

**The Mississippi River
& Tributaries Project:
Designing the Project Flood**



Information Paper

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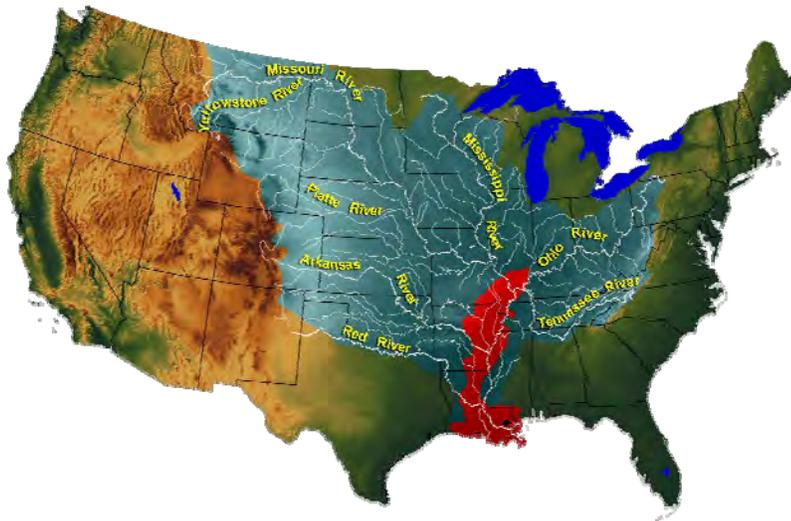
The Mississippi River & Tributaries Project

Designing the Project Flood

The Mississippi River & Tributaries (MR&T) project was authorized by the 1928 Flood Control Act. Following the devastating 1927 flood, the nation was galvanized in its support for a comprehensive and unified system of public works within the lower Mississippi Valley that would provide enhanced protection from floods while maintaining a mutually compatible and efficient Mississippi River channel for navigation. Administered by the Mississippi River Commission under the supervision of the Office of the Chief of Engineers, the resultant MR&T project employs a variety of engineering techniques, including an extensive levee system to prevent disastrous overflows on developed alluvial lands; floodways to safely divert excess flows past critical reaches so that the levee system will not be unduly stressed; channel improvements and



stabilization features to protect the integrity of flood control measures and to ensure proper alignment and depth of the navigation channel; and tributary basin improvements, to include levees, headwater reservoirs, and pumping stations, that maximize the benefits realized on the main stem by expanding flood protection coverage and improving drainage into adjacent areas within the alluvial valley.



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Since its initiation, the MR&T program has brought an unprecedented degree of flood protection to the approximate four million people living in the 35,000 square-mile project area within the lower Mississippi Valley. The nation has contributed nearly \$13 billion toward the planning, construction, operation, and maintenance of the project. To date the nation has received a 24 to 1 return on that investment, including \$306 billion in flood damages prevented. The success of the MR&T flood control program can be traced to a change in engineering policy. Prior to that change the control of floods on the lower Mississippi was attempted by building levees high enough to withstand the last great flood of record. Since the inception of the MR&T project, however, the comprehensive flood control program is designed to control the project design or the maximum probable flood.



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1928 Project Design Flood

The project flood used in the original design of the MR&T project was a combination of separate analyses conducted by the U.S. Weather Bureau (now the National Weather Service) and the Mississippi River Commission. The discharges and flood stages predicted by the agencies were very similar, but because the Weather Bureau analyzed the “maximum possible” flood in comparison to the commission’s analysis of the “maximum probable” flood, differences in the estimates did emerge. Where such differences did occur, the higher stage was used in putting together the final project flood design.

The Weather Bureau determined that the “maximum possible” flood would produce a discharge of 2,400,000 cubic feet per second (cfs) at Cairo, Illinois, with a confined stage of 66 feet. (The project flood flowline at the Cairo gage was established at 59 feet because the Birds Point-New Madrid floodway on the west bank of the Mississippi River was designed to siphon off 550,000 cfs during the project flood.) Bureau meteorologists reached their discharge figures by combining the maximum flood on the Ohio River with the upper Mississippi, Cumberland and Tennessee rivers simultaneously contributing their maximum predicted flood crests to create the greatest possible effect at Cairo. The Mississippi River Commission, on the other hand, determined that the “maximum probable” flood would produce a discharge of 2,250,000 cfs at Cairo, a figure that was greater than confined discharge of the 1927 flood, but less than that same confined flood added to the maximum recorded discharge of the Ohio River as experienced in 1913. Both the Weather Bureau and the Mississippi River Commission took the discharge passing Cairo and combined that flow with the maximum predicted flood stages of the Arkansas and White rivers to produce a discharge of 2,850,000 cfs at Arkansas City, Arkansas, with a maximum predicted stage of 74 feet. At the latitude of Red River Landing, Louisiana, the Weather Bureau taking into account the additional storage capacity of the channel and the added flows from the Yazoo and Red rivers, estimated a project flood discharge measuring 3,000,000 cfs.

1941 Project Design Flood

Congress requested a review of the MR&T project following the record-breaking flood of 1937, in which flood stages at Cairo reached 59.51 feet despite a combined discharge of only 2,100,000 cfs from the Ohio and Mississippi rivers. In 1941, the Mississippi River Commission and the Weather Bureau completed a cooperative analysis of the flow frequencies at Columbus, Kentucky, Arkansas City and Vicksburg, Mississippi. The agencies based the review on a 40-year period from the 1900 to 1939 and incorporated all independent flood crests equaling or exceeding 900,000 cfs. The study made provisions to increase flows at Columbus to account for historical discharges that had bypassed the town through gaps in the levee system, crevasses and the operation of the Birds Point-New Madrid floodway. For Arkansas City it took into account the state of the channel and backwater storage under 1939 conditions involving various



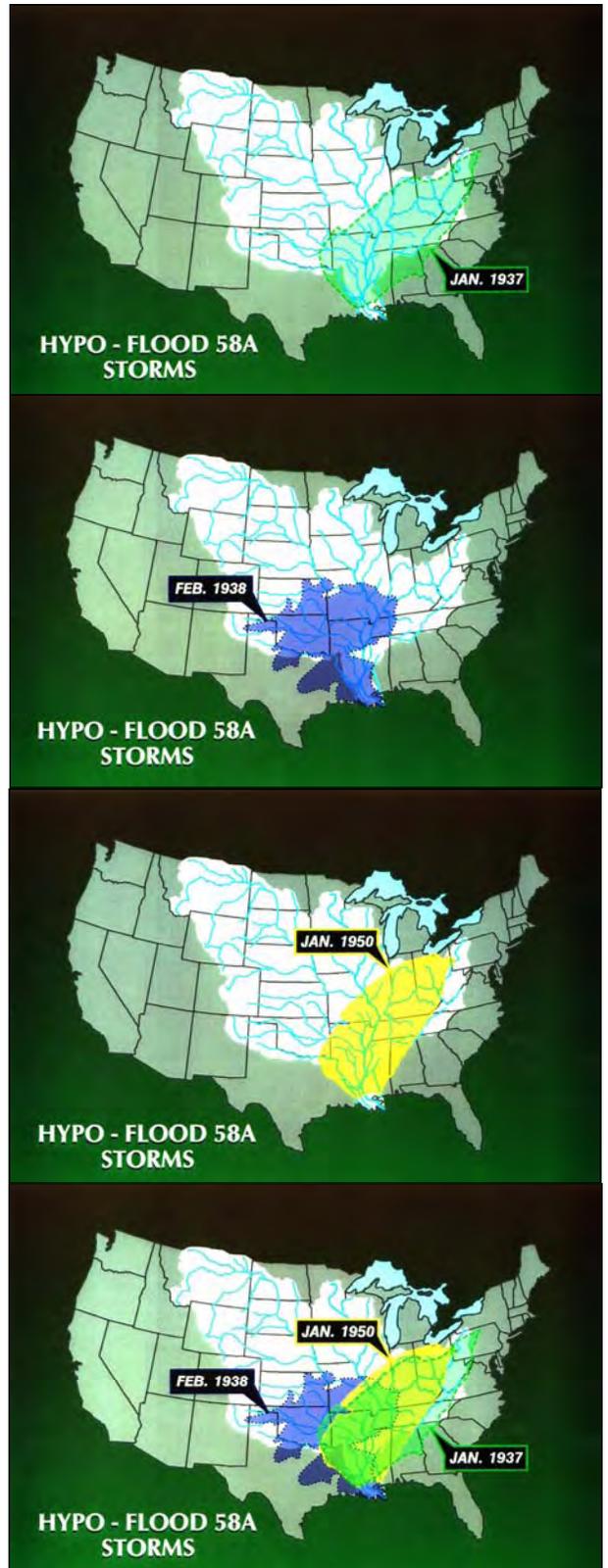
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assumptions with regard to the levees in the White River backwater area. From this data, the agencies plotted probability curves to show the frequency at which various flood discharges might occur. The frequency curves indicated that a peak discharge 2,600,000 at Cairo had the same probability of occurrence as a peak discharge of 3,065,000 cfs at Arkansas City with the White River backwater area levee overtopped. The discharge of 3,000,000 cfs at the latitude of Red River Landing remained unchanged. Before adopting the new project flood flows, the Mississippi River Commission made one last adjustment. In designing the project flood adopted in 1928, consideration was given to the possible effects of reservoirs, but those effects were not ultimately used in determining the project design flood. Since then dozens of reservoirs on the Missouri, upper Mississippi, Ohio, White and Arkansas rivers had been authorized by Congress through the flood control acts of 1936, 1937 and 1938. As such, the commission reduced the design flow between Cairo and the mouth of the Arkansas River by 150,000 cfs, setting the project design flood at 2,450,000 cfs at Cairo.

Current Project Design Flood

In 1954, the Senate Committee on Public Works requested another thorough examination of all components of the MR&T project that led to further revision of the project design flood. Pursuant to that request, the Mississippi River Commission and the Weather Bureau again conducted a cooperative study. This study incorporated previously unavailable data regarding the sequence, severity and distribution of past major storms and investigated 35 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 that





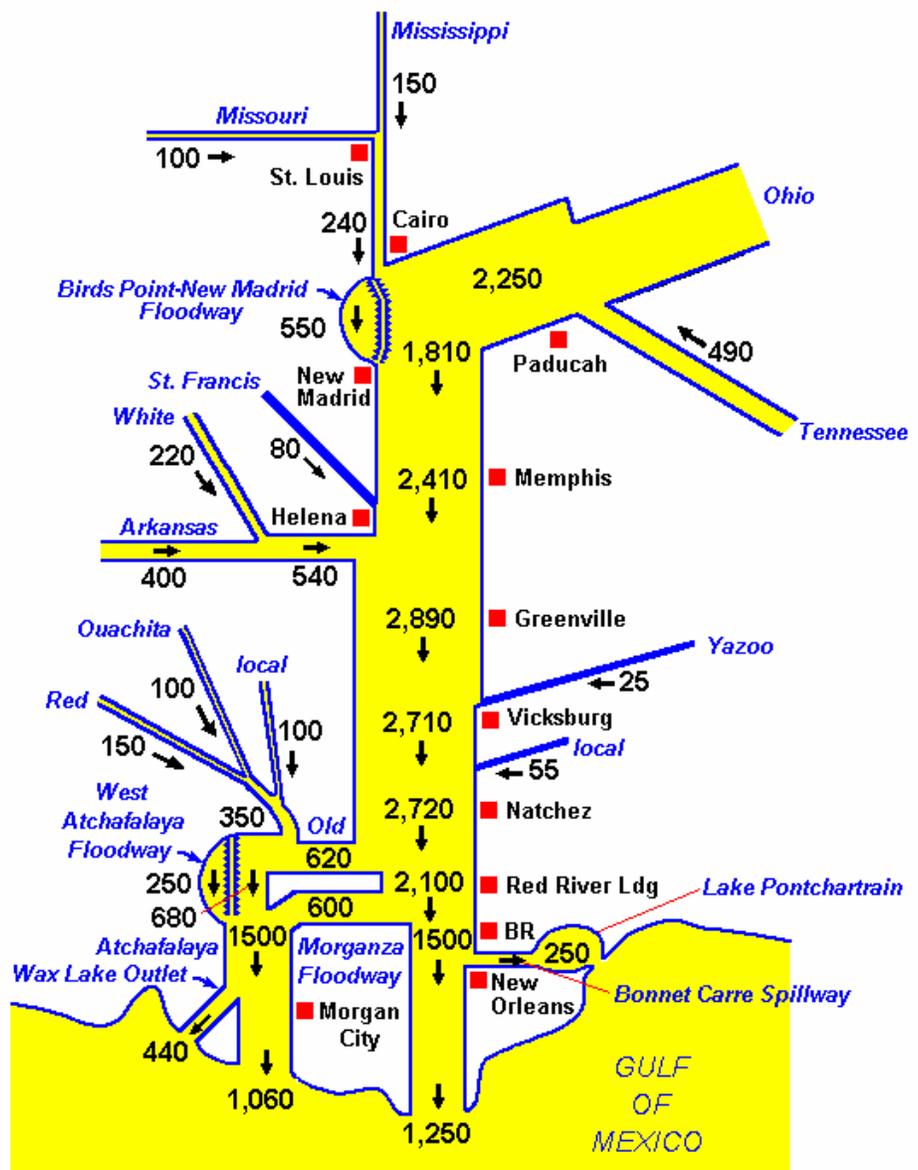
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were consistent with those occurring naturally to determine the most feasible pattern capable of producing the greatest amount of runoff on the lower Mississippi River. This included the consideration of storm transpositions, storm intensity adjustments, 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.

The studies revealed that Hypo-Flood 58A had the most probable chance of producing the greatest discharge on the lower Mississippi River from Cairo to the Gulf of Mexico. Three severe storms comprised Hypo-Flood 58A. The first storm is the 1937 storm that struck the Ohio and lower Mississippi River basins, with runoff increased by 10 percent. It is followed three days later by the 1950 storm over the same general area. This storm is followed three days later by the 1938 storm, with its center transposed 90 miles to the north and the rainfall pattern rotated by 20 degrees to maximize its 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 developed the flood flows that would occur from the three storms and routed them through the tributary systems under three conditions: unregulated by reservoirs; regulated by reservoirs that existed in 1950; and





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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 flowline and adopted it as the project design flood in 1956. The peak discharges for the revised project design flood were 2,360,000 cfs at Cairo; 2,890,000 cfs at Arkansas City, and 3,030,000 cfs at the latitude of Red River Landing.

Following the 1973 flood, the Mississippi River Commission once again 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. *(For a synopsis of how the MR&T project conveys the project design flood, please see, "Mississippi River & Tributaries Project: Controlling the Project Design Flood.")*

World's 3rd Largest Watershed
Drainage basin for 41% of the United States

