Chapter 8. Summary and Conclusions

Summary

The UMR-IWW System Navigation Study is being conducted by the U.S. Army Engineer districts of Rock Island, St. Louis, and St. Paul under the authority of Section 216 of the Flood Control Act of 1970. Commercial navigation traffic is increasing and, in consideration of existing system lock constraints, will result in traffic delays which will continue to grow into the future. The system navigation study scope is to examine the feasibility of navigation improvements to the Upper Mississippi River and Illinois Waterway to reduce delays to commercial navigation traffic. The study will determine the location and appropriate sequencing of potential navigation improvements on the system, prioritizing the improvements for the 50-year planning horizon from 2000 through 2050. The final product of the System Navigation Study is a Feasibility Report which is the decision document for processing to Congress.

As part of the UMR-IWW System Navigation Study, a field investigation of the current state of bank erosion on the Upper Mississippi River (UMR) and Illinois Waterway (IWW) was conducted by a team of scientists from the Illinois State Water Survey, University of Iowa, and Rock Island and Huntington District Offices of the U.S. Army Corps of Engineers in July, August, and September of 1995. The team surveyed the UMR reach from Cairo, Illinois, to the navigation head water above St. Paul, Minneapolis for a total of 857 miles. The IWW reach was surveyed from Grafton, Illinois to Brandon Road Lock and Dam at Joliet, Illinois, a total of 286 miles.

Six tasks were identified in the Initial Project Management Plan (IPMP) for this effort with a decision point after Task 3. Task 1 was to conduct a literature search to identify applicable and available references for use in decision making in the other tasks. Task 2 was to conduct a system-wide inspection of the Upper Mississippi River/Illinois Waterway systems with a multi-disciplinary team to determine the current state of bank erosion and to attempt to discern the probable causes of the observed erosion. Based on the pertinent literature and the field inspections, Task 3 involves qualitatively assessing the relative significance of commercial navigation on existing bank erosion. If navigation effects on bank erosion could not be discerned from other causative factors, or if navigation effects were not considered significant, the bank erosion study would terminate. Otherwise, Tasks 4 and 5 would require some type of “modeling” effort to establish future conditions with and without project, based on projections of future navigation traffic growth; and

Task 6 would be a final report. This Field Survey Report addresses Tasks 2 and 3 and makes a recommendation regarding Tasks 4 and 5.

Data on bank erosion severity, location of erosion areas, and bank materials samples were gathered during the field trips. Information gathered from these selected sites was used to develop a classification system for the observed bank erosion and to identify the potential causes of erosion on these sites. Team members also agreed on the possible causes of erosion for the selected sites. During the field trip, the following tasks were completed:

- A total of 29 sites and 3 observation sites on the IWW, and a total of 43 sites and 54 observation sites on the UMR were selected and detailed field data were collected.
- Both the banklines for IWW and UMR have been mapped on navigation charts for conditions such as: severely eroded, moderately eroded, alternate erosion and stable bank, or stable banks. Information was also gathered on the presence of riprap, bank protection work, rocks, or vegetation and the location of dredge disposal material placement sites.
- At each of the selected sites, data such as bank sections, bank and core samples, land use and vegetation cover of the bank, surrounding features related to erosion, and at least one river cross section at the midpoint were collected.

The study team adapted a near-shore rework and transport model for classification utilizing three bank features: scarp, berm, and bench. Further analysis included the classification of the selected banks into more descriptive types. All the measured bank sections were divided into six erosion types for both the IWW and UMR, although different criteria were used for each river.

Analysis and presentation of data for the selected sites have been separated for the two rivers.

Illinois Waterway Summary

Information obtained from the field survey study for the IWW can be summarized as follows:

- The river widths varied from 529 to 919 feet, and the thalweg depths varied from 12 to 21 feet.

- The scarp slopes varied from about 1V:3H to 1V:.037H, berm slopes varied from 1V: 8.06H to 1V: .83H, and the bench slopes varied from 1V: 83H to 1V:1H. Scarp and bench slopes showed little variation whereas berm slopes were highly variable.
- A total of 174 bank and nearshore bed material samples were analyzed. Of the 174 samples, 93 samples were collected from the riverbanks and 81 samples were collected from core samples. Bank soils consisted of fine sand and silt within the upper portion of the waterway and become silty and clayey within the lower reach of the waterway. Almost all the bank soil samples appeared to be well graded.
- Site lengths varied from a minimum of 0.09 mile to a maximum of 0.95 miles.
- Seventeen of the sites were located on the Right Descending Bank (RDB), and 12 on the Left Descending Bank (LDB). Thirteen were located on the straight reaches of the river, 11 on the outside bank, 3 on the inside bank, and 2 on the crossover reaches. All the selected erosion sites had natural land covers. The dominant land cover on the failure face was grass or weeds. The dominant land cover on the bank crest was woody vegetation followed by agricultural crops.
- Most of the sites from the uppermost and lowermost portions of the waterway are located within the straight portion of the river. Sites selected from the outside bank are evenly distributed throughout the waterway.

Although large floods could be the most significant cause of erosion on natural rivers, this study found 27% of the selected bank sections (80 of them in 29 sites), evidenced erosion which could have occurred only at high stages. At many sites erosion features were located within the range of stage fluctuation between the Ordinary High Water and Normal Pool stages, which cannot completely be attributed to high stages. Among these bank sections causes of erosion can be described as follows. Note that multiple causes of erosion were identified for each bank profile.

- 74% of the bank sections had evidence of seepage or piping. About 26% of these banks sections had piping holes or springs; the remaining 48% had wet subaerial benches, which likely resulted from poor drainage.
- 28% of the bank sections had small scarps on the bench that could be induced by waves, piping, seepage, or a combination of these causes.
- 24% of the bank sections showed evidence of traffic-induced disturbance. These include physical damages due to direct impact by barges and undercut banklines in fleeting areas and lock approaches.
- 10% of the selected bank sections can be associated with eddy/disturbed flow induced by riparian trees or gravel.
- 11% of the bank sections showed presence of surface drainage.

- Only about 4% of the bank sections showed erosion associated with weathering of surficial soils, which could be caused by freeze/thaw processes.

The eroded bank sections were classified into six types. Their distribution is discussed in Chapter 6. A measurement of the length of "severely eroded reaches", as marked on the navigation charts (Appendix J), shows that approximately 117 miles of the IWW bankline is severely eroded. This corresponds to approximately 20% of the total bank length (both banks) of the IWW. This percentage is very similar to the percentage represented by Types 1 and 2 in the analysis.

For the flat pool reaches including Peoria, La Grange, and Alton, Types 5 or 6 banks are generally found on the upper pool (free flowing reach) where normal stage fluctuations are high. The erosion Types then gradually change to Types 3 or 4 in the middle pool (transition reach), and to either Types 3 or 4 or Types 1 or 2 in the lower reach (pooled reach) where the stage fluctuations are minimal.

Upper Mississippi River Summary

Information obtained from the field survey study for the UMR can be summarized as follows:

1. Eroded bank sections along the Mississippi River study reach (RM 0.0 at the Ohio River confluence to RM 847.6 at Lock & Dam No. 1) can be classified into six distinct types.
2. Surficial bank soils along the upper study reach consist primarily of sand and gravel; silty and sandy deposits were more frequent along the middle study reach; and clayey and silty deposits dominated the lower study reach.
3. Much of the bank erosion in the St. Paul District was found at dredged material placement locations and along Holocene-aged landscapes. Deposits in this portion of the valley are generally coarser compared to those downstream, and historical alluviation is less there compared to downstream reaches.
4. Historical deposits are thicker along the channel margin in the Rock Island District. Erosion of Holocene surfaces is most severe in the upper portion of the pools. The lower pool reaches contain progressively thicker historical deposits which cover most Holocene surfaces. The more or less continuously-constructed protective levee system has greatly focused erosional

and depositional events between the levee and channel margins. Generally thickly-bedded historical silt and very fine sand laminae dominate the near-channel alluvial sequences downstream of the Des Moines River.

5. Below St. Louis, the continuous levee and open river systems reveal even more significant historical reworking along the channel margins. Scarps more than 20 ft high, showing historical alluvial sequences, are common. In addition, the relatively small areas where the channel abuts the valley wall, which contains late Wisconsinan and Holocene hill-slope and tributary deposits, have been eroded.
6. Because of the Great Flood of 1993, most of the bank-erosion sites investigated, in particular along the middle and lower study reaches, showed such vividly apparent flood impacts that it was extremely difficult to identify any wave-induced rework and transport except at a few fleeting and mooring sites. The lower study reach downstream from the Missouri River confluence also indicated apparent flood impacts of the floods of 1994 and 1995. Major floods have occurred along the study reach at an approximate interval of 5 to 10 years; for example, the flood of 1952, the flood of 1965, the flood of 1969, the flood of 1973, the flood of 1986, and the Great Flood of 1993. Flood effects appear to be much more significant than other erosion mechanisms.
7. Based on the individual geomorphological and hydraulic site characteristics, erosion potential of traffic-induced waves was estimated for each major study site. However, there is no means to estimate the exact rate of bank erosion due to waves from this field study. As stated above, the Great Flood of '93, the flood of 1994, and the flood of 1995 had left extensive erosion scours and smeared most of the erosion evidence due to other causes.
8. Among the seventy-five sites within the UMR pools, including the observation sites, thirty-one sites were located in the upper quarter pool; twenty sites in the upper middle quarter pool; twelve sites in the lower middle quarter pool; and twelve sites were located in the lower quarter pool. This means that fifty-one of the study sites (including the observation sites) within the UMR pools were located in the upper halves of the pools where the channel is narrower and the river stage varies more frequently than in the lower portion of the pool. Stage recession after floods is also greater in the upper ends of pools, and gradients and exposed bank heights for emergent seepage are larger in upper ends of pools.

9. On the basis of the present field study, approximately 14 percent of the Mississippi River banks are estimated to be actively eroded as of 1995.

Conclusions

The site evaluations presented in Chapters 6 and 7 provide estimates as to the relative significance of navigation use effects in the context of bank erosion processes on the UMR and the IWW. Physical forces generated by navigation traffic, such as drawdown, waves, return flow, propeller jets, and disturbed local flows could also cause erosion. These forces and their effect on bank erosion may be separated from other causative processes. The study team has determined that the bank erosion caused by navigation could be significant in mooring and fleeting areas, some lock approach and waiting areas, and in some very narrow channel reaches. Since in some study sites it has been proposed that the impacts of navigation traffic may be separated from other causative factors, and in locations the navigation induced bank erosion could be identified to be significant, the study team recommends proceeding to tasks 4 and 5.

Tasks 4 and 5 of the IPMP discuss development of regression equations which will be used to predict navigation induced erosion for the with- and without- project conditions. Usefulness of such equations has been debated among the study team members. However the team agreed that the development of a generalized equation or a set of equations that can be applied to the whole UMR and IWW would not be possible considering the time constraints and the costs associated with the field experimentation at the present time. Results from this study indicate that it may be possible to conduct field experiments at individual sites which would result in an equation or set of equations which could be applied to that individual site or at an identical site to estimate the rate of erosion caused by passing navigation traffic. Development of a set of equations which could be systematically applied to the entire UMR and IWW would require field experiments to be conducted at several representative sites so that the wide variety of bank conditions which exist on these two rivers are represented in the equations.

A correlative approach, in lieu of the regression equations discussed in Task 4 and 5 of the IPMP, as described below is suggested.

Bank Erosion Impact Assessment Study for the Upper Mississippi River/Illinois Waterway

Scope of Work

1. General. The scope of work to be accomplished consists of developing a model to assess the risk of bank erosion based on site specific field data for existing conditions and future conditions for the Mississippi River and Illinois Waterway system.
2. Available Data. The following data is available: Aquatic Areas Classification, Mapping, available data on bank erosion field survey, environmental and cultural resources, and GIS mapping/ database.
3. Develop correlations between apparent navigation induced erosion and physical parameters such as proximity to narrow channel reaches, locks, and mooring/fleeting activities, soil and sediment characteristics, land uses, etc. These correlations will be developed from data collected at the 72 detailed study sites during the 1995 bank erosion field study. In order to accomplish this task, the study team will develop a database for relevant physical parameters that were collected during the 1995 field study for both the Illinois Waterway and the Upper Mississippi River. This database is partially available in an EXCEL spreadsheet format with the remainder being in ARCINFO-GIS format. The study team will combine these two databases using Microsoft ACCESS so that any correlations between individual variables can be easily sought in a systematic manner. The study team will seek, beyond 72 detailed sites, additional data from the observation sites, the Navigation Chart Mapping, aerial video descriptions that could help increase the accuracy of the field data. Attributes to be considered for river banks and navigation traffic would include (but are not limited to) the following:

River Attributes

1. Geomorphic characteristics (inside bend/outside bend/cross over/island) – radius of curvature of bend
2. Channel width
3. Relative location of thalweg sailing line
4. Fetch length and average wind direction within fetch length/river-bank orientation
5. Closeness to flow-control structures
6. Nature of bank (natural/revetment/dredge material/etc.)
7. Bench width
8. Bench slope
9. Bench soil characteristics
10. Subaqueous lateral bed slope
11. Width of vegetation coverage on bench

12. Relative location of water edge on bench at predominant river stage
13. Relative location of erosion site with respect to Lock & Dam
14. Scarp height
15. Scarp slope
16. Bank soil characteristics
17. Bank face coverage (tree roots/vegetation/etc.)
18. Land use (farms/woods/industrial/etc.) and soil characteristics
19. Background features (closeness to lakes/wetlands/etc.)

Traffic Attributes

1. Locate major industries related to barge traffic (power plant/oil refinery/etc.)
2. Barge/leisure boats traffic records along rivers
3. Mooring activities
4. Traffic during high stages (connect with Item 10 above)
5. Tow/barge size (vary along river reach)
6. Drawdown, waves, return flow, propeller jets, and altered local shear stresses

This risk assessment study team, consisting of selected members of the Field Survey study team supplemented with experts in the ecological risk assessment field, will develop models to assess the risk of bank erosion, which is directly related to the increase in commercial navigation and recreation traffic. The study team will determine — based upon the data correlations for the Illinois and Mississippi rivers — if the river systems should be modeled separately or together. This model will be used to model the existing conditions (1992 commercial navigation traffic), the baseline conditions, and the future conditions without project.

The risk assessment study team using these correlations along with 1995 erosion mapping of both rivers, the Aquatic Areas Classification Mapping and existing resource mapping, will attempt to predict areas of adverse impacts where a measurable increase in navigation induced erosion will likely occur with increases in navigation traffic levels. Bank reaches will be classified as low, medium, and high risk areas for navigation induced erosion. The study team will identify and characterize the key assumptions and uncertainties associated with the development of the bank erosion model. Considering these assumptions and uncertainties, the study team will develop the model in a manner consistent with the fundamental concepts and methods of probabilistic risk estimation and assessment.