EXECUTIVE SUMMARY

From late September through early October 1986, a storm system extending across the central plains of the United States caused flooding of unprecedented proportions in northeastern Oklahoma and southeastern Kansas, an area within the Tulsa District, U.S. Army Corps of Engineers.

This report presents hydrologic and hydraulic data, an analysis of the flooding and actions taken by the Tulsa District to control the flood waters. It also describes emergency operations performed and discusses improvements to those operations.

THE ARKANSAS RIVER SYSTEM

The Arkansas River flows 1,450 miles southeasterly from Colorado, through Kansas, Oklahoma, and Arkansas, where it empties into the Mississippi River. The Arkansas River Basin, which includes an area of 160,000 square miles, provides the potential for large flows of water caused by rainfall. The region of interest in this report is northeastern Oklahoma and southeastern Kansas. This reach of the Arkansas River has several large tributary basins, including the Canadian, Cimarron, Grand (Neosho), Illinois, and Verdigris Rivers. Within these tributary basins are 35 multi-purpose lake projects operated by the Tulsa District. Congressionally authorized purposes for these projects include flood control, hydropower, water supply, water quality, navigation, irrigation, recreation, and fish and wildlife management. The primary project purpose under discussion in this report is flood control.

Corps of Engineers lake projects in the Tulsa District are designed to contain a portion of flood flows and release excess flows. Most of the lakes are designed to completely fill their flood control storage on an average of once every 10 to 30 years. Corps lakes in the Arkansas River Basin system have a total flood control storage of about 11 million acre-feet. Approximately 75 percent of this storage is in 11 lake projects which provide most of the flood control on the main stem of the Arkansas River.

THE STORM AND RESULTING FLOOD

The rainfall that caused the September-October 1986 flood was about one-half of the average annual rainfall in some areas. In many locations, the 6-day rainfall (29 September to 4 October) was more than twice that of the previous record. Several areas reported over 20 inches of rain, and many of the rainfall amounts exceeded previous records. As a result, several lakes in the Arkansas River Basin system filled to the tops of their flood control pools, even though the lakes had 100 percent of their flood control storage available immediately prior to the rainfall. Runoff not only exceeded the flood control capacity of the Arkansas River Basin system, it exceeded stream capacities throughout the area. The result was extensive flooding. Thirty-three counties in Oklahoma, two cities outside those counties, and ten counties in Kansas were included in flood disaster area declarations made by the President of the United States.

ROLE OF KEY AGENCIES

The primary responsibility of the U.S. Army Corps of Engineers during a flood event is operation of flood control projects. This involves direction and notification of releases from flood control dams. Other emergency activities include distributing sandbags, assisting with emergency engineering inspections, and offering technical advice to local communities. Other Federal and state agencies have responsibilities for weather and river forecasting, evacuation of citizens, and rehabilitation. Close cooperation and communication between agencies is essential for efficient flood emergency management.

During the flood event of September-October 1986, there was some confusion regarding communication responsibilities of the various agencies. Every agency has operating manuals expressing its functional plans and purposes. However, some of the objectives and responsibilities of the agencies overlap and require clarification. One of the actions underway will set into motion a mechanism whereby a clearer definition of key agency roles will be achieved.

FLOOD CONTROL SYSTEM OPERATIONS

As mentioned earlier, the portion of the Arkansas River Basin under discussion includes several flood control lakes which must be operated as a system. No lake is operated independently as each has an effect on the system as a whole. The system is managed in such a way so as to minimize downstream damages. During this flood, 11 lakes in the system completely filled or

exceeded their flood control storage capacity. In fact, Hulah Lake exceeded its surcharge, or safety zone, that portion **above** the top of the flood control pool.

EMERGENCY OPERATIONS

The Tulsa District staff began emergency flood operations on 29 September 1986. Contact was made with local law enforcement agencies, civil defense authorities, the media, and other interests. Corps advisory teams were sent to emergency command posts in several cities, including the city of Tulsa's Emergency Operations Center. Sandbags were dispensed to state and local governments. On-site assistance was provided for the emergency repair of two breaches in the Tulsa-West Tulsa levee system.

FLOOD DAMAGES AND DAMAGES PREVENTED

Flood damages amounting to about $283 million occurred to residential, commercial, agricultural, and public property. The damages include about $63.6 million in Tulsa County, Oklahoma and $39.7 million in Washington County, Oklahoma. Damages prevented by the flood control structures are estimated to be $725 million. Although two lives were lost in areas not controlled by flood control projects, the threat to human life was significantly reduced. Similar flooding in 1943, before the flood control structures were built, cost 26 lives.

EVALUATION OF EMERGENCY OPERATIONS PROCEDURES

Established and tested operating procedures were followed during this flood. Permission was granted by higher authority in two instances to deviate from those procedures in order to reduce the threat to loss of life and property.

Limited public knowledge of the flood control operations and procedures of the U.S. Army Corps of Engineers created misunderstanding and criticism. Concerns emerged regarding coordination between agencies and the dissemination of information. As with any event of this magnitude, questions will be asked, complaints will be filed, and lessons are to be learned.

The Corps routinely makes assessments of work performance and analyzes procedures following large flood events. This record-setting incident was no exception. Analyses of many aspects of emergency procedures have been conducted. Action has been, and will continue to be, taken in those instances where changes will enhance current methods and policies.

CONCLUSION

The flood of September-October 1986 far exceeded the flood control capabilities of the Arkansas River Basin projects. Although flood damages were severe, the Arkansas River Basin flood control system prevented considerable additional flooding and damage. An evaluation of the operation of the flood control projects indicated that no major changes are required. Areas needing strengthening have been identified. These include communications, forecasting, stream gaging, and structural modifications at some projects. Actions have been completed or are under way to make

improvements. Some identified items will require further analysis and/or additional funds. The Tulsa District will continue to seek out areas of possible improvement to achieve more effective emergency operations procedures and capabilities.

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