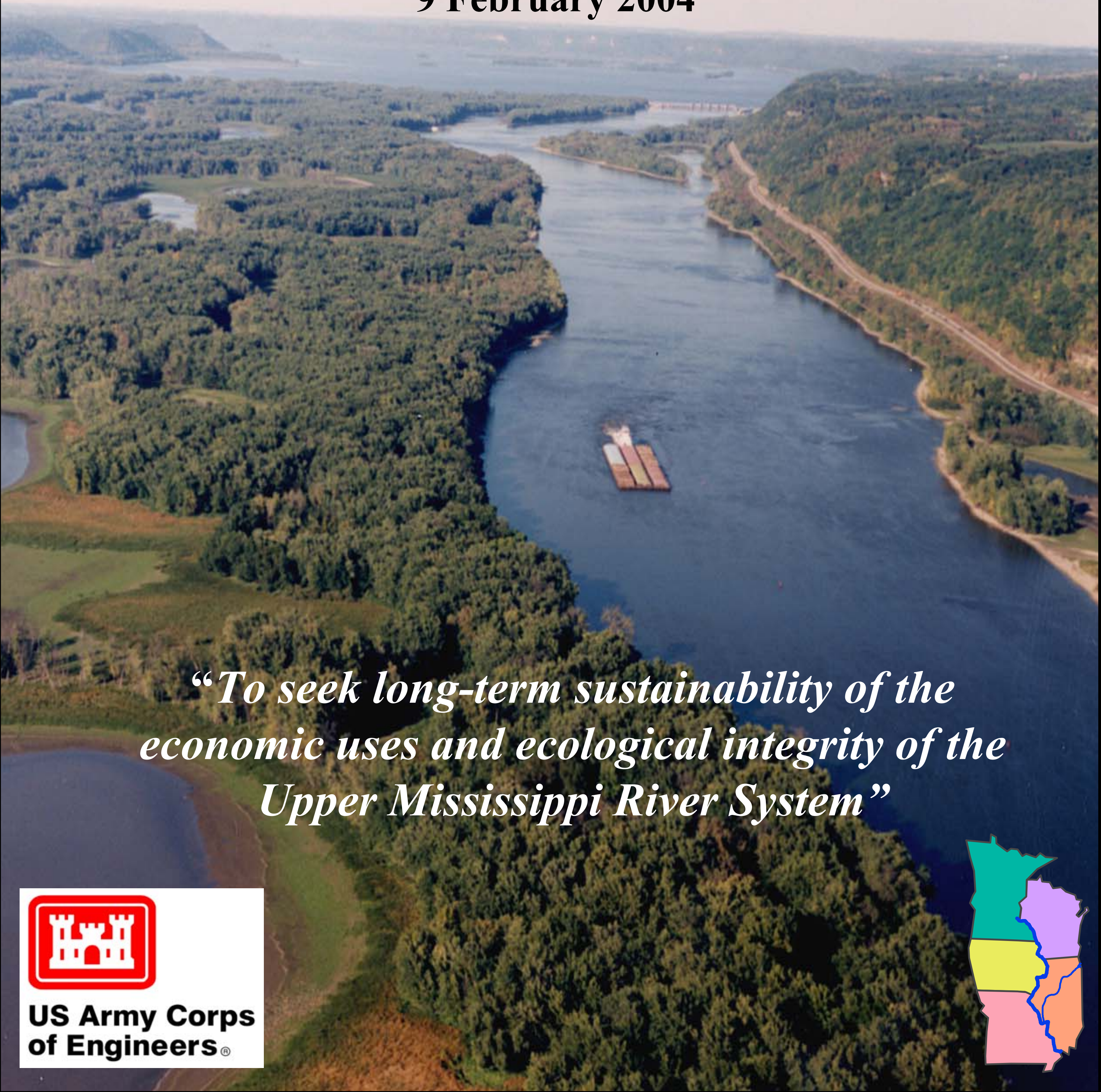
ALTERNATIVE FORMULATION BRIEFING
PRE-CONFERENCE REPORT

for the

UMR-IWW System Navigation Feasibility Study

9 February 2004



"To seek long-term sustainability of the economic uses and ecological integrity of the Upper Mississippi River System"

US Army Corps of Engineers®

PREFACE

This pre-conference Alternative Formulation Briefing (AFB) document is intended to provide a concise study overview, focused primarily on the Plan formulation process that has been followed to create viable alternatives and ultimately identify Draft tentatively selected plans for Navigation Efficiency and Ecosystem Restoration. The goal is to identify and resolve any relevant policy concerns that would otherwise delay or preclude approval of the Draft Feasibility Report. Other Federal and State agencies have been invited to participate in this briefing, and will be given the opportunity to provide comments during discussion of the various policy issues and the draft tentatively selected plan. The format of this document closely follows the Draft Feasibility Report outline and provides sufficient detail for a comprehensive understanding of the study history, purpose and plan formulation process.

The draft tentatively selected plans contained in this report are still a work in progress and no final decisions have been made. A draft recommended plan will ultimately be presented in the future draft feasibility report.

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1.1 Purpose

1.1.1 Purpose and Organization of Pre-Conference AFB materials

The pre-conference Alternative Formulation Briefing (AFB) document is intended to provide a concise study overview, focused primarily on the Plan formulation process that has been followed to create viable alternatives and ultimately identify Draft tentatively selected plans for Navigation Efficiency and Ecosystem Restoration. The goal is to identify and resolve any relevant policy concerns that would otherwise delay or preclude approval of the Draft Feasibility Report, and allow the District to release the Draft Report to the Public concurrent with the policy compliance review. The format of this document closely follows the actual Feasibility Report outline and provides sufficient detail for a comprehensive understanding of the study history, purpose and plan formulation process.

1.1.2 Study Purpose and Scope

The study was re-started in Aug 2001 under re-structuring guidance formulated in accordance with comments received from the National Research Council and from the Federal Principals Task Force. The original feasibility study was narrowly focused on the problem of reducing commercial traffic congestion on the system and associated environmental impacts. The restructured study will give balanced consideration of fish and wildlife resources along with navigation improvement planning. The feasibility study will ensure the waterway system continues to be a nationally treasured ecological resource as well as an efficient national transportation system by seeking ways to:

- Provide an efficient National Navigation System,
- Achieve an environmentally and economically sustainable system,
- Address ecosystem and floodplain management needs related to navigation,
- Operate and maintain the system to ensure economic, environmental, and social sustainability.

A key foundation of the restructured study has been the emphasis on collaboration with the stakeholders of the system. As part of the restructuring the stakeholders defined a new vision that reads:

"To seek long-term sustainability of the economic uses and ecological integrity of the Upper Mississippi River System."

The following definition of sustainability was collaboratively developed and agreed to by the group as well:

"The balance of economic, ecological, and social conditions so as to meet the current, projected, and future needs of the Upper Mississippi River System without compromising the ability of future generations to meet their needs."

The vision statement and definition of sustainability forms the basis for the restructured feasibility study. The sustainability concept will reflect that economic activity will be evaluated for environmental impact, and that environmental actions will be evaluated for economic impact.

1.1.3 Guidance Memorandums and Documentation

The following provides a quick reference to specific guidance memorandums or documents that have shaped and guided the restructured study since August 2001. Copies of these documents can be found on the CD accompanying this document or accessed on the study website: (http://www2.mvr.usace.army.mil/umr-iwwsns/):

a. August 2001: Memorandum, CECW-PM, dtd 2 Aug 20001, Subject: Upper Mississippi River and Illinois Waterway (UMR-IWW) System Navigation Study Project Guidance Memorandum.

b. October 2001: Memorandum for Commander, Mississippi Valley Division (CEMVD-MD), CECW-P, dtd 29 Oct 2001, Subject: Review of Upper Mississippi River Comprehensive Management Plan, Final Plan of Action.

c. July 2002: Interim Report for the Restructured Upper Mississippi River-Illinois Waterway (UMR-IWW) System Navigation Feasibility Study. July 2002

d. December 2002: Project Management Plan (PMP) for the Restructured UMR-IWW System Navigation Feasibility Study, Dec 2002.

e. February 2003: Memorandum For Record (MFR), CEMVR-PM, dtd 6 Feb 03, Subject: UMR-IWW Scenario Probabilities.

f. March 2003: Quality Management Plan (QCP) Updated Version, March 2003 (Original document dtd Dec 1997).

g. June 2003: Memorandum for Record: Upper Mississippi River-Illinois Waterway (UMR-IWW) System, Ecosystem Restoration – Discussion of Authorities and Cost Sharing Options, dtd. 25 June 2003.

h. August 2003: Memorandum for HQUSACE (CEDC), CEMVD-MD-PM, 11 August 2003, Subject: Upper Mississippi River-Illinois Waterway (UMR-IWW) System Navigation Study Benefit Model Sensitivity Analysis

The study is primarily being accomplished in accordance with the August 2001(ref a.) and October 2001(ref b.) Guidance Memorandums with the exception of the following:

a. Sensitivity Analysis - The Aug 2001 guidance letter stated that the ESSENCE model should not be used in the feasibility study and that a previously used and accepted model should be used in this study. Subsequent discussions highlighted the need for the use of the ESSENCE model to demonstrate the importance of the demand elasticity assumptions. The details on this topic are located in reference h.

b. Probabilities - The Aug 2001 guidance letter includes the requirement to include an assessment of the likelihood of each of the scenarios developed. The advisability of assigning probabilities to the scenarios was evaluated in reference e and found not to be recommended.

c. International Competitiveness - The August 2001 guidance letter also recommends addressing International Competitiveness in the analysis. International competitiveness and will not be a primary evaluative criterion in the final decision process. However, it is inferred that a more efficient Navigation System will maintain the lowest possible water based transportation rates, equating to a more competitive commodity price on the international marketplace. The economic models will produce outputs that can easily be converted to export quantities for the various commodities under each of the various alternatives and scenarios.

d. Alternative Modes Analysis - The August 2001 guidance letter recommends a thorough evaluation of capacity, environmental and social impacts on alternative modes resulting from a model shift due to a Federal action on the waterway. Alternative modes evaluations will only be evaluated to a limited extent for environmental and social considerations. A thorough capacity analysis will not be conducted for any of the alternatives. The measurement of NED transportation savings will follow the guidance of ER 1105-2-100 with respect to alternative mode capacity. Paragraph 6-60.a.(4) states, "In projecting traffic movements on other modes (railroad, highway, pipeline, or other), the without project condition normally assumes that the alternative modes have sufficient capacity to move traffic at current rates unless there is specific evidence to the contrary."

Any topics identified in subsequent stages of study completion, requiring concurrence or clarification, will be handled through the vertical team with the appropriate level of documentation. The Final Feasibility Report will provide a comprehensive accounting of study guidance and decisions.

1.2 Study Authority

Authority for the Upper Mississippi River-Illinois Waterway System Navigation Study (the Navigation Study) is contained in Section 216 of the Flood Control Act of 1970 (Public Law 91-611) which states:

> "*The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significantly changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest*."

1.3 Description of the Study Area

The study area comprises the Upper Mississippi River and Illinois Waterway (UMR-IWW) and lies within portions of Illinois, Iowa, Minnesota, Missouri, and Wisconsin (Figure 1.1). The Upper Mississippi River (UMR) extends from the confluence with the Ohio River, River Mile 0.0, to Upper St. Anthony Falls Lock in Minneapolis-St. Paul, Minnesota, River Mile 854.0. The Illinois Waterway (IWW) extends from its confluence with the Mississippi River at Grafton, Illinois, River Mile 0.0, to T. J. O'Brien Lock in Chicago, Illinois, River Mile 327.0. The UMR-IWW navigation system contains 1,200 miles of nine-foot deep channels, 37 lock and dam sites and thousands of channel training structures. The system is commonly broken into four broad regions including the Upper Impounded Reach (Navigation Pools 1-13), Lower Impounded Reach (Pools 14-26), Middle Mississippi River (Lock and Dam 26 to the mouth of the Ohio River), and the Illinois Waterway.

The UMR-IWW ecosystem includes the river reaches described above, as well as the floodplain habitats that are critically important to large river floodplain ecosystems. The total acreage of the river-floodplain system exceeds 2.5 million acres of aquatic, wetland, forest, grassland, and agricultural habitats. The Mississippi Flyway is used by more than 40% of the migratory waterfowl traversing the United States. These Trust Species and the threatened and endangered species in the region are the focus of considerable Federal wildlife management activities. In the middle and southern portions of the basin, the habitat provided by the mainstem rivers represents the most important and abundant habitat in the region for many species.

The total Illinois Waterway and Mississippi River Navigation System contains 37 lock and dam sites (43 locks), over 650 manufacturing facilities, terminals, and docks, and provides valuable habitat and recreational opportunities. The system provides:

1. A means for shippers to transport millions of tons of commodities within the study area—122 million tons on the Mississippi River and 44 million tons on the Illinois Waterway in 2000,
2. Food and habitat for at least 485 species of birds, mammals, amphibians, reptiles, and fish (including 10 federally endangered or threatened species and 100 state listed species),
3. Almost 285,000 acres of National Wildlife and Fish Refuge,
4. Water supply for 22 communities and many farmers and industries,
5. A multi-use recreational resource providing more than 11 million recreational visits each year,
6. Cultural evidence of our Nation's past.

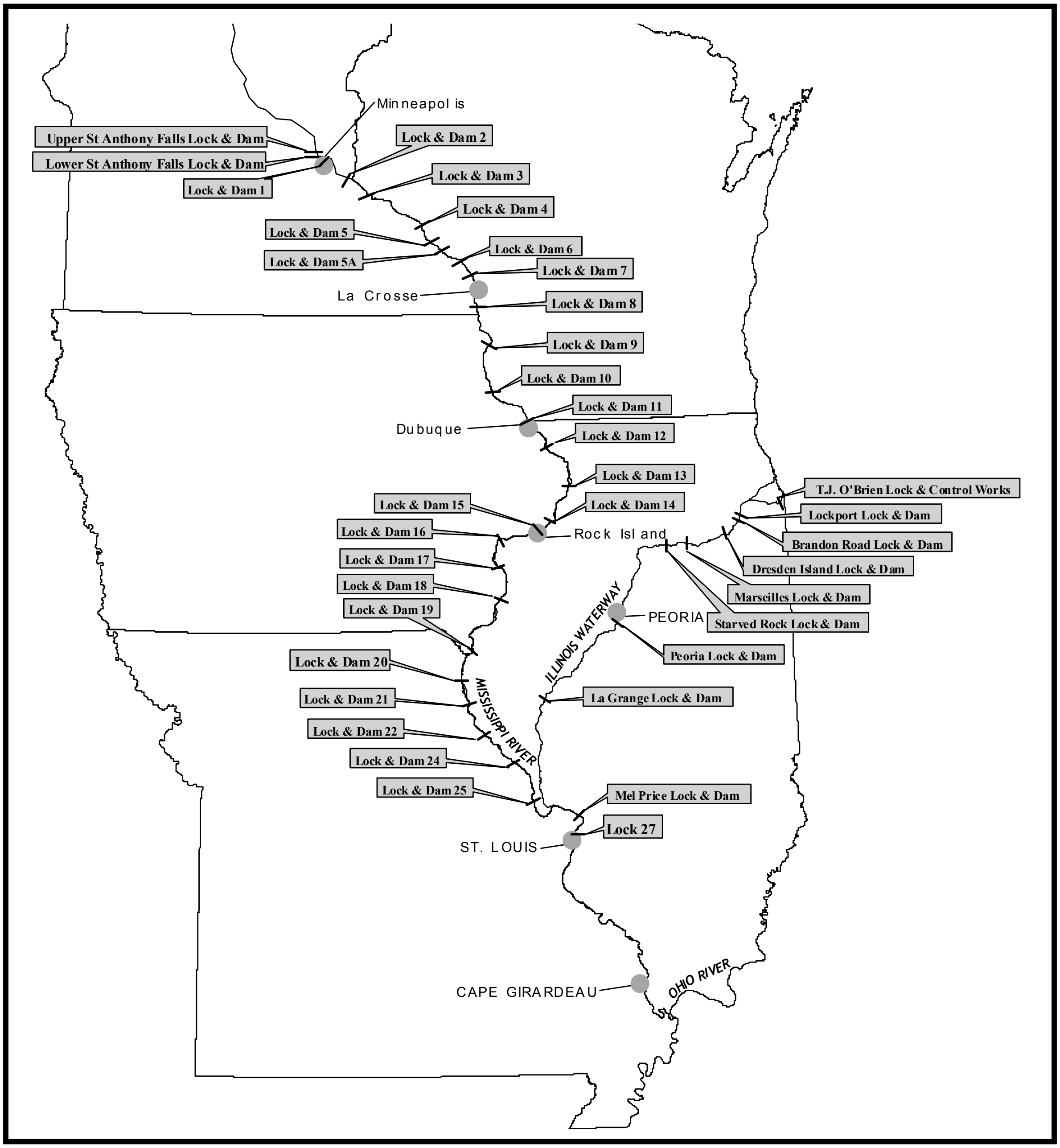

Figure 1-1. Upper Mississippi River Navigation System.

1.4 Background and History

1.4.1 Upper Mississippi River

The Federal Government began constructing navigation improvements on the Upper Mississippi as early as the 1820's. These initial efforts consisted primarily of removing snags, shoals, and sandbars; excavating rock ledges; and closing off meanders, sloughs, and backwaters to confine flow to the main channel. In 1878, Congress authorized the first comprehensive project on the Upper Mississippi River—the 4-1/2-foot channel—and in 1907, the 6-foot channel. In the next two decades, Locks and Dams 1 and 2 and what is now Lock and Dam 19 were authorized. Since 1930, when Congress authorized the 9-Foot Channel Navigation Project, the remaining 26 locks and dams were constructed between Minneapolis, Minnesota, and St. Louis, Missouri. Below St. Louis, Missouri "open channel" techniques, such as stone dikes, bank revetment, and dredging are used to maintain the channel. The 9-foot channel has been in operation since 1940.

In the 1960's, due to increasing congestion at Lock and Dam 26, a study was conducted to evaluate replacing the facility with a new lock and dam near Alton, Illinois. In 1978, Congress authorized the construction of a new dam with a single 110-foot by 1,200-foot lock chamber. Construction was initiated in 1979. This facility, eventually named the Melvin Price Locks and Dam, was completed in 1990. The authorization *(PL 95-502)* required to build that lock and dam also directed that a study be completed to assess further navigation capacity needs. That study, the *Comprehensive Master Plan for the Management of the Upper Mississippi River System*, recommended construction of a second 110-foot by 600-foot lock at the new facility. This "Second Lock" was authorized by the Supplemental Appropriation Act of 1985 *(PL 99-88)* and the WRDA of 1986, and construction was completed in 1994.

1.4.2 Illinois Waterway History

The Illinois Waterway is a major tributary of the Upper Mississippi River. It provides navigation from Lake Michigan and Chicago to the Upper Mississippi River, linking the Great Lakes with the inland waterway system. The term "Illinois Waterway" is used in place of the Illinois River, since navigation between the UMR and Great Lakes includes all or portions of the Illinois River, Des Plaines River, Chicago Sanitary and Ship Canal, Cal-Sag Channel, Little Calumet River, and Calumet River. The Illinois Waterway has been continuously developed for navigational purposes since 1822. In 1927, Congress approved legislation authorizing a 9-foot by 200-foot-wide channel on the Illinois River from Utica, Illinois, to Grafton, Illinois. This project was to complement a similar project then under construction by the State of Illinois extending from Utica to Lockport, Illinois. In 1930, Congress enacted legislation enabling the Federal Government to assume responsibility of the Utica-to-Lockport segment, already about 75 percent completed. Three years later, the Corps of Engineers completed the project, and combining it with the earlier authorized Federal project between Utica and Grafton, opened the Illinois Waterway to navigation in 1933. Navigation on the waterway was further improved with the construction of locks and dams at Peoria and La Grange from 1936 to 1938, and the addition of the Thomas J. O'Brien Lock and Controlling Works on the Calumet River in Chicago in 1960. Table 1.1 shows a timetable of navigation development activities for both rivers.

1.4.3 Economic Importance of the Navigation System

The system is a vital part of our national economy. The navigable portions of these rivers and the locks and dams that allow waterway traffic to move from one pool to another are integral parts of a regional, national, and international transportation network. The system is significant for certain key exports and the Nation's balance of trade. For example, in 1992, the Upper Mississippi River System carried approximately 60 percent of the Nation's corn and 45 percent of the Nation's soybean exports. Corn and soybeans are shipped via the waterway at roughly 60 to 70 percent of the cost of shipping over the same distance by rail. Other commodities shipped on the system include coal, chemicals, petroleum, crude materials (sand, gravel, iron ore, steel, and scrap), and manufactured goods.

The importance of the Upper Mississippi River-Illinois Waterway as a shipping artery is underscored by the increases in tonnage shipped on the system. Waterborne commerce on the Upper Mississippi River has more than tripled over the past 35 years—growing from about 27 million tons in 1960 to 84 million tons in 1995. On the Illinois Waterway, the nearly 23 million tons shipped in 1960 doubled over that same timeframe, growing to 47 million tons in 1995.

1.4.4 Ecological Importance of the Ecosystem.

The Upper Mississippi River system is considered a tremendous natural resource, leading to its Congressional. recognition (1986 WRDA) as a nationally significant ecosystem as well as a significant transportation system. The ecosystem consists of hundreds of thousands of acres of bottomland forest, islands, backwaters, side channels and wetlands—all of which support more than 270 species of birds, 57 species of mammals, 45 species of amphibians and reptiles, 113 species of fish, and nearly 50 species of mussels. More than 40 percent of North America's migratory waterfowl and shorebirds depend on the food resources and other life requisites (shelter, nesting habitats, etc.) that the system provides. The Upper Mississippi River System and associated environments have a rich record of human history spanning over 12,000 years that is increasingly being documented as one of the most archeologically and historically significant regions in the country. It also provides boating, camping, hunting, trapping and other recreational opportunities.

In addition, the Mississippi River basin's abundant and diverse ecological resources have attracted and sustained human populations for thousands of years. It is now home to more than 30 million people. Nearly 80 percent of the population lives in urban areas such as Minneapolis-St. Paul, Dubuque, Davenport-Bettendorf-Rock Island-Moline (Quad Cities), Muscatine, La Crosse, Quincy, Hannibal, Cape Girardeau, and St. Louis. Economic activities revolve around machinery, manufacturing, food and beverage processing, and crop, dairy and livestock production. Regional industries produce canned, frozen and dairy foods and manufacture broadcast equipment, construction equipment, agricultural machinery, ammunitions, chemicals, and aluminum sheet. Many of those industries depend on the network's commerce routes, which provides over 1,200 river miles of navigable channel with a minimum depth of 9 feet.

1.4.5 Study Background

Aspects of the Upper Mississippi and Illinois Waterway System Navigation Feasibility Study have been underway for more than a decade. The size and complexity of the system, uncertainty regarding economic forecasts and environmental impacts, and ultimately, the temporary halt of the study have contributed to this lengthy process. An initial appraisal regarding potential navigation traffic capacity increases on the UMR and the IWW was developed in May 1988. The initial appraisal recommended developing a plan of study to investigate a long-term solution to meet increased navigation demand and reduce delays for commercial traffic on the system. In August 1989, a Plan of Study for the Upper Mississippi River and Illinois Waterway navigation feasibility investigation was completed. This document recommended undertaking two separate navigation reconnaissance studies for investigating potential navigation improvements—one for the Illinois Waterway and the other for the Upper Mississippi River. Specific investigations were recommended to define the base condition, analyze congestion problems, determine system benefits, and examine environmental impacts. The reconnaissance-level investigation was to begin the process of establishing prioritized, waterway-specific, capital investment recommendations, including efficiency measures, required to meet future traffic demand. Both documents, completed in 1991, concluded there was economic feasibility for major capital improvements between 2000-2050 and recommended performing more detailed systemic feasibility level

Table 1-1. Timetable of Navigation Development Activities on Upper Mississippi River and Illinois Waterway.

Activity	Year
Upper Mississippi River:	
Congress authorizes removal of snags and local obstructions	1824
Congress authorizes 4-1/2-foot channel from mouthof Missouri River to St. Paul	1878
Congress authorizes 6-foot channel	1907
Construction of Lock and Dam 19	1914
Construction of Lock and Dam 1	1917
Congress authorizes 9-foot-deep, 300-foot-wide channel from St. Louis to Cairo, Illinois	1927
Congress authorizes extension of 9-foot channel to St. Paul, Minnesota, through construction of locks and dams	1930
Construction of 29 locks and dams	1930-1950
Construction of Lock and Dam 27	1953
Construction of 1,200-foot chamber at Lock and Dam 19	1957
Upper and Lower St. Anthony Falls authorized	1937
Lower St. Anthony Falls constructed	1956
Upper St. Anthony Falls constructed	1963
Congress authorizes new dam and single 1,200-foot chamber at Lock and Dam 26	1978
Congress authorizes construction of second chamber (600-foot) at Lock and Dam 26(R)	1985
Construction of 1,200-foot chamber at Melvin Price Locks and Dam (formerly Lock and Dam 26 (R))	1990
Construction of 600-foot chamber (2^{nd} Lock) at Melvin Price Locks	1994
Major Rehabilitation/Maintenance	1986-present
Illinois Waterway:	
Congress authorizes construction of the Illinois and Michigan Canal	1822
Construction of Chicago Sanitary and Ship Canal and 5 low navigation locks and dams	1900
Construction of present-day system of 7 locks and dams	1933-1939
Construction of Thomas J. O'Brien Lock and Controlling Works	1960
Major rehabilitation/maintenance	1975-present

environmental, engineering, and economic studies. In October 1991, the two studies were combined into one feasibility study providing a system approach in solving navigation problems common to both rivers. This systems approach was to include, as appropriate, environmental studies proposed by the Lock and Dam 26 (Melvin Price), Second Lock, Alton, Illinois *Plan of Study* that were needed to address navigation traffic impacts.

1.5 Study Organization

The study boundaries cross three Corps of Engineers Districts (Rock Island, St. Paul, and St. Louis), five states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin), 77 counties, and 38 major river communities. In addition, a large number of agencies, interest groups, and the general public have an interest and stake in the study outcome.

1.5.1 Study Team

The study is a multi-disciplinary and multi-district effort. Numerous team members are involved from the following Mississippi Valley Division (MVD) Corps of Engineers district offices: Rock Island (MVR), St. Paul (MVP), St. Louis (MVS) and New Orleans (MVN). Additional study team support and guidance has been provided by representatives from the Corps of Engineers Headquarters (HQ), Mississippi Valley Division (MVD), Engineering Research and Development Center (ERDC) and Institute for Water Resources (IWR). The study efforts were conducted by organizing efforts within five primary Corps work groups (Project Management/Plan Formulation, Economics, Engineering, Environmental/Historic Properties, and Public Involvement). Work group activities included the support and involvement of research facilities, universities, other agencies, and independent contractors when necessary.

The following paragraphs provide a brief description of the purpose and responsibilities for these five work groups.

1.5.1.1 Project Management/Plan Formulation

This group assured that work group elements and activities were completed on time and within funds allocated. It was charged with facilitating information sharing between work groups, ensuring efficient study progress, and leading and coordinating plan formulation efforts. The following provides a brief description of the tasks accomplished by this workgroup:

- Provided overall management to the multi-District study team.
- Managed study funds (Figure 1-2) and schedules.
- Led plan formulation efforts in the evaluation of measures and alternatives.
- Served as spokesman for the Corps on all study related activities.

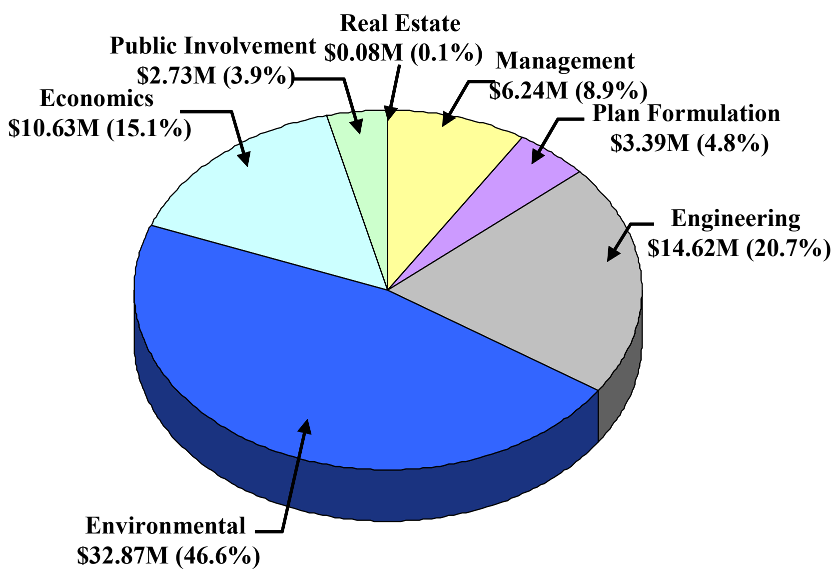

Figure 1-2. Distribution of Upper Mississippi and Illinois Waterway Navigation Study expenditures (Recon + Feasibility) through December 2003 (Total = $70.57M) for the seven main study components ($ in millions and percent of total).

1.5.1.2 Economics

This group conducted economic evaluations to assure that system-wide effects of specific alternative plans were estimated and prepared the economic and social analysis section of the feasibility report. The following provides a brief description of the tasks accomplished by this workgroup:

- Developed description of historic traffic in terms of tonnages, average delay times at each lock, and a breakdown of the various commodity groups that are transported on the system.

- Developed waterway traffic forecasts to the year 2050 including the eight major commodity groups: grain and soybeans, agricultural chemicals, prepared animal feeds, coal, industrial chemicals, petroleum products, construction materials, and steel/steel sector raw materials.
- Developed a new economic benefit model.
- Helped establish the without-project condition.
- Performed sensitivity analysis for key parameters.
- Performed transportation rate analysis.

1.5.1.3 Engineering

This work group evaluated the current navigation system and anticipated without-project operations and maintenance, rehabilitation, and replacement needs. It also conducted engineering and cost estimating efforts to develop and evaluate potential measures and assure that estimates and recommended solutions were identified within reasonable limits. The following provides a brief description of the tasks accomplished by this workgroup:

- Determined the future physical condition and investments needed to maintain the current system at an acceptable level of performance.
- Evaluated efficiency improvements that could be considered in the without-project condition.
- Evaluated the feasibility of a universe of 92 small-scale structural and nonstructural measures to reduce lock congestion.
- Evaluated the feasibility of large-scale navigation improvements at 16 sites to include lock extensions and new locks. Developed several innovative techniques for construction of lock extensions or new locks.

1.5.1.4 Environmental/Historic Properties

This workgroup collected, analyzed, and interpreted environmental data and developed adequate tools to assess the impacts of the various Navigation Efficiency alternative plans over the without-project condition. It also developed the mitigation requirements and costs associated with various alternatives. It coordinated and prepared the environmental and historic properties portions of the feasibility report, assured project compliance with environmental statutes, executive orders, and memoranda, and started to prepare an Environmental Impact Statement (EIS) in compliance with the National Environmental Policy Act (NEPA) requirements. The following provides a brief description of the tasks accomplished by this workgroup:

Environmental Impact Assessment

- Through an extensive scoping and coordination process, identified biological, special concern, cultural/historic, socioeconomic, and recreational resources of concern for the UMR-IWW.
- As part of the initial screening process for large-scale improvement measures, completed preliminary assessments of site-specific construction impacts.
- Oversaw the completion of over 60 technical studies/reports conducted in support of the overall environmental impact analysis.
- Developed state-of-the-art impact assessment tools to predict hydraulic forces generated by tows, and resultant assessment of biological effects.
- Facilitated or participated in supporting studies on alternative modes impacts and cumulative effects.

- Developed a landform sediment assemblage database, and completed draft programmatic agreement documentation, as part of the cultural resources/historic properties analysis.
- Developed an initial strategy for implementation of identified mitigation requirements.

Ecosystem Restoration Alternatives

- Developed a comprehensive database of specific, quantitative, local to regional scale UMR-IWW environmental objectives building on previous work from the Environmental Management Program Habitat Needs Assessment, Mississippi River Environmental Pool Plans, USFWS Comprehensive Conservation Plans, and related Study Efforts.
- Structured and conducted four regional two-day workshops to collaboratively review, refine, and add to the UMR-IWW environmental objective database.
- Identified appropriate restoration measures that are most likely to contribute to achieving the established environmental objectives.
- Used multiple sources of input (e.g., UMR-IWW Corps Districts, stakeholders, historical project costs and results, etc.) to establish potential costs and outcomes of the restoration measures.
- Combined varying types and numbers of restoration measures into alternative plans to address local, river reach, and system-wide needs of the UMR-IWW ecosystem. Through collaborative work with UMR-IWW stakeholders, coordinating committees, and the Navigation Study Science Panel, these tentative alternative plans were developed to provide a range of ecosystem protection and restoration opportunities.

1.5.1.5 Public Involvement

This group's role was to facilitate efforts to identify and include all potentially affected public interests in the study process, and provide opportunities to inform, educate, and solicit feedback. The public's comments and concerns were collected and identified from newsletter comment sheets, incoming correspondence, input at meetings, and messages left on the toll-free number. In addition, an internet web site was developed which facilitated the sharing of interim reports and other study information with the public. The following provides a brief description of the tasks accomplished by this workgroup:

- Distributed 24 newsletters from 1993 to September 2003 to a distribution of nearly 10,000 subscribers.
- Conducted Public Meetings
  - Oct-Nov 1993 – Public Informational Meetings (14 locations)
  - Nov 1994 – Public meetings and NEPA Scoping Meetings (8 locations)
  - Nov-Dec 1995 – Public Open Houses (5 locations)
  - Jul-Aug 1999 – Public Workshops (7 locations)
  - Nov 2000 – Public Open Forum Hearings (7 locations)
  - March 2002 – Public Meetings to present and get the public's reaction to the study's new direction (5 locations)
  - Oct 2003 – Public Meetings to present Tentative Alternative Plans (7 locations)
- Developed and maintained a toll free information phone and message service.
- Developed and maintained a study website.

1.5.2 Collaboration

A recent National study of 105 ecosystem management projects found that *collaboration* was cited more than any other variable (61%) as critical to project success (Yaffee, Phillips et al. 1996). A key foundation of the restructured study is the emphasis on collaboration among Federal and State agencies, non-governmental organizations, and the general public. Collaboration is an important mechanism for increasing cooperation and communication, fostering trust and understanding among participants, and allowing a greater set of interests to be met.

The study team re-defined and re-structured their organizational structure in August 2001 to support an increased level of regional and national collaboration with stakeholders, federal partners, the five UMR-IWW states, and senior management. Upon approval of the study framework laid our in the Interim Report (July 2002), the study team developed a revised Project Management Plan (PMP) and re-defined the manner in which information would be shared amongst the technical components, stakeholders, federal partners and senior management (Figure 1.3). The study team has been working very closely with the stakeholders of the system in providing real time information at coordination meetings and through monthly status reports posted to the study website. The following provides a brief description of the primary interagency coordination committees that have been involved with the UMR-IWW Navigation Feasibility Study since it began in 1993:

Governors' Liaison Committee (GLC) - The GLC consists of designated representatives of the governors of the five study states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin). The goal of establishing the GLC was to assure that study recommendations would merit the support of the people of each state. The purpose of this key committee is to build consensus among the study area states and to provide the Corps with the position of the governor of each state on Navigation Study matters. A total of 23 GLC meetings have been held to date.

Navigation Environmental Coordination Committee (NECC) - The NECC consists of members from state natural resource agencies, the U.S. Fish and Wildlife Service, and the U.S. Environmental Protection Agency. This committee was established to facilitate coordination for study compliance with the National Environmental Policy Act (NEPA), Fish and Wildlife Coordination Act, Endangered Species Act, and other environmental statutes requiring interagency coordination. Many Non-governmental Organizations (NGOs) have regularly participated in the NECC. The NECC has met more than 40 times to help refine environmental modeling procedures and to provide comments on environmental studies conducted as part of the overall study.

Economics Coordinating Committee (ECC) - The ECC consists of representatives from each of the five states, and one representative each from the Maritime Administration, the U.S. Department of Agriculture, Midwest Area Rivers Coalition (MARC) 2000, and the Corps of Engineers, who chaired the group. The purpose of the ECC is to allow partners and stakeholders with an opportunity to share their views on economic matters pertaining to the study, to facilitate efforts to arrive at a consensus on those matters among the members, and to engender a shared set of goals and expectations for the economic position of the study among all committee members and the public. The ECC has met 19 times to review key economic assumptions, and provide their input to the study.

Engineering Coordinating Committee (EnCC) - The EnCC consists of representatives from each of the five states in the study area and the Corps. They met three times during the study to discuss key engineering assumptions and findings. The EnCC met with navigation industry technical experts and representatives on several occasions to review the practical and logistical application of both small-scale and large-scale engineering alternatives. The Engineering Work Group also conducted several expert elicitation forums by inviting experts from construction and engineering firms to recommend and review conceptual designs and delay figures associated with construction and operation activities.

Public Involvement Coordinating Committee (PICC) - The PICC consists of representatives from each of the five states in the study area and the Corps. The PICC was established in 1993 to assist in the revision of the public involvement plan. Since then, the PICC has worked to create a shared set of goals and expectations regarding public involvement matters among all committee participants, the navigation industry, and the public.

Regular and open communication with our diverse group of stakeholders, state/federal agencies, and general public is a cornerstone of the re-structured study that has proven very beneficial. The distribution of preliminary data, analyses and documents has created a more open and trustful environment in which to discuss and collaboratively resolve many important technical or political issues. Previously the stakeholders would be engaged only after a final product had been delivered or final decision rendered. In the current organizational structure they are part of the process from initial development through final resolution. This approach has avoided many obstacles or deficiencies that may have only been identified after the fact. Detailed responses to frequently asked questions are provided on the study website and updated periodically. In addition, newsletters are published semi-annually and distributed to a mailing list of over 9,500 stakeholders and members of the interested public, and the study website is updated regularly with the latest meeting minutes, upcoming events/activities, reports, and information bulletins.

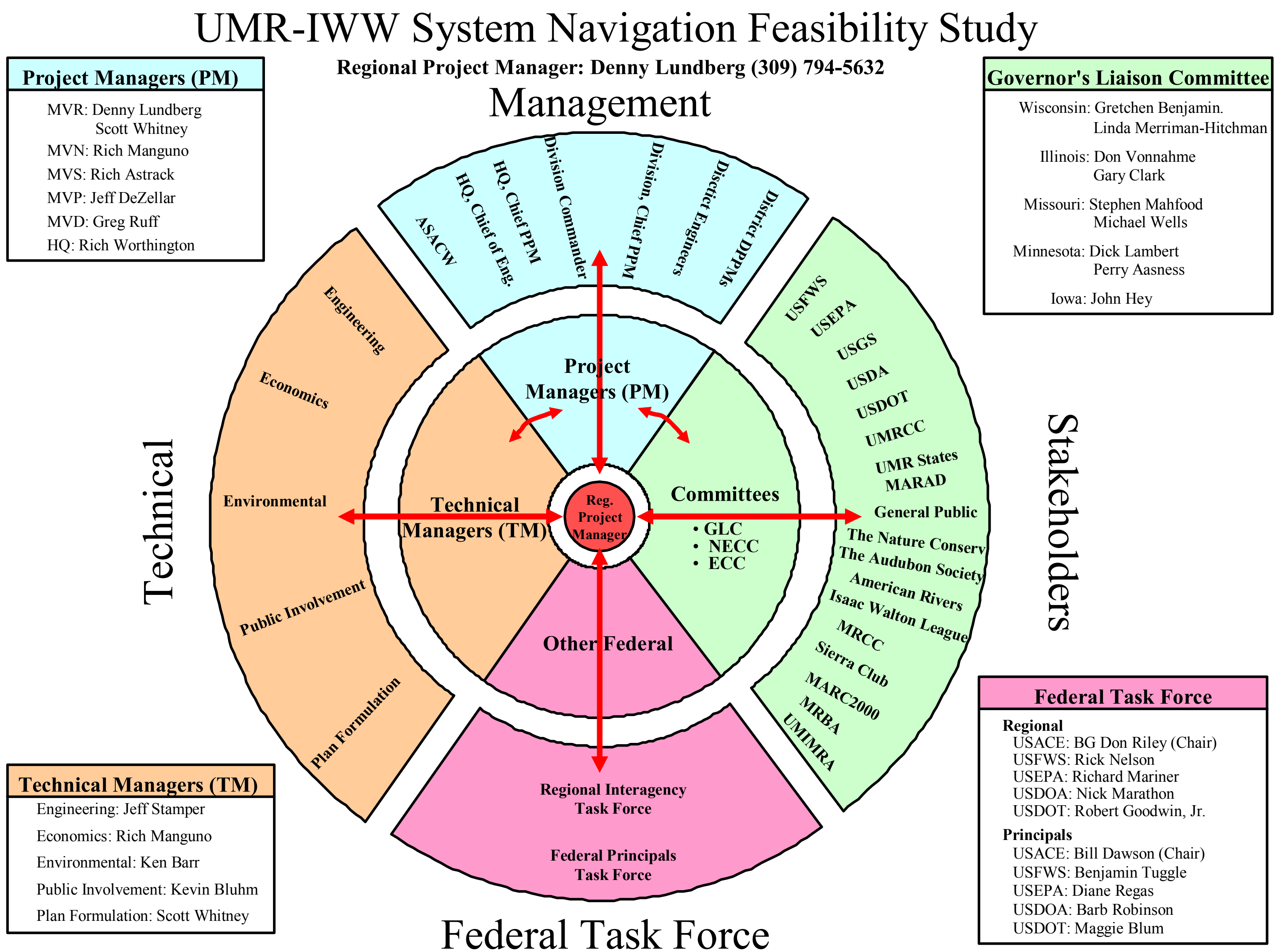

Figure 1-3. UMR-IWW System Navigation Feasibility Study Organizational Structure Schematic.

1.6 UMR-IWW System Navigation Study Technical Reports

A diverse range of evaluative and investigative studies were undertaken to gain a comprehensive understanding of the social, economic, engineering and environmental issues, concerns and implications associated with accomplishing the study objectives. To accomplish such studies, the study team engaged a diverse array of technical expertise to conduct the necessary evaluations and investigations. In many cases the study team relied on the technical expertise of scientists, engineers, and economist from other state/federal governmental agencies, private sector consulting firms, and universities. Coordinating committees identified in section 1.5.2 were involved in nearly all aspects of the planning, implementation and review of these interim products. The following provides a comprehensive listing of the interim products and reports generated by each of the respective technical study workgroups:

ENVIRONMENTAL REPORTS

ENV 1 - *Flume Study Investigation of the Direct Impacts of Navigation - Generated Waves on Submersed Aquatic Macrophytes in the Upper Mississippi River* by Robert M. Stewart, Dwilette G. McFarland, Donald L. Ward, Sandra K. Martin, and John W. Barko.

ENV 2 - *Rates of Net Fine Sediment Accumulation in Selected Backwater Types of Pool 8, Upper Mississippi River* by James T. Rogala, William F. James, and Harry L. Eakin.

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- **(a)** Upper Mississippi River-Illinois Waterway (UMR-IWW) System Navigation Study Accidents and Hazardous Spills Task. Report prepared under Contract No. DACW25-95-M-0236 by Transportation Research and Analysis Center, Inc., Delaplane, Virginia, for the U.S. Army Corps of Engineers, Rock Island District, Rock Island, Illinois. Final Report, August 1996 (180 pages-including blank pages).
- **(b)** Emissions and Fuel Use Analysis for Upper Mississippi River Basin. Report prepared under Contract No. DACW2S-97-M-0574 by The University of Memphis Transportation Studies Institute, Memphis, Tennessee. April 1998 (35 pages).
- **(c)** Accidents and Hazardous Spills Analysis for Upper Mississippi River Basin. Report prepared under Contract No. DACW25-97-M--0539 by The University of Memphis Transportation Studies Institute, Memphis, Tennessee. September 1998 (49 pages).
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PI 2 - Responses to Issues Raised at the Public and NEPA Scoping Meetings of November 1994.

PI 3 - Content Analysis Report from the November 1994 Public Meetings.

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PI 5 - Interim Report: Open House Meetings Held November and December 1995.

PI 6 - Content Analysis Report of July-August 1999 Public Workshops.

PI 7 - Transcripts of July-August 1999 Public Workshops, 1999.

PI 8 – Content Analysis Report from the March 2002 Public Meetings. 2002

PI 9 - Transcripts of October 2003 Public Workshops. 2003

PI 10 - Content Analysis Report from the October 2003 Public Meetings. 2004.

NOTE: The Public Involvement Workgroups was also responsible for the publication and distribution of 24 newsletters from 1993 to September 2003 to a distribution of nearly 10,000 subscribers

2 Plan Formulation

2.1 Description of Study Process

Following the August 2001 guidance, the study team shifted the study purpose from a singular (Navigation Efficiency) to a dual-purpose (Navigation Efficiency and Ecosystem Restoration) approach while still employing the Corps traditional six step planning process (Figure 2-1). While a dual purpose approach is not a completely foreign concept, the geographical scale, systemic approach, 50-yr planning horizon and seemingly conflicting nature of economic, social and environmental interests, posed a very unique challenge. Meeting such a challenge, required innovation, nontraditional approaches and a considerable amount of multidisciplinary collaboration. As figure 2-1 indicates, the Navigation and Ecosystem components proceeded on similar yet parallel tracks through the first 5 steps in the planning process. However, there were several management actions identified that required consideration under both components (e.g. water level management (Pool), fish passage). All steps within the study process are essentially iterative requiring the meticulous acquisition, analysis and interpretation of a diverse array of new data and historic information. Approximately 140 individual technical reports were generated during the first three steps in the study process (see section 1.6). Assembling this considerable body of work into a single meaningful document and recommendation, Draft Feasibility Report, is still underway and is indeed a very complex and challenging endeavor. The remainder of Section 2 provides the first comprehensive description and explanation of the UMR-IWW System Navigation Study process leading to the identification of a DRAFT Tentatively Selected Plan for Ecosystem Restoration (Section 2.3) and Navigation Efficiency (Section 2.4).

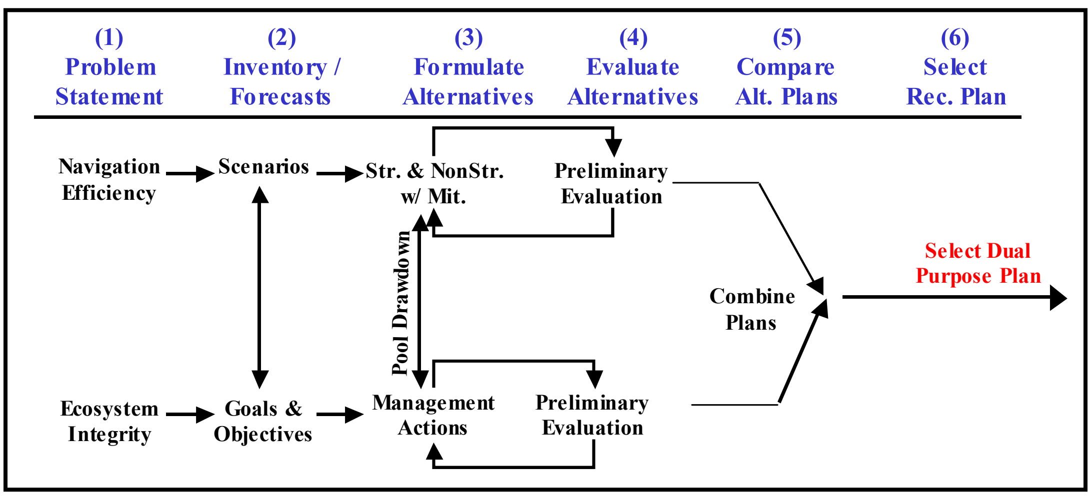


Figure 2-1. Decision Model for UMR-IWW System Navigation Feasibility Study.

2.2 Assessment of Problems, Opportunities, and Constraints

The principal **navigation** problem addressed by this study is the potential for significant traffic delays on the UMR-IWW Navigation System within the 50-year planning horizon. The principal **environmental** problems addressed by this study are changes to ecosystem structure and function imposed by the operation and maintenance of the existing 9-Foot Channel Navigation Project, and potential navigation system improvements. The primary opportunities are to reduce or eliminate commercial traffic delays and improve the national and regional economic conditions while restoring, protecting, and enhancing the environment. The goal of the feasibility study is to outline an integrated dual-purpose plan to ensure the economic and environmental sustainability of the UMR-IWW Navigation System. To fully address these feasibility study issues, the study team has identified the following three planning objectives:

OBJECTIVE 1. Recommend measures to provide for a safe, reliable, efficient, and sustainable UMR-IWW navigation system over the planning horizon.

OBJECTIVE 2. Recommend measures to address the cumulative impacts including ongoing effects of the operation and maintenance of the UMR-IWW Navigation System.

OBJECTIVE 3. Assure that any recommended measures are consistent with protecting the Nation's environment; avoiding, minimizing, or mitigating significant environmental, cultural, or social impacts.

The following four major constraints or assumptions have limited the range of options and investigations undertaken as part of this study:

a) No systemic modifications to deepen or widen the channel were considered.

b) This report represents a system level feasibility study that assesses the navigation efficiency and ecosystem restoration needs for the 50 year planning horizon. As such, it differs from a traditional feasibility study in scope and level of detail of site specific planning and engineering. Recommendations for navigation efficiency and ecosystem restoration improvements will generally require additional site specific planning and engineering documentation prior to initiation of construction activities.

c) This study will only address ecosystem and floodplain management needs related to the navigation system. While this study is systemic in nature, it does not represent a comprehensive river basin study.

d) Due to authority, resource, and time constraints, this study does not represent a full multi-modal study. The study did not attempt to fully assess all possible future alternative transportation modes which could be developed (e.g., possible development of grain pipelines, magnetic levitation trains, etc.) nor a full comprehensive analysis of the potential environmental impacts associated with increased use of alternative modes if waterway improvements are not made. However, some evaluations of existing primary alternatives (e.g., railroads) were conducted, including an evaluation of transportation cost comparisons and limited evaluation of environmental impacts.

2.3 Ecosystem Restoration

The Upper Mississippi River Basin, including the Illinois River, is a prominent feature in the landscape and heritage of the Midwest region. The resources of the river system, also called goods and services, attract animals and people from throughout the World. The fact that many of the goods and services provided by the UMR-IWW are uniquely important to the nation was validated when the U.S. Congress in WRDA 1986 declared the area "a nationally significant ecosystem." The following is a sample of the many uses, species, and habitats that are of particular importance in the UMR-IWW or are rarely found in other areas.

- It is a 2.5 million acre large river floodplain laboratory. It is a "system of systems" for us to use, understand and appreciate. It is a place for this and future generations to learn how to restore and maintain a "living river" in the face of a global human population that will grow by 1 billion people in the next 12 years.
- Mississippi River is the largest riverine ecosystem in North America and third largest in the world.
- Combined with the floodplains of the navigable sections of the Illinois, Minnesota, St. Croix, Black and Kaskaskia Rivers cover 2.5 M acres of land and water area.
- Commercial and recreational fishery.
- Today, some 297,000 acres of the floodplain are now within the National Wildlife Refuge System.

- About half of the 30 million residents of the watershed rely on the water from the UMR and its tributaries for municipal and industrial water supplies.
- It provides for over $6.6 billion dollars in revenue annually from some 12,000,000 visitor-days of use by people that hunt, fish, boat, sightsee or otherwise visit the river, its magnificent bluffs and communities.
- Recreation and tourism employ 143,000 people in the corridor.
- It is a migratory flyway for 40% of all North American waterfowl.
- It is a globally important flyway for 326 bird species (60% of all species in North America).
- At least 260 fish species have been reported in the basin (25% of all fish species in North America).
- The river is habitat for 37 species of fresh-water mussels.
- The river corridor is habitat for 45 amphibian and reptile species and 50 mammal species.
- It is critical habitat for 286 state-listed or candidate species and 36 federal-listed or candidate species of rare, threatened or endangered plants and animals endemic to the UMR Basin.
- It provides the important, but intangible, benefit of over 1,200 river miles of diverse natural, rural and urban open space for human exploration, experiential education, spiritual renewal and aesthetic enjoyment.

* (Unless otherwise noted these bullets are excerpted from UMRCC, 2000)

2.3.1 Inventory and Forecast of Ecosystem Conditions

2.3.1.1 Historical Condition

Prior to widespread European settlement of the region, the Upper Mississippi River Basin was a diverse landscape of tallgrass prairie, wetlands, savannas, and forests. Logging, agriculture, and urban development over the past 150 years has resulted in the present landscape that is more than 80 percent developed. Millions of acres of wetland drainage, thousands of miles of field tiles, road ditches, channelized streams, and urban stormwater sewers accelerate runoff to the mainstem rivers. The modern hydrologic regime is highly modified, with increased frequency and amplitude of changes in river discharge. Dams and river regulation throughout the basin also modify river flows. The modern basin landscape delivers large amounts of sediment, nutrients, and contaminants to the river. Since impoundment, sediment accumulation and littoral (i.e., wind and wave) processes in the navigation pools have greatly altered aquatic habitats.

At the system-wide scale there were natural gradients in habitat among river reaches. Northern river reaches were more forested and were composed of mixed silver maple forests, river channels, seasonally flooded backwaters, floodplain lakes, marsh, and prairie. Beginning around the northern Iowa border and along the lower Illinois River, grasslands and oak savanna dominated floodplain plant communities. Historic surveys reveal a higher proportion of oaks and other mast trees in the forest community than at present. Below the Kaskaskia River, the floodplain was heavily forested with species characteristic of southern bottomland hardwood communities. Impacts of river floodplain development include forest loss and water gain in northern reaches, and grassland and forest losses in the rest of the UMR-IWW.

2.3.1.2 Significant Ecological Disturbances

European settlement in the Upper Midwest region brought many changes to the landscape and waterways. The rivers provided efficient transportation and were the focal point of commerce and colonization. The spread of the population upstream along the Illinois River is well documented. As the Midwest economy and population grew, so did the demand for water transport. The U.S. Government got involved in Mississippi River navigation in 1824 when the Army Corps of Engineers was tasked with removing logs and other obstructions from the river channels to ease constraints on steamboat travel which was very hazardous.

2.3.1.2.1 Early Commercial Navigation

Beyond their impact on the channel environment, steamboats created a huge demand for fuel wood. Large forest tracts were cleared to feed the demand for fuel. High-grading, where select hardwoods were sought, was common initially, but eventually entire forests were cleared. Where large tracts were cleared, agriculture typically followed in the clearings and prevented forest regeneration. Where regeneration did occur, it was typically from light seeded species such a elm, maple, and cottonwood. The hard mast communities never really recovered. The abundance of timber was reduced by 20 to 60 percent of the floodplain area during the steamboat era (1820-1920s).

2.3.1.2.2 Contemporary Commercial Navigation Traffic

Navigation traffic affects ecosystem conditions in many ways. The physical effects of towboat drawdown, entrainment, and sediment resuspension have direct and significant impacts on fish, plants, and side channel/backwater habitats. Shoreline areas that are subject to drawdowns and wake waves cannot support vegetation and inshore invertebrates. Fish are affected by propeller strikes on adult fish but more significantly from shear stress on eggs and larval fish. A larval fish entrainment model estimated that approximately 150,000 equivalent adult fish were lost per year from shear stress over the project area (of the 25 species of most interest on the UMR-IWW). Waves created by towboats can break aquatic plant stems and reduce plant growth by resuspending sediment, limiting light penetration, and inhibiting photosynthesis. Sediments resuspended by recreational and commercial boat traffic can be carried into sensitive backwaters and side-channels causing additional sedimentation. These areas are critical elements of large river ecosystems. Impacts of towboats operating in the main channel on freshwater mussels were investigated, but the effects were minimal. The incremental impacts of increased traffic resulting from increased lockage capacity on fish, vegetation, side channels, and backwaters are addressed as part of the mitigation plan.

2.3.1.2.3 Fleeting

The environmental effects of fleeting have not been comprehensively assessed, but there are some well known impacts that raise concern. Tying barges off to trees can cause many forms of damage, from directly knocking them down to stripping bark and making them more susceptible to pests or disease. There is also the factor of barges scraping the bottom of the river in shallow channel border areas. This is where freshwater mussels and other benthic fauna may be impacted by direct contact or prop wash. There are hydraulic and propeller strike impacts in fleeting areas from the frequent movement of tow boats dropping off and picking up barges. Finally, there are aesthetic impacts where large numbers of rusting barges degrade the view from riverfront towns or natural areas.

2.3.1.2.4 Water Quality

Development in the UMR-IWW region had tremendous effects on water quality for several reasons. First, large human populations needed to dispose of their sewage, and the easiest disposal was to pipe sewage to the rivers. This was especially problematic downstream from large cities. Large fish kills and mussel die-offs were documented below Minneapolis, Minnesota, the Quad Cities, Illinois and Iowa, and St. Louis, Missouri. The most extreme example is the case of the Illinois River where the flow of the Chicago River was reversed through a series of canals and rivers to shunt pollution away from the city's water supply, Lake Michigan. The migration of the pollution downstream was slow, but steady, and the decline of aquatic communities was well documented. At one point the river was so degraded that most native plants and animals were eradicated for more than 100 miles. The Diversion, as it is known, also increased water levels throughout the river causing significant changes to the distribution and character of floodplain lakes and channels (see impoundment effects below)

Development throughout the UMR basin also caused significant changes to water quality. Deforestation, plowing the prairies, and urban development all disturbed native land cover and soil, which in turn released huge quantities of sediment and nutrients through the stream network. Sedimentation and excessive nutrient and pesticide runoff continue today as some of the most critical ecological impacts in the mainstem rivers and Delta. Much of the sediment transported to the mainstem rivers is mobilized from stream beds and banks where it is either latent deposits from earlier land use practices or from active erosion. There are estimates that latent sediments may take 100 or more years to flush through the system once erosion rates are controlled. Stormwaters carry an array of pesticides, fertilizers, oils, solvents, detergents, and other contaminants emanating from rural and urban landscapes.

2.3.1.2.5 Impoundment and River Regulation

The UMR-IWW navigations dams transformed the rivers from free flowing, hydrologically variable, and complex channels to a series of navigation pools that create a stairstep from St. Louis to Minneapolis and Chicago. The dams impound water to increase the depth of the main channel to 9 feet or greater and can cause substantial changes in the distribution of surface waters. To varying extents, the dams impose a hydrologic zonation in each pool with an impounded region close to the downstream dam that blends into shallow aquatic, marshy habitats at mid-pool, and riverine characteristics in upper pool reaches. A broad open water impounded area and increased backwater area are most evident in Pools 5 to 13, the other pools do not show substantial increases in water area as a result of impoundment. They all, however, currently lack the low river stages characteristic of the undeveloped river during low flow periods.

The effects of the impoundment to support commercial navigation was perceived as ecologically beneficial for many years after the dams were completed. In many areas north of Clinton, Iowa aquatic habitat was expanded across low elevation floodplain areas, resulting in large increases in the amount of open water area. The effect of water diversions from Lake Michigan in the late 1800s was very similar, and the dams at Peoria and La Grange did little to increase the stage, rather they fixed the high stage, preventing low flow drying and sediment compaction. In areas south of Clinton there was relatively little change in the amount of open water area, but the low flow river stage was raised and fixed to support commercial navigation. New aquatic habitats were quickly colonized by fish and aquatic plants, resulting in a dramatic boon of river productivity. These high quality habitats remain in tact in many of the northern pools, but they have been severely degraded in southern pools where sediment accumulates. Upstream reaches of most pools experience relatively natural water level variation, and the mid and lower pool portions of dams using “hinge point” operation (especially Pools 24 – 26) are periodically exposed and consolidated during drawdowns.

The term “pool aging” is a generic term for the numerous changes that occurred in the pooled UMR-IWW reaches over the last 60 years. Sediments from upland sources and eroding islands and river banks have filled many deepwater areas. Wind generated waves in the large open water habitats created by the dams have eroded plant beds and limited submersed aquatic plant production because they resuspend sediment and reduce light penetration through the water. Sediment quality is also degraded because the dams fix the low flow river stage and thus do not allow backwater sediments to be exposed as they would be in an unregulated river. Sediments retain a high moisture content and are unconsolidated because they are never exposed.

The navigation dams impact fish movement by blocking fish movements through the dam, since most species can only pass during high flow periods when the dam gates are out of the river. Some dams present more complete barriers than others (see connectivity discussion below).

2.3.1.2.6 Agricultural Industrialization

Following WWII there were significant changes in farming practices basin wide. There were not many entirely new farming practices introduced, rather, the equipment, farms, and use of chemicals, and emphasis on monocultures all got bigger. Many of the problems with erosion and mass wasting in hilly landscapes were solved with the incorporation of terraces, grassed buffer strips, more densely planted crops, no till crop management, etc. under the guidance of the Soil Conservation Service (current Natural Resources Conservation Service). Many more problems were introduced or intensified though. Waterway ditching and field tiling increased the magnitude and timing of storm run-off and drained prairie wetlands. Stormwater is now transported to the mainstem rivers at a rapid rate and they are noticeably more erratic or flashy. In the river floodplain, agriculture accounts for about 50 percent of the entire floodplain area.

2.3.1.2.7 Exotic Species

Several prominent species introduced during the last decade have been exerting great pressure on environmental and economic components of the UMR-IWW. Zebra mussels introduced to the Great Lakes rapidly spread through the UMR-IWW. They have impacted industrial water users whose pipes needed to be cleaned and monitored for encrustation. They also impacted freshwater mussels where they colonized the shells in thick mats by competing for food and polluting the native mussels in their waste. Zebra mussel transport upstream in the UMR from the IWW was aided by the transport of adult zebra mussels on barges. Common carp introduced in 1800's are currently among the most abundant fish species in the river. Asian carp introduced in the 1990's are dispersing rapidly upstream. Their potential competition with native species could be great based on food requirements, but the impacts have not been quantified. Some notable plant introductions are purple loosestrife in wetlands, an European variant of Reeds canary grass, and Dutch elm disease.

2.3.1.2.8 Environmental Improvements

Recognition of health and safety risks of pollution and habitat impacts of poor land use prompted significant environmental regulations and conservation incentive programs since the 1970s. Improvements in water quality and upland habitat have been very significant with most surface waters now in compliance with established standards. The degraded zones below cities discussed earlier have all demonstrated improvements in water quality and the recurrence of sensitive species like freshwater mussel and mayflies. Mass emergences of mayflies are once again blanketing river banks and riparian areas; snowplows are sometimes needed to clear bridges.

There is a long and complicated history of land use in the Midwest, but some examples of erosion in the early 1900s are quite extreme. There were massive efforts of the CCC and WPA in the 1930's to curb the extensive erosion problem throughout the Upper Midwest. Thousands of dry dams and ponds were constructed. Improved land use through the century has substantially controlled erosion and sedimentation in streams, but there are still problems and need to restore degraded areas. Marginal lands that were set aside and planted to wildlife cover have been beneficial for terrestrial species.

Effective habitat protection, management, and restoration have been critical elements in maintaining high quality river-floodplain habitats in the UMR-IWW. Habitat quality and quantity are directly related to the abundance of public land, so the Upper Impounded Reach (Pool 1 to 13) has greater potential under existing conditions. Natural resource managers in the reach have considerable experience with harvest and land management, they have more recently incorporated small and large scale habitat restoration. Large scale water level management is an emerging tool for cost effective land management. Other UMR-IWW reaches have more limited opportunities because of geomorphic and hydrologic conditions, as well as a lack of public land. Restoration on existing parcels has demonstrated the effectiveness of habitat management measures. Restoration on new land acquisitions are demonstrating that natural regeneration of wetlands is possible if naturalistic hydrologic patterns can be recreated.

Recent experience clearly demonstrates the restorative capabilities of rivers like the UMR-IWW and the positive return on investments in environmental restoration. This experience is used later to help predict the benefits and outcomes of restoration measures proposed in the environmental alternative plans.

2.3.1.3 Existing Habitat Conditions

The previous section briefly described some of the major impacts affecting the UMR-IWW. These are collectively referred to as cumulative impacts and are the sum of human influence on ecological systems. It is exceedingly difficult to parse out the amount of impact imposed by one element of the system on other elements in the system because they all occur together, but may operate at different temporal or spatial scales. These impacts have been reviewed many times, specifically for the Nav Study in the UMR-IWW Cumulative Effects Report (WEST Consultants, Inc. 2000) and in the U.S. Fish and Wildlife Service's Draft Coordination Act Report (USFWS 2002). Other comprehensive reviews of UMR-IWW ecosystem conditions are available in the Upper Mississippi River System Long Term Resource Monitoring Program Ecological Status and Trends Report (USGS 1999) and in the Upper Mississippi River System Habitat Needs Assessment (USACE 2000). The following sections briefly state the current conditions of important ecosystem components and processes.

2.3.1.3.1 Land Cover

The Upper Mississippi River System floodplain area encompasses 2,643,376 acres. Agriculture is the dominant land cover class, occupying about 50 percent of the floodplain. Open water is the second dominant land cover class, covering 17 percent of the floodplain. Floodplain forests follow closely, occupying 14 percent of the floodplain. No other class of vegetation exceeds 10 percent of the floodplain area, and only developed land areas exceed 5 percent.

Land cover classes are unevenly distributed throughout the river system, and the absolute floodplain area of river reaches and pools may also differ greatly. The largest differences occur in the amount and distribution of agriculture (2-2) and the proportion of open water in the floodplain. Agriculture dominates the floodplain south of Rock Island, Illinois (Pool 14), and open water occupies a greater proportion of the floodplain between Minneapolis (Pool 1) and Clinton, Iowa (Pool 13). Wetland classes are generally more abundant between Minneapolis and Clinton. Grasslands are fairly evenly distributed but are rare throughout the river system. Woody classes are important throughout the river system and generally occupy between 10 to 20 percent of the floodplain.

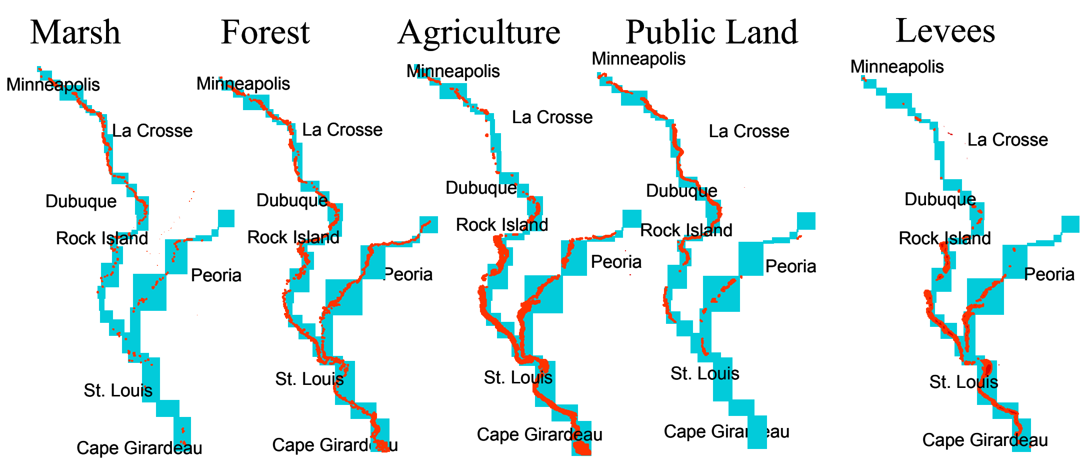


Figure 2-2. Marsh, forest, agriculture, public land, and levee distribution in the Upper Mississippi River System. Red shaded areas depict the abundance of land cover or land use categories to emphasize their distribution (USACE 2000). Light blue areas represent open water.

2.3.1.3.2 Floodplain and Aquatic Areas

Geomorphic areas, or aquatic and terrestrial features within river reaches, are parts of the river system that have similar geologic origins, formed by similar river processes or manmade structures. They include channel, backwater, and floodplain areas. Aquatic areas are either contiguous (connected with the river) or isolated (normally not connected with the river). Similarly, floodplain areas are either contiguous or isolated from the river by levees that were put in place to protect people, infrastructure, and agricultural lands. The geomorphic area data is limited to Upper Mississippi River Pools 4 through 26, a reach of the Middle Mississippi River (River Miles 31-75), and the Illinois River La Grange Pool. The summary of the reach from Lake Pepin to St. Louis, Missouri shows that about 40 percent of the total floodplain area (including both aquatic and floodplain areas) is leveed, but levees are concentrated south of Rock Island, Illinois (Figure 2-2). This figure closely approximates the amount of agriculture in the floodplain. The distribution of leveed floodplain as proportion of total floodplain area is about:

- 3 percent north of Pool 13;
- 50 percent from Pool 14 through Pools 26;
- 80 percent in the Open River; and
- 60 percent of the lower 160 miles of the Illinois River.

Contiguous floodplain susceptible to seasonal flooding constitutes about 23 percent of the floodplain area system-wide. Islands are about 8 percent of the floodplain area, bringing the total terrestrial area to about 70 percent of the floodplain from Minneapolis to St. Louis.

The range of the proportional contribution of aquatic area types was 10 to 70 percent of the total river floodplain and aquatic area, which is indicative of the geomorphic variability among river reaches and the differing effects resulting from impoundment. Backwater aquatic area classes are more prominent in the northern pooled reaches, and channel habitats are more prominent in the southern pooled reaches. Overall:

- channel border is 6.6 percent of the total area,
- impounded area is 4.6 percent,
- contiguous backwaters are 3.9 percent,
- secondary channels are 3.7 percent,
- navigation channel is 3.2 percent,
- shallow aquatic area is 2.8 percent,
- and isolated backwaters are 2.0 percent.

Tailwaters, tertiary channels, tributary channels, and excavated channels are 0.2 percent or less of the total floodplain area, respectively.

2.3.1.3.3 Terrestrial Habitat Distribution

It is useful to examine the patterns of landscapes when assessing their ability to support desirable animal communities. An analysis of long-term change in several broad habitat classes helps assess general change over time. When examining existing conditions, or managing for discrete habitat or species, attention to fine details of habitat may be more appropriate.

Grassland

The Mississippi River floodplain from Iowa to southern Illinois has experienced a marked loss of grassland land cover. The extent of grassland fragmentation and conversion are the most extreme changes in many parts of the UMR-IWW. Grassland patch connectivity has been highly reduced, and connectivity to other natural habitats has been reduced where agriculture or development are adjacent to grassland patches.

Forest

Forest was and remains an important component of the floodplain landscape for many reptile and amphibian, bird, and mammal species. Contemporary forests are distributed differently and have different species composition than in the past. They are even aged and have low tree species diversity. Changes in response to river and floodplain development differ among geomorphic reaches. Floodplain forests in upper pooled reaches were replaced mostly by water impounded by dams and also by development. Forests remaining in the upper pooled reaches have species composition similar to the past. In the southern pooled reaches, the lower Illinois River, and the Open River south to the Kaskaskia River, open forests and grassland-oak savannas joining dense riparian forests and grasslands were eliminated, but riparian forests remain largely intact (Figure 2-1). In the Open River south of the Kaskaskia River, the floodplain was almost completely forested, but it was largely cleared and levees were constructed to provide various levels of protection.

Marsh

Marsh fragmentation is difficult to assess because river marshes were not well mapped in early periods and they are inherently fragmented along backwater margins, wet meadows, and river banks. Generally, contemporary marsh communities are more abundant in northern river reaches than in southern reaches (Figure 2-1), where there are few backwaters, river water is turbid, and sediment quality is poor.

Agriculture

Croplands currently occupy about one-half of the total UMR-IWW floodplain area, and agriculture is the dominant land cover class. Cropland distribution is skewed toward southern river reaches where levees protect the wide fertile floodplains. Agriculture is the largest continuous land cover class in the lower 500 miles of the Upper Mississippi River and the lower 200 miles of the Illinois River. Grasslands once occupied most of the current agricultural land, and forested areas were also converted to crops. Natural habitat along fencerows, riparian areas along streams and ditches, wetland patches, and set aside areas provide habitat within these agricultural landscapes. In 2000, these remnant patches made up 15% of the leveed areas and included native habitats characteristic of the region: forest, grassland, marsh, and open water.

2.3.1.3.4 Connectivity

Seasonal flooding is an ecologically important process in large river floodplain ecosystems because it connects the river with its floodplain. In the UMR-IWW many low elevation floodplain areas are no longer subject to seasonal flooding because they are permanently flooded from impoundment by navigation dams. Comparing pre-dam and post-dam, total open water area has decreased or remained stable in Pools 4 and 14 to 25, the Open River, and the Illinois River, but it increased in Pools 5 to 13 and 26. Stability implies that dams had little effect on the plan form outline and amount of open water area. Decreases in water area are attributable to several geomorphic processes including: loss of contiguous backwaters, filling of isolated backwaters, loss of secondary channels, filling between wing dams, and delta formation. Increases in water area are apparent where dam impacts inundated significant amounts of low elevation floodplain in lower pool areas.

The leveed areas enumerated above (see Figure 2-1 also) reduce aquatic habitat connectivity with floodplain habitats. Aquatic-terrestrial connectivity is important for many physical, chemical, and biological functions. Floodwater flow moves sediment and nutrients over the floodplain to shape it and to enrich the soils and rejuvenate marshes, prairies, and forests. Chemical transformations in floodplain habitats consume and transform nutrients to balance input and outputs and nutrient discharge to coastal areas (e.g., The Gulf of Mexico). Biological responses to flooding can be diverse and prolific; microbial and invertebrate production thrives on inundated floodplain vegetation, fish feed on the invertebrates and spawn in flooded land, stranded fish feed a variety of predators and scavengers, and shorebirds are drawn to exposed mudflats surrounding backwater lakes. Reduced connectivity to floodplain habitats impacts the functions described above, and also impacts connected habitats and receiving waters be concentrating sediments and nutrients in smaller areas or shunting them downstream.

Connectivity of UMR-IWW aquatic habitats has also been modified by dams that block fish migration on the mainstem rivers and up into tributaries. Flood control and hydroelectric dams block access to over one-half of the length of tributary streams and rivers. Fish use tributaries for spawning and to seek refuge from harsh flow or water quality conditions on the main river. Upper Mississippi River System navigation dams are used to maintain low flow navigation, so the dams were constructed to allow high flows to pass freely through the dams with all gates open. Locks and dams 1 and 19 present nearly complete barriers to upriver fish migration because they are also hydroelectric dams with high fixed crests. The other dams are open from 1 to 30 percent of the time, which provides some opportunity for upriver fish passage (Figure 2-3).

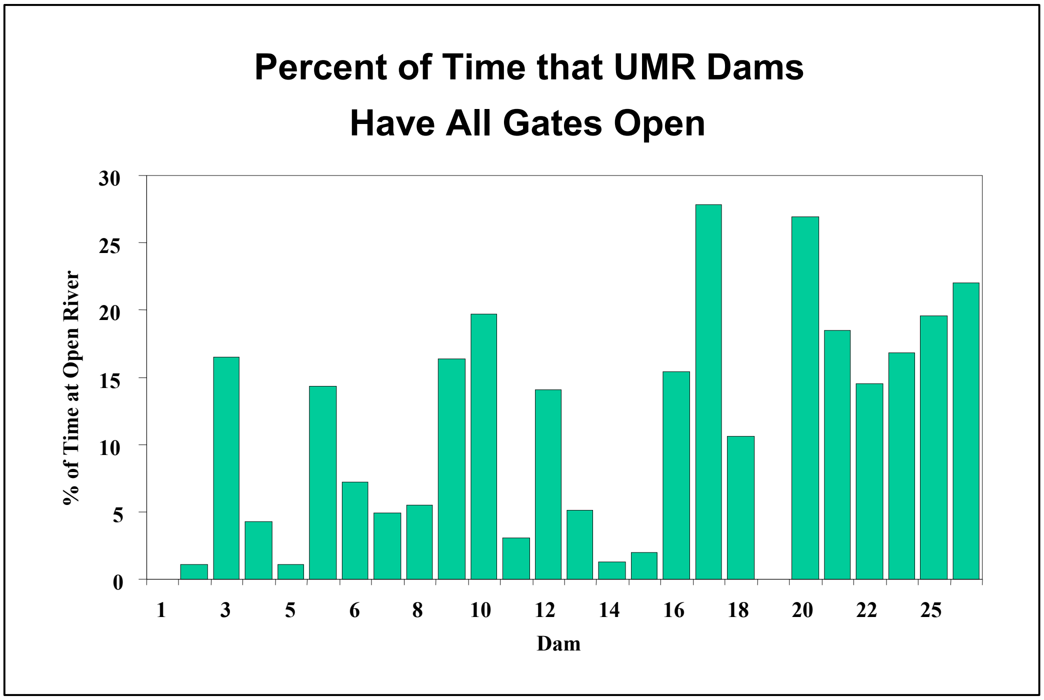


Figure 2-3. Percent of time that Upper Mississippi River navigation dam gates are raised out of the water, enabling upriver passage by some fish species.

2.3.1.3.5 Fragmentation

Natural habitats are highly connected south of Minneapolis to Clinton, Iowa, though river impoundments have disrupted the continuity of terrestrial floodplain communities. However, discontinuity in the distribution of public lands and levees (see Figure 2-2) has resulted in significant habitat fragmentation south of Rock Island and along the lower Illinois River. The riparian forest remains fairly contiguous in a narrow band along the longitudinal gradient of the rivers, but large tracts of other native floodplain terrestrial communities only remain as remnants in the national wildlife and fish refuges and state conservation areas.

2.3.1.3.6 Diversity

Habitat diversity is a measure of the different types of habitats, their size, and their relative abundance in a defined area. Habitat diversity can be calculated for both land cover and geomorphic areas. Land cover diversity is highest along Minnesota, Wisconsin, and northern parts of Illinois and Iowa in the Upper

Impounded Reach (Pools 1 – 13). The other river reaches (i.e., Lower Impounded, Open River, and Lower Illinois River) have the lowest diversity scores. These lower reaches are highly developed for agriculture. Geomorphic area diversity follows a pattern very similar to land cover diversity.

2.3.1.4 Forecast of Future Habitat Conditions

2.3.1.4.1 Geomorphic Change

The Cumulative Effects Study (WEST, Inc. 2000) concluded that the UMR-IWW plan form features are quite stable and are not projected to change much in absolute area over the next fifty years. The projected changes for all the pools along the UMR-IWW include a prediction that total water area will decrease by only 1.4 percent by the year 2050. The system-wide area of aquatic area classes are predicted to change as follows:

- contiguous backwaters decrease by 2.1%;
- isolated backwaters decrease by 3.6%
- main channel decreases by 0.7%;
- secondary channels decrease by 2.6%;
- island area decreases by 2.0%.

Island loss is largely due to island erosion predicted to occur in Pools 5, 8, 9, and 10. For many other reaches, the area of islands increases. The total perimeter of islands, a measure of shoreline complexity, is predicted to decrease by 3.7%. The area change predictions should not be considered to be precise estimates of change, but should rather be considered as indicators of the location, types, and general amounts of changes likely to occur in the future. Also, it must be emphasized that the predictions include changes in surface area only, and do not account for many factors (depth, structure, vegetation, etc) that affect habitat quality.

The Cumulative Effects Study geomorphic change assessment of Mississippi River reaches concluded that Pools 8, and 9 have been, and are predicted to continue to be dominated by island erosion. Pools 5-9 is the only reach where water area is expected to increase, including both isolated and contiguous backwater. This is because of the predicted continued erosion of islands in the reach. In all other reaches, total water area is expected to decrease, including both isolated and contiguous backwater areas.

Pools 10 – 20 have experienced loss or little change in the amount of contiguous backwater area. Generally, aquatic area losses and gains in this Mississippi River reach are expected to continue in the future at slower than historical rates. The Illinois River was estimated to lose 25 percent of its present aquatic area in the next 50 years. Continued secondary channel loss was projected for the Open River reach.

Natural resource managers were surveyed for local knowledge of habitat conditions for the Habitat Needs Assessment. The managers identified aquatic habitat change, especially loss of backwater depth, that was not apparent in time-series photographs reviewed for the Cumulative Effects Study. The resource managers identified more than 530 areas that were degraded and expected to decline further.

2.3.2 Establishing Goals and Objectives for Condition of the Ecosystem

It was determined at the outset of the restructuring of the Nav. Study that ecosystem restoration planning needed to be based on a strong set of ecologically and socially desired future ecosystem conditions. These desired future conditions are often described as definitive goals and objectives for the condition of the UMR-IWW ecosystem. Goals and objectives must be set at different levels (Table 2-1). At the highest level, the broad goal of sustainability of the UMR-IWW was defined as described above. A second level of goals can more specifically address the condition and management of the river ecosystem and specific economic and social goals related to floodplain land use and the navigation system (Table 2-2). Such broad goals for integrated and adaptive river management have been applied in many other river management situations world-wide.

Table 2-1. Tiered goals for integrated river planning.

Level of Goal	Scale	Example
First Tier Goals	System-Wide Consensus Based	Sustainability of system components
Second Tier Goals	Broad Qualitative Integrated and Adaptable	Restore and maintain evolutionary and ecological processes; maintain reliable, efficient inland waterway
Third Tier Goals and Objectives	Quantitative Local to Regional Component Specific	1,000,000 duck use days in Pool X; lock improvements at Locks 20 - 25

Table 2-2. Tier 2 ecosystem goals (Grumbine, R. Edward. 1994. What is ecosystem management? Conservation Biology 8(1): 27-38.).

1. Maintain viable populations of native species in situ
2. Represent all native ecosystem types across their natural range of variation
3. Restore and maintain evolutionary and ecological processes (i.e., disturbance regimes, hydrological processes, nutrient cycles, etc.)
4. Integrate human use and occupancy within these constraints

At a third level, measurable objectives for the condition of the river, floodplain, and navigation systems should be identified. As part of the UMR-IWW Nav. Study a series of regional workshops were conducted to collaboratively review, refine, and add to a database of regionally explicit ecosystem objectives. These workshops built upon previous objective setting exercises performed under the EMP Habitat Needs Assessment, Pool Plans, UMRCC Reports, USFWS Comprehensive Conservation Plans, Cumulative Effects Study, and related study efforts to develop specific, quantitative, local to regional scale environmental objectives for the UMR-IWW. The final workshop report (DeHaan et al. 2003) provides a detailed explanation of the process and methodology that were followed to incorporate and build upon these previous objective setting exercises to create a standardized GIS database (Figure 2-4) that provides a comprehensive documentation and rationale for the UMR-IWW environmental restoration objectives. This objective setting exercise resulted in almost 2,600 spatially explicit objectives for the condition of the river ecosystem.

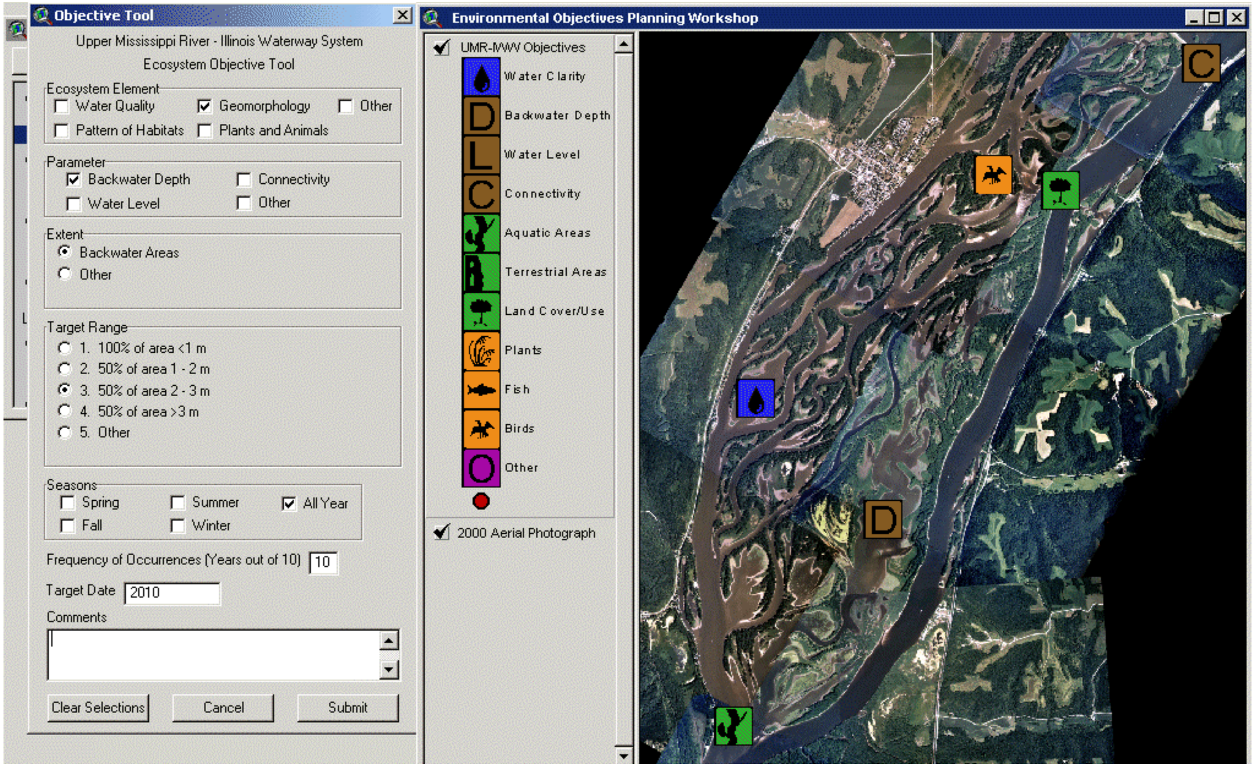


Figure 2-4. UMR-IWW Environmental Objectives Database.

The Objectives Database was extensively reviewed by an Environmental Science Panel convened to review the environmental restoration components of the UMR-IWW Nav. Study. The interdisciplinary panel combined and categorized the comprehensive list of over 2,600 objectives to a, still long, but more manageable list of 89 objectives categorized by Essential Ecosystem Characteristics: biogeochemistry, geomorphology, hydrology/hydraulics, habitat, and biota.

The process used to establish objectives is quite useful to account for numbers of practical projects, their general locations, sizes, shapes, and features. Benefits can be estimated based on the influence and performance of similar restoration efforts. However, the process does not capture the concept or vision of the desired future condition. Without establishing it as a reference condition, the presettlement ecological condition of the UMR-IWW helps understand the natural potential of the system. The river systems were essentially continuous networks of streams, wetlands, prairies, and forests. Aquatic and terrestrial systems were intimately linked through seasonal flooding and drying cycles that supported nutrient and energy exchange, allowed animal migrations, and created and maintained habitat. Human impacts have altered these conditions and processes to the extent described above and the system no longer functions or produces as it did in the past. In some cases the current conditions are degraded, in others they are unchanged or recovered. The objectives identify locations to restore ecological conditions and processes to a recovered condition, a desired future condition. The objectives do not state that the entire system needs to be restored to natural habitat, but suitable habitats do need to be available at a frequency and quality to maintain native species. For some species habitat needs to be spaced as rest areas along migration corridors, for others, relatively high quality habitat in a small backwater lake can support resident populations. Corridors connecting habitat patches are important for population dispersal and seasonal movements. The rationale for the distribution of measures to address specific habitat needs are presented in Section 2.3.3.3.

A careful review of the objectives database reveals that the categories of environmental objectives in this study are uniformly distributed through the IMR-IWW. Implementing restoration measures to address all the objectives would not achieve, nor even approach, the presettlement condition because of the large amount of land isolated from the river by levees, hydrologic changes, and changes in ecosystem drivers at the basin scale. Implementing no, or few, environmental restoration measures would result in more environmental degradation of the types described above. The UMR-IWW environmental restoration alternatives distribute restoration measures to address important ecosystem conditions and processes, an ideal plan would match the needs of resident and migratory animals, support native habitats, and provide ecosystem services important to people in the region.

The impacts of an ecosystem restoration plan can be observed as it is implemented. Habitats can be mapped, animals can be counted, and people's activity can be documented. The value of ecological services can be quantified and compared to the cost of remediating them or reproducing them. The ecosystem report card recommended by the Environmental Science Panel can be tailored to provide the outcome measures desired by decision makers.

2.3.3 Formulation of Ecosystem Restoration Alternative Plans

The Navigation Study was conducted to address following considerations for the continued operation, maintenance, and potential improvement of the system: "to relieve lock congestion, achieve an environmentally sustainable navigation system, and address ecosystem and floodplain management needs related to navigation in a holistic manner" (USACE 2001). A major emphasis of the study is identifying a method to shift the way the Corps operates and maintains the system to strive for environmental sustainability. The dual purpose (i.e., economic and environmental) approach also emphasizes the importance of collaboration among affected publics, industries, communities, agencies, and organizations. These partners worked together to develop a vision of a sustainable system, one that is compatible with the Environmental Operating Principals of the Corps of Engineers. Ecosystem restoration alternatives (Table 2-3) were developed accordingly, with increasing effort devoted to protecting existing habitats, restoring areas directly affected by the navigation project, and, finally, restoring areas marginally affected by or not affected by the navigation project.

Table 2-3. UMR-IWW Navigation Feasibility Study ecosystem alternative plans.

Alternative A. No action/Without project (current environmental management activities and rehabilitation efforts continue at historic levels).
Alternative B. Protect and maintain existing environmental diversity (current mosaic of habitat types and ecological diversity maintained into the future: no net loss).
Alternative C. Restore the first increment of habitats most directly affected by the navigation project.
Alternative D. Restoration to a level which includes management practices and cost effective actions affecting a broad array of habitat types.
Alternative E. Restoration to include most environmental objectives that could be accomplished in the context of the navigation project.

The approach to and rationale for developing these alternatives are described in Section 2.3.3.3.

2.3.3.1 Adaptive Management

Implementation of any alternative needs to be done in the context of a comprehensive and integrated plan for river management because so many system components are intrinsically linked. Making decisions to address and resolve the complex assortment of ecological needs and objectives within the UMR-IWW should be conducted in the context of a long-term commitment to a policy of adaptive management. Adaptive management is a process that seeks to aggressively use management intervention as a tool to strategically probe the functioning of an ecosystem. Management measures are designed to test key hypotheses about the structure and functioning of the ecosystem. This approach is very different from a typical management approach of "informed trial-and-error" which uses the best available knowledge to generate a risk-averse, "best guess" management strategy, which is then changed as new information modifies the "best guess". Adaptive management identifies uncertainties, and then establishes methodologies to test hypotheses concerning those uncertainties. It uses management actions as tools to not only change the system, but as tools to learn about the system.

There are several elements both scientific and social that are vital components of adaptive management:
1. Management is linked to appropriate temporal and spatial scales
2. Management retains a focus on statistical power and controls
3. Use of computer models to achieve ecological consensus
4. Use embodied ecological consensus to evaluate strategic alternatives
5. Communicate alternatives to stakeholders for negotiation of a selection

Specific elements incorporated into the UMR-IWW adaptive management program would include:
1. Organization
    - River Management Council
    - Science Panel
    - River Management Teams
2. Systemic Studies
    - Ecosystem Modeling (numerical and conceptual)
    - Information Needs Assessment
    - Biological data collection (example Fish Stock Assessment)
    - Physical data collection (bathymetry)
    - Etc.
3. Restoration Measure Evaluation
    - Island Building
    - Fish Passage
    - Side Channel Restoration
    - Etc.

The success of an adaptive management approach will require an open management process that seeks to include partners and stakeholders during the planning and implementation stages. Consequently, adaptive management must be a social as well as scientific process. It must focus on the development of new institutions and institutional strategies just as much as it must focus upon scientific hypotheses and experimental frameworks. Adaptive management attempts to use a scientific approach, accompanied by collegial hypotheses testing to build understanding, but this process also aims to enhance institutional flexibility and encourage the formation of the new institutions that are required to use this understanding on a day-to-day basis.

One of the main benefits of adaptive management is the development of an iterative and flexible approach to management and decision-making. This iterative approach emphasizes the fact that management actions can be viewed as experimental manipulations of the system of interest. The results of the manipulations can be monitored and future management decisions can be informed by the outcomes of previous decisions. Another important benefit of adaptive management lies in the opportunity for scientists and managers to collaborate in the design of novel and imaginative solutions to the challenges of managing complex and incompletely understood ecological systems. Alternative management actions can be stated as hypotheses and addressed from the perspectives of rigorous experimental design and decision analysis. The probable (possible) outcomes of management alternatives and the values of such outcomes can be estimated in relation to management goals and objectives. The adaptive approach recognizes that uncertainty is unavoidable in managing large-scale ecological systems. Importantly, uncertainty can be analyzed and exploited to identify key gaps in information and understanding. The results of such analyses of uncertainty can be used to efficiently allocate limited management resources to new research or monitoring programs.

2.3.3.2 Categories of Potential Improvements

Prior to conducting the environmental objectives workshops referenced above, important ecosystem characteristics that can be affected by specific management actions were considered. Improvements to the UMR-IWW ecosystem can be accomplished by influencing the function and structure of the system with these actions. Ecosystem functions consist of ongoing processes (e.g., variable hydrology, sediment transport, etc.) that shape the structure (e.g., plant communities, distribution of aquatic habitats, etc.) of the system. Potential ecosystem improvements identified in the UMR-IWW Environmental Objectives Database were grouped into four categories of functional and structural elements (Table 2-4). The functional elements include *water quality* and *geomorphology* and structural elements consist of *pattern of habitats* and *plants and animals*. This hierarchical structure further breaks these elements down into additional ecosystem parameters (e.g., connectivity, land cover/use, etc.).

Table 2-4. UMR-IWW ecosystem objective categories.

Functional	Structural

• Water Quality
  o Water Clarity
• Geomorphology
  o Backwater Depth
  o Water Level
  o Connectivity
	• Pattern of Habitats
	  o Aquatic Areas
	  o Terrestrial Areas
	  o Land Cover/Use
	• Plants and Animals
	  o Plants
	  o Fish
	  o Birds

2.3.3.3 Ecosystem Management and Restoration Measures

There are many management and restoration measures appropriate to the UMR-IWW that have been applied or have potential application. These range in temporal and spatial scale from routine and frequent actions that affect smaller areas (e.g., daily operation of the gates at a dam), to infrequent actions that affect larger areas over longer periods of time (e.g., a pool-scale growing season drawdown to re-establish emergent aquatic plants). Regulatory, operational, and structural measures, approximately 400 individual actions, were identified and reviewed for their potential to address UMR-IWW environmental objectives. Twelve overarching categories of restoration measures were selected after considering input from UMR-IWW stakeholders, coordinating committees, and the Navigation Study Science Panel (Table 2-5). A relational database was developed to better identify the multiple linkages between UMR-IWW ecological objectives and associated measures. Table 2-6 provides a simplified depiction of the relation between measures and the ecological objectives they address. Some measures are more broadly effective and address several objectives, others are more specific and may only address a single objective, but these measures collectively represent general methods of management and restoration that could be employed to achieve the identified UMR-IWW ecosystem objectives. Further refinement of the combinations, timing, and placement of management and restoration measures will occur through adaptive management and detailed planning for major restoration projects.

Table 2-5. UMR-IWW ecosystem restoration measures.

- Island Building
- Island Protection
- Shoreline Protection
- Fish Passage
- Floodplain Restoration
- Water Level Management – Pool
- Water Level Management – Backwater
- Backwater Restoration (Dredging)
- Side Channel Restoration
- Wing Dam/Dike Alteration
- Improve Topographic Diversity
- Dam Point Control

Table 2-6. UMR-IWW ecosystem measures and related objectives.

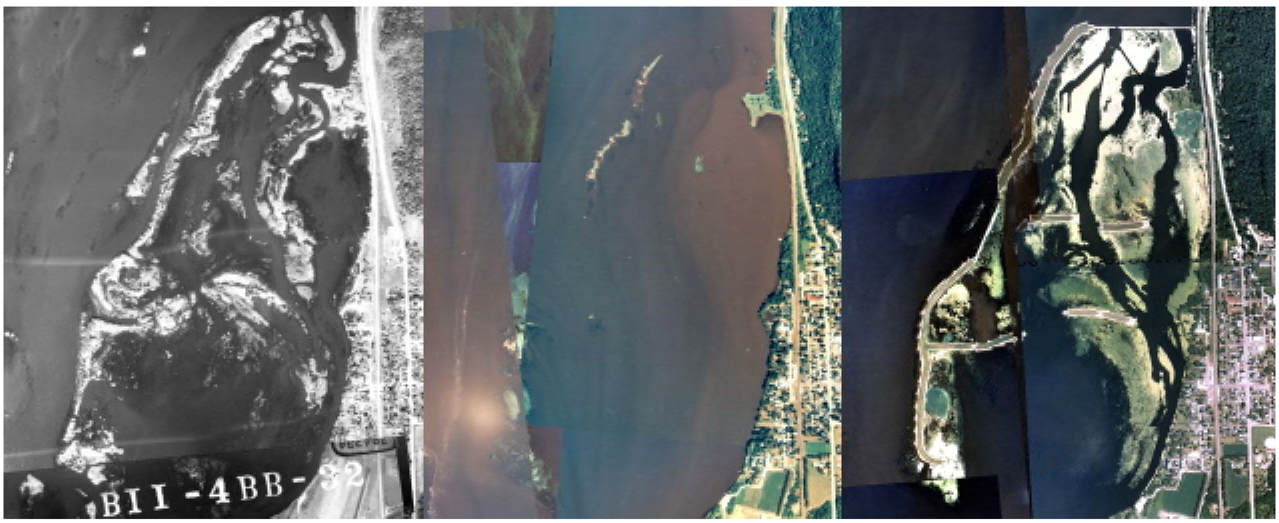
Restoration Measure	Environmental Objective(s)	
	Habitat	Process
Island Building	Aquatic, terrestrial	Flow, erosion
Island Protection	Terrestrial, aquatic	Erosion
Shoreline Protection	Terrestrial, aquatic	Erosion
Fish Passage	Aquatic	Connectivity
Floodplain Restoration	Marsh, terrestrial	Connectivity
Water Level Management – Pool	Marsh, aquatic	Hydrology
Water Level Management – Backwater	Marsh	Hydrology
Backwater Restoration (Dredging)	Aquatic	Water quality, connectivity
Wing Dam/Dike Alteration	Aquatic	Connectivity
Side Channel Restoration	Aquatic	Connectivity
Improve Topographic Diversity	Terrestrial	Hydrology (water table)
Dam Point Control	Marsh, aquatic, terrestrial	Hydrology

2.3.3.3.1 *Island Building*

Islands are common features of the UMR-IWW landscape, especially in the northern pooled reaches where the geology and glacial outwash created a classic island-braided channel form. This form is also common below some major tributaries and below floodplain constrictions at Rock Island, Illinois and Keokuk, Iowa. Islands create off-channel areas that are sheltered from river currents and waves. These characteristics create conditions ideal for a variety of aquatic plants and highly productive wetlands. They also increase habitat diversity by providing conditions suitable for a variety of forest and wetland communities. In addition, they create ideal habitat for ground nesting birds, helping them avoid predation.

Many islands were present when the lock and dam system was completed. In some areas islands have been lost to erosion and in other areas they have grown as a result of sedimentation. Islands can be constructed in areas of high bed sediment transport by starting with a rock "seed island." The river then deposits sediment below the "seed island" to create a larger island. Island building includes constructing islands from sediment (sand, clay, or silt) dredged from the bottom of the river to replace islands eroded by waves and river current. They may also be constructed in open water areas to create sheltered off-channel habitat to promote backwater communities. Past experience has led to designs that can protect large areas (>1,000 acres) with as little as 30 acres of island. Island construction can be done

Pool 8 Islands HREP Phase II, near Stoddard, Wisconsin



October 1961 August 1994 August 2000

concurrently with channel maintenance dredging, providing beneficial use for dredged material and reducing channel maintenance costs.

Proposed island restoration is most frequently identified in the upper pooled reaches where island erosion is most pronounced, but the action will have wide application to create wave breaks and to store sediment dredged to create deepwater habitat in other river reaches.

2.3.3.3.2 *Island and Shoreline Protection*

Shoreline and island erosion are natural processes that characterize dynamic rivers. In the UMR-IWW, shoreline erosion is exacerbated by commercial and recreational boats and by wind-generated waves in the impounded system. Shoreline erosion is a problem where it damages private property, important habitats, or archeological resources.

Island and shoreline protection (either bankline or off-shore revetments) includes armoring banks with stone or vegetation to prevent erosion. Erosional areas have been mapped and can be targeted for protection. This measure is viewed as a habitat protection measure that maintains existing conditions to the extent possible. This restoration measure will be applied widely throughout the river system.

Natural resource managers have identified numerous locations where island and bank erosion is threatening critical resources. Highly valuable forest stands such as heron and egret nesting colonies, eagle roosting trees, or rare bottomland hardwoods are targets for protection of terrestrial resources.

Erosion of natural levees or islands is undesirable in locations where introduction of sediment laden river flow, bed load, or currents may degrade backwater habitat.

2.3.3.3.3 *Fish Passage*

As noted in the Fish Passage Workgroup Report, there are at least 30 species of native migratory fish in the UMR-IWW. Fish movement among pooled river reaches is critical for them to access high quality spawning, rearing, feeding, and winter habitat. Some notable species, such as eels and skipjack herring, migrate from the ocean to the headwaters, others are large river migrants that may travel throughout the Mississippi River Drainage (e.g., the Missouri, Ohio, Illinois, Mississippi Rivers and their tributaries). There are also many species the make seasonal movements of a few miles to 30 miles or more to reach spawning or overwintering habitat.

UMR-IWW dams restrict upstream fish movement during most portions of a given year. Technical fishways, such as fish ladders, and naturalistic by-pass channels through spillways were the primary measures considered, although some benefits may be gained from modified dam operation and embankment lowering. The primary benefit is increased opportunities for seasonal fish migrations, but recent introductions of exotic Asian carps are forcing biologists to reconsider risk of allowing the exotic species to spread.

All UMR-IWW dams are eligible for consideration for fish passage measures, but some offer greater benefits, in terms of stream miles made available, habitat, and cost, than others. The best locations to provide fish passage connect large river reaches, especially tributary stream networks. A work group was formed to evaluate the problem and opportunities for fish passage and they recommended 14 locations for initial consideration.

2.3.3.3.4 *Floodplain Restoration*

Floodplain habitats are integral components of large river ecosystems because of the seasonal flood pulse that inundates them and connects them to the river. Many species of plants and animals are adapted to this flood cycle and take advantage of habitat and food resources as they are made available. Many important sediment and nutrient transfers also occur when floodplains are inundated.

Floodplain habitats throughout the UMR-IWW have been altered for many reasons. In northern river reaches, dams spread water across low elevation floodplain areas to greatly increase aquatic habitat connectivity in the floodplain. Floodplain restoration in the north is a mix of protecting some areas with islands, connecting isolated backwaters, and restoring tributary channels. In southern river reaches the floodplain is much more developed for crop production and flood protection, and is thus much more isolated from the river. Floodplain restoration in southern reaches includes a mixture of water level manipulation in management areas, wetland/habitat management in leveed areas (e.g., WRP, CRP, etc.), or restoration of agricultural areas to aquatic, floodplain forest and prairie habitats. Restoration of privately-owned floodplain areas requires landowner cooperation or acquisition of real estate interests from willing sellers and donors.

Spunky Bottoms, Illinois River Mile 80

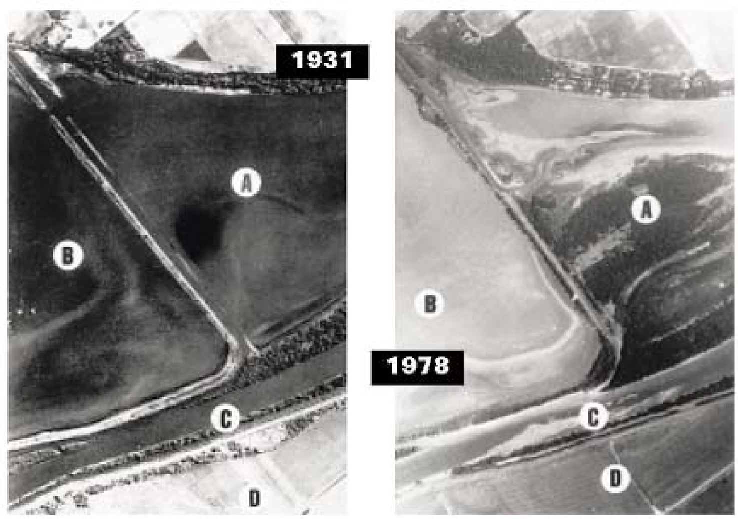
2.3.3.3.5 *Water Level Management*

Large river ecosystems such as the UMR-IWW are characterized by seasonal cycles of flood and drought (or low flow). As mentioned above, a variety of ecological functions and processes are linked to this cycle. Development of water resources for hydropower or navigation typically alters and disrupts these natural cycles. Fortunately in the UMR-IWW, the flood stage of the hydrograph is relatively unaltered, but low stages have been eliminated to support commercial navigation.

Water level management is a broad topic that includes maintaining water levels in the channel to support commercial navigation, modifications of the dam operating procedures for environmental benefits, or managing water levels in isolated management areas on the floodplain. Water level management in the navigation channel is the typical operating procedure that created and maintains the existing array of habitats. Modified dam operations for environmental benefits includes lowering water levels (drawdowns), changing flow distribution through dams gates, minimizing water level fluctuations, and changing control points (i.e., dam point vs. hinge point operations). The greatest current interest of stakeholders considering water level management is drawdowns to expose sediment to establish emergent perennial or annual wetland plants in shallow aquatic areas. Pool scale drawdowns can be accomplished while maintaining navigation. In some cases, advance dredging will be required to maintain adequate channel depths. The extent and duration of drawdowns used for alternative formulation purposes was 2 feet for 60 consecutive days to simulate natural low flow conditions and consolidate substrates and allow plant germination. Drawdown implementation will be adaptive to fit environmental conditions and stakeholder desires, so that drawdowns may be more or less extensive in time or space. Aquatic plants then provide structure and refuge for a variety of invertebrates and fishes. Water level management in backwaters is a popular management action in some river reaches, but it is infrastructure and labor intensive, and may also exclude fish from important habitats.

2.3.3.3.6 *Backwater Restoration (Dredging)*

Large river ecosystems support a variety of habitats, of which, backwaters are an important component. Backwater habitats support many popular sport fishes, waterfowl, shorebirds and wading birds. Backwaters are also quiet areas off the main channel where people and animals alike can seek refuge from the busy main channel environment.



Many UMR-IWW backwaters have been degraded by excessive amounts of sediment emanating from the basin, tributaries, and mainstem sources. The degradation is in the form of loss of depth, poor sediment quality, poor water quality, and sediment resuspension that blocks light required by aquatic plants. The remedy to the problem can be in the form of backwater dredging, or backwater water level management discussed above. Backwater dredging typically consists of dredging channels with fingers extending from the main dredge cut to a depth of 6 - 8 feet deep. Past projects have dredged about 20 acres which provides enough area for fish from larger areas to concentrate into during winter and other harsh climate conditions. Sediment dredged to create depth can be used to enhance aquatic areas with islands, or terrestrial areas with increase topographic diversity and elevation which promotes the growth of oaks and other mast tress species.

Backwater sedimentation and loss is especially pronounced in southern pooled reaches and the Illinois River where sediment from the Corn Belt was excessive in the past. Streambank erosion throughout the basin is another important source of sediment filling backwaters. Backwater restoration is required throughout the UMR-IWW.

2.3.3.3.7 *Side Channel Restoration*

Side channels provide off-channel habitat that shelters fish and other animals from the harsh conditions of the main channel. In braided channel habitats of the northern river reaches, side channels are numerous and provide a variety of habitat conditions. Further south, side channels are typically larger and more uniform in their configuration.

Side channels have been degraded by sedimentation and channelization. Where sedimentation is the issue, restoration includes dredging the upper and lower connections similar to what is done in backwaters. Restoration in response to channelization typically involves modifying channel regulating structures to increase connectivity and flow between the main and secondary channels. In the Middle Mississippi Reach side channels have been created by notching the landward end of wing dams to allow flow between the bank and island (see figure below). In most cases, work within the side channel may include constructing barbs to alter flow patterns or augmenting woody debris piles or other structure.

Side channel restoration is needed throughout the UMR-IWW.

2.3.3.3.8 *Wing Dam/Dike Alteration*

Wing dams are prominent channel regulating features common in main channel habitats. In northern river reaches most wing dams are artifacts of earlier channel management efforts for the navigation project. They provide important habitat in channel border areas. In southern river reaches, and especially the Middle Mississippi River Reach, wing dams are very prominent features of the channel environment. They are used to concentrate flow in the main channel to reduce dredging needs. Wing dams are usually constructed in groups called dike fields. These areas are depositional zones that often fill from the bank outward toward the channel. Notching, lowering the profile, or altering the angle to the channel are some measures that can be used to increase habitat diversity in dike fields. The practice has met great success in some river reaches.

Dike alteration will be an important component of the restoration of the Middle Mississippi River Reach and will have beneficial application elsewhere in the system.

2.3.3.3.9 *Improve Topographic Diversity*

When the dams were put into operation, the floodplain water table elevation was increased in many areas. The result in the terrestrial plant communities was the elimination of flood intolerant tree species that require a dry root zone. Improving topographic diversity simulates the ridge and swale topography of the natural floodplain by using material dredged from the channel. This newly elevated land area is then planted with oaks and other mast trees.

2.3.3.3.10 *Dam Point Control*

UMR navigation dams have two operating procedures, dam point control and hinge point control. Water levels are maintained at specified stages at the dam or near mid-pool (hinge point), respectively. With hinge point control, at moderate discharge levels water levels are reduced (drawn down) in the lower half of the pool. This reduces flooding at mid and upper pool areas. This phenomenon has been incorporated into environmental management plans as possible with great success, but there could be greater benefits if managers had the option to use hinge point control or dam point control depending on the management objectives in a given year. Switching to dam point control requires acquiring land or easements in mid-pool reaches that would be subject to increased flooding. Changing from hinge point control to dam point control would require no structural modifications to the dams.

Hinge point water level management (Figure 2-5) impounds water to the "maximum controlled pool stage (A) during low flow periods. Water levels are lowered, which narrows the channel width at the dam during moderate flow (B) to limit the amount of land that may be flooded. The difference (C shaded area) is the approximate area that could be flooded more often with a shift to dam point control.

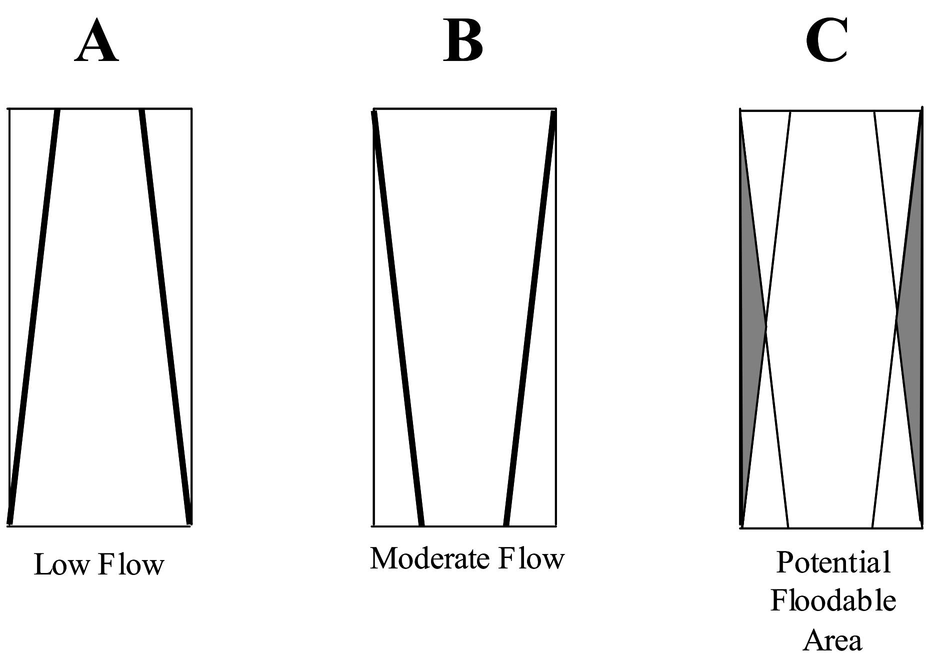


Figure 2-5. Probable changes in the distribution of surface water as a result of shifting from hinge point to dam point control.

2.3.3.3.11 *Rationale for Selecting, Combining, and Distributing Measures into Alternative Plans*

Varying types and numbers of restoration measures were combined into alternative plans to address local, river reach, and system-wide needs of the UMR-IWW ecosystem. Through collaborative work with UMR-IWW stakeholders, coordinating committees, and the Navigation Study Science Panel, five alternative plans (see Table 2-3) were developed to provide a range of ecosystem protection and restoration opportunities.

The UMR-IWW Environmental Objectives Database (DeHaan et al. 2003) provides an estimate for the desired future condition of the UMR-IWW ecosystem. This desired future condition is also referred to as the UMR-IWW Virtual Reference throughout the alternative formulation and evaluation process. This definition differs slightly from the Science Panel description, but is integral to the Virtual Reference as defined by the Science Panel. The objectives from the database were distributed across alternatives considering planform area change estimates developed for the UMR-IWW Navigation System Feasibility Study Cumulative Effects Report (WEST, Inc. 2000), the Upper Mississippi River System Habitat Needs Assessment (USACE 2000), and other information and considerations

The predicted change in plan form area of main channel, secondary channel, contiguous backwaters, isolated backwaters, and island area, habitats directly affected by the navigation system,was used as a gauge for the allocation of objectives across alternative B. The projected loss of aquatic area features was applied to the desired objectives which were roughly allocated at that level.

The allocation of off-channel habitat objectives (i.e., secondary channel, backwater, island, dike alteration, and floodplain restoration excluding land purchases) for Alternatives C, D, and E were based on the habitat requirements of species that are representative of other species using similar habitats. For example, bluegill movement to overwintering habitat provided a basis for the allocation of off-channel aquatic habitat objectives because they are a relatively weak swimmer whose requirements meet or exceed most other lentic species' needs. Radio tracking data in Iowa (Iowa DNR 2000, 2003) documents seasonal movements up to about 8 miles, but most individuals tracked moved less than three miles. The simple schematic sketch (Figure 2-6) illustrates a distribution scheme that allocates projects in a hypothetical ten mile river reach. At Alternative C, 1 off-channel habitat objectives is allocated in ten miles. For Alternative B, two off-channel objectives are allocated in a ten mile reach. Three off channel objectives were allocated under Alternative E. If there were more than 3 objectives for a given reach, they were included in the Virtual Reference. The Cumulative Effects Study (WEST, Inc. 2000) historic plan form area change estimate and the Habitat Needs Assessment (USACE 2000) estimate of geomorphic change also informed, but did not drive, the allocation of projects across Alternatives C, D, and E.

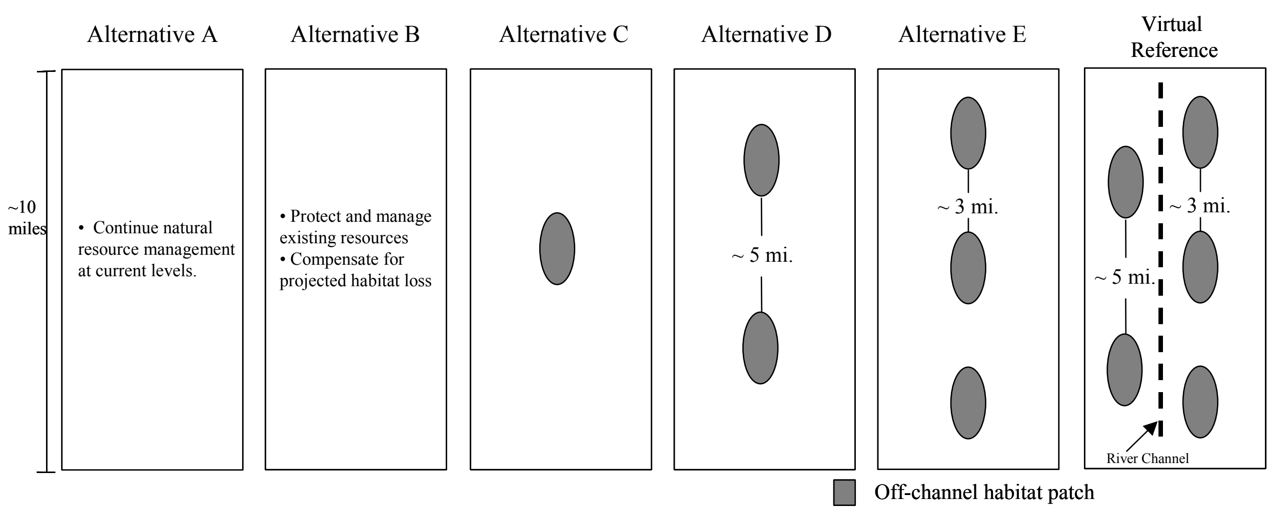


Figure 2-6. Distribution of off-channel habitat patches to meet bluegill habitat requirements (i.e., off-channel habitat every 3-5 miles; Iowa DNR 2001, 2003).

There were 98 objectives for some sort of floodplain restoration. The objectives ranged from relatively small-scale connections to isolated backwaters in the Upper Impounded Reach to comprehensive levee district buy-outs and floodplain restoration in the lower river reaches. The floodplain restoration objectives in the Upper Impounded Reach were allocated similar to other off-channel habitat restoration objectives, and also informed by the estimate of loss of isolated backwater habitat presented in the Cumulative Effects Study (WEST, Inc. 2000). The larger scale floodplain restoration objectives were treated as a desire to restore large contiguous blocks of habitat, either forest, grassland, wetlands, or, most likely, a mix of these cover types. The literature is mixed regarding the size of the "core area" required by specific species and much work still needs to be done to determine the exact configuration of the "habitat blocks."

The spacing of these habitat blocks was allocated considering the home range characteristics of mallard ducks, which "range out about 25 miles from rest lakes searching for food" (Bellrose 1954). Bellrose (1954) recommended establishing refuges approximately 50 miles apart along migrational routes, like beads along a string of pearls. This density, or greater, of habitat should provide resting and feeding areas, and hopefully disperse birds to reduce the incidence of disease that occurs in overcrowded refuge areas. Similar to the rationale for off-channel; aquatic habitat, this density of large floodplain habitat blocks should meet the needs of many migratory birds and other wildlife. The connections between habitat blocks will have to be considered later in the planning and adaptive management process.

The first increment of floodplain restoration is initiated in Alternative B, but it is only 1,000 acres in the Upper Impounded Reach. In Alternative C, the first increments of large scale floodplain restoration are initiated, bringing the total to 16,000 acres. Alternatives D and E are the restoration levels where significant amounts of floodplain could potentially be restored, with 105,000 acres in Alternative D that achieves a suitable distribution of habitat along the migration corridor and 250,000 acres in Alternative E that achieves an optimal distribution of habitat along the migration corridor.

An interagency work group evaluated issues of habitat connectivity, migratory species in the UMR-IWW, existing constraints to fish movement, potential measures to improve fish passage, and costs and benefits of providing fish passage (Wilcox et al. 2004). They conclude with recommendation for nature-like fish passage structures at 14 dam sites initially including 2, 4, 5, 8, 9, 10, 11, 13, 14, 18, 19, 22, 26, and Kaskaskia with others to be considered later. The results are incorporated in Alternative D fish passage objectives at 14 locations. Objectives for fish passage at 19 additional locations are included at Alternative E and the Virtual Reference. A smaller number of fish passage structures were not included in Alternatives B or C because of an identified threshold of need. That is, the systemic improvement of fish passage connectivity was not minimally obtained until fish passage was restored at the 14 identified locations.

A water level management work group was formed to evaluate the potential to: lower water levels (drawdown), raise water levels, use multiple control points, modify flow distribution through dam gates, limit water level fluctuations, and induce flow into backwaters during winter. The group considered many factors, especially the hydrologic factors, impacts to other users, and costs to maintain a 9-foot channel depth (Landwehr et al. 2004). The major findings of the group resulted in recommendation to conduct growing season drawdowns at pools: 5, 7, 8, 9, 11, 13, 16, 18 19, 24, 25, and 26. They also recommend changing from hinge-point to dam-point control at pools 16, 24, and 25 to increase options for water level management, to modify flow distribution through gates to improve fish passage or provide attracting flow, and to minimize water level fluctuations on the Illinois Waterway. The drawdown objectives are included in Alternative B because they are likely a cost effective measure to increase sediment quality, water quality, aquatic plant production, and aquatic habitat. Changing control points at Pools 25 and 16 are included at Alternative C, Pool 24 is included in Alternative E, and Pool 26 is not included in any alternative because of probable impacts to developed areas. Modifying flow distributions and minimizing water level fluctuations were determined to be issues that should be considered as part of an adaptive management scheme.

Wing dam and dike alterations are measures that change the configuration of channel training structures so they diversify or otherwise improve aquatic habitat in channel border areas. They range from relatively small submersed structures in the Upper Impounded Reach to very large emergent structures in the Middle Mississippi River. Regardless of their size, the work usually involves notching structures to allow river currents to scour and flow in more diverse patterns between structures. These measures were allocated similar to other off-channel habitat objectives described above. In the Middle Mississippi Reach they are spaced slightly farther apart than in other reaches because resource managers believed that fishes found in this river reach move greater distances.

Island and shoreline protection includes measures to protect the existing plan form features of the aquatic and terrestrial features of the river. Typical measures include rip rapped shorelines, but more environmentally sympathetic measures including off-shore revetments, plantings (bioengineering), low gradient slopes, rock groins and others are being incorporated along with traditional measures. These measures may also be used to alter the overflow portions of the dams. Considering the desire to maintain the existing plan form features, island and shoreline protection measures are included in Alternative B and carried through the others.

Measures to increase topographic diversity include the placement of dredged material, typically in ridges, on the floodplain to raise the root zone of flood intolerant mast trees. These measures are frequently complimentary to channel maintenance and other restoration measures. They are included in Alternative B because of the probability to combine these objectives with other measures and channel maintenance activities.

2.3.3.4 Summary of Preliminary Costs

The potential costs of the UMR-IWW ecosystem alternatives were developed through collaborative work with the UMR-IWW Corps Districts and stakeholders. Estimates of alternative costs were arrived at by first identifying the average per project cost of UMR-IWW ecosystem measures (Table 2-7). For example, a 30 acre island building project would cost approximately $3.5 million to build (including all labor and materials) and $250 thousand to operate and maintain over 50 years (about $5,000 annually). The anticipated ecosystem measure expenses are based on the best available information including historical project costs and current UMR-IWW material and labor costs.

A majority of floodplain restoration occurring in the system would include additional real estate costs. The Navigation Study Real Estate Component Team developed estimates of real estate costs for areas throughout the system. These estimates were then used to arrive at the average real estate cost $3,000 per acre for the UMR-IWW system.

2.3.3.5 Formulation and Reformulation of Alternative Plans

Working with the Navigation Study workgroups, science panel, coordinating committees, states, and other stakeholders, the ecosystem alternatives were formulated and refined to better and more efficiently meet the identified range of ecosystem protection and restoration opportunities. This included establishing and evaluating potential ecosystem measure performance (e.g., area of influence, cost per acre, etc; Table 2-8). The Navigation Study environmental workgroups performed a thorough investigation of potential fish passage and water level management projects to better formulate the distribution of these measures throughout the alternatives.

Table 2-7. UMR-IWW ecosystem measure costs in 2003 dollars.[a]

Ecosystem Measures	Project Footprint	Project Costs (50 years) Measure	O&M
Island Building	30 Acres	$3,459,000	$247,500
Fish Passage	1 Site	$23,500,000	$1,500,000
Floodplain Restoration (Pools 1-13)	500 Acres	$1,000,000	$375,000
Floodplain Restoration (Rest of UMR-IWW)[b]	5,000 Acres	$25,000,000	$3,750,000
Water Level Management - Pool	1 Site	$4,504,000	$0
Water Level Management - Backwater	1,000 Acres	$3,400,000	$1,000,000
Backwater Restoration (Dredging)	20 Acres	$2,326,000	$0
Side Channel Restoration	100 Acres	$1,450,000	$575,000
Wing Dam/Dike Alteration	5 Structures	$785,000	$68,750
Island Protection	3000 Feet	$528,900	$82,500
Shoreline Protection	3000 Feet	$528,900	$82,500
Topographic Diversity	5 Acres	$767,500	$60,000
Dam Point Control	1 Site	$10,750,000	$2,250,000
Floodplain Restoration-Immediate Opportunities	5,000 Acres	$25,000,000	$3,750,000

[a]Costs do not include contingency or planning, engineering, and design costs.

[b]Floodplain Restoration (Rest of UMR-IWW) includes an additional $3,000/acre real estate cost.

Table 2-8. UMR-IWW ecosystem measure costs and benefits in 2003 Dollars.

Ecosystem Measures	Project Footprint	Project Costs (50 years) Measure	O&M	Benefits Acres of Influence	Cost per Acre of Influence
Island Building	30 Acres	$3,459,000	$247,500	1,000	$3,500
Fish Passage[a]	1 Site	$23,500,000	$1,500,000	-	-
Floodplain Restoration (Pools 1-13)	500 Acres	$1,000,000	$375,000	500	$2,000
Floodplain Restoration (Rest of UMR-IWW)[b]	5,000 Acres	$25,000,000	$3,750,000	5,000	$5,000
Water Level Management - Pool[a]	1 Site	$4,504,000	$0	-	-
Water Level Management - Backwater	1,000 Acres	$3,400,000	$1,000,000	1,000	$3,400
Backwater Restoration (Dredging)	20 Acres	$2,326,000	$0	600	$3,900
Side Channel Restoration	100 Acres	$1,450,000	$575,000	100	$14,500
Wing Dam/Dike Alteration	5 Structures	$785,000	$68,750	10	$78,500
Island Protection	3000 Feet	$528,900	$82,500	240	$2,200
Shoreline Protection	3000 Feet	$528,900	$82,500	3	$176,300
Topographic Diversity	5 Acres	$767,500	$60,000	8	$96,000
Dam Point Control	1 Site	$10,750,000	$2,250,000	3,000	$3,600
Floodplain Restoration-Immediate Opportunities	5,000 Acres	$25,000,000	$3,750,000	5,000	$5,000

[a]Fish Passage and pool-scale Water Level Management benefits were assessed separately.
[b]Floodplain Restoration (Rest of UMR-IWW) includes an additional $3,000/acre real estate cost.

2.3.3.5.1 Area of Influence

The area of influence of environmental restoration measures is highly variable depending on the particular measure under consideration. Some measures have little impact beyond their actual construction or activity footprint, others may have a small footprint area yet directly affect much larger areas. The influence area of all measures is complicated by the mobility of target organisms, which may move from very far distances to use habitats created by a project for a particular season or purpose. Or, there may be resident populations that benefit from the measure for their entire life cycle. The rationale for estimating the area of influence of each of the major categories of restoration measures will be discussed below.

2.3.3.5.1.1 Island Building

Islands are constructed for two primary reasons, 1. to create topographic diversity to break up large open water areas with long wind fetch that generates waves and degrade water quality or to 2. dispose of material generated to create deep water habitat. They generally consider multiple environmental needs in their design, such that islands built to block wind fetch will acquire material from areas that also need deep water habitat and vise versa.

Several completed restoration projects and advanced planning documents were referenced to determine the areas affected by islands. The first islands were poorly placed in that they affected only small “wind shadow” areas. Later project island designs created large barriers that encompassed much larger areas to create backwater-like habitats, with interior islands to add diversity and structure. The area of influence of the latter projects was much greater than the former. Based on the design and wind fetch modeling results of 5 projects, the area of influence of islands was estimated to be approximately 1:33 so that the standard 30 acres project used for plan formulation would affect about 1,000 acres.

2.3.3.5.1.2 Fish Passage

Prior to the implementation of the 9-Foot Channel Project, fishes had relatively unimpeded access to the entire basin stream network. Natural barriers such as rapids and falls were the primary determinant of the distribution of fish stocks. Stronger swimmers, naturally, had greater home ranges and migration patterns. The first groups of fishes typically considered in this context are the long distance migrants, but resident species also make seasonal movements from 5 to 30 miles. Barriers to these movements could prevent access to critical seasonal habitats.

The area of influence of fish passage measures incorporated the number of stream miles of specific stream orders made accessible in a metric called the Longitudinal Connectivity Index (LCI). The LCI was created primarily as a planning tool to compare the relative value of providing fish passage at the barriers imposed by UMR-IWW navigation dams. The footprint of these measures is relatively small, but they may make literally thousands of miles of stream available. Thus, in one sense, the area of influence is the structure that fish swim through to traverse the barrier, while in another, it is the range of habitats made available. Two evaluation techniques can be used to help refine this effort: 1. fish tracking through built structures, and 2. fish tracking through the basin. Ultimately, stock improvements may be detected if more favorable habitat conditions are made accessible.

2.3.3.5.1.3 Floodplain Restoration

The area of influence of floodplain restoration is estimated at 1:1, meaning that one acre of habitat is restored for each acre in the project area. There may be measures constructed to influence the entire project area, that actually have a very small footprint. A ring levee with a water control structure, for example, will have a small footprint, but the entire area it surrounds is the floodplain restoration bounds. The species that are influenced are numerous with many resident species that will be directly benefited. Many species may also travel long distances to use floodplain habitats for a short time during critical life stages. The direct area of influence is relatively easy to measure in this case, but the indirect benefits are difficult to measure.

2.3.3.5.1.4 Water Level Management

Water level management is conducted on at least two scales, pool scale using dam operations and backwater scale using pumps and levees. The direct area of influence can be relatively easily estimated as the area either inundated or exposed by dam operations or by the extent of a backwater project area. The former is estimated using elevation mapping and hydrologic models. The latter is estimated by project design features and pumping capability. The water level management work group evaluated the areal extent of drawdowns system-wide at various degrees (i.e., one to four feet drawdown). The areal extent of two-foot drawdowns (which are incorporated in the Ecosystem Alternatives) was averaged to establish a 2,350 acre area of influence. Several existing or planned projects were reviewed to estimate the influence of backwater projects. Even within the category of backwater projects, there are large-scale ones using permanent management levees and fixed pumps affecting thousands of acres compared to small backwaters isolated with temporary berms and drawndown with portable pumps affecting less than 100 acres.

2.3.3.5.1.5 Backwater Restoration (Dredging)

Backwater dredging is conducted primarily to improve water quality conditions for backwater fishes. The activity typically includes dredging channels and holes in distinct backwater areas that have experienced high rates of sedimentation over time. It is known that fish make seasonal movements to these habitats, so that they may be attracted from many miles during certain critical time periods. The area of influence for this measure, however, was restricted to the area of the backwater lake in which dredging was conducted. Based on a range of experience with other projects, it was estimated that the average project would dredge 20 acres in a 600 acre lake for a 1:30 footprint to influence ratio.

2.3.3.5.1.6 Side Channel Restoration

Side channel restoration is meant to maintain flowing water channels adjacent to the main channel. The measures to accomplish this primarily include dredging and flow deflection structures at the upstream end of a side channel. There are usually structures constructed to increase flow and improve bathymetric and structural diversity within the channel. Because actions may be implemented throughout a side channel area, a 1:1 project area footprint to area of influence, similar to floodplain restoration, was used even though the actual constructed feature or dredge cut may be smaller. Also similar to other measures, fish may be attracted from many miles during certain times of year, so the influence may extend to an entire fish population.

2.3.3.5.1.7 Wing Dam/Dike Alteration

The typical wing dam/dike alteration was estimated to include 5 structures that may affect 10 acres. This is a very rough estimate of the area that may be incorporated within a dike field. This represents the area where scour holes, sand bars, and flow refugia may be created. Although this is a relatively small area, the habitat may benefit species that travel extensively. While fish movements in upstream reaches may extend from 1 – 10 miles, the channel oriented fish species common in dike fields may move much greater distances.

2.3.3.5.1.8 Island and Shoreline Protection

Bankline protection measures are used to protect existing resources in the floodplain and on islands. The footprint of island and shoreline protection measures are the same, but the area of influence between them differs. This is because island protection was projected to the entire area of an island, whereas the shoreline was projected to protect only a few acres in the vicinity of the placed material. There is an obvious area of influence on the affected patches of land, but how this is translated to animals that use these resources is more uncertain. Again, local species will benefit most directly, but migratory or transient species may also benefit.

2.3.3.5.1.9 Topographic Diversity

Topographic diversity is similar to dike alteration in that the measure is very localized in a relatively small area, but may have wider benefits. The measure is important to recreate species diversity that has been degraded by hydrologic changes to the system. Thus, improvements in desirable tree species abundance may translate to resident and migratory birds. However, the relation between this site specific measure and wider ranging species is tenuous, so a more conservative area of influence was used.

2.3.3.5.1.10 Dam Point Control

Dam point control refers to the location in a navigation pool where target water levels are maintained to achieve channel depth objectives. In some pools this is at a mid-pool control point which results in lower pool drawdowns that expose or displace aquatic resources. The objective of this measure is to provide the capability to use either dam point or mid pool control to benefit natural resource management priorities. The switch to dam point control requires land acquisition because some areas not previously affected by the project would be flooded under the new operating procedures. This area is readily modeled and the lands identified, so the footprint and direct area of influence of the project is easy to estimate. The indirect area of influence is much more difficult because fish may come from great distances to exploit flooded terrestrial areas, or energy transported from the floodplain to the river may be processed many miles away. The change in flood regimes can also directly and indirectly affect floodplain plant communities.

2.3.3.5.2 Navigation Study Environmental Workgroups

During the process of identifying and allocating measures among alternative plans, two environmental workgroup reports (i.e., Fish Passage and Water Level Management) were used to assist in prioritizing, sequencing, and potentially screening the occurrence of measures. The performance and efficiency of fish passage and pool-scale drawdowns occurring at various UMR-IWW locations were evaluated. The water level management (i.e., pool drawdown) workgroup evaluated several parameters when assessing drawdown benefits and costs associated with UMR-IWW navigation pools. Benefit assessment included identifying the potential for varying drawdown depths to succeed, the area exposed (i.e., area of influence), and the impacts to infrastructure (e.g., water intakes). Costs were primarily related to supplemental dredging required to maintain navigation and connectivity to river facilities. Fish passage structures and locations (i.e., projects) were assessed by comparing habitat connectivity, need, and cost. Habitat connectivity was calculated for each pool by determining the length tributaries to the first obstruction and the total water surface acres of the pool. The need for fish passage was quantified by comparing the frequency that the dam is in "open river" condition. Habitat connectivity and need were then compared to the cost of constructing and maintaining fish passage structure at each dam location. The results of the workgroup assessment were used to screen less efficient fish passage projects out of Alternative D. Less effective water level management projects were also screened out of Alternatives B-D.

2.3.3.5.3 Cultural Resources Management/Mitigation

The ecosystem restoration measures have a potential to affect significant historic properties including archeological resources, historic structures and shipwrecks. Major efforts under this study have compiled and consolidated information on the location and potential for historic properties (see list of reports earlier in this report). Actions are proposed to assess effects and integrate historic property management with ecosystem restoration. The actions will allow for the further identification and protection of significant historic properties being lost due to the Cumulative impacts including ongoing effects of the operation and maintenance of the UMR-IWW Navigation system.

2.3.3.5.4 Additional Ecosystem Alternative Components

Additional ecosystem alternative components include a systemic fleeting plan, forestry management component, and the formulation of a rigorous adaptive management program.

2.3.3.6 Ecosystem Alternative Plan Costs and Cost Sharing

2.3.3.6.1 Alternative Plan Cost Estimates

Estimates of alternative costs were developed by first identifying the average per project cost of UMR-IWW ecosystem measures (see Table 2-6) (e.g., Island Building – 30 Acre Project – Construction: $3.5 Million). These costs were multiplied by the number of projects within a given alternative to determine the total ecosystem measure construction costs (Table 2-9). A 35% contingency cost was then applied to the total construction cost and additional costs were added for forestry management, a systemic fleeting plan, cultural resource management/mitigation, adaptive management, and real estate. Finally, a 30% planning, engineering, and design and 9% supervision and administration cost was applied to the total above and final ecosystem alternative costs were developed. The costs of the alternative components are based on the best information available (e.g., existing UMR-IWW material, labor, and project costs).

2.3.3.6.2 Cost Sharing

The costs associated with the ecosystem alternatives will be shared between the Federal government, States, and Non-governmental organizations. Several potential cost sharing options were developed and reviewed in an effort to fairly distribute the financial responsibility of the alternatives between the partner agencies and organizations (see 5.1 Cost Sharing Policy Issue). As a result, the following cost share option was selected:

<u>Cost Sharing Option C.</u>
Measures involving modification of the structures and operations of existing projects; on Corps Project lands and lands included in the National Refuge System; and measures in the main channel or directly connected backwater areas below the Ordinary High Water Mark will be 100 percent Federal regardless of current ownership. Measures on other public or privately owned lands would be cost shared 65/35.

Using this methodology, ecosystem measures funded 100% Federal will include:

- Fish Passage
- Pool-Scale Water Level Management (Drawdown)
- Wing Dam/Dike Alteration
- Dam Point Control
- Island Building
- Side Channel Restoration

Table 2-9. Ecosystem alternative cost estimates (over 50 years in 2003 dollars).

UMR-IWW Ecosystem Measure Construction Costs	Cost ($1,000,000's)				
Ecosystem Measure	**Alternative A**	**Alternative B**	**Alternative C**	**Alternative D**	**Alternative E**
Island Building	$0.0	$107.2	$235.2	$314.8	$401.2
Fish Passage	$0.0	$0.0	$0.0	$329.0	$775.5
Floodplain Restoration	$0.0	$2.0	$77.0	$496.0	$1,208.0
Water Level Management - Pool	$0.0	$54.0	$54.0	$54.0	$117.1
Water Level Management - Backwater	$0.0	$0.0	$3.4	$23.8	$30.6
Backwater Restoration (Dredging)	$0.0	$167.5	$321.0	$483.8	$628.0
Side Channel Restoration	$0.0	$84.1	$155.2	$213.2	$250.9
Wing Dam/Dike Alteration	$0.0	$14.1	$40.0	$50.2	$53.4
Island Protection	$0.0	$83.0	$83.0	$83.0	$83.0
Shoreline Protection	$0.0	$124.2	$124.2	$124.2	$124.2
Topographic Diversity	$0.0	$24.6	$24.6	$24.6	$24.6
Dam Point Control	$0.0	$0.0	$23.2	$23.2	$32.2
Total Construction Costs (with real estate)	$0.0	$660.8	$1,140.8	$2,219.8	$3,728.7
Contingency					
Contingency (35% construction costs)	$0.0	$231.3	$383.5	$677.2	$1,058.3
Adaptive Management Costs					
Adaptive Management	$0.0	$223.0	$369.8	$653.0	$1,020.5
Additional Costs					
Forestry Management	$0.0	$75.0	$87.5	$100.0	$125.0
Systemic Fleeting Plan	$0.0	$0.3	$0.3	$0.3	$0.3
Cultural Res. Management/Mitigation	$0.0	$26.8	$44.4	$78.4	$122.5
Planning, Engineering, Design, and Management Costs					
Planning, Eng., Design, and Admin (30%)	$0.0	$365.1	$607.9	$1,118.6	$1,816.6
Supervision and Administration (9%)	$0.0	$109.5	$182.4	$335.6	$545.0
UMR-IWW Ecosystem Alternative Costs	**$0.0**	**$1,691.7**	**$2,816.6**	**$5,182.8**	**$8,416.7**

The following non-structural measures will also be included as 100% Federal:

- Forestry Management
- Systemic Fleeting Plan
- Cultural Resources Management/Mitigation

Measures consisting of a mixture of 100% Federal and 65/35 cost share will include:

- Floodplain Restoration
- Topographic Diversity
- Backwater Water Level Management
- Backwater Restoration (Dredging)
- Island and Shoreline Protection

The adaptive management component of the alternative plans will also be partially cost shared. Specifically, performance evaluation on cost shared projects will be cost shared 65/35 by partnering agencies.

Operation and maintenance costs will be borne by the Corps for measures involving modification of structures or operations of existing Corps projects. These include Fish Passage, Pool-scale Water Level Management, Wing Dam/Dike Alteration, and Dam Point Control.

O&M costs for the remaining measures will be borne by the partnering agencies managing the land.

As a component of the measures, real estate costs (e.g., land acquisition or easements) are borne by non-Federal interests that will receive cost sharing credit for their value.

Using this cost sharing methodology, 12-26% of the ecosystem alternative costs will be cost shared 65/35% (Table 2-10) and the remainder funded 100% Federal. The Corps would fund 2-14% of the Operation and maintenance costs and the remainder would be the responsibility of the partner agency managing the land (Table 2-11).

Table 2-10. Ecosystem alternative costs in 2003 dollars ($ Millions).

	Alternative A	Alternative B		Alternative C		Alternative D		Alternative E	
100% Federal	$0.0	$1,482.3	88%	$2,480.7	88%	$4,131.6	80%	$6,209.9	74%
Cost Shared (65/35)[a]	$0.0	$209.4	12%	$335.9	12%	$1,051.2	20%	$2,206.9	26%
Total		$1,691.7		$2,816.6		$5,182.8		$8,416.7	

[a]The non-federal responsibility would be 35% of the costs shown in this line.

Table 2-11. Operation and maintenance costs in 2003 dollars ($ Millions).

	Alternative A	Alternative B		Alternative C		Alternative D		Alternative E	
Corps	$0.0	$1.3	2%	$8.0	6%	$29.9	12%	$60.9	14%
Non-Corps	$0.0	$76.0	98%	$125.6	94%	$227.4	88%	$360.1	86%
Total		$77.3		$133.6		$257.3		$421.0	

2.3.3.7 Ecosystem Alternative Plans

After preliminary evaluation of the ecosystem measures and refinement of the alternative plans, five restoration alternatives were developed to address the identified needs of the UMR-IWW ecosystem. The alternatives consist primarily of the ecosystem measures previously described (see Table 2-5, Figure 2-7) and a rigorous adaptive management program, forestry management, and systemic fleeting plan.

2.3.3.7.1 Alternative A (No Action/Without Project; $0)

- Continue current environmental management activities and rehabilitation efforts at historic levels.

Under this alternative environmental degradation would continue and the habitat loss projected in the Cumulative Effects Study and Habitat Needs Assessment would be realized. While the ongoing efforts to protect, maintain, and restore habitat would be beneficial, the current level of effort would not be sufficient to counteract the cumulative impacts affecting river resources. This alternative does not promote a sustainable system.

Primary Components

- Environmental Management Program
- Continuing Authorities Programs
- Endangered Species Work
- Corps Forestry Program
- Refuge Management
- State Conservation Programs
- NGO Initiatives

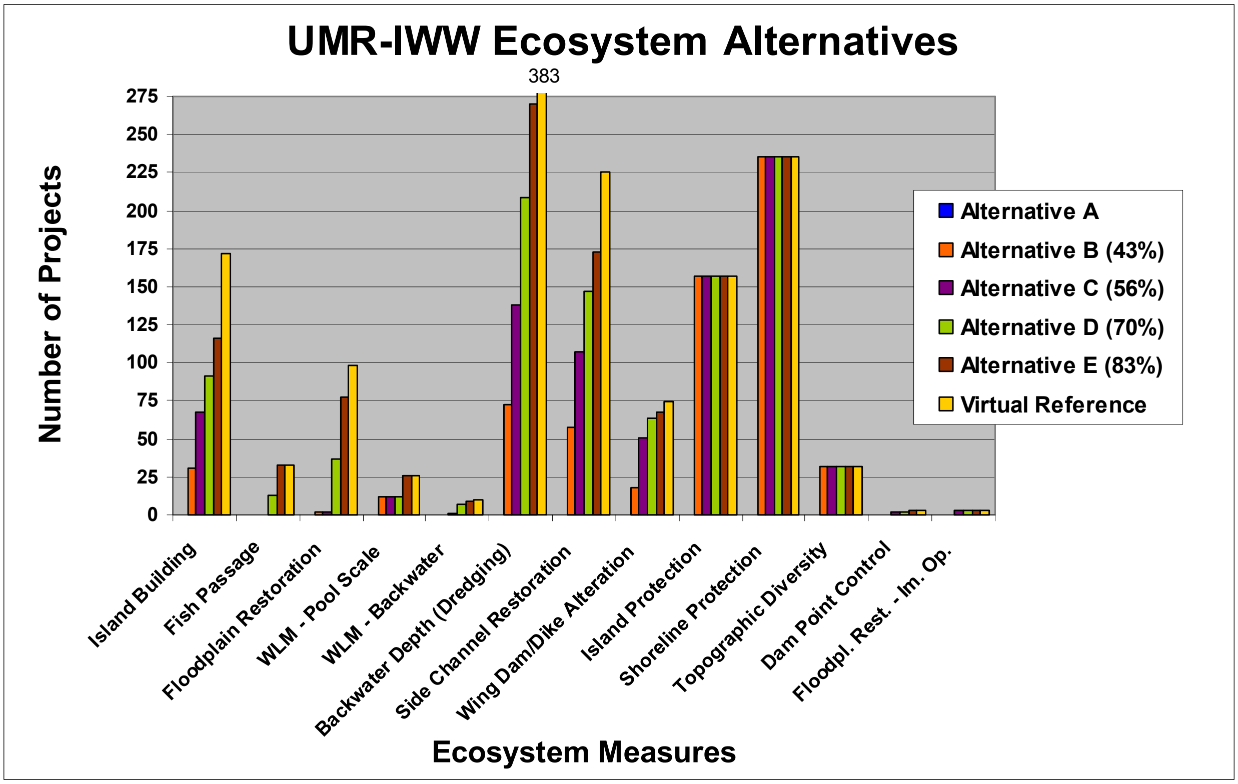


Figure 2-7. Number of ecosystem alternative measures (i.e., projects).

2.3.3.7.2 Alternative B (Protect and maintain existing environmental diversity; $1.7 Billion + O&M Costs

- Current mosaic of habitat types and ecological diversity maintained into the future: no net loss.

This alternative (Table 2-12) is structured to address projected habitat degradation, primarily in the form of habitat features seen in plan form projection (e.g., islands, channels, backwater lakes, etc.). In the development of the alternative the approximate areas and amount of habitat projected in the Cumulative Effects Study to be lost over the next 50 years would be either stopped or replaced. This is accomplished by armoring banks to prevent erosion of existing features or by recreating habitat features that will be lost. Habitat quality issues are addressed on large scales by pool-scale water level management and more locally through forest management plans. The entire river management scheme requires an effective Adaptive Management plan for integrated river management.

Primary Components

- Build 31 Island Complexes
- Restore 2 Floodplain Areas
- Conduct Water Level Mngt. in 12 Pools
- Restore 72 Backwater Areas
- Restore 58 Side Channels
- Alter 18 Wing Dam/Dike Structures
- Protect 392 Islands and Shoreline Areas
- Improve Topographic Diversity in 32 Areas
- Forestry Management Program
- Systemic Fleeting Plan
- Adaptive Management Program

Table 2-12. Alternative B – Number of ecosystem projects, costs, and benefits over 50 years.

Ecosystem Measures	Project Footprint	Number of Projects	Project Costs (Millions) Measure	O&M	Benefits Acres of Influence
Island Building	30 Acres	31	$107.2	$7.7	31,000
Fish Passage[a]	1 Site	0	$0.0	$0.0	-
Floodplain Restoration (Pools 1-13)	500 Acres	2	$2.0	$0.8	1,000
Floodplain Restoration (Rest of UMR-IWW)	5,000 Acres	0	$0.0	$0.0	0
Water Level Management - Pool[a]	1 Site	12	$54.0	$0.0	-
Water Level Management - Backwater	1,000 Acres	0	$0.0	$0.0	0
Backwater Restoration (Dredging)	20 Acres	72	$167.5	$0.0	43,200
Side Channel Restoration	100 Acres	58	$84.1	$33.4	5,800
Wing Dam/Dike Alteration	5 Structures	18	$14.1	$1.2	180
Island Protection	3000 Feet	157	$83.0	$13.0	37,680
Shoreline Protection	3000 Feet	235	$124.2	$19.4	705
Topographic Diversity	5 Acres	32	$24.6	$1.9	256
Dam Point Control	1 Site	0	$0.0	$0.0	0
Floodplain Restoration-Immediate Opportunities	5,000 Acres	0	$0.0	$0.0	0
Additional Costs[b]			$1,030.9	$0.0	
	Total	617	$1,691.7	$77.3	119,821

[a]Fish Passage and pool-scale Water Level Management benefits were assessed separately.
[b]Additional costs are derived from Table 2-9 categories of adaptive management, forestry management, systemic fleeting plan, cultural resource management/mitigation, contingency, PED, and administration.

2.3.3.7.3 Alternative C; (Restore the first increment of habitats most directly affected by the navigation project $2.8 Billion + O&M Costs)

- This alternative initiates large scale floodplain restoration at sites with capable cost-share partners. It also begins to address the minimal off-channel habitat needs of many aquatic species.

The development of this alternative is based on historic and projected change in aquatic habitats directly affected by the operation of the navigation project. All of the habitat protection measures of Alternative B would be carried into Alternative C (Table 2-13) and a minimal portion of the identified historic change in aquatic habitats would be addressed (see rationale for distribution of projects above). Islands would be constructed to replace those that have been eroded, water level management would be used in areas that have a high likelihood of success, dredging would restore degraded backwaters and side channels and to increase connectivity among aquatic habitats as desirable, and a program of rock work (bank stabilization, wing dams, etc.) would protect and improve habitat conditions. Several immediate opportunities for large scale floodplain restoration would be undertaken to address the sustainability of resources that require both aquatic and floodplain habitats (e.g., floodplain spawning fishes, wading birds, many reptiles, etc.). Habitat quality issues are addressed on large scales by pool-scale water level management and more locally through forest management plans. The entire river management scheme requires an effective Adaptive Management plan for integrated river management.

Table 2-13. Alternative C – Number of ecosystem projects, costs, and benefits over 50 years.

Ecosystem Measures	Project Footprint	Number of Projects	Project Costs (Millions) Measure	O&M	Benefits Acres of Influence
Island Building	30 Acres	68	$235.2	$16.8	68,000
Fish Passage[a]	1 Site	0	$0.0	$0.0	-
Floodplain Restoration (Pools 1-13)	500 Acres	2	$2.0	$0.8	1,000
Floodplain Restoration (Rest of UMR-IWW)	5,000 Acres	0	$0.0	$0.0	0
Water Level Management - Pool[a]	1 Site	12	$54.0	$0.0	-
Water Level Management - Backwater	1,000 Acres	1	$3.4	$1.0	1,000
Backwater Restoration (Dredging)	20 Acres	138	$321.0	$0.0	82,800
Side Channel Restoration	100 Acres	107	$155.2	$61.5	10,700
Wing Dam/Dike Alteration	5 Structures	51	$40.0	$3.5	510
Island Protection	3000 Feet	157	$83.0	$13.0	37,680
Shoreline Protection	3000 Feet	235	$124.2	$19.4	705
Topographic Diversity	5 Acres	32	$24.6	$1.9	256
Dam Point Control	1 Site	2	$23.2	$4.5	6,000
Floodplain Restoration-Immediate Opportunities	5,000 Acres	3	$75.0	$11.3	15,000
Additional Costs[b]			$1,675.8	$0.0	
	Total	**808**	**$2,816.6**	**$133.6**	**223,651**

[a]Fish Passage and pool-scale Water Level Management benefits were assessed separately.
[b]Additional costs are derived from Table 2-9 categories of adaptive management, forestry management, systemic fleeting plan, cultural resource management/mitigation, contingency, PED, and administration.

2.3.3.7.4 Alternative D; (Restoration to a level which includes management practices and cost effective actions affecting a broad array of habitat types; $5.2 Billion + O&M Costs)

- This alternative expands large scale floodplain restoration to suitable levels, initiates fish passage measures, and brings off-channel habitat restoration to a suitable level.

The development of this alternative is based on historic and projected change in aquatic habitats directly affected by navigation traffic or the infrastructure to support it and by the recognition that the aquatic and terrestrial components of river-floodplain ecosystems are inextricably linked by key functions and processes that drive the system. All of the habitat protection measures of Alternative B and C would be carried into Alternative D (Table 2-14) and a suitable portion of the identified objectives for aquatic and floodplain habitats would be addressed (see rationale for distribution of projects above). Islands would be constructed to replace those that have been eroded, water level management would be used in areas that have a high likelihood of success, dredging would restore degraded backwaters and side channels and to increase connectivity among aquatic habitats as desirable, and a program of rock work (bank stabilization, wing dams, etc.) would protect and improve habitat conditions. Several immediate opportunities for large scale floodplain restoration would be undertaken to address the sustainability of resources that require both aquatic and floodplain habitats (e.g., floodplain spawning fishes, wading birds, many reptiles, etc.), and there would be efforts to increase the opportunity to restore and connect isolated floodplain habitats to achieve a more sustainable, naturally functioning, and complete river-floodplain ecosystem. Longitudinal connectivity issues are introduced at some dams in this alternative to provide greater opportunity for the movement of migratory fishes. Habitat quality issues are addressed on large scales by pool-scale water level management and more locally through forest management plans. The entire river management scheme requires an effective Adaptive Management plan for integrated river management.

Table 2-14. Alternative D – Number of ecosystem projects, costs, and benefits over 50 years.

Ecosystem Measures	Project Footprint	Number of Projects	Project Costs (Millions) Measure	O&M	Benefits Acres of Influence
Island Building	30 Acres	91	$314.8	$22.5	91,000
Fish Passage[a]	1 Site	14	$329.0	$21.0	-
Floodplain Restoration (Pools 1-13)	500 Acres	21	$21.0	$7.9	10,500
Floodplain Restoration (Rest of UMR-IWW)	5,000 Acres	16	$400.0	$60.0	80,000
Water Level Management - Pool[a]	1 Site	12	$54.0	$0.0	-
Water Level Management - Backwater	1,000 Acres	7	$23.8	$7.0	7,000
Backwater Restoration (Dredging)	20 Acres	208	$483.8	$0.0	124,800
Side Channel Restoration	100 Acres	147	$213.2	$84.5	14,700
Wing Dam/Dike Alteration	5 Structures	64	$50.2	$4.4	640
Island Protection	3000 Feet	157	$83.0	$13.0	37,680
Shoreline Protection	3000 Feet	235	$124.2	$19.4	705
Topographic Diversity	5 Acres	32	$24.6	$1.9	256
Dam Point Control	1 Site	2	$23.2	$4.5	6,000
Floodplain Restoration-Immediate Opportunities	5,000 Acres	3	$75.0	$11.3	15,000
Additional Costs[b]			$2,963.0	$0.0	
	Total	**1,009**	**$5,182.8**	**$257.3**	**388,281**

[a]Fish Passage and pool-scale Water Level Management benefits were assessed separately.
[b]Additional costs are derived from Table 2-9 categories of adaptive management, forestry management, systemic fleeting plan, cultural resource management/mitigation, contingency, PED, and administration.

2.3.3.7.5 Alternative E (Restoration to include most environmental objectives that could be accomplished in the context of the navigation project; $8.4 Billion + O&M Costs)

- This alternative achieves and optimal level of large scale floodplain restoration, makes fish passage measures systemic, and achieves and optimal level of off-channel habitat restoration.

The development of this alternative is based on historic and projected change in aquatic habitats directly affected by navigation traffic or the infrastructure to support it and by the recognition that the aquatic and terrestrial components of river-floodplain ecosystems are inextricably linked by key functions and processes that drive the system. All of the habitat protection measures of Alternative B, C, and D would be carried into Alternative E (Table 2-15) and an optimal portion of the objectives for aquatic and terrestrial habitats would be addressed (see rationale for distribution of projects above). Islands would be constructed to replace those that have been eroded, water level management would be used in areas that have a high likelihood of success, dredging would restore degraded backwaters and side channels and to increase connectivity among aquatic habitats as desirable, and a program of rock work (bank stabilization, wing dams, etc.) would protect and improve habitat conditions. Several immediate opportunities for large scale floodplain restoration would be undertaken to address the sustainability of resources that require both aquatic and floodplain habitats (e.g., floodplain spawning fishes, wading birds, many reptiles, etc.), and there would be efforts to increase the opportunity to restore and connect isolated floodplain habitats to achieve a more sustainable, naturally functioning, and complete river-floodplain ecosystem. Longitudinal connectivity issues are included at most dams in this alternative to provide greater opportunity for the unimpeded movement of migratory fishes. Habitat quality issues are addressed on large scales by pool-scale water level management and more locally through forest management plans. The entire river management scheme requires an effective Adaptive Management plan for integrated river management.

Table 2-15. Alternative E – Number of ecosystem projects, costs, and benefits over 50 years.

Ecosystem Measures	Project Footprint	Number of Projects	Project Costs (Millions) Measure	O&M	Benefits Acres of Influence
Island Building	30 Acres	116	$401.2	$28.7	116,000
Fish Passage[a]	1 Site	33	$775.5	$49.5	-
Floodplain Restoration (Pools 1-13)	500 Acres	33	$33.0	$12.4	16,500
Floodplain Restoration (Rest of UMR-IWW)	5,000 Acres	44	$1,100.0	$165.0	220,000
Water Level Management - Pool[a]	1 Site	26	$117.1	$0.0	-
Water Level Management - Backwater	1,000 Acres	9	$30.6	$9.0	9,000
Backwater Restoration (Dredging)	20 Acres	270	$628.0	$0.0	162,000
Side Channel Restoration	100 Acres	173	$250.9	$99.5	17,300
Wing Dam/Dike Alteration	5 Structures	68	$53.4	$4.7	680
Island Protection	3000 Feet	157	$83.0	$13.0	37,680
Shoreline Protection	3000 Feet	235	$124.2	$19.4	705
Topographic Diversity	5 Acres	32	$24.6	$1.9	256
Dam Point Control	1 Site	3	$32.2	$6.8	9,000
Floodplain Restoration-Immediate Opportunities	5,000 Acres	3	$75.0	$11.3	15,000
Additional Costs[b]			$4,688.0	$0.0	
	Total	**1,202**	**$8,416.7**	**$421.0**	**604,121**

[a]Fish Passage and pool-scale Water Level Management benefits were assessed separately.
[b]Additional costs are derived from Table 2-9 categories of adaptive management, forestry management, systemic fleeting plan, cultural resource management/mitigation, contingency, PED, and administration.

2.3.4 Evaluation of Ecosystem Restoration Alternatives

2.3.4.1 Description of the Evaluation Process

The best plan can not be selected from among a set of good plans unless we have some way to compare them. It is only by comparison that a plan is no longer good enough, or that a good plan becomes the best plan. The purpose of the comparison step is to identify the most important criteria to evaluate the plans with and compare the various alternative plans across those criteria. Ideally, the comparison of plans concludes with a ranking of plans or some identification of the best course of action for the decision makers. The comparison method must be transparent. That is it must be easy to explain and easy for the stakeholders and decision makers to follow and understand.

The selection of a recommended plan requires that individual alternative plans be compared against the without project condition and against one another using pre-established rules, criteria and system of accounts. Alternative plan comparisons were largely driven by the evaluation of information generated during the formulation of the alternatives (e.g., costs, area of influence, etc.). Additional information regarding alternative completeness, social effects, and adaptability was also acquired and assessed.

Ecosystem restoration alternatives were evaluated under seven accounts of (A) National Ecosystem Restoration Benefits, (B) Environmental Quality, (C) Regional Economic Development, (D) Other Social Effects, (E) Contribution to Planning Objectives, (F) Acceptability, and (G) Adaptability. A brief description of each of these accounts is provided in section 2.3.4.2.

The first four accounts listed above are pursuant to the Corps' Principles and Guidelines (ER-1105-2-100) primary accounts to facilitate an evaluation process. Within these accounts, the four P&G evaluation criteria of completeness, efficiency, effectiveness, and acceptability are included to provide the primary basis of comparing and evaluating the ecosystem alternative plans. Completeness and effectiveness criteria are captured in the (B) Environmental Quality account. Additionally, these criteria are also included in the (E) Contribution to Planning Objectives account. Cost effectiveness measures within the (A) Environmental Benefits (NER) account provide measures of the alternative efficiency in meeting ecosystem objectives. The evaluation of social and institutional acceptability is included in the (F) Acceptability account.

2.3.4.2 System of Accounts

The evaluation of ecosystem alternatives relied primarily on qualitative analyses and estimated quantitative outputs. The quantitative analysis relied primarily on assessment of environmental benefits and quality. The qualitative analysis focused on the predetermined criteria of adaptability, uncertainty, acceptability, and other social effects.

Quantitative
Alternative costs
Acres of influence
Cost effectiveness
Ecosystem Completeness
Regional Economic Development (income and jobs)

Qualitative
Ecosystem Diversity
Ability to address Upper Mississippi River Conservation Committee ecosystem objectives
Maintenance and enhancement of ecosystem goods and services
Contribution to study planning objectives
Acceptability of the alternative
Adaptability of the alternative

The evaluation and comparison of ecosystem restoration alternatives requires the consideration of a great deal of information developed over the past decade. To be most useful it is important that this accumulation of information be effectively organized for consideration by team members, stakeholders, the public and decision makers for use in the comparison step. The Corps P&Gs establish a system of four primary accounts to facilitate the comparative process. These accounts have been devised to encompass all significant effects of a plan as required by the national Environmental Policy Act of 1969 and Section 122 of the Flood Control act of 1970. The accounts established by the P&G include (A) Environmental Benefits - National Ecosystem Restoration (NER), (B) Environmental Quality (EQ), (C) Regional Economic Development (RED), and (D) Other Social Effects (OSE). All of the alternative plan effects are typically assigned to and displayed in one of these four robust categories. Strictly speaking only the NER account is required. For the purposes of this study, three additional accounts were established to include other important comparative considerations: (E) Contribution to Planning Objectives, (F) Acceptability and (G) Adaptability. The following descriptions of each of the seven accounts were developed to ensure interested parties were clear on the intent and application of these accounts in the alternative plan comparison process:

A. Environmental Benefits-National Ecosystem Restoration (NER).

The environmental equivalent to the NED is the National Ecosystem Restoration (NER) benefits. For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost-effective and justified to achieve the desired level of output. Typically, an ecological alternative would yield some measure of benefit expressed in terms increased acres of habitat, percentage of improved functionality, or abundance of species X or Y, few of which lend themselves to a direct monetary amortization of benefit.

Traditional Corps of Engineers Ecosystem restoration project evaluations include an assessment of increases in ecosystem (often habitat) quality and quantity as well as a cost effectiveness - Incremental cost analysis pursuant to ER-1105-2-100. It was not feasible to exercise Habitat Evaluation Procedures (HEP) which quantitatively consider anticipated changes in both quantity and quality of habitat for specified target species over the 1200 river mile long project area. Likewise an incremental cost effectiveness analysis based on habitat units could not be conducted. These will be important tools in designing and right sizing specific projects within defined river reaches and pools during the adaptive implementation phase.

In lieu of a formal HEP based cost effectiveness analysis the environmental benefits of the ecosystem restoration alternatives were assessed by examining their costs in comparison to the potential area of influence (acres). The cost effectiveness of Fish passage and Water Level Management elements of the alternatives were assessed separate from the other elements of the alternatives and then recombined in the final analysis in order to better assess the benefits offered by these two measures.

B. Environmental Quality.

The obvious question that generally follows this type of ecological accounting is "How much is enough? or Is this output significant?" With these questions in mind, the assessment of ecosystem restoration alternatives has been designed around the spatially explicit ecosystem goals and objectives endorsed by the study team, regional stakeholders, and Science Panel convened for this study. These objectives represent a virtual reference or desired ecological condition for the UMR-IWW system.

Environmental quality effects were evaluated primarily by assessing ability of the alternative to fully address the needs of the UMR-IWW ecosystem. By examining the number, type, and potential results of restoration measures, the completeness and diversity of ecosystem alternatives were quantitatively and qualitatively assessed. This process included identifying the extent to which the alternative plan:

- maintains or exceeds the existing condition,
- accounts for ecosystem needs identified in the virtual reference,
- accounts for nine essential UMR-IWW ecosystem objectives identified in *A River that Works and a Working River* report, and
- effects ecosystem diversity.

C. Regional Economic Development (RED).

The income and employment benefits for each alternative were computed for the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri along with the lower Mississippi Region and the rest of the U.S. This information is being presented at request of the states and should assist them in formulating their respective position statements. RED benefits are presented as average annual income and average annual jobs created from 2005-2035. This timeframe was used (rather than a 50 year timeframe) due to limitations of the RED model. The RED assessment only considered income and employment directly related to alternative construction which made up approximately 75% of the total alternative cost. This information was developed by the Tennessee Valley Authority using the REMI model.

D. Other Social Effects (OSE).

Other social effects were assessed primarily in the form of ecosystem goods and services maintained or enhanced by the alternative plans. Ecosystem management and restoration included in the alternatives increase or maintain ecosystem processes, biodiversity, biological productivity, and the carrying capacity of ecosystems to support human societies. The benefits of ecosystem management and restoration in federal water resources planning language are called outputs. The outputs of ecosystem management and restoration are the net increases in ecosystem goods and services (e.g., water quality, nutrient processing, recreation, commercial fishing, etc.).

E. Contribution to Planning Objectives.

The goal of the feasibility study is to outline an integrated plan to ensure the economic and environmental sustainability of the UMR-IWW Navigation System. To fully address these feasibility study issues, the study team has identified the following three primary planning objectives:

1. Provide for a safe, reliable and efficient UMR-IWW navigation system over the planning horizon consistent with protecting the nations environment;
2. Address cumulative impacts including ongoing effects of the operation and maintenance of the UMR-IWW Navigation System; and
3. Measures are consistent with protecting the nations environment.

The ability of the ecosystem alternatives to contribute to the study planning objectives was assessed.

F. Acceptability

Acceptability is the workability and viability of the alternative plan with respect to acceptance by Federal, State and local entities; the general public; and compatibility with existing laws regulations and public policies (P&G Section VI.1.6.2(c)(4)). To be acceptable, a plan has to have a perceived value, cost effectiveness and high probability of success. There are many factors that can render a plan infeasible in the minds of individuals. These factors can generally be categorized as technical (engineering or natural world limitations), economic, financial, environmental, social, political, legal and institutional.

The examination of stakeholder acceptability was organized into two categories.

1. Overall institutional and social alternative plan acceptability.
2. Acceptability of the partner requirements to aid in funding and implementing the alternative plans.

G. Adaptability

Adaptability is defined as the ability to adjust the alternative based on changes in future conditions and our understanding of the system. Alternatives that offer the greatest amount of flexibility could be viewed more favorably under a high degree of uncertainty or risk. Adaptability is an implementation tool that will be fully considered during development of the tentative plan.

2.3.4.3 Account Specific Evaluation Criteria and Scores

Each of the seven accounts will have associated evaluation criterion and data which have been identified as the foundational elements of the ecosystem restoration alternative plan comparisons. Asterisks next to the specific criterion indicate their elevated importance in the final decision process.

A. Environmental Benefits (NER)

A1. Project Cost

- Costs associated with implementing the UMR-IWW ecosystem alternative plans (Table 2-16).

Table 2-16. UMR-IWW ecosystem alternative costs in 2003 dollars.

	Cost ($1,000,000's)				
	Alt. A	**Alt. B**	**Alt. C**	**Alt. D**	**Alt. E**
A1a. Total Cost	$0	$1,691.7	$2,816.6	$5,182.8	$8,416.7
A1b. Cost (without Fish Passage or WLM)	$0	$1,561.9	$2,686.8	$4,262.7	$6,272.8
A1c Total Average Annual Cost (from 2005)	$0	$35.1	$58.4	$106.3	$174.5

A1a. Total Cost
- Total ecosystem alternative plan cost (without O&M).

A1b. Cost (without Fish Passage or WLM)
- Total ecosystem alternative plan cost (without Fish Passage or WLM).

A1c. Total Average Annual Cost (Base Year 2005)
- Average annualized cost of the ecosystem alternative plan over 50 years with a base year 2005.

A2. Environmental Benefits (Acres of Influence) (without Fish Passage and WLM)

- Potential area of influence (i.e., improvement) produced by the ecosystem alternative plans (Table 2-17). This does not include areas influenced by fish passage or water level management.

Each alternative will influence varying amounts of the system depending on the type and quantity of measures included in the alternative. In this assessment, the acres of potential influence was identified for each measure, and then totaled to identify the total area of influence for each alternative. Fish passage was assessed separately due to the reduced accuracy of associating area of influence with tributary length benefits and the potential to double-count its benefits with other measures. Water level management was also assessed separately because of the increased potential for double-counting the benefits of this measure. For example, the area of influence benefits of water level management and side channel restoration may occur in the same area.

Table 2-17. Potential ecosystem alternative area of influence.

UMR-IWW Ecosystem Measure Benefits	Area of Influence (Acres)				
Ecosystem Measure	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Island Building	0	31,000	68,000	91,000	116,000
Fish Passage	0	0	0	287,236	577,815
Floodplain Restoration	0	1,000	1,000	90,500	236,500
Water Level Management - Pool	0	28,200	28,200	28,200	44,650
Water Level Management - Backwater	0	0	1,000	7,000	9,000
Backwater Restoration (Dredging)	0	43,200	82,800	124,800	162,000
Side Channel Restoration	0	5,800	10,700	14,700	17,300
Wing Dam/Dike Alteration	0	180	510	640	680
Island Protection	0	37,680	37,680	37,680	37,680
Shoreline Protection	0	705	705	705	705
Topographic Diversity	0	256	256	256	256
Dam Point Control	0	0	6,000	6,000	9,000
Floodplain Restoration - Immediate Opportunities	0	0	15,000	15,000	15,000
Total Area of Influence	0	148,021	251,851	703,717	1,226,586
Area of Influence (w/out Fish Passage and WLM)	0	119,821	223,651	388,281	604,121

*A3. Cost Effectiveness

- The efficiency of ecosystem alternative plans in addressing the UMR-IWW environmental needs. Efficiency was assessed by examining the cost effectiveness of fish passage, water level management, and the combined efficiencies of the remaining alternative measures.

A3a. Alternative Cost Effectiveness
- Alternative plan cost per acre of influence (A1b ÷ A2) (Table 2-18).

Table 2-18. Alternative plan cost effectiveness (i.e., cost per acre of influence).[a]

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
A1b. Alternative Cost (w/out Fish Passage or WLM)	$0	$1.6B	$2.7B	$4.3B	$6.3B
A2. Environmental Benefits (area of influence)	0	119,800	223,700	388,300	604,100
A3a. Alternative Cost Effectiveness (cost per acre)	$0	$13,000	$12,000	$11,000	$10,400

[a]Estimates of alternative cost effectiveness do not include fish passage or water level management costs and benefits.

The efficiency of ecosystem alternatives in addressing the environmental needs was assessed by examining their overall cost effectiveness (i.e., cost ÷ area of influence). This estimate of cost effectiveness was primarily influenced by the type and quantity of measures making up the alternative. That is, an alternative with a higher proportion of efficient measures would be more cost effective and have a lower cost per acre of influence. The costs and benefits of water level management and fish passage measures contained in the alternatives are evaluated below.

A3b. Water Level Management Cost Effectiveness
- The cost effectiveness of water level management measures included in the alternative plans.

Whereas the overall cost effectiveness of alternatives was affected mainly by the type and quantity of measures, measure cost effectiveness was influenced primarily be selecting more cost efficient locations for specific measures. By examining the cost and benefits of individual measures in each alternative, the most efficient level of investment could be determined. A detailed assessment of water level management was performed by a multi-district workgroup. The group examined the cost effectiveness of water level management modifications driven by acres effected, cost, and the likelihood of a successful 60-day drawdown. Water level management conducted in the 12 pools included in Alternatives B-D were determined to be more efficient than the 26 pools in Alternative E (Figure 2-8).

A3c. Fish Passage Cost Effectiveness
- The cost effectiveness of fish passage measures included in the alternative plans.

A comprehensive assessment of fish passage techniques and potential locations was also conducted by a technical workgroup. Fish passage sites were evaluated by examining added stream miles, surface areas of pools, projected costs, and the amount of time fish passage can currently take place (with gates out of the water). A longitudinal connectivity index (LCI: available stream miles) value was used instead of area of influence due to the difficulty in converting stream lengths to estimates of area. Fish passage measures incorporated into Alternative D exhibit higher efficiencies than the measures in Alternative E (Figure 2-9). This is due to the workgroups identifying the more efficient measure locations and having them incorporated into Alternative D. The locations were also selected based on existing need (i.e., percent of time the dam gates are out of the water: Figure 2-3). The 14 fish passage locations included in Alternative D have a cost per LCI of $9,100, whereas the cost per LCI of the 33 fish passage structures in Alternative E is $14,800.

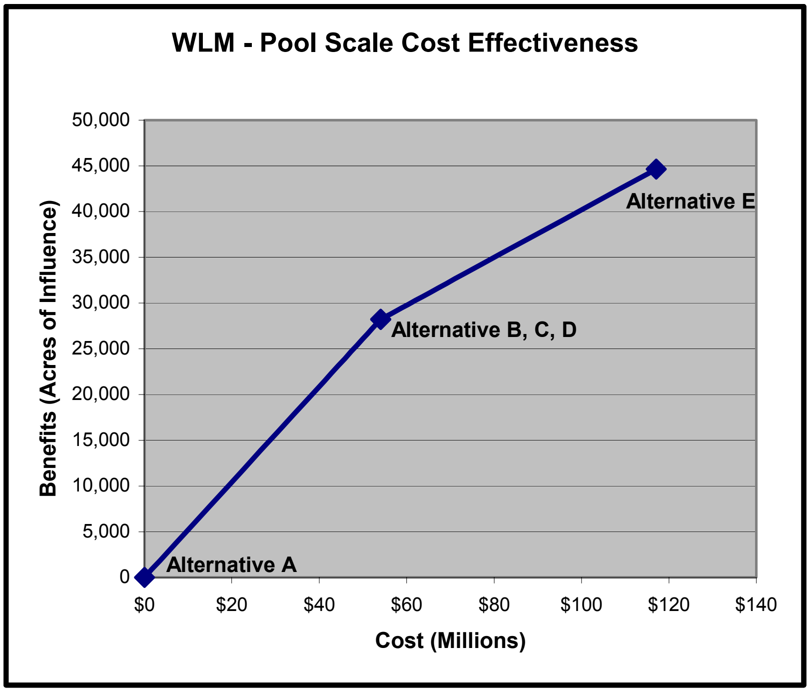


Figure 2-8. Water level management cost effectiveness.

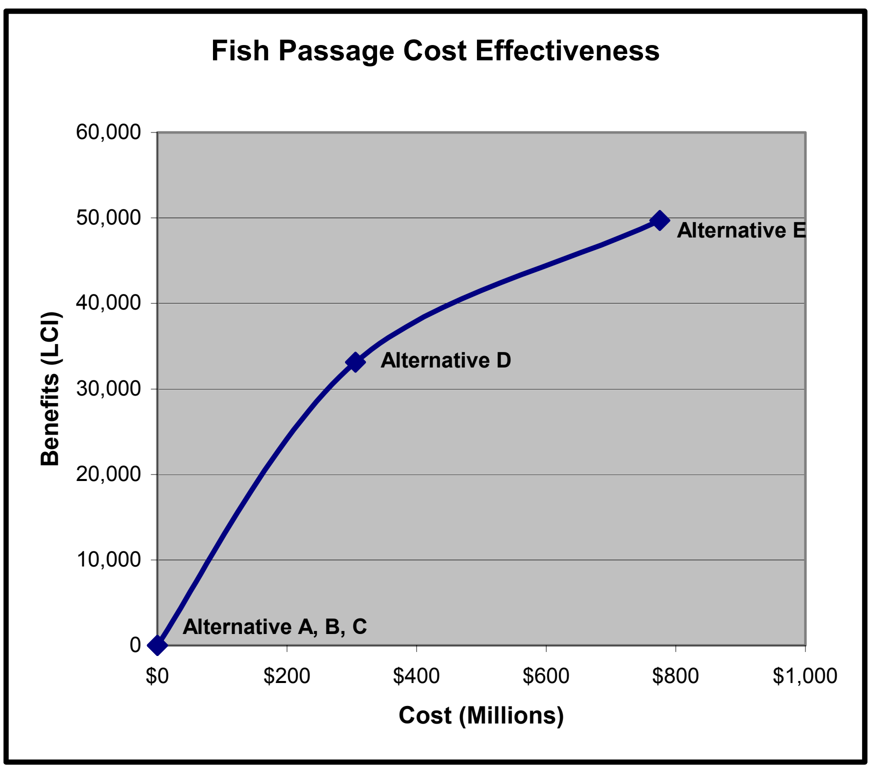


Figure 2-9. Fish passage cost effectiveness.

B. Environmental Quality

*** B1. Completeness**

- The extent to which the ecosystem alternative plan meets the identified needs of the UMR-IWW ecosystem.

B1a. Relation to Existing Condition (Without-project comparison)

- Relation of the alternative to the existing condition (Table 2-19). The without-project condition is described in relation to the existing condition.

Table 2-19. Alternative plan relation to the existing condition.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
B1a. Relation to Existing Condition	Lose Habitat	Maintain Habitat	Maintain/ Restore	Maintain/ Restore	Maintain/ Restore

The Cumulative Effects Study and Habitat Needs Assessment Reports describe the UMR-IWW ecosystem condition as a state of continued habitat loss and degradation over time. In an effort to assess the completeness of the ecosystem alternative plans, they were evaluated against the existing condition. This evaluation identified whether they lost, maintained, or restored habitat in relation to current ecosystem conditions. It is estimated that the no action plan (Alternative A) will result in continued loss of habitat. Alternative B attempts to maintain the existing mosaic of habitat quality and quantity. Alternative C-E result in increasing levels of restoration.

B1b. Proportion of the Ecosystem Measures

- The extent to which the alternative plan accounts for ecosystem needs identified in the virtual reference.

The UMR-IWW Environmental Objectives Database was developed to provide an estimate for the desired future condition (i.e., virtual reference) of the UMR-IWW ecosystem. This database was used to identify the type and quantity of restoration measures needed to achieve the virtual reference condition (Table 2-20). The proportion of virtual reference measures addressed by the ecosystem alternatives provides an initial estimate of the completeness of the ecosystem alternative plans. For example, Alternative C addresses 56% of the identified Virtual Reference measures collectively. It is important to keep in mind that both the cost and benefits of individual virtual reference measures vary greatly. That is, a fish passage structure costing in excess of $20 million is counted as a single reference, the same as a modest stream bank protection action.

Table 2-20. Number of ecosystem measures within each alternative.

Ecosystem Measure	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Virtual Reference
Island Building	0	31	68	91	116	172
Fish Passage	0	0	0	14	33	33
Floodplain Restoration	0	2	2	37	77	98
WLM - Pool Scale	0	12	12	12	26	26
WLM - Backwater	0	0	1	7	9	10
Backwater Restoration (Dredging)	0	72	138	208	270	383
Side Channel Restoration	0	58	107	147	173	225
Wing Dam/Dike Alteration	0	18	51	64	68	74
Island Protection	0	157	157	157	157	157
Shoreline Protection	0	235	235	235	235	235
Topographic Diversity	0	32	32	32	32	32
Dam Point Control	0	0	2	2	3	3
Floodplain Restoration - Im. Op.	0	0	3	3	3	3
Total	**0**	**617**	**808**	**1,009**	**1,202**	**1,451**
Percent of Total	**0%**	**43%**	**56%**	**70%**	**83%**	**100%**

B1c. UMRCC Environmental Objectives (River that Works Report)
- The extent to which the alternative plan accounts for nine essential UMR-IWW ecosystem objectives identified in *A River that Works and a Working River* report, a popular reference document with many stakeholder groups.

The UMRCC report *A River that Works and a Working River* identified nine environmental objectives vital to restoring and maintaining the health of the UMR-IWW ecosystem (Table 2-21). Assessing the number of essential UMRCC objectives considered by each ecosystem alternative provides an additional estimate of their completeness in achieving the environmental needs of the system.

Table 2-21. Alternative contribution to essential UMR-IWW ecosystem objectives.

Ecosystem Objectives (from River that Works Report)	Alt A	Alt B	Alt C	Alt D	Alt E
1. Improve Water Quality for all Uses	0	1	1	1	1
2. Reduce Erosion and Sedimentation Impacts	0	1	1	1	1
3. Restore Natural Floodplain	0	0	1	1	1
4. Restore Natural Hydrology	0	1	1	1	1
5. Increase Backwater Connectivity with Main Channel	0	1	1	1	1
6. Increase Side Channel, Island, Shoal, and Sand Bar Habitat	0	1	1	1	1
7. Minimize or Eliminate Dredging Impacts	0	1	1	1	1
8. Sever Pathways for Exotic Species Introductions/Dispersal	0	0	0	0	0
9. Improve Native Fish Passage at Dams	0	0	0	1	1
Total	0	6	7	8	8

Although the spread of exotic species is not directly addressed by measures within the restoration alternatives, non-native species will maintain a high priority as a component of the ecosystem alternative plan's rigorous adaptive management program. This program will seek to acquire necessary information to contribute to better understanding of exotic species dispersal, effects, and potential means of control.

***B2. Ecosystem Diversity**
- A qualitative assessment of the alternative plan effect on ecosystem diversity (Table 2-22).

Ecological diversity is a complex concept because it can involve species, populations, communities, habitats, processes, and many other issues. In this evaluation the alternatives were all presumed to affect overall ecosystem diversity to some degree. Rather than itemize species, habitats, and processes, the second tier objectives (see Section 2.3.2) were used to represent the large array of ecosystem elements likely to be affected by each alternative at a programmatic level. These categories (Table 2-22) were then ranked low, moderate, or high based on their likelihood to influence ecological diversity. A low rank will likely maintain existing habitat conditions and populations, but won't restore floodplain function. A moderate rank restores some habitats and functions. A high rank restores significant habitats and functions. Each project will be evaluated in more detail using traditional Habitat Evaluation Procedures during detailed project design.

Table 2-22. Alternative effect on UMR-IWW ecosystem diversity.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
B2a. Maintain viable populations of native species in situ.	-	Low	Moderate	High	High
B2b. Represent all native ecosystem types across their natural range of variation.	-	Low	Moderate	High	High
B2c. Restore and maintain evolutionary and ecological processes.	-	Low	Low	Moderate	High
B2d. Integrate human use and occupancy within these constraints.	-	-	-	-	-

The proposed ecosystem restoration alternatives address population viability primarily through affecting physical conditions to achieve a desired habitat or organismal response (e.g., creating deepwater habitat will provide better overwintering conditions and thus increase fish populations because individual fish will be healthier and produce more, healthier offspring). Some measures also address diversity directly through planting (e.g., trees, grassland, marsh, etc.). Alternative A was not ranked because no action under this plan will affect native species, habitats, or processes, though ongoing programs may. Alternative B addresses a moderate level of diversity because it emphasizes processes that affect diversity. Alternative B includes water level management that will affect marsh communities, it creates topographic diversity that will increase forest community diversity, and it is also structured to maintain the existing abundance and quality of backwaters, secondary channels, islands, and channel border habitat. Alternative C addresses similar elements as Alternative B, but at a level that achieves the first increment of restoration. Floodplain restoration is also introduced in Alternative C, which is an initial effort to restore some of the evolutionary and ecological processes that occur in floodplain habitats. Alternatives D and E achieve the highest levels of diversity because they address an array of ecosystem components and processes, and by extension diversity, at environmentally suitable and optimal levels, respectively. All the ecosystem elements addressed in the other alternatives are addressed in Alternative D and E, but they amount of effort allocated and the distribution of potential projects is greater.

All these alternatives will be designed and implemented within the constraints of human use and occupancy of the UMR-IWW System, but floodplain restoration will have more unavoidable human impacts than other restoration efforts. Floodplain restoration will require conversion of crop land to other uses, which could displace farmers willing to sell their land. However, some floodplain restoration objectives could be achieved through federal agency, non-federal agency or landowner involvement. Pool-scale water level management will have minor short-term impacts on recreation, but these will be offset by the substantial benefits obtained from this measure. Other proposed measures will have little to no impact on the human uses of the UMR-IWW system. This includes commercial navigation which will not be impacted by the restoration measures. An integrated adaptive management framework will optimize coordination among river users and uses.

C. Regional Economic Development

C1. Avg Annual Income to the Five States

- The average regional income provided annually by the construction of ecosystem restoration alternatives from 2005-2035 (Table 2-23).

Table 2-23. Average annual income (millions).

Region	Alt A	Alt B	Alt C	Alt D	Alt E
Minnesota	$0.0	$3.3	$5.3	$8.2	$14.5
Wisconsin	$0.0	$4.1	$6.8	$11.3	$16.8
Iowa	$0.0	$2.5	$4.2	$7.7	$10.6
Illinois	$0.0	$9.9	$17.0	$30.8	$51.2
Missouri	$0.0	$2.9	$4.5	$8.2	$13.3
L Miss	$0.0	$0.8	$1.7	$2.0	$4.4
Rest of U.S.	$0.0	$4.5	$7.5	$10.1	$14.7
Total	**$0.0**	**$28.0**	**$47.0**	**$78.2**	**$125.6**

The income displayed in Table 2-23 does not include contingency, planning, engineering, design, or administration costs. Factoring in these additional components will increase the total annual income provided to the states.

C2. Avg Annual Employment for the Five States

- The total number of jobs added or lost regionally each year due to alternative plan construction needs from 2005-2035 (Table 2-24).

Table 2-24. Average employment per year (jobs).

Region	Alt A	Alt B	Alt C	Alt D	Alt E
Minnesota	0	64	105	161	278
Wisconsin	0	78	128	212	314
Iowa	0	58	97	178	251
Illinois	0	148	248	449	741
Missouri	0	55	90	164	261
L Miss	0	15	14	-5	55
Rest of U.S.	0	50	77	18	184
Total	**0**	**468**	**759**	**1,177**	**2,083**

The income and employment benefits for each alternative are reported for the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri along with the lower Mississippi Region and the rest of the U.S. In general, the higher the investment in an alternative, the greater the benefits to the region.

D. Other Social Effects

D1. Ecosystem Goods and Services

- Effect of the alternative plans on goods and services produced by ecosystem processes (Table 2-25).

Each ecosystem generates a different set of goods and services of value to human society. The UMR-IWW is a large floodplain river ecosystem that provides a wide range of goods and services (Table 2-25). Overall, the ecosystem restoration alternatives would have a net positive effect on UMR-IWW ecosystem goods and services including maintenance of biodiversity, cycling of nutrients, recreational opportunities, etc. Livestock watering and recreational boating are the only components that would be negatively affected by the alternatives, primarily through water level management (drawdown of the pool). These effects would be minimal based on the duration of the drawdown (i.e., 60 days every 5-7 years). Also, recreational boating would see an overall increase in benefits due to additional aquatic areas made accessible through alternative plan backwater and side channel restoration measures. The alternatives would have no effect on commercial navigation, water supply, hydroelectric power, and moderation of river valley climate.

Table 2-25. Effect of alternatives on UMR-IWW ecosystem goods & services.

Ecosystem Goods and Services	Alternative Effect		
	Positive	Negative	No Effect
Municipal water supply			X
Residential (groundwater) supply			X
Industrial process water			X
Industrial cooling water			X
Residential and commercial building cooling water			X
Irrigation water for agricultural crops			X
Irrigation water for urban landscapes			X
Livestock watering		X	
Hydroelectric power			X
Commercial navigation			X
Recreational boating	X	X	
Waste assimilation, purification	X		
Maintenance of aquatic and floodplain habitats	X		
Maintenance of biodiversity	X		
Production of human-edible food from fish, wildlife, vegetation	X		
Moderation of river valley climate			X
Attenuation of floods	X		
Cycling of nutrients	X		
Carbon sequestering, protection of atmospheric gas composition	X		
Generation and renewal of floodplain soils	X		
Soils that support floodplain agriculture	X		
Construction materials and fiber from floodplain forests	X		
Medicinal compounds	X		
Genetic materials for agriculture and medicine	X		
Aesthetic beauty, spiritual, cultural values	X		
Recreational opportunities	X		

E. Contribution to Planning Objectives

- Ability of the ecosystem alternative plan to contribute to the study planning objectives (Table 2-26).

Table 2-26. Ecosystem alternative contribution to planning objectives.

Planning Objective	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
E1. Provide for a safe, reliable…	-	Neutral	Neutral	Neutral	Neutral
E2. Address cumulative impacts…	-	Partial	Partial	Yes	Yes
E3. Measures are consistent…	-	Yes	Yes	Yes	Yes

***E1. Provide for a safe, reliable, efficient, and sustainable UMR-IWW navigation system over the planning horizon.**

- Positive/Neutral/Negative effect on this planning objective. Ecosystem Alternatives B-E were scored neutral for this objective. The measures included in the alternatives will not significantly affect the safety reliability or efficiency of the Navigation project.

***E2. Address cumulative impacts including ongoing effects of the operation and maintenance of the UMR-IWW Navigation System.**

- Yes/Partial/No as to whether this planning objective is achieved. Alternatives B and C partially address the wide array of cumulative effects on the system. Alternatives D and E contain all the types of measures, implemented at a sufficient level, needed to address the variety of ongoing and cumulative effects. For example, loss of river connectivity both with its floodplain (latitudinal) and between pools (longitudinally) has been identified as a significant cumulative effect on the Ecosystem. Alternatives D and E include fish passage and floodplain restoration at a level necessary to have systemic beneficial effects to address the connectivity issue. Alternatives B and C do not sufficiently address the connectivity issues.

***E3. Measures are consistent with protecting the nations environment.**

- Yes/Partial/No as to whether this planning objective is achieved. Ecosystem Restoration Alternatives B-E are consistent with protecting the nations environment.

F. Acceptability

F1. Alternative Plan Acceptability

- Overall workability and viability of the alternative plan with respect to acceptance by Federal, State and local entities; the general public; and compatibility with existing laws regulations and public policies. The feasibility study is not yet complete, however observations have started to surface that provide some insight into the acceptability of the alternatives. For this study we have organized stakeholder acceptability of the alternative plan into the following categories:

F1a. Institutional

- This stakeholder group includes representatives holding official governmental positions representing the interest of the various federal, state, and municipal agencies. For example, the five UMR states (IL, IA, WI, MN, MO), their respective departmental representatives, federal agencies (USFWS, USEPA, USDOT, USDA….etc).

The USFWS has endorsed Ecosystem Alternative E through a formal letter submitted to the Corps. The States of Minnesota and Wisconsin have expressed an interest in a modified version of Alternative E, but have not yet submitted a formal endorsement.

F1b. Social

- This stakeholder group includes the general public and non-governmental organizations such as MARC 2000, Audubon, National Corn Growers, The Nature Conservancy, Towboat industry, Mississippi River Basin Alliance, etc. The ecosystem alternatives were presented at a series of seven public meetings in October 2003. This meeting was structured to allow members of the general public to ask questions, voice their opinions on the study process or alternatives, submit written statements and complete a comment form.

Similar to the States of Minnesota and Wisconsin, some environmental interests have expressed the desire for a modified version of Alternative E.

The following provides a brief summation of the acceptability information obtained from the seven Public meetings held during October 2003:

- Average attendance at the series was over 180 persons.
- 57% of those that saw the slide presentation, turned in a comment form
- Of the 608 comment forms turned in:
  - Agriculture interest was the largest primary interest group at 34%, followed by other business/industry at 23%, and Environmental interest at 15%.
  - Over 79% said they understand how the study process was developed to arrive at the alternative plans presented.
  - Over 87% said they understand the principle navigation and ecosystem problems being addressed by the study.
  - Over 67% said they understand the process for evaluating navigation efficiency & ecosystem restoration alternatives.
  - Over 74% said they feel sustainability of the river system requires a balanced approach between econ & environmental interests.
  - Over 80% agreed that the Alternative plans presented reflect the study's dual purpose.
  - Over 72% agreed that the Alternative plans meet or address navigation efficiency & ecosystem restoration goals for the study.
  - Almost 72% agreed that the study's balanced emphasis on economic & environmental sustainability is reflected in the alternatives.
  - Almost 84% agreed that it is possible to sustain healthy river ecosystem & continue commercial barge traffic.

F2. Requirements of Partners

- Acceptability of the partner responsibility to aid in funding, implementing, and maintaining the ecosystem alternative plans under Cost Sharing Option C (Table 2-27).

Table 2-27. Partner cost share and operation & maintenance responsibilities.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Total Alternative Cost	$0	$1,692M	$2,817M	$5,183M	$8,417M
F2a. Cost Share ($)	$0	$209M	$336M	$1,051M	$2,207M
F2b. Cost Share (%)	0%	12%	12%	20%	26%
F2c. O&M (non-Corps) ($)	$0	$46M	$77M	$139M	$220M

Under Cost Sharing Option C, measures involving modification of the structures and operations of existing projects; on Corps Project lands and lands included in the National Refuge System; and measures in the main channel or directly connected backwater areas below the Ordinary High Water Mark will be 100 percent Federal regardless of current ownership. Measures on other public or privately owned lands would be cost shared 65/35.

F2a and F2b. Cost Share

- Alternative plan Cost Sharing Option C cost share requirements of the partners (noted as total dollars and proportion of the alternative cost).

Under this option, partners will be required to cost share 12-26% of the ecosystem alternative cost.

F2c. Operation & Maintenance

- Requirement of partners to fund and perform alternative plan operation and maintenance under Cost Sharing Option C. Partners will be responsible for $46-$220 million of project O&M costs.

On behalf of the five UMR-IWW States, the Upper Mississippi River Basin Association has expressed their support for Cost Sharing Option C. The USFWS has also submitted a letter declaring their support for Option C.

G. Adaptability

- Adaptability is the ability to adjust the alternative based on changes in future conditions. The implementation of ecosystem alternatives to address the complex assortment of ecological needs and objectives will be augmented using a rigorous adaptive management program. This process will seek to gather systemic information and monitor early projects to create the information tracking and feedback required in an adaptive management design. Utilizing this process, the ecosystem alternatives will be more adaptable in testing and improving on the design and performance of measures and in establishing efficient sequencing of project implementation. Elements of the adaptive management program would include:

1. Organization
    - River Management Council
    - Science Panel
    - River Management Teams
2. Systemic Studies
    - Ecosystem Modeling (numerical and conceptual)
    - Information Needs Assessment
    - Biological data collection (example Fish Stock Assessment)
    - Physical data collection (bathymetry)
    - Etc.
3. Restoration Measure Evaluation
    - Island Building
    - Fish Passage
    - Side Channel Restoration
    - Etc.

To aid in decision making, the UMR-IWW adaptive management program will develop a sound organizational structure and conduct restoration measure evaluations and systemic studies.

2.3.5 Comparison of Ecosystem Restoration Alternative Plans

2.3.5.1 Alternative Evaluation Scoresheet

A populated scoresheet (Figure 2-10) was used to assist in the ecosystem alternative comparison process. The Alternative Evaluation Scoresheet is merely a means to display the quantitative and qualitative evaluation information for each alternative plan. It serves as a quick reference to the data and criteria that have been assembled for the comparison process. The descriptions and definitions provided in the preceding sections of this document should be carefully reviewed by anyone attempting to interpret or utilize the information provided in the scoresheet. A single scoresheet can not fully represent the considerable supporting documentation used to develop and assess the alternatives. However, it is an important tool for facilitating dialog within the study team and with varied stakeholders.

ECOSYSTEM RESTORATION ALTERNATIVES *Alternative Evaluation Score Sheet*						
ACCOUNTS	**ALTERNATIVE PLANS**					
	A	**B**	**C**	**D**	**E**	**Other**
A. Environmental Benefits (NER)	**Rank**					
A1. Project Cost						
A1a. Total Cost	$0.0	$1,691,700,000	$2,816,600,000	$5,182,800,000	$8,416,700,000	
A1b. Cost (w/out Fish Passage or WLM)	$0.0	$1,561,900,000	$2,686,800,000	$4,262,700,000	$6,272,800,000	
A1c. Total Average Annual Cost (Base Year 2005)	$0.0	$35,080,000	$58,400,000	$106,290,000	$174,520,000	
A2. Env. Benefits (Acres of Influence) (w/out FP or WLM)	0	119,800	223,700	388,300	604,100	
* A3. Cost Effectiveness						
A3a. Alternative Cost Effectiveness (A1b ÷ A2)	$0	$13,000	$12,000	$11,000	$10,400	
A3b. Water Level Management Cost Effectiveness	-	High	High	High	Moderate	
A3c. Fish Passage Cost Effectiveness	-	-	-	High	Moderate	
B. Environmental Quality	**Rank/Considerations**					
* B1. Completeness						
B1a. Relation to Existing Condition	Lose	Maintain	Restore	Restore	Restore	
B1b. Proportion of the Ecosystem Measures	0%	43%	56%	70%	83%	
B1c. UMRCC Env. Objectives (River that Works R.)	0/9	6/9	7/9	8/9	8/9	
* B2. Ecosystem Diversity						
B2a. Maintain viable populations of native species in situ.	-	Low	Moderate	High	High	
B2b. Represent all native ecosystem types across their natural range of variation.	-	Low	Moderate	High	High	
B2c. Restore and maintain evolutionary and ecological processes (i.e., disturbance regimes, hydrological processes, nutrient cycles, etc.).	-	Low	Low	Moderate	High	
B2d. Integrate human use and occupancy within these constraints.	-	-	-	-	-	
C. Regional Economic Development (2005-35)	**Considerations**					
C1. Avg Annual Income to the Five States	$0	$28,000,000	$47,000,000	$78,200,000	$125,600,000	
C2. Avg Annual Employment for the Five States	0	470	760	1,180	2,080	
D. Other Social Effects	**Considerations**					
D1. Ecosystem Goods and Services	See detailed description of ecosystem goods and services					
E. Contribution to Planning Objectives						
* E1. Provide for a safe, reliable, efficient, and sustainable UMR-IWW navigation system over the planning horizon.	-	Neutral	Neutral	Neutral	Neutral	
* E2. Address cumulative impacts including ongoing effects of the operation and maintenance of the UMR-IWW Navigation System.	-	Partial	Partial	Yes	Yes	
* E3. Measures are consistent with protecting the nations environment.	-	Yes	Yes	Yes	Yes	
F. Acceptability	**Considerations**					
F1. Alternative Plan Acceptability						
F1a. Institutional						
F1b. Social						
F2. Requirements of Partners						
F2a. Cost Share ($)	$0	$209,400,000	$335,900,000	$1,051,200,000	$2,206,900,000	
F2b. Cost Share (%)	0%	12%	12%	20%	26%	
F2c. Operation & Maintenance (Non-Corps) ($)	$0	$46,400,000	$76,600,000	$138,700,000	$219,600,000	
G. Adaptability	**Implementation**					

Figure 2-10. Ecosystem alternative evaluation scoresheet.

2.3.5.2 Comparison Process for Ecosystem Restoration Alternatives

An evaluation process was developed and followed to compare the ecosystem restoration alternatives and ultimately select the best plan. It was structured to review and assess the criteria information within the alternative evaluation scoresheet, identify additional evaluation criteria and implementation considerations, and provide a final recommendation with supporting rational. Specifically, a four-step process for evaluating alternatives was developed and is described below:

Step 1: Compare and rank alternatives using key evaluation criteria (e.g., environmental benefits, efficiency, etc.) from the alternative evaluation scoresheet.

Step 2: Refine the alternative ranking with the remaining criteria (e.g., regional economic development and other social effects) in the evaluation scoresheet.

Step 3: Identify other criteria, implementation considerations, or technical information that were not included in the scoresheet. This step would include information provided by stakeholders and the general public.
Step 4: Provide a tentative recommendation with supporting justification. This final step takes into consideration all information presented in the preceding steps.

By adhering to this assessment structure, the alternative comparison process ultimately led to the selection of the recommended ecosystem restoration plan.

Step 1: Alternative Comparison and Ranking with Key Criteria

After reviewing the comprehensive set of criteria included in the alternative scoresheet, three evaluation criteria were identified as being best suited to select the most appropriate ecosystem plan. These criteria included:

1) evaluating the contribution of the alternatives to the Navigation Study planning objectives,
2) assessing the environmental quality (i.e., completeness and diversity) of the alternatives in addressing the UMR-IWW ecosystem needs, and
3) as part of the NER environmental benefits, evaluating the efficiency of the alternative in addressing ecosystem needs.

Contribution to Planning Objectives

The ecosystem alternatives were first assessed on how they contribute to the following planning objectives.

E1. Provide for a safe, reliable, efficient and sustainable UMR-IWW navigation system over the planning horizon.
E2. Address cumulative impacts including ongoing effects of the operation and maintenance of the UMR-IWW Navigation System.
E3. Assure that any recommended measures are consistent with protecting the Nation's environment; avoiding, minimizing, or mitigating significant environmental, cultural, or social impacts.

Alternatives D and E received the highest rank for their effect on the study planning objectives (Table 2-28) because they were the only alternatives to provide full contribution to both E2 and E3. Alternatives B and C were ranked 2nd because they had only partial contribution to E2. Alternative A does not meet the study planning objectives, therefore it was given the lowest ranking in this assessment. All the alternatives were evaluated as neutral (i.e., little to no impact) in their effect on the navigation transportation system (E1).

Table 2-28. Contribution of alternatives to study planning objectives.

Alternative	E1	E2	E3	Rank
A	-	-	-	3
B	Neutral	Partial	Yes	2
C	Neutral	Partial	Yes	2
D	**Neutral**	**Yes**	**Yes**	**1**
E	**Neutral**	**Yes**	**Yes**	**1**

Environmental Quality (Completeness and Diversity)

The environmental quality of the restoration alternatives was evaluated by examining how they contribute to UMR-IWW ecosystem completeness and diversity. Three parameters of completeness were evaluated including:

1) Relation to the existing condition
2) Proportion of virtual reference ecosystem measures addressed
3) Number of UMRCC essential ecosystem objectives addressed

As described in the Cumulative Effects Study and Habitat Needs Assessment Reports, the condition exhibited by the UMR-IWW ecosystem will continue to degrade over time. In assessing the relation of alternatives to the existing condition, Alternatives C, D, and E received the highest rank (Table 2-29) because of their ability to maintain and begin to restore the UMR-IWW ecosystem. The ability of the measures in Alternative B to only maintain the current condition over the next 50 years led to this alternative being ranked 2nd. Alternative A was given the lowest ranking because the ecosystem would continue to degrade with a loss in habitat.

Table 2-29. Alternative plan completeness – relation to existing condition.

Alternative	Relation to Existing Condition	Rank
A	Lose Habitat	3
B	Maintain Habitat	2
C	**Maintain/Restore Habitat**	**1**
D	**Maintain/Restore Habitat**	**1**
E	**Maintain/Restore Habitat**	**1**

The UMR-IWW Environmental Objective Database was used to identify the type and quantity of restoration measures needed to achieve the virtual reference (i.e., desired ecosystem condition). The proportion of virtual reference measures addressed by the ecosystem alternatives provides an estimate of the completeness of the ecosystem alternative plans. Alternative E was given the highest rank (Table 2-30) due to it addressing the highest proportion (i.e., 83%) of the virtual reference objectives. The remaining alternatives were ranked 2-5 from D-A based on their declining proportion of objectives addressed.

Table 2-30. Alternative plan completeness – addressing UMR-IWW ecosystem needs.

Alternative	Proportion of UMR-IWW Ecosystem Measures	Rank
A	0%[a]	5
B	43%	4
C	56%	3
D	70%	2
E	**83%**	**1**

[a] Although Alternative A is noted as addressing 0% of the virtual reference needs, other UMR-IWW programs will complete some of these restoration efforts. The Environmental Management Program will carry out approximately 100 restoration projects over the next 50 years. These activities will address a small proportion of the identified virtual reference measures.

Assessing the number of essential UMR-IWW ecosystem objectives (from the UMRCC *River that Works* report) addressed by each ecosystem alternative provided an additional estimate of their completeness in addressing the environmental needs of the system. Alternatives D and E received the highest ranking (Table 2-31) because they addressed eight of the nine UMRCC objectives. Alternative C and B were given rankings of 2 and 3 respectively, and Alternative A received the lowest ranking.

Table 2-31. Alternative plan completeness – addressing UMRCC ecosystem objectives.

Alternative	UMRCC Eco. Objectives	Rank
A	0/9	4
B	6/9	3
C	7/9	2
D	**8/9**	**1**
E	**8/9**	**1**

The one essential UMRCC ecosystem objective not directly addressed by the restoration alternatives relates to reducing the spread of exotic species into and within the UMR-IWW System. Though not directly addressed, exotic species will maintain a high priority as a component of the ecosystem alternative plan's rigorous adaptive management program. Future research will be conducted to further explore system management and restoration measures that could be employed to address the issue of exotic species.

The environmental quality of the ecosystem restoration alternatives was also evaluated by gauging how well alternatives contribute to ecosystem diversity. The following Tier 2 ecosystem goals (Grumbine 1994) were used to assess the alternative influence (i.e., low-high) on UMR-IWW ecosystem diversity.

B2a. Maintain viable populations of native species in situ.
B2b. Represent all native ecosystem types across their natural range of variation.
B2c. Restore and maintain evolutionary and ecological processes (i.e., disturbance regimes, hydrological processes, nutrient cycles, etc.).
B2d. Integrate human use and occupancy within these constraints.

Alternatives D and E received the highest rank for their effect on diversity (Table 2-32) because they provided a moderately high positive influence on UMR-IWW ecosystem diversity. The remaining alternatives were ranked 2-4 from C-A due to there decreasing influence on ecosystem diversity.

Table 2-32. Alternative effect on UMR-IWW ecosystem diversity.

Alternative	B2a	B2b	B2c	B2d	Rank
A	-	-	-	-	4
B	Low	Low	Low	-	3
C	Moderate	Moderate	Low	-	2
D	**High**	**High**	**Moderate**	**-**	**1**
E	**High**	**High**	**High**	**-**	**1**

NER Environmental Benefits (Efficiency)

The NER environmental benefits of the ecosystem alternatives plans were assessed by evaluating their efficiency in addressing the UMR-IWW ecosystem needs. This assessment was accomplished by first examining the alternative plan cost effectiveness (without fish passage or water level management). Alternative plan water level management and fish passage measures were then examined to determine their efficiency in addressing the system needs.

Assessment of the ecosystem alternative cost effectiveness (without fish passage or water level management) was accomplished by dividing the alternative cost by potential area of influence to establish the alternative cost per acre (Table 2-33). Ecosystem alternative cost effectiveness was primarily influenced by the type and quantity of measures making up the alternative. Because Alternative E had the highest proportion of cost effective measures, it was determined to be the most cost efficient (having the cheapest per acre cost). Therefore, Alternative E was given the highest ranking followed by Alternatives D-A in descending order. Alternatives D and E were fairly close in their assessed cost efficiency while the remaining alternatives exhibited larger declines in overall effectiveness.

Table 2-33. Ecosystem alternative plan cost, benefits, and effectiveness.

Alternative	Cost (no FP/WLM)	Area of Influence (no FP/WLM)	Cost/Acre	Rank
A	$0	0	$0	5
B	$1,561,900,000	119,800	$13,000	4
C	$2,686,800,000	223,700	$12,000	3
D	$4,262,700,000	388,300	$11,000	2
E	**$6,272,800,000**	**604,100**	**$10,400**	**1**

The effectiveness of individual restoration measures was also evaluated to gauge the efficiency of alternatives in addressing the ecosystem objectives. By examining the cost and benefits of individual measures in each alternative, the most efficient level of investment could be determined. Because of the detailed level of information required, a large proportion of the measures could not be evaluated in this way. However, with the additional effort accomplished by workgroups examining fish passage and water level management, a more detailed assessment of the efficiency of these measures could be performed.

Alternative D includes the most cost efficient fish passage measures (Table 2-34). This is due to the more efficient measure locations identified by the workgroups being incorporated into this alternative. For example, at a similar level of investment, fish passage at L&D 26 provides for greater connectivity to the main channel and tributaries than other locations. L&D 26 was one of the 14 fish passage measure locations selected for Alternative D. Alternative E incorporated the remaining less efficient locations for fish passage and therefore received a lower ranking.

Alternatives B-D include the most cost efficient water level management measures (Table 2.3.33). This was determined by assessing the cost, area effected, and likelihood of success of these measures.

Alternative D received the top ranking for measure cost effectiveness because fish passage and water level management measures in this alternative exhibited the highest efficiencies. Alternatives C-A received the lowest rankings because they were missing one or both of the measures being assessed. A smaller number of fish passage structures were not included in Alternatives B or C because of an identified threshold of need. That is, the systemic improvement of fish passage connectivity was not minimally obtained until fish passage was restored at the 14 identified locations.

Table 2-34. Water level management and fish passage cost effectiveness.

Alternative	WLM Cost Effectiveness	Fish Passage Cost Eff.	Rank
A	-	-	4
B	High	-	3
C	High	-	3
D	**High**	**High**	**1**
E	Moderate	Moderate	2

Step 1 Results:

By using the key evaluation criteria of adherence to the planning objectives, environmental completeness and diversity, and alternative efficiency, this assessment was successful in providing the information needed to identify the ecosystem alternative that best addressed the UMR-IWW environmental objectives. Using the information above, the following paragraphs document the selection process.

Evaluation of the ecosystem alternative contribution to the Navigation Study planning objectives determined that Alternatives D and E completely contributed to the planning objectives. Therefore, they received the highest ranking.

Assessment of the ecosystem alternative completeness was accomplished by examining the alternative relation to the existing condition, proportion of the virtual reference achieved, and number of UMRCC essential ecosystem objectives addressed. Based on the results of this assessment, Alternatives D and E were ranked very closely with Alternative E being preferred slightly over D.

Restoration alternative effects on Tier 2 ecosystem goals (Grumbine 1994) were assessed to qualitatively identify the influence of alternatives on UMR-IWW ecosystem diversity.
Alternatives D and E were determined to have the largest positive influence on the Tier 2 ecosystem goals. Therefore, they received the highest ranking for ecosystem diversity.

Environmental efficiency was evaluated by examining the cost effectiveness of fish passage, water level management, and the combined efficiencies of the remaining alternative measures. Alternative E was slightly more efficient than D when comparing the combined efficiencies of their measures (without fish passage and water level management). However, with more detailed assessment of fish passage and water level management measures, Alternative D was found to be more cost effective than E. Therefore, D was selected as the most efficient alternative in addressing the UMR-IWW ecosystem needs.

Based on assessment of these key evaluation criteria, Alternative D was selected as the preferred alternative. Though D and E were very close in there overall ranking, Alternative D was selected as the best alternative primarily because it achieved a high degree of completeness and diversity in the most efficient manner.

Step 2: Refinement of the Initial Ranking with Remaining Criteria

The second step of the evaluation process involved refining the ranking of the alternatives with the remaining scoresheet criteria. This step was conducted with two primary goals in mind:
1) assist in making a single selection if the initial evaluation (i.e., Step 1) resulted in two equally favored alternatives and
2) further consider benefits offered by the ecosystem alternatives.

Because the initial evaluation selected D as the recommended alternative, this step in the evaluation process will concentrate on the second goal of further considering the benefits offered by the ecosystem alternatives. Benefits produced through regional economic development, other social effects, acceptability, and adaptability are explained in detail below.

Regional Economic Development

The income and employment benefits for each alternative are reported for the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri along with the lower Mississippi Region and the rest of the U.S (Table 2-35). These income and employment effects are derived from direct construction expenditures required to implement an alternative. The greater the investment, the greater the benefits, thus alternative E has the greatest RED benefits. The remaining alternatives exhibit declining benefits moving from D to A. The RED benefits do not factor into the Federal decision making process, however they will influence the acceptability of an alternative to the region.

Table 2-35. RED benefits produced by the environmental alternatives.

	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
C1. Avg Annual Income to the Five States	$0	$28.0M	$47.0M	$78.2M	$125.6M
C2. Avg Annual Employment for the Five States	0	470	760	1,180	2,080

Other Social Effects

Overall, the restoration alternatives contribute to maintaining and restoring a wide range of UMR-IWW ecosystem goods & services. The fact that many of the goods and services provided by the UMR-IWW are uniquely important to the nation was validated when the U.S. Congress in WRDA 1986 declared the area "a nationally significant ecosystem". The following is a sample of the many uses, species, and habitats that are of particular importance in the UMR-IWW or are rarely found in other areas.

- The UMR-IWW is the largest riverine ecosystem in North America and third largest in the world.
- Combined with the floodplains of the Illinois, Minnesota, St. Croix, Black and Kaskaskia Rivers cover 2,570,000 acres of land and water area.
- Commercial and recreational fishery.
- Today, some 297,000 acres of the floodplain are now within the Wildlife Refuge System.
- Home and habitat for 485 species of fish, mussels, birds, mammals, amphibians and reptiles
- For some bird species, nest success may be higher in (UMR) floodplain forests than in upland forests, and in these cases floodplains are an important recruitment or "source" areas for certain bird populations. (UMRCC, 2002)
- About half of the 30 million residents of the watershed rely on the water from the UMR and its tributaries for municipal and industrial water supplies.
- It provides for over $6.6 billion dollars in revenue annually from some 12,000,000 visitor-days of use by people that hunt, fish, boat, sightsee or otherwise visit the river, its magnificent bluffs and communities.
- Recreation and tourism employ 143,000 people in the corridor.

- It is a migratory flyway for 40% of all North American waterfowl.
- It is a globally important flyway for 326 bird species (60% of all species in North America).
- At least 260 fish species have been reported in the basin (25% of all fish species in North America).
- The river is habitat for 37 species of fresh-water mussels.
- The river corridor is habitat for 45 amphibian and reptile species and 50 mammal species.
- It is critical habitat for 286 state-listed or candidate species and 36 federal-listed or candidate species of rare, threatened or endangered plants and animals endemic to the UMR Basin.
- It provides the important, but intangible, benefit of over 1,300 river miles of diverse natural, rural and urban open space for human exploration, experiential education, spiritual renewal and aesthetic enjoyment.
- It is a 2.5 million acre large river floodplain laboratory. It is a "system of systems" for us to use, understand and appreciate. It is a place for this and future generations to learn how to restore and maintain a "living river" in the face of a global human population that will grow by 1 billion people in the next 12 years.
  * (Unless otherwise noted these bullets are excerpted from UMRCC, 2000)

Acceptability

Based on current feedback (e.g., public meeting results), Ecosystem Alternative E (in its current or modified form) and Cost Sharing Option C have carried the most support among stakeholders. Although some NGOs, States, and Federal agencies expressed support for an alternative and funding mechanism, most have not yet endorsed a specific ecosystem alternative plan. Due to the inability to collect comprehensive feedback from all stakeholders, acceptability criteria cannot be ranked for the comparison of alternative plans. However, the current information can be used to obtain a general sense of stakeholder opinion on alternative acceptability.

Adaptability

Implementing the recommended alternative through a process of adaptive management will minimize uncertainty and risk. By developing a sound organizational structure, evaluating measure outputs, and monitoring systemic trends, the ecosystem alternative will be more adaptable in testing and improving on the design, performance, and sequencing of restoration measures.

One of the primary benefits of an UMR-IWW adaptive management program is the development of an iterative and flexible approach to management and decision making. It also provides an open management process that seeks to include partners and stakeholders in the planning and implementation stages of the recommended ecosystem alternative plan (see Section 2.5.4).

Step 3: Identify other Criteria and Considerations

After the initial assessment, additional criteria and considerations were identified and discussed by the Nav. Study Team and stakeholders. This led to a modification of the recommended alternative which will now be referred to as Alternative D*.

Based on UMR-IWW stakeholder input, embankment lowering at lock and dam sites will be included as a potential measure in Alternative D* to improve floodplain connectivity, shoreline stability, and fish passage. This measure will be incorporated into the existing measures of fish passage, floodplain restoration, and shoreline protection at no additional cost. It is anticipated that initial implementation will take place in conjunction with construction of fish passage structures.

Measures to reduce water level fluctuation on the UMR-IWW were also recommended by stakeholders. These measures would attempt to produce a more natural hydrograph in parts of the system that see sudden changes in water level. They would potentially include more frequent adjustment and remote operation of dam gates, centralization of water control on the Illinois Waterway, and structural modifications to the wicket dams at Peoria and La Grange. Based on stakeholder input and conclusions from the Water Level Management Workgroup, measures to reduce water level fluctuation on the Illinois River will be added to Alternative D* at an estimated cost of $140 Million dollars over 50 years.

It was recognized that in order to better understand the ecosystem needs and effects on the UMR-IWW system, an initial 7 – 12 year implementation plan should be generated.

Implementation of ecosystem sustainability measures must be conducted in the context of an integrated adaptive management program for all river uses. Navigation system maintenance and environmental protection have been coordinated in the past, but the process was not systemic and never fully integrated. Truly coordinated ecosystem and navigation system operation and maintenance can result in cost savings by first avoiding conflicts, but more so by using the same equipment, crews, and processes to satisfy both missions. For example, appropriate dredged material placement has been a challenge, but if coordinated, the material can actually become quite valuable for sculpting islands and floodplain topography where appropriate to enhance hardwood tree growth.

There would be an initial implementation stage, approximately 10 years, where the institutions required to manage, plan, and implement the program would be organized. A river coordinating council would need to be developed and staffed. A science panel would also need to be established to help refine and implement an Adaptive Management scheme for integrated river management. These two teams would provide guidance to prioritize project construction sequences. District level teams would need to be convened to help prioritize local navigation and habitat operation and maintenance and restoration needs that they would forward to the system level coordinating council. It is anticipated that existing coordination teams could be reorganized to accomplish this integrated mission. Additional information explaining the coordination of institutions during implementation is provided in Section 2.5.4 Institutional Relationships.

Implementation of the most cost-effective measures, pool-scale water level management for example, could be conducted early in the implementation because they are highly adaptable measures. They do not require large investments in infrastructure, but they do require significant planning and coordination among river users. In many cases, the cost effective measures are those that emulate or incorporate natural river processes into their design.

Some previously scoped restoration projects originally proposed for the Environmental Management Program or other ecosystem restoration authorities may best be accomplished under this restoration authority. These projects possess the benefit of having the support of project sponsors and a basic plan in place.

Some projects will only be implemented when the right opportunity presents itself. This is particularly true of large scale floodplain restoration, which means that land owners are willing project sponsors likely to cost share projects. There are several immediate opportunities to implement floodplain restoration on the system. The program needs the flexibility to respond to opportunities like those immediately following the flood of 1993.

Some measures, like fish passage, will be new and innovative. An early implementation of these will provide an opportunity to implement and evaluate them to determine if they should be more widely applied through the rest of the program.

Policy recommendations accompanying the selected plan will likely include USACE authority to approve individual projects up to $25 million. Projects in excess of that, primarily fish passage, could also be implemented early if they are given specific authority in the programmatic implementation legislation.

Step 4: Provide a Tentative Recommendation

2.3.5.3 Draft Tentatively Selected Ecosystem Restoration Plan

The Draft tentatively selected plan for ecosystem restoration is to seek approval of a $5.3 Billion 50-year plan (Alternative D). It will recommend authorization of an initial 10-year implementation strategy, which will be developed with the stakeholders to address critical ecosystem needs and to provide insight into the response of the environment to the various navigation project modifications and measures. The 10-year strategy will be based on those measures that provide:

1. The best return on investment.
2. Best gains in diversity.
3. Additional knowledge required to guide future investments.

The strategy will include both a programmatic and project specific authority. A report back to Congressional committee after the initial 10-year period will provide an assessment of the program and recommendations for any modifications to the Alternative D framework including potential further authorization. This plan also recommends implementation of measures on project lands or National Wildlife Refuge lands and certain other specific lands at 100-percent federal cost (Cost Share Option C). It should be recognized that this option is a regional recommendation and has not been approved by the administration or the Congress. The basis for plan selection was the completed technical analysis and comparison, and its potential acceptability in terms of its workability, viability and compatibility with existing laws, and public policies.

Additional implementation strategies for the timing and sequencing of work will be discussed with the stakeholders and an assessment provided in the draft feasibility study. The Chiefs report will include an implementation option recommendation.

Rationale. While the Alternative B framework could seek to maintain current conditions and Alternative C would begin to restore aspects of the ecosystem, they do not contain all the tools and measures necessary to address restoration of key ecological processes and ecological diversity. Alternative E contains the same tools and measures as Alternative D with increased attention to Fish passage modifications at all 33 Dams (versus 14 in Alternative D), water level management modifications in 26 pools (versus 12 in Alternative D) and floodplain restoration for 250,000 acres (versus 105,000 acres in Alternative D). The water level management and fish passage locations added to Alternative E are costly with less likelihood of success and less contribution to benefits than those contained in Alternative D. Most floodplain restoration will require non-federal cost-share partners.

There is much to learn concerning the response of the environment to modifications recommended. However, the region has ample information and experience necessary to get started on the integrated management of the Upper Mississippi River and Illinois Waterway System.

2.4 Navigation Efficiency

2.4.1 Inventory and Forecast of Navigation Efficiency Conditions

2.4.1.1 Historical Conditions

Traffic usage and tonnage increased rapidly through the 1970's, but growth rates have flattened considerably since the 1980's (Figure 2-11). Traffic increased by a factor of 8 between 1950 and 1980. Between 1965 and 1998, commercial traffic increased by an annual average growth rate of 2.3% for the UMR system, 1.3% for the IWW system, and 3.2% for the Middle Mississippi River system. Traffic is greatest at the downstream end of the navigation system as different regions add or consume commodities in the downstream or upstream direction, respectively.

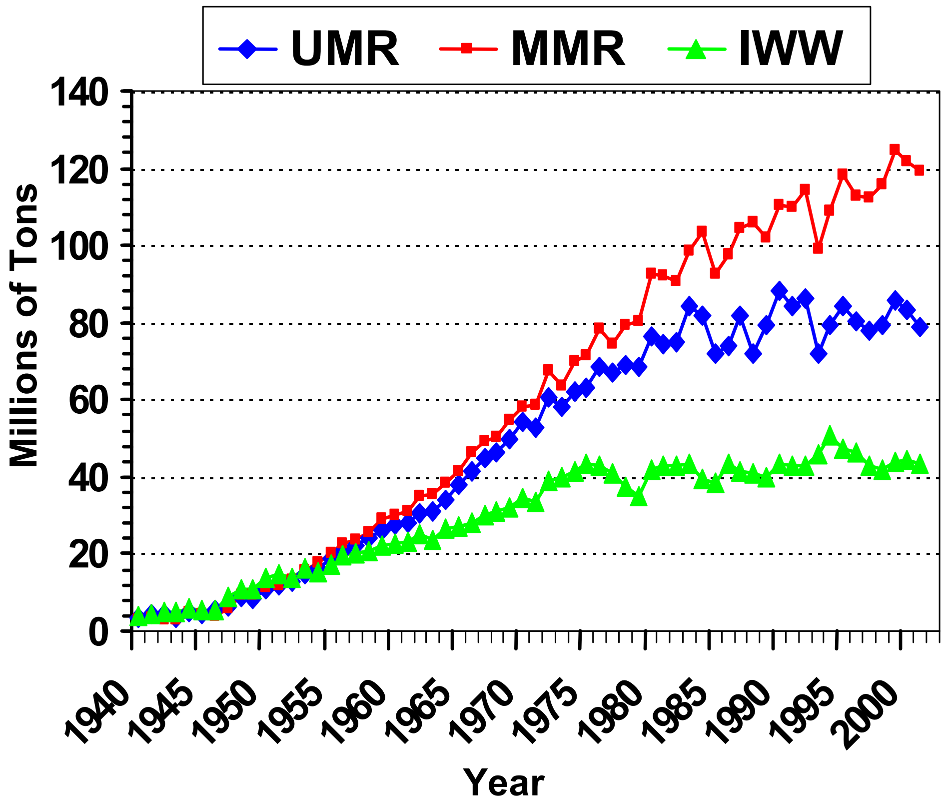


Figure 2-11. Historic commercial barge traffic levels (millions of tons) on the UMRS (Source: Waterborne Commerce Statistics Center).

2.4.1.2 Existing Conditions of the Navigation System

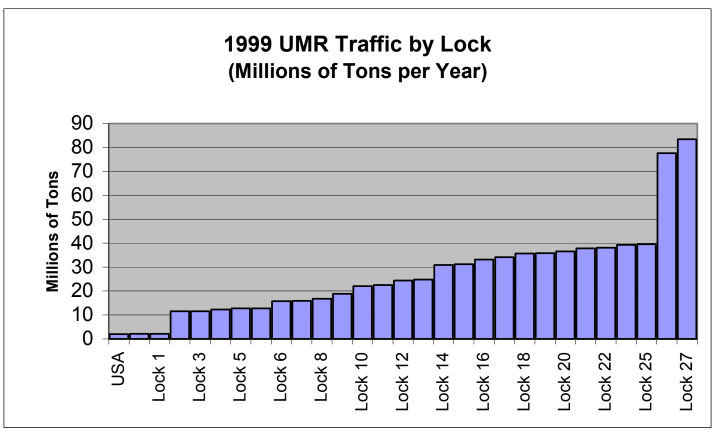
The existing UMR-IWW System provides considerable transportation cost savings to the Nation. Measured as the transportation rate differential between an all-land routing versus water, the existing system generates an estimated $0.8 billion to $1.2 billion (2001 prices) of transportation cost savings. These benefits compare with the average annual operation and maintenance costs of approximately $128 million/year.

2.4.1.2.1 Lock Sites and Structures.

The study area includes 29 lock sites (consisting of 35 locks – some with two locks) on the Upper Mississippi River (UMR) and 8 lock sites on the Illinois Waterway (IWW). Much of the UMR-IWW lock and dam system was in place by the 1940's. Except as noted below, the locks are 600 feet long, although, modern tow configurations commonly include 15 barges and approach 1,200 feet long. As a result, most tows must lock through using a time-consuming two-step process in which the first three rows of barges (9 barges) are locked through first and the last two rows of barges (6 barges) and the towboat are locked through second. The entire process may take 1.5 hours or longer depending on many variables. In contrast, Lock 19 has a 1,200-foot lock and Melvin Price Locks and Dam (Lock 26 replacement) and Locks 27 have both a 1,200-foot and a 600-foot chamber at each site. The lockage process takes an average of 1.0 hour at Lock 19 and 0.6 hour at Locks 26 and 27. The location, year opened, and physical characteristics of each of the UMR and IWW locks are listed in Table 2-36. Table 2-36 also lists lock utilization for 1999. Utilization reflects the total time a lock chamber is in use divided by the total time the chamber is available for use during the navigation season.

2.4.1.2.2 Lock Capacity.

In 1999, locked tonnage ranged from 30 to 40 million tons at UMR Locks 14 - 25, with tonnage increasing at downstream locks (Figure 2-12). Upstream from Lock 14, locked tonnage continues to taper off to a volume of 11 million tons at Lock 2. Above Lock 2, locked tonnage is 1 million tons or less. On the IWW, La Grange and Peoria processed (not all tonnage is locked due to intermittent open-pass conditions) tonnage in 1999 was 36 million and 31 million, respectively. Upstream of Peoria, locked tonnage on the IWW tapered off to 7 million tons at Thomas J. O'Brien Lock. Estimates of lock capacity are roughly 45 - 55 million tons at facilities with a single 110-foot by 600-foot chamber. The capacity at Peoria and La Grange is estimated to be larger due to year round navigation at these sites and open-pass conditions during roughly 40% of the navigation season.



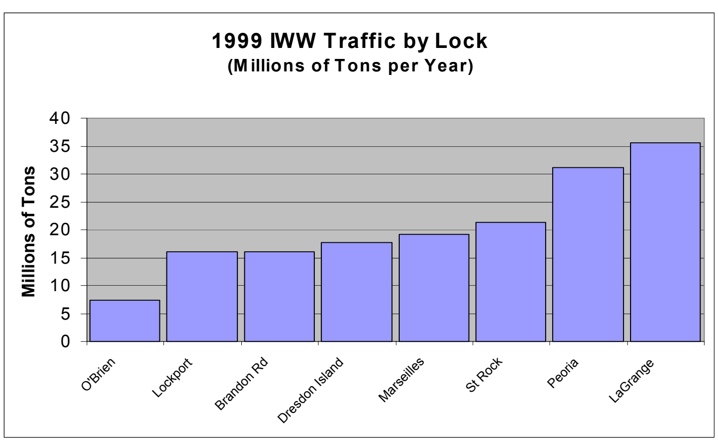


Figure 2-12. Tonnage of commodities passing through locks on the UMR and IWW (Source: USACE Lock Performance Monitoring System).

Table 2-36. Physical characteristics of locks on the UMR and IWW. (n.a. indicates information was not available for the specified year.)

Lock	River Mile	Year Opened	Length (Feet)	Width (Feet)	Lift (Feet)	1999 Utilization %
Upper Mississippi River System						
Upper St. Anthony Falls	853.9	1963	400	56	49	18
Lower St. Anthony Falls	853.3	1959	400	56	25	19
No. 1 Main Chamber	847.6	1930	400	56	38	20
No. 1 Aux. Chamber	847.6	1932	400	56	38	n.a.
No. 2 Main Chamber	815	1930	500	110	12	39
No. 2 Aux. Chamber	815	1948	600	110	12	n.a.
No. 3	796.9	1938	600	110	8	41
No. 4	752.8	1935	600	110	7	40
No. 5	738.1	1935	600	110	9	35
No. 5a	728.5	1936	600	110	5	34
No. 6	714	1936	600	110	6	42
No. 7	702	1937	600	110	8	43
No. 8	679	1937	600	110	11	44
No. 9	647	1938	600	110	9	44
No. 10	615	1936	600	110	8	47
No. 11	583	1937	600	110	11	52
No. 12	556	1938	600	110	9	53
No. 13	523	1938	600	110	11	51
No. 14 Main Chamber	493	1939	600	110	11	76
No. 14 Aux. Chamber	493	1922	320	80	11	6
No. 15 Main Chamber	482.9	1934	600	110	16	73
No. 15 Aux. Chamber	482.9	1934	360	110	16	18
No. 16	457.2	1937	600	110	9	70
No. 17	437.1	1939	600	110	8	75
No. 18	410.5	1937	600	110	10	72
No. 19	364.2	1957	1200	110	38	47
No. 20	343.2	1936	600	110	10	70
No. 21	324.9	1938	600	110	10	73
No. 22	301.2	1938	600	110	10	80
No. 24	273.4	1940	600	110	15	76
No. 25	241.4	1939	600	110	15	76
Melvin Price Main Chamber	200.8	1990	1200	110	24	50
Melvin Price Aux. Chamber	200.8	1994	600	110	24	20
No. 27 Main Chamber	185.5	1953	1200	110	21	56
No. 27 Aux. Chamber	185.5	1953	600	110	21	12
Illinois Waterway						
La Grange	80.2	1939	600	110	10	42
Peoria	157.7	1938	600	110	11	58
Starved Rock	231	1933	600	110	19	n.a.
Marseilles	244.6	1933	600	110	24	n.a.
Dresden Road	271.5	1933	600	110	22	n.a.
Brandon Road	286	1933	600	110	34	n.a.
Lockport	291.1	1933	600	110	40	55
Thomas J. O'Brien	326.5	1960	1000	110	4	36

Note: The computation of the percent utilization for LaGrange and Peoria is influenced by the amount of time the navigable pass is open, which is approximately 43% and 35%, respectively, on an average-annual basis.

2.4.1.2.3 Fleet Characteristics, Port Facilities, and Fleeting.

Roughly 50 towing or barge companies operate on the UMR-IWW System. These operators have approximately 12,500 hopper barges, 1,300 tank barges, and 550 towboats. There are 778 commercial docks in the UMR-IWW study area, with 453 (58%) providing services for shipping or receiving commodities. Facilities tend to be concentrated in medium and large urban centers such as Minneapolis/St. Paul, Chicago, St. Louis, Peoria, or the Illinois/Iowa Quad Cities area. About 160 fleeting areas are along the Upper Mississippi River and 42 along the Illinois Waterway.

2.4.1.2.4 Commodities shipped.

Farm products, including corn, soybeans, and animal feeds, are the largest single commodity transported on the system (Figure 2-13). Other major commodities shipped on the system include coal, chemicals, petroleum, crude materials (sand, gravel, iron ore, steel, and scrap), and manufactured goods.

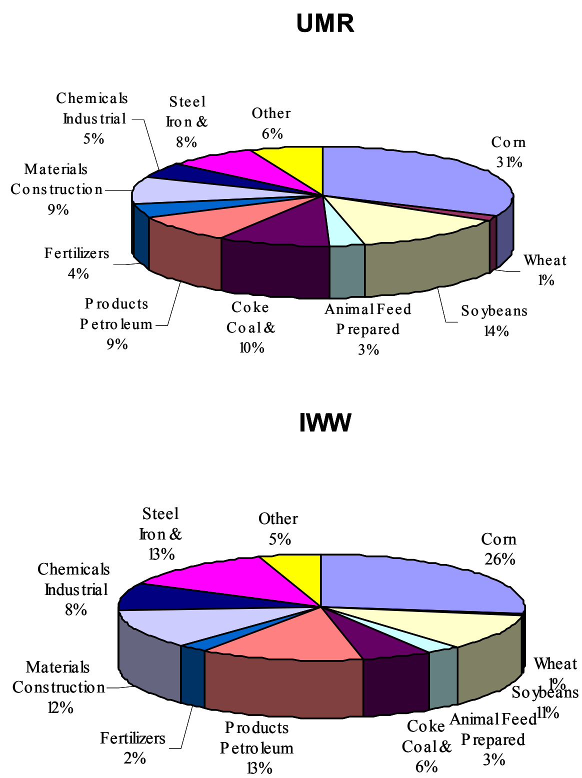


Figure 2-13. Commodity percentages by river for year 2000. (Source: Waterborne Commerce Statistics Center 2000).

2.4.1.2.5 Existing Lockage Delays.

Eight locks on the UMR and 3 IWW locks were among 20 locks with the highest average delays in 1987 at the beginning of this study. This remains the case as illustrated in Figure 2-14, which shows the distribution of peak monthly delays at locks around the country in 1998. The UMR-IWW System had over half (19 of 36) of the most delayed lock sites in the country.

Under current conditions, delays to tows are common at a number of locks on the UMR System. Existing delays vary based on location in the system. In general, delays are greatest at the most downstream 600-foot locks. For the 10-year period 1990-1999, delays per tow averaged 3.4 hours at Locks 20-25; 2.2 hours at Locks 14-18; 0.9 hour at Locks 8-13; and 0.4 hour for Upper St. Anthony Lock to Lock 7. On the IWW over the same period, delays per tow averaged 1.8 hours at Peoria and La Grange and 1.1 hours for each of the other six lock sites. Percent of tows delayed, average delay for tows, and the total ton-hours of delay by chamber during 1999 are presented in Table 2-37. Total ton-hours is the product of tons and average delay. Total ton-hours is the product of tons and average delay.

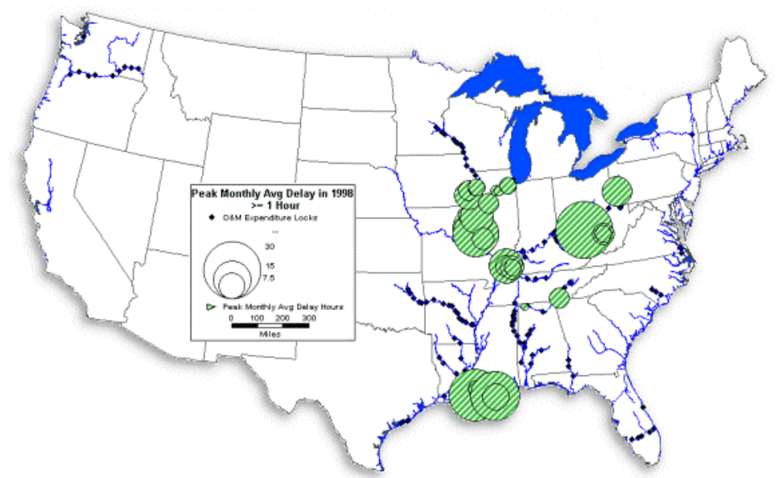


Figure 2-14. Peak monthly average lock delay in 1998 (Source: Navigation Data Center, 1999).

2.4.1.2.6 Transportation Costs.

An evaluation of transportation costs for the UMR System indicated that rate savings to waterway users averaged about $8.60 per ton (1994 prices) over the best possible all-land routing alternative (TVA, Transportation Rate Analysis: Upper Mississippi River Navigation Feasibility Study, 1996). Savings for each of the 11 commodity groupings identified for this analysis are summarized in Table 2-38.

2.4.1.2.7 Benefits of Existing System.

The presence of the rivers provides many benefits to the regions, states, and counties along the river corridor and the Nation as a whole. Benefits are derived from the employment and income generated from transportation of goods, recreation, hydropower production, and water supply for municipalities, commercial, industrial, and domestic use. The UMR-IWW navigation system contributes significantly to regional and national economic development by offering a means of shipping bulk commodities at low cost allowing for considerable transportation cost savings to the regional and national economy. The existing system generates an estimated $0.8 billion to $1.2 billion (2001 prices) of transportation cost savings (using Year 2000 traffic levels). These benefits compare with the average annual operation and maintenance costs of approximately $128 million/year.

Table 2-37. Average delay, percent tows delayed, and ton-hours of delay for year 1999.

Lock	Average Delay of Tows (Hours)	Percent of Tows Delay	Total Tonnage (Millions)	Ton-Hours of Delay (Millions)
Upper Mississippi River				
Upper St. Anthony Falls	0.3	8	2.1	0.7
Lower St. Anthony Falls	0.3	11	2.1	0.6
No. 1 Main Chamber	0.5	7	2.1	1.1
No. 2 Main Chamber	1.2	47	11.6	13.7
No. 3	1.1	44	11.6	12.4
No. 4	1.2	45	12.3	14.1
No. 5	1.2	38	12.8	15.1
No. 5a	1.1	48	12.8	13.4
No. 6	1.4	48	15.8	21.6
No. 7	1.3	50	15.9	20.5
No. 8	1.7	50	16.8	27.7
No. 9	1.4	49	18.8	26.7
No. 10	1.6	49	22	34.1
No. 11	1.6	59	22.5	36.2
No. 12	1.8	59	24.4	43.9
No. 13	1.8	57	24.8	43.4
No. 14 Main Chamber	4.8	81	30.8	148.8
No. 14 Aux. Chamber	0	0	0	0
No. 15 Main Chamber	3.7	74	30.6	112.6
No. 15 Aux. Chamber	0.2	13	0.6	0.1
No. 16	2.4	74	33.1	79.8
No. 17	2.8	76	34.2	96.8
No. 18	2.4	74	35.7	86.8
No. 19	1.3	57	35.8	46.2
No. 20	2.9	76	36.6	104.7
No. 21	2.6	76	37.9	96.6
No. 22	4.5	85	38.1	171.8
No. 24	3.6	82	39.3	139.9
No. 25	4.5	84	39.5	178.9
Melvin Price Main Chamber	1.2	56	69.6	84.9
Melvin Price Aux. Chamber	16.7	46	8	133.7
No. 27 Main Chamber	1.7	66	79.9	133.4
No. 27 Aux. Chamber	18.8	29	3.5	65.6
Illinois River				
La Grange	5.1	55	35.6	180.5
Peoria	3.4	38	31.1	106.1
Starved Rock	2.4	54	21.4	50.9
Marseilles	2.8	61	19.2	52.8
Dresden Island	1.9	54	17.7	33.1
Brandon Road	2.2	58	16.1	35.6
Lockport	2.5	56	16	39.4
Thomas J. O'Brien	0.3	18	7.4	1.9

Table 2-38. All land vs. water differential by commodity group (total system; 1994 prices).

Commodity Group	Weighted Differential ($)
Corn	7.05
Soybeans	11.51
Wheat	7.69
Farm NEC	2.64
Coal	6.77
Petroleum	12.26
Ind. Chemicals	13.59
Ag. Chemicals	6.43
Iron & Steel	12.12
Aggregates	7.53
Miscellaneous	8.13
Average	**8.60**

2.4.1.2.8 Existing Operations and Maintenance Costs for Navigation System.

Operations and Maintenance (O&M) costs include funding for lock and dam personnel, maintenance crews, dredging, utilities, minor repairs, and the maintenance of training structures south of St. Louis. These routine costs are incurred annually, but they have not historically been sufficient to maintain an acceptable level of performance, leaving a need for additional monies to maintain a system that otherwise will deteriorate over time. Appropriations for the O&M budget have been nearly "flat-lined" in recent years when compared with the necessary repairs and other demands. This has resulted in the deferring of many maintenance-type items There is a present backlog of unfunded critical maintenance items that exceed $75 million. The entire backlog of maintenance items through 2002, which includes necessary repairs as well as critical items, totals $406 million for Reaches 1 through 4.

O&M costs based on historical cost data from 1981 to 2002 are estimated at $115 million per year (in 2000 price levels). Lock and dam operations account for $45 million, dredging $32 million, maintenance $23.5 million, contract expenses $13 million, and engineering costs $1.5 million. The percentage breakdown of baseline O&M costs is depicted in Figure 2-15.

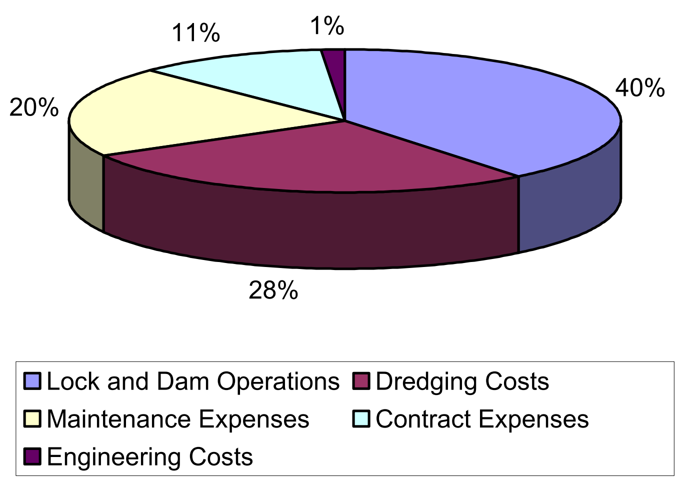


Figure 2-15. Existing Rehabilitation Program.

Rehabilitation of the lock and dam system has been ongoing since 1975. The program involves project feature restoration work intended to improve the reliability of the existing structures for an additional 25 years. Widely varying levels of Rehabilitation have been accomplished at the majority of lock sites on the Upper Mississippi and Illinois Waterways. Over $900 million has been expended on this program since 1975. The funds received through this program are in addition to the O&M funds presented above. Although $900 million has been spent, additional rehabilitations are underway, some are awaiting funding approval, and others are being considered for timely preparation of engineering study for consideration of rehabilitation. In other words, rehabilitation of the system will be a continuous process conducted on a project-by-project basis under the present funding method and policies.

2.4.1.3 Future Conditions

2.4.1.3.1 Scenarios for Traffic Forecasting

In an effort to address the difficulty and inherent uncertainty of forecasting for a 50-year planning horizon, a scenario-based approach to traffic forecasting has been employed. Such an approach follows the guidance provided by the Federal Principals Task Force. The scenarios developed represent a range of alternative views of the future demand for navigation on the UMR-IWW System. A consequence of applying a scenario-based approach to traffic forecasting is multiple representations of the without-project condition. As currently constructed, individual scenarios will not be evaluated with respect to numerical probability or likelihood of occurrence. A single most probable without-project condition therefore will not be identified. The scenario-based approach is consistent with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G), the procedural and analytical framework for Corps feasibility studies. (See Section 3.5 for additional discussion.) Specifically, this approach is intended to define a range of reasonable alternative future scenarios that ultimately describe the demand for inland waterway transportation of farm products for the waterway system.

A range of possible futures with respect to trends, policies, conditions, and events that could impact the U.S. agricultural sector and export markets are considered in the scenarios. It is not presumed that the scenarios encompass the absolute extremes, but rather are limited to the more plausible.

The impacts of each scenario are translated into demand for barge transportation for farm products for the waterway system broken down by the UMR and the IWW. The demand forecast horizon was to 2050, and the resulting demand forecasts were unconstrained with respect to increases in future lock delays or waterway capacity. The farm products barge demand forecasts included breakdowns for corn, soybeans, wheat, and prepared animal feeds (or meal).

In producing unconstrained estimates of waterway demand, the scenarios contribute to the definition of the without-project condition by establishing the basis for specifying the without-project condition levels of waterway traffic. However, the unconstrained traffic estimates generated by the scenarios do not define the without-project condition levels of waterway traffic directly. The unconstrained demand must be processed through the waterway system economic model in order to identify the level of traffic “constrained” by the processing capability of the waterway system. This estimate of “constrained” traffic over the 50-year planning horizon defines the without-project condition with respect to waterway volume. As indicated above, with a scenario-based approach to traffic forecasting, multiple without-project conditions will be generated with respect to traffic.

In order to reflect a complete forecast of waterway demand, all commodity groups must be addressed. To such an end, single 50-year forecasts of waterway demand forecasts for each non-farm commodity group have been evaluated. These non-farm commodity groups are coal, agricultural chemicals, industrial chemicals, petroleum products, construction materials, iron and steel, and other products. These non-farm forecasts were based on a review and update of previously developed forecasts prepared in the mid-1990's, and by assessing those forecasts with relevant changes in market conditions and with respect to the scenarios developed for farm products. The single forecast for each non-farm group was combined with each of the scenarios for farm commodities to produce a set of scenarios that incorporated forecast waterway demand for all traffic.

The approach followed in scenario construction was built on five basic fundamentals:

1. Over the long run (5-year or longer periods) world production and world usage are by definition nearly identical.
2. Factors that impact world production indirectly impact world consumption, and factors that impact world consumption indirectly impact world production.
3. Trade between countries resolves imbalances between production and usage within countries.
4. As a surplus producer, world trade directly impacts U.S. agriculture. World needs represent export opportunities for the U.S. and conversely their absence represents a lack of opportunities.
5. Barge movement volume was assumed to be unconstrained with respect to increases in the cost of water transportation.

The process of building the family of scenarios started with the construction of a central reference, the Central Scenario. The Central Scenario is intended to represent a "middle-of-the-road" U.S. export prospect. The Central Scenario essentially is a reference point with respect to the other scenarios. Around the Central Scenario, scenarios were developed that were more favorable and less favorable to U.S. agricultural trade. Each scenario has several key factors, or "drivers," that make it different and influence its relative output.

To define the scenarios, four key drivers were identified that impact exports favorably or unfavorably. The key drivers were world trade, crop area, crop yield, and consumption drivers. Each key driver contains several variables that best reflect the prospects for change and scenario variation. The key drivers and the corresponding variables are displayed in Figure 2-16.

The key world trade drivers include:

- General world attitude toward utilizing trade barriers to encourage or discourage trade (expansion or contraction of World Trade Organization (WTO) influence)
- Acceptance of Genetically Modified Organism technology (GMO) throughout the world and related trade limitations, if any
- China's posture toward self-sufficiency as compared to being import dependent for food supplies
- India's posture toward self-sufficiency as compared to being import dependent for food supplies
- Possible shifts in relative competitiveness among major surplus producing countries

The key crop area drivers include:

- Supply control policies in the U.S., expressed in terms of land removed from cultivation (i.e., set-a-side type policies)
- Conservation-oriented public policies removing land from cultivation
- Cropping practices adopted to manage the problem of Hypoxia in the Gulf of Mexico

The key crop yield drivers include:

- Rate and uniformity of increase
- Climate change, including a consideration of the disparate views of the scientific community regarding global warming

Scenario Drivers	Key Variables	Trade Scenarios: Least Favorable	Less Favorable	Central Scenario	Favorable	Most Favorable
World Trade	International trade policy (WTO)	The general movement toward less encumbered world trade relations is assumed to persist throughout the time period considered, though there will unquestionably be periods of more rapid advancement and even periods of retrenchment along with ever-present bilateral disputes.				
	GMO developments and acceptance	Identical to Central Scenario	Global non-acceptance is assumed.	Common acceptance is assumed. The use of GMO technology in grain and oilseed production is widely accepted through out the major producing regions of the world. Most importing countries accept GMO grains and oilseeds with no reservations while others require labeling of selected products derived from theri being processed. GMO technology is assumed to continue to expand into the foreseeable future.		
	China's willingness to participate in trade	Negligible grain trade is permitted with oilseed/meal trade unconstrained.	Identical to Central Scenario	Grain trade volume similar to that pledged by China as part of their WTO accension is assumed along with unconstrained oilseed/meal trade.	Identical to Most Favorable Scenario	Wheat imports more than three times and coarse grain imports nearly twice as large as those contained in the Central Scenario are permitted with unconstrained oilseed/meal trade.
	India's willingness to participate in trade	Negligible grain trade is permitted with oilseed/meal trade unconstrained.	Identical to Central Scenario	Consistent with ongoing policies, grain trade is assumed to be negligible and oilseed complex trade is unconstrained.	Identical to Central Scenario	Wheat and coarse grain imports are permitted to supply a notable portion of domestic needs with unconstrained oilseed/meal trade allowed.
	General competitiveness of U.S. agriculture	A decline in U.S. relative competitiveness is reflected by a moderation in supply availability (yield growth moderated).	Identical to Central Scenario	Assumed to be consistent with currently prevailing relationships.	Identical to Central Scenario	Identical to Central Scenario
Crop Area	U.S. supply control policy (set-a-side)	A U.S. acreage reduction policy of 5 percent is assumed to begin in 2005 and continue thereafter.	Identical to Central Scenario	Total absence of acreage limiting policies is assumed over the time period considered.	Identical to Central Scenario	Identical to Central Scenario
	Conservation issues	Identical to Central Scenario	CRP to grow by 3.2 million acres and WRP to grow by 1.25 million acres (by year 2007)	No allowance is made for policies that measurably impact cultivated area beyond that of existing programs. The development of desirable conservation practices that reduce soil, water, and air pollution will continue to evolve as they have in the past.		
	Hypoxia	Identical to Central Scenario	Specific crop area and yield impacts estimated in the Topic 6 Report on the Integrated Assessment on Hypoxia in the Gulf of Mexico were incorporated.	No specific policy addressing this issue is taken into consideration.	Identical to Central Scenario	Identical to Central Scenario
Crop Yield	Rate and uniformity of increase	A catch-up in technology used within producing areas outside the U.S. is incorporated through boosting non-U.S. yield growth rates relative to those assumed in the Central Scenario.	Global yield growth for corn and soybeans reduced by 10 % due to non-acceptance of GMO.	Yield changes consistent with that of the past 20-25 years are assumed to continue.	Identical to Central Scenario	Identical to Central Scenario
	Climatic variability	No specific adjusments are made to any scenario as sufficiently quantified impacts do not exist that deal with worldwide production.				
Consumption	Ethanol and Bio-diesel	Grain used for ethanol in the U.S. is assumed to grow nearly 30 percent faster than the more historic rate included in the Central Scenario.	Identical to Central Scenario	Growth consistent with that of the past 20-25 years is assumed to continue.	Identical to Central Scenario	Identical to Central Scenario
	Population	Central Sceanrio population estimates for the countries/regions considered are increased in line with the population implied by the U.N.'s low variant estimates.	Identical to Central Scenario	U.S. Bureau of Census population estimates used.	Identical to Central Scenario	Central Sceanrio population estimates for the countries/regions considered are increased in line with the population implied by the U.N.'s high variant estimates.
	Per capita consumption	Identical to Central Scenario	Identical to Central Scenario	Growth consistent with that of the past 20-25 years is assumed to continue.	Identical to Central Scenario	Grain and protein meal consumption growth outside the U.S. was boosted some 5 percent as compared to that of the Central Scenario.

Figure 2-16. Scenario development matrix.

The key consumption drivers include:
- Bulk agriculture commodity use as an alternative to petroleum-based energy (ethanol and bio-diesel)
- Alternative population growth assumptions
- Alternative per capita consumption rates

In order to quantify the prospects for U.S. grain and oilseed exports over an extended timeframe under several defined scenarios, an analytical framework was created in which production and use were independently estimated for five geographical regions of the world (Table 2-39). The surplus or deficits implied by production/use imbalances quantify that geographic area's need for trade with a surplus implying export activity and a deficit implying an import activity.

Table 2-39. Global geographic regions.

Countries/Regions				
USA Canada Mexico Brazil Argentina Other Latin America	West Europe	Central Europe FSU-15	Japan Taiwan South Korea China India Indonesia Malaysia Other Asia	Australia South Africa North Africa & Middle East Other Africa

The U.S. Department of Agriculture's World Production, Supply, and Demand database (USDA 2001) was the source of all historical area, yield, production, trade, and use data. That database begins in 1970 for most series, but is not complete across all countries of the world in the early years. The data set used in this study's analysis started with 1974 data.

Commodities included were wheat, rice, and coarse grains (corn, sorghum, barley, oats, and millet). The oilseeds included were soybeans, rapeseed, sunseed, peanuts, and cottonseed. Wheat, rice, and corn were individually considered and the remaining grains were lumped together as other coarse grains. For oilseeds, soybeans were considered individually and the others were lumped together as other oilseeds.

The analytical horizon spanned from 2001 through 2050. Within the analysis, annual estimates were made through 2010 and at 5-year increments through the remainder of the horizon.

In establishing production estimates, area and yield components were independently addressed (Figure 2-2-17). Area estimates were made with consideration given to trends which had occurred over the past 20-25 years, respect for cultivated area constraints suggested by historical cropping activity, and awareness of that region's agricultural characteristics. Individual and commodity group yield change rates were established with implied future yields then multiplied times area estimates to arrive at the production component.

Usage levels for each commodity group were established as the product of population estimates and per capita usage estimates. Population levels used in all scenarios quantified were directly derived from estimates made by the U.S. Department of Commerce, Bureau of the Census, and the United Nations. Per capita usage rates for grain fed to livestock, grains used in food and other uses, and for protein meal were derived for the 1975-2000 timeframe and rates of change were estimated for the analytical horizon. Historical rates of change, along with consideration with respect to reasonableness across the usage category, were the major factors impacting change rates established for the forecast horizon. In a manner identical to production, usage estimates were then derived as the product of two components.

Within the Central Scenario, world supply and usage estimates were balanced over the forecast horizon. The balancing activity was an iterative process over the time span of the 50-year forecast horizon. The objective was to successively equate world production and world usage estimates through time in order to depict real world developments that could plausibly be expected to occur. Adjustments to area under cultivation in Argentina and Brazil were the focal point of the iterative balancing activity. Implied exports and imports are equal with the sum of either reflective of world trade volume. U.S. exports represent the portion of world trade that is estimated to be produced in the U.S. but not used within the U.S., and for which there is an estimated deficit elsewhere.

For scenarios other than the Central Scenario, no attempt was made to balance world supply and use sums over the forecast horizon. Supply and use estimates implied by specified adjustments characterizing that alternative scenario were independently calculated. Implied country/regional imbalances quantify a need for trade under that scenario with the difference between total world supply and estimated world usage left unresolved. This inequality between estimated world supply and estimated world usage is, however, taken into consideration within the U.S. export estimates associated with each scenario. U.S. net exports implied by the scenario's U.S. production minus use calculation are adjusted up or down in proportion to the U.S. share of each commodity's Central Scenario world trade. The U.S. share of world trade within the Central Scenario is applied to the world's scenario imbalance. If the world imbalance is characterized by supply being greater than usage, the U.S. export estimate is adjusted proportionally downward; and if the world imbalance is characterized by usage greater than supply, the U.S. export estimate is adjusted proportionally upward. This approach allows the evaluation of adjustment combinations that could not practically be considered otherwise. At the same time, however, it also yields U.S. export levels that are biased upward in strong export scenarios and biased downward in weak export scenarios.

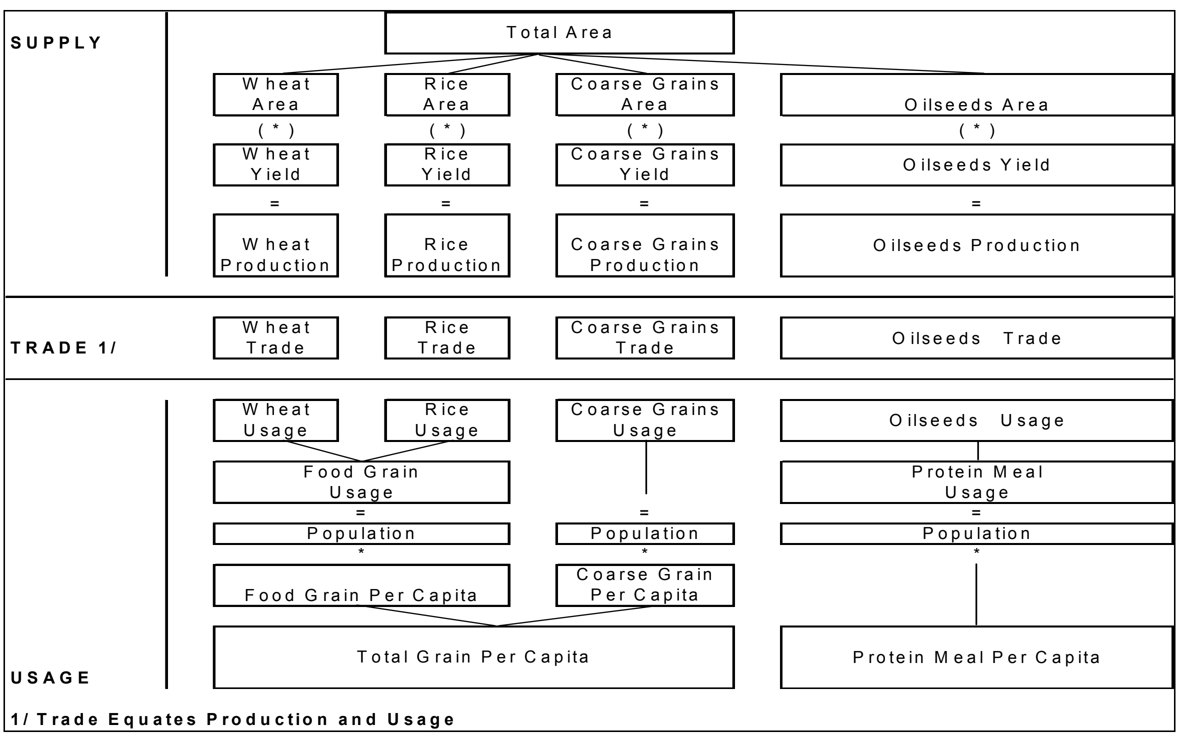


Figure 2-17. Country/region analytic framework.

The volume of grain moved on the UMR and IWW was determined by first allocating total U.S. exports of grain (corn, wheat, soybeans, and animal feed) by port range (Lakes, Atlantic, Center Gulf, Texas Gulf, Pacific, and Interior). The allocation of exports by port range was determined by applying the base year data (1995-2000), obtained from the USDA's Federal Grain Inspection Service, port share of grain to the export forecast for each grain. Barge movements of grain from the UMR and IWW are transported to ports located in the Center Gulf port range. The Center Gulf port range is located at the mouth of the Mississippi River where its confluence drains into the Gulf of Mexico. The Center Gulf port range includes ports where export grain elevators are located. Barges of grain that originated on the UMR-IWW are moved to these export elevators where they are unloaded either into temporary storage for loading onto a bulk ocean vessel or the grain is unloaded directly from the barge into the ocean vessel. The volume of grain moved on each river segment was determined by applying the river segment share of the base year data (1995-2000) to that of Center Gulf exports.

The results for barge demand in this study are reported as barge movements for each river segment, the UMR or the IWW, and were unconstrained by infrastructure. The forecasted volume of traffic on the UMR accounts for movements that either originated or terminated on the UMR, but does not include traffic that originated or terminated on the IWW.

A summary of the values and assumptions for key drivers for all scenarios, expressed relative to the Central Scenario, is shown in Table 2-40. Total farm product movement projections for the various scenarios are presented in Tables 2-41 through 2-45. Projections for individual crops are presented in the paragraphs below.

Exports of corn, wheat, soybeans, and protein meal were historically high in 1981 at 130.4 million metric tons. Over a 3-year period, 1979-1981, exports averaged 129.2 million metric tons. In 2000, exports of those same grains totaled 108.2 million metric tons, 17% below the historical high, but 50% greater than the level of exports in 1974. Between 1995 and 2000, total exports averaged 104.8 million metric tons per year. Based on the Central Scenario, exports are forecast to total 130.2 million metric tons in 2025 and 145.9 million metric tons in 2050. Somewhere between 2020 and 2025, total grain exports are forecast to equal the historical high, nearly 4 decades later. The range of exports across all scenarios by 2050 is projected to be as high as 161.4 million metric tons under the Most Favorable Trade Scenario, to as low as 36.8 million metric tons under the Least Favorable Trade Scenario. The range of exports could be as much as 15.5 million metric tons higher than the Central Scenario's projected export level or 109.1 million metric tons below the Central Scenario.

Exports of corn are expected to increase initially before retracting in about 2040 under all scenarios except the Least Favorable Trade Scenario. Under the Least Favorable Trade Scenario, corn exports are expected to be lower than exports in 2000 and fall below 5 million metric tons by 2050. Corn exports are expected to be at their highest level at 123.0 million metric tons in 2040 under the Most Favorable Trade Scenario. The next highest level for corn exports is under the Favorable Trade Scenario, but its high in 2040 would be about 5 million metric tons more than the Central Scenario high. The historical high for corn exports was 61 million metric tons in 1979, and depending on the scenario, corn exports could reach that level as early as 2007 under the Most Favorable Trade Scenario, to as late as sometime between 2015 and 2020.

Regardless of the scenario, exports of wheat are expected to decrease throughout the forecast period. Under the Least Favorable Trade and Less Favorable Trade scenarios, wheat exports are expected to fall below 5 million metric tons by 2050, and are expected to be close to 10 million metric tons in all the other scenarios.

Soybean exports are expected to be higher under all scenarios. The Central, Favorable Trade, and Less Favorable Trade Scenarios all increase in a similar fashion. Under the Most Favorable Trade Scenario, soybean exports initially rise to 37 million metric tons in 2035 before declining to 32.5 million in 2050. The reduction in soybean exports under the Most Favorable Trade Scenario after 2035 occurs as U.S. consumption increases and draws down soybean exports.

As with the case of wheat exports, protein or prepared animal feed exports are expected to be lower in all scenarios through 2050. Although, while exports under the Most Favorable Trade Scenario are mostly less than the Central and Favorable Trade Scenarios, exports of protein meal are expected to rebound after 2020 under the Most Favorable Trade Scenario.

The other commodity forecasts in this evaluation are adjustments made to a report prepared for the Corps during the mid-1990's by Jack Faucett and Associates. Industry experts for each of the other commodities prepared detailed forecasts for the JFA report. Since the original forecast had a greater level of detail, the original forecasts were only replaced, modified, or re-specified if a major assumption had changed. The forecasts from the JFA report were updated using barge movement data through the year 2000. The JFA report developed forecasts of the demand for barge transportation of coal and coke, fertilizer, industrial chemicals, petroleum products, construction materials, iron and steel, and other miscellaneous products for the UMR-IWW System.

For this effort, independent forecasts were specified as necessary, or modifications made to the original forecasts were adopted if a major assumption from the previous report required changing, or if the Central Scenario in the farm products section of this analysis warranted substantial changes to the forecast for other commodities from the mid-1990's report. In addition, all other commodities were examined by making forecasts using macro economic variables, and then comparing the results to the original forecast.

In general, the assumptions and forecasts for coal and coke, petroleum products, fertilizer, construction materials, and other products from the JFA report are still valid. For all other commodities, the absolute levels of barge movements for 2000 are adjusted to reflect the most recent data. The forecasted change in barge movement volumes over the next 50 years is consistent with the original forecasts for coal and coke, petroleum products, fertilizer, construction material, and other products. Major modifications were made to the original forecasts for iron and steel and industrial chemicals due to assumptions that have since changed. The non-farm commodity barge movements are summarized in Table 2-45. UMR-IWW tonnage forecasts for total farm products are summarized in Figure 2-18 below. Similarly, forecasts for all commodities are summarized in Figure 2-19.

2.4.1.3.2 USDA Baseline Projections.

Figures 2-20 and 2-21 provide a comparison of the Sparks scenarios described above and the USDA 10 year projection for soybeans and corn. The USDA offers the following note to users of their baseline projections., "USDA long-term agricultural baseline projections presented in this report are a Departmental consensus on a long-run scenario for the agricultural sector. These projections provide a starting point for discussion of alternative outcomes for the sector." The note goes on the say, "The scenario presented in this report is not a USDA forecast about the future. Instead, it is a conditional, long-run scenario about what would be expected to happen under a continuation of the 2002 Farm Act and specific assumptions about external conditions."

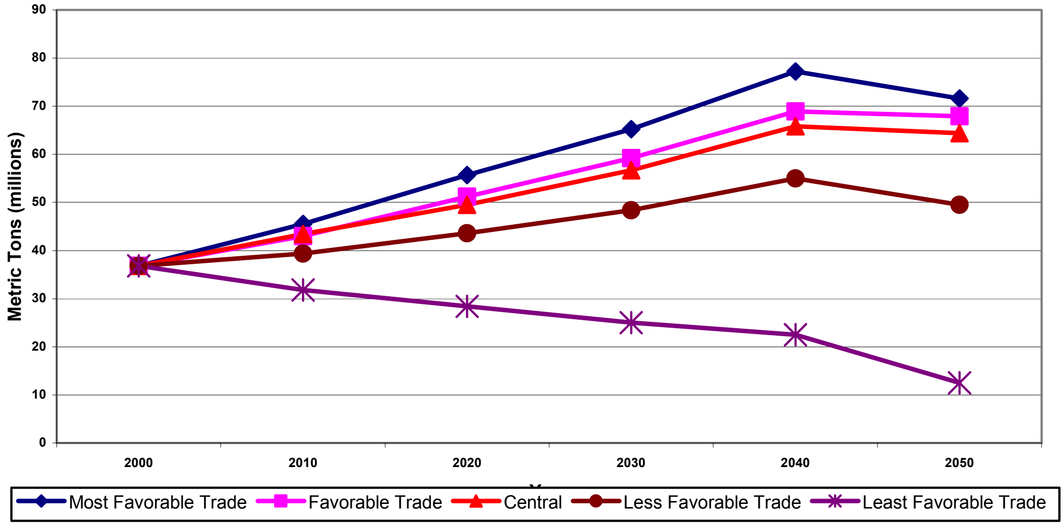


Figure 2-18. Upper Mississippi River System forecasts of total farm product movements by scenario.

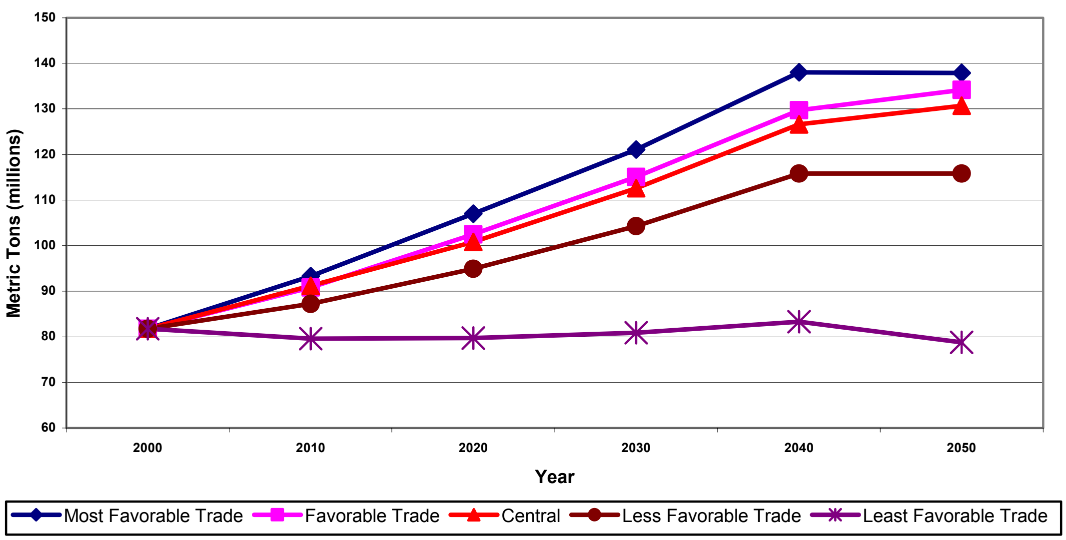


Figure 2-19. Upper Mississippi River System forecasts of all commodities by scenario.

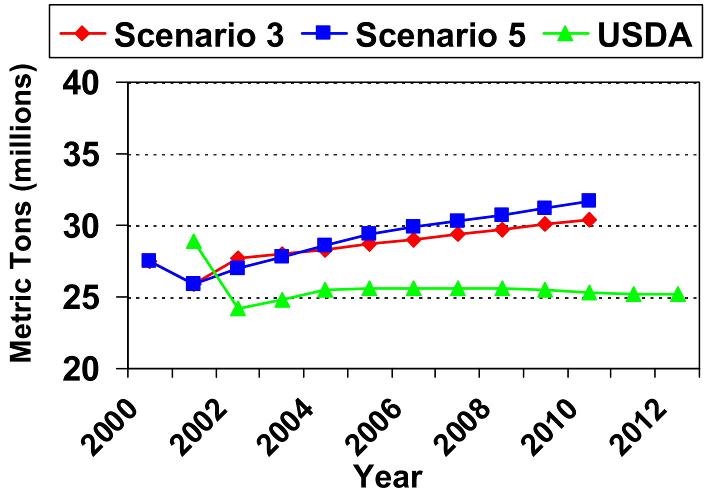


Figure 2-20. Comparison of the Sparks scenarios and the USDA 10 year projection for soybeans.

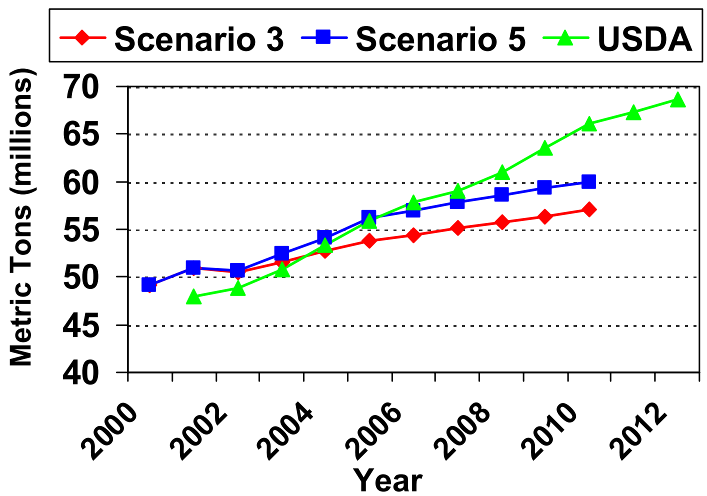


Figure 2-21. Comparison of the Sparks scenarios and the USDA 10 year projection for corn.

2.4.1.3.3 Operation and Maintenance for the Navigation System.

Operation and maintenance of the existing navigation infrastructure is expected to continue into the future. It is projected that the O&M budget will continue to be nearly flat (increasing only for inflation) at $128 million/year for the foreseeable future. Operating and maintaining the system to an acceptable level of performance will continue in the future. The backlog of maintenance items will continue to grow. Several factors were identified that are likely to influence future operations and maintenance costs, even though they have not been significant in the past. Those factors could add as much as 10% to the baseline estimate, or about $11 million a year, but they were not included in the baseline estimate because of the uncertainty that they will actually occur. They include:

- New environmental constraints on channel maintenance dredging and material placement,
- Zebra mussels accelerating corrosion of unprotected steel and clogging pipes,
- Stricter painting regulations that increase costs, and
- Increased lockages that increase wear and tear on lock components.

Table 2-40. Upper Mississippi River System total farm product movements – Central Scenario (million metric tons).

	2000	2025	2050	Change 00-25	Change 25-50
Corn	24.0	38.1	46.9	14.1	8.8
Soybeans	10.2	13.5	16.5	3.3	2.9
Wheat	0.9	0.6	0.4	-0.3	-0.3
Meal	1.7	0.7	0.6	-1.0	-0.1
Total	36.8	52.9	64.3	16.1	11.4

Table 2.2-41. Upper Mississippi River System total farm product movements – Most Favorable Trade Scenario (million metric tons).

	2000	2025	2050	Change 00-25	Change 25-50
Corn	24.0	45.1	58.4	21.1	13.4
Soybeans	10.2	14.0	12.3	3.8	-1.7
Wheat	0.9	0.7	0.3	-0.2	-0.4
Meal	1.7	0.6	0.6	-1.1	0.0
Total	36.8	60.4	71.7	23.6	11.3

Table 2-42. Upper Mississippi River System total farm product movements – Favorable Trade Scenario (million metric tons).

	2000	2025	2050	Change 00-25	Change 25-50
Corn	24.0	40.0	50.0	16.1	10.0
Soybeans	10.2	13.5	17.0	3.3	3.4
Wheat	0.9	0.6	0.4	-0.3	-0.3
Meal	1.7	0.7	0.5	-1.0	-0.2
Total	36.8	54.9	67.9	18.1	13.0

Table 2-43. Upper Mississippi River System total farm product movements – Less Favorable Trade Scenario (million metric tons).

	2000	2025	2050	Change 00-25	Change 25-50
Corn	24.0	32.7	35.1	8.7	2.4
Soybeans	10.2	12.9	14.4	2.7	1.5
Wheat	0.9	0.3	0.0	-0.6	-0.3
Meal	1.7	0.1	0.0	-1.6	-0.1
Total	36.8	46.0	49.4	9.2	3.4

Table 2-44. Upper Mississippi River System total farm product movements – Least Favorable Trade Scenario (million metric tons).

	2000	2025	2050	Change 00-25	Change 25-50
Corn	24.0	15.3	0.7	-8.7	-14.6
Soybeans	10.2	10.2	11.3	0.0	1.1
Wheat	0.9	0.3	0.1	-0.6	-0.2
Meal	1.7	0.5	0.4	-1.3	0.0
Total	36.8	26.3	12.5	-10.5	-13.7

Table 2-45. Summary of non-farm commodity barge movements, Upper Mississippi River System (million metric tons).

	2000	2025	2050	Change 00-25	Change 25-50
Coal & Coke	8.2	9.0	10.9	0.8	1.9
Pet. Prods.	8.5	9.4	9.1	0.9	-0.4
Agri. Chem.	3.1	2.9	2.6	-0.2	-0.2
Const. Mat.	10.0	11.4	13.6	1.4	2.3
Indus. Chem	4.1	6.8	12.0	2.6	5.3
Iron & Steel	6.4	7.4	9.0	1.0	1.6
Miscellaneous	4.7	6.8	9.1	2.1	2.3
Total Non-Farm	45.0	53.7	66.3	8.6	12.6

2.4.1.3.4 Rehabilitation Program in the without-project condition.

The need for future rehabilitation of locks and dams was based on a qualitative assessment using historical data, engineering judgment, and expert elicitation to estimate which components were likely to require restoration over the 50-year planning horizon. It was determined that periodic rehabilitation would be needed at most lock and dam sites approximately every 25 years, with variations based on equipment needs, degree of barge impact to gates and concrete, weather-related deterioration, and modernization. Anticipated future rehabilitation needs were determined to be $25 to $30 million per lock site, and $15 million per dam for each 25-year cycle of rehabilitation (1997 price levels). Therefore, two rehabilitation undertakings were planned over the 50-year period for each of the 37 lock and dam sites. That amounted to:

Lock Rehabilitation Projects	$2.0 billion
Dam Rehabilitation Projects	$1.0 billion
Total Rehabilitation, 2000-2050: (approximately $60 million per year over the planning horizon)	$3.0 billion

The study concluded that the life of existing locks and dams and their components can be extended with normal periodic rehabilitation for another 50 years and match the design life of any new construction being considered as part of the "with-project" condition.

When projected over the 50-year planning horizon, the total cost of the navigation system is projected to be an average annual amount of $205 million a year for the entire system (annual operation and maintenance costs of $128 million , annual rehabilitation of approximately $65 million, and continued environmental stewardship of $750 thousand).

2.4.1.3.5 Without-Project Efficiency Improvements

The with-project condition for this system study was defined to include all measures potentially implemented on a system basis by a Federal action for system efficiency reasons. This definition resulted in identification of measures that do not provide significant system efficiencies or require Federal actions and thus fall into the without-project condition.

For efficiency reasons, all small-scale measures, both with- and without-project items, were evaluated at the same time. The details of the evaluation can be found in *Detailed Assessment of Small-Scale Measures* and the *Summary of Small-Scale Measures Screening.* Small-scale measures likely to occur to some level in the without-project condition that could contribute to system efficiencies are summarized in

Table 2-46. The use of helper boats to assist lockage approaches is assumed to continue at existing rates (approximately 80% of 1200 ft downbound tows at Locks 20 through 25 use helper boats) into the future. Due to the high degree of uncertainty regarding the potential for increased use and implementation of deck winches and powered ratchets, these items are not recommended for inclusion into the final analysis. If new information becomes available in the years subsequent to this study, the Corps may choose to reevaluate this decision. The future use of industry self-help and lock operating procedures in the without-project was included and considered. Industry Self Help was considered to remain at its present level of use, which is about 1.8% of all tow lockages for the average of locks 20 through 25.

Table 2-46. Without-project small-scale measures.

Helper Boats
Industry Self-Help without Additional Facilities
Deck Winches
Powered Ratchets
Lock Operating Procedures (N-up/N-down)

2.4.2 Formulation of Navigation Efficiency Alternative Plans

2.4.2.1 Categories of Potential Improvements

Navigation efficiency improvement measures can be categorized into either small-scale or large-scale improvements. "Small-scale" measures of reducing traffic congestion can generally be defined as any navigation improvement less costly than constructing a new lock. The small-scale measures were divided into the categories of "structural" measures (requiring some amount of construction to implement) and "non-structural" measures (those not requiring construction, but rather procedural or policy changes). The overall performance (total lock transit time reduction) of small-scale measures is generally less effective and less efficient than demonstrated with the large scale measures. Variables that affect the performance of the small-scale measures include: site-specific operational conditions, flow-conditions, weather conditions, time of day, experience of crew, direction of travel, ect. While some of these variables were identified during the study process, quantifying their impacts on time savings, safety, and implementation was not always possible. A full explanation of the various small scale measures can be found in the Engineering Appendix or the aforementioned references. "Large-scale" measures of reducing traffic congestion cover extending the existing lock or providing a second lock at an existing lock and dam.

2.4.2.1.1 Formulation Considerations

The following characteristics of commercial inland navigation were considered due to their potential influence on performance or viability of the various small- and large-scale measures designed to improve navigation efficiency:

- **Operational Characteristics. –** Tows take empty barges up river dropping them off with local vendors who move barges to customers to load and pick up for southbound tows. Only 50% of upriver tows have any loaded barges. Southbound tows are predominantly loaded. Line-haul tows, in which the tows "tramp" on the river picking up and dropping off barges as ordered by the dispatchers from the various companies that dominate the commercial river traffic. Dedicated tows serving particular terminals on a regularly scheduled basis make up only about 10 percent of the total tows and carry mostly liquid cargoes, some aggregates and coal. The implication of these operational characteristics to traffic management is that it is very difficult for most tows to predict with any precision, in advance of initiating the trip when it will arrive at a lock. For most tows each trip involves a different combination of stops for barge pick-up and drop-offs. The number of stops may not be known even when the trip is initiated and even if known would involve variable times for barge pick-up and drop-off. These operational characteristics would make long-term scheduling impossible. Even with tradable permits, the number of trades would be so large and the trading would need to be so real- time that the management of such a system would be problematic.

- **Market Characteristics.** Farm products (grain and meal) make up about 50 percent of the tonnage on the Upper Mississippi and about 40 percent of the tonnage on the Illinois River. These products primarily are moved to the lower Mississippi for export. Farm products are largely moved in response to market conditions including both international grain market conditions and regional barge rates. Grain is stored, including being stored in barges, to wait for favorable market conditions. This means that grain movements are not predictable in advance which means that long-term scheduling is not feasible without abandoning the business advantages of market timing. It also means that there are not predictable and recurring traffic peaks and off-peak periods. Without predictable traffic peak periods, schemes to smooth out traffic flow through congested period fees or incentives to move traffic into off-peak periods are not feasible.
- **Other Users**. Commercial traffic is only one user of the system. A scheduling system would also have to accommodate government fleet, scheduled passenger vessels, and recreation craft. Recreational craft lockages account for an average of 15% of lockages (2000 LPMS database) at the lower 5 sites on the Mississippi River and the distribution of recreation craft arrivals is indeterminate.
- **River Conditions.** River conditions impact the movement and speed of tows. These variable conditions include channel conditions related to high and low water, fog, ice, and wind. These variables make it difficult to predict exact arrival times at locks and increase the difficulty of long-term scheduling.
- **Lock Closures.** Locks are subject to unscheduled outages due to equipment failures, weather conditions, and accidents. These occurrences are not predictable. Also, equipment failures are not always detectable or preventable by routine maintenance. Major rehabilitation is the most effective way to reduce but not eliminate unscheduled outages. Recurring major rehabilitation of the locks is part of the without project condition so is already factored into the economic analysis. Unscheduled outages would disrupt a scheduling measure by suddenly making the lock unavailable. Mississippi River locks average 50 unscheduled closures per year averaging about 10 hours in length.

2.4.2.2 Formulation/Evaluation of Measures

2.4.2.2.1 Small Scale Measures

The small-scale evaluation process began in 1994 with the identification of 92 possible structural and non-structural measures. This work is documented in the report entitled: *General Assessment of Small-Scale Measures* dated June 1995. These measures were obtained from previous studies, Corps staff recommendations, and coordination with members of private industry, State resource and transportation agencies, the U.S. Fish and Wildlife Service, the U.S. Coast Guard, and the U.S. Environmental Protection Agency. This general assessment qualitatively narrowed the list to 16 measures for further detailed assessment and quantitative study.

The quantification and evaluation of the 16 measures is documented in the report entitled: *Detailed Assessment of Small Scale Measures* dated December 1998. During the development of this report, five additional measures were identified for further evaluation. Small-scale, non-structural and structural, measures that emerged from the initial screening iterations are presented in Table 2-47.

Table 2-47. Small-scale, non-structural and structural, measures that emerged from the iterative process of screening over 90 possible navigation efficiency measures.

Non-Structural Measures	Structural Measures
(1) Optimizing Decisions: Scheduling Program	**(5) Tow Haulage Equipment**
(2) Towboat Power:	• Extended Guidewall
• Helper Boats	• Powered Traveling Kevel
• Switchboats	• Endless Cable
• Industry Self-Help	• Unpowered Traveling Kevels
(3) Tolls and Reports:	**(6) Mooring Facilities (Adjacent to Lock Approach)**
• Congestion Tolls	**(7) Crew Elements**
• Excessive Lockage Time Charges	• Universal Couplers/handWinches
• Lockage Time Charges	• Permanent Deck Winches
• Publish Lockage Times	• Minimum Crew Size with Training
(4) Recreational Vessels:	• Additional Personnel
• Scheduling Rec. Vessel Usage	• Powered Ratchets
• Rec. Craft Landing Above and Below Lock	**(8) Approach Channel Improvements**

These measures were further evaluated in the report entitled: *Summary of Small Scale Measures Screening*, dated April 1999. Five measures or their derivatives were considered to be part of the without-project condition, they are: helper boats, Industry Self-help without the construction of remote remake facilities, permanent deck winches, powered ratchets, and Lock operating procedures (N-up/N-down – a type of scheduling). The remaining with project small-scale measures that were combined with large-scale measures into alternatives included mooring facilities, and guidewall extensions with powered traveling kevels. Congestion fees and scheduling were screened from consideration based on implementability issues. This was the status of the study prior to restructuring of the study.

The restructured study re-evaluated of congestion fees and traffic management (scheduling) type measures as recommended by the National Research Council. In addition switchboats were added to the evaluation as a non-structural measure. A description of each measure evaluated to date as part of the restructured study is listed below.

- **Switchboats** – This non-structural measure provides for two switchboats at select locks to extract the first cuts of double lockages. Cuts can be removed to a location along the existing guidewall, to the end of the guidewall, or to an awaiting tow for remote remake. Timesavings increase with the distance from the lock, which requires weighted averaging for modeling purposes. Switchboats can also perform as helper boats to assist downbound tows with their approach to the lock.
- **Mooring Facilities –** These are either buoys (downstream of dam) or sheet-pile cells (upstream of dam) that provide a closer location to the lock for tows awaiting lock turn.
- **Congestion fees –** The objective of congestion fees is to improve overall system efficiency by charging all users a lock usage fee, subsequently inducing marginal users (those that benefit the least from system use) to leave the system. While the traffic that is induced to leave the system would experience a loss as a result of the fees, the potential gain in the form of lower average delays for all remaining traffic could more than offset this loss from an overall system efficiency perspective. The impacts of shifting traffic off the waterway could be landside congestion, differential air quality impacts, and differential accident rates. There are no existing instances of

fee-for-waterway use in the United States as a consequence of current law, which prohibits charge, or toll of any type for waterway use. Such a prohibition by current law does not however, prevent the evaluation of such fee-for-use mechanisms. Corps guidance allows that alternative plans may propose necessary changes in such statutes, administrative regulations, or established common law.

- **Tradable permits –** This measure is a type of scheduling tool that assigns a time slot via paper ticket to a certain vessel at a certain lock. The permit is tradable. The primary reason for trading would be the expectation that the time slot does not match the vessel's schedule. There is wide variability in a vessel's schedule, which would make the trading of permits frequent during a trip. The objective of the scheduling is to smooth out tow arrivals at the locks by placing lockages in time periods of low demand for lockage. This measure was found to not be practical due to the unpredictable nature of waterway traffic.
- **Lockage time charges –** This measure was studied with two options. The first option would charge a lockage fee commensurate with the elapsed time taken for lockage. The second option would charge a fee to the slowest performers during lockage with the goal to instill incentive for them to improve either by instituting hardware changes or crew training/changes. The first option was eliminated because it could result in hurried, unsafe locking practices.
- **Other Scheduling systems –** Master scheduling, or general scheduling, was briefly considered. Such a system would require that individual voyages be planned ahead of time with specific times at lock sites identified. Implementation details were not developed. In general, the same shortcomings and impediments to the successful implementation of tradable permits would apply to master scheduling.

  An appointment system would give operators the ability to call ahead one or more locks and might be an effective alternative to master scheduling for reducing the variability and length of queuing times. This practice now occurs on an informal basis at some locks during busy periods. The costs and benefits of an appointment system were not quantified. However, the potential savings of such a system would likely be limited to more efficiently conducted voyages, primarily from the standpoint of fuel consumption and scheduling of other necessities such as maintenance. Opportunities to expand the use of an appointment system could be explored.

2.4.2.2.2 Large Scale Measures

The Reconnaissance Report (1991) for the Upper Mississippi River and Illinois Waterway recommended that large-scale measures at 16 sites could potentially be justified on the UMR system in the next 50-years. The 16 sites include Locks and Dams 11-25 on the Mississippi River and Peoria and La Grange on the Illinois Waterway and served as the starting point for this feasibility study. Large-scale measures include extending the existing lock and/or constructing a second lock at the critical lock sites. Construction of a navigation pass through existing dams was also considered as a measure to reduce delays to navigation at the dams for which it had application, however this option was found not to be feasible. The analysis included developing and screening an array of feasible lock options and locations.:

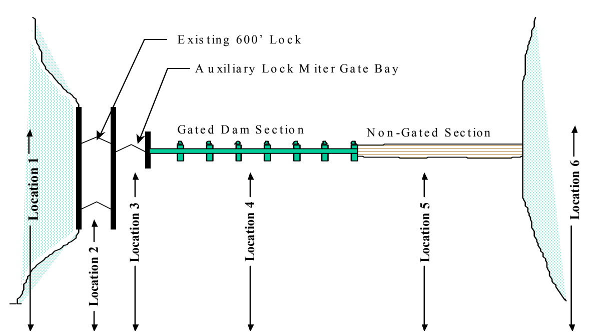
Several different lock design types (Types A, B, C, and R), generally with decreasing performance and reduced cost, were evaluated in the report titled, *Large-Scale Measures of Reducing Traffic Congestion, Conceptual Lock Designs*, February 1996. This report included development of concepts for 2 represnetative sites on the system. Lock 22 was selected as the rock founded site, and lock 25 as the sand founded site. Physical model studies were constructed and tested at these 2 sites. The details of this testing can be found in the reports titled - *Navigation Conditions at Lock and Dam 25, Mississippi River*; Technical Report CHL-97-28, September 1997 and *Navigation Conditions at Lock and Dam 22, Mississippi River* by Ronald T. Wooley Technical Report CHL-97-27 October 1997. Concepts developed for these sites were then site adapted to the other 14 sites under study. Additional design work was completed for the lock extension type R lock and can be found in the report titled *Interim Revised Lock Extension Design Concepts*, July 2000.

Several lock locations (Locations 1 through 6) at an existing lock and dam site as shown in the site plan on Table 2-48 were evaluated in the report *Large-Scale Measures of Reducing Traffic Congestion, Location Screening*, July 1999. This report included a qualitative screening of the locations and the surviving lock locations include either extending the existing locks to 1200 feet or constructing a new 1200 foot lock adjacent to the existing lock.

After qualitative, comparative, and quantitative screening of these options, as well as Plan Formulation screening, the surviving lock measures include either extending the existing locks to 1200 feet or constructing a new 1200 foot lock adjacent to the existing lock. The remaining lock locations and lock types are listed in Table 2-48.

Table 2-48. Final Surviving Lock Locations for lock extensions (X) and new locks (NL). All UMR Locks are proposed as "R" design types while IWW locks are "C" design types.

Lock Location and Types



Lock and Dam Sites	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
L/D 14		X				
L/D 15		X				
L/D 16		X				
L/D 17		X				
L/D 18		X				
L/D 20		X	NL			
L/D 21		X	NL			
L/D 22		X	NL			
L/D 24		X	NL			
L/D 25		X	NL			
Peoria	NL					
La Grange	NL					

2.4.2.3 Development of Cost Estimates

Lock costs include the construction costs of the lock, guidewall, channel work, real estate, relocations, and site-specific environmental mitigation. These construction costs include Planning, Engineering and Design (site-specific feasibility study), and plans and specifications totaling 15% of the construction costs, construction management costs at 10% of construction costs, and a 25% blanket contingency cost. Investment streams were computed for the costs of lock and dam major rehabilitation, lock major maintenance, and annual lock and dam operation and routine maintenance. Finally, since lock construction can cause delays to navigation traffic, the impacts to navigation during lock construction were computed for consideration in the cost comparisons of alternative plans.

A unit price-type cost estimate procedure was used instead of an MCACES format estimate. MCACES was considered for use, however the cost and resources required to produce MCACES estimates for 16 lock sites, 6 lock locations, and several different lock types made this impractical for a systems level of study. As lock options survived screening, they received more and more detailed characterization and cost refinement that built on completed work – especially the unit-price type estimates. The unit-price type estimate adequately served the purpose of the System Study, which is to determine if investment in navigation efficiency measures is necessary and, if so, to what extent.

Individual unit prices for the cost estimates were based primarily on the *Report of the USACE Task Force on Design and Construction Innovations for Locks and Dams*, historical cost data from Melvin Price Locks and Dam, results from the Innovative Navigation Program (an Corps R&D community effort supported by the Districts, Divisions, and HQUSACE to explore innovative and less costly ways to construct navigation projects), Braddock Dam replacement project, Olmsted Lock and Dam, Lock and Dam 24 Protection Cell, and from an independent review of innovative construction methods for locks.

An architectural-engineering firm checked selected samples of lock construction cost estimates by preparation of independent cost estimates in a report entitled "*Independent Review of Concept Design Construction Costs", June 2003*. The largest disparity in bottom-line price (including contingencies) was about 10% between the independent estimates and the Corps' estimates. This check resulting in a small difference in costs validates the Corps' cost estimates. The primary purpose for this effort was to address concerns about the construction costs stated in the committee's (Water Science and Technology Board, Transportation Research Board, and National Research Council) review of the Upper Mississippi River – Illinois Waterway Navigation System Feasibility Report.
The potential for occurrence of any HTRW concerns was reviewed and considered to be a negligible cost. The potential need for future lock replacement was investigated. None of the lock concepts were found to need replacement in the 50-year planning period given that they would receive major rehabilitation and maintenance as specified in the System Study.

Real Estate professionals within the Corps and from private contractors were engaged to support the engineering workgroup in the development of their respective cost estimates. Preliminary real estate appraisals were performed at each of the 11 lock and dam sites identified in the current list of navigation efficiency alternative to assess property values, easements, damages and relocation costs. A gross appraisal is under preparation for the recommended plan. A Real Estate Plan will be developed in conjunction with the Main Feasibility Report to document these cost appraisals and subsequent recommendations.

2.4.2.4 Construction Considerations

2.4.2.4.1 Lock Extension

Most of the on-site lock extension construction would occur in the wintertime to reduce the impacts to navigation. The lock would be closed for approximately 90 days for three consecutive winter seasons. For the lower five locks on the Mississippi River, the total construction schedule (depending on schedule alignments) could close the river for 10 consecutive winter seasons. The lower 5 locks can receive river traffic in typical winter months, but this would be impossible during lock extension activities due to conflicts with construction. The lock would be open for traffic with minor restrictions causing some delay during the remainder of each year of construction. Lock walls and many other components would generally be constructed of prefabricated elements and installed in the wet - without the use of a cofferdam and associated dewatering. There is substantial risk in experiencing a reduction in lock availability during construction of the lock extensions. The lock extensions are technically feasible, however there are inherent risks of construction delays (e.g. weather, contractor performance, planning, execution, etc.). In a situation where lock extensions were to experience construction delays, causing construction beyond the wintertime closure period, the consequences of navigation impacts would be large. Wintertime navigation closures were used to allow uninterrupted construction work. These were modeled as fixed durations of about 90 days each and then traffic would resume. If the construction activities were delayed beyond the closure period, navigation traffic would be delayed until completion of the specific construction activities. The chance of construction delay and the duration of delay were not considered in the economic model because both are uncertain.

2.4.2.4.2 New Locks

For new locks at Locks 20 - 25, a significant amount of construction occurs during the winter season. In all but the last year of construction of a new lock (due to dewatering of both locks), a scheduled opening(s) may be allowed to accommodate traffic that typically occurs on the lower 5 locks on the Mississippi River in the wintertime. It is doubtful that all traffic could be accommodated, but there would still be an economic benefit. The chance of construction delay for new locks and lock extension may be similar, but the consequences of prolonged construction schedules would be much worse for lock extensions. If construction delays occurred, the existing lock could be reopened for traffic in most situations.

2.4.2.5 Performance Considerations.

There are 2 primary performance differences between lock extensions and new locks is the lock approach and the filling/emptying time. Location 3 locks on the lower 5 locks on the Mississippi River would feature a riverside approach wall on the upstream end. This approach wall location with respect to the dam generally is considered safer than the present guidewall structure along the landside of the lock. Riverside approach walls are safer because they provide a physical barrier between the tow and dam that would reduce the chance and consequences of tow mishaps that result in barges breaking loose from the tows and sometimes subsequently running into the dam. The approach wall also would allow downbound tows to better align themselves for faster lock entry, thus reducing impact damage to miter gates and lockwalls resulting from the present lock entry conditions.

The difference in filling/emptying time between the existing lock, lock extension and new lock for Lock 25 are outlined in Table 49. The filling time for a new lock is 8 minutes. This lock can be constructed with minimal disruption (1%/yr over 3 seasons) to the traffic during the navigation season. The lock extension option for locks 20-25 has a filling time of 12.1 minutes primarily due to the fact that this alternative does not include extension of the filling/emptying culverts. See schematic of lock extension filling system. The lock extension would be built primarily in the winter closure period to minimize impacts to navigation. It would require some closures during the navigation season (5%/yr over 2 seasons). A lock extension with extended culverts was studied, however the construction sequencing required would result in significant closure time during the navigation season (25%/yr over 2 seasons). This resulted in significant impacts to navigation and this type was screened from further consideration. Extending the existing culvert system for an extended lock would require significant more work in tying into the existing lock monoliths. It was concluded that there is no practical way to accomplish this type lock and not significantly impact navigation.

Table 2-49. Difference in filling/emptying time between the existing lock, lock extension and new lock for Lock 25.

Lock Site	Lock Location	Lock Description, Type	**Constr. Cost (millions in 1996 prices)**	**Nav. Season Closures due to Lock Construction**	**Average Time to Fill the Lock (minutes)**
25	Existing Lock	600ft lock	n/a	n/a	4.1
	Lock Extension, Location 2	1200 ft lock, w/Extended Culvert, Type 2B	161	25%/yr over 2 nav seasons	8.0
		1200 ft lock, w/out Extended Culvert, Type 2R	125	5%/yr over 2 nav seasons	12.1
	New Lock, Location 3	1200 ft lock w/Extended Culvert, Type 3R	201	1%/yr over 3 nav seasons	8.0

2.4.2.6 Navigation Efficiency Alternative Plans

The navigation efficiency alternatives that have survived the initial levels of screening are described below:

ALTERNATIVE 1: No Action. The no action, or without project condition, describes the future in the absence of additional federal action. This does not preclude routine operation maintenance activities, to keep the system's components safe and operational, nor periodic major rehabilitation activities to ensure the structural soundness and reliability of the existing system. The No-Action alternative forms the baseline against which navigation efficiency alternatives are measured. **Without Project condition would require no additional construction costs and subsequently no mitigation. However, this assumes the continued operation and maintenance ($128M), periodic Major Rehabilitation of Locks and Dams ($65M) and continued environmental stewardship ($750K) would continue.**

ALTERNATIVE 2: Congestion Fees Implemented through a Lockage Fee (imposed on commercial traffic). The objective of this form of congestion fees is to improve overall system efficiency by charging all users a lock usage fee, subsequently inducing marginal users (those that benefit the least from system use) to leave the system. While that traffic that is induced to leave the system would experience a loss as a result of the fees, the potential gain in the form of lower average delays for all remaining traffic could more than offset this loss from an overall system efficiency perspective. Congestion fees present an option for "internalizing" the external social cost of additional traffic at a navigation lock. Potential impacts not traditionally measured by Corps feasibility investigations--typically impacts associated with landside transportation modes--should not be ignored when considering the performance of any fee-for-use scheme. Specifically these impacts could include such things as landside congestion, differential air quality impacts, and differential accident rates, all resulting from traffic shifted off the waterway. There are no existing instances of fee-for-waterway use in the United States as a consequence of current law, which prohibits charge, or toll of any type for waterway use. Such a prohibition by current law does not however, prevent the evaluation of such fee-for-use mechanisms. Corps guidance allows that alternative plans may propose necessary changes in such statues, administrative regulations, or established common law. **First Cost of Infrastructure Improvements: $0M; Total Mitigation Cost: $0M; Annual Administration cost: $2.5M; Completion Date: Continuous.**

ALTERNATIVE 3: Excess Lockage Fees. Excess lockage fees would provide incentives for efficient lockages by towboat operators. A fee would be imposed upon those operators that created delays due to exceptionally long lockage times. A training program for barge operators and acquisition of modern hydraulic coupling ratchets is assumed to be the industry response to the prospect of excessive lockage time fees that would generate additional operating efficiency and allow users to avoid the lockage fees. **First Cost of Infrastructure Improvements: $80M (training and equipment upgrades); Annual Administration cost: $12.5M; Completion Date: 2007.**

ALTERNATIVE 4: Moorings (12, 14, 18, 20, 22, 24, and LGR), Switchboats at Locks 20-25. Moorings are tie-off facilities that allow the next tow to be served to wait closer to the lock chamber, thereby decreasing approach time. Switchboats would be employed as hired vessels permanently stationed on both the upstream and downstream sides of a lock. Switchboats would assist in handling the cuts of a double lockage, resulting in a shorter lockage time. Switchboats as employed in this alternative and others are a substitute for guidewall extensions with powered traveling kevels (PTK) described in the Interim Report. Switchboats have replaced guidewall extensions w/ PTK because the current assessment of these two measures indicates that switchboats are both less costly and more efficient in reducing the time required for double cut lockages than guidewall extensions w/ PTK. **First Cost of Infrastructure Improvements: $84M; Annual SWB Operation Cost: $40.2M; Total Mitigation Cost: $79.4M; Total Avg. Annual Cost: $47.6M; Completion Date: 2009.**

ALTERNATIVE 5: Moorings (12, 14, 18, 24, and LGR), Lock Extensions at Locks 20-25, Switchboats at Locks 14-18, La Grange and Peoria. This alternative incorporates the next level of capacity expansion, 1200' lock extensions, at UMR Locks 20-25. It also includes switchboats at UMR Locks 14-18 to address potential induced traffic effects that may result from the downstream lock extensions. Moorings at UMR Locks 20 and 22 are eliminated with this alternative due to physical interference with lock extensions. On the Illinois Waterway, switchboats are also included at Peoria and LaGrange. **First Cost of Infrastructure Improvements: $795M; Annual SWB Operation Cost: $33.8M; Total Mitigation Cost: $151.0M; Total Avg. Annual Cost: $112.7M; Completion Date: 2023.**

ALTERNATIVE 6: Mooring (12, 14, 18, and 24), New Locks at 20-25, La Grange, and Peoria; Lock Extensions at 14-18; and Switchboats at Locks 11-13. This alternative includes a high level of capacity expansion, new 1200' locks, at UMR 20-25, and also at Peoria and La Grange on the Illinois Waterway. On the Mississippi River, additional capacity expansion is also included in the form of 1200' lock extensions at Locks 14-18, and switchboats at UMR Locks 11-13 to address potential induced traffic effects that may result from downstream lock improvements. Mooring at UMR Locks 20 and22, and LaGrange are eliminated with this alternative due to physical interference with lock improvements. New 1200’ locks at 20-25 differ from the 1200’ lock extensions described in alternative 5 in terms of both cost and performance. New locks, while representing the same chamber size as the lock extension are more efficient than the extensions because of a faster filling and emptying system and dual lock advantages. However, this added performance comes at the price of higher construction expenditures. **First Cost of Infrastructure Improvements: $2.268B; Annual SWB Operation Cost: $7.8M; Total Mitigation Cost: $207.0M; Total Avg. Annual Cost: $191.2M; Completion Date: 2035.**

ALTERNATIVE 7: Mooring (14, 18, and 24), New Locks (12) at 14-18, 20-25, PEO, and LGR, Lock Extensions at 11-13. This alternative includes the highest level of capacity expansion considered, new 1200' locks, at UMR Locks 14-18, 20-25 and at Peoria and La Grange on the Illinois Waterway. On the Mississippi River, additional capacity expansion is also included in the form of 1200' lock extensions at Locks11-13 to address potential induced traffic effects that result from downstream lock improvements. Mooring at UMR Locks 12, 20, and 22, and LaGrange are eliminated with this alternative due to physical interference with lock improvements. **First Cost of Infrastructure Improvements: $2.5B.**

2.4.2.2 Screening of Alternative Plans

During the alternative plan formulation process, a number of possible combinations of measures were explored. Preliminary information concerning the resulting alternative costs and net benefits served as and initial screening criteria to determine if the alternative warranted further attention. One such alternative, Alternative 7, was screened during the early evaluation phase. It was initially recognized that the magnitude of the additional system capacity expansion represented by Alternative 7 may be greater than the level that could be supported by the NED transportation savings. As a screening device for Alternative 7, model evaluations were completed for Alternative 6 under the most optimistic traffic scenario, Scenario 5. By examining the residual delays over the system, it was obvious that the small remaining delays could not provide the basis for additional system savings to the degree necessary to offset the additional costs associated with moving from Alternative 6 to Alternative 7. On the basis of this result, Alternative 7 was screened from further consideration.

2.4.3 Evaluation of Navigation Efficiency Alternatives

Evaluation like all other planning steps is an iterative process. Section 2.4.2 Formulation of Navigation Efficiency Alternatives, contained some preliminary evaluations to aid in the screening process and final formulation of primary alternatives. This section contains the detailed evaluations of the primary alternatives.

The detailed evaluations will include the system of four primary accounts established in the Principals and Guidelines (P&G). These accounts have been devised to encompass all significant effects of a plan as required by the national Environmental Policy Act of 1969 and Section 122 of the Flood Control act of 1970. The accounts established by the P&G include **(A)** national economic development (NED), **(B)** regional economic development (RED), **(C)** environmental quality (EQ), and **(D)** other social effects (OSE). The NED account is the major criteria that will be used for plan selection from the Federal perspective. For the purposes of this study, three additional accounts were established to include other important comparative considerations: **(E)** Contribution to Planning Objectives, **(F)** Acceptability and **(G)** Adaptability. The remainder of this section provides a brief description of the major accounts and criteria followed by the resulting evaluation data and information generated for each.

A. National Economic Development (NED).

The National Economic Development (NED) information provides a measurement of the monetary impacts to the national economy. These impacts include both positive and negative effects . The positive impacts associated with the navigation efficiency alternatives are primarily transportation efficiencies (measured as transportation cost savings) and avoided major rehabilitation expenditures that would be required in the absence of certain lock improvements. The negative impacts include primarily the costs required to implement and operate each alternative, including site-specific and system mitigation costs. The financial impacts to the navigation industry resulting from the adverse affects during project construction are also included as negative NED impacts.. Captured over the period of analysis both positive and negative impacts are expressed as average annual equivalent values that incorporate standard discounting techniques and the current federal discount rate. Annual net benefits are defined as the difference between annual benefits and annual costs. Positive net benefit numbers represent benefits to the nation and negative net benefit numbers represent a loss to the nation. The following provides a brief description of the criteria organized under the NED account, those designated with an asterisk represent the most influential criteria

A1. Project Cost and A2. Total Average Annual Cost

Total navigation efficiency alternative plan costs include first costs of construction; channel work; real estate and relocations; operation and maintenance; major rehabilitation and site specific environmental mitigation. The total average annual cost for each alternative is computed over the 50 year planning horizon. See Section 2.4.2.5 for alternative costs.

A3. Net Benefits

This evaluation recognizes the uncertainty associated with the future demand for waterway transportation and the lack of definitive data on demand elasticity for commodities shipped on the river, particularly grain. Five different scenarios represent the uncertainty in future demand for waterway transportation as described in Section 2.4.1.3. The uncertainty in demand elasticity is being represented by the use of 3 different economic modeling conditions. The question of demand elasticity centers on the issue of how the demand for waterway shipment of commodities responds to rising transportation costs. The condition reflecting an inelastic state is represented by the Tow Cost Model (TCM), while the ESSENCE Model represents the upper (EUB) and lower bounds (ELB) of an elastic condition. Net benefits were computed for each scenario and each assumption of elasticity, which results in 15 different economic conditions (Given 5 traffic scenarios and 3 economic model specifications). A description of the modeling conditions and results is summarized below.

As currently constructed, individual scenarios or economic conditions will not be evaluated with respect to numerical probability or likelihood of occurrence. A single most probable without-project condition therefore will not be identified. The intent is to evaluate alternatives across all scenarios and search for those that work well across a broad range. Such identification is uncommon in Corps feasibility studies; however, the scenario-based approach is consistent with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G), the procedural and analytical framework for Corps feasibility studies.

Paragraph 1.4.13 of the P&G presents guidance on dealing with risk and uncertainty in the evaluation of alternative plans and Supplement 1 – *Risk and uncertainty –Sensitivity analysis* presents additional guidance. Paragraph 1.4.13 describes a situation of uncertainty as those in which potential outcomes cannot be described in objectively known probability distributions. The guidance indicates that plans and their effects should be examined to determine the uncertainty inherent in the data or various assumptions and "A limited number of reasonable alternative forecasts that would, if realized, appreciably affect plan design should be considered." The guidance goes on to endorse performing a sensitivity analysis of the estimated benefits and costs of alternative plans using these alternative forecasts.

Supplement 1 to the P&G also deals with this subject of assigning probabilities in some detail. It recognizes that there are situations of uncertainty where outcomes cannot be described in objectively known probability distributions because future demographic, economic hydrologic, and meteorological events are essentially unpredictable because they are subject to random influences. This describes the situation with respect to 50-year forecasts of traffic on the UMR-IWW System. While the P&G certainly allows for assigning subjectively based probabilities to random future events, it does not endorse the approach and is very cautious in describing subjective probabilities indicating such approach must be justified on a case-by-case basis and carefully qualified as subjective. The discussion in Supplement 1 indicates that P&G would clearly allow the treatment of alternative forecasts as equally probable for purpose of sensitivity analysis.

Finally, the P&G indicates that the planner's primary role in dealing with risk and uncertainty is "to characterize to the extent possible the different degrees of risk and uncertainty and to describe them clearly so that decisions can be based on the best available information."

TOWCOST (TCM): TCM has been developed over many years by the Corps and has been used in numerous feasibility reports and Environmental Impact Statements supporting construction authorizations for major investments in inland navigation improvements**.** The Tow Cost Model measures the benefits of waterway improvements as the savings in transportation costs in using the waterway over the alternative transportation method. The results of the Tow Cost analysis are displayed to assess the performance of these alternatives versus other major inland navigation investments nationwide using a common benefit evaluation methodology. The Federal Principals Group endorsed the use of existing economic models, such as TCM, while research and development on improved models moves forward but within the context of an adaptive management process that would review study results as new models are developed, tested and accepted. The framework of the TCM assumes that individual waterway movements are not sensitive to the price of water transportation until the level of the next least costly mode of transportation is reached. At that point, zero quantity will be shipped. Alternative uses of the commodity (typically associated with a different destination and perhaps a different mode) and the possible substitution of supply regions are not recognized.

ESSENCE: The ESSENCE model introduces the notion that individual waterway movements are sensitive to the price of water transportation before the threshold level of the next least costly transportation mode is reached. This is the major contribution of ESSENCE in moving from the Corps traditional TCM framework to a framework that can be described as a spatial equilibrium. A spatial equilibrium framework would explicitly model producing and consuming regions for a commodity, and link these regions by means of the transportation costs and commodity prices. ESSENCE is not a fully developed spatial model. It does not explicitly model and link producing and consuming regions by the means described above; however, it does take a significant step by introducing the notion of transportation demand elasticity. The most controversial and weakest aspect of the ESSENCE model is the methodology for specifying the price responsiveness of the waterway movements. Rather than specifying a single elasticity value, ESSENCE evaluations l incorporated an upper (E_{UB}) and lower bound (E_{LB}) of demand elasticity. After a review of existing efforts to estimate transportation demand elasticities, it was concluded that there are limited current data that address waterway transportation demand elasticity for the specific geographic region of this feasibility study investigation. A wide range of elasticity values, representing a variety of commodity group aggregations, transportation modes, geographic settings, and age of analysis were identified. Using these findings and analyst judgment, the ESSENCE upper and lower bounds were selected. (The selected values were –1.0 for grain and –0.5 for non-grain for the lower bound, and –3.0 for grain and –2.0 for non-grain for the upper bound.) The Corps has initiated a Navigation Economic Technologies (NETS) research program to further develop and incorporate the spatial equilibrium concept into future economic modeling efforts. One product of the NETS program that will be used in this study will be price elasticity information for water transportation. This information will be incorporated into the feasibility decision process as appropriate.

Model Results. The net benefits for each of the navigation efficiency alternatives have been evaluated for each of the 15 different economic conditions described above. The average annual net benefits in millions of dollars for each alternative for each economic condition are displayed in Table 2-50 in matrix format. Positive numbers represent benefits to the nation and negative numbers represent a loss to the nation. Each cell represents a net benefits computation for an economic condition defined by a scenario and elasticity assumption. Table 2-50 also includes a column titled positive net benefits or robustness, which is the extent to which the alternative is economically justified under a wide range of traffic scenarios and economic model assumptions. The columns titled maximum and minimum net benefits define the number of times that alternative contains the greatest or least net benefits for all 15 economic conditions. Figure 2-22 is a display of the net benefits for each economic condition in bar chart format. Alternative 1 exhibits no net benefits since there is no incremental cost above the without project condition.

Table 2-50. Average annual net benefits ($ Millions) for navigation efficiency alternatives across the range of 15 possible economic conditions created by the use of five scenarios and three economic models. Columns to the right of net benefits depict alternative robustness across this range of 15 possible future economic conditions.

NET BENEFITS ($Millions)

Alt.	Model	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Pos. Net Benefits	Max. Net Benefits	Min. Net Benefits
1	EUB	0.00	0.00	0.00	0.00	0.00	0/15	0/15	7/15
	ELB	0.00	0.00	0.00	0.00	0.00			
	TCM	0.00	0.00	0.00	0.00	0.00			
2	EUB	20.00	44.56	62.04	63.93	70.24	15/15	14/15	0/15
	ELB	16.22	61.73	96.29	101.36	116.63			
	TCM	8.88	100.74	143.08	158.18	172.76			
3	EUB	-10.92	-11.74	-11.63	-11.85	-11.29	0/15	0/15	0/15
	ELB	-10.92	-11.74	-11.63	-11.85	-11.29			
	TCM	-10.92	-11.74	-11.63	-11.85	-11.29			
4	EUB	-33.36	-19.12	-10.02	-9.24	-6.20	8/15	0/15	0/15
	ELB	-28.03	3.99	21.55	22.19	28.24			
	TCM	-24.09	35.55	55.56	65.47	71.62			
5	EUB	-74.08	-40.70	-17.75	-17.19	-8.96	8/15	0/15	0/15
	ELB	-67.31	2.32	41.35	41.74	50.73			
	TCM	-63.59	71.31	115.01	110.65	121.97			
6	EUB	-132.03	-79.07	-42.68	-39.67	-22.92	7/15	1/15	8/15
	ELB	-126.15	-27.79	41.79	48.97	76.52			
	TCM	-126.15	45.13	131.44	157.01	188.98			

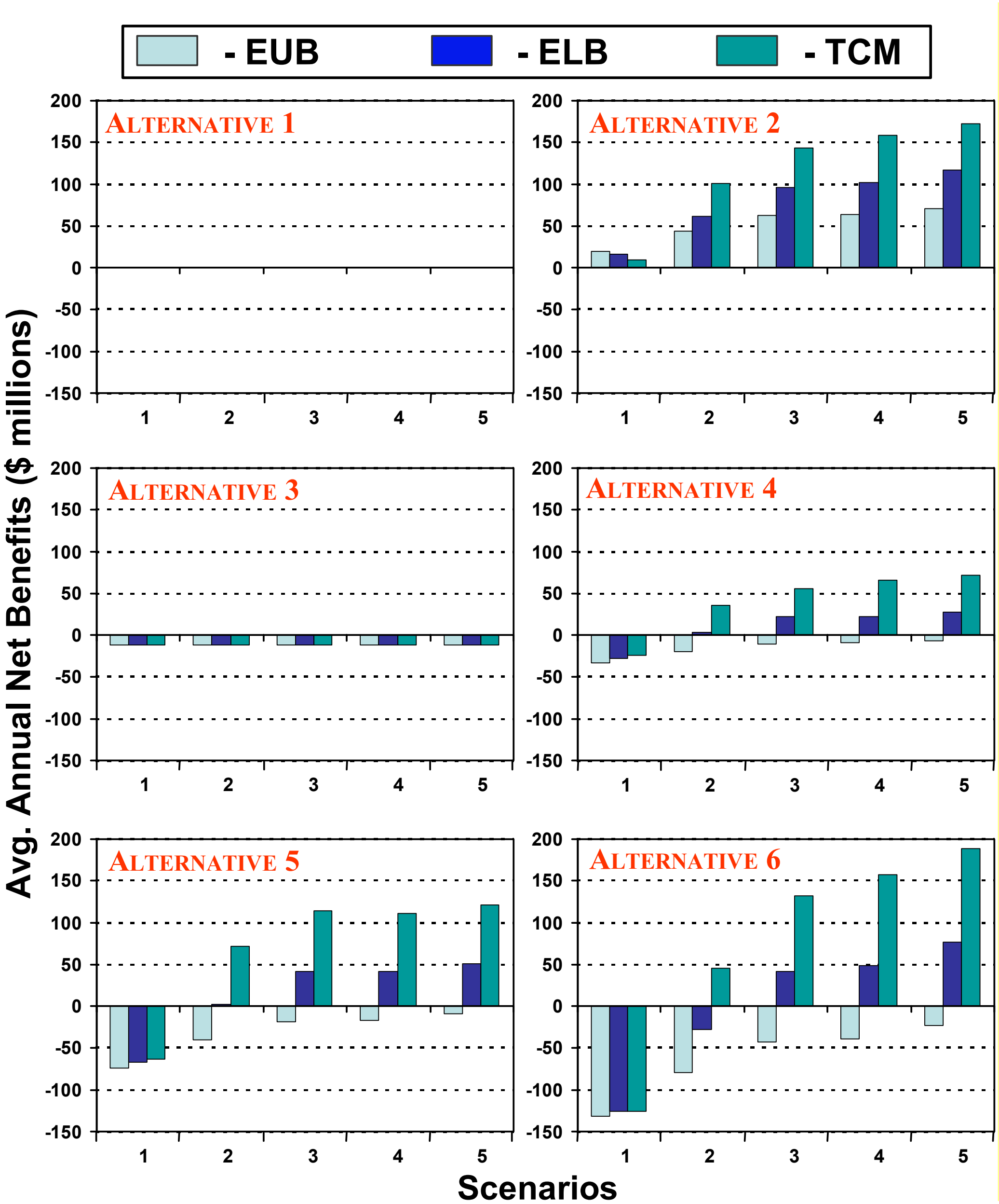


Figure 2-22. Average annual net benefits ($ Millions) for navigation efficiency alternatives across the range of 15 possible economic conditions created by the use of five scenarios and three economic models.

The model results can also be displayed in terms of a measurement of risk or the potential economic costs of selecting or not selecting an alternative as measured in foregone benefits. The risk for each alternative and economic condition is displayed in bar chart format in Figure 2-23. The foregone benefits are computed as the difference in net benefits between a specific alternative and the alternative with the highest net benefits for that economic condition. For example, if the no action alternative is selected and economic conditions represented by scenario 3 and the ESSENCE lower bound occur, the average annual net benefits foregone would equate to approximately $96 million dollars. Conversely if alternative 6 were selected and economic conditions represented by scenario 1and the ESSENCE lower bound occur, the cost of making this decision would equate to approximately $142 million dollars in average annual cost. Alternative 2 exhibits the least of amount of risk since it has the highest net benefits across 14/15 economic conditions and served as the basis for risk computation for the majority of the economic conditions. It is important to emphasize that the relative differences in risk cost between and among alternatives, and not the absolute magnitudes of risk expressed for each alternative, are the meaningful measures. The risk cost derive directly from t he computation of net benefits. In order to compare net benefits across alternatives it is necessary to reflect values that assume a common reference point for discounting purposes. The year 2023 has been selected as this common reference point. If an earlier or later common reference point had been chosen for the net benefit, and correspondingly for the risk costs, the absolute magnitude of the net benefits would have been either smaller or larger. As a consequence it is the relative differences in risk cost when comparing alternatives and the absolute magnitudes that are most meaningful.

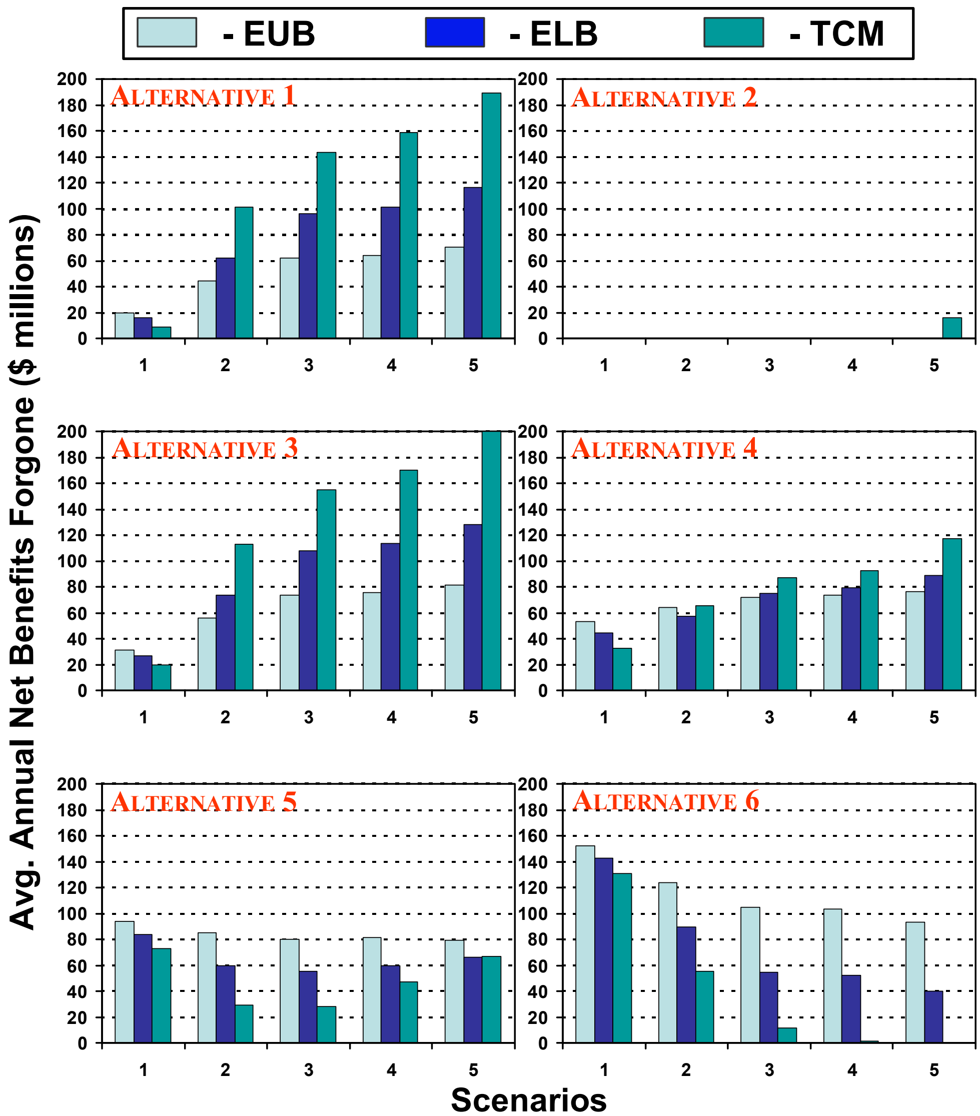


Figure 2-23. Alternative risk, expressed as the potential economic costs of selecting or not selecting an alternative as measured in foregone benefits.

B. Environmental Quality Effects

A Programmatic Environmental Impact Assessment (PEIS) is being developed to assess the effects of the proposed action. A supplemental or tiered Environmental Assessment (EA) will be developed to assess the site-specific impacts of those individual projects not specifically coordinated in the PEIS. Under the PEIS, environmental consequences resulting from any navigation improvement alternatives are monetized and included in the net benefit computations (see A3 above). A mitigation plan was developed to address the environmental effects these alternatives based upon the TCM traffic projection for each alternative at scenario 5 in the year 2040 (Tables 2-51 to 2-52). This combination (TCM, scenario 5, 2040) provided a "worst case" or greatest potential ecological impact for each alternative. Additional evaluations on incremental traffic impacts will be performed on the recommended plan if it differs from the previously identified alternatives. Site-specific impacts from construction activities were also computed for each alternative and are contained in the net benefits reported. Avoid, minimize, and mitigation measures were considered for each alternative. These following items represent the major environmental components of the proposed Mitigation Plan. Evaluation criteria B9 provides a total mitigation cost for each respective alternative (Table 2-52). This amount was included in the computation of Net Benefits (NED).

The PEIS will detail potential ecological risks posed by commercial traffic. These risks will be estimated using the models of ecological effects and the models that quantified the magnitude, extent, and duration of the physical forces produced by commercial vessels. The alternative traffic scenarios provide the input data (e.g., vessels/day, vessel and barge configuration, direction, speed, draft) for the physical forces models. The results of the physical forces models provide the inputs to the ecological models that estimate the corresponding impacts for each traffic scenario. Bias and imprecision are possible for each general component of the Navigation Study ecological risk assessments: traffic projections, physical forces models, and ecological effects models. The nature and sources of bias and imprecision associated with each aspect of the UMR-IWW risk assessments will be addressed during the Navigation Study. Where possible, uncertainties will be quantified, incorporated into the calculations of ecological impacts, and included in the assessment of impacts.

Any mitigation actions will be adaptive in nature, and an authorized mitigation plan and costs will have leeway to modify mitigation features and measures based on monitoring results and future river conditions. Adaptive management has been defined as an iterative approach to managing ecosystems, where the methods of achieving the desired objectives are unknown or uncertain. An adaptive approach should aim for an optimal management capacity, seeking critical knowledge, and generating innovative approaches. Adaptive management should consider a number of potential barriers, including fragmented system management, limited time and resources, and the resistance to moving forward with limited or imperfect information. An adaptive process is well suited for the temporal and spatial scales of the Navigation Study. The planning horizon for the Navigation study includes the next 50 years, during which technological and scientific advancements will likely improve our ability to identify and mitigate for adverse impacts. An adaptive mitigation plan takes into consideration discussions, presentations, and coordination with the Navigation Environmental Coordinating Committee (NECC), beginning in 1997 through the present.

The PEIS mitigation plan will describe the general mitigation approach and costs to implement. The plan will identify regional and site specific measures needed to ensure the continued health and well being of the UMR-IWW ecosystem by attending to those resource groups that may suffer adverse impacts resulting from the proposed federal action(s) (i.e. fish, plants, mussels, cultural resources, bank erosion, backwaters & sides channels). The mitigation plan provides a detailed narrative for each resource group and will focus on the following main topic areas:

Designation of Significance - process by which impacts and/or species are elevated or eliminated in terms of their relative importance.

Identification of Avoid/Minimize Measures - actions or measures that could be taken to prevent or decrease the impact or species losses.
Mitigation Alternatives - if impacts or losses are unavoidable due to a chosen course of action then measures will be considered to compensate for them.
Monitoring and Evaluation - monitoring is essential in the evaluation of an action's performance, success, and effectiveness.

Table 2-51. Description of avoid, minimize and mitigation measures recommended to offset the incremental effects of additional commercial traffic resulting from the navigation efficiency alternatives.

Mangement Actions	ALTERNATIVE PLANS					
	1	2	3	4	5	6
Efficiency Measures						
(1) Fees	NA	Congestion Fee Implemented through a Lockage Fee	Excess Lockage Time Fees	NA	NA	NA
(2) Moorings	NA	NA	NA	12, 14, 18, 20, 22, 24 & LGR	12, 14, 18, 24 & LGR	12, 14, 18 & 24
(3) Lock Switchboats	NA	NA	NA	20, 21, 22, 24 & 25	14, 15, 16, 17, 18, PEO & LGR	11, 12 & 13
(4) Lock Extensions	NA	NA	NA	NA	20, 21, 22, 24 & 25	14, 15, 16, 17 & 18
(5) New Locks	NA	NA	NA	NA	NA	20, 21, 22, 24, 25, PEO & LGR
Avoid, Minimize & Mitigation Measures						
(1) Islands and Shoreline Erosion	NA	NA	NA	10.8 miles of shore protection	10.8 miles of shore protection	10.8 miles of shore protection
(2) Backwaters/Side Channel Sedimentation	NA	NA	NA	31 Projects	31 Projects	31 Projects
(3) Aquatic Plants	NA	NA	NA	2 miles of plant bed protection	Water level management at up to three pools or up to 33 miles of bank protection	Water level management at up to three pools or up to 54 miles of bank protection
(4) Fisheries	NA	NA	NA	11 Projects	14 Projects	25 Projects
(5) Monitoring	NA	NA	NA	2 applied research studies and a limited annual bioresponse monitoring program	2 applied research studies and a limited annual bioresponse monitoring program	2 applied research studies and a limited annual bioresponse monitoring program
(6) Historic Properties	NA	NA	NA	Systemic evaluation of bank erosion	Systemic evaluation of erosion and site specific evaluation of construction	Systemic evaluation of erosion and site specific evaluation of construction
(7) Other	NA	NA	NA	Administration and Project Maintenance	Administration and Project Maintenance	Administration and Project Maintenance
(8) Site Specific Mitigation	NA	NA	NA	NA	5 Sites	12 Sites

Table 2-52. Cost of avoid, minimize, and mitigation measures for each of the navigation efficiency alternatives.

Avoid, Minimize & Mitigation Measures	Mitigation Cost ($ Millions) for Nav. Efficiency Alt. Plans					
	1	2	3	4	5	6
B1. Islands and Shoreline Erosion	NA	NA	NA	$14.2	$14.2	$14.2
B2. Backwaters/Side Channel Sedimentation	NA	NA	NA	$27.2	$27.2	$27.2
B3. Aquatic Plants	NA	NA	NA	$1.6	$32.4	$51.9
B4. Fisheries	NA	NA	NA	$12.4	$34.0	$42.7
B5. Monitoring	NA	NA	NA	$7.5	$9.4	$11.3
B6. Historic Properties	NA	NA	NA	$8.6	$9.6	$10.0
B7. Other	NA	NA	NA	$7.9	$15.5	$19.4
B8. Site Specific Mitigation	NA	NA	NA	$0.0	$8.7	$30.3
B9. TOTAL MITIGATION	$0.0	$0.0	$0.0	$79.4	$151.0	$207.0

C. Regional Economic Development (RED)

The income and employment benefits for each alternative were computed for the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri along with the lower Mississippi Region and the rest of the U.S. These income and employment effects are derived from direct construction expenditures required to implement an alternative and from the transportation efficiencies generated by the alternative. RED benefits for scenario 3 are presented in Table 2-53 as average annual income from construction and average annual jobs created. RED information for scenarios 2 and 5 were also computed and provided to the states. In general, the higher investment alternative, the greater will be the benefits to the region. Alternative 2, results in negative effects to this sector of the regional economy because there are no construction expenditures required to implement this alternative and transportation efficiencies are negatively influenced, at the regional level, by virtue of the fact that all traffic that remains on the system is required to pay the fee.

Table 2-53. Regional Economic Development Benefits for Scenario 3

REGIONAL ECONOMIC DEVELOPMENT (RED) (2005-2035)

UMR-IWW System Navigation Feasibility Study

NAVIGATION EFFICIENCY ALTERNATIVES

Average Annual Income ($ millions) Scenario 3

TOWCOST Model (TCM)

Region	Alt 2	Alt 4	Alt 5	Alt 6
Minnesota	-57.7	14.0	17.4	18.0
Wisconsin	-12.6	4.4	6.9	8.9
Iowa	-39.9	11.8	16.6	23.8
Illinois	-76.8	35.5	71.2	100.3
Missouri	-16.1	15.9	20.1	32.7
L Miss	3.5	7.2	6.3	5.2
Rest of U.S.	79.0	-12.4	-32.7	-38.7
Total	-120.7	76.4	105.8	150.2

ESSENCE Lower Bound

Region	Alt 2	Alt 4	Alt 5	Alt 6
Minnesota	-37.2	9.3	11.7	12.5
Wisconsin	-8.2	3.2	5.3	7.7
Iowa	-25.9	8.0	12.2	19.6
Illinois	-49.6	29.1	60.1	90.3
Missouri	-10.3	14.6	18.4	31.0
L Miss	1.6	4.9	6.3	4.5
Rest of U.S.	50.7	-15.6	-12.8	-32.2
Total	-78.9	53.5	101.3	133.3

ESSENCE Upper Bound

Region	Alt 2	Alt 4	Alt 5	Alt 6
Minnesota	-20.8	5.0	7.3	8.4
Wisconsin	-4.5	2.3	4.3	7.0
Iowa	-14.3	5.1	8.8	16.3
Illinois	-27.7	24.3	52.4	83.2
Missouri	-5.3	13.1	17.1	30.0
L Miss	-0.2	6.3	6.5	6.2
Rest of U.S.	25.9	-16.5	-8.3	-19.3
Total	-46.9	39.7	88.2	131.8

Average Employment per Year (jobs) Scenario 3

TOWCOST Model (TCM)

Region	Alt 2	Alt 4	Alt 5	Alt 6
Minnesota	-595	173	248	275
Wisconsin	-168	76	129	184
Iowa	-428	173	323	514
Illinois	-771	497	1,057	1,581
Missouri	-197	332	354	595
L Miss	145	105	72	85
Rest of U.S.	1,944	-308	-823	-884
Total	-70	1,048	1,360	2,351

ESSENCE Lower Bound

Region	Alt 2	Alt 4	Alt 5	Alt 6
Minnesota	-378	113	168	200
Wisconsin	-107	55	102	159
Iowa	-272	123	256	449
Illinois	-491	418	902	1,441
Missouri	-125	308	324	566
L Miss	91	100	106	99
Rest of U.S.	1,256	-184	-419	-564
Total	-27	933	1,437	2,350

ESSENCE Upper Bound

Region	Alt 2	Alt 4	Alt 5	Alt 6
Minnesota	-211	67	110	142
Wisconsin	-60	43	82	143
Iowa	-151	85	205	399
Illinois	-275	358	792	1,334
Missouri	-69	292	302	547
L Miss	39	118	126	143
Rest of U.S.	689	-54	-165	-220
Total	-39	909	1,452	2,488

D. Other Social Effects (OSE)

This work evaluates and quantifies positive or negative impacts of waterway traffic versus rail for the categories of emissions, accidents, and noise and other community impacts. A positive number indicates a project benefit, while a negative number indicates a project cost or disbenefit. While the effects described here are potentially NED in nature the level of input detail and lack of standardized measurement techniques within the Corps preclude these impacts from being considered in the NED formulation process.

D1. Emissions

The change in rail and waterway traffic emissions impacts attributable to each alternative can be quantified by comparing the gallons of fuel consumed in waterway and rail transportation for each alternative. Emission factors per gallon of fuel consumed can be used in developing the estimates.

The general conclusion of the Energy Efficiency Analysis is that there is no evidence to suggest that the potential waterway improvements would have a significant beneficial effect on annual fuel consumption. The emission of air pollutants is directly linked to fuel consumption. Therefore, it is unlikely that the potential waterway investments would have a significant beneficial effect on the emission of air pollutants

D2. Accidents

Included in this data are estimates of the differential financial cost of accidents and fatalities resulting from waterway and rail transportation. The National Safety Council unit costs of $3.5 million and $44 thousand are used in estimating fatality and injury costs respectively. Table 2-54 displays the projected change in accident costs for traffic scenario 3, and for each alternative. As the tables show, the net change is very large for some alternatives; $39 million in year 2050 under Alternative 6, ESSENCE – Upper Bound.

Negative signs associated with Alternative 2 (lockage fees) indicate that additional traffic would move on the railway instead of the waterway in the with-project condition resulting in negative benefits.

Table 2-54. Projected change in accident costs for traffic scenario 3, and for each navigation efficiency alternative.

Accident Costs (Injuries and Fatalities)
Scenario 3 (Millions of $)

TOWCOST Model (TCM)

Year	Alt 2	Alt 4	Alt 5	Alt 6
2025	-9.8	2.1	2.7	2.5
2035	-9.9	7.2	11.4	12.0
2050	-11.6	7.3	13.3	16.4

ESSENCE Lower Bound

Year	Alt 2	Alt 4	Alt 5	Alt 6
2025	-15.2	3.9	7.9	8.2
2035	-18.4	7.0	15.6	21.3
2050	-21.6	7.0	18.3	27.1

ESSENCE Upper Bound

Year	Alt 2	Alt 4	Alt 5	Alt 6
2025	-18.0	5.3	13.3	13.8
2035	-20.8	7.7	21.1	32.8
2050	-22.8	7.7	23.4	38.5

D3. Noise and Other Impacts

The change in rail and waterway traffic noise and other community impacts attributable to each alternative have been evaluated and quantified. Incremental railroad traffic will result in changes in traveler delay at railroad/highway crossings. A comprehensive analysis of grade crossing delay is beyond the scope of this study. However, several illustrations are presented based on probable routings. In the first illustration, half of the grain traffic to the Gulf (or 30% of the incremental traffic) is assigned to the UP lines that run through East St. Louis, Pine Bluff, AR, and several other cities en route to New Orleans. In the second illustration, all of the grain traffic to the gulf (or 60% of the incremental grain traffic) is assigned to UP lines.

The grade crossing delay and noise analysis procedures utilize the same database. Changes in noise levels are analyzed at the same crossings for the selected cities using the same number of incremental trains. Noise is an important community impact that is considered by the STB in rail-line analyses. Incremental railroad traffic may result in three main types of noise: (1) locomotive (propulsive) noise, (2) train noise, and (3) horn noise. The following tables list the estimated crossing delay and noise impacts, assuming that 30% of the incremental grain traffic moves via the Gulf route.

An example is used to illustrate the interpretation of the tables assuming 30 percent of the incremental grain traffic follows this route. Under Alternative 6 (TCM) in 2035, the projected change in housing units subject to railroad noise levels of 65dba or greater is 648, and 1,244,000 fewer highway vehicles would encounter grade crossing delays totaling 38,000 hours per year (Table 2-55).

Table 2-55. Crossing Noise and Delay impacts associated with Navigation Efficiency Alternatives using Scenario 3 traffic levels.

Crossing Noise and Delay Impacts
Scenario 3 - With 30% of Incremental Grain Traffic (YR 2035)

TOWCOST Model (TCM)

Impact	Alt 2	Alt 4	Alt 5	Alt 6
Housing units>65dba	451	451	648	648
Delay/yr. in hours	25,630	25,630	38,445	38,445
Vehicles delayed/yr.	829,264	829,264	1,243,897	1,243,897

ESSENCE Lower Bound

Impact	Alt 2	Alt 4	Alt 5	Alt 6
Housing units>65dba	648	241	648	837
Delay/yr. in hours	38,445	12,815	38,445	51,260
Vehicles delayed/yr.	1,243,897	414,632	1,243,897	1,658,529

ESSENCE Upper Bound

Impact	Alt 2	Alt 4	Alt 5	Alt 6
Housing units>65dba	648	451	648	1,016
Delay/yr. in hours	38,445	25,630	38,445	64,075
Vehicles delayed/yr.	1,243,897	829,264	1,243,897	2,073,161

E. Planning Objectives

The goals and objectives of the feasibility study is to outline an integrated plan to ensure the economic and environmental sustainability of the UMR-IWW Navigation System. The alternatives contained in Section 2.4.2 were formulated to meet these objectives. Outlined below is the definitions and evaluations of how well the alternatives meet each of the planning objectives.

OBJECTIVE E1. Provide for a safe, reliable, efficient, and sustainable UMR-IWW navigation system over the planning horizon.

DEFINITIONS.

Safety: The safety of the towboat crews and lock personnel were paramount in the development of measures and alternatives. Locking massive 15 barge tows in all kinds of weather, 24 hours a day, 7 days a week is inherently dangerous. The benchmark floor for safety is to not allow navigation efficiency improvements that are less safe than current operating procedures. In the formulation of measures and alternatives, improvements to safety were considered and incorporated as appropriate.

Reliability: Reliability is defined as the ability to provide consistent lockage service throughout the navigation season or construction period for new improvements, with minimal disruptions to commercial and recreational traffic. Ensuring the reliability of the navigation system is analogous to maintaining a chain, whereby the system or chain is only as strong as the weakest link. The disruption of one lock essential impacts the entire system. The benchmark floor for reliability will be to not allow navigation efficiency improvements that are less reliable than current operating conditions. Increases in reliability were considered in the formulation of measures and alternatives.

Efficiency: The shipment of commodities on the system has national and regional economic implications. Grain and other commodity prices are very sensitive to transportation costs and an efficient system is essential to maintaining a competitive transportation system. The benchmark floor for efficiency will be to not allow navigation efficiency improvements that are less efficient than the current system. The efficiency of navigation efficiency improvements is primarily measured by National Economic Development benefits.

Sustainability: The transportation system of the United States is a multi-modal system that requires the efficient interaction between rail, truck, air, and waterway modes of transport. The economy of the country and its competitiveness in world markets depend on a safe, reliable and efficient transportation system. The role of the Federal government is to provide for a transportation system that allows the free market society to maximize its use for economic gain to the country. Sustainability is defined as the "The balance of economic, ecological, and social conditions so as to meet the current, projected, and future needs of the Upper Mississippi River System without compromising the ability of future generations to meet their needs." Meeting future needs of the system is defined as allowing for future growth to meet the needs of the region and nation. The benchmark floor for sustainability will be to not allow any navigation efficiency improvements that stifle growth on the system.

The following paragraphs provide evaluative information on how well the alternatives meet the planning objective E1:

Alternative 1: **No action**. By definition, alternative 1 serves as the benchmark for safety, reliability, and efficiency. The question of whether the no action alternative is sustainable depends on the future demand for waterway transportation. If increases in demand occur, the no action alternative would not meet the sustainability objectives.

Alternative 2: Congestion Fees Implemented through a Lockage Fee (imposed on commercial traffic). This alternative is safety and reliability neutral. It does provide more efficiency to the system, which is reflected in the NED computations. Alternative 2 improves efficiency by imposing a fee that drives marginal users off the system. However, it fails to meet the primary planning objective of ensuring an economically sustainable navigation system, since it constrains the future growth on the system.

Alternative 3: Excess Lockage Time Fees. This alternative could have safety implications by creating an incentive to move through the double lockage process faster. This alternative includes the installation of winches that may speed up the uncoupling and recoupling process, however they have resulted in some increases in back injuries as reported by industry. This alternative is reliability neutral. The NED benefits and efficiency measurement for this alternative are negative. This alternative is not sustainable due to the negative benefits created from its implementation.

Alternative 4: Moorings (12, 14, 18, 20, 22, 24, and LGR), Switchboats at Locks 20-25.

Safety (Alt. 4):

Moorings - Additional moorings will either be cells or buoys at select lock sites. The purpose of a mooring is to speed overall lock processing time by mooring the waiting tow closer to the lock to reduce its approach time. This will require a change in practice by the towboat operators that could have some associated mishaps until the use of the mooring became common practice. It is likely they would take the time necessary to ensure safety rather than add any risk for the sake of efficiency. Therefore, moorings would not increase or decrease safety.

Switchboats - The use of switchboats to pull the first cut out of the lock chamber in lieu of the tow haulage unit will require different types of line handling. In the present condition, a lockman handles the tow-haulage equipment and cable to start the cut moving and deckhands stop the cut movement by checking the head of the cut using a line and braking the cut at the stern using a separate line. Switchboats will replace the tow haulage activities and line work associated with head checking and braking of the cut. The crew of the switchboat will attach wires from the boat to the cut in order to pull and control it. On the surface, there would seem to be a tradeoff of the safety of line handling using the present tow haulage method vs. the switchboat method of extracting first cuts. Switchboat introduction could have potential for increasing personal injuries since more individuals (two deckhands and one towboat pilot) will be used on each switchboat. Overall the safety of switchboats will depend on the experience and training of the towboat captain and crew.

Reliability (Alt. 4):
Moorings – The placement of the moorings in the System Study was coordinated with the towing industry, the eventual users. Despite the coordination efforts, some moorings may not get used to their fullest extent based on historical uses of similar mooring installations. Some moorings have been installed for the purposes of increasing efficiency, but the towboats don't always use them or they use them as a last resort. The users don't all find the moorings useful or better than mooring along the bankline. If this practice were to continue, then the reliability of the timesavings modeled in the study would be reduced or the timesavings completely eliminated. This will likely not be realized until the moorings are installed and the industry's reaction studied under a variety of conditions such as varying river flows, weather, etc. The timesavings of moorings were considered to be 100% reliable in the economic analysis, but overall moorings will not increase or decrease the reliability of the system since the reliability of the lock is not addressed.

Switchboats – The use of switchboats was modeled with two switchboats at each lock site. The primary purpose of using two boats was that if one were delayed in returning to the lock from a remote remake condition, the other would always be ready to service the next tow. Any use of switchboats would probably be implemented starting with one boat at a site and adding second boat as required for reliability or to maximize timesavings. Overall switchboats will not increase or decrease the reliability of the system since the reliability of the lock is not addressed.

Efficiency (Alt. 4): Moorings and switchboats do provide positive efficiency benefits to the system as measured by the NED benefits.

Sustainability(Alt. 4): Moorings and switchboats will be sustainable for low growth scenarios, however they will not be sustainable for high growth scenarios.

Alternative 5: Moorings (12, 14, 18, 24, and LGR), Lock Extensions at Locks 20-25, Switchboats at Locks 14-18, La Grange and Peoria.

Safety (Alt. 5): The safety aspects of moorings and switchboats are contained in the alternative 4 descriptions. Lock extensions at Locks 20 thru 25 will eliminate double-cut lockages (approximately 75% of all lockages) and the associated personal-injury hazards at those sites. A double-cut lockage requires the breaking and remaking of as many as eight couplings made with wire ropes. The work involves laying the wire ropes, connecting them and tightening them in an orderly manner. Three deckhands work together to complete this task that requires skill, strength, stamina, and safety awareness. Also, deckhands would not have to climb ladders onto the lock wall, and eventually climb down, in order to lock the first segment of the double-cut lockage. Finally, any tasks associated with tow haulage and checking the cut to full stop and their associated hazards (see switchboat discussion above for these hazards) would be eliminated. Lock extensions would eliminate these hazards for five locks. The overall risk of personnel injury to deckhands and lockhands is reduced because there is reduced exposure to hazards. There could also be some additional safety benefits because the tows crew would be more rested because of the less strenuous duties required locking through 1200 ft long locks.

Reliability (Alt. 5): The reliability aspects of moorings and switchboats are contained in the alternative 4 description. Lock extensions reduce the number of operating cycles of machinery by eliminating the need for the double-cut lockage of tows. Reduced cycles affect the machinery life, related unscheduled lock closures, and intervals of Major Rehabilitation. All these beneficial effects were considered in the economic modeling. Lock extensions would improve the reliability of the system once they are completed and in service, however performance would be less than a new lock. The filling and emptying system for the lock extensions relies on the system from the existing 600 foot lock. Filling and emptying from only 600 feet of a 1200 foot lock will slow down processing time compared to a new lock.

Most of the on-site lock extension construction would occur in the wintertime to reduce the impacts to navigation. The lock would be closed for approximately 90 days for three consecutive winter seasons. For the lower five locks on the Mississippi River, the total construction schedule (depending on schedule alignments) could close the river for 10 consecutive winter seasons. The lower 5 locks can receive river traffic in typical winter months, but this would be impossible during lock extension activities due to conflicts with construction. (In contrast, for new locks, scheduled openings of the existing lock can be used to accommodate some winter traffic. See Alternative 6 for further explanation). The NED losses due to winter closure periods were considered in the economic model, but the long-term impact on businesses was not considered.

There is substantial risk in experiencing a reduction in reliability during construction of the lock extensions. In a situation where lock extensions were to experience construction delays, causing construction beyond the wintertime closure period, the consequences of navigation impacts would be large. Wintertime navigation closures were used to allow uninterrupted construction work. These were modeled as fixed durations of about 90 days each and then traffic would resume. If the construction activities were delayed beyond the closure period, navigation traffic would be delayed until completion of the specific construction activities. The chance of construction delay and the duration of delay were not considered in the economic model because both are uncertain.

Efficiency (Alt. 5): Moorings, switchboats, and lock extensions do provide positive efficiency benefits to the system as measured by the NED benefits for some economic conditions.

Sustainability (Alt 5): Moorings, switchboats and lock extensions will not be sustainable for low growth scenarios, however they will be sustainable for high growth scenarios.

Alternative 6: Mooring (12, 14, 18, and 24), New Locks at 20-25, La Grange, and Peoria; Lock Extensions at 14-18; and Switchboats at Locks 11-13.

Safety (Alt. 6.): The safety aspects of moorings, switchboats, and lock extensions are contained in the alternative 4 and 5 description. New locks have the same benefits listed for lock extensions along with other safety advantages. Locks 20-25 and Peoria and LaGrange would retain use of the existing locks. The existing 600ft lock can be used for recreation craft and other small vessels. This separates the small craft from the large commercial tows. Also, their interferences on approaching the lock would be reduced, therefore reducing the chance of conflict between vessels. Sometimes recreation craft attempt to bump into line in order to lock through faster. This can cause delays to those expecting their lock turn and is not the safest of boating practices. Also, location 3 locks on the lower 5 locks on the Mississippi River would feature a riverside approach wall on the upstream end. This approach wall location with respect to the dam generally is considered safer than the present guidewall structure along the landside of the lock. Riverside approach walls are safer because they provide a physical barrier between the tow and dam that would reduce the chance and consequences of tow mishaps that result in barges breaking loose from the tows and sometimes subsequently running into the dam. The approach wall also would allow downbound tows to better align themselves for lock entry, thus reducing impact damage to miter gates and lockwalls resulting from the present lock entry conditions.

Reliability (Alt. 6): The reliability aspects of moorings, switchboats and lock extensions are contained in the alternative 5 description. New locks have the same benefits listed for lock extensions along with other advantages. Locks 20-25 and Peoria and LaGrange would retain use of the existing locks. This reduces the number of operating cycles that either lock must perform. The cycles are reduced because there would normally be no double lockages for the small lock, no recreation craft for the long lock, and fewer small commercial craft (600 ft long or less) for the long lock. Operating cycles are a major driver in the timing and need for lock major rehabilitation and repair. Most of this affect was captured in the economic modeling of new lock construction. The increase in recreational craft lockages being able to be accommodated by the smaller lock was not considered because there are no reliable projections for the amount of recreation traffic increases. However, in general, recreational boaters are increasing in number.

Also, a second lock at the existing projects offers the opportunity to temporarily remove a lock from service for repairs that could result in restored performance. This convenience will allow both locks to operate at full output. (In contrast, for lock extensions, any reduction in performance due to malfunction is accepted and its associated repair delayed until the wintertime when navigation demand is reduced). This benefit was not captured in the economic model.

Also, in the event of future needs for major rehabilitation, a second lock allows construction to occur during seasons other than the winter, which is the exiting practice on the Upper Mississippi River. Construction work during better weather conditions will allow increased productivity and likely increased quality. This benefit was not considered in the economic model.

Most of the on-site lock extension construction would occur in the wintertime to reduce the impacts to navigation. The lock would be closed for approximately 90 days for three consecutive winter seasons. For Locks 14 thru 18, there is minimal wintertime traffic making the construction impact less than for lock extensions at Locks 20 through 25 in Alternative 5. The NED losses due to winter closure periods were considered in the economic model.
For new locks at Locks 20 - 25, a significant amount of construction occurs during the winter season. In all but the last year of construction of a new lock (due to dewatering of both locks), a scheduled opening(s) may be allowed to accommodate traffic that typically occurs on the lower 5 locks on the Mississippi River in the wintertime. It is doubtful that all traffic could be accommodated, but there would still be an economic benefit. This benefit was not captured in the economic model.

In a situation where lock extensions were to experience construction delays, causing construction beyond the wintertime closure period, the consequences of navigation impacts would be large. Wintertime navigation closures were used to allow uninterrupted construction work. These were modeled as fixed durations of about 90 days each and then traffic would resume. If the construction activities were delayed beyond the closure period, navigation traffic would be delayed until completion of the specific construction activities. The chance of construction delay and the duration of delay were not considered in the economic model because both are uncertain.

For new locks, a prolonged construction season would likely mean that the existing lock could still be opened on time for the navigation season. The chance of construction delay for new locks and lock extension may be similar, but the consequences of a prolonged construction schedules would be much worse for lock extensions. This benefit was not captured in the economic model because the probability of occurrence of a prolonged schedule as well as its duration is uncertain.

Efficiency (Alt. 6): Moorings, switchboats, lock extensions and new locks do provide positive efficiency benefits to the system as measured by the NED benefits for some economic conditions.

Sustainability (Alt 6): Moorings, switchboats, lock extensions and new locks will not be sustainable for low growth scenarios, however they will be sustainable for high growth scenarios.

OBJECTIVE E2. Address cumulative impacts including ongoing effects of the operation and maintenance of the UMR-IWW Navigation System.

An assessment of cumulative effects was conducted using an interdisciplinary team of experts and archival information concerning changes in the system since construction of the Nine foot channel project (ENV Report 40). The cumulative effects assessment provided the context against which to consider both the extent and significance of any direct or secondary effects which may result form the alternatives. This effort also contributed important information on the likely future (without) condition of the UMR-IWW ecosystem. Objective E2 guided the development of alternatives for Ecosystem restoration alternatives including modifications to the operation and maintenance of the Navigation project for environmental considerations addressed in section 2.3 of this AFB report.

OBJECTIVE E3. Assure that any recommended measures are consistent with protecting the Nation's environment; avoiding, minimizing, or mitigating significant environmental, cultural, or social impacts.

The development of measures and alternatives took into consideration avoiding and minimizing environmental cultural and social impacts. Where impacts could not be avoided, a mitigation plan was developed and these costs are included in the NED development outlined above. An adaptive mitigation strategy was developed to address any significant construction site impacts or systemic impacts associated with any incremental impacts of traffic over the without project condition. The Mitigation strategy focused on the incremental effects from the implementation of any alternatives in the context of ongoing and cumulative effects referenced above.

Alternative 1: No action. By definition, there are no additional environmental impacts above the without project condition.

Alternative 2: Congestion Fees Implemented through a Lockage Fee (imposed on commercial traffic). This alternative may result in positive environmental consequences on the waterway since it has the potential takes traffic off the system. These effects have been quantified using the traffic effects models. However, they were not monitized for inclusion in the NED analysis. A preliminary assessment of environmental and social consequence resulting from shifting traffic to alternative transportation modes other described in the other social effects section of this report.

Alternative 3: Excess Lockage Time Fees. No environmental impacts were assessed since incremental traffic is zero and there are no site-specific impacts.

Alternative 4: Moorings (12, 14, 18, 20, 22, 24, and LGR), Switchboats at Locks 20-25. This alternative results in an incremental increase in traffic, which has been assessed and is included in the NED analysis. There are no site-specific mitigation costs for this alternative. The moorings may provide some unquantifiable positive benefits by allowing waiting tows to moor against a hardpoint rather than along the bankline. Switchboats may have some minor unquantifiable negative benefits due to the additional resuspension of sediment around the lock areas and additional potential fish entrainment.

Alternative 5: Moorings (12, 14, 18, 24, and LGR), Lock Extensions at Locks 20-25, Switchboats at Locks 14-18, La Grange and Peoria. This alternative results in an incremental increase in traffic and site specific impacts, which has been assessed and is included in the NED analysis. The moorings and switchboats provide the same minor effects presented in alternative 4. The lock extensions may result in some minor unquantifiable positive benefits early in the planning horizon by reducing the use of current waiting areas above and below the lock sites..

Alternative 6: Mooring (12, 14, 18, and 24), New Locks at 20-25, La Grange, and Peoria; Lock Extensions at 14-18; and Switchboats at Locks 11-13. This alternative results in an incremental increase in traffic and site specific impacts, which has been assessed and is included in the NED analysis. The moorings and switchboats may provide the same minor effects outlined in alternative 4. The lock extensions and new locks may result in some minor unquantifiable positive benefits by reducing the use of current waiting areas above and below the lock sites.

F. Acceptability

Acceptability is the workability and viability of the alternative plan with respect to acceptance by Federal, State and local entities; the general public; and compatibility with existing laws regulations and public policies (P&G Section VI.1.6.2(c)(4)). The feasibility study is not yet complete, however observations have started to surface that provide some insight into the acceptability of the alternatives. For this study we have organized stakeholder acceptability into the following categories:

F1. Institutional

This stakeholder group includes representatives holding official governmental positions representing the interest of the various federal, state, and municipal agencies. For example, the five UMR states (IL, IA, WI, MN, MO), their respective departmental representatives, federal agencies (USFWS, USEPA, USDOT, USDA....etc).

The Department of Transportation and Department of Agriculture have expressed a desire to do something other than the no action alternative and alternative 2, although they have not yet endorsed any specific alternative. Current law prohibits alternative 2 and current national policy calling for full use of all transportation modes to reduce congestions and facilitate economic growth makes institutional acceptance of this alternative doubtful. The Fish and Wildlife Service has taken a neutral stance on navigation efficiency alternatives. The Environmental Protection Agency has expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks. None of the states has yet endorsed a specific navigation efficiency alternative. However, the states have collectively voiced general support for economically justified and environmentally acceptable navigation improvements.

F2. Social

This stakeholder group includes the general public and non-governmental organizations such as MARC 2000, Audubon, National Corn Growers, The Nature Conservancy, Towboat industry, Mississippi River Basin Alliance, etc. The primary alternatives were presented at a series of seven public meetings in October 2003 (Table 2-56). This meeting was structured to allow members of the general public to ask questions, voice their opinions on the study process or alternatives, submit written statements and complete a comment form.

The navigation and agriculture non-governmental organizations have fully endorsed implementation of Alternative 6 in a phased in approach. The environmental interests have expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks.

Specific to alternative 2

Acceptability. Present law prohibits a fee such as contained in alternative 2 and current national policy makes institutional acceptability of this alternative plan doubtful. The Department of Transportation and Department of Agriculture have indicated that Alternative 2 is incompatible with national policy that calls for efficient use of all transportation modes and incompatible with reducing congestion on the Nation's highways and railroads. None of the states has yet endorsed a specific navigation efficiency alternative. The navigation and agriculture non-governmental organizations have expressed negative comments, while the environmental interests have generally expressed the need to fully consider this alternative plan.

The following provides a brief summation of the acceptability information obtained from the seven Public meetings held during October 2003:

- Average attendance at the series was over 180 persons (see summary table for attendance numbers for the open house and formal presentation at each location).
- 57% of those that saw the slide presentation, turned in a comment form
- Of the 608 comment forms turned in:
  - Agriculture interest was the largest primary interest group at 34%, followed by other business/industry at 23%, and Environmental interest at 15%.
  - about 62% of the persons returning comment forms were from an economic interest (including Agriculture, waterborne industry, and Other industries/Business)
  - Personal interest was 8% and Recreation was 4% of those who turned in a comment form. (5% did not answer)
- Navigation Acceptability related questions- 5 point scale with a no answer option
  - over 79% said they understand how the study process was developed to arrive at the alternative plans presented.
  - over 87% said they understand the principle navigation and ecosystem problems being addressed by the study.
  - over 67% said they understand the process for evaluating navigation efficiency & ecosystem restoration alternatives.
  - over 74% said they feel sustainability of the river system requires a balanced approach between econ & environmental interests.
  - almost 84% said they feel collaboration is an important mechanism for a greater set of interests in this study to be heard.
  - over 82% said they feel collaboration is critical to project success.
  - over 68% said they feel the collaborative study approach will provide a recommendation that encompasses desired holistic approach.
  - over 46% said they have attended a prior Nav. Study public meeting in the past.

Other Observations:

- over 80% agreed that the Alternative plans presented reflect the study's dual purpose.
- over 72% agreed that the Alternative plans meet or address navigation efficiency & ecosystem restoration goals for the study.
- almost 72% agreed that the study's balanced emphasis on economic & environmental sustainability is reflected in the alternatives.
- almost 84% agreed that it is possible to sustain healthy river ecosystem & continue commercial barge traffic.
- almost 85% said the meeting was worth attending, while 6% were neutral, 2% disagreed, and 6% did not answer.

Table 2-56. Summary Table of October Public Meetings for UMR-IWW System Navigation Feasibility Study. Attendance numbers differentiate between Open House / Formal Presentation attendance.

Location	Attendance	Q&As	Statements	Survey
STL	133 / 100	72	29	44
QUI	180 / 130	46	23	76
PEO	215 / 190	60	32	134
DAV	252 / 224	90	37	110
BLM	99 / 89	43	24	61
LAX	165 / 127	78	34	70
DBQ	218 / 198	67	42	113
TOTALS	1262 / 1058	456	221	608

- Media Correspondents = 31 (Range 1 – 7)
- Congressional Representation = 18 (Range 0 – 4)

G. Adaptability

Adaptability is defined as the ability to adjust the alternative based on changes in future conditions. The extent to which an alternative defers the commitment of resources or the degree to which the commitment is reversible. Alternatives that offer the greatest amount of flexibility could be viewed more favorably under a high degree of uncertainty or risk. Adaptability is an implementation tool that will be fully considered during development of the tentative plan. The following provides a brief description of possible adaptive approaches for each of the primary alternatives:

Alternative 1: Base condition.

Alternative 2: The implementation of congestion fees will require congressional action and could be in place within a relatively short timeframe (assumed to be 2 years). This alternative is very flexible in that, once authorized, it can be implemented or dismantled relatively quickly.

Alternative 3: Not justified for any of the economic conditions.

Alternative 4: The implementation timeline for this alternative is divided into a planning, engineering and design phase, and a construction phase. Each of these phases could be considered a decision point in an adaptive management type of process. For instance, a decision could be made to complete the planning, engineering and design phase and then re-evaluate the need for this alternative. This would minimize the risk by controlling the magnitude of the investment decisions. An advantage of the switchboats is that they can be put in place and removed in a relatively short amount of time.

Alternative 5: This alternative can also be divided into distinct phases for consideration in an adaptive management framework. Decision points could be established at the end of major building blocks and would serve as re-evaluation points. For example, a recommendation could be to start only the planning, engineering and design for alt. 5. A re-evaluation would be accomplished at a future decision point to confirm the initial investment decisions and proceed with construction.

Alternative 6: This alternative is similar to alternative 5 in that distinct phases could be developed that would control the magnitude of the investment decisions.

2.4.4 Comparison of Navigation Efficiency Alternative Plans

2.4.4.1 Description of Comparison Process

The purpose of this step is to compare the results from the evaluations outlined in Section 2.4.3, for the purpose of developing a Draft tentatively selected plan that will address the Navigation Efficiency concerns. The primary comparison information will be the NED benefits as measured by robustness and risk. Robustness is the extent to which an alternative is justified across a broad range of economic conditions. Risk is a measurement of the potential economic costs of selecting or not selecting an alternative as measured in foregone benefits. Other evaluation information will be considered as appropriate. Alternative Evaluation Scoresheet displays a summary of the quantitative and qualitative evaluation information for each alternative plan (Figure 2-24). It serves as a quick reference to the data and criteria that have been assembled for the comparison process. The comparison of alternative plans is an iterative process that includes the following steps.

Step 1. Compare results of the NED evaluations to the without project condition to determine the plan that maximizes net benefits to the Nation. Plans that demonstrate negative benefits will be screened from further consideration.

Step 2. Analyze the tentative plan that maximizes net benefits to ensure that it meets the minimum requirements for all other evaluation criteria. If it meets the other criteria, then it will be selected as the tentative plan. If it does not meet the other criteria, then the process will return to step 1.

2.4.4.1.1 Initial NED Comparison.

The NED benefits for each of the 6 alternatives are displayed in Figure 2-25. The distribution of risk, measured as forgone benefits, for each alternative plan is displayed in Figure 2-26. The foregone benefits are computed as the difference in net benefits between a specific alternative and the alternative with the highest net benefits for that economic condition. It is important to emphasize that the relative differences in risk cost between and among alternatives, and not the absolute magnitudes of risk expressed for each alternative, are the meaningful measures. Table 2-56 displays the comparison of values for robustness, maximum and minimum net benefits. As seen in Table 2-57, alternative 2 provides positive net benefits for all 15 economic conditions. Alternative 2 also contains the least amount of risk across these same conditions as displayed in Figure 2-24, because it contains the highest net benefits for 14 out of 15 economic conditions. Therefore alternative 2 is initially the best plan based solely on the NED comparisons, however it needs to be further analyzed against the other criteria. Other observations to note are that if future traffic is flat as represented in scenario 1, alternatives 4, 5, and 6 would not be justified. Some increases in future demand will be required to economically support these alternatives. It also should be noted that the net benefits are very sensitive to the assumption of demand elasticity. If the demand elasticity is represented by the upper bound ESSENCE assumption, alternatives 4, 5, and 6 would not be justified regardless of the scenario. In addition, alternative 3 can be screened from further consideration since it does not produce positive benefits across any of the economic conditions. Alternative 1 is also not desirable due to the risk involved in taking no action.

NAVIGATION EFFICIENCY ALTERNATIVES *Alternative Evaluation Scoresheet*							
	ACCOUNTS	**ALTERNATIVE PLANS**					
		1	**2**	**3**	**4**	**5**	**6**
	A. National Economic Development (NED)	**RANK**					
	A1. Project Cost	NA	$0	$80,000,000	$84,000,000	$795,000,000	$2,268,000,000
	A2. Total Avg Annual Cost	NA	$2,500,000	$12,500,000	$47,600,000	$112,700,000	$191,200,000
*	A3. Net Economic Benefits ($ Millions)	NA	***See Table 2-57 & Fig. 2-25 for Net Benefits for each of the 15 Economic Conditions***				
*	A4. Risk	NA	***See Fig. 2-26 depicting Risk across the 15 Economic Conditions***				
*	A5. Robustness	NA	***See Table 2-57 & Fig. 2-25 depicting Robustness across the 15 Economic Conditions***				
	B. Environmental Quality	**INCLUDED IN NED / CONSIDERATION**					
	B1. Islands and Shoreline Erosion	NA	NA	NA	$14,200,000	$14,200,000	$14,200,000
	B2. Backwaters/Side Channel Sedimentation	NA	NA	NA	$27,200,000	$27,200,000	$27,200,000
	B3. Aquatic Plants	NA	NA	NA	$1,600,000	$32,400,000	$51,900,000
	B4. Fisheries	NA	NA	NA	$12,400,000	$34,000,000	$42,700,000
	B5. Monitoring	NA	NA	NA	$7,500,000	$9,400,000	$11,300,000
	B6. Historic Properties	NA	NA	NA	$8,600,000	$9,600,000	$10,000,000
	B7. Other	NA	NA	NA	$7,900,000	$15,500,000	$19,400,000
	B8. Site Specific Mitigation	NA	NA	NA	$0	$8,700,000	$30,300,000
	B9. TOTAL MITIGATION	NA	NA	NA	$79,400,000	$151,000,000	$207,000,000
	C. Regional Economic Development	**CONSIDERATIONS**					
	C1. Avg Annual Income	NA	***See Table 2-53 for Avg. Annual Income by State/Region***				
	C2. Avg Annual Employment	NA	***See Table 2-53 for Avg. Annual Income by State/Region***				
	D. Other Social Effects	**CONSIDERATIONS**					
	D1. Emissions	NA	***See detailed description of emissions comparison***				
	D2. Accidents	NA	***See Table 2-54 providing a differential financial cost of accidents and fatalities***				
	D3. Noise and Other Impacts	NA	***See Table 2-55 providing a differential for traffic noise and other community impacts***				
	E. Contribution to Planning Objectives						
	E1. Provide for a safe, reliable, efficient, and sustainable UMR-IWW navigation system over the planning horizon.						
	E1a. Safety	Neutral	Neutral	Neutral	Neutral	Positive	Positive Plus
	E1b. Reliability	Neutral	Neutral	Neutral	Neutral	Positive for completed Project, Potential negative during construction	Positive for both completed and during construction
	E1c. Efficiency	Neutral	Positive	Negative	Positive	Positive	Positive
	E1d. Sustainability	Neutral	Negative	Negative	Depends on traffic Growth	Depends on traffic Growth	Positive for all Traffic Growth Scenarios
	E2. Address the cumulative impacts including ongoing effects of the operation and maintenance of the UMR-IWW Navigation System.	NA	Neutral	Neutral	Neutral	Neutral	Neutral
	E3. measures are consistent with protecting the Nation's environment; avoiding, minimizing, or mitigating significant environmental, cultural, or social impacts.	NA	YES	YES	YES	YES	YES
	F. Acceptibility	**CONSIDERATIONS**					
	F1. Institutional						
	F2. Social						
	G. Adaptability	**IMPLEMENTATION**					

Figure 2-24. Alternative Evaluation Scoresheet for Navigation Efficiency Alternatives.

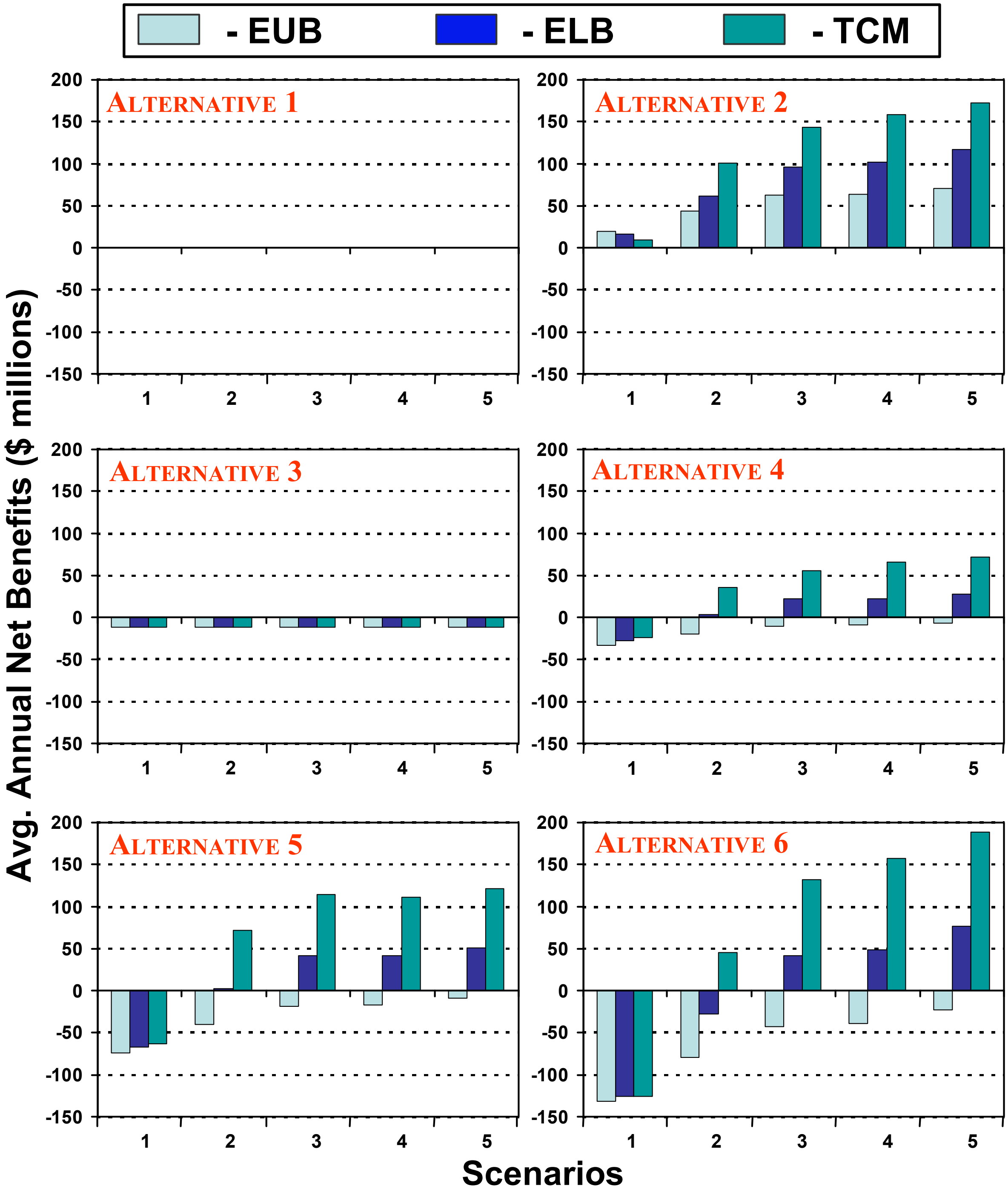


Figure 2-25. Average annual net benefits ($ Millions) for navigation efficiency alternatives 1-6.

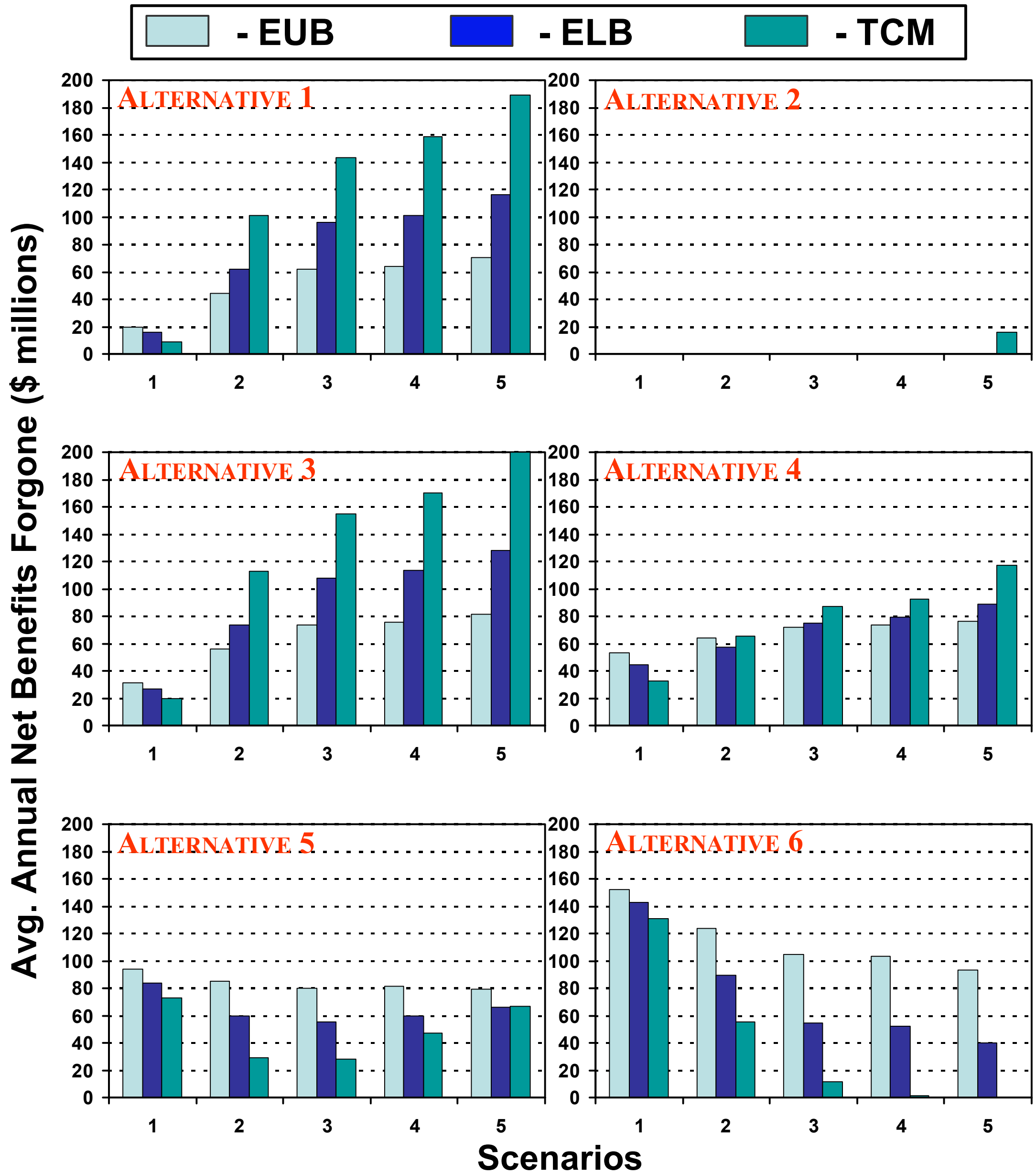


Figure 2-26. Risk assessment for Navigation Efficiency Alternatives 1-6.

Table 2-57. Initial NED Comparison of Navigation Efficiency Alternatives 1-6.

Alternative	Robustness (Pos. Net Ben)	Greatest Net Benefits Per Economic Condition	Least Net Benefits Per Economic Condition
1	0/15	0/15	7/15
2	15/15	14/15	0/15
3	0/15	0/15	0/15
4	8/15	0/15	0/15
5	8/15	0/15	0/15
6	7/15	1/15	8/15

2.4.4.1.2 Application of Other Criteria and Conclusions of Initial NED Comparisons

2.4.4.1.2.1 Environmental Quality

Based on best available information, none of the plans create serious negative environmental consequences that cannot be avoided, minimized, or mitigated to an acceptable level in the context of the adaptive mitigation strategy proposed. Refer to Tables 2-51 and 2-52 for description and cost of avoid, minimize and mitigation measures for the navigation efficiency alternatives.

2.4.4.1.2.2 Regional Economic Development

Alternative 2, results in negative effects to income and employment benefits to five-state regional economy. The REDs do not factor into the Federal decision making process, however they will influence the acceptability of an alternative to the region. Refer to Tables 2-53 for examples of RED benefits of the navigation efficiency alternatives.

2.4.4.1.2.3 Other Social Effect

Implementation of alternative 2 may result in a cost to society in terms of additional accidents by moving traffic off the waterway and on to other transportation modes. While the effects described here are potentially NED in nature the level of input detail and lack of standardized measurement techniques within the Corps preclude these impacts from being considered in the NED formulation process.

2.4.4.1.2.4 Planning Objectives

Alternative 2 reduces congestion by imposing a fee that drives marginal users off the system. This alternative is safety and reliability neutral. It does provide positive benefits across a broad range of economic conditions. The alternative fails to meet the planning objective of ensuring an economically sustainable navigation system, since it constrains the future growth on the system.

2.4.4.1.2.5 Acceptability

Present law prohibits a fee such as contained in alternative 2 and current national policy makes institutional acceptability of this alternative plan doubtful. The Department of Transportation, Department of Agriculture and the states have also expressed negative comments on this alternative plan. The navigation and agriculture non-governmental organizations have expressed negative comments, while the environmental interests have generally expressed the need to fully consider this alternative plan.

2.4.4.1.2.6 Adaptability

Alternative 2 is highly adaptable in that it could be implemented quickly and removed quickly as needed.

<u>CONCLUSION</u>.

Alternative 3 is screened from further consideration since it produces negative benefits across all economic conditions. Alternative 2 fails to fully meet the planning objectives. Current law prohibits alternative 2 and current national policy makes institutional acceptability of this alternative doubtful, therefore it is screened from further consideration. Since Alternative 2 is screened, a second iteration of NED comparisons must be done to determine the best plan.

2.4.4.2 Second Iteration of NED Comparisons

A second iteration was completed comparing alternative plans 1, 4, 5 and 6. The NED benefits and robustness described above are unchanged, however the risk charts have been modified due to the screening of alternative 2. The new risk charts are displayed in Figure 2-27. Table 2-58 displays the new summary comparison of robustness, and maximum and minimum net benefits.

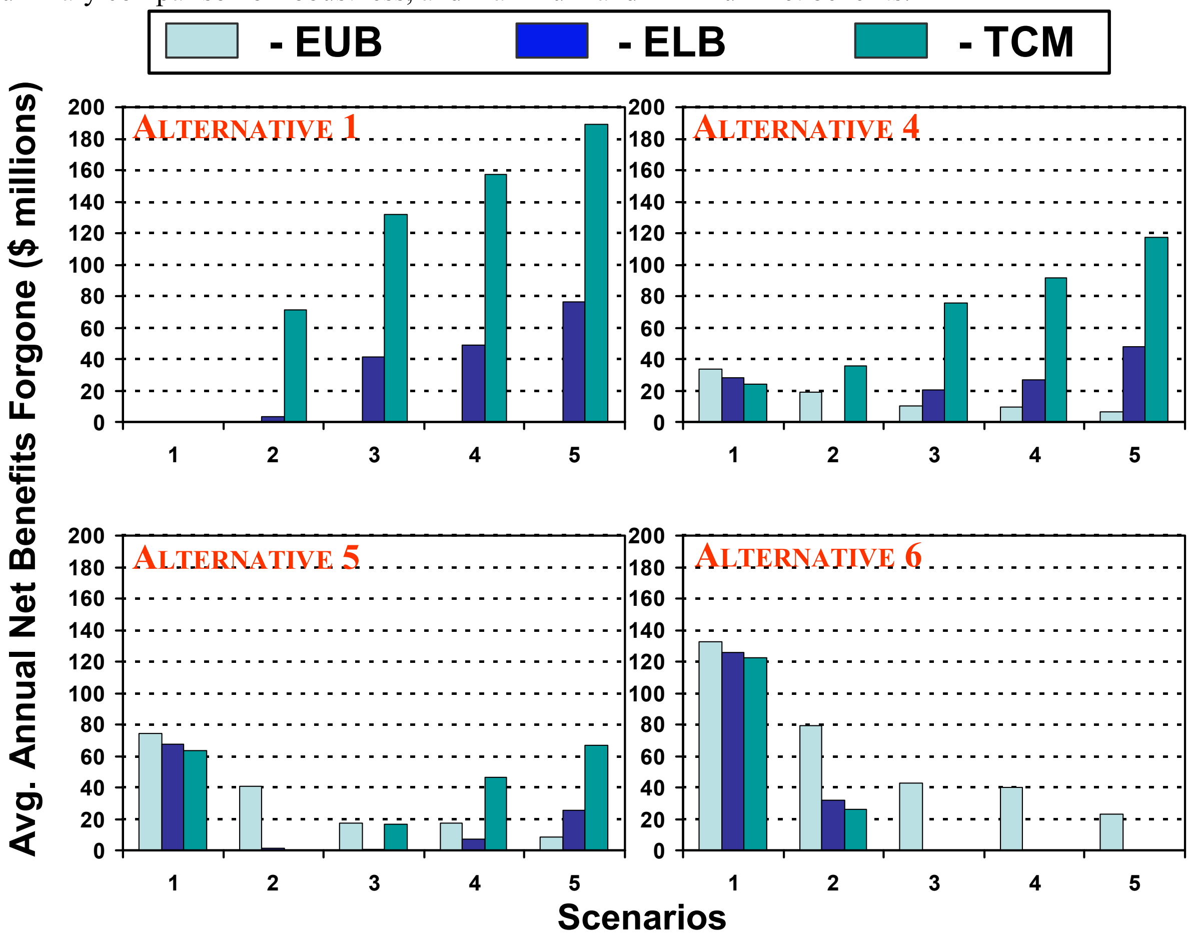


Figure 2-27. Average annual net benefits ($ Millions) for navigation efficiency alternatives 1, 4, 5 and 6 (Alternatives 2 and 3 screened in initial NED comparison).

Table 2-58. Secondary NED Comparison of Navigation Efficiency Alternatives 1, 4, 5 and 6.

Alternative	Robustness (Pos. Net Ben)	Greatest Net Benefits Per Economic Condition	Least Net Benefits Per Economic Condition
1	0/15	7/15	7/15
4	8/15	1/15	0/15
5	8/15	1/15	0/15
6	7/15	6/15	8/15

The comparison of robustness shows that alternatives 4, 5, and 6 exhibit essentially the same number of positive net benefits, with no indication of a clear winner. The no action alternative contains 7 out of 15 of the greatest net benefits and 7 out of 15 of the least net benefits. Alternative 6 contains the maximum number of net benefits 6 out of 15 times. This variation in net benefits again supports no clear winner. The comparison of risk indicates that if traffic increases in the scenario 3 to 5 range there is a great amount of risk in selecting alternative 4. If flat lined traffic occurs as in scenario 1, there is a great amount of risk in selecting alternative 6. Alternative 5 is risky at the upper and lower bounds of the traffic scenarios. The comparison of risk does not identify any additional information to make a clear selection. The other criteria need to be compared to determine if they can help select a best plan.

2.4.4.2.1 Application of Other Criteria and Conclusions of Second iteration of NED Comparisons

2.4.4.2.1.1 Environmental Quality

Environmental impacts on the waterway increase with increases in proposed construction and associated projected increases in Navigation traffic. These impacts have been quantified and an acceptable adaptive mitigation strategy developed for each alternative.

2.4.4.2.1.2 Regional Economic Development.

The income and employment benefits for each alternative are reported for the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri along with the lower Mississippi Region and the rest of the U.S. These income and employment effects are derived from direct construction expenditures required to implement an alternative and from the transportation efficiencies generated by the alternative. The greater the investment, the greater the benefits, thus alternative 6 has higher RED's than alterative 4. The RED's do not factor into the Federal decision making process, however they will influence the acceptability of an alternative to the region. The states have not yet endorsed an alternative.

2.4.4.2.1.3 Other Social Effects

The positive numbers indicated for alternatives 4, 5 and 6 all indicate a benefit to society. Generally the greater the investment in improvements, the greater the benefits. While the effects described here are potentially NED in nature the level of input detail and lack of standardized measurement techniques within the Corps preclude these impacts from being considered in the NED formulation process

2.4.4.2.1.4 Planning Objectives

Alternative 4

Safety:

Moorings – Neutral.
Switchboats – Neutral.

Reliability:

Moorings – Neutral.
Switchboats – Neutral.

Efficiency: Moorings and switchboats do provide positive efficiency benefits to the system as measured by the NED benefits.

Sustainability: Moorings and switchboats will be sustainable for low growth scenarios, however they will not be sustainable for high growth scenarios.

Alternative 5

Safety: Positive. Lock extensions at Locks 20 thru 25 will eliminate double-cut lockages (approximately 75% of all lockages) and the associated personal-injury hazards at those sites. Alternative 5 is an improvement in safety over alternative 4.

Reliability: Positive for completed project, potential negative during construction. Lock extensions reduce the number of operating cycles of machinery by eliminating the need for the double-cut lockage of tows. Reduced cycles affect the machinery life, related unscheduled lock closures, and intervals of Major Rehabilitation. Lock extensions would improve the reliability of the system once they are completed and in service. Alternative 5 has greater reliability than alternative 4.

Performance would be greater than alternative 4.

There is substantial risk in experiencing a reduction in reliability during construction of the lock extensions. The lock extensions are technically feasible, however there are inherent risks in the construction sequencing. In a situation where lock extensions were to experience construction delays, causing construction beyond the wintertime closure period, the consequences of navigation impacts would be large. Wintertime navigation closures were used to allow uninterrupted construction work. These were modeled as fixed durations of about 90 days each and then traffic would resume. If the construction activities were delayed beyond the closure period, navigation traffic would be delayed until completion of the specific construction activities. The chance of construction delay and the duration of delay were not considered in the economic model because both are uncertain. Alternative 5 will result in a potential for a less reliable system during the construction period.

Efficiency: Alternative 5 is more efficient then alternative 4.

Sustainability: Alternative 5 is more sustainable for high levels of traffic than alternative 4.

Alternative 6

Safety: Positive plus. New locks have the same benefits listed for lock extensions along with other safety advantages. Locks 20-25 and Peoria and LaGrange would retain use of the existing locks. The existing 600ft lock can be used for recreation craft and other small vessels. This separates the small craft from the large commercial tows. Also, location 3 locks on the lower 5 locks on the Mississippi River would feature a riverside approach wall on the upstream end. This approach wall location with respect to the dam generally is considered safer than the present guidewall structure along the landside of the lock. Riverside approach walls are safer because they provide a physical barrier between the tow and dam that would reduce the chance and consequences of tow mishaps that result in barges breaking loose from the tows and sometimes subsequently running into the dam. Alternative 6 is superior in safety considerations to alternative 5B

Reliability: New locks have the same benefits listed for lock extensions along with other advantages. Locks 20-25 and Peoria and LaGrange would retain use of the existing locks. This reduces the number of operating cycles that either lock must perform. The cycles are reduced because there would normally be no double lockages for the small lock, no recreation craft for the long lock, and fewer small commercial craft (600 ft long or less) for the long lock. Also, a second lock at the existing projects offers the opportunity to temporarily remove a lock from service for repairs that could result in restored performance. Alternative 6 has superior normal operating reliability characteristics compared to alternative 5B.

In a situation where lock extensions construction activities were delayed beyond the closure period, navigation traffic would be delayed until completion of the specific construction activities. New locks reduce this risk to near zero and also allow normal wintertime traffic to transit the system on the lower part of the system by incorporating planned lock openings into the construction schedule. Alternative 6 contains less construction risks over alternative 5B.

Efficiency: Alternative 6 is incrementally justified over 5B in 6 out of 15 economic conditions.

Sustainability: Alternative 6 is more sustainable for the high growth scenarios.

2.4.4.2.1.5 Acceptability

The Fish and Wildlife Service have taken a neutral stance on navigation efficiency alternatives. The Environmental Protection Agency has expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks. The Department of Transportation and Department of Agriculture have supported a national policy that calls for efficient use of all transportation modes and incompatible with reducing congestion on the Nation's highways and railroads. None of the states has yet endorsed a specific navigation efficiency alternative, although Minnesota and Illinois have unofficially leaned toward alternative 6. However, the states have collectively voiced general support for economically justified and environmentally acceptable navigation improvements. The navigation and agriculture non-governmental organizations have fully endorsed implementation of Alternative 6 in a phased in approach. The environmental interests have expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks.

2.4.4.2.1.6 Adaptability

Adaptive management concepts can be applied through a phased implementation approach for any of these alternative plans. Adaptability is an implementation concern and cannot be used to further define the selection.

CONCLUSION.

The NED and other criteria comparison of alternatives 4, 5, and 6 do not result in a clear winner. Additional alternative plans were subsequently formulated to fully understand the incremental benefits of the individual measures and sites under consideration, and determine if a clear winner can be identified.

2.4.4.3 Additional NED Comparisons

In order to better understand the incremental effects of the various measures, additional alternatives plans were formulated and evaluated. The description of these new alternatives designated 5A, 5B, 6A, and 6B and the results of the net benefits evaluation are presented below. Environmental effects, RED's, and other social effects were not evaluated for these alternatives.

2.4.4.3.1 Alternative 5A

Alternative 5A substitutes 1200' new locks for 1200' lock extensions. All other improvement measures of Alternative 5 and Alternative 5A are identical. The evaluation of this plan addresses whether 1200' new locks would be superior to 1200' lock extensions from a NED perspective. Substitution of new locks adds \$365 million of initial construction costs and \$39.2 million of average annual costs (costs reflect 2001 price levels and a base year of 2023 for annual cost computations; Figure 2-28). Completion timeframe for the two alternatives is unaffected.

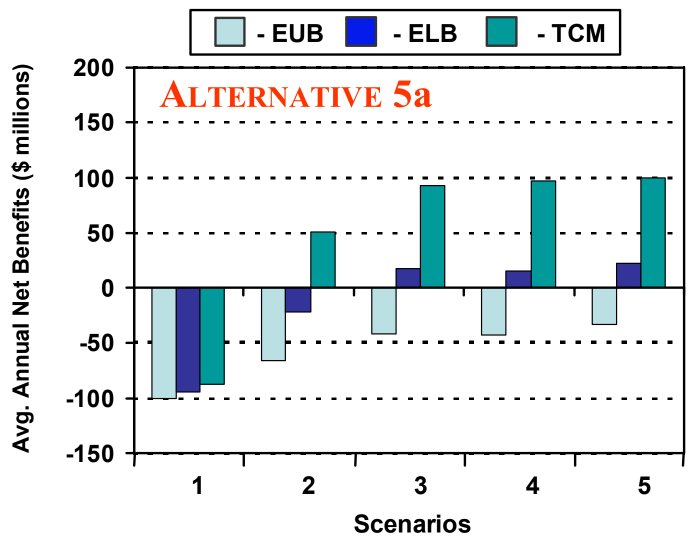


Figure 2-28. Average Annual Net Benefits ($ Millions) for Incremental Alternative 5A (w/o mitigation costs).

Alternative 5A produces positive net benefits for 7 of 15 economic conditions, only one less economic condition than with Alternative 5. However, an incremental assessment of Alternative 5A reveals that while Alternative 5A adds $39 million to annual costs compared to Alternative 5, the range of increase in benefits over the 15 economic conditions is only approximately $1 million to $15 million. Therefore, for all 15 economic conditions the substitution of 1200' new locks for 1200' lock extensions adds significantly more to annual costs than to annual benefits. Said differently, for each economic condition the average annual net benefits for Alternative 5A are lower than for Alternative 5. (Note that system mitigation costs were not specifically developed for Alternative 5A and that the average annual net benefit graph above does not include system mitigation costs. If average annual mitigation costs of $10.9 million, equal to the system mitigation costs of Alternative 5, were incorporated into the above graph, average annual net benefits would decline by $10.9 million. However, inclusion of this mitigation cost assumption would not change the number of positive net benefit cases. Also note that that the incremental cost comparison assumes an equal level of average annual mitigation costs.)

2.4.4.3.2 Alternative 6A

Alternative 6A is identical to Alternative 6 with the exception that Alternative 6A does not include any improvements at Peoria and La Grange Locks. Consideration of Alternative 6A addresses the question of incremental NED justification of 1200' new locks at Peoria and La Grange. By comparing the change in average annual benefits between Alternative 6 and Alternative 6A, incremental justification of the new locks can be determined. Note that the incremental justification is with respect to the implementation time frame reflected in Alternative 6 (2021 start and 2034 finish for Peoria and La Grange).

Alternative 6A generates positive average annual net benefits for 7 of 15 economic conditions. (These results are exclusive of system mitigation costs. System mitigation costs are currently not disaggregated in sufficient detail so as to identify mitigation costs for this alternative.) However, as suggested above, it is the incremental performance of 1200' new locks at Peoria and La Grange that is of specific interest. Moving from Alternative 6 to Alternative 6A results in a reduction in average annual net benefits for 10 of 15 economic conditions. Since Alternative 6A eliminates 1200' new locks at Peoria and La Grange, a reduction in average annual net benefits means that new locks (with a 2021 start) are incrementally justified for 10 of 15 economic conditions. (Note again that these results are exclusive of mitigation costs.)

The first costs of the new locks at Peoria and La Grange total $393 million and average annual costs are $35.5 million (costs reflect 2001 price levels a base year of 2023 for annual cost computations). The range of average annual benefits over the 15 economic conditions is $14.4 million to $65.6 (Figure 2-29).

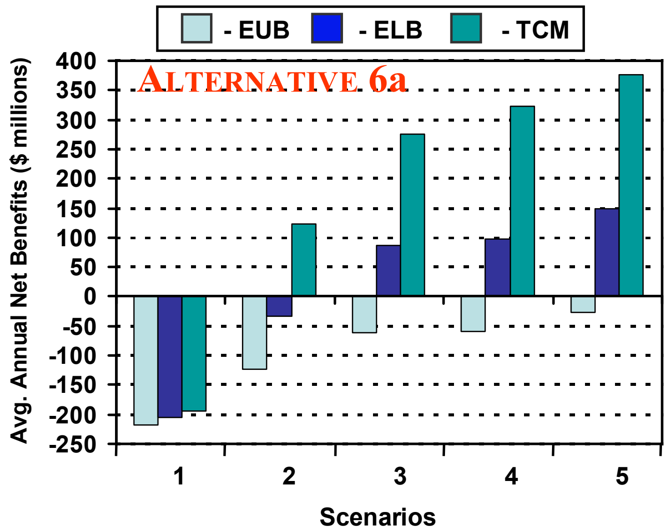


Figure 2-29. Average Annual Net Benefits ($ Millions) for Incremental Alternative 6A (w/o mitigation costs).

2.4.4.3.3 Alternative 6B

Alternative 6B includes 1200' new locks at Peoria and La Grange with no other improvements elsewhere on the system. Alternative 6B was developed to address the question of an immediate start (2005) for 1200' new locks at Peoria and La Grange. Average annual net benefits are positive for 6 of 15 economic conditions exclusive of system mitigation costs. (Net benefits reflect 2001 price levels and a base year of 2023 for annual net benefit computations; Figure 2-30).

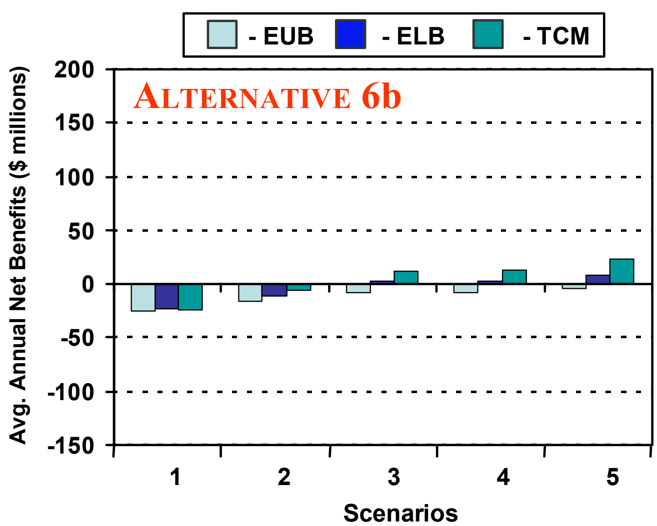


Figure 2-30. Average Annual Net Benefits ($ Millions) for Incremental Alternative 6B (w/o mitigation costs).

2.4.4.3.4 Alternative 5B

Alternative 5B was developed to address stakeholder interest in a “seven-lock” alternative plan (Locks 20-25 on the Mississippi River and Peoria and La Grange Locks on the Illinois Waterway) that reflected a “reasonable” start for all seven locations (i.e. no delay due to budget or economic timing considerations). The performance of such an alternative plan was approximated by combining the net benefits of Alternative 5 and Alternative 6B. The results are approximate because elements of both benefits and costs are double counted when the net benefits of Alternative 5 and Alternative 6B are simply combined. Costs are double counted because the net benefits reflect costs for both switchboats and 1200’ new locks at Peoria and La Grange. Similarly, benefits for both switchboats and new locks are also include in the net benefits. In developing this “seven-lock” alternative, the lock extensions of Alternative 5 were incorporated into this new alternative instead of the new locks of Alternative 5A because of the superior incremental performance of Alternative 5 over Alternative 5A.

While it would be a relatively simple matter to adjust the cost for this combined alternative to properly reflect the desired measures, an accurate capture of benefits would not be possible without the expense of additional economic model computations. Because the annual cost of Peoria and La Grange switchboats are relatively modest in the context of the net benefits for this alternative and also because switchboat costs are offset to some degree by switchboat benefits, the combined net benefits described here represent a reasonable approximation of the true net benefits of this alternative plan.

Alternative 5B generates positive net benefits for 7 of 15 economic conditions (Costs reflect 2001 price levels and a base year of 2023 for annual net benefit computations; Figure 2-31). Note that the net benefits include only partial system mitigation costs. Specifically, the system mitigation costs for 1200’ new locks at Peoria and La Grange over and above the system mitigation costs for switchboats at Peoria and La Grange are not captured.

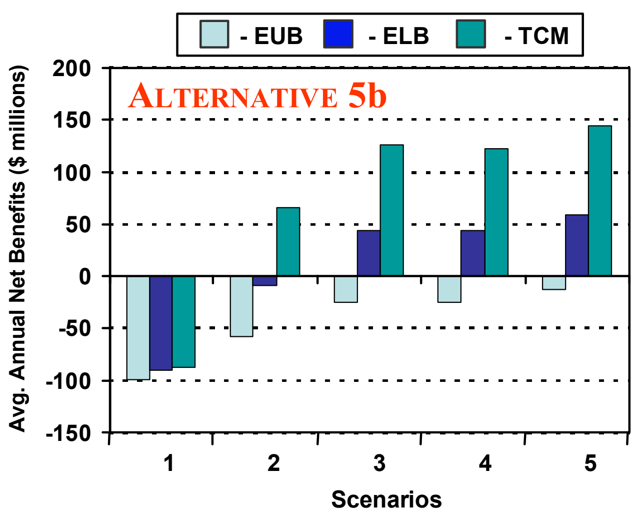


Figure 2-31. Average Annual Net Benefits ($ Millions) for Incremental Alternative 5B (w/o mitigation costs).

By comparing the results of 5 and 5A the conclusion was made that for all economic conditions, the substitution of new 1200' locks in place of 1200' lock extensions added more to annual costs than to annual benefits. From a system efficiency perspective, the additional processing capability of new locks would not be significantly realized without upstream improvements more expansive than switchboats (i.e. lock extension at 14-18). Alternative 5A will not be carried forward for further consideration.

By comparing the results of alternatives 6 and 6A the incremental contribution of the new locks at Peoria and La Grange in Alternative 6 could be isolated. The comparison revealed mixed results across economic conditions. For 9 of the 15 economic conditions, exclusive of system mitigation costs, new locks at Peoria and LaGrange contributed more to annual benefits than to annual costs. This determination applies to a start and completion dates of 2021 and 2033, respectively (the timeframe reflected in Alternative 6). Therefore alternative 6A will not be carried forward since Peoria and La Grange are incrementally justified. Alternative 6B will not be carried forward since an alternative plan that only considers lock construction at Peoria and LaGrange is impractical.

For 6 of 15 economic conditions Alternative 5B would generate higher net benefits than Alternative 5 (Figure 2-32).

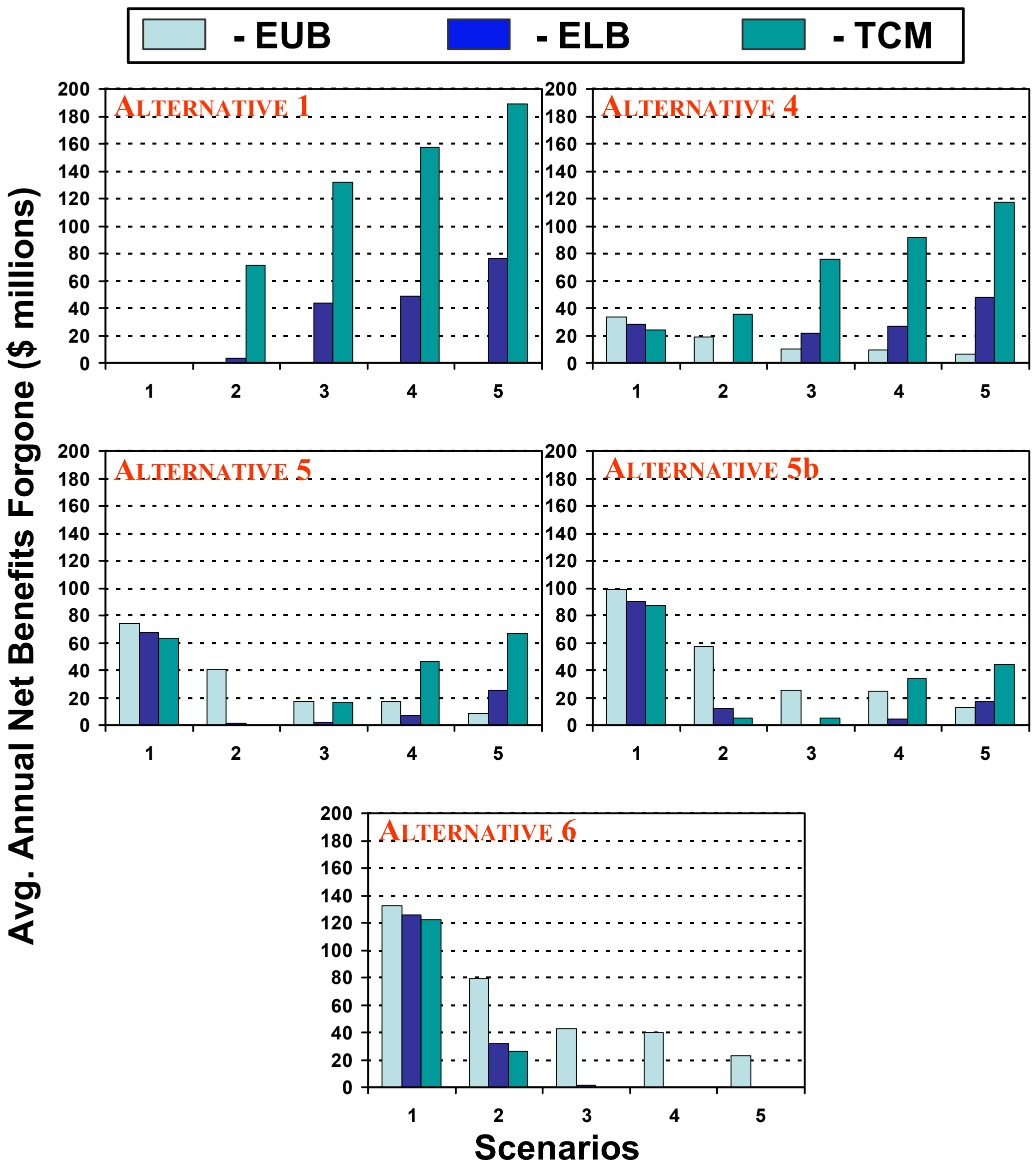


Figure 2-32. Risk assessment for Navigation Efficiency Alternatives 1, 4, 5, 5B and 6.

Table 2-59 displays the new summary comparison of robustness and maximum and minimum net benefits for the additional alternatives evaluated.

Table 2-59. Additional NED Comparison of Navigation Efficiency Alternatives 1, 4, 5, 5B and 6.

Alternative	Robustness (Pos. Net Ben)	Maximum Net Benefits Per Economic Condition	Minimum Net Benefits Per Economic Condition
1	0/15	7/15	7/15
4	8/15	0/15	0/15
5	8/15	1/15	0/15
5B	7/15	0/15	0/15
6	**7/15**	**7/15**	**8/15**

Additional evaluations for Environmental Quality, RED and other social effects were not performed for the additional alternatives.

Conclusion

- **The substitution of new locks for lock extensions at Locks 20-25 (as with Alternative 5A) would not be desirable from and NED perspective (unless improvements are considered upstream as in Alternative 6).**
- **Incremental NED justification of new locks at Peoria and La Grange exists for a number of economic conditions in the context of Alternative 6 (a 2021 start), as well as for an early (2005) start.**
- **The robustness of alternatives 4, 5, 5B, and 6, are essentially the same. The range of greatest net benefits are variable between alternative 1 and 6, and the distribution of risk is on the same order of magnitude.**
- **The information provided by these additional alternatives does answer several important formulation questions; however, the information does not fundamentally change the basic conclusion reached with the initial set of alternatives, regarding the absence of a clear winner.**

2.4.4.4 Incremental Analysis between Alternatives 4, 5, 5B, and 6.

As additional information for the comparison of plans, an incremental analysis was performed to view the incremental justification of each alternative in terms of benefits and other criteria contained on the Scoresheet. Table 2-60 contains the first cost, average annual costs, average annual benefits, and average annual net benefits for alternatives 5, 5B and 6. This comparison begins with a description of alternative 4, and then moves on to a comparison with alternative 5, 5B and 6.

2.4.4.4.1 Alternative 4: Moorings (12, 14, 18, 20, 22, 24, and LGR), Switchboats at Locks 20-25.

National Economic Development (NED):

First Cost of this alternative is $84 million. Average annual costs are $47.6 million. Alternative 4 produces positive net benefits in 8 of 15 economic conditions. Listed below are the average annual benefits in millions for each economic condition.

	Alt 4
TCM-S1	23
ELB-S1	20
EUB-S1	14
TCM-S2	83
ELB-S2	52
EUB-S2	28
TCM-S3	103
ELB-S3	69
EUB-S3	38
TCM-S4	113
ELB-S4	70
EUB-S4	38
TCM-S5	119
ELB-S5	76
EUB-S5	41

Environmental Quality:

The cost to avoid, minimize and mitigate for this alternative is $79.4 million over the 50 year planning horizon.

Regional Economic Benefits (RED):

The RED's for scenario 3 for all economic modeling conditions is shown on Table 2-53.

Other Social Effects (OSE):

The OSE are listed in the AFB Report on pages 69 - 70.

Contribution to Planning Objectives:

Safety:

Moorings – Neutral.
Switchboats – Neutral.

Reliability:

Moorings – Neutral.
Switchboats – Neutral.

Efficiency: Moorings and switchboats do provide positive efficiency benefits to the system as measured by the NED benefits.

Sustainability: Moorings and switchboats will be sustainable for low growth scenarios, however they will not be sustainable for high growth scenarios.

Acceptability: The Fish and Wildlife Service have taken a neutral stance on navigation efficiency alternatives. The Environmental Protection Agency has expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks. The Department of Transportation and Department of Agriculture have supported a national policy that calls for efficient use of all transportation modes and incompatible with reducing congestion on the Nation's highways and railroads. None of the states has yet endorsed a specific navigation efficiency alternative, although Minnesota and Illinois have unofficially leaned toward alternative 6. However, the states have collectively voiced general support for economically justified and environmentally acceptable navigation improvements. The navigation and agriculture non-governmental organizations have fully endorsed implementation of Alternative 6 in a phased in approach. The environmental interests have expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks.

2.4.4.4.2 Alternative 5: Moorings (12, 14, 18, 24, and LGR), Lock Extensions at Locks 20-25, Switchboats at Locks 14-18, La Grange and Peoria.

National Economic Development (NED):

First cost of this alternative is $652 million. Average annual costs are $113 million. Alternative 5 produces positive net benefits in 8 of 15 economic conditions. Listed below are the average annual benefits in millions for the 15 different economic conditions for both alternatives 4 and 5, and the difference in benefits.

	Alt 4	Alt 5	Delta
TCM-S1	23	49	26
ELB-S1	20	45	25
EUB-S1	14	39	25
TCM-S2	**83**	**184**	**101**
ELB-S2	52	115	63
EUB-S2	28	72	44
TCM-S3	**103**	**228**	**125**
ELB-S3	**69**	**154**	**85**
EUB-S3	38	95	57
TCM-S4	**113**	**223**	**110**
ELB-S4	**70**	**154**	**84**
EUB-S4	38	95	57
TCM-S5	**119**	**235**	**116**
ELB-S5	**76**	**163**	**87**
EUB-S5	41	104	63

An incremental assessment of Alternative 5 reveals that Alternative 5 adds $65.4million to annual costs compared to Alternative 4; the range of increase in benefits over the 15 economic conditions is approximately $25 million to $125 million. Seven of 15 economic conditions are incrementally justified (higher benefits) over alternative 4, with 2 conditions being marginally close.

Environmental Quality:

The cost to avoid, minimize and mitigate for this alternative is $151 million over the 50 year planning horizon. This is an increase in cost of $71.6 million over alternative 4

Regional Economic Benefits (RED):

The RED's for scenario 3 for all economic modeling conditions is shown on Table 2-53. The RED's are controlled by the magnitude of the construction alternative, thus alternative 5 produces more RED's than alternative 4.

Table 2-60. First cost, average annual costs, average annual benefits, and average annual net benefits for alternatives 5, 5B and 6.

Costs, Benefits, and Net Benefits
Alternatives 5, 5A, and 6

Economic	First Cost ($mil)			Average Annual Costs ($mil)			Average Annual Benefits ($mil)			Average Annual Net Benefits ($mil)		
Condition	Alt 5	Alt 5B	Alt 6	Alt 5	Alt 5B	Alt 6	Alt 5	Alt 5B	Alt 6	Alt 5	Alt 5B	Alt 6
TCM - S1	652	1,044	2,015	113	157	191	49	69	69	-64	-88	-122
ELB - S1	652	1,044	2,015	113	157	191	45	67	65	-67	-90	-126
EUB - S1	652	1,044	2,015	113	157	191	39	58	59	-74	-99	-132
TCM - S2	652	1,044	2,015	113	157	191	184	223	236	71	66	45
ELB - S2	652	1,044	2,015	113	157	191	175	208	163	2	51	-28
EUB - S2	652	1,044	2,015	113	157	191	72	100	112	-41	-57	-79
TCM - S3	652	1,044	2,015	113	157	191	228	283	323	115	126	131
ELB - S3	652	1,044	2,015	113	157	191	154	200	233	41	44	42
EUB - S3	652	1,044	2,015	113	157	191	95	131	149	-18	-25	-43
TCM - S4	652	1,044	2,015	113	157	191	223	280	348	111	123	157
ELB - S4	652	1,044	2,015	113	157	191	154	201	240	42	45	49
EUB - S4	652	1,044	2,015	113	157	191	95	132	152	-17	-25	-40
TCM - S5	652	1,044	2,015	113	157	191	235	302	380	122	145	189
ELB - S5	652	1,044	2,015	113	157	191	163	216	268	51	59	77
EUB - S5	652	1,044	2,015	113	157	191	104	144	168	-9	-13	-23

Costs and benefits reflect 2001 price levels, and a discount rate of 5.875 percent and base year of 2023 for average annual computations.
First Costs do not include switchboat or system mitigation costs.

TCM = Tow Cost Model
ELB = ESSENCE Lower Bound
EUB = ESSENCE Upper Bound
S1 thru S5 = Trafffic Scenarios 1 thru 5

Other Social Effects (OSE):
The OSE are listed in the AFB Report on pages 69 - 70. The OSE evaluates the impacts of waterway traffic versus rail. Generally the more traffic that is put on the system by higher investment alternatives, the greater the benefits for the OSE. Alternative 5 has greater OSE benefits than alternative 4.

Contribution to Planning Objectives:

Safety: Positive. Lock extensions at Locks 20 thru 25 will eliminate double-cut lockages (approximately 75% of all lockages) and the associated personal-injury hazards at those sites. Alternative 5 is an improvement in safety over alternative 4.

Reliability: Positive for completed project, potential negative during construction. Lock extensions reduce the number of operating cycles of machinery by eliminating the need for the double-cut lockage of tows. Reduced cycles affect the machinery life, related unscheduled lock closures, and intervals of Major Rehabilitation. Lock extensions would improve the reliability of the system once they are completed and in service. Alternative 5 has greater reliability than alternative 4.

Performance would be greater than alternative 4.

There is substantial risk in experiencing a reduction in reliability during construction of the lock extensions. The lock extensions are technically feasible, however there are inherent risks in the construction sequencing. In a situation where lock extensions were to experience construction delays, causing construction beyond the wintertime closure period, the consequences of navigation impacts would be large. Wintertime navigation closures were used to allow uninterrupted construction work. These were modeled as fixed durations of about 90 days each and then traffic would resume. If the construction activities were delayed beyond the closure period, navigation traffic would be delayed until completion of the specific construction activities. The chance of construction delay and the duration of delay were not considered in the economic model because both are uncertain. Alternative 5 will result in a potential for a less reliable system during the construction period.

Efficiency: Alternative 5 is more efficient then alternative 4.

Sustainability: Alternative 5 is more sustainable for high levels of traffic than alternative 4.

Acceptability: The Fish and Wildlife Service have taken a neutral stance on navigation efficiency alternatives. The Environmental Protection Agency has expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks. The Department of Transportation and Department of Agriculture have supported a national policy that calls for efficient use of all transportation modes and incompatible with reducing congestion on the Nation's highways and railroads. None of the states has yet endorsed a specific navigation efficiency alternative, although Minnesota and Illinois have unofficially leaned toward alternative 6. However, the states have collectively voiced general support for economically justified and environmentally acceptable navigation improvements. The navigation and agriculture non-governmental organizations have fully endorsed implementation of Alternative 6 in a phased in approach. The environmental interests have expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks.

2.4.4.4.3 Alternative 5B: Moorings (12, 14, 18, 24, and LGR), Lock Extensions at Locks 20-25, Switchboats at Locks 14-18 and new locks at La Grange and Peoria.

National Economic Development (NED):

First cost of this alternative is $1044 million. Average annual costs are $157 million, $44m more than Alternative 5. Alternative 5B produces positive net benefits in 7of 15 economic conditions. Listed below are the average annual benefits for the 15 different economic conditions for both alternatives 5 and 5B, and the difference in benefits.

	Alt 5	Alt 5B	Delta
TCM-S1	49	69	20
ELB-S1	45	67	22
EUB-S1	39	58	19
TCM-S2	184	223	39
ELB-S2	115	148	33
EUB-S2	72	100	28
TCM-S3	**228**	**283**	**55**
ELB-S3	**154**	**200**	**46**
EUB-S3	95	131	36
TCM-S4	**223**	**280**	**57**
ELB-S4	**154**	**201**	**47**
EUB-S4	95	132	37
TCM-S5	**235**	**302**	**67**
ELB-S5	**163**	**216**	**53**
EUB-S5	104	144	40

An incremental assessment of Alternative 5B reveals that Alternative 5B adds $44 million to annual costs compared to Alternative 5, the range of increase in benefits over the 15 economic conditions is approximately $19 million to $67 million. Six of 15 economic conditions are incrementally justified(higher benefits) over alternative 5. These economic conditions are the scenario's 3, 4, and 5 for TCM and ELB.

Environmental Quality:

Not developed.

Regional Economic Benefits (RED):

Not developed.

Other Social Effects (OSE):

Not developed.

Contribution to Planning Objectives:

Safety: Alternative 5B provides the same benefits in safety have alternative 5.

Reliability: Alternative 5B provides the same level of reliability as alternative 5.

Efficiency: Alternative 5B provides more efficiency to the system with the inclusion of new locks at Peoria and LaGrange.

Sustainability: Alternative 5 and 5B provide the same sustainability benefits.

Acceptability: The Fish and Wildlife Service have taken a neutral stance on navigation efficiency alternatives. The Environmental Protection Agency has expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks. The Department of Transportation and Department of Agriculture have supported a national policy that calls for efficient use of all transportation modes and incompatible with reducing congestion on the Nation's highways and railroads. None of the states has yet endorsed a specific navigation efficiency alternative, although Minnesota and Illinois have unofficially leaned toward alternative 6. However, the states have collectively voiced general support for economically justified and environmentally acceptable navigation improvements. The navigation and agriculture non-governmental organizations have fully endorsed implementation of Alternative 6 in a phased in approach. The environmental interests have expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks.

2.4.4.4.4 Alternative 6: Mooring (12, 14, 18, and 24), New Locks at 20-25, La Grange, and Peoria; Lock Extensions at 14-18; and Switchboats at Locks 11-13.

National Economic Development (NED):

First cost of this alternative is $2015 million. Average annual costs are $191million, $34m more than Alternative 5B. Alternative 7 produces positive net benefits in 7of 15 economic conditions, the same as 5B. Listed below are the average annual benefits for the 15 different economic conditions for both alternatives 5 and 5B, and the difference in benefits.

	Alt 5B	Alt 6	Delta
TCM-S1	69	69	0
ELB-S1	67	65	-2
EUB-S1	58	59	1
TCM-S2	223	236	13
ELB-S2	148	163	15
EUB-S2	100	112	12
TCM-S3	**283**	**323**	**40**
ELB-S3	**200**	**233**	**33**
EUB-S3	131	149	18
TCM-S4	**280**	**348**	**68**
ELB-S4	**201**	**240**	**39**
EUB-S4	132	152	20
TCM-S5	**302**	**380**	**78**
ELB-S5	**216**	**268**	**52**
EUB-S5	144	168	24

An incremental assessment of Alternative 6 reveals that it adds $34 million to annual costs compared to Alternative 5B while the range of increase in benefits over the 15 economic conditions is approximately $0 million to $78 million. Six of 15 economic conditions are incrementally justified (higher benefits) over alternative 5B. These economic conditions are scenarios 3, 4, and 5 for TCM and ELB, the same as for alternative 5B.

Environmental Quality:

The cost to avoid, minimize and mitigate for this alternative is $207 million over the 50 year planning horizon. This is an increase in cost of $56 million over alternative 5.

Regional Economic Benefits (RED):

The RED's for scenario 3 for all economic modeling conditions is shown on Table 2-52. The RED's are controlled by the magnitude of the construction alternative, thus alternative 6 produces more RED's than alternative 5.

Other Social Effects (OSE):

The OSE are listed in the AFB Report on pages 55-57. The OSE evaluates the impacts of waterway traffic versus rail. Generally the more traffic that is put on the system by higher investment alternatives, the greater the benefits for the OSE. Alternative 6 has greater OSE benefits than alternative 5.

Contribution to Planning Objectives:

Safety: Positive plus. New locks have the same benefits listed for lock extensions along with other safety advantages. Locks 20-25 and Peoria and LaGrange would retain use of the existing locks. The existing 600ft lock can be used for recreation craft and other small vessels. This separates the small craft from the large commercial tows. Also, location 3 locks on the lower 5 locks on the Mississippi River would feature a riverside approach wall on the upstream end. This approach wall location with respect to the dam generally is considered safer than the present guidewall structure along the landside of the lock. Riverside approach walls are safer because they provide a physical barrier between the tow and dam that would reduce the chance and consequences of tow mishaps that result in barges breaking loose from the tows and sometimes subsequently running into the dam. Alternative 6 is superior in safety considerations to alternative 5B

Reliability: New locks have the same benefits listed for lock extensions along with other advantages. Locks 20-25 and Peoria and LaGrange would retain use of the existing locks. This reduces the number of operating cycles that either lock must perform. The cycles are reduced because there would normally be no double lockages for the small lock, no recreation craft for the long lock, and fewer small commercial craft (600 ft long or less) for the long lock. Also, a second lock at the existing projects offers the opportunity to temporarily remove a lock from service for repairs that could result in restored performance. Alternative 6 has superior normal operating reliability characteristics compared to alternative 5B.

In a situation where lock extensions construction activities were delayed beyond the closure period, navigation traffic would be delayed until completion of the specific construction activities. New locks reduce this risk to near zero and also allow normal wintertime traffic to transit the system on the lower part of the system by incorporating planned lock openings into the construction schedule. Alternative 6 contains less construction risks over alternative 5B.

Efficiency: Alternative 6 is incrementally justified over 5B in 6 out of 15 economic conditions.

Sustainability: Alternative 6 is more sustainable for the high growth scenarios.

Acceptability: The Fish and Wildlife Service have taken a neutral stance on navigation efficiency alternatives. The Environmental Protection Agency has expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks. The Department of Transportation and Department of Agriculture have supported a national policy that calls for efficient use of all transportation modes and incompatible with reducing congestion on the Nation's highways and railroads. None of the states has yet endorsed a specific navigation efficiency alternative, although Minnesota and Illinois have unofficially leaned toward alternative 6. However, the states have collectively voiced general support for economically justified and environmentally acceptable navigation improvements. The navigation and agriculture non-governmental organizations have fully endorsed implementation of Alternative 6 in a phased in approach. The environmental interests have expressed the desire to have non-structural and small-scale measures implemented prior to any consideration for large-scale improvements such as new locks.

Conclusion

This comparison confirms that the higher investment alternatives are incremental justified under certain economic conditions.

2.4.4.5 Premise Sets Comparison

As outlined above, the NED analysis is very sensitive to the future traffic forecasts and assumptions of demand elasticity. The development of forecasts did not include selecting the most probable scenario or assigning probabilities to individual scenarios. Likewise, no probability distribution was defined for the range of demand elasticity values utilized. Premise Sets is a process where by conditions are set by the decision maker to help define an outcome. In layman's terms it's described as, "If you believe X will occur, than the recommendation should be for Y". The results of this process are provided as a means to help decision makers to understand the sensitivity of any recommendation to the assumptions made on elasticity, and traffic growth in the analysis. Premise sets will be established for assumptions on demand elasticity of grain and for scenarios.

2.4.4.5.1 Premise Set No. 1: Tow Cost Model

If you believe that the future demand for grain will be very inelastic as represented by the tow cost model results, the following table of net benefit numbers should serve as the basis for selection of a plan.

Alternative Plans	Net Benefits (millions) by Scenario				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
4	-24.09	35.55	55.56	65.47	71.62
5	-63.59	71.31	115.01	110.65	121.97
5B	-87.55	66.02	126.40	123.17	144.80
6	-126.15	45.13	131.44	157.01	188.98

The plan that maximizes net benefits is still very much dependent upon the traffic scenarios. Scenario 1 traffic levels result in no plan being justified , scenario 2 traffic levels result in an alternative 5 selection, and scenarios 3 ,4, & 5 result in alternative 6 selection.

2.4.4.5.2 Premise Set No. 2: ESSENCE Upper Bound

If you believe that the future demand for grain will be very elastic as represented by the ESSENCE upper bound results, the following table of net benefit numbers should serve as the basis for selection of a plan.

Alternative Plans	Net Benefits (millions) by Scenario				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
4	-33.36	-19.12	-10.02	-9.02	-6.2
5	-74.08	-40.7	-17.75	-17.19	-8.96
5B	-99.21	-57.22	-25.40	-24.86	-12.93
6	-132.03	-79.07	-42.68	-39.67	-22.92

Under this premise set, no alternative plans are justified regardless of the traffic levels assumed.

2.4.4.5.3 Premise Set No. 3: ESSENCE Lower Bound

If you believe that the future demand for grain will be somewhat elastic as represented by the ESSENCE lower bound results, the following table of net benefit numbers should serve as the basis for selection of a plan.

Alternative Plans	Net Benefits (millions) by Scenario				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
4	-28.03	3.99	21.55	22.19	28.24
5	-67.31	2.32	41.35	41.74	50.73
5B	-90.10	-8.56	43.53	44.59	58.80
6	-126.15	-27.79	41.79	48.97	76.52

The plan that maximizes net benefits is still very much dependent upon the traffic scenarios. Scenario 1 traffic levels result in no justification, scenario 2 traffic levels result in alternative 4 selection, and scenarios 3,4, & 5 result in alternative 6 selection.

2.4.4.5.4 Premise Set No. 4: Scenario 1

If you believe that scenario 1 traffic is the most likely condition to occur in the future, the following table of net benefit numbers should serve as the basis for selection.

Alternative Plan	Economic Model Condition	Net Benefits Scenario 1 ($ millions)
4	EUB	-33.36
	ELB	-28.03
	TCM	-24.09
5	EUB	-74.08
	ELB	-67.31
	TCM	-63.59
5B	EUB	-99.21
	ELB	-90.10
	TCM	-87.55
6	EUB	-132.03
	ELB	-126.15
	TCM	-126.15

The net benefit numbers are negative across all economic conditions, which means that none of the plans is economically justified under scenario 1 traffic levels.

2.4.4.5.5 Premise Set No. 5: Scenario 2

If you believe that scenario 2 traffic is the most likely condition to occur in the future, the following table of net benefit numbers should serve as the basis for selection.

Alternative Plans	Economic Model Condition	Net Benefits Scenario 2 ($ millions)
4	EUB	-19.12
	ELB	3.99
	TCM	35.55
5	EUB	-40.7
	ELB	2.32
	TCM	71.31
5B	EUB	-57.22
	ELB	-8.56
	TCM	66.02
6	EUB	-70.07
	ELB	-27.79
	TCM	45.13

The plan that maximizes net benefits is still very much dependent upon the assumption for demand elasticity. EUB assumptions result in no justification, ELB assumptions result in alternative 4 selection, and TCM assumptions result in alternative 5 selection.

2.4.4.5.6 Premise Set No. 6: Scenario 3

If you believe that scenario 3 traffic is the most likely condition to occur in the future, the following table of net benefit numbers should serve as the basis for selection.

Alternative	Economic Model Condition	Net Benefits Scenario 3 ($ millions)
4	EUB	-10.02
	ELB	21.55
	TCM	55.56
5	EUB	-17.75
	ELB	41.35
	TCM	115.01
5B	EUB	-25.40
	ELB	43.53
	TCM	126.40
6	EUB	-42.68
	ELB	41.79
	TCM	131.44

The plan that maximizes net benefits is still very much dependent upon the assumption for demand elasticity. EUB assumptions result in no justification, ELB and TCM assumptions result in alternative 6 selection.

2.4.4.5.7 Premise Set No. 7: Scenario 4

If you believe that scenario 4 traffic is the most likely condition to occur in the future, the following table of net benefit numbers should serve as the basis for selection.

Alternative	Economic Model Condition	Net Benefits Scenario 4 ($ millions)
4	EUB	-9.24
	ELB	22.19
	TCM	65.47
5	EUB	-17.19
	ELB	41.74
	TCM	110.65
5B	EUB	-24.86
	ELB	44.59
	TCM	123.17
6	EUB	-39.67
	ELB	48.97
	TCM	157.01

The plan that maximizes net benefits is still very much dependent upon the assumption for demand elasticity. EUB assumptions result in no justification, ELB and TCM assumptions result in alternative 6 selection.

2.4.4.5.8 Premise Set No. 8: Scenario 5

If you believe that scenario 5 traffic is the most likely condition to occur in the future, the following table of net benefit numbers should serve as the basis for selection.

Alternative	Economic Model Condition	Net Benefits Scenario 5 ($ millions)
4	EUB	-6.2
	ELB	28.24
	TCM	71.62
5	EUB	-8.96
	ELB	50.73
	TCM	121.97
5B	EUB	-12.93
	ELB	58.80
	TCM	144.80
6	EUB	-22.92
	ELB	76.52
	TCM	188.98

The plan that maximizes net benefits is still very much dependent upon the assumption for demand elasticity. EUB assumptions result in no justification, ELB and TCM assumptions result in alternative 6 selection.

2.4.4.5.9 Premise Set No. 9: Scenario 3 and ESSENCE Lower Bound

If you believe that scenario 3 traffic and ESSENCE lower bound elasticity values represent the most likely future condition, the following table of net benefit numbers should serve as the basis for selection.

Alternative	Net Benefits Scenario 3, ELB ($ millions)
4	21.55
5	41.35
5B	43.53
6	41.79

The plan that maximizes net benefits is alternative 5B.

CONCLUSIONS: The summary of the premise set comparisons is displayed in Table 2-61:

Table 2-61. Alternative that maximizes net benefits for each economic condition based on premise set comparison.

Demand Elasticity Assumption	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
TCM	**Alternative 1**	**Alternative 5**	**Alternative 6**	**Alternative 6**	**Alternative 6**
ELB	**Alternative 1**	**Alternative 4**	**Alternative 5B**	**Alternative 6**	**Alternative 6**
EUB	**Alternative 1**	**Alternative 1**	**Alternative 1**	**Alternative 1**	**Alternative 1**

*Scenario 3 ELB average annual net benefits are essentially equal for alternative 5($41M), alternative 5B($44M), and alternative 6($42M).

- **The need for navigation efficiency improvements is very much dependent on the assumptions of demand elasticity. ESSENCE upper bound assumptions result in no justification for improvements. The ESSENCE lower bound and Tow Cost Model assumptions result in the same conclusion for most scenarios of traffic. Scenario 1 traffic levels result in no justification, scenario 2 traffic levels result in alternative 4 selection for ELB, and alternative 5 for Tow Cost Model, and scenario 3 traffic levels result in alternative 5B for ELB, and scenario 4, & 5 result in alternative 6 selection for both.**

- **The need for future navigation efficiency improvements is very much dependent on the traffic forecasts. Scenario 1 traffic results in no justification for any of the alternatives under consideration. If the elasticity of grain is somewhat elastic as represented by ELB or completely inelastic as represented by Tow Cost, alternative 5B maximizes net benefits for scenario 3 and alternative 6 maximizes benefits for scenarios 4, and 5. Scenario 2 results in alternative 4 and 5 conclusion respectively.**

2.4.4.6 Draft Tentatively Selected Navigation Efficiency Plan

In a traditional Corps study, a single most probable future without condition is determined and the National Economic Development (NED) plan that maximizes net benefits is developed. For the approach outlined in this study, there are 15 economic conditions or without project conditions that must be evaluated. Since this study did not attempt to define the probabilities of any of these conditions, they are by default considered to be equally likely to occur. Thus there is one NED alternative plan for each of the 15 economic conditions as determined in the premise set comparison and again outlined in Table 2-62.

Table 2-62. Alternatives that maximize average annual net benefits.

Demand Elasticity Assumption	Scenario 1	Scenario 2	Scenario 3*	Scenario 4	Scenario 5
TCM	Alternative 1	Alternative 5	Alternative 6	Alternative 6	Alternative 6
ELB	Alternative 1	Alternative 4	Alternative 5B	Alternative 6	Alternative 6
EUB	Alternative 1	Alternative 1	Alternative 1	Alternative 1	Alternative 1

*Scenario 3 ELB average annual net benefits are essentially equal for alternative 5($41M), alternative 5B($44M), and alternative 6($42M).

Alternative Description

Alternative 1: No Action

Alternative 4: Moorings (12, 14, 18, 20, 22, 24, and LGR), Switchboats at Locks 20-25. First Cost of Infrastructure Improvements: $84M; Annual SWB Operation Cost: $40.2M; Total Mitigation Cost: $79.4M; Total Avg. Annual Cost: $47.6M; Completion Date: 2009.

Alternative 5: Moorings (12, 14, 18, 24, and LGR), Lock Extensions at Locks 20-25, Switchboats at Locks 14-18, La Grange and Peoria. First Cost of Infrastructure Improvements: $795M; Annual SWB Operation Cost: $33.8M; Total Mitigation Cost: $151.0M; Total Avg. Annual Cost: $112.7M; Completion Date: 2023.

Alternative 5B: Moorings (12, 14, 18, 24, and LGR), Lock Extensions at Locks 20-25, Switchboats at Locks 14-18 and new locks at La Grange and Peoria.

Alternative 6: Mooring (12, 14, 18, and 24), New Locks at 20-25, La Grange, and Peoria; Lock Extensions at 14-18; and Switchboats at Locks 11-13. First Cost of Infrastructure Improvements: $2.268B; Annual SWB Operation Cost: $7.8M; Total Mitigation Cost: $207.0M; Total Avg. Annual Cost: $191.2M; Completion Date: 2035.

As indicated in Table 2-62 above, the comparison of plans concludes that no single alternative is a clear best alternative across a broad range of economic conditions. It also concludes that the analysis is very sensitive to the traffic forecasts and to the assumptions of demand elasticity. A review of Table 2-62 indicates that in 7 of 15 economic conditions, alternative 1 is the best alternative. Table 2-62 also reveals that if some action will be warranted, it will be as a result of one of the 8 remaining economic conditions. Alternative 6 is the plan of choice in 5 of 8 remaining conditions. Alternatives 4, 5, and 5B make up the other 3 selections. Clearly the risks are high if no action is taken and high traffic forecast scenarios occur. Risks are also high if a large investment is made and increases in traffic do not materialize. Any recommendation will contain some risk in the face of an uncertain future.

The recommended approach will include a blending of measures contained in alternatives 4 and 6, or 4 and a derivative of 6. It will include immediate implementation of some small-scale structural and non-structural measures, and 3 potential options for implementation of alternative 6 or its derivative. Each of these options contains some adaptive concepts that include decision points to allow re-evaluation of current and future investment decisions. The draft tentatively selected plan is to seek Congressional approval of a framework plan consisting of a blending of alternatives 4 and 6 as follows:

1. Authorization and immediate implementation of small scale structural and non-structural measures within the framework of alternative 4 as follows:
   - Mooring facilities @ 12, 14, 18, 20, 22, 24 and LaGrange
   - Switchboats @ 20-25
   - Initiate mitigation for effects based on alternative 4
   - Continue development and testing of an appointment scheduling system.

The moorings are low cost measures that will provide immediate benefits to the system. There is minimal risk in implementing the moorings since they are common to alternatives 4, 5, 5B, and 6, and also provide some site-specific environmental benefits. Installing switchboats immediately in a phased in approach allows them to be tested at multiple sites to validate performance, cost, and operational acceptability, before they would be installed for broader use. The switchboats should also provide immediate benefits in reducing delays. The use of switchboats is very adaptable and can be implemented and removed in a short amount of time. Mitigation for the moorings, switchboats, and associated traffic increases would begin based on the requirements for alternative 4. Also, during this period the development and testing of an appointment scheduling system could be performed to ascertain its feasibility.

2. Implementation of alternative 6 or a derivative of 6 (see "Formulation Concerns" below) in accordance with one of the following three options for the timing of approval for and sequencing of the initiation of construction of new locks and lock extensions. These options will be discussed with the stakeholders and at the AFB, and an assessment provided in the draft feasibility report. The Chief's report will include an implementation option recommendation.

Option 1. Recommend approval of Alternative 6 as a framework plan. Recommend authorization for construction of 7 locks identified in Alternative 6 as the first increment of construction. Planning, Engineering and Design (PED) on the first increment of construction would begin immediately upon appropriation of funds. Upon completion of PED of the first increment, Congress would be notified of the latest information available as to traffic delays and updated forecasts. Authorization and construction of the lock extensions at 14 –18 would be conditioned on a future report.

Description of Option 1. This option provides authorization of the first increment of construction and requires Congressional approval of appropriations only. The option provides a firm commitment to major structural improvements on the UMRIWW while eliminating some of the uncertainty facing market and business investment decision makers. The increase in efficiency and reduction in uncertainty achieved with this option comes with greater investment risk than the other decision options because alternative 6 is not economically justified under conditions of declining or flat traffic or high elasticity in the demand for waterborne transportation

Option 2. Recommend approval of Alternative 6 as a framework plan. Recommend authorization for construction of 7 locks identified in Alternative 6 and initiation of Planning, Engineering and Design (PED). Approval for construction appropriation would be conditioned upon committee resolution based on a new report to be submitted either a) immediately after PED providing any information then available as to traffic delays, updated forecast, and modeling results, or b) at a future decision point when updated information on traffic delays, forecasts, and modeling results becomes available. The report would include an assessment of changes in tow traffic patterns, average delays and economic and world grain market conditions, land use, crop yield technology, and developments in China regarding import trends. The report would also include any updated economic analysis including approved models and updated information on demand elasticity if available. Authorization and construction of the lock extensions at 14 through 18 would be conditioned on a future report.

Description of Option 2. Option 2 includes additional reporting and Congressional action in approving construction for the first 7 locks and authorizing lock extensions for Locks 14 –18. The alternative adaptively manages risk by mandating additional reporting and Congressional construction authorization prior to funds appropriation. This would allow for halting or postponing of construction initiation based on future conditions and economic analysis. The report supporting or not supporting a construction approval could occur immediately after PED if warranted by available information or could be deferred until more information was available.

Option 3. Recommend authorization for constructing the complete package of alternative 6. Planning, Engineering and Design (PED) for the first increment of construction would begin immediately. Approval for construction appropriation would be conditioned upon committee resolution based on a new report to be submitted either a) immediately after PED providing any information then available as to traffic delays, updated forecasts and modeling results, or b) at a future decision point when updated information on traffic delays, forecasts, and modeling results becomes available. The report would include an assessment of changes in tow traffic patterns, average delays and economic and world grain market conditions, land use, crop yield technology, and developments in China regarding import trends. The report would also include any updated economic models if available.

Description of Option 3. The decision to begin construction is adaptively managed by mandating additional reporting and Congressional resolution. This would allow for halting or postponing of construction initiation based on traffic patterns, delays, and world grain market, yield, and consumption conditions. The report supporting or not supporting a construction approval could occur immediately after PED if warranted by available information or could be deferred until more information was available.

Option 4. Recommend approval of Alternative 6 as a framework plan. Recommend immediate authorization of Planning, Engineering and Design (PED) for construction of 7 locks identified in Alternative 6. Congressional authorization for construction would be based on a new report to be submitted either a) immediately after PED providing any information then available as to traffic delays, updated forecast, and modeling results, or b) at a future decision point when updated information on traffic delays, forecasts, and modeling results becomes available. The report would include an assessment of changes in tow traffic patterns, average delays and economic and world grain market conditions, land use, crop yield technology, and developments in China regarding import trends. The report would also include any updated economic analysis including approved models and updated information on demand elasticity if available. Authorization and construction of the lock extensions at 14 through 18 would be conditioned on a future report.

Description of Option 4. Option 4 includes additional reporting and Congressional action in approving construction authorization for the first 7 locks and authorizing lock extensions for Locks 14 –18. The alternative adaptively manages risk by mandating additional reporting before Congressional authorization for construction. This would allow for halting or postponing of construction initiation based on future conditions and economic analysis. The report supporting or not supporting a construction approval could occur immediately after PED if warranted by available information or could be deferred until more information was available.

Formulation Concerns: This Draft tentatively selected plan does leave a few formulation questions unanswered. One question concerns the incremental justification of new locks vs. lock extensions at Locks 20-25. Alternative 5A answers this question assuming upstream improvements are limited to switchboats only. Still unanswered is the question of new vs. extended locks when upstream improvements are more extensive than switchboats. An alternative that included lock extensions at Locks 20-25 and also at Locks 14-18 would provide the necessary information to address the question. This alternative is designated as alternative 6c and is being evaluated. An additional concern is the early start of Peoria and LaGrange. The analysis of Alternative 6B showed that an early start does provide positive net benefits for 6 out of 15 economic conditions. While these results do not indicate an optimal implementation timeframe, some insight into optimal timing is provided.

2.5 INTEGRATION TO CREATE A DUAL PURPOSE PLAN

The UMR system is a multi-purpose river system that provides economic and environmental benefits to the nation. The stakeholders of the UMR system have expressed their desire to seek a balance among the economic, ecological, and social conditions to ensure the waterway system continues to be a nationally treasured ecological resource as well as an efficient national transportation system. The Draft tentatively selected plans for navigation efficiency and ecosystem restoration, identified in the preceding sections, will ensure this balance throughout the planning horizon. It is recommended that these two tentatively selected plans be combined into a single plan to be executed under a dual-purpose authority that would allow balanced management of the river for both navigation and ecosystem restoration.

2.5.1 Dual Purpose Plan.

Currently, the Upper Mississippi River and Illinois Waterway System projects have a single authorized purpose of inland navigation. Therefore, funds appropriated for operation and maintenance of the system are limited to supporting the navigation purpose. This operation and maintenance responsibility must comply with environmental laws and policies regulating all Federal activities and responsible environmental stewardship of the system's land and water resources. This enables the Corps to minimize environmental impacts from operations and maintenance activities; however, ecosystem restoration is not an authorized purpose in the UMR-IWW projects. This has made management of the system to ensure environmental sustainability problematic.

2.5.2 Compatibility of Plans.

The ecosystem restoration measures under consideration will address the ongoing and cumulative impacts of the nine-foot channel project and other human activities can be accomplished while still maintaining a nine-foot channel project. The primary ecosystem restoration measure that could impact navigation efficiency is the water level management strategies that could reduce pool levels below the current operation band of the authorized nine-foot channel project. Impacts to navigation traffic as well as recreational craft, water supply, and hydropower can be mitigated by advanced planning and dredging. The costs for these actions are included in the water level management estimates. Changes in water level management have been previously demonstrated on the system with little to no impacts to navigation traffic.

The navigation efficiency improvements under consideration can be accomplished without impact to the ecosystem restoration measures. Mitigation for site specific and system traffic effects will be fully incorporated into the adaptive management approach for ecosystem restoration. The dual-purpose authority would allow operation and maintenance activities to fully support ecosystem restoration objectives when appropriate. For instance, material disposal from channel maintenance dredging could be used for island building. In addition, backwater dredging could be included with channel maintenance dredging when it makes economic sense and hydrologic conditions can be managed for both navigation and the environment.

2.5.3 Integrated Management

The dual-purpose plan will strive to integrate Federal river management activities to achieve sustainability of the system. The Federal activities to be coordinated under the sustainability umbrella include operation and maintenance of the 9-Foot Channel Navigation Project, the Environmental Management Program, Environmental Continuing Authorities Programs (CAP; i.e., Sections 204, 206, and 1135), the WRDA 1999 (Public Law 106-53 §459) Comprehensive Plan for the floodplain, U.S. Fish and Wildlife Service Refuge management, and the Illinois River Basin Restoration initiatives (Illinois River Ecosystem Restoration Feasibility Study and WRDA 2000, Public Law 106-541 Section 519, Illinois River Basin Restoration), Department of Agriculture programs and other activities. (see descriptions below). A conceptual model of the floodplain and the areas of responsibility for these various ongoing Federal actions are presented in Figure 2-33.

The development of the feasibility study provides the mechanism to define the baseline ecosystem sustainability goals and objectives to be used across Federal management activities within the spatial limits described in Figure 3. Each individual program will then determine implementation requirements within its area of responsibility. The Navigation Feasibility Study will define management for sustainability within the limits of the navigation project. Likewise, the Comprehensive Study will define management for sustainability in the context of flood damage reduction for the Mississippi River floodplain. The Illinois River Basin Restoration initiatives will define management for sustainability throughout the entire Illinois River Basin. These three programs are all currently in the alternatives evaluation phase. It is anticipated that the tentatively selected plans for each component will contain synergistic opportunities as well as some duplication and overlap. This can best be managed as part of an adaptive implementation with integrated management oversight.

The Environmental Management Program and Environmental CAP (Sections 204, 206, and 1135) are ongoing authorized programs and will continue to operate throughout the river system. The U.S. Fish and Wildlife Service Refuge Comprehensive Conservation Plans are ongoing planning efforts for existing refugees and incorporate many of the baseline needs and assumptions contained in the sustainability goals and objectives described for this Navigation Study. A schematic of these planning relationships is shown in Figure 2-34 and described in text below.

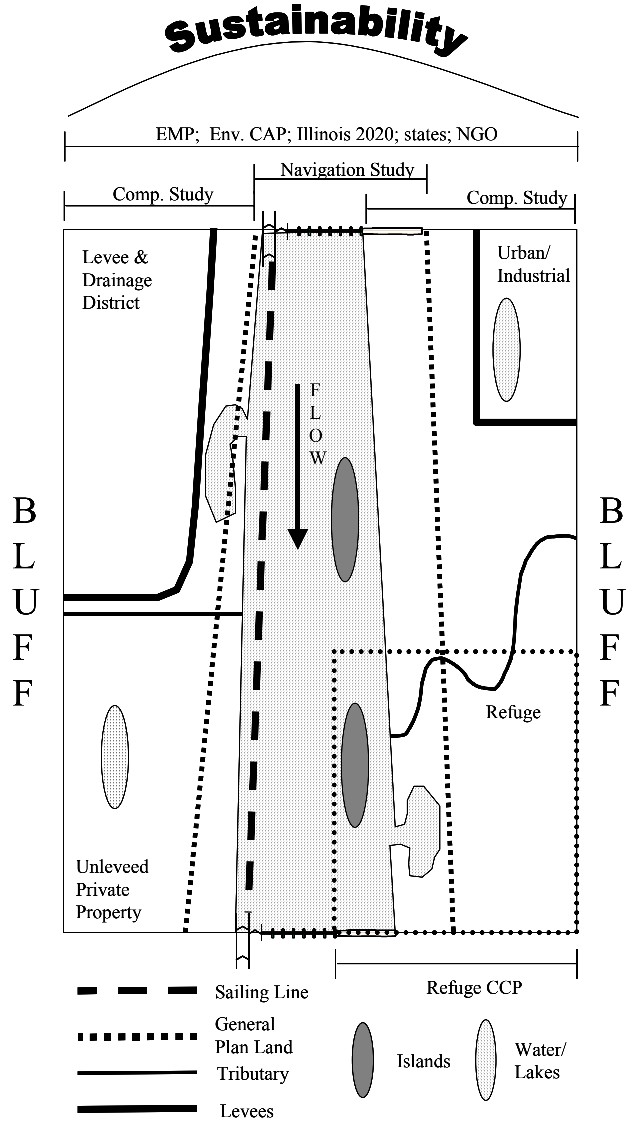


Figure 2-33. Schematic representation of a river reach illustrating the general types of land uses and ownership and the approximate extent of river management authorities including: the Environmental Management Program, Environmental CAP, states and NGOs, U.S. Fish and Wildlife Service Refuges, the floodplain Comprehensive Study, Illinois River Restoration (Illinois 2020), and the Navigation Study.

Figure 2-34. Goals and Objectives for the UMR-IWW have been established in a comprehensive fashion under the authority of the restructured navigation feasibility study. Detailed planning and implementation will be distributed among many applicable authorities.

Environmental Management Program (EMP). The UMRS-EMP was authorized by the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662), extended through the year 2002 by the WRDA 1990 (Public Law 101-640 §304), and given continuing authority in WRDA 1999 (Public Law 106-53 §509). This systemic program provides a well-balanced combination of monitoring, research, and habitat restoration activities. Program accomplishments to date include: (1) the completion of 41 habitat restoration and Enhancement projects (HREP) resulting in the direct physical restoration of approximately 71,000 acres of riverine and floodplain habitats; 28 more projects in various stages of design will add another 54,000 acres of restored habitat when implemented; (2) the Long Term Resource Monitoring Program (LTRMP) has collected millions of data samples (primarily fish, water quality, vegetation, and invertebrates) critical to carrying out the trend analysis and applied research that is leading to enhanced understanding of the dynamics of large floodplain rivers and successful multi-purpose resource management; (3) the development of extensive digital data bases, mapping products, and establishment of an information clearinghouse through which UMRS data and information can be universally accessed; and (4) a partnership between a multitude of Federal and state agencies, non-governmental organizations, and the general public under the Environmental Management Program Coordinating Committee (EMPCC).

The EMP program, along with the ongoing ecosystem restoration and management programs of other agencies, such as for the National Wildlife Refuges and state management areas and species-specific efforts such as rare and endangered species management and recovery, have provided a limited framework under which ecosystem restoration needs at the system level have been partially addressed. The current EMP has an annual appropriation limit of $22,750,000 for Habitat Rehabilitation and Enhancement (HREP) and $10,420,000 for Long Term Resource Monitoring. These funding levels are not sufficient to meet the restoration goals and objectives. One option for implementation of the ecosystem restoration plan is to seek authorization for increasing the EMP program limits. The Corps does not recommend this option. Increasing the EMP program limits does not maintain the linkage with navigation which would be achieved through authorization of an integrated plan for navigation improvements and ecosystem restoration and budgeting for Construction, General appropriations to accomplish the dual purposes of that plan. Because of the effective and efficient State and Federal partnership and institutional arrangements that have been created to implement the EMP program and the record of accomplishment of the program, it is proposed that the EMP continue and that a portion of the measures to achieve the restoration goals and objectives be identified for accomplishment through the EMP program. However, the primary implementation framework for accomplishment of the ecosystem restoration is the authorization and funding of a dual purpose integrated plan for the Upper Mississippi River and Illinois Waterway. Until a dual-purpose authority is achieved and appropriations secured, EMP will continue to constitute the primary implementation framework for ecosystem restoration. If a dual-purpose integrated plan is authorized, a review of the future of this program will need to be accomplished in the next report to Congress.

Upper Mississippi River Comprehensive Plan (UMRCP). The UMRCP study was authorized by Section 459 of WRDA 1999 to "develop a plan to address water resource and related land resource problems and opportunities in the upper Mississippi and Illinois River basins from Cairo, Illinois, to the headwaters of the Mississippi River, in the interest of the systemic flood damage reduction by means of—

(1) Structural and nonstructural flood control and floodplain management strategies;
(2) Continued maintenance of the navigation project;
(3) Management of bank caving and erosion;
(4) Watershed nutrient and sediment management;
(5) Habitat management;
(6) Recreation needs; and
(7) Other related purposes."

This study will focus primarily on planning for the 500-year floodplains of the reach of the UMR between Anoka, MN, and Thebes, IL, and the reach of the Illinois River between its confluence with the Mississippi and the confluence of the Kankakee and Des Plaines Rivers. Although the development of the Comprehensive Plan will be at Federal expense, any feasibility studies resulting from development of the plan will be subject to cost sharing under Section 105 of WRDA 1986 (33 U.S.C. 2215).

The UMRCP will embrace the dual overarching national goals of flood damage reduction, and associated environmental sustainability. The study will focus on development and evaluation of multiple systemic alternatives plans composed of various combinations of structural and nonstructural measures that, if implemented, would result in reduced flood damage potential and net improvements to floodplain habitat conditions. An integrated study approach in developing ecosystem goals and objectives has been accomplished with the Navigation Study. The navigation study will address these goals and objectives related to the navigation system, and the Comprehensive Study will address those related to flood damage reduction.

The report will be completed in the summer of 2004, with submission to the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Environment and Public Works of the Senate scheduled for December 2004. This schedule assumes adequate funding amounts will be made available for the expeditious conduct of the study. Additional integration of the Comprehensive Study may be needed once a formal recommendation is developed and potential projects authorized.

Environmental Continuing Authorities Programs (CAP). The Environmental CAP is composed of three separate ecosystem restoration authorities—Sections 1135, 206, and 204. These authorities apply nationwide and are limited to smaller individual projects. Section 204, authorized in WRDA 1992 (Public Law 102-580), provides authority for projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in connection with dredging for construction, operation, or maintenance of an authorized navigation project.

Section 1135, authorized in WRDA 1986 (Public Law 99-662), provides authority to review and modify structures and operations of water resource projects completed by the Corps prior to 1986 for the purpose of improving the quality of the environment when it is determined that such modifications are feasible, consistent with the authorized project purposes, and will improve the quality of the environment in the public interest.

Section 206, authorized in WRDA 1996 (Public Law 104-303), provides authority for the development of aquatic ecosystem restoration and protection projects that improve the quality of the environment, are in the public interest, and are cost effective.

There has been some localized success in implementing the 1135 program in the context of the navigation project however caps on project size and authorization limitations prevent the systemic application of the CAP authorities in addressing the diverse array of ecosystem restoration objectives.
Operation and Maintenance of the 9-Foot Channel Navigation Project
The Congress authorized the Upper Mississippi River and Illinois Waterway for the single purpose of providing a navigation channel on the Upper Mississippi and Illinois Rivers. This includes operation and maintenance of the lock and dam structures, channel training structures, periodic dredging of the channel, and periodic structural rehabilitation. This operation and maintenance responsibility extends to the stewardship of the land and water resources of the Federal projects making up the system. Ongoing environmental activities include avoid and minimize measures accomplished in conjunction with the construction of the Mel Price Lock and Dam and under the operation and maintenance authority of the existing projects. Ongoing natural resource management includes the operations and maintenance of 31 recreation areas along the Mississippi River and the management of lands purchased for the 9-Foot Channel Navigation Project. Seventy-three additional recreation areas are located on Corps lands but are leased to other organizations that are responsible for operation and maintenance. The natural resource management program also supports forest management programs that provide the proper forest inventory, reforestation, harvest, and monitoring activities to sustain valued forest resources.

The dual-purpose authority will allow the system to be operated and maintained for both navigation and the ecosystem. Channel maintenance activities and water level management will be fully integrated into ensuring a sustainable system. The ability to successfully and efficiently address the cumulative effects including the operation and maintenance of the Navigation project on the ecosystem depends on integrated management for both Navigation transportation and the environment.

National Fish and Wildlife Refuge Comprehensive Conservation Plans. The U.S. Fish and Wildlife Service is preparing Comprehensive Conservation Plans and associated environmental impact statements for the National Wildlife Refuges nationwide and on the UMR-IWW. The Comprehensive Conservation Plans will guide management decisions on the refuges for 15 years. The U.S. Fish and Wildlife Service is the principal Federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the Nation. The agency enforces Federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign governments with their conservation efforts. It also oversees the Federal Aid program that distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies. **Future relationship with FWS CCP[FWS Input]**

Illinois River Basin Restoration

A single comprehensive plan for the restoration of the Illinois River Basin is being completed under the authority provided by Section 519 of the Water Resources Development Act (WRDA) 2000, Public Law 106-541, (Illinois River Basin Restoration), and Section 216 of the 1970 Flood Control Act (Illinois River Ecosystem Restoration Feasibility Study). The Corps of Engineers and Illinois Department of Natural Resources (sponsor) are working together on this comprehensive plan. In addition to the comprehensive plan, critical restoration projects were authorized in Section 519 of WRDA 2000.

The plan will identify the Federal and State interest in addressing problems in the entire Illinois River Basin defined as the Illinois River, Illinois, its backwaters, its side channels, and all tributaries, including their watersheds, draining into the Illinois River. The study will address the need for four components: a restoration program; a long term resource monitoring program; a computerized inventory and analysis system; and program for innovative sediment removal and beneficial use. The Illinois River Basin has experienced the loss of ecological integrity due to sedimentation of backwaters and side channels, degradation of tributary streams, increased water level fluctuations, reduction of floodplain and tributary connectivity, and other adverse impacts caused by human activities. A restoration vision was developed for the Illinois River in 1997 as part of the development of the State of Illinois' *Integrated Management Plan for the Illinois River Watershed.* This vision for the Illinois River Basin was accepted for this comprehensive plan minor modification. The vision is for:

> *A naturally diverse and productive Illinois River Basin that is sustainable by natural ecological processes and managed to provide for compatible social and economic activities.*

The following list of Illinois River Basin system wide ecosystem restoration goals were developed (not listed in priority order, except for the first goal):

- **Goal 1.** Restore and maintain ecological integrity, including habitats, communities, and populations of native species, and the processes that sustain them,
- **Goal 2.** Reduce sediment delivery to the Illinois River from upland areas and tributary channels with the aim of eliminating excessive sediment load,
- **Goal 3.** Restore aquatic habitat diversity of side channels and backwaters, including Peoria Lakes, to provide adequate volume and depth for sustaining native fish and wildlife communities,
- **Goal 4.** Improve floodplain, riparian, and aquatic habitats and functions,
- **Goal 5.** Restore and maintain longitudinal connectivity on the Illinois River and its tributaries, where appropriate, to restore or maintain healthy populations of native species,
- **Goal 6.** Restore Illinois River and tributary hydrologic regimes to reduce the incidence of water level conditions that degrade aquatic and riparian habitat, an
- **Goal 7.** Improve water and sediment quality in the Illinois River and its watershed.

In addition to the comprehensive plan, $100 million in critical restoration projects were authorized. Current activities include study and design work on seven project areas throughout the Illinois River Basin. Additional projects will be identified through the implementation framework developed as part of the comprehensive plan.

While the navigation study will address restoration goals and objectives related to the navigation system, the Illinois River Basin Restoration Comprehensive Plan will address the restoration needs for the entire river basin. A major focus will be on the major tributaries and sub-watershed draining into the Illinois River.

The report will be completed in 2004. Additional integration of the Illinois River Basin Restoration Comprehensive Plan with the navigational study will occur as a formal recommendation is developed and potential projects authorized.

2.5.4 Institutional Arrangements.

River management on the UMR has been fragmented between agencies, activities, and over time. The lack of an integrated approach to river management has resulted in a lack of a defined vision for desired future condition of the UMR, continuing deterioration in the condition of the UMR ecosystem, and economic losses. Although recent activities are contributing to a more comprehensive understanding of the UMR, river management remains fragmented. A clear need exists to knit these efforts together and to complement them through a formal collaborative planning process for integrated water resources management of the UMR.

The existing framework of institutional arrangements needs some modification to enable more integrated, science-driven, inclusive, efficient, and cost-effective management of the UMRS. At the system-wide scale, the present Environmental Management Program Coordinating Committee (EMPCC) attends to the UMRS Environmental Management Program (EMP), but not to other aspects of river management including navigation system O+M, refuge, fish and wildlife, water quality, floodplain, and recreation management. These other major categories of river management activities presently do not have a system-wide coordinating forum.

The implementation of an integrated plan will require a review and possible re-evaluation of existing institutional arrangements. This re-evaluation will not take place as part of the feasibility study, but instead it will be adaptively developed within the region once an implementation plan is developed. One possible consideration is to re-organize and expand the responsibilities of the EMPCC to become a River Management Council. The River Management Council could coordinate integrated management of the UMRS and provide input to the implementing agencies. The River Management Council would be comprised of regional leaders of the Army Corps of Engineers, U.S. EPA, U.S. Fish and Wildlife Service, U.S. Geological Survey, Maritime Administration, USDA Natural Resources Conservation Service, U.S. Coast Guard, state natural resources management agencies, and state transportation departments. Interested non-governmental agencies would be encouraged to participate voluntarily and serve an advisory role to the Council. Integrated management of the UMRS would encompass the existing UMRS-EMP as well as other river management activities of the member agencies. The Council would receive recommendations from a Science Panel, and give direction to the River Management Teams (see below).

River Management Teams. The existing District-level interagency river management teams could be expanded with additional responsibilities, and made more consistent in mission between Corps Districts. The size, membership composition, and attention to different aspects of river management will differ between Districts, as appropriate to the challenges of river management in the different river reaches. Four River Management Teams could be considered, one for each Mississippi River reach corresponding to Corps of Engineers District boundaries and one for the Illinois River. The River Management Teams would be comprised of engineers, scientists, and resource managers from the Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. EPA, the U.S. Coast Guard, the USDA NRCS, state natural resource management agencies, and state departments of transportation.

Science Panel. The Science Panel would be comprised of nationally recognized ecologists, engineers and planners that would be retained to further develop a set of working ecosystem models and provide scientific guidance for ecosystem management and restoration work on the UMRS. Army Engineer Research and Development Center (ERDC) senior scientists would play a key role in coordinating work of the Science Panel. The ERDC System-Wide Water Resources Research Program will contribute to UMRS Science Panel work. The Science Panel would also work closely with the River Management Teams to:

- Collaboratively develop a set of ecosystem models for the UMRS
- Refine and expand objectives for condition of the river ecosystem
- Set endpoints and metrics for monitoring and performance evaluation
- Simulate the ecological effectiveness of different combinations of ecosystem management and restoration actions
- Quantify the outputs of ecosystem management and restoration investments

In addition to ecosystem modeling, the Science Panel will:
- Develop a science-based process for sequencing ecosystem management and restoration work system-wide.
- Conduct an assessment of information needed for river management.
- Provide technical oversight for EMP Long Term Resource Monitoring Program research and monitoring activities.
- Provide technical direction to performance monitoring and evaluation, systemic studies, and major survey data acquisitions.
- Evaluate monitoring results, review and report on progress.
- Interact with the River Management Teams, and advise the River Management Council.

3 Remaining Milestones and Schedule

Activity	Completion
Pre-Brief for 27 Jan Task Force Meeting (1530-1700)	21 Jan 04
Regional Group Call (1500-1600)	22 Jan 04
Submit Pre-AFB Materials to MVD/Districts	22 Jan 04
GLC Conference Call	26 Jan 04
Federal Task Force (0900-1200)	27 Jan 04
Congressional Briefing (1400 House & 1600 Senate)	27 Jan 04
Audubon Society (8:30 at GAO)	28 Jan 04
Communications Release	29 Jan 04
Comments returned on Pre-AFB Materials	29 Jan 04
NECC/ECC	28-29 Jan 04
State of Iowa Brief (1300-1500)	30 Jan 04
Submit Pre-AFB Materials with Rec. Plan to USACE	5 Feb 04
NRC Briefing (tentative)	19-20 Feb 04
AFB (final date pending discussions with HQ)	24 Feb 04
Transmittal of DRAFT Feasibility Rpt. and DEIS for ITR	27 Feb 04
3-d Meeting with study team and ITR reviewers	9-11 Mar 04
Review Comments due to CEMVR	19 Mar 04
Study Team provides responses back to ITR comments	2 April 04
Deadline for final ITR Certification	9 April 04
Draft Feasibility Report to Press	14 April 04
Release Draft Feasibility Report (begin 90-d Public review)	30 April 04
MVD/HQ begin policy review of Draft Report/DEIS	5 May 04
Notice in Federal Register initiates review of Draft Report/DEIS (45-day minimum)	10 May 04

MVD/HQ completes policy review	4 Jun 04
Public comment period for Draft Report/DEIS ends	30 Jul 04
District notifies CECW-B that Final Reports have been sent to printer; District transmits electronic copies of Final Report/FEIS to MVD/HQ along with final report submittal package including draft MRC and Chief's reports	15 Sep 04
District Engineer submits Final Report/EIS to MVD and HQ	29 Sep 04
CECW starts final policy review	1 Oct 04
CECW-P transmits approval and coordination package to District to initiate State and Agency review (This package includes signed transmittal letters for S&A review and filing the FEIS with EPA)	1 Oct 04
MVD issues Division Engineer's Notice of Report	1 Oct 04
District dates and mails transmittal letters and enclosures according to HQUSACE instructions for State and Agency Review and public review and files Final Report/FEIS with EPA (Report must be received at EPA by 6 August)	1 Oct 04
EPA Notice in Federal Register-Initiates 30-day Public Review of Final Report/FEIS (30-day State and Agency review runs concurrent with NEPA public comment period)	12 Oct 04
MVD submits Notice of MRC Hearing to Federal Register	18 Oct 04
CECW Policy Review comments provided to MVD and District	26 Oct 04
Notice of MRC Hearing published in Federal Register	26 Oct 04
District/ MVD Staff Respond to HQ Policy Review Comments	10 Nov 04
30-day NEPA/State and Agency Comment Period Ends	13 Nov 04
MRC Hearing/ MRC Report Signed	14 Nov 04
MVD submits MRC Report to HQ	16 Nov 04
Final Chief's Report Signed	24 Nov 04

4 Quality Management

4.1 Quality Control Plan

The quality management for the Navigation Study is established in its Quality Control Plan (QCP) dated December 1997 (revised March 2003), and the Quality Control and Quality Assurance Guidance received from Mississippi Valley Division. The QCP is a living document, and not intended to limit the inclusion of other appropriate measures to ensure the production of high quality products. The purpose of the QCP is to describe the procedures that will be employed during the execution of the Upper Mississippi River - Illinois Waterway System Navigation Feasibility Study to ensure compliance with technical and policy requirements. All products described in the original Project Study Plan (PSP) and subsequent revisions, were managed, planned, and executed in such a way as to ensure the maximum level of quality commensurate to the level of committed resources.

In addition to the internal quality control procedures, numerous collaborative mechanisms were established to allow information exchange and input from interested stakeholders. These collaborative mechanisms include: In-Progress Reviews (IPR's); work group meetings; Governor 's Liaison Committee; Coordinating Committees for economics, engineering, environmental, and public involvement; Modeling Integration & Simulation Team (MIST); Engineering Steering Committee; technical managers' meetings; technical review conferences; Federal Principals Task Force (National), Regional Federal Task Force, Regional Navigation Design Team (RNDT); Planning & Plan Formulation Steering Committee; public meetings and outreach; Alternative Formulation Briefing; and Feasibility Review Conference. Through in-progress reviews, monthly study team meetings, quarterly coordination committee meetings, and Public Involvement Workshops, each product or its results were afforded wide distribution and opportunity for input from a diverse group of stakeholders. This high level of collaboration has greatly improved the level of trust among stakeholders, allowed for increased transparency to the plan formulation process, and ensured the highest possible quality products.

4.2 Independent Technical Reviews

Independent Technical Reviews (ITR's) are not only performed on the draft Feasibility Report and Draft Environmental Impact Statement (DEIS), but also for many of the numerous interim products of this system navigation study. Components of the overall review process are: internal review by the product production team and management; independent technical review performed by qualified individuals not involved with the specific product development or production; and review by appropriate members of the study coordinating committees or their representatives. The lead study team member for the specific product, in coordination with the Study Manager, distributes the product along with requisite instructions and comment forms to the identified ITR members. ITR members provide comments to the lead study team member within 30 calendar days (unless otherwise specified) of receipt of the review package by their organization. Upon receipt of comments, the lead member coordinates with appropriate study team members to provide responses to comments. Comments that cannot be resolved by these parties follow the issue resolution process specified in the QCP.

The master file of draft and final reports and review documentation will be retained by Rock Island District for future reference as well as use during quality assurance visits. The Study Manager, Technical Managers and ITR leaders regularly discuss the results of individual report ITR's to help ensure that repeat comments or trends can be addressed early on for the benefit of the study team. The ITR documentation for the draft Feasibility Report and EIS will be available to the public via a separate volume, as are/will the ITR documentation for the interim products.

Independent Technical Review team members are to perform their review of a product for compliance with established policy principles and procedures, and utilization of justified and valid assumptions. This effort includes review of: assumptions; methods; procedures; alternatives evaluated; the appropriateness of data used; and, reasonableness of results.

4.3 Environmental Science Panel

A Science Panel was convened in early 2003 to provide guidance to the Corps of Engineers (Corps) in implementing the ecosystem restoration project plan for the UMR-IWW Navigation Feasibility Study. The Panel's work focused primarily on the evaluation of environmental goals and objectives, river ecosystem restoration, basic modeling, and adaptive management. Adaptive management is the underlying theme of their recommendations. Because of the importance of working from clear goals and objectives, the Panel spent a great amount of time discussing and refining these with Corps staff. The Panel helped clarify some of the original stakeholder objectives. The Panel directed considerable efforts toward constructing the necessary basic relationships (i.e., "conceptual models") and describing the modeling processes that will be required in the future. The conceptual models now can be used to build more detailed numerical simulation models to forecast likely ecosystem outcomes of management actions. The panel recommended that management actions be implemented in the context of system-wide objectives, with appropriate attention to risk and uncertainty. Considering the inherent risk and uncertainty of management action outcomes, they also recommend that there be a commitment to monitoring and evaluation to ensure that project objectives are met. Furthermore, the commitment to learning and adaptive management should foster a willingness to experiment in a way that leads to innovative management, but also fosters a better understanding of the underlying ecosystem processes and principles. Panel members expressed much interest in continuing work as may be necessary (see report Recommendations) both during and following the Feasibility Study process.

4.3.1 Panel Recommendations:

Adaptive Management

We recommend that planning for a formal Adaptive Management approach on the UMR-IWW be accelerated and expanded to include multiple organizations and programs.

Goals and Objectives

We commend the Corps and the UMR-IWW partners for collaboratively developing and supporting a vision of economic and ecosystem sustainability for the UMR-IWW, but recommend continued clarification and integration of the ecosystem goals and objectives developed so far through stakeholder input. Further we note the need to begin, also collaboratively, a structured process for rigorous and quantifiable evaluation of unavoidable trade-offs between the ecological and economic values of the system.

Modeling

We recommend that conceptual and simulation modeling be formally established as vital steps in the adaptive management process to: 1) record the current state of the system; 2) create a holistic “virtual” reference system, based on goals and objectives expressed by stakeholders; and 3) predict system-level outcomes of alternative actions and policies.

Management Actions

We recommend that management actions available for implementation on the UMR-IWW focus on the attainment of goals and objectives at the system level--with appropriate attention to risk and uncertainty as key considerations in the Adaptive Management process.

Monitoring and Evaluation

We recommend the development of an UMR-IWW Ecosystem Report Card procedure and appropriate monitoring program to regularly evaluate system condition and progress toward attainment of objectives

Adaptation and Learning

We recommend that selected future management actions be specifically considered as experimental manipulations, intended not only to achieve stated objectives and to enhance ecosystem health, but also to provide knowledge in a predictable and structured way.

4.4 National Research Council

The current National Research Council (NRC) review is phase II of the NRC interaction with the feasibility study. The Department of the Army initially requested the NRC to review the feasibility study in 2000 in response to public controversy on the study. The NRC completed a report on their review early in 2001 and the Chief of Engineers paused the study to evaluate the recommendations of the NRC. A Federal Principals Group was formed to advise the Corps on the conduct of the study. The study was restructured in response to the NRC and Principals Group recommendations. The U.S. Army Corps of Engineers (Corps) requested a second review by the NRC of the restructured study. The NRC has formed a new study review committee to conduct this current phase II review that was initiated with a meeting of the study committee in September of 2003.The NRC initiated its review in June of 2003 and will extend its work through the completion of the Chief of Engineers report scheduled for October 2004. The Corps believes that the NRC review is essential for large and controversial studies like the Upper Mississippi River and Illinois Waterway navigation feasibility study to insure the quality of the study analysis and process and to insure that the best available science and engineering are applied in conducting the study.

5 Policy Issues

5.1 Cost Sharing

Section 3.32 of the Interim Report dated July 2002 contains preliminary discussion of authority and cost sharing considerations pertaining to the implementation of ecosystem restoration measures to meet established restoration goals and objectives and assure the ecological integrity of the UMR-IWW. The Interim Report indicated that the ecosystem restoration measures would be implemented through a combination of 100 percent Federal and cost shared measures and that the criteria for cost sharing would be addressed in the feasibility study.

5.1.1. Background.

As documented in Sections 2.3.2.2.7 and 2.3.3.3 of the Interim Report, the environmental impacts of the human activities has resulted and continues to result in a decline in the environmental quality of the UMR-IWW. The resource impacts include backwater and secondary channel sedimentation, altered hydrology, loss of connectivity of the floodplain to the river, impeded fish migration, loss of island habitat, endangered plant and animal species, and loss of native plant community diversity and abundance. Although large increments of ecosystem decline can be attributed to the construction and operation of the navigation system, there are many ecological stressors contributing to ecosystem degradation including land use changes, floodplain development, exotic species, sedimentation resulting from land use practices, construction of the levee system, and non- point source pollution. The Army Corps of Engineers currently has several mechanisms for addressing ecosystem issues:

a. Operations and Maintenance Activities. The UMR-IWW has a single authorized purpose of inland navigation. Therefore, funds appropriated for operation and maintenance of the system are limited to supporting the navigation purpose. This operation and maintenance responsibility must comply with environmental laws and policies regulating all Federal activities and responsible environmental stewardship of the system's land and water resources. This allows the Corps to avoid and minimize environmental impacts from operation and maintenance activities.

b. Environmental Management Program (EMP). The UMR-EMP, authorized by the Water Resources Development Act (WRDA) of 1986 and amended in WRDA 1990 and WRDA 1999, is a systematic program to provide monitoring, research, and habitat restoration activities. Program accomplishments to date include: (1) the completion of 39 habitat restoration projects resulting in the direct physical restoration of approximately 60,000 acres of riverine and floodplain habitats; 21 more projects in various stages of design will add another 29,000 acres of restored habitat when implemented;

(2) the collection of millions of data samples (primarily fish, water quality, vegetation, and invertebrates) critical to carrying out the trend analysis and applied research that is leading to enhanced understanding of the dynamics of large floodplain rivers and successful multi-purpose resource management; (3) the development of extensive digital data bases, mapping products, and establishment of an information clearinghouse through which UMR System data and information can be universally accessed; and (4) a partnership between a multitude of Federal and state agencies, non-governmental organizations and the general public. The authorizing legislation provides that EMP habitat projects are to be cost shared in accordance with Section 906(e) of WRDA 1986. Section 906(e) provides guidance on cost sharing for fish and wildlife enhancement projects forward to Congress for authorization. Under Section 906(e) projects on Federal refuge land and projects that benefit Federally listed threatened or endangered species, species of national economic importance, species subject to international treaties, and anadromous fish are 100 percent Federal cost. As a matter of Administration policy under the EMP, only the habitat projects on National Refuge lands are 100 percent Federal for construction with operation and maintenance by the U.S. Fish and Wildlife Service or managing State agency. Other habitat projects are cost shared on a 65 percent Federal and 35 percent non-Federal basis. The President's FY 04 budget contains $33 million for the EMP.

c. Section 1135 of WRDA 1986, As Amended. This legislation provides authority to review and modify the structures and operations of water resources projects completed by the Corps for the purpose of improving the quality of the environment when it is determined that such measures are feasible, consistent with the authorized project purposes, and will improve the quality of the environment in the public interest. The cost-sharing for Section 1135 projects is 75 percent Federal and 25 percent non-Federal and projects have a $5 million Federal funding limit and a $25 million per year annual program limit. The President's FY 04 budget contains $14 million for the Section 1135 program nationwide.

d. Section 206 of WRDA 96, As Amended. This legislation provides authority for the development of aquatic ecosystem restoration and protection projects that improve the quality of the environment in the public interest and are cost effective. The cost sharing for Section 206 is 65 percent Federal and 35 percent non-Federal and projects have a $5 million Federal funding limit and a $25 million per year annual program limit. The President's FY 04 budget contains $10 million for the Section 206 program nationwide.

e. Section 204 of WRDA 1992, As Amended. This legislation authorizes the Corps to carry out projects for the protection, restoration, and creation of aquatic and ecologically related habitat in conjunction with dredging of authorized navigation projects. The incremental costs of the beneficial use of the dredged material for habitat creation are shared 75 percent Federal and 25 percent non-Federal. There is no per project limit on Federal cost but the annual program limit is $15 million. The President's FY 04 budget contains $3 million for beneficial use of dredged material programs.

Despite the significant accomplishments using these authorities, the ecosystem of the UMR-IWW system continues to decline, in part, as a result of the construction and operation of the Federal navigation project. Therefore, the Corps is undertaking a restructured feasibility study to address the navigation efficiency needs of the UMR-IWW, the ongoing cumulative effects of navigation, and the ecosystem restoration needs with a goal of attaining an environmentally sustainable navigation system. The Interim Report concluded that the current level of authority and authorized appropriations in the Environmental Management Program (EMP) and national programmatic authorities and the limited environmental management activities available under a single purpose navigation project has been insufficient for environmental needs on the Upper Mississippi River Navigation System. Therefore, the feasibility report will:

* Identify and evaluate alternative plans that add ecosystem restoration as a project purpose.
* Formulate measures for ecosystem restoration in response to identified goals and objectives, combine these measures into ecosystem restoration plans at alternative levels of investment, and combine these

ecosystem restoration plans with navigation efficiency improvements to produce integrated ecosystem restoration and navigation alternative plans.

* Evaluate the plans by identifying net contributions to National Economic Development (NED) and National Ecosystem Restoration (NER).

* Evaluate the Federal interest in recommending a plan adding ecosystem restoration as a project purpose including plan implementation actions.

5.1.2 Issue.

As noted in the Interim Report, a fundamental issue is determining the appropriate cost - sharing that would apply to ecosystem restoration plans and the method of implementation of these plans. The Interim Report tentatively concludes that implementing ecosystem restoration measures to assure the sustainability of the system will require a combination of 100% Federal and cost-shared measures with criteria for application developed as part of the feasibility study. The following paragraphs in this section (5.1) presents options and recommendations for cost sharing and implementation actions.

5.1.3 Mitigation of Navigation Improvement Impacts.

In accordance with current policy, the Corps would address any adverse environmental impacts associated with future navigation improvements through the implementation of mitigation measures. These measures would be designed to avoid, minimize, or compensate for the incremental impacts projected to result from navigation improvements. Impacts might include loss of habitat and effects of increased traffic levels such as larval fish mortality, turbidity, sedimentation, and erosion. The objective is to maintain the existing condition of the system including side channels and backwaters. The costs of such measures would be assigned to inland navigation, shared in accordance with Section 102 of WRDA 86. Implementation of these measures is considered mitigation, not ecosystem restoration, and the measures would be implemented through specific authorizations and appropriations and implemented concurrently with the construction of navigation improvements.

5.1.4 Basic Cost Sharing Options for Ecosystem Restoration:

There are three cost sharing options that may apply to measures within the Corps' area of responsibility that address the identified goals and objectives for restoration of the ecological integrity of the system. Impacts to be addressed could include loss of connectivity, loss of seasonal variation, and loss of connectivity to backwaters. Potential measures include fish passage, pool level fluctuations, environmental dredging, restoration of connectivity to backwaters, modification of training structures, and opening of side channels. Additional land acquisition could be included.

a. COST SHARING OPTION I: Share as Environmental Protection and Restoration Under Section 103(c) of WRDA 86, As Amended. These measures would be identified as environmental protection and restoration cost and shared 65 percent Federal and 35 percent non-Federal. This is consistent with existing Corps policy to address any possible impacts of existing Corps projects as restoration. As such it is consistent with the Comprehensive Everglades Restoration Plan (CERP) which includes many modifications to existing projects although an important distinction may be that the Central and South Florida Project that is being modified historically had a project sponsor which had operational responsibility for portions of the project. Also, the special 50/50 cost sharing for the CERP is influenced by the fact that the plan has water supply as well as ecosystem restoration outputs. This approach would also be consistent with the cost- sharing authorized for the Ohio River Ecosystem Restoration.

b. COST SHARING OPTION II: 100 Percent Federal as Addressing Ongoing Impacts of a Federally Constructed and Operated and Maintained Project. This "full Federal cost" approach would cost-share in accordance with the cost sharing applicable to the existing project which is 100 percent Federally funded. The Columbia River Fish Mitigation is an example of a 100 percent Federally funded program to address fish passage impacts. In the Columbia River case, the appropriations are reimbursed from hydropower revenues and fish passage was authorized in the original project authorizations although downstream passage facilities were not constructed. The Columbia River fishery program is also heavily influenced by endangered species considerations. The Missouri River Mitigation is another precedent for 100 percent Federal funding. One hundred percent Federal funding may be justified because the system has been recognized in statute by Congress as a nationally significant ecosystem and commercial navigation system. Other factors favoring Federal funding are the significant Federal investment in the basin in the 285,000 acres of Federal refuges and the presence of Federally recognized, regulated and protected resources including migratory birds and endangered species.

c. COST SHARING OPTION III: Cost Sharing as Enhancement of Fish and Wildlife Resources Under the General Guidelines of Section 906(e) of WRDA 86. Although seldom used, this authority allows the Secretary of the Army, as part of a report to Congress, to recommend, at 100 percent Federal cost, activities to enhance fish and wildlife resources, when (1) such enhancement provides benefits that are determined to be national, including benefits to species that are identified by the National Marine Fisheries as of national economic importance, species that are subject to treaties or international conventions to which the United States is a party, and anadromous fish; (2) such enhancement is designed to benefit species that have been listed as threatened or endangered by the Secretary of the Interior under the Endangered Species Act, as amended; or (3) such activities are located on lands managed as a national wildlife refuge. The restoration measures that meet these criteria would be 100 Federal and other restoration would be cost shared. Section 906(e) cost sharing was applied to the Environmental Management Program (EMP) except that the 100 percent Federal funding has been limited to measures on land managed as a Federal refuge. The Section 906(e) application has also been modified for the EMP to provide for operation and maintenance of completed projects by the agency managing the land on which the project is located and 65 percent Federal and 35 percent non-Federal cost sharing for cost shared projects.

5.1.5 Criteria for Determining Cost-Sharing.

There are four options for determining those measures to be cost shared versus those measures to be funded at 100 percent Federal cost as presented below.

a. CRITERIA OPTION A: Measures attributable to addressing the ongoing and cumulative existing project impacts. This option is based on the premise that measures to address the ongoing and cumulative impacts of the navigation project should be 100 percent Federally funded and that these measures should be identified through a quantification process. This approach would involve: (1) quantifying the impacts to the ecosystem based on a baseline (pre-project or immediate post impoundment) but including the impact of pre-impoundment flow control measures (wing dikes); (2) determining what portion of these impacts are attributable to the project; and (3) formulating the most cost effective measures to address these impacts to be funded at 100 percent Federal. Measures to meet the environmental goals and objectives that are not attributable to addressing the impacts of the navigation project would be cost shared 65 percent Federal and 35 percent non-Federal. While, as part of the feasibility study, the Corps and its partner agencies are identifying ecosystem restoration goals and objectives to achieve ecosystem integrity by assessing the stressors and impacts on the existing system and cumulative impacts, this assessment does not involve the degree of quantification and detailed accounting of cause and effect relationships that would be needed to implement this option. The Study Team concluded that the kind of analysis needed to implement this option would significantly add to the scope and time required for the feasibility study.

b. CRITERIA OPTION B: Measures Involving the Modification of the Structures and Operations of the Existing Projects and Measures on Project and Lands Included in the National Refuge

System Would be 100 Percent Federal with Measures on Other Public Lands or Requiring Land Acquisition Would Be Cost Shared. This option is also based on the premise that measures to address the ongoing and cumulative impacts of the navigation project should be 100 percent Federally funded and that these impacts are largely within the project limits including Refuge lands. Measures to meet ecosystem restoration goals and objectives that involve the modification of structures and operations of the project including such measures as fish passage, flow control structure notching, and pool fluctuations not requiring additional land acquisition would be 100 percent Federal. Also measures that would be located on project lands or lands included in Federal Refuges would be 100 percent Federal. Attachment 1 provides a table listing these project and refuge lands by pool. Operation and maintenance responsibility for the measure would be retained by the agency, operating and maintaining the structure or managing the land or potentially could be provided by a non-Federal partner under a leasing arrangement. Measures to meet the established restoration goals and objectives that are outside the limits of the project lands but are related to the project and its adjacent floodplain including floodplain forest restoration, floodplain connectivity restoration, and isolated backwater restoration would be accomplished in a cost shared 65-35 ecosystem restoration program. The four ecosystem restoration alternatives under consideration range in cost from $1.7 billion for Alternative B to $8.4 billion for Alternative E. Under this cost-sharing option the non –Federal share ranges from about $ 415 million for Alternative B representing about 25 percent of the total cost to about $ 2.9 billion for Alternative E representing about 35 percent of the total costs. The increasing share of ecosystem restoration costs for the larger ecosystem restoration plans (Alternatives D & E) reflects the inclusion of large blocks of land acquisition and floodplain restoration in these plans that would be shared on a 65 percent Federal and 35 percent non-Federal basis. The study team proposes that the cost shared restoration program be authorized to provide for sponsorship by private not-for-profit environment interests, credit for work-in-kind up to the limit of the non-Federal share, and the carry-over of excess land value credits between projects.

c. CRITERIA OPTION C: Measures Involving the Modification of the Structures and Operations of the Existing Projects, Measures on Project and Lands Included in the National Refuge System and Measures in Backwater Areas Connected to the Main River Channel Regardless of Current Ownership Would be 100 Percent Federal with Measures on Other Public Lands or Requiring Land Acquisition, Other Than Connected Backwater Areas, Would Be Cost Shared. This option is the same as Option B. except that it adds 100 percent Federal funding for measures in backwater areas and side channels that are directly connected to the main channel, regardless of present ownership and including the cost of land acquisition. This additional category of 100 percent Federal measures would address the disparity in the amount of Federal land between the reach of the Upper Mississippi River containing locks and dams versus the Illinois River and middle Mississippi River. The four ecosystem restoration alternatives under consideration range in cost from $1.7 billion for Alternative B to $8.4 billion for Alternative E. Under this cost-sharing option the non –Federal share ranges from about $210 million for Alternative B representing about 12 percent of the total cost to about $2.2 billion for Alternative E representing about 26 percent of the total costs. The increasing share of ecosystem restoration costs for the larger ecosystem restoration plans (Alternatives D & E) reflects the inclusion of large blocks of land acquisition and floodplain restoration in these plans that would be shared on a 65 percent Federal and 35 percent non-Federal basis. The decrease in non-Federal share over Alternative B is a result of 100 percent Federal funding of backwater and side channel restoration within the navigation servitude in the middle Mississippi River and Illinois River where Federal fee ownership is limited.

d. CRITERIA OPTION D: Measures Producing National Benefits Under the Guidelines of Section 906(e) of WRDA 1986 Would Be 100 Percent Federal. The Section 906(e) guidelines most applicable to UMR-IWW are measures to benefit species subject to treaties or international conventions to which the United States is a party, measures on lands managed as Federal Refuge, and measures primarily benefiting Federal threatened or endangered species. Operation and maintenance responsibility for measures would be retained by the agency that operates and maintains the structure or manages the land or is provided by a non-Federal partner under a lease arrangement. For measures on Corps of Engineers lands, operation and maintenance would be done by the Corps of Engineers or by a non-Federal partner under a lease. Measures not meeting the national benefits criteria would be cost shared as ecosystem restoration. Cost sharing for this option was not calculated since it was dropped from consideration since it shifts the Federal nexus from the navigation project to species and land management definitions of Federal responsibility. In so doing, this cost sharing option would also likely skew the program toward species-based management rather than the broader and more appropriate objective of ecosystem sustainability.

5.1.6 Implementation Options.

There are three primary implementation options for the ecosystem restoration implementation as follows.

a. IMPLEMENTATION OPTION 1: Expanded Environmental Management Program (EMP). The current EMP has an annual appropriation limit of $22,750,000 for Habitat Rehabilitation and Enhancement (HREP) and $10,420,000 for Long Term Resource Monitoring. These funding levels are not sufficient to meet the restoration goals and objectives. One option for implementation is to seek authorization for increasing the EMP program limits. The Corps does not recommend this option. Increasing the EMP program limits does not maintain the linkage with navigation which would be achieved through authorization of an integrated plan for navigation improvements and ecosystem restoration and budgeting for Construction, General appropriations to accomplish the dual purposes of that plan. Because of the effective and efficient State and Federal partnership and institutional arrangements that have been created to implement the EMP program and the record of accomplishment of the program, it is proposed that the EMP continue and that a portion of the measures to achieve the restoration goals and objectives be identified for accomplishment through the EMP program. However, the primary implementation framework for accomplishment of the ecosystem restoration is the authorization and funding of a dual purpose integrated plan for the Upper Mississippi River and Illinois Waterway. Until a dual-purpose authority is achieved and appropriations secured, EMP will continue to constitute the primary implementation framework for ecosystem restoration.

b. IMPLEMENTATION OPTION 2: Programmatic Authorizations. The dual purpose integrated plan could include authorizations of a program or programs to accomplish the 100 percent Federal projects and cost shared projects. The program or programs would have defined limits on the size of the project that could be accomplished and the overall program limits. The program or programs would be authorized with provision for project approval by the Secretary of the Army before implementation. In the Everglades Comprehensive Plan the programmatic authority had a $25 million per project limit and an overall size of about $200 million. The program size was based on an initial identification of potential smaller scale projects that could be accomplished under a programmatic authority.

c. IMPLEMENTATION OPTION 3a: Project Specific Authorizations. The dual-purpose integrated plan could include feasibility level identification of specific projects for authorization. Such projects would be larger scale projects such as fish passage facilities or pool management requiring additional land acquisition. Based on feasibility level analysis, such projects could be authorized in the integrated plan for immediate construction.

d. IMPLEMENTATION OPTION 3b: Project Specific Authorization with Subsequent Approval of Project Implementation Reports by the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Environment and Public Works of the Senate As a Condition for Appropriations for Construction. The plan could include identification of projects for authorization at a less than feasibility level of detail that could be authorized for construction with subsequent approval of project implementation reports by the Secretary of the Army and approved by resolution of the House and Senate public works committees as a condition for appropriations for construction. The plan could include identification of projects at a reconnaissance level of detail that would be subsequently authorized based on completion of feasibility level reports. Such projects would be larger scale projects such as fish passage facilities or pool management requiring additional land acquisition.

5.1.7 Review Team Recommendation.

The review team recommendation on the cost sharing criteria as presented in paragraph 6c is Criteria Option C. This recommendation is based on national and regional coordination with the feasibility study partners. The study team's responses to initial partner and stakeholder comments on early Drafts of this MFR, are provided as Attachment 2. Option C is endorsed by the five study area states as indicated in the letter of 8 December 2003 (Attachment 3) that is attached. It is also supported by the U.S. Fish and Wildlife Service in a letter of 19 December 2003, provided as (Attachment 4). The review team believes that Option C best reflects an appropriate Federal role in addressing the declines in the ecosystem resulting from the existing 9-foot navigation project including impacts on Federal refuges while providing for a significant cost sharing responsibility for the non-Federal partners particularly where additional land acquisition is required. The review team recommends implementation of the ecosystem restoration plan through a combination of Options 2, 3a and 3b, specified in section 7b-d above. Specifically implementation would be accomplished through a 100 percent Federal programmatic authorization with appropriate project cost limits for habitat restoration projects within the navigation servitude including water level management, backwater and side channel restoration, wing dam and dike alteration, and island building. A second programmatic authority would be proposed for cost-shared land acquisition and habitat protection and restoration for projects for floodplain restoration, island and shoreline protection, and topographic diversity. Finally specific authorization would be proposed for larger scale projects including fish passage and hinge point to dam point control.

(Attachments referenced in the Cost Sharing Section 5.1 can be found on the attached CD)

5.2 NEPA Compliance

Issue: Decision to not develop mitigation for effects of the Operation and Maintenance of the Nine foot channel project pursuant to Section 906(b) of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662).

The EPA, FWS and other consulting parties have repeatedly requested the development of a mitigation plan in the context of updating existing Nine foot channel Navigation Project NEPA documents originally prepared in the 1970's. Mitigation for completed Corps projects is addressed under Section 906(b) of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662).

This section establishes a comprehensive mitigation policy for water resources projects; subsection 906(b) dealing with post-authorization mitigation, states in part "*After consultation with appropriate Federal and non-Federal agencies, the Secretary (of the Army) is authorized to mitigate damages to fish and wildlife resulting from any water resources project under his jurisdiction, whether completed, under construction, or to be constructed*."

Engineering Regulation ER 1105-2-100, revised version dated 22 April 2000, Appendix C, paragraph 15, Post-authorization Mitigation, states " *Section 906(b) of the Water Resources Development Act of 1986 authorizes the Secretary of the Army to mitigate damages to fish and wildlife without further specific Congressional authorization within certain limits. Current budgetary constraints do not provide for the implementation of Section 906(b)*."

In consultation with the Federal Principals Task Force it was determined that the current navigation study would provides a framework for addressing the cumulative environmental effects of navigation and the needs for ecosystem restoration as an integral part of the restructured navigation study with a goal of an environmentally sustainable navigation system. The Principals Group endorsed adding ecosystem restoration as an authorized purpose of the Upper Mississippi River and Illinois Waterway Navigation System and supported the concept of developing an implementation plan for ecosystem restoration which incorporates both 100% Federal and cost-shared components.

5.3 The National Research Council Review of the Upper Mississippi River – Illinois Waterway Restructured Feasibility Study

5.3.1 Background

The Upper Mississippi River-Illinois Waterway (UMR-IWW) feasibility study was initiated in 1993 to examine the need for improvements in navigation efficiency for the upper and middle portions of the Mississippi River and the entire Illinois Waterway. The study area encompasses about 1,200 miles of navigable waterway and includes 28 dams and locks on the Upper Mississippi river, one lock site on the Middle Mississippi, and 8 dams and locks on the Illinois River. Portions of Illinois, Iowa, Minnesota, Missouri and Wisconsin are in the study area.

The current National Research Council (NRC) review is the second NRC interaction with the feasibility study. The Department of the Army initially requested the NRC to review the feasibility study in 2000 in response to public controversy on the study. The NRC completed a report on their review early in 2001 and the Chief of Engineers paused the study to evaluate the recommendations of the NRC. A Federal Principals Group was formed to advise the Corps on the conduct of the study. The study was restructured in response to the NRC and Principals Group recommendations. The U.S. Army Corps of Engineers (Corps) requested a review by the NRC of the restructured study. The NRC has formed a new study review committee to conduct the restructured study review that was initiated with a meeting of the study committee in September of 2003.

5.3.2 Study Status

The feasibility study has been conducted as a collaborative effort with other Federal agencies, the five UMR-IWW states, and non-governmental organizations representing economic and environmental interests. In cooperation with these study partners, the Corps has formulated alternative plans for navigation efficiency and ecosystem restoration. These plans were presented for public review and comment in a series of six public meetings in the UMR-IWW study area in October 2003. The navigation efficiency alternatives range from non-structural measures to the construction of 7 new locks and 5 extended locks at cost ranging from a first cost of $1 million to $2.3 billion. The ecosystem restoration alternatives range from a plan to prevent further degradation of the ecosystem to a plan to comprehensively address all the identified restoration objectives related to the navigation project with implementation costs approximating from $1.7 to $8.4 billion. These alternatives are currently being evaluated in coordination with the study partners with a goal of tentatively selecting a recommended integrated plan for navigation efficiency and ecosystem restoration. The tentatively recommended plan will be presented in a draft feasibility report and draft environmental impact statement that is scheduled to be circulated for public and agency review beginning in May 2004. The final Chief of Engineers report is scheduled to be completed in November 2004. In a report dated December 11, 2003, the NRC provided its findings and recommendations arising from its initial interim review of the restructured feasibility study. The NRC will produce a second more comprehensive and detailed review report based on review of the Corps' draft report scheduled for issuance in April 2004. A final summary NRC report will be completed following the issuance of the Chief of Engineers report.

5.3.3 Responses to the Initial NRC Report on the Restructured Study

The Corps requested the NRC independent review of the feasibility study. The Corps believes that independent review is valuable for large and controversial studies like the Upper Mississippi River and Illinois Waterway (UMRIW) navigation feasibility study. Such review provides an independent assessment of the quality of the study analysis and process to insure that the best available science and engineering are applied in conducting the study. The Corps welcomes the NRC comments and findings contained in the Initial NRC Report, both positive and critical, and will evaluate and respond to the comments and findings as the study moves forward. While initial responses to the NRC comments are provided in this paper, the Corps believes that responding to the NRC will be an iterative and ongoing process. The Corps will seek the input of our cooperating Federal agencies of the Federal Principals Group, the states of Missouri, Iowa, Illinois, Wisconsin and Minnesota, and the non-government organizations participating in the study in addressing the NRC concerns. The Corps also recognizes that the December 2003 NRC report contains the initial impressions of the NRC on the restructured feasibility study and the NRC continues collecting and evaluating input to their review.

A discussion of the primary initial NRC findings and the Corps' response is presented below.

5.3.4 Spatial Price Model and ESSENCE

The NRC review committee had critical observations on both the Tow Cost and ESSENCE models used in the economic evaluation for the restructured study. The review committee noted that the Tow Cost Model (TCM) is not widely accepted by economic experts as a useful tool for modeling water transportation demand for grain and that the decision to adopt the TCM contradicts advice about demand modeling provided in the NRC 2001 report. The committee also did not see a useful role for the ESSENCE model in the restructured feasibility study noting the arbitrary values for the "N" coefficient and the highly simplified functional form of the model.

The Corps recognizes the limitations of both the Tow Cost and the ESSENCE models. In the original feasibility study, before restructuring, a decision was made to develop a new model with spatial characteristics due to the limitations of the TCM. This decision was made recognizing the unique characteristics of the traffic on the Upper Mississippi River -Illinois Waterway (UMR-IWW). Because of the complex nature of the UMR-IWW system, multiple simplifying assumptions are required to even approximate the system traffic response to commodity price change across a range of plausible economic futures. This makes the development of a model with spatial characteristics difficult. As the NRC noted in their 2001 report, the ESSENCE model used in the original study contained flawed assumptions and data. In restructuring the study, the Corps decided in coordination with the Federal Principals group, that the development of a perfect spatial model would require a number of years and considerable funding, the model may not inform the decision any more than the existing models, and this effort would more appropriately be conducted in a research and development setting. That research effort is ongoing and any tools resulting from this effort can be used for phased (future) decisions in an adaptive implementation approach. Additionally, the Corps recognizes the much greater impact that macro-economic changes have on system traffic that micro-economic models simply cannot account for. Therefore, the Corps, in coordination with the Principals Group, decided to utilize the existing TCM to the best of its capabilities. Recognizing the remaining need to consider the elasticity of price to demand, that decision was later modified to also utilize the available capabilities of the ESSENCE model under a prescribed range of elasticities to provide a higher confidence level of the range of economic benefits.

The Corps believes that the use of the two economic models and the five traffic scenarios adequately captures the range of plausible economic evaluation outcomes. The information provided by use of the models and scenarios provides an adequate basis for decision-makers. The Corps envisions using this information in a process which seeks solutions that are justified over a range of economic and traffic conditions. These solutions would be adaptively implemented in phases that allow for higher levels of investment as needed and justified. The research effort to develop better economic evaluation tools will continue as a high priority effort recognizing that development, testing and peer review of a spatial model is years from completion. The Corps will continue to work with the NRC and the study partners to apply the best available economic evaluation tools to the evaluation of navigation efficiency alternatives. There needs to be recognition that since perfect analytical economic evaluation tools are unavailable, that the use of the existing tools in the manner that they have been used is appropriate under the circumstances. Additionally, the Corps' efforts will include investigating the application of the Panama Canal transportation demand model to the UMR-IWW study as suggested by the NRC.

5.3.5 Demand Forecasts

The committee commended the Corps for applying a scenario approach to forecasting future waterway traffic demand but expressed some skepticism about projected increases in traffic reflected in 4 out of the 5 scenarios. The committee indicated that forecasts of increases in U.S. grain exports should present explanations for likely export trends after 2003 that are consistent with history and with expert opinion on likely future conditions in global grain markets. In their December 16, 2003 meeting the committee received expert input on global and national trends in grain supply and demand from the U.S. Department of Agriculture and a presentation from Sparks Company that provided the basis for the 5 scenarios. In the Corps' view, the information and macro-economic analysis presented to the committee supports the plausibility of growth in grain exports, particularly corn.

5.3.6 Managing Waterway Congestion

The committee indicated that the Corps should proceed as soon as practicable toward developing and implementing a nonstructural system to help alleviate waterway traffic congestion. The committee encouraged the Corps to examine a contingent fee that is levied at times of congestion and evaluate other nonstructural measures such as tradable arrival slots and industry self help systems. The Corps believes that the restructured feasibility study has examined the feasibility of nonstructural measures. The Corps hired the Volpe National Transportation System Center to evaluate a number of nonstructural measures including excess lockage time fees, scheduling systems and tradable permits, and a draft report was published in September 2003. The committee talked with a representative of the Volpe center in their December 16, 2003 meeting to gather more information on this effort. The analysis to date by the Corps and the Volpe Center has found that theoretically transportation savings benefits would be achieved by management of tow arrival times at locks so that tows arrive on a schedule which provides for "just in time" lockage without the need to wait in a line. However, the operational and market characteristics of commercial inland navigation and uncertainties attributable to variable river conditions, highly variable tow processing times and lock closures makes a traffic management plan providing for long-term scheduling to achieve "just in time" lock arrivals impractical. Lockage fees to reduce excess lockage times do not produce benefits that exceed their costs. The Corps also has taken the position that alternatives involving fundamental changes in business practices to facilitate traffic management are beyond the scope of the study. The Corps evaluated one form of congestion fees (i.e., a lockage charge that would remain constant within a year, but would vary from year-to-year) and presented the results at the October public meetings. While congestion fees in the form of constant lockage charges were shown to move traffic off the river and produce benefits exceeding costs, it is not clear that moving traffic off the river would be compatible with national policy on full utilization of all transportation modes or supported by the states. The NRC has recommended that the Corps consider a different form of congestion fee, i.e., a fee that changes with varying levels of congestion. The Corps will continue discussions with the NRC regarding the feasibility of implementing varying lockage charges based on varying levels of congestion.

The study to date has shown that a scheduling system allowing tow operators to call ahead one or more locks to reserve an appointment at the lock could result in more efficiently conducted voyages through fuel consumption savings and scheduling other necessities such as maintenance. Elements of such a system already exist on an informal basis. Such a system would not result in significant timesavings since it still would potentially involve waiting for lock availability during congested periods. The Corps will do more analysis of a short- term reservation system to describe the extent to which such a system is already in place and identify costs and benefits of further actions to implement this alternative. The Corps will evaluate whether such a system should be included as an alternative or an additional measure to be combined with other alternatives.

5.3.7 River Ecology

The committee indicated that, to the maximum extent feasible, the Corps should consider factors such as water quality, flood damage reduction, and sediment transport in order to reflect a more holistic approach to dealing with the diverse management issues in the UMR-IWW. The Corps supports a holistic watershed based approach to addressing water resources problems but believes there are legal and practical considerations that limit the scope of the restructured navigation study. The study is being accomplished under Section 216 of the Flood Control Act of 1970. Section 216 authorizes the Corps to review the operation of completed projects constructed in the interest of navigation, flood control, water supply and related purposes, when found advisable due to significantly changed physical or economic conditions. This project authority lacks provisions pertaining to the allowance of a comprehensive watershed study that would encompass all factors impacting the watershed. In addition, the five study area states supported the concept that the study should remain focused on navigation and an environmentally sustainable navigation system. The restructured study is founded on environmental sustainability objectives that can be achieved in the context of the navigation system. The Corps recognizes that water quality and sediment transport are strongly influenced by watershed practices, however watershed modifications are beyond the scope of this study. A diverse and healthy main stem ecosystem can contribute significantly to important aspects of water quality and sediment nutrient management. Flood plain restoration associated with the navigation project is contained in the current array of ecosystem restoration alternatives. There may be minor opportunities for flood damage reduction associated with flood plain restoration. The study ecosystem restoration objectives have been formulated for the entire floodplain and the study will identify other studies and programs to address objectives not completely achieved by the plan finally recommended by the restructured navigation study.

5.3.8 Adaptive Management

The committee recommended that the Corps should implement adaptive management concepts and approaches throughout all aspects of the planning process. The Corps will recommend to Congress that adaptive management be applied to the implementation of both ecosystem restoration and navigation efficiency alternatives. For the ecosystem restoration alternatives the adaptive management will consist of a process of monitoring the response of the ecosystem to restoration measures and adapting and modifying the measures based on the monitoring results. For the navigation efficiency measures an adaptive management process would potentially involve a staged implementation process that includes a continuing assessment of the measures recommended. This assessment might be based on improved economic modeling, if available, and an assessment of barge traffic patterns, delays, and economic and world grain market conditions, land use, yield technology and developments in China. The implementation plan could have "go" and "no-go" decision points based on the results of the continuing assessment.

5.3.9 Timing

The committee found that the Corps should extend its schedule for completing the feasibility study and issuing a Chiefs Report. The UMR-IWW navigation study has been ongoing since 1993 and the Corps believes it is important to provide the Administration, the Congress, the states, interest groups and the citizens of the Mid-West and the nation a recommendation on the improvement of this nationally important transportation corridor and ecosystem. While the Corps appreciates the NRC concern about allowing adequate time for analysis, the Corps also recognizes that perfect analytical tools will never be available, nor may newer models ever inform the decision-maker any better than present tools, and that macro-economic conditions have a much greater impact on waterway traffic than micro-economic models can account for. As a means to minimize risk in decision-making, an adaptive implementation schedule will be considered. This will help ensure that implementation recommendations are based on the best available evaluation tools that become available over time and reflect trends in traffic conditions, delays and emerging domestic and global trends.

In addition, the Congress has expressed its intent for the Corps to complete the study as soon as possible and present the study results to the Congress. The Conference Report accompanying the 2004 Energy and Water Development Appropriations Bill indicates "The conferees have provided additional funding above the Administration's request for the Upper Mississippi and Illinois Navigation Study with the intent that the Corps of Engineers diligently work to complete this critical study."

The text of H.R. 2557, the Water Resources Development Act of 2003 currently under consideration in the Congress provides: "**SEC. 4006. UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY, ILLINOIS, IOWA, MINNESOTA, MISSOURI, AND WISCONSIN.** The Secretary shall transmit to Congress a report on the results of the Upper Mississippi River and Illinois Waterway Restructured System Navigation Feasibility Study, Illinois, Iowa, Minnesota, Missouri, and Wisconsin, no later than July 1, 2004."

5.3.10 Prioritization and Sequencing

The committee noted that priority should be given to restoration projects based upon their promise of restoring natural processes, and to those that aim to achieve multiple objectives. The Corps will give priority to cost effective and complete measures that restore natural processes. This would include measures such as water level management to simulate a more natural hydrograph and flood plain connectivity. An additional consideration is identifying measures for early implementation where monitoring and adaptive management are needed to refine future design and implementation. The Corps is working with its study partners to identify the early priority program.

5.3.11 Cost Sharing and Funding

The committee found that the Corps should identify instances where Federal cost sharing rules are likely to restrict or preclude implementation of environmental restoration projects and non-structural measures. The study has evaluated options for cost sharing that would significantly reduce the local sponsor contributions compared to current national policy particularly for measures that address the ongoing and cumulative impacts of the existing navigation project. These options are currently being considered for incorporation into the feasibility study recommendation; however the Corps, Administration, or the Congress has not approved them. This information will be transmitted to the committee.

5.4 Application of Nav Servitude to Ecosystem Restoration

Aspects of the Ecosystem restoration measures will be constructed on, or effect, lands and waters not owned by the Federal government. Where these measures are constructed on lands hydrologically connected to the navigation system at or below ordinary high water it is proposed to assume the necessary real estate interests to construct the projects pursuant to navigation servitude rights. Assuming the navigation project is authorized as a dual purpose project, do we have adequate real estate interest to develop ecosystem measures within the servitude without acquiring additional real estate interests?

5.5 Alternative Mode Capacity

Alternative non-water transportation modes are assumed to have sufficient capability to move all traffic that would not be accommodated by water. All traffic moving by non-water modes in the future was assumed do so at current real (constant dollar) prices.

The above assumption follows directly from the planning guidance provided in Engineering Regulation (ER) 1105-02-100. The relevant section of this guidance indicates that, " the without-project condition normally assumes that the alternative modes have sufficient capacity to move traffic at current rates unless there is specific evidence to the contrary." This feasibility study investigated the issue of railroad capacity and addressed the question of future railroad rates in the face of significant volumes of potential waterway demand going unmet due to an increase in the cost of water transportation. That investigation is documented in a separate volume, "The Incremental Cost of Transportation Capacity in Freight Railroading." That work concluded, "In most cases, the line-haul segments that, together, form the routes over which expanded traffic flows must be accommodated can be modified to do so without placing undesirable pressure on competitively developed railroad rates."

Comments generated during the review of the work did not constitute a basis for an alternative conclusion. Therefore, in the absence of specific evidence to the contrary, the guidance provided by ER 1105-02-100 of a perfectly elastic supply of alternative mode service was incorporated into this feasibility analysis.

Beyond the issue of the supply function of alternative transportation modes for purposes of economic modeling, there is an additional consideration regarding the identification of NED costs associated with project implementation. Specifically, the issue involves private sector investments. A direct example would be additional investment in waterway equipment (towboats and barges) or investment in waterside facilities that might be necessary to accommodate project-induced traffic. If these investments are required to realize project outputs, the expenditures representing these investments would be treated as an NED cost. Another example demonstrates a private sector investment that could be avoided with project implementation. Investment to expand rail capacity along certain routes might be anticipated to accommodated expected traffic volume in the absence of project implementation. If the magnitude of this investment would be lower as a result of project implementation, the avoided expenditures would be treated as an avoided NED cost and reflected as a project benefit.

It is important to emphasize that in both examples mentioned above the relevant investment undertaken or investment avoided that would appropriately be considered an NED impact is only that amount associated with incremental traffic, i.e., the difference between traffic expected in the with-project condition and traffic in the without-project condition. The magnitude of incremental traffic varies with the year of analysis and traffic scenario, however, in absolute terms, incremental traffic is generally a small percentage of total system traffic. Owing to this fact and the absence of specific information to indicate significant private sector investment associated with incremental traffic, no associated private sector investments have been included in the NED analysis.

5.6 Linkage of Navigation and Ecosystem Restoration Appropriations

Background. The tentative recommendation is to seek an authorization for a dual -purpose plan that contains both navigation efficiency improvements and ecosystem restoration. This would be treated as a single project and funds appropriate based on budgetary request would be for a single Upper Mississippi River and Illinois Waterway project. The justification sheets supporting the budget request would contain information on the navigation improvement and ecosystem restoration features and projects that would be implemented with the requested funds. The environmental stakeholders on the system have a long held belief in the need for a trust fund to ensure a source of funding for appropriation of funds for ecosystem restoration. There concern in a dual- purpose plan is that funding for navigation projects will take precedent over ecosystem restoration. It has been suggested that the authorizing language contain a linkage or controls to ensure that one purpose does not receive more appropriations than the other. For example, no more than 50% of the appropriations in a given year can be expended on navigation improvements or ecosystem restoration. While this may provide some assurance of a balanced commitment of resources, it will also reduce flexibility in implementing the complexities of the dual - purpose plan. Examples of possible linkage language are presented below:

LINKAGE OPTION A - Appropriations for implementation of the integrated navigation and ecosystem restoration plan will be expended on navigation improvements and ecosystem restoration in proportion to the authorized costs for each purpose. The Chief of Engineers may deviate by 20 percent from the proportional expenditures in any fiscal year to provide flexibility in efficiently utilizing the appropriation.

LINKAGE OPTION B - Appropriations for implementation of the integrated navigation and ecosystem restoration plan will be expended on navigation improvements and ecosystem restoration in proportion to the costs of the respective navigation and ecosystem restoration purposes as contained in the approved framework plan. The Chief of Engineers may deviate by 20 percent from the proportional expenditures in any fiscal year to provide flexibility in efficiently utilizing the appropriation.

LINKAGE OPTION C – Appropriations for implementation of the integrated navigation and ecosystem restoration plan will be expended 50 percent for navigation improvements and 50 percent for ecosystem restoration in any fiscal year. The Chief of Engineers may deviate by 20 percent from the 50 percent expenditures in any fiscal year to provide flexibility in efficiently utilizing the appropriation.