per second. These projects include: (1) construction of the East and West Atchafalaya Basin Protection Levees, (2) construction of the Atchafalaya River Levees, (3) construction of the Morganza Floodway Control Structure, (4) enlargement of the Atchafalaya River, and (5) dredging of the main channel in the Atchafalaya Basin Floodway. According to the Corps of Engineers, the Mississippi River can now carry its share of the design project flood, 1,500,000 cubic feet per second.

However, the Federal Government [Corps of Engineers, 1963c] agrees that the completed projects in the Atchafalaya Basin Floodway do not meet the requirements of the plan. The inability of the Atchafalaya Basin Floodway to carry its share of the design project flood is the major problem. Three factors that have prevented attainment of the planned carrying capacity of the floodway are: (1) the subsiding of the lower East and West Atchafalaya Basin Protection levees, (2) the substantial silting of the Atchafalaya Basin Floodway, and (3) the changing discharge characteristics of the main channel in the floodway.

Other problems encountered in the implementation of the plan are not of a technical or engineering nature, but they play an important role in the flood control efforts. They relate to fishing, wildlife, encroachment of land by agricultural activity, and intrusion of salt water from the Gulf to municipal water supplies. These side effects, pertinent in the considerations of the policy makers, affect flood control planning in the floodway.

This analysis of the flood control capabilities of the Atchafalaya Basin Floodway begins with the literature on the geology of the region and the historical records of the flood control efforts and plans. After a study of the previous control works, an evaluation is made of their effects on the hydrology of the area.

Next, the existing control features of the floodway are examined to determine the magnitude and number of deficiencies which reduce the capacity below that required to effect the present plan. Current proposals by the Corps of Engineers to increase the capacity of the floodway also come under consideration.

From this, conclusions are reached and recommendations presented concerning effective flood control capacity of the Atchafalaya Basin Floodway.

CHAPTER II

GEOLOGIC HISTORY OF THE LOWER MISSISSIPPI RIVER AND THE ATCHAFALAYA BASIN

The geologic history of the Lower Mississippi River begins during the ice age. Later, the Atchafalaya Basin formed when natural levees along previous courses of the lower Mississippi became the boundaries of a low central region in south Louisiana. It served as a natural floodway for excess water from the Red River and the Mississippi; the stream that developed through this basin to the Gulf of Mexico is the present day Atchafalaya.

THE PLEISTOCENE SETTING

The morphology of the Mississippi River Valley resulted from climatic abnormalities of the Pleistocene or glacial epoch. The basic river system developed initially during the Quaternary period, about 1,000,000 years ago, when the Nebraskan glacier, which covered the northern part of the United States, blocked the flow of most northward-flowing streams of that region. The accumulation of ice on the northern United States caused a reversal in their flow. These streams descended toward the center of the continent to form one large river, the ancient Mississippi, which transported water from numerous tributaries almost straight southward to the Gulf of Mexico [Fisk, 1952a].

The level of the sea was lowered several hundred feet from the loss of water that accumulated as glacial snow and ice [Fisk, 1952a]. Steepening the slope of the streams and increasing their tractive force, this lowering brought about the erosion of a deep valley down the continent. Degradation (wearing down) continued until the water from the melting Nebraskan glacier began to raise the sea level. As the sea rose, the water velocities and transport capabilities decreased, some of the coarser gravels eroded from headwater streams settled out, and the finer gravel and sand deposited in the deep valley. This material accumulated above the Pleistocene substrata and now forms our fresh water aquifers. Finally, the melted ice restored the sea about four hundred feet to its original level, and the resulting flatter gradient, or height of fall, between the sea and the streams reduced their velocities still more. The finer suspenced silt and colloidal material in the river water settled to form the alluvial sub-plain.

Geologists accept the theory that the rise and fall of sea level occurred four more times after the Nebraskan glacier [Fisk, 1952b]. Similar erosion and settling of the gravelly material occurred during each glacial cycle. It is estimated that the Kansas glaciation occurred 650,000 years ago; the Illinoian, 300,000 years ago; the Early Wisconsin, 100,000 years ago; and the Late Wisconsin, 30,000 years ago. Each stage had the same sequence of events; the lowering of sea level, the degrading of the valley, the raising of sea level, the settling of the coarser material, and the deposition of the finer suspended material--each sequence ending in an apparently stable condition between the sea and the river. Figure No. 2 shows a general chronology.

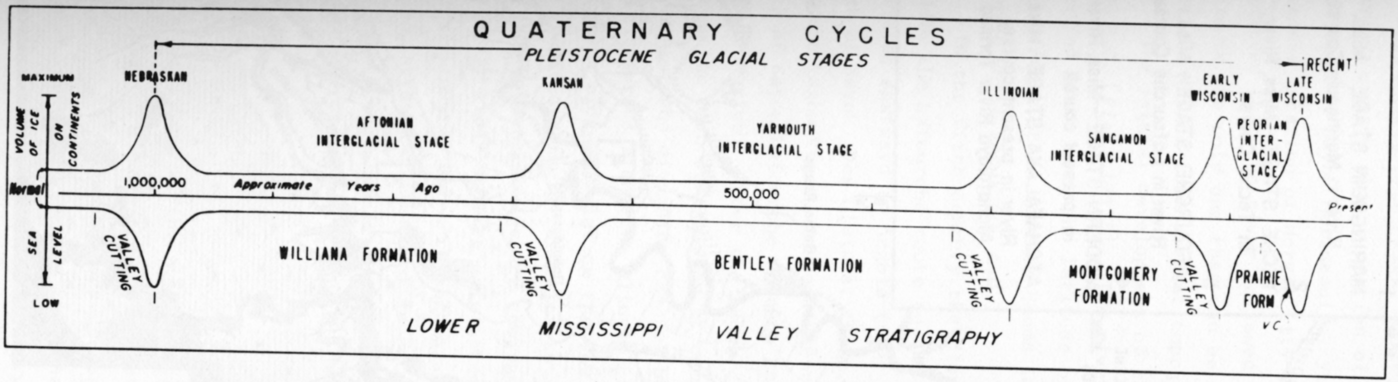
THE ATCHAFALAYA BASIN

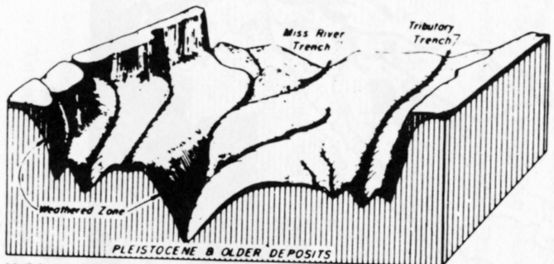
The Atchafalaya Basin is a low region bounded by ridges deposited from flood waters of previous courses of the Mississippi River. A large lake (Grand Lake), created in the southern portion of the low central area by the bordering natural levees, developed an outlet channel to the Gulf, the Lower Atchafalaya River.

"Gradual shifting of the Mississippi River from one side of its valley to the other has not occurred. Instead, the river is confined for long periods to a definite zone of migration, a meander belt, within which its channel shifts widely; it is only through diversion that the river leaves this belt to establish a new course." [Fisk, 1952c] There is evidence that during the past 10,000 years the Mississippi River formed numerous meander belts in Louisiana. The width of the belts has been approximately twice the width of the largest meander loops.

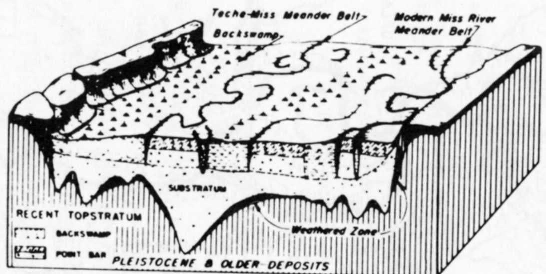
The development of a meander belt may be outlined as follows: after forming a ridge on both sides of the belt, the river begins to discharge increasing amounts to a distributary. At first, this occurs only during floods; then, as the distributary channel increases in size, a portion of the flow separates from the main stream at normal stages. As the distributary usually has a shorter course to the Gulf of Mexico and a steeper gradient, the flow in it increases while that in the main channel decreases. The outcome is a deterioration or silting-up of the main channel and a degrading or deepening of the distributary channel [Fisk, 1952c].

Although previous routes of the Mississippi River covered most of south Louisiana, only a few of the alignments were important in the formation of the Atchafalaya Basin. The three most recent courses preceding the present route of the Mississippi River were the Maringouin, the Teche, and the Lafourche--as determined by Fisk. He estimates that diversions of the river occurred in approximately 1,000 B.C., 100 B.C., and 400 A.D. respectively [1952d]. Figure 3 shows the three previous routes and the present one.





MISSISSIPPI RIVER ENTRENCHED VALLEY SYSTEM
DURING LATE WISCONSIN GLACIAL STAGE



FEATURES OF MODERN MISSISSIPPI ALLUVIAL PLAIN
AND RECENT DEPOSITS FILLING
LATE WISCONSIN ENTRENCHED VALLEY

QUATERNARY EVENTS
IN
LOWER MISSISSIPPI ALLUVIAL VALLEY

(After Fisk, 1952, Vol. I, p. 36)

Fig. 2

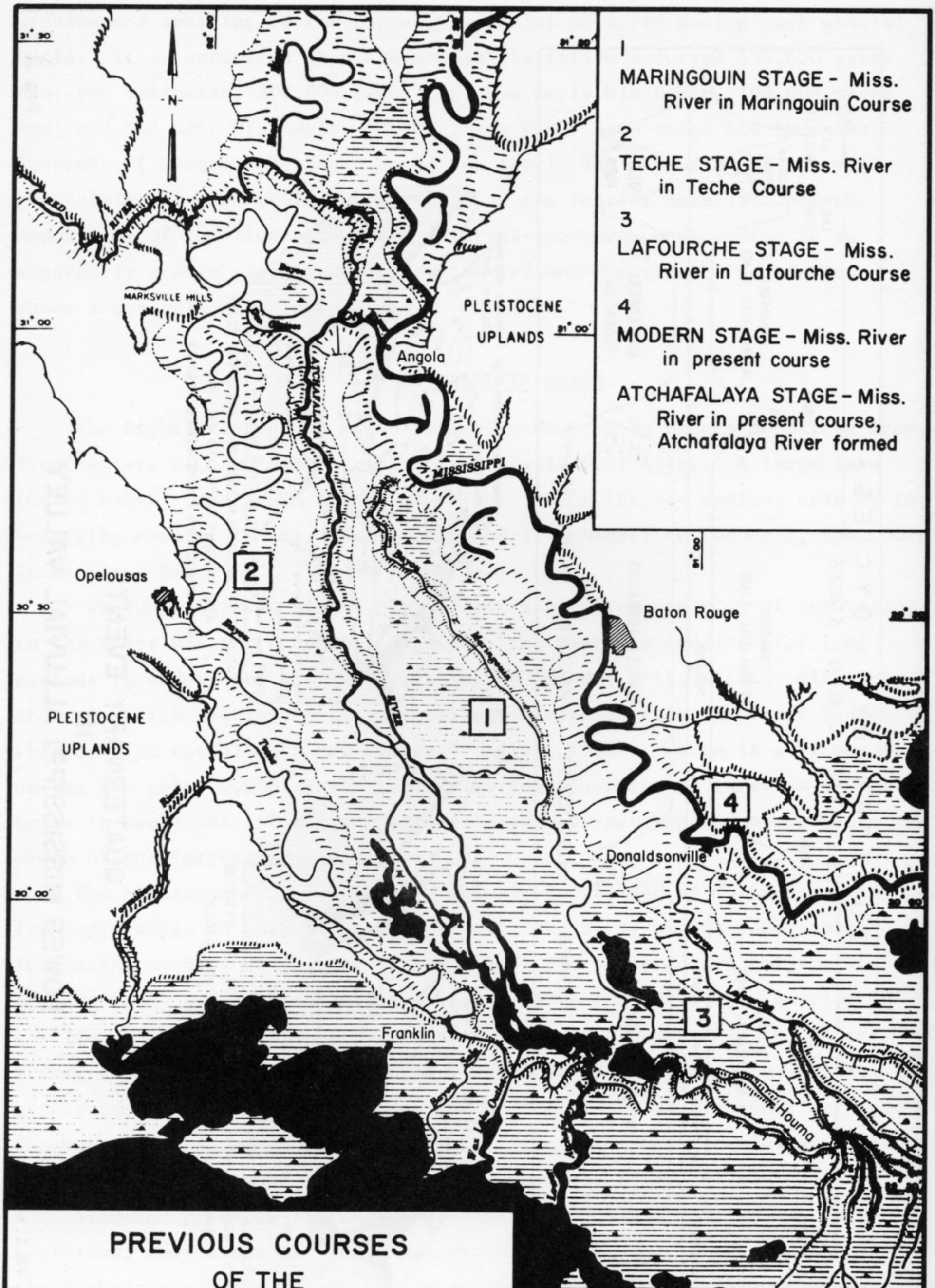

1
MARINGOUIN STAGE - Miss. River in Maringouin Course
2
TECHE STAGE - Miss. River in Teche Course
3
LAFOURCHE STAGE - Miss. River in Lafourche Course
4
MODERN STAGE - Miss. River in present course
ATCHAFALAYA STAGE - Miss. River in present course, Atchafalaya River formed
-N-
MARKSVILLE HILLS
PLEISTOCENE UPLANDS
Angola
ATCHAFALAYA
MISSISSIPPI
Opelousas
Baton Rouge
PLEISTOCENE UPLANDS
Donaldsonville
Franklin
Houma
PREVIOUS COURSES OF THE MISSISSIPPI RIVER
(After Fisk, 1952, Vol. I, p. 61)

Fig. 3

The only pre-Teche stage that can be traced with reasonable accuracy is the Maringouin path [Fisk, 1952e]. Geologists who have studied the soil deposits state that a portion of the pre-Teche course followed the present position of Bayou Maringouin. From Vicksburg it flowed southward beyond the present location of Morgan City and the Atchafalaya Bay. Although it is believed that the river followed many other routes prior to the Teche stage, this is the only one that can be traced throughout south Louisiana to the Gulf of Mexico from present topography.

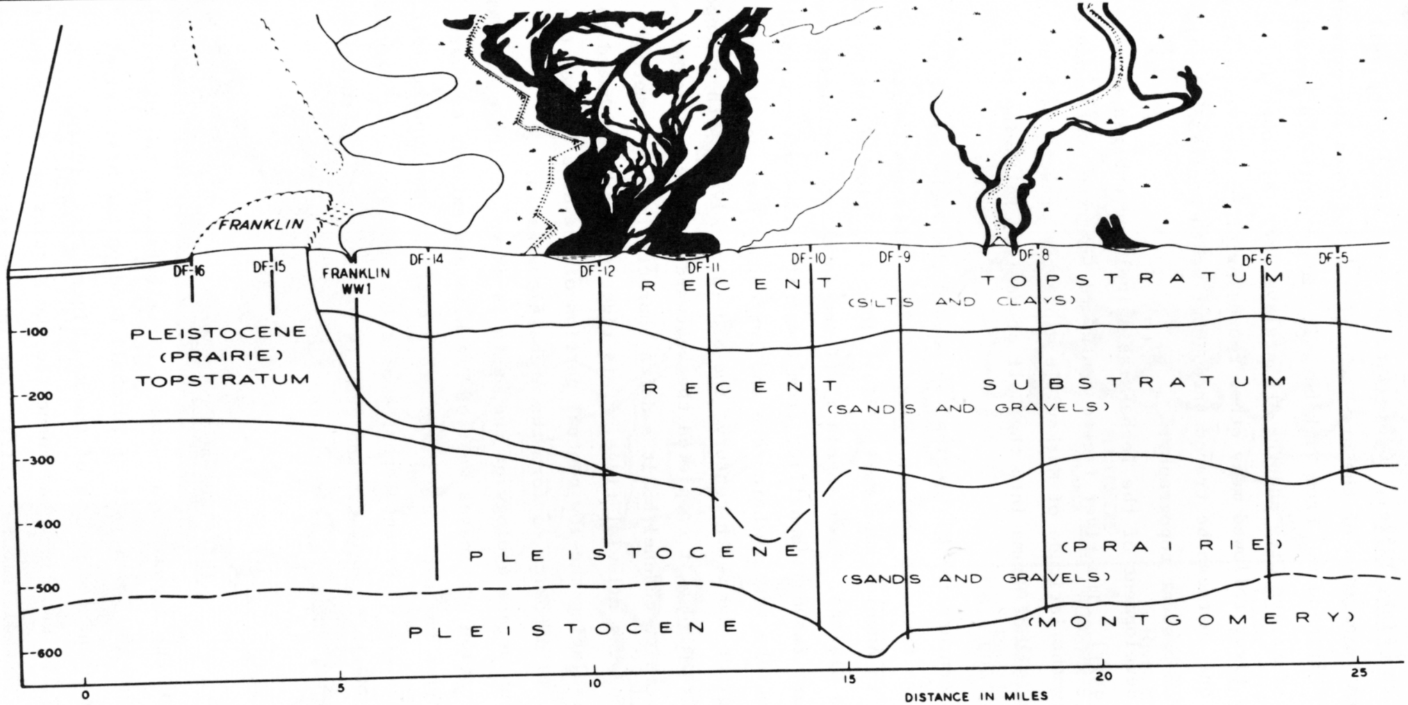
The initial development of the Teche-Mississippi route began about 100 B.C. [Fisk, 1952f]. The river flowed southward from the confluence of the Red River near the latitude of Marksville along the present path of Bayou Teche, then east of Houma into the Gulf of Mexico, following this course until about 400 A.D.

In the fifth century the Mississippi abandoned the Teche course to follow the Lafourche route to the sea [Fisk, 1952e]. This new course deviated eastward to Angola (near Marksville) along a portion of the present path of Bayou Des Glaises. From Angola it flowed southward, enlarging the ancient Yazoo River, to Donaldsonville; from there it followed the present path of Bayou Lafourche through Lafourche and Terrebonne Parishes to the Gulf of Mexico. After the tenth century, the old Yazoo River north of Angola became the main stream when it completed the westward Teche stage. The lower portion of the diversion channel built a delta characterized by numerous distributaries along the alluvial ridge. This ridge extended southward to the Teche ridge, isolating the low central portion of the area between the two elevated alluvial deposits to form the Atchafalaya Basin.

The present subsurface geology of the basin is shown on Figure 4. This particular cross-section originates west of Franklin and extends eastward approximately 20 miles through Grand Lake. To a depth of one hundred feet, the top stratum consists of Recent deposits of silts and clays. It is underlain by a Recent substratum of sands and gravels ranging from two to three hundred feet in depth. Beneath is the older Pleistocene layer.

THE ATCHAFALAYA RIVER

About 1500 A.D. the Atchafalaya became a distributary of the Mississippi River (Figure 5) when the lower part of Turnbull Bend on the Mississippi River caved into an abandoned course of the Red River [Fisk, 1952h]. The previous channel of the Red River had connected the Mississippi River and the Atchafalaya River. The distributary first came into operation when the Red River and the Mississippi River were both in flood stage; it acted as a



ATCHAFALAYA BASIN
SURFACE-SUBSURFACE RELATIONSHIP

Fig. 4

(After Fisk, 1952, Vol. II, Pl. 3)

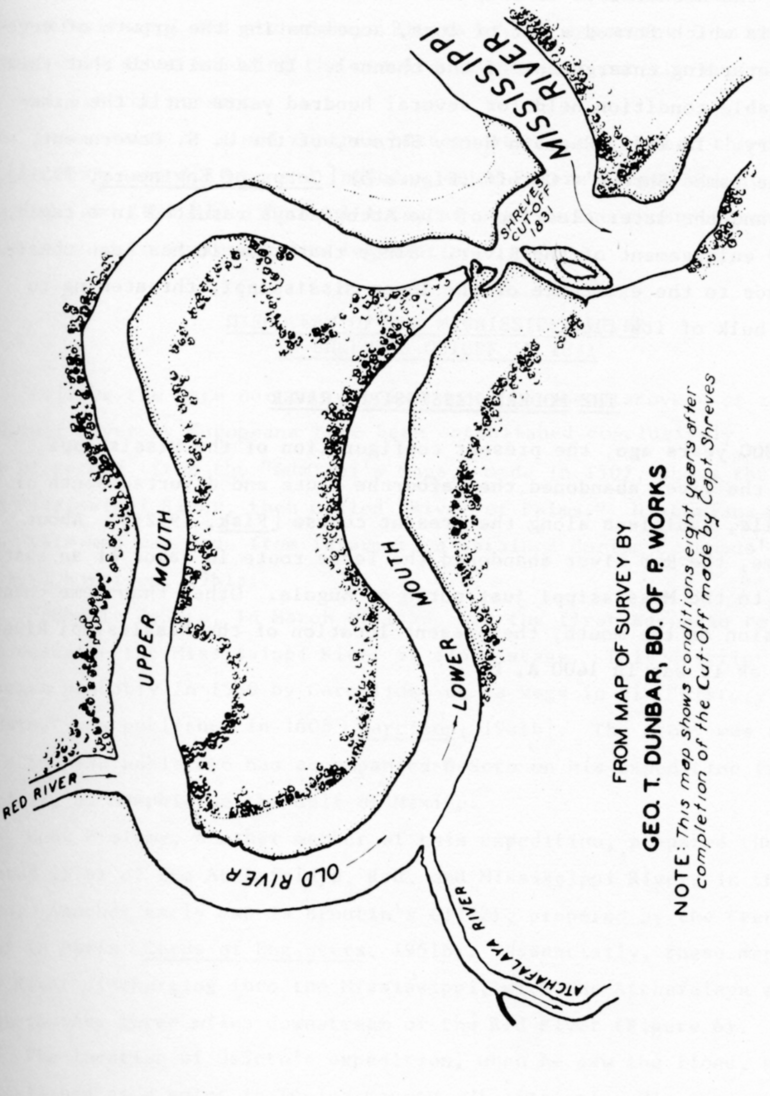


Fig. 5

OLD RIVER 1839

FROM MAP OF SURVEY BY GEO. T. DUNBAR, BD. OF P. WORKS

NOTE: *This map shows conditions eight years after completion of the Cut-Off made by Capt Shreves*

(After Fisk, 1952, Vol. II, Pl. 2)

natural floodway to divert excess water. Flood flows from these two main streams eroded a channel from near Angola beyond Simmesport through the basin to the Gulf of Mexico. This channel enlarged slowly to become the present Atchafalaya.

By chance, the location of the junction with the Mississippi River was detrimental to development. Its beginning on the west bank of the Mississippi caused the Atchafalaya to trap most of the debris floating on the main stream, debris which formed a mat of logs, accelerating the growth of vegetation and retarding enlargement of the channel. It is believed that this generally stable condition held for several hundred years until the nineteenth century. In 1831, Captain Henry Shreve, of the U. S. Government, excavated the famed Shreve's Cutoff (Figure 5) [Corps of Engineers, 1951a]. This cutoff and the later clearing of the Atchafalaya resulted in a rapid, uncontrolled enlargement of the River. Since that time it has been considered a menace to the existence of the lower Mississippi, threatening to capture the bulk of its flow.

THE MODERN MISSISSIPPI RIVER

About 800 years ago, the present configuration of the Mississippi formed when the river abandoned the Lafourche route and diverted south of Donaldsonville, Louisiana along the present course [Fisk, 1952i]. About the same time, the Red River abandoned the Teche route in favor of an eastward course to the Mississippi just north of Angola. Other than some changes in the position of the mouth, the present location of the Mississippi River is the same as it was in 1400 A. D.

CHAPTER III

HISTORY OF FLOOD CONTROL EFFORTS AND PLANS

The historical records of the flood control efforts on and plans for the Lower Mississippi and Atchafalaya Rivers are an important form of hydrologic data. Only after studying the results of the past can the engineer begin to evaluate the present.

This review of flood control history starts soon after the discovery of the Mississippi River and includes major Federal legislation, especially the 1927 and 1936 Flood Control Acts, as well as the construction actually accomplished to implement the legislation.

DISCOVERY OF THE MISSISSIPPI RIVER TO SHREVE'S CUTOFF IN 1831

Neither the date nor the circumstances of the discovery of the Mississippi River by Europeans have been established conclusively. The oldest map of record, from the "Admiral's Maps," made in 1507, shows the mouth of the Mississippi River, then called "River of Palms." Historians suspect that this map was made from information obtained during Columbus' fourth voyage [Harrison, 1961a].

Probably DeSoto, in March of 1543, was the first European to witness and describe the Mississippi River at flood stage. This description, written probably in 1580 by Garcilioso de la Vega in his "History of Hernando DeSoto," was published in 1605 [Harrison, 1961b]. The story was told to him by a Spanish noble who had accompanied DeSoto on his expedition from the vicinity of Memphis to the Gulf of Mexico.

Monk Ptolemy, another member of this expedition, prepared the first map (dated 1576) of the Atchafalaya, Red, and Mississippi Rivers in the Old River area. Another early map is Broutin's (1722), prepared by the French Government in Paris [Corps of Engineers, 1951b]. Essentially, these maps show the Red River discharging into the Mississippi, with the Atchafalaya a minor distributary three miles downstream of the Red River (Figure 6).

The location of DeSoto's expedition, when he saw the flood, has been established as a point in Tunica County, Mississippi. His account describes the tremendous expanse of water, which was estimated to be sixty miles wide, and informs us that the peak stage was not reached until the flood had endured for forty days. To preserve their food and other valuable supplies, the natives had to build storehouses above the flood level. This hydrologic

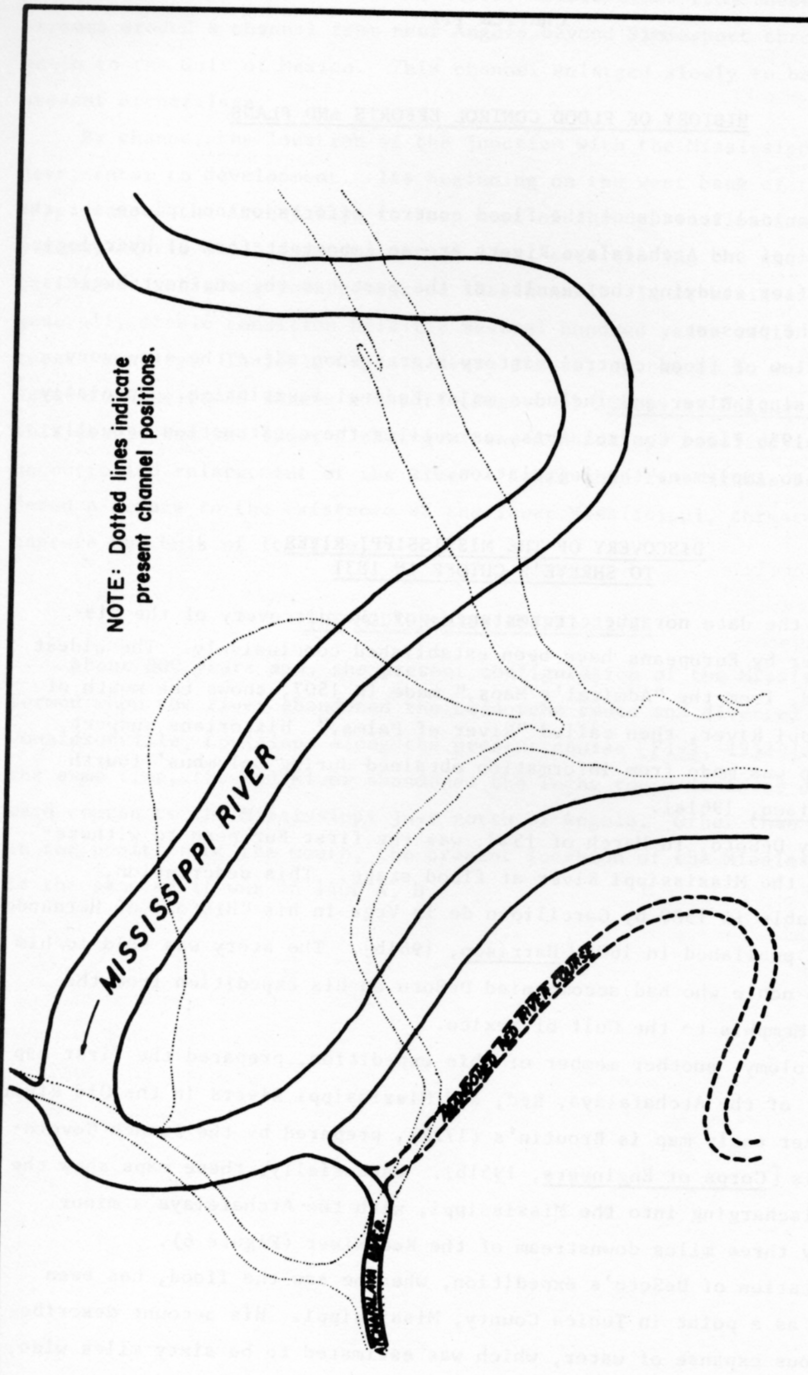


Fig. 6

MISSISSIPPI RIVER COURSES 1500 - 1944

(After Fisk, 1952, Vol. II, Pl. 2)

observation was perhaps the principal reason that the Spanish left the Mississippi Valley to the French and turned to other parts of the country.

The pioneer French Canadian brothers, Iberville and Bienville Le Moyne, sailed from France in 1698 and 1699 to claim the Mississippi River and its valley for France. In 1699 they explored from the mouth of the Mississippi to the vicinity of the present Old River, later camping at the site of the present city of New Orleans in March of the same year [Harrison, 1961 c].

In 1717 Bienville chose this same campsite for the location of a new settlement. On a ridge, it was nevertheless subject to flooding. Le Blond de la Tour, an engineer with Bienville, arguing that the land was not suitable for settlement because of frequent flooding, began laying out the city of New Orleans in the year 1718 after being overruled.

The highest water marks at the site of the planned city were only about three feet above the river banks. In view of this, de la Tour proposed that a levee be built about six feet high on the city front, in the belief that this would surely be more than adequate. It was sufficient for a while because the river, unconfined by levees, spread over the entire country during high water.

In 1718, a great flood inundated the town before the levees were completed. Although water covered the floors of the uncompleted houses, the settlers, confident that small levees along the river would keep them dry, continued their construction work. By 1721 there were 7,000 people, not including slaves, in the city. De la Tour's levees were not finished until 1727. With this construction, man was beginning to change the downstream portion of the Mississippi River.

The levee systems extended from twenty miles downstream of New Orleans to thirty miles upstream by the mid 1700's. Construction progressed little after this until the sale of Louisiana to the United States by the French in 1803 brought more settlers. In 1828, a continuous levee extended along the Mississippi River, from near Red River on the west bank and from Baton Rouge on the east bank, to below New Orleans. These levees, built by individuals, but with no overall grade having been established, ranged in height from a few inches to five feet above the natural surface of the land. Maintenance was the responsibility of the land owners.

FROM 1831 THROUGH THE 1927 FLOOD

Before 1831, the white man had not purposely attempted to improve the Atchafalaya River. At that time, a continuous "raft" approximately 30 miles long existed, with its upstream end starting 20 miles downstream from the confluence of the Atchafalaya and the Mississippi River. William Darby, in his "Geographical Description of Louisiana," noted that the river was first obstructed by timber in 1778 and that cattle could be driven over the raft. This great raft supported live willow trees and would rise and fall with the river. (It is interesting to note that the mouth of the Mississippi River, when explored by Bienville, was so blocked by logs that it was difficult to pass in a canoe).

This relationship between the Red, Atchafalaya, and Mississippi Rivers did not change until 1831, when Captain Henry Miller Shreve, a steam navigation pioneer and superintendent of western river improvement from 1827 to 1841, excavated his famed cutoff in 1831 (Figure 5). Turnbull Bend became an island and the lower limb of the bend, now called Old River, became the new connection between the Atchafalaya and Mississippi Rivers. With the primary purpose being navigation, probably little thought was given to the effects of the cutoff upon the flow relationship between the Atchafalaya and Mississippi Rivers.

In 1840, irate local residents, who had been petitioning the State to remove the Atchafalaya raft for navigation, took matters into their own hands. The "State Board of Engineers Report" of 1874 states that the raft was burned by local residents during the low water period of 1840 [State Board, 1874]. After the fire, which partially destroyed the raft, the State of Louisiana began systematic efforts to remove the debris. From 1840 to 1875, the State worked at the Atchafalaya raft for navigation. Although some reports by the U.S. Corps of Engineers state that the raft had been cleared by 1861, reports from the State Board of Engineers indicate that debris and drift still were being removed as late as 1875.

In 1879, the Mississippi River Commission was formed to prepare plans and make studies of all engineering aspects of the Mississippi River. It was faced with the problems of keeping the Atchafalaya and Red Rivers open for navigation and controlling the flow in the Atchafalaya. In its preliminary report of 1881, the Mississippi River Commission recommended the construction of a sill dam across the mouth of Old River between Turnbull Island and the Mississippi River. The report also put forward the study of a proposal to divorce completely the Mississippi River from the Atchafalaya and Red Rivers. In 1882, construction of the sill dam across the mouth of Old River began.

The Commission, in 1886, submitted a report with five separate plans for the Red-Atchafalaya Basin. These were:

1. Major Stickney's Plan: To build six submerged sill dams on the Atchafalaya.

2. Ead's Plan: To separate the Mississippi River from the Atchafalaya by means of a high dam on the Atchafalaya.

3. A Canal and Lock Plan: To construct a lock-canal from the Mississippi to the Atchafalaya.

4. The Mississippi River Commission Plan: Major Stickney's Plan, with the shutting off of the connection between the mouth of Red and Atchafalaya Rivers by means of a sill dam at the west of Turnbull's Island.

5. A Variation of Plan No. 4: To include construction of a long jetty from the lower point of Turnbull's Island into the Mississippi River to prevent direct flow from the latter into Old River.

Plan No. 5 was finally adopted, but apparently no work was done to implement the work on the Atchafalaya until 1888, in which year construction was started on the two low-sill dams below Simmesport. These dams were to allow the flow into the Atchafalaya only from flood discharges of the Red River, without obstruction to navigation. The first dam was built immediately below Bayou Des Glaises; the second, 1750 feet downstream from the first. In 1890, the River Commission reported the completion of the two dams. By 1892, a sill dam was also built across Old River, three quarters of a mile downstream from Sugar House Chute.

Levees were also constructed, extending downstream on both banks of the Atchafalaya. Table I shows the progress of levee extensions from the junction of the Atchafalaya and Old Rivers.

TABLE I

LEVEE CONSTRUCTION ON THE ATCHAFALAYA

Southward Extent River Miles*	Status East Bank	Status West Bank
14	1887	----
17	1888	----
26	1893	1881
31 (Melville)	1895	1893-1894
38	1889-1900	1905
42 (Krotz Springs)	1901	1907
52	1925	1933
55	1927 (End)	1934
58	----	1935
Lake LaRose	----	1948

*measured from the confluence of Old River and the Atchafalaya.

By 1911 the Mississippi River Commission had constructed what were then thought to be adequate levees on both the Atchafalaya and Mississippi Rivers for the control of floods [Harrison, 1961d]. In addition, the Commission believed that local interests could take over the flood control program. The floods in 1912 and 1913, however, damaged miles of levees and prompted the first Federal legislation in which flood control was an acknowledged purpose.

In 1917, before this legislation was passed, Congress wanted to know how high the levees should be built. The River Commission admitted that, although the levees were not high enough, it was unable to set a definite maximum high water grade at that time. Consequently, the flood heights from 1912 and 1913 were used as a guide.

The levees were built progressively higher until, in 1926, the Mississippi River Commission was again confident of the efficiency of its efforts. The best levee lines ever constructed contained 472,000,000 cubic yards of earth in 1926, compared to 251,000,000 cubic yards in 1913 and only 33,000,000 cubic yards in 1882 (Figure 7). (Presently the levees contain twice the yardage of the 1926 system.) The commission had spent over two hundred million dollars in protecting the flood plain, twenty times the original estimate of 1882.

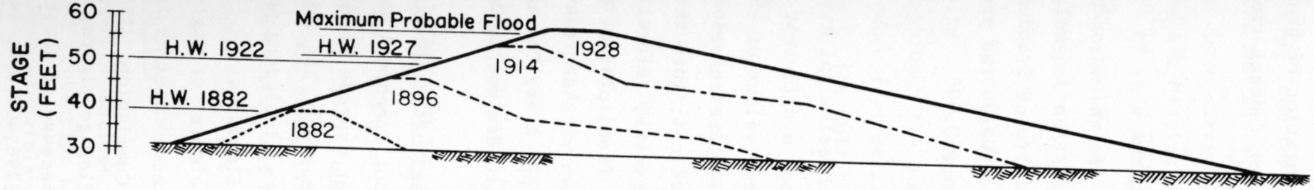
Because the levees were higher and could contain moderate floods, the flood stages increased, but the rate of flow decreased (Table II). New high water records in 1916 and 1922 were established in many places, but the Mississippi River Commission held firmly to its "levee only" policy.

TABLE II

Carrolton Gage Readings Near New Orleans, Louisiana, 1885 to 1922

YEAR	DAILY DISCHARGE (cubic feet per second)	GAGE RDG. (feet)
1885	1,102,000	13.6
1890	1,102,000	15.3
1900	1,091,000	15.7
1909	1,100,000	16.4
1913	1,076,000	17.9
1922	1,091,000	18.6

(Data from "Results of Discharge Observations, Mississippi River and Its Tributaries and Outlets, 1838-1923," Mississippi River Commission, 1925, p. 160.)



MAXIMUM STAGES
LAKE PROVIDENCE GAGE

High Water	1882	38.3 ft.
High Water	1922	49.5 ft.
High Water	1927	50.7 ft.
Max. Probable Flood		56.5 ft.

The elevation of the maximum probable flood indicated here is that contemplated by the present Flood Control Project authorized by the Act of May 1928. The year of adoption of each standard section is noted on the drawing.

The high water stages refer to the Lake Providence Gage. Mississippi River levees in the vicinity of Shipland, Miss. (Issaquena County) are comparable.

AREAS OF SECTIONS

1882	161 Sq. Ft.
1896	530 Sq. Ft.
1914	2158 Sq. Ft.
1928	3173 Sq. Ft.

STANDARD LEVEE SECTIONS

LOWER MISSISSIPPI RIVER

1882 - 1928

(Adapted from Figure 4, Harrison's "Alluvial Empire")

Fig. 7

In 1927, the largest flood ever known came down the Mississippi River. It resulted in the loss of 214 lives, displacement of 637,000 people, and the flooding of 26,000 square miles of land [MRC, 1964]. The damage was estimated to be $363,533,154. The 1912 flood, the most destructive before 1927, caused $78,188,000 [Harrison, 1961e]. This vast devastation of property and loss of human life convinced the nation of the need for federal flood control to protect the central region of the country.

THE 1928 AND 1936 FLOOD CONTROL ACTS

The Flood Control Acts of 1917, 1928, and 1936 are the major pieces of federal legislation passed for the single purpose of flood control. Although the 1917 Act did not include the present plan for utilizing floodways, it did provide for higher levees along the Mississippi River. The present flood control plans were authorized by the 1928 and 1936 Acts.

Act of 1928

The magnitude of the 1927 flood convinced the Mississippi River Commission that the "levee only" policy had failed and that a different method of flood control would be necessary to deal with the equivalent of the 1927 flood. The Flood Control Committee of the House of Representatives heard many different plans, some practical, others impractical; more than 300 plans were proposed. Construction of flood control reservoirs, reforestation of barren land, construction of river cutoffs, use of flood plains, and construction of higher levees were all considered in varying degrees and combinations. Two plans, one submitted by the Mississippi River Commission; the other, by the Office of the Chief of Engineers, were decided to be the most feasible [Harrison, 1961 f].

The Commission's plan called for protection against a flood 20 per cent greater in discharge than that of 1927. A five foot freeboard above the 1927 flood was proposed for levees, with outlets at Cypress Creek, the head of the Atchafalaya Valley, Bonnet Carre, and Caernarvon. The total estimated cost was nearly three-quarters of a billion dollars, including payment for rights-of-way and flowage rights in the proposed floodways.

The other plan, proposed by the Office of the Chief of Engineers, was named after General Edgar Jadwin, Chief of Engineers. Similar in many respects to that submitted by the Mississippi River Commission, it, however, contained no provisions for payment of damages, flowage rights, or rights-of-way for levee construction along floodways. Because of these differences the total cost of the Jadwin Plan was to be $296,400,000, less than half the estimated cost of the Commission's plan.

After prolonged debate, the Flood Control Act was approved on May 15, 1928. It utilized the Jadwin Plan, which was basically the plan now being used, providing against the maximum probable flood, the discharge of which at Old River was 3,000,000 cubic feet per second, with 2,800,000 of this coming from the Mississippi River and 200,000 cubic feet per second added by the Red River.

Under these circumstances, 700,000 cubic feet per second would be diverted from the Mississippi through Old River to join the 200,000 from the Red River. Of this 900,000 total, 650,000 cubic feet per second was to enter the Atchafalaya River directly. The remaining 250,000 was supposed to pass through the West Atchafalaya Floodway.

The 2,100,000 cubic feet per second remaining in the Mississippi would be decreased by 600,000 cubic feet per second through the Morganza Floodway; the remaining 1,500,000 cubic feet per second would lose 250,000 cubic feet per second through the Bonnet Carre Spillway into Lake Pontchartrain. Only 1,250,000 cubic feet per second would be carried by the river channel past New Orleans to the Gulf of Mexico (Figure 1).

Act of 1936.

The Flood Control Act of 1936, a supplement to the 1928 Act, provided for (1) a structure at the head of the Morganza Floodway, (2) an additional outlet for the Atchafalaya Basin, (3) improved discharge capacity of the leveed channel of the Atchafalaya River, and (4) immediate completion of the East and West Atchafalaya Basin Protection Levees to protect fully all lands outside of the floodway. This did not change any of the basic features of the Act of 1927, but it did add more protective measures.

ATTEMPTS TO IMPLEMENT THE 1928 FLOOD CONTROL PLAN TO 1966

The primary efforts in implementing the 1928 and 1936 Flood Control Acts consisted of (1) levee construction along rivers and floodways, (2) various flood control and navigation structures, (3) channel excavation to increase discharge capacities, and (4) bank stabilization to eliminate caving and levee setbacks.

Levee Construction.

The levees prescribed by the 1928 Flood Control Act are the Atchafalaya Basin Floodway Protection Levees, the Atchafalaya and Mississippi River Levees, the West Atchafalaya Fuse Plug Levee, and the ring levees for towns in the floodway.

Atchafalaya Basin Floodway Protection Levees. The West Atchafalaya Basin Protection Levee begins near Hamburg, Louisiana, continues in a southerly direction to the latitude of Krotz Springs, and thence extends in a southeasterly direction beyond the Charenton flood gates and Wax Lake Outlet to connect with the one mile long floodwall in Berwick, Louisiana. The portion north of U. S. Highway 190 is also the West Protection Levee of the West Atchafalaya Floodway.

The East Atchafalaya Basin Protection Levee, beginning just north of Morganza, Louisiana, extends in a southerly direction about twenty miles to U. S. Highway 190. The portion north of the highway is actually the east levee of the Morganza Floodway (Figure 1). From the high level crossing at U. S. Highway 190, the levee extends about 90 miles in a southeasterly direction beyond the Bayou Sorrel Locks to connect with 1.3 miles of floodwall at Morgan City, Louisiana.

Atchafalaya and Mississippi River Levees. Levee construction along the Atchafalaya and the Mississippi was continuous from 1928 to the present. Between 1928 and 1948 the Atchafalaya River levees were extended as shown in Table I. Most of the work along the Mississippi River during the same period was the replacement of levees lost to bank caving.

West Atchafalaya Floodway Fuse Plug Levee. While the West and East Atchafalaya Basin Protection Levees were being constructed, the 6.9-mile long fuse plug levee (Illustration No. 1) at the head of the West Atchafalaya Floodway was built between the towns of Simmesport and Hamburg to connect the West Protection Levee with the West Atchafalaya River Levee. When use of the West Atchafalaya Floodway becomes necessary, the fuse plug will either be eroded by high water or, if necessary, dynamited.

Levees for Simmesport, Krotz Springs, and Melville. Ring levees were built to protect three existing towns within the floodway--Simmesport, Melville, and Krotz Springs.

Structures.

The 1928 and 1936 Acts required the construction of various flood control structures, spillways, and navigation locks. Later, the Flood Control Act of September, 1954 authorized construction of the Old River Control Structure, the Overbank Structure, and the Old River Navigation Locks.

Old River Low-Sill. The low-sill control structure (Illustration No. 2), located at the head of the Atchafalaya River near the junction with the Mississippi River, controls the diversion from the Mississippi into the Atchafalaya River. It was completed in 1959.

COURTESY OF US C OF E WEST ATCHAFALAYA FLOODWAY ILLUST. 1
Portion Of Fuse Plug Levee At Head Of Floodway Between Simmesport And Hamburg

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OLD RIVER CONTROL STRUCTURES
Mississippi River In Foreground—Low-Sill Structure At Left—Overbank Structure At Center

ILLUST. 2

Overbank Control Structure. The overbank control structure (Illustration No. 2), immediately north of the Low-Sill Structure, is to increase the outlet capacity to the Atchafalaya River. This structure was also completed in 1959.

The Old River Navigation Lock. The purpose of this structure is to maintain the previous navigation routes between the Red, Atchafalaya, Ouachita, Black, and the Mississippi Rivers after the damming of Old River. Construction was begun in 1958 and completed in 1962, with lock operations starting in 1963.

The Morganza Flood Control Structure. This structure (Illustration Nos. 3 and 4) was built at the head of the Morganza Floodway to control the amount of discharge through the floodway. It was completed in 1954 at a cost of $20,680,000.

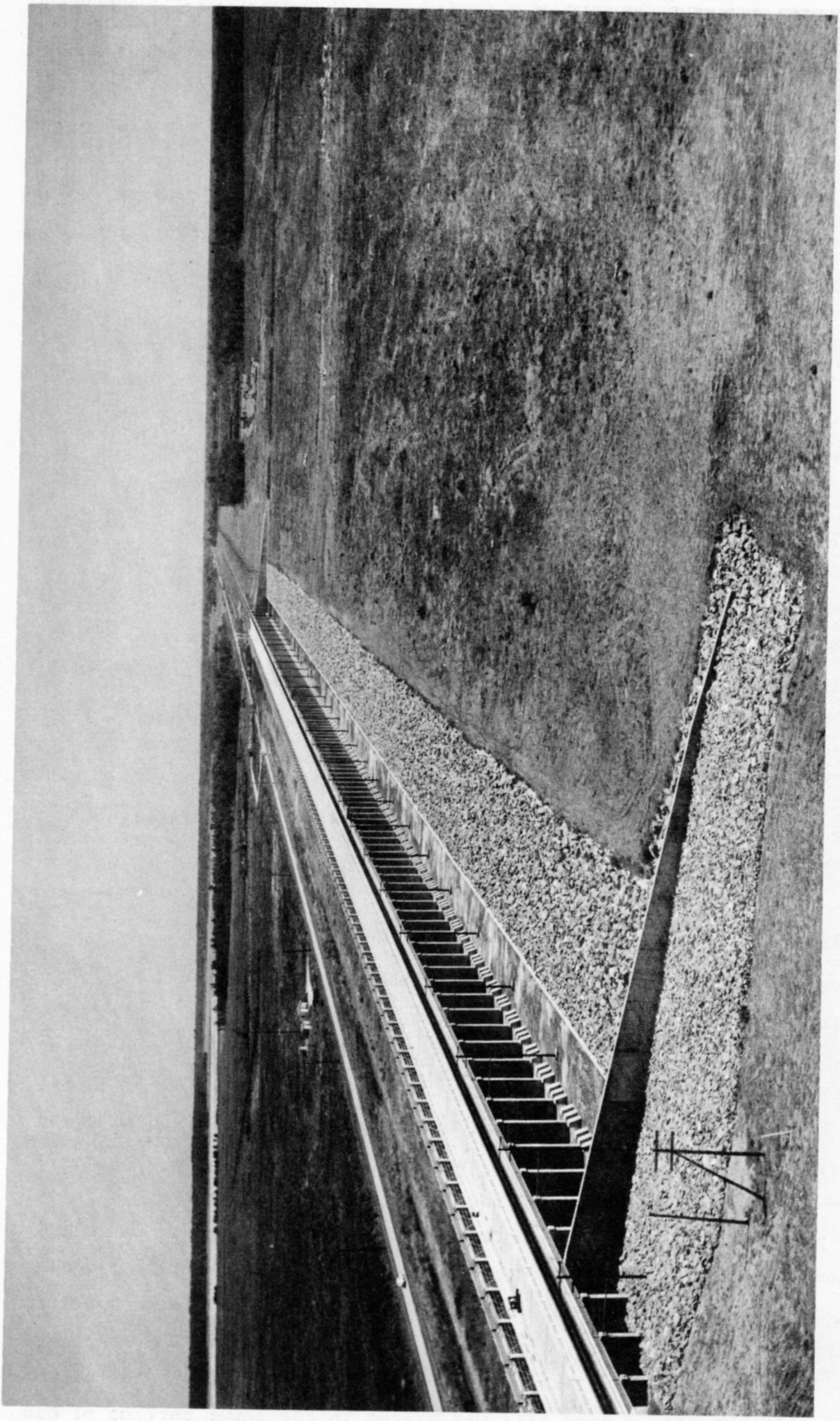
The Bonnet Carre Spillway. This floodway (Illustration Nos. 5 and 6), located about 33 miles north of New Orleans, between Lake Pontchartrain and the Mississippi River, was completed in 1935 at a cost of $14,213,000. To be used when the Carrollton (New Orleans) gage exceeds 20 feet, the floodway diverted water from the Mississippi during the 1937, 1945, and 1950 floods.

Miscellaneous Related Drainage and Navigation Structures. Other structures were also built concurrently with Atchafalaya Floodway. They include (1) Bayou Courtableau Drainage Structure, (2) Bayou Des Glaises Drainage Structure, (3) Bayou D'Arbonne Drainage Structure, (4) Pointe Coupee Drainage Structure, (5) Charenton Floodgate, (6) East and West Calumet Floodgates, (7) Berwick Lock, and (8) Bayou Sorrel Locks.

Channel Excavation.

Excavation in Old River, the Atchafalaya River, Wax Lake Outlet, and the Atchafalaya Basin Main Channel was required to achieve the large capacities for the project flood. Much of the necessary excavation has been completed in the Wax Lake Outlet Channel and the Atchafalaya River. Excavation in the Atchafalaya Basin has not been systematic, but efforts are now directed toward the excavation of one main channel.

Old River. Since 1928, dredging in the Old River has been a continual effort to provide for both flood control and navigation between the Atchafalaya, Red, and Mississippi Rivers. The most important engineering work affecting the Atchafalaya--Mississippi relationship was Carr Point Cut-Off, constructed in 1944 (Figure 8). Its purpose was to eliminate the need for bank stabilization to protect the levee in Pointe Coupee Parish. After completion of this cut-off, a sand fill was placed in the lower portion of Old River to accelerate enlargement [Corps of Engineers, 1951f].



ILLUST. 3

MORGANZA FLOODWAY CONTROL STRUCTURE
Mississippi River In Left Background

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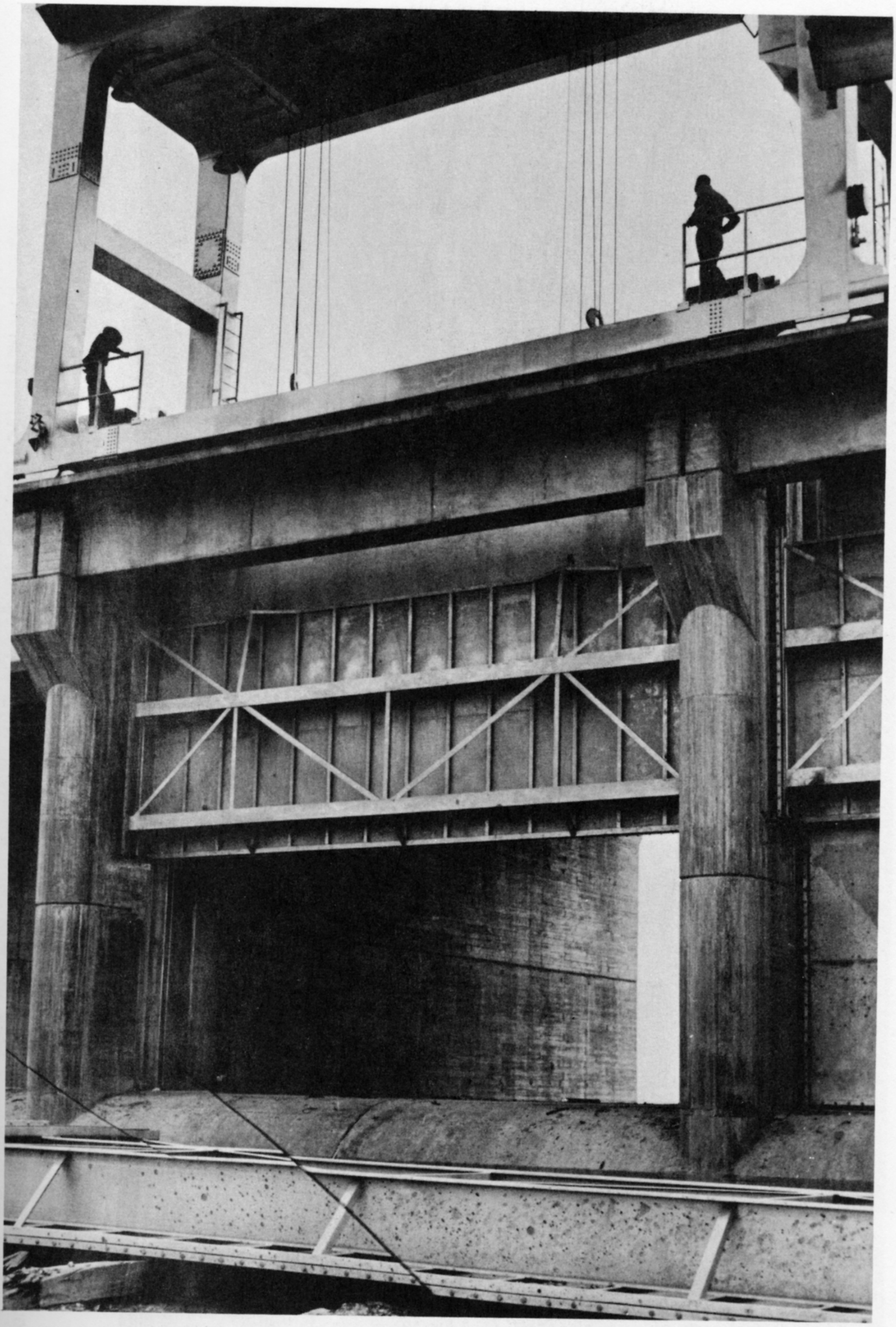

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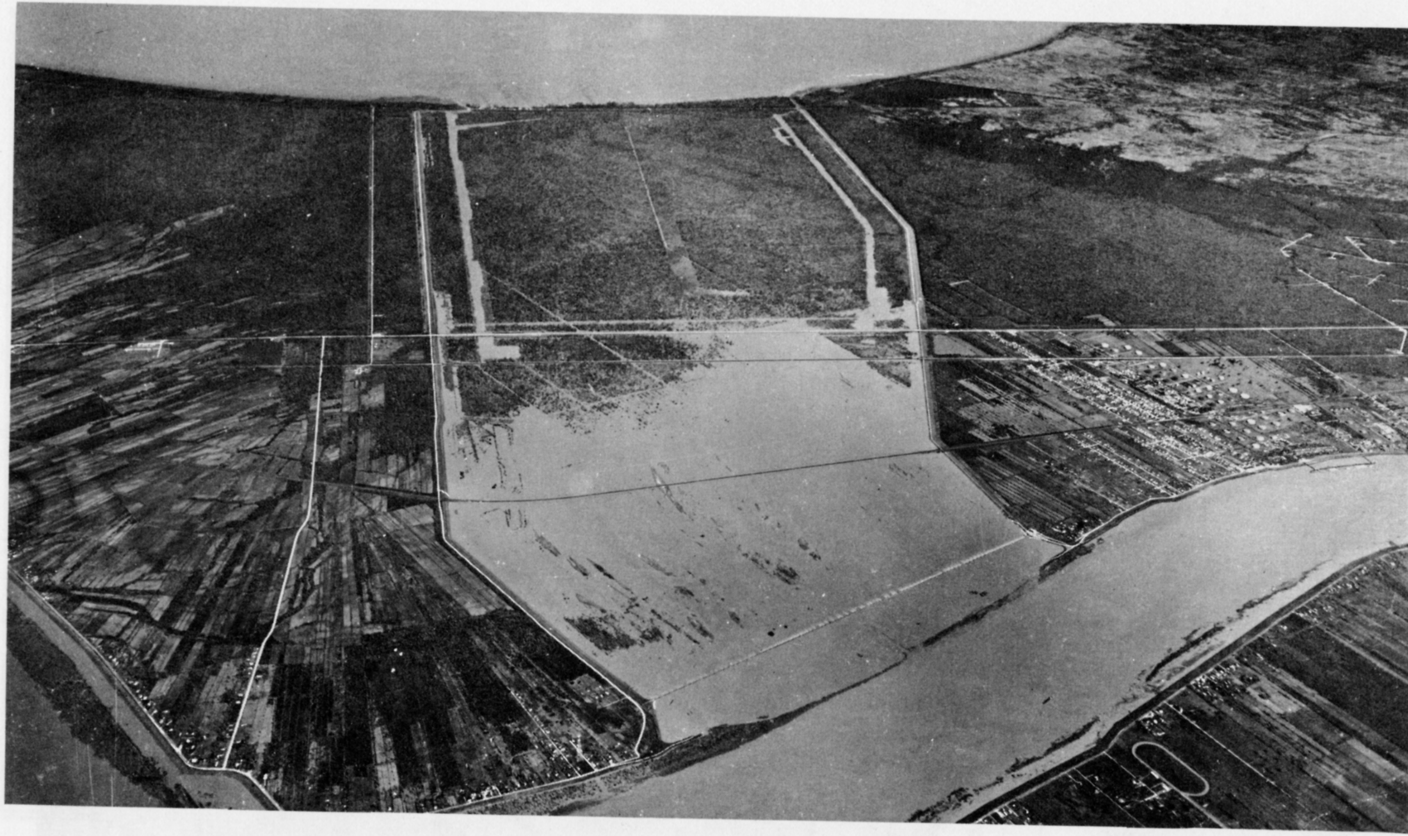
MORGANZA FLOODWAY CONTROL STRUCTURE
Gatebay From River Side Of Structure

ILLUST. 4



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BONNET CARRE SPILLWAY

1950 Operation, With Mississippi River In Foreground And Lake Pontchartrain In Distance

ILLUST. 5

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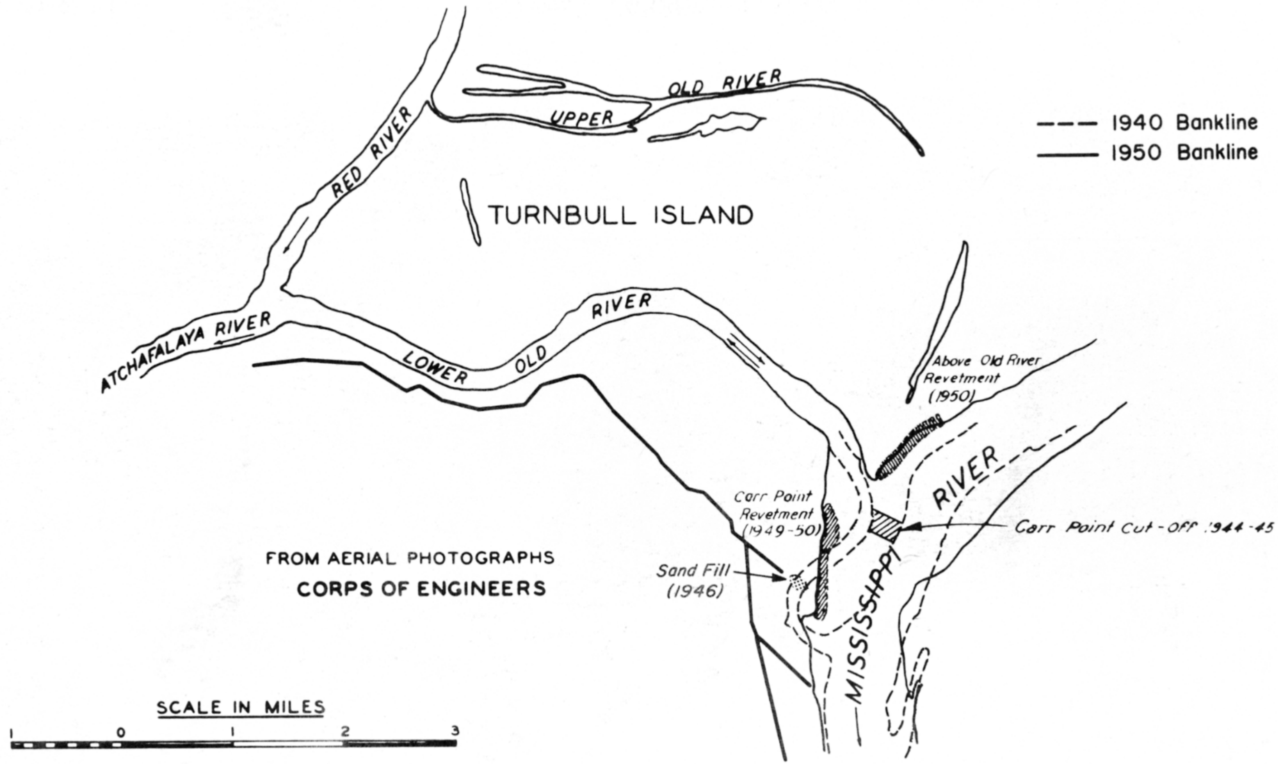
BONNET CARRE SPILLWAY
1950 Operation With One Gate Bay Partially Open

ILLUST. 6



MISSISSIPPI RIVER CHANNELS AT OLD RIVER
1940 & 1950

Fig. 8

(After Fisk, 1952, Vol. II, Pl. 2)

Atchafalaya River. Between 1932 and 1951, over 22 million cubic yards of material were dredged from the Atchafalaya River, from above Simmesport southward to Whiskey Bay Pilot Channel [Corps of Engineers, 1951e]. This was for both implementation of the 1928 Flood Control Act and provision for navigation.

Atchafalaya Basin Below Atchafalaya River. Of the more than 250 million cubic yards of material dredged in the Atchafalaya Basin between 1932 and 1963, most was removed to provide for the allotted flow defined by the Act of 1928 [Corps of Engineers, 1951e].

The present plan for the lower portion of the Atchafalaya Floodway includes the excavation of the Atchafalaya Basin Main Channel through the lower portion of the basin by way of Whiskey Bay Pilot Channel, Upper Grand River, Blind Tensas Cut, Lake Mongoulois, Bayou Chene Cut, Tarleton Bayou, Chicot Pass, Grand Lake, and Six Mile Lake. However, the first channels selected for the initial development and excavation during 1930-35 were Butte La Rose Cut-Off, Bayou La Rampe, Lake Chicot, Lake Long-Fausse Point, Big Tensas-Logan Chute Channel and Cowpen Bayou-Little Tensas Channel [Corps of Engineers, 1951e]. Contrary to the original expectations, these streams failed to scour and develop capacity.

Since 1932, there has been an increase in the annual volume of materials dredged in the Lower Atchafalaya Basin Floodway. Between 1932 and 1951, approximately 125,000,000 cubic yards were excavated; from 1954 to 1963, over 150,000,000 cubic yards. The amount per decade has more than doubled.

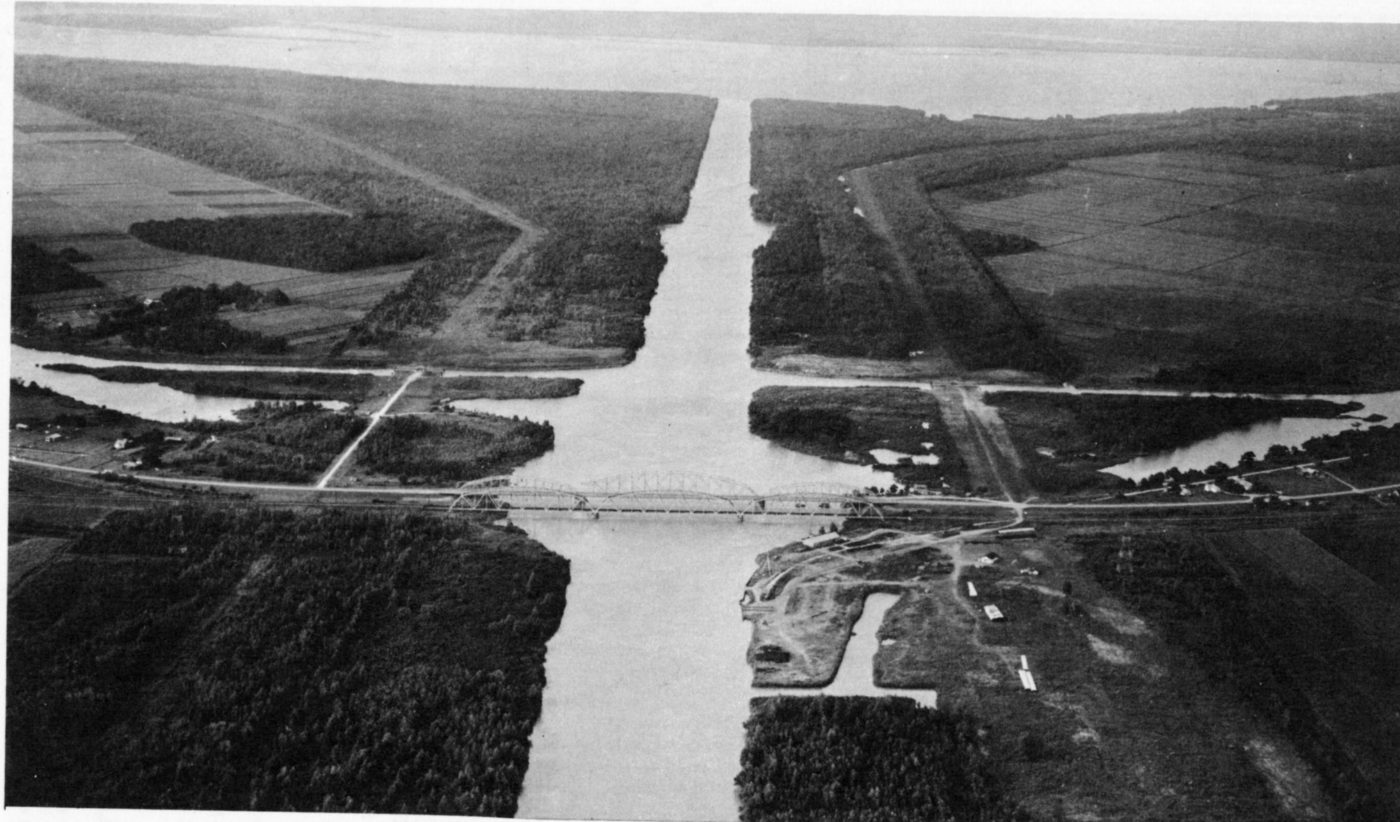
Wax Lake Outlet (Illustration No. 7) was constructed in 1942 to increase the the capacity of the lower portion of the Atchafalaya Basin Floodway. This additional outlet to the Gulf of Mexico provides for a discharge of 270,000 cubic feet per second.

Mississippi River. Since 1928, nearly all of the dredging in the Mississippi below Old River has been done to maintain a navigation channel which presently has widths varying from 450 feet to 1,500 feet and depths, from 30 feet to 40 feet.

An important engineering program, completed between 1932 and 1937, was the construction of thirteen cutoffs above Old River, reducing the length of the Mississippi River by 151.8 miles.

Bank Stabilization

Bank erosion on the Atchafalaya River has not been a serious problem, and failures of banks due to unstable side slopes have been infrequent. On the other hand, bank stabilization on the lower Mississippi River has



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WAX LAKE OUTLET
Looking North Toward Six Mile Lake

ILLUST. 7

been very necessary. "Already about 500 miles of articulated concrete mat are in place with more than a hundred miles to be completed." [Construction News, 1964]. This indicates the amount of paving already completed on the Mississippi River. Construction News states further, "This type of revetment is one of the more costly phases of the Project (between $70,000 and $1,000,000 per mile)." The cost of 600 miles of revetment will be over one-half billion dollars.

CHAPTER IV

THE FLOOD CONTROL PLANS

The hydrologic evaluation of the flood control plans and of the effects of engineering works built to implement them is very difficult; many experienced students of the Mississippi and Atchafalaya Rivers have failed to formulate effective plans. Moreover, the looking back at completed projects and analyzing of the subsequent hydrologic data to determine each project's effectiveness are much easier than the formulating of new plans and engineering works to solve present and future flood control problems. Hindsight is much easier than foresight. The failures and inconsistencies of the past are presented here to emphasize the complex and enormous problems still being met in attempts to protect the flood plains.

EVALUATION OF THE PLANS FOR THE MISSISSIPPI AND THE ATCHAFALAYA RIVERS

After the 1927 flood, two principal methods for flood control were proposed for the Lower Mississippi and the Atchafalaya. One was the "levee only" policy, followed for nearly two hundred years before its abandonment. The basic assumption had been that an alluvial river channel would adjust itself to its flows. Consequently, if confined by levees, the channel would enlarge to provide better flood protection. The second proposed method was the dispersion of water--the utilization of controlled floodways. Diversion of water from the main channel reduces the amount flowing downstream, which in turn lowers the stage.

A modified version of the second is now being used, with most of the floodways controlled by gates. This method is presenting many problems because it is physically impossible to operate any structure during a drought or flood in a manner that will simultaneously satisfy both the people who depend on the Mississippi and those who depend on the Atchafalaya.

Since the beginning of flood control on the Lower Mississippi and Atchafalaya Rivers, the accepted policy between 1718 and 1927 was the construction of levees to confine the flood water to the main streams. This theory was opposed by only a few of the authorities on hydrology.

The "levee only" policy was based on the practice and theory of Domenico Guglielmini, an Italian hydraulic engineer of the Seventeenth Century. Humphreys and Abbott, in their 1861 report on the hydraulics of the Mississippi River, stated, "Guglielmi [sic] was sensible of the great discrepancies between his theoretical and the practical laws of the rivers, and endeavored to explain them. His works have given him chief place among the Italian hydraulic engineers of his time [1876]. The basic hydraulic law was: the greater the slope, the higher the velocity; the higher the velocity, the greater the scouring; the greater the scouring, the larger the discharge capacity. Confinement of floods within levees increases the slope and velocity. The higher velocity brings about additional bed scouring, which enlarges the channel and, consequently, increases the discharge capacity; the stages do not increase.

James B. Eads, a nationally-known civil engineer of the late nineteenth century, was instrumental in the formation of the Mississippi River Commission in 1879. He was also a firm believer in Guglielmini's "hydraulic law." Before being appointed to the commission when it was first organized, Eads had used this "law" in 1875, after much opposition from the Corps of Engineers, to begin construction and maintenance of South Pass, a navigation channel at the mouth of the Mississippi. This project was a 20-year "no cure-no pay" maintenance contract with the U. S. Government, proposed by Eads. His plan, to use levees and permeable spur dikes to concentrate the flow through a 650-feet wide channel, thus scouring out a large sand bar, was successful in 1879.

Eads became further well known for both his knowledge of river hydraulics and his characteristic self-confidence and audacity. The achievement at South Pass was a constant testimonial employed by advocates of the "levee only" policy.

Two years later, a group of engineers attempted to change the new Commission's policy. At the annual convention of the American Society of Civil Engineers in 1881 a majority group presented Eads' "concentration of flow" theory; a minority group endorsed the "dispersion" or "utilization of floodway" theory. This conflict raised heated debates and created confusion. Unfortunately, Eads could not join in because of illness [Corthell, 1882].

In the first quarter of this century, the controversy continued, although the levees had afforded some protection from moderate floods. The Mississippi River Commission was convinced that the "levee only" policy would be victorious. Ockerson [1922], a consulting engineer, later a member of the Commission, wrote, "It is true that efforts to effect complete flood control and security are still short of satisfactory consummation, but good progress is being made, . . ., and the results are reflected in the greatly increased measure of protection shown in the flood of 1922.." He stated, concerning diversions and floodways, that "...the conclusion is reached that such devices greatly increase the flood hazard, have only a limited effect on the flood height, are expensive to construct and maintain, and would add new and serious dangers to the levees themselves. Therefore, the use of spillways for the purpose of reducing flood heights is impracticable." Beach [1924], a Major General and Chief of Engineers, stated, "The efficacy of levees for flood control is emphasized by the fact that 712 crevasses occurred in 1882, 1 in 1916, none in 1920, and 2 in 1922; but for 700 miles below Cairo there were no breaks in the controlling levee line." These renowned men in the field of flood control truly believed they had successfully utilized the best method.

During the same period before 1927, the proponents of the dispersion method of flood control continued their attempts to change the policy. John Klorer, City Engineer of New Orleans, stated [1924], "The flood of 1922 will be memorable. . .not by reason of the record-breaking elevations attained by the river. . . ,but because of the sweeping aside of many traditions, theories, and folk-lore ideas concerning the flood control of the Mississippi." However, he was mistaken in assuming that the existing flood control policy would be changed at once. The higher flood water elevations of 1922 were considered as important by the commission as the few levee breaks which had occurred.

However, after the 1927 flood caused nearly $400,000,000 in property damage, 214 deaths, and forty major breaks in the main levees, the Commission was convinced that the old policy could never provide against such a flood. Most of the statements previously made by members of the River Commission and the Corps of Engineers, assuring the people of the experts' confidence in the levee system, were nullified by the disaster. It was apparent, and now had been proved, to the Mississippi River Commission that the old method no longer worked.

The first decision by the Mississippi River Commission after 1927 was to determine the size of the flood for the planning of required projects. C. M. Townsend, past president of the Mississippi River Commission, explained that farmers were willing to lose an occasional crop due to floods in order to make use of the fertile land [1929a]. He believed that the engineer should consider probablities and stated, "If the interest is computed at 4% on the cost of some of the proposed projects, it would be greater in 15 years than the estimated damage caused by the flood (1927). A disaster (the 1927 flood) which will not probably occur once in 100 years is in the same category as an earthquake or cyclone. It is an Act of God for which the philanthropist should make provision. Because an earthquake formed Reelfoot Lake opposite New Madrid, Mo., 100 years ago, engineers do not make the buildings in the Mississippi Valley earthquake-proof" [1929b]. He added, "A burrowing animal can create a hole in the finest levee that has been devised, which, if not closed within a few moments, will insure its destruction" [1929c]. He concluded that to construct a levee line against "all the imaginary conditions...is to attempt the impossible." Nathan C. Grover, Chief Hydraulic Engineer with the U. S. Geological Survey, recognized that larger floods were possible [1929]. "Students of Hydrology have long realized that a flood like that of 1927 was inevitable. They know, too, that similar and even larger floods will occur in the future." After deliberation, the Mississippi River Commission agreed on a flood whose magnitude was about 25 per cent greater than the 1927 flood.

The second decision was to change over to the presently adopted Jadwin Plan (described in Chapter III), a dispersion method. It had become evident to the Mississippi River Commission that floodways would be required to divert part of the project flood.

An evaluation of the previous flood control plans indicates that complete flood protection was never accomplished. The method used for the first two hundred years, the "levee only" policy, had to be abandoned in 1928 after its failure in the 1927 flood. Floodway control is presently being used in the form proposed in 1928. Surprisingly, the project flood now in use is almost identical to the one proposed in 1928, even though the one used for design brought about almost forty years of construction that has not only changed the physical features of the upper portion of the Mississippi River watershed, but also has undoubtedly changed the concentration time of the basin. This construction includes drainage improvements, numerous reservoirs, cutoffs that have shortened the Mississippi River 152 miles, and other alterations of the terrain.

Although the diversion of flood waters has been utilized since the 1928 Flood Control Act, an important decision was made in 1950 to regulate diversion from the Mississippi through a gated control structure to the Atchafalaya River. The given reason was the imminent capture of the Mississippi by the Atchafalaya River before 1975, if no preventive measures were taken. The Corps of Engineers' report failed to comment on how previous projects had fostered and accelerated the natural diversion of the Mississippi into the Atchafalaya River.

Many unforeseen problems, resulting from the regulation of the Mississippi River below the latitude of the low-sill control structure, have appeared. First, the backwater area near Red River floods each year. The flooding could be checked by allowing the maximum amount of discharge in the Mississippi River. However, this might well cause deterioration of the Atchafalaya River main channel. Second, although additional water could be allowed to flow down the Mississippi River during the low water season, this increase would be harmful to the fishing in the Atchafalaya Basin, and could result in salt-water intrusion of the Morgan City water supply. Many previous natural droughts or floods, which in some instances hurt, or even helped, the economy of the people on both rivers, may now be duplicated deliberately with the gated structure. No satisfactory policy for its operation, to determine which stream gets the benefits, has yet been formulated.

EFFECTS OF WORKS CONSTRUCTED TO IMPLEMENT THE PLANS

The effects of the engineering works on the Lower Mississippi and the Atchafalaya are numerous. Before the 1928 Flood Control Act, the "levee only" policy governed. The Atchafalaya River was to be utilized only to convey the flood discharges from the Red River (200,000 cubic feet per second); projects were built to decrease the capacity of the Atchafalaya River. After the flood of 1927, the new dispersion policy required 650,000 cubic feet per second to be discharged through the Atchafalaya River. Projects to increase the discharge through the Atchafalaya River were successful, but after the 1945 flood, when the Atchafalaya River diverted more than its planned share of the flood waters, others had to be constructed to again decrease or limit the diversion. These changes in policy lacked consistent planning. Although the singular effects of each particular project can be estimated, the total effect of the combined engineering works may never be determined correctly.

Before 1831.

When de la Tour platted the city of New Orleans in 1718, the highest water marks were only three feet above the river banks. A conservative engineer, he proposed six-foot high levees, the first to be constructed on the Mississippi. They would have provided New Orleans with three feet of freeboard above the known high water.

An important factor, apparently missed by de la Tour, was the large overbank storage of the lowlands. These large areas, inundated by annual high waters, served as natural reservoirs. As pointed out elsewhere, river levees that confine the flood waters tend to increase the flood stages.

De la Tour did not foresee the difficulty from constrictive river levees. As described by Kemper, in Rebellious River, "To hold this water out with a small levee seemed simple. The settlers in the adjacent country had the same idea, so, according to Humphreys and Abbott, de la Tour, the engineer who laid out New Orleans in 1718, directed a levee or dyke to be raised in front, to more effectually preserve the city from overflow. Although this work was so early contemplated, it was not completed until November 1727, when Governor Perrier announced that the New Orleans levee was finished, it being 5400 feet in length and 18 feet wide on the top. He added that within a year a levee would be constructed for 18 miles above and below the city, which, though not so strong as that of the city, would answer the purpose of preventing overflow. And, he thought he was telling the truth."

To evaluate the effectiveness of these small levees is difficult. Kemper [1949] goes on to say, "The potato row levees then held out the small floods but not the big ones, so now, the mountains of earth do the same. There is a change in the characteristic of the floods; then, they were numerous small floods that came and went quickly and did only local damage; now they are less frequent, great floods that sweep vast areas." At most, one can say that the effectiveness of these first flood control levees only reduced the frequency of inundation.

<u>Shreve's Cutoff, 1831</u>.

In 1831, Captain Henry M. Shreve excavated a cutoff in the Mississippi River. At that time, navigation was the prime motive. Little thought was given to the effects on the flow relationships between the Atchafalaya and the Mississippi Rivers. Figure 5 shows the location.

The cutoff started an accelerated increase in the Atchafalaya's capacity. It would later be recognized as man's first unknowing step to begin a new course for the Mississippi.

<u>The Atchafalaya Raft</u>.

Another important engineering work, to improve navigation, was the removal of a 30-mile long raft on the Atchafalaya. The upper end of the raft was about 20 miles downstream from the Mississippi River. Only after 35 years of continual effort by the State of Louisiana and the U. S. Government was the stream cleared of debris.

The cleaning and improvement combined harmoniously with Shreve's Cutoff to accelerate the growth of the Atchafalaya. Judgment of this work should not be made in relation to the present flood control plan. It should be viewed only as an individual project accomplished for navigation. The engineers responsible for these projects failed to realize the long-range effects on the Atchafalaya-Mississippi affinity.

Low-Sill Dams.

After working for nearly 50 years to help the Atchafalaya River in capturing some of the Mississippi's flow, the Mississippi River Commission, in 1928, recommended the construction of a sill dam across Old River, the connecting stream between the Atchafalaya and the Mississippi, to reduce the discharge of the Atchafalaya during floods. Three sill dams were actually built, one in Old River and two in the Atchafalaya.

These dams did little, if anything, to halt the increase in capacity and average discharge. So, as there were no major effects caused, these projects proved to be fruitless, failing to accomplish their purpose.

Levee Construction, 1831 Through 1927.

As mentioned in Chapter III, the levees along the Atchafalaya and Mississippi Rivers were constantly being lengthened and raised. Table I, page 21, shows the progress of construction on the Atchafalaya River levees; Figure 7, page 23, illustrates the large increase in height and grade of the Mississippi River levees.

Although the construction of the river levees between 1831 and 1927 did protect the flood plains from some of the floods, complete protection was never accomplished. Whenever the levees had been reinforced to a larger cross-section and higher grade, another flood would come downriver to over-top them. Finally, after the 1927 flood in the lower Mississippi Valley had devastated property and caused loss of human life, the Mississippi River Commission admitted that its existing plan was inadequate. Because the Commission had primarily sought complete flood protection, the pre-1927 system was termed a failure. Had the Commission decided to form a plan for protection against only a 100-year frequency flood, the existing (1927) levee system would have been considered successful; the 1927 flood had a recurrence interval far greater than once in 100 years.

The construction of the Mississippi and Atchafalaya River levees was, then, the third major engineering work whose side effects during this period helped to divert more water from the Mississippi to the Atchafalaya. The high Mississippi levees confined the flood waters, resulting in higher stages for the same discharge. With such an increase at Old River, the Atchafalaya received more and more water from the Mississippi.

1928 to the Present.

The effects on the hydrology between 1928 and 1966 are chiefly due to the building of structures, the excavation of channels, and the enlargement of levees.

Structures.

The major structures completed between 1927 and 1966 (described previously in Chapter III) include: (1) the Old River Low-Sill structure, (2) the Overbank Structure, (3) the Morganza Control Structure, (4) the Old River Navigation Lock, and (5) the Bonnet Carre Spillway.

The Overbank Structure near Old River, the Morganza Control Structure, and the Old River Navigation Locks have not had any effects on the characteristics of the Mississippi and Atchafalaya Rivers. The Overbank Structure and the Morganza Structure were designed to take their share of the project flood, but their capacities are only theoretical because neither of the structures has ever been operated. The Morganza Floodway appears to be in doubt. The Corps of Engineers plans to use it for the first time during the next moderate flood, with discharge measurements to determine its actual capacity [Chatry, 1961].

The effect of the Low-Sill Structure on the relationship between the Atchafalaya and Mississippi Rivers is still being studied. The purpose of the structure is to regulate the Atchafalaya River flow from the Mississippi. (In March 1966 the Low-Sill Structure had to be closed after three loose barges accidentally sank near the structure, with one of them becoming wedged in a gate bay. Consequently, the stages on the Mississippi River were raised 8 feet higher than those normally expected during a flood with a five-year recurrence interval, due to unscheduled gate closures.) Certainly the structure will aid in developing the Mississippi, but, at the same time, the low discharges to the Atchafalaya will not be great enough during the high water periods to scour its bottom. It follows that deterioration (silting) of the Atchafalaya can be anticipated if closures of the Low-Sill Structure are frequent or prolonged.

Such side effects from man-made conditions can become complex and far reaching. For example, the sinkings at the Low-Sill Structure in 1966 required gate closures during barge removal operations, with subsequent abnormally high river stages at New Orleans. Nearly 100 barges there broke loose from their moorings as a result [Dyson, 1966]. One barge grounded hard on the river levee. Others battered the Corps of Engineers' docks, damaging equipment. If the regime of a river is changed, the author of the change becomes liable to everyone affected. This responsibility is large for any public body or agency

The Low-Sill Structure has decreased the low flows formerly diverted by Old River to the Atchafalaya. It was designed to reproduce the 1950 conditions between the Atchafalaya and Mississippi Rivers. However, as the flows in that year did not get very low, the three center bays were arbitrarily placed lower than the others, at a crest elevation of 5.0

feet below mean sea level. Figure 9 compares the flow diversion from the Mississippi before and after construction of the Low-Sill Structure.

Excavation.

The major excavation affecting the flood control on the Lower Mississippi River and the Atchafalaya River consists of (1) maintenance dredging in Old River, (2) enlargement of the Atchafalaya River, (3) construction of a main channel in the Atchafalaya Basin Floodway, and (4) cutoffs on the Mississippi River.

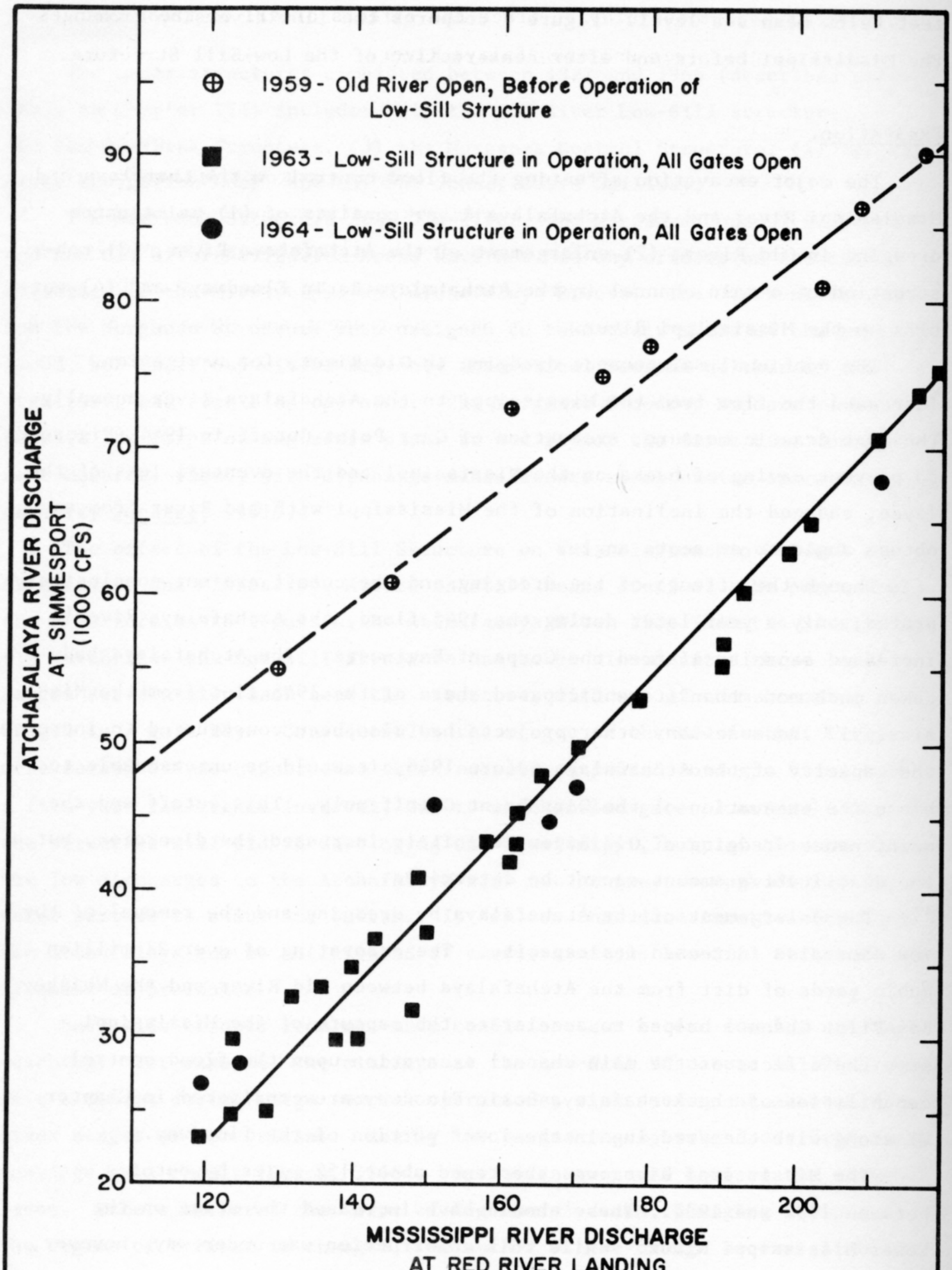
The continual maintenance dredging in Old River, for navigation, increased the flow from the Mississippi to the Atchafalaya River annually. The most drastic measure, excavation of Carr Point Cutoff in 1944 (Figure 8) to prevent caving of banks on the Mississippi and the eventual loss of the levee, changed the inclination of the Mississippi with Old River from an obtuse angle to an acute angle.

Though the effects of the dredging and the cutoff are not conclusively proved, only a year later during the 1945 flood, the Atchafalaya River's increased capacity alarmed the Corps of Engineers. The Atchafalaya had taken much more than its anticipated share of the 1945 flow from the Mississippi. Because many other projects had also been constructed to increase the capacity of the Atchafalaya before 1945, it would be unreasonable to blame the excavation of the Carr Point Cutoff only. This cutoff and the maintenance dredging of Old River definitely increased the diversion, but the quantitative amount cannot be determined.

The enlargement of the Atchafalaya by dredging and the removal of the low dams also increased its capacity. The excavating of over 22 million cubic yards of dirt from the Atchafalaya between Old River and the Whiskey Bay Pilot Channel helped to accelerate the capture of the Mississippi.

The effects of the main channel excavation upon the flood control capabilities of the Atchafalaya Basin Floodway are considered in Chapter VI along with the dredging in the lower portion of the floodway.

The Mississippi River was shortened about 152 miles by cutoffs between 1932 and 1937. These should have increased the stage on the Lower Mississippi River. While this construction was under way, however, the Atchafalaya River increased in size and discharge capacity. The combination of these two factors, excavation and cutoffs, along with the construction of many reservoirs on the upper watershed of the Mississippi River (T.V.A., Missouri Valley, Ohio River Flood Control, etc.) appears to have prevented higher flood stages on the Lower Mississippi River. It is



DISCHARGE RELATIONSHIP ATCHAFALAYA-MISSISSIPPI RIVERS 1959-1964

(Data from US Corps of Engineers) Fig. 9

difficult, if not impossible, to trace the effects of all of these changes on the Mississippi River and Atchafalaya River.

Levee Construction.

The enlargement and extension of the levees along the Atchafalaya and the Mississippi Rivers between 1927 and 1966 confined moderate and high flows to the main channels. This aided in the diversion of the Mississippi to the Atchafalaya, the increased slope and velocity causing scouring of the latter. However, the effects of the enlargement and extension of these levees, which merely confine the higher flood waters, are not as important as the initial construction.

CHAPTER V

EXISTING CONDITIONS IN THE ATCHAFALAYA FLOODWAY AND ON THE LOWER MISSISSIPPI RIVER

Before the evaluation of the existing construction, it will be helpful to review the principal works implementing the existing flood control plan. These are: (1) flood protection levees, (2) flood control structures, and (3) channels and rivers. The major structural and hydraulic inadequacies that will prevent execution of the plan are in the Atchafalaya Basin Floodway. Unless these are eliminated, the adopted flood control plan, after completed construction, will not protect the people of south Louisiana.

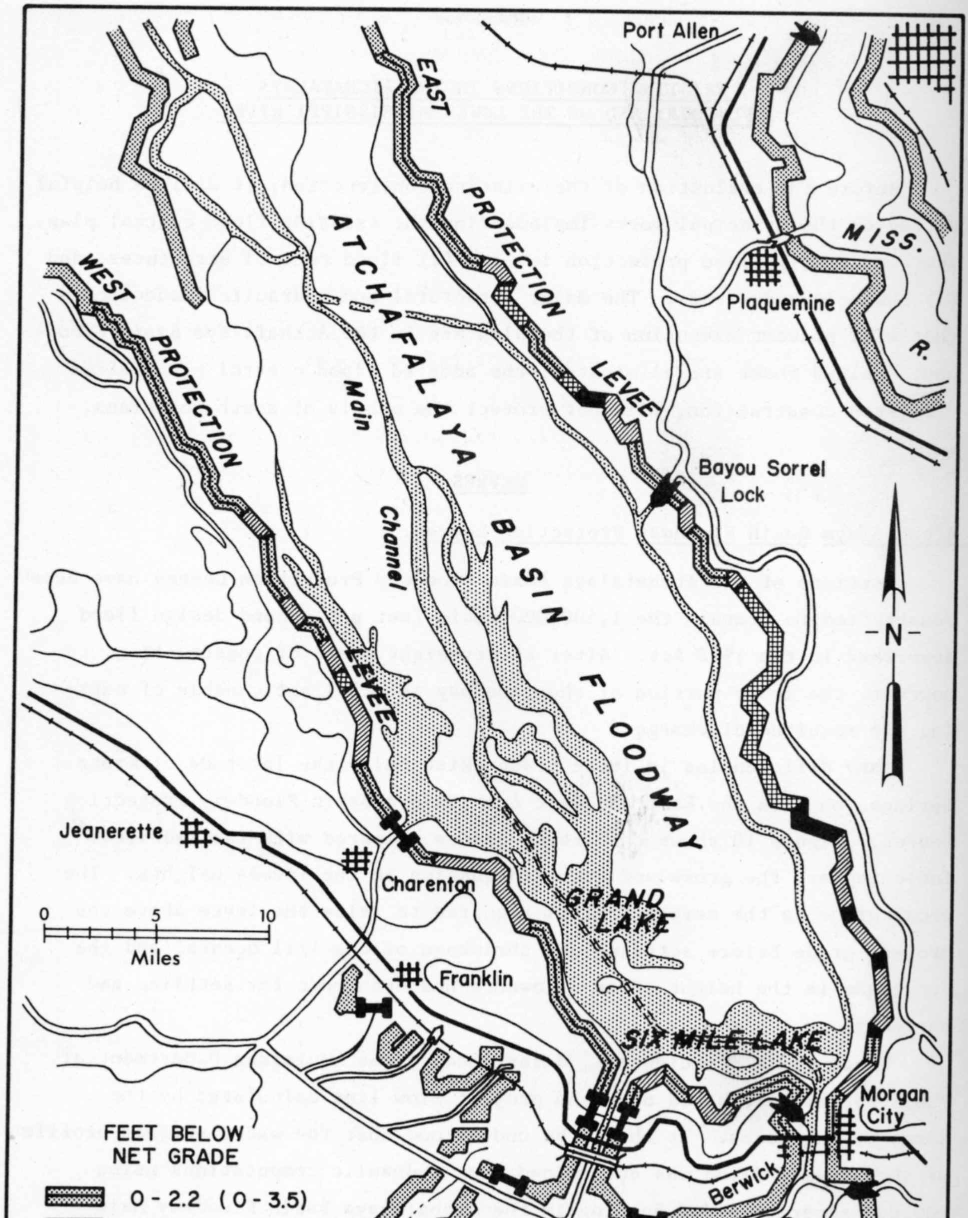
LEVEES

Atchafalaya Basin Floodway Protection Levees.

Portions of the Atchafalaya Basin Floodway Protection Levees have been constructed to contain the 1,500,000 cubic feet per second design flood described in the 1928 Act. After thirty-eight years of construction, however, the lower portion of the floodway is still not capable of carrying the required discharge.

Many deficiencies in levee grade exist below the latitude of Krotz Springs, on both the East and West Atchafalaya Basin Floodway Protection Levees. Figure 10 shows the actual grades compared with the required. Indicated are the gross and net inadequacies in the levees heights. The gross grade is the height of fill required to raise the levee above the project grade before settling and shrinkage of the fill occurs, and the net grade is the height after allowance has been made for settling and shrinkage.

These grade deficiencies, determined by the Louisiana Department of Public Works, are based upon the project flow line calculated by the Corps of Engineers. It should be understood that the water surface profile of the project flood was determined from hydraulic computations using 100,000 square feet of opening in the Atchafalaya Basin Floodway Main Channel. At present, from measurements in 1961, the average cross-sectional area of the Atchafalaya Basin Floodway Main Channel, about 50,000 square feet, is only one-half the area actually used in the hydraulic computations to determine the project flow line. New computations by the writer, who used the actual cross-sections, show that the project flow line should be approximately three feet higher. This raises



STATUS OF LEVEE GRADES
ATCHAFALAYA BASIN
1966

Fig. 10

the net grade that is required to carry the design flood by three feet and the gross grades, by something more than three feet.

Atchafalaya and Mississippi River Levees.

The levees along the Atchafalaya and the Mississippi Rivers have, in general, reached the elevations required by the present plan, with only minor levee construction problems compared with those in the lower Atchafalaya Basin Floodway. South of Krotz Springs, the Atchafalaya River levees are below the project grade at locations immediately above Whiskey Bay Pilot Channel. By comparison, at only one or two locations are the Mississippi River levees below the project grade.

The main problem in the construction of levees along the Mississippi is bank stabilization. The tendency of the river to change its course at bends causes bank caving that endangers the levees and often necessitates the reconstruction of the levees landward from the old alignment.

West Atchafalaya Floodway Fuse Plug Levee.

The West Atchafalaya Floodway Fuse Plug Levee was completed in 1958. Its condition is excellent, as it has never been overtopped. The raising of the levee is not a problem; on the contrary, the fuse plug may be too high. Dynamiting of this levee may be necessary to bring the West Atchafalaya Floodway into operation, although this would be accompanied by bank caving and possible loss of the Simmesport railway bridge due to high water velocities through the breaches.

Morganza Floodway Levees.

The west limit of the Morganza Floodway is the Atchafalaya River east levee, and the east limit, the guide levee south to U. S. Highway 190 near Lottie. These levees are presently to project dimensions and grades.

Ring Levees for Simmesport, Krotz Springs, and Melville.

The levees surrounding the towns of Simmesport, Krotz Springs, and Melville are generally up to project grade. However, the existence of these ring levees means that the confined towns cannot expand as normal communities. Local civic leaders realize the importance of expansion to their towns; consequently, political problems can be anticipated.

STRUCTURES

All of the principal structures required to implement the 1928 flood control legislation are completed. Those that have never been used as yet pose no problems. The others, however, that have already been utilized for flood protection have revealed shortcomings. Some of the difficulties were foreseen, but most were not.

Old River Low-Sill.

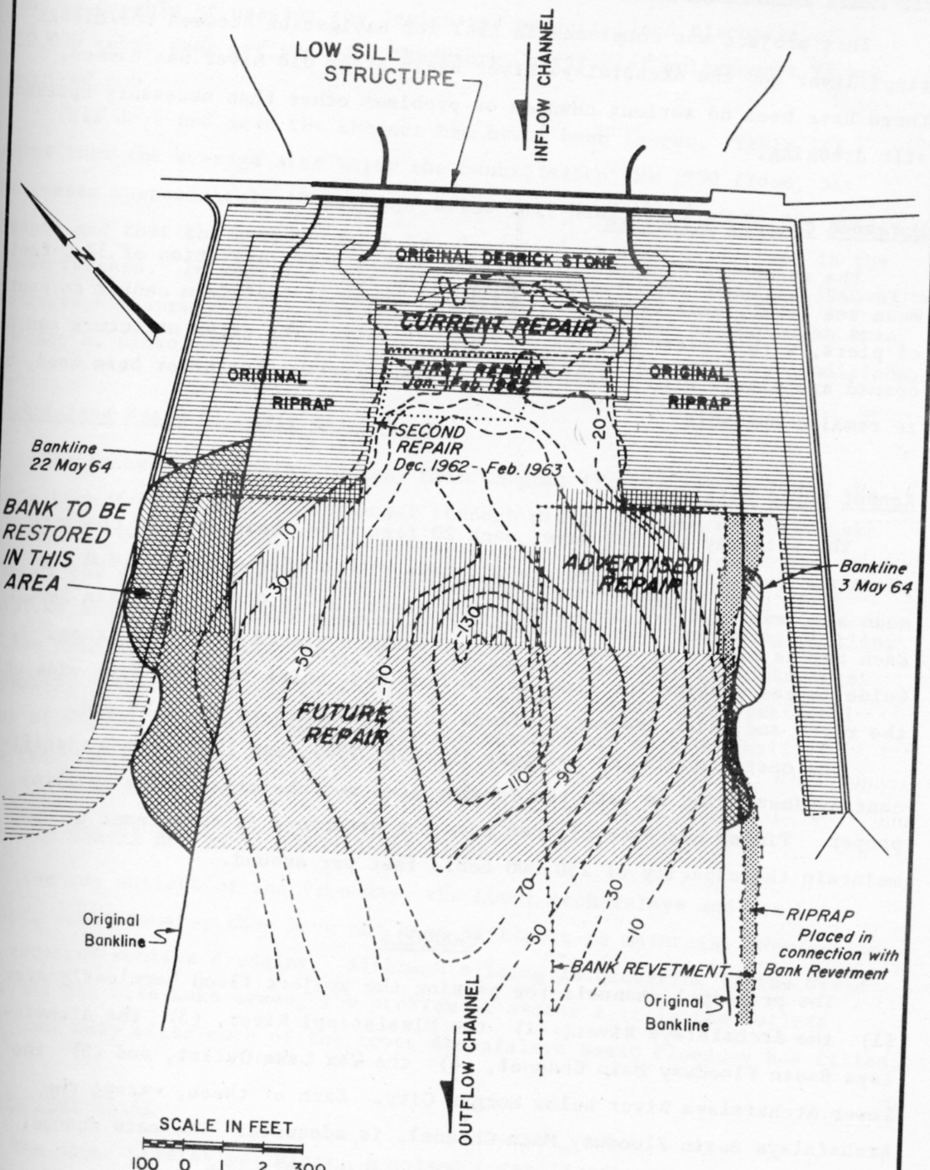
The low-sill structure consists of 11 gate bays, each with 44 feet clear width between piers. The weir crest is at elevation 10.0 above m.s.l. except for three center bays that have a crest elevation of 5.0 feet below mean sea level. These three lower bays permit diversion of the Mississippi during low stages. The total length of the structure is 566 feet between abutments. Downstream of the structure there is a stilling basin with baffles; upstream, a concrete apron.

In February, 1966 three barges accidentally sank near the low-sill structure. One barge went through a gate bay and foundered in the stilling basin between the baffle blocks. A second barge lodged underwater immediately upstream against the structure, and the third sank in the forebay of the structure about 100 feet upstream from the gates. The barges were loaded with riprap. This is the second time that barges have broken loose and floated either against or through the low-sill structure and sunk. Most of the time the gates must be closed during the salvage operations.

Another problem has been the large hole (Illustration No. 8) that scoured out in the channel downstream. Cross sections show depths greater than 150 feet below normal water stages. Riprap has been thrown in to build up a non-erodable layer on the upstream side; how much of the huge hole has been successfully covered is not yet known.

Overbank Structure.

The overbank flood control structure consists of 73 gate bays. Each bay has a 44 foot clear width between piers and a crest elevation of 52.0 feet above mean sea level. Concrete needle logs are used to close the structure, which has a total length between the abutments of 3,356 feet. A stilling basin with baffles is located downstream from the structure and riprap has been placed both upstream and downstream from the structure. As the structure has never been used, its condition is unchanged from the time of its completion in 1959.



OLD RIVER CONTROL SCOUR REPAIR MAY 1964

(After US Corps of Engineers Drawing)

ILLUST. 8

Old River Navigation Lock.

This project was completed in 1962 for navigation between the Mississippi River and the Atchafalaya River Basin after Old River was dammed. There have been no serious changes or problems other than necessary upstream silt dredging.

Morganza Control Structure

The structure consists of 125 bays with a crest elevation of 37.5 feet mean sea level, each bay having a span of about 31 feet from center to center of piers, with a clear opening of about 28 feet. The gated structure can be opened and closed with a rail crane. This structure has never been used, but it remains operable.

Bonnet Carre Spillway.

The spillway has 350 bays, each 20 feet wide, separated by concrete piers two feet thick. There are 176 bays with a weir crest at 18.0 feet mean sea level and 174 bays with their crests at 16.0 feet mean sea level. Each bay is closed by twenty creosoted timbers placed by a rail crane. Guide levees confine the flow in the floodway, which is 7,700 feet wide at the river and which gradually widens to 12,400 feet at the lake end.

The operation of the spillway in 1937, 1945, and 1950 caused significant sedimentation in both the forebay area and the area of the spillway proper. Timber has been cleared near the structure in an attempt to maintain the capacity of 250,000 cubic feet per second.

CHANNELS

The principal channels for passing the project flood harmlessly are: (1) the Atchafalaya River, (2) the Mississippi River, (3) the Atchafalaya Basin Floodway Main Channel, (4) the Wax Lake Outlet, and (5) the Lower Atchafalaya River below Morgan City. Each of these, except the Atchafalaya Basin Floodway Main Channel, is adequate. The main channel at present does not meet the hydraulic requirements.

Atchafalaya River.

The full-bank cross section of the Atchafalaya River generally has about 80,000 square feet. Figure 11 shows the channel cross-section to be more than 70,000 square feet from the mouth above Simmesport to the downstream confluence with the Whiskey Bay Pilot Channel. Because it has degraded (enlarged) over the years, the Atchafalaya in its present condition is capable of passing the designated project flood discharge of 650,000 cubic feet per second. Therefore, artificial enlargement is not required now.

This does not mean the channel has never been larger. Table III shows that the average area below the banks, since the 1950 flood, has decreased approximately 10 per cent below full-bank stage along its entire length and that the average depth has decreased as much as 12 feet in the lower reaches. In addition, the Corps of Engineers' data from the 1960-61 hydrographic survey shows that the Atchafalaya River has decreased in area and depth, since 1950, to a size approximately equal to the 1945 conditions.

Atchafalaya Basin Floodway Main Channel.

The Atchafalaya Basin Floodway Main Channel (Figure 11) includes the route from Whiskey Bay Pilot Channel through Grand Lake and Six Mile Lake to Wax Lake Outlet and the Lower Atchafalaya River below Morgan City. Passage of the project flood requires a 100,000 square-foot channel; the Corps of Engineers has been excavating various channels, including portions of the main channel, since 1931, in an attempt to increase the discharge capacity. Figure 11 shows that with the present average cross-sectional area of 40,000 to 60,000 square feet, the channel has only one-half of the required opening.

Wax Lake Outlet and Lower Atchafalaya River.

The two outlets of the floodway, the Lower Atchafalaya and Wax Lake Outlet, are adequate; they have not been difficult to maintain. Navigation has required routine dredging. Although silting is occurring in the Grand Lake and Six Mile Lake areas, the problem of excess silt in the outlets will come only after much of the lower Atchafalaya Basin Floodway has filled.

Mississippi River.

The Lower Mississippi River, a poised (stabilized) mature stream, is presently capable of carrying its share of the project flood. As might be expected, however, the channel size varies with the high and low flows, but the variations are small and systematic.

The major problem on the Lower Mississippi is bank stabilization, required to protect the levees from the river's tendency to meander. The cost of the bank stabilization on the Mississippi River now ranges from $700,000 to $1,000,000 per mile [Construction News, 1964].

TABLE III

AVERAGE DEPTHS AND CROSS-SECTIONAL AREAS

ATCHAFALAYA RIVER

BELOW BANKFUL STAGE

1938, 1944, 1945, 1950, and 1961 SURVEYS

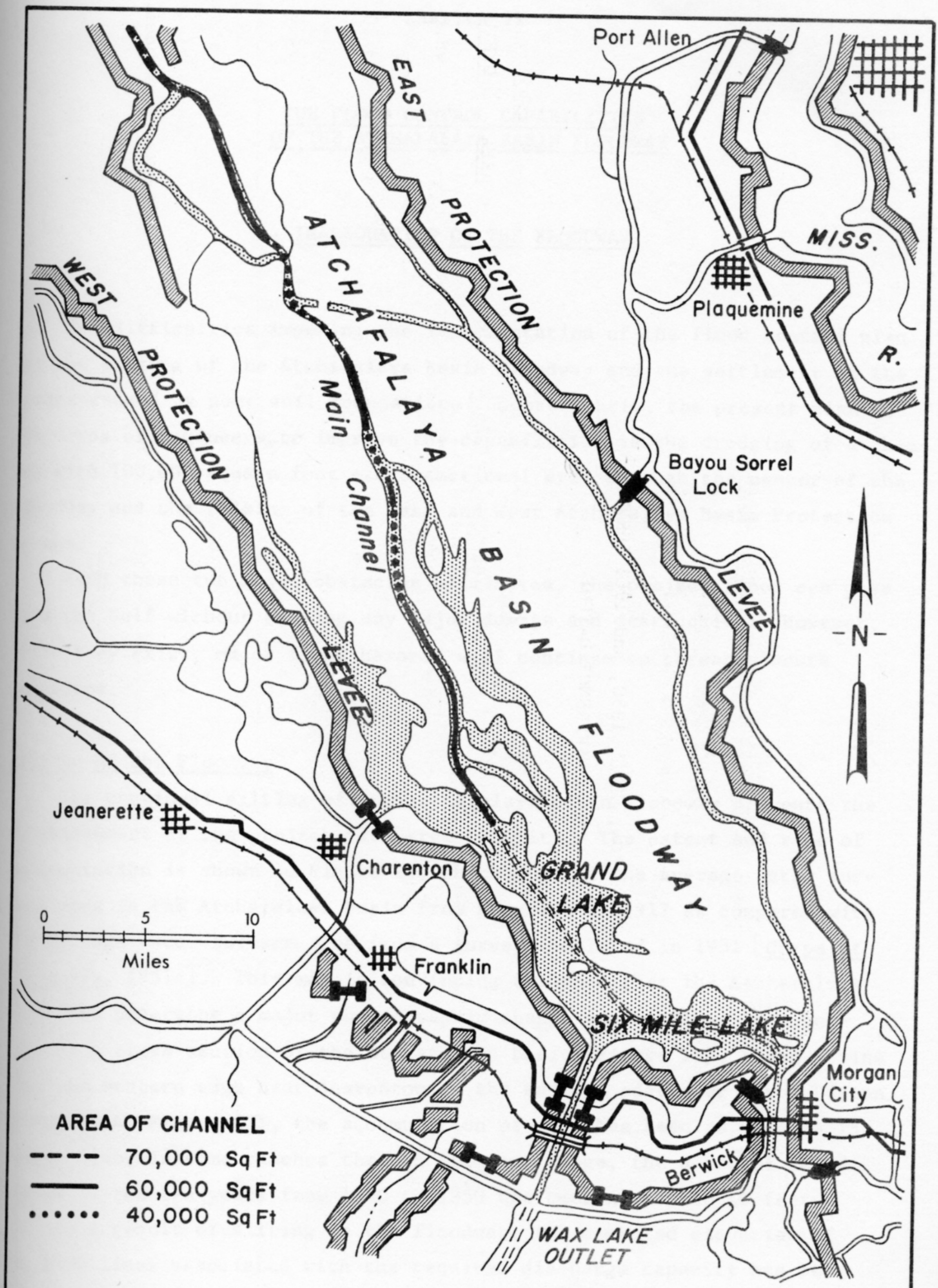
(1881 REFERENCE DATUM)

RIVER	1938		1944		1945		1950		1961	
MILES*	AREA	DEPTH	AREA	DEPTH	AREA	DEPTH	AREA	DEPTH	AREA	DEPTH
0 - 17.0	76,000	55.0	79,000	52.0	86,000	56.0	94,000	57.0	86,000	48.0
17.0 - 36.6	60,000	56.0	70,000	56.0	77,000	60.0	86,000	60.0	79,000	57.0
36.6 - 54.3	64,000	60.0	64,000	58.0	72,000	61.0	81,000	69.0	71,000	57.0

(AREAS IN SQUARE FEET - DEPTHS IN FEET)

*Mile 0.0 is about 0.6 miles upstream from the confluence with Red River, in the Old River channel. Mile 54.3 is at the upstream end of Whiskey Bay Pilot Channel.

(Computed with data obtained from the Corps of Engineers, U. S. Army, New Orleans District)



STATUS OF THE ATCHAFALAYA BASIN MAIN CHANNEL 1966

(Data Obtained From Louisiana Dept. of Public Works)

Fig. 11

CHAPTER VI

THE FLOOD CONTROL CAPABILITIES OF THE ATCHAFALAYA BASIN FLOODWAY

INADEQUACIES OF THE FLOODWAY

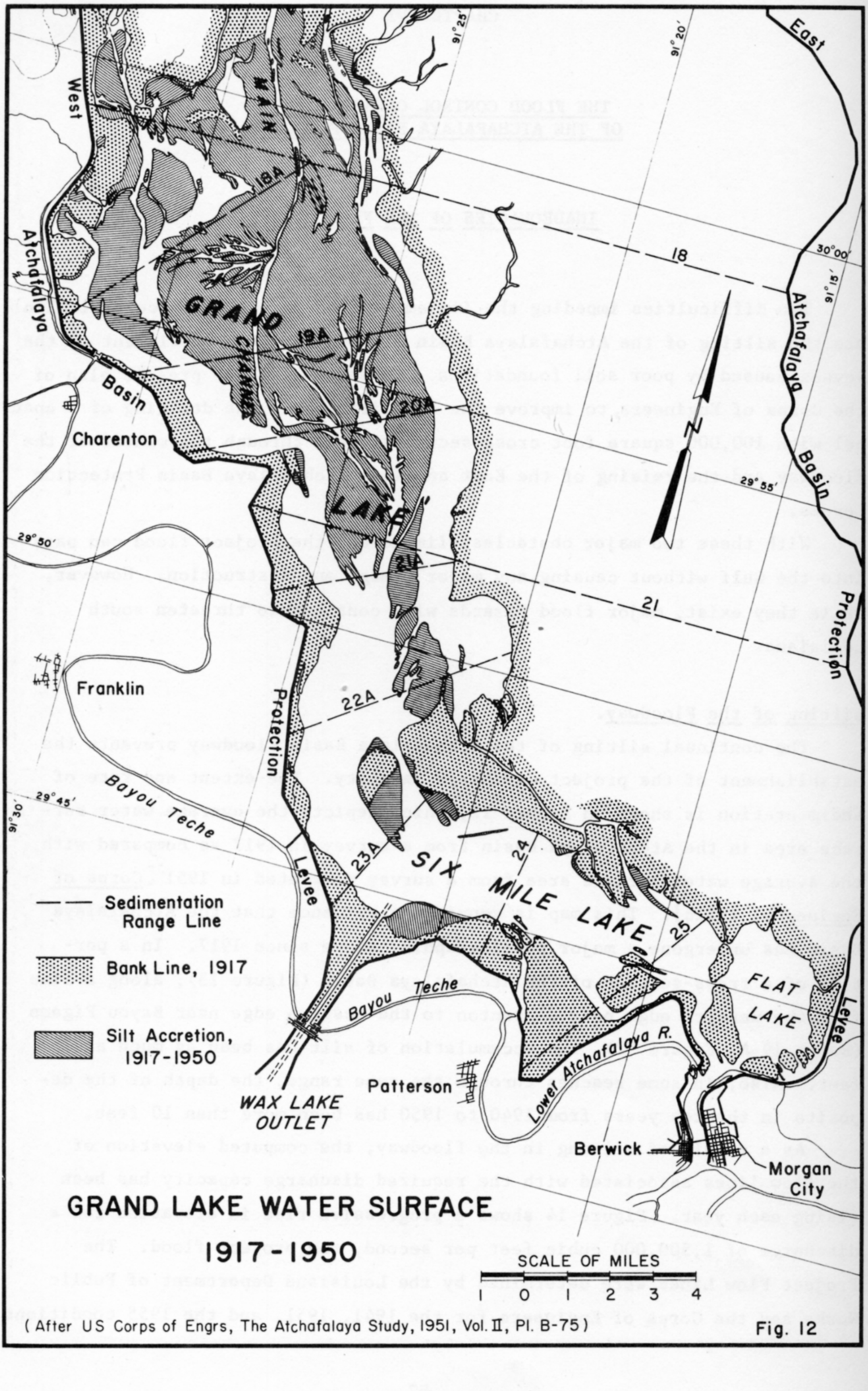
Two difficulties impeding the implementation of the flood control plan are the silting of the Atchafalaya Basin Floodway and the settlement of the levees caused by poor soil foundations. Consequently, the present plan of the Corps of Engineers, to improve the capabilities, is the dredging of a channel with 100,000 square foot cross-sectional area through the center of the floodway and the raising of the East and West Atchafalaya Basin Protection Levees.

With these two major obstacles eliminated, the project flood can pass into the Gulf without causing any major damage and destruction. However, while they exist, major flood hazards will continue to threaten south Louisiana.

Silting of the Floodway.

The continual silting of the Atchafalaya Basin Floodway prevents the establishment of the project discharge capacity. The extent and rate of sedimentation is shown in Figure 12, which depicts the average water surface area in the Atchafalaya Basin from a survey in 1917 as compared with the average water surface area from a survey completed in 1951 [Corps of Engineers, 1951c]. This map is convincing evidence that the Atchafalaya Basin has undergone a major physiographic change since 1917. In a portion of a cross-section of the Atchafalaya Basin (Figure 13), along a line from the western edge near Charenton to the eastern edge near Bayou Pigeon (Range 19-A, Figure 12), the accumulation of silt has been as much as 15 feet. Also, in some reaches through the same range, the depth of the deposits in the ten years from 1940 to 1950 has been more than 10 feet.

As a result of silting in the floodway, the computed elevation of the flow lines associated with the required discharge capacity has been rising each year. Figure 14 shows a progressive rise in elevation for a discharge of 1,500,000 cubic feet per second, the project flood. The Project Flow Lines were determined by the Louisiana Department of Public Works and the Corps of Engineers for the 1941, 1951, and the 1955 conditions,

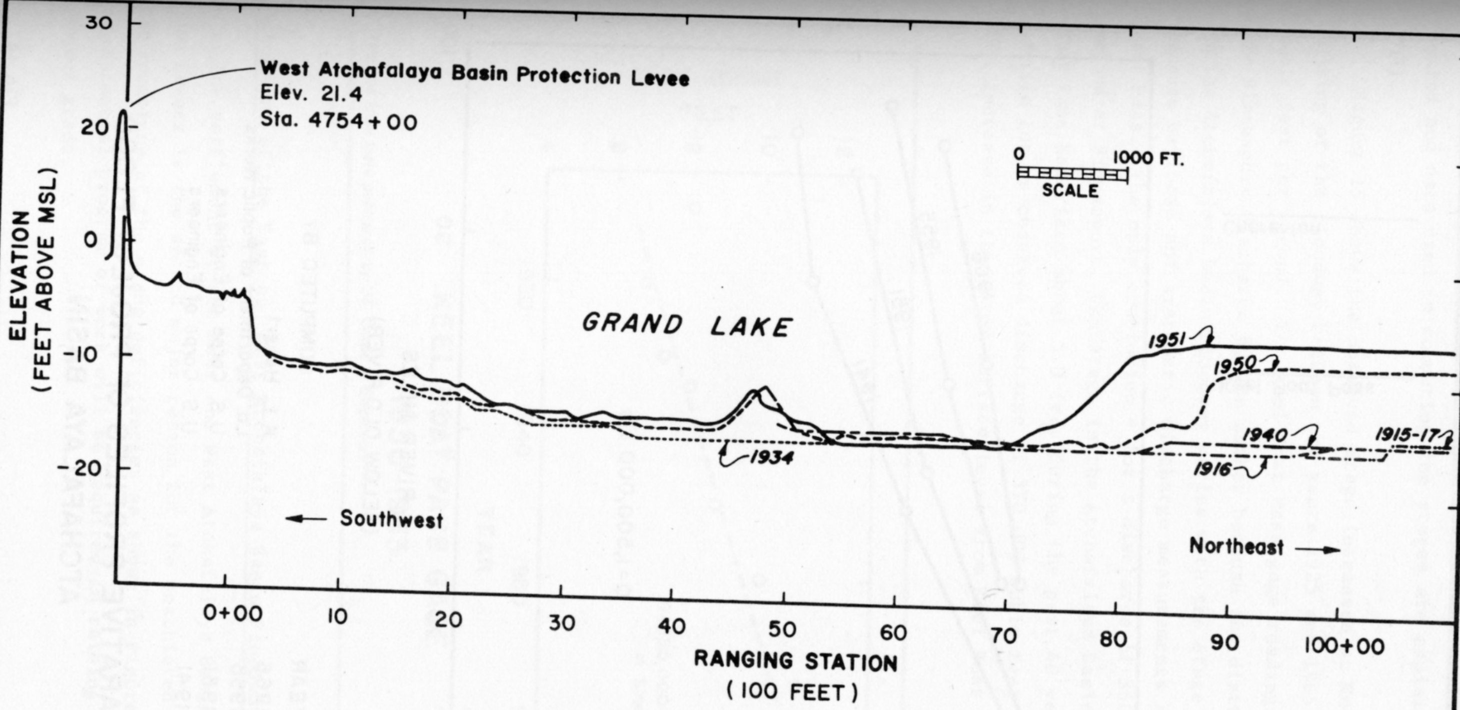


GRAND LAKE WATER SURFACE

1917-1950

(After US Corps of Engrs, The Atchafalaya Study, 1951, Vol. II, Pl. B-75)

Fig. 12

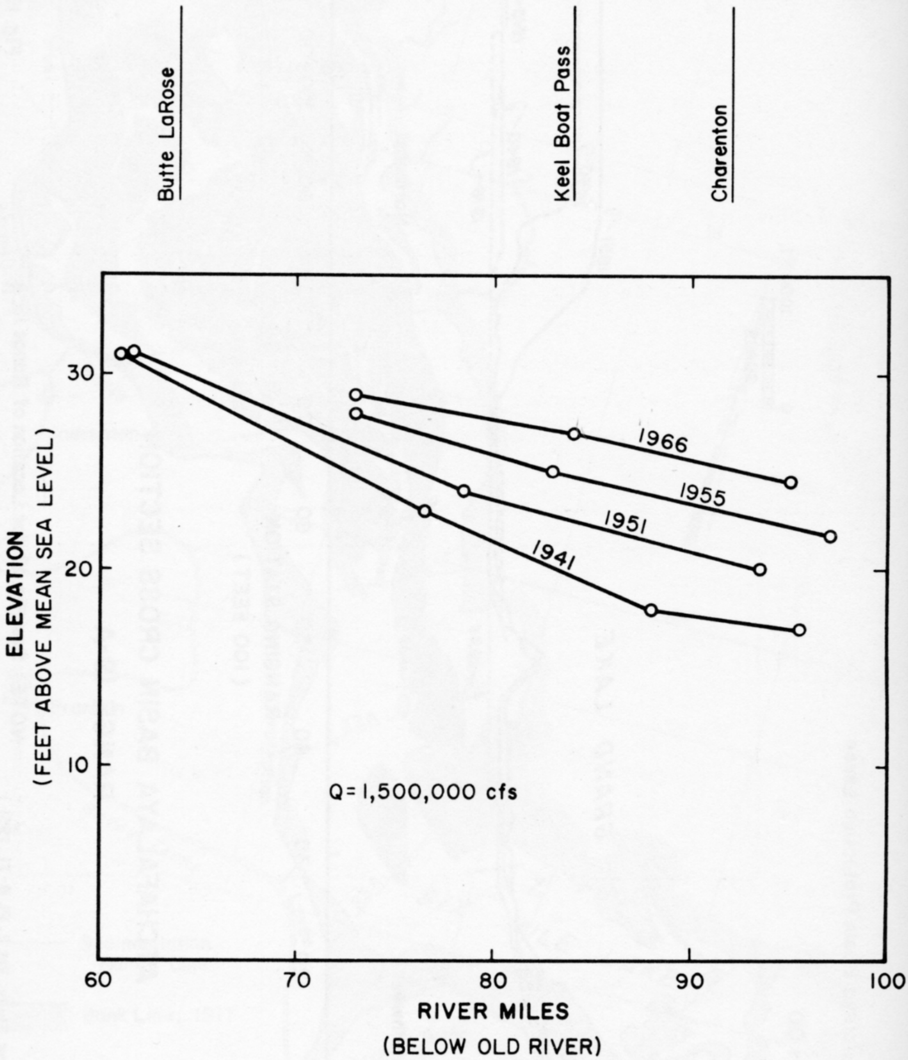


ATCHAFALAYA BASIN CROSS SECTION
RANGE 19-A

(After US Corps of Engineers, The Atchafalaya Study, Vol. 2, Pl. B-71, 1951)

NOTE: See Fig. 12 for Location of Range 19-A.

Fig. 13



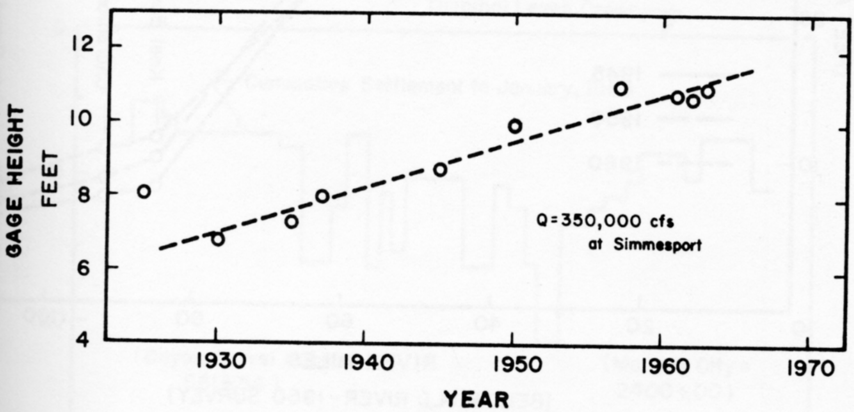
YEAR	COMPUTED BY
1966	K.L. Hebert
1955	La. Department of Public Works
1951	U.S. Corps of Engineers
1941	U.S. Corps of Engineers

COMPARATIVE PROFILES OF PROJECT FLOOD
ATCHAFALAYA BASIN

Fig. 14

and the writer has computed the elevations for the 1965 conditions. (The method and data used in computing the stages are explained fully in Chapter VII).

Figure 15 shows the observed stage increases at Keel Boat Pass due to silting of the floodway between the years 1925 and 1965 for a flow of 350,000 cubic feet per second. The Keel Boat Pass gage readings were plotted against the Simmesport discharge by the author because the distribution of flow in the Atchafalaya Basin Floodway varies with the stage and, more importantly, because periodic and systematic discharge measurements are not made at Keel Boat Pass. The only conclusion - for a discharge of 350,000 cubic feet per second at Simmesport, the stage in the Atchafalaya Basin Floodway near Keel Boat Pass has risen about 5.0 feet during the past 40 years. Figure 16, the profile for an observed discharge of 370,000 cubic feet per second, shows this increase in the water surface level from Keel Boat Pass to Morgan City.



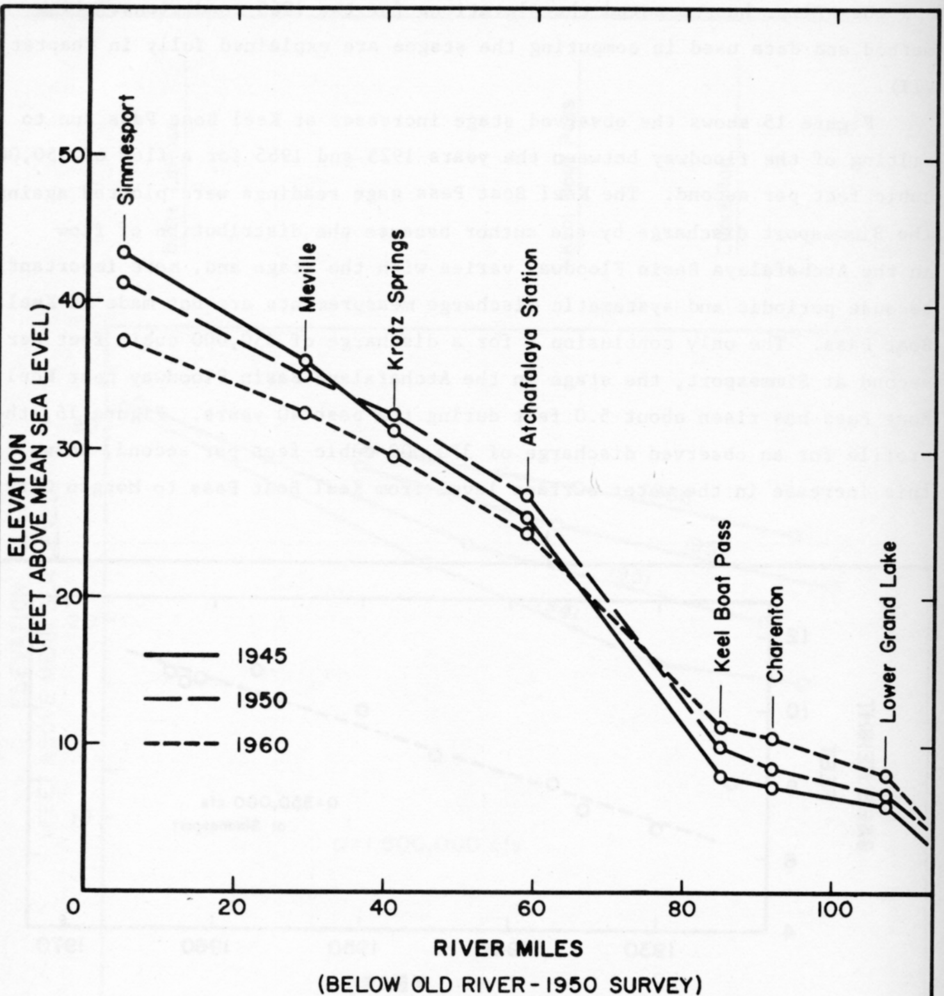
KEEL BOAT PASS GAGE
1930-1963

(Plotted from data published by US Corps of Engineers)

Fig. 15

Settlement of the East and West Atchafalaya Basin Floodway Levees.

The settlement of the East and West Atchafalaya Basin Floodway Protection Levees is the second major reason for the unachieved discharge capacity. The locations of the grade deficiencies as shown in Figure 10 indicate that a substantial program of work will be required in raising the levees to project grade.



WATER SURFACE PROFILES

ATCHAFALAYA RIVER

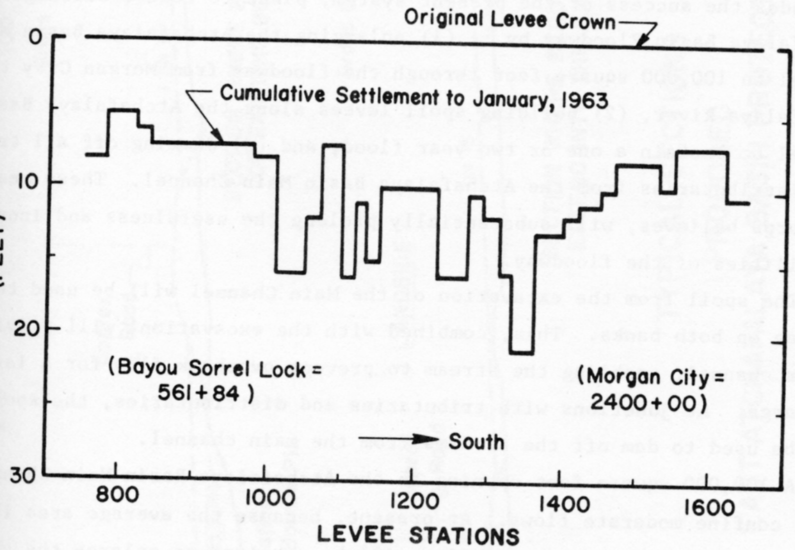
1945, 1950, 1960

Q=370,000 CFS

(Plotted from data published by the US Corps of Engineers) **Fig. 16**

Due to poor subsurface conditions, levee settlement has hindered the fulfillment of the present flood control plan, and statements from the General Design Memorandum evidence the immense problem confronted by the Corps of Engineers [1963d]:

"8. Settlement a. The cumulative settlement of the crowns of the existing levees, as of January 1963, is shown on plates 34 through 37 for the east and west basin levees. The average settlement of the levee crown on the east basin levee above Bayou Sorrel Lock is about 15 feet with a maximum of 21 feet, and the average below the lock is about 10 feet with a maximum of 21 feet. On the west basin levee, the average crown settlement is about 8 feet and the maximum is 15 feet. In the location of certain bayou crossings, where plastic flow and shear failure occurred during construction, the settlement is greater than the maximum stated above. The existing levee fills are still settling and the addition of fill to raise the levees will induce additional settlement."



CUMULATIVE SETTLEMENT
EAST ATCHAFALAYA BASIN PROTECTION LEVEE

(After US Corps of Engineers, Design Supplement No. I, Plate 34)

Fig. 17

Figure 17 is a cumulative plot for a portion of the levee crown up to January, 1963, near Ramah southward along the East Protection Levee. Representing average settlement of the reach, it shows that portions of the crown have settled more than 20 feet.

PLANS TO IMPROVE THE FLOODWAY

The current plans to eliminate the flood control inadequacies of the Atchafalaya Basin require the redesigning of the existing levee system and the excavation of a continuous channel through the middle of the floodway. The redesign of levees should reduce sedimentation in the basin; it should also help to maintain the river's cross-sectional area by confining moderate flows to only one channel.

Minimizing the Silting of the Atchafalaya Basin Floodway.

The Corps of Engineers, recognizing that the previous silting rate precludes the success of the present system, plans to reduce silting in the Atchafalaya Basin Floodway by : (1) enlarging the Atchafalaya Basin Main Channel to 100,000 square feet through the floodway from Morgan City to the Atchafalaya River, (2) building spoil levees along the Atchafalaya Basin Main Channel to contain a one or two year flood, and (3) damming off all tributaries and distributaries from the Atchafalaya Basin Main Channel. These measures, the Corps believes, will substantially prolong the usefulness and increase the capabilities of the floodway.

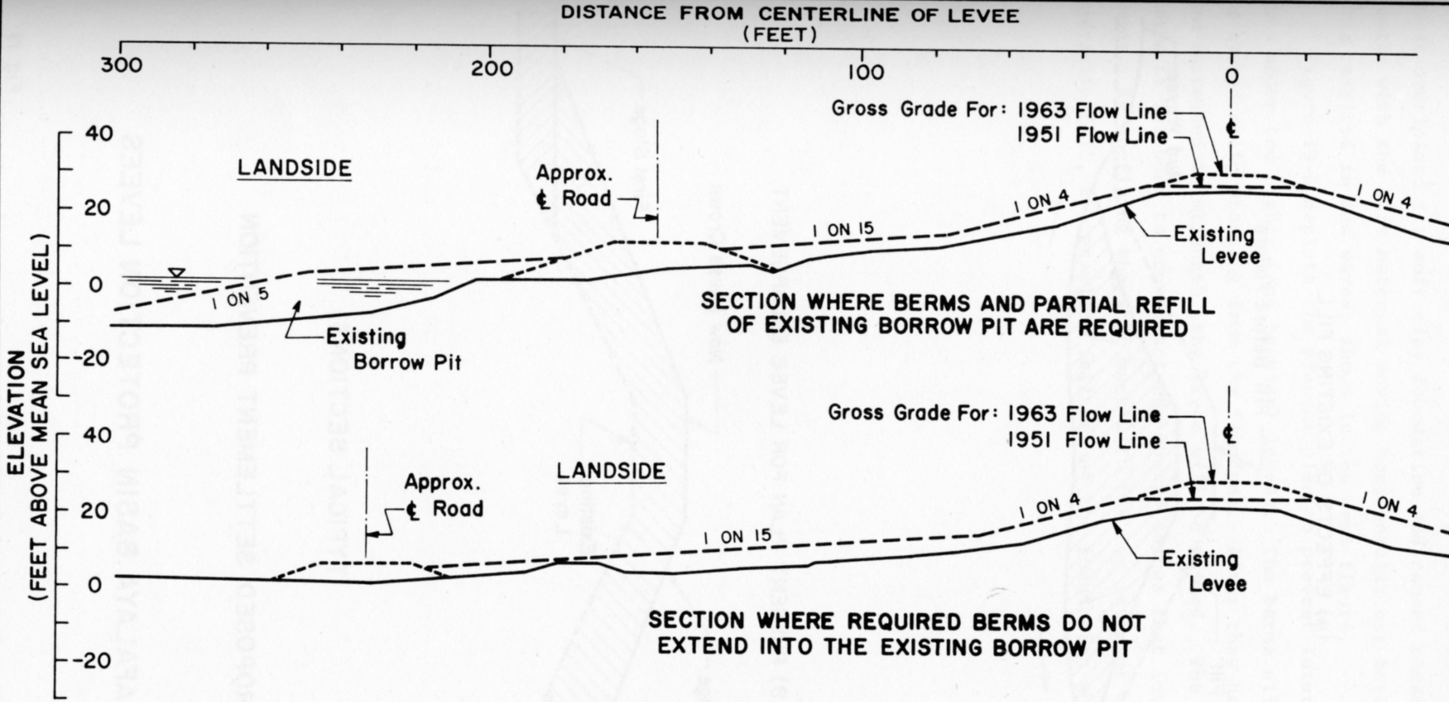
The spoil from the excavation of the Main Channel will be used to build a levee on both banks. This, combined with the excavation, will provide a deeper channel, enabling the stream to prevent overbank flow for a larger discharge. At junctions with tributaries and distributaries, the spoil will also be used to dam off the streams from the main channel.

A 100,000 square foot opening in the Atchafalaya Basin Main Channel would confine moderate flows. At present, because the average area is only 50,000 square feet, much excavation will be required to enlarge the channel to twice its present size.

Upgrading of the East and West Atchafalaya Basin Protection Levees.

Figure 18 shows typical sections 1 and 2 of the planned enlargement of the East and West protection levees. Flatter side slopes and new, wide berms will accompany the increased heights.

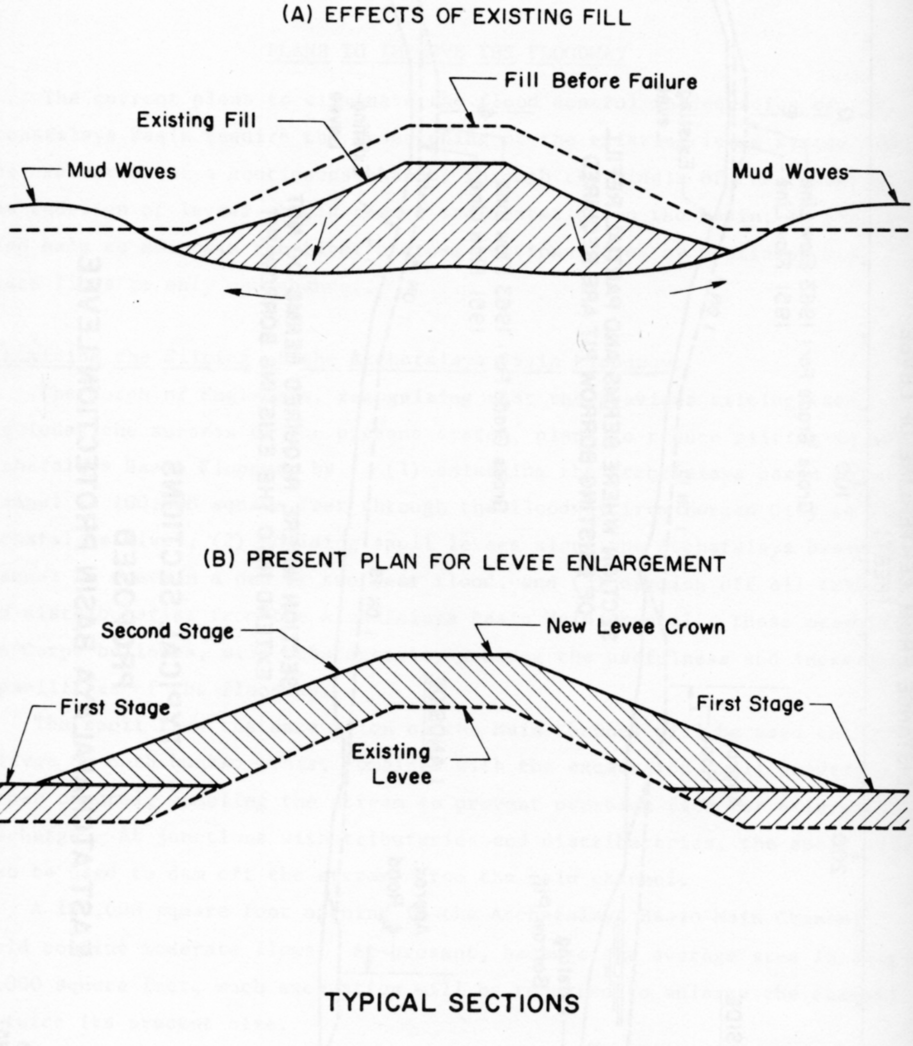
The plastic flow concept was used by the Corps of Engineers in their levee design, because of the soft underlying clays, to prevent shear failures due to the proposed enlargement. Figure 19-A shows schematically the



TYPICAL SECTIONS
PROPOSED
EAST ATCHAFALAYA BASIN PROTECTION LEVEE

(After US Corps of Engineers, 1963
Design Supplement No. 1, Plate 45)

Fig. 18



TYPICAL SECTIONS

PROPOSED SETTLEMENT PREVENTION

ATCHAFALAYA BASIN PROTECTION LEVEES

Fig. 19

results of previous attempts to attain the project grade. The existing levee overloaded its soft clay foundation and caused shear failure underneath, with the soft material moving horizontally out beyond the toe. This resulted in mud waves, shown in the same figure.

Figure 19-B depicts the present plan to prevent future shear failures under the higher (and heavier) levees. The berms will first be built up by hydraulic dredging from the floodway. After they have consolidated and increased in strength, the levee will be raised. The weight of these berms is intended to counteract the upward forces that formed the mud waves. By confining the soft muck with the top layer of consolidated hydraulic fill, the previous failures of the foundation should not occur.

CHAPTER VII

EVALUATION OF CURRENT PLANS TO IMPROVE THE FLOODWAY

THE PRESENT CAPABILITY OF THE FLOOD CONTROL PROJECT

The status of the existing flood control plan for the Atchafalaya Basin Floodway is summarized in a brief presented to the Mississippi River Commission in October of 1964 by the Louisiana Department of Public Works [1964b], which states,

> "In the Atchafalaya Floodway, which is to carry one-half of the project flood, there are several important facts which reveal the alarming inadequacy of the Floodway; and perhaps it is more significant that these same facts spell out the utter necessity of completing the Floodway within the shortest time possible. Consideration of the following serves an ultimatum on all who are associated with this great flood control program.
>
> 1. The Atchafalaya Floodway is the key to the successful passage of a project flood to the Gulf of Mexico.
>
> 2. The project flood assignment to the Floodway is 1,500,000 cfs; however, the present capacity is less than 1,000,000 cfs.
>
> 3. The West Protection Levee presently has thirty-five percent of its length below the 1963 grade, and the East Protection Levee has fifty percent below the 1963 grade. These serious deficiencies exist in the lower reaches of the Floodway.
>
> 4. During a two-year period, no protection levees above Morgan City have been raised, except for the interim narrow crown embankment constructed this summer in the very lowest spot of the East Protection Levee.
>
> 5. Overtopping of failure of the Protection Levees with a project flood, at about the latitude of Henderson, on the west side, would result in flooding and damaging at least 1,400,000 acres ---and on the east, an area of over 2,000,000 acres. These areas of Louisiana are highly developed and contain important towns, cities waterways, railroads, highways, utilities, industries, and agricultural developments."

The Federal appropriations requested by the Corps of Engineers to complete this ten year plan are listed in Table IV. At the present rate of allocation, there is a distinct possibility that it will never be completed. In the President's budget for the fiscal yaer 1967, a total of $7,800,000 is to be spent on the Atchafalaya Basin Floodway--approximately one-third of the required annual expenditure needed for ten years and the completion. The topographic changes in the floodway could well make the whole flood control plan obsolete if the Federal appropriations are not increased at a greater rate.

TABLE IV

APPROPRIATIONS REQUIRED TO IMPLEMENT THE PRESENT FLOOD CONTROL PLAN COMPARED TO THE ACTUAL APPROPRIATIONS

Year	Funds Required	Actual Appropriations
1963	$ 7,106,100	$ 3,660,000
1964	8,232,000	7,200,000
1965	12,084,700	8,600,000
1966	22,281,800	*11,000,000
1967	23,607,200	
1968	16,187,300	
1969	17,599,500	
1970	16,221,100	
1971	18,029,700	
1972	15,972,900	
1973	10,581,100	
1974	7,295,600	
TOTAL	$175,192,200	

*Presently in President's Budget (From General Design Memorandum, Corps of Engineers, July, 1963, Table No. 5, p. 44)

PROPOSED ENLARGEMENT OF THE ATCHAFALAYA BASIN MAIN CHANNEL

Possibility of Silting in the Atchafalaya Basin Main Channel.

The present plan requires the enlargement of the Atchafalaya Basin Main Channel to a cross-sectional area of 100,000 square feet. The basic question is whether the flow in the Atchafalaya River will maintain this area. The average depth of the Atchafalaya has decreased as much as 12 feet since 1950 (Table No. 3). Can the Corps of Engineers permanently set the dimensions of an alluvial river, one that will surely adjust its cross-section to the average flows? If the average flow requires 100,000 square feet of opening, the stream will maintain or make this area by scouring or deposition. The profile in Figure 16 shows that the channel has been silting up in the Lower Atchafalaya Basin Floodway as part of this natural shaping work.

The Low-Sill Control Structure was built to reproduce the 1950 diversion relationships between the Atchafalaya and Mississippi Rivers. In Figure 9 we see the reduction in flow at Simmesport between the 1959 condition, with Old River open, and the 1963-1964 condition after the Old River was completely dammed, with all control structure gates open. During low flows, the diverted percentage from the Mississippi River into the Atchafalaya has actually decreased since 1959; this decrease in the Atchafalaya flow will tend to oppose the artificial enlarging of the Atchafalaya Basin Main Channel by channel silting. The student of geomorphology will have difficulties with the reasoning that flow reduction at the upstream end of a silt-laden stream will assist in maintaining an enlarged, excavated channel in the lower end. He will expect deposition more than scour and channel maintenance.

The construction of the Low-Sill Control Structure decreased the diversion of the Mississippi into the Atchafalaya (Figure 9) and consequently increased the percent of flow into the Atchafalaya from the Red River. With an average concentration of sediment in the Red River of 1,300 parts per million, but only 640 parts per million in the Mississippi, the higher concentration will gain greater significance from the reduction in Mississippi flows. This anticipated increase in the sediment concentration of the Atchafalaya will expand the dredging requirements in the lower reaches.

The annual average sediment load of the Atchafalaya River is approximately 133,000,000 tons. If we assume a unit weight of 90 pounds per cubic foot, with 75 per cent of the load deposited in the Atchafalaya Basin, the yearly sediment would exceed 80,000,000 cubic yards. Records from the Corps of Engineers show, between 1954 and 1965, a total excavation in the Atchafalaya Basin Floodway of 190,000,000 cubic yards. This means that the Atchafalaya River might deposit more silt in two years than the Corps of Engineers could excavate in ten years. Because the average concentration was used to arrive at 80,000,000 cubic yards, and because most of the sediment is carried during floods, this is a conservative estimate.

The sediment is now being deposited in the lake areas; it is only a matter of time before all the lakes will be filled. Then, when the Main Channel becomes the only stream in the floodway to the Gulf, it will have to carry all of the sediment load. It must then adjust to the average flows and sediment load by changing its cross section and profile. To visualize now the channel dimensions for the expected conditions during the next twenty-five years is difficult, but twenty-five years is not too long a period to use. The proposed flood control projects may take that long to complete.

<u>Effects of the Possible Conditions of the Atchafalaya Basin Main Channel on the Flood Stages</u>.

The discharge capabilities of the Atchafalaya Basin Floodway with assumed cross-sectional areas of 50,000, 60,000, 80,000, and 100,000 square feet in the Main Channel were computed, the purpose of this hydraulic study being to ascertain the effects of the main channel on the flood stages.

First, it was necessary to determine whether backwater computations would be valid. Table V shows the results of these preliminary computations (with the Manning formula) for discharges of 630,000 and 1,000,000 cubic feet per second. The values of "n" (the coefficient of roughness) in the formula were the same as those used by the Corps of Engineers. The stages from these computations differ less than 0.5 feet from the stages found in model tests at the Waterways Experiment Station in Vicksburg, Mississippi (Figure 20). Therefore, the backwater computations may be used to estimate flood stages in the Atchafalaya Basin Floodway with realistic, meaningful answers.

Table VI summarizes the backwater computations with the four trial cross-sections in the Atchafalaya Basin Main Channel. The flow lines with 100,000 square feet of opening and a discharge of 1,500,000 cubic feet per second agreed with those found in the Corps of Engineers Project Flow Line. Figure No. 21 is the profile of the water surface for a discharge of 1,500,000 cubic feet per second. These elevations are from the results of the computations in Table VI. Figure No. 21 also shows the water surface for the project flood using the existing main channel, which varies from about 50,000 to 60,000 square feet of opening.

These computations for existing conditions show that if the project flood (1,500,000 cubic feet per second) were to occur now, flood stages would be from two to three feet higher than the 1963 Project Flow Line. To compensate for the existing 60,000 square feet of opening in the main channel, the deficient levee grades shown in Figure 10 should be increased by two or three feet.

TABLE V

ATCHAFALAYA BASIN FLOODWAY

PRELIMINARY BACKWATER COMPUTATIONS BY KERMIT L. HEBERT

ASSUMPTIONS:

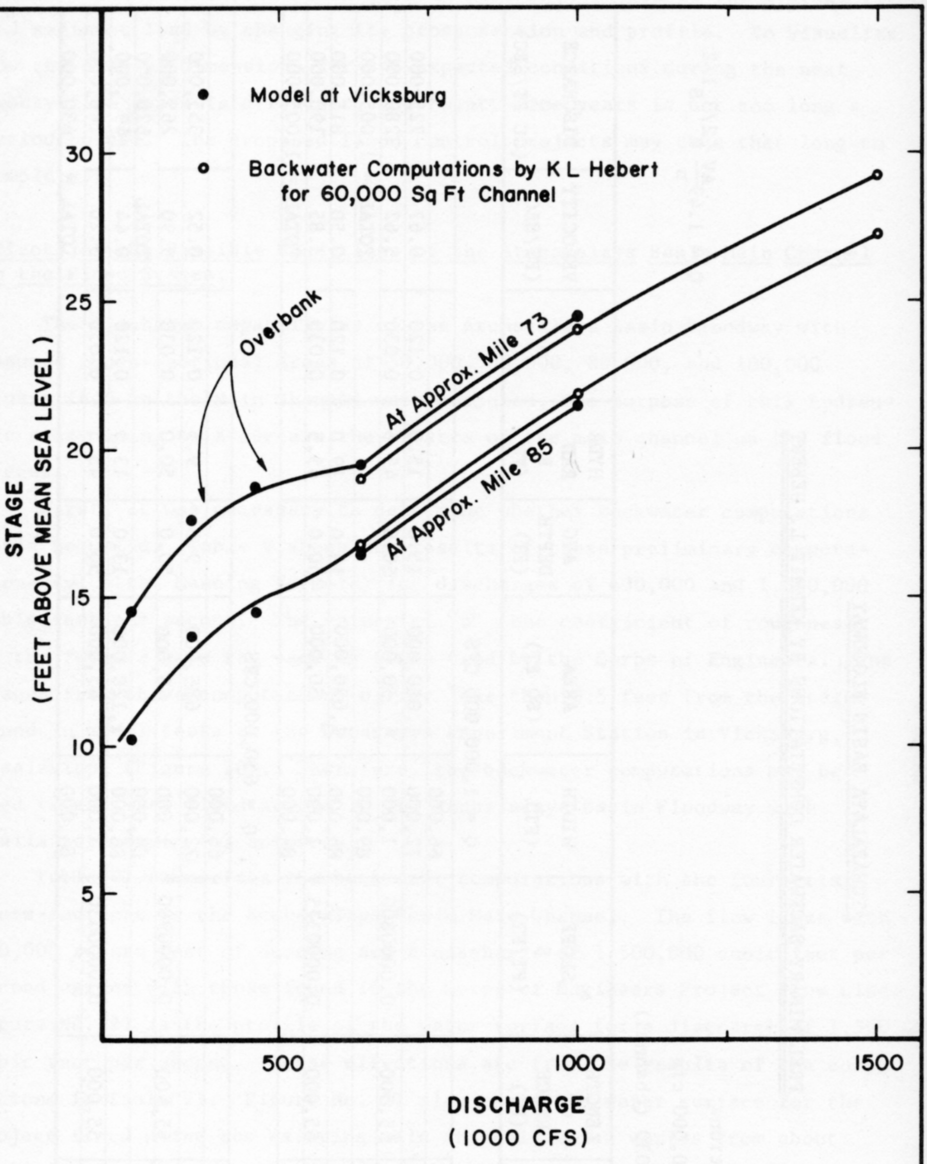
For Estimated 1966 Conditions

Q = 1,000,000 cfs and 630,000 cfs

n = 0.120 (overbank), 0.030 (channel)

$$Q = 1.49\frac{AV}{n} R^{2/3} S^{1/2}$$

RIVER MILE	WATER SURFACE ELEV (FT MSL)	H (FT)	LENGTH OF REACH (FT)	SLOPE S (FT/FT)	WIDTH (FT)	AREA (SQ FT)	AVG DEPTH (FT)	HYDR RAD R (FT)	n	VELOCITY (FT/SEC)	DISCHARGE Q (CU FT/SEC)
					Q = 1,000,000 CFS						
95.0	17.5				66,000						
					72,000	1,080,000	15.0	15.0	0.120	0.67	725,000
		4.4	55,500	0.0000800	1,000	50,000	50.0	45.5	0.030	5.62	280,000
85.0	21.9				89,000					TOTAL =	1,005,000
					86,000	1,630,000	19.0	19.0	0.120	0.50	815,000
		2.1	55,000	0.0000375	1,000	50,000	50.0	45.5	0.030	3.85	190,000
73.0	24.0				84,000					TOTAL =	1,005,000
					Q = 630,000 CFS						
95.0	11.8				66,000						
					72,000	685,000	9.5	9.5	0.120	0.52	355,000
		4.9	55,500	0.0000900	1,000	45,000	50.0	50.0	0.030	5.90	265,000
85.0	16.7				89,000					TOTAL	620,000
					86,000	1,120,000	13.0	13.0	0.120	0.44	490,000
		2.3	55,000	0.0000430	1,000	45,000	50.0	45.5	0.030	3.20	140,000
73.0	19.0				84,000					TOTAL =	630,000



MODEL RESULTS COMPARED WITH BACKWATER COMPUTATIONS

(After US Corps of Engineers, 1963 General Design Memorandum, App. I, Plate 14)

Fig. 20

TABLE VI

ATCHAFALAYA BASIN FLOODWAY

NEW BACKWATER COMPUTATIONS BY KERMIT L. HEBERT

ASSUMPTIONS:

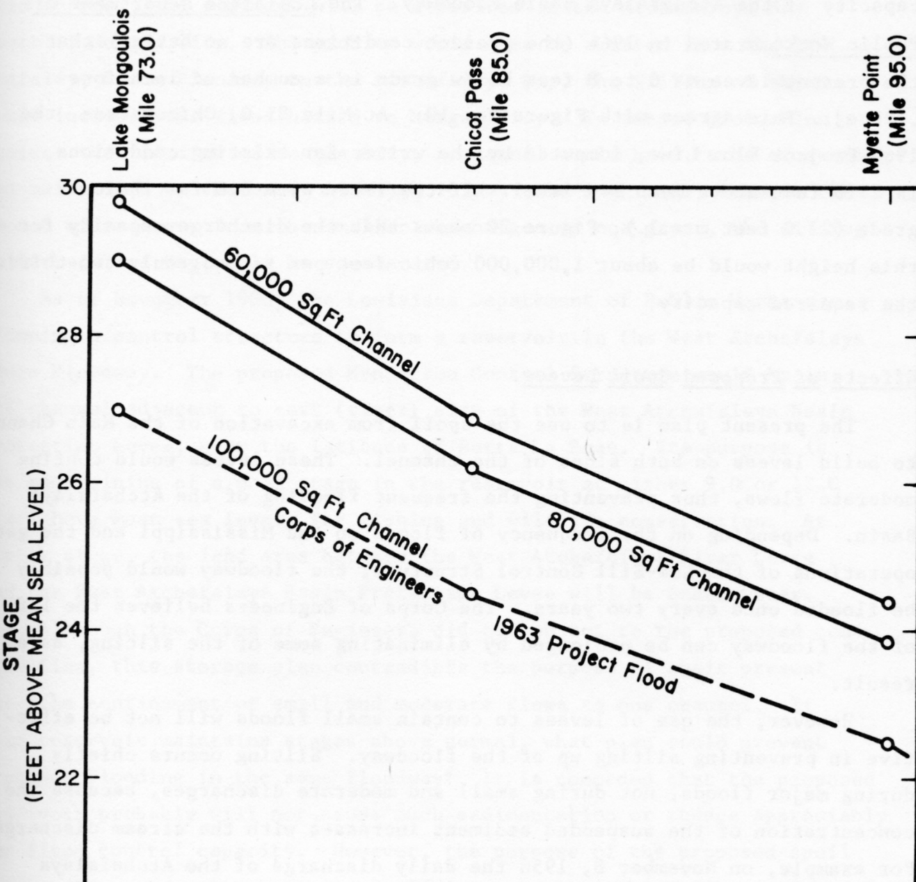
n = 0.120 (overbank), 0.030 (channel) Q = 1,500,000 (Project Flood)

RIVER MILE	WATER SURFACE ELEV	H (FT)	LENGTH OF REACH (FT)	SLOPE S (FT/FT)	WIDTH (FT)	AREA (SQ FT)	AVG DEPTH (FT)	HYDR RAD R (FT)	n	VELOCITY (FT/SEC)	DISCHARGE Q (CU FT/SEC)
					50,000 SQ FT CHANNEL						
105.0	20.0				66,000						
					66,000	1,190,000	18.0	18.0	0.120	0.94	1,120,000
		5.0	40,000	0.0001250	1,000	50,000	50.0	47.5	0.030	7.50	375,000
95.0	25.0				66,000					TOTAL =	1,495,000
					72,000	1,700,000	23.5	23.5	0.120	0.745	1,265,000
		3.0	55,500	0.0000545	1,000	50,000	50.0	47.5	0.030	4.77	240,000
85.0	28.0				89,000					TOTAL =	1,505,000
					86,000	2,100,000	24.5	24.5	0.120	0.625	1,310,000
		2.0	55,000	0.0000367	1,000	50,000	50.0	47.5	0.030	3.93	195,000
73.0	30.0				84,000					TOTAL =	1,505,000
					60,000 SQ FT CHANNEL						
105.0	20.0				66,000						
					66,000	1,190,000	18.0	18.0	0.120	0.85	1,060,000
		4.4	40,000	0.0001010	1,000	60,000	60.0	56.5	0.030	7.25	465,000
95.0	24.4				66,000					TOTAL =	1,525,000
					72,000	1,650,000	23.0	23.0	0.120	0.73	1,200,000
		2.9	55,500	0.0000530	1,000	60,000	60.0	56.5	0.030	5.31	320,000
85.0	27.3				89,000					=	1,520,000
					86,000	2,060,000	24.0	24.0	0.120	0.62 =	1,260,000
		2.0	55,000	0.0000360	1,000	60,000	60.0	56.5	0.030	4.55	270,000
73.0	29.3				84,000					TOTAL =	1,530,000

TABLE VI

(continued)

RIVER MILE	WATER SURFACE ELEV (FT MSL)	H (FT)	LENGTH OF REACH (FT)	SLOPE S (FT/FT)	WIDTH (FT)	AREA (SQ FT)	AVG DEPTH (FT)	HYDR RAD R (FT)	n	VELOCITY (FT/SEC)	DISCHARGE Q (CU FT/SEC)
					80,000 SQ FT CHANNEL						
105.0	20.0				66,000						
					66,000	1,120,000	17.0	17.0	0.120	0.77	895,000
		3.8	40,000	0.0000950	1,000	80,000	60.0	58.0	0.030	7.05	585,000
95.0	23.8				66,000					TOTAL =	1,480,000
					72,000	1,580,000	22.0	22.0	0.120	0.70	1,100,000
		2.8	55,500	0.0000505	1,000	80,000	60.0	58.0	0.030	5.25	420,000
85.0	26.6				89,000					TOTAL =	1,520,000
					86,000	1,980,000	23.0	23.0	0.120	0.59	1,170,000
		1.9	55,000	0.0000350	1,000	80,000	60.0	58.0	0.030	4.38	350,000
73.0	28.5				84,000					TOTAL =	1,520,000
					100,000 SQ FT CHANNEL						
105.0	20.0				66,000						
					66,000	1,050,000	16.0	16.0	0.120	0.78	820,000
		2.5	40,000	0.0000600	1,670	100,000	60.0	60.0	0.030	7.58	758,000
95.0	22.5				66,000					TOTAL =	1,578,000
					72,000	1,190,000	18.0	18.0	0.120	0.66	790,000
		2.0	55,500	0.0000350	1,300	100,000	75.0	72.0	0.030	6.65	665,000
85.0	24.5				89,000					TOTAL =	1,455,000
					86,000	1,950,000	22.0	22.0	0.120	0.58	1,100,000
		2.5	55,000	0.0000400	1,300	100,000	75.0	72.0	0.030	5.05	500,000
73.0	27.0				84,000					TOTAL =	1,600,000



WATER SURFACE PROFILES
(PROJECT FLOOD)

ATCHAFALAYA FLOODWAY

(After US Corps of Engineers, Design Supplement No. 1, Plates 1-13)

Fig. 21

The same computations can be used to determine the present discharge capacity of the Atchafalaya Basin Floodway. The Louisiana Department of Public Works stated in 1964 (the present conditions are no better) that the present levee is 6 to 8 feet below grade in a number of locations [1964a]. This agrees with Figure No. 10. At Mile 85.0, Chicot Pass, the 1963 Project Flow Line, computed by the writer for existing conditions, is 27.0 feet above mean sea level. If the levee were 6.0 feet below grade (21.0 feet m.s.l.), Figure 20 shows that the discharge capacity for this height would be about 1,000,000 cubic feet per second, only two-thirds the required capacity.

Effects of Proposed Spoil Levees.

The present plan is to use the spoil from excavation of the Main Channel to build levees on both sides of the channel. These levees would confine moderate flows, thus preventing the frequent flooding of the Atchafalaya Basin. Depending on the frequency of floods on the Mississippi and the gate operations of the Low-Sill Control Structure, the floodway would possibly be flooded once every two years. The Corps of Engineers believes the life of the floodway can be prolonged by eliminating some of the silting, as a result.

However, the use of levees to contain small floods will not be effective in preventing silting up of the floodway. Silting occurs chiefly during major floods, not during small and moderate discharges, because the concentration of the suspended sediment increases with the stream discharge. For example, on November 8, 1956 the daily discharge of the Atchafalaya River was 48,000 cubic feet per second; the total sediment concentration was about 100 parts per million. However, during high water the following year, on May 3, 1957, with the daily discharge of 400,000 cubic feet per second, the total sedimentation concentration was over 1,500 parts per million. This is a typical alluvial stream. That the total suspended load increases with discharge is common scientific knowledge; it need not be demonstrated here.

With moderate flows confined to the main channel, there is the possibility that the channel itself will silt. The sediment that previously fell in the Lower Atchafalaya Basin will settle out in the proposed enlarged Main Channel, unless the water surface slope is great enough. It would be difficult, if not impossible, to construct a large self-maintained channel for the various volumes of flows and concentrations of suspended material.

Even if the smaller flows are confined in, but do not silt, the main channel, the sediment will be deposited in the Atchafalaya Bay south of Morgan City. The problem would then be shifted from the Atchafalaya Basin Floodway to the Atchafalaya Bay, the filling of which would increase the flood hazard to Morgan City. To insure protection against the flooding of Morgan City, a channel would have to be excavated and maintained in the bay. Although it may take much time, because the amount of sediment from the smaller discharges is not great, the silting in Atchafalaya Bay would be accelerated.

As of November 1966, the Louisiana Department of Public Works was planning a control structure to form a reservoir in the West Atchafalaya Basin Floodway. The proposed Henderson Control Structure would be in the channel adjacent to east (river) side of the West Atchafalaya Basin Protection Levee, near the latitude of Butte La Rose. Its purpose is the maintaining of a pool stage in the reservoir at either 9.0 or 12.0 feet above mean sea level, for fishing and wildlife conservation. At either stage, the land area between the West Atchafalaya River Levee and the East Atchafalaya Basin Protection Levee will be under water.

Although the Corps of Engineers did not object to the proposed construction, this storage plan contradicts the purpose of their present one--the confinement of small and moderate flows to one channel. If this reservoir maintains stages above normal, what plan could prevent frequent flooding in the same floodway? It is conceded that the proposed reservoir probably will not cause much sedimentation or reduce appreciably the flood control capacity. However, the purpose of the proposed spoil levees along the main channel, to eliminate much of the sedimentation and prolong the life of the floodway, contradicts the more real concept used in defense of the proposed reservoir, that most of the sedimentation is caused by major floods.

Cross-sections of the floodway taken by the Corps of Engineers [1951d] show that most of the sedimentation occurs during the major floods. Figure 13 shows the vast amount of sedimentation that occurred in the Atchafalaya Basin Floodway between 1940 and 1951, during which time, in 1945 and 1950, two major floods occurred. The evidence is there; much of the sedimentation took place during these two high water periods.

Side Effects.

Wildlife and fishing interests oppose a channel with continuous levees to prevent frequent flooding of the floodway, and they have already gained some concessions for conservation. Under consideration are connections between the main channel and some of the tributaries.

There is no question that levees along the main channel would be detrimental to wildlife and fishing by reducing stages in backwater areas. Therefore, the usefulness of the spoil levees to prolong the discharge capabilities of the floodway must be weighed against the potential damage to the conservation programs. The damage can be estimated before, and evaluated after, construction of the levees, but determining their future utility for flood control and their effects on the sedimentation in the floodway will be very difficult, if not impossible.

Furthermore, with levees along the main channel to confine floods with a two year recurrence interval, there would be the possibility of agricultural encroachment in the floodway. Farmers who own land in the Atchafalaya Basin are carefully examining this possibility. Far fetched as that sounds, some of the lowlands outside the floodway limits are now utilized for farming, and, in some instances, these agricultural lowlands are below the elevation of the floodway. This explains the occasional appearance at a levee board meeting of landowners who are interested in agricultural development. If these levees are built, there will definitely be more attempts at land encroachment for agriculture.

THE PROPOSED RAISING OF THE LEVEE GRADE

Since the beginning of construction in the nineteen thirties, the cumulative settlement of the East and West Atchafalaya Basin Protection Levee crowns has been an inordinate problem. Figure 17 shows the amount of settlement along a portion of the East Levee, indicating that the average cumulative settlement for this reach is greater than 10 feet (below the original crown). The settlement in some of the areas exceeded twenty feet.

The major reason for this settlement is not the consolidation of the foundation or the levee, but is, instead, plastic flow from shearing stresses in the soft underlying material. Because of this, the Corps of Engineers, in their attempt to increase the elevation of the levee crowns, devised the previously described construction plan. If this or any other new method will economically increase the levee height, then the required flood control capability of the Atchafalaya Basin Floodway might be attained for the next thirty years, at least.

The Corps' present plan to dredge a stream with 100,000 square foot of cross-sectional area, would, when accomplished, lower the required levee grade needed to contain the project flood, due to an estimated stage reduction of two to three feet.

However, if all of the dredging in the Atchafalaya Basin Floodway were halted and the excavation funds were allocated instead for upgrading of the protection levees, then — assuming that some new method proves successful — the levees could be raised the additional two or three feet. Once the project grade of the levees is attained by eliminating the foundation failures, there would be little change in the physical dimensions.

On the other hand, even after the enlargement of the Atchafalaya Basin Main Channel, new problems from the changing physical characteristics of the alluvial stream will present themselves. The Corps of Engineers [1963a] states,

> "If the accelerated channel program were not undertaken, the flowline which might be established in 20 years, under the influence of natural channel development, would be higher and levee costs for its confinement would be an estimated $10,000,000 higher. This overall reduction of $10,000,000 in estimated levee costs might be considered as a savings attributable to the accelerated dredging program."

From Table 4, Appendix IV, of the same reference, one can calculate with the given data that the cost for enlarging the Atchafalaya Basin Main Channel to 100,000 square feet will be approximately 44 million dollars. May $40,000,000 for dredging be justified if the same results can be obtained with only $10,000,000 for levees?

The Corps [1963b] further claims that a relatively stable condition will eventually be reached. "The phenomena of overbank siltation and lake accretion, while progressive, tend to be self-limiting." If this self-limiting condition were ever approached, the flow lines for the project flood would become temporarily stable. The Corps of Engineers, in its published reports, does not show how it determined the most economical combination between levee enlargement and channel excavation.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

(1) In attempts to protect the plains of south central Louisiana, many of the previous flood control measures have been neither systematic nor effective. Some of the completed engineering projects, in fact, are in accord with neither existing nor previous flood control plans.

(2) The present discharge capacity of the Atchafalaya Basin Floodway, approximately 1,000,000 cubic feet per second, is only two-thirds of that essential to the present plan. If the design flood were to occur now, either the East or West Atchafalaya Basin Protection Levees would be overtopped. New Orleans would probably be free from flooding. Two reasons for the flood control inadequacies are the subsiding of the East and West Protection Levees and the silting up of the Atchafalaya Basin. The silting of the basin has progressively raised the computed water surface of the design flood.

(3) The past flood control efforts in the basin have not fully implemented the Acts of 1928 and 1936. The requisite funds to implement the projected ten-year flood control plan have not been allocated. Were the funds available, the construction of control works in the Atchafalaya Floodway would still await the solutions to many engineering and political problems.

RECOMMENDATIONS

(1) Make available the scheduled Federal funds to implement the flood control plan.

(2) Terminate the excavation of the Atchafalaya Basin Main Channel until it begins to adjust naturally to its required cross-section. The value of the previous channel dredging could then be appraised.

(3) Determine the effectiveness of the proposed method to be used in building the higher protection levees required along the Atchafalaya Basin Floodway. Should this method prove faulty, some other technique must be developed and used.

(4) Use the funds currently appropriated for excavation of the Atchafalaya Basin Main Channel to construct levees (assuming that the chosen method of construction will be effective) to provide south Louisiana with adequate protection against the design flood.

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