



Cost of Project Delays

**An Estimate of Foregone Benefits and Other Costs Related
to Schedule Delays of Inland Waterway Projects**

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Cost of Project Delays: An Estimate of Forgone Benefits and Other Costs Related to Schedule Delays of Inland Waterway Projects

Prepared by HDR | Decision Economics for the National Waterways Foundation

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This research study was performed for and in cooperation with the National Waterways Foundation (NWF). The contents of this report reflect the views of the authors, and do not necessarily reflect the views and policies of NWF. The authors are responsible for the facts and accuracy of the data presented herein.

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1.0 Executive Summary

This study was conducted with a view to better understanding the societal cost imposed by chronic delays and schedule slippages of inland waterways projects. We used an analytical approach that focused on a number of prominent inland waterways projects funded since 1995. Results of our analysis point to significant societal costs imposed by delays associated with these projects. We estimate that during the first five years, one year of delay of a new construction project is tantamount to losing an average of 37 cents on every dollar invested. Rehabilitation projects, when delayed, cost close to 17 cents on the dollar in the early years¹. In effect, this suggests that a delay of three years in a construction project effectively doubles the social cost.

The current projections of completion schedule at a project level, prepared by the Corps of Engineers, represent a cost of delay close to \$20 billion nationwide. These projections assume that all ongoing projects will receive full and efficient funding in the years ahead. The available funds, however, are grossly inadequate to fund all of the projects at the required level, rendering this estimate completely unrealistic. The Capital Development Plan prepared by a team of navigation experts from the waterway industry and the Corps of Engineers has taken a slightly more conservative view by representing completion dates of projects more in line with the then-existing budget assumptions. According to this plan the cost-of-delay estimate is closer to \$23 billion. Recent updates to the cost estimates for individual projects issued by the USACE, however, suggest that the available budget may not be able to support even this schedule. A realistic schedule² that can be supported by the available funding levels would result in a societal cost of \$34 billion. It is imperative that policy makers and stakeholders clearly understand the magnitude of societal costs involved, and take serious steps to address the issues that lead to these delays. This includes developing workable, realistic funding solutions, as well as instituting effective project controls.

The funding plan proposed by the Administration for the current waterway projects will cost about \$34 billion in foregone benefits and other costs related to schedule delays.

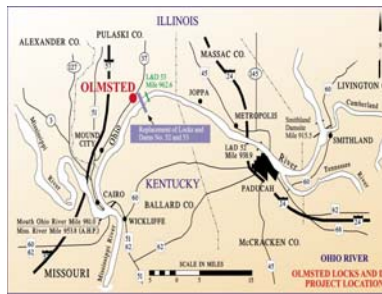
America's inland waterways move approximately 16% of domestic freight ton-miles. Freight transportation studies by the US Army Corps of Engineers (USACE) and others have assessed that U.S. waterways have a large untapped potential for the movement of goods within the country. One of the major concerns, however, is the continued deterioration of the navigation infrastructure. According to USACE, the economic service life of navigation structures is typically 50 years and currently more than half of these structures are beyond that age. The number of inland waterway lock outages, both scheduled and unscheduled, has continued to increase

¹ The cost of delay is computed in terms of foregone benefits and related costs, which are computed as present values of discounted streams. The cost of delay estimate indicated in this report is an average present value during the first five years, and has to be discounted to be applied to later years.

² The schedule assumed in this analysis assumes an annual budget outlay of \$170 million with \$150 million supporting construction projects, and the remaining allotted to the rehabilitation projects.

Olmsted Lock and Dam Project: A Case Study in Project Delivery Failure

The Olmsted Lock & Dam project originally funded in 1991 was aimed at developing a new structure that would replace two existing locks and dams #52 and #53 on the Ohio River. The final engineering design for the project featured an innovative approach for construction. While this approach had never been tried in the US before, no detailed risk assessment was performed prior to the approval of the engineering plans.



Over the last few years, this project again has encountered a series of problems leading to major delays and disruptions. The project, which was originally expected to be completed by 2006, is now projected to complete no sooner than 2024 and perhaps well after that depending on the results of a project re-evaluation that the USACE currently has underway. It has already prompted USACE to publicly announce another significant increase in the project's already-inflated project cost to \$3.1 billion from \$775 million that the Congress originally authorized in 1988. These delays and cost increase have imposed an estimated \$12 billion in societal cost.

significantly in recent years. Only a small number of the 239 locks at USACE's 193 active sites have had their useful lives extended in the last 15 years through major rehabilitation efforts. As infrastructure investments are put off, or funded initiatives are not well executed, fleet movements are impacted adversely due to increasing operational costs and delays. These impacts in turn lead to detrimental financial impacts on shippers, owners, and operators, and directly penalize the competitiveness of U.S. products in international markets.

In 1986, Congress revised the authority of USACE to plan and carry out navigation improvement projects. However, particularly over the past 15 years, the funds made available to build and improve inland waterways navigation projects have not been adequate to execute them efficiently. Although billions of dollars have been authorized for modernization of waterway projects, there has been a lack of strategic policy level support that is absolutely necessary for realizing the potential benefits that waterway transportation has to offer. When a project, initiated on the basis of need and anticipated long-term benefits is delayed, it represents an opportunity cost due to foregone benefits. Additionally, delays cause further deterioration of infrastructure increasing the investment needs even more.

The major capital inland waterways improvement projects carried out by USACE, pursuant to their navigation mission, can be classified into (1) construction, replacement or rehabilitation of locks and dams, and (2) first-time dredging of river channels and inland waterway harbors to increase authorized project depths.

Improvements to waterways infrastructure generate benefits to shippers, surrounding communities, and the nation as whole by

promoting a freight movement alternative that is more cost-effective and safe with less environmental impacts. Waterway freight movement benefits include:

- Reduced cost of shipping;
- Reduced congestion on highways;
- Reduced highway maintenance costs;
- Reduced environmental impacts; and
- Improved safety.

Each project funded by Congress has been justified on the basis of long-term benefits assessed by USACE. These assessments are provided in the feasibility reports and other documents used to authorize and initiate construction of the project and are updated in the so called *Justification Sheets* prepared at a project level. The level of benefits estimated by the USACE, however, do not take into account all benefit categories. In fact among the list of benefits listed above, only the shipping costs are accounted for in detail.

Table 1: Inland Waterway Projects Studied

Project Type	Name	Location	Original Investment	Original Completion Date Anticipated	Actual Completion Date (or Recent Estimate)
			(in 2011 \$ M)		
Construction	Olmsted	Olmsted, IL	\$775	2006	2023
	Lower Monongahela	Allegheny, Washington and Westmoreland counties, PA	\$556	2004	2031
	Kentucky	Gilbertsville, KY	\$533	2008	2041
	Chickamauga	Chattanooga, TN	\$267	2010	2036
	McAlpine	Louisville, KY	\$220	2002	2009
	Marmet	Kanawha, WV	\$230	2007	2009
Rehabilitation	Upper Miss 25*	Winfield, Missouri	\$52	1997	1999
	London(including lock extension)	London, WV	\$17	2003	2003
	Emsworth	Pittsburgh, PA	\$78	2011	2014
	Lockport**	Lockport, IL	\$137	2013	2013
	Markland	Warsaw, KY	\$31	2010	2012

*: The data for original completion date anticipated for this project was not available. For the purpose of analysis, the project team assumed it should have been finished two years ahead of actual completion date.

** : This project has not been finished yet and its completion date hasn't been revised. Therefore, the project team assumed this project has no delay in the mode

This study focused on evaluating the societal costs incurred, that are directly attributable to schedule delays or inefficient construction of projects. The study team developed a metric that

measured the annual loss of the return on investment that these delays and inefficiencies represented. The metric is derived on the basis of the benefits assessed by the USACE, and do definitely represent conservative estimates.

The team focused on a set of construction and rehabilitation projects funded since 1995, some of which have been subjected to major delays and scope revisions. Table 1 lists the candidate projects with their original proposed dates of completion and the actual (or currently anticipated) dates of completion. Where projects are yet to be completed, recent estimates are provided, based on a current-law scenario and \$170 million annual funding stream that dedicates \$150 million each year to Olmsted until it is completed, then to Lower Monongahela, Chickamauga and Kentucky – in that order – one project at a time.

Our study estimated the cost of delay for each of the projects shown in Table 1. In order to maintain consistency, all costs and benefits are represented in 2011 dollars thus accounting for the effect of price inflation. The value of time is incorporated by discounting streams of future benefits at an annual rate of 7% to obtain a present value.

The results of the cost of delay analysis are summarized in Table 2. The projects considered in the study represent a total investment in excess of \$7.5 billion (in 2011 dollars). The *Justification Sheets* assessed annualized present value of long-term benefits in the order of \$1.0 billion – a potential annual return on investment of approximately 13%³. However, these returns have not been realized in most cases. Our research revealed that construction projects have, on an average, been delayed by almost 22 years. As shown in Table 1, there are projects that have been delayed by more than 25 years. There are many experts who observed that even the most recent estimates of completion dates were unreliable and unrealistically optimistic. The reasons for delays vary from funding cuts to unforeseen engineering challenges, and all of them point to one thing – a clear lack of strong policy level recognition of inland waterways investments as a significant national priority.

Table 2: Cost of Delay

Project Type	Total Investment (2011 \$ M)	Expected Total Benefits Till Year 2030 (2011 \$ M)	Average Years of Delay	Foregone Benefits (Based on current projection of completion time) (\$ M)	Cost of Delay (in cents per dollar invested per year of delay)
Construction	\$ 7,109	\$21,145	22.3	\$ 19,143	37 cents
Rehabilitation	\$ 454	\$376	2.4	\$ 121	17 cents

In these times of economic challenges and pressing need for shoring up the nation’s infrastructure, the enormous opportunity cost imposed on society by these delays warrants

³ The original investment estimated was in the order of \$2.5 billion, which translated to \$6.0 billion in 2011 dollars and the corresponding rate of return of 15.5%

close attention. We feel that it is imperative that policy makers realize the magnitude of this cost, and begin to structure coordinated initiatives toward prioritizing and realizing the potential gains from inland waterway investments.

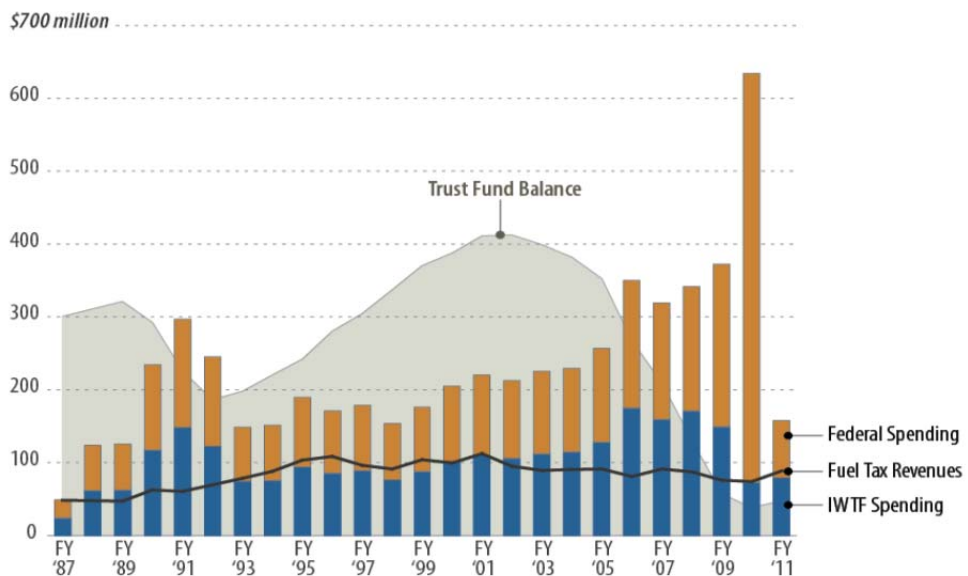
2.0 Introduction

This study is aimed at developing a quantitative framework to help measure and represent the actual cost imposed on the society by delays and budget shortfalls in inland waterways infrastructure projects.

Since the passage of Water Resources Development Act in 1986, the US Congress has approved funding for a number of initiatives aimed at restoring and modernizing the inland waterways infrastructure around the country. The total funding required to complete these projects is about \$8 billion, out of which \$7.5 billion is for construction projects. This includes all the projects identified in Table 1. In spite of this push, the waterways infrastructure is still lagging behind its potential. The fact of the matter is that several projects that were expected to be operational by now are still years behind completion. The anticipated benefits from these investments have never really materialized because the projects have not been completed and the anticipated benefits have not been accrued.

The funding for inland waterways modernization projects is provided in appropriations legislation by the US Congress. The funding, typically provided in the “construction” account of the Corps of Engineers portion of the Energy and Water Development Appropriations bills, is sub-allocated at a project level, and approved on the basis of benefit-cost analysis prepared by The Army Corps of Engineers. The projects are typically funded through general revenues and the Inland Waterways Trust Fund (IWTF) which is funded through fuel tax revenues. The IWTF balance is all but depleted today as shown in Figure 1, and it is important to examine new approaches to funding.

Figure 1: State of the Inland Waterways Trust Fund



Source: Army Corps of Engineers adapted by the Congressional Research Service (CRS), August 2011

As a part of its project proposals presented to Congress, the Corps provides benefit-cost ratios and net present values for each inland waterway construction project on the basis of benefit streams estimated over a period of 20-30 years after project completion. One of the important issues in infrastructure investment decisions is the trade-off between high upfront costs and long stream of benefits. Unless these benefits begin to accrue, it is hard to justify the high costs.

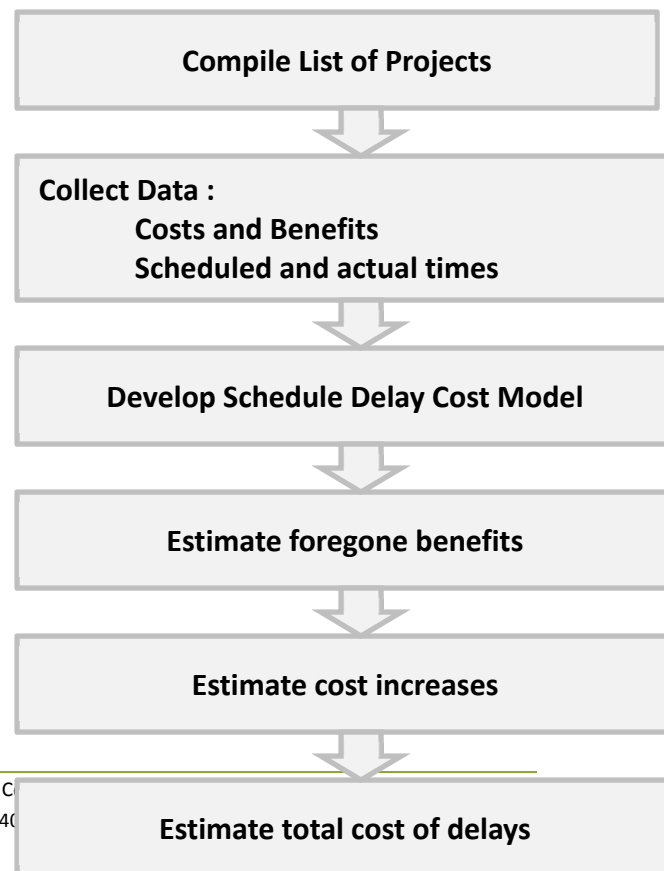
The operational slippages and budget cuts that stand in the way of project completion deny the opportunities for these benefits to accrue leading to opportunity costs. Although the concept of opportunity cost is well formulated, strategic planning efforts have typically failed to take it into account. This research work sponsored by the National Waterways Foundation is an effort to help derive and develop an effective framework to measure and reveal this opportunity cost for policy makers and decision makers.

This introduction is followed by a section detailing our research methodology. It discusses our approach, the data we used, and the analytical framework we developed and employed. The next section presents the results of applying the model to a set of projects that were funded since 1995 and estimates of the cost of delay based on foregone benefits. The last section contains a list of issues to consider and ends with a few recommendations for actions by policy makers and authorities in charge of the projects.

3.0 Research Methodology

In this study, we targeted a set of inland waterway projects that were funded by the Congress since 1995. These projects covered a variety of project types from relatively modest repairs to major new constructions. We gathered data on these projects including the original cost and the cost that we ended up spending, as well as the original and revised levels of benefits estimated by the Army Corps of Engineers. For the projects that are yet to be completed, we estimated the total costs on the basis of alternative construction schedule scenarios and on current project cost estimates provided by the Army Corps of Engineers. When a project completion date slips, the accrual of benefits is proportionately delayed. These schedule slippages also lead to additional costs due to further deterioration of the infrastructure, extended closures and other operational disturbances, as well as price inflation.

Figure 2: The Analysis Process



We estimated the societal cost of these schedule delays as the aggregate of a discounted stream of foregone future benefits, the additional operational costs incurred due to delays, and the cost escalation due to inflation. We conducted our analysis on a sample of projects for which we obtained reliable data on the cost estimates, original and actual (or anticipated) completion dates, as well as estimates of annual benefits.

In order to conduct the analysis, we compiled a list of 20 inland waterway projects funded since 1995. These projects varied in size and scope, and were located in different areas of the country. We then proceeded to collect detailed data on these projects including the original and revised cost estimates at an annual level, as well as the anticipated stream of benefits as forecast by the Corps of Engineers. Based on the reliability and completeness of data obtained, we focused on 11 projects to evaluate the impacts of delays. The overall research approach is illustrated in Figure 2.

The following sections describe the data we used and the analytical methodology we employed in greater detail.

3.1. Data

The list of 11 candidate projects selected for the analysis is shown in Table 3. As mentioned above, these projects were selected from an original list of 20 projects solely on the basis of data availability, and in the interest of maintaining analytical rigor. As shown in the table, our list included six construction projects that were originally estimated to cost a about \$6.0 billion (in 2011 dollars), with an average of \$1 billion per project, now is estimated to cost almost \$7.5 billion. The five rehabilitation projects, on the other hand, account for a total investment of less than \$500 million. The benefits estimated by the Corps for the construction projects, on an average, feature a benefit-cost ratio of 6.0 or more over thirty years. This usually translates to around 15% annual return on investment. These data elements were obtained from a variety of sources including project documents, justification sheets submitted to the Congress, as well as from interviews with engineers and program managers at the Corps. Detailed fact sheets for the projects are given in Appendix A.⁴

Table 3: Inland Waterway Projects Considered ¹

Project Type	Name	Location	Original Investment (in 2011 \$ M)	Original Completion Date Anticipated	Actual Completion Date (or Recent Estimate)
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⁴ The methodology used by the Army Corps of Engineers to assess future stream of project benefits is mostly based on the potential cost savings for shippers who use the facilities, and some level of safety benefits. There are several other categories of benefits that the approach disregards, including the impacts on highway transportation, environmental impacts of modal shifts in freight movements, as well as potential community level benefits related to recreation and water supply. Our recommendations for a more comprehensive approach are given in Appendix B of the report.

Project Type	Name	Location	Original Investment (in 2011 \$ M)	Original Completion Date Anticipated	Actual Completion Date (or Recent Estimate)
Construction	McAlpine	Louisville, KY	\$379.85	2002	2009
	Olmsted	Olmsted, IL	\$1,458.44	2006	2023
	Lower Monongahela	Allegheny, Washington and Westmoreland counties, PA	\$960.78	2004	2031
	Kentucky	Gilbertsville, KY	\$798.98	2008	2041
	Chickamauga	Chattanooga, TN	\$389.23	2010	2036
	Marmet	Kanawha, WV	\$361.70	2007	2009
Rehabilitation	Upper Miss 25	Winfield, MO	\$86.88	1997*	1999
	London(including lock extension)	London, WV	\$27.27	2003	2003
	Emsworth	Pittsburgh, PA	\$119.69	2011	2014
	Lockport	Lockport, IL	\$149.00	2013	2013**
	Markland	Warsaw, KY	\$46.26	2010	2012

*: The data for original completion date anticipated for this project was not available. For the purpose of analysis, the project team assumed it should have been finished two years ahead of actual completion date.

** : This project has not been finished yet and its completion date hasn't been revised. Therefore, the project team assumed this project has no delay in the mode

! These 11 projects were chosen on the basis of data availability. The 9 other projects funded are not included in the analysis solely because of the fact that only partial data was available for these projects

In addition to the data on specific projects, we used certain global parameters to conduct the analysis. These parameters and their values used in the analysis are given in Table 4. Most of the parameter values indicated in the Table are based on recommendations by the GAO, and are commonly used in assessing viability of public investments.

Table 4: Key Parameters and Values

Parameter	Value Assumed
Years of Analysis	20 years
Discount Rate	7%
Inflation Rate	Based on annual PPI

The following section describes the analytical framework that we developed and used in this study.

3.2. Analytical Model

The analytical model is structured around the key metric we developed to represent the monetary value of the impact of schedule delays. This cost of delay metric is defined as:

$$\text{Cost of Delay} = \frac{\text{Discounted Foregone Benefits} + \text{Cost Increase (after adjusting for inflation)}}{\text{Original Cost Estimated}}$$

The Cost of Delay is thus measured in terms of the wasted portion of the original investment. This is a slight

departure from the traditional notion of measuring simply the foregone benefits, which fail to account for the return on investment lost and does not provide any guidance toward prioritization and allocation. The cost of delay developed in this study, on the other hand, directly addresses the return on investment and helps classify investments based on their individual performance.

The analytical model developed to facilitate the estimation of Cost of Delay measures each of the three components featured in its definition at a project level, as well as at aggregated level. The diagram shown in Figure 3 shows the structure of the model. As shown in the figure, the key inputs to the model are the planned and actual levels of funding and expected stream of benefits. The foregone benefits computed from the benefit streams, and cost escalations are aggregated to estimate the actual cost of delays.

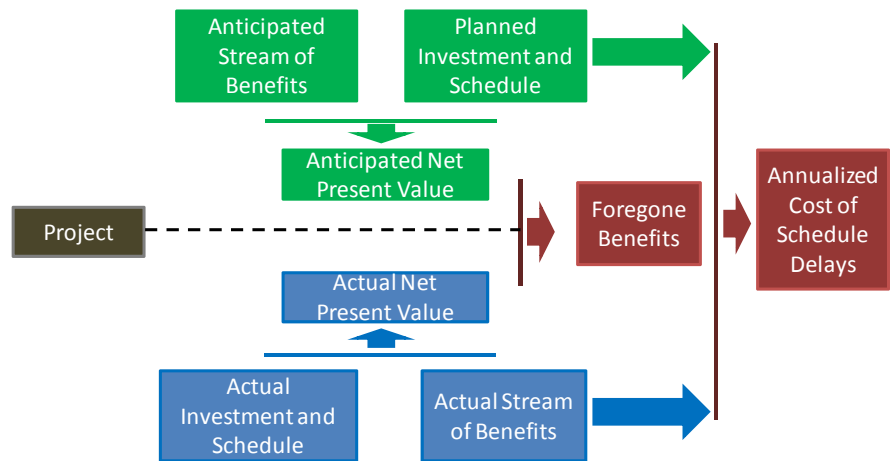
The model was implemented using a software framework to enable applications under various scenarios and to measure the sensitivity of the results to the parameter values. The measurement process implemented for each component of the cost model is described below.

3.2.1. Measuring Foregone Benefits

Foregone benefits are measured in terms of the difference in net present values of original stream of benefits and costs, and the actual stream of benefits (or revised stream of benefits) and original cost adjusted for inflation. The effect of inflation was incorporated into the model by projecting all monetary values in constant 2011 dollars. Foregone benefits are thus simply:

$$\text{Foregone Benefits} = NPV_{\text{original}} - NPV_{\text{revised}}$$

Figure 3: Analytical Framework for Measuring Cost of Schedule Delays



The NPV values are estimated at a discount rate of 7%, the rate recommended by the US Department of Transportation for use in benefit-cost analysis of investments. The discount rates employed by the Corps to estimate present values and NPV varied from project to project due to the variations in the recommended discount rates. The model factored these differences to convert all estimates to 2011 dollars with identical discount rates applied to future estimates of benefits.

3.2.2. Measuring Cost Increases Due to Delay

Delays in scheduled completion of projects can lead to additional deterioration of infrastructure that could have been avoided by timely completion. They also impose additional operational costs required to handle the impacts of closures, diversions etc. We employed a simple surrogate to measure these effects. A portion of the cost escalation in excess of inflationary effects was used to capture these effects. Clearly there are instances where the cost increases are simply due to original engineering design revisions, or some other extraneous events outside of the purview of the project management team. We feel, however, that this approach based on the assumption that original project conception accurately identified all risks and mitigation is justified.

Thus the cost increase due to delay is determined as

$$\text{Cost Increase} = \beta * (\text{Revised Cost} - \text{Original Cost adjusted for inflation})$$

The factor β was subjectively applied to represent the role of extraneous events and technical design issues in causing the delay for each project.

3.2.3. Estimating the Aggregated Cost of Delay

The cost components identified above were aggregated to determine the cost of delay at a project level as well as at an aggregated level. Table 5 below summarizes the results of the computation at a project level.

Table 5: Aggregated Cost of Delay by Project

Projects Type	Project Name	Inflated Original Cost (2011 \$ M)	Annual Net benefits Originally Estimated (Estimated Benefits, and Discount Rates)	Net Benefits Adjusted (in 2011\$ M at 7% Discount Rate)	Cost of Delay (in cents per dollar invested per year of delay)	Years of Delay
Construction	Olmsted	\$1,458.44	\$492.61 (2011\$) 7%	\$492.60	\$0.36	17
	Lower Monongahela	\$960.78	\$259.6 (2009\$) 7%	\$302.05	\$0.27	27
	Kentucky	\$798.98	\$60.77 (2011\$) 7%	\$60.76	\$0.08	33
	Chickamauga	\$389.23	\$68 (2009\$) 7%	\$79.12	\$0.19	26
	McAlpine	\$379.85	\$50.55 (2011\$) 8%	\$50.55	\$0.23	7

Projects Type	Project Name	Inflated Original Cost (2011 \$ M)	Annual Net benefits Originally Estimated (Estimated Benefits, and Discount Rates)	Net Benefits Adjusted (in 2011\$ M at 7% Discount Rate)	Cost of Delay (in cents per dollar invested per year of delay)	Years of Delay
Rehabilitation	Marmet	\$361.70	\$72.16 (2011\$) 7.625%	\$72.16	\$0.37	2
	Upper Miss 25*	\$86.88	\$1.11 (2008\$) 0%	\$1.18	\$0.09	2
	London(including lock extension)	\$27.27	\$0.48 (1997\$) 8.625%	\$0.75	\$0.00	0
	Emsworth	\$119.69	\$7.9 (2009\$) 7%	\$9.19	\$0.18	3
	Lockport**	\$149.00	\$5.9 (2011\$) 0%	\$5.90	\$0.00	0
	Markland	\$46.26	\$2.6 (2007\$) 7%	\$3.03	\$0.17	2

*: Assuming the actual project cost is the same as original planned cost because of missing actual project cost data.

** : The data for original completion date anticipated for this project was not available.

3.2.4. Examination of the Cost of Delay Estimates

The cost of delay varied among projects and locations. Given the difference in size and scope of costs and benefits between construction projects and rehabilitation projects, we recommend that the estimated cost of delays for them be examined and presented separately. Figure 4 shows the cost of delay estimates for the construction projects. As shown these estimates vary from 23 cents to 37 cents on the dollar amounting to hundreds of millions of dollars annually. On average, delays in construction projects cost the society 30 cents per year for every dollar invested.

Figure 4: Cost of Delay for Construction Projects

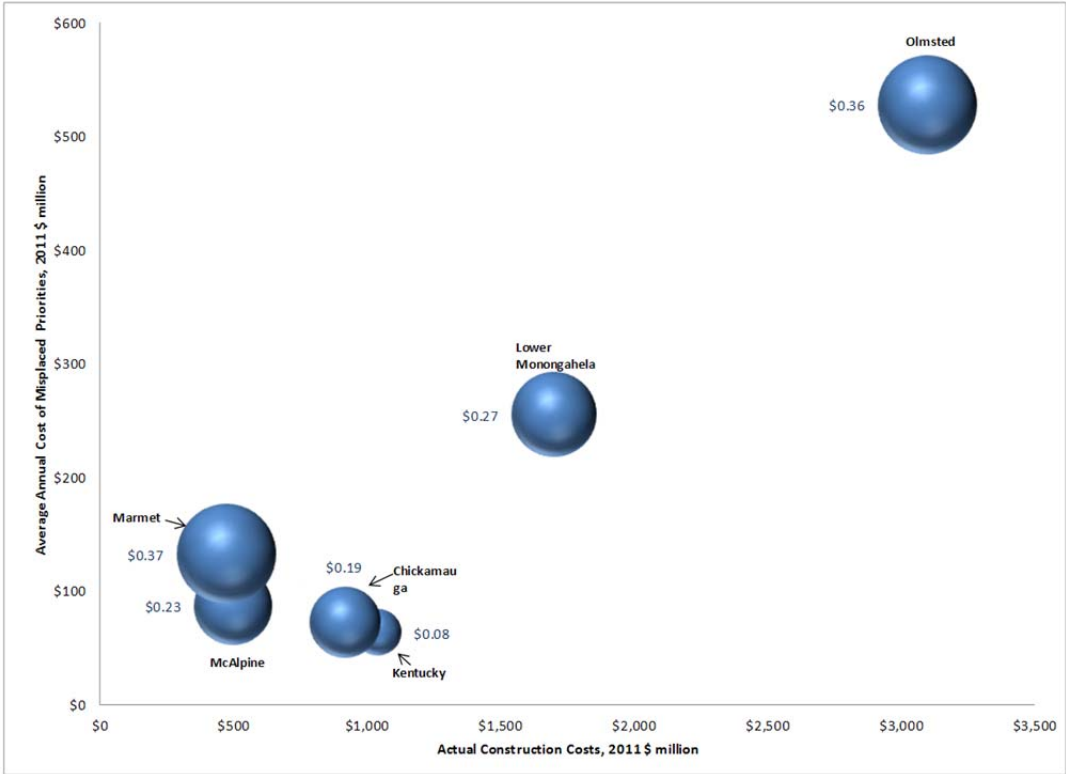
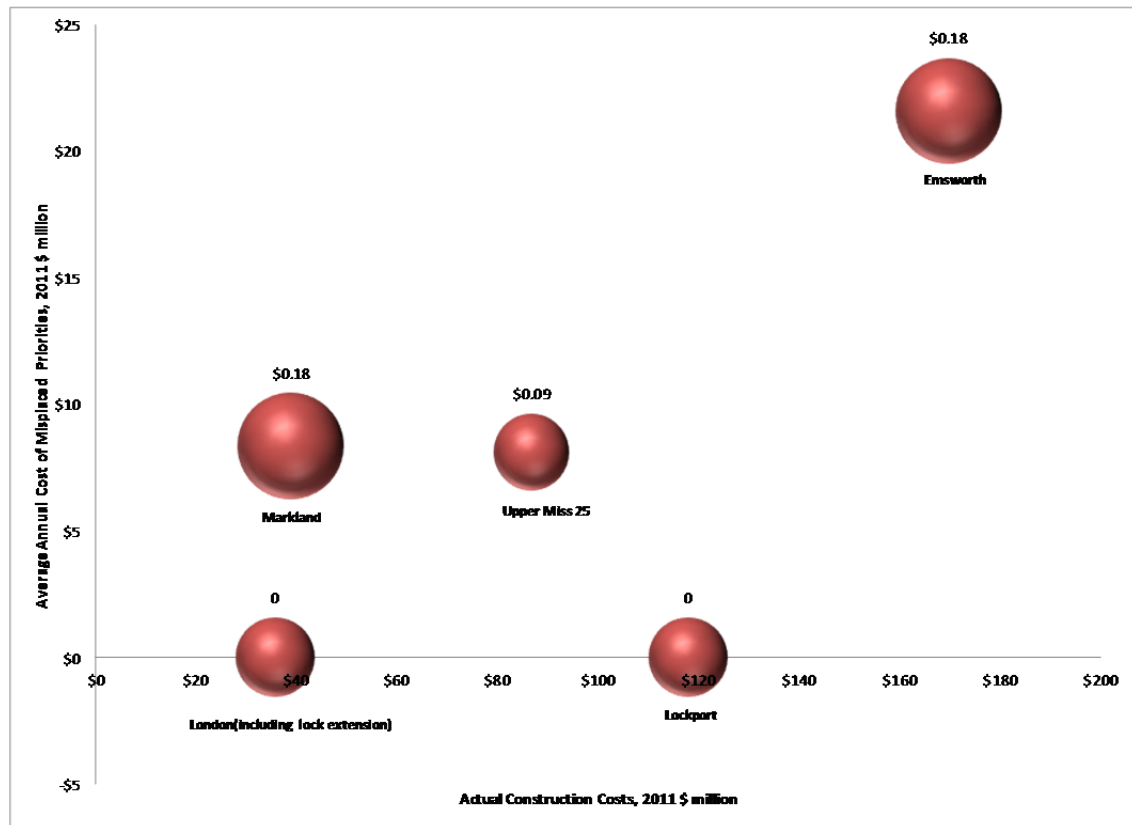


Figure 5 below shows the cost estimates of delay for the rehabilitation projects considered. As shown in the figure, two of the projects were, in fact, completed on time and by definition have no cost of delay associated with them. Those projects that were delayed resulted in about 17 cents lost on a dollar invested every year.

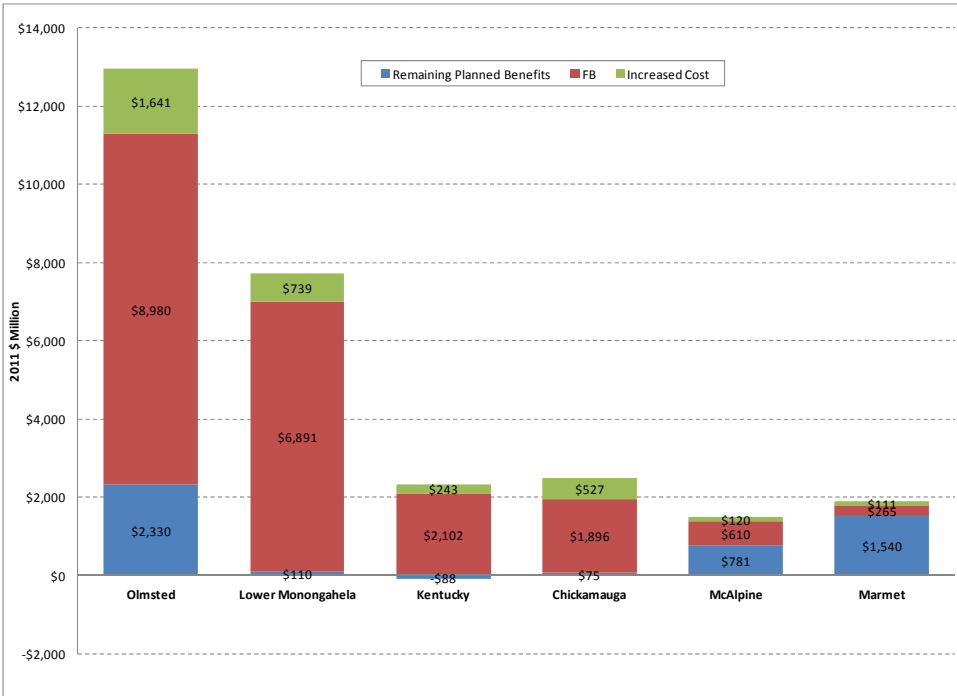
Figure 5: Cost of Delay for Rehabilitation Projects



An argument usually posed against using foregone benefits is that delays simply cause a shift in benefits and are not lost. This is not completely true, however. The loss of benefits in the initial years and escalation in costs can have a major impact on the overall benefits assessment. Figures 6 and 7 reflect the present value of the level of foregone benefits in comparison with the present value of original total benefits assuming full and efficient funding of all ongoing projects underway. Figure 6 shows three different components – present values of cost increments beyond inflation, the foregone benefits, and the remaining benefits that could be realized. The cost of delay is the sum of foregone benefits and cost increases, both calculated in terms of present values. It is clear from the figures that the societal costs imposed are not trivial in comparison with original estimates of benefits.

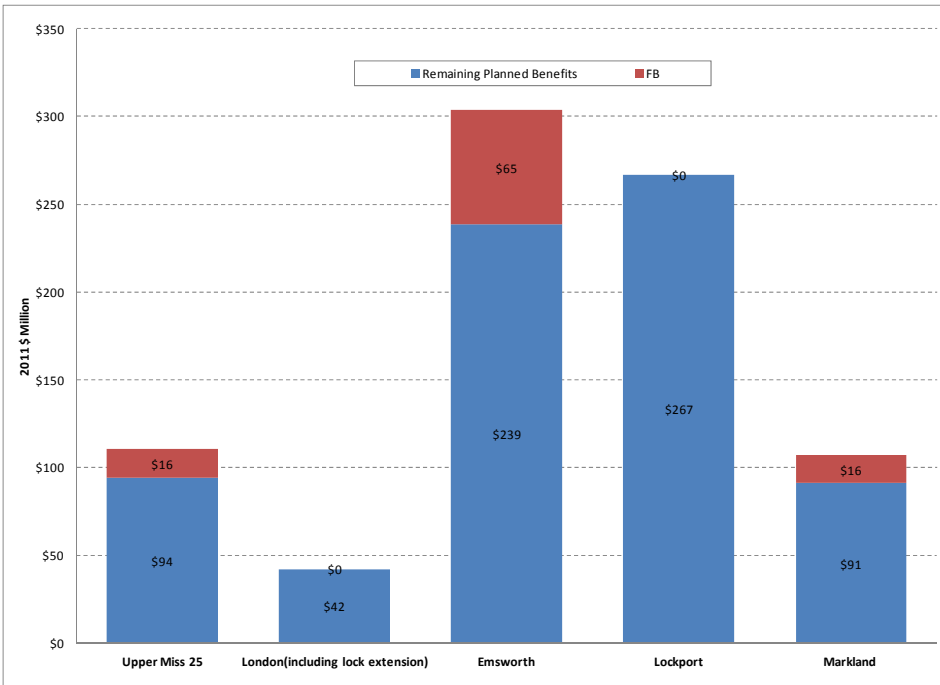
If all the current projects are fully funded in the coming years, the cost of delay incurred is about \$19 billion. The situation is in fact worse since the current funding level appropriated by Congress is not at all adequate to provide full funding for all the projects.

Figure 6: Foregone Benefits as a Share of Total Benefits (Construction Projects)



Note: All amounts shown are in present values at a 7% discount rate

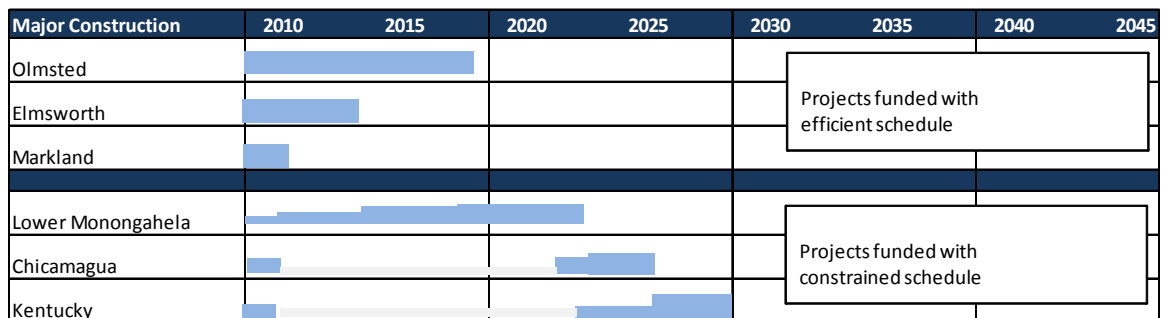
Figure 7: Foregone Benefits as a Share of Total Benefits (Rehabilitation Projects)



Note: All amounts shown are in present values at a 7% discount rate

The Capital Development Plan (CDP) took the budget constraints into account when they proposed a schedule that considered efficient funding of a subset of projects - Olmsted, Emsworth and Markland – and a constrained schedule for the other projects. This is shown in Figure 8. As shown in the figure, Lower Mon, Chickamauga and Kentucky receive partial funding until the other projects are completed. This essentially represents an extended schedule of completion. However, since the publication of this viable schedule in the Capital Development Plan, the Corps further revised the cost estimates for a few of the major construction projects.

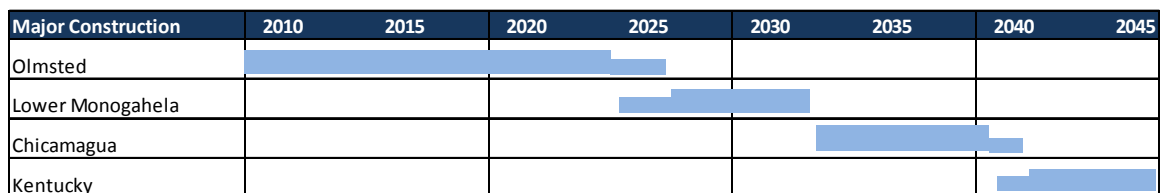
Figure 8: Schedule Proposed in the Capital Development Plan (based on current law \$170 million / year funding)



Source: Inland Marine Transportation Systems Capital Projects Business Model, IMTS Capital Investment Strategy Team, April 2010

This would then imply that the schedule needs to be further revised. A realistic schedule according to the recent cost estimates could take the major construction projects all the way to 2045. A likely schedule is shown in Figure 9. It is possible that this schedule is conservative and that opportunities for schedule optimization can be identified in order to start accumulating benefits earlier. But we feel that this will have limited impact on the estimate of the total societal cost.

Figure 9: Potential Schedule for Major Construction Based on Available Funding Levels (based on \$170 million per year and revised costs published in January 2012)



Note: Developed on the basis of \$170 million annual funding with \$150 million annually allocated to construction projects and \$20 million allocated to rehabilitation projects

4.0 Conclusion

This study revealed some very important insights into the state of affairs related to the inland waterways infrastructure development efforts. Even though there was a national effort backed by the Water Resources Development Act of 1986 resulting in a renewed strategic focus on funding waterways navigation infrastructure projects, we feel that there is a major gap in terms of managing and optimizing these investments. It is important that policy makers and stakeholders appreciate the actual societal cost of this lack of will and organize ways to address the principal issues that lead to this cost.

In this study, we proposed a departure from the traditional approach to assessing cost of delay. Rather than measuring simply the foregone benefits, we proposed measuring the cost imposed by the delay including cost escalations. This cost is particularly informative when expressed as a proportion of the original investment.

The analysis we conducted indicates that a construction project, when delayed, costs society about 37 cents on the original dollar invested every year that it is delayed during the initial years. In other words, more than three years of delay is equivalent to doubling the cost of the project. The disturbing reality is that construction projects on an average are delayed by more than 20 years. If the current funding levels are the only source of funding the projects, the major projects around the country would as long as 2045 to be completed. This represents a societal cost of around \$34 billion. If we do not implement strict measures to ensure that this plan is carried out hopefully at an accelerated schedule, it could cost more. We hope that recognition of these major cost impacts will stimulate the authorities to take proactive actions to address the underlying issues, and to identify means to provide additional funding.

It is important to recognize that these estimates of costs based on foregone benefits are conservative because they are based on benefits assessed by the Corps of Engineers, which is limited to the potential savings for the shippers who use the facilities, savings in repair spending, and incorporates limited references to benefits due to improved water quality. However, benefit categories associated with diversion from trucks, which in turn lead to highway maintenance cost savings, as well as environmental and safety benefits are not included. Further other cross sector benefits derived by water supply, tourism, flood control and power sectors are also ignored in these estimates. Appendix 2 provides an overview of a more comprehensive benefits estimation approach which could help highlight the merits of waterway investments in a more striking manner. Recognition of additional benefit categories and beneficiaries could help in resolving future funding challenges.

..... Three years of delay is equivalent to doubling the cost of the project. The disturbing reality is that construction projects, on an average, are delayed by more than 20 years.

5.0 References

1. Charles V. Stern. "Inland Waterways: Recent Proposals and Issues for Congress." Congressional Research Service. July 14, 2011
2. "Corps to Review Cost Estimate for Olmsted Locks and Dam". US Army Corps of Engineers, Great Lakes and Ohio River Division. August 9, 2011.
3. "Economic and Environmental Principles Guidelines for Water and Land Resources Management" . Water Resources Council. 1983
4. "Inland Marine transportation Systems (IMTS) Capital Projects Business Model". Inland Waterways Users Board. April 13, 2010.
5. "Inland Waterways Trust Fund Status and Trend Analysis". Revenue Options for the Inland Waterways Trust Fund Inland Nav CoP Workshop. Louisville, KY. September, 2007.
6. "Justification Sheet-Kentucky Lock and Dam, Tennessee River, Kentucky". US Army Corps of Engineers, Great Lakes & Ohio River Division. April 2001.
7. "Justification Sheet-Olmsted Locks and Dam, Illinois and Kentucky". US Army Corps of Engineers, Great Lakes & Ohio River Division. February 2011.
8. "Justification Sheet-Locks and Dams 2, 3, and 4, Monongahela River, Pennsylvania". US Army Corps of Engineers, Great Lakes & Ohio River Division. February 2011.
9. "Justification Sheet-Marmet Locks and Dam, West Virginia". US Army Corps of Engineers, Great Lakes & Ohio River Division. April 2001.
10. "Justification Sheet-McAlpine Locks and Dams, Kentucky and Indiana". US Army Corps of Engineers, Great Lakes & Ohio River Division. April 2001.
11. "Lower Monongahela River Locks & Dams 2, 3 & 4, PA". Waterway Council, Inc. January 2010
12. "Marmet Locks & Dams". Waterway Council, Inc. January 2010.
13. "McAlpine Lock Replacement Project Update". US Army Corps of Engineers. Louisville District. Summer, 2007.
14. Misganaw Demissie and Renjie Xia. "Feasibility of Rehabilitation of the Illinois and Michigan Canal at Lockport, Illinois". Illinois State Water Survey. 1990.
15. "Notice to Navigation Interests". US Army Corps of Engineers. Louisville District. January 12, 2012.
16. "Olmsted Locks & Dam". US Army Corps of Engineers. Louisville District.
17. "Project Fact Sheet-Emsworth Locks and Dams Ohio River". US Army Corps of Engineers. October 2006.
18. "Project Information". Waterways Council Inc. 2012
19. Richard O. Zerbe, Jr. and Joseph Cook. "Principles and Guidelines for Evaluating Federal Water Projects:
20. U.S. Army Corps of Engineers Planning and the Use of Benefit Cost Analysis", August 2009
21. "The Monongahela Packet-Historical Bulletin for the Lower Mon Project". US Army Corps of Engineers. Pittsburgh District. May 2002.

22. "Upper Mississippi River – Illinois Waterway System Locks & Dams". US Army Corps of Engineers, Mississippi Valley Division. September 2009.

6.0 | Appendix A: Project Fact Sheets

Project Fact Sheet	
Project Name: McAlpine Locks and Dam	Project Location: Louisville, KY
Division/District: Louisville District	Tributary/Waterway: Ohio River
Project Status: Completed	Project Type: New Construction-lock and dam
Project Description:	
<p>The proposed project will replace a 600-foot auxiliary lock chamber and an inactive 360-foot 2-stage chamber with a 1,200-foot lock on the Kentucky bank side of the existing lock and dam. This effort will result in twin 1,200-foot locks for tow traffic.*</p>	
Project Location Map:	
Estimated Foregone Benefit (FB) (2011 \$)	
FB per Dollar Invested per Delayed Year:	\$0.23
Annual Foregone Benefit:	\$87.08 M
Cost and Benefit (2011 \$)	
Actual Construction Cost:	\$499.49 M
Annual Net Benefit:	\$50.55 M
Project Schedule	
Construction Start Year:	2002
Planned Completion Year:	2002
Actual End Year:	2009
Number of Years Delayed:	7 Years
<p>*: Justification Sheet, The U.S. Army Corps of Engineers, April, 2001 Map Source: Inland Marine Transportation Systems Capital Projects Business Model, April 2010</p>	

Project Fact Sheet

Project Name: Olmsted Locks and Dam, Ohio River, IL & KY

Division/District: Louisville District

Project Status: Under Construction

Project Location: Olmsted, IL

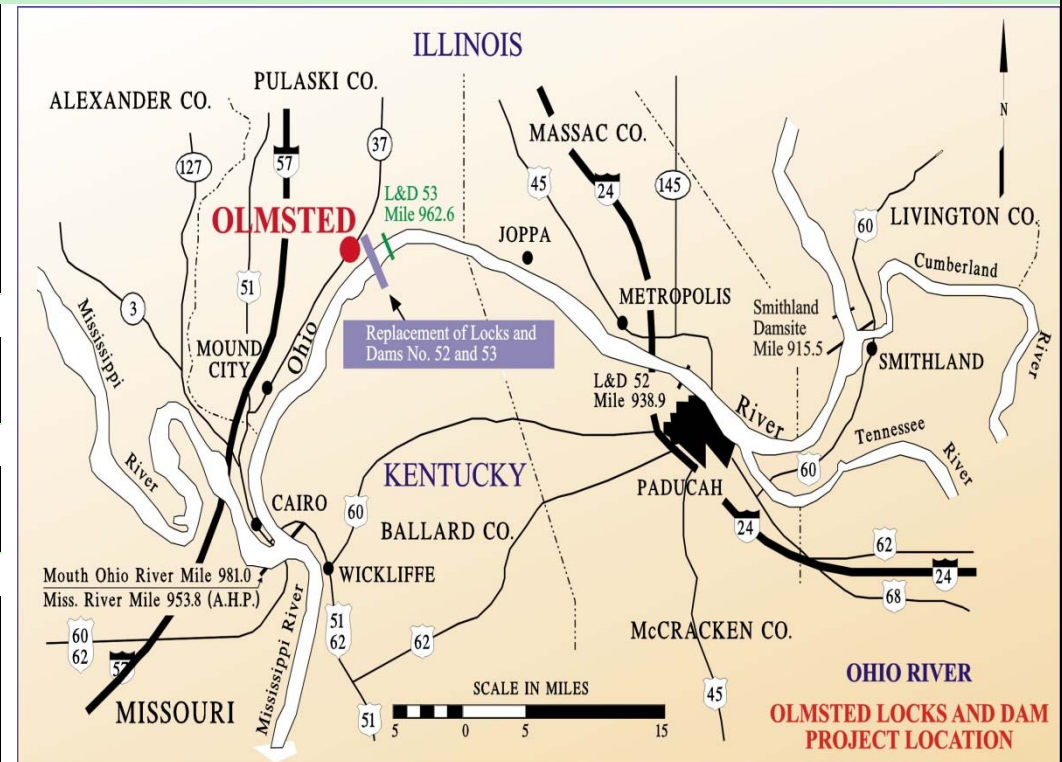
Tributary/Waterway: Ohio River

Project Type: New Construction-lock and dam

Project Description:

The Olmsted Locks & Dam project, located downstream of Locks and Dam 53 on the Illinois/Kentucky border, was authorized by the Water Resources Development Act of 1988. The proposed replacement structure will eliminate Ohio River Locks & Dams 52 & 53. The project consists of two 110' X 1200' locks adjacent to the Illinois bank, and a dam comprised of five tainter gates, 1400' of boat-operated wickets and a fixed weir. *

Project Location Map:



Estimated Foregone Benefit (FB) (2011 \$)

FB per Dollar Invested per Delayed Year:	\$0.36
Annual Foregone Benefit:	\$528.26 M

Cost and Benefit (2011 \$)

Actual Construction Cost(under review):	\$3,099.00 M
Annual Net Benefit:	\$492.60 M

Project Schedule

Construction Start Year:	1992
Planned Completion Year:	2006
Actual End Year:	2023**
Number of Years Delayed:	17 Years

*: Inland Marine Transportation Systems Capital Projects Business Model, April 2010

** : Extended project completion based on the budget constraints.

Map Source: www.lrl.usace.army.mil

Project Fact Sheet

Project Name: Lower Monongahela

Project Location: Allegheny, Washington and Westmoreland Counties, PA

Division/District: Pittsburgh District

Tributary/Waterway: Monongahela River

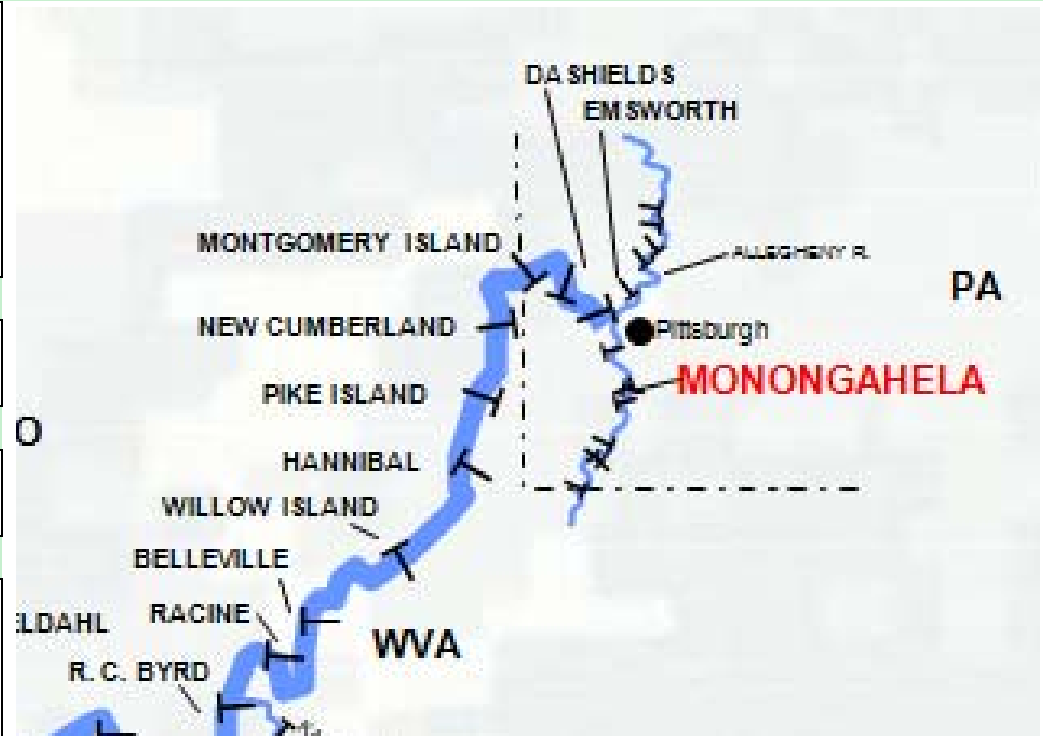
Project Status: Under Construction

Project Type: New Construction

Project Description:

Project Location Map:

The dam at L/D 2 has been replaced by a gated dam, built using an innovative in-the-wet method of fabricating segments off-site and floating them in place. The project has been renamed Braddock Locks and Dam. L/D 3 will be removed. Twin 84' x 720' locks will be built at L/D 4 (to be renamed Charleroi Locks and Dam).*



Estimated Foregone Benefit (FB) (2011 \$)

FB per Dollar Invested per Delayed Year:	\$0.27
Annual Foregone Benefit:	\$255.24 M

Cost and Benefit (2011 \$)

Actual Construction Cost:	\$1,700.0 M
Annual Net Benefit:	\$259.60 M

Project Schedule

Construction Start Year:	1994
Planned Completion Year:	2004
Actual End Year:	2031
Number of Years Delayed:	27 Years

*:<http://www.waterwayscouncil.org/WWSsystem/Fact%20Sheets/Mon234.pdf>

Map Source: US Army Corps of Engineers

Project Fact Sheet

Project Name: Kentucky Lock, TN River, KY

Division/District: Nashville District

Project Status: Under Construction

Project Location: Gilbertsville, KY

Tributary/Waterway: Tennessee River

Project Type: Construction

Project Description:

The Kentucky Lock and Dam project is located at Tennessee River Mile 22.4 in western Kentucky. The project consists of a new 110-foot by 1200-foot lock to be located landward and adjacent to the existing 110-foot by 600-foot lock. In addition three major relocations are required to construct the lock: 1) the relocation of four large transmission towers; 2) construction of a new two lane highway bridge across the Tennessee River; and 3) construction of a new single track railroad bridge across the Tennessee River. The new lock is needed because of the existing lock's inability to meet current and future traffic demands without significant delays. *

Project Location Map:



Estimated Foregone Benefit (FB) (2011 \$)

FB per Dollar Invested per Delayed Year:	\$0.08
Annual Foregone Benefit:	\$63.69 M

Cost and Benefit (2011 \$)

Actual Construction Cost:	\$1,042.5 M
Annual Net Benefit:	\$60.76 M

Project Schedule

Construction Start Year:	1998
Planned Completion Year:	2008
Actual End Year:	2041
Number of Years Delayed:	33

*: *Inland Marine Transportation Systems Capital Projects Business Model, April 2010*

Map Source: Inland Marine Transportation Systems Capital Projects Business Model, April 2010

Project Fact Sheet

Project Name: Chickamauga Lock, TN

Division/District: Nashville District

Project Status: Under Construction

Project Location: Chattanooga, TN

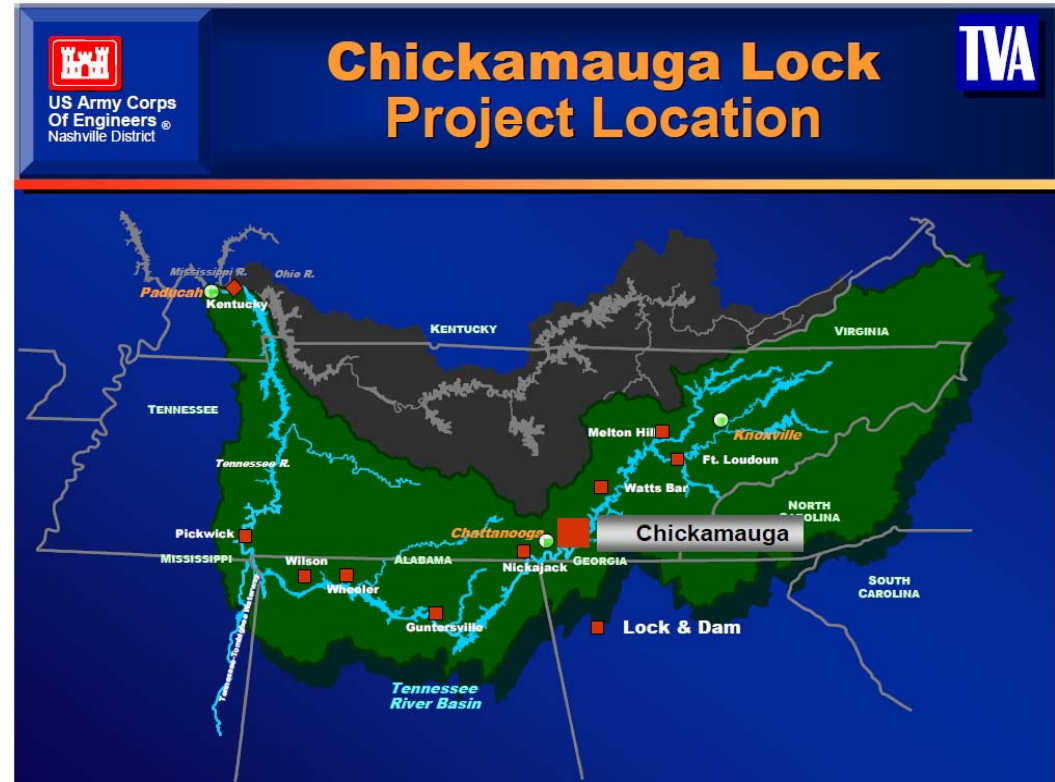
Tributary/Waterway: Tennessee River

Project Type: Construction

Project Description:

The Chickamauga Lock and Dam project is located at Tennessee River Mile 471 in Chattanooga, Tennessee. The lock replacement project, which was authorized by the Energy and Water Development Act of 2003, consists of a new 110-foot by 600-foot lock to be located riverward of the existing 60-foot by 360-foot lock and immediately downstream of Chickamauga Dam. In addition, local roadways and utilities adjacent to the lock will be relocated to provide access to the site for construction. *

Project Location Map:



Estimated Foregone Benefit (FB) (2011 \$)

FB per Dollar Invested per Delayed Year:	\$0.31
Annual Foregone Benefit:	\$119.69 M

Cost and Benefit (2011 \$)

Actual Construction Cost:	\$693 M
Annual Net Benefit:	\$68 M

Project Schedule

Construction Start Year:	2004
Planned Completion Year:	2010
Actual End Year:	2018
Number of Years Delayed:	8

*: *Inland Marine Transportation Systems Capital Projects Business Model, April 2010*

Map Source: *Inland Marine Transportation Systems Capital Projects Business Model, April 2010*

Project Fact Sheet

Project Name: Marmet Locks and Dam

Division/District: Huntington District

Project Status: Completed

Project Location: Kanawha, WV

Tributary/Waterway: Kanawha River

Project Type: Construction

Project Description:

The Marmet Locks and Dam project is located at Kanawha River Mile 67.7 near Belle, West Virginia. The Marmet Locks and Dam project provides for a new 110 by 800-foot lock, continued use of the existing twin 56 by 360-foot locks during maintenance closures of the new chamber, and rehabilitation of the navigation dam. The new lock became operational on January 22, 2008 and the lock construction contract is scheduled for completion in March 2009. *

Project Location Map:



Estimated Foregone Benefit (FB) (2011 \$)

FB per Dollar Invested per Delayed Year: \$0.37

Annual Foregone Benefit: \$132.69 M

Cost and Benefit (2011 \$)

Actual Construction Cost: \$472.15 M

Annual Net Benefit: \$72.16 M

Project Schedule

Construction Start Year: 1998

Planned Completion Year: 2007

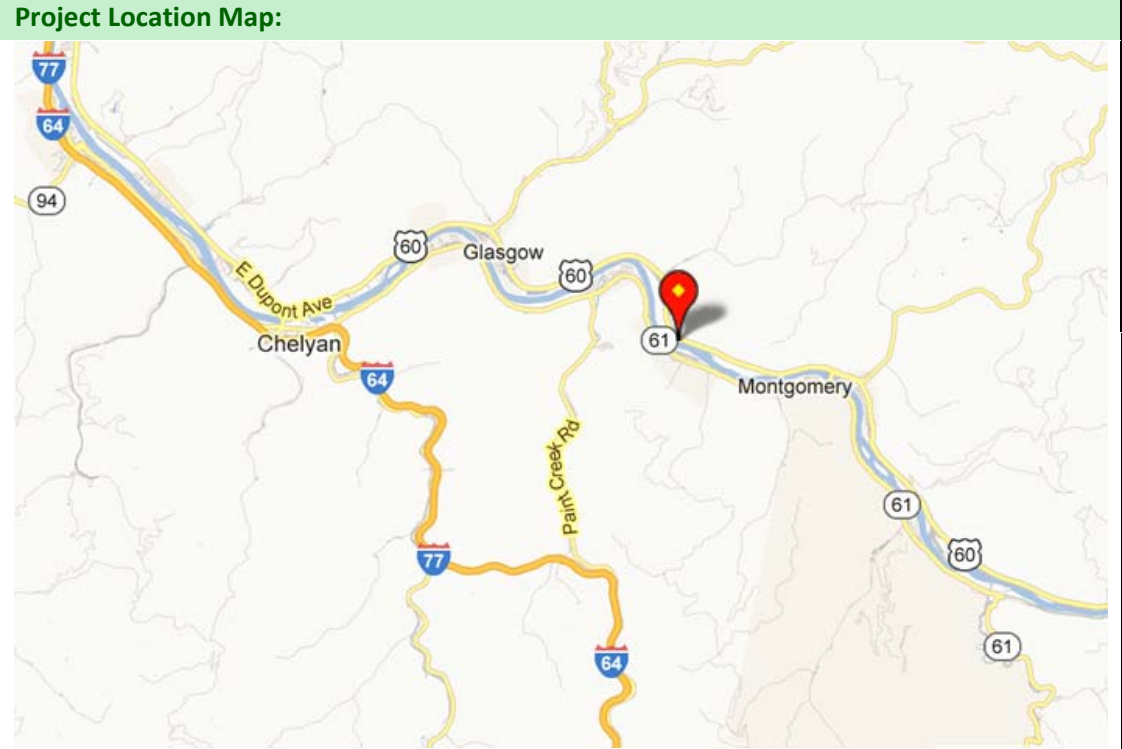
Actual End Year: 2009

Number of Years Delayed: 2 Years

*: Justification Sheet, The U.S. Army Corps of Engineers, April, 2001

Map Source: Engineering Geology Changes at the Marmet Lock Project, Mike Nield, US Army Corps of Engineers, Huntington District

Project Fact Sheet	
Project Name: London(including lock extension)	Project Location: London, WV
Division/District: Huntington District	Tributary/Waterway: Kanawha River
Project Status: Completed	Project Type: Rehabilitation
Project Description:	
It is located at Kanawh River, 82.8 miles above the mouth of river and about 2 miles downstream from Montgomery, WV. The construction project includes building of a 557-foot long non-navigable, high lift gated dam and a main lock chamber of 56-feet wide by 400-feet long with a parallel auxiliary lock chamber 56-feet wide by 360-feet long.*	
Estimated Foregone Benefit (FB) (2011 \$)	
FB per Dollar Invested per Delayed Year:	0
Annual Foregone Benefit:	0
Cost and Benefit (2011 \$)	
Actual Construction Cost:	\$35.83 M
Annual Net Benefit:	\$0.75 M
Project Schedule	
Construction Start Year:	2000
Planned Completion Year:	2003
Actual End Year:	2003
Number of Years Delayed:	0
*: http://www.lrh.usace.army.mil/projects/locks/lon/	
Map Source: Google Map	



Project Fact Sheet

Project Name: Emsworth Locks and Dams

Project Location: Pittsburgh, PA

Division/District: Pittsburgh District

Tributary/Waterway: Ohio River

Project Status: Under Construction

Project Type: Rehabilitation

Project Description:

Project Location Map:

Emsworth Locks and Dams are located on the Ohio River immediately downstream of the City of Pittsburgh in Allegheny County, Pennsylvania. The project includes two dams, one on either side of an island (Neville). The main channel dam and locks are located at river mile 6.2 and the back channel dam is located at river mile 6.4. The project creates the navigation pool for the City of Pittsburgh. The pool includes the uppermost 6.2 miles of the Ohio River, the lower 11.2 miles of the Monongahela River, and the lower 6.7 miles of the Allegheny River.*



Estimated Foregone Benefit (FB) (2011 \$)

FB per Dollar Invested per Delayed Year:	\$0.18
Annual Foregone Benefit:	\$21.59 M

Cost and Benefit (2011 \$)

Actual Construction Cost:	\$169.76 M
Annual Net Benefit:	\$7.9 M

Project Schedule

Construction Start Year:	2005
Planned Completion Year:	2011
Actual End Year:	2014
Number of Years Delayed:	3

*: *Inland Marine Transportation Systems Capital Projects Business Model, April 2010*

Map Source: *Inland Marine Transportation Systems Capital Projects Business Model, April 2010*

Project Fact Sheet

Project Name: Lockport

Division/District: Rock Island District

Project Status: Under Construction

Project Location: Lockport, IL

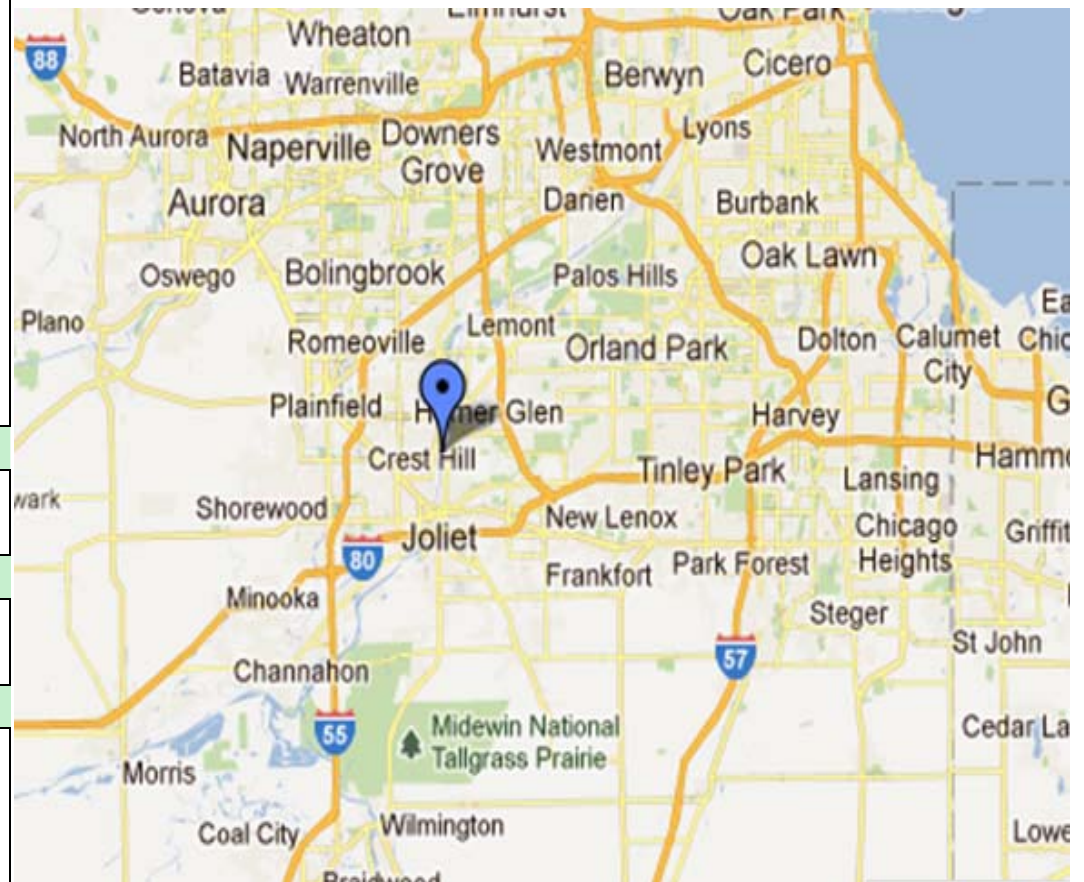
Tributary/Waterway:

Project Type: Rehabilitation

Project Description:

The project is located along a three-mile reach of the Chicago Sanitary Ship Canal (CSSC) just upstream of Lockport Lock. In 1984 Congress directed the Corps to assume navigation responsibility for the CSSC as a part of the Illinois Waterway project. The Approach Dike (right descending bank) was constructed in early 1900's of a limestone cement core wall and non-homogeneous materials. It has deteriorated to the point where its function as a seepage cutoff is limited. The CSSC concrete Canal Walls (left descending bank) are in an advanced state of deterioration that affects wall stability. Failure of the Approach Dike or the Canal Walls would cause loss of navigation pool, extensive flooding and potential loss of life. The Controlling Works is in need of rehabilitation to ensure operational integrity. The Lockport powerhouse and dam also retain the navigation pool.*

Project Location Map:



Estimated Foregone Benefit (FB) (2011 \$)

FB per Dollar Invested per Delayed Year:	0
Annual Foregone Benefit:	0

Cost and Benefit (2011 \$)

Actual Construction Cost:	\$118.00 M
Annual Net Benefit**:	\$5.90 M

Project Schedule

Construction Start Year:	2006
Planned Completion Year:	2013
Actual End Year:	2013
Number of Years Delayed:	0

*:<http://waterwayscouncil.org/WWSystem/Fact%20Sheets/Lockport.pdf>

**:*Missing value, assuming its B/C ratio is 2.*

Map Source: Google Map

Project Fact Sheet

Project Name: Markland Locks and Dam

Project Location: Warsaw, KY

Division/District: Louisville District

Tributary/Waterway: Ohio River

Project Status: Under Construction

Project Type: Rehabilitation

Project Description:

Project Location Map:

The Markland Locks and Dam are located at Ohio River Mile 531.5 and are 3.5 miles downstream of Warsaw, Kentucky. The navigation facility consists of two adjacent parallel locks located on the Kentucky bank. The main lock chamber has clear dimensions of 110' x 1200' and the auxiliary lock 110' x 600'. *



Estimated Foregone Benefit (FB) (2011 \$)

FB per Dollar Invested per Delayed Year:	\$0.18
Annual Foregone Benefit:	\$8.07 M

Cost and Benefit (2011 \$)

Actual Construction Cost:	\$43.38 M
Annual Net Benefit:	\$2.6 M

Project Schedule

Construction Start Year:	2009
Planned Completion Year:	2010
Actual End Year:	2012
Number of Years Delayed:	2

*: Inland Marine Transportation Systems Capital Projects Business Model, April 2010

Map Source: Inland Marine Transportation Systems Capital Projects Business Model, April 2010

Inland Waterway Cost of Misplaced Priorities-Projects Selected

	Project Information			Schedule			Project Cost				Benefits			
	Project Name	Location	Project Type	Actual Start Year	Planned End Year	Actual End Year	Original Cost (\$M)	Year of the \$ Value	Actual Cost /Current estimate	Year of the \$ Value	Annual Net Benefits (\$M)	Year of the \$ Value	B/C	Discount Rate
1	Olmsted	Olmsted, IL	Construction	1992	2006	2023	\$775.00	1988	\$3,099.00	2011	\$492.60	2011	3.1	7%
2	Lower Monongahela	PA	Construction	1994	2004	2031	\$556.40	1991	\$1,700.00	2011	\$259.60	2009	1.8	7%
3	Kentucky	TN River, KY	Construction	1998	2008	2041	\$533.00	2001	\$1,042.00	2011	\$60.76	2011	2.1	7%
4	Chickamauga	Chattanooga, TN	Construction	2004	2010	2036	\$267.20	2003	\$916.00	2011	\$68.00	2009	2.7	7%
5	McAlpine	Louisville, KY	Construction	2002	2002	2009	\$219.60	1990	\$429.30	2009	\$50.55	2011	1.8	8%
6	Marmet	West Virginia	Construction	1998	2007	2009	\$229.60	1996	\$405.90	2009	\$72.16	2011	2.9	8%
7	Upper Miss 25	Winfield, Missouri	Rehabilitation	1994	1997	1999	\$52.00	1994	\$52.00	1994	\$1.11	2008	2.06	Missing
8	London(including lock extension)	London, WV	Rehabilitation	2000	2003	2003	\$17.30	1997	\$24.60	2003	\$0.48	1997	Missing	8.63%
9	Emsworth	Pittsburgh, PA	Rehabilitation	2005	2011	2014	\$78.00	2002	\$160.00	2008	\$7.90	2009	1.9	7%
10	Lockport	Lockport, IL	Rehabilitation	2006	2013	2013	\$136.80	2010	\$118.00	2011	\$5.90	2011	2*	Missing
11	Markland	Warsaw, KY	Rehabilitation	2009	2010	2012	\$30.52	2000	\$39.80	2008	\$2.60	2007	3.1	7%

* Estimated by HDR study team.

7.0 Appendix B: Cost Benefit Analysis of Inland Waterway Investments: Current State and Recommendations for Improvement

Cost-benefit analysis is used to assess the viability of investments toward developing, improving, operating and maintaining infrastructure elements on the basis of benefits anticipated from them. A cost-benefit analysis typically produces financial investment metrics such as the net present value of investments, internal rate of return, benefit-cost ratio, and pay back period. The viability of specific investments is determined on the basis of these metrics.

In the case of infrastructure development, the investments have direct and indirect impacts.

- Direct impacts are the ones experienced by the users of the system. For example, repairing a lock system will immediately improve the freight flow and directly affect throughput and consequently the shipper costs. Besides freight forwarders and shippers, direct beneficiaries of inland waterway improvements include entities that draw municipal and industrial water supply from the pool created by these projects, as well as the utility companies that generate hydropower at some of these locations.
- Indirect impacts are experienced by non-users of the system due to the changes in usage patterns triggered by the investment. For example, the improvement of freight flow along waterways can lead to diversion of some freight movement from trucks and rail to waterways. These diversions can benefit highway users who experience congestion relief, as well as highway agencies that see lowering of pavement maintenance costs.

It is important to develop a comprehensive understanding of the impacts of an investment, including any additional impacts on continuing operating costs throughout the life cycle of the investment. A comprehensive evaluation will not only help assess viability of projects, but also identify individual beneficiaries and potential strategies for sharing investments. The cost side of the cost-benefit analysis that deals with the estimation of upfront investment and changes to ongoing costs and potential revenues is fairly straightforward. What makes cost-benefit analysis of infrastructure investments challenging is the identification and estimation of all the benefit categories and the development of strategies to monetize the benefits. The following sections contain a review of the approach utilized by the Army Corps of Engineers to assess the benefits of inland waterways projects followed by our recommendations on possible refinements to the approach.

7.1. Review of Benefits Estimated by the Army Corps of Engineers

The Army Corps of Engineers uses a standard benefits assessment process⁵ when evaluating inland waterways projects. The Corps model incorporates only a portion of the direct impacts and user

⁵A detailed discussion on the Army Corps of Engineers cost-benefit analysis approach is provided in *Economic and Environmental Principles Guidelines for Water and Land Resources Management*, 1983, and Analysis Guidelines in

benefits. These user benefits are typically expressed in the form of shipper time savings enabled by improvements to the navigation infrastructure. The assessment is usually limited to the current freight users of the system and the delays that they experience. The model also uses anticipated growth in cargo movements by the current users, and a generic estimate for new users.

There are a few noteworthy observations about the Corps' approach to direct benefits assessment. These are:

- The Corps uses a standard value of time savings across the board. While there is a general consistency in the type of commodities that are moved along waterways, there is enough variation that warrants a commodity specific application of the value of time savings. Further with the manufacturing and assembly efficiencies that industries have gained over the years, shipping and logistics have significant impact on just-in-time operations. These high impacts are mostly ignored by the model.
- The growth rates used by the Corps are derived from local estimates and do not align themselves with national level forecasts of commodity flow patterns. The inland waterways infrastructure is capable of handling a far more substantial component of the freight flow than it currently does. Applications of local growth rates often fail to capture this potential and subsequently lead to underestimation of future benefits.
- The Corps treatment of induced freight demand is fairly limited. Any improvement to the navigation infrastructure would enhance freight flow efficiencies and have the potential for inducing a modal shift from land based freight modes such as trucks and rail. The significant level of shipper cost savings gained by these "induced" users is missing in the model.
- The Corps' treatment of the environmental impacts is, in most cases, limited to the reduced levels of impacts on marine life. Any potential effect on water quality afforded by improved freight movements is not adequately captured. This leads to undervaluing of the investments directed at efficient handling of fuel leaks and spills.
- The treatment of safety benefits in the Corps model is based on the potential reduction in the number of accidents. The model uses the accident levels of today as the baseline. We feel that while assessing benefits, the baseline should be a "do nothing" alternative, and hence should capture the potential increase in accident rates due to increased traffic as well as worsened infrastructure.
- The Corps approach treats each project as a stand alone initiative. The improvements, however, can have impacts across the entire system. We feel that the benefits assessment should account for system level improvement in freight flow.

Table B-1 summarizes relevant benefit categories, along with our observations and recommendations. The recommendations are discussed in the following section in more detail.

the Water Resources Management Act of 2007 and in the document Use of Benefit Cost Analysis in Planning by the US Army Corps of Engineers, August 2009

7.2. Potential Enhancements to the Benefits Assessment Approach

We have identified a few potential improvements to the benefits assessment model. It is very possible that the current model incorporates these categories through global factors. If that is the case, introducing new categories will result in double counting and exaggeration of benefits. Therefore, it is important to study the current parameters and assumptions in more detail to ensure that this overlap of benefits is properly accounted for. The importance of understanding the levels of benefits by category is that it helps policy makers identify specific beneficiaries and the level of benefits. Transparency into these assessments is vital to structure partnerships among local communities, or public-private partnerships to realize the much needed development of the waterways infrastructure.

Modify existing mode of specifying baseline for the analysis

The current approach to define the baseline for benefit-cost analysis entails making the assumption that the current performance level of the system will continue unchanged into the future and the benefits are assessed in terms of improved services that the projects cause. However, in reality the system performance will deteriorate in the future because of added wear and tear coupled with increased demand. We recommend that the method of defining and specifying baseline service level be reviewed and modified to account for these effects.

Incorporate commodity groups into estimation of benefits from time savings

As described above, the real impact of time savings and flow streamlining will vary with the demand underlying the freight movement. Some commodity groups, such as perishables and high value goods are more sensitive to time, and those investments that serve areas that require such commodities will be valued higher. Our recommendation is that the time savings calculations be segregated by commodity groups, and corresponding value of time be applied.

Introduce a mode diversion module for estimating induced freight demand

Improvements to the navigation infrastructure would increase the efficiency of waterway mode and increases the potential to divert some of the land based shipments, particularly truck shipments, to inland waterways. Unit shipping costs along waterways is a fraction of the cost incurred on highways. Transportation of bulk commodities is a perfect candidate for this diversion. We recommend the development of a simple modal diversion model using factors for generalized cost elasticity of modal demand. The modal diversion approach should also address the issue of reducing the rail freight rate as the water compelled rate in competitive markets.

Modify baseline for safety benefits assessment

Benefits assessments should be based on a no-build baseline. A no-build scenario will involve growth in demand, as well as additional deterioration of the infrastructure. We recommend a parametric application of the accident rates as a function of the demand and processing capacity. A reliable parametric model can be developed using historical incident data.

Include water quality and associated benefits

The improvement of freight flow and reduced delays will reduce fuel consumption and emissions, and positively impact water quality. The current model accounts for the impact on fish and fishing industry, but pays little attention to other uses, including municipal and industrial water supply, irrigation, and flood control. We recommend that models that clearly articulate and quantify these impacts be developed and used in the assessment of benefits.

Introduce potential impacts on highway transportation

Diversion of truck traffic to waterways can have significant positive effects on highway travel. Reduction in trucks can relieve highway congestion, improve highway travel safety. Further, highway pavement maintenance deterioration would be reduced drastically leading to savings to highway agencies. These benefits have livability impacts as well.

Introduce potential cross-sector benefits

We recommend that benefits to other sectors be explicitly captured. This includes water supply agencies, the utility sector, tourism sector, recreational industry, as well as the fishing industry. Benefits to these industries directly translate to revenue gains attributable to waterways investments.

Develop a benefits allocation model

One of the key outcomes from the assessment of benefits should be an appreciation for the levels of benefits accrued to each beneficiary. The beneficiaries may be private sector firms, public entities, or communities and, of course, the national economy. A model that provides an allocation of overall benefits among various beneficiaries and offers a high level of transparency can drive credibility in the process, and can form the foundation for strategic partnership deals for development. Innovative and creative approaches to finance these investments will be needed in the future.

Implement a Risk Analysis Component

The parameters used in the assessment of benefits have significant levels of uncertainty associated with them. It is imperative that the results of the analysis reflect this uncertainty and their interpretation account for it. We recommend that the entire cost-benefit analysis framework be implemented on a risk analysis framework enabling the analysts to specify ranges of estimates for costs, benefits and other parameters rather than point estimates.

Incorporate System Wide Impacts

Each inland waterway project impacts the whole system in some ways. This may be in terms of improved flow through another location or impose additional costs for operational adjustments elsewhere in the system. We recommend that the overall assessment of benefits incorporate these effects and the associated costs and benefits in the analysis.

Table B-1: Benefit Categories of Inland Waterways Investments

Benefit Category	Benefit	Army Corps Model	Remarks
Waterways User Benefits	Shipper cost savings	Included	Should be classified by commodity groups
	Time savings	Included	Should be applied based on shippers
	Accident reduction	Included	Baseline should capture potential increase from current levels
	Growth in usage	Included	Should be tied to national forecasts of freight flow
	Induced demand	Included	Currently included as a part of growth. But needs to be based on a modal diversion model
Other Transportation and Public Benefits	Highway congestion reduction	Not included	Needs to be included based on modal diversion
	Highway safety improvement	Not included	Based on highway traffic models
	Pavement maintenance savings	Not included	Based on highway traffic impacts
	Increased linkages	Included	To be done at a transportation network and mobility level
	Environmental impacts	Included	Include water quality, air quality impacts of changes (including trucks)
Cross-Sector Benefits	Benefits to Utility Sector	Not included	Based on local demands
	Benefits to Water Supply and Sanitation	Not included	Based on local demands
	Benefits to Tourism Sector	Not included	Based on local potential
	Benefits to Recreational Services Sector	Not included	Based on local potential
Wider Economic Impacts	Short-term and long-term job creation	Included	To be included as additional insight, not as a “benefit” because it is already included
	Community development impacts	Not included	Based on local potential