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Upper Mississippi River-Illinois Waterway Navigation Expansion: An Agricultural Transportation and Environmental Context

Randy Schnepf, Resources, Science, and Industry Division

July 15, 2004

Abstract. In six sections, this report describes the major infrastructure and environmental issues associated with the UMR-IWW, reviews proposals by the U.S. Army Corps of Engineers to address these issues, evaluates the uncertainty surrounding the benefit of improving the rivers navigation infrastructure, and points out the views of various stakeholders.

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Randy Schnepf, Coordinator
Resources, Science, and Industry Division

Nicole T. Carter, John Frittelli, and Kyna Powers
Resources, Science, and Industry Division

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Summary

The Upper Mississippi River-Illinois Waterway (UMR-IWW) navigation system provides a vital export outlet for the agricultural bounty of the upper midwestern states of Minnesota, Iowa, Wisconsin, Illinois, and Missouri. The waterway is also a vital means for shipping other bulk commodities important to the regional economy. Commercial navigability on the UMR-IWW is dependent on a system of locks and dams built, maintained, and operated by the U.S. Army Corps of Engineers.

Commercial users of the UMR-IWW navigation system — primarily shippers and agricultural producers — claim that, since the 1980s, the UMR-IWW has been beset by increasing traffic congestion and delays related to its aging infrastructure and limited lock capacity. These groups advocate that the federal government should invest in major modernization and lock expansion on the UMR-IWW's navigation system. They argue that the economies of the UMR-IWW basin states, as well as U.S. export competitiveness, depend on navigation system improvements.

In contrast, budget watchdogs, environmentalists, and other interest groups argue that improving navigation must not needlessly damage river ecology; less expensive alternatives should first be fully exploited, and major spending on UMR-IWW improvements is not fully justified on economic grounds. Advocates of alternate transportation modes, particularly rail, question further federal support for barge transportation to the detriment of rail and truck transportation. Furthermore, considerable uncertainty surrounds projections of future barge demand and contributes to concern about the economic viability of large investments.

In 1993, the Corps began a multiyear feasibility study (called the Navigation Study) to assess navigation efficiency improvements for the UMR-IWW system over a 50-year planning horizon. Following a review of the Corps' draft feasibility study by the National Research Council (sparked by controversy over the economic justification for lock expansion), the economic analysis was reformulated, and the Navigation Study was restructured to include ecosystem restoration.

In April 2004, the Corps announced its preliminary recommendation for integrated investments in navigation and ecosystem restoration. The Corps' recommended navigation improvements are estimated at $2.4 billion; they would be funded 50% from federal general revenues and 50% from the Inland Waterways Trust Fund. The plan includes building seven new 1,200 ft. locks and possibly five lock extensions, as well as implementing helper boats and moorings while new locks are designed and constructed. The Corps also recommended a $5.3 billion, 50-year ecosystem restoration plan — approximately $4.25 billion federal and $1.05 billion nonfederal. For current status of UMR-IWW authorization, see CRS Issue Brief IB10133, *Water Resources Development Act (WRDA): Army Corps of Engineers Authorization Issues in the 109th Congress*, coordinated by Nicole T. Carter.

This report is unlikely to be updated.

Key Staff

Area of Expertise	Name	CRS Division	Telephone
U.S. Army Corps of Engineers	Nicole Carter	RSI	7-0854
Transportation	John Frittelli	RSI	7-7033
Ecosystem restoration	Kyna Powers	RSI	7-6881
Agricultural markets and trade	Randy Schnepf	RSI	7-4277

RSI = Resources, Science, and Industry Division.

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Purpose of this Report

This report is intended as an aid to congressional staff new to discussions about the Upper Mississippi River - Illinois Waterway (UMR-IWW) navigation system and proposals for its improvement. In six sections, this report describes the major infrastructure and environmental issues associated with the UMR-IWW, reviews proposals by the U.S. Army Corps of Engineers to address these issues, evaluates the uncertainty surrounding the benefit of improving the rivers' navigation infrastructure, and points out the views of various stakeholders.

The first section of this report briefly describes why the UMR-IWW is a significant navigation system. It also discusses how disagreement over the extent and nature of waterway congestion underlies much of the debate over whether the Corps should undertake infrastructure investment to expand the capacity of some locks. The second section briefly describes the decision-making process for the UMR-IWW, along with the Corps' proposal for a joint navigation and ecosystem restoration project. It also presents views of various stakeholders.

The third section describes the nature of freight movements on the UMR-IWW and how freight volume has varied over time and by river reach. Closely related to the third section, the fourth section explains why future agricultural demand for transportation on the UMR-IWW is important to investment decisions, but also an important uncertainty. It discusses how changes in domestic and international agricultural demand could cause the region's agricultural goods to be shipped via other transportation routes. Because these shifts in demand are difficult to forecast, the net benefit to agriculture of improving the navigation infrastructure is unclear.

The fifth section of this report places the UMR-IWW's barge transport in a multi-modal system context. It discusses how federal lock-expansion projects could affect rail and truck modes and how, in the absence of navigation improvements, alternative modes might cope with additional traffic. It also compares the different environmental and social effects of transportation by barge, rail, and truck.

The sixth section discusses how river management decisions on the UMR-IWW affect the environment. It describes both the environmental impacts of expanding the system's navigation capacity and the cumulative effects of ongoing navigation operations and the Corps' proposal for ecosystem resotration.

I. Background on Debate Over Expanding UMR-IWW Navigation Capacity

System of Locks and Dams

The Upper Mississippi River-Illinois Waterway (UMR-IWW) system is a multi-purpose river system that provides a variety of benefits to the communities and states that lie within its basin, including low-cost commercial transportation, hydropower production, recreation, wildlife habitat, floodplain management, and water supply for a range of users.

The UMR-IWW navigation system extends from Minneapolis, MN, to the mouth of the Ohio River. It contains nearly 1,200 miles of at least 9-foot deep channels, 37 lock and dam locations (with 43 locks), and thousands of channel training structures. (See **Figure 1**.) The UMR-IWW's system of locks and dams makes commercial traffic possible on the Mississippi River between Minneapolis and St. Louis, and allows the upper midwestern states of Minnesota, Iowa, Wisconsin, Illinois, and Missouri to tap into the potential benefits of low-cost barge transportation. This system of locks and dams is operated and maintained by the U.S. Army Corps of Engineers. The Corps is also responsible for maintaining a minimum channel depth of not less than 9 feet and a minimum channel width of not less than 300 feet at low water, with additional widths in river bends. In recent years the annual cost of lock and dam operations, dredging, maintenance, engineering, and other costs has averaged about $115 million.[1]

Barge transportation is a low-cost method for long-distance transport of bulk commodities such as grains and oilseeds, coal, petroleum, various ores, and primary manufactured products. (See **Appendix Table A4** and Section III, "Freight Traffic on the UMR-IWW.") From 1990 to 2002, more than 74.3 million metric tons (mmt) of freight moved annually within the UMR-IWW (both upriver and downriver) between Minneapolis and the mouth of the Missouri River.[2] Most of this volume (about 70%) traveled downriver to domestic processors located within the lower Mississippi River system or to Gulf ports for export to international markets. Freight volumes fall off sharply at lock locations further up the Mississippi. (See **Figures 2 and 3**.) The two locks furthest downriver, Locks 26 and 27, experience the largest share of river freight.

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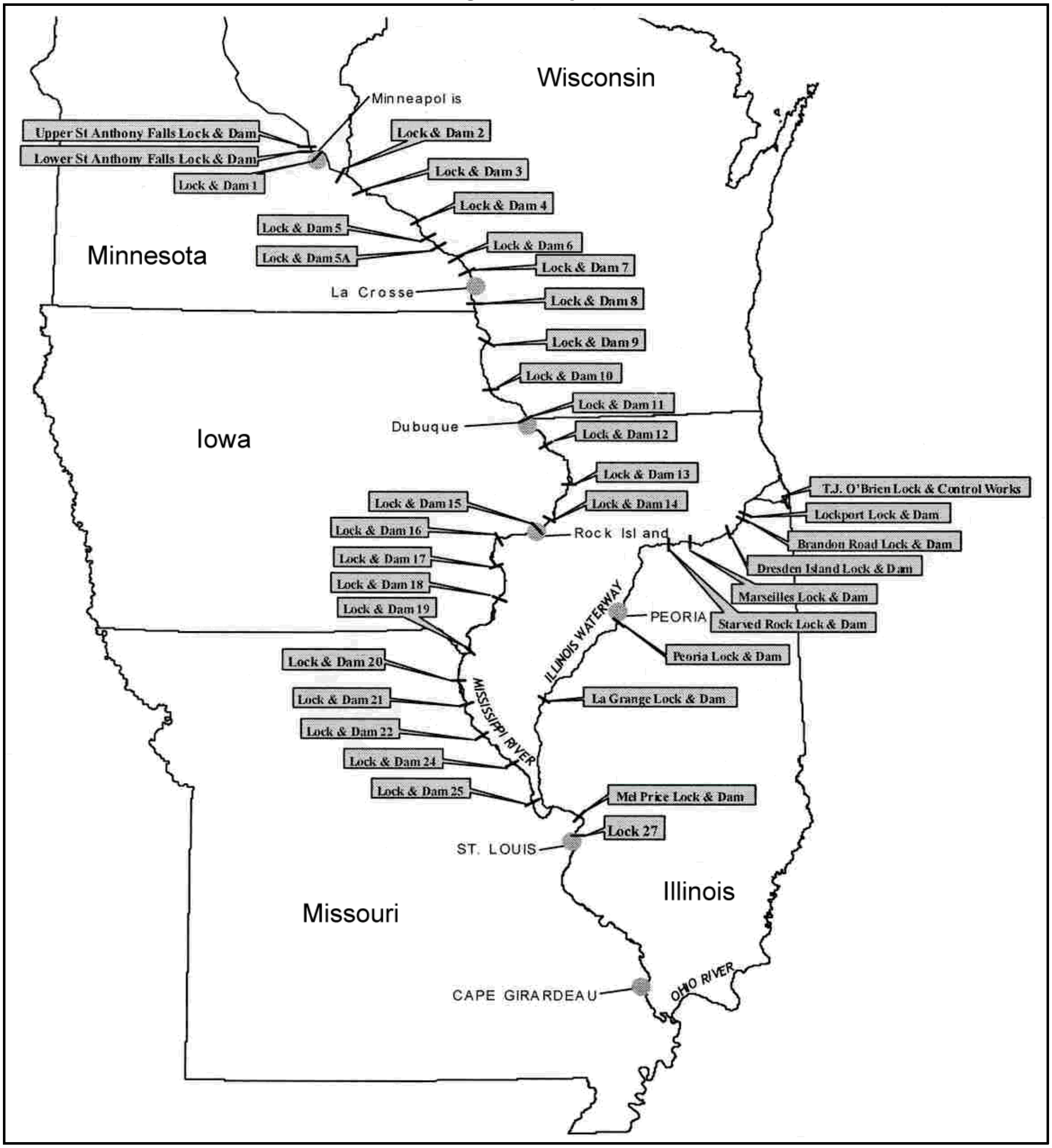
[1] U.S. Army Corps of Engineers, Rock Island District, *Draft Integrated Feasibility Report and Programmatic Environmental Impact Statement* (April 29, 2004), p. ii. Hereafter referred to as Corps *Draft Feasibility Report and PEIS.*

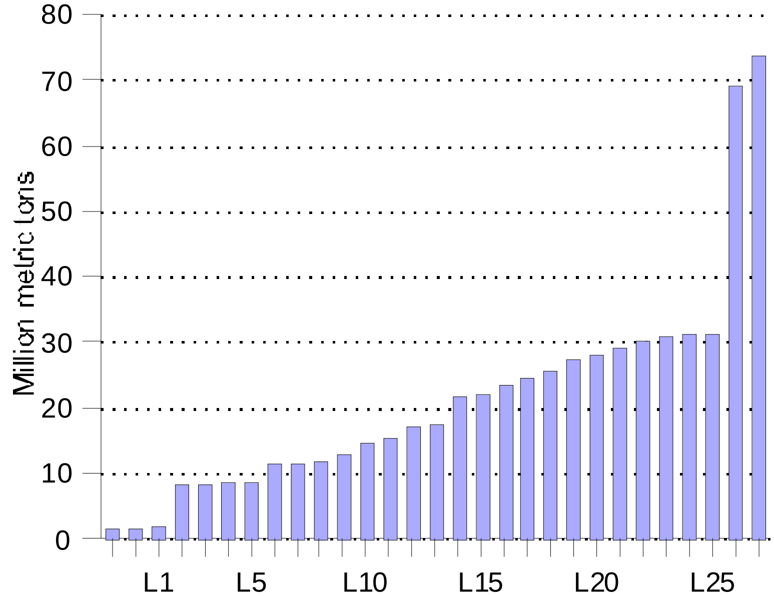
[2] Corps, *Waterborne Commerce of the United States*. UMR-IWW data refers to freight shipped on the Mississippi River above the mouth of the Missouri River, including the Illinois River between Chicago and the Mississippi River. This region encompasses those locks and dams presently under consideration by the Corps for modernization and/or expansion to 1,200 ft. Freight shipped on the Mississippi River below St. Louis is not included. Freight is presented in metric tons (one metric ton equals 1.1023 U.S. short tons) to permit comparisons with international trade data.

Figure 1. Upper Mississippi River - Illinois Waterway Navigation System



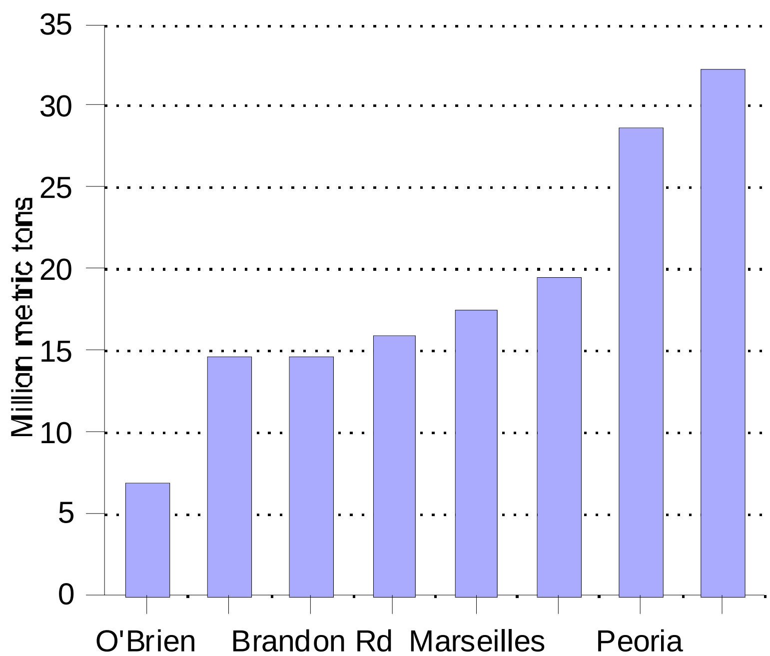
Source: U.S. Army Corps of Engineers, *Alternative Formulation Briefing Pre-Conference Report* (Feb. 9, 2004), p. 5.

Figure 2. UMR Freight by Lock, 2001



Note: Appendix Table A2 has a list of corresponding UMR locks.
Source: Corps, *Draft Feasibility Report and PEIS* (April, 29 2004), p. 45.

Figure 3. IWW Freight by Lock, 2001



Note: Appendix Table A1 has a list of corresponding IWW locks.
Source: Corps, *Draft Feasiblity Report and PEIS* (April 29, 2004), p. 45.

Infrastructure Reliability Concerns

Aging Infrastructure. Most of the locks and dams within the UMR-IWW navigation system were built by the Corps in the 1930s, with an initial projected life span of about 50 years. Commercial shippers and Corps officials estimate that delays due to the continuous degradation of the UMR-IWW system's aging lock-and-dam infrastructure have increased over the past 25 years. As a result, they argue that the Corps has had to continually decrease allowable traffic passing through the locks. Environmental and other groups contend that the Corps has spent over $900 million on UMR-IWW rehabilitation projects since 1975, extending the productive life of existing locks and dams for at least 30 years.[3] For example, in 2001 the Corps completed a major $25.9 million rehabilitation of the Lock and Dam 25.[4]

Lock Length Limits Capacity. Most of the locks in the UMR-IWW navigation system were originally designed to accommodate 600-foot-long barge tows. Twenty-six of the UMR's 29 lock locations have chambers that are 600 feet (ft.) in length. (See **Appendix Tables A1 and A2** for lock details.) The upper and lower St. Anthony Falls locks are 400 ft. and 500 ft., respectively. Three locks — Lock 19, Lock 26 (renamed as the Melvin Price Lock and Dam), and Lock 27 — are 1,200 ft. in length. With a 1,200 ft. lock chamber, a 1,100 ft. barge tow can pass through in about 45 minutes. In contrast, it generally takes between 90 and 120 minutes for an 1,100 ft. barge tow to pass through a 600 ft. lock due to the need to double-lock the barge tow. Double-locking is a procedure whereby a barge tow is broken into two sections; each is passed through the lock chamber separately; then the two sections are rejoined before continuing.

Commercial users argue that, not only do barge tow backups tend to occur at the 600 ft. locks where extensive double-locking causes delays, but double-locking increases the potential for work-related hazards associated with manipulating the binding and guide ropes, etc., while in the narrow lock chamber.[5] As a result, barge companies and corn and soybean producer groups have lobbied actively for the expansion of several of the lower locks. In contrast, budget watchdogs — such as the National Taxpayers Union and Taxpayers for Common Sense — and environmental groups have argued that inexpensive small-scale measures like traffic scheduling, congestion tolls, helper boats, and moorings could reduce lockage times by 20 minutes or more; and that, unlike new or expanded locks that will take decades to build, small-scale measures can be implemented right away at a fraction of the cost.[6]

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[3] *Twice-Cooked Pork: The Upper Mississippi River-Illinois Waterway Navigation Study*, a report prepared by a coalition of interest groups in opposition to large-scale lock expansion; available at [http://www.iatp.org/enviroag/]on June 28, 2004. Hereafter referred to as *Twice-Cooked Pork*.

[4] Ibid, p. 8.

[5] American Soybean Association, Soybean Trade Expansion Program (STEP), *Moving America's Harvest by Barge*, available at [http://www.soygrowers.com/step/barge.htm] on Feb. 11, 2004.

[6] *Twice-Cooked Pork*, p. 3.

Estimated Traffic Delays. The Corps reports that the UMR-IWW system has over half (19 of 36) of the most delayed lock sites in the country's system of inland waterways.[7] Existing delays vary based on the location in the system, but are generally greatest at the locks furthest downstream. (See **Table 1**.) These delays result from traffic backups due to congestion as well as closures for operation and maintenance. From 1990 to 2001, the Corps estimated cumulative average delays per tow of 48.5 hours (more than two days) on the UMR and 10.6 hours on the IWW. For perspective, a barge trip between Minneapolis and St. Louis is estimated to take about 11.4 days, on average, including delays.[8] In effect, the estimated average delays add about two days to what would otherwise be a nine-day trip. Completion of the Corps' recommended navigation improvements are not expected to completely eliminate all delays since a portion of delays are attributable to variability in demand[9] — more than one boat arriving at the same time results in delay, and the seasonality of crop harvesting assures strong autumn demand. Corps data suggest that Locks 26 and 27 experience some of the largest delays despite having undergone fairly recent renovation and having 1,200-ft. lock capacity. The Corps has not published an estimate of the proportion of delays expected to be eliminated by proposed investments.

Table 1. Average Cumulative Lock Delays, 1990 to 2001

Locks	Ave. Hours per Tow	
Upper Mississippi River (UMR): cumulative total	**48.5**	
Locks 1-7		3.9
Locks 8-13		5.2
Locks 14-18		10.8
Lock 19		0.9
Locks 20-25		17.0
Locks 26-27		10.8
Illinois Waterway (IWW): cumulative total	**10.6**	
Peoria Lock		2.5
Lagrange Lock		1.3
Other 6 Locks		6.7

Source: Corps, *Draft Feasibility Report and PEIS*, pp. 52-54.

[7] Corps, *Draft Feasibility Report and PEIS*, pp. 52.

[8] Discussion with Richard Kreider of the Minneapolis-based barge shipper Cargo Carriers, Apr. 16, 2004. According to Mr. Kreider, his firm estimates that a barge traveling either up or down river between Minneapolis and St. Louis moves at an average speed of about 75 miles per day. Thus, a barge would average 11.4 days to make the 854 miles voyage.

[9] David Ronen, Robert Nauss, and Matthew Doughty, *Upper Mississippi River and Illinois Waterways: How to Reduce Waiting Times of Vessels While Using the Current Infrastructure,* Univ. of Missouri-St. Louis, Center for Transportation Studies, Feb. 3, 2003.

Commercial interests complain that existing delays are excessive and significantly raise the cost of barge transportation on the UMR-IWW. Opponents of lock expansion argue that building longer locks will result in only minor time and cost savings for shippers — well below the cost of actually building the locks.[10]

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[10] Public Employees for Environmental Responsibility (PEER), *PEER Looks at the Numbers: Upper Mississippi and Illinois Waterway*, June 7, 2004; available at [http://www.peer.org/corps/] on July 2, 2004. Hereafter referred to as *PEER Looks at the Numbers*.

II. Authorization of UMR-IWW Investments: Issues Before Congress[11]

This chapter briefly describes the Corps' proposal for a joint navigation and ecosystem restoration project, then focuses on the major details of the navigation efficiency improvements component of the proposal. (The ecosystem restoration plan is discussed in Section VI, "Ecosystem Restoration," later in this report.) This chapter also briefly reviews the decision-making process for authorizing large-scale investments in UMR-IWW. Finally, it presents views of various stakeholders.

Corps' Recommended Proposal

To inform the congressional decision on whether to authorize investments in navigation improvements and ecosystem restoration activities on the UMR-IWW, the Corps has been studying the long-run navigation needs of the UMR-IWW system since 1993.[12] Several supporting reports and analyses have been released as part of the Corps' Navigation Study concerning proposed infrastructure alternatives. The Corps' Navigation Study itself has been the subject of controversy. In 2001, in response to criticism, the Corps reformulated its economic analysis and added ecosystem restoration to the study.[13]

In April 2004, the Corps released a draft preferred investment alternative after having analyzed multiple options for navigation and ecosystem restoration. The Corps' recommended 50-year plan integrates investments in both navigation efficiency and ecosystem restoration. The navigation improvements component would cost an estimated $2.4 billion, while the ecosystem restoration plan would cost an estimated $5.3 billion. The Corps recommends that Congress authorize a first increment of the navigation plan at $1.9 billion and a first increment of the ecosystem restoration plan at $1.5 billion.

Authorization, if it occurs, may be part of a Water Resources Development Act (WRDA),[14] which is the typical legislative vehicle for authorizing Corps projects to proceed with construction after a favorable feasibility study and Chief's report. Following authorization, the project would be contingent on Congress remaining

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[11] Prepared by Nicole Carter, Analyst in Environmental Policy, Resources, Science, and Industry Division.

[12] For more information see CRS Congressional Distribution Memorandum, *UMR-IWW Project History*, by Kyna Powers, May 3, 2004.

[13] The National Research Council (NRC) of the National Academies of Science (NRC, Transportation Research Board, *Inland Navigation System Planning: The Upper Mississippi River — Illinois Waterway* (Washington, DC: National Academy Press, 2001)), along with envrionmental organizations, criticized the Corps' UMR-IWW Navigation Study for limiting its environmental analyses to the incremental effects of navigation improvements.

[14] For more information on WRDA and current status of UMR-IWW authorization, see CRS Issue Brief IB10120, *Army Corps of Engineers Civil Works Program: Issues for Congress*, by Nicole T. Carter and Pervaze A. Sheikh.

involved in the UMR-IWW project through the annual appropriations process for the Energy and Water Development Appropriations Act.

Corps' Preferred Navigation Plan. The $2.4 billion, 50-year navigation improvement plan would be paid 50% from federal general revenues and 50% from the Inland Waterways Trust Fund.[15] The Corps recommends initial authorization of a subset of the 50-year plan at $1.9 billion.

This first increment of measures would include:

- authorization and immediate implementation of small-scale and nonstructural measures ($218 million) — mooring facilities at seven locks and phased in switchboats at five locks;[16]
- authorization and immediate implementation of seven new 1,200 ft. locks ($1.66 billion); and
- authorization of continued study and monitoring of the market and traffic conditions of UMR-IWW system and a lock appointment scheduling system.

According to the Corps, analysis has been sufficient to support this initial investment decision if implemented using an adaptive approach. The Corps' preferred plan would give it the authority to proceed with the planning, design, and construction of the seven new locks, but the Administration and Congress would be provided with opportunities to continue, stop, or delay work at three checkpoints.[17] The only activities of the 50-year plan not authorized by the first increment proposed by the Corps are the lock extensions and use of switchboats on the five locks upriver from the seven new locks.

[15] The IWTF is funded by a 20 cent per gallon diesel tax paid by barge operators of vessels engaged in commercial transportation on designated waterways. The IWTF pays half the cost of new construction and major rehabilitation of barge infrastructure. In recent years, collections have exceeded expenditures, so there is a growing unspent balance in the fund. For further information on the IWTF, see CRS Report RL32192, *Harbors and Inland Waterways: An Overview of Federal Financing*, by Nicole T. Carter and John F. Frittelli.

[16] Moorings are tie-off facilities, such as buoys, that provide a closer location to the lock for tows waiting for a turn through the lock, thereby decreasing lockage time. Switchboats would be used to assist tows, by managing the second half of their hauls as they move the first half through the 600-foot locks, resulting in a shorter lockage time. Switchboats would be employed as hired vessels permanently stationed on both the upstream and downstream sides of a lock.

[17] According to the Corps, *Draft Feasibility Report and PEIS*, "implementation of any plan needs to be done in an adaptive framework" (p. x).

The draft feasibility report also presents the analysis the Corps performed to support its recommendation; some conclusions from the analysis were:

- First, the preferred navigation alternative depends greatly on two variables: (1) traffic forecasts derived from future trade scenarios and (2) the price sensitivity of shippers.[18]
- Second, no single navigation alternative was a clear best choice across a range of economic conditions.[19]
- Third, "the risks are high if no action is taken and high traffic occurs. Risks are also high if a large investment is made and increases in traffic do not materialize."[20]

The Corps found that every alternative, including no action, contains risk in the face of an uncertain future. Ultimately, any authorization will likely be based on expectations for the future of the system, particularly as regards agricultural trade and transportation demand, as well as on perspectives of the value and likelihood of success of ecosystem restoration, the weighting of trade-offs among multiple uses, and the selected approaches to risk and uncertainty.

Competing Views on Large-Scale Navigation Investments

Numerous interest groups have expressed strong opinions about large-scale UMR-IWW infrastructure investments. Commercial users of the UMR-IWW navigation system — primarily shippers and agricultural producers — advocate large-scale investments. Major proponents include the National Corn Growers Association, state-level corn growers associations (Iowa, Illinois, Minnesota, Missouri, and Wisconsin), the American Soybean Association, and the shipping industry.[21]

Opponents are a collection of interest groups, including environmentalists, budget hawks, railroads, and truck companies, and economic research institutes who question the rationale for large-scale federal investment in the UMR-IWW system, and have questioned the validity of study estimates of the potential benefits and costs of such projects. Environmentalists argue that at a minimum improving navigation should be undertaken and funded in concert with ecosystem restoration. In contrast, navigation and agricultural groups contend that ecosystem restoration should be funded on its own merits, separate from navigation improvements.

The World Wildlife Federation, Taxpayers for Common Sense, and Public Employees for Environmental Responsibility (PEER) argue that the economic and environmental costs of large-scale capacity expansion on the UMR-IWW system would outweigh the potential benefits, and that many important non-market costs

[18] Ibid., p. 447 and 500.

[19] Corps, *Draft Feasibility Report and PEIS*, p. x, 426-427, 435, and 500.

[20] Ibid., p. 501.

[21] The websites for proponents, opponents, and interested parties are provided in the "For More Information" section at the end of this report.

have been excluded from the Corps' benefit-cost analyses. PEER estimates potential cost savings from proposed lock expansions at about $10 million annually compared with an annual implementation cost of about $191 million.[22] In addition, the Institute for Agriculture and Trade Policy argues that substantial efficiencies remain to be captured from improved management of existing infrastructure, which should be fully exploited before large investments are made in permanent infrastructure.[23]

Alternative transportation modes are less organized in their opposition or support for federal involvement in potential UMR-IWW projects. However, rail interests have argued that the barge industry already receives a disproportionate share of federal support relative to other transportation modes. This support includes the initial lock and dam construction undertaken by the Corps and financed entirely from federal general revenues, and Corps operation and maintenance of the lock and dam system financed 50% from general revenues.

Stakeholders' views on how to proceed with investments vary based on perspectives on the urgency of large-scale investments, its analysis of a range of measures for navigation demand and congestion management, and the sufficiency and credibility of the Corps' analysis of the economic conditions used to compare alternatives.

Urgency of Large-Scale Investments. Proponents of large-scale measures argue that investments need to be made now because the current locks are antiquated and dilapidated, to provide time for the new locks to come online, and for the United States to compete in world markets. They argue that making investment decisions now allows for the most efficient and cost-effective way to modernize the system by taking advantage of ongoing rehabilitation investments for maintenance. The Inland Waterways Users Board — an 11-member advisory committee made up of barge and towboat operators and shippers established by WRDA 1986 to advise the Corps on construction and rehabilitation priorities — places the UMR-IWW projects among its top five capstone projects, which it strongly urges the Administration and Congress to complete.[24]

Other stakeholders, such as the U.S. Environmental Protection Agency and the NRC, disagree about the urgency of such large investments; these stakeholders propose testing the need for large-scale improvements by first exhausting small-scale measures.[25] Environmental groups advocate waiting to make an authorization decision until more information is available. In particular, they argue that the decision should not be made before (1) the independent review of the draft feasibility report being conducted by a National Research Council panel is complete, (2) a

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[22] *PEER Looks at the Numbers*.

[23] Institute for Agriculture and Trade Policy, *Simple Steps Could Improve Mississippi River Barge Traffic*, Dec. 1, 2003; available at [http://www.iatp.org/iatp/library/admin/uploadedfiles/Simple_Steps_Could_Improve_Mississippi_River_B.pdf] on July 14, 2004.

[24] Inland Waterways Users Board, *18th Annual Report to the Secretary of the Army and the United States Congress* (Washington, DC: Army Corps of Engineers, March 2004).

[25] *Twice-Cooked Pork.*

complete economic-transportation model is available to analyze the costs and benefits of investments, and (3) a final Corps report is available. Those opposed to expanding lock capacity argue that the locks are not in disrepair, citing that the Corps has an ongoing rehabilitation program and that the existing locks are incorporated into the design of the new locks.[26] They also argue that the cost of new locks exceeds the value of the reduction in barge waiting time.[27]

Congestion Management and Other Small-Scale Alternatives. Small-scale measures to manage waterway congestion — for example, congestion tolls, tradable arrival slots, and industry self-help — have been discussed for use on the UMR-IWW. Small-scale measures can be either structural or nonstructural and are smaller in scope and cost than new locks or lock extensions. Some small-scale measures have been considered, independent of large-scale measures, either to better manage demand or to better operate existing infrastructure; other measures were analyzed for use in combination with large-scale improvements. The draft navigation plan recommended by the Corps includes the immediate implementation of two small-scale measures — moorings and switchboats — and the study of a lock appointment scheduling system as well as large-scale measures.

Some stakeholders, primarily environmental interests, have questioned whether large-scale investments could be delayed, or avoided, by implementing congestion management and other small-scale measures. These stakeholders criticize the Corps' analysis of small-scale measures as incomplete. Supporters of new locks argue that small-scale measures are impracticable and that they would provide only incremental benefits over existing operations. They argue that existing operations have serious shortcomings and question the logic of investing resources in small-scale measures when, they argue, large-scale measures are needed.

Analysis of Benefits and Costs. As part of a navigation feasibility study, the Corps generally forecasts demand for navigation movements over 50 years on a waterway and then uses this information to calculate benefits and costs for multiple investment alternatives. Creating long-term forecasts to support long-term decisions is an analytic challenge; long-term forecasts inherently contain large uncertainties. Consequently, traffic demand forecasting has been a contentious element in the development of the UMR-IWW feasibility study.

Rather than forecast demand over 50 years, the Corps' draft report used a scenario-based approach. Specifically, the Corps examined movements on the UMR-IWW for five future traffic scenarios that are based on differing world trade, crop area, crop yield, and consumption patterns. Then, it combined the five scenarios with

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[26] *Twice Cooked Pork*. In response, Midwest River Area Coalition 2000 (MARC 2000) — a coalition of shippers, carriers, agricultural, industrial, environmental and government interests to promote Midwest economic growth by responsibly developing and improving the UMR-IWW — released a report available at [http://www.marc2000.org/Documents/Twice_Cooked_Pork_vs_Reality_Final.pdf] on July 7, 2004. The Army Corps of Engineers has also responded; see [http://www.mvr.usace.army.mil/NewsReleases/newsform.asp?SEQNO=396], visited July 7, 2004.

[27] *PEER Looks at the Numbers*.

three different economic conditions to model the uncertainty in waterway traffic demand.

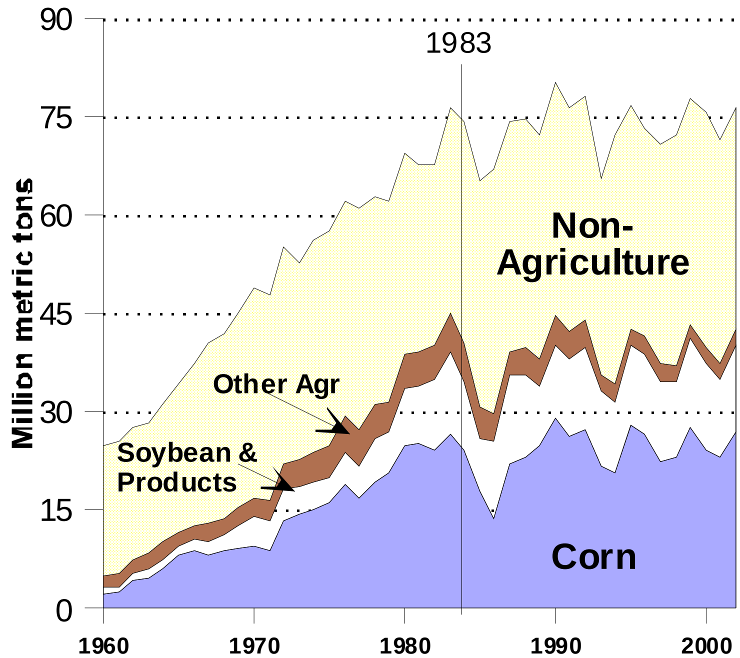
Both elements of this analysis — the five scenarios and the three conditions — have been criticized by stakeholders opposed to proceeding with large-scale measures, as well as by a National Research Council review committee. They argue that four of the five scenarios are unrealistically optimistic, which is inconsistent with export levels over the last 20 years. Regarding the economic modeling conditions, they argue that the conditions are based on either discredited or incomplete models. They also criticize the Corps for not assigning probabilities to the various scenarios. These same critics argue that the Corps has a history of overestimating barge traffic when justifying investments in inland waterways.[28] The Corps has defended its approach as an attempt to address the uncertainties and weakness of available tools. The Corps also states that it is actively engaged in improving its economic modeling capability, but that the results of this research are years away from application.

[28] *Twice-Cooked Pork*; and National Research Council, Transportation Research Board, *Inland Navigation System Planning: The Upper Mississippi River — Illinois Waterway* (Washington, DC: National Academy Press, 2001).

III. Freight Traffic on the UMR-IWW[29]

As noted in the previous section, the Corps found that its analysis of navigation imvestment alternatives was greatly dependent on two factors; one of these was the traffic forecasts derived from future trade scenarios. To appreciate the uncertainties surrounding what the future demand for navigation traffic on the UMR-IWW might be, it is useful to review the historic and current traffic.

Figure 4. UMR-IWW Navigation System Freight Traffic, by Major Category



Note: Traffic includes upward and downward freight movement on the Mississippi River and its tributaries between Minneapolis and the mouth of the MissouriRiver.
Source: Corps, *Waterborne Commerce of the United States.*

For most of the UMR-IWW's early history (1930 to 1970), agricultural commodities constituted a minor, albeit growing, share of freight transport on the Mississippi River. Instead, non-agricultural commodities such as coal, petroleum, various ores, lumber, and primary manufactured products accounted for the largest share of freight. However, by the 1970s agricultural bulk commodities caught up to and surpassed non-agricultural products as the dominant source for barge freight. (See **Figure 4**.) As a result, the linkage between the UMR-IWW region's agricultural sector and barge transportation on the Mississippi River system has been growing in economic importance. However, over the past decade domestic and international developments have gradually been changing the nature and intensity of

[29] Prepared by Randy Schnepf, Specialist in Agricultural Policy, Resources, Science, and Industry Division.

that linkage. This chapter provides background on the linkage between U.S. agriculture and the UMR-IWW navigation system.

Agricultural Commodities Constitute Majority of Traffic

During 1990 to 2002, an annual average of nearly 74.3 million metric tons (mmt) of freight moved on the UMR-IWW each year. (See **Appendix Table A4**.) Grain, oilseeds, and other agricultural products averaged 40.1 mmt or 54% of total barge traffic. Corn, soybeans, and soybean products composed the bulk of annual agricultural trade, averaging a combined 37.3 mmt — representing 93% of all agricultural freight or 50% of total freight. Corn constituted the largest share of agricultural bulk freight with an annual average of 25.2 mmt, while whole soybeans averaged 8.8 mmt, animal feeds (primarily soymeal) averaged 2.8 mmt, and vegetable oil (primarily soy oil) averaged 0.5 mmt.

In addition, the UMR-IWW system provides an important conduit for non-agricultural commodities that directly supports regional economic activity. During the 1990-2002 period, about 34.2 mmt of non-agricultural freight moved annually within the UMR-IWW. As with agricultural freight, total non-agricultural freight has shown no growth since the early 1980s. However, within the total non-agricultural freight category, both primary manufactured goods (such as cement, pig iron, and metal sheets) and non-energy raw materials (such as sand and gravel) freight volume has shown slow steady growth, while energy freight (i.e., coal and petroleum) has declined. In addition to energy and raw materials, the UMR-IWW system provides an inward conduit for fertilizers, fuel, and other non-agricultural commodities that are directly important as inputs to the region's agricultural sector. For example, during 1990-2002 more than 3 mmt of agricultural fertilizers moved annually within the UMR-IWW system in support of U.S. agricultural production.

Regional Agricultural Exports Moved on the UMR-IWW. The Upper Mississippi River basin encompasses large portions of the central and western Corn Belt and the eastern fringes of the Northern Great Plains. Five of the nation's top agricultural production states — Iowa, Minnesota, Illinois, Missouri, and Wisconsin — have traditionally relied on the UMR-IWW navigation system as their principal conduit for export-bound agricultural products — mostly bulk corn and soybeans. Together, these states accounted for over half of U.S. corn and soybean production, and nearly half of the value of U.S. corn and soybean exports during 1998-2002. (See **Table 2**). The region accounted for only about 10% of U.S. wheat production and exports.

While the UMR-IWW is an important transportation mode for regional corn and soybean exports, it is not the only carrier. In terms of total volume, the UMR-IWW carried about 53% of total U.S. bulk corn exports and 38% of bulk soybean exports during the 1998-2002 period. Only about 3% of U.S. bulk wheat exports moved via the UMR-IWW during the same period.[30]

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[30] Corps, *Waterborne Commerce of the United States*; and USDA, Foreign Agricultural Service, *Production, Supply and Distribution (PSD) online database*, available at (continued...)

Table 2. UMR-IWW Five-State Region: Corn, Soybean, and Wheat Production and Trade, Annual Average for 1998-2002

	Production				Exports[a]	
Crop/State	Planted	Output	Price	Value	Value	Share of Prod
	Million acres	Million bushels	$/bu.	$ million	$ million	%
CORN					Feed grains	
Five-state region	36.7	5,050	2.02	10,219	3,066	30%
Share of U.S.	47%	53%	—	54%	46%	
SOYBEANS					Soybean & products	
Five-state region	35.0	1,406	5.12	7,200	3,797	53%
Share of U.S.	48%	51%	—	55%	52%	
ALL WHEAT					Wheat & products	
Five-state region	4.1	191	2.81	538	487	91%
Share of U.S.	7%	9%	—	9%	10%	

Source: Crop production data is from USDA, National Agricultural Statistics Service, Agricultural Statistics Database, available online at [http://www.nass.usda.gov:81/ipedb/], visited on March 8, 2004; export data is from USDA, Economic Research Service, "State Export Data," available at [http://www.ers.usda.gov/data/stateexports/], visited on March 8, 2004.
[a]Export totals include the value of products. As a result, exports expressed as a share of the value of production represent an upper bound on the true bulk export share. Note also that not all of these exports are made via the UMR-IWW. See **Section IV** for more information on export outlets.

Variations in Traffic by River Reach

Agricultural barge freight on the UMR-IWW between Minneapolis and the mouth of the Missouri River grew rapidly for several decades in the post-WWII era, but has leveled off since the early 1980s. (See **Figure 5**.) There is disagreement over the cause for this lack of growth in barge demand. Is the fall-off in barge traffic a supply problem resulting from a shortage of lock infrastructure? Or is it a demand problem due to a stagnation in foreign demand for U.S. feedstuffs?

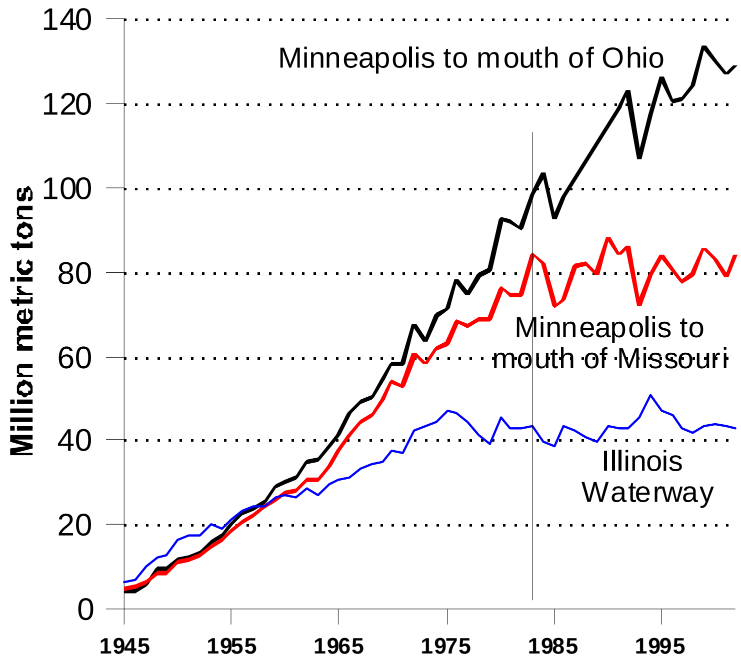
Shipping and agricultural interests argue that stagnant UMR-IWW barge traffic is due to delays associated with aging infrastructure and limited lock capacity; that the costly delays are increasingly forcing grain shippers to switch to alternate transportation modes to ensure timely arrival at downriver processing plants or Gulf ports; that the declining efficiency of the UMR-IWW is hurting both U.S. competitiveness in international markets and U.S. farm incomes at home; and that new investment is needed to modernize and expand the capacity of the locks.[31] In support of these arguments, officials from the Corps report that unplanned closures

[30] (...continued)
[http://www.fas.usda.gov/psd/] on April 8, 2004. The percentages represent a comparison of UMR-IWW freight as a share of total U.S. exports for each commodity.

[31] The websites for proponents, opponents, and interested parties are provided in the "For More Information" section at the end of this report.

due to aging infrastructure have increased, thus reducing the number of days annually that locks are open to traffic.[32]

Figure 5. Upper Mississippi River Freight Traffic by River Reaches



Note: Traffic includes upward and downward freight movement.
Source: Corps, *Waterborne Commerce of the United States.*

According to the Corps, commodity shippers under contract delivery deadlines are increasingly shifting to alternate, often more expensive transportation modes to ensure timely delivery. The Corps contends that this contributes to stagnant levels of freight traffic on the UMR-IWW system above the mouth of the Missouri River. The two remaining locks located below the mouth of the Missouri River — the Melvin Price Lock and Dam (formerly Lock and Dam 26) and Lock and Dam 27 — are both 1,200 ft. long. Below Lock and Dam 27, the Mississippi River is free-flowing to the Gulf ports. In contrast to the stagnant traffic flows on the UMR-IWW, freight traffic measured between Minneapolis and the mouth of the Ohio River (which excludes Ohio River traffic) has continued to grow during the past two decades, albeit at a much slower pace than during the four decades following World War II. (See **Table 3**.)

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[32] Telephone conversation with Arlene Dietz, Director of the Navigation Data Center, U.S. Army Corps of Engineers, April 16, 2004.

Table 3. Average Annual Growth in Freight Traffic for UMR-IWW Reaches: 1945-1983 Compared with 1983-2002

UMR-IWW region	Average annual growth rate	
	1945 to 1983	1983 to 2002
Minneapolis to mouth of Ohio	7.7%	1.4%
Minneapolis to mouth of Missouri	7.2%	0.0%
Illinois Waterway	4.8%	-0.1%

Source: Growth rates were calculated by CRS using data from Corps, *Waterborne Commerce of the United States*.

Other interest groups contend that growth in domestic demand, as well as international market conditions, have changed substantially since the period of rapid growth in barge demand experienced during the 1960s and 1970s.[33] Global events as reported in numerous USDA publications appear to support this conclusion.[34] Several of the more salient historical market phenomena include:

- Since most corn and soybeans traded in global markets are ultimately used for animal feed, international demand is highly dependent on general economic conditions. Global economic conditions were positive in the 1970s, but stagnated during the 1980s. (See **Figures 6 and 7**.) U.S. corn and soybean exports echoed this pattern as the weak economic growth translated into weak international demand for animal feeds.
- Widespread growth in foreign grain production during the 1980s and 1990s contributed to the general decline in U.S. corn exports.
- The early 1990s witnessed the loss of a major demand source for U.S. feedstuffs, particularly corn, with the breakup of the former Soviet Union (FSU) and the wide scale liquidation of Soviet animal herds.
- China entered world corn markets as a major exporter in 1984, just as the FSU was preparing to leave the market. Since 1984, China's corn exports have displaced U.S. corn in many Asian markets that had traditionally imported U.S. corn (e.g., South Korea, Taiwan, Philippines, and Indonesia).
- In the late 1980s, three major U.S. corn importers — Japan, South Korea, and Taiwan — began to import increasing amounts of beef, displacing their internal beef production and lowering their demand for feed grains. This trend continued through the 1990s and had the effect of reducing feed demand.

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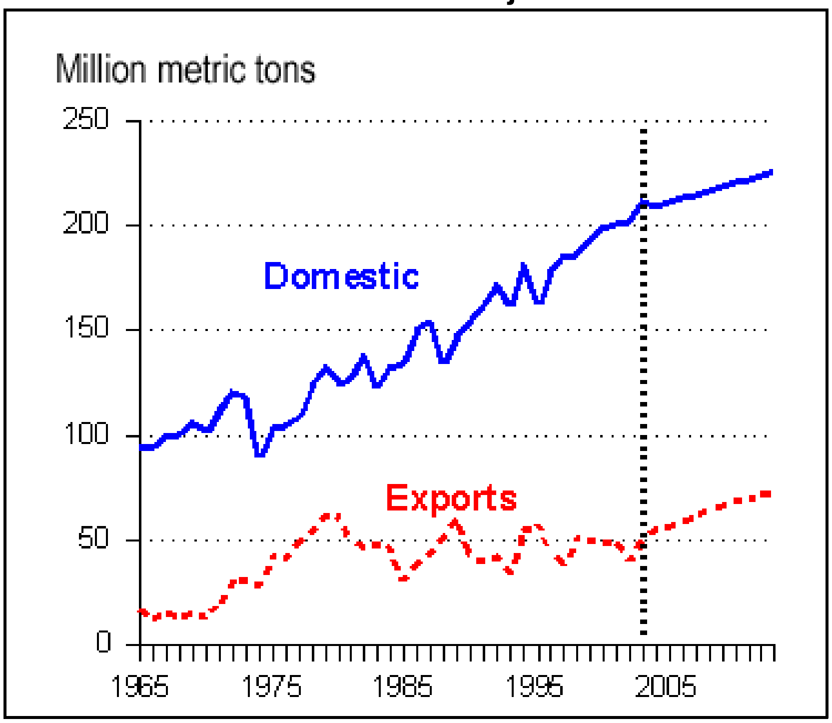
[33] Mark Muller, *Comments on the U.S. Army Corps of Engineers' Upper Mississippi River — Illinois Waterway System Navigation Study* (Minneapolis: Institute for Agriculture and Trade Policy, Oct. 28, 2003); available at [http://www.iatp.org/enviroag/publications.cfm], visited on Feb. 17, 2004.

[34] See CRS Report RL32401, *Agriculture as a Source of Barge Demand on the Upper Mississippi and Illinois Rivers: Background and Issues*, by Randy Schnepf, for a discussion of these events and USDA information sources.

- U.S. corn exports have been effectively shut out of EU markets since 1998, when the EU, in a dramatic policy reversal, imposed a de facto ban on agricultural products originating from genetically engineered seeds.[35]
- In the early 1980s, policy changes in the EU — the primary market for U.S. soybeans — expanded EU rapeseed production and curtailed EU oilseeds imports.[36]
- Increasing competition from Argentina and Brazil since the mid-1990s has cut into U.S. market share in international markets for soybeans and soybean products.

The net sum of these changes has been heightened competition in a demand-weakened international feedstuffs market, and volatile but essentially flat U.S. corn and soybean exports since the early 1980s.

Figure 6. U.S. Domestic and Export Demand for Corn, Historical and Projected

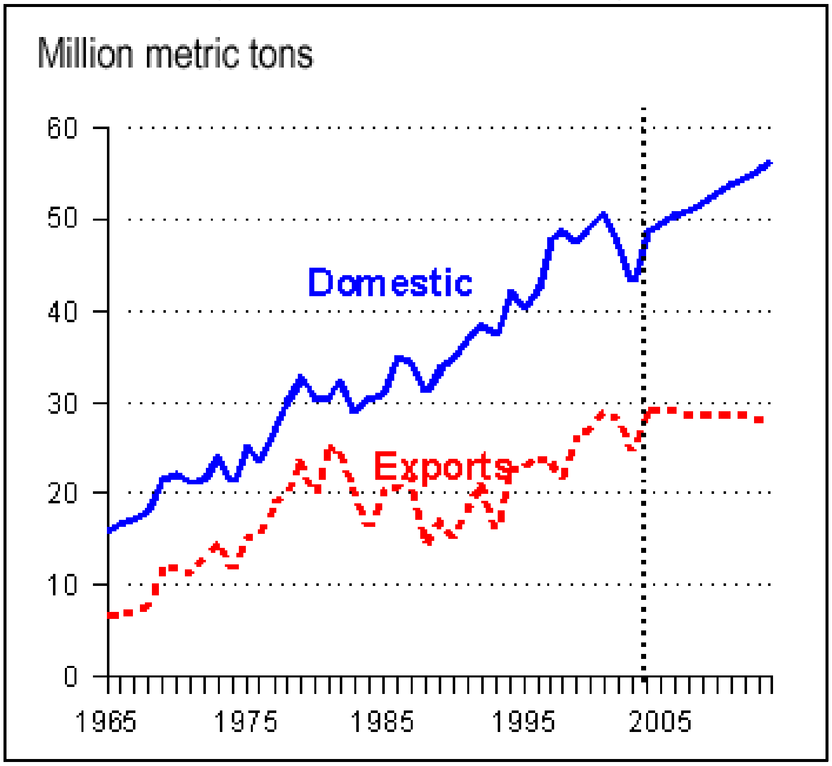


Source: 1965 to 2003 data: USDA, *Production, Supply, & Demand* online database (March 10, 2004); 2004 to 2013 data: *USDA Agricultural Baseline Projections to 2013* (Feb. 2004).

[35] CRS Report RS21556, *Agricultural Biotechnology: The U.S.-EU Dispute*, by Geoffrey S. Becker and Charles E. Hanrahan.

[36] USDA, Economic Research Service, *Background for 1995 Farm Legislation*, AER 715 (Washington, DC: May 1995), p. 21.

Figure 7. U.S. Domestic and Export Demand for Soybeans, Historical and Projected



Source: 1965 to 2003 data: USDA, Production, Supply, & Demand online database (March 10, 2004); 2004 to 2013 data: USDA Agricultural Baseline Projections to 2013 (Feb. 2004).

IV. Outlook for Agriculture-Related Barge Demand[37]

According to the National Research Council (NRC) of the National Academies of Science, "Good decisions regarding investments in large civil works projects such as lock extensions on the Upper Mississippi River require some consideration of the future demands for those projects."[38]

This chapter briefly discusses the Corps' long-run barge demand projections. Because UMR-IWW agriculture-related barge demand showed robust growth during the 1960s, 1970s, and early 1980s relative to non-agriculture demand, most economic analyses of future barge demand have focused on agriculture as the most likely

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[37] Prepared by Randy Schnepf, Specialist in Agricultural Policy, Resources, Science, and Industry Division. For a more detailed discussion of agriculture-related barge demand, see CRS Report RL32401, *Agriculture as a Source of Barge Demand on the Upper Mississippi and Illinois Rivers: Background and Issues*, by Randy Schnepf.

[38] National Research Council, *Review of the U.S. Army Corps of Engineers: Restructured Upper Mississippi River - Illinois Waterway Feasibility Study* (Washington, DC: National Academy Press, 2004), p. 7.

source of long-run growth, driven primarily by expectations for expanded international trade. In contrast, non-agricultural freight movement on the UMR-IWW — inasmuch as it represents raw material for construction and industrial processing — is expected to ebb and flow with the regional economy. As a result, this chapter focuses on key issues and uncertainties behind evolving trade patterns and projections for future agricultural freight traffic on the UMR-IWW. A preliminary conclusion is that there appears to be substantial potential for future agriculture-related barge demand to fall short of the expectations of proponents of large-scale investment in the UMR-IWW.

Corps' Long-Run Outlook Questioned

As previously noted, one of the Corps' objectives under the UMR-IWW navigation study has been to evaluate the potential barge demand over a 50-year time horizon (specifically, 2000 to 2050). However, the primary studies undertaken either by or for the Corps to examine projected UMR-IWW traffic flows and barge demand have met with skepticism from investment critics as well as from the NRC.[39] In particular, major shortcomings cited by the NRC include:

- The various models used by the Corps to estimate the benefits of UMR-IWW infrastructure investments have been characterized by flawed assumptions and data, and have relied on inadequate methodologies.
- Corps analyses have tended to ignore or minimize the potential for alternate routes to evolve based on international market conditions.
- Corps studies supporting new lock investments have relied on very optimistic growth projections for both international demand for bulk commodities and U.S. exportable surpluses of bulk commodities.

Other critics have also questioned the strong barge demand growth projections given that U.S. corn exports have shown no growth during the past two decades, while soybean exports have grown slightly but with substantial variability. At the same time, projections for global population and income growth would suggest that demand for agricultural products will increase. However, this alone is insufficient to justify projections for strong growth in bulk commodity flows on the UMR-IWW system. Any comprehensive analysis must consider the evolution of specific market forces and the potential shifts in trade flows and patterns that they are likely to engender. The following discussion considers these points.

Two Questions Underlie the Outlook for Barge Demand

Given the UMR-IWW basin's likelihood of remaining a major corn and soybean producer for the next several decades, projections of significant growth in barge demand on the UMR-IWW system hinge on the outlook for two aspects of U.S. corn and soybean production and trade:

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[39] References for Corps' economic studies and NRC reviews are in Section VII, "For More Information," at the end of this report.

1. **Prospects for Exportable Surplus.** How will growth in U.S. production compare with domestic use? In other words, what are the prospects for exportable supplies?

2. **Mode and Route Choices for Exportable Surplus.** What is the likelihood that such exportable surpluses, if realized, will demand barge transportation on the UMR-IWW navigation system rather than alternate transportation modes and routes? This hinges on the projected evolution of international demand and supply conditions.

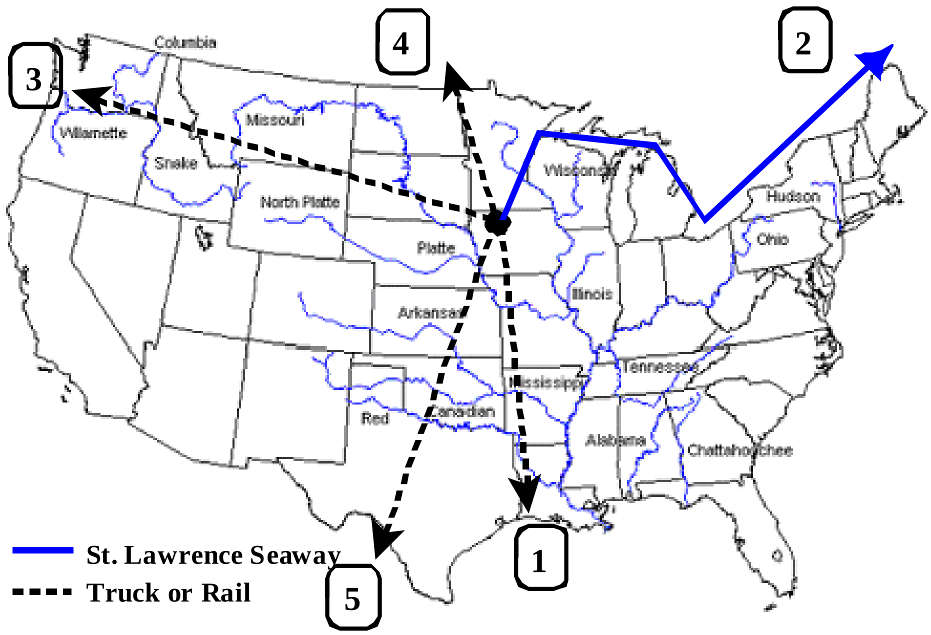
Prospects for Exportable Surplus. Strong growth in domestic demand — from the livestock sector, the food and industrial processing sector, and the biofuels industry (particularly corn-based ethanol production) — has steadily reduced the share of production that is available for export to international markets. (See **Figures 6 and 7**.) While the long-term outlook for corn production may be optimistic, the trend of the past five years suggests that domestic consumption, driven by growth in meat and dairy products, as well as increasing ethanol production, will continue to capture a growing share of total use. The introduction of a renewable fuels standard (RFS), as proposed in pending energy legislation, could accelerate this process.[40] Strong growth in domestic use as a share of total production tends to limit growth in exportable supplies for two reasons.

- Domestic users generally offer higher returns over international markets. As a result, exports are generally supplied as a residual outlet after domestic users have been satisfied.
- Strong domestic demand has traditionally kept U.S. prices at a slight premium with respect to other international exporters, hindering U.S. competitiveness, particularly as compared to foreign producers with heavier export orientations like Argentina and Brazil.

Mode and Route Choices for Exportable Surplus. In addition to the volume of exportable surplus, agriculture-related demand for barge transportation on the UMR-IWW is highly dependent on international market conditions and on the availability and cost of alternate transportation modes and routes. Considerable uncertainty surrounds long-run international market projections. Many of the projected long-run commodity trade outcomes hinge on policy decisions made by foreign countries, such as China, rather than the economic forces driven by supply and demand conditions. This is particularly true for the two major agricultural commodities historically shipped on the UMR-IWW — corn and soybeans.

[40] For more information, see CRS Report RL30369, *Fuel Ethanol: Background and Public Policy Issues*, by Brent D. Yacobucci and Jasper Womach.

Figure 8. Trade Route Alternatives to UMR-IWW out of Upper Midwest



1 = Gulf ports. 2 = St. Lawrence Seaway. 3 = Pacific Northwest ports.
4 = Canada feed demand. 5 = Mexican feed demand.
Source: Congressional Research Service.

A review of historical evidence suggests that shifts in the sources and nature of international demand — resulting from population and income dynamics, increasing competition from South American exporters, evolving bilateral and multilateral trade agreements, and trade disputes related to U.S. production and use of biotech crops — have induced exporters to seek nontraditional routes to new and expanding export markets, and have drawn exportable supplies of corn and soybeans away from the UMR-IWW system. (See **Figure 8**.) Several factors have contributed to shifts toward other trade routes and suggest that this trend is expected to continue.[41]

First, the North American Free Trade Agreement (NAFTA) among the United States, Mexico, and Canada, beginning in 1994, increased market access for U.S. agricultural products to Mexican and Canadian markets. Overland truck and rail routes to the NAFTA partners — Mexico and Canada — have expanded rapidly during the past 10 years, particularly for perishables, but also for grains and oilseeds. In addition, both Mexico and Canada have made major changes in their domestic agricultural policies that have contributed to growing imports of U.S. agricultural products. Together, the two NAFTA partners import a sizable share of U.S. corn and soybean shipments. During 2000-2003, Canada and Mexico accounted for about 19% of U.S. corn exports, up sharply from a 6% share during 1989-1993. U.S.

[41] USDA, Office of the Chief Economist, *USDA Agricultural Baseline Projections to 2013*, Staff Report WAOB-2004-1 (Feb. 2004).

exports of soybeans and soymeal to Canada and Mexico have shown similar growth increasing from a 17% share to a 26% share during the same time periods.

Second, as mentioned earlier, competition from Argentina and Brazil in international agricultural markets has increased sharply since the mid-1990s. Between 1995 and 2003, the two South American countries expanded their production by about 250% and their combined exports of soybeans and products expanded by 256%.[42] The U.S. share of the international market for soybean and products has declined from 72% in 1986 to less than 25% in 2003. This trend is expected to continue. U.S. exports that move via the UMR-IWW system to Gulf ports and the Atlantic directly confront growing South American competition. In contrast, overland routes to major ports on the West Coast offer direct access to the Pacific Ocean and Asian markets and are beginning to compete with the traditional UMR-IWW-to-Gulf-Ports-to-Panama-Canal route to Asia.

Third, phenomenal growth in soybean import demand from China in recent years has spurred the growth of rail shipments out of the Northern Plains and the UMR-IWW basin to the Pacific Northwest (PNW). Dramatic income growth since the mid-1980s has been accompanied by sharp increases in China's demand for meat products. One of several policy responses by China's government has been to permit increased soybean imports starting in the late 1990s. By 2002 more than one-third of all soybeans traded in international markets was destined for China. USDA projects that China will account for 73% of global soybean import growth over the next decade. As a result, U.S. soybean shippers are looking for the most cost-effective routes to China. Higher costs associated with the UMR-IWW system plus rising fees to pass through the Panama Canal have made the PNW route increasingly attractive, particularly for soybeans from the Dakotas.

Finally, two other factors have contributed to the development of an overland PNW route for soybeans from the western Corn Belt. First, recent genetic advancements have produced hardier soybean varieties that have pushed their production into the Plains states at the expense of traditional small grains crops. Soybean production in the Dakotas is located far enough from the UMR-IWW system to make a PNW route more cost effective. Once the Midwest-to-PNW route becomes established and economies of scale ensue, more soybeans from the western Corn Belt could potentially be diverted from the UMR-IWW. A second factor has been the increased use of 110-car shuttle trains to the PNW. These longer trains are designed to capture the economies of scale inherent in shipping larger volumes of a commodity long distances.

Considerable Uncertainty Clouds Long-Run Barge Demand. If a continuation of the evolving trade patterns described in the preceding section are realized, then future growth in barge demand from the agricultural sector may fall short of levels anticipated by proponents of large-scale investments in the UMR-IWW. **Table 4** compares the growth rates for agriculture-related barge demand on the UMR-IWW from the four scenarios developed for the Corps by Sparks

[42] USDA, Foreign Agricultural Service, *Production, Supply and Distribution (PSD) online database*, available at [http://www.fas.usda.gov/psd/] on April 8, 2004.

Companies, Inc. (SCI) with a hypothetical scenario developed by CRS based on USDA's long-run baseline projections (the adjusted UMR-IWW scenario).[43] Since USDA does not project port shares for U.S. exports, the CRS scenario adjusts USDA's total export growth rates for the potential effects of increased trade flows via the non-UMR-IWW routes suggested in the preceding section.

Table 4. Comparisons of UMR-IWW Average Annual Agricultural Freight Export Growth Rate Projections

Scenarios	Corn	Soybeans	Weighted Average
Sparks Companies, Inc. (SCI)[a]			
UMR-IWW (Most favorable scenario)	1.8%	0.4%	1.5%
UMR-IWW (Central scenario)	1.3%	1.0%	1.2%
UMR-IWW (Hypoxia scenario)	1.1%	0.8%	1.0%
UMR-IWW (Least favorable scenario)	-7.0%	0.2%	-2.0%
Adjusted UMR-IWW[b]	1.4%	-2.4%	0.3%

[a] Sparks Companies, Inc., *Upper Mississippi River and Illinois Waterway Navigation Study: Economic Scenarios and Resulting Demand for Barge Transportation*, May 1, 2002.
[b] Adjustments are made by CRS based on USDA's long-run market outlook and potential trade shifts as described in CRS Report RL32401, *Agriculture as a Source of Barge Demand on the Upper Mississippi and Illinois Rivers: Background and Issues*, by Randy Schnepf.

In every SCI scenario, with the sole exception of the SCI-least-favorable scenario, the average annual growth rates for UMR-IWW barge demand from corn and soybeans exceeds the adjusted UMR-IWW freight projections. For example, the SCI-central scenario assumed an average weighted annual growth rate of 1.2% for corn and soybean freight on the UMR-IWW. In contrast, the adjusted UMR-IWW growth rate was significantly smaller, at 0.3%.

Outlook Summary. The eventual UMR-IWW barge traffic will depend on corn and soybean production growing faster than domestic demand, and on whether the evolution of international market conditions favors or disfavors the UMR-IWW over alternate trade routes and transportation modes. While it is likely that investments in the UMR-IWW navigation system would result in lower barge freight rates and increased demand for barge services, the magnitude of these outcomes will depend on the interplay of the many forces affecting U.S. agricultural export markets. Based on an evaluation of USDA's long-run outlook for international commodity markets, there appears to be substantial potential for future agriculture-related barge demand to fall short of investment proponents' expectations.

[43] USDA, Office of the Chief Economist, *USDA Agricultural Baseline Projections to 2013*, Staff Report WAOB-2004-1 (Feb. 2004). Projections for 2003/04 to 2013/14 are available at [http://www.ers.usda.gov/publications/waob041/waob20041.pdf], visited April 29, 2004.

V. Transport System Issues[44]

This chapter examines the infrastructure needs of grain carriers and shippers from a systemwide perspective that considers the interplay of barge, rail, and truck transport markets. First, it describes the role of transportation costs in U.S. and international markets; in particular, it explains how changes in barge rates might affect grain producers. Then it briefly describes how grain is delivered to market, including major changes taking place across transport modes and the underlying reasons for those changes. Next, it discusses emerging rail issues and relates them back to barge transportation. Finally, it compares some of the environmental and social effects of transport by barge, rail, and truck.

Why Transportation Costs Matter to Agriculture[45]

In competitive grain and oilseed markets, transfer costs — handling and transportation charges — are a major factor in determining market price differentials. Agricultural producers are concerned about transportation costs because the price that they receive for their agricultural commodities is derived from the price established in major markets (whether a processing plant, feedlot, or export terminal) less transportation and handling costs. The more it costs to transport a commodity to a buyer, the less the producer will receive and vice versa. As a result, any process that reduces the cost of moving a commodity to a buyer likely benefits producers by raising the amount that they receive, which subsequently benefits the local economy by generating greater farm income and associated economic activity.[46]

In contrast, raising domestic transportation costs widens the farm-to-market price differential. A widening differential generally compels exporters to offer the products in international markets at higher prices — that is, less competitively. Higher U.S. export prices relative to international competitors will lower the demand for U.S. exports of corn and soybeans. Lower export demand reduces total demand, and consequently lowers the prices and income received by farmers for a given level of production.

Barge Transport Generates Cost Savings. Barge transportation represents a low-cost method of moving bulk commodities long distances. Most economists and market analysts agree that inexpensive barge transportation helps check rates charged by the rail and truck transportation industries. Low internal

[44] Prepared by John Frittelli, Analyst in Transportation; Nicole T. Carter, Analyst in Environmental Policy; and Randy Schnepf, Specialist in Agricultural Policy, Resources, Science, and Industry Division, as noted.

[45] Prepared by Randy Schnepf, Specialist in Agricultural Policy, RSI Division.

[46] For a discussion of the economy-wide economic costs associated with higher agricultural transportation costs (including higher consumer food prices, as well as local, state, and national tax revenue and employment losses), see Dr. Michael Evans. *Determination of the Economic Impact of Increased Congestion on the Upper Mississippi River - Illinois River Waterway* (Evans, Carroll & Associates, March 2002).

transport costs relative to export competitors such as Argentina and Brazil have helped U.S. products compete in international corn and soybean markets.[47]

Because barge rates are generally significantly lower than either rail or truck, the UMR-IWW navigation system provides considerable transportation cost savings to the regional and national economy. An evaluation of transportation costs for the UMR-IWW system commissioned by the Corps indicated that rate savings to waterway users averaged about $8.08 per ton (1994 prices) over the best possible all-land routing alternative.[48] The rate savings varied by commodity and included, for example, $0.18/bushel for corn (8% of the 1994 season average farm price (SAFP) of $2.26/bushel) and $0.35/bushel for soybeans (6% of the 1994 SAFP of $5.48/bushel).[49] Based on these cost savings relative to alternate transportation modes, the Corps estimates that the existing UMR-IWW system generates transportation cost savings of $0.8 billion to $1.2 billion (2001 prices) per year, based on 2000 traffic levels.[50] These benefits compare with average annual operation and maintenance costs of about $115 million.[51]

Barge Delays Increase Costs. Shippers of bulk commodities rely on volume to make a profit. For a barge plying the inland waterways, a key determinant of the amount of freight that can be carried in a season[52] is the time it takes to make each haul. The shorter the haul time, the more total hauls that can be made and the more freight that can be moved. As a result, delays associated with aging locks and dams represent lost time, lost potential freight, and lost profits. Waiting delays also represent lost fuel. Towboats on the UMR-IWW burn about 80 gallons of diesel fuel per hour.[53] The engines are kept running while each towboat waits for its turn through the lock.

An economic study found that lock delays on the UMR-IWW are associated with higher barge rates; however, the effect was not large — a 10% increase in delay at any given lock was estimated to increase barge rates by 0.16% to 0.59%.[54]

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[47] Randall D. Schnepf, Erik N. Dohlman, and Christine Bolling, *Agriculture in Brazil and Argentina: Developments and Prospects for Major Field Crops*, USDA, Economic Research Service, Agriculture and Trade Report No. WRS013, (Washington: Dec. 2001), pp. 53-60.

[48] U.S. Army Corps of Engineers and the Tennessee Valley Authority, *Transportation Rate Analysis: Upper Mississippi River Navigation Feasibility Study* (July 1996).

[49] Corps, *Draft Feasibility Report and PEIS*, p. 52. These data were reported on a per ton basis as $7.08/ton for corn and $12.85/ton for soybeans.

[50] Ibid., p. 55.

[51] Ibid., p. ii.

[52] The Upper Mississippi River closes for nearly four months every winter above the Quad Cities near Lock and Dam 15. This increases the time pressure to move a maximum quantity of the fall's harvest before the winter freeze occurs.

[53] American Soybean Association, STEP, *Moving America's Harvest by Barge*, available at [http://www.soygrowers.com/step/barge.htm] on Feb. 11, 2004.

[54] Tun-Hsiang Yu and Stephen Fuller, *Evaluation of Factors Affecting Lock Delays on the*
(continued...)

Furthermore, simultaneous lock delays at all 27 locks including the three 1,200-ft. locks (a generally unlikely event) would lead to about a 6% increase in the total barge rate between Minneapolis and Gulf ports. Using the April 2004 barge freight rate from Minneapolis to Gulf ports of about $0.27 per bushel of corn and $0.29 per bushel of soybeans (or about $10.71 per metric ton), a delay-induced 6% rise in the barge freight rate would push per-bushel costs for corn and soybeans up by approximately 1.6 and 1.7 cents, respectively, or less than 1% of the average farm value.[55] Even so, this represents an upward bound of potential costs given the unlikely simultaneous delay at all 27 locks.

As barge rates for corn and soybean freight rise, the demand for barge services declines. However, the decline is generally by a less-than-proportional amount. Economists have estimated a -0.5% decline in grain barge demand on the UMR and a -0.2% decline on the IWW in response to a 1% increase in barge freight rates.[56] In other words, a 6% rise in the barge freight rate would likely result in a 3% decline in the volume of corn and soybean freight (or about 1.2 mmt out of 40 mmt) on the UMR. The barge price rise would shift these commodities to alternate uses (feed, food, industrial, or storage), to alternate transport modes (rail or truck), or to alternate trade routes (e.g., Canada, Mexico, or the Pacific Northwest).

A possible effect of a sustained rise in barge transport rates is a rise in rail freight costs, due both to rising demand for rail as freight shifts away from barge and towards rail transport, and to decreased efficiency resulting from longer rail delays as more traffic moves over the same mileage of freight track and through the same number of terminals. The degree, if any, to which rail rates would rise in response to greater demand would depend on the level of slack capacity available to immediately absorb the agricultural freight that is being diverted from barge transportation. The level of rail slack capacity is seasonal, but tends to be near zero (i.e., near full capacity of rail use) at harvest time when barge demand is highest. In a study sanctioned by the National Corn Growers' Association, the barge-rail cross-price effect was found to be very small — it was estimated that railroad freight rates for farm products increase 0.25% for every 1% increase in UMR barge freight rates.[57] In other words, a 2-cents-per-bushel rise in barge freight rates for corn and soybeans would result in about a half-cent per bushel rise in rail freight rates for those commodities as some freight transport demand shifts from barge to rail.

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[54] (...continued)
Upper Mississippi and Illinois Rivers and the Effect of Lock Delay on Barge Rates, prepared for USDA, Agricultural Marketing Service (2002).

[55] USDA, Agricultural Marketing Service, Transportation and Marketing Service, *Grain Transportation Report* (Washington: April 29, 2004).

[56] Tun-Hsiang Yu and Stephen Fuller, *Estimated Grain Barge Demands for the Upper Mississippi and Illinois Rivers: Tentative Findings*, prepared for USDA, Agricultural Marketing Service (no date).

[57] Dr. Michael Evans, *Determination of the Economic Impact of Increased Congestion on the Upper Mississippi River - Illinois River Waterway* (Evans, Carroll & Associates, Mar. 2002), p. 39.

Modal Shifts in Grain Transport[58]

An Interdependent Transport Network. Barges are only one component of the grain-handling network. Trucks, railroads, and grain elevators are the other key components. A coordinated and comprehensive investment strategy requires examining the grain supply chain in its entirety, rather than concentrating on any one mode or segment of infrastructure. A General Accounting Office report on grain transportation recommends this approach, stating: "Efforts to improve grain transportation tend to concentrate on individual transportation modes rather than on the transportation network as a whole," and without "an integrated analysis that considers interrelationships between the various components of the grain transportation system ... implementing wise policies is difficult."[59]

The high degree of intermodal functioning in the grain supply chain essentially means that policy decisions affecting one mode affect all other modes. Any major capital project, even if mode-specific, is likely to affect the interrelationship among all the modes, as well as their grain customers. Optimizing a particular component of the grain delivery system without considering the whole system could merely reroute traffic rather than improving the system's overall performance. In addition, significant changes (described below) are taking place in the grain-handling network and these changes have important implications for the infrastructure that supports it.

Modal Specialization Based on Distance. Grain elevators are used to accumulate a critical mass of product that allows for economies of scale in shipping bulk grain. (See **Figure 9**). Trucks, trains, and barges compete and complement one another in moving grain to successively larger elevators — shipping distance often determines each mode's particular role.

Trucks traditionally have an advantage in moving grain for shorter distances (less than 250 to 500 miles) and therefore function primarily as the short haul gatherers of grain product. Railroads have a cost advantage in moving grain long distances, but barges have an even greater cost advantage where a waterway is available. However, barges cannot compete with trucks and trains in transit time, and waterways are not always available due to ice, floods, or drought.

To reach seaports, a large portion of U.S. grain exports must travel more than 1,000 miles, so rail and barge traffic is heavily dependent on the export grain market. A large share of exported corn and soybeans moves by barge since a significant portion of production acreage is located relatively close to either the Upper Mississippi, Illinois, or Ohio River waterways. Trucks are used for the initial leg of a grain export move (to the rail served elevator or barge served river port), as well as for the movement of grain domestically to a processor or feed lot.

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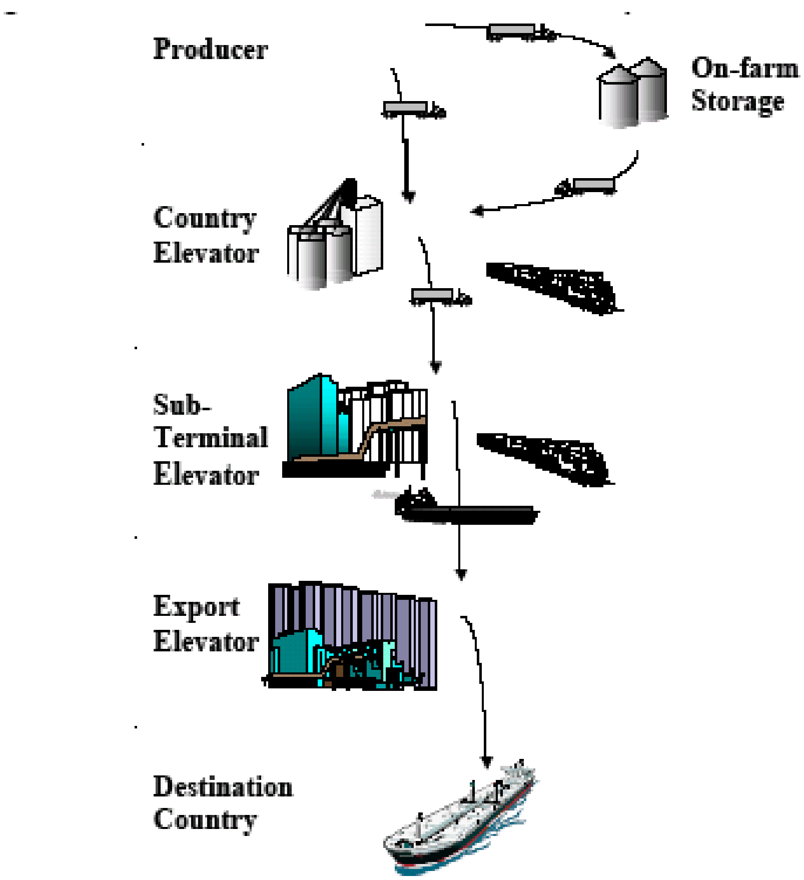
[58] Prepared by John Fritelli, Analyst in Transportation Policy, RSI Division.

[59] General Accounting Office, *U.S. Grain Transportation Network Needs System Perspective to Meet Future World Needs,* CED-81-59 (April 8, 1981).

Figure 9. Traditional Flow of Grain for Export



Source: U.S. Grains Council, *VEG Exporter Manual* (n.d.), p. 44.

Modal Share Shifting Over Time. Over the last two decades, there has been a substantial shift in the relative importance of modes in moving grain to market. (See **Figure 10**.) Barge modal share decreased slightly, rail share decreased substantially, and truck share made up the difference. The relative importance of modes has shifted because of farm consolidation (fewer but larger farms), Class I railroad rationalization[60] (fewer miles of track but more trains), and the doubling of domestic demand for grain while export demand has stagnated.

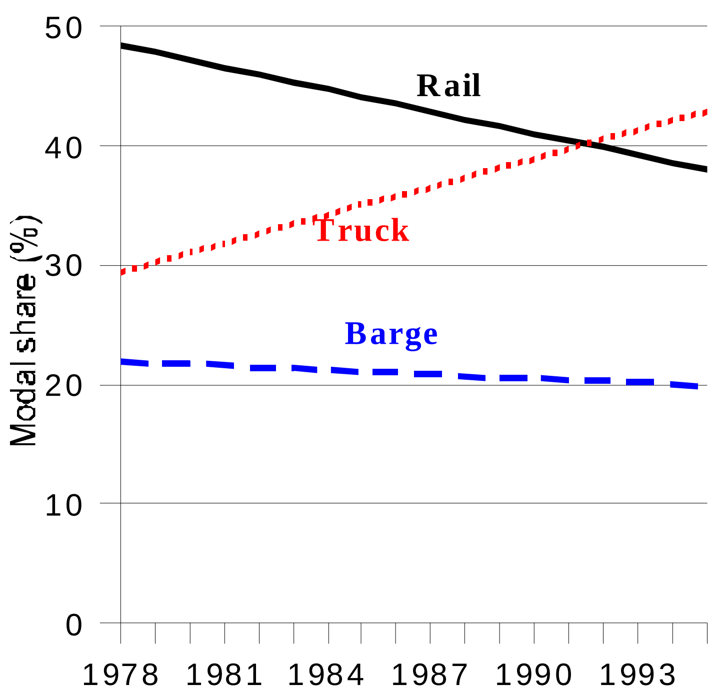
Truck Share Rising. Increasing domestic demand and static export demand has favored truck transport because, as mentioned above, trucks generally have an advantage over rail and barge for shorter haul shipments. Also, domestic buyers tend to buy grain in smaller volumes because they operate throughout the year.

Rail and Barge Share Declining. Class I railroads are more interested in long distance, trainload-size shipments, which suits the export market more than the domestic market. Barge transport is heavily dependent on exports from the corn belt

[60] Class I railroads are those with operating revenue of at least $272 million in 2002.

(upper Midwest) to the Port of New Orleans. Barges transport 90% of the corn moving to Center Gulf ports while railroads transport only 10%.[61] The static grain export market is reflected in the slight decrease in modal market share for barge transportation.

Figure 10. U.S. Grain Modal Shares, 1978-1995



Note: Data are based on the final leg of a shipment.
Source: USDA, Agricultural Marketing Service, *Transportation of U.S. Grains: a Modal Share Analysis, 1978-95* (March 1998).

Part of the growth in domestic demand for feed grains is due to increased Asian demand for livestock and poultry products, which are exported in refrigerated containers.[62] Despite the long inland hauls to seaports, a large share of chilled and frozen meat product exports are moved by truck rather than railroad because of the product's high value and high service requirements (in terms of transit time and temperature control). To the extent this trend continues, one can view it as the displacement of bulk grain exports moved by barge down the Mississippi with containerized meat exports moved by truck to coastal ports.

Emerging Rail Issues. As railroads are the primary competitors to barge transportation, it is informative to review market trends in this sector more closely.

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[61] Center Gulf ports include New Orleans and other Louisiana ports. In contrast, Western Gulf ports are located along the Texas coastline, while Eastern Gulf ports are found along the Mississippi, Alabama, and eastern Florida coastline.

[62] Chris Hurt and Lee Schrader, *Long-Term Structural Shifts in Grain, Oilseed, and Animal Industries in the United States* (USDA, Agricultural Marketing Service, Nov. 2000).

Class I rail consolidation is a contributing factor to the overall consolidation of the grain handling network. This consolidation affects barge transportation as well. As a result of consolidation, smaller capacity elevators and short line railroads are increasingly being bypassed in the grain supply chain. One survey of industry experts predicted that of the more than 10,000 grain elevators in today's network, one in four of these elevators will no longer be in existence a decade from now.[63]

Class I railroads are exploiting operating efficiencies by consolidating their trackage and rolling stock around larger, sub-terminal grain elevators. These larger elevators have enough grain to load not only longer trains but also trains using higher capacity hopper cars. The rail consolidation process emphasizes unit and shuttle trains, de-emphasizing carload service in favor of shipment sizes that can fill entire trains, and operating from single origins and destinations rather than multiple origins and destinations. These tactics are designed to reduce switching costs and improve car cycle times.[64] The railroads offer rate incentives for unit-grain-trains, which encourages centralization of the grain-elevator network and contributes to the diminishing role of country elevators and short line railroads.[65] While Class I rail rate incentives reduce the cost of rail hauls, consolidation of grain elevators may require longer and therefore more costly truck hauls. Trucks, because of their geographic flexibility, are more easily able to adapt to Class I rail consolidation than are short line railroads.

The increasing role of truck transport, to the disadvantage of short line rail transport, has raised debate over infrastructure constraints in these sectors as well. Key policy questions include whether rural roads and bridges leading to grain elevators are adequate to accommodate the increased traffic of heavy grain hauling trucks. Alternatively, would it be more cost effective (or environmentally sustainable) to assist short line railroads in upgrading their infrastructure to handle the heavier hopper cars that mainline railroads are increasingly using?

An emerging policy question that relates rail transport dynamics to UMR-IWW infrastructure investments is: "Will railroad rationalization and the growing use of unit and shuttle trains slow the decline of rail's modal share of grain transport, and thereby alter the long-run outlook, as projected from Figure 10?"[66] If the answer

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[63] Kimberly Vachal, *The Long-term Availability of Railroad Services for U.S. Agriculture,* paper presented at the Transportation Research Board's 81st Annual Meeting, Jan., 2002, Washington, DC.

[64] William W. Wilson, *U.S. Grain Handling and Transportation System: Factors Contributing to the Dynamic Changes in the 1980s and 1990s* (North Dakota State Univ., Nov. 1998).

[65] Marvin E. Prater, "The Implications for U.S. Agriculture of Long-Term Trends in Railroad Service," *Journal of The Transportation Research Forum,* Vol. 40, No. 4 (Fall 2001).

[66] A unit train refers to shipments of at least 52 cars. A shuttle train refers to shipments of more than 100 cars. For information on transport mode rate comparisons and brief reports on transport market developments refer to *Grain Transportation Report*, USDA, Agricultural Marketing Service, Transportation Services Branch; available at [http://www.ams.usda.gov/tmdtsb/grain/] on July 8, 2004.

proves to be yes, it will likely have important implications for barge demand prospects and the economic viability of major UMR-IWW infrastructure investments.

Environmental and Social Impacts of Travel by Mode[67]

Investments in any transportation project will have environmental implications. Supporters of large-scale navigation improvements on the UMR-IWW argue that generally barges are more environmentally friendly than rail or truck. Comparisons of environmental impacts of transportation modes are complicated by data availability and differences in the types of impacts and significance of ecosystems affected by land-based transport and water transport. The inability to compare directly some impacts does not diminish their significance and importance for decision-making. Because reduced damage to one environmental aspect (e.g., terrestrial ecosystem fragmentation) often comes as a tradeoff with environmental harm increasing for another aspect (e.g., riverine ecosystems), environmental assessments of alternate modes typically are evaluated within the context of modes' other advantages and disadvantages (e.g., costs, price, punctuality, and speed).

When modal comparison are made, they are typically limited to travel (i.e., vehicle operations to transport goods).[68] Supporters of large-scale UMR-IWW navigation investments have been using three metrics — fuel efficiency, air pollution, and safety — to make general modal comparisons. Although useful, these metrics provide only a partial picture of the environmental impacts of each transportation mode. The analysis below indicates that current data do not conclusively find barges superior to rail in terms of environmental impacts of travel, but barges are superior in terms of injuries and fatalities.

Energy Efficiency. Supporters of navigation expansion argue that a barge generally consumes less fuel to move a ton of cargo than rail or truck. The energy consumed to move a ton of cargo one mile (i.e., a ton-mile) can be used to compare the energy resource consumption efficiencies of transportation modes. The *Transportation Energy Data Book: Edition 23*, published in October 2003 by Oak Ridge National Laboratory, tracks energy intensity from 1970 through 2001. The following cautionary disclaimer appears above the energy intensity table in the data book: "Because of the inherent differences between the transportation modes in the nature of services available, routes available, and many additional factors, it is not possible to obtain truly comparable national energy intensities among modes." With that caveat, the table then indicates that the energy required to move one ton one mile, measured as British thermal units (Btu) expended per ton-mile, in 2001 was higher for barges at 444 and lower for rail at 346.[69] According to Oak Ridge data, the

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[67] Prepared by Nicole T. Carter, Analyst in Environmental Policy, RSI Division.

[68] Travel is only one of five activities in the transportation life-cycle — infrastructure construction; vehicle manufacture; travel; operation and maintenance; and disposal.

[69] Statistics are for domestic waterborne commerce and Class I railroads. Barge transport efficiency has fluctuated with an average of 420 btu per ton-mile for 1992-2001, varying from 369 to 508. The modal fuel efficiencies for freight transport as measured in ton-miles per gallon of diesel fuel — barge 514, rail 202, and truck 59 — commonly cited by groups supporting navigation, are from a now outdated 1980 report by S. E. Eastman, *Fuel*

(continued...)

earlier energy efficiency advantage of barge transport has been eliminated; rail energy efficiency has surpassed barge efficiency by more than 40 Btu per ton-mile since 1996. Although Oak Ridge does not capture truck fuel efficiency in a similar manner, other data sources suggest trucks are generally less efficient than barges or rail on a Btu per ton-mile basis.[70]

Other sources do not agree with the fuel efficiency advantage of rail over barge shown by the Oak Ridge data. Data provided to CRS by the Tennessee Valley Authority (TVA) show an average barge fuel efficiency of 535 ton-mile per gallon (260 Btu per ton-mile) for 1995 through 2002. Industry averages for railroads in 1998 were 384 ton-mile per gallon (361 Btu per ton-mile), according to a report produced for the Corps by Earth Tech and Tolliver.[71] The general trend that is agreed upon is that "railroads have become more fuel efficient over time and the relative energy benefits of waterway transportation have become smaller."[72] Detailed analysis of factors contributing to the improvement of rail energy efficiency has not been performed; however, increased tonnage per rail carload has been cited as a major cause, and longer rail hauls as another contributor.[73]

Air Pollution. Supporters of navigation expansion argue that barges emit fewer air pollutants per ton-mile than rail or truck.[74] Emissions are largely a function of the fuel efficiency and the emission control equipment employed. A study by Lee and Casavant in 1998,[75] indicates emissions per gallon of diesel fuel (not per ton-

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[69] (...continued)
Efficiency in Freight Transport (Arlington, VA: American Waterway Operators, 1980).

[70] Truck efficiencies are commonly presented in terms of btu per vehicle-mile (not ton-mile). For 2001, the *Transportation Energy Data Book: Edition 23* had a btu per vehicle-mile efficiency of 23,237. If capacity of a heavy truck is estimated at 20 to 25 tons, the energy intensity for trucks would be approximately 1,000 btu per ton-mile. The Association of American Railroads, in a January 2004 publication, *Railroads: Building a Cleaner Environment,* compared Oak Ridge's 2001 data for barge and rail to 3,337 btu per ton-mile for trucks, while other sources use truck efficiencies closer to 550 btu per ton-mile.

[71] Earth Tech and D. Tolliver, *Analysis of Energy, Emission, and Safety Impacts of Alternative Improvements to the Upper Mississippi River and Illinois Waterway* (North Dakota State Univ., March 2000), p. 7. Available at [http://www2.mvr.usace.army.mil/umr-iwwsns/documents/aug2000-entire%20report.pdf]. Hereafter referred to as Earth Tech and Tolliver.

[72] Ibid., p. vi.

[73] D. Greene, *Transportation and Energy* (Lansdowne, VA: Eno Transportation Foundation, 1996).

[74] The statistics comparing emissions for barge, truck, and rail per ton-mile used by groups supporting navigation show less hydrocarbon, carbon monoxide, and nitrous oxide emissions for barges than rail or truck; the source for these statistics is typically cited as being the Emission Control Lab of the U.S. Environmental Protection Agency. CRS was unable to locate the original document, and therefore, cannot assess whether these statistics represent current emissions levels for the three modes.

[75] N. S. Lee and Ken Casavant, *Impacts of a Snake River Drawdown on Energy Consumption and Environmental Emissions in Transporting Washington Wheat and*
(continued...)

mile) are generally comparable for rail and barge. There is not, however, sufficient data available to reliably compare all three modes. A conclusion that can be drawn from available data is that any advantages in total emissions that barge transport may have had in the past is likely to have decreased as a result of converging fuel efficiencies and emissions standards.

Barge transport, nonetheless, may have an advantage in certain circumstances because of the location of emissions. Air pollution's significance as an environmental impact partially depends on its proximity to urban areas and areas of significance, such as national parks, and the potential for human exposure, particularly in *nonattainment areas* — those areas failing to meet the National Ambient Air Quality Standards. Highways and rail lines generally pass through more urban areas than comparable waterways and thus their pollution may have greater significance than air pollution from barges.[76]

Safety. Safety of transportation modes can be compared based on accidents, injuries, and fatalities. The environmental significance of accidents depends on many factors, including human health exposure, the environment of the accident, and the ability to contain a spill and/or other damage. Barge traffic generally involves less urban exposure than either truck or rail, and it operates on a system that has few crossing junctions. The potential evacuation and human health care costs may be greater for rail and truck shipments than for barge movements.[77] However, a waterborne hazardous material or other spill has direct implications for water resources, whereas an overland spill by rail or truck shipment typically has a more geographically limited impact.[78] According to Earth Tech and Tolliver, an Army Corps study of the UMR-IWW concluded that small changes in risk between barge and rail should not be a factor in determining a recommendation for waterway infrastructure investment.

The death rate for barge tows in 1993 was 0.01 death per billion ton-miles, compared with 0.84 for trucks, and 1.15 for railroads; the injury rate for barges is reportedly 0.09 per billion ton-miles and 21.77 for railroads.[79] These statistics depict the less congested locks and the natural right-of-way of waterways and the slower speeds of barge operations in comparison to truck and rail.

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[75] (...continued)
Barley (Pullman, WA: Washington State Univ., April 1998).

[76] Earth Tech and Tolliver. Rail and truck movements' proximity to urban areas also can cause more noise pollution, congestion, and social disruption than barges. (U.S. Dept. of Transportation, Maritime Administration, *Environmental Advantages of Inland Barge Transportation* (Washington, DC: Aug. 1994).

[77] Earth Tech and Tolliver. Recent legislation requiring all new inland tank barges carrying liquid cargoes to be double-hulled has decreased the likelihood of barge spills.

[78] Earth Tech and Tolliver.

[79] C. J. Haulk, *Inland Waterways as Vital National Infrastructure: Refuting 'Corporate Welfare' Attacks* (Pittsburgh, PA: Allegheny Institute for Public Policy, 1998). The truck statistics provided by Haulk are limited to the death of truck occupants. More recent modal comparisons of injuries and deaths were not found, other safety statistics indicate that the ranking of the three modes in terms of safety has remained steady.

VI. Environmental Impacts of Barge Navigation[80]

Much of the discussion on UMR-IWW navigation focuses on the effects of possible investments on agricultural competitiveness and the capacity of alternate modes of transportation. However, UMR-IWW navigation and its proposed expansion also have environmental implications. The UMR-IWW ecosystem has been affected by the construction of the locks and dams, the flow management practices, and the operation of barges. The Upper Mississippi River and the Illinois River are managed for maintaining a 9-foot navigation channel rather than following a natural flow regime,[81] and the movement of barges damages the riverine ecosystem by creating hydraulic impacts and contributing pollutants to the aquatic ecosystem. The navigation causes these environmental impacts while producing the benefit of cost-effectively transporting goods long distances. The environmental and social questions under debate are:

- What would be the environmental impacts of expanding the navigation capacity of the UMR-IWW?
- What, if any, steps should be taken to address the impacts of the existing navigation system and ongoing navigation operations and maintenance?

UMR-IWW Ecosystem and its Decline

The navigation system on the UMR-IWW transformed the free-flowing river into a series of navigation pools that create a stairstep effect from St. Louis to Minneapolis and Chicago, inhibiting the movement of some species. The dams impound water to increase the depth of the main channel to 9 feet or greater and cause substantial changes in the distribution of surface water.[82] Changes in the rivers' hydrologic regime subsequently alter water quality parameters, such as temperature and dissolved oxygen, thereby ultimately affecting fish and wildlife.

In the Water Resources Development Act of 1986, Congress recognized the national significance of the Upper Mississippi River System (which includes the UMR-IWW system and the aquatic and terrestrial habitats and species that are critically important to the river floodplain ecosystem). This ecosystem is considered significant because it provides habitat and food to at least 485 species of birds,

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[80] Prepared by Kyna Powers, Analyst in Energy and Environmental Policy, and Nicole Carter, Analyst in Environmental Policy, Resources, Science, and Industry Division.

[81] Alterations of natural waterways to accommodate navigation generally reduce the variety of natural habitats by controlling the dimensions of the channel, changing the relationship of the river to its flood plain, and changing river hydrodynamics. Dredging disrupts and removes benthos, increases turbidity, and resuspends sediments. Dredged material requires disposal; the magnitude of disposal impacts varies according to the type of disposal, the disposal site, and the contents of the disposed material. (U.S. Army Corps of Engineers, Water Resources Support Center, *National Waterways Study — A Framework for Decision-Making — Final Report* (Washington, DC: GPO, January 1983)).

[82] Corps, *Draft Feasibility Report and PEIS*, p.34.

mammals, amphibians, reptiles, and fish, including 10 federally listed endangered or threatened species and 100 state-listed threatened or endangered species. It is a critical migration corridor for 40% of North America's waterfowl and shorebirds, and home to 118 or more species of fish and nearly 50 species of freshwater mussels.[83] The Upper Mississippi River System encompasses four National Fish and Wildlife Refuges, and three national parks lie within or immediately adjacent to the river system.[84] The UMR-IWW ecosystem is also viewed as significant because of its recreational use and the economic value of recreation. An estimated 12 million recreational visits to the UMR-IWW occur each day; boating, sightseeing, sports fishing, hunting, and trapping are some of the more popular recreational uses.[85]

According to the Crops, current investments in the UMR-IWW ecological monitoring and habitat rehabilitation and enhancement are inadequate to meet existing environmental needs and to prevent continued degradation of the UMR-IWW.[86] The ecosystem is in decline, and some groups fear that it may collapse.[87] That is, they fear a rapid alteration in environmental quality and ecosystem health indicators, likely resulting from changes to fundamental ecosystem functions and processes. In general, ecological health declines are occurring from the upper reach of the Mississippi River to the lower portions of the UMR.[88] The Illinois River is generally considered unhealthy, although it has experienced some recovery since a collapse in the 1950s.[89]

Commercial navigation, its infrastructure, and water management to support navigation is causing side channels, backwater, and wetlands to fill in with sediment. This sediment is easily suspended in the water column, thus reducing light penetration essential for plant growth. Less vegetation reduces aquatic insects, water fowl, fish, and other animals. For example, a U.S. Geological Survey scientist explained the impact of sediment on the health of the UMR as follows:

> The extent or abundance of many key native biotic communities and organisms — including submersed plants, unionid mussels, fingernail clams and other benthic invertebrates, and migratory waterfowl — has decreased along substantial

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[83] Upper Mississippi River Conservation Committee, *Facing the Threat: An Ecosystem Management Strategy for the Upper Mississippi River* (Rock Island, IL: 1993), available at [http://www.mississippi-river.com/umrcc/Call-for-Action.html].

[84] Corps, *Draft Feasibility Report and PEIS*, pp. 5 and 130-131.

[85] Ibid., pp. 134-135.

[86] Ibid., pp. iii, 88, 92, 96, and 97. Through WRDA 1986, Congress established the Environmental Management Program for the UMR-IWW. This Corps program — averaging about $15 million per year — consists of habitat rehabilitation/enhancement projects and long-term resource monitoring. The EMP has more than 50 projects, either operational or under construction, affecting more than 120,000 acres (11% of the UMR-IWW flood plain).

[87] Upper Mississippi River Conservation Committee, *Facing the Threat: An Ecosystem Management Strategy for the Upper Mississippi River* (1993).

[88] B. Carlson, *Upper Mississippi River System Environmental Management Program* (1998), available at [http://www.hort.agri.umn.edu/h5015/98papers/carlson.html].

[89] Ibid.

> reaches of the Upper Mississippi River in recent years or decades (Wiener et al. 1995, Wiener et al. in press). Recent declines in benthic invertebrates and submersed aquatic plants constituted a partial — yet significant — collapse in the benthic food web supporting key migratory waterfowl. The abrupt decline in submersed aquatic plants in the late 1980's, which was unprecedented in the Upper Mississippi, greatly affected migratory canvasback ducks, which feed on wild celery tubers. Similarly, the use of the river by migrating lesser and greater scaup, which feed heavily on fingernail clams, decreased greatly after the decline of this small mollusk.[90]

The navigation system, however, is not the only cause of ecosystem decline. The Mississippi River and Illinois River have a long history of impaired water quality attributable to contamination from agricultural, industrial, residential, and municipal sources.[91] The question of what, if any, ecosystem restoration to undertake in the context of UMR-IWW improvements is limited to the navigation channel, and is not inclusive of watershed or basin-wide measures that might address these other sources of water quality contaminants.

Environmental Impacts of Expanding UMR-IWW Capacity

Some environmental groups are concerned that additional stress, caused by construction activities and increases in barge traffic above current levels, could accelerate the decline of the ecosystem and perhaps the onset of a collapse. They argue that additional barge traffic would destroy aquatic life and fill in remaining side channels with sediment from wave action. In response, agricultural and navigation interests argue that the Corps has analyzed the incremental environmental impacts of new construction and additional barge traffic and that it has devised an "adaptive mitigation" approach to minimize these impacts.[92] These interests argue that, moreover, any aquatic environmental damage from expansion is offset by environmental benefits of transport by barge when compared to transport by rail or truck in terms of fuel efficiency, air pollution, and safety. (See "Environmental and Social Impacts of Travel by Mode,"from Section V.)

The Corps developed a preliminary Programmatic Environmental Impact Statement (PEIS) to evaluate the environmental and social impacts of navigation improvements. Under the PEIS, the Corps would produce site-specific environmental assessments for any improvements authorized by Congress. Large-scale navigation improvements would require mitigation (and monitoring) of bank erosion, backwater and secondary channel sedimentation, degradation of aquatic plant beds, fish loss, destruction of historic sites, and mitigation of construction site impacts. In its draft

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[90] J. G. Wiener, "Sediment-related Investigations at the Upper Mississippi Science Center," in Proceedings of the U.S. Geological Survey Sediment Workshop, February 4-7, 1997 (La Crosse, WI).

[91] Corps, *Draft Feasibility Report and PEIS*, p. 114.

[92] An adaptive mitigation strategy involves an iterative process of implementing and monitoring planned individual mitigation projects; then refining and re-implementing combinations of projects in terms of their timing, their placement, and their component parts to better meet the goals of the long-run mitigation strategy. Ibid., p. 372.

feasibility report, the Corps concludes that the impacts of large-scale UMR-IWW measures can be mitigated; it states, "using mitigation, the net effect from both increased traffic and site-specific impacts would be no loss to the five main areas of concern — fisheries, submerged aquatic plants, bank erosion, backwater and secondary channel sedimentation, and historic properties."[93]

The Corps' analysis concluded that navigation improvements probably would not significantly reduce fuel consumption or air pollution, or raise noise levels on the UMR-IWW from existing levels.[94] The Corps' analysis did find that increased barge traffic due to navigation improvements would generate social benefits, such as a decrease in the number of transportation-related accidents.

Environmental Impacts of Ongoing Navigation Operations

For federal decisions such as investing in new UMR-IWW locks, environmental impacts are assessed under the National Environmental Policy Act (NEPA). Under NEPA, environmental impact assessments of incremental increases to transportation infrastructure are required to consider impacts in the context of cumulative effects (40 C.F.R. §§1502.14, 1502.116, 1508.8, and 1508.7). In other words, environmental impact statements are required to analyze both local environment impacts of each component of a proposed project and the cumulative impacts of all project components combined. These analyses, however, generally do not evaluate the damage caused by existing infrastructure with the intention to mitigate for past or ongoing damage. In other words, the NEPA analyses are limited to the incremental environmental effects of proposed projects and propose strategies to mitigate that damage.

Environmental interests, the natural resource agencies of the five basin states, and the U.S. Fish and Wildlife Service argue that mitigation of incremental impacts of new navigation infrastructure construction and increased barge traffic is insufficient. In a 2001 report on an early draft of the UMR-IWW feasibility report, the National Research Council argued that "as part of the feasibility study, an analysis of the cumulative effects of the existing navigation system should be

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[93] Ibid., p. 405. While the Corps has not established a specific mitigation plan, it has identified potential mitigation measures for each river reach. For example, potential mitigation measures include dredging, gravel bars, dike alterations, large woody debris anchors, island building, bank stabilization and protection measures, and replanting. The planning, engineering, and design phase for mitigation measures would begin prior to undertaking lock expansion activities and would be adapted as additional studies are completed. (Corps, *Draft Feasibility Report and PEIS*, pp. 380 and 390-98.)

[94] Corps, *April 2004 Feasibility Report and PEIS*, p. 207-209 and 333. The Corps did not perform a modal analysis as part of its navigation study; the *April 2004 Feasibility Report and PEIS* states that "an increase in other transportation modes could have greater societal costs than an increase in navigation transport" (Corps, *April 2004 Feasibility Report and PEIS*, p. 335). This conclusion was based on information in the report by Earth Tech and Tolliver that concluded "there is a relatively small fuel advantage to barge transportation [for movements from Upper Mississippi region]" (p. vi).

conducted."[95] In response, the Corps restructured the study to include ecosystem restoration. The *Draft Feasibility Report and PEIS* satisfies the NEPA requirements by assessing, and providing for mitigation of, impacts directly associated with the navigation improvements in its preferred navigation alternative. In addition, it recommends a plan for ecosystem restoration for the environmental damage resulting from ongoing navigation operations and maintenance.

Ecosystem Restoration

Corps' Preferred Ecosystem Restoration Plan. In the *Draft Feasibility Report and PEIS*, the Corps recommended a $5.3 billion, 50-year ecosystem restoration plan. This plan includes 1,009 projects ranging from shoreline protection measures to fish passage structures. Federal revenues would fund approximately $4.25 billion of this plan, while the rest would be funded 65% by the federal government and 35% by nonfederal sponsors. The Corps recommends that Congress authorize a first increment of this 50-year plan at $1.5 billion. This increment would consist of 225 projects including:

- specific authorization ($250 million — 100% federal) for fish passage construction at four dams and planning and design at two dams, and dam point control at two dams;
- programmatic authority to implement measures that, according to the Corps, would provide substantial restoration benefits ($925 million, not to exceed $25 million/measure — 100% federal); and
- acquisition from willing sellers of 35,000 acres for flood plain connectivity and wetland and riparian habitat protection and restoration ($277 million total — 65% federal).

The Corps' analysis of ecosystem restoration alternatives focused on 50-year plans. According to the Corps, the recommended 50-year plan was selected based on cost-effectiveness, likelihood of successful implementation, and reasonable estimate of the potential cost-shared flood plain restoration opportunities.[96] This plan aims to mitigate the historic and ongoing impacts of the navigation projects through "management practices and cost effective actions affecting a broad array of habitat types."[97]

According to the Corps, the recommended alternative "expands large-scale flood plain restoration to suitable levels, initiates fish passage measures, and brings off-channel habitat restoration to a suitable level," thereby restoring a broad array of habitats and ecosystem processes.[98] The draft feasibility study also states that these projects will benefit the riverine ecosystem while not affecting commercial navigation, water supply, or hydro power. However, it states that the ecosystem

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[95] National Research Council, *Inland Navigation System Planning: The Upper Mississippi River - Illinois Waterway* (Washington, DC: National Academy Press, 2001), p. 81.

[96] Ibid., p. 509.

[97] Ibid., p. 509.

[98] Ibid., p. 195.

restoration component, specifically water level fluctuations, would cause limited harm to recreational boating and livestock watering.

Stakeholder Perspectives. Although few groups have made their formal positions known on the Corps' preferred ecosystem restoration plan, it appears that many environmental groups, some basin-state natural resource agencies, and the Iowa Department of Transportation are in favor of either the preferred plan or a more comprehensive restoration effort.[99] The Upper Mississippi River Basin Association, which represents the states that will be the nonfederal sponsors for some of the restoration costs, has expressed support for ecosystem restoration measures such as those included in the preferred plan.[100] Even so, there is uncertainty about how the Corps will measure the project's ecosystem benefits, how the Corps will balance ecosystem restoration and navigation objectives under a dual-purpose authorization, and whether long-term ecosystem restoration is compatible with a highly managed navigation system.

A main area of disagreement among stakeholders over UMR-IWW ecosystem restoration opinions is the question of how closely investments in navigation expansion should be tied to investments in ecosystem restoration. Some environmental groups see ecosystem restoration as necessary to mitigate damage caused by the ongoing operations and maintenance of the UMR-IWW, and believe that appropriations should not be made for additional navigation measures without investing in ecosystem restoration. They propose that appropriations for ecosystem restoration and navigation funding should be linked. Navigation and agricultural groups believe that ecosystem restoration should be funded on its own merits, separate from navigation improvements. In other words, the basic question on which stakeholders disagree is: why is ecosystem restoration part of the Corps' preferred plan — is it mitigation/rehabilitation for the ongoing navigation project, or is it separable from the navigation improvement project?

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[99] Ibid., pp. 494, 480, 492, and 476.

[100] Ibid., pp. 489-491.

VII. For More Information

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Appendix A: UMR-IWW Description

Navigation System. The Upper Mississippi River (UMR) system extends 854 miles from the confluence with the Ohio River to Minneapolis and includes the major tributaries — the Missouri, Illinois, and Wisconsin — that feed into the Mississippi River. The Illinois Waterway (IWW) extends 327 miles from its confluence with the Mississippi River at Grafton, IL, to Chicago and the Great Lakes. The UMR-IWW navigation system contains 1,200 miles of 9-foot deep channels, 37 lock and dam locations (with 43 locks), and thousands of channel training structures. (See **Tables A1 and A2**.) The UMR-IWW Navigation System is commonly broken into four regions:

1. *Upper Impounded Reach:* the navigation pools associated with the upper and lower St. Anthony Falls locks in Minneapolis and Locks and Dams1-13;
2. *Lower Impounded Reach:* Navigation Pools 14-26;
3. *Middle Mississippi River:* Lock and Dam 26 to the mouth of the Ohio River;
4. *Illinois Waterway:* Illinois River; portions of the Desplaines River; Chicago Sanitary and Ship Canal; the Calumet-Sag Channel; the Little Calumet River; and the Calumet River.

Freight traffic on the UMR is seasonal due to winter conditions in the region. Above the Quad Cities (Davenport, IA; Bettendorf, IA; Moline, IL; Rock Island, IL) at Lock and Dam 15, traffic on the Mississippi River closes in late November and re-opens in early to mid-March depending on ice and thaw conditions. The Illinois River is kept open year-round for freight traffic.

Table A1. Physical Characteristics of Illinois Waterway Locks

Lock	River mile	Year opened	Length (Feet)	Width (Feet)	Lift (Feet)	1999 Utilization %
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	1,000	110	4	36

Source: U.S. Army Corps of Engineers, Rock Island District, *Alternative Formulation Briefing Pre-Conference Report* (Feb. 9, 2004), p. 86.

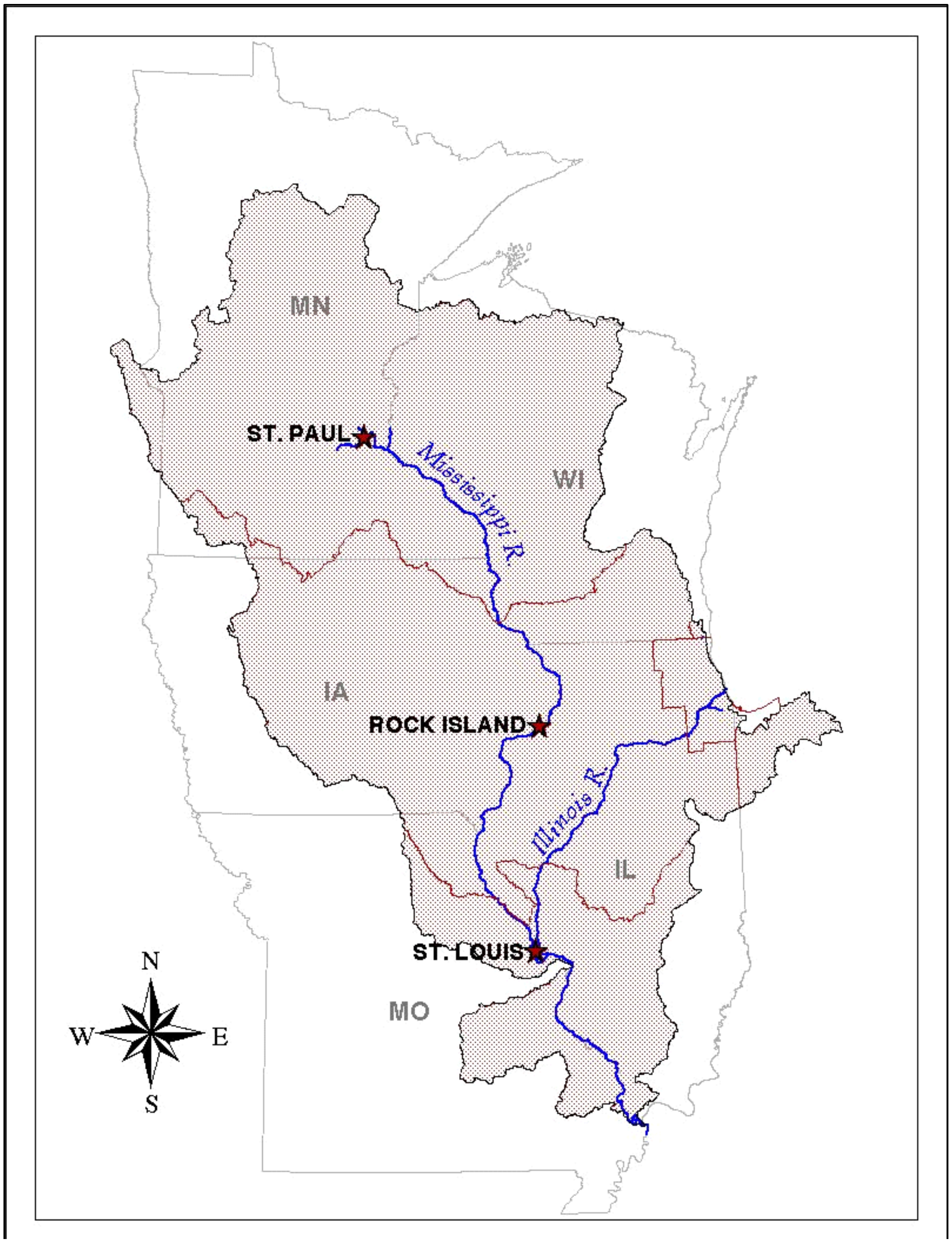
Table A2. Physical Characteristics of Upper Mississippi Locks

Lock	River mile	Year opened	Length (Feet)	Width (Feet)	Lift (Feet)	1999 Utilization %
Upper Impounded Reach: Navigation Pools 1-13						
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
Lower Impounded Reach: Navigation Pools 14-26						
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	1,200	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
Middle Mississippi Reach: Lock and Dam 26 to the mouth of the Ohio River						
Melvin Price Main Chamber200.8	200.8	1990	1,200	110	24	50
Melvin Price Aux. 18Chamber5.5	200.8	1994	600	110	24	20
No. 27 Main Chamber	185.5	1953	1,200	110	21	56
No. 27 Aux. Chamber	185.5	1953	600	110	21	12

Source: U.S. Army Corps of Engineers, *Alternative Formulation Briefing Pre-Conference Report* (Feb. 9, 2004), p.86.

UMR-IWW Floodplain. The UMR-IWW ecosystem includes extensive flood plain habitats. (See **Figure 11**.) Habitats vary with natural gradients across the four river reaches. The total acreage of the river flood plain system exceeds 2.5 million acres of aquatic, wetland, forest, grassland, and agricultural habitats. Also, the Mississippi Flyway is used by more than 40% of the migratory waterfowl traversing the United States.

Figure 11. Upper Mississippi River and Illinois Waterway Floodplain



Source: U.S. Army Corps of Engineers, Rock Island District, Jerry A. Skalak, Regional Project Manager, Upper Mississippi River Comprehensive Plan, presentation at Tulane University, November 14, 2002.

Appendix B: Early History of Corps Involvement in UMR-IWW

For much of the United States' early history only the lower portion of the Mississippi River — between St. Louis and the Gulf of Mexico — was navigable. In its natural state, the Mississippi River above St. Louis was significantly less navigable due to unpredictable water flows and fluctuations in the channel location and depth.

Since the mid-1800s, federal intervention on the UMR, primarily under the auspices of the Corps, has sought to address the problem of navigability.[101] (See **Table A3**.) In 1878 Congress authorized a 4½-foot channel between Minneapolis and St. Louis; in 1907, a 6-foot channel. During the next two decades, Locks and Dams 1 and 2 and what is now Lock and Dam 19 were authorized.[102] Federal intervention was accelerated in 1930 when, in an attempt to promote barge traffic and stimulate the economy of the Midwest during the Great Depression, Congress authorized the Corps to maintain a 9-foot channel on the UMR based on a system of locks and dams. This authorization resulted in a construction project consisting of 26 locks and dams on the UMR that was finished in 1940. Similarly, construction of the present-day system of locks and dams on the IWW was completed during 1933-1939 under congressional authorization. A surge in wartime river traffic during the 1940s, aided by the development of a new fleet of diesel towboats, saw the upper Mississippi River finally emerge as an important route for freight traffic.[103]

The Corps' activities on the UMR-IWW slowly grew beyond navigation to establishing a broader river-basin development plan. A series of flood control acts — in 1936, 1944, and 1950 — subsequently augmented the Corps' role in flood control activities and large multi-purpose projects. Under these various authorities, the Corps plans and undertakes flood control and navigation activities as part of its civil works program.[104]

Many navigation and flood control projects are multi-purpose — they provide water supply, recreation, and hydro power in addition to navigation and flood control. During the 1970s, additional legislation and several Executive Orders further required the Corps to consider the environmental impacts of its projects and

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[101] U.S. Army Corps of Engineers, Rock Island District, "The Upper Mississippi River Improvement," *The Landscape Photography of Peter Bosse*, by Ronald Deiss (1998); available at [http://www.mvr.usace.army.mil/Bosse/Introduction/UpperMississippi.htm] on July 8, 2004.

[102] U.S. Army Corps of Engineers, Rock Island District, *Alternative Formulation Briefing Pre-Conference Report*, Table 1-1, "Timetable of Navigation Development Activities on Upper Mississippi River and Illinois Waterway" (Feb. 9, 2004), p. 8.

[103] Dennis Brown, "The Nation's Inland Waterway System and Rural America," *Rural America*, Vol. 16, No. 4, USDA, Economic Research Service (March 2002), pp. 11-17.

[104] For the legislative evolution of Congressional demands on the Corps, see CRS Report RS20866, *The Civil Works Program of the Army Corps of Engineers: A Primer*, by Nicole T. Carter and Betsy A. Cody.

activities. It is often the competing objectives of these different uses — commercial, recreational, hydro power, and environmental — that make proposed changes to existing projects controversial. Today, the Corps — at the direction of Congress primarily through Water Resources Development Acts (WRDA) — continues to undertake water resources development projects under its civil works program.[105]

[105] Ibid.

Table A3. 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 4-½-ft. channel: mouth of Missouri to St. Paul	1878
Congress authorizes 6-ft. channel	1907
Construction of Lock & Dam 19	1914
Construction of Lock & Dam 1	1917
Congress authorizes 9-ft. channel: St. Louis to Cairo, IL	1927
Congress authorizes extension of 9-ft. channel to St. Paul, MN through construction of system of locks and dams	1930
Construction of 29 locks and dams	1930-1950
Construction of Lock & Dam 27	1953
Construction of 1,200-ft. chamber at Lock & 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 dam and 1,200-ft. chamber at Lock & Dam 26	1978
Congress authorizes second chamber (600-ft.) at Lock & Dam 26	1985
Construction of 1,200-ft. chamber at Melvin Price Locks & Dam (formerly Lock & Dam 26)	1990
Construction of 600-ft. chamber at Melvin Price Locks & Dam	1994
Major Rehabilitation/Maintenance	1986-present
Illinois Waterway:	
Congress authorizes construction of Illinois and Michigan Canal	1822
Construction of Chicago Sanitary & Ship Canal and 5 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

Source: U.S. Army Corps of Engineers, Rock Island District, *Alternative Formulation Briefing Pre-Conference Report* (Feb. 9, 2004), p. 8.

Table A4. Upper Mississippi River - Illinois Waterway Freight by Category, Volume and Share, 1990 to 2002

		Agricultural Freight				Non-Agricultural Freight						
Year	Total Freight	Sub-total	Corn	Soybean & Product	Other	Sub-total	Coal	Petro-leum	Other raw material[a]	Man-ufac-tured[b]	Fertil-izer	Other, mostly chemicals
Volume						Million metric tons						
1990	80.2	44.6	29.1	11.2	4.3	35.6	9.8	8.7	6.9	3.5	3.0	3.7
1991	76.3	42.2	26.4	11.5	4.3	34.1	8.7	8.8	6.4	3.5	3.0	3.7
1992	78.2	43.9	27.2	12.7	4.0	34.3	8.7	8.6	6.5	3.5	3.5	3.5
1993	65.5	35.5	21.6	11.5	2.4	30.0	7.3	5.8	6.6	3.2	3.5	3.3
1994	72.0	34.4	20.7	10.8	2.8	37.7	9.3	6.7	7.8	8.7	4.0	1.1
1995	76.6	42.4	28.1	12.1	2.2	34.1	8.2	8..8	7.3	6.3	3.4	0.3
1996	72.9	41.4	26.7	12.2	2.6	31.5	7.8	6.2	7.3	3.8	3.0	3.4
1997	70.6	37.3	22.3	12.4	2.6	33.3	6.8	7.0	8.4	4.7	2.7	3.7
1998	72.3	37.0	23.2	11.4	2.4	35.2	8.0	7.3	7.4	5.7	3.1	3.8
1999	77.7	43.4	27.8	13.3	2.3	34.3	7.8	6.6	7.5	6.0	2.9	3.6
2000	75.6	39.8	24.0	13.4	2.4	35.8	7.2	6.8	8.4	6.7	3.1	3.6
2001	71.5	37.2	23.2	11.7	2.3	34.3	6.9	7.5	8.4	5.2	3.2	3.1
2002	76.3	42.5	27.0	13.2	2.2	33.8	6.7	6.6	8.2	5.9	3.2	3.2
Period average: 1990 to 2002												
Volume	74.3	40.1	25.2	12.1	2.8	34.2	8.0	7.3	7.5	5.1	3.2	3.1
						Percent						
Share	100	54.0	33.8	16.3	3.8	46.0	10.7	9.9	10.1	6.9	4.3	4.1

Source: U.S. Army Corps of Engineers, *Waterborne Commerce of the United States*, various issues.

[a]Non-edible, non-energy raw materials such as forest products, sand, gravel, iron and steel scrap, non-metal minerals, etc.
[b]Primary manufactured goods such as lime, cement, pig iron, metal plates and sheets, etc.