Regional Impacts of Proposed Navigation and Ecosystem Improvements on the Upper Mississippi River and Illinois Waterway

Prepared for
The Rock Island District
U.S. Army Corps of Engineers

By
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Definitions

In this document, the reader will be exposed to regional impacts of navigation and ecosystem reconstruction impacts that will be measures by four indicators. These are as follows:

Gross Regional Product. For each state, the gross regional product is an estimate of that state's share of the nation's gross domestic product which is the total value of the goods and services produced by labor and property in the United States.

Employment. For each state, employment is defined by the Bureau of Economic Analysis as the sum of total full and part time jobs held by workers. Employment is based on the place of work and includes proprietors employment.

Output. Output is defined as the amount of production in dollars, including all intermediate goods purchased as well as value-added (compensation and profit). Output can also be thought of as sales.

Real Personal Income. Personal income is a Bureau of Economics Concept based on place of residence. It is the sum of wage and salary disbursements, other labor income, proprietors' income, rental income, personal dividend income, personal interest income, and transfer payments, less personal contributions for social insurance.

Executive Summary

The Rock Island District of the U. S. Army Corps of Engineers (USACE) is presently undertaking planning exercises regarding (1) navigation and (2) ecosystem restoration on the upper Mississippi River and the Illinois Waterway (UMR-IWW). The Tennessee Valley Authority (TVA) has been contracted to assist the USACE in estimating the regional benefits of each of the potential activities. A summary of TVA's findings regarding each activity is discussed below.

Navigation

Construction and Shipper Savings Impacts

The USACE has studied navigation issues in an area comprising an entire navigation system and a portion of another—the Illinois Waterway and the Mississippi River, respectively. The study area is defined precisely as the Illinois Waterway from the confluence with the Mississippi River at Grafton, Illinois, River Mile 0.0, to T. J. O'Brien Lock in Chicago, Illinois, River Mile 327.0, and the segment of the Mississippi River from the confluence with the Ohio River, River Mile 0.0, to Upper St. Anthony Falls Lock in Minneapolis-St. Paul, Minnesota, River Mile 854.0. Its combined area includes approximately 1,200 miles of navigable waterway.

Needs assessment and the increasing delays on the Upper Mississippi and Illinois River System caused the USACE to embark on the study which addresses the feasibility and impacts of providing improvements to 29 locks on the upper Mississippi River and 8 locks on the Illinois Waterway. But due to the high cost of making large scale navigation improvements and the limitations of funding for waterway capital projects, the USACE embarked on the task of identifying and screening large and small scale efficiency measures at various projects. The alternatives that have passed through the screening process now total four combinations of large and small scale navigation improvements.

For each alternative, the USACE estimated the net benefits, which are the transportation cost savings that would accrue to each improved navigation infrastructure option as compared to the cost of making the improvements. This methodology was laid out by the U. S. Water Resources Council in 1983. The USACE considered the magnitude of the net benefits and the benefit-cost ratios in determining the recommended alternative[1].

Regional benefits will not be considered in the estimation of net benefits, but these benefits are certainly germane to the decision making process at the State, local and Congressional levels of government. Local, regional, and state economies are impacted by increases in

[1] *Economic and Environmental Principles and Guidelines For Water and Related Land Resources Implementation Studies,* U. S. Water Resources Council, March 1983.

federal expenditures and increased lock efficiency. Increases in economic efficiency would decrease costs and change relative regional competitiveness. Also, increased employment at construction sites brings spending to the area and certainly increases local income.

This study attempts to quantify the regional impacts of navigation and ecosystem improvements on the study area, more generally defined to include the states abutting the river system: Illinois, Iowa, Minnesota, Missouri, and Wisconsin. Impacts are also estimated for a group of Lower Mississippi states consisting of Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Tennessee, and Texas, for a total of 6 regions (five individual states and one state group).

The navigation alternatives analyzed represent either (1) large- or small-scale improvements to the Upper Mississippi River and Illinois Waterway System or (2) lock congestion fees that could encourage some users to use the locks at less congested periods. These alternatives are designated as 2, 4, 5, and 6. Implementation of these alternatives would improve waterway traffic conditions by increasing the capacities of lock chambers, increasing the efficiency of barge approaches to locks, or improving queue conditions through navigational enhancements or congestion pricing.

Under Alternative 2, congestion fees would be imposed on commercial traffic by means of a lockage fee. Theoretically, lockage fees would induce some waterway users to select less congested lockage times or even reduce usage, thereby reducing overall delays.

Under Alternative 4, moorings would be constructed at Locks 12, 14, 18, 20, 22, and 24 on the Mississippi River and at LaGrange on the Illinois Waterway. Moorings are tie-off facilities that allow the next tow in a queue to wait closer to the occupied lock, thus decreasing the average approach time at heavily used locks. In addition, switchboats would be stationed permanently at Locks 20-25. Switchboats are hired vessels permanently stationed on the upstream and downstream sides of a lock to assist in the handling cuts during a double lockage.

Under Alternative 5, moorings would be constructed at Locks 12, 14, 18, and 24 on the Mississippi River and at LaGrange on the Illinois Waterway. In addition, Locks 20-25 on the Upper Mississippi River would be extended to accommodate 1,200-foot tows. Switchboats would also be included at various locations.

Under Alternative 6, moorings would be constructed at Locks 12, 14, 18, and 24 on the Mississippi River and new 1,200-foot locks would be constructed at Locks 20-25, as well as at Peoria and LaGrange on the Illinois Waterway. In addition, Locks 14-18 on the Mississippi River would be extended to 1,200 feet and switchboats would be located at Locks 11, 12, and 13.

It has been recognized in this study that forecasting traffic for a 50-year planning horizon is difficult and subject to a great deal of uncertainty. Therefore, a scenario-based approach to traffic forecasting is being used. Various scenarios have been developed, representing a range of alternatives for future demand for inland waterway transportation of farm products. A range of possible futures with respect to trends, policies, conditions, and events that could impact the U. S. agricultural sector and export markets are considered in these scenarios. The scenarios are intended to cover the more plausible possibilities, not to encompass the absolute extremes.

Further, two models are used in the simulation exercise to address the issue of elasticity of shipments to shifts in the cost of water transportation. These are the ESSENCE model that was run for two elasticity cases and the Tow Cost Model. The two ESSENCE model cases provide an upper bound or high elasticity alternative (hereafter termed ESSENCE upper bound-EUB), the ESSENCE low elasticity (hereafter termed the ESSENCE lower bound-ELB). The Tow Cost Model is based on the case where river traffic is invariate to transportation costs.

In the study, TVA estimated the impacts with an economic model constructed by Regional Economic Models Inc. (REMI) of Amherst, Massachusetts. REMI models are econometric models with highly detailed input-output industry categories. The direct impacts of the project proposals consist of the project costs, such as construction impacts or other spending for labor and for goods and services, and the savings to shippers that would arise from the improved efficiency of the navigation system. Data on project costs for each alternative, including the ecosystem enhancement alternatives, are furnished by the Corps of Engineers. In addition, forecasts of shipper savings for each alternative-scenario-model combination were supplied by the Corps of Engineers[2].

Direct construction activity results in indirect impacts in the local economy such that money spent on construction activity, labor and the purchase of materials, generates additional income and employment in a multiplier fashion. In a large construction project such as several of the alternatives considered for the Upper Mississippi and Illinois Waterway, impacts can range well distant from the local or regional construction area as purchases are made over long distances, construction workers often migrate to the construction site and leave their families at home where the construction earnings are partially spent, and certain of the construction work is done by private companies at remote locations.

One way to present the extraordinarily voluminous amount of data generated in the various simulations is to convert the annual estimates to present values. This is done by using the federally mandated discount rate of 5.875 percent. The impacts are measured in four variables: gross regional product (GRP), real personal income (RPI), output (OUTP), and employment (EMP). Annual values are presented for all four variables in the attached compact disk, and summary data are presented in the text.

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[2] TVA initially calculated the shipper savings values by commodity group and river segment for the U.S. Army Corps of Engineers (USACE) in 1996, reflecting work that began in 1994. The USACE applied the TVA estimates to their various forecasts and returned the data to TVA for input into the REMI model.

The economic impact on the 5-State Region summarized by scenario, model and alternative are shown in Tables 11 and 12 in the text. (Table 12 is shown below). The impacts range from positive to negative values depending on the alternative. Lockage fees, alternative 2 in each scenario, uniformly have a negative impact on the region[3]. This negative impact ranges from a loss of 529 jobs in the scenario one EUB case to a loss of 2,365 jobs in the TCM alternative five case. All other impacts as measured by present values are positive.

5-State Region Economic Impacts, Construction + Shipper Savings

(2005-2035 present values, millions of 2003 dollars; average annual employment)

Alter-native	Scenario	Model	GRP	Income	Output	Employment	Ratio GRP To Cost
6	5	TCM	$3,590.373	$2,668.227	$6,296.840	3,220	4.35
6	5	ELB	$3,001.351	$2,207.160	$5,479.177	2,748	3.63
6	5	EUB	$2,615.811	$1,887.254	$4,958.220	2,416	3.17
6	4	TCM	$3,395.667	$2,514.943	$6,033.906	3,060	4.11
6	4	ELB	$2,877.000	$2,097.411	$5,316.050	2,632	3.48
6	4	EUB	$2,546.704	$1,828.094	$4,864.575	2,349	3.08
6	3	TCM	$3,247.786	$2,404.348	$5,823.167	2,934	3.93
6	3	ELB	$3,096.074	$2,273.644	$5,660.327	2,816	3.75
6	3	EUB	$2,801.041	$2,046.150	$5,268.565	2,565	3.39
6	2	TCM	$2,855.209	$2,086.422	$5,283.249	2,610	3.46
6	2	ELB	$2,676.931	$1,859.786	$4,907.831	2,374	3.12
6	2	EUB	$2,492.192	$1,794.804	$4,796.609	2,292	3.02
6	1	TCM	$2,297.883	$1,637.951	$4,533.478	2,124	2.78
6	1	ELB	$2,252.064	$1,601.717	$4,464.392	2,097	2.73
6	1	EUB	$2,240.540	$1,586.358	$4,453.014	2,084	2.71
5	5	TCM	$2,864.290	$2,095.749	$4,775.312	2,328	6.39
5	5	ELB	$2,277.341	$1,633.587	$3,957.971	1,862	5.08
5	5	EUB	$1,875.343	$1,313.403	$3,392.985	1,537	4.18
5	4	TCM	$2,622.605	$1,900.674	$4,431.580	2,168	5.85
5	4	ELB	$2,166.171	$1,536.553	$3,800.253	1,769	4.83
5	4	EUB	$1,826.897	$1,280.861	$3,330.730	1,497	4.08
5	3	TCM	$2,792.106	$1,926.812	$4,847.490	2,276	6.23
5	3	ELB	$2,138.790	$1,520.879	$3,762.903	1,751	4.77
5	3	EUB	$1,821.350	$1,270.735	$3,326.043	1,491	4.06
5	2	TCM	$2,146.164	$1,529.979	$3,760.537	1,780	4.79
5	2	ELB	$1,875.332	$1,311.857	$3,394.427	1,534	4.18

[3] Lockage fees are imposed at the locks to redistribute traffic to time periods when demand is less. Those that have the least to gain by waiting in a queue would move to off-peak periods, and those that have the most to gain would pay to lock more quickly when they desire to do so. These fees would reduce shipper savings as the cost of business operations rises.

Alter-native	Scenario	Model	GRP	Income	Output	Employment	Ratio GRP To Cost
5	2	EUB	$1,773.719	$1,235.081	$3,258.301	1,446	3.96
5	1	TCM	$1,588.818	$1,078.462	$2,997.837	1,303	3.54
5	1	ELB	$1,575.554	$1,069.436	$2,976.763	1,290	3.52
5	1	EUB	$1,542.790	$1,040.488	$2,935.458	1,263	3.44
4	5	TCM	$1,795.557	$1,306.550	$2,926.859	1,353	8.00
4	5	ELB	$1,407.385	$969.305	$2,374.883	1,066	6.27
4	5	EUB	$1,138.093	$739.892	$1,988.325	881	5.07
4	4	TCM	$1,689.718	$1,216.584	$2,778.223	1,302	7.53
4	4	ELB	$1,362.537	$940.415	$2,308.563	1,052	6.07
4	4	EUB	$1,105.145	$721.070	$1,938.025	859	4.92
4	3	TCM	$1,631.714	$1,151.434	$2,698.554	1,251	7.27
4	3	ELB	$1,324.452	$905.667	$2,250.847	1,017	5.90
4	3	EUB	$1,090.267	$703.832	$1,916.742	845	4.86
4	2	TCM	$1,378.325	$959.423	$2,325.939	1,088	6.14
4	2	ELB	$1,165.778	$767.043	$2,021.352	903	5.19
4	2	EUB	$1,109.928	$717.664	$1,951.406	867	4.95
4	1	TCM	$1,009.067	$629.006	$1,806.496	780	4.50
4	1	ELB	$991.078	$613.445	$1,781.556	769	4.42
4	1	EUB	$952.346	$589.119	$1,726.134	744	4.24
2	5	EUB	-$1,249.770	-$1,093.850	-$1,798.400	-817	
2	5	ELB	-$2,192.530	-$1,926.790	-$3,139.430	-1,407	
2	5	TCM	-$3,666.860	-$3,220.410	-$5,252.020	-2,365	
2	4	EUB	-$1,189.240	-$1,041.100	-$1,710.770	-774	
2	4	ELB	-$2,147.450	-$1,885.090	-$3,080.790	-1,390	
2	4	TCM	-$3,179.000	-$2,796.110	-$4,541.230	-2,064	
2	3	EUB	-$1,173.600	-$1,026.190	-$1,687.520	-766	
2	3	ELB	-$2,117.980	-$1,852.600	-$3,037.620	-1,374	
2	3	TCM	-$3,264.310	-$2,869.080	-$4,683.610	-2,160	
2	2	EUB	-$984.847	-$863.803	-$1,408.970	-625	
2	2	ELB	-$1,988.420	-$1,741.070	-$2,853.810	-1,299	
2	2	TCM	-$3,333.040	-$2,926.970	-$4,775.990	-2,200	
2	1	EUB	-$835.590	-$723.740	-$1,200.340	-529	
2	1	ELB	-$1,439.920	-$1,246.220	-$2,073.890	-920	
2	1	TCM	-$2,589.550	-$2,268.900	-$3,710.390	-1,676	

The positive regional impacts on GRP in the 5-State Region range from a high value of $3.6 billion in the TCM Scenario 5, Alternative 6 to $952 million in the EUB case, Scenario 1, Alternative 4. Employment impacts range from 3,220 in the TCM Scenario 5, Alternative 6 and a low of 744 in the EUB, Scenario 1, Alternative 4. As would be expected, the range of employment impacts follows the GRP impacts pattern. The investments in the regional economy of the 5-State Region are shown to be very lucrative as reflected in the ratio of the present value of GRP to the present value of cost. This value ranges from a low of 2.71 in the EUB case for Scenario 1 and Alternative 6. The high value is 8.00 found in the Scenario 5, Alternative 4 in the TCM model.

By far, the greatest impact in the 5-State Region is on Illinois, which accounts for 44% of the five states' total GRP in Alternative 4. Missouri follows with 36% of GRP.

Construction Activity Only

The navigation study consists of four alternatives, one of which is the case of congestion fees. This leaves three construction scenarios in Alternatives 4, 5, and 6. Considering only construction activity, the impacts on GRP range from present values of $224 million in Alternative 4 to $826 million scenario in Alternative 6. Average annual employment ranges from 662 to 1,954.

Ecosystem Improvements

Project costs for the ecosystem enhancements consist of items such as labor costs and purchases of materials and supplies. These would operate in the economy in the same fashion as project costs for the navigation improvements, and therefore are entered into the REMI model in the same way.

In addition, however, the ecosystem enhancements would improve the attractiveness of the area and would enhance some recreational opportunities, resulting in an improved quality of life in the area. This improvement in quality of life is not a direct economic impact. However, there would be indirect economic impacts due to the increased comparative advantage of the area as a place to live, and thus as a place to locate a business, or organization, or industry. The value of this increased comparative advantage is the social rate of return on the investment required to achieve this comparative advantage. The social rate of return is comparable, conceptually, to the rate of return on any investment, and therefore can be expressed as a percentage rate of return on the project costs of the ecosystem enhancements.

Unlike the rate of return on a business investment, there is no easily measurable social rate of return for investments of this nature. TVA found no guidance in the literature for estimation of social rates of return for land reclamation as in the ecosystem proposals. Among the various articles that have been published on the subject, however, social rates of return are estimated by Taylor (1998) for four categories of expenditures. The annual rate values range from 5.31% in housing to 13.37% in non-housing investment that includes equipment and non-housing structures. But given that the projects are in rural areas that are far removed from major metropolitan areas, it was felt that a low-end social rate of return might be more appropriate for ecosystem impact analysis. Thus TVA, guided by Taylor's low end housing rate and reduced by one standard deviation, included a 3% annual rate.

Based on their knowledge of the research in the field and on use of the concept in economic modeling, however, the REMI staff recommended 7% as a reasonable annual rate[4] for this type of investment. TVA, therefore, estimated ecosystem impacts for both a 3% case and for a 7% case. Amenity effects are introduced into the REMI model directly through the **amenity amount policy variable**.

The amenity impacts of construction expenditures are implemented in the REMI model as follows. In the first year of the simulation, 3% of the value of construction expenditures is entered as an amenity impact in the 3% rate scenario case. In the second year of the simulation, 3% of the added ecosystem restoration expenditures are added to the amenity impact in addition to the impact from the first year of the simulation and so forth. This exercise is completed for both the 3% and 7% cases. Operation and maintenance costs were not included in this value because they are the cost of maintaining that value, not an increase in the value. In the REMI model, these economic benefits work through the migration functions, based on the assumption that the improvement in quality of life makes it less likely that people will migrate from the region and more likely that people will migrate into the region. Construction activity enters the REMI model straightforwardly through a construction demand variable.

In the analysis of ecosystem impacts four alternative plans have been proposed: A is the base case and B, C, D and E are the alternatives considered in the study. TVA modeled the impacts from 2005 to 2035 and, to the extent that the projects were projected to continue past 2035, these impacts are ignored in the TVA study. The input-output analysis estimates the impacts of the four alternative plans relative to the base case A. At the request of the Rock Island District the ecosystem alternatives are modeled in a twofold fashion. Ecosystem expenditures are modeled separately and then ecosystem expenditures are modeled with the 3% and 7% amenity effects. This assists the planner is segregating the impacts that accrue directly to construction activity and the impact of increased attractiveness on migration.

The ecosystem impacts (construction and construction plus amenities) for the 3% and 7% social rates of return are provided on the attached compact disk for GRP, RPT, OUTP, and EMP at five year intervals from 2005 to 2035. A principal observation from an examination of REMI output data is that the amenities variable has an highly elastic impact on migration and, thus, on economic activity in the five states.

In Alternative B with a 7% amenities value, the 2005 GRP impacts in the 5-State Region is $58.450 million, rising to $89.149 million in 2020. At a 3% amenities factor, GRP impact is about the same in 2005, but rises to $69.872 million for 2020, which is a drop of about

[4] Correspondence and phone conversations with David Morf, REMI, October 2003.

22% in value from the 7% case. In both cases, the amenity effect starts off slowly and then accelerates as migration is impacted by the enhanced attractiveness of the region. The total effect is sensitive to amenity values as in-migration builds and migrants become residents. The REMI model is, therefore, sensitive to the assumed value of the social rate of return, and, at either the 3% or 7% rate, the amenity effects are significant. The GRP impact for Alternative B is shown in the following table along with the present value of the impacts over the period 2005-2035:

Summary of Alternative B Ecosystem Impacts as Measured by GRP

(millions 2003 dollars; present values for 2005-2035)

	Present Value: 5-State Region	5-State Region: 2005	5-State Region 2020	Southern Region: 2005	Southern Region: 2020
Project cost	$555.534				
Construction + 3% Amenities	$898.809	$58.316	$69.872	$17.534	$8.216
Construction + 7% Amenities	$1,214.474	$58.450	$89.149	$17.534	$12.329
Construction Only	$733.082	$58.255	$54.961	$17.534	$1.096

In Scenario B the present value of the impacts due to construction returns about 32% more than the present value of the cost of the project. At a 3% social rate of return the present value of construction plus the amenity factor returns 62% more than the cost of the project. At a 7% rate of return, the project returns over 100% of the cost of the project. The ratio-to-cost data for Alternative B are fairly consistent across all scenarios.

The Alternative B present value GRP impact for construction-only stands at $733 million, rises to $899 million when the 3% amenities rate of return is included, and reaches $1.2 billion at the 7% rate. The corresponding impact values for Alternative E are $3.6 billion, $4.5 billion, and $5.6 billion.

Average annual employment gains in the 5-State Region range from 703 to 3,463, assuming only construction impacts. At a 3% social rate of return, employment gains average 899 to 4,430 from case to case. At a 7% rate, employment gains average 1,162 to 5,718, depending on the case. In the 3% social rate of return scenario, about 38% of the jobs are created in Illinois. After Illinois, average job creation is fairly constant among the remaining four states. Wisconsin is second in job creation with 18.8% of total employment, followed by Minnesota (16%) and Iowa and Missouri.

Multipliers

In this study we are define the multiplier values to be the ratio of present dollar value impacts (over the period 2005 to 2035) of gross product, income, and output relative to the present value of project costs over the same period. The multiplier for GRP in the Alternative B five-state aggregate (construction only) alternative is 1.31. Adding amenity impacts to the simulation, the multiplier rises to 2.41 for the five-state region in the 7% social rate of return case. A similar pattern follows for income and output.

Introduction

This study examines the regional impacts of two sets of projects—navigation and ecosystem restoration-- currently under evaluation by the U. S. Army Corps of Engineers (USACE). This work is being done by the Tennessee Valley Authority (TVA) under contract for the Rock Island District of the USACE. TVA is examining, first, the regional economic impacts of various waterway traffic scenarios and navigation alternatives. There are four navigation alternatives, which involve various potential improvements to increase efficiency of waterway movements. These include nonstructural measures (congestion fees), as well as structural measures such as guidewall extensions, lock extensions, and new locks. These alternatives are analyzed under various traffic scenarios. Also, various ecosystem restoration measures are included in the regional analysis. The ecosystem measures include beneficial adjustments to system operation and maintenance, ecosystem restoration opportunities, and environmental enhancement opportunities related to the navigation system.

Navigation Study

The Upper Mississippi and Illinois Rivers have proven to be efficient and cost-effective means of transporting a variety of goods and are thus a vital part of our national economy. The locks and dams that allow waterway traffic to move from one pool to another are integral parts of a regional, national, and international transportation network that is significant for certain key American exports but are also significant in the movement of many other commodities. Almost one half of our exports of corn are shipped on these waterways, with transportation costs being less than half that of a unit train movement to Baton Rouge (about $10.00 per ton vs. $22.00 per ton).

The importance of the Upper Mississippi and Illinois River waterways as shipping arteries is reflected in the continual increase in tonnage shipped there. On the upper Mississippi river tonnage has increased from 27 million tons in 1960 to 84.1 million tons in 2002. Illinois River traffic has grown from 23.0 million tons in 1960 to 43.0 million tons in 2002. Viewed as a system, combined Illinois and Upper Mississippi River traffic stood at 121.5 million tons in 2002 or about 23% of total domestic internal barge traffic. Many of the locks were designed to accommodate a fraction of the traffic that currently transits the system. For example, most of the locks on the system are 600 feet long, whereas many of the tows using the river are approximately 1,200 feet long. Tows must thus lock through in two steps which take approximately 1.5 to 2 hours. In contrast, a tow can lock through a 1,200 foot lock in approximately 0.5 hour. Eight of the 29 locks on the Upper Mississippi River and 3 of the eight Illinois Waterway locks were identified by the U. S. Army Corps of Engineers (USACE) as having the highest average delays of all locks in 1987. The *Inland Navigation Needs Assessment* identified 11 Upper Mississippi River locks as the highest priority locks for improvement on the Inland Waterway System. With growing usage, these delays will increase, resulting in higher costs in both time and dollars.

Due to the needs assessment and the increasing delays on the Upper Mississippi and Illinois River System, the USACE embarked on a feasibility study which addressed the feasibility and impacts of providing improvements[5] to 29 locks on the upper Mississippi River and 8 locks on the Illinois Waterway. Specifically, the principal problem addressed in the feasibility study is the potential for economic losses to the nation resulting from significant traffic delays on the system during the 50-year planning horizon (2000-2050). The study attempts to determine whether navigation improvements are justified and, if so, the appropriate navigation improvements, sites, and sequencing for the 50-year planning horizon. The feasibility study also includes the preparation of a system Environmental Impact Statement.

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

But due to the high cost of making large scale navigation improvements and the limitations of funding for waterway capital projects, the USACE embarked on the task of identifying and screening large and small scale efficiency measures at various projects. Large scale measures are navigation improvements involving extending the existing lock or providing a second lock at an existing lock and dam[6]. Small scale measures are navigation improvements of smaller scope such as mooring cells and powered kevel guidewalls[7]. The alternatives that have passed through the screening process now total nine combinations of large and small scale navigation improvements.

For each alternative, the USACE estimated the net benefits, which are calculated as the difference between the transportation cost savings that would accrue to each improved navigation infrastructure option and the cost of making the improvements. This methodology was laid out by the U. S. Water Resources Council in 1983. The USACE considered the magnitude of the net benefits and the benefit-cost ratios in determining the recommended alternative[8].

Regional benefits will not be considered in the estimation of net national benefits, but these benefits are certainly germane to the decision making process at the State, local and Congressional levels of government. Local, regional, and state economies are impacted by federal expenditures and lock efficiency. Increases in economic efficiency would decrease costs and change relative regional competitiveness. Also, increased employment at construction sites brings spending to the area and certainly increases local income.

Regional Description

The study area of the upper Mississippi River-Illinois Waterway is shown in Figure 1. The study area comprises an entire navigation system and a portion of another—the Illinois Waterway and the Mississippi River, respectively. The study area is defined precisely as the Illinois Waterway from the confluence with the Mississippi River at Grafton, Illinois, River Mile 0.0, to T. J. O'Brien Lock in Chicago, Illinois, River Mile 327.0, and the segment of the Mississippi River from the confluence with the Ohio River, River Mile 0.0, to Upper St. Anthony Falls Lock in Minneapolis-St. Paul, Minnesota, River Mile 854.0. Its combined area includes approximately 1,200 miles of navigable waterway.

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6 U. S. Army Corps of Engineers; Rock Island, St. Louis and St Paul Districts. *Upper Mississippi River - Illinois Waterway System Navigation Study, Draft Summary of Large-Scale Measures Screening*, October 1999.

7 U. S. Army Corps of Engineers; Rock Island, St. Louis and St Paul Districts. *Upper Mississippi River - Illinois Waterway System Navigation Study, Summary of Small-Scale Measures Screening*, April 1999.

8 *Economic and Environmental Principles and Guidelines For Water and Related Land Resources Implementation Studies*, U. S. Water Resources Council, March 1983.

Figure 1: The Study Area

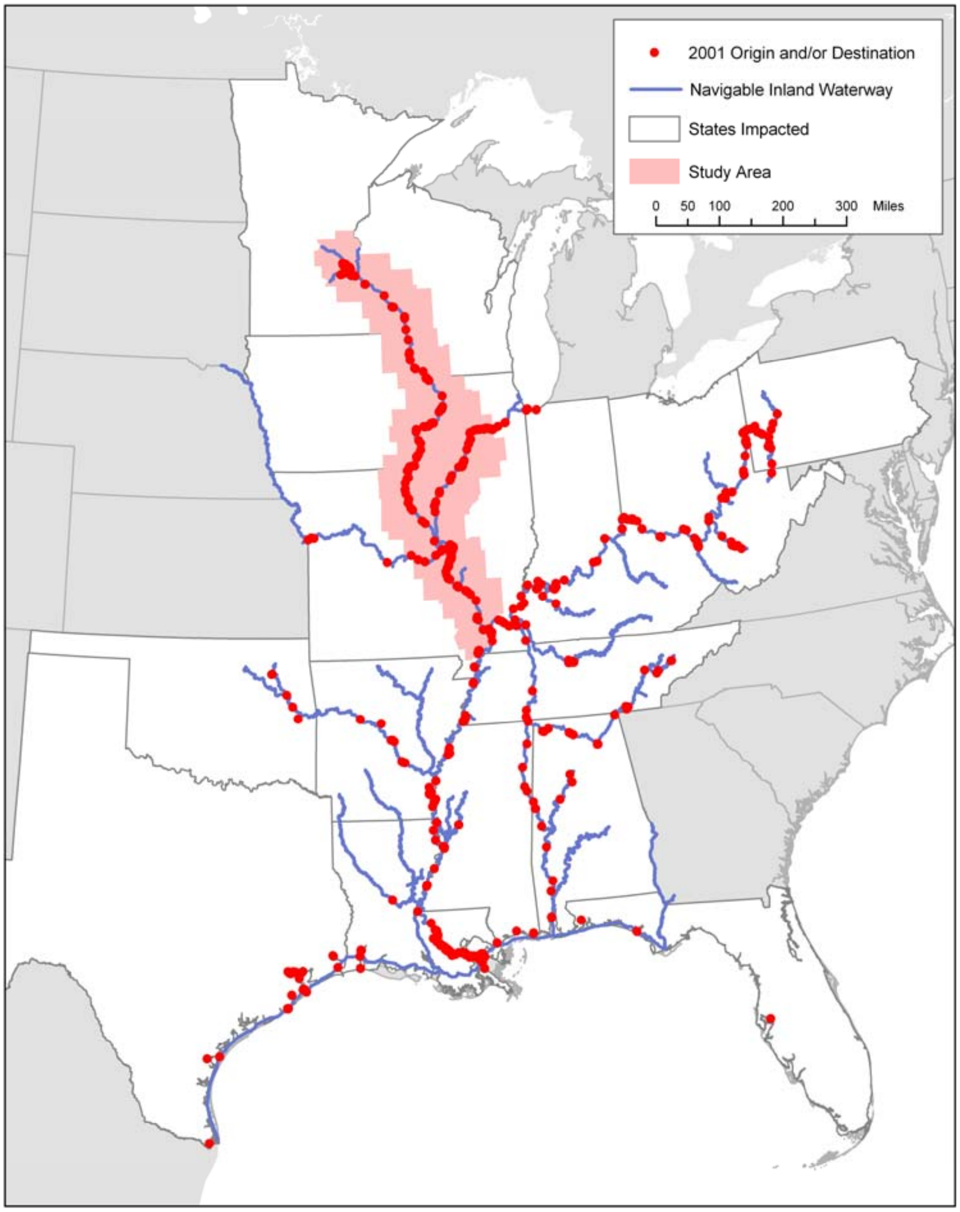
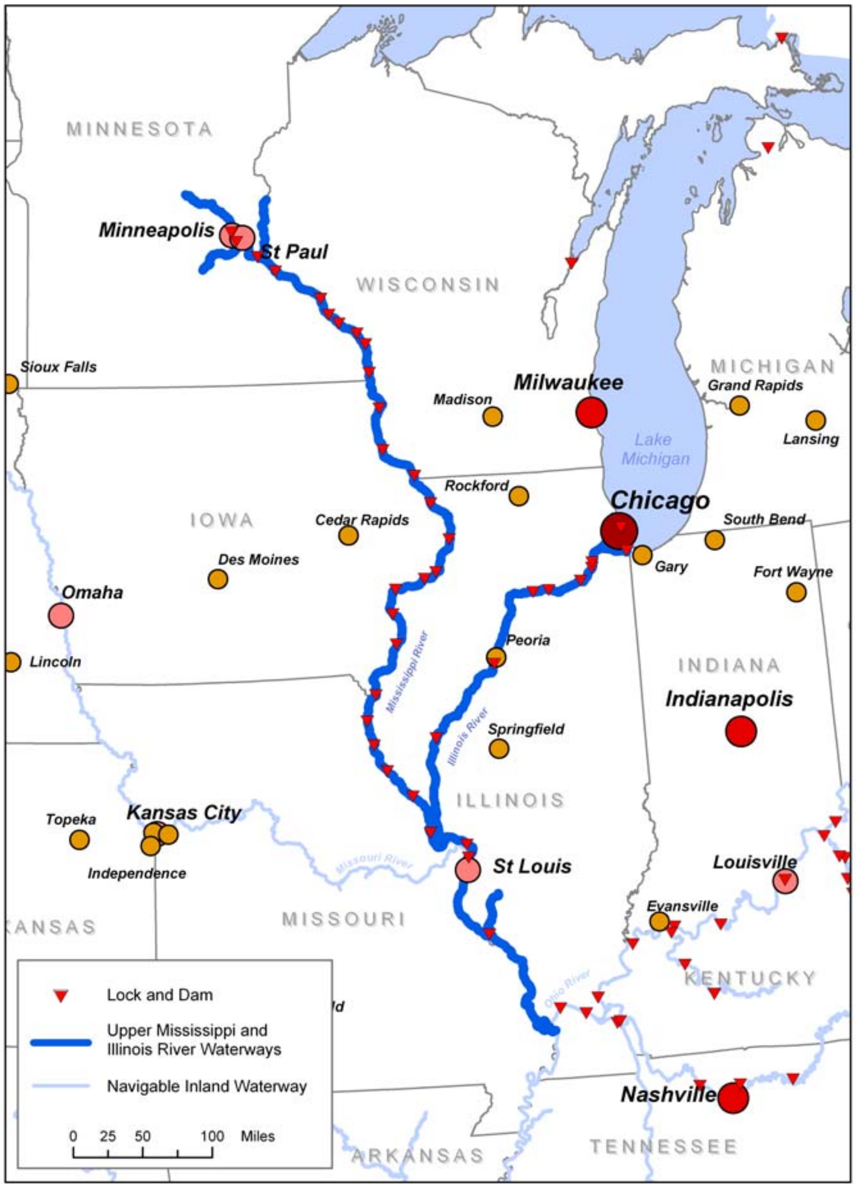


Figure 2: Penetration of upper Mississippi River Traffic



As shown in Table 1, the primary impact area of improvements to the Upper Mississippi River and Illinois Waterway includes five states: Illinois, Iowa, Minnesota, Missouri, and Wisconsin. Together, these states contain more than 11% of the nation's population, with total population in 2000 of about 31.2 million (Table 1). The states range in size from Illinois with a population of about 12.4 million to Iowa with a population of over 2.9 million. With the exception of Illinois, these states are more rural than the nation as a whole. Iowa is the most rural, with almost 39% of its population living in rural areas, followed by Wisconsin with almost 32% of its population in rural areas. All of the states in the primary impact area have been growing more slowly than the national average over the past several years. From 1980 to 2000, Iowa had a very small increase in population, about four-tenths of one percent, reversing a decline since the 1980s. The other four states experienced larger population increases, ranging from 20.7% in Minnesota to 8.7% in Illinois.

Average income levels in this area are slightly higher than the national average, with per capita personal income in 2001 at $30,959, compared to the national average of $30,413. The income range among the states is from $27,225 in Iowa, 89.5% of the national average, to $33,059 in Minnesota, 108.7% of the national average. All of the area states are more dependent on manufacturing earnings than the nation as a whole, especially Wisconsin which, in 2001, derived 23.2% of earnings from manufacturing. On the other hand, both Illinois and Missouri are only slightly more dependent on manufacturing, 13.8% and 13.6% of the total, respectively. With the exception of Iowa, the states derive about the same or less of their total earnings from agriculture. In 2001, Iowa derived 2.8% of its earnings from agriculture compared to the national average of 0.9%.

Table 1: Population, Income, and Employment Data for the Five Study State Area

	Illinois	Iowa	Minnesota	Missouri	Wisconsin
Population, 2000	12,419,293	2,926,324	4,919,479	5,595,211	5,363,675
Percent Rural, 2000	12.2	38.9	29.1	30.6	31.7
Population Increase, 1980-2000 (%)	8.7	0.4	20.7	13.8	14.0
Per Capita Personal Income, 2001	$32,990	$27,225	$33,059	$28,221	$29,196

	Illinois	Iowa	Minnesota	Missouri	Wisconsin
Earnings by industry (%):					
Agriculture	0.4	2.8	0.8	0.7	0.7
Manufacturing	13.8	18.7	15.2	13.6	23.2
Trade	12.3	13.5	13.1	12.4	12.4
Services	37.6	28.6	36.3	38.8	31.0
Government	13.5	16.5	13.4	15.5	14.8
Other	22.3	19.9	21.1	19.0	17.8

Source: U. S. Bureau of the Census; U. S. Bureau of Economic Analysis

This area is an important producer of the nation's major agricultural crops. In 2002, over half (54.6 percent) of the total value of soybean production was in this area, primarily in Illinois and Iowa. Almost half (48.7 percent) of the corn was also in this area, also primarily in Illinois and Iowa. And over half (51.7 percent) of the value of hog production was also in the area, concentrated primarily in Iowa with 27.6 percent. Dairy products, primarily in Wisconsin, were also important, contributing 23.1% of the nation's milk production by value and 39.3% of the volume of cheese produced in 2001. Minnesota is the source of most of the iron ore produced in this country, with production of 33.8 million metric tons in 2001, about 73% of the nation's production.

But as important and broad as the study area region as defined, the actual market area extends well beyond the states that border the Mississippi River to include the market area of the Missouri River. This broader study area includes movements from Kansas and Nebraska as shown in Figure 2.

The Traffic Base

As noted above, the waterborne commerce moving, originating or terminating on the upper Mississippi and Illinois Waterway in 2002 was 121 million tons. This is the most current data available from the USACE. Historical traffic data are shown in table 2 from the period 1965 to 2002. Grains traffic, accounting for 41% of the total, is the most dominant commodity on the combined waterway network. Other important commodities are coal and coke (21 percent); aggregates (14 percent); a miscellaneous group containing petroleum coke, cement, lumber and forest materials, asphalt, and animal feed (12 percent); chemicals, including fertilizers, alcohol, and styrene (6 percent);; petroleum fuels (3 percent); ores and minerals, including iron ore (3 percent); and iron and steel, including scrap metal (2 percent).

Table 2: Historical River System Traffic By Year (millions of tons)

	Upper Mississippi River	Illinois River	Middle Mississippi River
1965	37.8	27.2	41.5
1970	54.0	34.3	58.3
1975	63.1	43.6	71.6
1981	74.5	43.1	92.2
1982	74.7	42.7	90.5
1983	84.4	43.5	98.7
1984	81.8	39.6	103.6
1985	72.0	38.5	92.7
1986	73.7	43.4	97.7
1987	81.6	41.4	104.5
1988	72.0	41.0	106.0
1989	79.4	39.7	101.8
1990	88.4	43.3	110.3
1991	84.1	43.1	110.1
1992	86.2	42.7	114.5
1993	72.2	45.6	99.1
1994	79.4	50.9	108.9
1995	84.4	47.4	118.3
1996	80.4	46.2	113.0
1997	77.8	43.0	112.5
1998	79.6	41.8	115.8
1999	85.7	43.7	124.7
2000	83.3	44.2	121.6
2001	78.8	43.5	119.1
2002	84.1	43.0	121.5

Another manner in which to assess the traffic base of the upper Mississippi River and Illinois Waterway is through ton miles and average distance trafficked on this navigation system. These data are shown in Table 3 for the Upper Mississippi River and Illinois Waterway and also for the remainder of the nation. The most striking element in this table is the difference between miles per trip on the Upper Mississippi River and Illinois Waterway as compared to the remainder of the national inland river system: 719 miles as compared to 229 miles. The extreme difference in distance traveled is explained by the fact that the Upper Mississippi River navigation system provides a low cost transportation route for interregional and international trade as opposed to other river systems which are more intraregional in scope and purpose. The Upper Mississippi system has allowed the rural agricultural-based economy of the Midwest to flourish by providing an outlet for markets out of the region. By contrast, the Ohio River has provided a basis for industrialization for the resources in its area. One river system (the Ohio) is largely a shuttle system for coal and other industrial inputs, while the other system provides a conduit for grains to markets outside the region and nation.

Table 3: Miles Per Trip on the Mississippi River and Illinois Waterway and The Remainder of the Nation (2002)

Area	Ton miles (000,000)	Trip Miles (000,000)	Trips	Miles Per Trip
Upper Mississippi and Illinois Waterway	120,216.4	72,242.4	100,440	719
Remainder of the Nation	288,158.7	191,001.3	834,435	229

Also shown in Table 3 is a comparison of ton miles registered in the Upper Mississippi River systems as compared to the remainder of the nation. While the Upper Mississippi River accounts for 23% of inland river tonnage, this river system accounts for 29.4% of domestic ton miles of traffic. This difference is accounted for by the longer miles traveled per trip on the Upper Mississippi River system.

Navigation Alternatives

The navigation alternatives analyzed represent potential improvements to the Upper Mississippi River and Illinois Waterway System or lock congestion fees. These alternatives are designated as 2, 4, 5, and 6. Implementation of these alternatives would improve waterway traffic conditions by increasing the capacities of lock chambers, increasing the efficiency of barge approaches to locks, or improving queue conditions through navigational enhancements or congestion pricing.

Under Alternative 2, congestion fees would be imposed on commercial traffic by means of a lockage fee. Theoretically, lockage fees would induce some waterway users to select less congested lockage times or even reduce usage, thereby reducing overall delays.

Under Alternative 4, moorings would be constructed at Locks 12, 14, 18, 20, 22, and 24 on the Mississippi River and at LaGrange on the Illinois Waterway. Moorings are tie-off facilities that allow the next tow in a queue to wait closer to the occupied lock, thus decreasing the average approach time at heavily used locks. In addition, switchboats would be stationed permanently at Locks 20-25. Switchboats are hired vessels permanently stationed on the upstream and downstream sides of a lock to assist in the handling cuts during a double lockage.

Under Alternative 5, moorings would be constructed at Locks 12, 14, 18, and 24 on the Mississippi River and at LaGrange on the Illinois Waterway. In addition, Locks 20-25 on the Upper Mississippi River would be extended to accommodate 1,200-foot tows. Switchboats would also be included at various locations.

Under Alternative 6, moorings would be constructed at Locks 12, 14, 18, and 24 on the Mississippi River and new 1,200-foot locks would be constructed at Locks 20-25, as well as at Peoria and LaGrange on the Illinois Waterway. In addition, Locks 14-18 on the Mississippi River would be extended to 1,200 feet and switchboats would be located at Locks 11, 12, and 13.

Traffic Scenarios and Models

It has been recognized for this study that forecasting traffic for a 50-year planning horizon is difficult and subject to a great deal of uncertainty. Therefore, a scenario-based approach to traffic forecasting is being used. Various scenarios have been developed, representing a range of alternatives for future demand for inland waterway transportation of farm products. A range of possible futures with respect to trends, policies, conditions, and events that could impact the U. S. agricultural sector and export markets are considered in these scenarios. The scenarios are intended to cover the more plausible possibilities, not to encompass the absolute extremes.

For each alternative, the USACE estimated the net benefits, which are the transportation cost savings that would accrue to each improved navigation infrastructure option as compared to the cost of making the improvements. This methodology was laid out by the U. S. Water Resources Council in 1983. The USACE considered the magnitude of the net benefits and the benefit-cost ratios in determining the recommended alternative[9].

Further, two models are used in the simulation exercise to address the issue of elasticity of shipments to shifts in the cost of water transportation. These are the ESSENCE model that was run for two elasticity cases and the Tow Cost Model. The two ESSENCE model cases provide an upper bound or high elasticity alternative (hereafter termed ESSENCE upper bound-EUB), the ESSENCE low elasticity (hereafter termed the ESSENCE lower bound-ELB). The Tow Cost Model is based on the case where river traffic is invariate to transportation costs.

9 *Economic and Environmental Principles and Guidelines For Water and Related Land Resources Implementation Studies,* U. S. Water Resources Council, March 1983.

Project Costs and Impacts

Direct Impacts

The direct impacts of the project proposals consist of the project costs, such as constructions impacts or other spending for labor and for goods and services, and the savings to shippers that would arise from the improved efficiency of the navigation system. Data on project costs for each alternative, including the ecosystem enhancement alternatives, are furnished by the Corps of Engineers. In addition, forecasts of shipper savings for each alternative-scenario-model combination were supplied by the Corps of Engineers[10].

The costs and savings are summarized in the following two tables:

Table 4: Project Costs – Present Values By Alternative And State

(2005-2035 present values, in millions of 2003 dollars)

State	Alt 4	Alt 5	Alt 6
Illinois	$104.917	$246.344	$429.116
Iowa	$11.800	$39.908	$145.095
Minnesota	$0.000	$0.000	$0.000
Missouri	$107.704	$161.971	$250.126
Wisconsin	$0.000	$0.000	$1.817
5-State Reg.	$224.421	$448.223	$826.153

Table 5: Shipper Savings By Alternative-Scenario-Model

(2005-2035 constant dollar savings summed; in millions of 2003 dollar values)

Alternative	Scenario	Model	Shipper Savings
2	1	EL	-$2,036
2	1	EU	-$1,177
2	1	TCM	-$3,794
2	2	EL	-$2,954
2	2	EU	-$1,415
2	2	TCM	-$5,036
2	3	EL	-$3,115
2	3	EU	-$1,733
2	3	TCM	-$4,960

[10] TVA initially calculated the shipper savings values by commodity group and river segment for the U.S. Army Corps of Engineers (USACE) in 1996, reflecting work that began in 1994. The USACE applied the TVA estimates to their various forecasts and returned the data to TVA for input into the REMI model.

Alternative	Scenario	Model	Shipper Savings
2	4	EL	-$3,106
2	4	EU	-$1,750
2	4	TCM	-$4,712
2	5	EL	-$3,131
2	5	EU	-$1,841
2	5	TCM	-$5,321
4	1	EL	$241
4	1	EU	$177
4	1	TCM	$279
4	2	EL	$622
4	2	EU	$499
4	2	TCM	$1,148
4	3	EL	$923
4	3	EU	$480
4	3	TCM	$1,491
4	4	EL	$975
4	4	EU	$507
4	4	TCM	$1,611
4	5	EL	$983
4	5	EU	$542
4	5	TCM	$1,688
5	1	EL	$453
5	1	EU	$376
5	1	TCM	$482
5	2	EL	$1,150
5	2	EU	$867
5	2	TCM	$1,935
5	3	EL	$1,765
5	3	EU	$1,007
5	3	TCM	$2,815
5	4	EL	$1,810
5	4	EU	$1,025
5	4	TCM	$2,989
5	5	EL	$2,051
5	5	EU	$1,168
5	5	TCM	$3,332

Alternative	Scenario	Model	Shipper Savings
6	1	EL	$446
6	1	EU	$400
6	1	TCM	$493
6	2	EL	$1,295
6	2	EU	$1,015
6	2	TCM	$2,045
6	3	EL	$2,022
6	3	EU	$1,210
6	3	TCM	$2,985
6	4	EL	$2,099
6	4	EU	$1,238
6	4	TCM	$3,336
6	5	EL	$2,489
6	5	EU	$1,448
6	5	TCM	$3,830

Indirect Impacts

Direct construction activity results in indirect impacts in the local economy such that money spent on construction activity, labor and the purchase of materials, generates additional income and employment in a multiplier fashion. In a large construction project such as several of the alternatives considered for the Upper Mississippi and Illinois Waterway, impacts can range well distant from the local or regional construction area as purchases are made over long distances, construction workers often migrate to the construction site and leave their families at home where the construction earnings are partially spent, and certain of the construction work is done by private companies at remote locations.

In the study, TVA used an economic model constructed by Regional Economic Models Inc. (REMI) of Amherst, Massachusetts. REMI models are econometric models with highly detailed input-output industry categories. The specific model constructed for this project is a multiregional model, the regions being each of the five states in the Upper Mississippi area (Illinois, Iowa, Minnesota, Missouri, and Wisconsin) plus a Lower Mississippi region that is an aggregation of seven states (Alabama, Arkansas, Kentucky, Louisiana, Mississippi, Tennessee, and Texas), for a total of 6 regions. The model is discussed further in the discussion of Methodology, below.

Methodology

Economic Impact Analysis

The purpose of any economic impact analysis is to study the ways in which direct benefits and costs of a project or other action would affect the local, regional, or national economy. The most common focus of such studies, as is the case with the current study, is on the impacts to the output of goods and services, and to employment, income, and population. However, almost any economic variable can be a focus if the necessary data are available. Some studies, for example, include impacts on local tax revenues or impacts on housing.

Various techniques have been developed for estimating economic impacts. However, all of these techniques directly or indirectly involve the concept of multipliers. A multiplier quantifies the relationship between some change in an economy (a direct impact) and the succeeding economic activity that occurs as a result of that change (the indirect and induced impacts of the project or action). The jobs created by the project itself, such as the construction jobs created to build a structure or to operate a facility after it is constructed, and the income earned by these new workers are direct impacts, as is the purchase of materials used in construction. The purchase of materials will lead to additional spending by the suppliers of these materials; this additional spending is referred to as indirect impacts. The new income of the workers will lead to new spending for goods and services; this additional spending is referred to as induced impacts. The sum of the direct, indirect, and induced impacts is called the total impact.

Various types of economic models can be used to estimate the total impacts of a project or other change on a given geographic area. One commonly used approach is input/output (I/O) models. These models trace the linkages of purchases and sales among industries within a given region, state, or country. The basic data used to develop an I/O model describes the technological relationships among industries. These technological relationships are modified to reflect trade patterns within the area for which the analysis is being conducted (state, multicounty area, etc.). While I/O models can be used to estimate the impacts of changes, they are static in nature, reflecting the relationships at some point in time. By themselves, they do not capture dynamic impacts over time, including changes in the technological and trade relationships. Other items that would not be covered include dynamic impacts on wage levels, property values, prices and costs of other inputs and outputs, labor and capital productivity, and population or migration patterns.

Alternative approaches include dynamic econometric and general equilibrium models that estimate the effects over time of changing conditions in a given area. These models vary greatly, however, with regard to their industry detail and the degree to which they capture interindustry relationships. The model used in this study, a REMI model, is, in part, a dynamic econometric model.

The REMI economic simulation and forecasting model was leased from *Regional Economic Models, Inc.* (REMI) for this study. In addition to its simulation and forecasting equations, it also contains a detailed input-output structure, so that it combines the features of typical of both static I/O and dynamic models and is also multiregional. The version of REMI used for this study is described below.

The REMI Model

This REMI model was built especially for the Upper Mississippi River region for the purpose of better understanding the economic and demographic effects that policy initiatives or external events may impose on the Upper Mississippi River area economy. REMI's model-building system uses hundreds of programs developed over the past two decades to build customized models using data from the *Bureau of Economic Analysis*, the *Bureau of Labor Statistics*, the *Department of Energy*, the *Census Bureau* and other public sources.

REMI Policy Insight, the newest version of REMI's software, combines years of economic experience with a user-friendly software interface. A major feature of REMI is that it is a dynamic model, which forecasts how changes in the economy and adjustments to those changes will occur on a year-by-year basis. The model is sensitive to a very wide range of policy and project alternatives, and to interactions between the regional and national economies.

The REMI model is a structural model, meaning that the REMI Upper Mississippi Model (UMM) includes cause-and-effect relationships. Estimated changes to the five direct drivers are model inputs. These are the endogenous linkages in the REMI model: output; population and labor supply; labor and capital demand; market shares; and wages prices and profit. The model builds on two key underlying assumptions that guide economic theory: households maximize utility and producers maximize profits. Interested lay people as well as trained economists can understand the basic model because these assumptions make sense.

In the model, businesses produce goods to sell to other firms, consumers, investors, governments and purchasers outside the region. The output is produced using labor, capital, fuel and intermediate inputs. The demand for labor, capital and fuel per unit of output depends on their relative costs; an increase in the price of any of these inputs leads to substitution away from that input to other inputs. The supply of labor in the model depends on the number of people in the population and the proportion of those people who participate in the labor force. Economic migration affects the population size. People will move into an area if the real after-tax wage rates, the likelihood of being employed, and the access to consumer goods increases in a region. They will also move into an area if the attractiveness of the area improves due to changes in amenities.

REMI Model Structure

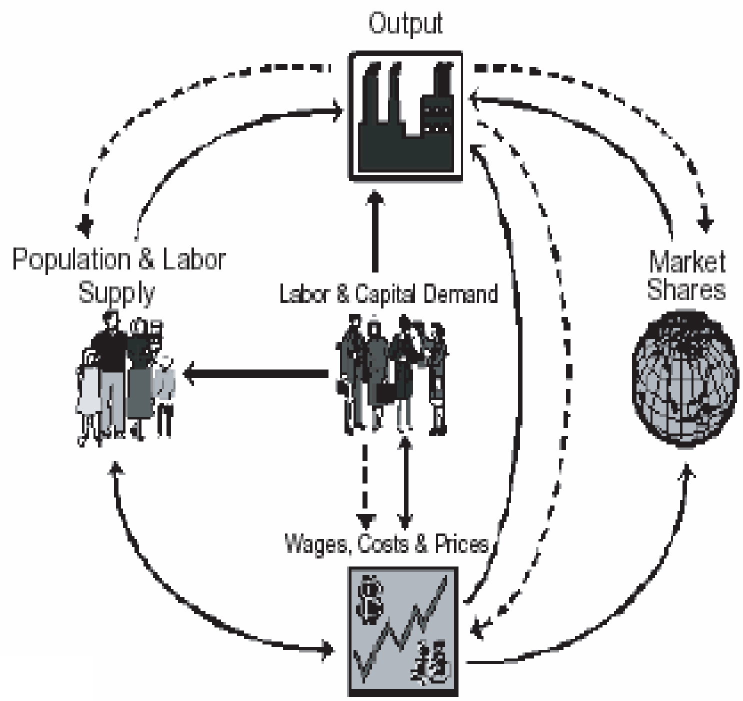


Figure 3: REMI Model Structure

Supply and demand for labor in the model determines the wage rates. These wage rates, along with other prices and productivity, determine the cost of doing business for every industry in the model. An increase in the cost of doing business causes an increase in production costs and the price of the goods or service, which would decrease the share of the domestic and foreign markets supplied by local firms. This market share, combined with the demand described above, determines the amount of local output. The model has many other feedbacks. For example changes in wages and employment affect income and consumption, while economic expansion changes investment and population growth affects government spending.

The Figure above is a pictorial representation of the model. The Output block shows a factory that sells to all the sectors of final demand as well as to other industries. The Labor and Capital Demand block shows how labor and capital requirements depend both on output and their relative costs Population and Labor Supply are shown as contributing to demand and to wage determination in the product and labor market. The feedback from this market shows that economic migrants respond to labor market conditions. Demand and supply interact in the Wage, Costs, & Prices block. Once costs and prices are established, they determine market shares, which along with components of demand determine output.

Linkages indicated by the dashed arrows account for the effects of agglomeration in both the labor and product markets. These effects are crucial to accurately capture the key to why certain areas with a concentration of similar businesses can prosper despite high wages and real estate costs. By having a choice of suppliers and workers, each firm can obtain specialized labor and inputs that best fulfill their needs. This increases productivity and efficiency.

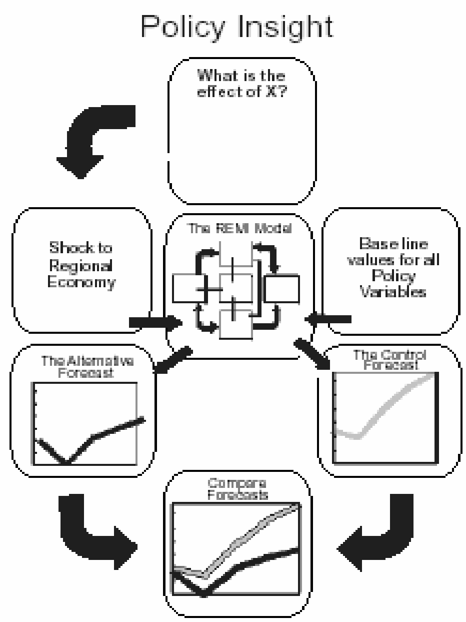
The dashed arrow from the Output block to the Cost block shows that more suppliers will increase the efficiency of inputs, which will then reduce production costs and competitiveness. The dashed arrow from the Labor block shows that more labor will increase the productivity of labor, thus reducing labor costs and thereby making the area more competitive. The arrow from Output to the Population block shows that the greater output provides more variety of choices and enhances consumer satisfaction, and thus inward migration. The arrow from the Output to the Shares block shows that the areas with concentration can offer more to purchasers, thus having an effect on market share in addition to the price advantages through the Cost & Price block.

The REMI model has strong dynamic properties, which means that it forecasts what will happen and when it will happen. The model brings together all of the above elements to determine the value of each of the variables in the model for each year in the baseline forecast. Inter-industry relationships contained in typical input-output models are captured in the REMI Output block; but REMI goes well beyond typical input-output models by including the relationships among all of the other blocks shown in Figure 4.

The REMI model for the Upper Mississippi Region is designed to examine the effects of policy changes or direct economic changes to the Upper Mississippi regional economy arising from the five economic drivers. The baseline forecast uses the baseline assumptions about the national and regional economic variables. Alternative forecasts are generated using appropriate input variable values for the five drivers that reflect changes resulting from potential project costs and shipper savings for any of the alternative-scenario-model combinations. The Figure below shows how this process would work for a waterway improvement called Alternative X.

The REMI model comes with default baseline economic forecasts for the United States and the Upper Mississippi region, referred to as “Control Forecasts.” A set of project costs and shipper savings developed as part of this project are direct impacts. These changes to economic sectors directly affected are introduced into the model, which is then run to produce a new forecast incorporating the impacts for the specific set of project costs and shipper savings. Impact results can be shown in terms of how the new forecast differs from the Control Forecast. For example, waterway changes that affect shipping costs would affect local farm income and resulting spending. The REMI model tracks these changes as changes in output by associated industries. Using the Upper Mississippi model, this study reports incremental changes between the baseline and each potential alternative.

Figure 4: How REMI Analyzes a Problem



Cost data for the various alternatives was developed by the Corps of Engineers, including estimated construction expenditures by year. In addition, they provided total costs for each alternative for items other than actual construction, such as engineering and design, management, etc. For purposes of this analysis, it was assumed that these expenditures would occur over time at the same rate as the construction expenditures. These project costs were then applied to appropriate REMI model policy variables in order to estimate total impacts.

Shipper Cost Savings (or Increases)

Operations (shipper savings) direct impacts for use in REMI were estimated as follows:

- Waterborne Commerce Statistical Center (WCSC) data for 2001 was used to tabulate tonnages by commodity (assigned to industries using SIC codes) and by Upper Mississippi Region state (Illinois, Iowa, Minnesota, Missouri, Wisconsin) for each of the four waterway improvement alternatives
- For each of the sixty combinations of alternatives (4), scenarios (5), and traffic forecast models (3), shipper savings were calculated using (a) percentage

distributions of the WCSC tonnages by alternative by state by commodity, and (b) total shipper savings by year (provided by the Corps of Engineers).

- Shipper savings were then entered into the six-region REMI model using appropriate policy variables, as discussed below.

In table 6, the top part of each data cell shows the percentage of total Mississippi River waterborne tonnages by grain and other (non-grain) commodities that originate or terminate in each combination of the Upper Mississippi region and rest-of-world. For combinations greater than one percent, the bottom part of the data cells indicates how barge movements are assigned to one of the five UM states: REG_O for state of origin or REG_T for state of termination. Combinations of less than 1% are not considered to be significant and therefore are not included in this study.

Table 6: Percentage of Grain Terminating

		Termination	
	Origin	*REG*	*RoW*
Grains	*REG*	1%	33% (REG_O)
	RoW	<1%	<1%
All Other Commodities	*REG*	18% (REG_O)	33% (REG_O)
	RoW	15% (REG_T)	<1%

REG = 5-State Region; RoW = Rest of World

Origin is taken to be the starting location of the barge movement; e.g., coal mined in RoW, but put on the river at a REG site, is considered REG origin.

Using this and origin-destination WCSC 2001 tonnages, a percentage is calculated for each alternative's combination of commodity and state (in the 5-State Region). These percentages are applied to the changes in total shipper costs, as provided by the Corps of Engineers, for each of the 60 alternative-scenario-model combinations. The result is changes in shipper costs by state and commodity for each of the alternative-scenario-model combinations.

Grain commodity exporters are price takers. If agricultural costs fall, their net income rises because they sell their commodities at a set fob destination world price. Non-agricultural shipments, on the other hand, are usually moved to market at competitive origin fob prices. In that case, the buyer gets the benefit of the transportation savings. If the buyer is in the region and the shipper is outside the region, the benefit is assigned to the company purchasing the good. If the shipper is inside the 5-state region and the buyer is inside the 5-state region (this is true in 18% of the movements), the transportation savings are assigned to the shipper inside the region because we do not know who the buyers are. Since the quantity of goods in this case is not large and since doing something possibly better would require excessive effort, TVA chose to take this simple path.

The next table summarizes how the shipper costs savings are treated for the economic analysis.

Table 7: Economic Variables Impacted by Savings to Commodity Buyers/Sellers

(o-Origin and t-termination refer to location of seller and buyer, respectively)

		Termination	
	Origin	REG_T	*RoW*
Grains	REG_O	na	farm income in REG_O[1]
	RoW	na	na
All Other Commodities	REG_O	production costs by industry in REG_T	???
	RoW	production costs by industry in REG_T	

These economic variables are inputs into REMI. The REMI policy variables used for production cost changes are production costs and value added. Value added is changed to offset any change in production costs in order to maintain balance in the economic accounting system. That is, any decrease in production costs would be offset by an increase in value added.

Additional REMI-related considerations include:

- (– [total shipper savings]) is input as intermediate demand for other transportation in Rest-of-US (there is, apparently, only one major shipping company in the 5-State Region). REMI will allocate impact expenditures by shippers in amounts and locations as dictated by the patterns for the "other transportation" industry in the Rest-of-US.
- No accounting is made in REMI for changes in federal government revenues from fees paid by shippers (Alt 2).
- Coal to regional power plants could impact power costs, but are ignored in this study.

- Any changes in spending by state and local governments for barged products are not accounted for.
- Impacts to farm income are assumed to be entirely local to each state.
- All dollars are converted to 1996 values for REMI runs, and results are adjusted to 2002 dollars.

A sample set of data for shipper savings is provided in the tables in Appendix A.

Project Expenditures

Alternative 2 is fees only and involves only shipper savings (negative).

Alternatives 4, 5, and 6 have labor costs and materials/equipment costs that have to be calculated for each.

Costs are provided by the Corps of Engineers by type of cost and by lock (where appropriate) for project sites in each of the three alternatives. These are broken out using the following percentages, as provided by the Corps of Engineers:

Labor	Equip	Material
35%	15%	50%

For the equipment and materials, the Corps estimates that 60% are purchased within the 5-State Region (IL, IA, MN, WI, MO) and 40% outside the 5-State Region. This is reasonably consistent with the trade flows in the REMI model, so the entire amount is put into exogenous final demand in the state or states where each lock is located. If the lock is on a border, equal allocations are made to the bordering states.

Equipment and materials expenditures are entered into REMI as exogenous final demand for specific industries. Industry assignments of equipment and materials for REMI are made as shown in the following table

Table 8: Equipment and Materials Industry Assignments

	Cost Categories	
	Equipment	*Materials*
Mooring Buoys	• industrial equipment (e.g. cranes)	• fabricated metal products (buoys)

	Cost Categories	
	Equipment	*Materials*
O&M Buoys	• industrial equipment (e.g. cranes)	• electrical equipment (e.g. motor parts)
Switch Boats	• rest of transportation equipment (e.g. ships and boats)	• petroleum products (fuel and oil)
Lock Extensions	• industrial equipment (heavy industrial equipment, e.g. cranes)	• fabricated metal products (steel) 50% • stone, clay, etc. (concrete) 50%
O&M Lock Ext	• industrial equipment (e.g. lighter construction equipment)	• fabricated metal prods (steel) 50% • stone, clay, etc. (concrete) 50%
Major Rehab	• industrial equipment (e.g. heavy industrial) 50% • electrical equipment 50%	• fabricated metal products (steel) 50% • stone, clay, etc. (concrete) 50%
New Locks	• industrial equipment (heavy industrial equipment—e.g. cranes)	• fabricated metal products (steel) 30% • stone, clay, etc. (concrete) 30% • electrical equip 40%
O&M New Locks	• industrial equipment (e.g. heavy industrial) 50% • electrical equipment 50%	• fabricated metal products (steel) 50% • stone, clay, etc. (concrete) 50%

For labor, Corps instructions are to allocate to type of labor as follows:

Unskilled	*Skilled*	*Mgmt*
7%	84%	9%
(2%)*	(30%)*	(3%)*

*Percent of total costs.

The resulting amounts are then broken out by state based on the percentage of population within 50 miles of the lock site. Labor costs are converted to employment using the wage rates in Table 9.

Table 9: Wage Rates Used in the Study

Project Cat.	*IA*	*IL*	*MN*	*MO*	*WI*
Management	$ 38,448	$ 43,091	$ 44,608	$ 40,879	$ 47,048
Skilled	$ 29,804	$ 34,559	$ 35,632	$ 32,182	$ 34,777
Unskilled	$ 22,802	$ 22,363	$ 23,222	$ 22,217	$ 21,349

These rates have been calculated from *BLS 2001 BLS -- Installation, Maintenance, and Repair Wage Rates*, where

BLS categories used are given by:

Management = Line Supervisors

Skilled = weighted average(electrical and electronic repairers, commercial and industrial equip; industrial machinery mechanics; maintenance workers, machinery)

Unskilled = helpers-installers, maintenance, and repair

Table 10 shows the sectors were employment is entered into the REMI sectors:

Table 10: REMI Sectors Affected by Employment

Cost Category	*REMI Sector*
mooring buoys	federal civilian government
O&M buoys	1/2 federal civilian government; 1/2 construction
switchboats	other transportation
lock extensions	construction contractors
O&M Lock Ext	1/2 federal civilian government; 1/2 construction
major rehab	1/2 federal civilian government; 1/2 construction
new locks	construction contractors
O&M new locks	1/2 federal civilian government; 1/2 construction

No offsets are being entered into REMI for project expenditures. Only exogenous final demand (positive) and employment (positive) are entered into REMI. The upshot of this assumption is that, given fully allocated resources in the nation, resources are diverted to the study region at the expense of some other region or regions. Thus, as would be expected, the solutions arrived at in REMI are purely regional gains or losses. The upshot of this fact is that the national summation of the regional solutions is a generally meaningless number.

Navigation Alternatives

As discussed above, the direct effects of navigation improvements are measured by shifts in expenditures and by shifts in shipper savings accruing to navigation shippers. Expenditures can be construction expenditures or shifts in operation procedures which can be switchboats, for example. A complete accounting of the direct effects is included in the attached compact disk.

This section summarizes the impact analysis undertaken for sixty (60) alternatives posited in the study. First, two models are used in the study: the ESSENCE and the Tow Cost models. Two versions of the ESSENCE Model are used: the ESSENCE high elasticity (hereafter termed EUB or Essence Upper Bound case) and the ESSENCE low elasticity (hereafter termed the ELB or ESSENCE Lower Bound case). In the ESSENCE model, varying degrees of sensitivity to transportation costs are exhibited in EUB and the ELB. The Tow Cost Model is termed the TCM. In the Tow Cost model river traffic is invariant to transportation costs. Second, there are five traffic scenarios. Third, there are four navigation alternatives as discussed below (3 versions of models x 6 traffic forecasts x 4 navigation alternatives = 60 alternatives).

The navigation alternatives are designated as 2, 4, 5, and 6. Under alternative 2, congestion fees would be imposed upon commercial traffic by means of a lockage fee. Under Alternative 4, moorings would be constructed at Locks 12, 14, 18, 20, 22, and 24 on the Mississippi River and at La Grange on the Illinois Waterway. Under Alternative 5, moorings would be constructed at Locks 12, 14, 18, and 24 on the Mississippi River and at LaGrange on the Illinois Waterway. In addition, Locks 20-25 on the Upper Mississippi River would be extended to accommodate 1,200 foot tows. Under Alternative 6, moorings would be constructed at Locks 12, 14, 18, and 24 on the Mississippi River and new 1,200 foot locks would be constructed at Locks 20-25, as well as at Peoria and La Grange on the Illinois Waterway. In addition, Locks 14-18 on the Mississippi River would be extended to 1,200 feet and switchboats would be located at Locks 11, 12, and 13.

It should be noted that, in the regional impact analysis, accommodation is made for the fact that the old system requires maintenance and this activity does stimulate the regional economy. With the construction of the new system, or modification of the operational procedures in the new system, certain maintenance on the old system might be more economic, especially where a dual locking system is created. Thus, this analysis examines the regional impacts of the net increase or decrease in expenditures.

Navigation Impacts

Shown in Table 11 are the summary impacts generated for the 5-State Region by the REMI model. The table is laid out to show the impacts by scenario, model, and alternative for four variables: gross regional product (GRP), personal Income (Income), output, and employment. For the variables measured in terms of dollars, the values shown are the present value calculations over the period 2005-2035 at a discount rate of 5.875 percent. Employment impacts are displayed as average annual values over the period 2005-2035. Additionally, the ratio of the present value of GRP to the present value of project cost (the direct effect) is shown. The data in Table 11 are sorted in descending order by GRP and shown in Table 12. Annual expenditure (direct effect) and impact data for gross regional product, income, output, and employment are displayed at five year increments in the attached compact disk. These data can be adjusted to display annual direct effects and impacts for the period 2005-2035.

The economic impact on the 5-State Region ranges from positive to negative values. Lockage fees, Alternative 2 in each scenario, uniformly have a negative impact on the region. This negative impact ranges from a loss of 529 jobs in the scenario one EUB case to a loss of 2,365 jobs in the TCM Scenario 5 case. All other impacts as measured by present values are positive. It is true that certain of the annual impacts are negative but such a case is caused by two factors inherent in the REMI model. First, there is a business cycle built into the REMI model which can move the indicators from positive to negative values. Second, there are adjustment mechanisms built into the model that can cause the simulation of the regional economy to adjust rather drastically to a shift in expenditure patterns. For example, eliminating regional expenditures that have been in effect for several years can cause a temporary negative adjustment in the regional economy.

Table 11: 5-State Region Economic Impacts By Alternative, Scenario, and Model, Construction + Shipper Savings

(2005-2035 present values, millions of 2003 dollars; average annual employment)

Alter-native	Scenario	Model	GRP	Income	Output	Employment	Ratio GRP To Cost
2	1	ELB	-$1,439.920	-$1,246.220	-$2,073.890	-920	
2	1	EUB	-$835.590	-$723.740	-$1,200.340	-529	
2	1	TCM	-$2,589.550	-$2,268.900	-$3,710.390	-1,676	
2	2	ELB	-$1,988.420	-$1,741.070	-$2,853.810	-1,299	
2	2	EUB	-$984.847	-$863.803	-$1,408.970	-625	
2	2	TCM	-$3,333.040	-$2,926.970	-$4,775.990	-2,200	
2	3	ELB	-$2,117.980	-$1,852.600	-$3,037.620	-1,374	
2	3	EUB	-$1,173.600	-$1,026.190	-$1,687.520	-766	
2	3	TCM	-$3,264.310	-$2,869.080	-$4,683.610	-2,160	
2	4	ELB	-$2,147.450	-$1,885.090	-$3,080.790	-1,390	

Alter-native	Scenario	Model	GRP	Income	Output	Employment	Ratio GRP To Cost
2	4	EUB	-$1,189.240	-$1,041.100	-$1,710.770	-774	
2	4	TCM	-$3,179.000	-$2,796.110	-$4,541.230	-2,064	
2	5	ELB	-$2,192.530	-$1,926.790	-$3,139.430	-1,407	
2	5	EUB	-$1,249.770	-$1,093.850	-$1,798.400	-817	
2	5	TCM	-$3,666.860	-$3,220.410	-$5,252.020	-2,365	
4	1	ELB	$991.078	$613.445	$1,781.556	769	4.42
4	1	EUB	$952.346	$589.119	$1,726.134	744	4.24
4	1	TCM	$1,009.067	$629.006	$1,806.496	780	4.50
4	2	ELB	$1,165.778	$767.043	$2,021.352	903	5.19
4	2	EUB	$1,109.928	$717.664	$1,951.406	867	4.95
4	2	TCM	$1,378.325	$959.423	$2,325.939	1,088	6.14
4	3	ELB	$1,324.452	$905.667	$2,250.847	1,017	5.90
4	3	EUB	$1,090.267	$703.832	$1,916.742	845	4.86
4	3	TCM	$1,631.714	$1,151.434	$2,698.554	1,251	7.27
4	4	ELB	$1,362.537	$940.415	$2,308.563	1,052	6.07
4	4	EUB	$1,105.145	$721.070	$1,938.025	859	4.92
4	4	TCM	$1,689.718	$1,216.584	$2,778.223	1,302	7.53
4	5	ELB	$1,407.385	$969.305	$2,374.883	1,066	6.27
4	5	EUB	$1,138.093	$739.892	$1,988.325	881	5.07
4	5	TCM	$1,795.557	$1,306.550	$2,926.859	1,353	8.00
5	1	ELB	$1,575.554	$1,069.436	$2,976.763	1,290	3.52
5	1	EUB	$1,542.790	$1,040.488	$2,935.458	1,263	3.44
5	1	TCM	$1,588.818	$1,078.462	$2,997.837	1,303	3.54
5	2	ELB	$1,875.332	$1,311.857	$3,394.427	1,534	4.18
5	2	EUB	$1,773.719	$1,235.081	$3,258.301	1,446	3.96
5	2	TCM	$2,146.164	$1,529.979	$3,760.537	1,780	4.79
5	3	ELB	$2,138.790	$1,520.879	$3,762.903	1,751	4.77
5	3	EUB	$1,821.350	$1,270.735	$3,326.043	1,491	4.06
5	3	TCM	$2,792.106	$1,926.812	$4,847.490	2,276	6.23
5	4	ELB	$2,166.171	$1,536.553	$3,800.253	1,769	4.83
5	4	EUB	$1,826.897	$1,280.861	$3,330.730	1,497	4.08
5	4	TCM	$2,622.605	$1,900.674	$4,431.580	2,168	5.85
5	5	ELB	$2,277.341	$1,633.587	$3,957.971	1,862	5.08
5	5	EUB	$1,875.343	$1,313.403	$3,392.985	1,537	4.18
5	5	TCM	$2,864.290	$2,095.749	$4,775.312	2,328	6.39
6	1	ELB	$2,252.064	$1,601.717	$4,464.392	2,097	2.73
6	1	EUB	$2,240.540	$1,586.358	$4,453.014	2,084	2.71
6	1	TCM	$2,297.883	$1,637.951	$4,533.478	2,124	2.78
6	2	ELB	$2,676.931	$1,859.786	$4,907.831	2,374	3.12
6	2	EUB	$2,492.192	$1,794.804	$4,796.609	2,292	3.02
6	2	TCM	$2,855.209	$2,086.422	$5,283.249	2,610	3.46

Alter-native	Scenario	Model	GRP	Income	Output	Employment	Ratio GRP To Cost
6	3	ELB	$3,096.074	$2,273.644	$5,660.327	2,816	3.75
6	3	EUB	$2,801.041	$2,046.150	$5,268.565	2,565	3.39
6	3	TCM	$3,247.786	$2,404.348	$5,823.167	2,934	3.93
6	4	ELB	$2,877.000	$2,097.411	$5,316.050	2,632	3.48
6	4	EUB	$2,546.704	$1,828.094	$4,864.575	2,349	3.08
6	4	TCM	$3,395.667	$2,514.943	$6,033.906	3,060	4.11
6	5	ELB	$3,001.351	$2,207.160	$5,479.177	2,748	3.63
6	5	EUB	$2,615.811	$1,887.254	$4,958.220	2,416	3.17
6	5	TCM	$3,590.373	$2,668.227	$6,296.840	3,220	4.35

Table 12: 5-State Region Economic Impacts By GRP, Construction + Shipper Savings

(2005-2035 present values, millions of 2003 dollars; average annual employment)

Alter-native	Scenario	Model	GRP	Income	Output	Employment	Ratio GRP To Cost
6	5	TCM	$3,590.373	$2,668.227	$6,296.840	3,220	4.35
6	4	TCM	$3,395.667	$2,514.943	$6,033.906	3,060	4.11
6	3	TCM	$3,247.786	$2,404.348	$5,823.167	2,934	3.93
6	3	ELB	$3,096.074	$2,273.644	$5,660.327	2,816	3.75
6	5	ELB	$3,001.351	$2,207.160	$5,479.177	2,748	3.63
6	4	ELB	$2,877.000	$2,097.411	$5,316.050	2,632	3.48
5	5	TCM	$2,864.290	$2,095.749	$4,775.312	2,328	6.39
6	2	TCM	$2,855.209	$2,086.422	$5,283.249	2,610	3.46
6	3	EUB	$2,801.041	$2,046.150	$5,268.565	2,565	3.39
5	3	TCM	$2,792.106	$1,926.812	$4,847.490	2,276	6.23
6	2	ELB	$2,676.931	$1,859.786	$4,907.831	2,374	3.12
5	4	TCM	$2,622.605	$1,900.674	$4,431.580	2,168	5.85
6	5	EUB	$2,615.811	$1,887.254	$4,958.220	2,416	3.17
6	4	EUB	$2,546.704	$1,828.094	$4,864.575	2,349	3.08
6	2	EUB	$2,492.192	$1,794.804	$4,796.609	2,292	3.02
6	1	TCM	$2,297.883	$1,637.951	$4,533.478	2,124	2.78
5	5	ELB	$2,277.341	$1,633.587	$3,957.971	1,862	5.08
6	1	ELB	$2,252.064	$1,601.717	$4,464.392	2,097	2.73
6	1	EUB	$2,240.540	$1,586.358	$4,453.014	2,084	2.71
5	4	ELB	$2,166.171	$1,536.553	$3,800.253	1,769	4.83
5	2	TCM	$2,146.164	$1,529.979	$3,760.537	1,780	4.79
5	3	ELB	$2,138.790	$1,520.879	$3,762.903	1,751	4.77
5	5	EUB	$1,875.343	$1,313.403	$3,392.985	1,537	4.18
5	2	ELB	$1,875.332	$1,311.857	$3,394.427	1,534	4.18
5	4	EUB	$1,826.897	$1,280.861	$3,330.730	1,497	4.08
5	3	EUB	$1,821.350	$1,270.735	$3,326.043	1,491	4.06

Alter-native	Scenario	Model	GRP	Income	Output	Employment	Ratio GRP To Cost
4	5	TCM	$1,795.557	$1,306.550	$2,926.859	1,353	8.00
5	2	EUB	$1,773.719	$1,235.081	$3,258.301	1,446	3.96
4	4	TCM	$1,689.718	$1,216.584	$2,778.223	1,302	7.53
4	3	TCM	$1,631.714	$1,151.434	$2,698.554	1,251	7.27
5	1	TCM	$1,588.818	$1,078.462	$2,997.837	1,303	3.54
5	1	ELB	$1,575.554	$1,069.436	$2,976.763	1,290	3.52
5	1	EUB	$1,542.790	$1,040.488	$2,935.458	1,263	3.44
4	5	ELB	$1,407.385	$969.305	$2,374.883	1,066	6.27
4	2	TCM	$1,378.325	$959.423	$2,325.939	1,088	6.14
4	4	ELB	$1,362.537	$940.415	$2,308.563	1,052	6.07
4	3	ELB	$1,324.452	$905.667	$2,250.847	1,017	5.90
4	2	ELB	$1,165.778	$767.043	$2,021.352	903	5.19
4	5	EUB	$1,138.093	$739.892	$1,988.325	881	5.07
4	2	EUB	$1,109.928	$717.664	$1,951.406	867	4.95
4	4	EUB	$1,105.145	$721.070	$1,938.025	859	4.92
4	3	EUB	$1,090.267	$703.832	$1,916.742	845	4.86
4	1	TCM	$1,009.067	$629.006	$1,806.496	780	4.50
4	1	ELB	$991.078	$613.445	$1,781.556	769	4.42
4	1	EUB	$952.346	$589.119	$1,726.134	744	4.24
2	1	EUB	-$835.590	-$723.740	-$1,200.340	-529	
2	2	EUB	-$984.847	-$863.803	-$1,408.970	-625	
2	3	EUB	-$1,173.600	-$1,026.190	-$1,687.520	-766	
2	4	EUB	-$1,189.240	-$1,041.100	-$1,710.770	-774	
2	5	EUB	-$1,249.770	-$1,093.850	-$1,798.400	-817	
2	1	ELB	-$1,439.920	-$1,246.220	-$2,073.890	-920	
2	2	ELB	-$1,988.420	-$1,741.070	-$2,853.810	-1,299	
2	3	ELB	-$2,117.980	-$1,852.600	-$3,037.620	-1,374	
2	4	ELB	-$2,147.450	-$1,885.090	-$3,080.790	-1,390	
2	5	ELB	-$2,192.530	-$1,926.790	-$3,139.430	-1,407	
2	1	TCM	-$2,589.550	-$2,268.900	-$3,710.390	-1,676	
2	4	TCM	-$3,179.000	-$2,796.110	-$4,541.230	-2,064	
2	3	TCM	-$3,264.310	-$2,869.080	-$4,683.610	-2,160	
2	2	TCM	-$3,333.040	-$2,926.970	-$4,775.990	-2,200	
2	5	TCM	-$3,666.860	-$3,220.410	-$5,252.020	-2,365	

The positive regional impacts on GRP in the 5-State Region range from a high value of $3.6 billion in the TCM Scenario 5, Alternative 6 to $952 million in the EUB case, Scenario 1, Alternative 4. Employment impacts range from 3,220 in the TCM Scenario 5, Alternative 6 and a low of 744 in the EUB case, Scenario 1, Alternative 4. As would be expected, the range of employment impacts follows the GRP impacts pattern. The investments in the regional economy of the 5-State Region are shown to be very lucrative as reflected in the ratio of the present value of GRP to the present value of cost. This value ranges from a low of 2.71 in the EUB case for Scenario 1 and Alternative 6. The high value is 8.00 found in the Scenario 5, Alternative 4 in the TCM model.

Table 13 shows the geographic distribution of impacts for one case, the EUB case for scenario 1. It is interesting that in the congestion fee case, Alternative 2, the impacts on all five states are negative as farmers lose money and nonfarm industry is projected to have increased production costs. The direct effects on the Southern Region are positive. In the REMI model the direct effect of the rise in transportation costs on the upper Mississippi River and Illinois Waterway shifts resources to the region termed the "rest of the nation[11]." Major towing companies are headquartered here and are projected to increase their share of the national towing business given the rising costs in the 5-State Region. Thus, the revenues lost from the five states are input into intermediate demand in the rest of the nation. Regional trade flows built into REMI cause a rise in economic activity in the southern region.

By far, the greatest impact in the 5-State Region is on Illinois which accounts for 44% of GRP in Alternative 4. Missouri follows with 36% of GRP. The impact on the Southern Region GRP ranges from $48.3 million in Alternate 2 to $280.8 million in Alternate 6.

As with GRP, Illinois dominates in terms of employment with an average annual impact of 329 in Alternative 4. Missouri follows with 282 employees. Employment generated in the remaining three states is as follows: Iowa, 61; Minnesota, 36; and Wisconsin, 35.

Table 13: The Geographic Distribution of Impacts For Scenario 1 - Essence High Case

(Millions of 2003 Dollars, Average Annual Employment)

	Alt 2	Alt 4	Alt 5	Alt 6
		GRP ($03M)		
Illinois	-$340.252	$416.822	$846.076	$1,154.393
Iowa	-$152.123	$82.963	$174.939	$309.072
Minnesota	-$204.706	$53.485	$74.828	$100.210
Missouri	-$78.397	$343.503	$346.150	$514.156
Wisconsin	-$60.112	$55.572	$100.796	$162.708
5-States	-$835.590	$952.346	$1,542.790	$2,240.540
Southern Region	$48.324	$162.924	$212.903	$280.816

(continued on next page)

[11] Data for "rest of nation" are provided on the accompanying compact disk. Data for "rest of nation" are not presented in this report because additional direct effects may be required to properly account for the impacts there.

	Alt 2	Alt 4	Alt 5	Alt 6
		Real Personal Income ($03M)		
Illinois	-$268.028	$306.364	$640.251	$959.595
Iowa	-$142.630	$46.169	$86.816	$177.370
Minnesota	-$210.744	$34.670	$44.800	$50.129
Missouri	-$57.427	$176.968	$220.979	$330.589
Wisconsin	-$44.911	$24.948	$47.642	$68.674
5-States	-$723.740	$589.119	$1,040.488	$1,586.358
Southern Region	-$4.827	$32.561	$45.509	$43.508
		Output ($03M)		
Illinois	-$458.704	$754.097	$695.000	$2,265.947
Iowa	-$217.040	$135.531	$165.000	$609.564
Minnesota	-$307.556	$94.705	$56.000	$190.548
Missouri	-$112.827	$628.426	$282.000	$1,053.025
Wisconsin	-$104.216	$113.376	$66.000	$333.931
5-States	-$1,200.343	$1,726.134	$1,263.000	$4,453.014
Southern Region	$89.632	$349.184	$115.000	$605.532
		Employment		
Illinois	-189	329	695	1128
Iowa	-105	61	165	336
Minnesota	-147	36	56	74
Missouri	-48	282	282	432
Wisconsin	-41	35	66	113
5-States	-529	744	1263	2084
Southern Region	31	101	115	138

Navigation Impacts-Construction Only

The navigation study consists of four alternatives, one of which is the case of congestion fees. This leaves three construction scenarios in Alternatives 4, 5, and 6. Shown in Table 14 are the navigation impacts attributable only to construction activity in the 5-State Region. Shown first is the impact on GRP, personal income, output and employment. All dollar values are shown as present values (2005-2035) discounted at the rate of 5.875 percent. Also shown is the ratio of GRP to cost. The impacts on GRP range from present values of $829 million in Alternative 4 to $2.9 billion in Alternative 6. Average annual employment ranges from 662 (Alt. 4) to 1,954 (Alt 6).

While most of the benefits occur inside the Upper Mississippi five-state region, the trade flow patterns built into REMI result in significant impacts in the Southern Region. For Alternative 6, the present value impact to the Southern Region is nearly $300 million.

Average annual employment effects are also shown in Table 14. Average annual employment for the five-state region is estimated to be 662 for Alternative 4 and 1,954 for Alternative 6, while the corresponding impacts in the Southern Region are 114 , and 146.

Table 14: Summary--Construction Only for Alternatives 4, 5, and 6

(Note: monetary data is present value, 2005-2035, millions of 2003 dollars; employment is annual average value)

5-State Region Costs and Impacts

Alternative	Project Costs	GRP	Real Personal Income	Output	Employment	Ratio GRP to Cost
4	$224.421	$829.881	$486.189	$1,549.907	662	3.70
5	$448.223	$1,358.214	$899.267	$2,677.407	1123	3.03
6	$826.153	$2,942.289	$1,469.247	$4,246.286	1954	2.53

GRP Impacts

Alternative	5-State GRP	Southern Region GRP
4	$829.881	$176.153
5	$1,358.214	$216.623
6	$2,089.791	$289.198

Annual Average Employment Impacts

Alternative	5-State	Southern Region
4	662	114
5	1,123	116
6	1,954	146

Ecosystem Study

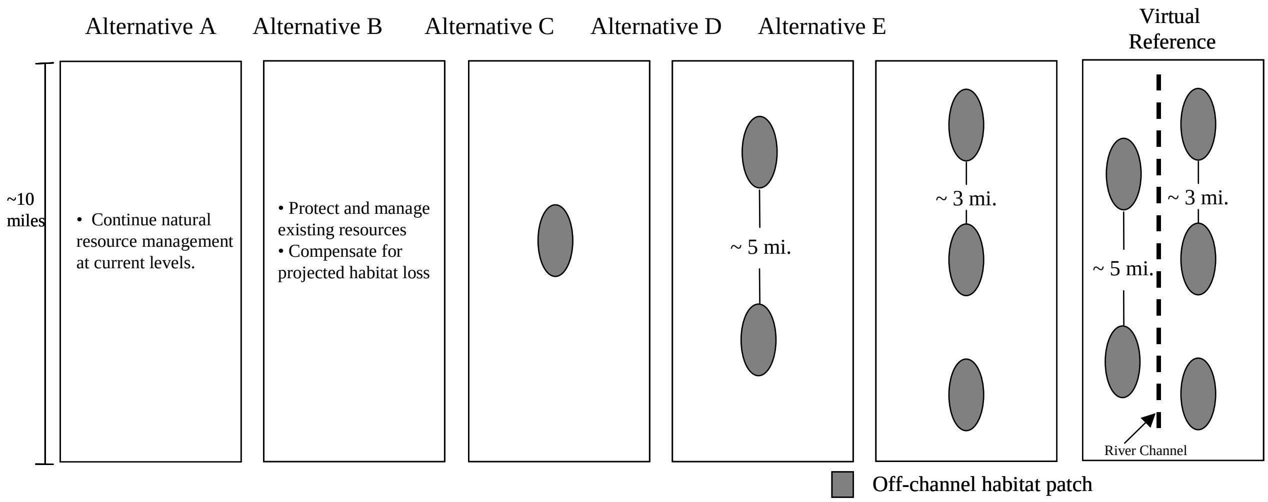
Ecosystem Restoration Measures

Varying types and numbers of restoration measures were combined into alternative plans to address local, river reach, and system-wide needs of the UMR-IWW ecosystem. Through collaborative work with UMR-IWW stakeholders, coordinating committees, and the Navigation Study Science Panel, five alternative plans were developed to provide a range of ecosystem protection and restoration opportunities. The without project conditions is labeled Alternative A. Four additional alternatives are considered with varying concentrations with ecosystem restoration. These are discussed below and taken essentially *verbatim* from the USACE Rock Island District's UMR-IWW System Navigation Feasibility Study Alternative Formulation Briefing (February, 2004).

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

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

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



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

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

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

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

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

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

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

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

Ecosystem Alternative Plans

After preliminary evaluation of the ecosystem measures and refinement of the alternative plans, five restoration alternatives were developed to address the identified needs of the UMR-IWW ecosystem. The alternatives, named A,B,C,D, and E, where A is a no-action alternative, consist primarily of the ecosystem measures and a rigorous adaptive management program, forestry management, and systemic fleeting plan. The number of projects per alternative is given in Figure 6.

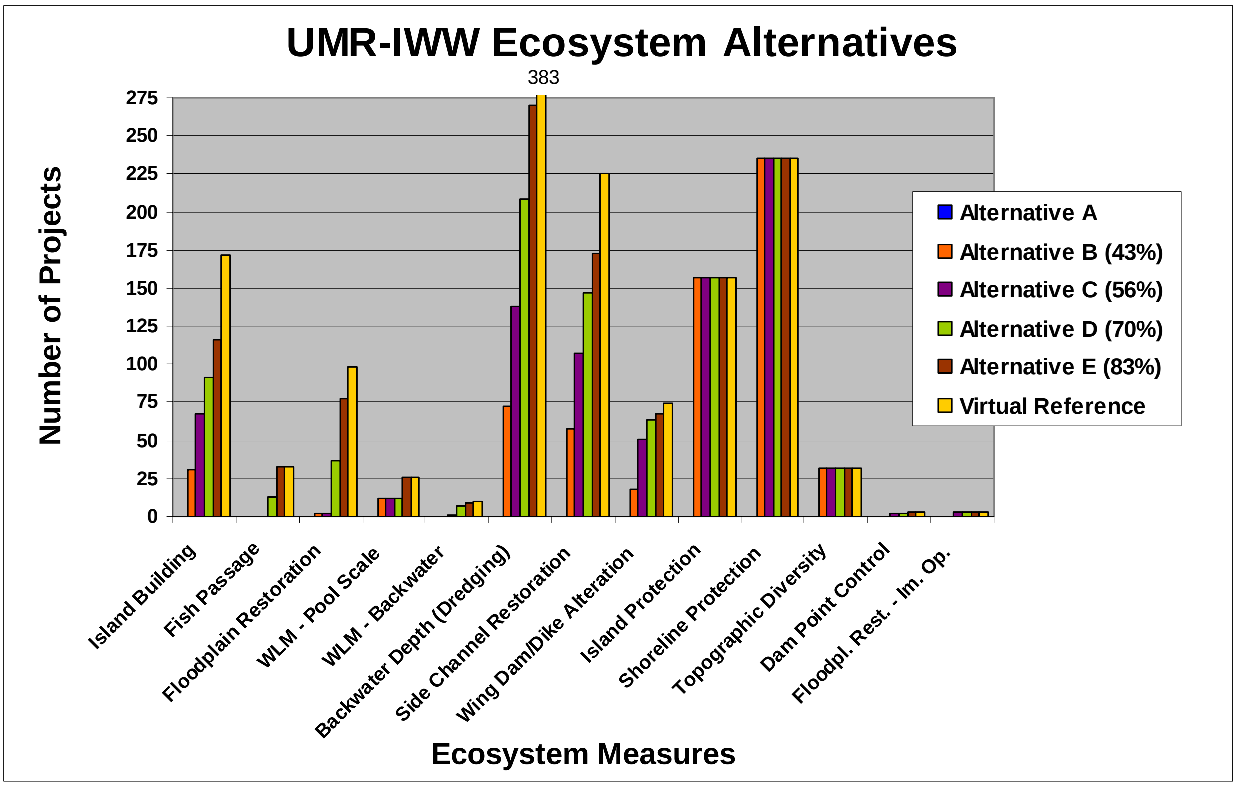


Figure 5: The Number of Ecosystem Alternative Measures (projects)

Alternative A *(No Action/Without Project)*

($0)

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

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

Primary Components

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

Alternative B

($1.7 Billion + O&M Costs)

- Protect and maintain existing environmental diversity (current mosaic of habitat types and ecological diversity maintained into the future: no net loss).

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

Primary Components

- Build 31 Island Complexes
- Restore 2 Floodplain Areas
- Conduct Water Level Management in 12 Pools
- Restore 72 Backwater Areas
- Restore 58 Side Channels
- Alter 18 Wing Dam/Dike Structures

- Protect 392 Islands and Shoreline Areas
- Improve Topographic Diversity in 32 Areas
- Forestry Management Program
- Systemic Fleeting Plan
- Adaptive Management Program

The number of alternative projects and costs in Alternative B is given in Table 15.

Table 15: Alternative B Number of Projects and Costs Over 50 Years

Alternative B - Number of Ecosystem Projects, Costs, and Benefits over 50 Years

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

Fish Passage and pool-scale Water Level Management benefits were assessed separately.

Alternative C

($2.8 Billion + O&M Costs)

- Restore the first increment of habitats most directly affected by the navigation project.
- This alternative initiates large scale floodplain restoration at sites with capable cost-share partners. It also begins to address the minimal off-channel habitat needs of many aquatic species.

The development of this alternative is based on historic and projected change in aquatic habitats

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

The number of project and costs over 50 years for Ecosystem C are given in Table 16.

Table 16: Number and Cost of Alternative C Alternatives over 50 years

Alternative C - Number of Ecosystem Projects, Costs, and Benefits over 50 Years

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

[a] Fish Passage and pool-scale Water Level Management benefits were assessed separately.

Alternative D

($5.2 Billion + O&M Costs)

-Restoration to a level which includes management practices and cost effective actions affecting a broad array of habitat types.

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

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

Table 17: Number of Ecosystem Projects, Costs and Benefits over 50 Years

Alternative D - Number of Ecosystem Projects, Costs, and Benefits over 50 Years

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

[a] Fish Passage and pool-scale Water Level Management benefits were assessed separately.

Alternative E

($8.4 Billion + O&M Costs)

- Restoration to include most environmental objectives that could be accomplished in the context of the navigation project.

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

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

Table 18: The Number of Ecosystem Projects, Costs, and Benefits Over 50 Years

[a] Fish Passage and pool-scale Water Level Management benefits were assessed separately.

Alternative E - Number of Ecosystem Projects, Costs, and Benefits over 50 Years

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

Project costs of each alternative plan are given in Tables 15 - 18. The cost of Alternative A is zero since this is a no-action alternative.

Modeling Methodology

Project costs for the ecosystem enhancements consist of items such as labor costs and purchases of materials and supplies. These would operate in the economy in much the same fashion as project costs for the navigation improvements and are entered into the REMI model through the construction demand policy variable.

In addition to construction impacts, the ecosystem enhancements are expected to improve the attractiveness of the area and enhance some recreational opportunities, resulting in an improved quality of life in the area. This improvement in quality of life is not a direct economic impact. However, there would be indirect economic impacts due to the increased comparative advantage of the area as a place to live, and thus as a place to locate a business, or organization, or industry. The economic value to the area from this increased comparative advantage is the social return on the investment required to achieve this advantage.

On any investment, the social rate of return is the percentage rate at which the present value of the social benefits from this investment exactly equal the present value of its social costs. In the ecosystem restoration project we do not know either the social benefits or the social costs–all we know is the cost to construct the ecosystem projects. The assumption of a high rate of return on this investment would reflect in a high level of social benefits, and a low rate would reflect in a low level of social benefits.

The social rate of return is conceptually similar to the rate of return on private investment. Unlike many private investments, there are no readily available guidelines to specify a social rate of return for investments of this nature. TVA found little guidance in the literature for determining social rates of return for land reclamation such as that proposed in the ecosystem alternatives. Social rates of return in the literature on a variety of projects range from very low to over 100% per year for certain infrastructure projects in undeveloped counties.

One study, Taylor (1998), provides social rates of return estimates for four categories of public expenditures. The estimates range from 5.31% in housing to 13.37% in non-housing investment that includes equipment and non-housing structures. But given that the projects are in rural areas that are far removed from major metropolitan areas, it was felt that a low-end social rate of return would be more appropriate for ecosystem impact analysis. TVA thus included a 3% rate that is guided by Taylor’s low end housing rate reduced by one standard deviation.

In a 1992 study, REMI’s George Treyz estimated that the direct effect on the rate of migration of a fixed 1-percent increase in income is 0.357. The expected path of the economy given a shift in attractiveness from an initial shock to the economy in 1990 is explained as follows (Treyz, 1992, pp. 249-250):

> The first year increase is less than 0.357 because increased net migration reduces relative employment opportunity and relative wage rate, which mitigates the initial increase in migration. The real wage decreases because the initial increase in migration. The real wage decreases because nominal wages decrease due to the increased labor supply and because increased land costs and housing prices outweigh reduced labor costs to increase the personal consumption expenditure deflator. Reduced production costs increase the production share of both the export and local market, which stimulates employment growth.
>
> By 2007 the migration response is complete and even becomes negative as children of earlier migrants become labor force age. At this point the increase in the attractiveness of the region for migrants due to improvements in the quality of life has been exactly offset by the effects of drops in the probability of being employed and in the real wage rate.

Based on their knowledge of the research in the field and on use of the concept in economic modeling, the REMI staff recommends 7% as a reasonable rate[12] for this project's type of investment. TVA, therefore, performed model simulations for both 3% and 7% cases.

REMI experts recommend that in the REMI model amenity direct effects be taken to be the social rate of return applied to the project construction expenditures. Amenity direct effects are introduced into the REMI model through the **amenity amount policy variable**. Unlike the Treyz 1992 study, which was a one time increase in income, the ecosystem projects entail expenditures throughout the REMI study period (up to 2035), and amenity values thus accumulate through time. To implement the 3% and 7% rates in the REMI model, the percentages of project expenditures are computed from the year of expenditure and that amount continues throughout the study period.

In the 7% rate of return case, for example, 7% of the first year of expenditures is the amenity value for that year. In the second year, the previous amenity value is augmented by 7% of year two's project expenditures, and so forth through the all years of the simulation. Each year's amenity value, then, is an accumulation of the values for the previous year plus the current value.

Operation and maintenance costs are not included in the amenity value calculations because they are the cost of maintaining that value, not an increase in the value.

TVA found that REMI model results are quite responsive to changes in amenity values. In the REMI model, these economic benefits, working through migration changes, are based

[12] Correspondence and phone conversations with David Morf, REMI, October 2003.

on the assumption that the improvement in quality of life makes it less likely that people will migrate from the region and more likely that people will migrate into the region.

Amenities values, therefore, enter the REMI model through an economic migration function where migration responds to economic and amenity factors. This is discussed in (Treyz, 1993, pages 305-307). When the regional economy becomes more attractive relative to the remainder of the nation, migrants are attracted to the region. The estimated equation takes the basic functional form of

$$ECMG = f(REOxRWRxRWM, Ac / Au),$$

where ECMG = economic migration,

REO = relative employment opportunity,

RWR = relative wage rate,

RWM = - relative wage rate mix, and

Ac = amenities in the region and nation.

Ecosystem Impacts

In the analysis of ecosystem impacts four alternative plans have been proposed. These alternatives were previously discussed and are numbered as per the designations: A is the base case and B, C, D and E are the alternatives considered in the study. TVA modeled the impacts from 2005 to 2035 and, to the extent that the projects were projected to continue past 2035, these impacts are ignored in the TVA study. The input-output analysis estimates the impacts of the four alternative plans relative to the base case A. The cost of each plan is shown in Table 19. In the first year of the simulation, costs or expenditures range from $35.35 million in Alternative B to $175 million in Alternative E, and range in costs of a factor of five. In the final year of the simulation, the range in costs from Alternative B to Alternative E holds at a factor of five.

Table 19: Projects Costs for Alternatives B-E, Present Values And Selected Years

(present values, 2005-2035; millions of 2003 Dollars)

	PV	2005	2010	2015	2020	2025	2030	2035
Alt B	555.534	35.350	35.350	44.187	44.187	44.187	44.187	26.512
Alt C	926.592	58.961	58.961	73.701	73.701	73.701	73.701	44.220
Alt D	1,671.304	106.348	106.348	132.935	132.935	132.935	132.935	79.761
Alt E	2,756.763	175.417	175.417	219.272	219.272	219.272	219.272	131.563

The distribution of the present value costs by states is given in Table 20. Cost data for all years is given in the attached compact disk. While project costs are greatest in Illinois for all alternatives, rankings among the other states shift among the alternatives. For example, expenditures in Wisconsin rank second to Illinois in Alternative B ($105 million), while in Alternative E expenditures in Iowa are higher than those in Wisconsin. There will be no ecosystem expenditures in any state outside the five study area states.

Table 20: Distribution By State of Ecosystem Present Value Costs by State

(present values, 2005-2035; millions 2003 dollars)

State	Alternative B	Alternative C	Alternative E	Alternative E
Illinois	$199.114	$362.187	$625.695	$1,097.797
Iowa	$94.326	$160.844	$307.125	$439.235
Minnesota	$79.951	$120.187	$200.163	$971.815
Missouri	$76.831	$129.525	$245.638	$404.447
Wisconsin	$105.312	$153.848	$292.682	$443.471

Construction plus Amenities Effects

The ecosystem impacts (construction and construction plus amenities) for the 3% and 7% social rates of return are provided on the attached compact disk for GRP, RPT, OUTP, and EMP at five year intervals from 2005 to 2035. The principal observation from an examination of REMI output data is that the amenities variable has a strong impact on migration and, thus, on economic activity in the 5-State Region. For example, in the 7% scenario in Alternative B, 2005 GRP in the 5-State Region is $58.45 million and rises to $89.149 million in 2020. At a 3% growth rate, GRP rises to $69.87 million which is a drop of about 22% in value. In both growth cases, the amenity effect starts off slowly and then accelerates as migration is impacted by the enhanced attractiveness of the region.

Two factors stand out from the REMI results. First, construction activity alone produces significant impacts, but the pure amenity effect ultimately exceeds that of construction as project expenditures decline while in-migration—and its permanent addition to each region's population base—continues to occur. Second, the REMI model is sensitive to the assumed valued of the social rate of return, and at either the 3% or 7% rate, the amenity effects are significant.

One way to present the extraordinarily voluminous amount of data generated in the numerous simulations is to convert annual dollar impacts to present values; employment impacts can be condensed by calculations of average annual values. The former is done by using the federally mandated discount rate of 5.875 percent. For ease of exposition, only the GRP and employment data are presented for the 5-State Region in Table 21. Annual values are presented for all four variables in the attached compact disk.

Table 21: GRP Present Value (2005-2035), millions of 2003 dollars, and Average Annual Employment Impacts for the Construction Only and Construction Plus Amenity Impacts

Variable	Alternative B	Alternative C	Alternative D	Alternative E	Ratio to Alternative B Costs
			Construction Only		
GRP	$733.082	$1,221.112	$2,185.858	$3,635.573	1.32
Employment	703	1,166	2,089	3,463	
			Construction Plus Amenities 3% social rate of return		
GRP	$898.809	$1,500.860	$2685.431	$4,465.601	1.62
Employment	899	1,492	2,674	4,430	
			Construction Plus Amenities 7% social rate of return		
GRP	$1,124.474	$1874.023	$3,368.73	$5,570.968	2.02
Employment	1,162	1.928	3,468	5,718	

In Alternative B the present value of the impacts due to construction returns about 32% more than the present value of the cost of the project. At a 3% social rate of return the present value of construction plus the amenity factor returns 62% more than the cost of the project. At a 7% rate of return, the project (construction plus amenities impacts) returns over 100% of the cost of the project. The ratio-to-cost data for Alternative B are fairly consistent across all alternatives and there is thus no need to reproduce them in this table.

In the construction only scenario, the present value of construction stands at $733 million in Alternative B and rises to $3.635 billion in Alternative E. At a 3% rate of return, GRP stands at $898 million and rises to $4.5 billion. At a 7% rate of return, GRP is $1.1 billion in Alternative B and rises to $5.6 billion in Alternative E.

Average annual employment gains in the 5-State Region range from 703 to 3,463 assuming only construction impacts. For construction and amenity impacts at a 3% social rate of return, employment gains average 899 to 4,430 from case to case. At a 7% rate, employment gains average 1,162 to 5,718 depending on the case. In the 3% social rate of return scenario, about 38% of the jobs are created in Illinois. After Illinois, average job creation is fairly constant among the remaining four states. Wisconsin is second in job creation with 18.79 percent of total employment, followed by Minnesota (16 percent) and Iowa and Missouri. This is shown in Table 22.

Table 22: Average Annual Number of Jobs Created (2005-2035) by State For Construction Plus 3% Case Amenities

Alternative	Illinois	Iowa	Minnesota	Missouri	Wisconsin
B	341	126	144	119	169
C	604	213	217	200	258
D	1,054	398	370	374	478
E	1,817	586	665	614	748

The ecosystem alternatives also impact the Southern Region. These and the 5-State Region impacts are shown in Table 23. The present value of the 5-State gross product ranges from $898.8 million to $4.5 billion. Impacts on the Southern Region range from $123.0 million for Alternative B to $624.3 million for Alternative E.

Table 23: Impact on GRP in each Geographic Region by Alternative (Present Value, 2005-2035) For Construction Plus 3% Amenities Scenario

Alternative	5-State Region	Southern Region
B	$898.809	$122.976
C	$1,500.860	$213.304
D	$2,685.431	$370.096
E	$4,465.601	$624.347

Multipliers

In this study we define multiplier values to be the ratio of the present values (over the period 2005 to 2035) of gross product, income, and output relative to the present values of project costs. The multiplier for 5-State Region GRP in the Scenario B, construction-only alternative is 1.31. When amenity impacts are added to the simulation, the multiplier rises to 2.41 for the 7% social rate alternative.

Table 24: 5-State Region Multipliers for the Year 2005-2035

Variable	5-State Region
GRP-construction	1.31
GRP-construction plus amenities (7%)	2.41
RPI-construction	1.04
RPI-construction plus amenities (7%)	2.07

Final Note On Ecosystem Analysis, Amenities, And Results

The REMI model was used to examine the impacts on five states for four ecosystem alternatives. The variables used to summarize the impacts are GRP-gross product, RPI-real personal income, OUTP-output, and EMP-employment. The relative values of the variables scale upwards as expected, given increases in ecosystem construction expenditures. Through time the variables increase modestly if only construction impacts are measured. Adding the amenity effects to construction expenditures, the total effect builds through time reflecting ever increasing in-migration.

The impacts' growth rates are high relative to traditional analyses, such as the typical impacts from a manufacturing plant location analysis. TVA's position on the amenity effects is that this concept, while reasonable at a theoretical level, is very difficult to measure. The only guidance given to TVA was by REMI which suggested that a 7% annual "social rate of return" be used to measure the concept as a percent of the expenditures dedicated to ecosystem restoration. As construction expenditures rise through time, the direct amenity effect rises reflecting the 7% of a given year's expenditures and the accumulation of the percentages from previous years. TVA believes that the economics of the model and the underlying concept of amenities are, however, valid. A lower rate of return, of course, would yield a lower impact.

In any case, undertaking the habitat restoration and other ecosystem projects can be expected to yield well more than the direct dollars spent.

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APPENDIX A

Appendix A: Tons and Shipper Savings Data

ALT2	TWO-DIGIT SIC	IA	IL	MN	MO	WI	IA	IL	MN	MO	WI
SIC	INDUSTRY NAME	TONS	TONS	TONS	TONS	TONS	%'S	%'S	%'S	%'S	%'S
1	FARM	6,293,171	4,309,343	6,933,685	1,284,726	521,122	16.81%	11.51%	18.52%	3.43%	1.39%
10	MINING	-	638,371	8,936	116,007	-	0.00%	1.71%	0.02%	0.31%	0.00%
15	CONSTRUCTION	-	-	1,036	-	2,047	0.00%	0.00%	0.00%	0.00%	0.01%
20	FOOD (MFG)	2,039,722	1,455,020	165,189	5,689	4,134	5.45%	3.89%	0.44%	0.02%	0.01%
22	TEXTILES (MFG)	-	-	1,400	-	-	0.00%	0.00%	0.00%	0.00%	0.00%
24	LUMBER(MFG)	7,365	17,160	1,600	3,200	-	0.02%	0.05%	0.00%	0.01%	0.00%
28	CHEMICALS (MFG)	43,265	59,943	-	55,895	-	0.12%	0.16%	0.00%	0.15%	0.00%
29	PETROLEUM PRODUCTS (MFG)	1,103	250,518	106,202	-	1,725	0.00%	0.67%	0.28%	0.00%	0.00%
32	STONE,CLAY,ETC. (MFG)	161,102	1,061,256	512,808	935,413	227,653	0.43%	2.83%	1.37%	2.50%	0.61%
33	PRIMARY METALS (MFG)	34,511	484,354	51,854	38,534	102,655	0.09%	1.29%	0.14%	0.10%	0.27%
34	FABRICATED METALS (MFG)	74,771	572,767	83,455	2,967	-	0.20%	1.53%	0.22%	0.01%	0.00%
35	MACHINERY&COMPUTER EQUIPMENT (MFG)	-	26,062	1,400	-	-	0.00%	0.07%	0.00%	0.00%	0.00%
36	ELECTRIC EQUIPMENT (MFG)	3,112	-	-	-	-	0.01%	0.00%	0.00%	0.00%	0.00%
43	OTHER TRANSPORTATION	-	29,268	-	1,479	-	0.00%	0.08%	0.00%	0.00%	0.00%
49	PUBLIC UTILITIES	41,122	295,581	4,200	-	171,473	0.11%	0.79%	0.01%	0.00%	0.46%
50	WHOLESALE	879,191	3,260,687	1,821,956	307,380	92,630	2.35%	8.71%	4.87%	0.82%	0.25%
91	GOVERNMENT	493,535	354,374	800,512	4,637	180,108	1.32%	0.95%	2.14%	0.01%	0.48%

ALT 4	TWO-DIGIT SIC	IA	IL	MN	MO	WI	IA	IL	MN	MO	WI
SIC	INDUSTRY NAME	TONS	TONS	TONS	TONS	TONS	%'S	%'S	%'S	%'S	%'S
1	FARM	6,365,854	4,386,128	7,013,012	1,284,726	521,122	16.04%	11.05%	17.68%	3.24%	1.31%
10	MINING	341,342	942,701	8,936	116,007	-	0.86%	2.38%	0.02%	0.29%	0.00%
15	CONSTRUCTION	-	-	1,036	-	2,047	0.00%	0.00%	0.00%	0.00%	0.01%
20	FOOD (MFG)	2,044,122	1,455,020	165,189	5,689	4,134	5.15%	3.67%	0.42%	0.01%	0.01%
22	TEXTILES (MFG)	-	-	1,400	-	-	0.00%	0.00%	0.00%	0.00%	0.00%
24	LUMBER (MFG)	7,365	17,160	1,600	3,200	-	0.02%	0.04%	0.00%	0.01%	0.00%
28	CHEMICALS (MFG)	67,865	59,943	-	55,895	-	0.17%	0.15%	0.00%	0.14%	0.00%
29	PETROLEUM PRODUCTS (MFG)	2,503	250,518	106,202	-	1,725	0.01%	0.63%	0.27%	0.00%	0.00%
32	STONE,CLAY,ETC. (MFG)	234,877	1,061,256	512,808	1,091,713	227,653	0.59%	2.67%	1.29%	2.75%	0.57%
33	PRIMARY METALS (MFG)	43,535	484,354	51,854	38,534	102,655	0.11%	1.22%	0.13%	0.10%	0.26%
34	FABRICATED METALS (MFG)	74,771	572,767	83,455	2,967	-	0.19%	1.44%	0.21%	0.01%	0.00%
35	MACHINERY&COMPUTER EQUIPMENT (MFG)	-	26,062	1,400	-	-	0.00%	0.07%	0.00%	0.00%	0.00%
36	ELECTRIC EQUIPMENT(MFG)	3,112	-	-	-	-	0.01%	0.00%	0.00%	0.00%	0.00%
43	OTHER TRANSPORTATION	-	29,268	-	1,479	-	0.00%	0.07%	0.00%	0.00%	0.00%
49	PUBLIC UTILITIES	523,722	295,581	4,200	-	171,473	1.32%	0.74%	0.01%	0.00%	0.43%

ALT 4	TWO-DIGIT SIC	IA	IL	MN	MO	WI	IA	IL	MN	MO	WI
SIC	INDUSTRY NAME	TONS	TONS	TONS	TONS	TONS	%'S	%'S	%'S	%'S	%'S
50	WHOLESALE	1,392,653	3,295,037	1,882,947	307,380	92,630	3.51%	8.30%	4.75%	0.77%	0.23%
91	GOVERNMENT	493,535	354,374	800,512	4,637	180,108	1.24%	0.89%	2.02%	0.01%	0.45%

ALT 5	TWO-DIGIT SIC	IA	IL	MN	MO	WI	IA	IL	MN	MO	WI
SIC	INDUSTRY NAME	TONS	TONS	TONS	TONS	TONS	%'S	%'S	%'S	%'S	%'S
1	FARM	6,365,854	4,749,137	7,013,012	1,284,726	521,122	13.27%	9.90%	14.62%	2.68%	1.09%
10	MINING	427,483	2,262,007	8,936	157,271	-	0.89%	4.72%	0.02%	0.33%	0.00%
15	CONSTRUCTION	-	3,534	1,036	-	2,047	0.00%	0.01%	0.00%	0.00%	0.00%
20	FOOD (MFG)	2,044,122	1,756,374	165,189	5,689	4,134	4.26%	3.66%	0.34%	0.01%	0.01%
22	TEXTILES (MFG)	-	-	1,400	-	-	0.00%	0.00%	0.00%	0.00%	0.00%
24	LUMBER (MFG)	7,365	136,854	1,600	4,600	-	0.02%	0.29%	0.00%	0.01%	0.00%
28	CHEMICALS (MFG)	67,865	434,287	-	55,895	-	0.14%	0.91%	0.00%	0.12%	0.00%
29	PETROLEUM PRODUCTS (MFG)	2,503	1,026,763	106,202	1,428	1,725	0.01%	2.14%	0.22%	0.00%	0.00%
32	STONE,CLAY,ETC. (MFG)	234,877	1,577,815	512,808	1,096,489	227,653	0.49%	3.29%	1.07%	2.29%	0.47%
33	PRIMARY METALS (MFG)	43,535	568,613	51,854	38,534	102,655	0.09%	1.19%	0.11%	0.08%	0.21%
34	FABRICATED METALS (MFG)	74,771	826,301	83,455	2,967	-	0.16%	1.72%	0.17%	0.01%	0.00%
35	MACHINERY&COMPUTER EQUIPMENT (MFG)	-	27,662	1,400	-	-	0.00%	0.06%	0.00%	0.00%	0.00%
36	ELECTRIC EQUIPMENT (MFG)	3,112	-	-	-	-	0.01%	0.00%	0.00%	0.00%	0.00%
43	OTHER TRANSPORTATION	-	30,738	-	1,479	-	0.00%	0.06%	0.00%	0.00%	0.00%
49	PUBLIC UTILITIES	523,722	299,491	4,200	-	171,473	1.09%	0.62%	0.01%	0.00%	0.36%
50	WHOLESALE	1,392,653	6,711,634	1,882,947	317,182	92,630	2.90%	13.99%	3.93%	0.66%	0.19%
91	GOVERNMENT	493,535	966,216	800,512	4,637	180,108	1.03%	2.01%	1.67%	0.01%	0.38%

ALT 6	TWO-DIGIT SIC	IA	IL	MN	MO	WI	IA	IL	MN	MO	WI
SIC	INDUSTRY NAME	TONS	TONS	TONS	TONS	TONS	%'S	%'S	%'S	%'S	%'S
1	FARM	6,365,854	4,749,137	7,013,012	1,284,726	521,122	13.13%	9.79%	14.46%	2.65%	1.07%
10	MINING	427,483	2,262,007	8,936	157,271	-	0.88%	4.66%	0.02%	0.32%	0.00%
15	CONSTRUCTION	-	3,534	1,036	-	2,047	0.00%	0.01%	0.00%	0.00%	0.00%
20	FOOD (MFG)	2,044,122	1,756,374	165,189	5,689	4,134	4.22%	3.62%	0.34%	0.01%	0.01%
22	TEXTILES (MFG)	-	-	1,400	-	-	0.00%	0.00%	0.00%	0.00%	0.00%
24	LUMBER (MFG)	7,365	136,854	1,600	4,600	-	0.02%	0.28%	0.00%	0.01%	0.00%
28	CHEMICALS (MFG)	77,465	434,287	-	55,895	-	0.16%	0.90%	0.00%	0.12%	0.00%
29	PETROLEUM PRODUCTS (MFG)	2,503	1,026,763	117,202	1,428	1,725	0.01%	2.12%	0.24%	0.00%	0.00%
32	STONE,CLAY,ETC. (MFG)	234,877	1,577,815	512,808	1,096,489	227,653	0.48%	3.25%	1.06%	2.26%	0.47%
33	PRIMARY METALS (MFG)	43,535	568,613	51,854	38,534	102,655	0.09%	1.17%	0.11%	0.08%	0.21%
34	FABRICATED METALS (MFG)	74,771	826,301	83,455	2,967	-	0.15%	1.70%	0.17%	0.01%	0.00%
35	MACHINERY&COMPUTER EQUIPMENT (MFG)	-	27,662	1,400	-	-	0.00%	0.06%	0.00%	0.00%	0.00%
36	ELECTRIC EQUIPMENT (MFG)	3,112	-	-	-	-	0.01%	0.00%	0.00%	0.00%	0.00%

ALT 6	TWO-DIGIT SIC	IA	IL	MN	MO	WI	IA	IL	MN	MO	WI
SIC	INDUSTRY NAME	TONS	TONS	TONS	TONS	TONS	%'S	%'S	%'S	%'S	%'S
43	OTHER TRANSPORTATION	-	30,738	-	1,479	-	0.00%	0.06%	0.00%	0.00%	0.00%
49	PUBLIC UTILITIES	981,922	299,491	4,200	-	171,473	2.03%	0.62%	0.01%	0.00%	0.35%
50	WHOLESALE	1,392,653	6,711,634	1,925,506	317,182	92,630	2.87%	13.84%	3.97%	0.65%	0.19%
91	GOVERNMENT	493,535	966,216	800,512	4,637	180,108	1.02%	1.99%	1.65%	0.01%	0.37%