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Divine Providence: The 2011 Flood in the Mississippi River and Tributaries Project

Charles A. Camillo

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DIVINE PROVIDENCE

MISSISSIPPI RIVER COMMISSION

LISTENING • INSPECTING • PARTNERING • ENGINEERING

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ESTABLISHED JUNE 1879

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by

Charles A. Camillo

Foreword by George C. Grugett
Executive Vice-President
Mississippi Valley Flood Control Association

Postscript by T. Stephen Gambrell
Executive Director
Mississippi River Commission

Mississippi River Commission
Vicksburg, Mississippi
2012

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DIVINE PROVIDENCE

Contents

Foreword

In my many years of experience on the magnificent lower Mississippi River I have read many articles, books, and periodicals concerning the Mississippi River and Tributaries Project. I am certain that the major change I have discerned through all this reading is that, for some reason that I have never really examined, modern-day historians such as Charles Camillo have found the secret of making their writings of historical events a lot more “readable” than those experts of years past. I am certain that the readers of this account of the Great Flood of 2011 will agree with that personal assessment.

Mr. Camillo was there on the spot, if you will, during those periods of anguish when the Mississippi River Commission made the difficult decisions that allowed this flood of record to flow to the Gulf of Mexico without the loss of a single life and with not one acre of land flooded that was not supposed to be flooded. Those gut-wrenching moments are captured in this book in such a manner that you do not have to be a water resources engineer to feel the tension and the need for the correct decision to be made at the proper time.

What happened during the Great Flood of 2011 did not happen because of some overnight miracle. It happened because of the foresight of the people that formed a triad more than 80 years ago. The triad consisted of the United States Congress, the United States Army Corps of Engineers, and last, but certainly not least, the local people who had organized themselves in 1922 into what is now the Mississippi Valley Flood Control Association. Working together to solve the problems created by uncontrolled flooding of the Mississippi River and its tributaries, the triad successfully secured passage of the Flood Control Act of

May 15, 1928 that created, among other things, the Mississippi River and Tributaries Project. The Mississippi River and Tributaries Project is a comprehensive project that not only provides flood control but also a permanent and reliable navigation channel. In addition, the project plays a large role in the protection and restoration of man's natural environment. It turns the third largest watershed on the planet into the greatest river basin in the world, not because of its size but because of its greatness, greatness because of the benefits derived from the entire watershed. These benefits are possible because the mighty river from Cape Girardeau, Missouri, to the Gulf of Mexico has been controlled. It is now a huge asset to the entire Nation and one that belongs to the people because the people made it possible. It could well be called the People's River.

No one in his right mind looks forward with any degree of pleasure to experiencing a major record-setting flood because they are always a devastating and damaging event; but when a great flood has been experienced and passed in record time to the Gulf, then it has at least two beneficial results. One, it gives us confidence that what man has designed and constructed has been well done and two, it discloses where the weaknesses are in the system, even the one that worked so well. If we are smart, we will learn and make the necessary corrections, improvements and repairs before the next flood occurs as it surely will.

This book will be of great assistance to those who read it and learn. I hope you use it wisely and for the good of the people of this great Nation.

George C. Grugett
Executive Vice President
Mississippi Valley Flood Control Association
January 29, 2012

Preface

As the historian for the Mississippi River Commission and the Mississippi River and Tributaries project, I face the dilemma of leaving behind a record of current events for future generations. Oddly, it is easier for me to document the activities and accomplishments of the commission and the project from one hundred years ago than five or ten years ago. This is because very few paper records exist nowadays. The U.S. Army Corps of Engineers and the Mississippi River Commission generate voluminous amounts of memoranda, studies, correspondence, and briefings, but most can only be found in an electronic format. It was against this backdrop that I endeavored to produce this study.

I do not view the pages that follow as a historical study, although I do incorporate historical material to provide context for key elements of the story. Instead, the narrative is more representative of an eyewitness account of a historic event. During several presentations and speaking engagements that I delivered after the flood, my audiences seemed to want the answer to three basic questions. The first involved the decision-making processes at the three floodways placed into operation in 2011. The second involved the history of the Birds Point-New Madrid floodway. The third involved the absence of a floodway to relieve pressure between the Birds Point-New Madrid floodway and the Old River control complex. This study attempts to addresses those questions.

The chapters that chronicle the 2011 flood rely heavily on my own notes – a diary of sorts – interviews conducted after the event with key players that I identified during my coverage of the flood, daily situation reports from the district offices, daily emergency management briefings that tracked changing conditions, and electronic correspondence. To that end, one of the purposes of this study is to leave behind a transparent record of the 2011 flood so that future historians will have a central repository to work from. Yet, there is one caveat. The flood roughly spanned a three-week period and impacted the entire Mississippi River and Tributaries project system. Naturally, I could not be in all places at once, so coverage is limited to the three floodways and the flood fight in the Vicksburg Engineer District. Heroic flood fights took place along both banks of the Mississippi River from Cape Girardeau, Missouri, to the Gulf of Mexico and the Atchafalaya River from Simmesport to Morgan City. The absence of a detailed discussion at any specific location is in no way intended to trivialize those desperate efforts to convey the flood.

The chapters that provide historical context rely heavily on my personal collection of primary source material accumulated over the past decade in the form of correspondence, technical papers, reports, and *Engineering News-Record* articles. For those interested in learning more about the history of the Mississippi River and Tributaries Project, I strongly recommend *Designing the Bayous: The Control of Water in the Atchafalaya Basin, 1800-1995*, by Martin Reuss and *Upon Their Shoulders: A history of the Mississippi River Commission through the advent of the Modern Mississippi River and Tributaries Project*, by Charles Camillo and Matthew Pearcy. For those interested in comparing what could have been during the historic 2011 flood to what happened in the valley during the 1927 flood prior to the establishment of the Mississippi River and Tributaries Project, I recommend *Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America*, by John Barry.

I am grateful to serve as a historian in the United States Army. The military as a whole appreciates the field of historical study for what it really is: a tool to strengthen the understanding of the past so that improvements can be made for our future. The uniformed and civilian leadership of the Army live by that creed, as evidenced by their reliance on after-action reports and lessons-learned studies. During the 2011 flood, the Mississippi River Commission and leaders from the U.S. Army Corps of Engineers' district offices in the lower valley granted me full access to meetings, operations, personal discussions, and documentation so I could produce an account of events to strengthen their decision-making processes. This unfettered access provided the unique opportunity to note facial expressions, body language, verbal exchanges, tone of voice, and sense of urgency that otherwise would have gone undocumented. These elements bring the story to life. Most professional historians – at least historians of river engineering in the Mississippi Valley – can only dream of incorporating such features when constructing a narrative.

This behind-the-scenes narrative is edgy at times, yet there was no attempt by the Mississippi River Commission or the U.S. Army Corps of Engineers to sanitize the story during the review and approval process. That is a testament to the integrity of both agencies. Some reviewers disagreed with my interpretation of certain events or the conclusions I developed from the evidence at hand. As Mark Twain once opined, "The very ink with which all history is written is merely fluid prejudice." As a historian, I am very cognizant of that fact. As much as I might try to suppress my own influences and biases, they are certain to be reflected in the pages that follow. For this reason, it must be noted that the views and conclusions expressed in this study are mine; they do not necessarily represent those of the U.S. Army Corps of Engineers, the Mississippi River Commission, the Army, or the United States.

I accumulated many debts throughout the preparation of this book. My supervisor, Stephen Gambrell, provided generous understanding and support from concept to completion. Pam Vedros and Edie Whittington selflessly took on many of my routine responsibilities as I concentrated on research and writing. The staff at the Louis Latzer Memorial Public Library in Highland, Illinois, graciously provided a comfortable and

quiet space from which to work – an environment free from visitors, email, and telephones. I am also indebted to my colleague Damon Manders, who, had it not been for his untimely deployment to Afghanistan with the Alabama National Guard, most likely would have been co-author of this study. Prior to his deployment, Mr. Manders prepared much of the background material in chapters one and three. Without the aforementioned support, I would not have accomplished my goal within the tight self-prescribed deadline.

Even though I am a historian for the world's premier engineering organization, I must admit that I only know enough about engineering to be dangerous. I relied heavily on the expertise and input from several engineers and professionals. Charles Shadie and Bill Frederick of the Mississippi River Commission and Mississippi Valley Division, Deborah Lee of the Great Lakes and Ohio River Division, David Busse, Russell Errett, Elizabeth Behrens, and Jacob Prebianca of the St. Louis Engineer District, David Berretta and Jon Wilson of the Memphis Engineer District, Robert Simrall, Lanny Barfield, and Kent Parrish of the Vicksburg Engineer District, and William Veatch of the New Orleans Engineer District all generously withstood my constant requests for clarification, analysis and information. I truly appreciate their knowledge, professionalism, and patience.

Maj. Gen. Michael Walsh, Col. Vernie Reichling, Col. Jeffrey Eckstein, Col. Edward Fleming, Charles Shadie, Stephen Gambrell, David Busse, Deborah Lee, Russell Davis, James Lloyd, Robert Simrall, Lanny Barfield, John Lonnquest, Douglas Wilson, and Matthew Pearcy, representing either the Mississippi River Commission or the U.S. Army Corps of Engineers, graciously reviewed and commented on parts or all of the manuscript, as did external reviewers George Grugett, Lester Goodin, Kevin Pritchett, Peter Nimrod, Robert Rash, and Robert Thompson. Col. Fleming, Stephen Gambrell, Deborah Lee, David Busse, Walter Baumy, Jon Wilson, Col. Thatch Shepard, and Captain Todd Mainwaring provided crucial access to emails and electronic documents that otherwise would not have been incorporated into the manuscript. I am grateful to several Corps of Engineers' photographers — Alfred Dulaney, Brooks Hubbard, Oscar Reihsmann, and others — that captured the many images used in this manuscript. My colleague Brian Rentfro edited the manuscript. Brian Everitt designed the reference maps and Colleen Cummins redesigned several graphics used in the manuscript. Their combined efforts greatly improved the final product.

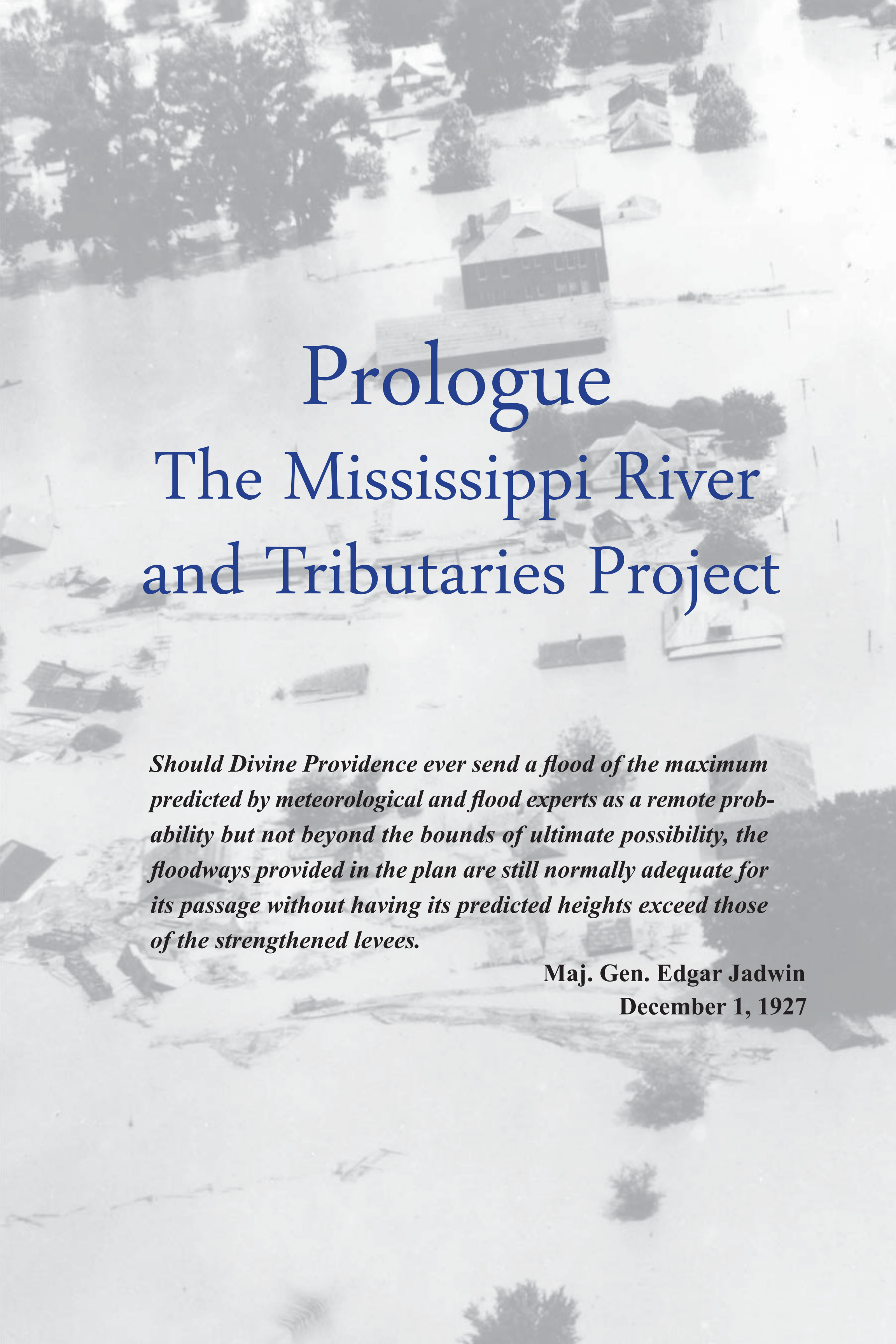
I also extend my gratitude to Marilyn Holt for the layout and graphic design of the book and Pat Caldwell for designing the cover. Their talents are unmatched.

This study is dedicated to everyone who has ever played a role in the development of the Mississippi River and Tributaries project — from the visionaries who conceptualized it, the engineers who modified and improved it, the congressional members who secured funding, the levee districts who maintain its features, the Mississippi Valley Flood Control Association who champions it, and the great people who call the valley home.

Charles A. Camillo
Historian, Mississippi River Commission
January 25, 2012

MISSISSIPPI RIVER COMMISSION

ESTABLISHED JUNE 1879

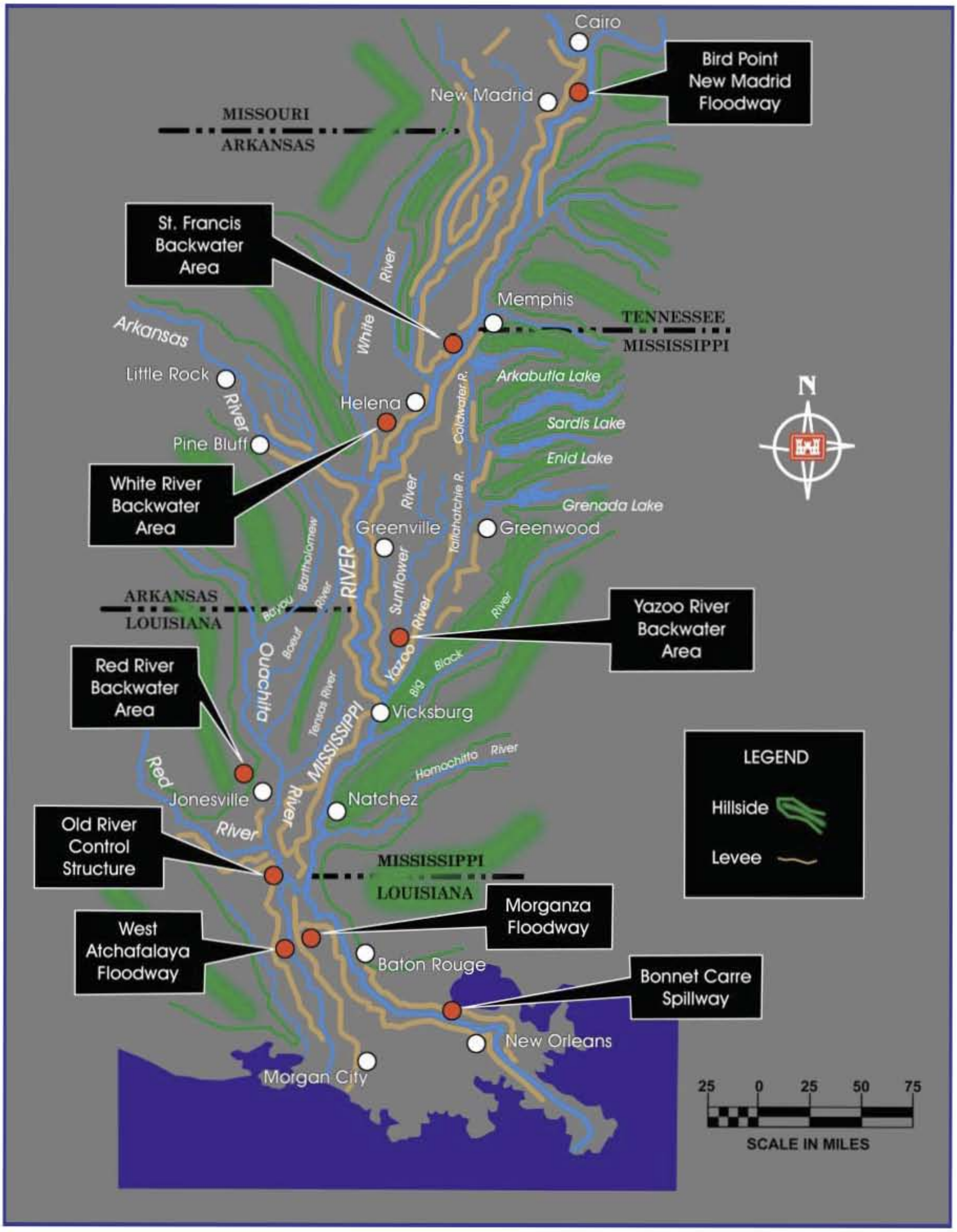


Prologue

The Mississippi River and Tributaries Project

Should Divine Providence ever send a flood of the maximum predicted by meteorological and flood experts as a remote probability but not beyond the bounds of ultimate possibility, the floodways provided in the plan are still normally adequate for its passage without having its predicted heights exceed those of the strengthened levees.

Maj. Gen. Edgar Jadwin
December 1, 1927



MR&T Project Features

During the overnight hours of May 1-2, 2011, a powerful thunderstorm hammered the tri-state area flanking the confluence of the Mississippi and Ohio rivers. The storm, the last of a series of successive violent storms that had dropped massive amounts of rain over the preceding two weeks, was the most severe yet. From mid-April through early May, rainfall amounts exceeding at least half of the yearly average precipitation fell over large swaths of seven states in the mid Mississippi Valley. The heavy rains transformed the normally-scenic Mississippi River, made legendary by the quaint and entertaining stories of Samuel Clemens, into a swollen, angry and indomitable torrent.

As Americans across the nation stirred to the celebratory news that U.S. armed forces had killed Osama bin Laden, the mastermind behind several terrorist acts against the nation, Maj. Gen. Michael Walsh, the president of the Mississippi River Commission, sat alone in his command post on the motor vessel *MISSISSIPPI*, which sat moored in the Mississippi River one mile south of the bridge that connected Cairo, Illinois, from what was at the time to most of the general public a little known spot on the map called Birds Point, Missouri. Walsh was in anything but a cheerful mood as he mulled over his decision to activate the Birds Point-New Madrid floodway – the first of three floodways he ultimately ordered into operation to manage the massive flood. He was gravely concerned. Driving rain pelted the windows of his lonely stateroom as he pored over river forecasts and situation reports from flood fight teams desperately trying to hold the flood control system that protected millions of people and their homes. Brilliant bolts of lightning lit up the night sky, followed by powerful thunderclaps that shook the vessel. Walsh was confident the system would hold, but he knew the storm that night would turn what had been a severe flood into a historic flood. *This is the big one*, he thought to himself, *the flood we've always feared*![1]

The burgeoning flood around Walsh represented, perhaps, the act of "Divine Providence" that Maj. Gen. Edgar Jadwin, the Chief of Engineers during the Great Flood of 1927, had prophesized 84 years earlier when he promoted his concept of making room for the river through the incorporation of floodways into the general plan for flood control in the lower Mississippi Valley. Whether an act of divine direction or not, by all indicators the flood was a monster. Before it was over, the flood shattered previous gage records from Cairo to Caruthersville, Missouri, and from Vicksburg, Mississippi, to Red River Landing, Louisiana. According to the official measurements taken by the U.S. Geological Survey, the flood also established new peak flood discharge records from Cairo to Baton Rouge, Louisiana.[2]

As the massive flood unfolded, the Mississippi River Commission, the Corps of Engineers, levee districts, and residents of the lower Mississippi Valley put their faith in the readiness of the flood control system that had protected the valley since 1928 – the Mississippi River and Tributaries (MR&T) project. The project is a comprehensive flood control and navigation system that sits at the foot of the Mississippi River drainage basin. The basin drains roughly forty-one percent of the forty-eight contiguous United States. Runoff from all or parts of thirty-one states and two Canadian provinces drains into the MR&T project footprint on its way to the Gulf of Mexico. In that way, the MR&T resembles the spout of a large funnel. What began in 1928 as a simplistic plan first championed by Maj. Gen. Jadwin to relieve pressure on the levee system by providing room for floods to expand through designated floodways has since been transformed into a truly comprehensive project through dozens of complex modifications during its 84-year life span.

The MR&T project is an anachronism. While today the Corps of Engineers uses terms such as flood damage reduction or flood risk management to describe its flood protection projects, the MR&T system remains as what can only be called a flood control system. The MR&T employs a variety of engineering techniques to control Jadwin's flood of "Divine Providence." The engineering features include an extensive levee system to prevent disastrous overflows on developed alluvial lands; floodways to safely divert excess flows past critical reaches; backwater areas to store surplus floodwaters and reduce pressure on the levee system; channel improvements to increase the flood-carrying capacity of the river; channel stabilization features to protect the integrity of the levee system and to ensure proper alignment and depth of the navigation channel; and tributary basin improvements, to include levees, headwater reservoirs, and pumping stations, to maximize the benefits realized along the main channel by expanding flood protection coverage and improving drainage into adjacent areas within the alluvial valley. Since its initiation, the MR&T program has brought an unprecedented degree of flood protection to the approximate 4 million people living in the 35,000 square-mile project area within the lower Mississippi Valley. The nation has contributed roughly $14 billion toward the planning, construction, operation, and maintenance of the project. It has proven to be a wise investment that has prevented more than $478 billion in flood damages – a $34 return for every dollar invested.[3]

The administration of the project also reflects its throw-back status. The project is prosecuted by the Mississippi River Commission, a seven-member governing body established by Congress in 1879 to heal a growing schism between the Army's engineers and the civilian engineering community by combining their talents to transform the Mississippi River into a reliable commercial artery, while protecting adjacent towns and fertile agricultural lands from destructive floods. Three general officers, three civilian members (two of whom must be civil engineers), and one admiral from the National Oceanic and Atmospheric Administration comprise the seven members of the commission. The President of the United States appoints each member with the advice and consent of the United States Senate. Upon its establishment, the commission quickly assumed the role of an active federal agent capable of transcending the regional issues that had previously hampered the development of a more effective river improvement system. The commission's biannual inspection trips, held since the 1880s, promote face-to-face interaction while nurturing a connection between a government entity and the people it serves that is unmatched anywhere in the nation, possibly the world.

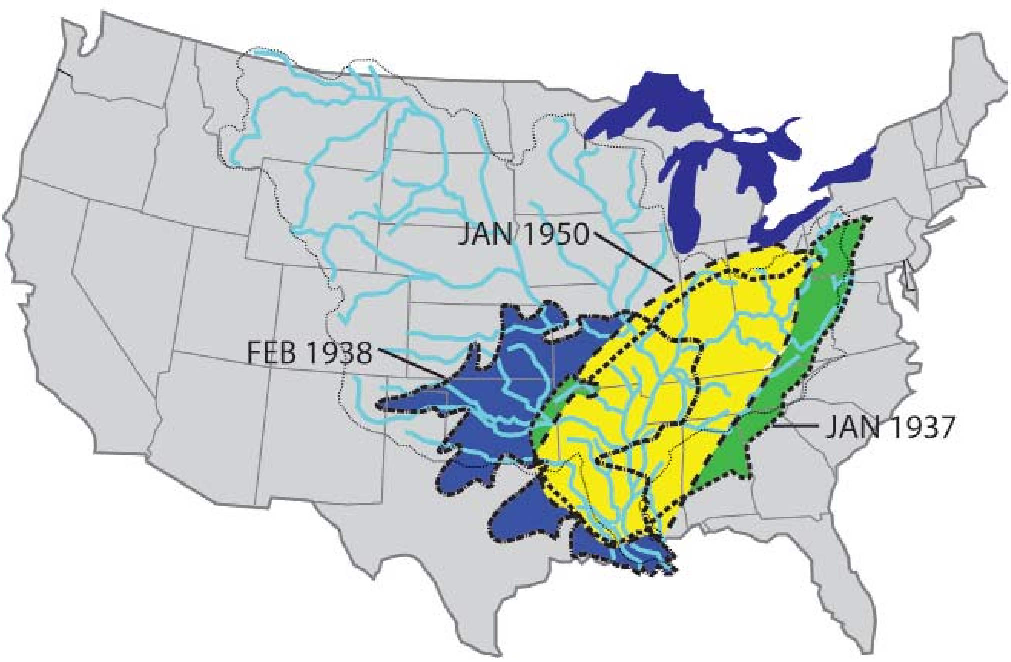
The Project Design Flood

The long and storied success of the MR&T flood control program can be traced to a change in policy following the 1927 flood. Prior to that tragic flood event, the Mississippi River Commission and levee districts attempted to control floods on the lower Mississippi by building levees high enough to withstand the last great flood of record. Since the inception of the MR&T project in 1928, however, the comprehensive flood control system controls a "project design flood," or the maximum probable flood.

The U.S. Weather Bureau (now the National Weather Service) developed the current project design flood in 1954 after the Senate Committee on Public Works requested a thorough examination of all components of the MR&T project. The flood represented the worst thing the bureau could conjure based on actual storms that had occurred in the past. The Weather Bureau study incorporated previously unavailable data regarding the sequence, severity, and distribution of past major storms and investigated thirty-five different hypothetical combinations of actual storms that produced significant amounts of precipitation and runoff. The Weather Bureau arranged the historical storms sequentially to mimic frontal movements and atmospheric situations consistent with those occurring naturally to determine the most likely pattern capable of producing the greatest amount of runoff on the lower Mississippi River. This included the consideration of storm transpositions, storm intensity adjustments, seasonal variations, and storm mechanics. In simpler terms, the Weather Bureau developed the project design storm series from various combinations of storms and resultant floods—referred to as hypo floods—that had a reasonable probability of occurring from a meteorological viewpoint. Preferring to err on the side of caution, the bureau tweaked the storms to make them as severe as possible. The studies revealed that Hypo-Flood 58A had the most probable chance of producing the greatest discharge on the lower Mississippi River from Cairo, Illinois, to the Gulf of Mexico.

Three severe storms comprised Hypo-Flood 58A. The first storm is the January 6-24, 1937 storm that struck the Ohio and lower Mississippi River basins and produced the record-setting flood of that year. To be conservative, the Weather Bureau increased the runoff from the 1937 storm by ten percent. Three days later the January 3-16, 1950 storm that caused widespread flooding falls over the same general area as the 1937 storm. The 1950 storm is followed three days later by the February 14-18, 1938 storm, with its center transposed 90 miles to the north and the rainfall pattern rotated by twenty degrees to maximize its

HYPO--FLOOD 58A STORMS



coverage over all the tributary basins on the lower Mississippi River. To convert Hypo-Flood 58A into the project design flood, the Mississippi River Commission assisted the Weather Bureau in developing flood flows that would occur from the three storms and routed the flows through the tributary systems under three conditions: unregulated by reservoirs; regulated by reservoirs that existed in 1950; and regulated by existing reservoirs, plus those proposed to be constructed in the near future (1960 timeframe). The flood flows were then routed down the Mississippi River to determine the peak discharges at key locations. The Mississippi River Commission selected the 58A flood with near-future reservoirs condition, referred to as 58A-EN (existing or near completion), as the basis for the project flood flows and adopted it as the project design flood in 1956.[4]

The project design flood reflects the worst that the Weather Bureau could dream up. Even regulated by reservoirs, the flood is about twenty-five percent greater than the devastating 1927 flood. The peak discharges for the project design flood in cubic feet per second (cfs) are: Cairo 2,360,000; Arkansas City 2,890,000; and Latitude of Red River Landing 3,030,000. Following the 1973 flood, the Mississippi River Commission reviewed the adequacy of the project design flood. The review concluded that the thorough approach used in 1955 was based on sound technology that was still reliable by current standards. The project design flood peak discharges remained unchanged.

Conveying the Project Design Flood[5]

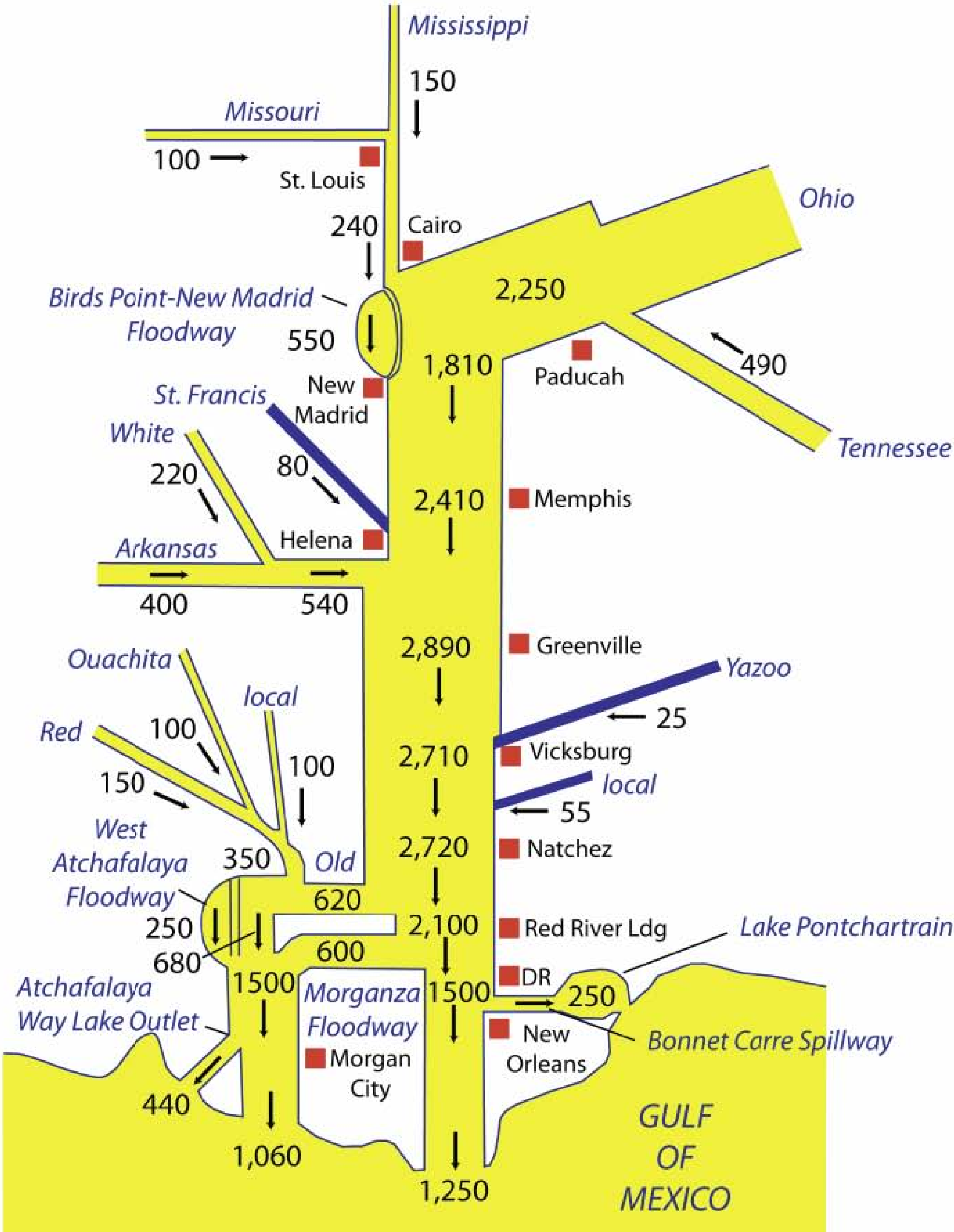
To fully appreciate the performance of the MR&T project during the 2011 flood, it is important to understand how the system operates. Levees are the backbone of the MR&T project flood control plan. The levees protect the vast expanse of the developed alluvial valley from periodic overflows of the Mississippi River. The mainline levee system begins at Cape Girardeau, Missouri, and continues to Venice, Louisiana, approximately ten miles above the Head of Passes near the Gulf of Mexico. The MR&T levee system includes 3,727 miles of authorized embankments and floodwalls. Of this number, nearly 2,216 miles are mainline levees along the Mississippi River. Backwater, tributary, and floodway levees comprise the remaining levees. The grade and section of the present levee system dwarfs by comparison those of the levee system overwhelmed during the 1927 flood. In addition to higher and wider levees, the MR&T levee system design incorporates technological breakthroughs from the science of soil mechanics that take into account the type, condition, and moisture content of material used in the construction of the levees.

The integrity of the current levee system is bolstered by advancements in the design, construction, installation, and maintenance of seepage control measures, to include landside berms, drainage trenches, drainage blankets, and relief wells. More than 1,000 miles of articulated concrete mattress revetment protect the levee system from erosion and assure reliability of the navigation channel. In an effort to further guarantee the soundness of the system, levee districts and other local sponsors implement strict annual levee maintenance programs with their own labor and funds. Activities include mowing, clearing brush and trees, filling holes, restoring rain-washed areas, clearing drainage ditches, correcting drainage problems, and spraying chemicals to control noxious and unwanted growth. Personnel from the Corps of Engineers' district offices ensure that maintenance requirements are met through annual inspections that identify any deficiencies and weak spots in the levee system so that immediate corrective actions can be taken. The addition of fifteen-foot wide, all-weather access roadways on top of the levee system aid federal personnel and local levee districts during the inspection process and during flood-fighting operations.

To maximize protection from floods, current levee grades provide for freeboard – the distance between the project design flood flowline and the top of the levee. The presently-authorized freeboard is a minimum

MR&T Project Design Flood

Discharge in 1,000 cfs



of three feet above the project design flood on the Mississippi River levees below Cairo, Illinois, and two feet on the Atchafalaya basin floodway levees. Levee grades between Cape Girardeau and Cairo and along the south banks of the Arkansas and Red rivers provide for a three-foot minimum freeboard over the maximum tributary flood meeting the maximum flood of record on the Mississippi River, with provisions to ensure that the same flood meeting the project design flood will not overtop the levee. In the vicinity of New Orleans, Louisiana, the authorized freeboard exceeds five feet because of the increased danger to the urban areas from wave wash and storm surges common along coastal areas.

When flood stages begin to approach project design flood dimensions, additional project features activate to control and convey potentially-damaging floodwaters to relieve stress on the levee system. The first key location on the flood control system is in the vicinity of Cairo. When the river reaches critical stages on the Cairo gage, the Birds Point-New Madrid floodway goes into operation to prevent the project flood from exceeding the design elevation of the levees and floodways at and near Cairo, the levees along the west bank above Birds Point, and the east bank levee adjacent to the floodway. The floodway varies in width from about three to ten miles and has a length of nearly thirty-six miles. The floodway diverts up to 550,000 cfs from the Mississippi River during the project design flood and provides up to seven feet of stage lowering in the vicinity of Cairo, with smaller reductions above Cairo and through the floodway reach. The floodway has special fuseplug levees at its upper and lower end. The floodway is activated when sections of the frontline levee naturally overtop or when artificially crevassed by the Memphis Engineer District. The floodway requires timely operation to insure its design effect during a flood approaching the project flood magnitude. For this reason, the plan of operation involves the placing and detonation of explosives at the required crevasse locations. The president of the Mississippi River Commission, with advice from the members of the commission, directs the operation of all floodways within the MR&T project after consultation with the chief of engineers.

There are two major reservoirs—Kentucky and Barkley lakes—on the Tennessee and Cumberland rivers that are not features of the MR&T project, but are authorized through the 1944 Flood Control Act to reduce flood stages on the Mississippi River in the vicinity of and downriver from Cairo. Because of the close proximity of the reservoirs to the confluence of the Mississippi and Ohio rivers, regulation of the reservoirs has a major predictable impact on the operation of the Birds Point-New Madrid floodway. During the development of the project design flood, the Weather Bureau accounted for the impacts of these reservoirs. The 1944 Flood Control Act directs the Tennessee Valley Authority to regulate the release of water from the Tennessee River into the Ohio River in accordance with instructions from the Corps of Engineers. Objectives developed by the Great Lakes and Ohio River Division for the Kentucky-Barkley reservoir outflows have priorities to safeguard the Mississippi River levee system, to reduce the frequency of use of the Birds Point-New Madrid floodway and to reduce the frequency and magnitude of flooding of lands along the lower Ohio and Mississippi rivers which are unprotected by levees. When floods threaten the flood control features along the upper reaches of the MR&T project, the Mississippi River Commission president and the Great Lakes and Ohio River Division commander—a position that also serves as a member of the Mississippi River Commission—work together to regulate releases from Barkley and Kentucky lakes with the concurrence of the general manager of the Tennessee Valley Authority to accomplish these objectives.

Between the lower end of the Birds Point-New Madrid floodway and the Old River control complex, the system relies on levees to confine the project design flood. A combination of flood control reservoirs in the Arkansas-White basin and a comprehensive channel rectification program supplement the levee system in confining floods. The channel rectification program greatly improved the carrying capacity of the main channel and lowered the project flood flow line through the use of cutoffs (severing large bends from the river) and corrective dredging. Between 1932 and 1942, the Mississippi River Commission executed fifteen artificial cutoffs that, along with one natural cutoff, chute enlargements, and other corrective dredging techniques reduced the length of the river by nearly 170 miles and achieved stage reductions in the project flood flow line by up to twelve feet.

The levee system between Memphis and Old River is supplemented by four backwater areas located at the mouths of the St. Francis, White, Yazoo, and Red rivers. Significant portions of the upper sections of these backwater areas receive protection from overflows of the Mississippi River afforded by the mainline levees. The lower portions of these areas serve as natural storage during larger floods approaching the project flood design. The backwater levees overtop at a time sufficient to reduce project flood peak stages along the main stem of the Mississippi River. When flood stages on the Mississippi River or its tributaries subside, floodwaters from within the backwater areas drain through floodgates and pumps, with the exception of the Yazoo backwater area, which does not have a pump station despite congressional authorization for one since 1941.

From the Red River backwater to the Gulf of Mexico, including the Atchafalaya basin, the MR&T project represents an elaborate plumbing system designed to orchestrate the diversion and control of flood waters. The first key component of that system is the Old River control complex at the head of the Atchafalaya River basin. Construction of the complex began in 1954 to prevent the Atchafalaya from capturing the Mississippi River. The complex is designed to maintain the 1950 flow distribution between the Mississippi River and the Atchafalaya River of seventy percent to thirty percent, respectively.

Approximately thirty miles downstream from Old River, the MR&T flood control plan provides for a major diversion of floodwaters from the Mississippi River to the Atchafalaya basin through the Morganza floodway. Governed by a 3,900-foot long and a 125-bay intake structure, the floodway can divert up to 600,000 cfs from the Mississippi River during the project design flood when the Mississippi River flows below Morganza are projected to exceed 1,500,000 cfs. The West Atchafalaya floodway extends along the west side of the Atchafalaya River. The floodway contains an eight-mile long fuseplug section of levee at its head. When the fuseplug section crevasses or when the west bank Atchafalaya River levee overtops, the floodway can divert up to 250,000 cfs. The West Atchafalaya floodway would be the last feature of the flood control system to be used under the project design flood. The Atchafalaya River, the Morganza floodway, and the West Atchafalaya floodway converge at the lower end of the Atchafalaya River levees to form the Atchafalaya basin floodway. This floodway is designed to carry 1,500,000 cfs or nearly one-half of the project flood discharge of 3,000,000 cfs at the latitude of Red River Landing, including flows through the Old River control structures. Levees confine flows to a point below the latitude of Morgan City, Louisiana, whereby 1,200,000 cfs is conveyed to the Gulf of Mexico by the Atchafalaya River and the remaining 300,000 cfs is passed to the Gulf through the Wax Lake Outlet.

The flood control system provides protection against the remaining 1,500,000 cfs in the Mississippi River below the Morganza floodway through the Bonnet Carré spillway, located approximately thirty miles above New Orleans, Louisiana. The 7,200-foot long spillway structure is governed by 350 intake bays and connects to a six-mile long floodway that empties into Lake Pontchartrain. The floodway is designed to divert up to 250,000 cfs from the Mississippi River, thereby insuring a peak discharge flow under project flood conditions at New Orleans not to exceed 1,250,00 cfs.

Comparing Systems

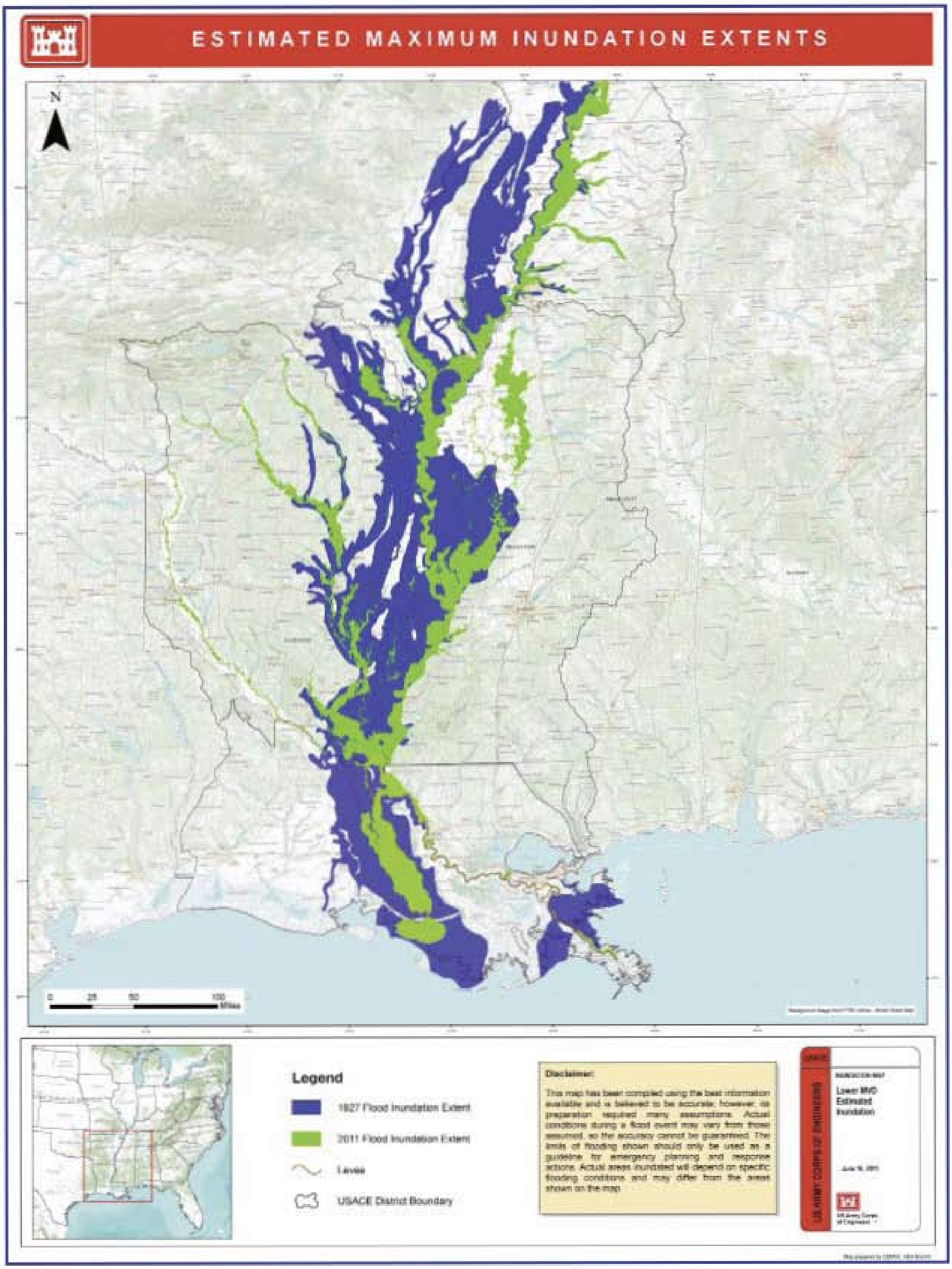
No one can deny the severity of the 2011 flood, but some have argued the Great Flood of 1927 that devastated the lower Mississippi Valley was a much larger flood than the 2011 event; that the stages and discharges would have been greater in 1927 than actually measured had the federal levee not sustained seventeen major crevasses and allowed the floodwater to spread out. That may or may not be true. On the other hand, it can also be argued that stages and discharges in 2011 would have been greater than occurred had it not been for the three floodways placed into operation and the many dozens of post-1927 reservoirs constructed in the Missouri, Ohio and Arkansas/White basins that impounded massive amounts of water during the winter and early spring, as well as for the major dredging program executed in the 1930s and 1940s that drastically shortened the river and increased the flood carrying capacity of the channel. As a result, the only way to provide a relative comparison of the two benchmark floods from the standpoint of hydraulics with the different protection systems employed would be to approximate flows and stages of the 1927 flood under 2011 project conditions or vice versa. In either case, this is a difficult task to accomplish. It is fairly simple, though, to compare the performance of the flood control systems in place during the two precedent-setting floods.

For nearly five decades prior to 1927, the Mississippi River Commission completed and then improved the general levee system begun by the states in the mid-nineteenth century. The commission coordinated local efforts, set standards and specifications for levee construction, and allotted funds to cash-strapped levee districts throughout the lower valley. The commission believed the levees not only provided adequate protection from flooding, but would also promote scouring of the riverbed and provide a deeper navigation channel. For this reason, the commission rejected alternative methods of flood control, such as diversions, floodways, spillways, cutoffs and reservoirs. Critics derided the commission's approach as the "levees only" policy. As one flood after another overpowered the levee system, the commission responded by building the levees higher. The policy eventually left the lower Mississippi Valley shattered after the Great Flood of 1927, as the massive flood completely overwhelmed the outmatched levee system. Crevasses caused by the deluge numbered between 120 and 225, with seventeen of those being major crevasses on federal levees. The remainder of the breaks – ranging in size from half a mile wide to a mere trickle – occurred in state or local levees. The unshackled floodwaters inundated 16.8 million acres in 170 counties in seven states – a swath roughly 50 to 150 miles wide running from Cairo to Baton Rouge on the east bank and Cape Girardeau to the coast on the west bank. The vast majority of the properties in the flooded regions were a total loss. Those buildings that remained standing quickly rotted from exposure. Estimates are that nearly one million people lived in the region, only slightly less than one percent of the total U.S. population at the time. This means one of roughly every 100 to 120 persons in the country lived through or was impacted by the flood.[6]

Statistics demonstrate the far-reaching impact of the 1927 flood. Estimates of the death count range from 150 to 500. Some sources suggest a total number as high as 1,000 including indirect deaths such as from starvation. Many more were left homeless. Roughly 162,000 homes were unlivable, and 41,000 buildings were destroyed. The flood turned approximately 700,000 people into refugees; about 600,000 received aid from the Red Cross or other organizations. Seventy counties from seven states received some flood damage; nineteen of them were more than 70 percent inundated. The flood destroyed some two million acres of farmland valued at $102.5 million. At maximum market value, the amount of land not used or ruined reached nearly $2 million. This does not include the value of the more than 1.2 million poultry and 271,000 livestock that died in the flood, including 26,000 cattle and 127,000 pigs. In Louisiana, the floods decimated the 6.2 million muskrat population that formed a large part of Cajun income. It took years to restore these populations. In addition, damages to public infrastructure – roads, telephone poles, bridges and railroads – totaled $10 million. Estimates of the total value of losses reached up to $1 billion, during an era when the federal budget rarely exceeded $3 billion.[7]

Equally disconcerting for the average citizen were the dramatic changes to the landscape imposed by the flood, which lingered long after it receded. When waters poured through crevasses, they left behind grooves and channels. In several locations, blue holes – large lakes of clear water a hundred feet deep – remained where floodwaters dug out holes when dumping through the levees. Such lakes now mark the spot of crevasses all along the river. Many landmarks had changed or disappeared beneath the silt left behind by the waters. Sandbars four and five feet high grew up many miles from a crevasse. Silt and sand covered roads, first floors of buildings, and acres of farmland, which required digging out to reach the fertile valley soil. It took several years for many farms to return to pre-flood profitability. Public facilities, if not buried, were eroded or destroyed. Bridges washed out, roadways were full of holes and gaps, and railroads twisted, appearing as picket fences. Debris – driftwood and destroyed homes – piled up in many locations, and most buildings had water marks on them. Large gaps existed in the levees, which in some cases had eroded until little more than small bumps remained. Even after floodwaters receded, lands normally prone to flooding remained underwater. Ditches turned to creeks, and creeks to wide rivers. Much of the Atchafalaya Basin returned to swampland. The impression it left in the minds of its victims lingered for decades.[8]

Following the Great Flood of 1927, the nation galvanized its support to prevent another similar tragedy from happening again. Congress authorized the Jadwin plan and then modified it dozens of times to produce the comprehensive MR&T project. Unlike the levees-only system during the 1927 flood, the comprehensive MR&T system functioned as designed during the 2011 flood. Not a single life was lost as a result of



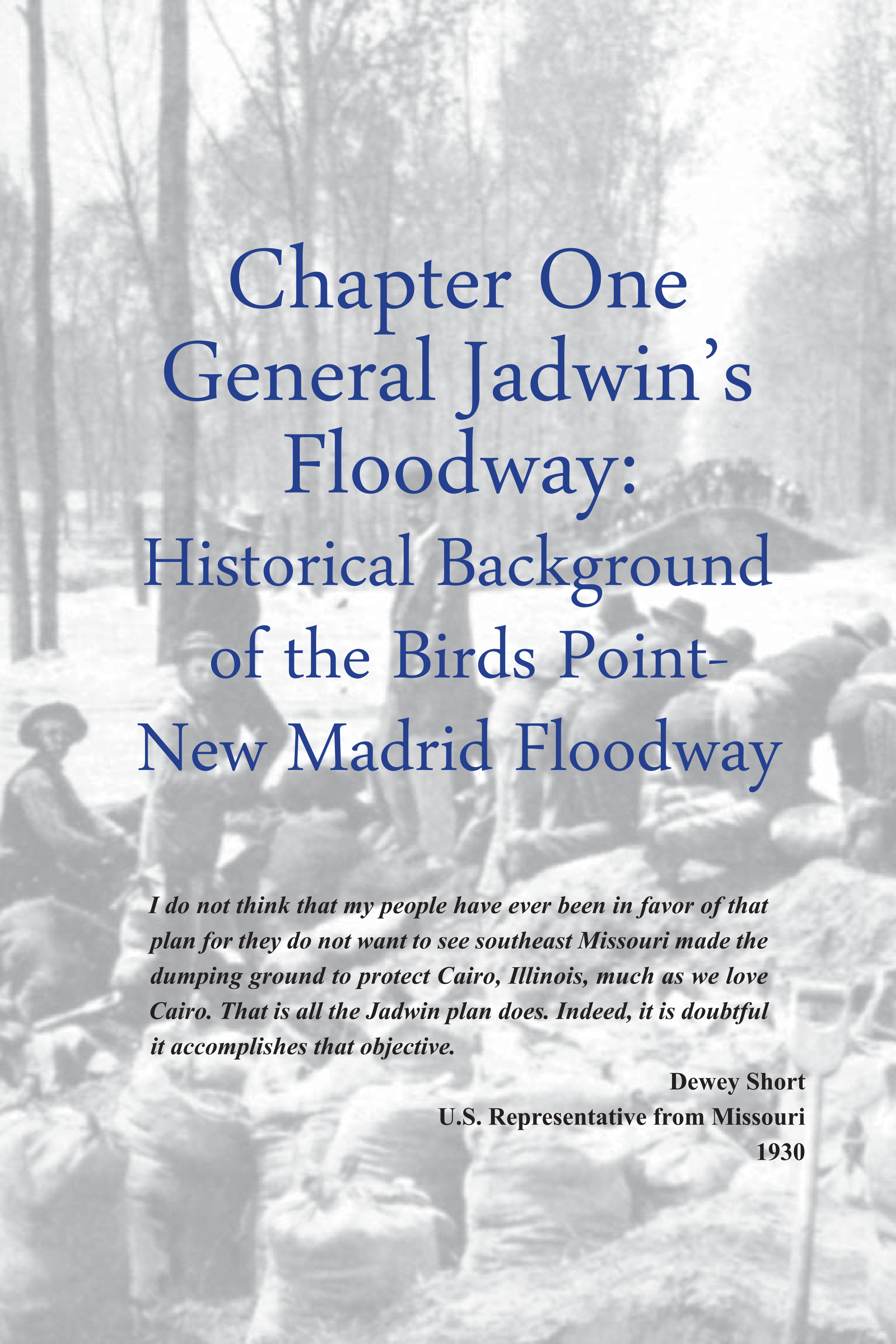
Comparison of overflowed areas during the 1927 and 2011 floods.

the flood. Water lapped at the top of floodwalls and levees the length of the river, exerting unprecedented levels of pressure on the backbone of the protection system, but the levees withstood the record stages and pressure due in large part to the operation of three floodways and the storage capacity provided by non-MR&T reservoirs in the Ohio and Arkansas-White basins. Flood fight teams, composed of federal, state, and local resources that battled unusually frigid temperatures, high winds, and stinging rain, also assisted the levees in holding back the onslaught of the river. With the levee system not experiencing any crevasses, only 6.3 million acres flooded within the 22.4-million acre project footprint. In other words, sixty-two percent of the property inundated during the 1927 flood escaped overflow in 2011. Nearly all of the land that flooded during the 2011 flood was located between the levees or other unprotected areas, or within the designated floodways and backwater areas. Approximately 950,000 households, along with major industrial, commercial, and retail facilities that stood in harm's way escaped the flood undamaged. Most of the estimated 35,000 households damaged by the flood were located in unprotected areas or within the designated floodways. MR&T project features also prevented $7.3 billion in crop losses. All told, the MR&T project prevented $110.6 billion in damages, not including potential losses from interrupted business activities and related impacts.[9]

The pages that follow endeavor to provide a transparent depiction of the 2011 flood within the MR&T footprint and, in the process, give evidence to the realities just described, while providing necessary historical context for greater understanding of key features of the project. It is the story of prudent foresight, heroic actions, agonizing decisions, and extreme personal sacrifice.

MISSISSIPPI RIVER COMMISSION

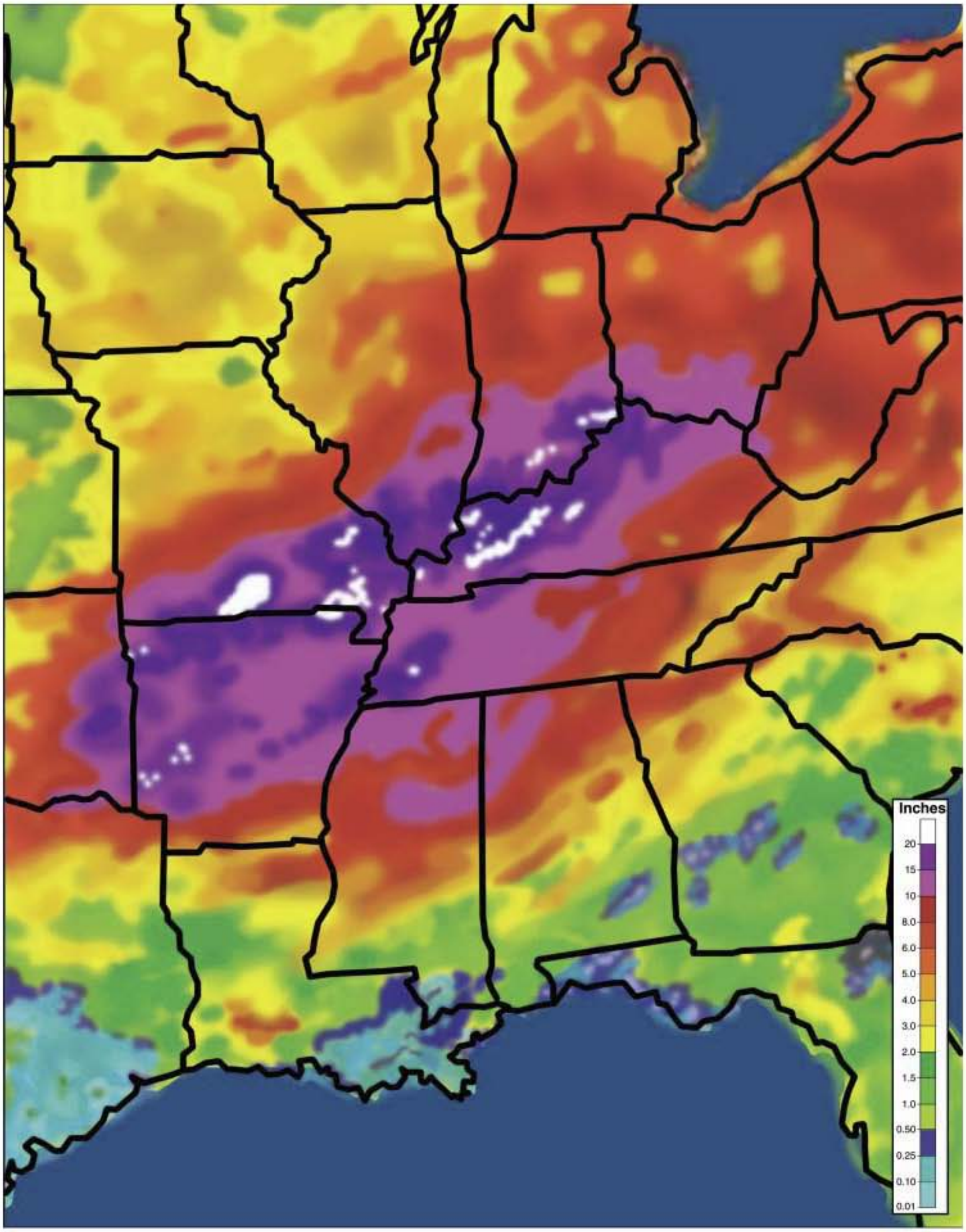
ESTABLISHED JUNE 1879



Chapter One
General Jadwin's Floodway:
Historical Background of the Birds Point-New Madrid Floodway

I do not think that my people have ever been in favor of that plan for they do not want to see southeast Missouri made the dumping ground to protect Cairo, Illinois, much as we love Cairo. That is all the Jadwin plan does. Indeed, it is doubtful it accomplishes that objective.

Dewey Short
U.S. Representative from Missouri
1930



30-Day Rain Totals
(April 5 - May 5, 2011)

During January and February of 2011, a prolonged and active cold weather pattern hit the Midwest, dropping significant snowfall across the Upper Mississippi River Valley and southward along the Ohio River Valley. By mid-February a larger and deeper-than-normal snowpack covered large sections of the drainage basin above the Cairo gage, situated at the confluence of the Mississippi and Ohio rivers. As the late winter thaw set in across the region, widespread heavy rains dropped up to 300 percent above normal amounts in most areas along the Ohio and middle Mississippi. The rivers, which were below flood stage, began to swell. In late February the rivers climbed even higher, as unseasonably warm temperatures rapidly melted the remaining Ohio Valley snowpack in less than 48 hours, releasing up to four additional inches of water as runoff. The melted snow and weeks of excessive rains caused widespread, but minor, flooding along the Ohio and middle Mississippi rivers. At the Cairo gage, the river reached 43 feet on February 28, just three feet above flood stage, but it had jumped 25 feet in the ten days since February 18. The wet pattern was not over, though. Heavy and repeated rains continued to pound the Ohio Valley. By mid-March, the Cairo gage exceeded 50 feet, eventually climbing to more than 13 feet above flood stage on March 18. Then, much to the relief of flood-stricken areas along the middle and upper portions of the Ohio River, the active storm track shifted northward into the upper Mississippi River basin. The heavy rains and warmer temperatures had the same effect on the snowpack and rivers across Wisconsin, Minnesota, and Iowa. By early April a significant flood wave developed on the upper Mississippi River, with an anticipated arrival date of late April at Cairo. The Ohio River had crested and dropped below flood stage at Cairo in early April, but the heavy rains returned and reversed the descent. The Cairo gage jumped back above flood stage on April 10. It did not permanently drop below that point again until early July.[10]

On April 20, the Cairo gage stood at just below 49 feet. It had risen almost a foot in 24 hours. The official National Weather Service called for a rise to 52 feet by April 30, but contingency forecasts, which represent worst case scenarios, indicated a possible rise to 58 feet on the gage. How high the river would get was a matter of timing, or unusual timing in this instance. The early warm temperatures and sustained rains in the upper Midwest led to an earlier-than-normal snowmelt crest on the Mississippi River. The arrival of that crest was expected to coincide with the arrival of the second crest pulsing down the Ohio River. If both crests arrived at the same time, the confluence area and the lower Mississippi River would face a deluge. If it rained on top of that, the resultant flooding would be worse – much worse. The National Weather Service, indeed, was keeping a close eye on an area of high pressure to the east and a trough over the Central and Western United States. That pattern created favorable conditions for a frontal system to become stationary over the Arkansas and Ohio valleys. If warm and moist air from the Gulf of Mexico streamed northward along the western periphery of the high pressure system and collided with the cooler air to the north of the front, forecasters expected heavy precipitation. With each passing moment, the likelihood of persistent rains arriving at the same time as both crests on the Mississippi and Ohio rivers became more of a reality.[11]

On the morning of April 21, Bill Frederick, the staff meteorologist at the U.S. Army Corps of Engineers, Mississippi Valley Division (MVD) delivered his daily weather report. The National Weather Service expected the frontal system to become stationary over the Ohio, middle Mississippi, and Arkansas valleys, bringing daily rounds of intense rainfall totaling up to eight inches over the entire area through April 27. The National Weather Service still anticipated the Cairo gage to reach 52 feet on April 30, but the forecast did not include the heaviest rains expected for the ensuing five days. They would release an updated forecast, to include the anticipated five-day rainfall totals, later in the afternoon during the Lower Ohio-Mississippi River Coordination Teleconference – a daily call among representatives from the National Weather Service river forecaster centers and Corps of Engineers water control offices from the Great Lakes and Ohio River Division (LRD), MVD, and the MVD district offices.[12]

During the afternoon coordination call, the National Weather Service divulged its contingency forecast. Incorporating expected rainfall over the ensuing five days, the contingency forecast showed a possible crest of 61.1 feet on the Cairo gage late on May 3 or early on May 4. Isolated models called for 62.3 feet on the gage. Anyone on the call remotely familiar with the Birds Point-New Madrid floodway immediately took notice of those numbers. According to the 1986 floodway operations plan, the forecast would necessitate the activation of the floodway for the first time in 74 years. An action that many on that coordination call never thought would happen in their lifetimes – blowing up the Birds Point-New Madrid levee – had just become a strong possibility.

Bottleneck at the Confluence

Authorized in the aftermath of the 1927 flood and constructed during the early 1930s, the Birds Point-New Madrid floodway represented Maj. Gen. Edgar Jadwin's solution to the decades-long flood problem at the confluence of the Mississippi and Ohio Rivers. The confluence area had plagued the Mississippi River Commission's flood control efforts since the late nineteenth century. Historically during larger floods, the Mississippi River found room to expand through a natural outlet or diversion through a low gap in the bank below Cape Girardeau, Missouri. Depending on the magnitude of the flood, up to 300,000 cfs escaped the main channel through the gap and coursed through the St. Francis basin before returning to the Mississippi River near Helena, Arkansas. While the diversion of floodwaters proved devastating to low-lying lands in both the upper and lower St. Francis basins in Missouri and Arkansas, it helped to keep flood stages somewhat in check on the east bank of the river at Cairo, Columbus and Hickman, Kentucky, and Tiptonville, Tennessee, and the slightly elevated lands along the west bank in Missouri.

The diversion, though, clashed with the commission's levees-only policy, which rested on the premise of confining floodwaters between the levee system with the aim of increasing the scouring energy of the river so that it would erode or dig the riverbed deeper to lower flood heights and provide adequate depths for navigation.[13]

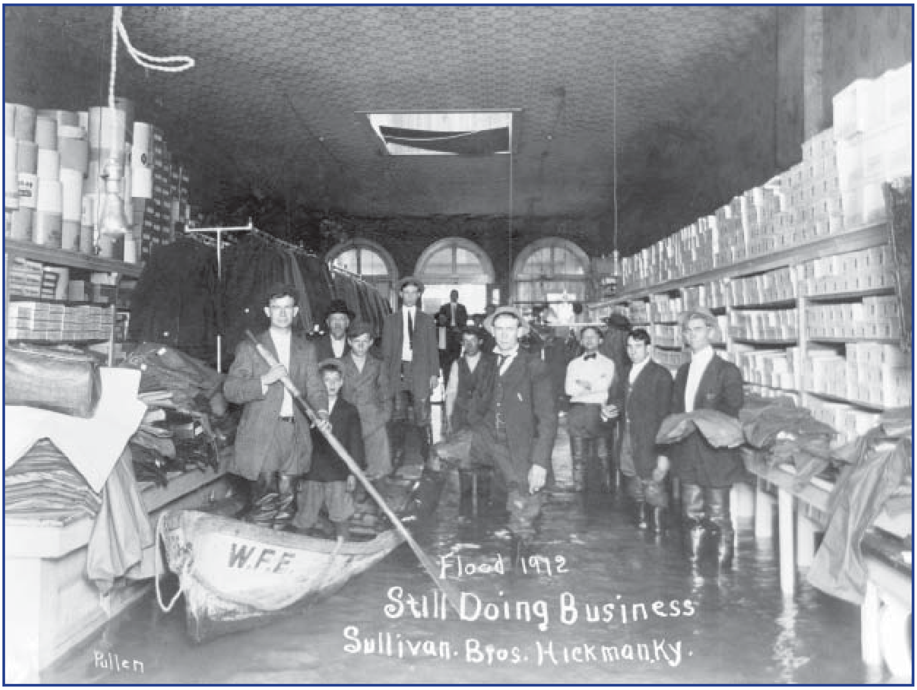
At the twilight of the nineteenth century, the federal levee system on the west bank extended in a continuous line from just below New Madrid, Missouri, to Pecan Point below Osceola, Arkansas. From New Madrid northward to Commerce, Missouri, individual landowners had constructed smaller, detached levees that merely connected various ridges of higher ground to protect against minor seasonal flooding. Between 1899 and 1907, the commission assisted local levee districts in Missouri with constructing a federal levee between Birds Point and Dorena. Because the commission's jurisdiction at that time was limited to the area below the confluence, the levee districts completed the levee line between Commerce and Birds Point with their own resources. In 1909, the levee eventually sealed off the river's access to the natural diversion into the St. Francis basin and denied the river the necessary room to expand. Across the river, Cairo had long enjoyed levee protection since the 1830s. Further to the south in the Reelfoot basin, the town of Hickman did not have a protective levee. Hickman sat on slightly elevated ground on the bank of the river, but the levee construction on the west bank dictated countermeasures on the east bank. In 1902, the commission began assisting the state in constructing a levee from the Hickman bluffs down to the state line with Tennessee, where it connected with the existing levee that extended southward for five miles to Slough Landing.[14]

The levees on both banks were built close to the low-water channel, which created narrow constrictions during high water events. The constrictions impeded the flow of floodwaters and caused the floods to stack up and place tremendous pressure on the system of levees and floodwalls extending from above the confluence to several miles below.

With the natural diversion near Cape Girardeau walled off by a levee, there was nowhere for the water to escape. Eventually the river would find the room to expand. Where it would find the room remained an unanswered question that haunted landowners along both banks, particularly those living in Cairo. While the city of Cairo has recently fallen on hard times due to labor and racial strife, it represented the crown jewel of the area in the early part of the twentieth century. Home to approximately 16,000 people, Cairo was a bustling commercial center in the heartland of America. Cairo had it all – lavish antebellum homes, a quaint garden district, a prosperous downtown lined with shops that offered the latest goods, thriving night clubs, a booming "red-light" district, and navigation, rail, and highway connections. Cairo's geographic location, which made it the ideal river hub, was precisely the root of the problem. The city sat on a massive, low-lying, sand pit. The Mississippi and Ohio rivers flanked the town on three sides, which explains why Cairo was the first leveed city on the Mississippi River north of New Orleans. During floods, the intense pressure on the underbelly of the town caused massive sinkholes and underseepage. That same pressure also threatened the massive floodwalls and levees protecting it, particularly at the neck of the peninsula, where the rivers ran closest to each other and the pressure was at its greatest.[15]

During the flood of 1912, the first major flood since the commission and levee districts had completed construction of the confluence area levees, the river established a new record height of 53.9 feet on the Cairo gage that shattered the existing flood record set in 1883 by an astonishing two feet. The U.S. Weather Bureau anticipated an even higher crest at Cairo, but the river overtopped and crevassed the east bank levee just downriver from Hickman, sending floodwaters coursing through the entire 304 square-mile area behind the newly-constructed levee. In 1913, the river again established a new record stage on the Cairo gage, surpassing the stage of the previous year by nearly one foot before floodwaters crevassed the levee near Birds Point at four locations and caused 29 small breaks on the west bank levee opposite Columbus and Hickman. The crevasses allowed the river to spread out and spared the east bank levee from crevassing a second time. The crevasses also lowered the crest at Cairo by a little more than three feet. Prior to the crevasse, the river was forecast to reach 58 feet, but as the river expanded into the floodplain in Missouri, the Cairo gage crested at 54.8 feet. During the 1927 flood, the river established a new record stage on the Cairo gage for the third time in 15 years when it reached a height of 56.5 feet. Once again the river threatened the levee system in the confluence area until a crevasse at Dorena, just north of New Madrid, reduced stages at the Cairo and Hickman gages by two feet in less than 24 hours.[16]

As evidenced by the floods of 1912, 1913, and 1927, the constrictions and closure of the diversion threatened the levee system along the entire reach. In May 1927, while the Great Flood was still ravaging the Mississippi Valley, Maj. Gen. Edgar Jadwin instructed the Mississippi River Commission to develop an alternative to the levees-only policy. By September, the commission submitted a report to address the flood problem on the lower Mississippi River. The commission's plan, with an estimated cost of a then staggering $882 million, recommended higher and stronger levees supplemented by several floodways – leveed pathways to divert excess flows – to make room for the river during larger and more severe flood events. All of the proposed floodways were to be located below the mouth of the Arkansas River. From Cape Girardeau to the Arkansas River, the commission plan represented a continuation of the levees-only policy. To protect Cairo and the levee system along the entire reach, the commission studied a number of alternatives to include elevating the town of Cairo above the floodplain and constructing diversion channels to siphon off excess flows from the main channel. Elevating Cairo to the prescribed height, according to some estimates, would take at least 57 million cubic yards of earth. Elevating the city also necessitated replacing the sewer system, 23 miles of



A flooded store in Hickman, Kentucky, during the 1912 flood. (Library of Congress)


Flood fighting at Fulton County during the 1927 flood. (National Archives)

street, 40 miles of sidewalks, and nearly 4,000 homes and businesses at a cost of $30 million. The Commission also investigated five diversion routes coinciding with the historic natural diversion prior to its closure by the levee system. The diversions were intended to accommodate up to 300,000 cfs from the main channel and redirect the water through the St. Francis basin to the White River basin, but the commission discovered that the cheapest routes to construct would cost at least $220 million. Instead, the commission proposed levee setbacks at the constriction points on the river where high water tended to pile up and threaten the levee system. The commission also proposed raising the level of protection at Cairo to 70.4 feet on the Cairo gage.[17]

Jadwin, though, rejected the report largely because of exorbitant costs and instructed the commission to rework the plan. He had previously held conversations with Secretary of War Dwight F. Davis and President Calvin Coolidge emphasizing the importance of keeping costs manageable, and believed lower cost solutions were possible if the commission reduced levee heights and eliminated the $91 million it had budgeted for damages and rights-of-way costs to local interests. Col. Charles L. Potter, the commission's experienced president, argued with Jadwin over the issue of damages in the floodways. He did not believe that spillways and floodways could be put across people's land without their being compensated for it, and he desired to include a "*full* estimate" of costs. On November 28, Potter forwarded the revised report to Jadwin. The revised plan did not

Maj. Gen Edgar Jadwin, Chief of Engineers, 1926-1929. (Office of History, U.S. Army Corps of Engineers)

The Mississippi River Commission of 1926-1927. Front row, from left to right: Charles West, Col. Charles Potter, and John Stipes. Back row: Col. George Hoffman, Col. Charles Kutz, Edward Flad, Capt. Robert Faris, and Capt. Willis Teale.

substantially change the engineering features recommended in the original report, particularly with respect to Cairo and the confluence area, but it did reduce the estimated cost to $774 million, including $91 million in damages for the planned floodways below the Arkansas River. Potter knew that the changes would not satisfy Jadwin. In a response to a request from Sen. Joseph E. Ransdell of Louisiana for data to defend the commission in upcoming congressional hearings, Potter noted that "you will probably find arrayed against you some powers from whom you might not expect opposition."[18]

Potter was correct in his prediction. Maj. Gen. Jadwin was not pleased with the revised report and did not submit it to Congress. A week later, he submitted his own plan to Secretary Davis on December 1, 1927, who forwarded it through President Coolidge to Congress on December 8. The Jadwin plan, which carried an estimated price tag of only $296 million – a number that was well-received by the fiscal conservatism of the Coolidge administration – differed from the commission plan in a number of ways. One of the more noticeable engineering differences involved Cairo and the confluence area. In addressing the channel constrictions and the Cairo dilemma, Jadwin argued that the levees protecting the town already towered 20 feet above parts of the city. The commission's plan would take those levees 10 to 12 feet higher than that. He advised that "levees are now about as high as they should be" and the city "should not be subject to the jeopardy of levees higher than they are now." Jadwin insisted on the need to provide room for the river to expand, especially at the confluence area. Instead of higher levees and individual levee realignments, Jadwin called for an overbank floodway on the west bank of the river to be created by the construction of a new levee about 5 to 10 miles west of the existing levee. The new levee – called the setback levee – would extend from Birds Point to St. John's Bayou just east of New Madrid and would form the west boundary of the new floodway. Jadwin's plan kept the existing levee in place, but lowered it by three to five feet to allow the river to escape into the wide 130,000-acre floodway between the new and old levees when river stages exceeded 55 feet on the Cairo gage. The lowered sections – called fuseplugs – would cause the main levee, or frontline levee, to naturally crevasse. Jadwin insisted that the floodway would only operate at a frequency of about once every ten years. He also maintained that the lands within the floodway would remain "capable of cultivation" during all floods with the exception of larger, but less frequent, floods. By Jadwin's estimation, the additional room for the river provided by the Birds Point-New Madrid floodway would lower stages at the Cairo gage by as much as six feet during extreme floods, with other areas along the reach achieving smaller reductions.[19]

Critics lost little time in assailing elements of Jadwin's plan. The incorporation of floodways into the general plan represented a necessary, but stark, about-face from the previous levees-only policy. The overpowering of the levee system during the disastrous 1927 flood had forced that change, but even in the wake of the flood's widespread devastation, a controversy emerged over the reality of implementing the floodway concept. Highborn and arrogant, but nationally popular, Jadwin was unfazed by the criticism. He boasted, "Neither the plan nor any feature of it has yet been punctured by criticism, nor can it be, because, previous to its submission, it was subjected to every vital engineering test." Jadwin, though, had not accounted for the upcoming test of public opinion. Residents and landowners within the floodways were ill-prepared for the reality of floodways – a reality that assured their lands would be sacrificed to reduce flood damages elsewhere. Under the Jadwin plan, the Birds Point-New Madrid floodway was designed to do just that – protect the levee system protecting Cairo and land elsewhere in Illinois, Kentucky, Tennessee, and even Missouri. Critics of the floodway desperately needed an alternative to the confluence flood problem.[20]

The Mississippi River Commission had posited an alternative, but Jadwin had suppressed their report. Word soon reached Congress, though, that a viable alternative plan existed. Slighted that Jadwin had simply by-passed them, both houses of Congress requested an official copy. At the request of the Senate Commerce Committee and introduced by Sen. Thaddeus H. Caraway of Arkansas, the Senate officially requested a copy in January 1928. Senate Resolution 90 ordered the Secretary of War to "furnish to the Senate said preliminary estimates, or suggestions and recommendations, if any, of both the Chief of Engineers of the Army and the Mississippi River Commission touching flood control." Davis responded on January 12 by sending the report "with many caveats."

During hearings before the House Flood Control Committee, Jadwin, when asked about the plan, complained, "We have not forwarded their report to you officially. That report came in the back door." A week later, Rep. Frank Reid of Illinois, the chairman of the committee, asked Potter to forward the report through the Secretary of War to Congress. "They said that this report got in at the back door. We will get it in at the front door." On Potter's objection that it would be "very unmilitary" to bypass the chief of engineers, Reid agreed to sending it through Jadwin, to which Potter responded, "I do not think that I will remain president of the Mississippi River Commission long after I do that." Reid insisted, and Potter sent a letter to Jadwin explaining the directive of the committee to forward the report and quoting the Mississippi River Commission Act of 1879: "It shall be the duty of said commission … to submit to the Secretary of War a full and detailed report of their proceedings and actions, and of such plans, with estimates of the cost thereof … to be by him transmitted to Congress."[21]

During congressional hearings on the Jadwin plan, critics of the proposed Birds Point-New Madrid floodway desperately latched onto the commission's plan as a favorable substitution. Opposition to Jadwin's floodway came from two distinct angles – one political and the other engineering. From the political side, Missouri's congressional delegation attempted to seize on the sympathy factor. Discounting claims that the floodway provided protection to the entire reach, including the Missouri levees between Commerce and Birds Point and the Reelfoot basin in Kentucky and Tennessee; Missouri politicians argued that the floodway represented an unfair burden on southeast Missouri solely to protect Cairo – one city in another state. Rep. James Fulbright, a native of Millersville in nearby Cape Girardeau County, blasted the floodway, calling it "a tragedy to southeast Missouri" that would provide "no benefit to any part of the State." Rep. William Nelson, a former farmer, demanded further study to find a more suitable solution.[22]

Col. Potter and Lucius Berthe, a consulting engineer for the three Missouri levee districts comprising the upper St. Francis basin, led the attack from the engineering side. Potter indicated the floodway would not provide any relief to stages on the Cairo gage and went so far as to say that it was not "feasible from an engineering standpoint." Berthe conceded that the floodway would lower stages on the Cairo gage and along the levees protecting the Reelfoot and St. Francis basins, but not to the level promised by Jadwin. Citing the crevasses along the proposed fuseplug levee during the floods of 1912 and 1913, Berthe contended that the overbank floodway experiment had already been tried by nature. On both occasions, the crevasses lowered the crest at Cairo by three feet, not six, according to Berthe. He further pointed out that the Dorena crevasse during the 1927 flood only lowered the crest by two feet. Berthe argued that the overbank floodway would not be as successful in keeping stages down as the former natural diversion. The former diversion rerouted floodwaters; the proposed floodway did not. It kept the excess flow in the river. "If we took down all of our levees," Berthe informed the House committee, "I … wouldn't guarantee your getting a five foot reduction at Cairo."[23]

The main engineering criticism of the plan, though, was its incorporation of fuseplug levees at the entrances to the floodways. One prominent railroad engineer had never heard of them, and many others, including Col. Potter and current and former members of the commission argued that fuseplugs provided less reliability and control over the amount of water sent into a floodway than a controlled structure. James Kemper, a nationally-renowned civil engineer, denounced the use of fuseplugs levees as unpredictable and dangerous. Berthe concurred with that sentiment, insinuating that the fuseplug would not trigger as expected. He hinted that dynamite might be necessary "to open it up." George Schoenberger, the chief state engineer for Louisiana, argued that the kinetic energy from the water released through the crevasse of a fuseplug would destroy private property and insisted that lands within the floodways should be purchased by the government.[24]

Not that everyone opposed the floodway or at least some form of relief through the state of Missouri. For example, Rep. Edward Denison of Illinois blamed the dire situation at Cairo on the closure of the natural diversion through Missouri and the creation of bottlenecks through levee construction. "Cairo is now absolutely prone and is in a position where she can not do anything more for herself," he told the House Flood Control Committee. He suggested that the government should not only establish the Birds Point-New Madrid floodway, but should purchase the land outright as compensation to the landowners. To counter the sentiment that Missouri interests were being sacrificed for the benefit of another state, Rep. William Gregory of Kentucky argued that Hickman and the rest of Fulton County did not suffer from floods until the state of Missouri constructed levees on the west side of the river. Gregory argued that more than 6,000 people in western Kentucky faced destruction from floods "not by the act of God … and not by any mistake on the part of Kentucky," but because of Missouri's lack of consideration for its neighbors. Kentucky's senators also blamed levee construction in Missouri for pushing more water into their state, however, they were quick to deflect the blame from the state of Missouri by pointing out that the Mississippi River Commission had built the levees. Sen. William Sackett argued that if the river were allowed to overflow into Missouri as it did before the levees were constructed, it would provide "a great safety valve to protect the town of Hickman." Sen. Alben Barkley insisted that any permanent solution to the problem "must contemplate a widening of the area between the levees." To support these arguments, engineers from the Fulton County and Reelfoot levee districts provided scientific testimony showing that the levees on the Missouri side of the river had caused flood stages to increase in Kentucky and Tennessee with each passing flood and pointed to how the crevasses on the west bank of the river in 1913 and 1927 had saved their levees from collapse.[25]

By the conclusion of the congressional hearings in February 1928, the federal legislature remained divided on how to protect the lower Mississippi Valley from floods, not just at the confluence area, but along the entire alluvial valley. A large block in both houses endorsed the comprehensive and budget-friendly plan advanced by the Corps of Engineers. Others, championed by Chairman Reid, favored the less-intrusive commission plan that offered fewer and smaller floodways controlled by gated structures and provided more generous compensation for the use of private land to be incorporated into the flood control plan. With competing bills advanced in both houses and with time running out on the first session of the 70th Congress, federal legislators, operating under the constant threat of a presidential veto, crafted a series of compromises to appease those legislators holding up passage of the bill. Passed by both houses of Congress on May 8 and signed into law by Coolidge on May 15, the Flood Control Act of 1928 received great acclaim by members from both parties as a nonpartisan effort to provide relief to the flood victims.[26]

The new law was a pioneering legislative act, if for no other reason than its authorization of what eventually evolved into the MR&T project in the form of the Jadwin plan. Hailed by Reid as the "greatest piece of constructive legislation ever enacted," the 1928 Flood Control Act more accurately reflected compromise legislation that resulted in ambiguities and internal contradictions. Section one of the act clearly approved the engineering aspects of the Jadwin plan, but it also established a special engineering board to help select the best features from among the Corps of Engineers and commission plans. The Birds Point-New Madrid floodway represented one of the few engineering differences between the plans to be considered by the board. The fate of the proposed floodway, as well as that of the residents and landowners within it, hung in the balance.

Establishment of the Floodway

To critics of the Birds Point-New Madrid floodway, the adoption of Maj. Gen. Jadwin's plan was to be tempered by the creation of the special engineering board, whose job was to evaluate, reconcile, and choose the best options presented by both plans submitted to Congress in 1927. The chief of engineers, the president of the Mississippi River Commission, and a civilian engineer nominated by Coolidge would comprise the board. The board would consider the engineering differences in the plans and make recommendations to Coolidge, whose decision would "be followed in carrying out the project." Congressional supporters of the commission plan anticipated major revisions to the project, but the special engineering board would not drive those changes. Within days of the passage of the act, Coolidge nominated retired Col. Carleton W. Sturdevant as the third member of the special board. Sturdevant was a prominent railroad and canal engineer who had gotten his start working for the Mississippi River Commission, most recently as superintendent of dredging from 1897 to 1902. He was, therefore, familiar with the Mississippi River problem, albeit primarily from a dredging perspective. The primary mark against him was that he had a close relationship with Jadwin, having served under him in the 15th Engineers in France during World War I and consulted on the St. Lawrence Waterway from 1925 to 1927. Although members of the Senate Commerce Committee expressed concern that having a third member of the board under personal obligation to Jadwin might defeat the purpose of the board, Sturdevant made a good impression and convinced them that he would keep an open mind and be an independent arbiter of the two plans. As a result, the Senate confirmed his nomination before the end of May 1928. Still, Sen. Harry Hawes and others believed Sturdevant "was appointed at the request of Jadwin, and … nobody else" and that little good would come of it.[27]

Floodway opponents, though, had great faith that Mississippi River Commission president and recently-promoted Brig. Gen. Charles Potter would stand up to Maj. Gen. Jadwin and fight to replace the Bird's Point-New Madrid floodway with a plan for higher levees. At a minimum, they would settle for a gated or controlled spillway instead of the fuseplug levees envisioned by Jadwin. Potter was evidently looking forward to the board and had been gathering data. In a letter dated June 8, 1928, Berthe stated he had heard from news reports that the board was to start conducting hearings within weeks. Surprised at the rumor, Potter immediately forwarded the note to Jadwin and wrote that "a lot of study is necessary before we can expect local interests to present their side of the case, especially where many technical questions are involved." He still believed he would be participating in the board.[28]

On June 10, after Congress had recessed for the summer, Jadwin named Col. Thomas H. Jackson to replace Potter as the Western Division Engineer, and Coolidge appointed him as commission president pending Senate approval. The move came as a shock to those depending on Potter's influence on the board. Jackson had gained a reputation for considerable expertise with floodways while working on the Sacramento River and later as a member of the California Debris Commission, and he had even suggested in 1913 that floodways could solve Mississippi flood problems. But he had no experience with the Mississippi River, and he also had close connections to Jadwin, having worked with him during World War I. No doubt Jadwin chose him both for his experience and loyalty and hoped to avoid further delay or conflict over implementing his plan. Potter took the news gracefully. He spent his last day in office preparing memoranda outlining problems with the gage at Cairo and supporting his view that the Birds Point-New Madrid floodway was unnecessary. He then retired. Two months later, he was dead, "hastened on his last journey by the shock resulting from his summary dismissal," according to Berthe.[29]

The special engineering board made only a single trip downriver to hold hearings. Participants complained of not being given adequate notice to prepare. In New Madrid, conflict over the lack of notice curtailed debate over the Birds Point-New Madrid floodway. Jadwin declined a continuance, forcing Berthe to submit a report via mail for the five Missouri levee districts opposing the floodway. The merits of the arguments would not be heard in person.[30] On August 8, 1928 – a mere 60 days after it had been organized – the special board delivered its report. In short, the report summarized, "the adopted project is, all things considered, the best comprehensive plan that can be formulated," and it recommended against further studies of the comprehensive commission plan. On August 13, Coolidge approved the recommendations of the board, other than acquiring rights-of-way for lands required for building the spillways and floodways, which he wished to consider. Four months later, the president approved the purchasing of property and flowage rights – a one-time indemnity paid to landowners for the right to flood their land during the operation of the Birds Point-New Madrid floodway – but stipulated that the fuseplug levee could not be degraded by the necessary three to five feet until at least fifty percent of the flowage easements had been secured. Coolidge also authorized the purchase of a strip of land adjacent to the fuseplug section at a price capped at two times the 1928 assessed value of the land.[31]

Criticism of the board and its findings started almost immediately. Nearly everyone was taken aback at the time it spent coming to its conclusions. "There is perhaps no record in the world of so highly controversial a question, involving the peace and happiness of so many people and the expenditure of such a great sum of money being disposed of with such speed as this," Kemper concluded. The *Engineering News-Record* editorialized that "the board complied with the letter but disregarded the spirit of its mandate," which was "to inform itself fully and obtain such data as might be needed for determining upon *the best plan*." Another point of contention was that Jadwin and his protégés comprised the board, which one member of congress referred to as the "Jadwin, Jadwin, and Jadwin Board."[32]

Although the special engineering board made no major surveys to support its work, the Corps of Engineers completed several surveys and studies to determine details of the plan. To answer critics who believed the floodway would not lower flood heights at Cairo, Maj. Donald Connolly of the Memphis Engineer District completed a new study in May 1928 that found it would lower flood stages by three to four feet. This confirmed studies by consultant E.C. Williamson submitted in late 1927 that the best plan was to lower the flood heights through the use of a floodway rather than raising the city or its levees. More problematic were findings revealed by surveys that the setback levee would cross several drainage ditches and cause local flooding. A study by consultant T.T. Knappen completed July 31, 1929, provided three plans to reroute drainage ditches to St. John's Bayou or place culverts in the Mississippi River or setback levee costing between $557,000 and $731,000. The final option selected was a modification of the drainage ditch plan.[33]

Despite calls from the American Engineering Council, who argued that "it would be a grave mistake" to begin construction of floodways "until the engineering practicability and economic feasibility are studied by a non-partisan and competent Board of Engineers," the Memphis Engineer District made progress at the Birds Point-New Madrid floodway. On receiving presidential approval, Jadwin ordered construction of levees not impacting drainage canals on December 15, 1928, and obtaining flowage rights and levee rights-of-way through condemnation. Current market value for land was $50 to $150 per acre depending on location. By December 1928, the district had started receiving commitments on sale of rights-of-way. In June 1929, the government initiated condemnation proceedings. However, there were already litigants claiming that the government was forcing sale without appropriate compensation. Judge Charles Davis of St. Louis denied one request for injunction on May 22, 1929. Only a few weeks later, in *Kirk vs. Good*, George W. Kirk sought an injunction and sued the government on the grounds that it was taking his land without due process for less than its value, and that he could not borrow money on the land or sell it. Davis again denied the injunction and dismissed the suit on July 11. Condemnation proceedings had not been initiated on Kirk's land, and any losses of income were, according to Judge Davis, "mere consequential damages" to construction of levees. If damages were to be realized through the operation of the floodway, Judge Davis determined that the landowner had "complete and adequate remedy" for compensation under the provisions of the1928 Flood Control Act. In response to government condemnation suits, one group of landowners argued that offers were \$12 million to \$15 million less than market value and that flowage rights should be purchased simultaneously to avoid impacts to land value. At least one organization – the Mississippi County Levee District – had been making this argument since November 1928. Even as it proceeded with condemnations, the Memphis district was receiving bids for construction. By June 1929, it had received all bids, and with resolution of the Kirk suit construction began on the setback levee on October 21, 1929. This work was completed by the end of October 1932.[34]

The only remaining work involved degrading the fuseplug levee to a height corresponding to 55 feet on the Cairo gage. By 1932, the Memphis Engineer District had come to agreement with 288 of the landowners over flowage rights. The remainder of the 660 condemnation suits remained tied up in court. By 1936, the district had obtained 77 percent of flowage rights, surpassing the mandated 50 percent necessary to degrade the fuseplug levee. However, during deliberation of condemnation proceedings for flowage rights in the U.S. District Court of Eastern Missouri in Cape Girardeau, Judge Charles B. Faris ruled he would seek an injunction if the Memphis district attempted to lower the fuseplug levees before obtaining all of the flowage rights in the floodway.[35] The acquisition of flowage easements and land rights had proved difficult and time consuming. It was not until January 1942, fourteen years after the passage of the 1928 Flood Control Act, that the federal government completed the acquisition of flowage rights on the necessary acres within the floodway – a figure that did not include acreage in the backwater area. The cost of flowage easements totaled $2,385,546 at an average price of $22.34 per acre.[36]

First Activation - 1937 Flood

As the Memphis district actively pursued flowage rights, the Great Flood of 1937 along the Ohio and Mississippi valleys provided the first significant test of the MR&T flood control project and its protection of the confluence area. During a three-week period in January, steady rain fell over the entire Ohio River basin and the confluence region, with some locations receiving in excess of 15 inches of precipitation. The Ohio Valley had already been saturated by heavy precipitation in December that, because of abnormally warm temperatures, fell in the form of rain rather than snow. The additional intense January rains immediately turned into runoff, swelling the Ohio, Tennessee, and Cumberland rivers.[37] On January 15, the Memphis Engineer District mobilized for a flood fight as the massive crest moved down the Ohio River toward the confluence. With rain continuing to pound the Ohio Valley, Brig. Gen. Harley Ferguson, the Mississippi River Commission president, approved the request by Col. Eugene Reybold, the Memphis district commander, to authorize an evacuation of the 3,000 inhabitants residing in the floodway. On January 21, the river reached 51.6 feet on the Cairo gage – up more than1.5 feet from 24 hours earlier. Radio stations began broadcasting the evacuation notice while district personnel travelled through the floodway distributing handbills with the news. On January 23, the Cairo gage surpassed 56 feet – one foot higher than the height at which the fuseplug levee at the head of the floodway was intended to overtop and crevasse. The fuseplug levee, though, had not been cut down to a height corresponding to 55 feet on the Cairo gage because of Judge Faris's order.[38]

The Weather Bureau anticipated that stages would reach 61 feet on the Cairo gage within a week, but the flood had not yet crested at Pittsburgh at the origin of the Ohio River. Rain continued to fall, making it difficult to accurately predict the ultimate stage on the Cairo gage. Nonetheless, Reybold instructed district flood fighters to prepare the levee system between Cairo to Memphis for a possible stage of 62 feet on the Cairo gage. With the help of a 15,000-man workforce, composed mainly of Civilian Conservation Corps, Works Progress Administration, and inmate laborers, the flood fight teams strengthened and topped the levees throughout the confluence area. While the majority of Cairo's citizens fled to higher ground, laborers constructed wooden bulkheads or "mudboxes" on the tops of the levees and floodwalls protecting the low-lying city from complete inundation. After completing the wooden bulkheads and bracing them in place, workers lugged sacks of clay brought to site on railcars to the top of the structure and dumped the contents in the box. They then used wooden tampers to hand-tamp the clay into place. Upon completion, the bulkheads effectively raised the level of protection to 63.3 feet on the Cairo gage. A similar frantic battle against the river took place at Hickman, where the failure of the levee would flood eastern Kentucky and Tennessee all the way down to the Obion River. Engineers also feared the failure of the levee might lead to a permanent change in course of the river.[39]

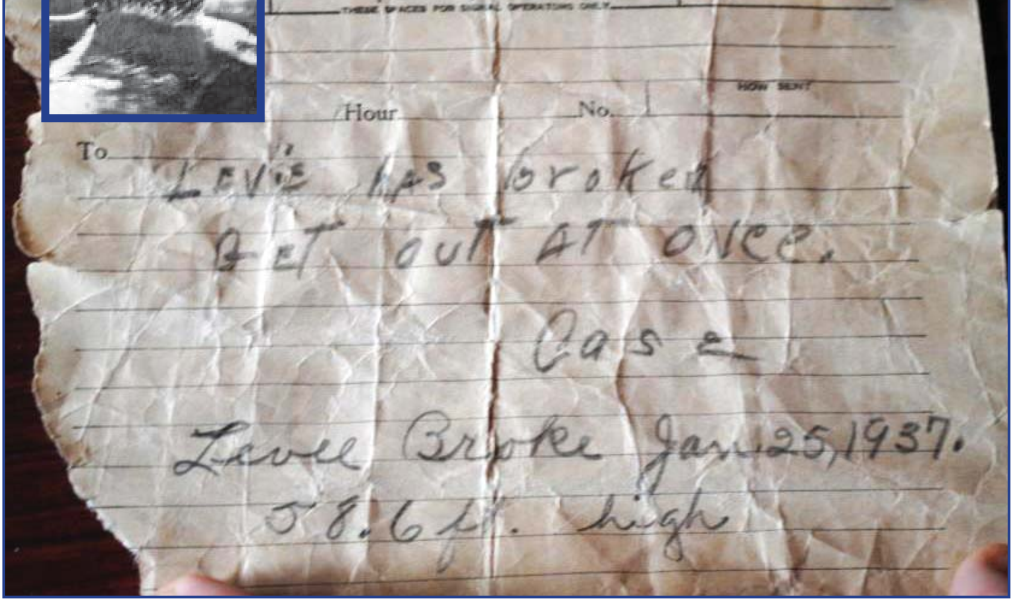
While the flood fight continued in the confluence area, Reybold dispatched Maj. R.D. Burdick to the floodway to evaluate the situation. When Burdick arrived, he joined two senior engineers working for the Mississippi River Commission, Charles Schweitzer and George Clemens, and Dan Fordice, a surveyman from the district, in making his assessment. The engineers found the river already spilling over the frontline levee at several locations. They were concerned. They knew the rate of overtopping was not enough to hold the stage below 60 feet on the Cairo

Workers raise the level of protection at the Cairo floodwall during the 1937 flood.
(Farm Security Administration - Office of War Information Photograph Collection, Library of Congress)

gage. The levee needed to be crevassed artificially. Burdick instructed Fordice's survey crew to use picks and shovels to cut a trench across the crown of the levee to encourage flow and scour sufficient to create a complete break, but the attempt failed to achieve the desired results. Just as Lucius Berthe had predicted in 1928, Burdick reached the conclusion that dynamite was necessary to crevasse the levee. The failure of the manmade cuts, though, proved to be a fortunate circumstance when the crews discovered several locals had ignored the evacuation order and were trying to raise the level of protection along the frontline levee. Reminiscent of the 1927 flood, some of the stragglers were armed and threatened to prevent the opening of the floodway by force, prompting Missouri Governor Lloyd C. Stark to summon the Missouri National Guard to protect workers attempting to open the floodway.

In the early morning hours of January 25, the Cairo gage read 58.2 feet. Burdick and his team braved the frigid temperatures and began preparations to crevasse the sleet-covered levee with dynamite. With stinging rain and sleet whipping across the region, they spent the morning digging and drilling three rows of three holes through the frozen levee to a depth of eight feet at two locations about 350 feet apart. The crews placed approximately 1,000 pounds of dynamite in each hole at both locations. At approximately 1100 hours, with the Cairo gage reading 58.4 feet, the charge was blown, creating a 70-foot wide gap in the levee. The swollen river rushed through the opening. Airplanes flying over the floodway began dropping metal canisters containing hand-written U.S. Army field messages that alerted floodway residents of the impending danger. “Levee has broken. Get out at once.” the messages warned. About 90 minutes later, the crew opened a second gap measuring 50 feet. More water gushed into the floodway. Burdick observed active erosion and caving at both openings and anticipated that they would grow to form one large crevasse. They crews repeated the process and opened two additional gaps in the levee by nightfall. By 2300 hours, the river was still climbing, having reached 58.7 feet on the Cairo gage. Burdick realized that the crevasses were not enlarging as quickly as he originally anticipated. By his estimation, the crevasses were only discharging roughly 30,000 cfs into the floodway. Using an additional 17,000 pounds of dynamite, Burdick and his team created five more crevasses in the levee on January 26. By 2000 hours, the Cairo gage had dropped four-tenths of a foot to 58.3 feet, despite rising stages upriver from the gage. By January 27, the crevasses had an aggregate length of 1,000 feet that passed an estimated 150,000 cfs into the floodway, with additional inflows coming through the natural crevasses and overtopping.[40]

Army Field Message dropped by plane into the Birds Point-New Madrid floodway during the 1937 flood. (Photo by Kevin Pritchett)
Inset: Activation of the Birds Point-New Madrid floodway, 1937.



The activation of the floodway caused only a minor drop in actual stages at the Cairo gage, but the flood crest had not yet reached the confluence area and the river resumed its ascent. The Ohio River crested 10 feet above the previous record stages at Cincinnati on January 26 and Evansville on January 27. It took another week for the crest to reach the Cairo gage, where the river reached 59.51 feet on February 3. By that time, the length of the crevasses had grown to 9,200 feet. Despite the flawed activation process, Burdick concluded that the floodway, which passed approximately one-fourth of the entire flood discharge at Cairo at the height of the flood, had reduced the February 3 crest at Cairo by 3.5 feet – a significant reduction considering that the floodwalls and levees, with the emergency bulkheads in place, only protected to a height slightly above 63 feet. The operation of the floodway also delayed the crest long enough for the town of Hickman to construct bulkheads by placing earth-filled bulkheads on top of the floodwall and levees protecting the city. More importantly, the use of the floodway reduced the stress on the entire levee system in the confluence area. Following the flood, the Memphis Engineer District closed all crevasses in the frontline levee, with the exception of those at the very bottom of the floodway, with an interim levee by May 1, 1937. According to the *Annual Report of the Mississippi River Commission*, the interim levee held back the spring rise on the Mississippi River and the farmers in the floodway enjoyed excellent crops during the 1937 growing season. By the 1938 flood season, the frontline levee had been restored to its pre-flood height.[41]

The 1937 flood shattered stage records on every major gage from Huntington, West Virginia, to Cairo on the Ohio River and from the confluence to Helena, Arkansas, on the Mississippi River. At the Cairo gage, it surpassed the 1927 record stage by more than three feet; at New Madrid it topped the old 1913 mark by more than three feet; at Memphis the 1913 record by more than 6.5 feet; and at Helena the 1927 height by nearly 3.5 feet. Even though the improved mainline levees along that reach held firm, communities like Cairo, Hickman, and Tiptonville had to raise the level of protection to prevent the levees and floodwalls from overtopping. Longtime critics of the floodway, such as Berthe, questioned the adequacy of the operation. Citing the four-tenths of a foot drop on the Cairo gage, they scoffed at Burdick's estimation that the floodway lowered stages at Cairo by 3.5 feet. To many, the smaller immediate reduction proved Berthe's contention from the congressional flood control committee hearings in 1928 that the floodway would not provide the six-foot stage reductions envisioned by Maj. Gen. Jadwin. Berthe also questioned the adequacy of the project design flood. The project flood to which the MR&T project was designed to protect against allowed for a maximum discharge at Cairo of 2.25 million cfs to 2.4 million cfs, with additional levee heights to spare. The 1937 flood registered a peak discharge just a shade over two million cfs, yet several towns barely escaped disaster with the Birds Point-New Madrid floodway in operation.[42]

Before the flood crest had cleared the Mississippi River, the House Committee on Flood Control sent a request to Maj. Gen. Edward Markham, the chief of engineers, to submit revised comprehensive plans for the Mississippi and Ohio valleys. The operation of the floodway had left an indelible impression on Markham. He had received reports detailing the damages in the floodway and had seen pictures of homes being washed away by the torrent unleashed through the floodway. "I am now of the opinion that no plan is satisfactory which is based upon deliberately turning floodwaters upon the homes and property of people," he lamented, "even though the right to do so may have been paid for in advance." Markham conceded that the existing project flood dimensions at the Cairo gage were insufficient and suggested that the maximum

The Birds Point-New Madrid floodway in operation during the 1937 flood.

probable flood could reach as high as 2.6 million cfs. To keep the rate of discharge manageable at the confluence area, he recommended the construction of additional reservoirs in the Ohio Valley.[43]

Increasing the Level of Protection

Over the next two decades, the Corps of Engineers and the Mississippi River Commission initiated projects and modifications to reduce the likelihood of activating the floodway, while maintaining it as an essential safety feature in the event of a flood approaching project flood dimensions. Whether or not it was a direct result of Markham's plea, Congress authorized the construction of Kentucky Dam across the Tennessee River the following year and later authorized the Barkley Dam across the Cumberland River. Though not features of the MR&T project, the 1944 Flood Control Act authorized the Corps of Engineers to operate the dams to reduce flood stages to safeguard the levee system on the Mississippi River in the vicinity of and downriver from Cairo and to reduce the frequency of operation of the Birds-Point New Madrid floodway.[44]

The floodway came perilously close to operation during the 1945 and 1950 floods, with the Memphis Engineer District mobilizing resources to activate, but in both instances stages remained below the trigger point. After 1950 the Mississippi River did not experience any significant floods for more than two decades, however, backwater flooding resulting from minor high water events entering the floodway through the 1,500-foot outflow gap continued to plague more than 80,000 acres in the lower portion of the floodway. The commission sought to provide partial protection for the backwater area by recommending a new levee to project grade extending across the 1,500-foot gap and providing for the construction of a gravity drainage structure. Under the plan, 32,000 acres of low land near the control structure would be utilized as a sump area. The plan also required local interests to furnish all lands, easements, rights-of-way, and flowage rights. In 1959, the St. John Levee and Drainage District began acquiring the necessary easements within the backwater area, but landowners in the vicinity of the gap, where property fell within the proposed ponding area, resisted overtures to provide easements. They preferred the construction of a pumping plant in conjunction with the authorized gravity drainage structure. Because of the lack of cooperation, the levee district was unable to acquire the necessary easements, forcing the acquisition program into dormancy and preventing the work from proceeding. While the lower portion of the floodway continued to experience significant backwater flooding, the inability to close the gap and construct the drainage structure posed no threat to floodway operations.[45]

Much had changed within the floodway since it was first operated during the 1937 flood. In the 1930s, wooded areas comprised approximately fifty percent of the lands within the floodway. By the 1950s, that same area had been transformed into some of the richest cropland in the nation, with nearly 98 percent of the floodway invested with agricultural production. As part of that transformation, the Mississippi River Commission estimated that nearly 10,000 people lived in several communities, complete with homes, churches, commercial establishments, and supporting infrastructure. The stakes were much higher. A second operation of the floodway would unleash more extensive damage than was experienced in 1937. In 1959 the commission advanced a plan to raise the frontline levee to a grade corresponding to 62 feet on the Cairo gage to provide additional protection made possible by the enlargement of the mainline levees in the vicinity of Cairo. The commission plan also contained provisions to raise the fuseplug sections to a grade corresponding to 60 feet on the Cairo gage. The levee improvements, along with existing and planned reservoirs in the Ohio basin, would enhance the level of protection within the floodway by reducing the expected frequency of its operation from once every 17 years with Kentucky and Barkley lakes in operation to once every 80 years. The 1965 Flood

Control Act authorized these recommendations. The act also stipulated that, while the floodway would not be placed into operation by overtopping until a flood stage of 60 feet was predicted, the commission maintained the right to create artificial crevasses in the fuseplug levee or elsewhere when stages reached 58 feet on the Cairo gage and a stage higher than 60 feet was predicted.[46]

Following the passage of the 1965 Act, the Mississippi River Commission further modified the plan for operating the floodway. The new plan raised the fuseplug sections to a height corresponding to 60.5 feet on the Cairo gage, raised the frontline levee to 62.5 feet, and raised the setback levee to a height of 65.5 feet. The plan called for the operation of the floodway only through explosives detonation at the upper fuseplug section when stages reached 58 feet at Cairo with a forecast of stages to exceed 60 feet. These changes necessitated a round of modified easement acquisition covering 80,982 acres of land, of which more than 76,000 acres were already embraced under the original easements obtained between 1928 and 1942. Between 1968 and 1974, the federal government acquired the necessary modified flowage easements at prices ranging from $1 to $100 per tract. The easements conformed to the new plan of operation and reserved for the federal government the right to operate the floodway by artificial crevassing. The easement also reserved to the owners the right to compensation if operation of the floodway resulted in "excessive deposits of sand and gravel" upon the land.[47]

After a 23-year hiatus from severe high water, the Mississippi Valley experienced a severe flood in 1973. Unlike the major floods of 1937 and 1950, the bulk of the floodwaters during the 1973 flood emanated from the upper Mississippi River, not the Ohio basin. The fuseplug sections at the Birds Point-New Madrid floodway had not yet been fully raised to the 60.5 feet on the Cairo gage as called for under the modified operations plan. Col. John Parish, the Memphis Engineer District commander, closely watched river forecasts. By March 22, river forecasters announced that they did not expect the river to climb above 55 feet on the Cairo gage. The Memphis district and local levee boards were heavily engaged in flood fight activities at the Commerce to Birds Point levee, Cairo, and the Reelfoot/Obion sector. After surveying the situation, Parish was confident that flood stages would not necessitate the activation of the floodway. "Our levees are in no danger of failing," he informed local newspapers in the confluence area.

Parish approached Maj. Gen. Charles Noble, the president of the Mississippi River Commission, with the recommendation to flood fight at the Birds Point-New Madrid floodway as a precautionary measure to prevent overtopping of the fuseplug levee. "We want to be prepared for a 60-foot river. We do not expect it." Noble gave his consent. In late March, a crew consisting of 42 laborers and fifteen bulldozers, under the leadership of Jim Patridge of the Memphis district, raised eleven miles of the fuseplug levee by two feet – a height equivalent to 60 feet on the Cairo gage. Battling rain, wind, and mud, Patridge's crews pushed 35,000 cubic yards of material from the landside of the levee to the levee crown in less than 48 hours. Throughout the emergency operation, Parish continued to warn floodway residents that the effort was a precautionary measure. "If stages hit 58 feet, we must evacuate the floodway," Parish told local newspapers. He also intended to activate the floodway if the forecast changed and pushed stages higher than 60 feet on the Cairo gage. The warnings, though, did little to damper the happy mood of floodway residents. For the first time since Maj. Gen. Jadwin had conceived the floodway concept, they were being allowed to flood fight to save their property. The emergency action, though, created a false sense of optimism that perhaps such actions would be common in the future. That optimism would not last long.[48]

After the floods of 1973, 1975, and 1979, the Mississippi River Commission once again revised the floodway operations plan after concluding that activation would be more safe and effective if artificial crevasses, including the use of explosives, were not limited to the upper fuseplug section. The new plan of operation included artificial crevasses at four locations along the frontline levee: two at the upper fuseplug section, one at the lower fuseplug section, and one in the frontline levee opposite Hickman, Kentucky. To assure the artificial crevasses came at the precise time to protect against floods approaching the project design flood dimensions, the plan incorporated the use of explosives if necessary. The Memphis Engineer District, though, soon realized that it did not possess sufficient property rights to enable personnel to access the levee to place explosive materials as prescribed in the modified plan. The original and modified easements obtained under the authority of the 1928 and 1965 flood control acts covered only those lands between the landside toe of the frontline levee and the riverside toe of the setback levee. The easements did not extend to lands upon which the frontline levee rested. On July 20, 1981, Colonel W.H. Reno, the district commander, requested that the St. John Levee and Drainage District and Levee District No. 3 of Mississippi County, Missouri, grant rights of entry for district personnel to access the levee in order to artificially crevasse it with explosives in the event river conditions warranted operation of the floodway. Both sponsors refused.

In 1983 another flood struck the Mississippi Valley. The National Weather Service forecast flood stages to reach 60 feet on the Cairo gage, prompting the commission to make contingency plans for the operation of the floodway. The federal government instituted eminent domain proceedings seeking immediate possession of the necessary easements to allow Memphis district personnel to access the frontline levee and put the plan of operation into effect if conditions warranted. In response, several landowners joined with Levee District No. 3 in filing a lawsuit with the Federal District Court in Cape Girardeau seeking a temporary injunction to prevent the operation of the floodway. On May 10, Judge Kenneth Wangelin issued a permanent injunction against the plan to operate the floodway with four artificial crevasses. In making his decision, Judge Wangelin ruled that the 1965 Act did not provide congressional approval to artificially crevasse the frontline levees, to include the fuseplug sections, and that no substantial evidence existed to suggest that it was necessary to make artificial crevasses to ensure operation of the floodway. Judge Wangelin also ordered that if his injunction was reversed by appeal, the federal government must deposit $10.4 million dollars with the court for "just compensation" if the commission activated the floodway. The predicted flood stages never materialized during the 1983 flood due in part to the reduction in stages provided by Kentucky and Barkley lakes, but the district court's injunction remained intact. The federal government appealed the case to the Eighth Circuit Court of Appeals. On April 15, 1984, the appellate court reversed the district court's decision by finding the plan to operate the floodway was not "arbitrary, capricious or an abuse of discretion." The court also questioned Judge Wangelin's authority to review the case at all by finding the decision to operate the floodway "is one committed to agency discretion by law…and is unreviewable." Last the court ruled that the district court had erred in instructing the federal government to deposit the $10.4 million as compensation.[49]

In the aftermath of the 1983 flood, the commission tweaked the floodway operational plan in an effort to reduce preparatory actions and to delay the operation of the floodway until later in the project design flood curve. The intent of the modified plan, known as the 1986 operations plan, was to allow natural overtopping along more than eight miles of the upper fuseplug section before artificially crevassing the levee. To this end, the plan included raising 2.5 miles of the upper fuseplug section and 1.5 miles of the lower fuseplug, and imbedding the raised sections with polyethylene pipe that could be filled with blasting agent in less than a day. The additional height in the levee was necessary to provide a dry platform for crews to pump the explosives through access wells into the buried lines. The explosives could also be removed safely in the event that river stages did not necessitate the operation of the floodway. The timetable for the new operational plan

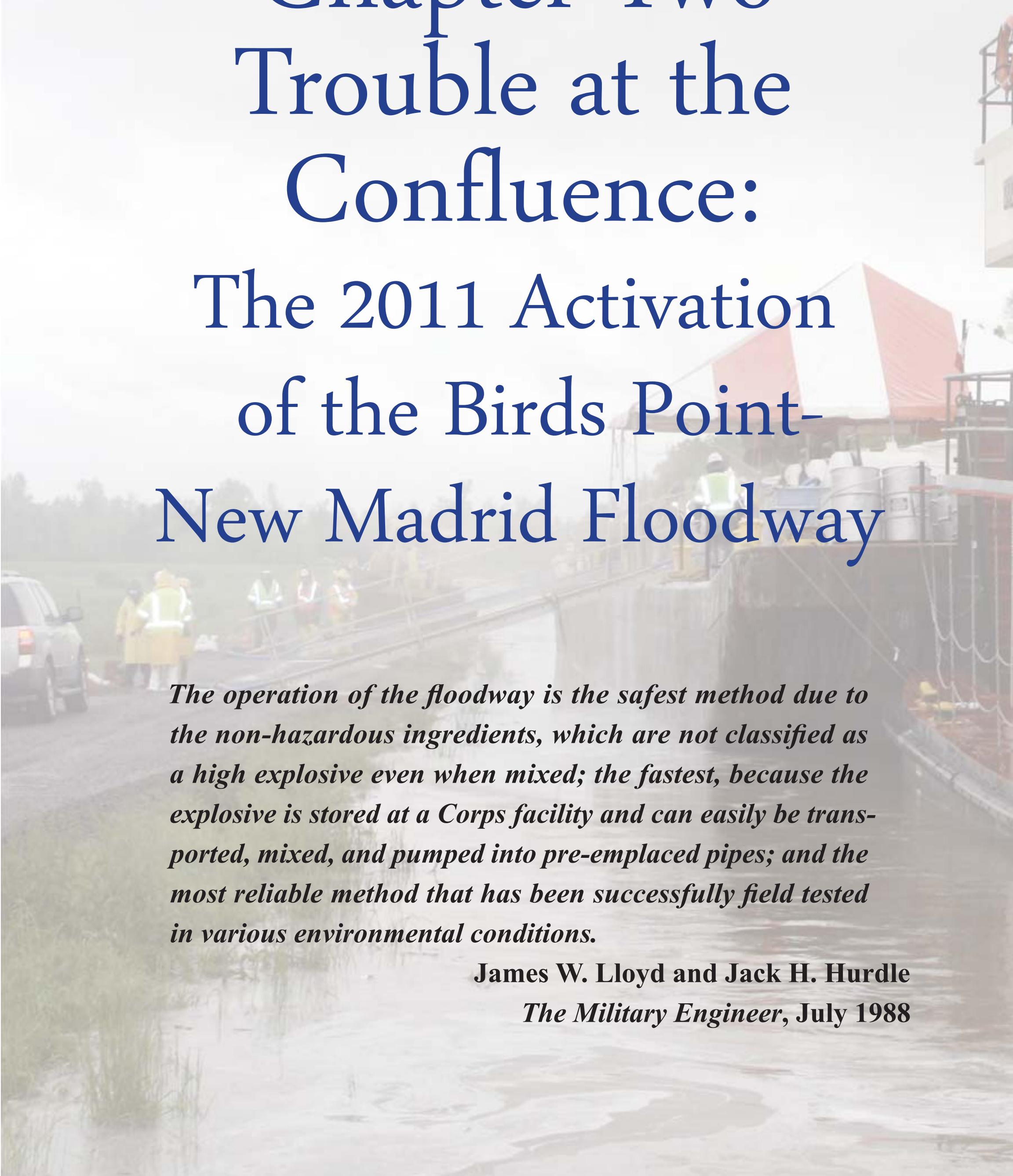
The Birds Point-New Madrid Floodway under the 1986 operations plan.

was based on the river elevations projected in the design hydrograph for floods approaching the project design flood. When stages reached 56 feet on the Cairo gage, a tow with the necessary equipment would depart the Ensley Engineer Yard. Preparation of the inflow crevasse would begin when stages reached 59 feet and would be completed by the time the river reached 60 feet. Artificial crevassing of the levee would commence upon the command of the commission president prior to river stages reaching 61 feet on the Cairo gage with additional stage increases forecast. Despite the changes, the federal government reserved the right to activate the floodway, if necessary, when stages reached or exceeded 58 feet on the Cairo gage and the levee system showed any signs of severe stress.[50]

Residents within the floodway, though, pushed for its outright abandonment. In 1987, Rep. William Emerson of Missouri prodded the House Committee on Public Works and Transportation to pass a resolution directing the commission to determine feasible alternatives to operating the floodway. This resulted in a 1990 reconnaissance by the Memphis Engineer District that investigated several alternatives to include purchasing the land within the floodway at a cost of more than $200 million and leasing it back to farmers at the their own risk; constructing permanent auxiliary channels in the floodway to confine floodwaters diverted into the area, rather than allow them to overflow the entire floodway; realigning and setting back the frontline levee at five locations to provide a wider floodplain; executing a cutoff at Bessie Bend to increase the slope and lower flood stages upstream of the bend throughout the floodway reach; and a plan of natural overtopping of the frontline levee. The study concluded that several of the alternatives were feasible from an engineering viewpoint, but were not justified economically. The study further concluded that the plan of natural overtopping of the frontline levee without artificial crevasses would serve as an alternative to the 1986 plan of operation and would provide a higher level of protection for the lands within the floodway. This alternative required raising the upper fuseplug section to a height corresponding to 64.5 feet on the Cairo gage, while leaving the elevation of the lower fuseplug section and the remainder of the frontline levee unchanged. Under this proposed alternative, though, hydraulic models indicated an increase of flood stages on the Cairo and Hickman of 3.7 feet and 2.2 feet, respectively.[51]

The reconnaissance study served as the basis for engineering review of the potential impacts of the natural overtopping plan along both banks of the Mississippi and Ohio rivers. Published in 1991 by the Memphis district, in coordination with the Louisville district, the engineering review determined that the implementation of the modified plan required improvements to existing levees and floodwalls and alterations to existing pumping stations and culverts throughout the confluence area in both districts at a cost of $140 million – $100 million in the Memphis district and $40 million in the Louisville district. In April 1992, the Mississippi River Commission endorsed the modified plan and requested that the district furnish copies to local and congressional interests because the implementation of the plan would require congressional authorization. Congress, however, never took action.[52]

General Jadwin's floodway remained the authorized solution to the dilemma at the confluence. The floodway had been modified several times between 1937 and 1986. Through those modifications, the Mississippi River Commission through the Memphis Engineer District had raised the fuseplug sections of the frontline levee from a height equivalent to 55 feet on the Cairo gage to 60.5 feet. Each modification not only raised the level of protection, but also reduced the likelihood of activation. Yet, the floodway remained as a viable safety valve to reduce pressure on the system in the event of a massive flood. In 2011, as the snowmelt crests on the Mississippi and Ohio rivers converged on the confluence area and the National Weather Service intently watched a developing storm pattern that threatened additional intense rains, the 1986 operations plan remained in effect and set in law.

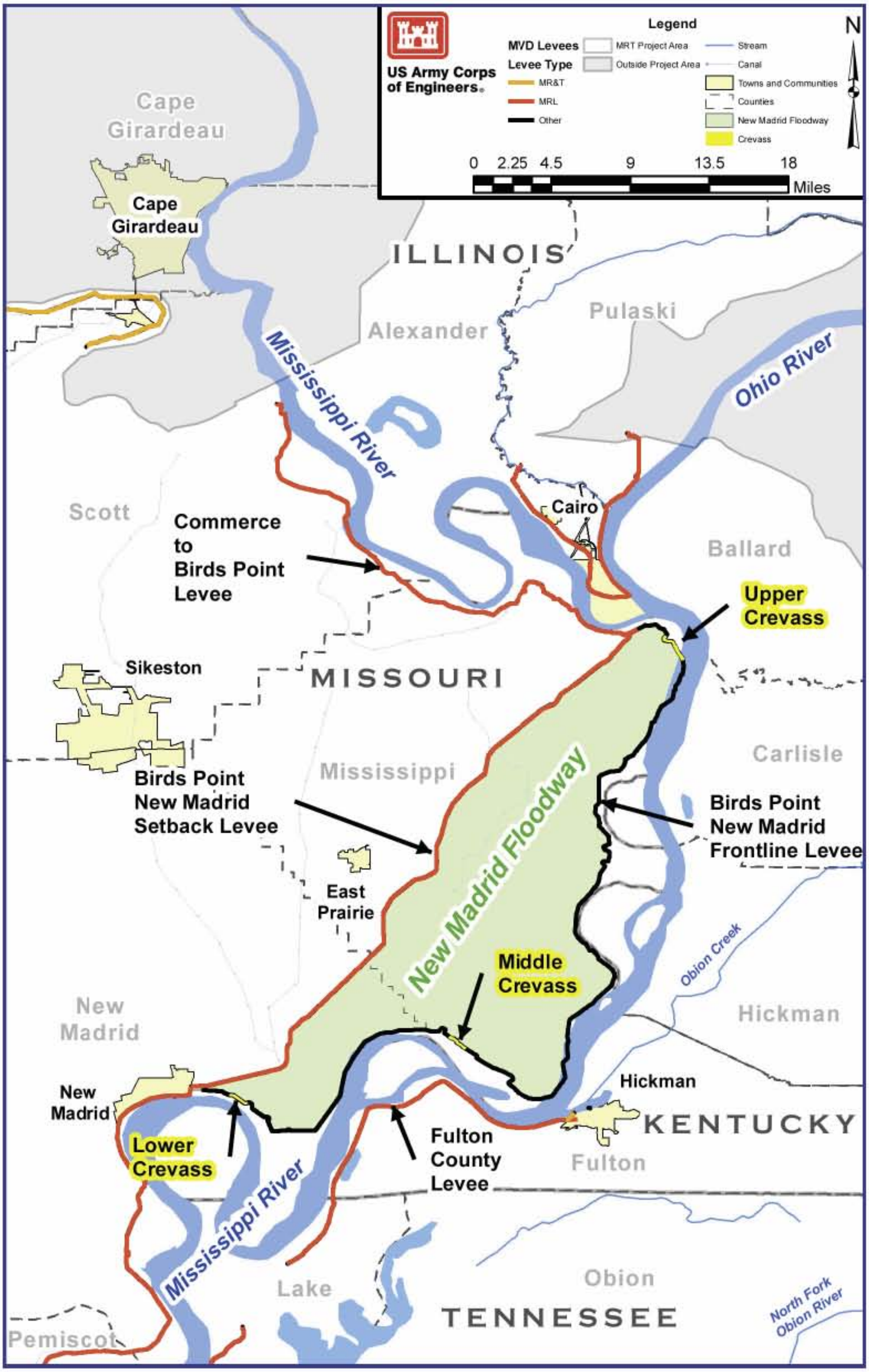


Chapter Two Trouble at the Confluence:

The 2011 Activation of the Birds Point-New Madrid Floodway

The operation of the floodway is the safest method due to the non-hazardous ingredients, which are not classified as a high explosive even when mixed; the fastest, because the explosive is stored at a Corps facility and can easily be transported, mixed, and pumped into pre-emplaced pipes; and the most reliable method that has been successfully field tested in various environmental conditions.

James W. Lloyd and Jack H. Hurdle
***The Military Engineer*, July 1988**



US Army Corps of Engineers
Legend
MVD Levees
Levee Type
MR&T
MRL
Other
MRT Project Area
Outside Project Area
Stream
Canal
Towns and Communities
Counties
New Madrid Floodway
Crevass
N
0 2.25 4.5 9 13.5 18
Miles
Cape Girardeau
Cape Girardeau
ILLINOIS
Alexander
Pulaski
Mississippi River
Ohio River
Scott
Commerce to Birds Point Levee
Cairo
Ballard
Upper Crevass
Sikeston
MISSOURI
Carlisle
Mississippi
Birds Point New Madrid Setback Levee
New Madrid Floodway
Birds Point New Madrid Frontline Levee
East Prairie
Obion Creek
Middle Crevass
New Madrid
Hickman
Hickman
New Madrid
KENTUCKY
Lower Crevass
Fulton County Levee
Fulton
Mississippi River
Lake
Obion
TENNESSEE
North Fork Obion River
Pemiscot

On April 22, 2011, Milus Wallace stood outside his lovely brick ranch home and looked over his sprawling 2,300-acre farm situated in the Birds Point-New Madrid floodway. He quietly and proudly took in the serenity offered by the little slice of paradise that he and his wife, Wanda, had carved out of the landscape during their 35-year marriage. On that Good Friday morning on April 22, Wallace intended to go fishing to restock his supplies for his famous fish fries, where anyone and everyone was welcome to stop by the Wallace home and enjoy good food and even better company. As he stood surveying his land, the backwater flooding entering the floodway from the 1,500-foot gap near New Madrid concerned him. The backwater threatened to cover the roads leading from his home to New Madrid. He needed to move nearly 17,000 bushels of beans before the roads closed. But that was the extent of his worries. The backwater would not flood his property. Wallace had lived in the floodway his entire life. His parents had also lived in the floodway, having endured the 1937 operation. His mother gave birth to one of his siblings in a tent on the levee in the aftermath of the great flood of that year. Wallace understood the risks associated with living and farming in the floodway. With each high water event, he always knew in the back of his mind that there was a chance that the Mississippi River Commission and the Corps of Engineers would blow the levee. The floodway was designed to save lives and property. Wallace respected that. At the same time, a part of him did not think that they would ever actually activate it.[53]

The Rain Begins

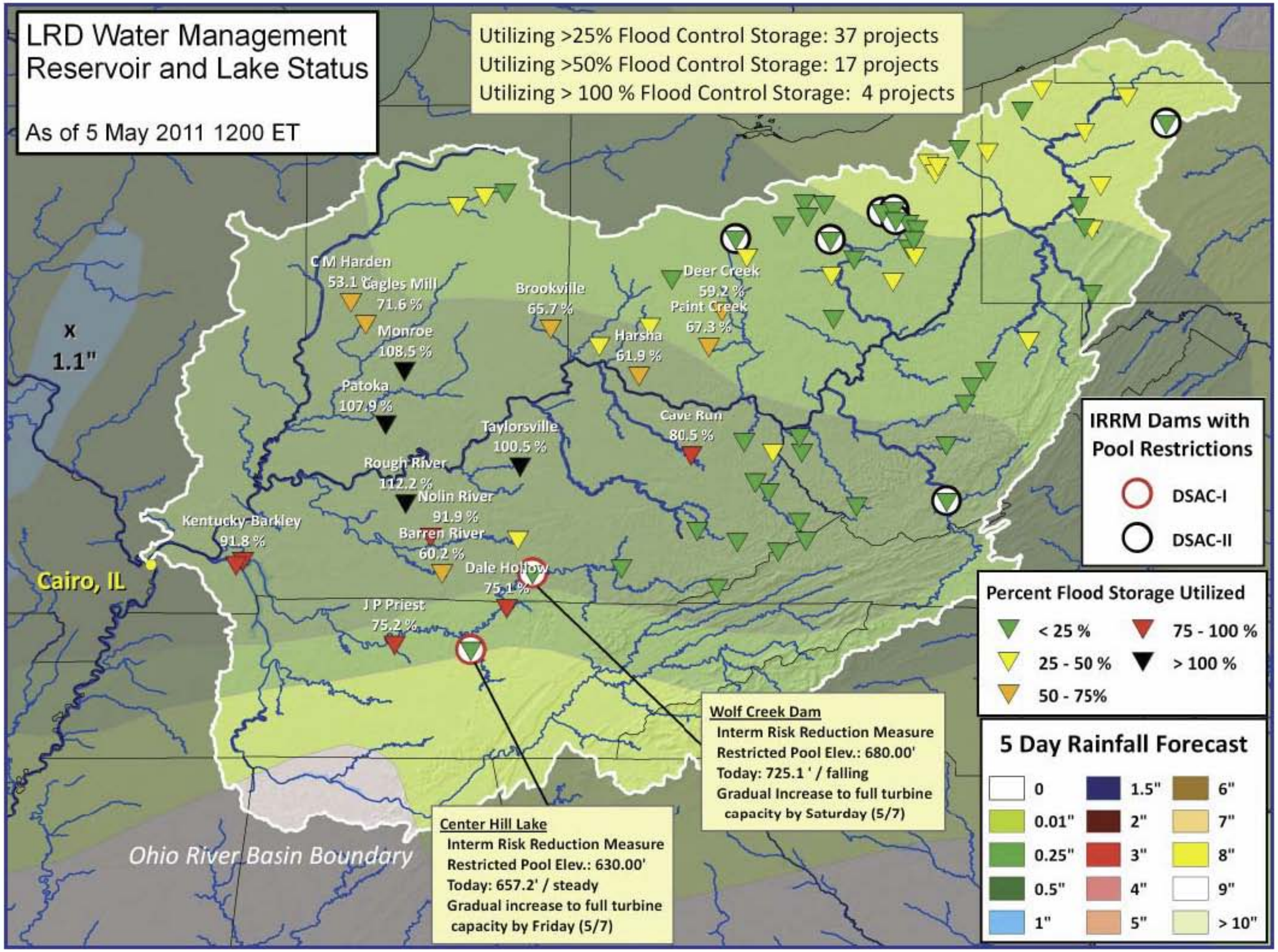
The April 21, 2011, contingency forecast for 61.1 feet on the Cairo gage late on May 3 or early on May 4 certainly alarmed water control managers at MVD and LRD. The specter of activating the Birds Point-New Madrid floodway remained only a remote possibility. The forecast, after all, merely represented a worst-case scenario – but it captured the undivided attention of the Mississippi River Commission and the Memphis Engineer District. Up to that point, the flood had been a routine late winter/early spring flood. The new forecast and the threat of additional rain represented the first real indication of big trouble. Charles Shadie and Deborah Lee, the chiefs of water management at MVD and LRD, respectively, and David Berretta, the long time chief of hydraulics at the Memphis Engineer District, immediately held a second conference call to discuss potential stage scenarios at the Cairo gage, impacts to the floodway, and possible options to store water in the massive flood control reservoirs upriver of the confluence area.

They also alerted their respective commanders of the contingency forecast. Shadie contacted Maj. Gen. Michael Walsh, the Mississippi River Commission president and MVD commander since February 2008. A native of Brooklyn, New York, Walsh possessed an impressive resume based heavily on civil works experience with the Corps of Engineers. He had served as the commander of the Sacramento Engineer District, the South Atlantic Division, and the Gulf Region Division in Iraq. He had also served stints as the executive director for civil works and chief

Maj. Gen. John W. Peabody (left) and Maj. Gen Michael J. Walsh during the 2011 flood.

of staff at the Corps of Engineers' headquarters in Washington, D.C. As president of the Mississippi River Commission, it would be Walsh's decision as to if and when to operate the floodway. Berretta notified Col. Vernie Reichling, Jr., the Memphis Engineer District commander since July 2010. Reichling, a combat engineer who led his platoon in the initial assault into Panama during Operation Just Cause and participated in Operation Desert Storm and Operation Enduring Freedom, was relatively new to the Corps of Engineers' civil works mission. He would be Walsh's point man on the ground responsible for preparing the floodway for operation if conditions warranted. Lee notified Maj. Gen. John Peabody, the LRD commander and member of the Mississippi River Commission since August 2008. A native of northern Ohio and a graduate of the U.S. Military Academy at West Point, Peabody had spent most of his career as a combat engineer and had been one of the first men in during the invasion of Iraq during Operation Iraqi Freedom. As LRD commander, he oversaw the first line of defense against floods represented by the Corps of Engineers' flood control reservoirs in the Ohio basin. Peabody would be called upon to store water in those reservoirs in an attempt to lower flood stages along the confluence area and try to prevent the activation of the Birds Point-New Madrid floodway.

Under Section 7 of the 1944 Flood Control Act, Peabody was in direct command of the Cumberland River system in the Nashville Engineer District, including Barkley Lake, and the Tennessee Valley Authority's reservoir system, including Kentucky Lake. As Peabody's agent, Lee directed releases from Kentucky and Barkley dams. At that point, the entire reservoir system in LRD was in overall good shape in terms of storage utilization. The Cumberland system, though, represented the only viable tool to protect the confluence area. Lee's immediate plan called for the release of water from behind Kentucky and Barkley dams to clear storage space for the rains expected over the weekend. The main problem confronting LRD water control managers involved the Wolf Creek, Center Hill, Dale Hollow, and J. Percy Priest dams on the



Reservoirs in the Ohio basin.

Cumberland River system upriver from Kentucky and Barkley lakes. The Wolf Creek and Center Hill dams were undergoing critical dam safety repairs to protect the integrity of the structures. They held restrictive ratings on the Dam Safety Action Classification (DSAC) ranking system, which meant that dam safety officers feared failure of the dams was a real possibility if the necessary repairs were not completed. As such, the pool elevations in the reservoirs behind those dams had been lowered substantially to prevent seepage failure. To keep pool elevations below restricted levels, the dams were releasing maximum discharges. If the anticipated rain over the next week fell behind those dams, LRD faced a difficult decision – continue maximum discharges which would take away valuable flood storage capacity at Kentucky and Barkley lakes, or hold back water behind the dams with the restrictive ratings.[54]

On April 22, one to three inches of rain fell over most of the middle Mississippi basin below St. Louis and along the Ohio River. Some areas received five inches or more of heavy localized precipitation. LRD water control managers increased the discharges through the Kentucky and Barkley dams to clear additional storage space to accommodate runoff from additional storms in the forecast. On April 23, three to five additional inches of rain fell between Caruthersville and Chester. Southeastern Missouri got the worst of it – 3.2 inches fell in Cape Girardeau, 3.2 inches in Popular Bluff, 4.7 inches in Greenville, and 3.8 inches in Fisk – but the rain also hammered the southern portions of Illinois, Indiana, and Ohio, as well as northwest Kentucky and western Tennessee. Cairo's two-day rainfall total reached 3.5 inches.[55]

Deborah Lee pressed the National Weather Service to publish its contingency forecast. That forecast typically served only federal audiences for informational purposes because the forecast relied heavily on precipitation as far away as five days into the future. Conditions often changed, causing adjustments to the forecasts. The weather service normally did not publish its contingency forecasts out of concern of causing an overreaction among the public. The agency considered the forecasts far too unreliable. The service's various models predicted a broad array of expectations at the Cairo gage ranging from 51.3 feet to 62.3 feet, which reflected on the uncertainty of how much rain it expected to fall and where it would fall over the ensuing five days. Lee expressed her concern about the timing of the rainfall. It was Easter weekend. People would be distracted by family festivities. She wanted to get the information out to the public so that they and emergency response agencies could accelerate their preparedness if, indeed, the worst-case scenario materialized. The National Weather Service relented and began publishing a qualifying statement with its forecasts indicating that, taking future rainfall into consideration, river stages could potentially rise two to three feet higher than forecasted in some areas.[56]

At 0600 hours on Easter morning, April 24, the Cairo gage stood at 52.5 feet. The river had risen nearly 1.5 feet in 24 hours, one-half foot higher than the official National Weather Service forecast from the afternoon before. The steady downpour over the preceding two days had dropped more rain than anticipated. Still it kept raining. Three inches of rain fell at New Madrid. Another 2.3 inches fell at Cairo. Four more inches dropped at Paducah. That afternoon, the weather service revised its projected crest at Cairo to 60 feet on May 3, but warned that the rain was far from over. Another three to eight inches was anticipated over the middle Mississippi and the Arkansas, Ohio, and Tennessee valleys. In LRD, the torrential rains were filling up the reservoir system. System-wide flood storage utilization stood at 15 percent. Nineteen reservoirs already topped 25 percent of their authorized flood control storage; seven of those reservoirs reached greater than 50 percent. Col. Keith Landry, commander of the Louisville Engineer District, reported that six of the eleven flood control lakes in his area of operations approached record pool elevations. The situation pressed Maj. Gen. Peabody into issuing "over-arching guidance" to the senior leaders on his staff and to his district commanders. Stating the ongoing flood had "the potential to reach epic proportions," Peabody directed that flood duty missions take the top priority over all actions at LRD and its district offices. "We must do every single thing we possibly can do – no matter how small or seemingly insignificant – to reduce the projected maximum crest at Cairo," he wrote. Peabody wanted his staff to consider all alternatives, including those outside of the division's normal operating procedures, "It is essential that we pull out the stops to fight the peak river crest for this event."[57]

By the morning of April 25, the Cairo gage reached 54.5 feet. The confluence area was a mess as a result of the deluge of the past week. Cairo was almost an island, with only a narrow strip of slightly elevated land containing Illinois Route 3 providing access to and from the city. Further to the south on the east side of the river, seepwater and impounded rain covered much of Fulton County, Kentucky, and Lake County, Tennessee. Standing water covered the flat farmland in the four-state area and inundated low-lying state and county roads with several inches of water. Creeks and drainage ditches overflowed their banks. Because the Mississippi River stages were so high, the interior drainage had nowhere to go, unless it was pumped through or over the levees. At St. John's Bayou on the west side of the river, the floodgates were closed in late February, which caused the bayou to back up and flood low-lying lands in East Prairie and Sikeston. Water began to encroach upon Interstate 55, the major north-south thoroughfare in the Mississippi Valley. Levee conditions across the confluence area degraded. Small boils exploded everywhere across the region, particularly in the Cairo and Fulton County sectors where relief wells had not been installed.[58]

Underseepage and sand boils represent major concerns during floods. When river levels rise, the additional weight of the water creates pressure that tries to find an escape route through the foundation of the levee system. As the underseepage makes its way to the surface on the landside of the levee, it boils up through the ground – hence the term boil. Excessive pressure causes the underseepage to drag or pipe soil particles from the foundation along with it – hence the term sand boil.

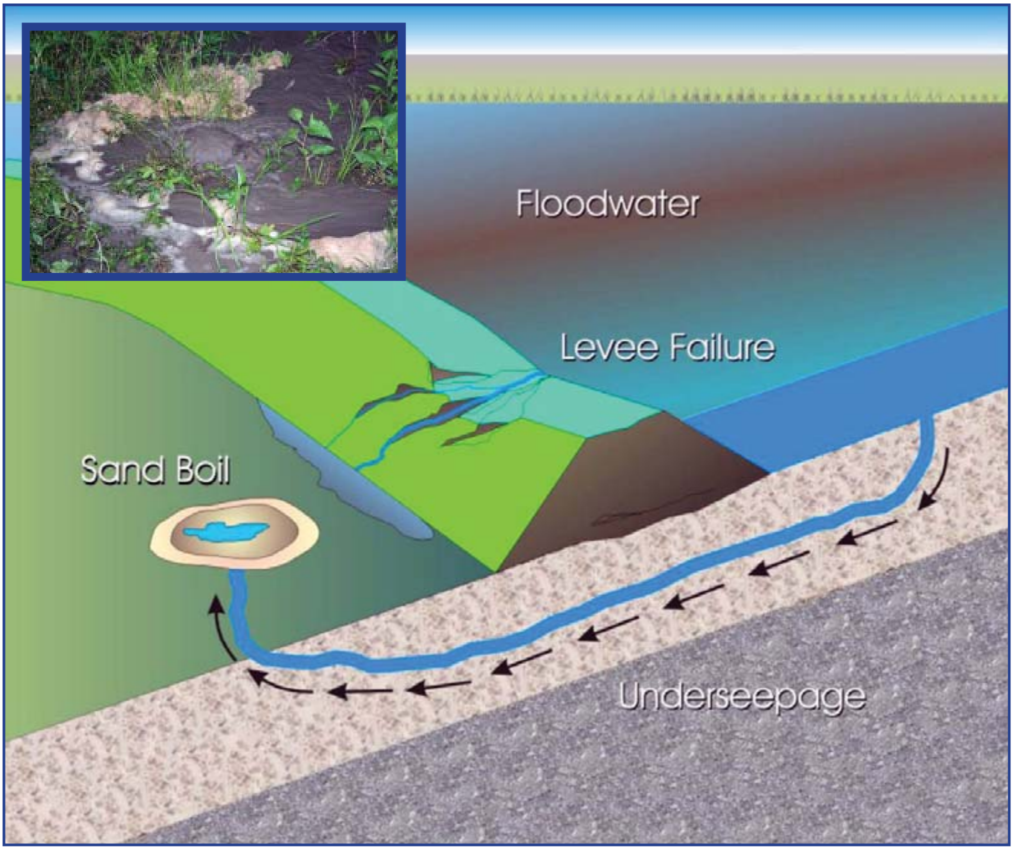


Illustration depicting the potential danger of a sand boil.
Inset: A dreaded sand boil piping sediment.

Left unchecked, sand boils create voids under the levee, which can lead to an eventual collapse of the levee. The Corps of Engineers uses relief wells and seepage berms to dissipate the pressure to the point that the underseepage will not erode the levee foundation. In levees where relief wells have not been installed, the Corps of Engineers fights boils by building rings, usually with sandbags, around the sand boils. As the rings fill with water, the weight of the water inside the ring dissipates the pressure and prevents the piping of foundation material.

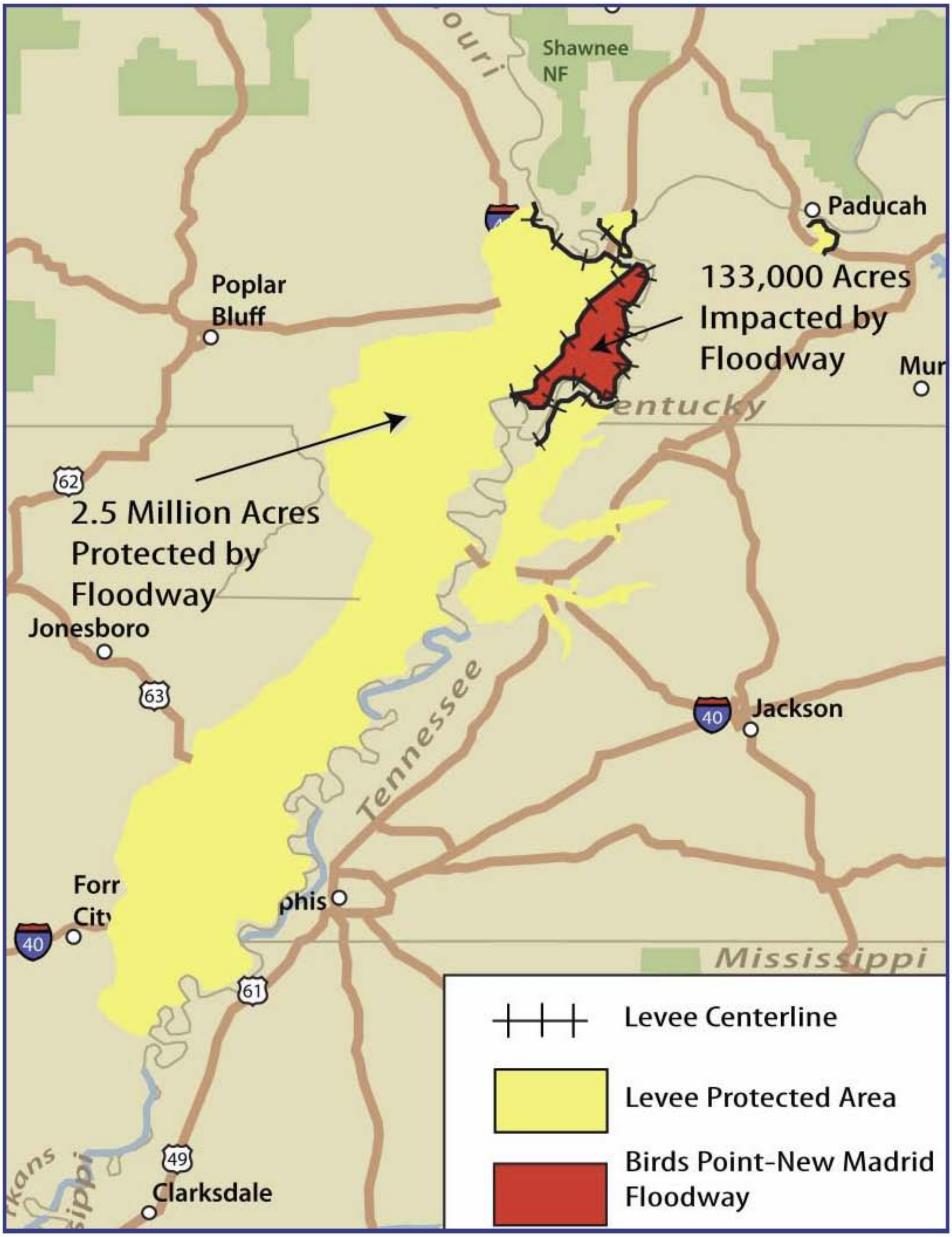
On April 25, the National Weather Service expected another eight inches of rain over much of the area during the next three days. The pressure on the levee system would continue to mount. The Memphis

Engineer District had moved into Phase II operations – the highest level possible – across the entire confluence area the day before. Flood fight teams, coordinating with local levee districts, patrolled levees and floodwalls on a 24-hour basis, intently searching for any sign of weakness threatening the integrity of the levee system. At 0630 hours on April 25, Col. Reichling, following the Birds Point-New Madrid floodway operations plan, ordered crews in Memphis to commence loading the barges with the explosives and necessary equipment. Crews loaded two pump barges each with 192 barrels of aluminum powder, six 2,500 gallon tanks of liquid blasting agent, two mix-pump units, and two forklifts. They also loaded two dozers and two backhoes on an equipment barge. The process took 12 hours to complete. In the meantime, it kept raining. Southeast Missouri and the Ohio Valley received another pounding. Nearly six inches of rain fell on Poplar Bluff and two inches at New Madrid. Cairo received another inch and a half; Paducah received more than two inches. Hopkinsville, Kentucky, received nearly 3.5 inches.[59]

The continued intense rains and rising river stages forced Peabody's hand on April 25. Going into the flood, he faced the difficult decision with regard to storing water behind the restricted dams on the DSAC ranking system – particularly the Wolf Creek and Center Hill dams – in order to conserve storage space at Kentucky and Barkley lakes and keep flood stages at the confluence in check. He had to reduce the outflows from Kentucky and Barkley, but that action, along with maximum releases coming in from the Cumberland system, would rapidly diminish his available storage. He knew that he did not stand a chance at preventing activation of the floodway without that extra storage. After intensive study and exhaustive analysis of the dam safety issue, Peabody took decisive action to initiate reductions from Kentucky and Barkley dams, while reducing to nearly zero the discharges from the restricted dams at Wolf Creek, Center Hill, Dale Hollow, and J. Percy Priest and other dams on the Cumberland system to reduce the amount of water flowing into Kentucky and Barkley lakes. This would have the effect of driving up water levels behind the restricted dams well above acceptable norms, but the LRD engineers expressed confidence that the dams would hold if the higher pool elevations lasted only a few weeks.[60]

On April 26, the Cairo gage reached 56.5 feet, up more than two feet from the previous morning. The National Weather Service projected a new crest of 61 feet on the gage for May 3. Weather forecasts for the day called for up to two more inches of rain over the afflicted areas. Conditions at Cairo and Fulton County continued to degrade. At Hickman the floodwall had cracks that seeped water. Flood fighters stuffed sandbags around the stop logs in the floodwall to prevent additional leakage. The Dyer County Little Levee board in Tennessee, facing an eventual overtopping of their levee, voted to create an artificial breach at the south end of the levee to allow floodwater to slowly back into the area, rather than face the torrent and scour from overtopping at the north end. At Lake County, a flood fight team discovered that a mile-long segment of the levee was two feet below the designed height and began making plans to raise the low spots. At Dutchtown, Missouri, the Memphis district worked with local officials to raise a portion of the Hubble Creek levee to protect the town from flooding. At Caruthersville, city officials contemplated raising the height of the floodwall protecting the city. Over at Lake Wappapello at the head of the St. Francis basin, the rain of the past week had been the most severe. Lake levels had risen more than 40 feet in a matter of four days. Corps of Engineers officials warned that the lake was near full and would soon go to emergency spillway operations. The only shred of good news involved the Commerce to Birds Point levee, where patrols reported no problems.[61]

The Commerce to Birds Point levee is, as David Berretta described, "the most critical levee" in the Mississippi Valley. A break in the levee, located at the head of the alluvial valley, would inundate more than two million acres in the Missouri bootheel and most of the St. Francis basin in northeast Arkansas. Some estimates put the number of acres potentially flooded at more than three million. Following the 1927 flood,



Areas protected by the Birds Point-New Madrid floodway.

Missouri congressman William Nelson described the levee as the “roof” of the flood control system on the west bank of the MR&T project. Nelson’s roof needed to be leak proof. The Commerce to Birds Point levee had served as the source of major scares during past flood events. During the severe 1973 flood, a 1,500-foot section on the riverside of the levee caved into the river. The caving extended to the top of the levee, which caused intense fears it would fail. Personnel from the Memphis Engineer District addressed the problem by placing 18,000 tons of riprap stone – carried to the site on barges – to prevent additional caving and to shore up the levee. The aggressive response saved the levee from failure. Twenty years later during the 1993 flood, the levee again provided an anxious moment. The private Len Small levee on the opposite bank of the river typically overtopped or failed during larger floods, which lowered river stages and reduced pressure on the Commerce to Birds Point levee. The owners of the Len Small levee, though, had strengthened their levee during the 1980s. During the 1993 flood, the levee held against a stage under which it normally failed. The river remained confined and it climbed to within a few feet of the top of the Commerce to Birds Point levee. Sand boils developed, which flood fight teams attacked with sandbag rings until the underseepage stabilized. Beginning in 1995, with strong support and encouragement from U.S. Congressman William Emerson and the Mississippi River Commission, the Memphis Engineer District raised and strengthened the Commerce to Birds Point levee and installed relief wells. But as the 2011 flood developed, the district kept a close eye on the levee.[62]

On April 26, Maj. Gen. Walsh ordered the movement of the fleet carrying the explosives and equipment from the Ensley Engineer Yard at Memphis to the harbor at Hickman, Kentucky. A driving rain pounded the Memphis area with nearly four more inches of rain as the fleet prepared to ship out. Walsh also ordered the land-based crews to deploy to the floodway and begin preparations for possible activation. James Lloyd, one of the developers of the Birds Point-New Madrid operations plan, gathered the floodway task force in the auditorium at the Ensley Engineer Yard to do one last systems check. They could not leave anything behind. "If we don't have it with us, we will have to work without it," Lloyd warned. He also ensured that every single person – the boat captains, the survey men, the hose handlers, and so on – knew their roles. He expressed the importance of focusing on the mission at hand. More importantly, he cautioned them to expect the unexpected. "If we have to do this," Lloyd warned, "fate will probably dictate that we will have to do this at night and in the rain."[63]

With intense rains hammering much of the confluence area and Ohio Valley with two inches of rain on April 26, total rainfall accumulations continued to climb higher, as did river levels on the Cairo gage. By the morning of April 27, the river had climbed more than a foot higher than the previous morning. Bill Frederick's morning weather report called for another widespread and severe weather event that carried a high risk of strong tornadoes, large hail, and damaging winds over the Tennessee Valley. The National Weather Service anticipated another one to three inches of rain between Cape Girardeau and Arkansas City, with the heaviest rains falling along the Cumberland and Tennessee watersheds. The report, however, contained some good news. As the storm front moved through the region, it would bring an end to the torrential rains of the past week. Clear skies were in the forecast for the next two days.[64]

The Cairo gage stood at 57.9 feet, but the official projected crest dropped from 61 feet on May 3 to 60.5 feet on May 1. Maj. Gen. Peabody's decisive move to reduce outflows from the restricted dams in the Cumberland system to conserve storage at Kentucky and Barkley lakes was paying off. While the local population's concern grew over the possible use of the Birds Point-New Madrid floodway, the performance of the LRD reservoirs and the anticipated respite from rains for the next few days created a sense of unspoken and guarded optimism among Corps of Engineers and Mississippi River Commission officials that the floodway might not be needed. That afternoon, Maj. Gen. Walsh and two civilian members of the commission, Sam E. Angel and R.D. James, conducted an aerial assessment of the four-state area impacted by the deluge of the past week. Water was everywhere, sometimes as far as their eyes could see. The situation remained serious, to be sure, but if Peabody could continue to work his magic and the rain held off, the commissioners believed the flood might be manageable.[65]

Following the aerial tour, Walsh, Angel, and James travelled to East Prairie, Missouri, to attend a town-hall style meeting organized by Rep. Jo Ann Emerson. Her congressional district encompassed the floodway, and she intended to help her constituents. Earlier in the day, Emerson along with Missouri's two U.S. senators, Claire McCaskill and Roy Blunt, sent a letter to President Barrack Obama urging him to consider alternatives to using the floodway. In the cramped Creative School Zone building in East Prairie, she took her fight to a new level. With approximately 75 deeply-concerned citizens packed around her, Emerson pulled out a photocopied page from the Mississippi River Commission history book, *Upon Their Shoulders*, and read a quote from Maj. Gen. Edward Markham, the chief of engineers at the time the floodway was last activated in 1937. "I am now of the opinion," Emerson read aloud from the page before her, "that no plan is satisfactory which is based upon deliberately turning floodwaters upon the homes and property of people even though the right to do so may have been paid for in advance." The crowd cheered. "We're going to do everything possible to prevent the Corps from operating the floodway," Emerson told them. They cheered again. She then informed the audience that she arranged the meeting to help combat rumors about the possible operation of the floodway—rumors that were leading to panic across the region. She hoped that Walsh could help calm the situation by answering their questions. She turned the floor over to Walsh.[66]

Maj. Gen. Walsh faced the large audience huddled around him in a semi-circle. They were angry and they were right on top of him. If

Above: Aerial view of flooding in the confluence area.
Below: Members of the Mississippi River Commission and staff conduct an aerial assessment of the extensive flooding at the confluence area on April 27, 2011.

The April 27 public meeting at East Prairie, Missouri. (Photo by Kevin Pritchett)

Emerson intended for the close proximity of the crowd and the cramped, stuffy quarters to make Walsh uncomfortable, her plan worked initially. His face reddened. His voice wavered when he started to speak, but he quickly recovered. "I recognize all of your livelihoods will be impacted," Walsh explained, "but when it gets to 61 feet, these levees have never been under this kind of pressure before." For the better part of the next hour, Walsh and Reichling answered pointed questions and anxious concerns presented by the highly-intense audience. *How much notice will we have? Will the setback levee hold? Why won't you let the floodway naturally overtop? When you will give the order? Why are you willing to destroy my livelihood?* Reichling gave his assurances that the setback levee was up to standard. He also bravely explained to the hostile crowd that the floodway protected more than just Cairo – it protected the entire system along that reach, especially the critical Commerce to Birds Point levee that protected many in attendance. Walsh emphasized that no decision had yet been made and that operating the floodway remained a last resort, but he sternly added, "At the end of the day, I am going to do my duty."[67]

Later that afternoon, Walsh and the commission's senior leaders went to the frontline levee at Birds Point, where Reichling's task force prepared the floodway for activation. The frontline levee contained two fuseplugs sections that would allow the Mississippi River into the floodway. The upper fuseplug, located at the northern tip of the project area, served as the main introduction point for floodwaters. The inflow site was eleven miles long, with nine miles of that length built to a height corresponding to 60.5 feet on the Cairo gage. The lower elevation allowed gradual overtopping in the event of a massive flood. The Corps of Engineers, though, constructed sections of the fuseplug to a height of 62.5 feet on the Cairo gage – the same height as the rest of the frontline levee. The higher elevation sections on the fuseplug housed nearly two miles of buried polyethylene pipe connected at 1,000-foot intervals by access wells buried in the levee. Under the operations plan, crews would pump liquid explosives into the buried lines through the access wells. At the lower end of the floodway sat two inflow/outflow areas equipped with more access wells and buried lines. These sections allowed the floodwaters to enter the floodway, but they were also designed to evacuate the floodwaters when river levels eventually subsided.[68]

Working under security provided by the Mississippi County Sheriff Department to address any potential confrontation with landowners, the survey crews, equipped with maps, global positioning satellites, and magnetometers, travelled the length of the frontline levee marking and locating the 46 buried access wells with wooden stakes and orange tape. The ground crews followed behind. Using the backhoes brought to the levee on the equipment barge, the ground crews uncovered the wells. Workers then used shovels to clear the wells of any loose dirt and gravel. Once this was accomplished, they installed fittings on the pipes to accommodate the hoses from the pump barges, if necessary. With Walsh and his staff on the levee, Reichling, Lloyd, Russell Davis – Reichling's operations chief – and Bartley Durst, the explosives team leader from the Engineer Research and Development Center (ERDC), detailed the processes the task force would employ to prepare the access wells, charge the lines, and, ultimately, detonate the explosives to artificially crevasse the levee. While on the levee someone – most likely either Davis or Durst – indicated to Walsh that filling the lines with explosives did not commit him as Mississippi River Commission president to operating the floodway. In other words, the action of charging the lines did not signal a point of no return as it was possible to neutralize the explosive slurry and pump the mixture from the lines. Lloyd, the subject matter expert, pulled Walsh aside, though, and explained that while it was possible to clear the lines, he knew "from hands-on experience" that it was a very complicated process that took weeks, if not

A briefing on the levee. From left: Col. Thatch Shepard, James Lloyd, David Sills, Bartley Durst, Edward Belk, and Richard Lockwood brief Maj. Gen. Michael Walsh (squatting) and Col. Vernie Reichling (with back to camera) on the potential operation of the floodway.

Memphis Engineer District work crews unearth the access wells at the Birds Point-New Madrid floodway fuseplug levee.

months, to accomplish. If the crews pumped the slurry in and Walsh did not give the activation order, the district would have to arrange security until the explosives were removed. People would not be able to return to their homes until then. To complicate matters, the district could not clear the lines until after the flood season ended because all available materials required for activation were already on site. There was not a reserve stash of explosives at the Ensley Engineer Yard in Memphis. Lloyd then delivered a stern recommendation to hold off on the pumping operations until Walsh was certain he would give the order to activate. "Sir, you don't want to pump it [the explosive slurry] in, if you aren't going to detonate," Lloyd cautioned. Reichling concurred with the assessment. Lloyd's advice would resonate with Walsh through the entire flood fight.[69]

The April 27 frontal system that brought an end to the rains that pounded the area for the past week did so with a deadly vengeance. The National Weather Service reported that 160 tornadoes, 292 damaging wind events, and 178 large hail reports had left 178 dead in one day. Perhaps the most notorious killer was the massive tornado that ripped a 132-mile path through Mississippi and Alabama and virtually wiped the town of Heckleburg, Alabama, from existence. The rain, though, was over for the time being. Since April 20, at least six inches of rain had fallen over a huge section of Missouri, Illinois, Indiana, Kentucky, Tennessee, Arkansas, and Mississippi. That was just the minimum amount, most areas received a foot or more, with Springdale, Arkansas, recording the most at 19.7 inches. By the morning of April 28, the Cairo gage reached 58.7 feet. The river had climbed nearly another foot, testing the levee system like never before.[70]

Pressure on the System

At LRD, the total system storage reached 23 percent on April 28. Col. Landry reported to Peabody that three reservoirs in the Louisville Engineer District – Rough River, Monroe, and Patoka – were approaching emergency spillway operations. The lakes had almost reached their design limitations. Other than that, the LRD and TVA reservoir systems were in good shape considering the circumstances. Because of Peabody's April 25 order to conserve storage space, Kentucky and Barkley lakes still maintained close to 80 percent of their available flood storage. Peabody's aim was to hold the Cairo gage steady long enough for Walsh to give the order to load the pipes. At 0700 hours, he instructed Deborah Lee to operate the Kentucky and Barkley pools to an elevation of 374.5 feet – four and one-half feet above the record pool elevation – with the goal of managing stages at Cairo. The full 375 feet as called for in the flood control manual could not be used; the cofferdam protecting the new Kentucky Lock construction would be overtopped at 375 feet with the potential for undermining and loss of control of Kentucky Lake. Even leaving only one-half foot of freeboard was risky; a wind aligned with the lake's axis could push the water 1.5 to 2 feet higher. Lake Barkley's control gates also were not engineered to sustain overtopping and long-recognized vibration issues with them precluded surcharging operations (raising the gates to get higher pool elevations above 375 feet).

Deborah Lee knew they were walking a very tight line between maximizing an effective operation and potentially losing control of Kentucky and Barkley lakes with devastating consequences for the nation. If the cofferdam project overtopped, the Barkley hydropower unit would be destroyed. If that happened, LRD would likely lose the ability to control floodwater for up to a year. Peabody, though, had seen Lee in action as she masterfully manipulated water levels in the system. He had total confidence in her ability. He also directed further increases of storage on the Cumberland system reservoirs in a manner consistent with any DSAC concerns. He then sent an email to Walsh recommending that the task force load the slurry at the floodway as soon as possible, as LRD expected the river to rise above 60 feet in the next 24 to 48 hours.[71]

Walsh received Peabody's recommendation during a decision briefing by Col. Reichling. He did not respond immediately. During that briefing, Reichling informed Walsh that his engineers were highly concerned about the integrity of the levee system at Fulton County. The number of sand boils developing along the levee represented a marked increase over previous high water events. If the river continued to climb as forecasted, his engineers on the ground were not confident they could hold for an extended period of time. Engineers from the Cairo sector also reported an increased number of sand boils, but, to date, no large high-energy boils had been discovered. The situation at the Commerce to Birds Point levee, the Caruthersville floodwall, and Lake County remained stable. Reichling informed Walsh that, while the operations plan allowed for activation of the floodway at 58 feet on the Cairo gage if the levee system could not handle the pressure, the integrity issues at Fulton County and Cairo did not warrant activation. Instead Reichling favored waiting. The task force needed roughly 24 hours in advance of the Cairo gage reaching 60 feet to prepare the floodway for operation. Based on input from his water control office, his assessment was that the gage would not break 60 feet for at least another 48 hours. Reichling recommended that Walsh hold the barges at Hickman harbor for the time being.[72]

Walsh notified Peabody of his decision to hold the barges. Peabody responded that he had been making his decisions to hold the stage at Cairo to "facilitate the placement of slurry" at the request of MVD. The

Memphis Engineer District had earlier sent a plea for LRD to hold the Cairo gage at 59 feet so that the task force could prepare the floodway. Meeting that request, according to Peabody, had "unnecessarily used up storage" at Kentucky and Barkley lakes. He went on to add that he did not have legal authority to manage those reservoirs for the purpose of preparing the floodway. He could only operate them to keep the maximum crest at Cairo below 61 feet. In other words, Peabody told Walsh that as LRD commander he had done all that he could – probably more than he should have – to buy Walsh time to prepare the floodway for activation. He could do nothing more to facilitate that action below 61 feet on the Cairo gage. Walsh was on his own if he did not get the pipes loaded by that stage. "We were holding back everything we could to give General Walsh time to load the pipes," Lee later recalled. "We knew we were reaching the breaking point," she continued, "but he wasn't making the decision" to commence loading.[73]

Cairo was just starting to reach the breaking point. On the evening of April 28, Thomas Morgan, an engineer from the Memphis district assigned to the Cairo sector flood fight team, gave Col. Reichling and Malcolm Gay, a reporter with the *New York Times*, a tour of the Cairo area. Morgan attempted to explain to the reporter the immense pressure the river exerted on the floodwall and surrounding levee system. Almost as an afterthought, he took Reichling and Gay to an abandoned piezometer located a few hundred feet from the floodwall at one of the narrowest points at the neck of the peninsula. The piezometer was well known to veteran area flood fighters. When river stages climbed and increased pressure in the aquifer, the piezometer spouted water several feet into the air, which perfectly illustrated the point Morgan wanted to make. As he explained the pressure on the system, he noticed a small sand boil near the base of the piezometer. The throat or opening of the boil was only about nine inches in diameter, but it was growing right before Morgan's eyes. Another small boil developed a few inches away from the first. Within moments they joined to together to former a larger boil. Then it happened again. Morgan knew the boil was a serious problem. It was precisely the type of high-energy boil that Reichling had reported the absence of during his briefing earlier in the morning. He called Mike Watson and Chip Newman, two fellow Memphis district flood fighters, and apprised them of his observations.[74]

Newman arrived at the scene just after 1900 hours. By then the boil had grown to two feet in diameter. Newman took one look at the high-energy boil and recognized that the traditional treatment of building a sandbag ring around it to equalize the pressure would not suffice. He had another plan in mind, though. Newman called Jeff Denny, the Alexander County Engineer, and representatives from the Bunge Corporation and the nearby water treatment plant. Newman suggested they construct a ring berm around the sand boil using a nearby stockpile of flyash cinder owned by Bunge. The representatives from Bunge agreed. As the night's mission progressed under a bank of emergency work lights, the team's resources grew to include dozers, backhoes, loaders, excavators, dump trucks and approximately 40 people, including Edward Dean and James Nabakowski from the Memphis Engineer District. By 0100 hours, the crew constructed a 50-foot diameter ring berm to a height of 6.5 feet. The sand boil, however, continued to pipe sediment at an alarming rate. The river was too high and exerted too much pressure. The berm needed to go higher.[75]

Newman was dejected. Fatigue had set in. His mind began to race. He had never seen the river this high before or a boil this large. His thoughts turned to the people of Cairo. If he could not get the boil under control, the floodwall would probably fail. He prayed to God that his efforts would be successful. So many lives were at stake. At 0130 hours, Newman met with the Cairo mayor, Judson Childs, and police chief, Gary Hankins. The discussion quickly turned to the possibility of a mandatory evacuation, but Childs resisted for the time being. Their discussion took place in the middle of the night, so there would be no way to spread the word other than by door-to-door. They agreed to meet

Above: R.D. James, left, and Maj. Gen. Michael Walsh discuss the mega boil with Chip Newman as rain continues to pound Cairo..
Below: The flyash cinder ring berm at the Cairo mega boil.

again later in the morning. If the work crew could not get the sand boil under control by then, Newman would give Mayor Childs an engineering assessment with regard to evacuation. Newman went back to work. The crew raised the berm another two feet. At 0400 hours, though, the boil took on more energy and began piping material again at an accelerated rate. The crew had hoped to build the berm wider for additional stability, but the boil's increase in energy forced them to abandon the notion. They continued building higher without the benefit of a wider base. By 0630, the berm stood 10 feet high. The boil's energy finally began to dissipate.[76]

The crew had the boil under control, but as seasoned flood fighters, they realized the pressure would try to find a new outlet. Newman instructed the crew to search the adjacent flooded field for additional boils. They discovered another high-energy boil directly behind the NAPA auto parts store. Acting quickly, Illinois National Guardsmen filled sandbags in the parking lot of the NAPA store, carried the bags on flat bottom boats through two feet of water, and constructed a five-foot high berm around the boil. Once the second boil stabilized, the crew built an access road so they could haul in rock to reinforce the sandbag ring. Morgan later found a third mega boil on 27th Street, approximately 500 feet from the floodwall. The boil was smaller than the first two, requiring a four-foot high sandbag ring. All three high-energy boils stabilized for the time being. The river was still forecasted to go higher. The pressure on the levees and floodwall would increase along with river stages. The fight was not over. Mayor Childs recognized as much and issued a voluntary evacuation of the city.[77]

While crews fought the high-energy mega boils at Cairo, conditions at Fulton County continued to degrade. The levee in Fulton County represented a traditional trouble spot during floods along the lower Mississippi River, due mostly to uncontrolled underseepage. The number and size of sand boils appearing in that sector worsened with each high water event. If the levee failed at Fulton County, the river would flood western Kentucky and western Tennessee all the way down to the Obion River. The Memphis Engineer District had designed a plan to solve the problem through the extensive application of relief wells, but local landowners resisted granting the necessary rights-of-way to allow the improvements to proceed.[78] By the time the week-long downpour ended on April 27, the Fulton County area was a sloppy mess. Darian Chasteen, the Memphis district's man in charge of the flood fight at Fulton County, found it difficult to address the significant number of sand boils developing in the area. On April 28, the Fulton County Detention Center sent roughly two dozen inmates to assist Chasteen, the Fulton County Levee Board, and the Kentucky National Guard in the flood fight. To help combat the mud, David Weatherly, the president of the levee board, secured three Hydratreks – tracked vehicles capable of navigating through the quagmire while hauling 1,000 pounds of sandbags. With the added resources, the flood fight team successfully gained control of several severe sand boils at the toe of the levee by constructing

Sand boil rings near the toe of the levee surround a home in Fulton County.
Inset: Darian Chasteen stands next to a sand boil ring in muddy Fulton County, Tennessee.

five-foot high sandbag rings to equalize the pressure. While Chasteen appreciated the inmates, referring to them as "lifesavers," he realized that he could not continue to treat the sand boils on an individual basis. More materialized and the crews, no matter how valiantly they tried, could not keep pace with their development.[79]

Chasteen, Nicholas Bidlack, a geotechnical engineer, Jack Ratliff, the area commander from the Dyersburg office, and Thomas Minyard, the Memphis district's chief of engineering and construction, met to discuss the situation. They knew the National Weather Service expected the river to rise at least another two feet. To a man they had reservations that the levee could withstand that kind of intense pressure for any prolonged period. They devised a plan to construct a berm perpendicular to the levee and extending approximately 1,500 feet to higher ground. They could pump additional water into the area enclosed by the berm, thereby creating a water blanket over the entire area to counteract the pressure from the river. If the flood fight team could not fight the sand boils individually, then they would create one, large sand boil ring over the entire area. It was a plan of last resort. It was also a plan that would take time to complete.[80]

While the flood fight continued at Cairo and Fulton County, residents and landowners in the floodway continued their evacuations. On April 25, Mississippi County Sheriff Keith Moore declared a state of emergency in the Birds Point-New Madrid floodway. Two days later, he and New Madrid County Sheriff Terry Stevens ordered all 230 residents in the floodway to evacuate. Missouri Governor Jay Nixon, who staunchly opposed the activation of the floodway, but respected the need for law and order, sent more than 700 national guardsmen to the area to assist with the evacuation and establish checkpoints to secure the homes and property once the people left. With water high on the riverside of the levee some 25 to 30 feet above them, people like Milus and Wanda Wallace, Mark and Rebecca Dugan, Larry and Cathy Allred, McIvan Jones, and hundreds of others packed their belongings, their treasures and heirlooms, and whatever they could move from their homes. As national media outlets covered Great Britain's royal wedding, floodway residents boarded up windows and tried to seal their homes with little attention other than from the local media. Farmers moved what equipment they could and tried to secure the rest. They also rounded up livestock and other animals and either sold them or whisked them away to nearby farms outside the floodway. Deer and turkey, too, seemed to sense the danger as they flocked to high ground on the levee. Utility crews removed electrical boxes. More ominously, crews from the U.S. Geological Survey placed sensors to measure the discharge if activation became necessary. Tension mounted across the floodway. Everyone just watched and waited. Aside from the river stabilizing and dropping, there was one last hope. If the river would not cooperate, perhaps the courts would.[81]

The previous Monday, the State of Missouri filed suit in the Eastern District Court of Missouri seeking a temporary restraining order to prevent activation the floodway. Missouri Attorney General Chris Koster sought the injunction on the grounds that operating the floodway violated the state's Clean Water Act and that alternative flood control methods, other than operating the floodway, could alleviate the flooding in the region. On April 27, after reviewing written affidavits, U.S. District Judge Stephen N. Limbaugh, Jr., announced his intention to hold an evidentiary hearing the following day. During five hours of testimony at the U.S. Courthouse in Cape Girardeau, Koster and his assistant, John McManus, attempted to prove that the activation of the floodway would contaminate bodies of water under the jurisdiction of the State of Missouri. Farmer Milus Wallace, a long-time owner of 2,300 acres in the floodway, testified that he used many forms of herbicides and fertilizer as part of his farming operations and stored those chemicals on property, as did other farmers in the floodway. Davis Minton, the deputy director for operations for the Missouri Department of Natural Resources, claimed that numerous petroleum storage tanks, farm chemical storage buildings, and liquid propane gas tanks dotted the floodway. Some of the tanks in the backwater area and other locations were cut off by interior flooding and could not be removed or cleared. Minton contended that the torrent of water released into the floodway through activation of the fuseplugs would wash away the storage tanks and contaminate surrounding bodies of water in the floodway. Knowing that the federal government was immune from suit under the federal Clean Water Act for activities related to the maintenance of navigation, Koster and his team attempted to divorce the navigation and flood control features of the MR&T project by arguing that it was the intent of Congress to do so.[82]

The legal team representing the federal government consisted of Nicholas Llewellen, of the U.S. Attorney's Office in St. Louis, and Department of Justice attorneys Ed Passarelli and Ty Blair. Relying on the expert testimony of Memphis district employees David Berretta, James Lloyd, and Robert Learned, the defense successfully demonstrated that the MR&T project was a comprehensive project that encompassed both flood control and navigation improvements. Berretta, in particular, testified that operating the floodway would pose less harm to navigation than if the floodway was not used because an unintended levee failure elsewhere in the system might lead to a shift in the course of the river that would disrupt navigation and harm commerce.[83] Limbaugh adjourned the hearing without issuing a ruling from the bench, choosing instead to weigh the information before him. The next day he finally rendered a decision. He denied the temporary restraining order. Koster appealed the decision to the Eighth Circuit Court of Appeals. The motion was denied. Undeterred, he appealed to the U.S. Supreme Court, but once again the State's request was denied. The path to floodway activation had been cleared if conditions warranted.[84]

By Saturday, April 30, landowners completed their mandatory evacuation of the floodway. The situation at Cairo and Fulton County appeared to stabilize after receiving aggressive flood fighting measures.

Conditions at those two trouble spots remained threatening, but the past few days of dry weather had helped, as had Peabody's reservoir directives. While the Cairo gage reached 59 feet for only the second time in history, the rate of rise had slowed considerably, due in large part to the diligent efforts by the LRD water control team to store water behind the Kentucky and Barkley dams. Throughout the day, though, any lingering hopes that the worst of the flood had passed began to crumble.

In the early morning hours, Bill Frederick released his latest daily weather report. For several days those reports warned of another round of rain slated to begin on April 30, but the slim possibilities remained that the expected weather system would shift to the north or south or even potentially dissipate. Unfortunately, none of these scenarios materialized. Frederick reported that the National Weather Service expected a frontal system to become stationary along the Arkansas and Ohio valleys later in the evening, bringing another round of intense rains – up to 7.5 inches – lasting through the afternoon of May 2. The area was already completely saturated. Most locations within a 50 miles radius of the confluence area had been pounded with at least ten inches of rain between April 20 and April 27. Some locations in southeast Missouri, northern Arkansas, southern Illinois, and western Kentucky and Tennessee received anywhere from 12 to 16 inches of rainfall during that same period. Any new precipitation could not be absorbed; the rain would immediately turn into runoff and cause the rivers to swell even higher.[85]

Despite the expected rainfall, the National Weather Service did not raise the projected crest for the Cairo gage. They continued to call for a crest of 60.5 feet, but moved the crest date from May 1 back to May 3. Peabody, though, had a problem. The LRD reservoirs were filling up. He needed to increase releases from Kentucky and Barkley dams immediately to retain storage if the forecasted rainfall fell behind the reservoir system. At Kentucky Dam, the pool elevation climbed to within feet of overtopping the cofferdam at the new lock under construction. He could not afford to lose that project. Peabody ordered the increase of releases to stabilize the pools and conserve storage. By the next morning – May 1 – Kentucky and Barkley dams were releasing nearly 2.5 times the amount of water from the previous day into the Ohio River.[86]

At 1030 hours on April 30, Col Reichling provided another decision brief over the telephone to Maj. Gen. Walsh. At the time, Walsh and Peabody were in a small office in the Cincinnati-Northern Kentucky International Airport preparing for a flyover of the flood-stricken region in Peabody's area of operations. Reichling informed the commission president that the Cairo sector flood fight team had discovered a third large high-energy boil the previous day. While his engineers did not believe the floodwall was in imminent danger of failing, they advised Mayor Childs to start a mandatory evacuation. Furthermore, flood fight teams at Fulton County discovered more sands boils. "Sir, my engineers are concerned about the levee system performance at Cairo and Fulton County at these current stages!" Reichling reported before recommending that Walsh authorize the move to H minus 21 in the operational timeline. H minus 21 equated to breaking up the tows and positioning the barges on the frontline levee at Birds Point, but stopped short of mixing and pumping the explosive slurry into the buried lines in the levee. Reichling knew he was running out of time. Walsh knew such an action would create a stir with the public, the press, and the politicians. He wasn't ready to act yet. He still believed that activating the floodway might not be necessary and he still recalled Lloyd's advice. Instead of approving the recommendation, he modified it by ordering the motor vessel *MISSISSIPPI* and the barges to move from Hickman, where they had been staged since April 27, to Wickliffe, Kentucky, some three hours closer in the operational timeline to Birds Point.[87]

Following the briefing, Walsh, Peabody and their staffs conducted an aerial tour of the Ohio basin. High pool elevations and backwater flooding at the reservoirs along the Cumberland and Tennessee rivers were evident from the air, as were the dire conditions at Evansville, Smithland and Paducah, not to mention Cairo, which remained a virtual island. The amount of water was staggering. It was everywhere. Deborah Lee could not mask her deep concern over what she saw. She and the others on the flight found it difficult to discern where the normal channels of the Ohio and Mississippi ended and the surrounding low-lying floodplains started. "I knew I was sitting on a ticking time bomb," she later remarked. When she first arrived at LRD in July 2001, George McKee, the long-time hydrologist who taught Lee how to manage flood operations, told her, "If we ever hit 13 percent [of total system storage capacity], build an ark!" On April 30, that percentage approached 30 percent."[88]

Upon arrival at the Sikeston Memorial Municipal Airport, Walsh and Peabody met up with fellow commissioner R.D. James and began the 20-minute drive to Cairo to inspect the mega boil that had developed near the floodwall. When they arrived, they found a throng of reporters, cameramen, and photographers crowded across the access road to

Thomas Morgan (left), Maj. Gen. Walsh, and Capt. Todd Mainwaring at the Cairo mega boil.

the boil, partially blocking their view. As they made their way past the crowd they were stunned by what they saw. It was the largest sand boil ring any of them had ever seen. For that matter it was the largest that even the most seasoned and experienced flood fighters had ever seen. "My God," Col. George "Thatch" Shepard, the commission secretary, exclaimed, "That's not a sand boil; that's more like a swimming pool!" The commissioners and accompanying staff made their way to the massive ring, where Chip Newman and Tom Morgan were busy raising the ring berm and shoring it up with rock. Newman and Morgan detailed the dramatic effort they and their crews had accomplished to prevent the failure of the floodwall. Walsh, Peabody and Reichling huddled with Mayor Childs. He was considering a mandatory evacuation. They turned to the press and began answering their questions. As they did, the National Weather Service released a new contingency forecast of 61.5 feet for the Cairo gage on May 4. That height would be nearly 2.5 feet higher than the gage reading that morning.[89]

Walsh and fellow commissioners, Angel, James, and Smith, returned to the levee at Birds Point. Water reached high on the riverside of the levee. Three feet of freeboard – the distance between the top of the river and the top of the levee – still remained where the access wells were located, but only one foot remained at the fuseplug sections where the levee was constructed to an equivalent height of 60.5 feet on the Cairo gage. Members from the floodway task force once again described the processes for filling and charging the lines. Lloyd reiterated his recommendation to Walsh to load the pipes only if he intended to activate the floodway.[90]

Following the briefing, Walsh, Peabody, James, Reichling, and various staff members climbed into a van bound for the Sikeston airport. They learned that Childs issued a mandatory evacuation for Cairo. The commissioners held serious discussions about precipitation forecasts, river stages, and operations. They knew the tide was turning again. What was already a major flood was about to become a monster flood, perhaps even the project design flood. The discussion turned to Peabody. *Could he hold back more water?* He told the commissioners that he was doing all that he could. Four reservoirs were already at or near spillway operations. LRD was nearing record pool elevations at numerous reservoirs across the Cumberland, Tennessee, and lower Ohio basins. The reservoirs backed up water everywhere in Kentucky, Indiana, and Tennessee. He would continue to hold as much as he could for as long as he could, but he could not lose the cofferdam at Kentucky Lake.

After dropping off the commissioners, Reichling, Lloyd, and Julie Ziino, Reichling's forward operating executive assistant, sat in the van outside the airport and reflected on the day's developments. It had not started raining yet, but they were deeply concerned. They knew Peabody could not hold back much more water. He had to release it. When he did, the river would go up quickly. At that point a realization swept over Lloyd. He turned to Reichling and said, "We're going to operate." Reichling looked him back in the eyes and replied, "You're right." In that brief instant, Reichling, Lloyd, Ziino, and the entire floodway task force transitioned from preparation to execution mode. A few hours later, the rain started to fall. At 0200 hours on May 1, the river on the Cairo gage surged past 59.5 feet. The river had never before reached that high on the gage and it continued to climb.[91]

The Decision

At 1000 hours on Sunday, May 1, Maj. Gen. Walsh, Sam Angel, and R.D. James arrived at Cape Girardeau Regional Airport to hear Col. Reichling's latest decision brief. Reichling did not waste time getting straight to the point, "Sir, we have moved from an 'if' to a 'when' situation." With this in mind, he recommended three immediate actions. First, he requested permission to move to H minus 3 in the operational timeline, which meant moving the barges into position at the frontline levee and loading the pipes with explosive agents. Second, he recommended contacting the county sheriff to give him 24 hours to begin the final sweep of the floodway. He also wanted permission to advise the U.S. Coast Guard of the decision to move to H minus 3 so they could issue a notice to mariners. Reichling clarified that he was not asking for permission to activate the floodway, but he explained that for the safety of the workers, they needed to begin loading immediately. The safety plan called for crews to be off the levee by the time the Cairo gage reached 60.5 feet, which according to his forecasters would happen sometime between 0300 hours and 0400 hours on May 2. They were running out of time. The floodway task force needed to move immediately.[92]

Walsh, though, was not ready to load the pipes. Looking at the current and anticipated stages and realizing how long it would take to complete preparations for floodway activation, he still thought he had more time. He understood the safety risks and adverse conditions the crews would face, but he wanted to balance that with the risk of loading prematurely. Lloyd's advice to Walsh on the levee not to load the explosives unless he planned to detonate had made an impact on the commission president's thought processes. Walsh was still not convinced that floodway activation would ultimately be necessary. Instead of approving Reichling's recommendation, Walsh ordered the tows to move from Wickliffe to the levee at Birds Point. He asked to be briefed again at 1500 hours.[93]

Col. Reichling appeared shocked, perhaps even angry, that Walsh denied his recommendation. His jaws clenched; his face reddened. He may have come to his realization the previous night, but his superior officer had not. Reichling quickly recovered, though, and acknowledged the order. He still had a major flood fight on his hands. His team needed leadership.[94] At Fulton County, Darian Chasteen remained deeply concerned about the integrity of the levee. Construction of the water berm had commenced at 0500 hours. The contractor, James Coffey, was making good progress under the circumstances, but the standing water and deep mud proved to be tough obstacles. A driving rain pounded the area – another three inches fell in the county that day. The river exerted unprecedented pressure. New sand boils exploded into existence. The levee was coming apart. Chasteen knew it would not hold much longer. He desperately needed to know if and when Walsh would give the order to operate the floodway. Chasteen needed to ease the pressure on the levee through activation of the floodway or he needed the water berm to counteract the pressure – perhaps he needed both. He and the team were losing the fight.[95] A little farther north at Cairo, the heavy rains had caused a new problem. Chip Newman and his crew raised the berm around the massive mega boil to a height of almost 13 feet to combat the increased pressure from the rising river. That was not the main concern, though. The heavy rains had saturated the flyash berm. The berm turned to mush. It began to fail. Newman and his crew set to work immediately in the cold driving rain to cover the berm with plastic and reinforce it with rock. The city of Cairo could not afford to lose the berm.[96]

Back at Birds Point, the floodway task force crews assembled prior to 0700 hours in anticipation of receiving the order to load the explosives sometime after the 1000 hours decision brief. They were eager to get to work. Not that they wanted to activate the floodway – no one did – but they knew what lay ahead. Davis and Lloyd had prepared them mentally to handle the difficult assignment under less than ideal circumstances. Like Col. Reichling, they knew they were running out of time. They were on the levee. They saw the river creeping higher and higher into their work space. Davis described the workers as "attack dogs on short leashes." They were ready to go. After receiving instruction to stand down, Davis and Lloyd set out to keep them focused. "We were trying to keep their heads in the game, trying to keep them from wandering off," Lloyd later recalled. Having already come to the realization that activation was *fait accompli* in his own mind, Lloyd knew that Walsh eventually would reach the same conclusion. The crews had to be ready to go when he did.[97]

At around 1500 hours, Col. Reichling, the civilian members of the commission, and assorted members of the division, district, and commission staffs waited patiently in the airport conference room for Maj. Gen. Walsh. It was raining hard again. A thick sense of tension permeated the room. *What will Walsh do?* The question entered everyone's mind. They had to wait for the answer. Walsh was in a nearby room engaged in a telephone conversation with Robert Fitzgerald, chief of engineering at the division office. Fitzgerald provided Walsh with his engineering assessment of the levee system in the confluence area. The river had never before reached its current stage. Likewise, the pressure on the levee system had never been this great. Fitzgerald voiced his opinion that the commission and the Corps of Engineers could manage the flows under existing conditions, but the system was beginning to unravel. It was the last advice Walsh received prior to the decision brief.[98]

Walsh entered the conference room for the briefing and took his place at the table next to Col. Reichling. Bill Frederick, calling in from the commission's emergency operations center in Vicksburg, led things off. Those sitting at the table leaned in slightly closer to the speaker phone to hear Frederick's thin voice over the driving rain that pelted the windows of the airport conference room. His report did not contain a shred of good news. The latest weather forecasts called for an additional three to five inches of rainfall over the Ohio basin over the next 24 hours, with the heaviest rains coming after dark. With the Cairo gage reading 59.9 feet and rising at 1400 hours, Frederick informed Walsh that the river would move above 60 feet within the next few hours and would break 60.5 feet late in the morning of May 2. The National Weather Service expected the river to remain above 60 feet for nine days and above 61 feet for 5 days, with a forecasted crest of 61.8 feet on May 4. Frederick then tossed in a wild card for Maj. Gen. Walsh to consider, "The National Weather Service is concerned that heavy localized rainfall will cause stages to spike even quicker than forecasted."[99] That caution would later prove prescient.

David Berretta and Tom Minyard phoned in their reports. Berretta went first, giving a quick snapshot of the reservoir operations in LRD. His report contained more bad news. Kentucky and Barkley lakes had reached record pool elevations and continued to climb. On the morning of April 27, those lakes utilized only 21 percent of their flood storage. On May 1 they were at 74 percent and 70 percent, respectively. Half of the flood storage pools filled with water in just four days.[100] Deborah Lee and the LRD water control team had done a masterful job of skillfully managing the reservoir system along the Cumberland and Tennessee rivers and they continued to try to match releases from Kentucky and Barkley dams with the amount of water flowing into the reservoirs. The reservoirs that fed into Kentucky and Barkley lakes, though, were filling at a rapid pace.[101] LRD could not hold back much longer. They would need to release water soon. Minyard followed with his own engineering analysis. The entire levee system in the Cairo to Caruthersville reach remained under tremendous stress. Newman and his crew had kept the existing boils at Cairo stabilized. No new high energy boils developed, but a significant number of sand boils materialized at Fulton County. Conditions at Lake County and Caruthersville continued to degrade.[102] The levee system was holding, but it faced unprecedented pressure with each passing hour and would have to continue to handle that pressure for at least another nine days, maybe longer.

The mood in the room can only be described as sobering. Rain continued to lash at the conference room window; the rumblings of thunder to the west hinted that more severe weather was on the way. Russell Davis spoke next. As the chief of operations for the Memphis Engineer District, he was Col. Reichling's man on the ground. It was his responsibility to prepare the floodway for activation once Walsh delivered the order. He got straight to the point, "Sir, bottom line up front: we need to move to H minus three." Davis recommended breaking up

The 1500 hours decision brief on May 1, 2011, at the Cape Girardeau Regional Airport. Seated at the table from left to right are Sam Angel, R.D. James, Stephen Gambrell, Col. Vernie Reichling, Maj. Gen. Michael Walsh, Edward Belk, and Richard Lockwood. Dennis Norris is seated against the window between Reichling and Walsh.

the tows, positioning the equipment and vessels at the frontline levee, filling the buried pipes with explosives, rigging them for detonation, and then going into a holding pattern awaiting command to activate the floodway if necessary. It would take roughly 18 hours to make the preparations. He then articulated his overriding concern – the safety of the work crews. Less than two feet of distance stood between river levels and the top of the levee at some locations where work needed to be done, and the river continued to rise at an alarming rate. Darkness, additional pounding rain, and the possibility of lightning concerned him. Davis ended his report, "Sir, we need to get the work done as quickly as possible for the safety of our crews."[103]

Col. Reichling closed the briefing with a passionate plea, 'Sir, conditions are continuing to degrade. You can hear the rain outside lashing against this building. The river is rising fast. We need to prep now!" Reichling explained that under the operations plan, preparations to activate the floodway should have been completed by the time the Cairo gage hit 60 feet and "we are there right now." With the river rising at a rapid clip, his crews would eventually run out of levee to work with.

Reichling warned that even if everything went according to plan, his crews would be cutting it close. "We run the risk of not being able to put this 'safety valve' to use if we need to operate later," Reichling emphasized as he ended the briefing.[104]

All eyes in the room turned toward Maj. Gen. Walsh. He calmly removed his reading glasses, placed one of the arm pieces in the corner of his mouth, and leaned back slightly in his chair. He was deep in thought, weighing and processing all of the information just presented to him. Col. Reichling, Walsh's man on the ground, wanted to move now, but Lloyd, the subject matter expert on the operations plan, advised him not to load the pipes unless he intended to blow the levee. Walsh still remained uncertain that he would eventually give that order. Fitzgerald, his engineering chief back in Vicksburg, indicated it might be possible to manage the flow if conditions did not worsen, but Minyard's systems analysis pointed to rapidly deteriorating conditions. Maj. Gen. Peabody was holding back as much water as possible, but Frederick warned of localized rain possibly causing a spike in river levels regardless of the LRD reservoirs. Davis cited concerns about crew safety – one loss of life would render the operation a failure. Perhaps most conflicting was the fact that across the table sat R.D. James. As a landowner in the floodway, James personified every single person who lived or owned property in the floodway and he symbolically brought each and every one of them into that conference on that cold and rainy day. That often-repeated quote from Maj. Gen. Markham after the 1937 activation of the floodway suddenly flashed through Walsh's mind. *I am now of the opinion that no plan is satisfactory which is based upon deliberately turning floodwaters upon the homes and property of people even though the right to do so may have been paid for in advance.* The quote weighed heavily on Walsh. His decision would impact lives.[105]

Walsh sat back at attention, looked across the table, and asked the two members of the Mississippi River Commission present if they had anything to add. R.D. James looked forlorn. His normally broad shoulders slumped forward; both forearms resting on the conference table as he stared at the pen that he slowly twisted in his hands. He looked like he had something to say. He and his family had a financial stake in the decision being made, though, so he recuesed himself from the discussion. He only offered his support to Walsh's decision – whichever way that decision went. Walsh then turned to Sam Angel. A 32-year member of the commission, Angel knew what the decision needed to be – everyone in the room did. He looked at Walsh, shrugged his shoulders and nodded his head in deference to as if to say, *This is a tough decision, General, but it is your decision to make.*

Walsh still did not announce his intentions. He turned to two of his trusted advisors, Edward Belk and Dennis Norris. Belk, a 24-year veteran of the Corps of Engineers, served as the chief of programs for the division office. More importantly he had cut his teeth in the Memphis Engineer District, serving as the chief of project development, executive assistant to the district commander, and the deputy district engineer for project management. He knew the Memphis Engineer District. He knew its projects. He knew the people it served. "Sir, with the forecast facing us, our window to prep is getting smaller," Belk calmly advised, "H minus three and hold is where we need to be." Norris, the commission's respected chief of operations, spoke next. He began his career with the Corps of Engineers in 1980 and spent 30 of those years in the operations sector. He was a river man; someone who got things done. When he spoke, his words carried weight. If Belk knew the Memphis district, then Norris knew operations like no other. "Sir," Norris calmly stated in his reassuring southern drawl, "in ops things never go as planned. Recommend we go to H minus three." His words would prove prophetic in a few hours.[106]

Walsh nodded in recognition. "In six days the Cairo gage has gone up six feet," he announced. "Go to H minus three and give me a progress report every two hours." He had made the decision to move.[107]

Activation

At Birds Point Davis relayed Walsh's approval to deploy the barges to the inflow crevasse site and commence pumping operations. The plan was for the tender *GOODWIN* and one pump barge to begin filling the lines at the lower end and work their way upriver. The motor vessel *STRONG* and the second pump barge would start at the upper end and work their way downriver. As the vessels moved into position on the frontline levee, Davis, Lloyd, Durst and other task force leaders met to discuss the impact of weather conditions on the operation. The primary concern was lightning. Even though the explosives components were extremely stable and not yet primed, Durst advised against commencing pumping operations until the threat of lightning had cleared. Davis and Lloyd concurred. The task force would wait out the storm before commencing work. If Walsh had his own timeline in mind throughout the entire decision-making process, he had not accounted for lightning. No one had, not even Lloyd, one of the developers of the operations plan. "Working at night didn't bother us. Rain didn't bother us," Lloyd recalled, "but when those thunderstorms popped up, we had to shut down."[108] Dennis Norris was correct; things were not going as planned. Davis notified Walsh of the delay just prior to the general's press conference with Governor Nixon. The river climbed passed 60 feet on the Cairo gage and approached 60.5 feet.

At 1930 hours, Davis informed Walsh that the crews remained in a holding pattern awaiting a break in the weather. After completing the press conference with Governor Nixon, Walsh established his command post on the motor vessel *MISSISSIPPI*, which was moored in the river channel approximately one mile south of the Birds Point-Cairo bridge. Walsh, Angel, James and the commission staff boarded the *MUDDY WATERS*, a small survey boat, and made the long trip to the *MISSISSIPPI* in the driving rain. As he boarded the vessel, Walsh received a note from J. Lawrence Barnett, lead counsel at the division office, informing him that the Supreme Court denied the state's request for an injunction. The floodway survived the legal challenges, but if the task force could not prepare it for activation, the point was moot. High winds continued to rock the *MISSISSIPPI*. Walsh listened to the rain lashing against the windows and decks. These were the heaviest rains yet, but he remained confident, adamantly so, that the system could manage the flows without the use of the floodway. A mile away at Birds Point, Davis shut down the operation. The National Weather Service did not foresee an end to the severe weather until after 0100 hours at the earliest. The crews were mentally exhausted having experienced so many varying degrees of highs and lows throughout the day. They needed rest. At 2200 hours, he ordered them back to quarterboats for a few hours of dry downtime. As the rain and lighting picked up in intensity and the river broke new stage records by the hour, everyone involved in the operation wondered if this last storm would be the event that would break the back of the operations plan and the MR&T project.[109]

At 0400 hours on May 2, Frederick informed Walsh that the area continued to receive higher than expected localized rainfall. The previous day, three inches of rain fell over Cairo and Paducah. More than that fell over Fulton County, where the flood fight team continued to build the water berm to stabilize the severe underseepage that threatened the levee. The Cairo gage was only three inches shy of 61 feet. The National Weather Service's latest forecast, issued at 0230 hours, still projected a crest of 61.5 feet on May 4, but the river continued climbing faster than predicted. The persistent and heavy localized rains hammered areas not protected by the LRD reservoirs. Frederick indicated that the forecast center would begin additional model runs in the next few hours. He promised to keep the general posted on any development. For the first time Walsh's confidence that the system could manage the flows started to erode. Four hours later, it completely evaporated. The National Weather Service informed Frederick that the latest models projected a crest of 63.5 feet on the Cairo gage on May 5. Upon hearing the news, a recent memory popped into Frederick's mind – a memory of the time he stood face-to-face with Walsh's predecessor, Brig. Gen. Robert Crear, on August 29, 2005, and informed him that the storm surge from Hurricane Katrina would probably overwhelm the levees at New Orleans. He could still visualize the long, silent and awkward stare on Crear's face and the slow nod of his head in acknowledgement of the news. Frederick shook off the memory and notified Walsh of the forecast.[110]

At 0800 hours, Maj. Gen. Walsh held a teleconference with all of his district commanders and his crisis management team. Just prior to the call, Maj. Gen. Peabody reported that conditions on the Ohio River were deteriorating. He confirmed the sentiment shared by Frederick a few hours earlier. The heavy rains fell outside of the storage capabilities of the LRD reservoirs. The mayor of Smithland, Kentucky, ordered a mandatory evacuation. As Walsh took his seat at the conference table on the motor vessel *MISSISSIPPI*, Frederick delivered another blow. The National Weather Service anticipated another one to four inches of rain to fall over the next 24 hours. The heavy rains of the previous night had not only hit the confluence area and the Ohio Valley, but they had

R.D. James buries his face in his hands after hearing the updated forecast crest of 63 feet at the Cairo gage during the 0800 hours briefing on May 2, 2011, in the second floor conference room on the *MISSISSIPPI*.

also pounded the Arkansas Valley. The flood was moving south and it was growing. The weather service expected the lower Mississippi River at Arkansas City to rise by two to four feet. Col. Thomas O'Hara, commander of the St. Louis Engineer District, reported Lake Wappapello overtopped a rock berm constructed across the emergency spillway at 0200 hours. O'Hara expected the pool to rise another five feet before cresting, which would result in excess of 25,000 cfs being released into the St. Francis River and additional flooding downstream.

Col. Reichling spoke next. Normally possessing a reserved demeanor, Reichling was anything but that on this day. He talked rapidly, which lent a sense of urgency to his report. He notified Walsh that the task force commenced pumping operations at 0500 hours. The crews discovered medium-sized sand boils along the frontline levee. They also reported water flowing over the fuseplug section of the levee; the floodway was going into passive operation. Conditions continued to deteriorate across the region. The mega boil at Cairo grew and began piping sediment again. Sinkholes appeared below the elevated railroad tracks on the north end of the town. His engineers questioned the integrity of the floodwall. Significant underseepage continued to plague Fulton County. Failure of the levee was not imminent, but the number and size of the new boils presented a major concern. Chasteen and his crew continued to construct the water berm, but it would take at least another day to complete it. Because of the situation at Lake Wappapello, Reichling reported that his engineers were concerned about the potential for levee overtopping in the upper St. Francis basin. At the lower end of that basin, the W.G. Huxtable pumping plant at the St. Francis backwater area operated at full capacity. Flood fight teams were also concerned about rising river levels on the Commerce to Birds Point levee. The levee faced additional pressure because the Len Small private levee had held thus far. The freeboard levels at the Tiptonville levee and the floodwalls at Hickman and Caruthersville were slowly disappearing. "The system is holding," Reichling ended his report, "but it is showing considerable strain."[111]

Passive activation of the floodway. The Mississippi River overtops the lower sections of the Birds Point-New Madrid floodway fuseplug levee early on May 2, 2011.

At the floodway, crews had assembled in the early morning hours at the inflow crevasse and commenced pumping operations. Rain continued to fall, but the lightning shifted to the west and the north, clearing the way for work to begin. The task force lost nearly a full day's work due to the lightning. Lloyd was on the levee to monitor the operation; Davis and Reichling remained at their command post to provide top cover. The *GOODWIN* crew, at first, worked deliberately. It took more than an hour to fill the first line. The only prior experience the crews had involved test operations conducted on 400-foot sections in dry and sunny conditions. The May 2 operation was not an exercise – it was the real thing. The crews braved cold temperatures and stinging rain made worse by blustery winds. Their work space on the barges, where they mixed the liquid blasting agent with aluminum powder, was limited and

The Goodwin and pump barge at the Birds Point-New Madrid floodway. Note the cloud of aluminum powder dust.

surrounded by a rising river on three sides. The gangplanks were small and the levees were muddy. Footing everywhere was slippery. Clouds of aluminum powder dust floated about and coated everything. The crews dragged heavy hoses across the soggy levee and connected them to the pipe fittings in the wells. One thousand feet away, a crew member stood prepared to signal when the line was full. Each 1,000-foot segment had three lines to be filled. The explosive slurry was a thick mixture so it took considerable pressure to move it through the pipes. When the line was full and crews attempted to remove the hose, the back pressure caused the hose to whip around for a few seconds, spilling the slurry. A member from the ERDC explosives team moved in immediately once the line was full and placed the blasting cap and detonation cord in place. As they progressed down the line and became more comfortable with the operation, they reduced the fill time to 60 minutes.[112]

At the upper end of the inflow crevasse site, though, the *STRONG* crew and its pump barge encountered their first problem. The frontline levee in their area of operations took on a horseshoe shape. This was a direct result of the 1937 operation of the floodway, which caused a massive scour hole. When the Memphis district rebuilt the levee, they rebuilt a section around the scour hole, creating the large bend. The bend was part of the levee to be crevassed; it contained access wells that needed to be filled. The problem was not the bend; the problem was a spur levee – a levee projecting from the frontline to direct erosive river currents away from the frontline levee – that blocked the entrance to the bend. The *STRONG* had a seven-foot draft and could not navigate over the spur levee to push the pumping barges into place. To alleviate this problem, the task force used the *WARD*, which could safely navigate

Members of the floodway task force provide the Mississippi River Commission with an operational update.

over the spur because it only had a five-foot draft. As the *STRONG* and *WARD* burned up valuable time jockeying the pump barge into position around the bend, one of the mix pump units began to break down, causing the operation to slow even more considerably.[113]

After a brief visit to observe operations along the frontline levee, Walsh and R.D. James met with Reichling and Davis. Davis informed Walsh that the crews would complete pumping operations in 12 hours. It was 1030 hours, so by Davis's timeline, the floodway would be ready for activation by 2230 hours. Walsh, though, wanted a plan to get the job done in eight hours. He intended to operate the floodway; however, he was not prepared to make his decision official. He would wait to inform governors Nixon and Quinn of his intentions until after the new timeline had developed. Reichling reminded Walsh that the river already exceeded 61 feet on the Cairo gage. They were already past the trigger point for activation in the operations plan. Reichling voiced his

Members of the floodway task force prepare the explosive slurry mix.

primary concern – preparing the outflow channels at the lower end of the floodway. Reichling was confident the task force would complete the preparation at the inflow site, but he expressed concerned about having enough time to prepare the two outflow channels at the lower end of the floodway. According to the operations plan, preparations at all three sites were to be complete in advance of the gage reaching 60 feet. If Walsh unleashed up to 550,000 cfs into the floodway with the lower outflow areas remaining closed, he risked overtopping the set back levee at New Madrid. Walsh reiterated his demand. He would not make his decision official until he received a new and shortened timeline.[114]

After the meeting Walsh, James, and Stephen Gambrell, the commission's executive director, climbed into James's white Denali and set out from Birds Point for a visual inspection of the situation at Cairo and to meet with Governor Quinn, who was scheduled to hold a press conference. As they headed out of Missouri on Interstate 57, they observed the result of the persistent rains of the past 10 days, particularly the deluge that hammered the area the previous night. Water was everywhere. It covered low-lying fields for as far they could see. The water went right up to the elevated highway. The ditches separating the north and southbound lanes were flooded. Conditions were worse once they crossed into Illinois. Sheets of water flowed across Route 3, the main road leading to and from Cairo. At the entrance to the city, two police cars blocked the tunnel through the massive levee and railroad embankment. James stopped the truck. A police officer checked their credentials and then waved them through. As they travelled down Sycamore Street, they noticed the town looked deserted. Everything was saturated. A thin layer of water covered the paved street and sidewalks. As he turned left on 40th Street – the road leading to the mega boil – James noticed Mayor Childs trying to flag down his vehicle. James pulled over and rolled down the window. Childs, soaked from the steady downpour falling on the city, leaned his head in the window. "General,' he said, as water ran from his ball cap onto Walsh's lap, "we are ready for your decision!"[115]

After a brief inspection of the mega boil, where Chip Newman, Tom Morgan, and the flood fight team were raising the ring berm to match the rising river and the pressure it exerted, Walsh, James, and members of the commission staff climbed to the top of the floodwall in a steady downpour. As they reached the top, the view before them was unbelievable. The floodwall that usually towered above them when they made periodic visits to the city during their high and low water inspection trips barely stuck out of the water by a few feet. At that moment, the Cairo gage read 61.1 feet; nearly 2.5 feet lower than the projected crest. The river looked angry, violent. Chocolate colored waves crashed against the floodwall. James turned to Walsh and shouted through the howling wind, "General, there is nowhere for this water to go." Walsh shook his head as if to acknowledge the comment and register his disbelief at what he was seeing. "Can you imagine what this river is going to look like at sixty-three?" James yelled. Walsh shook his head again.[116] If he could help it, the river would never reach 63 feet on the gage, but that depended on the floodway task force fulfilling its mission.

Back at Birds Point, as Lloyd monitored the pumping operations, he realized that the task force was running through the supply of liquid blasting agent at a rate not consistent with the amount of pipes that had been filled. If this continued, there would not be enough explosives to fill the lines at the inflow/outflow sites at the lower end of the floodway. Lloyd began conferring with crew leaders to determine the cause of the problem. Col. Reichling heard Lloyd's discussion with the crew leaders over the radio. He asked for Lloyd to come to the command post to give him an update. Lloyd told Reichling, "Sir, we've got issues. We need to make a change." He explained the operation was using up too much of the liquid blasting agent. He was not certain whether this was due to waste or the product was getting lost in the lines, but his bottom line was "right now we don't have enough liquid to get the job done."

Jim Lloyd discusses options with Russell Davis (left) and Col. Vernie Reichling at Reichling's command post.

The task force needed to conserve enough liquid to prepare the lower inflow/outflow crevasse site; the other middle inflow/outflow site was not important. Lloyd explained that the middle inflow/outflow site was designed for use with the 1,500-ft gap at the bottom of the levee closed as part of the St. John's Bayou-New Madrid floodway pumps project. The project had been delayed, so the gap remained open. To conserve liquid, Lloyd recommended abandoning the uppermost access wells at the bend. Doing so would reduce the length of the crevasse site from the planned 11,000 linear feet to 9,000 linear feet, thereby reducing the amount of flow into the floodway, but he believed the crevasse would draw off enough water to get the desired reduction in stages across the system. Lloyd's plan involved allowing the *GOODWIN* crew to continue working up the line because they were making decent progress. Lloyd, though, wanted the *STRONG* to cease operation once it had completed filling the wells at the horseshoe section and proceed downriver to commence operations at the lower inflow/outflow crevasse site. Reichling conferred with Berretta, who validated Lloyd's conclusions. The plan fit Walsh's directive to Davis to complete the preparations in eight hours. "Go. Make it happen!" Reichling told Lloyd.[117]

At 1515 hours, the *STRONG* departed for the lower inflow/outflow crevasse site. Lloyd resumed monitoring the *GOODWIN* crew. The Cairo gage read 61.3 feet. As he looked at the clock and watched the river rise, he realized that the operation was taking too much time. Before long, there would not be much levee to work with. The crews had been concerned about spillage and waste, but Lloyd was more concerned about speeding up the process. He instructed the crews to run the equipment at a higher rate. He needed to reduce the fill time from 60 minutes to 20 minutes.[118] At the command post, Davis briefed Walsh on the shift in the operation. Davis explained that Reichling had approved dividing the crews and sent the *STRONG* downriver to commence preparations at the lower inflow/outflow site. He then articulated the limitations of the plan. The plan meant the task force had to

Russell Davis explains the task force's accelerated plan with Maj. Gen. Michael Walsh as Col. Thatch Shepard and Col. Vernie Reichling look on.

sacrifice any redundancies. If one of the *GOODWIN*'s pumps went out of commission for any reason, they had no back-up measures to institute. They would have to proceed with a single pump. He also informed Walsh the plan necessitated giving up a section of the fuseplug. Model tests confirmed an acceptable reduction in stages, despite the smaller crevasse. Last, he informed Walsh about the shortage of liquid blasting agent. The task force faced the prospect of running through its supply before it could prepare the middle inflow/outflow site for operation.[119]

After the briefing, two additional civilian members of the commission, Sam Angel and William Clifford Smith, joined Walsh and James at Reichling's command post. Tension grew in the cramped command post. Reports from the field detailing the immense stress and pressure on the flood control system flowed in on a continual basis. Walsh was being overwhelmed by email messages that begged him to activate the floodway immediately and an equal amount pleading for him not to. Rain and wind continued to lash against the command post as a constant reminder of the rough weather outside. Even during the intermittent dry spells, the television cycled the Doppler radar depicting a narrow band of storms centered over the confluence area and the Ohio River. "It just keeps raining," a dejected Stephen Gambrell complained as he watched the radar, "it just keeps raining!" Then Frederick delivered more bad news. The National Weather Service released its forecast for the entire lower Mississippi River. The service predicted record stages at Greenville, Vicksburg, Natchez, and Red River Landing over the next three weeks. At approximately 1630 hours, Walsh initiated the official notification process. He called Governor Nixon and informed him that he would have to operate the floodway sometime between 1900 hours and 2400 hours. Nixon was gracious in his response and thanked Walsh for keeping him informed. Walsh and Gambrell made additional calls to other congressional members from the tri-state area. Walsh sent a note to Maj. Gen. Peabody asking him to inform the governors of Kentucky and Indiana. Peabody responded that both supported his decision.

Next, he called Governor Quinn. Walsh then informed the media of his decision to operate.[120]

By 1900 hours, Lloyd and his crew completed the pumping operations. They had filled 27,000 linear feet of lines with approximately 115 tons of explosives. It would take the ERDC crews approximately three hours to charge the lines and establish a blasting site approximately 5,000 feet from the fuseplug. The river stymied their efforts. Water encroached up the gravel road surface and threatened to inundate two wells, forcing the ERDC team to build sandbag rings to keep the water out prior to detonation. In the meantime, national guardsmen completed their final sweep of the floodway. At 2030 hours, Reichling informed Walsh that the floodway was 45 minutes from being operational.[121]

The tension in the command post thickened – minutes seemed like hours. R.D. James knew the time for activation was imminent. Try as he might, he could not displace thoughts of what the operation of the floodway would mean to his friends and neighbors. He also worried about the ultimate fate of his own farm. He stared at the flood and quietly "prayed for the safety of all involved and for all affected." While everyone in the command post was tired, James looked completely fatigued. The past week had taken its toll on the 30-year veteran of the commission. As a member of the commission, he was well-known through the entire confluence area. Both Walsh and Reichling relied on him as a liaison with elected officials from Missouri and local levee districts. Not only was he a local, who owned land in the floodway, but he was also a native of Hickman on the Kentucky side of the river. Throughout the week, parties from both sides of the river besieged him with questions and concerns. Floodway landowners begged him for constant updates. City leaders from New Madrid asked for his advice on the possibility of issuing an evacuation order. Acquaintances and officials in Fulton County pleaded with him to provide insight into Walsh's thought processes. Missourians everywhere wanted to know if the Commerce levee would hold. Perhaps nothing weighed on his mind more than the date – May 2 – which was his beloved daughter's birthday. Virginia Elizabeth James had passed away in 1996. She was only nineteen years old. A wide range of emotions danced through his conscience as his mind raced from topic to topic. Finally, James broke the silence in the command post by asking Gambrell to lead everyone present in a prayer. Gambrell obliged:

> We remember God's Word ... I John 1:9 "If we confess our sins, He is faithful and just to forgive us our sins, and to cleanse us from all unrighteousness." Father, in a time like this when we don't know what to pray we ask for You to intercede for us and for all the people who will be helped and harmed by the results of the actions we take. We acknowledge that You are the only one who can forgive sin, restore hope and truly help. In Jesus strong name we pray, Amen.[122]

From the blasting site, Lloyd notified Reichling, "Ready to operate on your order."

Reichling entered the command post, "Sir, I am requesting permission to blow the levee. The ERDC team leader is ready to go hot."

"Approved," Walsh replied. He said nothing else.

Reichling notified Lloyd that Walsh and the commissioners were on their way to the blasting site, "As soon as they get there, you are green light to go."[123]

At 2200 hours, the river reached 61.7 feet on the Cairo gage. As the members of the Mississippi River Commission travelled to the frontline levee, floodway residents and landowners coped in their own ways. Some, including Milus Wallace, stood nervously on the setback levee to witness the operation, sickened as they pondered the fate of the homes and property. Others anxiously watched news coverage on television sets in their hotels or at the homes of family and friends. For some, the emotional stress was too great – they could not bear to watch in person or on the television.[124]

The Mississippi River Commission on the frontline levee at Birds Point just moments before the activation of the floodway.

At Birds Point, it was pitch black outside with the exception of the glow from the city lights at Wickliffe, Kentucky, which created a perfect backdrop that illuminated the crevasse site. The floodway was eerily silent. Ponded rain and seepwater extended like fingers across the fields. A light mist fell. Suddenly, Durst called out, "T minus three minutes!" The tension mounted. No one said a word. Another minute ticked off the clock until Durst broke the silence, "T minus two minutes!" Another minute later, he called out again, "Radio silence!" This alerted everyone that only 60 seconds remained prior to detonation. After what seemed an eternity, but was only less than a minute, he signaled to Walsh to begin the countdown.

"Fire in the hole! Fire in the hole! Fire in the hole!" Walsh bellowed, with Angel, James, and Smith echoing in unison. "Five. Four. Three."

Fireballs light up the night sky as the Birds Point-New Madrid floodway is placed into operation. (Photo by Oscar Reihsmann)

"Wait!" Durst interrupted. Norris was correct; operations still were not going as planned. The episode provided a brief moment of humor to an otherwise long and ominous day. "Okay, start over," Durst declared as he finished tinkering with his equipment.

Walsh and the commissioners resumed counting, "Five. Four. Three. Two. One."

An impressive fireball illuminated the floodway, then another, and another, and so on down the fuseplug. The frontline levee trembled slightly from the violent explosion. A pressure wave from the blast followed a few seconds later. The force of the wave blew out windows in a house in nearby Wyatt. As far away as Cape Girardeau, people reported hearing the explosion. A thick cloud of smoke billowed up and slowly drifted across the floodway, masking the view of the crevasse site. As the smoke eventually cleared, the commissioners did not see any water rushing through the floodway, but heard a roar from the crevasse. An hour later, Frederick reported the Cairo gage read 61.3. The river, which had been climbing at an alarming rate, had dropped six inches. By 0600 hours the next morning it had dropped more than one foot.[125]

At the 0800 hours commander's briefing on May 3, Frederick reported that the rain had finally ended. Since April 20, all locations from Chester in the north, to Arkansas City in south, and extending from Little Rock in the west to Cincinnati in the east, received at least eight inches of rain. The vast majority of that region received more than 12 inches and several large areas received more than 20 inches. An incredible amount of rain had fallen – totals exceeded the normal rainfall for that two-week period by 600 to 1,000 percent – and it fell just as the snowmelt crest on the Mississippi River and the flood crest on the Ohio River arrived at the confluence. Lt. Col. Hamilton, Col. Reichling's deputy, informed Walsh that the floodway operation achieved the desired effects. Chip Newman and his crew had the Cairo sand boils under control. Conditions at Fulton County stabilized even though the water berm remained incomplete. The river came within two feet of the top of the Commerce to Birds Point levee at some locations, but already stages were dropping. Peabody sent word that the National Weather Service, taking the floodway activation into account in their calculations, lowered the crest at Smithland by three feet. The floodway, thus far, was operating as designed and reducing the pressure on the system.[126]

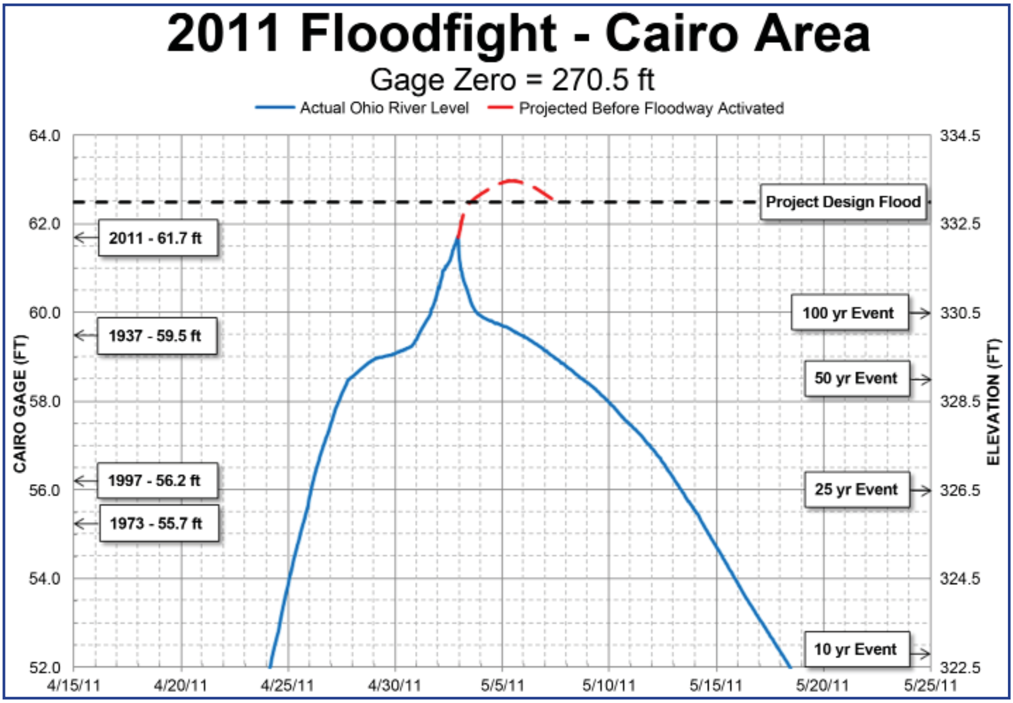
The floodway operation, though, was not complete. At 1100 hours, Walsh briefed Angel, James and Smith on the progress at the lower inflow/outflow site. The vessels encountered severe winds, rains, and lightning while travelling from Birds Point to the lower end of the floodway, which delayed their arrival times. The crews successfully filled two of the six wells, but found the remaining four wells filled with rainwater. They pumped the water from the wells and successfully filled three before running out of liquid blasting agent. The crew could not prepare the middle inflow/outflow site. Even though his hydraulics experts had advised him that the lower inflow/outflow was sufficient to drain the floodway, Walsh wanted to stick to the operations plan. He gave Reichling 12 hours to procure additional explosives. At 1240 hours, the task force activated the lower inflow/outflow site, with the Mississippi River Commission standing on the levee at New Madrid, approximately 1.5 miles away. The daylight provided a much different perspective than the previous night. As the 56 tons of explosives detonated, a cloud of black dirt from the levee flew high into the air, followed by a billowing cloud of white smoke. It took several seconds for the five distinct sounds waves to reach the commission. A large crowd on the levee cheered their approval, giving the commissioners a "thumbs up" sign. Two days later, the task force opened the middle inflow/outflow site using an alternate explosive agent. The alternate explosives used were not as effective as the original explosives. The levee only partially crevassed – not anywhere near the optimum design level.[127]

Water roars through the upper inflow crevasse at the frontline levee the day after activation.

Above: Activation of the lower inflow/outflow crevasse site on May 3, 2011.
Below: Aerial view of the upper crevasse site after activation of the floodway.

It took nearly three days for the floodway to fill with flood water. Each day, floodway residents and farmers travelled through the area on boats to examine their property. Water stood high in their homes and on their lands – too high to determine the extent of their losses. It took weeks for the water levels to recede as the river did not cease flowing into the floodway through the crevasse sites until June 8. Their sacrifice had been great. The Food and Agricultural Research Policy Institute estimated the crop losses alone at $85 million, with the broader economic impact exceeding $156 million. The figures did not account for damages to public and private infrastructure. Some lost everything; but their sacrifice saved so many elsewhere in the confluence area.[128]

In its May 2 forecast, the National Weather Service projected the river to crest at 63.5 feet on the Cairo gage on May 5. At 0700 hours on May 5, the Cairo gage read 59.6 feet – nearly four feet lower than originally anticipated. The maximum discharge into the floodway measured approximately 400,000 cfs, nearly 150,000 cfs below the projected

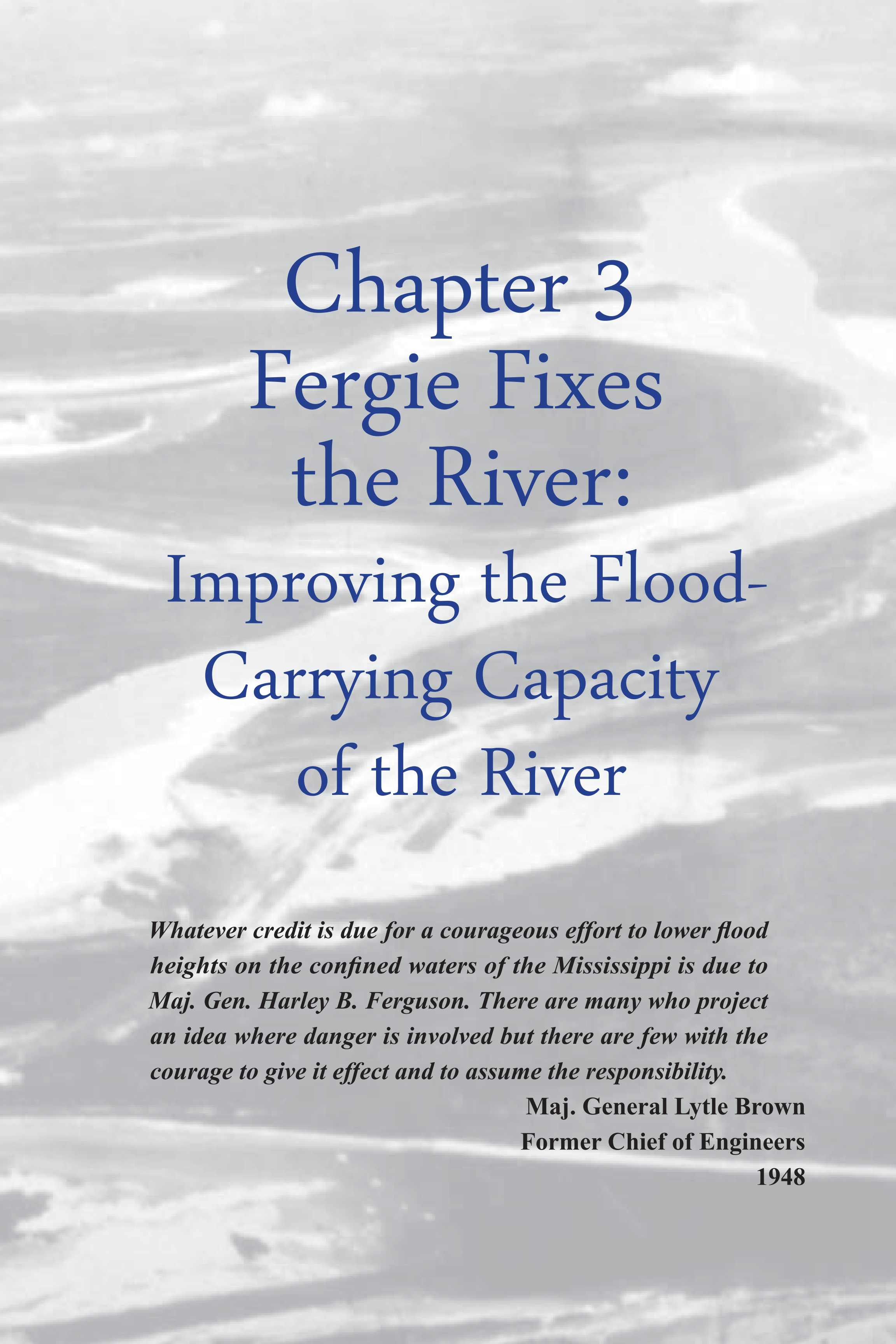


maximum project flood design capacity. The peak discharge at Cairo reached 2.1 million cfs – only 89 percent of the project design flood flow of 2.36 million cfs. Also, the task force only crevassed a portion of the levee, which accounted for some of the difference. The successful activation of the floodway rested on the shoulders of the task force. The crews on the ground braved severe weather and a dangerous work environment, while continually changing plans on the fly. "They did everything that was asked of them on short notice and without complaint," Davis later recalled. LRD had done its part as well in preventing a system collapse. April 2011 had been the wettest April in the Ohio Valley in the past 117 years. Peabody's informed and decisive move to store water behind the restricted dams on the Cumberland system created nearly five feet of storage at Kentucky and Barkley lakes. By May 5, ten reservoirs in LRD had reached record pool elevations. Eight of those were in the Louisville Engineer District – eight of eleven reservoirs in the district set new records. Four of those went beyond full capacity. Total system storage in LRD reached 38.9 percent, shattering the old record of 35 percent. Without that storage capacity, the river would have reached 65.5 feet on the Cairo gage and overtopped the critical Commerce to Birds Point levee and other levees and floodwalls in the confluence area. Peabody and his water control managers had done all that they could. "This wasn't a man-made disaster," Peabody later recalled, "It was a God-made scenario."[129]

In other words, it was Divine Providence.

MISSISSIPPI RIVER COMMISSION

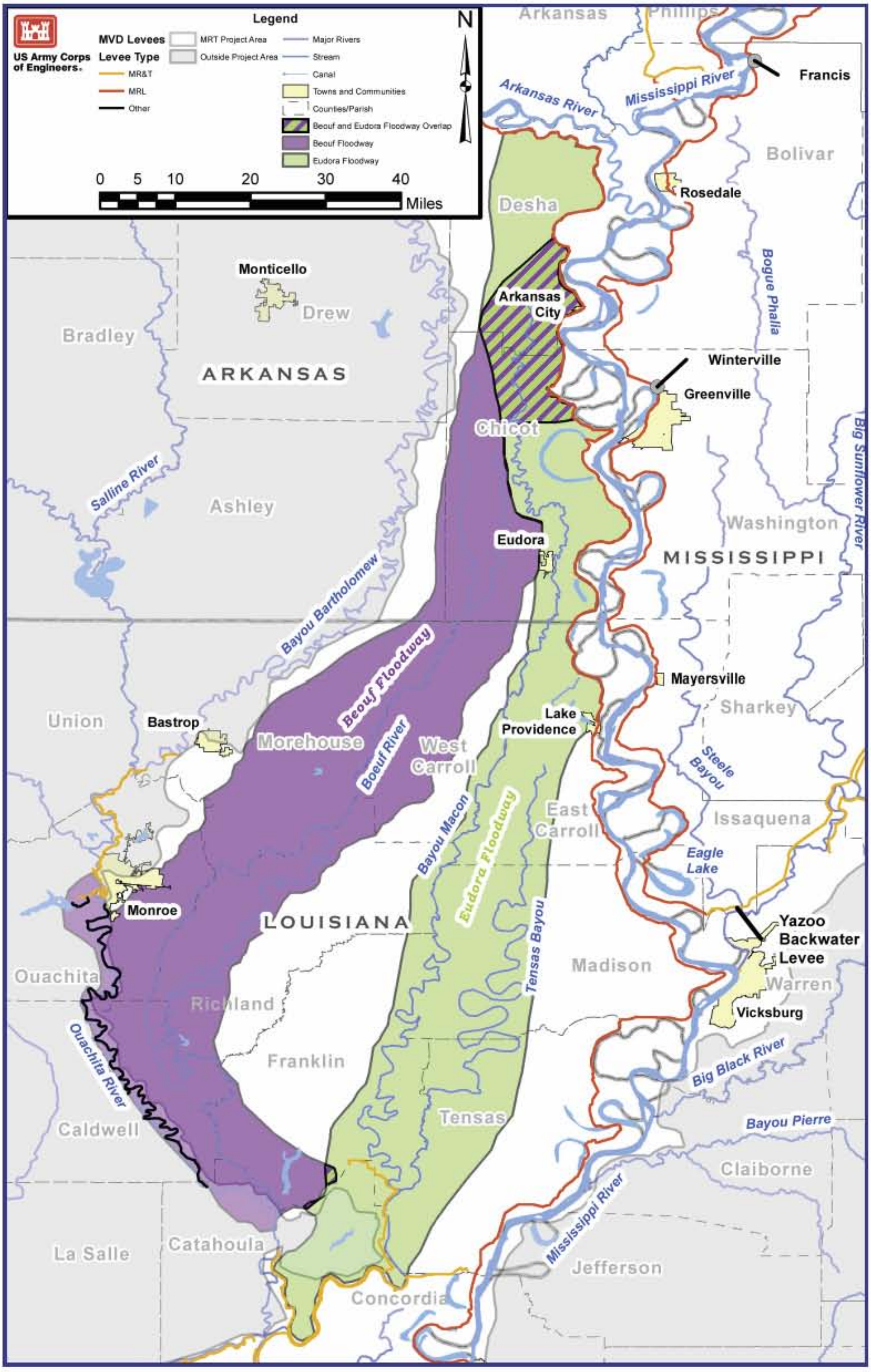
ESTABLISHED JUNE 1879



Chapter 3
Fergie Fixes the River:
Improving the Flood-Carrying Capacity of the River

Whatever credit is due for a courageous effort to lower flood heights on the confined waters of the Mississippi is due to Maj. Gen. Harley B. Ferguson. There are many who project an idea where danger is involved but there are few with the courage to give it effect and to assume the responsibility.

Maj. General Lytle Brown
Former Chief of Engineers
1948


Legend
US Army Corps of Engineers
MVD Levees
Levee Type
MR&T
MRL
Other
MRT Project Area
Outside Project Area
Major Rivers
Stream
Canal
Towns and Communities
Counties/Parish
Beouf and Eudora Floodway Overlap
Beouf Floodway
Eudora Floodway
N
0 5 10 20 30 40
Miles
Arkansas
Phillips
Francis
Mississippi River
Arkansas River
Bolivar
Rosedale
Desha
Monticello
Drew
Arkansas City
Bogue Phalia
Bradley
ARKANSAS
Winterville
Greenville
Chicot
Big Sunflower River
Saline River
Ashley
Washington
Eudora
MISSISSIPPI
Bayou Bartholomew
Beouf Floodway
Mayersville
Union
Bastrop
Lake Providence
Sharkey
Morehouse
Boeuf River
West Carroll
Steele Bayou
East Carroll
Issaquena
Bayou Macon
Eudora Floodway
Eagle Lake
Monroe
LOUISIANA
Yazoo Backwater Levee
Ouachita
Tensas Bayou
Madison
Warren
Richland
Vicksburg
Ouachita River
Franklin
Big Black River
Tensas
Caldwell
Bayou Pierre
Claiborne
Mississippi River
La Salle
Catahoula
Jefferson
Concordia

May 10, 2011 was a beautiful day in Vicksburg, Mississippi. The normally sleepy town was alive with excitement. A cool breeze out of the north carrying the sweet fragrance of honeysuckle ushered in noticeably mild temperatures and low humidity for that time of year, which the Purple Martins undoubtedly enjoyed as they whistled and chirped their delight. Along Washington Street – the brick-paved thoroughfare lined with quaint shops and colorful crepe myrtles – throngs of onlookers dodged the unusually high numbers of cars, pick-up trucks, and recreation vehicles as they nonchalantly strolled toward the best unobstructed view of the river creeping higher and higher up the wonderfully-decorated floodwall. Festive jazz music rang out from the speakers outside each storefront along Washington Street. The carnival-like atmosphere was reminiscent of the celebrations during the golden age of the steamboat era, when the sound of the calliope awakened townsfolk from their mundane and isolated lives, drawing them to the riverfront to learn the latest gossip or to be first in line to see the new goods for sale.

That beautiful May day in Vicksburg, not a single park bench remained empty. Outside the historic Biedenharn Candy Manufacturing Company, one aged reveler commented to his entourage that he had never seen the water that high. The others nodded in agreement. Yet, the flood crest was still days away and the water would rise another four feet on the floodwall. Similar scenes, no doubt, played out in other river towns – Memphis, Greenville, Natchez – but away from the cities the mood was anything but celebratory. Engineers, levee boards, and flood fighters along the levee system from Memphis to Natchez were engaged in the fights of their lives. River stages attained levels never before experienced at most locations along the reach, exerting unprecedented pressure on the system. Yet, unlike the northern and southern sections of the MR&T project, the middle section was not equipped with floodways to divert excess flow and relieve pressure on the levee systems – though that had not always been the case.[130]

The Boeuf Floodway

The 1927 flood demonstrated the futility of the levees-only policy between the Arkansas River and Old River. The severely swollen Mississippi and Arkansas rivers placed incredible pressure on the overmatched levee system. The rivers wanted out of their confined spaces. The first major crevasse of a levee considered commission grade occurred at Mound Landing north of Greenville on April 21, 1927. At the time of the crevasse, the Arkansas City gage had reached 60 feet – 2.55 feet above record. An eddy had been eroding the levee for several days and, with water flowing over the levee at several locations, Greenville residents valiantly worked to reinforce it. Despite the heroic effort, floodwaters eventually blew out the banquette, taking several persons with them. The crevasse eventually widened to nearly half a mile as nearly 500,000 cfs crashed violently into the Mississippi delta. The uncontrolled torrent broke through a back levee protecting Greenville,

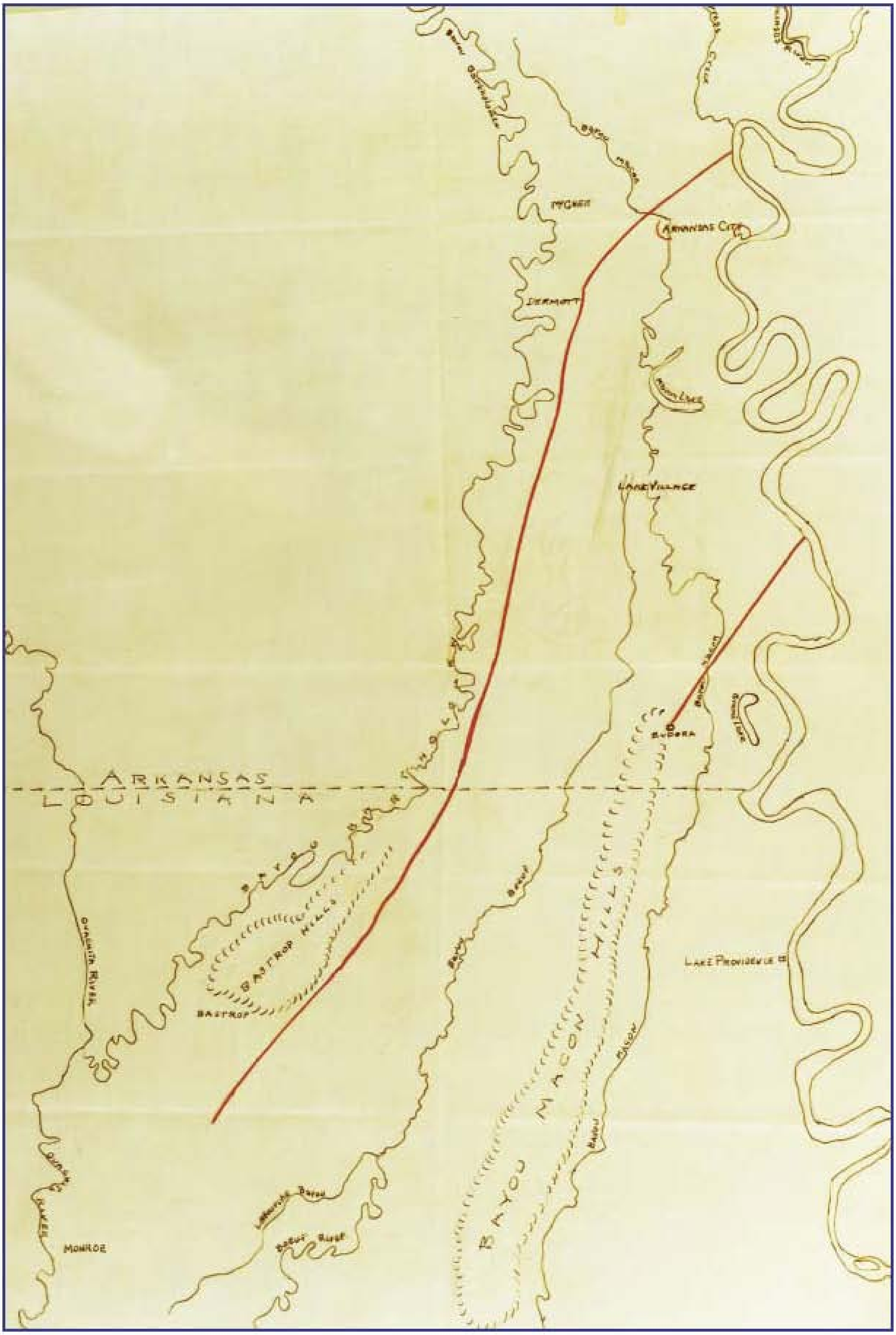
Greenville, Miss., after the Mound Landing levee crevasse.

flooding the city to a depth of six feet on April 24. Several counties, including Bolivar, Tallahatchie, Sunflower, and Humphreys, saw greater than 75 percent losses. More than 50,000 evacuated. On the same day that the levee crevassed at Mound Landing, levees on the Arkansas River failed at Pendleton and Medford. At Pendleton, water overtopped the levee, washing away sandbags faster than crews could replace them. Just a short distance downriver at Medford, crews fled after the Pendleton levee failed out of fear of being isolated. A week later, another Arkansas River levee that was below grade washed away after being weakened by overtopping. On May 1, Mississippi River levees along a 16-mile stretch just south of Natchez crevassed after overtopping at Glasscock, Brabston and two locations near Bougere, Mississippi. On May 3, with floodwaters from Mound Landing returning to the Mississippi River via the Yazoo River and increasing stages considerably, another crevasse occurred at Cabin Teele in Louisiana across and slightly upriver from Vicksburg. The crevasse inundated most of the Tensas basin between Macon Ridge and the Mississippi River.[131]

Floodwaters inundate Tallulah, La., after the Cabin Teele levee crevasse.

The series of crevasses represented the defining moment of the 1927 flood in the region and prompted Maj. Gen. Edgar Jadwin to incorporate a floodway on the west bank of the river to prevent a repeat of a similar tragedy. The Corps of Engineers had considered a floodway through the Boeuf and Tensas basins in southeast Arkansas and northeast Louisiana since the mid nineteenth century. Charles Ellet, Jr., and Capt. Andrew Humphreys completed thorough investigations for the Corps of Engineers that made provisions for a west bank floodway to accommodate excess flow from the river at extremely high stages. Their recommendations, however, never came to fruition as the levees-only policy became dogma. Jadwin intended to reverse that course. Under the original Jadwin plan, the project called for higher and stronger levees on both sides of the river from the mouth of the Arkansas River to Old River. The levees were to be constructed to the higher 1928 grade as the first line of defense against floods. The only exception was a 30-mile stretch of levee extending from Cypress Creek to a point in Arkansas nearly five miles west of Greenville. The project called for this segment of levee to remain at its existing height in order to function as a fuseplug entrance into a 1.32 million-acre floodway, known as the Boeuf floodway.[132]

Historically, Cypress Creek had served as a natural diversion or outlet that allowed the Mississippi to expand and disperse overflows through the Boeuf and Tensas basins. In 1921, the Tensas Basin and Southeast Arkansas levee districts, with the consent of the Mississippi River Commission, extended the mainline levees across the outlet, thereby denying the Mississippi access to its historic floodplain. Through his flood control plan, Jadwin envisioned restoring the Boeuf diversion to redirect Mississippi River flows in excess of 1,950,000 cfs in the vicinity of Arkansas City to keep river stages at or below 62.5 feet on the Arkansas City gage. Jadwin estimated the fuseplug trigger point to be at a height equivalent to 60.5 feet on the Arkansas City gage. This height represented a 10-foot increase over the historical point of



Map depicting the guide levees that were to define the Boeuf floodway.

overflow prior to the closure of the Cypress Creek gap. Under project flood conditions, the 9.5-mile wide floodway, flanked by 80 miles of protection levee on the west and 100 miles on the east, would divert 900,000 cfs through the Boeuf basin to the Red River backwater area in Louisiana and eventually to the Gulf of Mexico via the Atchafalaya basin.[133]

Similar to the stiff resistance to the Birds Point-New Madrid floodway mounted by residents and elected officials from southeast Missouri, residents and landowners in the Boeuf and Tensas basins bitterly opposed Jadwin's inclusion of the Boeuf floodway in the general flood control plan for the lower Mississippi Valley. But unlike the situation at the confluence of the Mississippi and Ohio rivers, the Mississippi River Commission had also proposed a floodway in the Boeuf basin. The commission's floodway was smaller than Jadwin's, with a capacity to divert only 600,000 cfs from the Mississippi River, and less intrusive by avoiding the inclusion of higher value properties. It was also more palatable to those impacted because it was to be governed by a concrete weir or a gated structure instead of Jadwin's dreaded fuseplug levee concept.[134]

The most significant difference between the Jadwin and the commission plans involved payments for damages after use of the floodway. Jadwin believed that all land within the floodway was naturally subject to flooding and thus the Corps of Engineers was not liable for damages if it let nature take its course. The commission argued that the current system already protected much of the land – particularly along Cypress Creek – and that it was illegal to take land and not pay in some way for its use. Adding to the problem was that the Jadwin plan flooded more land more often – only about two thirds of property in the valley would receive complete protection with the others receiving various levels depending on their location in the floodways and backwater areas. By protecting fewer areas and not paying for damages, Jadwin reduced the costs considerably. Local businessmen and landowners, meanwhile, argued that forced purchase of flowage rights and local condemnation devalued property and made it impossible to sell. Railway operators in particular believed they should receive compensation for moving their lines. The only way to ensure fair market value was for the federal government to purchase the land at an earlier cost.[135]

On May 15, President Calvin Coolidge signed the 1928 Flood Control Act into law. The new law provided for a special board to consider the differences between the Jadwin and commission plans. Boeuf floodway residents and their allies hoped the board would clarify a stark contradiction found in section four of the 1928 act. Section four authorized the federal government to purchase flowage rights for "additional destructive waters" resulting from "diversions from the main channel of the Mississippi River," but the last-minute insertion of "additional" left it unclear whether all lands in the floodways were included. Jadwin had announced his attention to purchase flowage rights at the Birds Point-New Madrid and Bonnet Carré, but not the Boeuf and Atchafalaya floodways. It was a question that would plague the Boeuf floodway for years to come.[136]

After the special engineering board refused to touch the compensation issue and endorsed the engineering features of the Jadwin plan, President Calvin Coolidge instructed Jadwin to proceed with the implementation of his flood control plan, but specifically delayed any decision pertaining to the acquisition of land rights for constructing the floodways. Shortly after the 1928 elections, which boosted Herbert Hoover to the presidency, the lame-duck Coolidge approved the site for the Bonnet Carré spillway and authorized Jadwin to purchase the necessary land and flowage rights for that element of the plan. Three weeks later he did the same for the Birds Point-New Madrid floodway. Lastly, in two separate orders in January 1929, Coolidge authorized the acquisition of rights-of-way and construction of the protection levees within the Boeuf and Atchafalaya floodways. Provisions for the purchase of flowage rights in the Boeuf and Atchafalaya floodways were conspicuously absent in the final two communiqués. The Corps of Engineers had determined that landowners in the Boeuf and Atchafalaya floodways would not be subjected to *additional* destructive waters. There was to be no compensation paid to landowners.[137]

More than 50,000 people resided within the Boeuf floodway in the late 1920s. Some landowners quickly settled on prices to sell rights-of-way for levees or agreed to damage waivers for their mostly undeveloped land. Others refused to accede to threats of condemnation largely because of a recent spike in property values generated by the success of gas and oil wells in the region. Many argued that the Jadwin plan constituted a reopening of the Cypress Creek gap. For that, they believed the federal government owed compensation. No matter what the reason for their refusal, they quickly found allies among leading engineers. When Louisiana State Engineer George Schoenberger wrote Sen. Joseph Ransdell opposing the findings of the special board in August 1928, he explained that fuseplug levees would create great velocity in the first few miles and then flood the floodways to a depth of about 20 feet, greatly damaging property. "If water must be diverted down the Boeuf Basin ... then the land within the floodway area should be bought by the government at a fair price and dedicated to floodway purposes." In his book published November 1928, James Kemper observed that the special board had proposed providing $6 an acre for easements – the cost to plant the land – but that many would lose homes, fencing, livestock, and food. "It makes one fear that an autocracy is growing that will soon be necessary to curb," he wrote. In the spring of 1929, the American Engineering Council's Flood Control Committee – Baxter Brown, John Freeman, Arthur Morgan, and Gardner Williams – noted that "sufficient study … of flood control on the Mississippi River has not been made" because "the intent of Congress and the best interest of the nation were defeated by the constitution and action" of the special board. "It would be a grave mistake to permit the letting of contracts" on the floodways "until the engineering practicability and economic feasibility are adequately studied by a non-partisan and competent board of engineers." The secretary of the council forwarded the report to President Hoover on May 20, 1929.[138]

From the start, congressional members from the lower Mississippi Valley region had advocated a truly comprehensive flood control plan supported by large federal expenditures. As it became apparent that the flood control act was flawed in its application of compensation and that the federal government did not intend to purchase property or flowage rights in the Boeuf and Atchafalaya floodways, pressure mounted from their constituents to delay and change the project. Many found hope in the new president. Coolidge and Jadwin may have been the main architects of the project, but it would be implemented by the Mississippi River Commission under Hoover's watch. Although his administration represented a continuation of the previous one as far as party affiliation and fiscal conservatism, Hoover, unlike his seemingly unsympathetic predecessor, was actively involved in the 1927 flood fight, winning the respect of many southerners.

On May 9, 1929, a congressional delegation representing the lower Mississippi Valley led primarily by Southern Democrats petitioned Hoover to suspend work on the project pending a presidential and congressional interpretation and review of the 1928 Flood Control Act. The delegation stressed that Congress' intent under section four of the act was "to assure compensation for flowage rights over land embraced within all spillways and floodways and for damage where injury is done to property." They argued that section one placed the responsibility of approval or rejection of particular elements of the plan squarely on the shoulders of the president. Furthermore, the delegation insisted that Coolidge issued his instructions to Jadwin to proceed with the acquisition of rights-of-way for levees, but not flowage rights, without having before him "a full and complete report" on the commission and the Jadwin plans. Therefore, Coolidge did not have the opportunity "to pass upon the question of compensation for flowage rights under both plans in the Boeuf and Atchafalaya Basins." With this in mind, the delegation suggested that if Hoover did not reach the same interpretation, he then should call for a temporary cessation of work on the project to allow Congress to revisit and clarify the issue through a legislative amendment. [139]

Hoover sent the brief, along with a supplemental support statement, to Secretary of War James W. Good. On May 27, Good forwarded the documents to Attorney General William D. Mitchell asking for his opinion as to whether the adopted project was subject to change at the behest of the president or was it fixed by law. He also asked Mitchell if the existing law required the federal government to purchase flowage rights in the Atchafalaya and Boeuf floodways. The attorney general published his official decision a little more than three weeks later. Mitchell expressed his view that the law did not authorize the purchase of flowage in the Boeuf and Atchafalaya basins. The project was fixed by law and could only be changed by Congress. As to Good's inquiry into the legality involved in purchasing flowage rights in the Atchafalaya and Boeuf floodways, Mitchell responded, "I must fully decline to express an opinion on your question," citing existing litigation in federal court.[140]

Mitchell's reference to existing litigation centered on a number of lawsuits brought before the federal courts. Having failed the test of public opinion, the Jadwin Plan now faced several legal tests. The most prominent suit commenced on June 15, 1929, two days before bids for the construction of protection levees within the Boeuf floodway were to be received. On this date, R. Foster Kincaid, an owner of 160 acres toward the lower end of the proposed Boeuf floodway, filed a lawsuit in the Federal Court of Western Louisiana against the United States, the secretary of war, the Corps of Engineers, and the members of the Mississippi River Commission in an effort to halt the receiving of bids and the awarding of contracts for construction of the guide levees that would define the floodway boundaries and confine floodwaters entering through the fuseplug entrance. The suit alleged that the planned floodway through the Boeuf basin subjected Kincaid's land to additional destructive floods. His lawyers argued that Kincaid's land was valued at $9,000, but the federal government, by advertising and receiving bids for construction of the protection levees, had "cast a cloud upon" the title of the land, thereby impairing Kincaid's ability to sell or to borrow money against it. As such, the proposal to initiate work in the basin without condemnation proceedings was tantamount to the taking of his land "without due process of law and without just compensation."[141]

A similar application for an injunction to stop the awarding of contracts in the Birds Point-New Madrid Floodway – *Kirk v. Good* – had been denied in late May by Judge Charles B. Davis of the Federal Court in Missouri. Jadwin desired another decision along those lines. As R.N. Duffy and Maj. Paul S. Reinecke prepared to testify for the Mississippi River Commission in the preliminary hearing of the Kincaid case, Jadwin worked to coordinate on the message for future legal action. First he did not focus on the fact that some of these lands might flood, which federal lawyers admitted, but instead he stressed that no "additional" floodwaters would enter the floodway from the Mississippi by way of operating the floodway. Second, he contended that because the overall plan lowered flood stages on the Mississippi, less water would enter the floodway from the main channel. Last, he argued that building levees to protect property adjoining the floodways in no way prevented local interests from protecting their citizens by building their own levees as they had in the past. When Duffy seemed not to grasp this in an internal memo, afraid that "such errors might lose the Government cases in the Mississippi Valley," Jadwin requested Reinecke go over the legal position with Duffy or else "keep him out of Louisiana and either handle the case yourself or get someone who can. Your other work is of small importance compared to this."[142]

Despite this preparation, the Kincaid case went against the government from the beginning. Unlike the Kirk case, where the plaintiff could find remedy in condemnation proceedings, Judge Benjamin C. Dawkins of the Western Louisiana District Court ruled that the Kincaid case had merit to proceed to trial and agreed to a temporary injunction. This had impact, not just on construction, but on purchase of the levee rights-of-way. In an ongoing condemnation case, *United States v. Stubbs*, Dawkins ruled the government could not take immediate possession of the property of Col. Frank P. Stubbs and others in the Monroe circle in Louisiana without putting up the maximum value of the property until the Kincaid case was resolved. In response, Good instructed the attorney general, "After decision has been rendered in the injunction suit and when it has been decided to resume work on these levees, the matter can be taken up and the question of depositing funds in the registry of the court then determined." The only other condemnation ongoing, against the Jewell Realty and Chicot Trust companies, which had filed numerous interventions claiming damages for $3 million, was also put on hold, essentially shutting down all progress on the floodway until resolution of the case.[143]

The Kincaid case went to trial October 15, 1929. Testifying for Kincaid were well-known opponents of the Jadwin plan: James Kemper, Lucius Berthe, and Harry Jacobs, the new Louisiana State Engineer; for the government, commission members Brig. Gen. Thomas Jackson and Col. Earnest Graves, as well as Capt. John P. Dean. As expected, the trial hinged on the interpretation of "additional" floodwaters. On this, opinions varied, as there were a number of ways of defining additional. One was the frequency of the Arkansas City gage reaching 60.5 feet to trigger use of the floodway, which Kemper placed at one in four years, Dean one in 13, and Graves perhaps even more infrequent, compared to flooding every two to three years previously. Jacobs testified that the Cypress Creek levee had protected Kincaid's land until the current project, but Dean stated that "The waters pass naturally as they always have passed down through the natural Boeuf basin." Kemper argued additionally that when floods came, they would be violent because of crevassing the fuseplug levee, a statement Graves confirmed. A second definition involved the amount of discharge. Mississippi River Commission figures used by Kemper showed the floodway would pass 350,000 cfs more through the basin than experienced in 1927. Although Graves disputed the reliability of these figures, Jackson admitted there would be an increase in discharge of at least 150,000 cfs. A third definition was the depth of floodwaters. Kincaid's land previously flooded frequently, but Jacobs argued that construction of guide levees 16 feet higher than his property showed intent to flood his land to this depth. Although Dean initially argued that the levees were to protect "adjoining lands" and that flood heights would be no higher than in 1927, under "rigid cross-examination" he admitted that, in fact, water would rise four feet higher on his property than in 1927. In his ruling issued December 13, Judge Dawkins reasoned that although flooding might be infrequent, it would damage property. "It will not be assumed that Congress intended to violate the Fifth Amendment to the Constitution by taking private property for public purposes without just compensation," so the act required obtaining property through purchase or condemnation. On February 10, 1930, he upheld the injunction to prevent construction of the guide levees until purchase of flowage rights.[144]

Jubilation sprang forth across the Boeuf and Atchafalaya floodways. An editorial in the *Engineering News-Record* called Dawkins' ruling, "a common sense decision." Long opposed to many aspects of the Jadwin Plan, in particular to the issue of compensation for floodway residents, the editors admonished Jadwin, Coolidge, and the Army engineers testifying in the case:

> The outcome is surprising only in view of the fact that a former Chief of Engineers deliberately planned to utilize the land for a flood control channel without compensation, that a former President issued an order to this very end, and that the government witness at the trial in Monroe strained their integrity to

show that destructive flooding would not occur, until after cross examination they admitted the contrary."[145]

The impacts of the decision extended beyond the immediate issue of just compensation for those living within the Boeuf floodway. Back in September of 1929, after Judge Dawkins ruled that the case had merit, Hoover announced that he would delay new work on the Boeuf and Atchafalaya floodways if "the Senators and Representatives of the interested states are willing to assume the responsibility by making the request" since "there has been a great deal of division of opinion" requiring resolution. After receiving formal requests from at least six of the congressmen, he approved cessation of work on the Boeuf and Atchafalaya floodways. Although his order left the Jadwin plan otherwise intact, the delay "opened a way for reconsideration of portions of the diversion plans for Mississippi flood control," the *Engineering News-Record* editorialized.[146]

With construction of the Boeuf floodway guide levees stalled, however, the flood control system protecting the middle section of the project contained an ominous and threatening weak spot. While Jadwin envisioned excess floodwaters escaping through the natural diversion in the Boeuf basins, with no guide levees to confine the overflow, a large flood would unleash a torrent of uncontrolled water down the Boeuf and Tensas basins, sowing havoc and devastation. Yet, Jadwin was gone, having retired in October 1929, just prior to Judge Dawkins' ruling. The new chief of engineers, Maj. Gen. Lytle Brown, possessed more political savvy and flexibility than his confrontational and obstinate predecessor. Brown particularly generated great excitement among lower valley interests when he hinted that changes to the Jadwin plan might be in order by describing the plan as a "piece of emergency work" developed hastily to protect the citizens of the lower valley as quickly as possible. Moreover, Brown, recognizing that "very little effort has been made by those responsible for the work toward inquiry as to how the

Maj. Gen. Lytle Brown, Chief of Engineers, 1929-1933. (Office of History, U.S. Army Corps of Engineers)

general plans might be changed," encouraged a reevaluation of the existing flood-control plan. While Brown understood that a widespread hostility toward altering the Jadwin plan existed among many within the Corps of Engineers and certain blocs within Congress—hostility which discouraged inquiries into potential modifications of the plan—he was taken aback that no suggestion from a responsible authority had been made proposing the elimination or modification of contested elements of the project. Brown promptly issued a challenge to the engineer community to explore and develop new answers to the flood-control question. It was in this context that a new plan emerged—the use of man-made cutoffs and channel rectification to lower flood stages.[147]

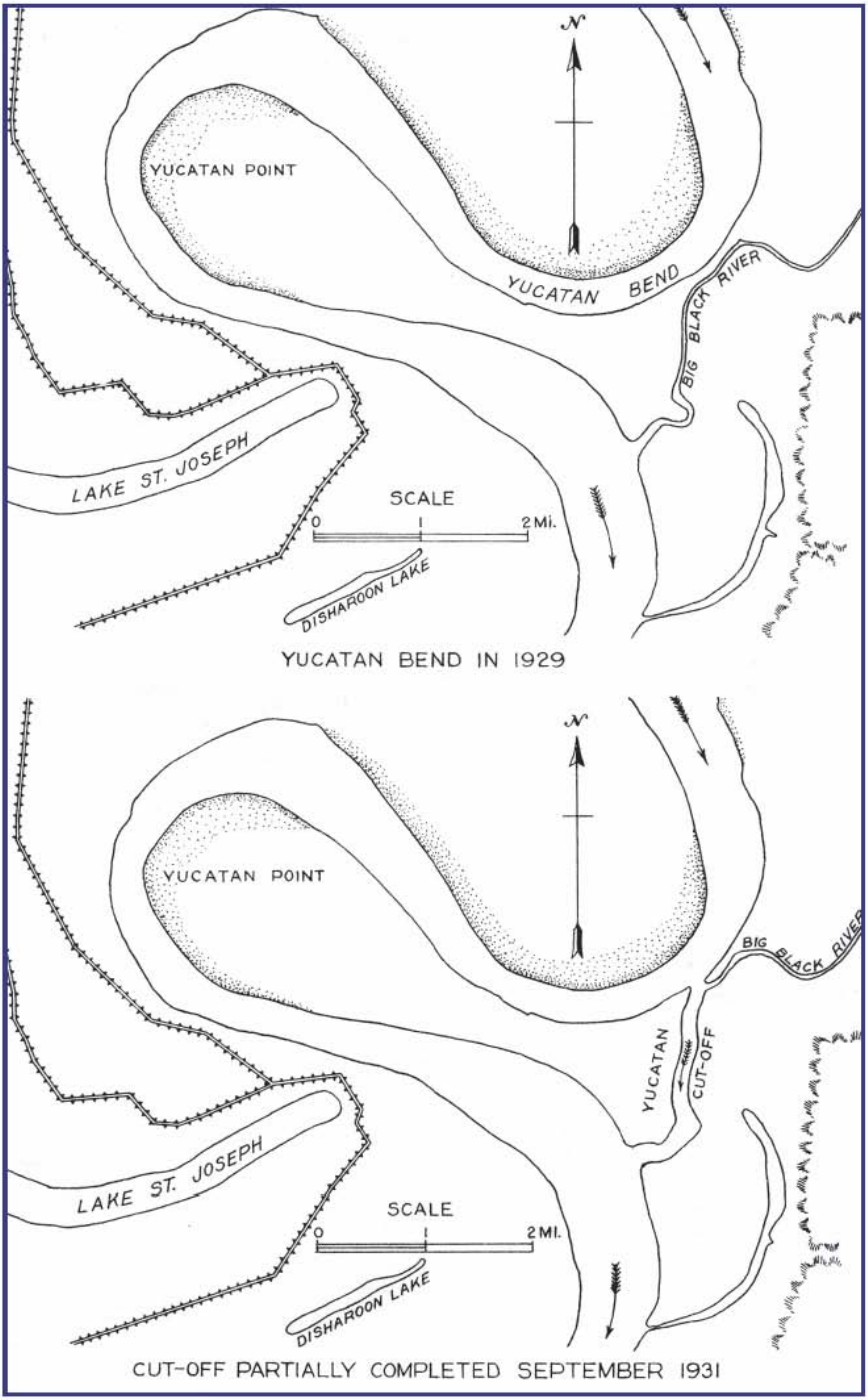
More Water at Lower Stages

The Mississippi River is an alluvial stream that creates bends or loops as it meanders through the valley. Bends reduce the slope or velocity of the river. As a result, the river typically pools in the bends during floods, causing floodwaters to pile up above the bend. Left unchecked by bank revetment, the bends lengthen as they develop until only a narrow neck of land separates the upstream bend from the downstream bend. A cutoff occurs when a new channel is carved – whether naturally or artificially – across the neck, eventually divorcing the old bend from the river and transforming it into an oxbow lake. Since the 1850s, engineers dabbled with the concept of artificial cutoffs to prevent floodwaters from stacking up and to speed floodwaters through the system.

While the merits of cutoffs as a method of flood control had been discussed in engineering circles since the mid nineteenth century, the renewed push came from William Elam, an engineer with the Mississippi Levee Board. Elam had been studying cutoffs since 1913, when he witnessed the Albemarle Chute Cutoff—a gradual widening of a narrow side channel between Willow Point and Newman Towhead about 30 miles north of Vicksburg that had the same effect of cutting a new main channel. The old main channel started to cave in 1910, and the commission tried to revet the banks, but within three years abandoned it. Because the new channel funneled the current against the east bank, the commission started to build a levee in expectation of a cave-in per the old theories, but found it unnecessary. "It was enough to create doubt about old theories," Elam wrote. Over the next 15 years, he developed his findings of cutoffs. After the Flood of 1927, Elam wrote articles for the *Engineering News-Record* and the *Proceedings of the American Society of Civil Engineers* that laid out a plan that comprised revetment, levees, sandbar removal, and cutoffs to flatten the slope of the river and reduce flood stages. Altogether, he identified 35 cutoffs – most prominently at the Greenville Bends – that would lower flood stages between Arkansas City and Vicksburg by an estimated 10 to 20 feet.[148]

By the time Elam prepared the articles, the 1928 act had already incorporated Jadwin's position that cutoffs were "too uncertain and threatening to warrant adoption" and that "it is advisable to adhere to the present policy of preserving the river generally in its present form."[149] The Mississippi River Commission, too, opposed cutoffs, having adopted a policy to prevent natural cutoffs in 1880 out of fear of harming the regimen of the river. Yet Elam's articles and the attention they garnered appeared to have at least one effect. When a cutoff started to develop at Yucatan Point in 1929, Jadwin approved letting it proceed, apparently with the intent of proving its ill effects. For some years, the commission was aware of the possibility of a cutoff at Yucatan Point, where the Big Black River traversed the neck of the point and emptied into the Mississippi River at the lower bend. The bank was caving on both sides of the bend, gradually narrowing the distance between the Big Black River and the Mississippi River on the upper bend. In August and September 1928, the commission placed revetment to prevent the Mississippi from breaking into the Big Black, but by order of Jadwin did no more work to prevent the cutoff. During the winter months of 1929 and 1930, floodwaters from the Mississippi overwhelmed the ridge and broke through to the Big Black, effectively cutting off Yucatan Point. At that point, at the request of Brown, engineers began taking gage readings and discharge measurements, and Brig. Gen. Thomas H. Jackson ordered establishment of cross-section surveys to observe the cutoff's development. The ensuing cutoff developed slowly and afforded the commission its first opportunity in more than a generation to study the progress of a cutoff and to make detailed observations on the impacts to the river. As the cutoff developed over many months, the commission observed no immediate or violent changes to the regimen of the river. In August 1930, engineers reported depth measurements in excess of 18 feet.[150]

With initial data from the Yucatan Cutoff already starting to disprove the long-held belief that cutoffs harmed the regimen of the river, Elam submitted his ideas for the improvement of both the Mississippi and Atchafalaya rivers through cutoffs to Maj. Gen. Brown in March 1930 while attending the Mississippi River Commission's high-water inspection tour of the Mississippi River. Impressed with the concept as a method to perhaps avoid building the Boeuf floodway, Brown studied Elam's ideas carefully. He later met Elam in Greenville, Mississippi, and continued to correspond with him about cutoffs throughout the year. In the meantime, in November 1930, Col. Harley Ferguson, a member of the Board of Engineers for Rivers and Harbors, submitted



Map depicting the progression of the natural cutoff at Yucatan Point, 1929-1931.

a detailed plan influenced by Elam's findings and the observations from the Yucatan cutoff.[151]

One of the most prominent Army engineers before World War II, having earned a reputation by raising the *USS MAINE* in Havana Harbor, Ferguson was the South Atlantic Division commander. He had been studying Mississippi flooding since at least 1928, when he requested that Capt. Lewis A. Pick provide him with data and maps. By October 1930, when he pulled in his engineer in charge of surveys, Gerard H. Matthes, to aid him in drafting the plan, Ferguson had already conceptualized a proposal of flood stage reductions through cutoffs, corrective dredging, and stabilization of the new channel through revetment. Submitted to the Board of Engineers on November 22, 1930, the plan outlined the issue: "The flood problem above the Arkansas is solved by levees. The problem below Old River is solved by the Atchafalaya floodway and the Bonnet Carré spillway." The critical stretch was from the Arkansas to the Red River, where flood heights proved unmanageable by other means. His plan argued for increasing the carrying capacity of this stretch through targeted cutoffs, closing secondary channels, checking bank erosion using revetment, deepening the channel, and restricting crossovers where the river channel crosses from one side of a bend to another. These activities would allow the river to further dredge its own channel. As Ferguson noted, the kinetic energy of the river "is equivalent to more than 50 dredges." Essential to controlling the river and improving drainage in that reach were removal of the clay ridge near Natchez, Mississippi, deepening Old River, and improving the Atchafalaya River. "The river itself is the main dredge," Ferguson wrote, "The channel from Natchez to Old River is the pipeline."[152]

While Ferguson's channel rectification program proposed various bank revetment and dredging operations, the cutoffs represented the most revolutionary part of his plan. "There can be no possible harm in reducing the river to the length which it had in 1880," he wrote. Among the cutoffs he proposed were at Gaillardo Lake (Glasscock), Giles Bend, Grand Gulf (Diamond Point), and the Greenville Bends. He would generally work from south to north, improving the reach from Natchez to Old River and then from Greenville to Vicksburg. At the same time, it was the combination of correction and cutoffs that defined his unique approach. His method was to enlarge the riverbed through "corrective dredging" to improve slope and navigation, and place revetment and dikes to stabilize the river above and below a proposed cut. He cautiously added, "it will be necessary to have several dredges on hand" to ensure navigation. He even recommended the type of dredges and revetment required. Based on these improvements, he predicted lowering flood heights by at least three to seven feet for $50 million within three years. Finally, he argued, "the amount by which the flood capacity of the main river channel can eventually be increased can be determined only by proceeding with the work and measuring the effects." In other words, Ferguson argued that the only real way to prove the stage lowering effects of cutoffs was to proceed with his experimental program.[153]


Col. Harley B. Ferguson

On reading the plan in December 1930, Pick noted "you will meet a lot of opposition to your plan. This, of course, is not based on anything except the old school of thought." Indeed, the plan met almost immediate opposition, starting with Board of Engineers for Rivers and Harbors member and former Mississippi River Commission member Col. Edward Schulz. At a hearing of the board to consider Ferguson's plan on January 5, 1931, Schulz tried to convince the board mathematically that cutoffs would not lower the riverbed and that its benefits would dwindle to zero above the cut. Despite Schulz's efforts, on February 5, 1931, the majority of the board approved Ferguson's plan. Many Mississippi River Commission employees, too, opposed the plan because of its long stance against cutoffs. Jackson, the commission president, made clear his own views in an article that January. While not denying cutoffs could improve discharge, he noted their dangers and high costs. Jackson concluded, "In flood-control plans of the past, the cutoff has played an unimportant role, and there is little prospect of it playing a more important one in the future."[154]

Not surprisingly, Ferguson's plan impressed Maj. Gen. Brown. The bold and innovative approach represented the exact type of exploration he had challenged the Corps of Engineers to produce upon replacing Maj. Gen. Jadwin as chief of engineers. On February 28, 1931, Brown submitted a plan to modify the MR&T project to Congress. The plan included the recommendation for the Board of Engineers to initiate a program of "experimental work, including channel rectification and stabilization, dredging, and bank protection." Only a year later, after receiving permission from Congress to pursue further investigations into cutoffs in January 1932, Brown assigned a board of review that included Ferguson, Spalding, Dean Anson Marston of Iowa State College, and Lt. John P. Dean. The board assembled in Memphis on March 9 and proceeded downriver on the *INSPECTOR*, including a trip to the Atchafalaya River. It made another trip in May to Cairo and the St. Francis and Tensas basins. Although the ostensible goal of this board was review of the floodways as well as increases in discharge in the river, it spent considerable time discussing cutoffs during its early months. Among others, the board interviewed Jackson for suggestions concerning the Jadwin plan, but he made no statements showing favoritism to cutoffs and suggested that he only desisted from preventing the Yucatan Cutoff after revetment had failed.[155]

It should come as no surprise that, given Jackson's disagreement with cutoff plans and Ferguson's interest in implementing them, Brown would allow Jackson to retire in May 1932 and nominate Ferguson as the new president of the Mississippi River Commission. Ferguson was widely considered the most talented officer in the Corps of Engineers. According to one version of the story, Brown called Ferguson to his office to tell him of the assignment. They sat smoking pipes until Ferguson finally asked his superior officer, "Do you want me to write a book or fix a river?" Brown, inhaled the smoke from his pipe then exhaled slowly before replying, "Fergie, you get the hell out of here and go fix that river." From that moment, Ferguson let nothing stand in his way. Raised in the North Carolina-Tennessee backcountry, Ferguson had a way of explaining his plan that appealed to the public. "The Mississippi wants out. Let it out. Don't try to bridle it and make it stay inside roundabout, twisting, inadequate channels…. Put it to work. Keep it from damaging its banks and make it carry the load in its bed."[156]

When Ferguson arrived in Vicksburg on June 15, 1932, he initially found most of his staff biased against his plan. Therefore, his first act was to convince and instruct them in a series of memoranda outlining his views in pithy comments. "A cut-off reduces the distance, hence the resistance to flow, between two points," he wrote in June. "River engineering is fundamentally a question of energy," he added. "Clay will stand a very swift current. Sand will not. The banks are composed of alternate layers of sand and clay, or gumbo," he explained in a discussion of revetment in July. "The correct location of revetment is to put it along a line pointing downstream where we wish the river to go for the next five miles." He wrote in October on effective dredging, "For any particular depth in a river there is a range of velocities which will not cause scour or deposit." In November, "If we enlarge the section above the outlet until its capacity is equivalent to that below … the river will be stable." In December, "If we can increase the power of transportation in the lower reaches or decrease the erosion in the upper reaches, we will accomplish our purpose."At the same time, he ordered studies of a range of topics and frequently made suggestions borrowed from others, such as using Navy torpedo nets to close secondary channels, experimenting with board revetment, or deciding where to place dredged material. In June, he ordered George Clemens to coordinate revetment experiments at the Waterways Experiment Station and the Memphis Engineer District. He also requested studies of additional proposed cutoff locations at the Waterways Experiment Station. He then began an extensive regimen of data collection; personally planned dredging work for 1932 based on available funding, and on June 17 and July 5 held conferences to develop plans for where to correct the channel or place revetment and how to proceed with his plan.[157]

The first cutoff in Ferguson's program was at Diamond Point below Vicksburg. The technique used, as with all of the cuts, was to add revetment and improve the alignment and slope of the river above and below

Gerard Matthes, left, and Brig. Gen. Harley Ferguson, with arms crossed, inspect operations at the Diamond Point cutoff.

the cut through dredging and then make a pilot channel from either side using dragline machines and cutterhead dredges instead of allowing the river to carve its own channel. This avoided the flooding below the cut that previously resulted from cutoffs. Ferguson left the old bends open to allow “valley storage,” or natural reservoirs to temporarily store overflow from the new channel during high water. He also took great care to select the location of the cutoffs. He tried to choose stable stretches of river from which to extend the cut, with mild curvature, no islands or chutes, and no excessive bank erosion or silting so as to avoid any impediments to navigation. He avoided cuts across narrow necks where instability already existed, did not attempt to straighten the river unduly and risk excessive bank caving, and in general tried to plan cuts in close proximity from south to north to allow the cuts to carry eroded material from a new cut. The commission initiated the cutoff at Diamond Point on January 8, 1933, dramatically dynamiting the narrow ridge separating the pilot channels for a total cost of $500,000. The *New Orleans States* later contrasted this with the first shot of the Battle of Lexington. Instead of the shot heard around the world, “Nobody even noticed much the shot that should have echoed up and down the Mississippi Valley.” Ferguson started work on planned cutoffs at Glasscock Point and Giles Bend near Natchez in March and May 1933, with preparation begun for several others.[158]

By the 1935 high-water season, Ferguson had made substantial progress implementing his program. Seven artificial cutoffs were in operation at Diamond Point, Glasscock Point, Giles Bend, Leland Neck, Worthington Point, Willow Point, and Marshall Point. Along with the natural cutoff at Yucatan Point cutoff, Ferguson’s effort had shortened the river by 70 miles. The corrective dredging in the reaches between the cutoffs had also significantly widened and improved the alignment of the channel, which allowed the kinetic energy of the river to scour its bed deeper. While none of the cutoffs had fully developed by the 1935 high-water season, they, along with the corrective dredging measures, produced substantial results during a flood that spring. The flood was lengthy in duration, but only moderate in height. At the Arkansas City gage, the peak flow surpassed that of the 1932 flood, but the crest of the 1935 flood was nearly two feet lower – the river carried more water at a lower stage. Ferguson's plan was working.[159]

Dividends of Channel Rectification

Buttressed by that initial success, the Mississippi River Commission proposed several sweeping modifications to the Jadwin plan. The most intriguing modification involved the Boeuf floodway. The commission proposed eliminating the 1.32 million-acre floodway from the plan and replacing it with a smaller 820,000-acre floodway through the Tensas basin. The proposed replacement, known as the Eudora floodway, was farther south and east. Under the commission's new plan, the Eudora floodway would extend five miles west of the Mississippi River and then southward from Eudora, Arkansas, along the eastern edge of Macon Ridge to the Red River backwater area. The floodway was capable of diverting up to 700,000 cfs from the Mississippi River. Along with the increased channel capacity created by Ferguson's program, the floodway provided the necessary overflow relief under project flood conditions. Being nearly 800 square miles smaller than the Boeuf floodway, it also eliminated the prospect of future inundation to hundreds of thousands of acres of fertile, valuable, and taxable farmlands. To the delight of longtime critics of the Boeuf floodway, the commission also recommended eliminating the use of a fuseplug levee as contemplated under the Jadwin plan. Instead the commission intended to construct control works—either gated spillways or concrete weirs—that would commence operation at a stage corresponding to 51 feet on the Vicksburg gage. The commission believed that the substitution of control works for the fuseplug levee allowed for the flexibility to open the floodway only when high and prolonged flood stages warranted operation, thereby

Anatomy of a Cutoff

An earthen plug is all that separates the dredged pilot channels.

Dynamite removes the plug and opens the cutoff.

Fifteen minutes after opening.

One hour after opening, erosion of the plug has spread.

improving flowage conditions and regulating the extent and duration of diversion.[160]

The commission also sought to address the nagging issue of compensation by exploiting the generosity of New Deal Democrats, but recognized that an impediment still existed in the Corps of Engineers. That agency still maintained the position that the floodways were natural outlets for overflows, therefore, the federal government held no obligation to compensate landowners. To remedy the situation, the commission asked the Corps of Engineers to revise its real estate policy by advising the secretary of war to enter into an agreement with the states of Arkansas and Louisiana to hasten the acquisition process. Under the agreement, the states or other local authorities would acquire and transfer land rights to the federal government. The secretary of war would, in turn, reimburse the states at a cost not to exceed 1.5 times the total 1934 assessed value of the land rights acquired. Maj. Gen. Edward Markham, Brown's successor as chief of engineers, concurred with the commission's proposal, but slightly modified the recommendation by insisting on 1935 assessed values.[161]

The commission's proposed modifications, which also included substantial improvements in the Atchafalaya basin, were warmly received by many longtime critics of the Jadwin plan. In commenting on the changes in the Atchafalaya basin, James Kemper, an outspoken opponent of the Jadwin Plan and long-time critic of the Mississippi River Commission, remarked, "For the first time I appear to approve and support . . . the main engineering features of this new project." Harry Jacobs, another vocal opponent of the Jadwin Plan and the former chief engineer with the Louisiana Board of State Engineers, gave a similar ringing endorsement by calling the commission plan a "splendid recommendation" and asked Congress to authorize the modifications, posthaste. The Board of State Engineers shared its former chief engineers' sentiments. In a letter to House Flood Control Committee Chairman Riley Wilson, the board concluded that the plan came "as near being a perfect plan, consistent with justifiable outlay of funds, as it is possible to conceive. The Board of Mississippi Levee Board and the Yazoo-Mississippi Delta Levee Board also endorsed the modifications.[162]

One obstacle remained. Support for the commission plan ended at the Boeuf and Tensas basins. The success of Ferguson's program sparked a movement to eliminate any floodway in southeast Arkansas and northeast Louisiana. That movement had actually gained momentum the year before when the commission completed a study that examined a system of reservoirs in the Arkansas and White basins with a combined storage capacity of 15 million acre-feet. The study concluded that the 26 reservoirs, if built, would lower flood stages between Arkansas City and Old River by as much as five feet. Residents in the Boeuf and Tensas basins latched onto the finding and the results of Ferguson's program and launched a campaign insinuating that they were being forced to take on water to protect Mississippi interests across the river. In their view, this was a severe inequity worthy of remediation. Their proposed solution was to abandon the floodway in favor of levees of equal height on both sides of the river to give everyone an equal chance to life and property.[163]

Across the river, Mississippi delta interests, led by Mississippi Congressman Will Whittington, opposed the complete abandonment of a west bank floodway. Citing the historic floods of 1897, 1913, and 1927, they claimed that the equal protection theory was impractical. The Tensas and Boeuf basins were natural outlets; the Yazoo basin was not. When the historic floods crevassed the levees protecting the Yazoo basin, the water coursed southward through the Mississippi delta and reentered the Mississippi River near Vicksburg, eventually causing the levees on the Louisiana side of the river to break as the floodwaters sought a natural outlet, as had been the case following the Mound Landing crevasse in 1927. The fuseplug levee on the western bank assured, in a very certain way, where dispersion would take place; to abandon it and replace it with levees would remove this uncertainty and render the entire stretch of the river between the Arkansas River and Old River vulnerable to levee crevasses and overflow at points nearly impossible to predict. Furthermore, confinement meant higher flood elevations in the Yazoo backwater area. Appreciably sympathetic to the plight of their neighbors on the west side of the river, Mississippians exercised great care to not alienate them by reiterating their full support for just compensation, controlled spillways, a narrower floodway and, perhaps eventually, the incorporation of tributary reservoirs.[164]

For his part, Maj. Gen. Markham recognized the near impossibility of gaining a consensus between the two camps. While appearing before the House Flood Control Committee to answer questions on the proposed modifications, Markham remarked, "As you talk with Tom, Dick, or Harry, each has his own opinions and will stick to it very tenaciously." Markham wanted to find a more equitable solution to the floodway dilemma, but he was certain that dispersion, not confinement, was the answer. The channel rectification program was paying dividends in terms of increasing the carrying capacity of the main channel, yet he simply could not consent to any plan calling for the abandonment of a west bank floodway. He believed that the Eudora floodway concept was as reasonable and generous a solution as conceivably possible from both the engineering and economical view points, much more so in light of the provision for a controlled spillway at the head of the floodway.[165]

Ferguson's testimony somewhat echoed that of Markham. He began by explaining that measurements taken during the recent high water event of 1935 showed a significant increase in the ability of the main channel to carry more water at lower stages between Arkansas City and Vicksburg. He indicated, however, that the carrying capacity of the river did not reach the point where dispersion was no longer necessary. The channel rectification program was designed to confine floodwaters and secure as rapid a discharge as possible, but would permit dispersion when absolutely necessary to prevent catastrophe. During a heated exchange with committee member John L. McClellan, in which the Arkansas congressman prodded Ferguson with a salvo of questions as to whether or not the purpose of the Eudora floodway was to divert floodwaters to protect the Mississippi delta, the commission president fired back, "It permits the diversion of waters where of necessity they must go." He continued, "You have a physical situation that outranks the laws of Congress and all the opinions of engineers."[166]

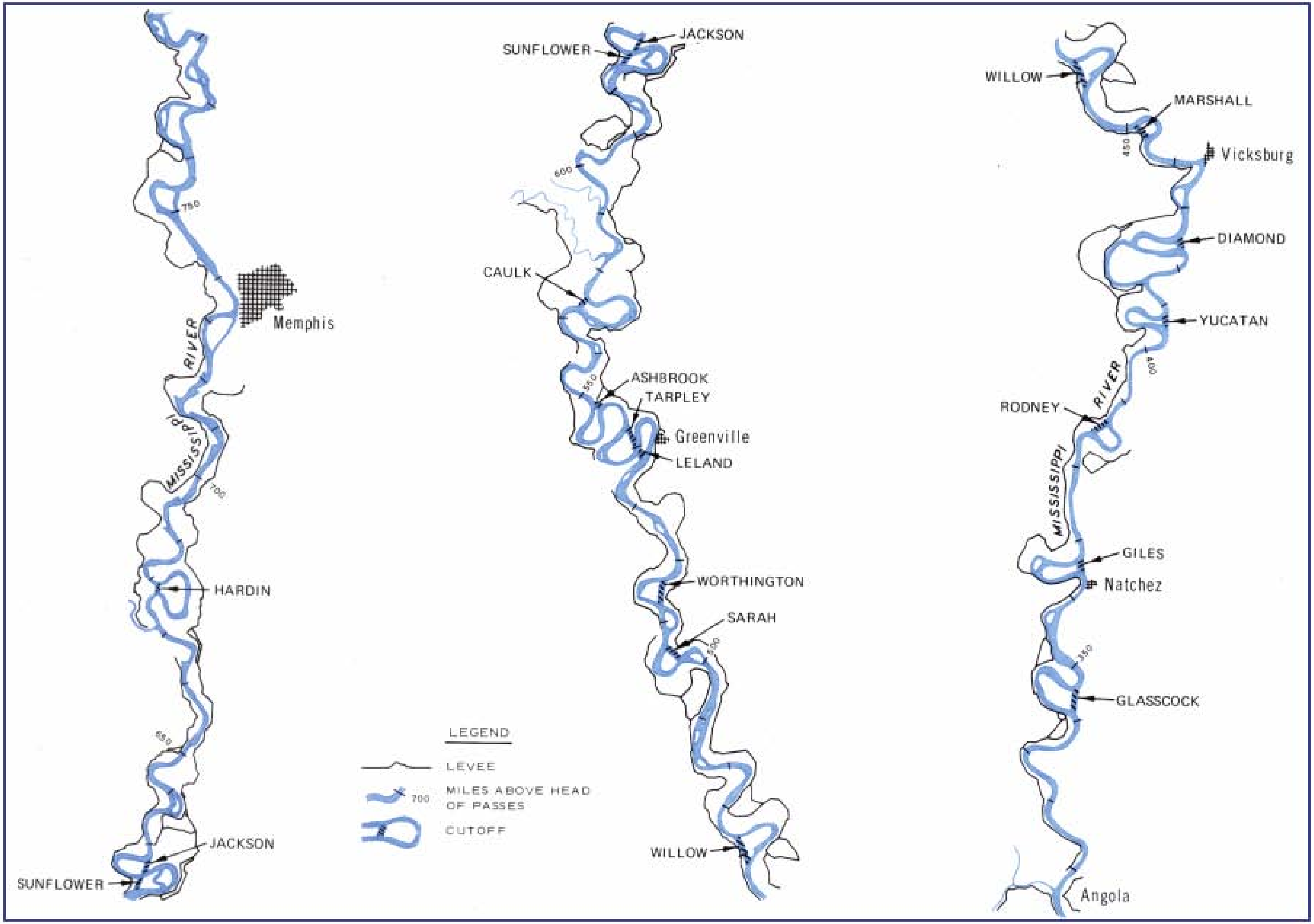
After nearly a year of political haggling, congressional delegations from Arkansas, Louisiana, and Mississippi finally brokered a compromise. On June 15, 1936, Congress passed the Overton Act, which, along with other system-wide improvements, approved the elimination of the Boeuf floodway from the project upon the completion of the Eudora floodway. The Overton Act prohibited the construction of the guide levees for the new floodway until after the federal government acquired at least 75 percent of the required flowage easements. The new law had solved the floodway dilemma – at least on the surface. By the end of 1936, roughly 30 percent of the requisite number had been secured. As a new year dawned, the intended fuseplug levee for the Boeuf floodway remained at a height that stood lower than surrounding levees. No guide levees had been constructed. If a major flood developed and breached the fuseplug levee, there would be no way to confine the overflow, leaving a large portion of southeast Arkansas and northeast Louisiana vulnerable to uncontrolled flooding. Just such an event occurred in January 1937 when a staggering amount of rain began falling over the Ohio Valley. It was the onset of the Great Flood of 1937.[167]

As the 1937 flood swept down the Ohio Valley, residents on the Boeuf and Tensas basins anxiously watched as the swollen river shattered old stage records from Huntington, West Virginia, to Cairo. That anxiety turned to gripping fear after the Mississippi River Commission activated the Birds Point-New Madrid floodway. As the flood crest rolled past the confluence and down the Mississippi River, it established new stage records at each passing gage – Hickman, New Madrid, Tiptonville, Caruthersville, Osceola, Memphis, and Helena. News outlets predicted new records flows – as much as 25 percent greater than any flows experienced before. Rumors began to spread that the Boeuf floodway would overtop and fail, unleashing an unstoppable wall of water through the basin. Local landowners began patrolling the fuseplug levee and threatened armed resistance to any attempt to activate the floodway through artificial means.[168]

Fortunately, the dreaded predictions below Helena never materialized. Throughout the stretch of the river between the Arkansas River and Old River, Ferguson's channel rectification program had dramatically increased the carrying capacity of the river. Floodwaters did not seriously challenge the fuseplug levee at the Boeuf floodway. The cutoffs and chute enlargement operations that had performed so admirably in lowering flood stages during the 1935 high-water season had more fully developed in the two years since that event. By 1937, Ferguson had also executed four additional cutoffs – Tarpley Neck and Ashbrook Neck in the Greenville Bends, Rodney Bend, and Sarah Island. These cutoffs brought the total number of artificial cutoffs to eleven. Along with the natural Yucatan cutoff, they shortened the river by 100 miles. The performance of Ferguson's program during the 1937 flood demonstrated the unmistakable signs of improvement, even with variances in the size and parameters of floods. During the 1929 flood, the Arkansas City gage had reached 58.7 feet when discharge was 1.78 million cfs. At that same discharge during the 1937 flood, the gage read 47.2 feet – a reduction of 11.5 feet. At 53.7 feet, the discharge was 1.4 million cfs in 1929 and 2.1 million cfs in 1937, an increase in carrying capacity of more than 700,000 cfs or nearly 50 percent. Just below the Greenville Bends, the peak discharge of the 1937 flood was 20 percent greater than that of the 1929 flood, but the peak crest was one foot lower. Vicksburg saw an increase in capacity of 317,000 cfs (18 percent greater than 1929) for a reduction in stages of 5.2 feet.[169]

In the aftermath of the Great Flood of 1937, Maj. Gen. Markham, shaken by the experience of operating the Birds Point-New Madrid floodway, recommended an $82 million plan calling for thirteen reservoirs in the Arkansas-White basin, in addition to the six reservoirs already authorized through the 1936 flood control act. His advocacy of the reservoir plan, which would reduce the flood discharge on the Mississippi River below Arkansas City by 200,000 cfs was tied to his desire to eventually eliminate or at least reduce the probability of operating the Boeuf/Eudora floodway. Ferguson, for his part, remained confident in the value of his program, but he would not commit to abandoning the floodway until that program had fully developed. Until it did, he warned that it was necessary to keep the floodway as an insurance policy to protect the integrity of the mainline levees.[170]

Ferguson executed one final cutoff at Caulk Neck on May 13, 1937, before retiring two years later. In 1941, the Mississippi River Commission, while maintaining the Boeuf and Eudora floodway concepts were feasible and sound from an engineering standpoint, but impractical because of intense local opposition, conceded that it was possible to eliminate the Boeuf/Eudora floodway from the MR&T project. Citing the success of Ferguson's program and the storage capacity of newly-authorized reservoirs in the Arkansas-White basin, the commission suggested that if those improvements had been in place in 1928, more serious consideration would have been given to confining the project flood with higher levees below the Arkansas River. Through the 1941 Flood Control Act, Congress eliminated the Boeuf and Eudora floodways from the MR&T project. The law also mandated that the mainline levee on the east bank of the river south the Coahoma-Bolivar county line have a two-foot height superiority over the levees on the west bank. In other words, the law authorized the levee on the east bank to have three feet of freeboard above the project flood flowline, but limited the west bank levee to only one foot of freeboard. Because the higher levees on both sides of the river would confine floodwaters and cause



Mississippi River cutoffs, 1929-1942.

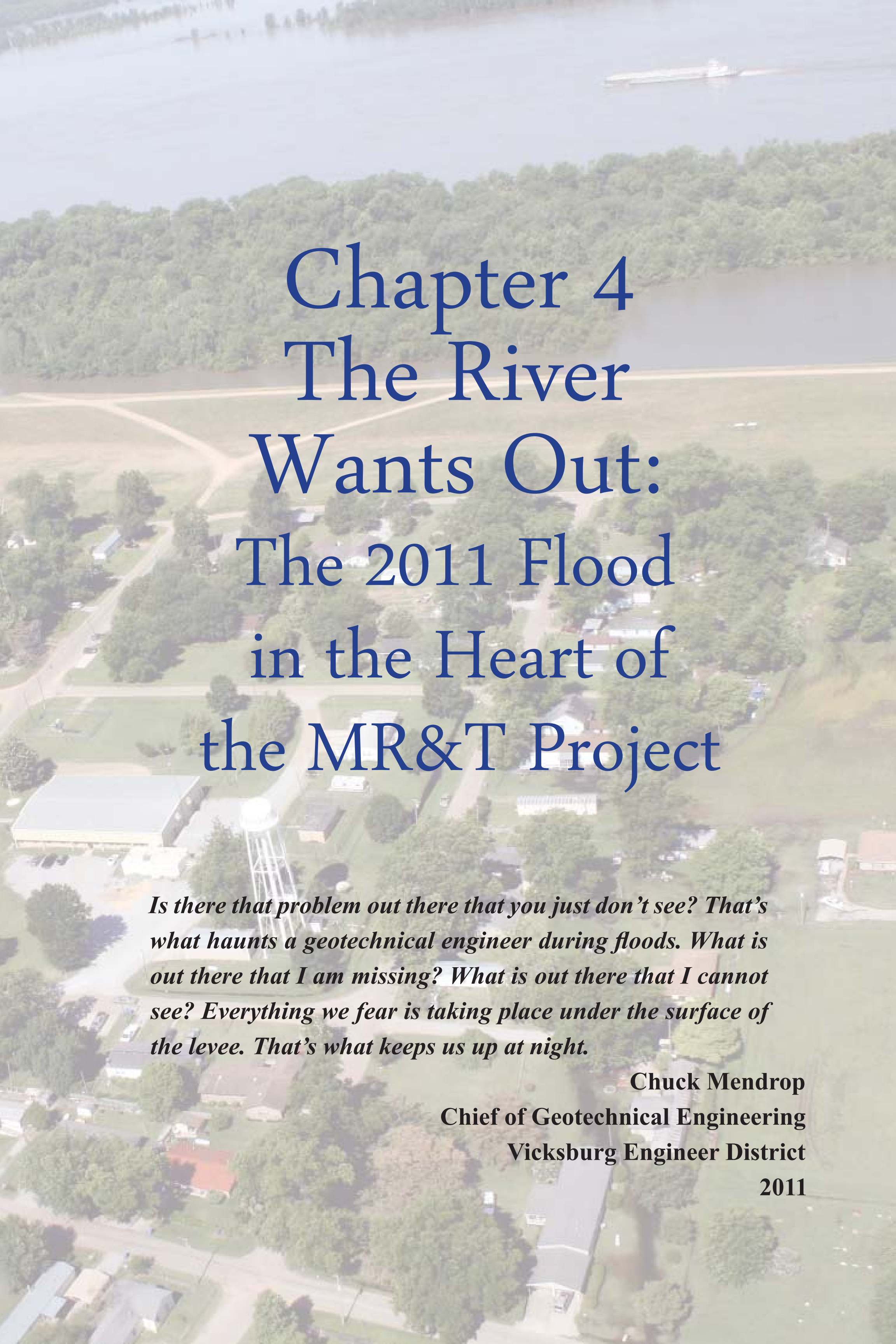
higher flood stages in the Yazoo backwater area, the law authorized extensive improvements to alleviate backwater flooding in the lower Yazoo basin.[171]

Ferguson's replacement as commission president, Brig. Gen. Max Tyler, carried out three additional cutoffs between the Arkansas River and Memphis at Jackson, Sunflower, and Hardin. By 1942, there were 16 cutoffs in operation. These reduced the length of the Mississippi River between Memphis and Baton Rouge by 151.9 miles. Corrective dredging, chute enlargements, and other improvements — carried out in addition to the cutoffs — brought the total reduction in length to 170 miles. The channel realignment program not only lowered flood stages, it also improved transportation costs. Prior to the cutoffs, the average time for a towboat and barges to travel from Baton Rouge to Helena took 125 hours. By 1938, with the cutoff program only 75 percent complete, that same trip took an average of 105 hours – a savings of nearly one full day. In 1944, the commission reported, "The river now has the best alignment, the best navigation channel, and the greatest flood-carrying capacity it has ever had." The navigation industry and levee board engineers heartily agreed.[172]

The problems of maintaining the stage reductions achieved through channel realignment, protecting the integrity of the levee system from a meandering river, and providing an adequate channel for safe and reliable navigation were inseparable. To retain the stage reductions and to prevent the river from regaining its former length, the commission launched a massive channel stabilization program consisting of a large-scale bank revetment program, channel contraction works, and dredging. As Charles Senour, the chief engineer for the commission explained, the channel stabilization program "is the necessary sequel to the flood control and navigation improvements hitherto accomplished, which it is designed to supplement and protect."[173]

From the beginning, Maj. Gen. Brown's stated intent was to try to eliminate or reduce the proposed Boeuf floodway, which residents opposed and whose cost had increased by millions of dollars because of court rulings that the Corps of Engineers had to pay for flowage rights. Ferguson's cutoff plan had cut across the grain of accepted engineering theory. Despite opposition from leading engineers, Brown had courageously adopted it out of necessity to solve the problems in building the floodway. Yet it was Ferguson who earned near universal acclaim, not just for proposing and implementing cutoffs, but for continuing the program until he saw real results. "The remarkable feature of the Ferguson plan is its boldness," Gerard Matthes wrote to a reporter in 1937. "A foot or two of stage lowering would have satisfied many engineers. Not so General Ferguson." He did not quit until there was a stage reductions of 12 feet at Arkansas City and seven feet at Vicksburg. Later cutoffs implemented by Tyler improved the carrying-capacity of the river as far upstream as Memphis, where the commission estimated up to two feet of stage reduction had been achieved. The Ferguson plan thus not only affected a profound change in Mississippi River policy but a change in engineering practice as well. The only question that remained was whether the improvements in the river resulting from the cutoffs were sustainable through the channel stabilization program.[174]

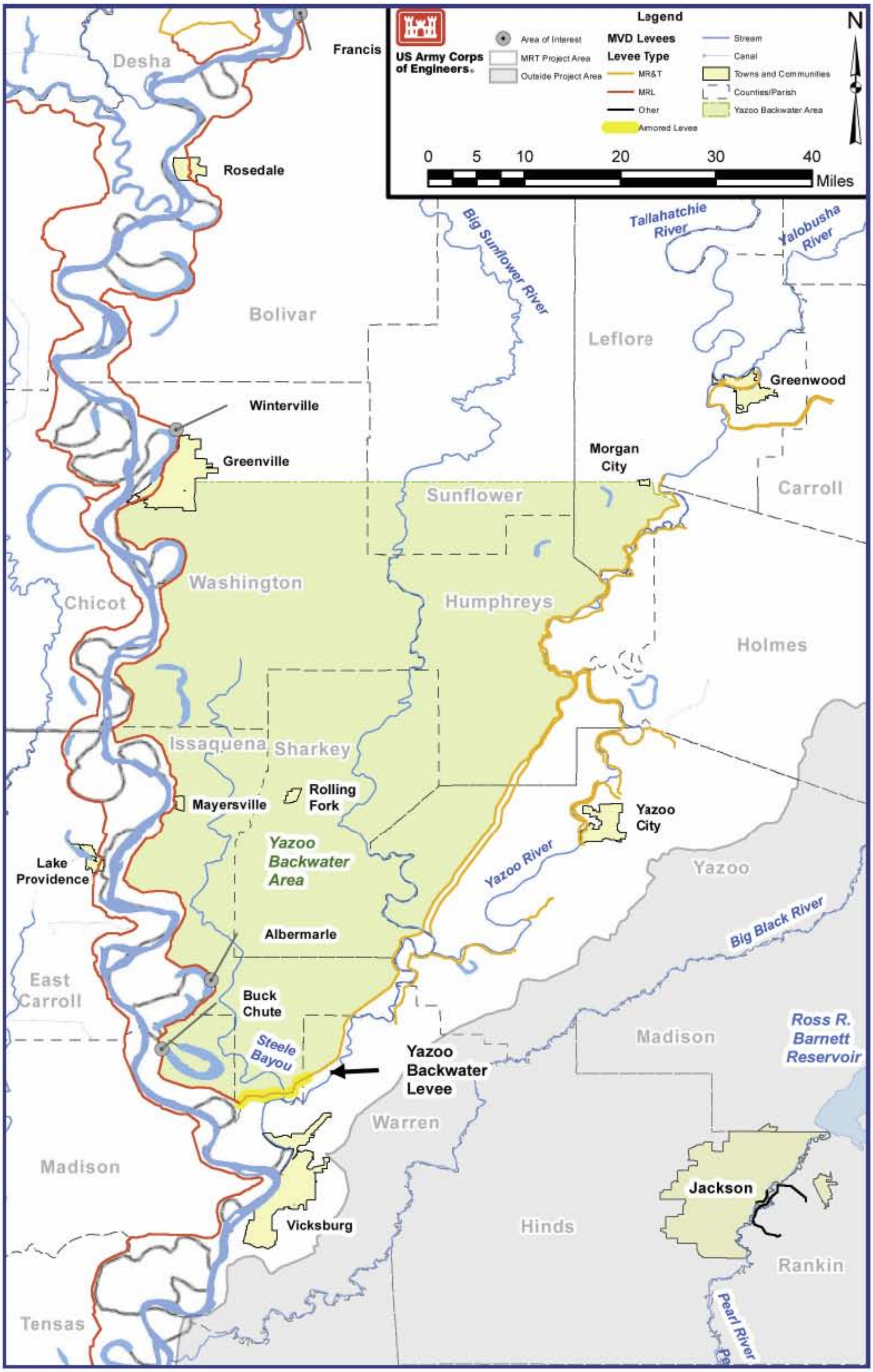
As the 2011 flood crest slowly worked its way down the Mississippi River, engineers from Memphis to Natchez asked themselves that same question. With no floodways to relieve the pressure on the levee system, the flood-carrying capacity of the channel would be the first line of defense.



Chapter 4
The River Wants Out:
The 2011 Flood in the Heart of the MR&T Project

Is there that problem out there that you just don't see? That's what haunts a geotechnical engineer during floods. What is out there that I am missing? What is out there that I cannot see? Everything we fear is taking place under the surface of the levee. That's what keeps us up at night.

Chuck Mendrop
Chief of Geotechnical Engineering
Vicksburg Engineer District
2011


Legend
US Army Corps of Engineers
Area of Interest
MRT Project Area
Outside Project Area
MVD Levees
Levee Type
MR&T
MRL
Other
Armored Levee
Stream
Canal
Towns and Communities
Counties/Parish
Yazoo Backwater Area
N
0 5 10 20 30 40
Miles
Desha
Francis
Rosedale
Bolivar
Big Sunflower River
Tallahatchie River
Yalobusha River
Leflore
Greenwood
Winterville
Greenville
Morgan City
Sunflower
Carroll
Washington
Chicot
Humphreys
Holmes
Issaquena
Sharkey
Rolling Fork
Mayersville
Yazoo City
Lake Providence
Yazoo Backwater Area
Yazoo River
Yazoo
Albermarle
Big Black River
East Carroll
Buck Chute
Steele Bayou
Yazoo Backwater Levee
Madison
Ross R. Barnett Reservoir
Warren
Madison
Jackson
Vicksburg
Hinds
Rankin
Tensas
Pearl River

On April 22, several staff members from the Vicksburg Engineer District gathered in a conference room in the district headquarters building to participate in the Lower Ohio-Mississippi River coordination teleconference. The teleconference represented a daily gathering of forecasters from the National Weather Service and Corps of Engineers water control managers. The main focus of the day's teleconference centered on the Mississippi River and Ohio River flood crests building toward the Cairo gage. Although the major Mississippi River gages in the Vicksburg district at Arkansas City, Greenville, Vicksburg, and Natchez remained anywhere from three to five feet below flood stage, there was a strong hint of trouble in the air. The engineers present in the conference room had been alerted to the contingency forecast for the Cairo gage in excess of 61 feet issued the previous day by the National Weather Service, but they knew that it only represented a worst-case scenario. The official forecast was nine feet lower. Still, the threat of additional rain over the Arkansas and Ohio valleys created an ominous feeling in the conference room. The water at Cairo would eventually work its way down the valley and combine with the added flows of the Arkansas and White rivers before coursing through the heart of the MR&T project in the Vicksburg Engineer District. The amount of water the district needed to accommodate depended on the amount and location of additional precipitation. Finally, the Lower Mississippi River Forecasting Center broke the news. Based on anticipated rainfall five days into future, the National Weather Service anticipated a crest of 59 feet on the Greenville gage on May 11 and a crest of 53.5 feet on the Vicksburg gage on May 13.[175]

Everyone in the conference room was stunned – it was as if a major flood had just materialized out of nowhere. Amid the gasps and confusion, Robert Simrall, the chief of water control at the Vicksburg district, glanced at Wayland Hill, the 35-year veteran river forecaster who had spent his entire career studying the dynamics of the river, and blew out a long whistle as he leaned back in his chair and placed his hands behind his head. *Fifty-three and a half feet!* The number bounced around his mind as he tried to place the figure into context with the stages produced by previous major floods. That stage, if it materialized, would surpass the stages of the devastating floods of 1937 and 1973 – the two major benchmark floods of the MR&T era. That stage would be the highest stage and produce the greatest amount of pressure on the MR&T system since its establishment in 1928. A gage reading of 53.5 feet would register as the second highest stage ever recorded, behind only the Great Flood of 1927. The other engineers in the room had similar thoughts. Collectively they snapped back to attention. The crest was still three weeks away. They still had time to prepare.[176]

The Weak Link

The forecast shocked Kent Parrish as well. As the district's senior project manager for the Mississippi River levee system, his immediate concern was what he considered the weakest link in the entire system – the mainline levee at Buck Chute. The levee at Buck Chute, near Eagle Lake, Mississippi, represented a significant threat to the safety of the lower Mississippi delta. The levee was a traditional problem area in terms of underseepage and sand boils, even during periods of low flood stages. If the levee failed, the delta would see flooding not experienced since 1927. The Vicksburg district addressed the problem by installing relief wells in 1999 and 2007. In early 2010, the Mississippi Levee Board identified several sand boils – which had likely formed during the 2008 flood, but had gone undetected – about 2,000 feet upriver from the newly-installed improvements. During the 2010 high water season, the board detected several massive sinkholes at the toe of the levee. Upon closer inspection, the 10 to15-foot wide and six to eight-foot deep holes turned out to be the result of sand boils. The fact that the boils first appeared when the river was less than a foot above bank full alerted the levee board of the significance of the problem. Peter

Nimrod, the chief engineer for the levee board, notified the Vicksburg district and the Mississippi River Commission of the critical nature of the problem. Following the 2010 high water, the district took soil borings and performed cone penetrometer tests in the area to determine the ability of the soil to withstand pressure. Based on the findings, the district designed plans to remediate the problem with a 1,500-foot long and 200-foot wide landside seepage berm to add extra weight and cross section to the levee with the intent of dissipating pressure on the levee during flood events. The design also included the installation of 25 relief wells. The district intended to finalize plans and specifications and to begin advertising the contract for construction in May 2011. They never got the chance. The flood of 2011 struck before they could take action.[177]

The early flood pulse in March 2011 forced the Mississippi Levee Board to take temporary measures. After consulting with geotechnical engineers from the Vicksburg district, the board filled the holes with sand and placed engineering fabric over the sand. The levee board also constructed a low earthen dike around the area, which was allowed to fill with seepwater, to counteract the pressure from the minor flood stages experienced. Upon hearing the updated forecast for the Vicksburg gage on April 22, Kent Parrish and other district officials knew that the critical situation at Buck Chute required immediate and aggressive action. The existing temporary remediation measures at Buck Chute did not stand a chance against the onslaught of pressure at a stage of 53.5 feet. Representatives from the district's geotechnical, hydraulics, operations, and project management offices immediately analyzed various options to address the problem. In the meantime, Chuck Mendrop, the chief of geotechnical engineering at the Vicksburg district, and his staff developed an interim plan to construct a thick earthen berm over the levee board's makeshift filter.

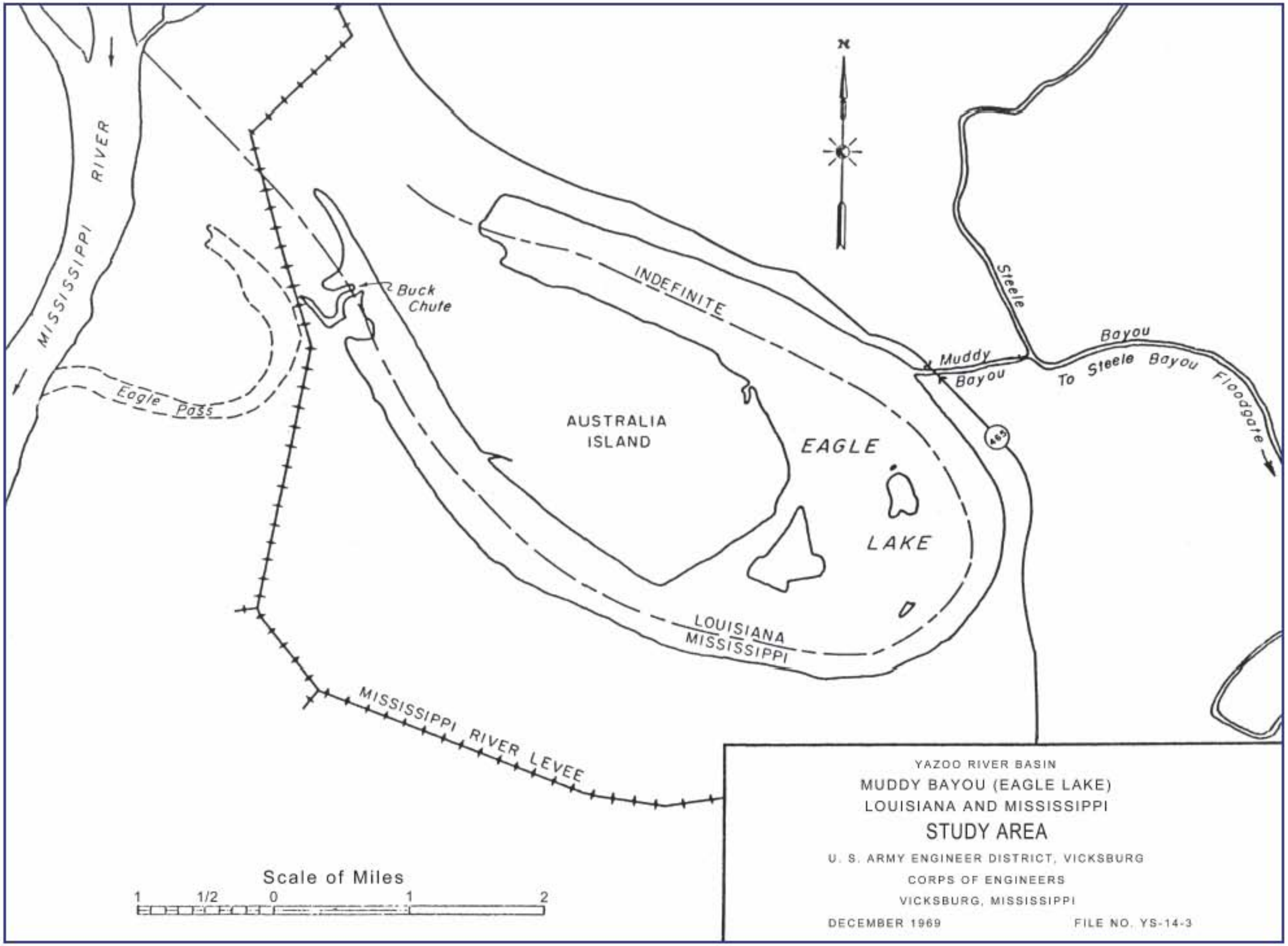
As the district team established a more detailed plan, Parrish immediately called Jimmy Coldiron, a supervisory mechanical engineer from the district's river operations branch, and notified him of the dire nature of the problem at Buck Chute. Coldiron dispatched his assistant, Bobby Stokes, to the site to coordinate with the district's geotechnical engineers and to assess what resources and assets were needed to get the job done. Stokes immediately observed that the site was a mess. It was heavily wooded. A tornado the year before had toppled many of the trees, creating a tangled mess that needed to be cleared. Below the trees and logs stood one to two feet of seepwater impounded by the remnants of the levee board's small water berm. The conditions on the ground did not particularly disturb Stokes – his guys could clear the area without any problems – but he needed clay to build the berm. The job necessitated a lot of it. The district crews could not just take the clay to build the dike from anywhere. Taking it from the landside of the levee was not an option. Doing so would threaten the integrity of the levee. Taking it from a nearby farm was not an option without compensating the landowner. Hauling the clay from a distant location would use up valuable time. The Mississippi Levee Board, though, had already identified an

A view of the Buck Chute area prior to clearing operations. Note the elevation marked on the tree.

adequate borrow pit less than a mile from the site. But the borrow pit was on the river side of the levee. The good news was that the river was still five feet below flood stage. The bad news was that the river was coming up fast and would engulf the borrow pit in a matter of days.[178]

Coldiron and Stokes immediately began securing the necessary resources. The equipment and personnel they needed were scattered throughout the district on various high-priority projects. Speaking of the operation at Buck Chute, Parrish told Coldiron, “This is the new top priority. Everything else can wait.” Within hours, Coldiron had lined up seven dozers, four trackhoes, a dozen dump trucks and excavators, and a bank of emergency lights for the nightshift operations. He also assembled two, twelve-man crews, pulling crew members from dredges, the mat-sinking unit, and other projects. By Saturday, April 23, the hired-labor crew and equipment were at Buck Chute clearing debris from the area and racing against the river to relocate 20,000 cubic yards of fill from the riverside borrow pit. It was Easter weekend, but that was the farthest thing from their minds. They had a job to do. The safety of the lower Mississippi delta depended upon their success.[179]

By the morning of April 25, the Mississippi River on the Vicksburg gage reached 39.2 feet, still nearly four feet below flood stage, but it had climbed by more than a foot since April 22. Over the weekend, the district’s multi-discipline team continued to analyze options to combat the Buck Chute problem. Coldiron’s hired-labor crew had already commenced constructing the dike around the entire two-acre area, but Mendrop’s geotechnical team was not overly confident that an earthen berm alone would provide enough of a safety factor. The geotechnical engineers determined that because the levee did not fail during the 2008 flood, a similar head differential – the difference in height between the water level on the outside of the levee and the land on the protected side of the levee – would sufficiently prevent the underseepage from undermining the levee. With a predicted stage of 53.5 feet on the Vicksburg gage, that meant they needed to raise the


MISSISSIPPI RIVER
Eagle Pass
Buck Chute
INDEFINITE
AUSTRALIA ISLAND
EAGLE LAKE
LOUISIANA
MISSISSIPPI
Muddy Bayou
Steele Bayou
To Steele Bayou Floodgate
465
MISSISSIPPI RIVER LEVEE
Scale of Miles
1 1/2 0 1 2
YAZOO RIVER BASIN
MUDDY BAYOU (EAGLE LAKE)
LOUISIANA AND MISSISSIPPI
STUDY AREA
U. S. ARMY ENGINEER DISTRICT, VICKSBURG
CORPS OF ENGINEERS
VICKSBURG, MISSISSIPPI
DECEMBER 1969
FILE NO. YS-14-3

berm on the protected side of the levee to an elevation equal to 87 feet – an elevation approximately ten feet higher than the natural ground. Mendrop approached Ron Goldman's hydraulic engineers and asked if it was possible to create a blanket of water over the earthen berm to provide extra weight. Goldman's crew indicated it would be no problem. To make it a reality, Coldiron's hired labor crew would continue constructing the earthen dike around the Buck Chute, fill the dike with a three-foot layer of sand, and cover the sand with a two-foot thick clay cap. In the meantime, the water control office would open the gates at the Muddy Bayou control structure and allow Steele Bayou to back into and raise the elevation of Eagle Lake, which, in turn, would flood and blanket the earthen berm with several feet of water until it reached an elevation of 87 feet, perhaps even higher if conditions warranted.[180]

The plan faced a few obstacles. First, the job required sand for the core of the Buck Chute berm. The Vicksburg Engineer District had an available stockpile across the river in Delta, Louisiana, at a local mat casting field. The sand, which was to be used to make articulated concrete mattress for bank revetment purposes, had been stockpiled on the riverside of the levee. The rising river would soon engulf the mat casting field and the sand stockpile along with it. The district quickly awarded an emergency contract to remove and relocate the sand to Buck Chute. Within hours, dozens of trucks began hauling sand, day and night, from Delta and stockpiled it near the construction site at Buck Chute. To speed the hauling operation, Warren County Sheriff Martin Pace coordinated with law enforcement agencies in Louisiana to allow the trucks to bypass the weigh station on Interstate 20 in Louisiana.

Changing the flow of water at the Muddy Bayou control structure also represented an obstacle. The structure was built to prevent agricultural runoff from Steele Bayou from entering Eagle Lake. During dry periods, the control structure prevented the lake from draining into Steele Bayou. Raising the elevation of Eagle Lake represented a reversal in the intended purpose of the control structure. Any such reversal required a deviation from the water control plan for the Muddy Bayou control structure. Maj. Gen. Walsh, the president of the Mississippi River Commission, would need to approve the deviation, and he would not grant it automatically, given the potential impacts to more than 800 residents and their property along Eagle Lake. Those potential damages originally gave the district reason to pause, but the inundation maps depicting a levee failure at Buck Chute quickly wiped away the hesitation. According to the inundation map, a breach would cover nearly all of Issaquena and Sharkey counties with anywhere from five to twenty feet of water. Higher elevated lands at Mayersville, Onward, Rolling Fork, and Cary might only see a few inches to five feet of water, but the lower lying lands in the southern parts of the counties, as well as those in northern Warren County and western Yazoo County could possibly experience depths in excess of 20 feet. The devastation from a possible breach extended all the way into southern Washington and Humphreys counties. The potential damages were too great. The levee had to hold. The district team determined that the proposed plan was the appropriate safety measure to ensure the levee, in fact, held.[181]

As Coldiron's crews continued constructing the dike, the district's water control team began coordinating the deviation request for the Muddy Bayou water control plan with the watershed management team at the Mississippi Valley Division headquarters across town, as well as the U.S. Fish and Wildlife Service, the Mississippi and Louisiana departments of wildlife, the Warren County Board of Supervisors, the Madison Parish president, and state and local entities. It took several days to get everything in order. Finally, on April 27, the district formally sent the deviation request to Maj. Gen. Walsh. Charles Shadie, the chief of water management at the division office, relayed Walsh's desire for input from residents of Eagle Lake before approving the deviation. At the district office, Goldman took this to mean that Walsh was not inclined to approve the deviation.

The following day, Goldman, Mendrop, and Parrish accompanied Col. Jeffrey Eckstein, commander of the Vicksburg Engineer District, to meet with Walsh. Eckstein took command of the district in December 2009, but this would be his first major flood fight. Parrish had taken him to Buck Chute over Easter weekend to observe, firsthand, the criticality of the problem. The visit convinced Eckstein that the levee represented an imminent threat to the lower Mississippi delta. He was prepared to present his case to Walsh. At the meeting, Walsh asked pointed questions. The water control plan was established for a reason; deviating from the plan could leave the Corps of Engineers open to criticism. He wanted assurances that there were no other options available. As Walsh spoke, Goldman thought to himself, *He is going to turn us down.* Goldman understood that deviations should not be made lightly, but to him the Buck Chute dilemma represented an instance where a deviation was absolutely necessary. Eckstein and his staff provided pointed answers to Walsh's direct questions. They informed the commission president that the levee at Buck Chute was the weakest link in the levee system. In their estimation, it would not withstand the pressure exerted by the river without the added counter pressure that the water berm would provide. If the levee failed, approximately 3,000 homes and 1,450 square-miles of land – nearly seven times the amount of land in the Birds Point-New Madrid floodway – faced inundation. They needed to act quickly. They had made a compelling case. Walsh concurred and signed the deviation approval letter before they left his office.[182]

On the morning of April 28, the Mississippi River surged past 41 feet on the Vicksburg gage and completely engulfed the riverside borrow pit that Coldiron's crew had been using to secure earth for the Buck Chute dike. The river had come up fast, but his crew loaded and hauled dirt 24 hours a day as they raced the rising tide to get as much material out of the pit before the river overtook it. Nimrod, who stopped by to check on their progress, was amazed by their effort and dedication. *These guys*

Hired-labor crews construct the earthen berm around Buck Chute, while continuing to clear the area.

are fearless, he thought to himself as he watched the loading operations with the river nipping at the margins of the pit. The crews had constructed an elevated, but narrow, access road constructed of timber mats so they could squeeze every possible yard of dirt from the pit. As the river climbed higher, the crew raised the road higher. *Absolutely fearless!* Having won the race against the river, Coldiron's crew had no time to relax, though. Another race would soon commence. This time they would be racing against the rising water from Eagle Lake on the other side of the levee.[183]

Peter Nimrod and Jimmy Coldiron at Buck Chute.

The following day, Col. Eckstein and Peter Nimrod held a public meeting at Eagle Lake to explain the need and consequences of raising the elevation of the lake. Approximately 500 people crammed into and around the Eagle Lake Fire Station. Most in attendance were not as concerned with raising the water level of Eagle Lake as they were with the potential failure of the Buck Chute levee. Rumors had run rampant through several local communities. *The levee is going to fail! The Corps is doing everything it can, but failure is imminent!* People were scared. They needed answers. Eckstein and Nimrod attempted to calm their fears. Eckstein explained the emergency action that the district and levee board had undertaken. "If we don't do anything," he explained, "we will have a 32-foot head differential" between the stage on the riverside of the levee and the natural ground. "We aren't confident with that." Eckstein explained that his geotechnical engineers wanted to raise the level of the lake to reduce that head differential to 19 feet "to take away the threat of imminent failure." Still, he wanted everyone to know that the action did not alleviate all risk of failure. He urged the crowd to make prudent measures to protect their own lives and property.[184]

The hired-labor crew begins placing the clay cap over the sand fill as water from Eagle Lake climbs higher against the earthen berm.

At 0700 hours on April 30, the Vicksburg district opened the gates at the Muddy Bayou control structure. Five days earlier on April 25, the district had closed the gates that allowed Steele Bayou to drain into the Yazoo River to prevent the Yazoo from backing into the bayou. With no outlet to allow the escape of interior drainage, Steele Bayou reached the elevation of 88.6 feet on April 30, but was expected to rise to 94 feet with additional normal rainfall. Opening the gates at Muddy Bayou allowed water from Steele Bayou to overflow into Eagle Lake until the two water levels reached equilibrium. To prevent the scour and erosion to lands on the Eagle Lake side of the control structure, the district only partially opened the gates. The slow release of water also served another purpose. It gave Coldiron's crew time to complete the dike. The crew had completed the base, but it had yet to reach the final height. Nonetheless, it was of sufficient height to allow the sand filling operation to begin. The dike, sand fill, and clay cap needed to be complete before the lake overflowed and covered the area. The hydraulic engineers provided Coldiron with a sheet of paper depicting the anticipated lake elevation for each day of construction. They expected the lake to reach an elevation of 80 feet by May 2 and then rise roughly 1.5 feet per day thereafter until it reached its final elevation around 87 feet. Coldiron's crew fought to stay ahead of the rising lake. By the time the water from Eagle Lake reached the dike, it was about 75 percent complete, but the base was above the water line. They still had a dry working space to complete the operation. The weather continued to cooperate as well, at least in the lower Yazoo basin, where it had not rained since April 25. The same could not be said for the Arkansas and Ohio valleys to the north. Another round of heavy and persistent rains moved into that area on April 30 and lingered for several days, just as the flood crests from the upper Mississippi and Ohio rivers converged at the confluence.[185]

Yazoo Backwater Levee

On May 2, the major flood bearing down on the Vicksburg Engineer District was about to become worse. During the Lower-Ohio Mississippi River coordination teleconference that day, the National Weather Service formally delivered its revised forecast for the Cairo gage. "Sixty-three feet," Robert Simrall said aloud in amazement. Henry Dulaney, the relatively new chief of engineering and construction at the Vicksburg district became alarmed by Simrall's reaction. The obscure number on a distant gage did not register with Dulaney – who had a background in design and technical services – as it had with Simrall and the other members of the water control team present. He looked at Simrall and asked, "What does 63 mean?" Simrall replied, "It means our whole world is fixing to change!"[186]

As the teleconference continued, the magnitude of the flood in the midsection of the MR&T project began to crystallize. The heavy rains had not only worsened flood conditions at the confluence of the Mississippi and Ohio rivers, but they also wreaked additional havoc in the already swollen Arkansas and White basins. Three of the five major reservoirs comprising the White river system – Beaver, Table Rock, and Norfolk lakes – went to emergency spillway operations. The two other major reservoirs – Greer's Ferry Lake and Bull Shoals Lake –did not require spillway discharges, but experienced extremely high pool elevations, nonetheless. The Arkansas River also experienced significant flooding. The rain fell where the eleven major flood control reservoirs in the Arkansas system could not be of use, but the Southwest Division deviated from its water control plans and reduced discharges from the dams to reduce flows downstream. By May 6, water control managers from the Southwest Division anticipated the combined flows entering the Mississippi River from the Arkansas and White rivers to approach

500,000 cfs, just days before the crest rolling down the Mississippi River arrived. All of this translated into a stunning forecast for the major gages in the Vicksburg Engineer District: Arkansas City 53.5 feet, Greenville 64.5 feet, Vicksburg 57.5 feet, and Natchez 64 feet – a range of 14.5 feet to 16.5 feet above flood stage on each gage.[187]

While the mainline levees in the system stood high enough to hold back the river without overtopping – with the exception of significant low spots spanning nearly 3,000 feet near Vidalia, Louisiana – the levees would soon be facing a level of pressure never before experienced. At Greenville, the predicted crest stage would fall about one foot shy of the record stage reached in 1927, but it would break the 1973 stage by more than six feet. At Vicksburg, the new forecasted stage would top them all – more than one foot higher than 1927, more than four feet higher than 1937, and more than six feet higher than 1973. The thought of a flood six feet greater than 1973 flood stages at Greenville

Flooding in the Yazoo backwater area during the 1973 flood.

and Vicksburg sent a shiver of fear through most of the people living in the Mississippi delta. Those people could not relate to the floods of 1927 and 1937 because the events had taken place 84 years and 74 years ago, respectively. The same could not be said of the 1973 flood. The majority of delta residents 40 years of age or older vividly recalled the devastation of that flood, when nearly one million square-miles of land were inundated in the Yazoo basin alone. While areas in Arkansas and Louisiana, particularly those in the Ouachita basin, suffered extreme hardships during the 1973 flood, approximately 45 percent of the land flooded during the event was in Mississippi. The Yazoo basin, particularly the area known as the Yazoo backwater area, served as the epicenter of devastation in Mississippi.[188]

Backwater areas are the necessary result of gaps left in the Mississippi River levee system at the mouths of major tributaries that empty into the river. Prior to the construction of the levee system, the backwater areas were no different than most lands comprising the alluvial valley. They flooded when the Mississippi River overflowed its natural alluvial banks or backed into the tributary streams. As the levee system gradually extended upriver, the confinement of Mississippi River floodwaters protected lands upriver from the backwater areas from overbank flows, but floods continued to back up through the gaps and around the lower end of the levees, inundating the low-lying areas behind the levees. As originally authorized in 1928, the MR&T project did not contemplate protection of the major backwater areas in the lower Mississippi valley at the mouths of the St. Francis, White, Yazoo, and Red rivers. Historically, the Mississippi River Commission recognized the importance of maintaining the natural storage capacities of the backwater areas as a benefit for flood control. The low-lying lands stored vast quantities of floodwaters, thereby lowering flood stages on the river by reducing the peak flows downstream of the backwater areas. After the initial success of Maj. Gen. Harley Ferguson's channel realignment and rectification program carried out in the 1930s, which improved the ability of the river to carry more water at lower stages, calls for improving conditions in the backwater areas gained momentum. The call was particularly strong in the Yazoo basin, where several reservoirs and other improvements had been authorized through the 1936 Overton Act to provide protection from headwater floods emanating from the hill country in the upper part of the basin. All that remained for the basin to maximize the benefits achieved through the enhanced mainline levees, the improved carrying capacity of the Mississippi River channel, and the protection from headwater flooding was protection from backwater flooding at the lower end of the basin.

While maintaining the position that the backwater area could never be fully redeemed from flooding, the Mississippi River Commission eventually conceded that the Yazoo basin could receive substantial protection from floods, provided the improvements did not hamper the natural reservoir effect the area provided during larger floods approaching project design flood elevations. The 1941 Flood Control Act authorized a plan developed by the Mississippi River Commission to provide for a level protection – corresponding to a height of 56.5 feet on the Vicksburg gage – for roughly 634,000 acres in the Yazoo backwater. The commission's plan involved the construction of a backwater levee extending from the existing Mississippi River mainline levee along the west bank of the Yazoo River to Yazoo City, where the levee would connect with the levee authorized under the 1936 Overton Act to control headwater floods. Recognizing that the backwater levee would impound runoff from the tributaries that traversed the backwater area and emptied into the Yazoo River, the commission recommended constructing a drainage structure at the Little Sunflower River and a combination of structures and pumping plants at the mouths of the Big Sunflower River, Deer Creek, and Steele Bayou to evacuate impounded water. When stages on the Mississippi and Yazoo rivers were too high to allow for gravity drainage, the plan made provisions for pumping stations at three locations with a total discharge capacity of 14,000 cfs – Big Sunflower River (11,000 cfs), Deer Creek (700 cfs) and Steele Bayou (2,300 cfs).[189]

Following a comprehensive review of the MR&T project in 1959, the Mississippi River Commission recommended changes to the plan after noting that channel improvements in the Mississippi River and reservoirs and associated works in the upper basin had reduced the frequency and duration of flooding in the backwater area. The plan called for replacing the previously-authorized pumping stations at the Big Sunflower River, Deer Creek, and Steele Bayou with improved gravity drainage structures and a 20-mile long and 200-foot wide channel connecting the Sunflower River and Steel Bayou ponding areas to the outlets at the Little Sunflower and Steele Bayou floodgates. The 1965 Flood Control Act authorized the proposed modifications and construction of the project quickened. In 1969 the Steele Bayou drainage structure, designed to discharge 19,000 cfs from the ponding area into the Yazoo River, was completed. In 1975, the drainage structure at Little Sunflower River capable of discharging 8,000 cfs was completed.[190]

In between the dates of completion for the two drainage structures, the 1973 flood struck the lower Mississippi Valley. The backwater levee had yet to be constructed, leaving the lower end of the Yazoo basin exposed. In early April 1973, the swollen Yazoo River overtopped a natural ridge along Deer Creek and began filling the Steele Bayou ponding area. A week later, the river and backwater levels equalized at an elevation of 99 feet, creating a lake 60 miles long and 40 miles wide. But the water levels continued to rise, cresting another two and a half feet higher on May 15. The backwater continued to creep farther north into the Yazoo basin until more than 1,000 square miles lay under water. It took several more weeks for the water to drain out. Thousands of people, many of them farmers, returned to find their homes and property destroyed.[191]

The May 2, 2011, forecast of 57.5 feet on the Vicksburg gage certainly caught the attention of the district's water control engineers. Most engineering analyses and model tests dating back to the 1950s indicated that the Yazoo backwater levee would overtop as designed when the Mississippi River approached a range of 56.2 to 56.6 feet on the Vicksburg gage. The information on channel conditions used in development of the studies, though, was several decades old. The 2008 flood afforded the Vicksburg Engineer District the opportunity to gather fresh information. The river reached 57.3 feet on the Greenville gage and 51 feet on the Vicksburg gage in 2008. Both stages were less than one foot lower than stages experienced on both gages during the 1973 flood. Ronald Goldman, the district's chief of hydraulic engineering, used the flood as an opportunity to gain more knowledge of the river. As the peak flow moved downstream through the district, contract crews in a survey boat measured the depth of the centerline of the channel, while additional crew members at the exact latitude on the levees on both sides of the river plotted the exact high water mark. They repeated the process every half mile. Hydraulic engineers used the data to develop a modern or updated profile of the river in terms of its slope and the relationship between stage and discharge. From this profile, the Vicksburg district developed a new baseline to more accurately determine how the river would respond under existing channel conditions. The 2008 profile confirmed what previous studies had shown – the Yazoo backwater levee would overtop when the river reached 56.3 feet on the Vicksburg gage. With an anticipated crest stage of 57.5 feet on the Vicksburg gage, the backwater levee would overtop by more than one foot.[192]

At the Mississippi Levee Board office, Peter Nimrod could not believe what his ears were hearing. "What? No way!" Kent Parrish had called to inform him that the Vicksburg district's hydraulic engineers expected the 28-mile backwater levee to overtop by more than a foot for at least ten days. The overtopping itself did not concern him. It would certainly create some hardship in the lower Yazoo basin, but he believed that the levee board could manage the additional water. Nonetheless, he would press the Vicksburg district to flood fight at the backwater levee; to raise the levee with sandbags and HESCO bastions – large containers filled with sand. No, the overtopping was not Nimrod's main concern. The prospect of losing the backwater levee entirely, though, terrified him.

Ten days! Nimrod thought to himself. *Ten days!* The hydraulic engineers at the Vicksburg district expected more than a foot of water to flow over the top of the 28-mile long backwater levee for ten days. It was disconcerting enough for him to know that the water on the river side of the levee would be approximately 17 feet higher than the ground on the landside. The highest differential the levee had ever experienced in the past was a little more than nine feet in 2008. The immense pressure on the levee from the head differential alone was extremely worrisome, but the added powerful and constant force of more than a foot of water eroding the crown, the landside slope, and the toe of the levee for ten consecutive days frightened Nimrod. The backwater levee was a fine and well-constructed levee, but under those conditions, ten days represented a lifetime. Nimrod started doing the calculations in head. If the levee failed, the south Mississippi delta faced a catastrophe. Water levels in the backwater area would be six feet higher than those experienced during the 1973 flood. Rolling Fork and Mayersville, both of which stayed high and dry during the 1973 flood, would be inundated. Nimrod pictured a map of the backwater levee in his mind. *Twenty eight miles of levee overtopping for ten days!* The levee had to hold.[193]

On May 3, Goldman, Simrall, and Wayland Hill began poring over profiles and data in more detail. Residents in the backwater area were about to catch their first break. The 2008 profile that Goldman had commissioned showed a steeper slope in the Yazoo River than originally thought – as much as a half a foot steeper. Using information collected during the 2008 flood, the district's hydraulic engineers determined that if the river reached 57.5 feet on the Vicksburg gage, the backwater levee would only overtop along a four-mile stretch extending from the junction of the Mississippi River mainline levee and the Yazoo

The clay cap nears completion at Buck Chute as water from Eagle Lake continues to rise.

backwater levee up to the vicinity of the Steele Bayou control structure. Attempting to prevent a breach along 28 miles of levee in a short period of time seemed nearly impossible; doing the same along a four-mile segment was doable. Armed with this information, the district team decided to examine the impacts that temporarily raising the backwater levee would have on the Mississippi River levees. Nimrod was ecstatic upon hearing the news.[194]

At Buck Chute, Coldiron's crew continued to push toward completing the emergency berm. By May 3, the three-foot sand layer inside the dike was complete and the process of capping it with a two-foot layer of clay had commenced, with an estimated completion date of May 7. All that remained was for Eagle Lake to rise to the prescribed height. The four-foot increase in the Mississippi River forecast meant that the water berm needed to go higher than an elevation of 87 feet, but Robert Simrall, who prepared the deviation request, wisely incorporated some leeway for the district to maneuver in the event that the forecast crest increased. While the original plan called for providing an elevation of 87 feet, Simrall worded the request to allow for raising Eagle Lake up to an elevation of 90 feet. The geotechnical engineers confirmed that the elevation of 90 feet provided enough of a safety factor. There would be no need to secure an additional deviation request unless the National Weather Service raised the forecast. The concern at Buck Chute, in terms of completing the emergency measures to protect the levee, was getting enough water on top of the earthen berm. When the plan was originally conceived over Easter weekend and the gates closed on April 25, Steele Bayou stood at 87 feet. Water control managers expected the bayou to reach an elevation of 94 feet with normal rainfall, but Steele Bayou remained stable at 89.9 feet. The only way to raise the elevation of Eagle Lake was for additional precipitation to fall and drain into Steele Bayou. In another example of the unique nature of the 2011 flood, the Vicksburg district and local levee boards were fighting a flood in the middle of a drought – the deluge they prepared for had emanated primarily from above the confluence of the Mississippi and Ohio rivers. It had not rained in the Yazoo basin since April 25, other than trace amounts. It would not rain again until after the gates were reopened on June 18 – a period of 55 days.[195]

During the morning commander's briefing on May 4, Col. Eckstein informed Maj. Gen. Walsh that Mississippi Governor Haley Barbour was gearing up a task force to assist in the flood fight. Eckstein knew that the state and the Mississippi Levee Board were prepared to formally ask the district to raise the backwater levee or armor the backside slope along the four-mile stretch from Steele Bayou to the mainline levee on the Mississippi River. Walsh stiffened in his chair as he heard Eckstein's report, wincing at the thought of a flood fight at the backwater area. Walsh recognized the severity of the problem at the backwater levee, but he faced a tough dilemma. The Yazoo backwater area was meant to overtop to relieve pressure on the system. Only 34 hours earlier, he had directed the operation of the Birds Point-New Madrid floodway to protect the integrity of the system in the confluence area, despite intense political and local pressure to flood fight along the fuseplug levee instead. Now he was being asked to flood fight. His initial thought was that he simply could not approve the request. Walsh still remained on the motor vessel *MISSISSIPPI* in the confluence area while overseeing the operation of the lower inflow/outflow crevasses at the floodway. He had been there since May 1, so he did not have a good feel for system conditions in the Vicksburg region. He wanted more information. "We didn't flood fight at Birds Point," Walsh told Eckstein, "so we need to study the impacts of flood fighting on the system." He asked Eckstein to talk to him offline after the briefing.[196]

At 0945 hours, Eckstein called Walsh as instructed. The engineering and operations staffs from the commission and the district were on the line as well to discuss the possibility of flood fighting. Confusion over the authorized height of the backwater levee ensued. The l941 Flood Control Act that authorized improvements in the Yazoo backwater area required the Mississippi Levee Board to provide assurances that it would not raise the backwater levee above limitations established by the Chief of Engineers. The Chief of Engineers, at the recommendation of the Mississippi River Commission, established the limitation at a height equivalent to 56.5 feet on the Vicksburg gage (elevation 107) as long as the backwater levee improvements did not confine floodwaters and push river levels to within five feet from the top of the mainline Mississippi River levees. The confusion over the issue came from subsequent authorizations stemming from the 1973 levee enlargements. The enlargement of the mainline levees authorized the enlargement of the Yazoo backwater levee by almost six feet. Some engineers from the district believed this justified temporarily raising the backwater levee during the flood. Others argued that raising the backwater levee was contingent on the completion of the mainline levees and other improvements, which had yet to be fully constructed. To make matters worse, sections of the backwater levee were deficient – a foot lower than authorized. Those areas needed to be raised to prevent premature overtopping.

Walsh digested the information presented to him. There were still too many unknowns. He was concerned that the district staff in Vicksburg might be caving to pressure from friends and associates back home. The backwater area essentially represented the district's back yard. He asked Eckstein to prepare and deliver a decision briefing later in the evening. "There will be pressure to the contrary," Walsh told Eckstein, "but we need to operate as a system. The integrity of the mainline levee is of paramount importance."[197]

Eckstein's engineers quickly determined that they were not authorized to flood fight along the backwater levee, even though protecting the levee from overtopping would raise flood heights along the mainline levees by only a fraction of an inch. They had to draw the line somewhere. Nimrod took the news generally well. The 2011 flood, thus far, had proved to be a battle of inches. He understood the situation – raising the backwater would place additional strain on the mainline levee system, particularly the low spot being raised with a HESCO bastion by the Fifth Louisiana Levee District near Vidalia. Nimrod, though, reminded the Vicksburg district that the backwater levee was designed to overtop, not fail. He pressed the district to authorize the armoring of the levee to prevent a breach if overtopping occurred. Nimrod also had a dilemma of his own. The anticipated flood crest was still two weeks away, but the levee board's resources were already stretched to the limit. The board maintained 212 miles of levees, 37 miles of which were deficient in height or section. Levee board crews were busily shoring up those areas. Crews were also preparing the levees for the ensuing flood fight by mowing the levees crowns, checking relief wells, and repainting station markers. Other crews were already ringing boils and sandbagging roads and infrastructure. Armoring the backwater levee, if approved, was beyond the board's capability. He knew he needed the Vicksburg district's help. That afternoon, he sent an official request to Col. Eckstein asking the district to assume leadership of any flood fight or emergency actions on the backwater levee west of Highway 61.[198]

As Eckstein's staff continued to prepare the decision briefing to be given to Walsh later that night, Simrall and Parrish set out to provide desperately-needed information to residents of the lower Mississippi delta. Word of the forecast left those residents understandably shaken. The memories of the devastation caused by the 1973 flood remained fresh in their minds. Now, the National Weather Service predicted stages six feet higher than 1973. The Vicksburg district exacerbated the problem by informing people in Vicksburg that if they experienced flooding in 1973, they would be flooded again. The message was intended for unprotected areas south of the Yazoo River, not the Yazoo backwater area, because the backwater levee had been constructed after the 1973 flood. Rumors began flying across the region. News of the forecast came on the heels of the nationally-televised Birds Point-New Madrid floodway operation. Genuine concern grew that the commission intended to blow the backwater levee to reduce pressure on the system.[199]

As their car got to within a mile of the meeting location at the National Guard Armory in Rolling Fork, Simrall and Parrish noticed cars lined up on both sides of the road for as far as they could see. More than 1,500 people waited for their arrival. As the two district employees pushed their way through the burgeoning crowd, Simrall thought

The public meeting at Rolling Fork, Miss.

to himself, *they're fixing to hang us*. He could feel the tension. As the meeting began, though, his fear quickly dissipated. The crowd was not angry; it was scared. No one pointed fingers. They simply wanted to know what was going to happen. Simrall and Parrish, along with Nimrod, spelled out the possibilities. They wanted the audience to clearly understand the risks they faced. The district expected the backwater levee to overtop by as much as a foot of water for ten days, which would flood approximately 450 square miles. They also warned the audience that the levee might not survive the onslaught. If the torrent of water breached the levee, the water would engulf approximately 1,900 square miles – including Rolling Fork, Mayersville, and other towns not flooded in 1973. To help prevent that scenario, the district was seeking approval to armor the landside slope of the levee. Much like the Buck Chute meeting at Eagle Lake, they instructed their audience to prepare and make plans for evacuation. They also put to rest the rumor that the commission intended to blow the backwater levee.[200]

A similar situation played out at Yazoo City. City leaders planned on holding the meeting at the county courthouse, but the crowd quickly outgrew the capacity of the meeting space. They moved the meeting to the library. Again, the crowd grew beyond available space. Finally, they settled on the First Baptist Church, which could accommodate up to 700 people. It rapidly filled to near capacity. Simrall and Parrish found the Yazoo City crowd possessed a similar temperament as the Rolling Fork audience. Again, no one cast blame; they just desperately wanted to know more about what the two district employees thought would happen. But Simrall and Parrish could only posit the possibilities. The rest depended on the decision to be made that night by Maj. Gen Walsh.[201]

At 2100 hours on May 4, Walsh and the three civilian members of the commission – Sam Angel, R.D. James, and Clifford Smith – gathered in the second floor conference room on the motor vessel *MISSISSIPPI* to hear Eckstein's brief on the Yazoo backwater area. Eckstein delivered the briefing by telephone, but the slides he used projected onto a large screen that the commissioners could view from the conference table. Eckstein explained the intent behind the backwater area and how its operation related to the Vicksburg gage. He showed two inundation maps, one depicting areas impacted by overtopping and the other depicting areas overflowed with a levee failure. If the levee overtopped, approximately 286,000 acres faced inundation; if the levee failed the number grew to 1.2 million acres. Eckstein explained that more than 3,000 people would be impacted by a levee failure. He then went directly to the point of the briefing, "Sir, I request permission to raise low spots to elevation 107 and to armor the landside of the levee to protect against erosion."[202]

Walsh only momentarily pondered the request before glancing around the room at Angel, James, and Smith, who all nodded their concurrence. "Recommendation approved," Walsh replied.[203]

Eckstein's engineers in Vicksburg had already begun researching the best way to armor the levee. They devised a plan to install a thick landfill liner over the landside slope of the levee. The liner, which was 40 millimeters thick, had proven more durable than regular polyethylene plastic sheeting. Eckstein approved the plan. In the meantime, ten members from Coldiron's crew moved from the Buck Chute operation to the Yazoo backwater levee to begin raising the low spots and filling cattle gaps on the backwater levee. They also began constructing a 2,000-foot long makeshift HESCO bastion floodwall along the junction of the Mississippi river levee and the backwater levee to prevent any damage to the mainline levee.

The district office soon encountered a problem. The supplier of the liner – GSE Lining Technology – could not install the product. To make matters worse, the liner came in rolls that needed to be overlapped. To be effective, the seams along the overlapped areas needed to be sealed with a special tool that acted as a large iron and melted or welded the two pieces together. The American Environmental Group (AEG), an

Ohio-based contractor, possessed the necessary equipment and expertise to install the liner and seal the seams, but it would be difficult to reposition the necessary heavy equipment to move and lift the liner rolls to the backwater levee in a short amount of time. A local contractor would need to provide the equipment and infrastructure. Fordice Construction – a Vicksburg-based contractor – secured the contract. Dan Fordice, the company's vice president, told Henry Dulaney, the district's engineering and construction chief, that "My grandfather fought the '37 flood and my dad fought the '73 flood. This one is ours to deal with." The flood fight, as with most flood fights, was personal.[204]

Armoring the backwater levee necessitated several moving parts working together as a team. Each contractor had to know his or her particular part of the mission and work with the other contractors to accomplish the critical task. On May 7, GSE Lining Technology delivered the

Armoring the Yazoo backwater levee.

liner to the site. Fordice Construction dug a one-foot wide and two-foot deep trench along the landside crown of the levee. With AEG providing technical guidance on the installation process, Fordice positioned the liner rolls above the trench. Crews then moved down the landside slope of the levee and unrolled the liner until they reached and covered the toe of the levee.

Next, the liner was pinned into place at the crown of the levee before the trench was backfilled with dirt and gravel. At that point, AEG began welding the seams together. The contractors repeated the process until the landside slope of the four-mile levee segment was covered. By May 11 – four days after the operation began – the contractors completed the armoring process just as the river approached 54 feet on the Vicksburg gage. Everyone in the lower delta simply watched and waited as the river continued its rapid ascent.[205]

Water from Eagle Lake creates a water berm over the earthen berm at Buck Chute. Note the outline of the earthen berm under the water.

The Pig in the Python

As water levels at Eagle Lake continued to cover the clay-capped berm at Buck Chute and the armoring of the Yazoo backwater levee raced toward completion, the Mississippi River, on May 8, topped 60 feet on the Greenville gage for the first time since the 1927 flood. The following day the river surged past 52 feet on the Vicksburg gage – the highest gage reading since the 1927 flood. Both stages represented the highest the river had ever climbed against the MR&T levee system – and the crest was more than a week away. Mississippi Governor Haley Barbour, as only he could, described the rapidly-swelling flood pulse bulging through the system as a pig moving through a python.[206] As the river crept higher, pressure on the system mounted.

To the north in the Memphis Engineer District, Col. Vernie Reichling reported on May 9 that the river crested on the Memphis gage nearly one foot shy of the 1937 record, despite a discharge that exceeded the previous record flow by nine percent – a shade more than 200,000 cfs. In the St. Francis Levee District of Arkansas, Robert Rash, the captivating chief engineer of the levee district, possessed a cocksure attitude, despite the immense pressure on the system. The 160 miles of mainline levees in the St. Francis levee district, equipped with hundreds of relief wells, seepage berms, slope flattening, and flyash injections, represented arguably the finest in the MR&T system. At the flood crest, his levees maintained up to ten feet of freeboard above the swollen river. When a local official approached him about concerns that the district was not properly protected, Rash replied, "I don't care if you're comfortable or not. I'm telling you, this is what we do. The levees won't breach!" To Rash, the 2011 flood defined the improved state of the levee system. When Rash was first hired by the levee district in 2001, Tommy Patterson, a fifty-year employee with the levee district, took him to Blue Lake, Arkansas. When they arrived, Patterson used his foot to draw a circle in the dirt. He told Rash, "This is the first place we see seepage in our district when the river reaches 34 feet on the Memphis gage." Rash doubted the information, but the following year underseepage occurred at that exact spot when the Memphis gage reached 33.8 feet – Patterson's assessment had been right on target. After the 2002 high water, the Memphis Engineer District installed 88 relief wells at Blue Lake. During the 2011 flood, the levee did not experience underseepage until the Memphis gage reached 44 feet. The relief wells and other levee improvements provided the St. Francis levee district with a ten-foot head start in its flood fight effort.[207]

On the east bank of the river, where the Memphis district's jurisdiction extended to the approximate latitude of Clarksdale, Mississippi, the levees remained under intense stress from the pressure exerted by the high stages. By May 11, the crest, for all intents and purposes, had passed through Reichling's area of operations, but he expected the river to remain at dangerously-high stages for a week or more before slowly and steadily dropping off. The most pressing problem was near Rena Lara, Mississippi, where Kelly Greenwood and the Yazoo-Mississippi Levee Board combated underseepage and multiple sand boils with a large water berm.[208]

The mainline levees in the Vicksburg Engineer District in Arkansas, Louisiana, and Mississippi had been plagued by underseepage of varying degrees for days. The Vicksburg district used aircraft with forward looking infrared technology to identify colder river water flowing from sand boils, which gave flood fighters an early warning and adequate time to address the problems. In Arkansas, the Southeast Arkansas Levee District and the state assembled what amounted to a well-equipped, small army to combat the flood. Flood fight teams consisting of National Guard soldiers, inmate laborers, hired laborers, and levee district members worked around the clock to address sand boils at historically active areas near Rohwer, Dewey, Leland Chute, Otter Bayou, and Willow Lake with sandbag rings or water berms. The most serious trouble spot in Arkansas was at Lake Chicot. As Early as May 2, Eric Woerner, the district's deputy sector commander in southeast Arkansas, reported ten large boils and numerous smaller boils – called pin boils – near the Greenville bridge, approximately 500 feet from the toe of the levee. The area had not been considered a traditional seepage problem area, but the extent of sediment deposits – several hundred cubic yards of material – discovered by levee inspectors indicated that the sand boils had formed during previous high water events without being detected. With that being the case, the levee was already in a weakened state prior to the flood. Crews tried to ring the individual boils, but – much like the Darian Chasteen's heroic effort at Fulton County – they could not keep pace with the development of new boils. The weakened state of the levee and the rapidly growing number of developing boils necessitated the construction of a water berm.[209]

To the south, the Fifth Louisiana Levee District also worked around the clock to protect the integrity of the 260 miles of Mississippi River levees under its jurisdiction. As early as April 25, the Vicksburg district held a coordination call with Reynold Minsky, the levee district president, and James Shivers, the superintendant, to make certain they understood the scope and magnitude of the flood coursing through the system and to ensure they had the necessary resources to combat it. Minsky,

White sand boil rings near the toe of the levee at the Greenville bridge in Arkansas.

The river climbs high against the levee and towers above the protected town of Greenville, Miss.

The river encroaches upon the gravel road at the crown of the armored Yazoo backwater levee. Note the trapped interior drainage to the right of the levee.

Arkansas City, Ark., during the 2011 flood.

Shivers, and the levee district, though, were already prepared. Corps of Engineers officials considered them experienced, master flood fighters for a reason. Because of the small tax base in their district, Minsky and Shivers were accustomed to doing more with less. The Fifth Louisiana Levee District had highly-detailed and closely-coordinated standing orders for their flood fight teams to follow during flood events to get out ahead of the problems and treat them in advance. They knew the hot spots and they knew how to address them. Having fought a significant flood only three years prior also helped. During the 2008 flood fight, the levee district utilized nearly 300,000 sandbags to construct rings and berms at many traditional problem areas – Henderson, Ice Box Hole, Milliken Bend, Mound, Davis Landing, Lake Bruin, Kemp Bend, and Lake St. John. Many of those sandbags remained in place. The various berms and rings needed to be repaired and solidified, but the levee district already had a head start. That head start and the advanced forecast from the National Weather Service were all that Minsky, Shivers, and their boys needed. In many cases, Corps of Engineers levee inspectors, who responded to reports of sand boils, arrived to find the boils already ringed and stabilized. The Fifth Louisiana Levee District was ready and confident. A week before the crest, Minsky told Maj. Gen. Walsh, "We're in good shape, General. We can pass this flood."[210]

On the Mississippi side of the river, the flood fight took on a little different flavor. The 2008 flood had highlighted numerous trouble spots in Arkansas and Louisiana. The levee districts in those states used that experience to their advantage in preparing for the 2011 flood upon them. The Mississippi Levee Board did as well, particularly at Buck Chute, but the 2008 flood had not highlighted as many problem areas as it had across the river. This was a reflection of the fine condition of the levees managed by the Mississippi Levee Board, which had begun an extensive levee enlargement and relief well program during the 1990s. The 2011 flood, though, was a much larger flood. The pressure exerted by the river surged past the 2008 thresholds, causing new problem areas to rise to the forefront.[211]

By early May, with the river reaching stages not experienced since 1927, potential problem areas exploded into existence throughout the Mississippi delta. The Mississippi Levee Board preferred close consultation with the Vicksburg district flood fighters before taking action. Bradley Martin, an experienced geotechnical engineer from the Vicksburg district, spent a few days in the Greenville area at Peter Nimrod's request inspecting boils and other potential trouble areas. By late afternoon on May 9, he had not discovered anything out of the ordinary. Nimrod asked Martin to accompany Bobby Thompson, the levee board's assistant engineer, to check on one last reported boil near Francis, Mississippi. The area, located at the northern end of Bolivar County, just upriver from the mouth of the Arkansas River, traditionally experienced significant underseepage during flood events, but the inspectors noted at least one particularly massive boil. Martin agreed to survey the area.

At 1730 hours, he phoned Nimrod, "We've got a serious problem!" Martin had never seen a sand boil this large before, and it was located at the toe of the levee berm. It was a high-energy boil. Water gushed powerfully through the basketball-sized throat, spewing sediment that had eroded from beneath the surface. "We can't leave this until morning," he warned Nimrod. It would not take long for the sand boil, if left unchecked, to possibly undermine the levee.[212]

Nimrod arrived about an hour later and quickly surveyed the area. Underseepage had completely saturated the ground. As he traversed the site, Nimrod felt like he was walking across a waterbed. He had never before witnessed such complete and thorough saturation. He grabbed a nearby willow tree with both hands and shook it forcefully. The waterlogged earth rolled back and forth in rhythm with every push and tug. Martin and the levee board crew immediately began building a small, five-foot high, C-shaped sandbag berm around the boil, with each end of the berm tying into the toe of the levee. After several hours of backbreaking work, they finally gained control of the boil – at least so they thought. At approximately 2200 hours, as the ring filled with seepwater, a second boil suddenly developed a few feet from the original boil. The second boil undermined the berm, causing it to collapse. Martin, Nimrod, Thompson and the crew were back at square one; only now they had two large boils to contend with.

Nimrod and Martin conferred. They agreed that sandbagging alone would not remedy the problem. Additional measures were needed. As the crew immediately began constructing an extension to the sandbag berm to envelop both boils, Martin called Chuck Mendrop and informed him that a sandbag berm would not be able to produce enough counter-pressure to completely check the boil. Martin recommended that Mendrop send a hired-labor crew to construct a 75-foot wide, 200-foot long dike around the massive boil – and several smaller boils that had since developed – to serve as a water berm. In the meantime, Nimrod knew the crew needed assistance, so he contacted Mack Grimmett, the

A sand boil spews sediment-laden waters at Francis, Miss.

From left to right: Robert Thompson, Chuck Mendrop, and Lanny Barfield discuss the flood fight at Francis, Miss.

Bolivar County Sheriff. Grimmett secured volunteer inmate laborers from the Mississippi Department of Corrections to assist the operation. With the added manpower, the crew completed the extension by 0530 hours the next morning. The flood fighters rested on the levee and anxiously watched the water levels rise inside the berm. The rate of sediment transport was beginning to decelerate. All of a sudden, they heard another abrupt "whoosh." A section of the berm had collapsed again. The berm was too high. It did not withstand the weight of the water. They needed to build the berm wider to provide additional stability. They were back at square one again.

The weary flood fighters laid on the levee, trying to harness enough energy to tackle the boil for a third time. They were exhausted – both physically and mentally. Throughout the night and early morning hours, they had filled, carried, and stacked sandbags. The hired-labor crew would arrive soon. The flood fight team desperately needed the break. As they rested on the levee, they engaged in small talk. Thompson puffed on a cigarette and stated nonchalantly, "We really need some giant super sacks" or sandbags to plug the gap in the berm. Martin sat up. He felt a sudden bolt of energy. Thompson was correct – that is exactly what they needed. The small sandbags they used would not stay in place, but a giant sandbag would easily plug the breach. He pulled out his cellular phone and called an acquaintance – an agricultural seed supplier in nearby Cleveland, Mississippi. The seed supplier had hundreds of large super sacks in stock only a short thirty-minute drive from Francis. Nimrod dispatched an employee to retrieve the bags.

Mendrop and Lanny Barfield, one of Mendrop's section chiefs in the geotechnical engineering branch, arrived at Francis shortly thereafter. Laborers began constructing the water berm dike on the periphery. The three geotechnical engineers examined the boil. It was still piping a considerable amount of material. They knew it would take days for the crews to complete the dike and get enough water over the area to counteract the pressure. The high-energy boil demanded immediate attention. Shoring up the berm with the "super sacks" would help in the short term. Barfield and Martin discussed a possible experiment – creating a filter over the sand boil. During a 2010 flood fight operation near Vidalia, Louisiana, Martin had dropped gravel in a boil to act as a filter that allowed the boil to continue to flow and relieve pressure. The gravel also trapped the sediment and checked further erosion of the subsurface foundation. Barfield and Martin approached Mendrop and asked if they could try it again. Mendrop looked at the ominous boil and replied, "I'll try anything."

The hired-labor crew hurriedly moved earth around the boil-plagued area. At the same time, Barfield, Martin and the levee board crew improved the sandbag berm. After two of the super sacks were filled with sand, a trackhoe lifted each bag from the levee and lowered them into place to plug the breach. To seal the remaining leaks, the flood fighters stuffed smaller sandbags around the "super sacks." Once the berm was stabilized and sealed, they poured large quantities of sand into the

Bradley Martin, left, gives a "thumbs up" to the trackhoe operator as inmates guide a "super sack" into place.

boil before dumping several loads of number 57 stone – a coarse gravel aggregate ranging from a half inch to 1.5 inches in size – on top of and around the boil. Martin had not slept for nearly 36 hours, so Mendrop drove him back to Vicksburg, leaving Barfield behind to oversee the operation. By the following day, the murky water contained by the sandbag berm began to lose its turbidity. The boil was running clear. The filter experiment worked. A few days later, the hired labor crew completed the earthen water berm, which provided a higher safety factor.[213]

As flood fighters addressed the Francis boil at the north end of the delta, Col. Eckstein escorted Maj. Gen. Walsh and the civilian members of the Mississippi River Commission – Sam Angel, R.D. James, and Clifford Smith – on a helicopter flyover of the Vicksburg region on May 10. The extent of flooding looked severe. Water stood high against the levees on both banks of the river. From the air, it appeared that the river had reached the tops of the levees, but in reality there was plenty of freeboard available—which was fortunate. The Vicksburg gage read just inches shy of 53 feet, but the river was expected to rise at least another

The completed water berm at Francis, Miss. Note the additional sand boil rings in the foreground and the river stage in the background.

4.5 feet. Sam Angel elbowed R.D. James and said, “The flooding here is different.” Indeed, it was different, compared to the conditions the commission had just witnessed over the past few weeks at the confluence of the Mississippi and Ohio rivers. Violent storms had dropped up to nearly two feet of rain in some parts of southeastern Missouri, southern Illinois and western Kentucky and Tennessee. Standing water was everywhere in the confluence area. Overflowing creeks, bayous, and ditches had nowhere to drain because of the high river stages, causing them to back up and spread out across the surrounding terrain. But this was not the case in the heart of the MR&T project.

The commission observed the MR&T system working as designed. The river may have stood high against the levees, but the land and infrastructure on the protected sides of the levee remained dry. Wheat, corn, beans, and cotton flourished in the flat, low-lying farmlands below. Smith mentioned the irony of irrigation pivots slowly spinning across several farms, “Look at that – a drought in the middle of a flood!” Cars and trucks sped east and west along Interstate 20, seemingly oblivious to the high river stages pressing against the levee. In the heart of the MR&T, the flood – at least thus far – remained confined between the levees, with the exception of backwater flooding along the Yazoo River and Steele Bayou. Still they noticed the rooftops of several homes jutting from the water on the Mississippi side of the river. From the helicopter, they looked like stepping stones across a shallow pond. Those homes had been built on the riverside of the levee. Many stood above the 100-year flood elevation, but the MR&T levees towered above that elevation for a reason. The river was high and it was expected to rise at least another 4.5 feet. The pig had not yet fully reached the Vicksburg portion of the python.[214]

At the northern end of the Vicksburg district, with Francis water berm complete and the sand boil under control, Barfield set out to return to Vicksburg on May 12. As he drove south, his phone rang. It was Mendrop asking for him to meet up with Bobby Thompson to check on a reported boil near Winterville, Mississippi, just a few miles north of Greenville. Barfield met Thompson and they drove to the site together. Thompson wanted Barfield's advice on whether or not the boil needed immediate attention or if it could wait until the morning. With each passing day, as the river climbed higher and exerted more pressure, numerous boils exploded everywhere across the region, further thinning the stretched resources of levee districts.

As they drove along the levee, Barfield detected water violently erupting from the ground in a clump of trees near the toe of the levee berm. He looked at Thompson, "Oh, no! This is not good!" He climbed from the car and rushed to examine the boil. Like the Francis boil, the 18-inch throat piped heavy sediment-laden water. "We've got to do something and we have to do it now!" he told Thompson. "This can't wait!" As Thompson hurriedly phoned in a request for men and material, Barfield inspected a ditch next to the sand boil for freshly-deposited silt. By his field estimation, the boil had eroded more than 100 cubic yards

Lanny Barfield checks the high-energy boil at Winterville, Miss.

of subsurface material. He had never seen a boil develop to the point of a levee failure other than on training videos. He wanted to keep it that way. The heavy sediment load erupting from the boil and the amount of silt already deposited in the ditch worried him. No matter how badly he wanted to, Barfield could not possibly know what was happening beneath the surface. He checked with the landowner, who told him that the sand boil was not there the day before. It was a high-energy boil. It had virtually exploded into existence out of nowhere and quickly moved a large quantity of material – 100 cubic yards of material. As he rechecked the freshly-deposited sediment, Barfield thought to himself, *Where did it come from? Just beneath the surface? Was it piping vertically? Was it piping horizontally under the landside seepage berm? Was the boil working toward the levee?* To make matters worse, the boil continued to grow before his eyes.

The sand boil sat at an extremely critical location under the Mississippi Levee Board's jurisdiction. It was nearer the upper end of the district, slightly north of two of the larger population centers in the Mississippi delta – Greenville, with a population of nearly 35,000, and Leland, with a population of approximately 5,500. Unlike a possible levee breach at Buck Chute or the Yazoo backwater levee at the lower end of the district, where floodwaters would slowly back up through the delta, a levee break at the upper end of the levee district would unleash a torrent of water that would rush southward and engulf the delta much like the devastating crevasse at Mound Landing during the 1927 flood. Perhaps more threatening, a levee break at Winterville would inundate Greenville in less than six hours; Leland in twelve hours. More than 40,000 people would need to be evacuated in less than one-half of a day, most of them sooner than that. For this reason, Governor Barbour's task force had quietly staged buses in the area to quickly evacuate large quantities of people on short notice. Having gained valuable emergency management experience during Hurricane Katrina, the Deepwater-Horizon oil spill, and several nasty tornados, Barbour knew how to

Levee workers and inmates address the high energy boil at Winterville.

prepare for a disaster. The state was ready to act, but it would not need to if Barfield and Thompson could get the boil under control.

Once the necessary resources arrived, Barfield, Thompson and the flood fight team – mainly composed of inmate labor – formed a human conveyor belt, passing sandbags from the levee through the knee-deep water in the ditch to construct a sandbag and plywood dike to trap the seepage and create a water berm. Fresh off of the successful experiment at Francis, Barfield also decided to create a filter over the boil. The deep water and the clump of large trees partially blocked access to the site, but the team used a trackhoe to reach between the trees and across the water berm to dump the sand and number 57 stone on the boil. The experiment went smoother than the initial test at Francis the day before. Within a matter of hours, the filter was complete. Barfield checked the ditch for newly-developed boils and found none. Clear water began cascading from the gravel mound. The high-energy boil had been checked.[215]

Ups and Downs

The high-energy sand boils at Francis, Winterville, and other locations were indicative of the enormous pressure exerted by the extremely swollen river on the levee system. Across all ten of the Vicksburg district's flood fight sectors covering Arkansas, Mississippi, and Louisiana, levee inspectors responded to more than 300 sand boil incidents. Reported incidents most often involved clusters of boils, rather than single or isolated boils, so the number of boils that actually developed dwarfed the number of incidents reported. The system was springing leaks everywhere, but it was holding together. "The river wants out," Col. Eckstein told a group of reporters in trying to explain the significant number of boils in the area, "We want that, too. We just want to control it so it doesn't move material and undermine the levee." That much was true, but treating and controlling a sand boil could only be accomplished if the problem was identified. As the river continued to rise and the pressure on the system continued to mount, undetected activity below the surface of the levees threatened to materialize at a moment's notice. Geotechnical engineers, levee board members, and flood fighters throughout the region asked themselves the same questions that Chuck Mendrop asked himself back at the Vicksburg Engineer District, *What is out there that I am missing? What is out there that I cannot see?*[216]

On May 12, the Mississippi River reached 63.5 feet on the Greenville gage and 54.5 feet on the Vicksburg gage. The river was also climbing fast at the Natchez gage, having reached 58 feet, more than ten feet above flood stage. By 0800 hours the following day, the river stormed past 64 feet on the Greenville gage. The crest, which had yet to reach the Arkansas City gage further upriver, was still at least four days away. Everyone expected the river to continue to rise. At 1400 hours, the gage stood at 64.13 feet, but the gage reading an hour later depicted a drop in river levels by three-hundredths. The reading at 1600 hours showed another drop. By 1800 hours, the river had dropped back below 64 feet on the gage. The 2000 hours gage reading recorded yet another drop, down a tenth of a foot from two hours earlier. Walter Mattingly, working in the Vicksburg district's emergency operation center, called Ron Goldman at home and told him, "The stage is falling at Greenville."

Those words hit Goldman like a bombshell. He was scared and understandably so. A sudden drop in a river gage prior to the arrival of the crest could only mean the gage had malfunctioned or, worse, a levee had finally succumbed to the relentless pressure of the river. He immediately returned to the district office to determine the cause of the problem. Mattingly also contacted Paul Keene at the district's Greenwood area office. Keene began organizing the sector commanders on both sides of the river to inspect the levees to determine if a breach had taken place.[217]

Keene, in turn, notified the Mississippi Levee Board. Upon hearing the news, Thompson decided to call Nimrod, who was at his Greenville home stealing a few hours to get some much needed sleep. Nimrod had left his cellular phone in the kitchen and did not hear it ringing. Thompson hung up and called Nimrod's house phone. When Nimrod answered Thompson informed him of the news, "Peter, something's wrong! The gage just dropped!" The sudden rush of adrenaline immediately sapped the fog of weariness from the chief engineer of the levee board. Thompson passed on the Vicksburg district's belief that either the gage had malfunctioned or a levee had breached. Within minutes, the Greenwood area office notified Nimrod that the gage was working properly and that water marks on a nearby sign post also depicted a drop in river levels. By 2100 hours, the gage reading had dropped another tenth of a foot, which confirmed water was leaving the system somewhere. Nimrod began calling members of his crews. They had spent the day riding the levees with personnel from the Greenwood area office and would have noticed any problems. None reported noticing anything substantial. Nimrod pondered his next step. The gage had checked out. It was working properly. His levees checked out. No breaks were found. Perhaps a levee crevassed on the other side of the river. The clock was nearing midnight. The river had dropped six inches over the previous nine hours. Nimrod called Sam Angel, a member of the Mississippi River Commission who lived across the river in Lake Village, Arkansas. "Mr. Angel, did the levee break on your side?" he asked. Angel, who had been asleep when his telephone rang, considered the question an odd one. “Not that I know of,” he replied. Nimrod explained the situation. Angel indicated that he would check with levee district officials in Arkansas, but he soon discovered that no break had been reported.[218]

By 0300 hours the following morning – May 14 – the river stopped falling on the Greenville gage and resumed its ascent. Within hours, the water control managers at the district office had determined the culprit. On May 12, the river overtopped an abandoned MR&T levee at Wilson Point, near Lake Providence, Louisiana. The Mississippi River Commission had constructed a new mainline levee further to the west, but the abandoned levee remained intact, providing substantial protection for approximately 12,000 acres of prime farmland. In the early afternoon of May 13, the abandoned levee –with close to a foot of water violently pouring over its crown and landside slope – crevassed, allowing the river to fill the 12,000-acre bowl between the levees. The incident proved to be a false alarm in terms of a possible catastrophic break in the levee system, but it served notice of the destructive dynamics involved in the overtopping of a levee. The Wilson Point levee had crevassed with a foot of water pouring over the levee after only one day. Residents in the Mississippi delta took notice of that. All eyes nervously turned to the newly-armored Yazoo backwater levee, which was expected to be overtopped by more than a foot of water for ten long days. Admittedly, the Wilson Point levee was not an MR&T levee, and it had not been armored as the backwater levee had, but it was originally constructed to MR&T specifications. Residents continued to watch and pray as the river inched higher and higher against the backwater levee.[219]

Their prayers were soon answered. At the onset of the 2011 flood, Ron Goldman wanted to gather more data on the river. He instructed Michael Warren to establish a temporary gage near a small spur levee that jutted out toward the channel from the mainline levee at its junction with the backwater levee. The 2008 profile had established a high water mark on the upstream side of the spur levee. Data obtained from that 2008 high water mark had led to the discovery of the greater slope along the Yazoo River and the determination that only the lower four miles of the backwater faced overtopping when the Vicksburg gage would reach 57.5 feet. Upon arriving at the levee, Warren witnessed the flurry of activity where the hired-labor crew busily prepared the HESCO bastion floodwall on the backwater levee. Attempting to stay out of the way, Warren established the gage on the downstream side of the spur levee, only a few hundred feet away from the location of the 2008 high water mark.

The new gage started collecting data on May 8, the day after the Vicksburg gage surged past 50 feet and the day after the backwater levee armoring project commenced. Within a few days, the district's hydraulic engineers noticed something odd. The new gage depicted a one-foot drop in the slope of the river from the upstream and downstream sides of the spur levee. The development piqued Goldman's curiosity. The normal fall in the river averaged one-half foot per mile, yet the gage depicted a one-foot slope spanning a distance of only a few hundred feet. Goldman went to inspect the gage personally. He could hear water rushing along the spur levee. Goldman surmised that the water was hitting the spur and piling up. If the same thing happened in 2008, it probably caused an artificially high reading on the temporary gage upstream of the spur. If that was the case, the backwater levee might not overtop until the Vicksburg gage reached 57 feet or higher. That prospect excited Goldman, but he remained uncertain. The situation was too unique, too odd. The possibility remained that the differential could equalize and therefore dissipate as the river continued to rise. He wanted to see how the river responded before reaching a concrete conclusion. By May 14, Goldman was convinced that the one-foot differential would not change. He went to see Col. Eckstein. In the colonel's office, Goldman drew a schematic of what was transpiring on a large piece of butcher board paper. Eckstein flashed a broad smile. It was becoming more and more evident that the backwater levee would not overtop.[220]

On May 15, the worst of the flood was nearly upon the entire Vicksburg district. The river climbed back above 64 feet on the Greenville gage. On the Vicksburg gage, the river surpassed the 1927 high water mark of 56.2 feet. During the morning commander's briefing, Walsh asked Eckstein for an update on the Yazoo backwater levee. Eckstein reported that the river was about a foot from the gravel road on the crown of the levee. "It's going to be close if it overtops at all," he informed the commission president. Eckstein closed his report by informing Walsh that flood conditions in the Vicksburg Engineer District had reached a steady state – at least for the time being. Conditions seemed not only to be holding steady, but improving slightly, with no new boils reported in the Vicksburg district over the preceding 24 hours. Still, Dennis Norris, Walsh's chief of operations, reminded everyone to stay vigilant, "the unprecedented boils and seepage we are experiencing may translate into levee slides after the river falls off."[221]

Robert Thompson intently watches the development of a sand boil.

On May 16, the Mississippi River crested on the Arkansas City gage, but the steady-state of conditions came to a crashing end. A levee inspector discovered a cluster of boils in the levee toe near Albemarle, Mississippi, just a short distance north of Buck Chute. Chuck Mendrop dispatched Lanny Barfield to take a look at the boils, but Peter Nimrod and a levee board crew arrived at the scene first. They immediately discovered the boils were the least of their problems. They had a levee slide to contend with. A slide may occur when a portion of the levee face becomes saturated and shifts or slides down the slope of the levee, typically when the river recedes. Most slides that occur along the Mississippi River levee system in the region are, for the most part, unrelated to high water events, with most slides caused by various wetting and drying cycles that weaken the soil. Slides typically occur on the riverside of the levee, where the levee slopes are steeper. The slide at Albemarle was on the landside slope of the levee, less than 50 feet downriver from the boils.

The water gushing from the face of the levee terrified Nimrod. The Albemarle levee had yet to be enlarged, so it was not equipped with a landside seepage berm or relief wells. The ongoing levee enlargement program had advanced and stopped approximately 2,000 feet upriver. While the levee was constructed to a substantial height and width, it was not as strong as the levees located a few thousand feet to the north. Nimrod was worried. The levee was completely saturated. The river was nearing its crest, and it placed tremendous pressure against the weakened levee. He called Barfield, who was in transit to the site, and notified him of the slide. Barfield arrived minutes later. He examined the boils first. They were good-sized boils that piped a considerable amount of sediment. Compared to the boils at Francis and Winterville, though, the boils were noticeably less aggressive, leading Barfield to conclude that the inspectors had discovered the boils early in the developmental stage. Barfield studied the slide next. He tried to determine if the water flowing from the face of the levee was underseepage or seepage through levee. The origin of the seepage mattered to Barfield. He hoped it was underseepage. Seepage through the face was more disconcerting because it would be easier for the newly-formed cavity to creep back toward the levee face and cause a failure, than to crawl under the levee. Barfield concluded that it was probably underseepage flowing from the levee, but he was not certain. He called Mendrop and apprised him of the situation.[222]

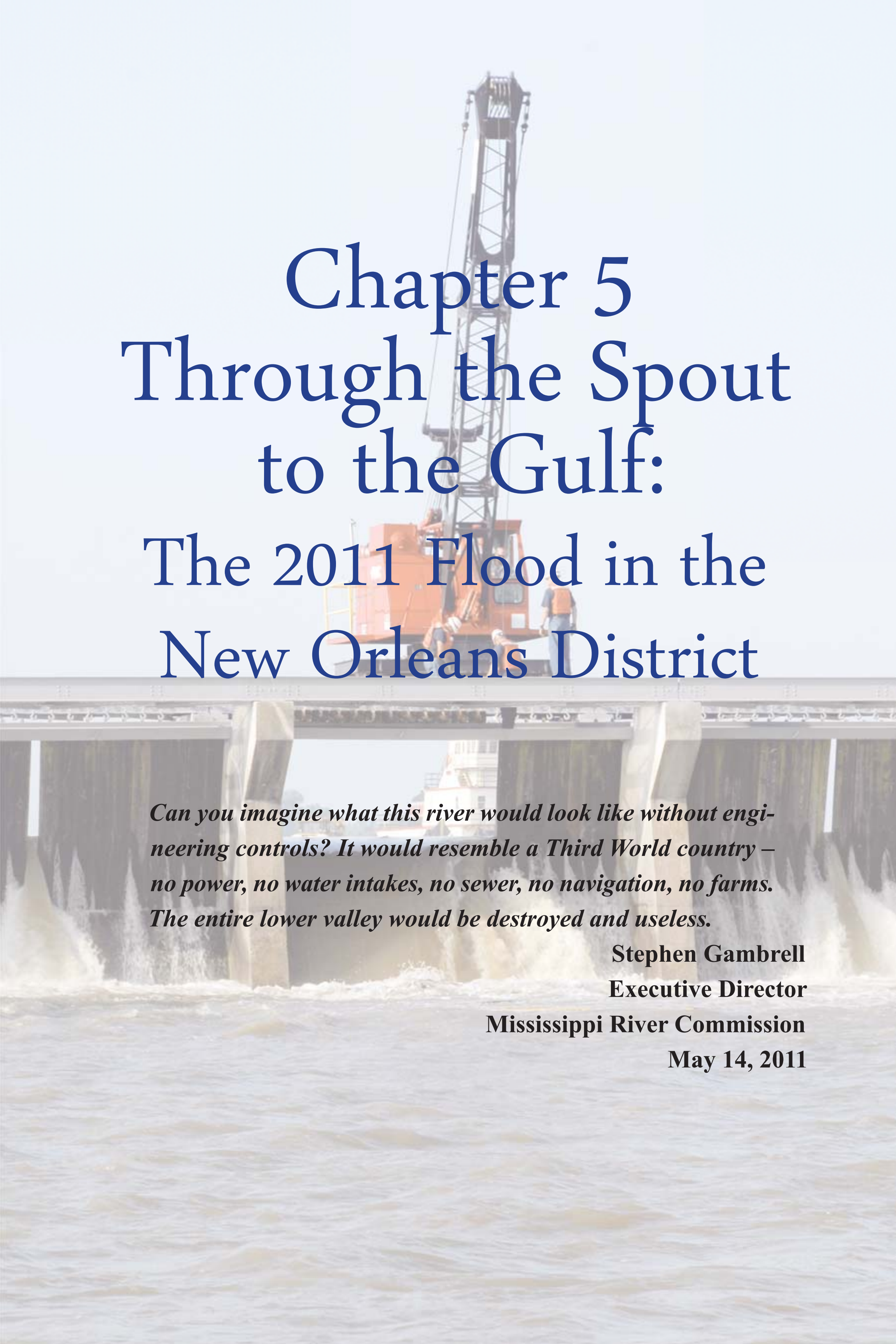
Mendrop and two of his senior geotechnical engineers – Noah Vroman and Brad Arcement – dropped what they were doing and drove to Albemarle to assist Barfield. Together, the engineers determined that the levee had been constructed in an abandoned river channel. The existence of sand boils and clay deposits near the toe of the levee, along with the presence of what appeared to be iron in the seepwater, led them to conclude that the slide was the result of underseepage and the uplift pressures associated with it. Mendrop decided to get the boils under control first, before addressing the slide. He shared Barfield's view that the boils, while severe, were not as problematic as the boils at Francis and Winterville. The boils and slide did not overly concern him at that moment, but he knew the situation could deteriorate rapidly. If they were not able to get the problem under control, he knew they could possibly lose the levee and unleash flooding far worse than what had been predicted if the levee at Buck Chute failed. Mendrop called Jimmy Coldiron. Within hours, Coldiron's hired-labor crew was on the scene building a rock dike at the landside toe of the levee. The dike was to be filled with sand to stabilize the levee.[223]

On May 17, as Coldiron's crew constructed the rock dike at Albemarle, the Mississippi River crested at 64.2 feet on the Greenville gage, approximately one foot lower than the 1927 high water mark. Two days later, it crested at 57.1 feet on the Vicksburg gage, which broke the old record mark set in 1927 by almost a foot. The river climbed to the gravel road on the crown of the Yazoo backwater levee but stopped four inches shy from overtopping it. The flood, though, was far from

Col. Jeffrey Eckstein discusses the Yazoo backwater armoring operation at a press conference on the levee.

over. After first reaching 60 feet on the Greenville gage on May 7, the river remained above that mark for a staggering 19 days before finally dropping below it on May 26. At the Vicksburg gage, the river remained above 51.6 feet – the high water mark of the devastating 1973 flood – until June 4. The river had first topped that mark on May 9 and remained there for 26 days.

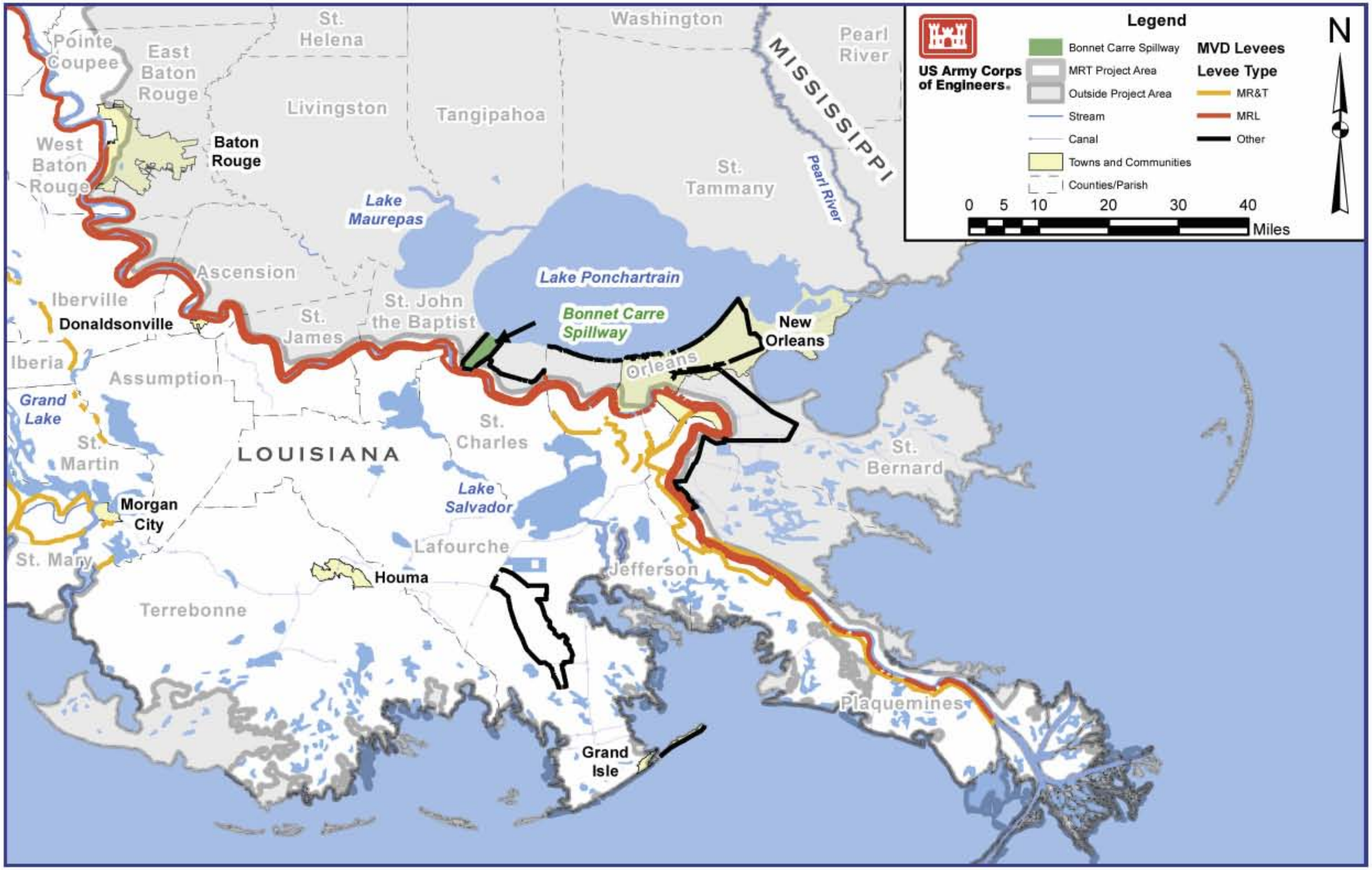
The Vicksburg and Memphis districts, along with the levee boards in Arkansas, Louisiana, and Mississippi had faced several harrowing moments, but the MR&T system held the flood in check despite facing unprecedented pressure. The river wanted out and the MR&T system provided room through managed seepage. The project had advanced a long way since the 1973 flood. The 2011 flood set stage records from Cairo to Caruthersville and from Vicksburg to Natchez by one to two feet, but from Memphis to Greenville the flood crested from one to six feet below the records established in 1937 at Memphis and 1927 in Greenville. Yet at the same time, the flood established new record flows from Cairo to Baton Rouge. The flood exceeded previous record flows at Helena by 8 percent; Arkansas City by 6 percent; Vicksburg by 11 percent; and Natchez by 9.5 percent. The improved capacity of the river to carry more water at lower stages – resulting from Ferguson's channel realignment and rectification program and the subsequent channel stabilization measures to maintain the stage-lowering benefits achieved – was primarily responsible for the reach between Memphis and Greenville not setting new stage records in 2011 and for keeping stages more manageable along the entire reach between Memphis and Natchez. The improved carrying-capacity also proved pivotal in preventing the Yazoo backwater levee from overtopping and preventing similar damages as those experienced during the 1973 flood.



Chapter 5
Through the Spout to the Gulf:
The 2011 Flood in the New Orleans District

Can you imagine what this river would look like without engineering controls? It would resemble a Third World country – no power, no water intakes, no sewer, no navigation, no farms. The entire lower valley would be destroyed and useless.

Stephen Gambrell
Executive Director
Mississippi River Commission
May 14, 2011


Legend
US Army Corps of Engineers
Bonnet Carre Spillway
MRT Project Area
Outside Project Area
Stream
Canal
Towns and Communities
Counties/Parish
MVD Levees
Levee Type
MR&T
MRL
Other
N
0 5 10 20 30 40
Miles
Pointe Coupee
East Baton Rouge
St. Helena
Livingston
Tangipahoa
Washington
Pearl River
MISSISSIPPI
Pearl River
St. Tammany
West Baton Rouge
Baton Rouge
Lake Maurepas
Lake Ponchartrain
Ascension
Iberville
Donaldsonville
St. James
St. John the Baptist
Bonnet Carre Spillway
New Orleans
Orleans
Iberia
Assumption
Grand Lake
St. Martin
LOUISIANA
St. Charles
St. Bernard
Lake Salvador
Morgan City
St. Mary
Lafourche
Houma
Jefferson
Terrebonne
Plaquemines
Grand Isle

On the morning of May 2, the Mississippi River Commission and its staff gathered in the second flood conference room on the motor vessel *MISSISSIPPI* for the daily 0800 hours briefing. Only four hours earlier, Bill Frederick, the staff meteorologist at the division office, had informed Maj. Gen. Walsh, the president of the commission, of the new forecast for 63 feet at the Cairo gage. Everyone in the tension-filled conference room knew what that meant. They could not mask the concern on their faces, nor their exhaustion. The violent thunderstorm that rocked the vessel the previous night had not been conducive for sleeping. They all realized the persistent rains made activation of the Birds Point-New Madrid floodway unavoidable. As the commission members and staff waited for the conference call to begin, the normally-gregarious group said little, which reflected on the gravity of the situation.

Edward Belk, the MVD chief of programs, surveyed the room as the district commanders phoned in the situational reports for their areas of operations. He could sense the fatigue – both mental and physical – of the group before him. He knew they were running on the adrenaline created by the crisis unfolding at the confluence of the Mississippi and Ohio rivers. That concerned him. While still at least fourteen hours away, the activation of the Birds Point-New Madrid floodway was, for the most part, *fait accompli*. It was going to happen. Nothing could stop it from operating if Col. Reichling's task force could load the pipes with explosives in time. The tension-packed series of events from the past week were rapidly building toward a crescendo – the ultimate activation of the floodway. The natural reaction after the operation, Belk knew, would be for the tired and weary decision-makers and flood fighters to let down their guards as if the worst of the flood was behind them. But it was not behind them. The flood was just beginning. Activating the floodway would only serve as the opening salvo of a larger battle. With this in mind, Belk calmly and astutely warned the participants on the conference call, "As the flood moves downstream, we need to reload and re-cock, and be ready for the next challenge."[224]

The Need for Engineering Control

The ammunition in Belk's "reload and re-cock" analogy referred to the engineering controls in the lower end of the MR&T project. If the Mississippi drainage basin represents a gigantic funnel stretching across 41 percent of the United States, and the lower Mississippi represents the spout, then the MR&T project below Natchez represents the tip of the spout. Under project design flood conditions, the tip must convey a flow of three million cfs – a massive amount of water roughly 12.5 times greater than the amount of water that passes over Niagara Falls each second. To control that discharge, the developers of the MR&T project devised what amounts to an elaborate plumbing system, with two entrance points – the Mississippi River flowing past Natchez and the Red River; three transfer points – the Old River control complex, the Morganza floodway, and the West Atchafalaya floodway; and four exit points – the Bonnet Carré spillway into Lake Pontchartrain, the Wax Lake outlet into Atchafalaya Bay, and the mouths of the Mississippi and Atchafalaya rivers into the Gulf of Mexico. The goal of the system is to divert flows a little at a time so that the Mississippi River discharge will not exceed the manageable rates of 1.25 million cfs past New Orleans and 1.5 million cfs past Baton Rouge, while insuring a distribution of thirty percent of the combined waters and sediment of the Mississippi and Red rivers at the latitude of Red River Landing are passed through to the Atchafalaya basin.

Since the early nineteenth century, engineers had been debating the merits of creating expansion room for the river as a way to supplement the rapidly-extending line of levees. George Graham, the U.S. General Land Office Commissioner, first proposed a floodway through the Atchafalaya basin in 1828. In 1852, Charles Ellet, Jr., a prominent

Catahoula
Concordia
Adams
Homochitto River
Franklin
MISSISSIPPI
Red River
Bayou Cocodrie
Buffalo River
Avoyelles
Amite
Wilkinson
Simmesport
West Feliciana
East Feliciana
Morganza Spillway
Jackson
St. Helena
St. Francisville
Atchafalaya River
Morganza Floodway
East Baton Rouge
Pointe Coupee
St. Landry
West Baton Rouge
Livingston
Krotz Springs
Baton Rouge
LOUISIANA
Mississippi River
Lafayette
Iberville
St. Martin
Ascension
Lafayette
Donaldsonville
St. James
Grand Lake
Atchafalaya Floodway
Iberia
Vermilion
Assumption
Lafourche
Franklin
Morgan City
Houma
St. Mary
Terrebonne
Legend
US Army Corps of Engineers
Stream
Canal
Towns and Communities
Counties/Parish
MRT Project Area
Outside Project Area
MVD Levees
Levee Type
MR&T
MRL
Other
N
0 5 10 20 30 40
Miles

civil engineer working under a commission from the secretary of war, proposed a system of outlets through the Atchafalaya River, Bayou Plaquemine, Bayou Lafourche, and Lake Borgne. A month later, the State of Louisiana published a plan developed by Samuel Ricker that mostly mirrored Ellet's proposal, but expanded it by calling for man-made outlets at Morganza and Red River Landing. A decade later, Army engineers Capt. Andrew Humphreys and Lt. Henry Abbot published the *Delta Survey*, which advocated using, but not enlarging, the natural outlets through bayous Plaquemines and Lafourche. More importantly, Humphreys and Abbot urged complete resistance to the growing temptation of divorcing the Atchafalaya River from the Mississippi River, as such an action would deprive the Mississippi floodwaters of a vital diversion route.[225]

Instead of heeding these recommendations, the Mississippi River Commission recommended upon its establishment the completion of the levee line begun by local levee districts and the closure of most outlets, with the exception of the Atchafalaya River. Levees – at least conceptually – promised protection from the river; while floodways, outlets, and spillways meant surrendering land to the river. The commission's policy rested on the theory that closing off the outlets would increase the velocity of the river and scour the riverbed deeper, perhaps to the point that levees would no longer be needed to confine floods. By the dawn of the twentieth century, though, the commission began to ease on its stance against dispersion. Following the 1912 flood, which set a record stage of 21 feet near New Orleans on the Carrollton gage, Louisiana interests began pushing for the construction of emergency spillways to relieve pressure on the levee system during floods. The commission relented and studied the feasibility of constructing a spillway. The commission investigated six sites: Bonnet Carré, Kenner, and Lake Borgne on the east bank of the river; Willow Bend, Waggaman, and Jesuit's Bend on the west bank. Coming as no surprise to spillway advocates in New Orleans, the report concluded that a flood stage exceeding 21 feet on the Carrollton gage, indeed, threatened the security of the region's commercial and business interests. The report suggested as a solution the construction of a 6,000-foot long spillway capable of diverting 230,000 cfs from the main channel, but—citing fears of interrupting the continuity of the existing levee line and the threat of backwater flooding to New Orleans—surmised that a suitable location for a spillway could not be found.[226]

The call for spillways again jumped to the forefront during the 1922 flood, when the river established a new record on the Carrollton gage at 21.3 feet before the levee crevassed at Poydras, approximately 12 miles downriver from New Orleans. Although more than four feet separated the flood crest from the crown of the levee protecting the city, New Orleans residents believed that the Poydras crevasse lowered flood heights to the point of sparing them from calamity. In short order, several plans emanated from the civilian engineering community. John Klorer, the New Orleans city engineer, revitalized Ellet's 1852 plan for an artificial outlet from the Mississippi into Lake Borgne. John Freeman, the principal advocate for establishing a national hydraulic laboratory, set forth his own plan to draw flows out of the Mississippi above New Orleans through the enlargement of the Atchafalaya.[227]

In 1924, the Louisiana state legislature authorized the Orleans Levee District to design a spillway below New Orleans to protect the integrity of the levees lining the city front. On January 26, 1925, the levee district submitted a plan to lower eleven miles of levees at Pointe-a-la-Hache, approximately 50 miles downriver from New Orleans, to serve as a spillway. The Louisiana Board of State Engineers reviewed the plan and soon fragmented over differences of opinions on the subject. One faction believed that the spillway would reduce flood heights by as much as two feet. Another faction, while still advocating the necessity of spillways, believed Pointe-a-la-Hache was too far downriver to have any impact. Both factions did agree, however, that construction and implementation of the spillway would provide "an opportunity to procure valuable data for future reference." That statement reflected a matter of considerable importance. New Orleans interests hoped the data gathered through the spillway experiment would ultimately lead to a more systematic employment of spillways to protect southern Louisiana. This hope manifested itself through the efforts of Louisiana Congressman Riley J. Wilson, who was busily preparing a bill seeking authorization of a federal survey to determine the feasibility and cost of controlling Mississippi River floods between Old River and the Head of Passes through controlled spillways.[228]

The Louisiana Board of State Engineers approved the plan on February 10, two weeks prior to the next session of the Mississippi River Commission. On February 25, Gervis Lombard, the assistant state engineer for the board, and Marcel Garsaud, chief engineer for the Orleans Levee District, appeared before the commission to plead their case. Lombard took the lead, explaining that the proposed spillway would benefit the levee system near New Orleans and that all parties impacted by the plan agreed to the necessity of its construction. Colonel Potter, the commission president, reflecting on the irony of the people near Pointe-a-la-Hache agreeing to lower their own levee to benefit people upstream, commented, "It is not very long ago that levees were guarded with shot guns down in that country." Lombard answered, "In times of stress people do lose their heads." On February 26, the commission passed a resolution endorsing the state's plan to modify the 11-mile stretch of the levee. The State of Louisiana completed the Pointe-a-la-Hache spillway in 1926 at a cost of nearly $500,000. Shortly after its completion, President Calvin Coolidge signed Congressman Wilson's bill authorizing the Corps of Engineers to study the feasibility and costs of controlling Mississippi River floods south of Old River by means of spillways and levees. The Corps of Engineers, in turn, established a spillway board to survey plans to keep flood stages in New Orleans below 20 feet and at Simmesport on the Atchafalaya River below 48 feet. As the spillway board commenced its investigation in the fall of 1926, heavy rains drenched a large portion of the Mississippi drainage basin. The rains continued into the winter and spring of 1927, sending one flood crest after another through the lower Mississippi Valley. The spillway board's final analysis would come too late.[229]

As the 1927 flood developed and placed tremendous pressure against the levees in south Louisiana, fear of a levee crevasse reached panic levels, particularly after word spread of the crevasses at Laconia Circle and Whitehall in Arkansas and at Dorena, Missouri. On April 19, New Orleans Mayor Arthur J. O'Keefe and Garsaud met privately with the Mississippi River Commission in St. Louis to inquire about the steps to create an artificial cut in the levees to lower flood levels if it became necessary. Among the requirements outlined were getting permission from the Chief of Engineers and the Secretary of War as required by Section 14 of the Rivers and Harbors Act of 1899 and the assumption of all costs and responsibility by the local government. Two days later the Mound Landing levee crevassed, inundating the entire Mississippi delta and further spiking panic levels in New Orleans. On April 25, with gage readings exceeding 21 feet, Garsaud, publisher President James W. Thompson, Sen. Joseph Ransdell, Rep. James O'Connor, and other Louisiana powerbrokers urged permission to breach the levee. The Mississippi River Commission quickly passed a resolution that "to avoid the loss of life and property" it "is advisable to create a break" if Louisiana Gov. Oramel Simpson provided a formal statement requesting it and assumed responsibility for damages. The commission would then get permission from Maj. Gen. Jadwin, the Chief of Engineers. Only five hours later, Governor Simpson sent a telegram with his and Mayor O'Keefe's concurrence to cut the levee near the site of the 1922 Poydras crevasse. The following night, Jadwin and Secretary of Commerce Herbert Hoover conferred with the commission. Jadwin sent telegrams to Simpson and to Secretary of War Dwight F. Davis, who telegrammed Simpson, that they "interpose no objection" to the state's plan to dynamite the levee.[230]

Three days later, on April 29, after the evacuation of residents of St. Bernard Parish, George C. Schoenberger, chief of the Louisiana board of state engineers, oversaw the execution of the proposed cut with the national guard standing by to prevent interference. The actual site selected was at Caernarvon, Louisiana, about 13 miles below New Orleans. As reporter George W. Healy, Jr., observed, “The first blast, on Friday, April 29, was a flop, literally and figuratively. Soil blown out of the levee went straight up in the air and then flopped down into the

The Caernarvon levee in late April 1927. (Library of Congress)

Workers prepare the Caernarvon levee crevasse site. (Library of Congress) holes in the levee's crown whence it had been blown." Only a trickle of water was getting through the hole. Several attempts to dynamite the levee followed, expanding it to about 800 feet on May 1, but Roger McWhorter of the New Orleans Levee District noted, the "batture is scouring more slowly than expected.... This levee was built of ideal material and is one of the best in the state." Only after a diver placed additional charges under the batture on May 3 did the levee finally collapse, opening up a 2,600-foot gap. The Carrollton gage showed an immediate decline. No one had taken measurements during the 1922 crevasse at Poydras, so the Caernarvon cut was the first opportunity to prove the effect of spillways on the city. According to Klorer, "Ocular demonstration has convinced most of those not committed to spillways that relief of this kind is essential." The Corps of Engineers spillway board agreed. Its final report, which the board submitted to Jadwin on November 12, 1927, recommended the construction of floodways at Bonnet Carré and on both banks of the Atchafalaya River. The report concluded that "it is by this means only that the safety of the city and port of New Orleans can be positively and unqualifiedly assured."[231]

After the Caernarvon levee crevasse. (Library of Congress)

Less than a month later, Jadwin submitted his formal plan to the project design flood in Louisiana with a combination of levees and floodways. The dynamiting of the levee at Caernarvon had blasted the levees-only policy out of existence. The end result transformed the lower Mississippi River and the Atchafalaya basin into some of the most engineering-controlled waterways on the planet.

One Flood, Three Floodways

By midday on May 2, 2011, Edward Belk's call for vigilance proved insightful. The second round of storms that began hammering the White and Ohio valleys late on the night of April 30 had quickly transformed the flood into a game-changing event, not just at the Birds Point-New Madrid floodway, but the entire MR&T system – particularly along the lower reaches of the project in the New Orleans Engineer District. Based on that additional rainfall, the Lower Mississippi River Forecast Center predicted record stages at Natchez, Red River Landing, and Baton Rouge. Estimates for the peak discharge expected at Red River Landing exceeded 1.8 million cfs. During the 84-year lifespan of the MR&T project, the peak discharge at Red River Landing had never reached 1.5 million cfs – the key rate of flow and trigger point in the elaborate plumbing system designed to convey the project design flood below the Old River control structures. The river had come close to reaching that magic number on several occasions, exceeding 1.4 million cfs during the floods of 1937, 1950, 1973, 1979, 1983, 1997, and 2008, but in each instance the discharge stayed below 1.5 million. But in 2011, the New Orleans district faced the possibility of exceeding that discharge by nearly twenty percent. As the forecast became public, Louisiana Governor Bobby Jindal tried to calm any fears, "We are going to do everything we can to prepare for the worst-case scenario, while we are still hoping for the best case."[232]

Col. Edward Fleming, New Orleans Engineer District Commander.

On the morning of May 3, Col. Edward Fleming, commander of the New Orleans Engineer District, informed Walsh that he intended to make a formal recommendation to open the Bonnet Carré spillway later in the day. Depending on the outcome of an ongoing engineering analysis by his staff, Fleming hinted that he would request to open the structure on either May 6 or May 9. He also informed Walsh that the National Weather Service and his own water control managers anticipated the river would quickly surpass the trigger point (1.5 million cfs at Red River Landing) to activate the Morganza floodway, perhaps as early as

Louisiana Governor Bobby Jindal and Col. Edward Fleming discuss flood readiness.

May 11. Fleming's announcement that the Morganza floodway was in play stunned the commission staff, which only hours before had witnessed the activation of the Birds Point-New Madrid floodway. Walsh noticed the inquisitive looks – raised brows and darting eyes – on the faces of those sitting around the conference table on the *MISSISSIPPI*. Grasping for a talking-point to take to the press, Walsh, who had ordered the operation of the Bonnet Carré spillway during the 2008 flood, asked his staff if he would be the first commission president to operate the structure twice. "It's bigger than that, sir," one staff member replied, "This will be the first time we've activated three floodways during the same flood."[233]

The statement testified to the historic nature of the 2011 flood. The commission had opened the Bonnet Carré to limit flows past New Orleans on nine occasions since its completion in 1932 or about once every nine years. Opening the structure had become fairly commonplace, but three floodways was an entirely different story. Prior to 2011, the commission had placed multiple floodways into operation during the same flood on only two occasions. During the 1937 flood, the commission activated the Bonnet Carré and Birds Point-New Madrid floodways. The Morganza floodway, though, had not been completed, although river discharges would not have necessitated its use. During the 1973 flood, the commission opened the Bonnet Carré and Morganza structures. The discharge rate of the river did not reach the trigger point to place the Morganza floodway into operation, but Maj. Gen. Charles Noble, the commission president, ordered its activation to relieve pressure on the low sill component of the Old River control structures after scour threatened the integrity of the structure. Now in May 2011, the commission faced the prospect of activating three floodways simultaneously. Walsh and the others in the room understood the message. It was time to reload and re-cock.

On the afternoon of May 3, Fleming sent a memorandum to Walsh that requested permission to open the Bonnet Carré spillway. Walter

Baumy, Fleming's chief of engineering at the district office, authored the district's recommendation, which Fleming attached to his official request. The district had anticipated the possibility of opening the Bonnet Carré spillway as early as April 25. The new forecast on May 2 transformed the possibility into a necessity.[234] Historically, opening the structure had proven less controversial than operating the other floodways in the MR&T system because the federal government had purchased the property behind the spillway, rather than merely paying for the right to flood it. That land was all federal property; no homes or farms stood to be inundated. The most controversial aspect of opening the spillway involved the introduction of a large amount of fresh water into the brackish water of Lake Pontchartrain, which could impact oyster populations and related industries. Many oyster grounds in the lake had reported damage during the Deepwater Horizon oil spill and were only beginning to recover.

Citing the National Weather Service forecast of 1.8 million cfs at Red River Landing, Baumy stressed that the flood bearing down on the New Orleans Engineer District "would rank as the largest since measurements began in 1930." He pointed out that from a historical standpoint the approval to open the spillway had been granted when the discharge at Red River Landing reached 1.3 million cfs combined with a rising hydrograph. The weather service and the district's water control managers expected this to occur on May 10. Baumy also expressed concerns about freeboard deficiencies in the levees and floodwalls at Avondale, Carrollton, Holy Cross, and the Industrial Harbor Navigation Canal, as well as seepage concerns along the levees at Jefferson Heights, Algiers, Chalmette, Lake Borgne, and other known problem areas. Baumy noted that the authorized water control manual governing the operation of the structure was clear. The Bonnet Carré spillway was to be opened when the Mississippi River discharge below Baton Rouge reached 1.25 million cfs on a rising hydrograph *or* to preserve a desired freeboard on deficient levees in the New Orleans area. Opening the Bonnet Carré spillway would keep stages lower and reduce pressure and the resulting seepage along the system. In anticipation of flows in excess of 1.25 million cfs below Bonnet Carré on May 10, Baumy recommended that Fleming request "approval to have the flexibility to initiate operation" of the Bonnet Carré spillway as early as May 9, "as the rate of rise may necessitate gate openings in a sufficient manner to limit flows" on May 10.[235]

Walsh acknowledged receipt of the Bonnet Carré spillway request and informed Fleming that the commission had it under advisement. In the meantime, he wanted Fleming to prepare an informational briefing on the Morganza floodway, which had not been opened since 1973. At 2030 hours on May 4, Col. Fleming provided a brief detailing the layout, trigger points, and processes of the Morganza floodway. Once the preliminaries were covered, he set forth his operational concept for activating the floodway. Fleming's timeline called for Walsh's approval of the operational plan on May 5 and the issuance of a public notice of intent to operate Morganza on May 6. The notice of intent would initiate the floodway evacuation phase. Fleming explained that the National Weather Service anticipated a discharge of 1.8 million cfs at Red River Landing, which meant that the Morganza floodway would siphon off roughly 300,000 cfs from the Mississippi River and divert it to the Atchafalaya basin. The 300,000 cfs represented roughly one-half of the 600,000 cfs design capacity of the floodway under project design flood conditions.

Although the National Weather Service did not expect the discharge at Red River Landing to reach the trigger point of 1.5 million cfs until May 13, Fleming planned for a slow opening of the Morganza structure on May 10, when the anticipated discharge would reach 1.3 million cfs. The slow release procedure amounted to partially opening the gates to allow a gradual introduction of floodwaters under minimum velocities. Fleming's staff believed the slow release was necessary from the environmental viewpoint in that it would allow wildlife, particularly the endangered Louisiana Black Bear, time to seek refuge before the heaviest flows inundated the floodway. The black bear had been listed as a threatened and endangered species in 1992 and the floodway designated as its critical habitat in 2009.

A gradual opening would also serve notice that the commission was serious about its intent to operate the floodway and force people to get out of harm's way. The commission had not activated the spillway in 38 years, and even then it only did so because of the problem with the wing wall at the Old River low sill structure. Like Milus Wallace at the Birds Point-New Madrid floodway, some residents that would be impacted by the Morganza floodway did not think the commission would activate they floodway. They had been lulled into complacency. With an assumed flow of 272,000 cfs through the floodway and 760,000 cfs flowing through the Atchafalaya River, Fleming's inundation map showed much of the floodway and the lower Atchafalaya basin covered with anywhere from ten to twenty feet of water, which would impact a population approaching 10,000 people and nearly 6,000 homes. These figures included people and homes protected by ring levees at Simmesport, Krotz Springs, and Melville, but did not account for potential impacts from backwater flooding. The local citizens needed to know that the commission was serious about sticking to the plan.[236]

Fleming expected a decision from Walsh, but the commission president offered none. Walsh intended to stick to the trigger of 1.5 million cfs laid out in the official Morganza water control plan and the 2011 MVD operation plan. Similar to the situation at the Yazoo backwater levee, when the Vicksburg Engineer District first advocated flood fighting, Walsh did not feel comfortable that he had enough information to announce his intention. Because there were so many variables and unknowns that had not been fully vetted with the commission and its staff, he desired more information on the impacts to the backwater area at the lower end of the Atchafalaya basin. That area represented a very sensitive situation. Much of it was not in the floodway, but opening the Morganza spillway would put additional pressure on Morgan City and more water in surrounding areas. Fleming's inundation map did not depict those impacts. Walsh also had questions about evacuation plans. Although Fleming assured his commanding officer that the district staff would be meeting the following day with Governor Jindal, parish presidents, levee boards, and other stakeholders – all of whom knew the trigger points – Walsh was not yet sold. He wanted everything on the table handled properly and deliberately.[237]

The following morning, May 5, the commission voted unanimously to give Fleming the authority to open the Bonnet Carré spillway "in accordance with the approved Water Control Manual," but Walsh did not open the discussion on the request to open the Morganza spillway. On May 6, Fleming sent a memorandum to Walsh officially requesting approval to activate the Morganza floodway. He attached another detailed engineering justification developed by Baumy, his engineering chief. In his analysis, Baumy mentioned that the river had reached a stage of 15 feet on the Carrollton gage and 37 feet on the Baton Rouge gage. If the discharge at Red River Landing reached 1.8 million cfs as expected, the National Weather Service anticipated crest stages at Carrollton and Baton Rouge to reach 19.5 and 47.5 feet, respectively, without the Morganza floodway in operation. The higher stages, according to Baumy, would place unprecedented pressure on the levee system and required major flood fight efforts along more than 200 miles of levees that protected large population centers and numerous chemical plants and refineries between Baton Rouge and Bonnet Carré. Of particular concern were Duncan Point, where the district had placed nearly 12,000 sandbags to serve as a seepage berm; a three-mile segment of levee at Manchac Bend, which would overtop by up to two feet of water; and the Baton Rouge front. Baumy also noted that the Morganza structure itself faced overtopping. The resulting scour "could potentially jeopardize the stability of the structure," and place more stress on the Old River control structures. Even if flood fighting efforts proved successful throughout the reach of the Mississippi below Morganza, Baumy warned that the increased velocity in the channel posed another level of unacceptable risk by increasing the probability of errant barges or vessels damaging or breaching the levee system. All of these potential threats could be alleviated, though. With the floodway in operation, the predicted crests would only reach 17 feet on the Carrollton gage and 43.5 feet on the Baton Rouge gage and river velocities would remain manageable.[238]

After formally submitting the written request, Fleming verbally delivered a second decision briefing to Walsh and the commission. To avoid any confusion, Fleming stated at the onset that the purpose of the briefing was to secure the commission president's approval to operate the floodway. Fleming's new operational timeline called for the floodway evacuation to commence immediately and for Walsh to approve the operation by the following day – May 7. Fleming still intended to begin with a slow release, but he pushed the date back from his original proposal of May 10 to May 11. River forecasters expected the Mississippi River discharge at Red River Landing to approach 1.4 million cfs on May 11. Fleming's timeline, as it had originally on May 4, still called for the structure to be fully operational by May 14. To support his argument for the slow opening, the district commander emphasized that the *Flood of 1973 Post-Flood Report* prepared by the district recommended a gradual introduction of floodwaters to limit velocities to one foot per 24 hours to "provide terrestrial wildlife an opportunity to vacate the floodway with a minimum of distress." It was one of the lessons learned from the one and only operation of the floodway. The slow release also addressed a crucial engineering concern in that it would help to alleviate scour on the downstream side of the structure. This was an important consideration and another key lesson learned from the 1973 activation of the floodway. During the 1973 operation, massive scour holes developed below the stilling basin causing extensive damage. Left unchecked, the scour could work its way back toward the gates and undermine the structure. Scour was such a concern that the district placed more than a dozen scour indicators below the stilling basin. The indicators, eight inch by eight inch wooded floats anchored to metal disks, were buried to a depth of five feet. In the event that releases through the gates scoured the land on the backside of the structure and uncovered the indicators, the floats would surface and alert the district of the problem.[239]

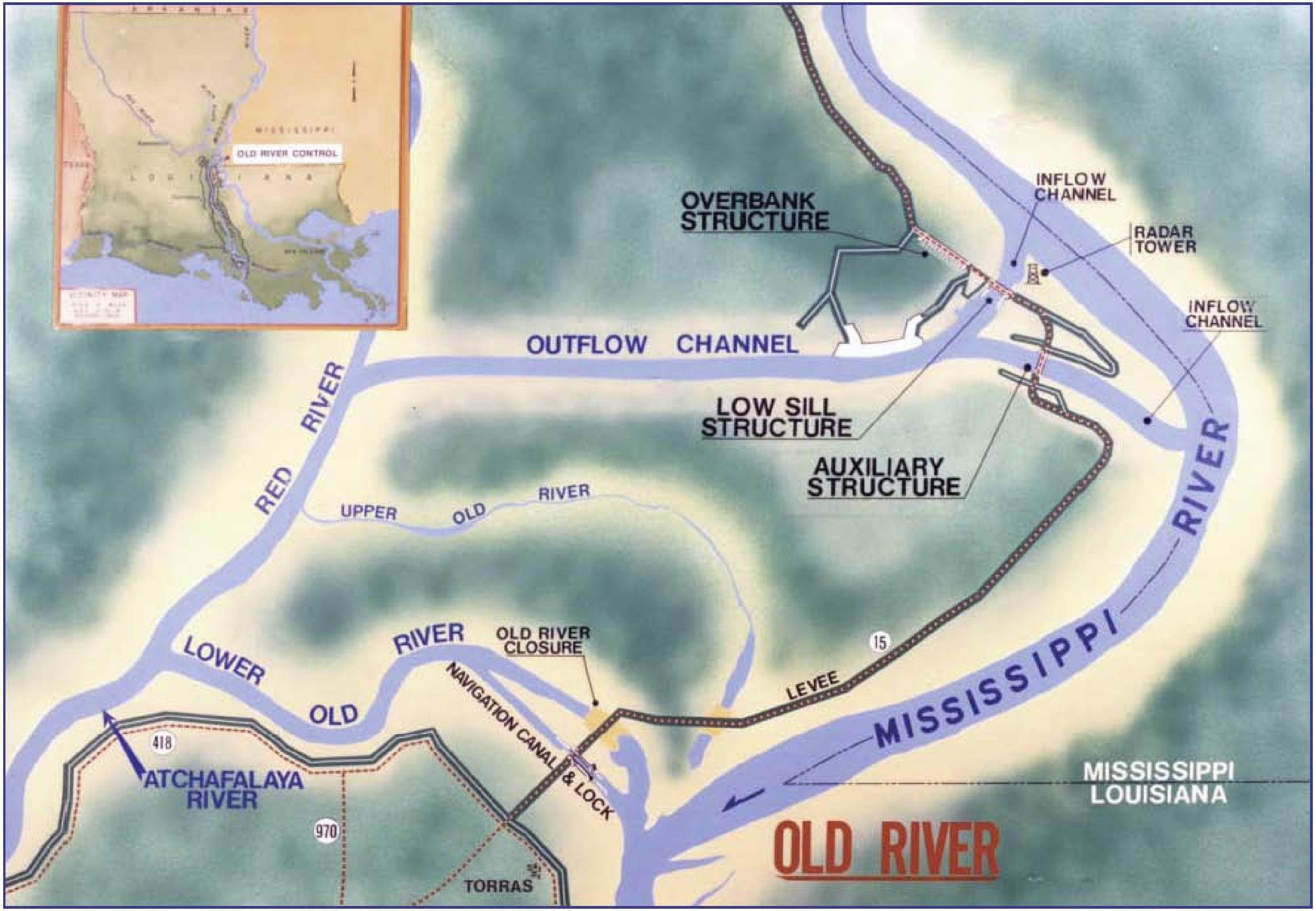
The inundation map Fleming used in the briefing was the same as the one he used on May 4, at least in respect to the Atchafalaya basin floodway guide levees. According to the new map, which used roughly the same assumptions as the previous map – 300,000 cfs flowing through the Morganza spillway and 760,000 cfs down the Atchafalaya River – the Morganza floodway and much of the Atchafalaya basin floodway below Interstate 10 would be inundated with anywhere from ten to twenty feet of water. Sections toward the lower end of the West Atchafalaya floodway in the vicinity of Melville and Krotz Springs could expect anywhere from a few inches to ten feet of water. The Pointe Coupee loop and the northern portions of the West Atchafalaya floodway would remain dry, as would the towns of Simmesport, Melville, and Krotz Springs, whose combined populations of 2,800 received protection from ring levees. By Fleming's estimation, operating the floodway would impact nearly 2,500 people and nearly 2,000 homes, with the highest concentrations of people being found along State Highway 105 between Melville and Krotz Springs (600 residents), along the West Atchafalaya Levee Road south of Krotz Springs (350 residents), and in the Butte La Rose area, east of Henderson (475 residents).

Fleming also sought to address concerns about impacts to the backwater area presented by Walsh during the May 4 briefing. The inundation map indicated that large sections of Iberville, Assumption, and Terrebonne parishes to the east of the eastern basin levee would be inundated by up to five feet of backwater flooding from the combined flows of the Atchafalaya River and the Morganza floodway. Fleming informed Walsh that flooding would impact up to 22,500 people and nearly 11,000 homes in the backwater areas, including Amelia and Stephenville near Morgan

City in St. Mary Parish; communities in Terrebonne Parish between Houma and Morgan City, including Humphreys, Gibson, and Donner; Pierre Part and Belle River in Assumption Parish; and communities along Bayou Sorrel and Grand River in Iberville Parish.[240]

The potential impacts to the large numbers of people and property in the backwater area left an impression on Walsh. Although they were not in the floodway, he knew that the flood would impact them and that they would need to seek legal remedies for their losses. After the briefing, Walsh sent a note to Maj. Gen. Bo Temple, the deputy chief of engineers, informing him of the backwater situation and asking the Corps headquarters "to seek authority and funding to set up a claims process that would include paying for impacts." Temple responded by suggesting a review of alternate scenarios to compare the impacts of operating the floodway against potential impacts to the MR&T system below Morganza. "The less impact we have in either case, the better," Temple wrote to Walsh, "realizing there'll be impacts no matter what we do." Walsh, in turn, instructed Charles Shadie, his chief of water management, to work with the New Orleans Engineer District to develop an assessment of various scenarios.[241]

Only three basic scenarios existed. The first was to stick to the approved water control plans and divert 300,000 cfs through the Morganza floodway, while passing 1.5 million cfs through the system between Baton Rouge and the Bonnet Carré spillway. The second involved not operating the floodway and attempting to pass 1.8 million cfs – a discharge roughly twenty percent greater than the project design flood – past Baton Rouge, while flood fighting along 200 miles of levees along the vital corridor. The third was to avoid operating the floodway and compensate by pushing an additional 300,000 cfs through the Old River control structures to maintain a project design flood discharge past Baton Rouge. The first two scenarios had already been addressed in Baumy's engineering justification attached to Fleming's May 6 written request to open the Morganza floodway. As for the Old


OLD RIVER CONTROL
MISSISSIPPI
OVERBANK STRUCTURE
INFLOW CHANNEL
RADAR TOWER
INFLOW CHANNEL
OUTFLOW CHANNEL
LOW SILL STRUCTURE
AUXILIARY STRUCTURE
RED RIVER
UPPER OLD RIVER
MISSISSIPPI RIVER
LOWER OLD RIVER
OLD RIVER CLOSURE
NAVIGATION CANAL & LOCK
LEVEE
15
418
ATCHAFALAYA RIVER
970
TORRAS
MISSISSIPPI
LOUISIANA
OLD RIVER

River control scenario, Baumy had already commenced developing an assessment the previous day. It was a tricky situation.

Congress authorized the Old River control structures in 1954, after Mississippi River Commission studies revealed a “definite” possibility that the Mississippi River might change course and divert its flow through the Old River link to the Atchafalaya River, thereby causing greater flooding in the Atchafalaya basin and the abandonment of the existing Mississippi River channel below Old River, which would have created extreme economic hardship to ports, the navigation industry, and industrial facilities between Baton Rouge and New Orleans.

The original structures consisted of a closure dam across Old River, a gated low sill structure to regulate the daily flow of water at all stages from the Mississippi River into the Red-Atchafalaya system, a massive overbank structure to pass excess flows during floods, and a navigation lock to maintain the waterborne commerce link between the Mississippi, Red, and Atchafalaya rivers. A hydropower plant and an auxiliary structure – designed to reduce stress on the low sill structure after it was damaged during the 1973 flood – were added to the control complex in 1986 and 1990, respectively. Because the Atchafalaya River was a distributary of the Mississippi River, it received a continuous flow of water and sediment from the Mississippi via the Old River link. To maintain that existing relationship, the law required the Corps of Engineers to regulate the structures so that 70 percent of the combined flows and sediment of the Red and Mississippi rivers would continue down the Mississippi River, while thirty percent of combined Red and Mississippi River flows and sediment would be conveyed through the Atchafalaya River.[242]

The Old River area is a very dynamic place, with a long history of attack from the river. For that reason, Baumy’s assessment of the scenario reflected a harsh reality. If the goal was to not activate the Morganza floodway, but still maintain project design flood flows past Baton Rouge, he contended that a total flow of 920,000 cfs needed to be conveyed through the Old River control structures. The project design flood called for 620,000 cfs to pass through the structures, so the scenario necessitated a fifty percent increase. To distribute the increased flows under this scenario, Baumy intended to pass 350,000 cfs through the low sill structure, 350,000 cfs through the auxiliary structure, and 220,000 cfs through the overbank structure. The potential for increased velocity and scour was the main concern. The control structure had passed 620,000 cfs during the 1973 flood. The increased velocity caused numerous bank failures and severe erosion to levee setback. In 2009, the New Orleans Engineer District fully opened the gates at the auxiliary structure to flush sediment. The surge of water flanked the revetment on both banks of the inflow channel and caused bank failures near the upper guide levee and the south entrance channel. Baumy also surmised that the additional water would overtop the levees on the east bank of the Atchafalaya River and reduce the freeboard on the west bank levees to less than one foot at their intersection with the Melville and Krotz Springs ring levees.[243]

More problematic were the low sill and overbank structures. In 1964 and 1965, the district closed the gates after barges had broken free from their upstream fleeting areas and crashed into the low sill structure on separate occasions. The reopening of the gates resulted in extensive scouring in the outflow channel. Less than a decade later, the 1973 flood severely damaged the low sill structure. The high-velocity flow through the structure scoured a 50-foot-deep hole in front of and partially under the structure. It was this scour that resulted in the infamous collapse of the wing wall and the subsequent activation of the Morganza floodway. Had the scour holes in the inflow and outflow channels connected, the entire low sill structure may have collapsed. The low sill structure had since been repaired, but it had sustained permanent damage, which resulted in restricting the head differential from the Mississippi River side of the structure to the downstream side of the structure from 37 feet, as originally designed, to 22 feet. It was this restriction that necessitated the construction of the auxiliary structure. Baumy touted the soundness of the low sill structure, but cautioned, "excessive velocities can cause damage in unanticipated ways…the potential for scour and undermining, undetectable during the event, could result in significant damage or failure."[244]

The overbank structure also posed two problems – Baumy addressed one in his analysis. When the structure was first used during the 1973 flood, severe scour occurred near the south guide levee that connected the overbank exit channel to the low sill structure outflow channel. The New Orleans Engineer District addressed the problem by installing a 120-acre gabion field over the scour area. During the 1983 flood, though, a massive scour hole developed in the gabion field. The added capacity to convey water through the auxiliary structure had alleviated the need to open the overbank structure during larger floods in 1997 and 2008. As the 2011 flood developed, the district had no intention of using the overbank structure in an effort to avoid new scour to the gabion field. Therein lay the second problem. The overbank structure had limitations. It needed to be operated before the head differential between the riverside and landside of the structure reached thirteen feet. As Baumy developed the scenario, the river rapidly approached that level. Use of

Water seeps through the overbank structure at the Old River Control Complex on May 4, 2011.

the overbank structure required a quick trigger. The river would exceed the thirteen-foot head limitation by the afternoon of May 11.[245]

When you gonna do it?

By May 8, the Mississippi River reached 40 feet on the Baton Rouge gage, five feet above flood stage. The river had risen seven feet in seven days. At the Carrollton gage near New Orleans, the river reached 16 feet. Pressure mounted on the levee system, but it held firm. For flood fighting purposes, the New Orleans Engineer District divided the reach of the river below Baton Rouge into sectors. The Pontchartrain, Orleans-Jefferson, and Lake Borgne sectors comprised the 183 miles of levee on the east bank. The Pontchartrain sector covered 98 miles of levees between Baton Rouge and the Bonnet Carré spillway. The Orleans-Jefferson sector encompassed 37 miles of levees from Bonnet Carré to the Orleans-St. Bernard Parish line. The Lake Borgne sector started at the same county line and covered 48 miles of levees extending down to Bohemia. On the west bank, the Lower West Mississippi sector covered 92 miles of levee between the Morganza spillway and Donaldsonville. The Lafourche sector encompassed the 90 miles of levee between Donaldsonville and the Algiers Canal. The Lower Coast sector covered the 77 miles of levee extending between the canal and Venice. Stuart Waits served as the area engineer for the east bank sectors, as well as the Lafourche and Lower Coast sectors, and Ted Eilts as the area engineer for the West Lower Mississippi sector and all sectors in the Atchafalaya basin and on the Mississippi River above Morganza.[246]

The river regularly climbs above 11 feet on the Carrollton gage, the trigger point for phase I flood fight activities. In fact the New Orleans district had been in phase I since early March. Phase I activities equate to inspecting every mile of levee in the system, two to three times a week. Phase II – daily inspections and 24-hour operations – commences when the Carrollton gage exceeds 15 feet. Going into the 2011 flood, the

New Orleans district was well prepared. The 2008 flood had helped the district and levee boards indentify potential problem areas. That flood had crested at 43.1 feet on the Baton Rouge gage and 16.8 feet on the Carrollton gage, therefore, the 2008 high water had placed similar pressure loads on the system and exposed problematic underseepage areas, sand boils, and other related issues. As the river climbed higher in May 2011, exerting its force and weight against the levees as it sought an escape route under the structures, flood fighters knew exactly where to look for potential weak spots identified during the 2008 flood fight.

The ongoing dry spell in the region also assisted in the identification of problem areas. Unlike previous major floods, like 1973 and 2008, persistent localized rainfall did not accompany the 2011 high water. The 2011 flood emanated entirely from above. Normally during floods, ditches, low spots, and surrounding fields are covered with impounded rain, making it difficult for flood fighters to determine the difference between seepage and runoff. While the drought conditions had a downside, namely causing shrinkage and cracks in the levees, the dry conditions made the identification of underseepage easier for weary levee inspectors. As Waits noted, "it had been so dry for so long, that any landside water we saw was seepage." According to Waits, the dry conditions also allowed flood fighters "to identify a lot of areas that we wouldn't have noticed before."[247]

Despite these good fortunes, not all was well within the system. There were several areas of intense concern, particularly with regard to underseepage. Chief among them was the levee at Duncan Point, just south of Baton Rouge. The levee had been plagued with severe underseepage since the 1973 flood. It was a known trouble spot. Following the development of several sand boils during the 2008 flood, the New Orleans district constructed a stability berm to address the problem, but as the river placed pressure on the levee during the 2011 event, the underseepage migrated to the north of the berm on the landside toe of the levee. This prompted the Pontchartrain levee district to construct an extension to the berm using in excess of 12,000 sandbags. Aside from underseepage, another cause for heightened anxiety among the levee districts involved barges. Several levee districts complained that barges were pushing and mooring too far up on the levees. They were concerned that the barges might bump or push against the levees and threaten the integrity of the all-too-important structures. The levee districts found some comfort in the fact that the district had formed a Rapid Response Team, which had developed a number of "what if" scenarios and accompanying plans to address a catastrophic levee failure, but that comfort only went so far. The only thing that would ease their fears was the activation of the Morganza floodway.[248] The Morganza floodway was really at the heart of the issue. Walsh had not authorized its opening or even hinted that he would, despite two very public requests by Fleming. Flood stages of 44 feet and 17 feet at the Baton Rouge and Carrollton gages, respectively, would certainly test the system from Baton Rouge

The levee along the corridor between Baton Rouge and New Orleans holds back the river.

on down the river, but the system had already passed that test in 2008. Without the Morganza floodway in operation, though, the predicted stages on those same gages would reach 47.5 feet and 19.5 feet. That represented an entirely different test – one that the levee districts, the state, and the public wanted to avoid.

Governor Jindal and the levee districts simply wanted predictability. The fact that the commission and the district were analyzing alternatives to operating the floodway created a strong sense of uncertainty. From the state's perspective, they had the resources they needed to get into place. They needed to evacuate the first floors of hospitals, open shelters, pre-position food and water, and prepare for evacuations. They had to consider high population centers, schools, and infrastructure. They had to allocate flood fighting resources. Where would the national guard and inmate laborers be needed most to fill sandbags? All depended on whether or not Walsh intended to operate the Morganza floodway and when. If he intended to activate the spillway, those resources would be needed in the Atchafalaya basin. If he intended to pass the water past Baton Rouge and through the system, the resources needed to be staged farther to the east. The same went for the Mississippi River levee districts. They desperately wanted Fleming's staff to provide a little foresight. They needed to know how high to raise their levees during the flood fight. Deficiencies in levee heights under project design flood flows certainly existed but not along the entire reach below Baton Rouge. The deficiencies were manageable, but raising 300 or more miles of levees was no simple task. The effort would use up resources – resources that could be devoted to other purposes, such as levee inspections. If Walsh intended to use the floodway, the levee districts could reallocate those resources.[249]

The private sector was feeling the heat, too. The emergency preparedness manager the Waterford nuclear power station in St. Charles Parish – one of two nuclear plants in the state – sent a message to Michael Stack, the New Orleans district's emergency management chief, asking for the district's intention with respect to operating the Morganza floodway. He was worried that the plant would be forced to initiate a shutdown if the Morganza floodway was not placed into operation. Citing concerns about the station's intake structure and the stability of the power grid, he noted that the plant's leadership faced several decisions about moving assets and equipment to provide protective measures. He was not trying to influence the decision one way or the other. Rather, he simply asked whether or not the district anticipated opening the structure before river stages would force the plant to shut down. The plant's emergency preparedness manager may not have been pressuring the district for a decision, but Steve Wilson, the president of the Pontchartrain levee district, did. "Folks, this is a nuclear power plant," he wrote to the district, "You think we might want to consider Morganza? Please."[250]

Forecasted stages between Baton Rouge and New Orleans also led to concern for the Coast Guard, which acted as the manager of commercial transportation, a mission that included overseeing maritime safety. The

The Mississippi River levee between Baton Rouge and New Orleans.

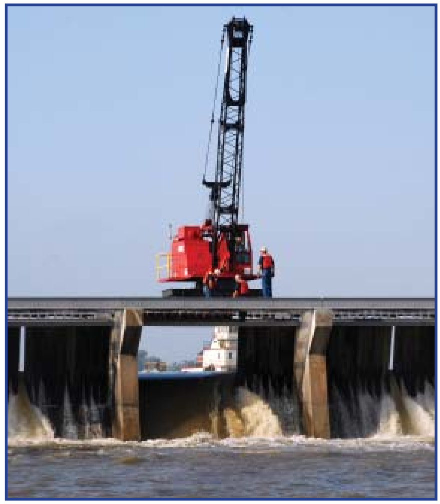
Coast Guard notified the Corps of Engineers that if the predicted stages materialized, it would close the river to navigation. The threshold for closure would only be reached if the Mississippi River Commission did not activate the floodway. The notification was not a threat or an attempt to influence a decision – the Coast Guard respected that it was Walsh's call – but their potential action was a reality necessitated by the river forecasts. The navigation industry, recognizing that nearly 500 million tons of water commerce moved through the Mississippi River system annually, began placing pressure on the district to operate the floodway. "I can't tell you how many times the navigation folks said, 'Hey, Corps, pull the trigger, baby,'" Christopher Accardo, the New Orleans district's chief of operations, later recalled. All Col. Fleming and New Orleans district staff could do was relay the concerns to Maj. Gen. Walsh and the Mississippi River Commission. Fleming would oversee the execution of the project, but it was Walsh's decision as to if and when the structure would be operated.[251]

As pressure on the system mounted, so did the public pressure on Col. Fleming and his staff. By this point in the overall system-wide flood fight, Walsh's *modus operandi* with respect to the floodways took on a hint of brinksmanship. Making room for the river by dispersing excess flows through the floodways made perfect engineering sense on paper, but actually making the decision to intentionally flood people's homes, property, and business interests, though unavoidable, was no easy task. Whether intentional or not, Wash's deliberate decision processes created the impression that he was willing to push the system to the limit and avoid using the floodways. One theory is that Walsh wanted to build a regional consensus on the necessity of operating floodways. He wanted to create anxiety among the public who stood to benefit from the operation of the floodways. He wanted them to experience the same level of tension as those living in the floodways. He wanted them and their elected officials to put pressure on him, as the commission president, to operate.[252] Such had been the case at the

Birds Point-New Madrid floodway, where Walsh's deliberate process created a high level of discomfort. By the time he gave the order to activate at Birds Point-New Madrid, he had received several notes from officials from Illinois, Kentucky and Tennessee – even from Missouri officials from outside the floodway – pleading for him, even demanding for him, to blow the levee. The same was beginning to happen at the Morganza floodway. Population centers, levee districts, the navigation industry, the power industry, the Coast Guard, and the governor were anxious. Their level of discomfort grew with each passing day, as did their acknowledgement that the floodways were vital parts of the system for a very important reason.

On the morning of May 9, Maj. Gen. Walsh, along with fellow commissioners Sam Angel and Clifford Smith, travelled to the Bonnet Carré spillway to oversee the opening of the structure. The Mississippi River roared past the structure at rate of 1.24 million cfs. This resulted in a reading of 16.5 feet at the Carrollton gage. Farther upstream, the discharge rate at Red River Landing reached 1.32 million cfs. Higher flows

Aerial view of the Bonnet Carré floodway just moments after the spillway was opened.



Raising the needles at the Bonnet Carré spillway.

and higher stages were on the way, necessitating the opening of Bonnet Carré. River water seeped through the needles at the structure, partially inundating the floodway on the protected side of the structure. A large crowd of people were in attendance, which created a festival-like atmosphere. That atmosphere would continue for days, as more than 40,000 visitors would ultimately travel to the spillway to witness the diversion. At 0900 hours, Fleming gave the order to open the first set of needles to allow the swollen and pressure-packed river to relieve its pressure and crash into the floodway. Crews continued raising needles until the river flowed through 28 bays at a rate of 26,000 cfs. The onrushing water quickly formed small channels that began wending through the floodway toward Lake Pontchartrain, approximately seven miles to the north. Within five days, crews had opened 300 of the 350 bays, allowing so much water to escape the river that the discharge through the spillway actually exceeded its design capacity of 250,000 cfs.[253]

Later in the afternoon, Fleming presented the three scenarios that Walsh had requested with respect to the Morganza floodway. Going into the briefing, Fleming was confident that his commanding officer would grant permission to operate the Morganza floodway now that the opening of the Bonnet Carré spillway was out of the way. He knew it was unrealistic to try to pass more than 1.5 million cfs past Baton Rouge. Furthermore, the previous day Walsh had instructed Fleming to develop "a sequence of activities to open Morganza into discrete actions" and put those action into a timeline of H-hours, similar to the operational plan Col. Reichling had developed for the Birds Point-New Madrid floodway activation. Fleming responded that there were not any

Walter Baumy, left, explains the three scenarios to Sam Angel and Maj. Gen. Michael Walsh.

discreet actions at Morganza floodway. The process was entirely different from the process used by Col. Reichling and the Memphis Engineer District. The operational plan for the Missouri floodway contained a series of decision points that telegraphed the ultimate outcome. There was a separate decision to load and move the barges, to locate and uncover the access wells, to pump the explosives into the pipes, and to activate the floodway. At Morganza there was only one action – open it or do not open it. Still, the request signaled to Fleming that Walsh was moving closer to making a decision. Governor Jindal shared Fleming's confidence. Aware that the district commander was prepared to brief Walsh, Jindal expressed optimism to the media that "Walsh will make a decision today."[254]

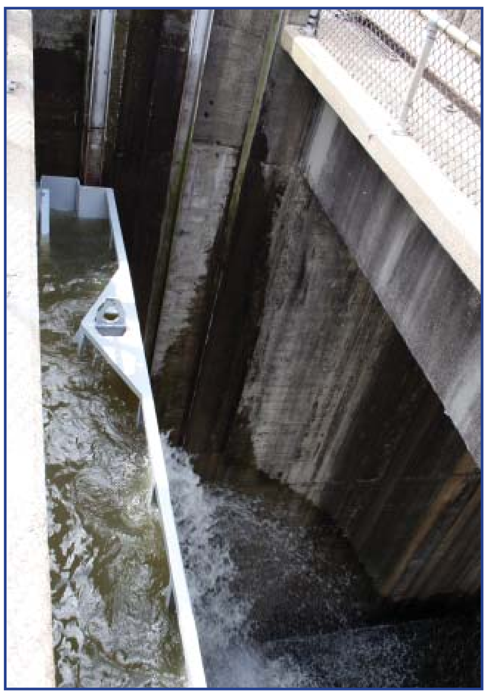
During the briefing, Fleming informed Walsh of the many levees, freeboard, and seepage concerns that he had in the system and communicated the issues involving the navigation industry and the nuclear power plant. He also presented the three scenarios. After emphasizing that the second and third scenarios (attempting to pass more than 1.5 million cfs past Baton Rouge and deviating through the Old River control structures) posed too great a risk to the system, Fleming recommended opening the Morganza spillway. Walsh concurred with Fleming's recommendation. Sticking to his practice of brinksmanship, though, he did not grant permission to open the spillway; rather, he confirmed that he would operate the floodway according to the operations plan "when I make the decision concerning the use of the Morganza Floodway." This at least confirmed that the commission would not try to pass a discharge greater than 1.5 million cfs past Baton Rouge or deviate through the Old River control structures.[255]

The decision relieved some of the anxiety demonstrated by the levee districts along the Mississippi River below Baton Rouge, but for Col. Fleming and the district staff, the questions from the public merely went from "are you going to do it?" to "when are you going to do it?" As Fleming later recalled, "When you gonna do it? When you gonna do it? When you gonna do it? That's all anyone wanted to know. When you gonna do it?" Even Maj. Gen. Temple asked Walsh, "When do you estimate you'll make the Morganza decision?" The governor's office wanted to know the same thing. They needed to issue a mandatory evacuation, but they also needed to know when to make the declaration. The governor's office and local officials encouraged a voluntary evacuation, but any progress proved slow. Instead of moving their belongings, many floodways residents were sandbagging and building temporary levees to protect their homes.[256]

We Have Serious Issues

By the morning of May 10, Fleming realized that he had an additional specter with which to contend. The New Orleans district had completed the construction of the Morganza spillway by the time Congress authorized the Old River control structures in 1954. The operational plan for the floodway rested on the assumption that a Mississippi River discharge of 1.5 million cfs at Tarbert Landing – located about 4 miles upriver from Red River Landing – would equate to a stage no higher than 56 feet at the Morganza spillway. With the top of the gates reaching an elevation of 60 feet, the structure possessed four feet of freeboard above the maximum expected stage of the river – at least conceptually. The 1973 flood, as it had at so many MR&T project features, exposed a problem. Rating curves developed after the flood indicated a "progressive deterioration of the discharge capacity" for the reach of the river between the Old River control structures and the Morganza spillway, possibly due to the changes in the dynamics of the river created by the control structures. In other words, higher stages than expected for a given flow had materialized. The phenomenon occurred again during subsequent floods. In 1983, the discharge at Tarbert Landing peaked at 1.47 million cfs, but the stage at the structure reached 58.1 feet, more than two feet higher than expected. Further changes to the dynamics of the river were created by the construction of the auxiliary structure and hydropower plant at Old River in 1986 and 1990, respectively. In 2008, the Tarbert Landing discharge measured 1.46 million cfs and the river crested at 57.6 feet in the spillway. The New Orleans district water control managers noticed the same anomaly in 2011. When the discharge at Tarbert Landing reached 1,335,000 cfs in 1973, the estimated corresponding stage at the spillway was 52 feet. In 2008, when the discharge reached that same rate of flow, the stage at the spillway reached 54 feet, an increase of nearly two feet. By May 9, 2011, the discharge at Tarbert Landing reached 1,335,000 cfs. The stage at the Morganza spillway was 55 feet. The discharge trigger for operating the floodway was not correlating to the proper stage. The phenomenon did not catch the district off guard, but it was becoming clear to Fleming that, based on the rate of rise, there was a strong probability that the river would overtop the gates at the Morganza spillway.[257]

Water spills over the gates at the Morganza spillway.



The potential overtopping of the gates presented several problems. From an operational standpoint, overtopping threatened the ability to open the gates. The spillway is a 3,906-foot-long structure with 125 gated openings, each a little more than 28 feet wide and separated by three-foot-wide piers. Each opening contains steel vertical lift gates. Upper and lower leafs comprise each gate. Each leaf is equipped with rollers that allow the gates to slide up and down in the slots between the piers. The structure has two gantry cranes that move along the structure and raise the gates. The gantry cranes lift the gates to allow water to pass through the structure. Each gate leaf has two lifting eyes. The gantry cranes lower lifting beams equipped with pins into the slots. The pins attach to the lifting eyes and the gantry crane raises the gates. Aligning the pins into lifting eyes requires visual assistance and confirmation. The concern with overtopping was two-fold. First, head pressure higher than the design limit of 56 feet increased the possibility of the roller gates locking up, which, in turn, could stress or possibly damage the gantry cranes. The facility possessed a back-up crane, but its operation depended on the use of slings that had to be manually connected to the gates. Such an operation would be impossible with water cascading over the gates. The second concern was that overtopping would inhibit the crew's ability to visually align the pins with the lifting eyes.[258]

Not being able to operate the structure was a concern in terms of maintaining the project design flood discharge and safeguarding the levees below Baton Rouge, but higher head stages and overtopping threatened the integrity of the structure itself. Geotechnical and structural engineers from the district were somewhat concerned that the pressure from the extremely high stages might actually move or uplift the structure. The probability was low, but the concern warranted surveys and observation. The more pressing concern centered on the curtain walls at both ends of the spillway. The curtain walls extended from the gated sections of the spillway to the abutments on either end. The walls were constructed to the same elevation as the gates. The areas immediately below the curtain walls did not have scour protection. If the walls overtopped, the resultant scour threatened to undermine the structure. The district contemplated sandbagging the curtain walls to add height, but concerns for the safety of the individuals who would have to work on the narrow wall – with little margin of error separating them from the rising river – forced the abandonment of the idea. Little could be done, other than to open the spillway to relieve stages.

During the May 11 daily briefing, Charles Shadie reported that the National Weather Service had adjusted the forecast flows at Red River Landing downward from 1,800,000 cfs to 1,626,000 cfs. For several days, the water control managers at the New Orleans district and MVD believed the forecast was too high and coordinated their suspicions with the official forecasters. They suspected that the raw models used by the weather service were interpreting the higher stages in the tributaries as inflow into the system, rather than the Mississippi River backing into the tributaries, which was actually the case. The downward revision simply confirmed the age-old axiom that forecasts always get better closer to the event. The downgrade was both good news and bad news for Fleming. It was good news from the standpoint that it meant less water that needed to be diverted from the Mississippi River into the Morganza floodway. On the other hand, he knew that forecast might influence Walsh to reconsider his May 9 decision to operate according to the operations plan when the river discharge reached the 1.5 million cfs trigger point at Red River Landing.

Fleming went into immediate damage control mode when it was his turn to speak during the briefing. He pointed out that the river had climbed two feet in two days at the Morganza structure. By the morning of May 11, the river exceeded 57 feet – one foot higher than the assumed design stage for operating the spillway. The river was within three feet of overtopping the spillway gates and the south guide levee. He relayed his newest concern to Walsh, "If we overtop, we will have great difficulty moving the gates when the time comes." He also relayed his concerns about the curtain wall, which he warned "cannot tolerate overtopping." He then almost pleaded with Walsh not to change direction by arguing, "I understand the forecast flow change at Red River Landing, but nothing we have heard changes our recommendation to operate the floodway." Sensing that "there will be further affects as the flows hit backwaters and trees and friction points in the river," Walsh instructed Fleming to "Hold the line as you are." In the meantime, he wanted Fleming's staff to run the three scenarios presented to him on May 9 against the new predicted discharge numbers.

To Fleming, the tasking to run the scenarios only amounted to homework. He saw the river racing toward the trigger point. In the early morning hours of Friday, May 13, he sent a note to Walsh, seeking his permission to inform Jindal at the governor's daily briefing that "we will open Morganza within 36 hours as long as the flow at Red River hit 1.5M [1.5 million cfs]." Based on the forecasts, the river would reach the trigger point on the afternoon of May 14. Fleming knew he was pressuring his commanding officer, but he had a good reason. The evacuation was still progressing slowly. The governor's unified command group would be at the briefing and they could notify people quickly that the floodway would be activated. Fleming was concerned that if they waited until later in the day, state officials would experience difficulties in getting the word out. He also requested permission to tell his staff, so that they could stop working on other scenarios and focus entirely on the floodway operations. The request drew a strong rebuke from Walsh, "The decision has not been made." Walsh instructed Fleming to "Tell [Governor Jindal] as always at 1.5 [million cfs] on the gage we will operate . . . work all scenarios until a decision is reached."[259]

A little more than an hour later during the daily commanders briefing, Fleming announced that he expected the Bonnet Carré spillway to reach its design capacity discharge of 250,000 cfs sometime during the course of the day; the discharge flowing past New Orleans had reached the project design flood dimension of 1,250,000 cfs. The stage at Morganza had reached 58.6 feet, less than 1.5 feet from overtopping the gates. "We are ready to operate," Fleming told Walsh. He also informed Walsh that once the district received the order, the district would notify the Louisiana National Guard, the state police and individual mayors and "they will go door-to-door in the communities to insure the floodway is clear." At 1500 hours that same day, Walsh sent an official order in writing that directed Fleming to "be prepared to operate the floodway within 24 hours," upon Walsh's order to execute and in accordance with the approved operational plan.[260]

The approved operational plan specified a trigger point of a 1,500,000 cfs discharge at Red River Landing. Because the Morganza spillway was designed under the assumption that the gates would open prior to river stages reaching 56 feet at the structure, all tables, graphs, and data in the water control manual ended at that stage. Rating curves and various equations used by the district's hydraulic engineers to

The Low Sill Structure at the Old River Control Complex on May 14, 2011.

extrapolate stages, therefore, were not as precise as needed. This posed an incredible challenge for the district. Baumy had sent personnel to the Morganza spillway and Old River control structures to monitor the situation and check gages around the clock. At 2200 hours on May 13, Nancy Powell, the district's chief of hydraulics, was at her home checking the gages from her phone, when she noticed a sizeable uptick in the river stages at Morganza. She checked the most current reading against previous readings. The river was climbing at a rapid pace. At that rate, Powell knew the gates at the spillway would overtop sometime during the night. She called Baumy and advised him of her assessment. Not knowing whether or not Walsh intended to open the spillway, Baumy instructed the gate operators at the Old River auxiliary structure to divert more water from the Mississippi River to keep the gates from overtopping. The gate change increased the total discharge through the Old River control structures to 672,000 cfs, more than 50,000 cfs above the project design flood discharge. The gate change had prevented the river from overtopping the gates at Morganza, but it also siphoned off some of the discharge at Red River Landing.[261]

On the morning of May 14, the Mississippi River Commission and its staff assembled in the conference room on the *MISSISSIPPI*, which was moored at Baton Rouge, for the daily 0800 hours conference call. It was a few minutes prior to the meeting, so all were present but Walsh, who was in his stateroom reviewing situational reports from his district commanders. As was usual, individual paper copies of the slides for the morning presentation sat on the conference table in front of each chair. Upon taking their places the commission members and staff examined the briefing and intently flipped to the page that contained the operational timeline for the Morganza floodway. The timeline was a chart that mapped out the previous, current, and forecasted daily high discharges at Red River Landing, along with key decision points. Almost everyone anticipated that the May 14 forecast would depict at least 1,500,000 cfs at Red River Landing. To a person, they were shocked to see the forecast at 1,480,000 cfs.[262]

On paper, 20,000 cfs seems like a huge difference, but in reality it is not when it pertains to predicting the discharge of a river as big, fast, and deep as the Mississippi River. Various phenomena such as reverse flow, vertical flow, underwater sand dunes, and anti-dunes constantly form and disappear. Furthermore, when predicting the flow of the river, forecasters do not have an infinitely fine ruler. They can only measure with a certain degree of accuracy, with the typical margin of error being from five to ten percent. William Veatch, a hydrologist for the New Orleans district, described the difference between 1,480,000 cfs and 1,500,000 cfs as almost a "philosophical question – you're almost asking what minute did you measure it." Philosophical question or not, that 20,000 cfs might impact Walsh's decision. One commission staff member walked up to Stephen Gambrell, the executive director for the commission, and tapped his finger on the May 14 discharge entry on

Gambrell's copy of the timeline and whispered, "Does this mean he won't pull the trigger?"[263]

Col. Fleming and the district staff were asking themselves that very same question: *Does this mean he won't pull the trigger?* To Fleming, it was a moot point. It did not matter what the flow was. The gates were about to overtop. Walsh needed to approve opening the structure. Fleming was convinced that Walsh would give the order. "There was no other way we could go. It was a slam-dunk," he later recalled. He had been confident that he would secure approval after his initial request on May 4, and again on May 6 and May 9, though. Fleming was confident, but not overly so. In fact, Walsh still had not reached a decision in his own mind, even as the commission departed the *MISSISSIPPI* at Baton Rouge and drove to the Morganza spillway. Walsh did not want to operate the structure prematurely. While he was certainly leaning toward opening the gates, he intended to stick to the operational trigger point of 1.5 million cfs at Red River Landing as spelled out in the approved water control manual.[264]

When the commission arrived at the Morganza spillway, they immediately went out on the structure to gain a more thorough perspective on the gates and their relationship to the height of the river. Going in, Walsh was convinced that the crews would be able to connect the pins to the lifting eyes and raise the gates even if the gates were under water. His trip to the structure convinced him otherwise. Water lapped at the top of the gates and spilled over when wave after wave crashed against the structure. Walsh turned to Russell Beauvais, the operations manager for the Morganza spillway and Old River control structures, and asked him, "Will you be able to lift the gates?" Beauvais, a burly Cajun, answered in his thick accent, "Yes, sir. It shouldn't be an issue, as long as we don't overtop." The district had taken a precautionary measure to insure that they would at least be able to open the first two gates on the structure. Fearing that they might lose the ability to hook the lifting mechanisms into the gates as water spilled over the top, the

Col. Edward Fleming, left, delivers his final decision brief to the Mississippi River Commission.

crews had already made the necessary connections. Lifting the first two gates would not pose a problem; lifting the remaining gates necessary to keep pace with the rising river was another story.[265]

Moments later, Maj. Gen. Walsh and the three civilian members of the commission, Sam Angel, R.D. James, and Clifford Smith gathered in the cramped main office at the spillway for another decision briefing. Col. Fleming, Christopher Accardo, Michael Stack, Thomas Holden, and Beauvais represented the district in person, while Baumy and Powell phoned in from the district office in New Orleans. Fleming set the stage by informing the commission that the river had set a new record stage of 62 feet at the Red River Landing gage. The river was higher than it had ever been and it was heading toward the Morganza structure, which already had reached the stage of 59.4 feet. Fleming expressed concern that the system was unraveling, "as you just saw, water is spilling over the gates." Furthermore, the district had lost its battle to save the south guide levee. For days, the district had been sandbagging the levee to keep it from overtopping and crevassing. The levee did not protect property – it merely served the purpose of guiding water toward the structure – but it tied into the spillway and the adjacent mainline levee that protected the town of Morganza. The river was now overtopping and eroding the levee, which generated concern that the crevasse would work its way toward the structure and the mainline levee. “Operating the spillway will take the head pressure off that levee,” Fleming advised.

Baumy followed with an update on river conditions. The latest National Weather Service forecast only called for the Mississippi River discharge to reach 1,430,000 cfs at Red River Landing later in the day, approximately 70,000 cfs below the trigger point for opening the gates. The district water control staff projected the discharge would not reach 1.5 million cfs until the following day – May 15. “We have serious concerns about gate openings, particularly at night,” Baumy warned. He stated flatly that there were only two possible actions to address the freeboard problem at the structure and to relieve pressure on the guide levee, “open the gates now or deviate through Old River.”

Fleming interjected, “Sir, the National Weather Service forecast does not change my recommendation. We have serious issues at this structure!”

Perhaps sensing that Walsh was bothered by the forecast, Thomas Holden, the Deputy District Engineer for Project Management, entered the conversation. Holden had served as the secretary for the commission from 2001 to 2002, so he knew how the commission and the MR&T project operated. Holden stated bluntly, “General, this is not an ‘if’ but a ‘when’ scenario.” He went on to add, “If we don’t operate today, we will have to deviate through Old River. We simply cannot go another day without doing something. We simply can’t!”

Fleming interjected again, “Sir, I request permission to open one gate at 1500 hours. Then we’ll let the river dictate how we proceed.”

Sitting erect at the small office desk in the center of the room, Walsh nodded to acknowledge he understood the seriousness of the situation. He jotted a few notes in his green field notebook and then looked at the civilian members of the commission that sat crowded around him on the opposite side of the desk. "Members?" Walsh asked, signaling that he wanted their input. Angel, James, and Smith each concurred with Fleming's recommendation. He looked at Fleming, "Approved!" He then called Governor Jindal to notify him of the decision. The governor informed Walsh that the floodway was clear.[266]

Outside the office, Holden had the demeanor of a person who had just survived a car crash or near-death experience and was left to ponder the "what ifs." Holden and Walsh had served together as army majors in the 92nd engineer regiment, so he had a history with the commission president. He knew Walsh's command style – never let anyone know what you are thinking. As Holden walked hurriedly past a throng of reporters, trying to burn off the adrenaline that had accumulated in his system, he slowly shook his head and huffed, "I thought he was going say no. I REALLY thought he was going to say no."[267]

The commission made the half-mile trek to the middle of the spillway to get another overview on the gate lifting process. It was actually a pleasant day weather-wise, with the mild temperatures and low humidity ushered in by the cool, stiff breeze out of the north. The sun shone brightly, with only a few isolated clouds present. A large crowd of reporters gathered at the south end of the structure, but unlike the opening of the Bonnet Carré spillway, the Morganza operation was closed to the public. Still there was a buzz in the air – literally – as several state police and news helicopters fluttered across the peaceful blue sky. The view from the structure allowed a glimpse of two worlds. On one side of the structure stood a 23-foot wall of water. The angry river itched to be freed from its shackles, looking for room to expand and relieve its own pressure. Wind-driven waves slammed against the structure. Violent eddies swirled near the structure like vultures circling prey. The water

Aerial views of the Morganza floodway shortly after activation.

was literally at the top of the gates. On the other side of the structure rested a serene and tranquil timbered landscape that seemed oblivious to the threat just a few hundred feet to the east.[268]

At 1500 hours, Col. Fleming made the long walk from the south end of the structure to the middle, where the commission awaited his arrival and the opening of the gates. He appeared confident and relaxed. A thin smile stretched across his face as if a large weight – not to mention the enormous pressure of the system in his area of operations – had been lifted off of his shoulders. Without hesitation, he gave the signal to open the first gate. The entire structure vibrated from the sudden and loud surge of water as the gantry crane lifted the gate. The violent torrent of water unleashed its energy into and across the shallow stilling basin below before beginning its slow crawl across the dry land and disappearing into the timber.[269]

The Atchafalaya Basin

The activation of the Morganza floodway had immediate results on the MR&T protection system on the Mississippi River. By May 15, the district had opened nine bays at the spillway which siphoned off roughly 100,000 cfs per second from the Mississippi River. At the 0800 hours daily briefing on May 15, Shadie announced that the system was controlling the flood as designed. Because of the diversion at Morganza, the National Weather Service lowered the projected crests at Baton Rouge and New Orleans by 2.5 feet. The weather service expected the river to flatten out and crest at 17 feet at the Carrollton gage that day and for the river to crest at 45 feet on the Baton Rouge gage by May 16. With the lower forecasts would come less stress and pressure on the levee system than originally anticipated. Stuart Waits, the area engineer for the levees below Baton Rouge, reported that most seepage problems and freeboard concerns dissipated after the opening of the spillway. Unfortunately, the transfer of water from the Mississippi

An example of "flood proofing" in the Atchafalaya basin.

River had the opposite effect on the Atchafalaya basin. The additional water, expected to reach upwards of 175,00 cfs, would put more stress on the Atchafalaya basin levees and the unprotected communities in the backwater area. At Butte La Rose, a small community on the river near Interstate 10, the National Weather Service expected the Atchafalaya River to reach 27 feet on May 24, just inches shy of the record stage set in 1973. The projected stage was only 2 feet above flood stage, but that represented a significant river elevation for the low-lying town that had no flood protection system. At that stage, some areas could expect more than ten feet of water. For Morgan City, at the bottom of the basin, the weather service expected the crest to reach 11 feet, a half a foot higher than the 1973 record stage. During that flood, the floodwall protected the city to a stage of 11 feet, but it had since been raised to 22 feet. Still, Mayor Tim Matte expressed concern that the improved floodwall had never been tested by the amount of pressure expected.[270]

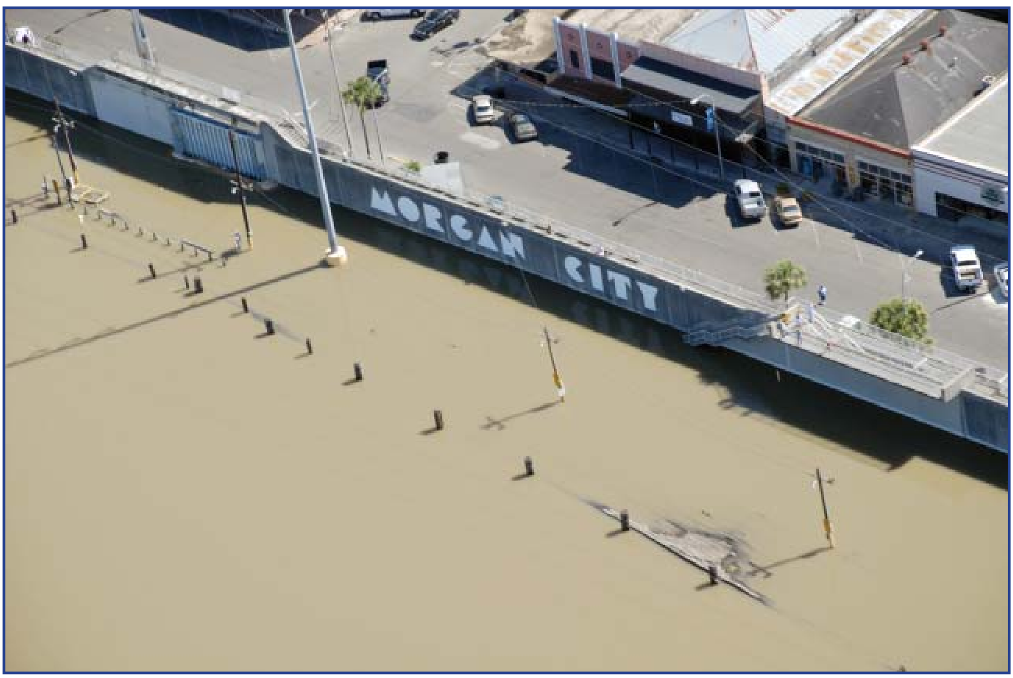
In the days leading up to the opening of the Morganza floodway, the New Orleans Engineer District held public meetings at most communities that would be impacted by the introduction of additional water in the Atchafalaya basin – Butte La Rose, Morgan City, Berwick, Pierre Part, Stephenville, to name but a few. Fleming suspected that the meetings would be very intense, maybe even hostile, but he felt it a personal obligation to provide the best information at his disposal, whether good or bad. “It is not easy telling folks that they are going to flood, but you have to let them vent,” he later recalled. Based on the inundation maps developed by the district, Fleming or his surrogates – Lt. Col. Mark Jernigan, Holden, Accardo and Eilts – informed the public that they could expect to see the same amount of water, if not more, than experienced during the 1973 flood. At meeting after meeting, Fleming heard loud gasps emanating from the audiences, and for good reason. The 1973 flood produced “extensive flooding to depths seldom experienced,” according to the post-flood report of that year. More than 1,226 square miles of land had been inundated in the Atchafalaya basin, resulting in an estimated $37 million in damages.[271]

Fleming and his representatives had to contend with the “us versus them” mentality, with the “us” representing Atchafalaya basin residents and the “them” representing the cities of New Orleans and Baton Rouge. The issue first gained traction as far back as May 3, when Fleming announced that operating the Morganza floodway was on the table. That statement drew a rebuke from a Morgan City councilman, “If there’s a choice between Morgan City and New Orleans, we know who the choice is going to be.” To Fleming, it was not an either/or choice. The system was designed around the floodway to keep the flows manageable at and below Baton Rouge. Operating the system did not preclude flood fighting at Morgan City and other locations. “We will not flood Morgan City to save New Orleans,” Fleming argued, “We will run the system how it is designed to run and we will flood fight where we can.”[272]

The New Orleans Engineer District, the state, parishes, and levee districts were well-prepared for the fight. During the 2008 flood, a single area engineer had responsibility for the 650 miles of levees in the Atchafalaya basin and along the west bank Mississippi River levees extending from the lower end of the Fifth Louisiana levee district and Donaldsonville. It was a large area for one person to administer the resources necessary for a flood fight. During the after-action review process, the district decided to split that responsibility between two area commanders – one for the Atchafalaya sectors and one for the Mississippi sectors. The change afforded the opportunity for the area commanders to focus on a smaller area and more precisely manage their assets and resources. The two area commanders – Kinney Siffert with the Mississippi River sectors and Kinney Benoit with the Atchafalaya basin sectors – would now report to Ted Eilts, the Lafayette area engineer. The 2008 after action review also convinced the district to realign the trigger points for flood fight activities. Prior to 2011, the district based all flood fight movements off of stages on the Carrollton gage. When the gage reached 11 feet, the entire district mobilized for Phase I actions. When the gage reached 15 feet, the entire district transitioned to Phase II. The 2008 flood fight demonstrated that incorporating trigger points at the Simmesport and Morgan City gages provided greater local control over the necessary assets and resources in the Atchafalaya basin than a central trigger at the lower end of the Mississippi River.[273]

The 2008 flood, like it had in the Mississippi delta and the Mississippi River below Baton Rouge, also provided a strong test of the levee system in the Atchafalaya basin, exposing numerous potential trouble spots. With the experiences gained in that flood and the data contained in the 1973 post-flood report, levee inspectors and levee district personnel, for the most part, knew where to look for problem areas. The drought conditions also aided their efforts in identifying underseepage, just as it had in the Mississippi River sectors. While the flood was aided by past experience and dry conditions, the engineers at the district office still had concerns about I-walls in the Atchafalaya basin. The Corps of Engineers had learned much about I-walls during the aftermath of Hurricane Katrina and issued new guidance about pressure loads, but that guidance had only recently been finalized, so the improvements had not been implemented in the basin. In preparing for the high river stages building the Atchafalaya system, the district conducted load tests by simulating the pressure anticipated under the forecasted stages to determine if any of the I-walls needed reinforcing in advance of the flood.[274]

To back up his earlier promise to flood fight in the backwater area, Fleming established a command post in Morgan City to coordinate the delivery of HESCO bastions, sandbags, and other resources, while helping levee districts address gaps in the system. He wanted a strong presence in the backwater area to send a clear message that someone was there to look out for south Louisianans and that the district did not operate the spillway and then walk away. Fleming's actions, along with Mayor Matte's leadership, and proactive planning by local levee



The Atchafalaya River climbs against the floodwall at Morgan City.

districts, imparted a strong level of confidence to local residents that the flood was manageable. For these reasons, Walsh and the commission travelled to the backwater area to meet with parish presidents and the levee districts. On May 15, the commission drove from Baton Rouge to Morgan City, travelling alongside the west bank Mississippi River levees between Port Allen and Donaldsonville. The levees towered above the surrounding terrain. Although the commission members could not see the river, it was obvious that the water level on the opposite side of the levee was several feet higher than the farms, homes, businesses, industry, and infrastructure on the protected side of the levees. The scene served as a clear validation of the vision of the designers of the MR&T project.[275]

Clifford Smith, a thirteen-year veteran member of the Mississippi River Commission with more than 55 years of engineering experience, was clearly exhausted after nearly two weeks of non-stop meetings,

Clifford Smith explains the flow of water in the Atchafalaya basin to Capt. Todd Mainwaring in Col. Fleming's command post at Morgan City.

Maj. Gen. Michael Walsh, Morgan City Mayor Tim Matte, and Clifford Smith at Amelia, Louisiana.

briefings, and site visits, but the drive through the bayous rejuvenated him. Smith, a native of Houma, Louisiana, was in his element. He seemed to know the complete history of every city, body of water, business, and nook and cranny in south Louisiana. Long ago, that ability had earned him the loving moniker "Uncle Clifford" from his fellow commissioner, R.D. James. As the commission travelled past a farming operation, Smith noticed a tractor kicking up dust in a parched field adjacent to the road. He put his arm around Sam Angel and directed his attention to the wind-driven dust cloud, "This north wind is exactly what we need!" The north winds kept the moist air from the gulf in check. "It's so dry in the Morganza that the ground and the wind are going to soak all the water up."

During its visit to south Louisiana, the commission held face-to-face meetings with various leaders to assess the situation on the ground and to answer their concerns. They met with state representatives and local elected officials, the mayors of Morgan City and Berwick, the parish presidents of St. Mary, St. Martin, and Terrebonne parishes,

Aerial view of the operations at Bayou Chene.

representatives from the Chitimacha Nation, the navigation industry, and levee districts. Despite its decision to operate the Morganza floodway, the commission was well-received at each meeting. Because of its annual inspection trips through the Atchafalaya basin and the many engagements that accompanied those trips, the commission had developed strong bonds with many partners in the basin. The commission was not a faceless governmental bureaucracy. Those people knew the commission personally. They understood its mission. They respected the commission for having their boots on the ground in the affected areas.[276]

Perhaps the most compelling part of the trip involved an emergency operation at Bayou Chene, where a joint effort by the New Orleans district, the state, and the newly-formed St. Mary Parish levee district aimed to seal off the bayou from the Atchafalaya River. The current from Bayou Chene generally flows in a southerly direction before entering the Atchafalaya River south of Morgan City. When stages in the Atchafalaya River rise higher than the stage in the bayou, the river actually surges into Bayou Chene, forcing the current to reverse its flow and threaten backwater communities, such as Amelia, with inundation. The St. Mary Parish levee district devised the operation, which consisted of sinking a massive 500-foot-long submersible oceangoing barge in the center of the channel, flanked by smaller barges sunk on both ends. Once the barges were in place, crews drove 70-foot-long, interlocking sheet pile on the Atchafalaya River side of the barges, with the sunken vessels providing added weight and reinforcement. The sheetpile dam extended across the channel and tied into higher elevations on both banks. The tie-ins, in turn, were reinforced with 17,000 tons of rock. As Bill Hildago, the levee district president explained to the commission, the goal of the $6 million operation was to create a makeshift dam to block the reverse flow from the Atchafalaya and force the excess water to sheet flow into lower elevation marshes away from communities and investments. Clifford Smith smiled as he looked over the operation, "This is Cajun ingenuity at its finest!"[277]

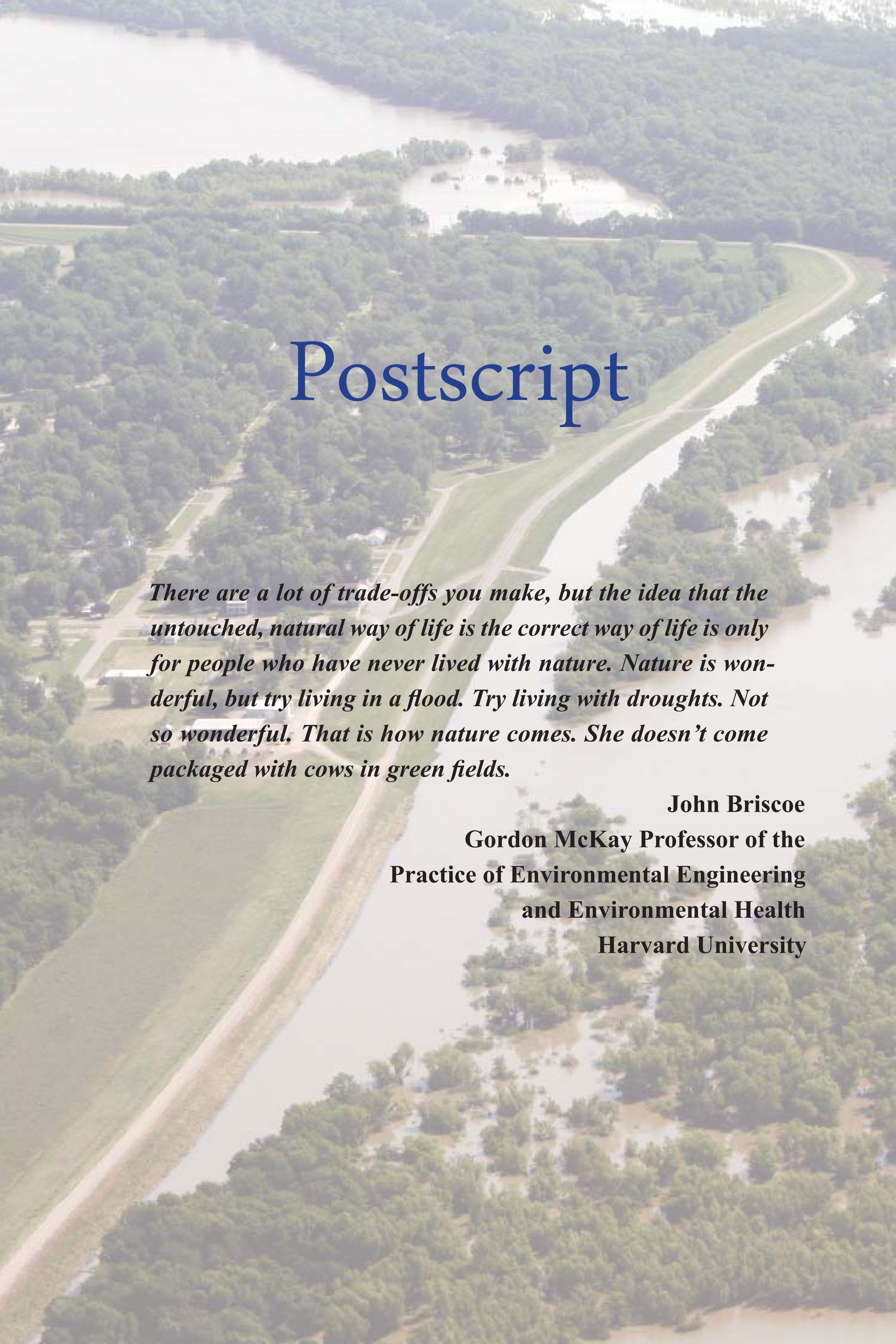
The Mississippi River Commission and staff view the Bayou Chene operation.

On May 19, the Mississippi River crested on the Vicksburg and Natchez gages. With the river having already crested on the Baton Rouge and Carrollton gages because of the engineering controls at Old River, Morganza, and Bonnet Carré, the only major gage where the Mississippi had not crested was at Red River Landing, but even it was only inches shy of cresting. Intense pressure on the Mississippi River levee system would remain until river levels subsided, but exhausted flood fighters could at least see the light at the end of the tunnel. In the Atchafalaya basin, though, the crest was still another ten to eleven days away. By May 19, the Morganza spillway had 17 bays open, contributing approximately 180,000 cfs into the basin. The Butte La Rose gage reached 21 feet; six feet shy of the expected crest elevation. The Morgan City gage exceeded 8 feet; three feet shy of the expected crest.[278]

On May 21, Atchafalaya residents caught their first break. The National Weather Service adjusted the forecast crest for Butte La Rose downward from 27 feet to 24.5 feet, roughly three feet higher than the stage of 21.3 feet reached on the gage that day. Clifford Smith's observation had proven correct. Dry conditions in the Morganza floodway allowed the parched land to absorb more water than expected. Dry ditches and culverts, half-empty ponds and lakes, and dry stream beds all held more water – realities that computer models had no way of predicting. During his many trips through the Atchafalaya basin, Col. Fleming, noting the irony of massive sandbag rings and temporary levees built to keep water out of homes while sprinkler systems watered lawns within the rings, had drawn the same hopeful conclusion as Smith. Four days later, the weather service lowered the Butte La Rose by another foot. On May 27, the river crested on the Butte La Rose gage at 23.2 feet. The lower crest at Butte La Rose translated into lower stages at Morgan City. On May 30, the river crested on the Morgan City gage at a stage of 10.2 feet – approximately eleven inches below the original crest.

Finally, during the daily briefing on the morning of June 1, Col. Fleming reported to Maj. Gen. Walsh, "Sir, it is safe to report that the crest has completely passed through the MR&T system."[279]

If the intense rainfall and snowmelt that caused the massive flood to build at the confluence of the Ohio and Mississippi rivers was, indeed, "Divine Providence," then the extreme drought in Louisiana that helped to absorb the Morganza floodway waters and made life easier and less of an impact on residents was a sign of His grace – a rainbow, in a sense, across the south Louisiana parishes parched by the sun.



Postscript

There are a lot of trade-offs you make, but the idea that the untouched, natural way of life is the correct way of life is only for people who have never lived with nature. Nature is wonderful, but try living in a flood. Try living with droughts. Not so wonderful. That is how nature comes. She doesn't come packaged with cows in green fields.

John Briscoe
Gordon McKay Professor of the Practice of Environmental Engineering and Environmental Health
Harvard University

MISSISSIPPI RIVER COMMISSION

ESTABLISHED JUNE 1879

THE NATION HAS LONG RECOGNIZED THE VALUE OF the lower Mississippi Valley. Nineteenth century capitalists coined it the "Alluvial Empire" for its untapped potential, fertile lands, and abundant natural resources. Frequent and devastating Mississippi floods were the main impediments to the realization of that potential. Following the Great Flood of 1927, the nation united behind a bold vision to prevent another similar tragedy from happening again. The Mississippi River and Tributaries system that controlled the 2011 flood is the result of that vision. The MR&T system has prevented roughly one-half trillion dollars in damages since its inception. The estimated value of the total benefits to the nation is many times greater if consideration is given to the fact that not all can be calculated and captured in bland, one-size-fits-all formulas. Despite the overall success of the MR&T project, we have yet to realize the vast benefits of the Alluvial Empire, the additional under-developed resources of America's Great Watershed. The high-value economic engine in the heart of the country has been long overlooked or undervalued by many as a true difference maker in national and global competition.

A benchmark. The flood will be remembered by most for the activation of three floodways, but the 2011 event set several records. More than a dozen flood control reservoirs in the Ohio, Arkansas-White, and St. Francis basins established new pool elevation records as water control managers desperately tried to store water to keep downstream stages at manageable levels. Several of those reservoirs went beyond full capacity. As the flood wave consolidated at the confluence and rolled down the lower Mississippi River, it established new gage records through much of the system. The flood also established new peak flood discharge records from Cairo, Illinois, to Baton Rouge, Louisiana. The event was also lengthy. It was not until June 1 that the Mississippi River Commission declared the flood crest had passed through the MR&T system, but the Mississippi River remained above flood stage at the Red

River Landing gage until June 26, and the Atchafalaya River stayed above flood stage on the Morgan City gage until July 26 – nearly four months after the Cairo gage reached flood stage on April 3rd.

Diversions. Engineered structures in the system diverted more than 1,573,000 cubic feet per second (cfs) to provide a level of protection and predictability for the nation's corridor of commerce. The U.S. Geological Survey recorded peak flows of 186,000 cfs at Morganza Floodway, 316,000 cfs at Bonnet Carré Spillway, 400,000 cfs at the Birds Point-New Madrid floodway, and 671,000 cfs at the Old River Control Structures. This level of control brings to mind something that John Briscoe, a McKay professor of the practice of environmental engineering and professor of the practice of environmental health at Harvard University said:

> There are a lot of trade-offs you make, but the idea that the untouched, natural way of life is the correct way of life is only for people who have never lived with nature. Nature is wonderful, but try living in a flood. Try living with droughts. Not so wonderful. That is how nature comes. She doesn't come packaged with cows in green fields.

Room for the River. The MR&T system is designed to pass a larger flood. It has room to handle more water. The 2011 flood, while record-setting in many areas, remained below project design flood levels. At the Cairo gage, the 2011 flood reached 89 percent of the project design flood; at the Arkansas City and Red River Landing gages, the flood reached 79 percent and 78 percent, respectively, of the project design flood. This equates to another 360,000 cfs at the Cairo gage, 597,000 cfs at the Arkansas City gage, and 459,000 cfs at the Red River Landing gage. Additional room for larger floods can be accommodated by the river's use of floodways and backwater areas. At peak discharges, the three floodways placed into operation had the design capacity to divert a combined total of approximately 1.4 million cfs from the Mississippi River. During 2011, the combined maximum discharge barely exceeded 900,000 cfs, or 65 percent of the maximum design capacity. Adding in the unused West Atchafalaya Floodway and its 250,000 cfs maximum design discharge, the total percentage drops to 55 percent. Put another way, the four floodways possess the capacity to divert an additional 750,000 cfs over what was diverted in 2011. Likewise, the total acreage in the massive backwater areas numbers 1,652,000 acres, but only 20 percent (335,000 acres) were used during the 2011 flood. That leaves a little more than 2,000 square miles of land available to store water up to 20 feet deep.

Local people have a voice. One of the things that made the MR&T project successful in the flood of 2011 was the long-term, regular dialogue and input from the local people. The comprehensive MR&T project is so unique because it captures all the decisions from regular systematic local input and dialogue with the federal government and the many interests and partners convened over the past 133 years (since 1879). The thoughts, ideas, changes, additions, and improvements are captured in the form of the current project as it exists today.

State of the system. The engineers have assessed damages to the system with the tools available, but the extent of the damage can only be determined by the next flood event. The flood tested the system and the system worked – that much we know. We do not know the potential damages that cannot be seen clearly on the system – a system comprised of thousands of miles of earthen and concrete structures and channel. By the end of May, teams of engineers and inspectors started damage assessments as the flood water receded, compiling a list based on specific criteria to determine priorities. By the time the Mississippi River Commission met in August 2011, a senior engineer team had reviewed, developed, and negotiated a priority list of 93 critical repair needs totaling $800 million. The commission deliberated during the Low-Water

Inspection trip and the commission president forwarded the list to the U.S. Army Corps of Engineers to help receive emergency funds related to life safety impacts for immediate work. Due to the leadership of the Mississippi Valley Flood Control Association, the voice of the local citizens, and the action of congress, a bill passed at the end of December 2011 to cover the initial cost of infrastructure damages. It will take another billion dollars to restore the system. The nation has no option other than to reset, restore, and continue to improve the system based on regular dialogue with citizens and other interests so that future generations will be able to live, work, and produce in a sustainable, reliable, and productive living environment. The people's MR&T project is the foundation of the success of this great productive valley.

Much to learn! As engineers, our deliberate processes rooted in science, engineering, and logic are a part of our training and responsibilities. But, we do not have all the answers — it takes local on the ground knowledge, diverse resources and relationships, and understanding along with the ever present questions … "what's the federal interest" and "what's the public value." Our successful, highly productive agrarian, maritime nation continues to benefit from the infrastructure investments of the past, yet the long-term sustainable approach for the nation's economy and man's environment is yet to be fully realized. Our decisions and investments over the next couple of decades will determine the success of our nation's next 200 years.

A common occurrence and local sentiment that the Commission experienced from the pre-flood days and throughout the flood fight among many of the people and stakeholders in the valley reflected a thoughtful sincere expression of dependence on the Divine that was expressed in conversations with the Creator about the resources that we, the locals and the government, get to help manage.

The Mississippi River Commission and the strong partners in the valley continue to keep an ear to the past, a hand on the present, and a clear voice for our nation's bright and productive future.

Many of the nation's leaders agree on the need for a thoughtful, regular, and structured water infrastructure investment based on the nation's priorities for economic and social development. This will help relieve the burden of imminent system failure and the subsequent ridiculous amount of resources wasted on recovery and rebuilding brought about by a shutdown of an economy generating part of the fabric of our infrastructure. While that need, indeed, sounds simple, we have yet to see it addressed. We still have an embarrassingly poor report card from science and engineering on the state of the nation's water infrastructure and investment. A strong future requires the dedication of the world's best minds and untiring, focused effort of wisely-blended practitioners and academics. The art of which we speak will serve watersheds around the globe for generations.

Listening, Inspecting, Partnering and Engineering!

T. Stephen Gambrell
Executive Director
Mississippi River Commission
February 1, 2012

MISSISSIPPI RIVER COMMISSION

ESTABLISHED JUNE 1879

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Prologue

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[2] Email, Charles Shadie to David Berretta, et al., January 2, 2012, Subject: 2011 Flood – Peak Flows; Mississippi River Commission, *2011 MR&T Flood Report*, pp. 21.

[3] Ibid., pp. 2.

[4] House of Representatives, *Mississippi River and Tributaries Project*, House Document No. 308 (88th Cong., 2d Sess.) Vo1.2, Annex C.

[5] This section is a revised version of an earlier information paper, "The Mississippi River & Tributaries Project: Controlling the Project Flood," written by Charles Camillo for the Mississippi River Commission in 2007.

[6] Pete Daniel, *Deep'n As It Come: The 1927 Mississippi River Flood* (Fayetteville, Ar.: University of Arkansas Press, 1996): pp. 8; Arthur D. Frank, *The Development of the Federal Program of Flood Control on the Mississippi River* (NY: AMS, 1968): 187-194; Charles Camillo and Matthew Pearcy, *Upon Their Shoulders: A history of the Mississippi River Commission from its inception through the advent of the modern Mississippi River and Tributaries Project* (Mississippi River Commission, 2004) 139-144; John Barry, *Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America* (New York: Touchstone, 1998) pp. 285-286.

[7] Frank, *Development of Flood Control*, pp. 187-200; Daniel, *Deep'n As It Come*, pp. 8, 87-97; Camillo and Pearcy, *Upon Their Shoulders*, 139-144; Barry, *Rising Tide*, pp. 285-286; "Congress and Mississippi Flood Control," *Congressional Digest* (Feb.): 41. On death counts, compare Daniel, pp. 126-133 and Herbert Hoover, *The Memoirs of Herbert Hoover, Vol. 2: The Cabinet and the Presidency, 1920-1933* (NY: Macmillan, 1952): 125; Letter, Capt. William E. Teal to R.F., Feb. 29, 1928.

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9 Larry Kilgo, "MRT FDO Breakout of 3 Districts," January 9, 2012. This source is actually a spreadsheet compiled by Corps economists.

Chapter One

10 Great Lakes and Ohio River Division, *After Action Report: 2011 Spring Floods*, DRAFT document dated September 9, 2011.

11 Ibid. Email, Deborah Lee to MG John W. Peabody, et. al., April 20, 2011, Subject: LRD has initiated lower Ohio-Mississippi River teleconferences.

12 Email, Bill J. Frederick to Undisclosed Recipients, April 21, 2011, Subject: 4-21-11nws.ppt; Email, Charles Shadie to MG Michael Walsh, April 21, 2011, Subject: Cairo Forecast. Gage versus gauge - river engineers in the United States tend to use the variant spelling of "gage."

13 Mississippi River Commission, *Annual Report*, 1917, pp. 3531-3536; Camillo and Pearcy, *Upon Their Shoulders*, 57-66.

14 Mississippi River Commission, *Annual Report*, 1917, pp. 3531-3536.

15 W.W. De Berard, "Today in the Mississippi Flood Area: The Cairo Problem and Its Proposed Solution," *Engineering News-Record*, February 23, 1928, pp. 311-316.

16 W.W. De Berard, "Today in the Mississippi Flood Area: The Cairo Problem and Its Proposed Solution," *Engineering News-Record*, February 23, 1928, 311-316; Mississippi River Commission, *Special Report of the Mississippi River Commission on Revision of Plans for Improvement of Navigation and Flood Control of the Mississippi River*, (St. Louis: Mississippi River Commission, Sept. 28, 1927): 60-137; House of Representatives, Committee on Flood Control, *Hearings, Control of Destructive Flood Water of the United States*, 70th Cong., 1st Sess., 1927-1928, Vol. 6, 4199-4213, Berthe testimony,(Hereafter cited *House Flood Control Hearings*, 1927-1928); D.O. Elliott, *The Improvement of the Lower Mississippi River for Flood Control and Navigation* (Waterways Experiment Station, Vicksburg, MS 1932), pp. 199-200, Plate XXVIII (b)-XXVIII (C).

17 Mississippi River Commission, *Special Report of the Mississippi River Commission*, September 1928, pp. 73-74; W.W. De Berard, "Today in the Mississippi Flood Area: The Cairo Problem and Its Proposed Solution," *Engineering News-Record*, February 23, 1928, 311-316.

18 Camillo and Pearcy, *Upon Their Shoulders*, 150-156; Letter, Potter to Commission, Possible Changes, emphasis in original; Letter, Jadwin to Potter, Special Report on Flood Control and Navigation, Nov. 18, 1927; Letter, Jadwin to Schulz, Nov. 18, 1927; Memorandum by Edward Flad, Suggested Alterations of the Special Report, Nov. 23, 1927; Memorandum, from Potter to Members, Mississippi River Commission, Nov. 21, 1927; Potter to Chief, Special Report

dated November 29, 1927, Nov. 29, 1927; letter, Ransdell to Potter, Nov. 24, 1927; quotes from letter, Potter to Ransdell, Dec. 1, 1927.

19 House of Representatives, *Flood Control in the Mississippi Valley*, House Document 90 (70th Cong., 1st Sess.), 6, 29. (Hereafter cited as *House Document 90*.)

20 Camillo and Pearcy, *Upon Their Shoulders*, 154, 177.

21 U.S. Congress, *Congressional Record* (Jan. 4, 1928): 925; *House Flood Control Hearings, 1927-1928*, Vol. 4, 2102-2111, Vol. 5, 3564-3567; quotes from Vol. 5, 3582, and Vol. 6, 4539; Memorandum, Potter to Chief of Engineers, Mississippi River Commission, Special Report – November 28, 1927, Feb. 15, 1928; Camillo and Pearcy, *Upon Their Shoulders*, pp. 154-14.

22 Frank R. Reid, *Flood Control in the Mississippi Valley*, H.R. Report 1072, pp. 51-70, 101-109, 116-117; U.S. Congress, *Hearings Before the Committee on Flood Control, House of Representatives, on Flood Control on the Mississippi River*, 1930, Vol. 1 (71st Cong., 2nd Sess.): 8.

23 *House Flood Control Hearings*, 1928, 2116 (Potter Testimony), 4199-4213 (Berthe Testimony).

24 Camillo and Pearcy, *Upon Their Shoulders*, p. 179-180; Reid, *Flood Control in the Mississippi Valley*, H.R. Report 1072, pp. 51-70, 101-109, 116-117; *House Flood Control Hearings*, 1927-1928, 2116, 3004.

25 *House Flood Control Hearings*, 1927-1928, 941-942 (Sackett Testimony), 949-954 (Barkley Testimony), 1075-1081 (Stone Testimony), 1082-1093 (Donaldson Testimony), 2928 (Gregory Testimony), 3272-3278 (Denison Testimony).

26 Camillo and Pearcy, *Upon Their Shoulders*, 157-165.

27 "Sturtevant Named as Third Member of the Flood-Control Board" and "Washington Notes," *Engineering News-Record* 100:21 (May 24, 1928): 826-829; "Appointment of Sturtevant to Mississippi Board Confirmed," *Engineering News-Record* 100:22 (May 31, 1928): 874; *Jackson and Graves Nomination Hearings*, p. 2.

28 Memorandum, Mississippi River Commission to Chief of Engineers, Hearings of Special Flood Control Board, June 9, 1928. Potter received his promotion effective May 15, 1928, on the passage of the act as a result of section 8; Camillo and Pearcy, *Upon Their Shoulders*, 164-167.

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Control of Water in the Atchafalaya Basin, 1800-1995 (College Station: Texas A&M University Press, 2004). pp. 121-123; Camillo and Pearcy, *Upon Their Shoulders*, pp. 166-167; Berthe quoted in James P. Kemper, *Floods in the Alluvial Valley: A National Calamity, What Should be Done About It* (New Orleans: National Flood Commission, 1928), p. 173; *Jackson and Graves Nomination Hearings*, pp. 23; Kemper, *Floods in the Valley*, pp. 165, 169-179, 198-233; James P. Kemper, *Rebellious River*, (Boston: Bruce Humphries, Inc, 1949) pp. 163-167; Jackson to R.C. Donaldson, Jul. 14, 1928.

30 Kemper, *Floods in the Valley*, pp. 165, 169-179, 198-233; Kemper, *Rebellious River*, pp. 163-167; Jackson to R.C. Donaldson, Jul. 14, 1928. The copy of the Berthe letter in Kemper dated Jul. 13 references the death of Potter on Aug. 6, so Berthe or Kemper edited it for publication.

31 "Report of Board" (Wash., D.C.: GPO, 1928): quotes pp. 2, 7, 9; Jackson to district engineers, Report of the Mississippi Flood Control Board, Aug. 25, 1928; "Jadwin Flood-Control Plan Approved by Special Engineer Board," *Engineering News-Record* (Aug. 23, 1928): 283-286; Reuss, *Designing the Bayous*, pp. 124-127; Camillo and Pearcy, *Upon Their Shoulders*, p. 167; U.S. Congress, *Opinion of the Attorney General in Regard to Certain Provisions of the Mississippi Flood Control Act of May 15, 1928*, Flood Con. Comm. Doc. 2 (71st Cong., 1st Sess.): 10-12.

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969; "Another Injunction Sought to Halt Floodway Construction," *Engineering News-Record* (June 20, 1929): 1009; "New Madrid Landowners Ask Higher Compensation," *Engineering News-Record* (Jul. 4, 1929): 33; *Kirk vs. Good*, 13 F. Supp. 1020, 349 (Mo. Dist. Ct. 1929); Mississippi River Commission, *Annual Report*, 1933.

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37 Camillo and Pearcy, *Upon Their Shoulders*, pp. 230-233.

38 Ibid; Maj. R.D. Burdick, *Report on Placing the Birds Point-New Madrid Floodway into Operation*, n.d.; Floyd M. Clay, *A Century on the Mississippi: A History of the Memphis District, U.S. Army Corps of Engineers*, pp. 145-149; Mississippi River Commission, *Annual Report*, 1937, pp. 1674-1679.

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41 Ibid, H.W. Richardson, "Superflood Devastates Lower Ohio and Now Threatens Mississippi Levee System," *Engineering News-Record*, February 4, 1937, pp 151-152; Mississippi River Commission, *Annual Report*, 1937, pp. 1739-1740.

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[43] House Committee on Flood Control, *Comprehensive Flood Control Plan For Ohio and Lower Mississippi Rivers*, Committee Document No. 1 (75th Cong., 1st Sess.) April 28, 1937.

[44] Ibid; *Lower Ohio and Middle Mississippi Rivers Flood Management*; Camillo and Pearcy, *Upon Their Shoulders*, 233-237. The additional reservoirs are a reference to the reservoirs already authorized in the 1936 Flood Control Act.

[45] Clay, *A Century on the Mississippi*, pp. 181, 198; United States Senate, *St. John's Bayou and New Madrid Floodway, Missouri*, Senate Document No. 95-87 (87th Cong., 2d Sess.); Memorandum for Records, Harris T. Vandergriff to President, Mississippi River Commission, "Letter Supplement No. 3 to Real Estate Design Memorandum, Flowage Easements, Birds Point-New Madrid Floodway, Missouri", June 26, 1998. The 1986 Water and Resources Development Act authorized the St. John's Bayou-New Madrid Floodway project as a related, but separate, project to the 1954 authorization to close the 1,500-foot gap in the frontline levee and construction of the gravity drainage structure. Authorized improvements under the 1986 act included the widening and straightening of approximately 144 miles of three separate channels to speed the evacuation of water within the St. John's Bayou basin and the lower portion of the New Madrid floodway. The act also authorized the construction of a 1,000 cfs pumping station for the St. John's Bayou area and a 1,500 cfs pumping station for the New Madrid floodway area to evacuate impounded floodwaters during periods of high stages on the Mississippi River. In 2004, however, the Environmental Defense Fund and the National Wildlife Federation filed a lawsuit to prevent the construction of the project features authorized by the 1954 and 1986 acts. In September 2007, Judge James Robertson of the U.S. District Court issued an injunction preventing further work. Robertson also ordered the dismantling of work already completed. In the summer of 2008, the Department of Justice, after reviewing the court's ruling, determined that it would not appeal the decision.

[46] U.S. House of Representatives, *Mississippi River and Tributaries Project*, House Document No. 308 (88th Cong., 2d Sess.) pp 10-11, 33, 57-58, 148; Legal Analysis RE: Birds Point-New Madrid Floodway, n.d.; J. Frank Randall, Attorneys Opinion: Authority for Continued Acquisition of Modified Easements, Birds Point New Madrid Floodway, Missouri, n.d.; Preparing To Operate the Floodway Under The 1965 Act, n.d.

[47] Legal Analysis RE: Birds Point-New Madrid Floodway, n.d.; J. Frank Randall, Attorneys Opinion: Authority for Continued Acquisition of Modified Easements, Birds Point New Madrid Floodway, Missouri, n.d.

[48] Memphis District, *Post Flood Report: Mississippi River and Tributaries System Flooding, 1973*, October 1972, pp 13-19; "Engineers Raise Levee in Emergency Operation," *The Enterprise Courier*, March 29, 1973; "Work Crews Add Two Feet to Fuse Plug Levee System," *Cairo Evening Citizen*, March 26, 1973.

[49] Memphis District, *Post Flood Report: May-June 1983*, September 16, 1983. This document contains a series of newspaper articles that trace the flood and the ensuing litigation; United States Court of Appeals for the Eighth Circuit, *Story v Marsh*, Case No. 83-1643, April 13, 1984; Herbert Morgan, Jr., *Through Shifting Currents: A History of the Memphis District, U.S. Army Corps of Engineers*, 1982-1998, pp. 20-27.

[50] Ibid., 20-27; Memphis District, *Birds Point-New Madrid Floodway Operations Plan*, January 1986; James W. Lloyd and Jack H. Hurdle, "TEXS Blows the Plug: A Tactical Explosive Adapted for Flood Control," *The Military Engineer*, July 1988, pp. 428-431; Memphis District, *Analysis of Potential Modification to the Plan of Operation for the Birds Point-New Madrid Floodway*, May 1985.

[51] Herb Morgan, *Through Shifting Currents*, 20-27; Memphis District, *Reconnaissance Report: Birds Point-New Madrid Floodway, Mississippi County, Missouri*, March 1990.

[52] Morgan, *Through Shifting Currents*, 20-27; Memphis District, *Birds Point-New Madrid Floodway, Mississippi County, Missouri*, Memphis District, *Engineering Review Report: Modified Plan of Operation*, Vol. 1, Nov. 1991.

Chapter Two

[53] Interview with Milus Wallace, by Charles Camillo, November 11, 2011.

[54] Email, Deborah Lee to MG John W. Peabody, et. al., April 21, 2011, Subject: lower Ohio-Mississippi River flood outlook. Center Hill and Wolf Creek were both DSAC 1 dams. The DSAC 1 classification is the highest and most critical designation. Dale Hollow and J.P. Priest are DSAC 2 dams.

[55] Precipitation data pulled from numerous sources.

[56] Interview with Deborah Lee by Charles Camillo, August 9, 2011; Email, Deborah Lee to MG John W. Peabody, et. al., April 21, 2011, Subject: Lower Ohio-Mississippi River flood outlook.

[57] Email, MG John W. Peabody to Richard Hancock, et. al, April 24, Subject: Afternoon Water Management Update – 24 April 2011; Email, Richard Hancock to MG John W. Peabody, et. al., April 24, Subject: Afternoon Water Management Update – 24 April 2011; Email, Robert Moyer to DLL-CERD, Subject: Afternoon Water Management Update – 24 April 2011.

[58] Camillo, *Flood Notes*, April 25; Ibid., April 27; Memphis District, MVM Flood April 2011: Situation Report No. 4; Memphis District, MVM Flood April 2011: Situation Report No. 5.

[59] Camillo, *Flood Notes*, April 25; Ibid., April 27; Memphis District, MVM Flood April 2011: Situation Report No. 4; Memphis District, MVM Flood April 2011: Situation Report No. 5.

[60] Interview with Deborah Lee by Charles Camillo, August 9, 2011. LRD Timeline, n.d.; Reid, *Flood Control in the Mississippi Valley*, House Report No. 1072, pp. 293. The reduction of outflows from the dams on the Cumberland

system was initiated on April 25 and carried out in steps through April 27. April 28 represented the first day that the daily average outflow equaled zero. It is important to note that Peabody had been the LRD commander for three years prior to the 2011 flood. He had spent considerable time and energy on the dam safety issue, especially with regard to the Wolf Creek Dam. His decision to store water behind the high-risk dams was well-informed and calculated based on years of experience and in-depth analysis.

61 Email, Bill Frederick to Undisclosed Recipients, April 26, 2011, Subject: 4-26-11nws.ppt; Memphis District, MVM; Flood April 2011: Situation Report No. 5; Memphis District, MVM Flood April 2011: Situation Report No. 6.

62 Interview with David Berretta, by Charles Camillo, June 23, 2011; Clay, *A Century on the Mississippi: A History of the Memphis District*, 255-256; Memphis District, *Post Flood Report: Mississippi River and Tributaries System Flooding, 1973*, October 1973, pp iv, 3; Lester Goodin, "Securing the C/BP Mainline Levee," November 1997.

63 Interview with James Lloyd, by Charles Camillo, June 23, 2011; Memphis District, MVM Flood April 2011: Situation Report No. 9.

64 Email, Bill J. Frederick to Undisclosed Recipients, April 27, 2011, Subject: 4-27-11nws.ppt.

65 Camillo, *Flood Notes*, April 27, 0756; Ibid., 1140.

66 Ibid.,1500; Letter from Claire McCaskill, Roy Blunt, and Jo Ann Emerson to President Barrack Obama, dated 27 April, 2011. Camillo and Pearcy, *Upon Their Shoulders*, p 236; M.D. Kittle, "Residents voice concerns about floodway," *Southeast Missourian*, April 28, 2011.

67 Ibid., Walsh quote taken from article in the *Southeast Missourian*; M.D. Kittle, "Corps explains process, impact of breaching Birds Point levee," *Southeast Missourian*, April 28, 2011. Camillo, *Flood Notes*, April 27, 1500; Interview with Maj. Gen. Michael Walsh, by Charles Camillo, October 19, 2011.

68 U.S. Army Corps of Engineers, Memphis District, *Birds Point – New Madrid Floodway Operation Plan*, January 1986.

69 Ibid., Interview with James Lloyd, by Charles Camillo, June 23, 2011; Interview with Maj. Gen. Michael Walsh, by Charles Camillo, August 24, 2011; Camillo, *Flood Notes*, April 27, 1530.

70 Email, Bill Frederick to Undisclosed Recipients, April 27, 2011, Subject: 4-27-11nws.ppt.

71 Email, COL Keith Landry to MG John W. Peabody, April 27, 2011, Subject: Wednesday, April 27, 2011.; Email, MG John W. Peabody to Deborah Lee, April 28, 2011, Subject: CG Guidance; Email, MG John W. Peabody to MG Michael Walsh, April 28, 2011, Subject: KY-Barkley.

72 Memphis District, *Birds Point-New Madrid Floodway, Plan of Operation*, dated April 25, 2011. This document was a decision brief delivered by Reichling to

Walsh on April 28. Apparently, Memphis District personnel did not change the date on the cover slide from a previous briefing.

73 Email, MG Michael Walsh to LTG Robert Van Antwerp, et. al., April 28, 2011, Subject: Recommendation from District Commander Regarding Operation of the Floodway; Email from MG John W. Peabody to MG Michael Walsh, April 28, Subject: Recommendation from District Commander Regarding Operation of the Floodway; Interview with Deborah Lee, by Charles Camillo, August 9, 2011.

74 Interview with Thomas Morgan, by Charles Camillo, June 23, 2011.

75 Interview with Chip Newman, by Charles Camillo, June 23, 2011.

76 Ibid., Memphis District, MVM Flood April 2011: Situation Report No. 9.

77 Interview with Thomas Morgan, by Charles Camillo, June 23, 2011; Memphis District, MVM Flood April 2011: Situation Report No. 9.

78 Interview with Thomas Minyard, by Charles Camillo, June 23, 2011; Interview with Darian Chasteen, by Charles Camillo, June 23, 2011.

79 Interview with Darian Chasteen, by Charles Camillo, June 23, 2011; Memphis District, MVM Flood April 2011: Situation Report No. 11.

80 Ibid.

81 Camillo, *Flood Notes*, April 29, 0900-1500.

82 U.S. District Court, Eastern District of Missouri, Southeast Division *State of Missouri v United States Army Corps of Engineers, Case No 1:11CV00067 SNJL*, April 29, 2011.

83 Ibid.

84 Camillo, *Flood Notes*, April 29, 0838, Ibid., April 29, 1600; Ibid., April 30, 2100; Ibid., May 1, 2100.

85 Email, Bill J. Frederick to Undisclosed Recipients, April 30, 2011, Subject: 4-30-11 nws.ppt; MVM Flood April 2011: Situation Report No. 10; Precipitation data pulled from numerous sources; Mississippi River Commission, *2011 MR&T Flood Report*, 6.

86 Interview with James Lloyd, by Charles Camillo, June 23, 2011. Email, Robert Moyer to DLL-CELRD, April 30, 2011, Subject: Morning Water Management Update; Email, Robert Moyer to DLL-CELRD, May 1, 2011, Subject: Morning Water Management Update.

87 Camillo, *Flood Notes*, April 30, 1030; Ibid., 1130; Memphis District, *Floodway Decision Brief*, April 30, 2011.

88 Interview with Deborah Lee, by Charles Camillo, August 9, 2011. Email, Deborah Lee to Charles Camillo, September 9, 2011, Subject: clarification on a quote; Camillo, *Flood Notes*, April 29, 2011.

89 Camillo, *Flood Notes*, April 30, 1300.

90 Ibid., 1545.

[91] Memphis District, MVM Flood April 2011: Situation Report No. 10; Interview with James Lloyd, by Charles Camillo, June 23, 2011.

[92] Memphis District, Floodway Decision Brief, May 1, 2011; Camillo, *Flood Notes*, May 1, 1000.

[93] Interview with Maj. Gen. Michael Walsh, by Charles Camillo, August 24, 2011; Camillo, *Flood Notes*, May 1, 1000.

[94] Camillo, *Flood Notes*, May 1, 1000.

[95] Interview with Darian Chasteen, by Charles Camillo, June 23, 2011; Darian Chasteen, "Timeline for Fulton County Water Berm Construction," June 23, 2011.

[96] Interview with Chip Newman, by Charles Camillo, June 23, 2011.

[97] Interview with James Lloyd, by Charles Camillo, June 23; Camillo, *Flood Notes*, May 2.

[98] Camillo, *Flood Notes*, May 1, 1440; Interview with Dennis Norris, by Charles Camillo, August 16, 2011; Interview with Maj. Gen. Michael Walsh, by Charles Camillo, August 24, 2011.

[99] Camillo, *Flood Notes*, May 1, 1513.

[100] Maj. Gen. John W. Peabody, *Great Lakes and Ohio River Division: 2011 Flood Overview*. This is a presentation delivered by Maj. Gen. Peabody at the public meeting in New Madrid on August 15, 2011, during the Mississippi River Commission Low Water Inspection.

[101] Ibid., 1513

[102] Ibid., 1513

[103] Ibid., 1513

[104] Ibid., 1513

[105] Interview with Maj. Gen. Michael Walsh, by Charles Camillo, August 24, 2011.

[106] Camillo, *Flood Notes*, May 1, 1513.

[107] Ibid., 1513.

[108] Interview with James Lloyd, by Charles Camillo, June 23, 2011; Email, Russell Davis to MG Michael Walsh, May 1, 2011, Subject: BPNM update 1730 hrs, 1 May.

[109] Email, Russell Davis to MG Michael Walsh, May 1, 2011, Subject: BPNM update 1930 hrs, 1 May; Email, Larry Barnett to MG Michael Walsh, May 1, 2011, Subject: SCT denies Missouri's request!; Email, Russell Davis to MG Michael Walsh, May 1, 2011, Subject: BPNM update 2130 hrs, 1 May Interview with Maj. Gen. Michael Walsh, by Charles Camillo, August 24, 2011.

[110] Email, Bill Frederick to Maj. Gen. Michael Walsh, May 2, 2011, Subject: Cairo Update; Interview with Maj. Gen. Michael Walsh, by Charles Camillo, August 24, 2011; Email, Bill Frederick to Maj. Gen. Michael Walsh, May 2,

2011, Subject: Cairo model; Interview with Bill Frederick, by Charles Camillo, August 24, 2011.

111 Camillo, *Flood Notes*, May 2, 0742-1030; MVM Flood April 2011: Situation Report No. 11.

112 Interview with James Lloyd, by Charles Camillo, June 23, 2011; Camillo, *Flood Notes*, 0920.

113 Interview with James Lloyd, by Charles Camillo, June 23, 2011; Email, Jon Wilson to Charles Camillo, July 7, 2011, Subject: Specific questions – MVM flood history.

114 Camillo, *Flood Notes*, May 2, 1030.

115 Ibid., 1140.

116 Ibid., 1140.

117 Interview with James Lloyd, by Charles Camillo, June 23, 2011.

118 Interview with James Lloyd, by Charles Camillo, June 23, 2011; Email, Jon Wilson to Charles Camillo, July 7, 2011, Subject: Specific questions – MVM flood history.

119 Camillo, *Flood Notes*, 1315.

120 Ibid., May, 1100.

121 Interview with James Lloyd, by Charles Camillo, June 23, 2011; Email, Jon Wilson to Charles Camillo, July 7, 2011, Subject: Specific questions – MVM flood history; Camillo, *Flood Notes*, May 2, 2040.

122 Camillo, *Flood Notes*, May 2, 2040; Mississippi River Commission, *2011 MR&T Flood Report*, 10; Interview with James Lloyd, by Charles Camillo, June 23, 2011; Email, Jon Wilson to Charles Camillo, July 7, 2011, Subject: Specific questions – MVM flood history.

123 Interview with James Lloyd, by Charles Camillo, June 23, 2011 (This is the source for the exchange between Lloyd and Reichling); Camillo, *Flood Notes*, May 2, 2030-2125.

124 Interview with Milus Wallace, by Charles Camillo, November 11, 2011. Stephen Deere, "Farmers in Missouri floodway race to salvage growing season," *St. Louis Post Dispatch*, June 24, 2011; Mary Delach Leonard, "Back to the spillway: In Dorena, Mo., the breach of the Birds Point levee swept away what time had speared," *St. Louis Beacon*, July 7, 2011; Joseph Barrett, "After the Flood, Farmers Try to Dig In," *The Wall Street Journal*, June 6, 2011.

125 Camillo, *Flood Notes*, May 2, 2200-2330; Ibid, May 3, 0230-0630.

126 Ibid., May 3, 0650-0800; Ibid., May 5, 0800.

127 Ibid., May 3, 0800-1120; Ibid., May 3, 1230; Ibid., May 5, 1435.

128 Stephen Deere, "Farmers in Missouri floodway race to salvage growing season," *St. Louis Post Dispatch*, June 24, 2011; Mary Delach Leonard, "Back to the spillway: In Dorena, Mo., the breach of the Birds Point levee swept away

what time had speared, " *St. Louis Beacon*, July 7, 2011; Joseph Barrett, 'After the Flood, Farmers Try to Dig In," *The Wall Street Journal*, June 6, 2011.

129 Camillo, *Flood Notes*, May, 1635; Camillo, *Low Water Inspection Notes*.

Chapter Three

130 Camillo, *Flood Notes*.

131 "Mississippi Record Flood Crest Passes Memphis," *Engineer News-Record*, p. 703-5; Mississippi River Commission, *Special Report of the Mississippi River Commission on Revision of Plans for Improvement of Navigation and Flood Control of the Mississippi River*, September 28, 1927, App. A, pp. 125-7; "Mississippi Record Flood Crest Passing Vicksburg," *Engineering News-Record* 98:18 (May 5, 1927): 741-745; "Mississippi Foods Now Threaten Southern Louisiana," *Engineering News-Record* 98:19 (May 12, 1927): 789-791; "Failure of Levees in Atchafalaya Basin Spread Mississippi Flood," *Engineering News-Record* 98:20 (May 19, 1927): 829-831; "Levee Failure at McCrea Flood region Between Atchafalaya and Mississippi Rivers," *Engineering News-Record* 98:21 (May 26, 1927)

132 *House Document 90*, 70th Cong., 1st sess., Senate Executive Document No. 49, 32nd Cong., 1st sess., 1852; Andrew A. Humphreys And Henry L Abbot, *Report Upon The Physics and Hydraulics Of The Mississippi River; Upon The Protection Of The Alluvial Region Against Overflow; Upon The Deepening Of The Mouths; Based Upon Surveys And Investigations Made Under the Acts Of Congress Directing The Topographical And Hydrographical Survey Of The Delta Of The Mississippi River, With Such Investigations As Might Lead To Determine The Most Practical Plan For Securing It From Inundation, And The Best Mode of Deepening The Channels At The Mouths Of The River*, Professional Papers of the Corps of Topographical Engineers, U.S. Army, No. 13 (Washington, D.C.: GPO, 1876).

133 "Boeuf Floodway for Mississippi Flood Control," *Engineering News-Record*, September 5, 1929, 379-383; U.S. Congress, House of Representatives, Committee on Flood Control, *Control of Floods in the Alluvial Valley of the Lower Mississippi River* (71st Cong., 3rd sess.) March 3, 1931, House Document No. 798, p. 2, (Hereafter cited as *House Document #798*); "Today in the Mississippi Flood Area: The Cypress Creek Diversion Down the Boeuf River," *Engineering News-Record*, March 29, 1928, 512-516.

134 Mississippi River Commission, *Special Report of the Mississippi River Commission on Revision of Plans for Improvement of Navigation and Flood Control of the Mississippi River*, September 28, 1927, pp 86-91.

135 Wooten, "Washington Notes," Jan. 26, 1928, p. 169; Jadwin quote from *House Document 90*, p. 9; Mississippi River Commission, *Special Report*, pp. syllabus, 73, 81-90; Frank, pp. 234-236; Reuss, *Designing the Bayous*, p. 118; Reid, *Flood Control in the Mississippi Valley*, H.R. Report 1072, pp. 11-16, 70, 110-114.

[136] U.S. Congress, *An act for the control of floods on the Mississippi River and its tributaries, and for other purposes*, PL 70-391 (70th Cong., 1st Sess.); "Provisions for Flood Control Under New Law," *Engineering News-Record* 100:21 (May 24, 1928): 824-825; Camillo and Pearcy, *Upon Their Shoulders*, 179.

[137] U.S. Congress, House of Representatives, Committee on Flood Control, *Opinion of the Attorney General in Regard to Certain Provisions of the Mississippi Flood Control Act of May 15, 1928*, 71st Cong., 1st sess., July 19, 1929, Committee Document #2, 10-12. (Hereafter cited as *Committee Document #2*).

[138] Letter, Schoenberger to Ransdell, Aug. 28, 1928; L. Wallace, Eng. Council, to Hoover, May 20, 1928; Kemper, *Floods in the Alluvial Valley*, p. 184; Camillo and Pearcy, *Upon Their Shoulders*, pp. 178-180.

[139] *Committee Document #2*, 1-6. The brief was signed by Representatives Riley J. Wilson (D-LA), William J. Driver (D-AR), Jere Cooper (D-TN), William V. Gregory (D-KY)Dewey Short (R-MO), Hubert D. Stephens (D-MS), Thaddeus H. Caraway (D-AR), Will M. Whittington (D-MS) and Senators Frederick M. Sackett (R-KY), Joseph E. Ransdell (D-LA), Harry B. Hawes (D-MO) and Kenneth D. McKellar (D-TN).

[140] Ibid., 13-16.

[141] *Kincaid v. United States*, 35 F.(2d) 235, See also Reuss, *Designing the Bayous*, 130-133.

[142] Letter, Jadwin to Reinecke, Jul 15, 1929; Letter, Jadwin to Duffy, Jul. 17, 1929.

[143] "Boeuf Floodway Suit to Go to Trial," *Engineering News-Record* (Aug. 15, 1929): 272; "Judge Rules for Landowners in Flood-Control Project," *Engineering News-Record* (Oct. 17, 1929): 631; U.S. vs. Col. Frank P. Stubbs, et. al., No. 1809 (W. La. Dist. Ct., 1929); Good to AG, Nov. 12, 1929; Charles F. Cole to AG, Nov. 7, 1929; Reuss, *Designing the Bayous*, pp. 130-131.

[144] "Conflicting Testimony Given in Floodway Suit," *Engineering News-Record* (Oct. 24): 668-9; "Flood-Control Work in Boeuf Basin Is Enjoined by Court," *Engineering News-Record* (Dec. 19, 1929): 983-4; Decree and Order of Injunction No. 335, 35 F. 2d (W. La. Dist. Ct., 1930); Reuss, *Designing the Bayous*, pp. 131-133; Camillo and Pearcy, *Upon Their Shoulders*, pp. 182-183.

[145] *Kincaid v. United States*, 35 F.(2d) 235; "Flood-Control Work in Boeuf basin is Enjoined by Court," *Engineering News-Record*, December 29, 1929, 983-984; "A Far Reaching Decision," *Engineering News-Record*, December 19, 1929, 951.

[146] *AG Opinion*, pp. 13-16; Letters to Hoover from Wilson, Tilman Parks, Pearl Oldfield, Otis Wingo, Whittington, and Caraway, Sept. 20-21, 1929; Telegram, Hoover to W.J. Driver, Sept. 20, 1929; "Engineering Features of Flood-Control Plan Not Subject to Change by President," *Engineering News-Record* (Aug. 1, 1929): 186-7; Wooton, "Hoover Willing to Hold Up Doubtful Flood-Control Work," *Engineering News-Record* (Sept. 12, 1929): 432; quote from "The

President Acts on Mississippi Flood Control," *Engineering News-Record* (Sept. 19, 1929): 441; Reuss, *Designing the Bayous*, p. 130.

147 Norman R. Moore, *Improvement of the Lower Mississippi River and Tributaries, 1931-1972,* (Vicksburg: Mississippi River Commission, 1973), pp. 149-150; "Flood Control Being Tested on the Mississippi," *Engineering News-Record*, February 11, 1937, 222-225.; *House Flood Control Hearings*, 1930, V: 1283; Lytle Brown, "Mississippi Flood Control," *Engineering News-Record*, February 6, 1930 230-231; Lytle, Brown, "Discussion on Cutoffs," *Transactions of the ASCE*, 113 (1948): 22, (Discussion of Gerard H. Matthes, "Paper No. 2329, Mississippi River Cutoffs, With Discussion by Messrs. W. E. Elam, C. L. Hall, H. D. Vogel, Harry N. Pharr, Lytle Brown, Anson Marston, E. J. Williams, Jr., and Eugene A. Graves, and Gerard Matthes," *Transactions of the ASCE*, 113 (1948): 1-39.) Hereafter cited as *Transactions of the ASCE*, 1948. In the *ENR* article, Brown indicated that any modifications to the plan would secure dependable, affordable and timely protection based on a possible combination of levees, floodways and reservoirs.

148 W.E. Elam, *Speeding Floods to the Sea or The Evolution of Flood Control Engineering on the Mississippi River*, (New York: The Hobson Book Press, 1946), pp. 45-54, "Flood Control Through Slope Correction," and "Flood Control with Special Reference to the Mississippi River" reprinted in *Speeding Floods*, pp. 119-160; Camillo and Pearcy, *Upon Their Shoulders*, pp. 187-188.

149 Jadwin, Mississippi River Commission, and Elam quoted in Elam, *Speeding Floods*, pp. 54-61, 137-145. The commission also rejected a cutoff plan, which "has recently been brought up," probably by Todd. These pronouncements came despite progress made when the Navigation Board suggested studying the use of dredging for flood control by lowering the slope, for example through cutoffs. Because of the reigning opinion, Elam believed there was no chance of influencing the investigation of the Special Board then ongoing, but felt ethically bound to provide advanced notice of his articles. He convinced James S. Allen, chief engineer of the Mississippi Levee Board, to present the articles during his statement to the Special Board. After the hearing, Jadwin asked how many years Elam had worked on the river. "I remarked that I had been on the river for more than twenty years and that in my first few years I knew more about the river than at the time I wrote those papers," Elam wrote, perhaps playing off the Mark Twain adage that he was surprised how much his father had learned in seven years. Jadwin said he planned on appointing a board to consider the matter, though no such board ever came into being, and the Special Board went on to condemn cutoffs as heartily as the Jadwin plan. A few months later, Elam published his articles to the praise of Williams and Coleman and general approval of Col. Charles Townsend, former commission president.

150 Elam, *Speeding Floods*, p. 61; Memo for the President, MRC, Yucatan Bend Cut-Off, Jun. 10, 1932; D. Persons, Memo, Yucatan Bend Cut-off, Shift of Navigation to, Jan. 22, 1934; Camillo and Pearcy, *Upon Their Shoulders*, pp. 188-189. Discharge through the cutoff increased from 10 percent in 1930, to

40 percent by January 1932, to 58 percent by mid-April with a peak of 850,000 cubic feet per second. Observations showed gradual enlargement of the channel with a rapid change in the "controlling" section from January to April 1932. Cross-sections showed great variability in slope, with very little change above and a slight increase immediately below the cut, but seemed to indicate that very little change or even a slight decrease further downstream. A comparison of readings from 1930 to 1932 showed lowering of stages above and a slight increase below, with no change five or six miles upstream or downstream. Based on what were the best observations of a cutoff to that time, it appeared that changes to stages were very slight and localized to the vicinity of the cutoff, and that there were no major impacts to navigation. By September 9, 1932, the U.S. Lighthouse Willow reported navigation was established on the cutoff and that around Yucatan Bend discontinued.

151 "Mature Consideration Urged for Changes in Flood-Control Plans," and "Straitening Channel Proposed as Mississippi Flood Solution," *Engineering News-Record* (Oct. 23, 1930): 665-666 and 700-701.

152 Letter, Pick to Ferguson, Jun. 15, 1928; Ferguson, Memo for Board of Engineers for Rivers and Harbors on Control of Mississippi River Floods, Nov. 22, 1930; Matthes, *Transactions of the ASCE*, 1948, pp. 28-30; Camillo and Pearcy, *Upon Their Shoulders*, pp. 189-193.

153 Ferguson, Memorandum on Control of Mississippi River Floods; Matthes, *Transactions of the ASCE*, 1948, pp. 28-30; Camillo and Pearcy, *Upon Their Shoulders*, pp. 189-193.

154 Pick to Ferguson, Dec. 10, 1930; Matthes, *Transactions of the ASCE*, 1948, pp. 30-31; Jackson, "Flood Control," pp. 107-108.

155 Elam, pp. 84-91, Ferguson quote on 91; *Control of Floods in the Alluvial Valley of the Lower Mississippi River*, pp. 13-14; OCE Special Orders No. 16, Mar. 1, 1932; Matthes, *Transactions of the ASCE*, 1948, pp. 22-35.

156 Ferguson to U.S. TAG, Consideration for appointment, Mar. 14, 1929; Thompson quote from J.B. Tiffany, ed., *History of the Waterways Experiment Station*. (Vicksburg: Waterways Experiment Station, 1968): IV-2; Meigs O. Frost, "River Control by New Principles Is Devised," *New Orleans States* (Sun., Jul. 9, 1933): 1; Camillo and Pearcy, *Upon Their Shoulders*, pp. 203-205.

157 Ferguson, Cut-Offs, Jun. 3, 1932; Use of Gravel, Jun. 18, 1932; Revetment, Jul. 2, 1932; Closing Secondary Channels, Jul. 2, 1932; Revetments, Jul. 9, 1932; Dredging, Jul. 12, 1932; Effective Dredging, Oct. 31, 1932; Outlets, Nov. 4, 1932; General, Dec. 7, 1932; Dredging, Dec. 7, 1932; Memo, Results of Conference of July 5, 1932 re Revetment and Channel Adjustments in Vicksburg District, Jul. 7, 1932; Matthes, *Transactions of the ASCE*, 1948, pp. 29-30.

158 Matthes, *Transactions of the ASCE*, 1948, pp 3-15, 28-30, 33; quote from Frost, "River Control," p. 1; "Dredging of Cut-Off in Mississippi River Begun," *Engineering News-Record* (Oct. 13, 1932): 451; Schweizer, Diamond Point Cutoff, Jan. 9, 1933; Camillo and Pearcy, *Upon Their Shoulders*, pp. 107-210.

[159] Mississippi River Commission, *Annual Report*, 1935, 1645; House Flood Control Hearings, April 1-13, 1935, 76; Clemens, "Straightening the Father of Waters," *Engineering News-Record*, February 20, 1936, 276; U.S. Waterways Experiment Station, "Studies of Existing Cut-Offs and Atchafalaya River Improvements," *Technical Memorandum No. 92-7*, dated October 5, 1937; See also U.S. Waterways Experiment Station, "Experiment to Determine the Effects of Proposed Dredged Cut-Offs in the Mississippi River," April 15, 1932; U.S. Waterways Experiment Station, "Experiment to Determine the Effects of a Cut-Off at Tarpley Neck"; U.S. Waterways Experiment Station, "Experiment to Determine the Effects of Various Cutoffs in the Greenville Bends"; U.S. Waterways Experiment Station, "Experiment to Determine the Superflood Flowline of the Mississippi River in the Vicinity of Slough Landing Neck."

[160] *Committee Document #1, 1935*, 21-23; *House Flood Control Hearings*, April 1 to 13, 1935, 3, 13. The commission did not recommend modifications to the project above the Arkansas River despite the commission's early resistance to the Birds Point-New Madrid floodway. By the time of the report the commission considered the floodway a *fait accompli*.

[161] Ibid.; William Willingham, *Civil Works, 1933-1941: From Depression to War*, 44-46; Reuss, *Designing the Bayous*, 181-185.

[162] *House Flood Control Hearings*, April 1-13, 1935. Jacobs' testimony can be found on pages 258-267; Kemper's on page 774. Statements from the Board of Mississippi Levee Commissioners and the Yazoo-Mississippi Delta levee board can be found on pages 217-219. The latter from the Louisiana Board of State Engineers is quoted in Reuss, *Designing the Bayous*, 181.

[163] *House Document #359*, 15; *House Flood Control Hearings*, 73rd Cong., 2nd sess., on H.R. 8146 and H.R. 8048, February 27, 1934.

[164] *House Flood Control Hearings*, February 27, 1934, 18-21; ibid., April 1-13, 1935, 818-829 (Whittington statement).

[165] *House Flood Control Hearings*, April 1-13, 1935, 3-8. (Markham testimony).

[166] Ibid., 75-78, 85-96. (Ferguson testimony).

[167] Camillo and Pearcy, *Upon Their Shoulders*, pp 226-232.

[168] Ibid, 233-234; "Superflood Devastates Lower Ohio and Threatens Mississippi Levee System," *Engineering News-Record*, February 4, 1937, 151; "Mississippi Flood Fighting Begins," *Engineering News-Record*, February 4, 1937, 205.

[169] Camillo and Pearcy, *Upon Their Shoulders*, 234; Matthes to Mr. Meigs O. Frost, Mar. 6, 1937; Ferguson, Increasing the Flood Carrying Capactiy of the Mississippi River from White River to Cairo, Oct. 30, 1937.

[170] House Committee on Flood Control, *Comprehensive Flood Control Plan For Ohio and Lower Mississippi Rivers*, Committee Document No. 1 (75th Cong., 1st Sess.) April 28, 1937; *House Flood Control Hearings*, April 6, 1937.

[171] *House Document No. 359*.

172 Camillo and Pearcy, *Upon Their Shoulders*, 214; House of Representatives, *Mississippi River between Cairo, Ill., and Baton Rouge, La.,* House Document No. 509, (78th Cong., 2nd Sess.), March 22, 1944.

173 *House Document No. 509*; Charles Senour, "New Project for Stabilizing and Deepening Lower Mississippi River," *Transactions of the ASCE*, Vol. 112, 1947, pp 277-300.

174 Camillo and Pearcy, *Upon Their Shoulders*, 208; Quote from Matthes, Memo for Mr. Meigs O. Frost; Moore, *Improvement of the Lower Mississippi River and Tributaries*, 43-47.

Chapter Four

175 Camillo, *Flood Notes*, May 2, 1625, Interview with Robert Simrall, by Charles Camillo, Nov. 8, 2011; Interview with Kent Parrish, by Charles Camillo, Nov. 8, 2011. All gage information for this entire chapter was obtained from *www.rivergages.com*.

176 Interview with Robert Simrall, by Charles Camillo, Nov. 8, 2011.

177 Peter Nimrod, *2011 Flood Report: A Success Story*, (Mississippi Levee Board) June 30, 2011; Interview with Kent Parrish, by Charles Camillo, Nov. 8, 2011; Interview with Chuck Mendrop, by Charles Camillo, Nov. 8, 2011; Interview with Lanny Barfield, by Charles Camillo, Nov. 9, 2011; Interview with Peter Nimrod, by Charles Camillo, Nov. 10, 2011.

178 Interview with Jimmy Coldiron, by Charles Camillo, Nov. 9, 2011; Interview with Robert Stokes, by Charles Camillo, Nov. 9, 2011; Interview with Kent Parrish, by Charles Camillo, Nov. 8, 2011.

179 Interview with Jimmy Coldiron, by Charles Camillo, Nov. 9, 2011; Interview with Kent Parrish, by Charles Camillo, Nov. 8, 2011; Interview with Lanny Barfield, by Charles Camillo, Nov.9, 2011.

180 Robert Simrall, Memorandum to CEMVD-PD-W, Subject: Approval for a major deviation from the approved Water Control Plan at Muddy Bayou Control Structure is requested, April 27, 2011; Interview with Chuck Mendrop, by Charles Camillo, Nov 8. 2011; Interview with Lanny Barfield, by Charles Camillo, Nov. 9, 2011.

181 Robert Simrall, Memorandum to CEMVD-PD-W, Subject: Approval for a major deviation from the approved Water Control Plan at Muddy Bayou Control Structure is requested, April 27, 2011; Interview with Robert Simrall, by Charles Camillo, Nov. 8, 2011; Interview with Ron Goldman, by Charles Camillo, Nov. 8, 2011.

182 Ibid., Interview with Col. Jeffrey Eckstein, by Charles Camillo, Nov.8, 2011; Interview with Kent Parrish, by Charles Camillo, Nov. 8, 2011; Interview with Maj. Gen. Michael Walsh, by Charles Camillo, Aug. 24, 2011, Robert Simrall, Memorandum to CEMVD-PD-W, Subject: Approval for a major deviation from the approved Water Control Plan at Muddy Bayou Control Structure is

requested, April 27, 2011; formal approval was granted in a memorandum for Maj. Gen, Michael Walsh to commander, Vicksburg District, Subject: Approval for a major deviation from the approved Water Control Plan at the Muddy Bayou Control Structure, dated April 28, 2011.

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185 Vicksburg District, MVK Spring Flood 2, Situation Report No. 5; Interview with Jimmy Coldiron, by Charles Camillo, Nov. 9, 2011.

186 Interview with Robert Simrall, by Charles Camillo, Nov. 8, 2011.

187 Camillo, *Flood Notes*, May 2, 1625, U.S. Army Corps of Engineers, Little Rock District, *After Action Flood Report, Spring 2011 Event*, September 2011, 1-8, Email, Ron Bell to Charles Shadie, et. al., November 19, 2011, Subject: Question on Ark/White.

188 Vicksburg District, *Post Flood Report: Flood of 1973*, 1973, pp. 3-4, 7-8, A-8, A-11; MVK Spring Flood 2, Situation Report No. 8; Interview with Col. Jeffrey Eckstein, by Charles Camillo, Nov. 8, 2011.

189 United States Congress, House of Representatives, *Flood Control on the Lower Mississippi River*, 77th Cong., 1st sess., *House Document No. 359*, pp. 3-4, 37-41; Camillo and Pearcy, *Upon Their Shoulders*, 243-244.

190 United States Congress, House of Representatives, *Mississippi River and Tributaries Project*, 88th Cong., 2d sess., 21 May 1964, House Document No. 308, 1964, Vol. 1; Moore, *Improvement of the Lower Mississippi*, pp. 160-161. Charles Camillo, "Mississippi River and Tributaries Project: Backwater Areas," April, 2008 . The Steele Bayou structure has a design capacity of 19,000 cfs, but the structure has passed up 50,000 cfs during certain flood events.

191 Vicksburg District, *Post Flood Report: Flood of 1973*, 1973, pp. 3-4, 7-8, A-8, A-11.

192 Interview with Ron Goldman, by Charles Camillo, Nov. 8, 2011.

193 Interview with Peter Nimrod, by Charles Camillo, Nov. 10, 2011; Peter Nimrod, *2011 Flood Report: A Success Story*, June 30, 2011.

194 Interview with Ron Goldman, by Charles Camillo, Nov. 8, 2011; Interview with Peter Nimrod, by Charles Camillo, Nov. 10, 2011.

195 MVK Spring Flood 2, Situation Report No. 8; MVK Spring Flood 2, Situation Report No. 9; Robert Simrall, Memorandum to CEMVD-PD-W, Subject: Approval for a major deviation from the approved Water Control Plan at Muddy Bayou Control Structure is requested, April 27, 2011; Peter Nimrod, *2011 Flood Report: A Success Story*, June 30, 2011.

[196] Camillo, *Flood Notes*, May 4, 0800; Interview with Maj. Gen. Michael Walsh, by Charles Camillo, August 24, 2011.

[197] Camillo, *Flood Notes*, May 4, 0945; Col. Jeffrey Eckstein, "CG Brief, Yazoo Backwater," May 4, 2011.

[198] Peter Nimrod, *2011 Flood Report: A Success Story*, June 30, 2011; Interview with Peter Nimrod, by Charles Camillo, Nov. 10, 2011; Letter from Peter Nimrod to Col. Jeffrey Eckstein, re: Request for Corps to assume leadership of YBW Levee Flood Fight Operations, dated May 4, 2011.

[199] Interview with Kent Parrish, by Charles Camillo, Nov. 8, 2011; Interview with Col. Jeffrey Eckstein, by Charles Camillo, Nov. 8, 2011.

[200] Peter Nimrod, *2011 Flood Report: A Success Story*, June 30, 2011; Interview with Robert Simrall, by Charles Camillo, Nov. 8, 2011; Interview with Kent Parrish, by Charles Camillo, Nov. 8, 2011.

[201] Interview with Robert Simrall, by Charles Camillo, Nov. 8, 2011.

[202] Col. Jeffrey Eckstein, "CG Brief, Yazoo Backwater," May 4, 2011; Camillo, *Flood Notes*, May 4, 2100.

[203] Ibid.; Formal approval was granted in a memorandum from Maj. Gen. Michael Walsh to Col. Jeffrey Eckstein, Subject: Yazoo Backwater Levee (MR&T), dated May 4, 2011.

[204] Interview with Col. Jeffrey Eckstein, Nov. 8, 2011; Email, Lamar Jenkins to Charles Camillo, Nov. 23, 2011, Subject: YBW Armoring Project.

[205] MVK Spring Flood 2, Situation Report Nos. 13-16.

[206] Campbell Robertson, "In Mississippi Delta, All Eyes on Swelling River," *The New York Times*, May 6.

[207] Camillo, *Flood Notes*, May, 4, 1500; Ibid., May 9, 0800.

[208] Ibid., May 10, 0800; Ibid., May 11, 0800; Ibid., May 15, 0800.

[209] Vicksburg District, " Problem areas noted on West Bank MRL Arkansas and Louisiana during Spring 2011 Ms. River Flood Fight II (April - May 2011), .n.d.; Interview with Bradley Martin, by Charles Camillo, Nov. 28, 2011; Interview with Eric Woerner, by Charles Camillo, Nov. 16, 2011. Information for the paragraph was also pulled from multiple SITREP reports spanning from May 4 to May 23.

[210] Vicksburg District, " Problem areas noted on West Bank MRL Arkansas and Louisiana during Spring 2011 Ms. River Flood Fight II (April - May 2011), .n.d.; Interview with Kent Parrish, by Charles Camillo, Nov. 8, 2011. Information for the paragraph was also pulled from multiple SITREP reports spanning from May 4 to May 23.

[211] Interview with Bradley Martin, by Charles Camillo, Nov. 28, 2011; Interview with Kent Parrish, by Charles Camillo, Nov. 8, 2011.

212 Interview with Bradley Martin, by Charles Camillo, Nov. 28, 2011; Vicksburg District, MVK Spring Flood 2, Situation Reports No. 15, No. 16 and No. 17.

213 The depiction of the flood fight at Francis was compiled from the following interviews: Interview with Bradley Martin, by Charles Camillo, Nov. 28, 2011; Interview with Peter Nimrod, by Charles Camillo, Nov. 10, 2011; Interview with Lanny Barfield, by Charles Camillo, Nov. 9, 2011; Interview with Chuck Mendrop, by Charles Camillo, Nov 8, 2011.

214 Camillo, *Flood Notes*, May 10, 1030.

215 The depiction of the flood fight at Winterville was compiled from the following interviews: Interview with Lanny Barfield, Nov. 9, 2011; Interview with Peter Nimrod, by Charles Camillo, Nov. 10, 2011; Interview with Chuck Mendrop, by Charles Camillo, Nov. 8, 2011.

216 Camillo, *Flood Notes*, May 13, 1400; Interview with Chuck Mendrop, by Charles Camillo, Nov. 8, 2011;

217 Interview with Ron Goldman, by Charles Camillo, Nov. 8, 2011.

218 Proceedings of the Mississippi River Commission, 386th Session, Testimony of Peter Nimrod before the Mississippi River Commission, Lake Providence, Louisiana, August 17, 2011. (The discussion between Nimrod and Angel is contained in the audiotapes of the Lake Providence hearing; Interview with Peter Nimrod, by Charles Camillo, Nov. 10, 2011.

219 Camillo, *Flood Notes*, May 14, 0800.

220 Interview with Ron Goldman, by Charles Camillo, Nov. 8, 2011.

221 Camillo, *Flood Notes*, May 15, 0800.

222 Ibid., May 17, 0800; Interview with Peter Nimrod, by Charles Camillo, Nov. 10, 2011; Interview with Lanny Barfield, by Charles Camillo, Nov. 8, 2011.

223 MVK Spring Flood 2, Situation Report No. 22. Interview with Chuck Mendrop, by Charles Camillo, Nov. 8, 2011, MVK Spring Flood 2, Situation Report Nos. 23-26.

Chapter Five

224 Camillo, *Flood Notes*, May 2, 0800; Interview with Edward Belk, by Charles Camillo, May 4, 2011.

225 Reuss, *Designing the Bayous*, 37-52. Reuss's study is unmatched in its research and discussion of the history of the development of engineering controls on the Atchafalaya and lower Mississippi Rivers.

226 Major Clarke S. Smith, "Report on Spillways, Vicinity of New Orleans, LA," dated October 8, 1914; Elliott, *Improvement of the Lower Mississippi River*, II: 317; Reuss, *Designing the Bayous*, 98; Kemper, *Floods in the Valley of the Mississippi*, 37.

[227] Reuss, *Designing the Bayous*, 97-99; John Klorer, "The Flood Problem of the Lower Mississippi River," *Transactions of the ASCE*, LXXXVIII (1924): 1007-1014.

[228] *Report of the Board of State Engineers of the State of Louisiana*, 1924-1926, 84-85.

[229] Ibid., *Proceedings of the Mississippi River Commission*, 1925, 1922-1925, session 167 (February 25-26, 1925), Reuss, *Designing the Bayous*, 101. Wilson's bill was authorized as Public Law 69-134 on April 17, 1926.

[230] Roger McWhorter, "Breaching the Levee Below New Orleans," *Engineering News-Record* 98:18 (May 5, 1927): 742-5; *Proceedings of the Mississippi River Commission, April 19-29, 1927*: 4355, 4367-4369; *Flood Control Hearings, 1927-1928*: 2066-2075. For more on the negotiations that took place among city leaders, St. Bernard Parish leaders, and the governor's office, see Barry, *Rising Tide* pp. 213-258.

[231] Daniel, *Deep'n as it Come*, pp. 69-73; Roger McWhorter, Breaching the Levee Below New Orleans," *Engineering News-Record* 98:18 (May 5, 1927): 745; Shaw, "Spillway Gives Relief at New Orleans," Engineering News-Record 98:22 (June 2, 1927): 912; Cowdrey, *Land's End*, 36-7; Frank, *Development of the Federal Program for Flood Control*, pp. 218-219; Klorer quoted in W.W. DeBarard, "Today in the Mississippi Flood Area: IV. What New Orleans Thinks of Flood Protection," *Engineering News-Record* 99:25 (Dec. 22, 1927): 1004; *Spillways on the Lower Mississippi River*, House Document 95 (70th Cong., 1st Sess.): 1-10, quote on 22; Kemper, *Rebellious River*, pp. 116-118.

[232] Camillo, *Flood Notes*, May 2, 1625; Ibid., May 3, 0746; Mississippi Valley Division, *Water Control Manual, Morganza Floodway*, April 1984, Revised February 2000, pp. 2-5; Jindal and Minsky quotes taken from "Deep South braces for rising Mississippi River," *The Messenger-Online*. May 3.

[233] Camillo, *Flood Notes*, May 3, 0800.

[234] Memorandum from Col. Edward R. Fleming to President, Mississippi River Commission, Subject: Bonnet Carré Spillway Operation, May 3, 2011; New Orleans District, Spring 2011 High Water: Situation Report No. 40; Emory Kemp, "Stemming the Tide: Design and Operation of the Bonnet Carré Spillway and Floodway," *Essays in Public Works History*, December 1990, No. 17. Kemp's essay on the Bonnet Carré spillway is an excellent starting point for those interested in a more detailed history of the structure.

[235] Memorandum from Walter Baumy to Commander, New Orleans District, Subject: Operation of Bonnet Carré Spillway, May 3, 2011.

[236] Camillo, *Flood Notes*, May 4, 2030; New Orleans District, *Morganza Spillway Briefing, May 4, 2011; Water Control Manual, Morganza Floodway*, pp. 1-14; Interview with Christopher Accardo, by Charles Camillo, December 6, 2011.

[237] Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011; Interview with Maj. Gen. Michael Walsh, by Charles Camillo, August 24, 2011.

[238] Camillo, *Flood Notes*, May 5, 0930; Memorandum from Maj. Gen. Michael Walsh to Col. Edward Fleming, Subject: Bonnet Carré Spillway Operation, May 5, 2011; Memorandum from Col. Edward Fleming to President, Mississippi River Commission, Subject: Morganza Control Structure and Floodway Operation, May 6, 2011 (This document contains Baumy engineering assessment as an attachment); Interview with Walter Baumy, by Charles Camillo, December 10, 2011.

[239] Camillo, *Flood Notes*, May 6; U.S. Army Corps of Engineers, 2011 Flood Response, Decision Brief to the President of the MRC, May 6, 2011 (This document is a PowerPoint presentation containing Fleming's Briefing to Walsh on the Morganza operation).

[240] Ibid.

[241] Email, MG Michael Walsh to MG William Grisoli, et al., May 7, 2011, Subject: Morganza Floodway Execution; Email, MG Bo Temple to MG Michael Walsh, May 7, 2011, Subject: Morganza Floodway Execution.

[242] House of Representatives, *Mississippi River and Tributaries with respect to Old River Control*, House Document No. 478 (83r Cong., 2d Sess.) July 26, 1954, pp.14-21; Reuss, *Designing the Bayous*, 209-238, 243-247; Ben Fatheree, *The First 75 Years: History of Hydraulic Engineering at the Waterways Experiment Station*, (ERDC 2004), 99-102; 177-179.

[243] Walter Baumy, *White Paper: Mock Scenarios for Passing the 2011 Mississippi River Flood*, May 7, 2011.

[244] Ibid., Reuss, *Designing the Bayous*, 242-245.

[245] Baumy, *White Paper: Mock Scenarios for Passing the 2011 Mississippi River Flood*, May 7, 2011; New Orleans District, Flood of 1974: Post Flood Report, 37-38; New Orleans District, *Flood of 1983: Post Flood Report*; 29-31; Interview with Walter Baumy, by Charles Camillo, December 9, 2011; Interview with Russell Beauvais, by Charles Camillo, December 12, 2011. Email, William Veatch to Charles Camillo, January 11, 2011, Subject: Overbank Structure.

[246] Interview with Stuart Waits, by Charles Camillo, Dec. 6, 2011; Interview with Ted Eilts, by Charles Camillo, December 7, 2011; *Flood of 1973: Post Flood Report*, 65-80. Various SITREP reports were used to define the sectors.

[247] Interview with Stuart Waits, by Charles Camillo, December 6, 2011; Interview with Ted Eilts, by Charles Camillo, December 7, 2011.

[248] New Orleans District, Spring 2011 High Water: Situation Report No. 48; Interview with Stuart Waits, by Charles Camillo, December 6, 2011; Interview with Christopher Accardo, by Charles Camillo, December 6, 2011.

[249] Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011.

[250] Email, Gregory Fey to Michael Stack, May 9, 2011, Subject: Morganza Spillway Opening – Request for Information; Email, Steven Wilson to Christopher

Accardo, et al., May 9, 2011, Subject: Morganza Spillway Opening – Request for Information.

251 Interview with Christopher Accardo, by Charles Camillo, December 6, 2011; Interview with Col. Edward Fleming, by Charles Camillo, December 9, 2010.

252 This is entirely the opinion of the author. Maj. Gen. Walsh maintains that his motivation was to be slow, deliberate, and transparent to ensure the district and MRC were not being reactive, unnerved or uncoordinated.

253 Camillo, *Flood Notes*, May 9, 0900; Ibid., May 16, 0800;

254 Email, MG Michael Walsh to COL Edward Fleming, May 9, 2011, Subject: Pls break down the; Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011; "US Army Corps Decision to Open Morganza Spillway Could Come Today," *KATC-TV Online*, May 9 (Jindal quote).

255 Camillo, *Flood Notes*, May 11, 0800; Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011;

256 Ibid.; Email, MG Bo Temple, to MG Michael Walsh, et al., May 9, 2011; Subject: Morganza Floodway Operation.

257 Water Control Plan, Morganza Floodway, pp 2-7; Interview with Will Veatch, by Charles Camillo, December 6, 2011; Email, William Veatch to Charles Camillo, December 9, 2011, Subject: Stage-Discharge at Morganza; Interview with Walter Baumy, by Charles Camillo, December 9, 2011; *Flood of 1983: Post Flood Report*, 37. Prior to 1963 and the completion of the Old River control structures, the discharge at Red River Landing was used rather than Tarbert Landing.

258 *Water Control Manual, Morganza Floodway*, 1-7; Walter Baumy, White Paper: Morganza Control Structure, Operational Assessment – Overtopping Situation, May 13, 2011; Interview with Russell Beauvais, by Charles Camillo, December 12, 2011.

259 Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011; Email, COL Edward Fleming to MG Michael Walsh, May 13, 2011, Subject: Morganza; Email, MG Michael Walsh to COL Edward Fleming, May 13, 2011, Subject: Morganza.

260 Camillo, *Flood Notes*, May 13, 0800; Ibid., 1500; Operation Watershed: Emergency Management Briefing, 0800, May 10, Ibid., May 31, 2011 (These PowerPoint briefings contains information about stages and discharges).

261 Interview with Nancy Powell, by Charles Camillo, December 6, 2011; Interview with Will Veatch, by Charles Camillo, December 6; Interview with Col. Edward Fleming by Charles Camillo, December 7, 2011; Interview with Walter Baumy, by Charles Camillo, December 10, 2011; Memorandum from Maj. Gen. Walsh to Commander, New Orleans District, Subject: Morganza Floodway Operation, May 13, 2011, 1500 hours.

262 Camillo, *Flood Notes*, May 14, 0800.

[263] Interview with Will Veatch, by Charles Camillo, December 6, 2011; Camillo, *Flood Notes*, May 14, 0800.

[264] Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011.

[265] Camillo, *Flood Notes*, May 14, 1200; Interview with Maj. Gen. Michael Walsh, by Charles Camillo, August 24, 2011; Interview with Russell Beauvais, December 12, 2011; Interview with Walter Baumy, by Charles Camillo, December 10, 2011.

[266] Camillo, *Flood Notes*, May 14, 1215. All quotes and descriptions from the decision meeting at the Morganza structure were taking from personal notes.

[267] Ibid., 1245.

[268] Ibid., 1430.

[269] Ibid., 1500.

[270] Camillo, *Flood Notes*, May 15, 0800; Ibid., May 15, 1245; Interview with Stuart Waits, by Charles Camillo

[271] *Flood of 1973: Post Flood Report*, 126-132; Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011; Interview with Christopher Accardo, by Charles Camillo, December 6, 2011; Interview with Ted Eilts, by Charles Camillo, December 7, 2011.

[272] Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011; Claire Taylor, "Rising tide may bring floods to Morgan City," *Lafayette Daily Advertiser – Online*, May 4, 2011, (Councilman quote).

[273] Interview with Ted Eilts, by Charles Camillo, December 7, 2011.

[274] Ibid., Interview with Walter Baumy, by Charles Camillo, December 10, 2011.

[275] Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011; Camillo, *Flood Notes*, May 15, 1245.

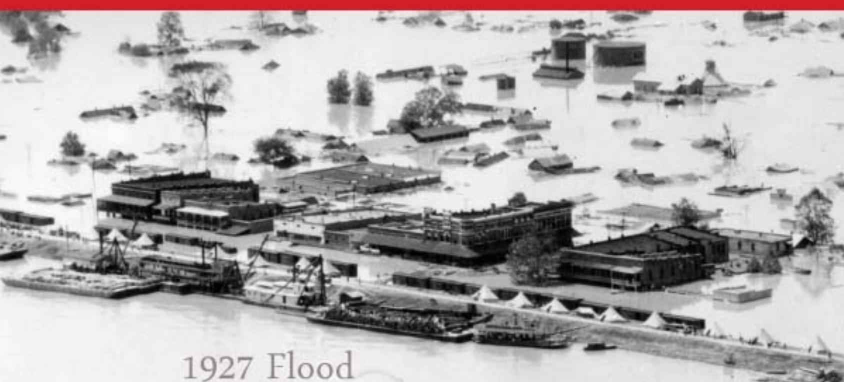
[276] Camillo, *Flood Notes*, May 15 (complete entry); Interview with Col. Edward Fleming, by Charles Camillo, December 7, 2011; Camillo, *Flood Notes*, May 15, 1245.

[277] Camillo, *Flood Notes*, May 15, 1330.

[278] Camillo, *Flood Notes*, May 19, 0800; Operation Watershed: Emergency Management Briefing, 0800, May 31, 2011.

[279] Ibid., Camillo *Flood Notes*, May 21, 0800; Ibid., May 25, 0800; Ibid., June 1, 0800.

LISTENING • INSPECTING • PARTNERING • ENGINEERING



1927 Flood

"Should Divine Providence ever send a flood of the maximum predicted by meteorological and flood experts as a remote probability but not beyond the bounds of ultimate possibility, the floodways provided in the plan are still normally adequate for its passage without having its predicted heights exceed those of the strengthened levees."

Maj. Gen. Edgar Jadwin
Dec. 1, 1927