

## EXECUTIVE SUMMARY

### Review of Physical Effects of Navigation Structures – Middle Mississippi River February 2010

1. Overview: Dating to the construction of the first navigation structures in the 1800's, a continuing effort has been made to fully understand their physical effects on both the riverbed and water surface. As part of the navigation project the Corps of Engineers has continuously monitored the river's response to navigation structures, and has found no effect on water surface elevations at higher flows. Recently, however, external interest groups have expressed concerns that the construction of navigation structures has significantly increased water surface elevations at higher flows.

In an effort to update on-going evaluations of the physical effects of the navigation structures, the Corps of Engineers, St. Louis District entered into contracts with external technical experts in the fields of river data collection, river engineering, hydraulics, and statistics. These experts studied the physical effects of navigation structures on water surfaces on the Middle Mississippi River (MMR). The Middle Mississippi River is described as the section of the Mississippi River between the confluence of the Missouri and Ohio Rivers. The results of these expert external reviews all lead to the conclusion that the navigation structures have not resulted in increased water surface elevations. The following paragraphs detail the efforts and conclusions of each expert. The St. Louis District will continue to monitor the physical effects of all construction in the river.

#### 2. Study Results:

##### **a. The United States Geological Survey (USGS), *Examination of Direct Discharge Measurement Data and Historic Daily Data for Selected Gages on the Middle Mississippi River, 1861-2008.***

(1) Background: The United States Geologic Survey (USGS) has been the primary collector of data on the Mississippi River since the early 1930's. Data collected by the USGS is the source hydrologic data of most empirical studies.

(2) Scope of Study: The USGS was contracted to examine and analyze data from selected gages on the MMR to determine stage-discharge relation changes through time and to investigate potential cause-and-effect mechanisms through the examination of hydraulic geometry and channel elevation.

#### (3) Findings:

- a.) Study does not show a cause and effect relationship between river training structures and increased water surface elevation.
- b.) Stage measurements at discharges less than bankfull (500,000 cfs at the St. Louis Gage) have decreased with time whereas the stage measurements at discharges higher than bankfull have increased slightly with time. The decrease in stage with time for discharges less than bankfull is likely caused

by navigation structures. The apparent slight increase in stage with time for discharges greater than bankfull likely is caused by levees on the floodplains.  
c.) Historic discharge measurements taken using antiquated measurement techniques by the USACE overestimated discharge.

(4) Supporting Analysis:

- a.) As levee projects have been completed through time, the measured and rated stages for a given discharge have increased; however, after the completion of the last comprehensive MMR levee system (Alton to Gale) in the mid-1960's, rated stages for a given discharge have decreased.
- b.) Due to the overestimation of discharges taken using antiquated measurement techniques, directly comparing early USACE data with USGS data will show misleading trends.

**b) Biedenharn Group, *Specific Gage Analyses of Stage Trends on the Middle Mississippi River.***

(1) Background: The Biedenharn Group consists of experts in the fields of river engineering, hydraulics and fluvial geomorphology. The primary researchers for the Biedenharn group were Dr. David Biedenharn, P.E., a retired river engineer at the Engineer Research and Development Center, and Dr. Chester Watson, P.E., a retired professor from the Department of Civil and Environmental Engineering at Colorado State University. Dr. Biedenharn has often been cited as the leading expert on the use of specific gage analysis. Dr. Watson is an internationally recognized expert in the field of river engineering.

(2) Scope of Study: The Biedenharn Group was contracted to develop specific gage analyses in order to evaluate if there was a trend in river stages and if a trend existed, to determine if that trend can be attributed to the construction of river training structures.

(3) Findings:

- a.) Study found that there is no relationship between river training structures construction and increased stages for within bank flow (flows less than 500,000 cfs). Also, it found that any increases in overbank flood stages may be the result of levees, floodplain encroachments, and extreme hydrologic events and cannot be attributed to navigation training structures.
- b.) Historical discharge measurements taken using antiquated measurement techniques should not be used in a specific gage analysis

(4) Supporting Analysis:

- a.) The specific gage analyses conducted by the Biedenharn group utilized field data rather than data extracted from rating curves.
- b.) Too much uncertainty exists when making comparisons of discharge measurements taken with varying methods. This uncertainty is due to the overestimation of discharges by earlier methods (specifically the early methods used by the USACE), inconsistency with respect to the location of the discharge range and the insufficient measured data at higher flow ranges. This uncertainty combined with the availability of a long term consistent record after the USGS took over data collection lead to the conclusion that

historical discharge measurement, prior to the 1930s, should not be used in a specific gage analysis.

c) **Dr. V. Samaranayake**, *The Statistical Review of Three Papers on Specific Gage Analysis*.

(1) Background: Dr. V. Samaranayake is a statistics professor at the Missouri University of Science and Technology.

(2) Scope of Study: Dr. Samaranayake was contracted to conduct a critical review of the statistical analysis presented in three recent publications on physical effects of navigation structures on water surfaces to determine if the analysis was statistically appropriate. All three papers used variations of specific gage analysis to attempt to study the long term stage-discharge trends on the Middle Mississippi River.

(3) Findings: Estimating discharges from USGS rating curves masks the natural variation of the data and can lead to mistaken conclusions. To avoid this problem, measured discharges should be used to conduct any type of specific gage analysis. He further asserted that even if the methods were applied correctly in the reviewed papers, they did not provide analyses to support their conclusions that the navigation structures are increasing stages for higher discharges.

d) **The Iowa Institute of Hydraulic Research (IIHR)-Hydroscience and Engineering, University of Iowa**, *Hydraulic Simulation of the Effects of Chevron Dikes on Water Surface Elevations in the Mississippi River at St. Louis Missouri*.

(1) Background: The Iowa Institute of Hydraulic Research (IIHR)-Hydroscience and Engineering, University of Iowa, is our nation's oldest and one of our nation's most preeminent hydraulic research and teaching laboratories.

(2) Scope of Study: The director of IIHR, Larry Weber, Ph.D., P.E. was contracted to conduct an independent investigation of the influence of river training structures constructed by the Army Corps of Engineers on flood stages on the MMR. This investigation included the use of a two dimensional numerical model.

(3) Findings: Findings are pending, upon completion of the study

(4) Supporting Analysis: