Predictable Funding for Locks and Dams

Final Report

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Prepared by
Texas A&M Transportation Institute
3135 TAMU
College Station, Texas 77843-3135

for
Soy Transportation Coalition

Authors
Nicolas D. Norboge
Brianne Glover, J.D.
Brett Huntsman
Max Steadman
C.J. Kruse
Loraine Maxwell
Jacqueline A. Kuzio

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CHAPTER 1 – INTRODUCTION

For decades, the U.S. Army Corps of Engineers (Corps), and to a lesser extent, the U.S. Department of Transportation (USDOT), have played a pivotal role in developing and maintaining the nation's inland waterway infrastructure. The U.S. inland waterway system, a network of inland, intracoastal, and coastal waterways, includes thousands of miles of navigable waterways that represent a critical component of the freight transportation system in the U.S. As shown in Figure 1 below, this network helps to connect the Gulf Coast, the East Coast, and the Central and Midwest regions of the country through a system of navigable waterways, carrying approximately 15 percent of the nation's domestic freight (*1*).

Figure 1: U.S. Inland Waterway Network.
Source: (1)

As is also evident in Figure 1, the nation's inland waterway network is comprised of a system linked by a series of rivers and major canals. As a result, a series of locks and dams are critical to enabling the upstream and downstream movement of cargo. In fact, this system includes more than 241 locks managed by the Corps at 195 sites around the U.S. (1). The economic significance of the inland waterway system is considerable. However, it is worth noting that traffic can vary significantly across the waterways system. Similar to how the interstate highway system constitutes only a small portion of total lane-miles but carries a significant portion of vehicle traffic, there are high-use segments of the waterway network, which tend to be located along the Mississippi and Ohio Rivers in the Central U.S. Figure 2 below illustrates the high-use, moderate-use, and low-use segments of the inland waterway system (2). (Additional waterborne commerce statistics can be found in Appendix 1.)

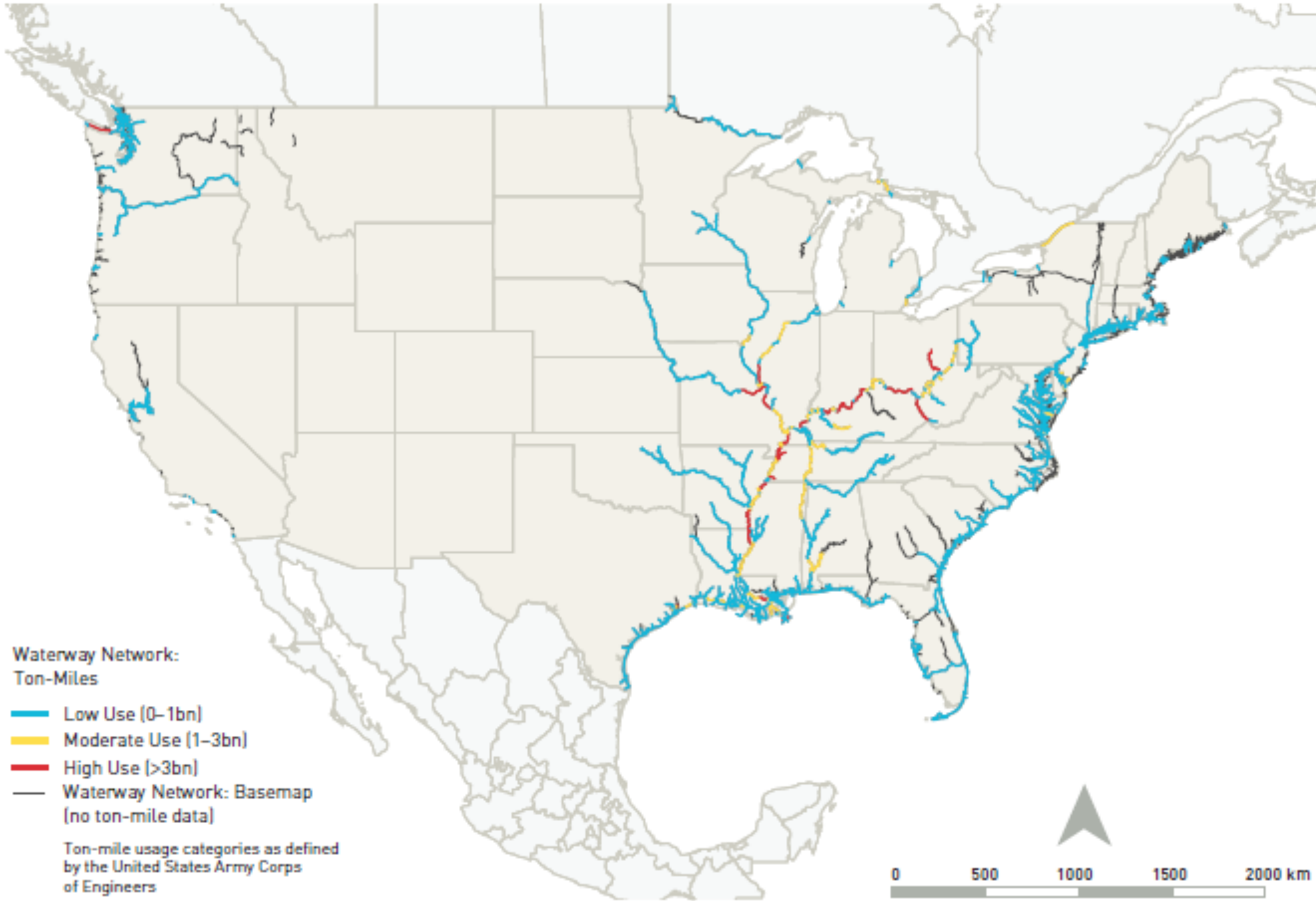


Figure 2: Inland Waterways Network, High-Use, Moderate-Use, and Low-Use Segments.

Source: (2)

Note: The data presented in Figure 2 above should be evaluated with caution. Some locks that experience periods of "high-use" are on waterways designated as "low use" or "moderate use" based on average annual ton-miles. For example, whereas the entire Arkansas and Tennessee Rivers are "low use", the Upper Mississippi, Illinois, and Tennessee–Tombigbee Rivers and the Gulf Intracoastal Waterway (GIWW) have "high-use" locks in waterway sections that would be classified as "moderate" or "low use." This situation can occur because of seasonal peaks in the movement of certain commodities such as harvested food and farm products or because of navigation closures due to annually recurring weather conditions such as ice or flooding. For prioritization, the tonnage moved through each lock during peak demand periods, as well as the type and value of the cargo, needs to be considered; usage should not be assessed merely on the basis of average annual waterway ton-miles. Likewise, some rivers and waterborne corridors may, on a seasonal basis, move as much or more tonnage as rivers classified as high use but receive "low-use" classification due to annual ton-miles of transport rather than seasonal peak ton-miles. For further information, please refer to *(2)*.

With growing levels of cargo and congestion occurring on the nation's inland waterway system, there is increasing concern that the funding levels for this system of locks and dams is insufficient to meet future freight demand. Specifically, a comprehensive analysis of the nation's lock and dam infrastructure by the National Research Council (NRC) Committee on Reinvesting in Inland Waterways developed the following conclusions (*2*). First, this study found that reliability and performance of the inland waterways freight system are the priorities for funding. In addition, reliability and performance depends on the capital expenditures for some of the larger locks. Overall, this study found that a combination of program efficiencies and new revenue stream strategies could be used to help pay for the growing commercial navigation demands placed on the nation's inland waterways system.

Key findings from this research include the following:

1. Reliable and predictable funding, coupled with integrated asset-focused approaches to improve lifecycle investment decisions, can help to improve the useful life of the nation's inland waterway system.

2. The inland waterways system is a small but important component of the national freight system.

3. The most critical need for the inland waterways system is a sustainable and well-executed plan for maintaining system reliability and performance that ensures efficient use of limited navigation resources.

4. Asset management can help prioritize and ascertain the level of funding required for the system.

The question remains: what is the best way forward for the Corps if no new money is appropriated to meet the required needs of the nation's lock and dam infrastructure? Over the years, the Soy Transportation Coalition (STC) has explored the need to prioritize funding, operations, and maintenance of current lock and dam sites. Two previous studies examined this topic: *America's Locks & Dams: A Ticking Time Bomb for Agriculture?* (December 2011) and *New Approaches for U.S. Lock and Dam Maintenance and Funding* (June 2012) (*3,4*). In addition, TTI conducted a 2015 study for the Texas Legislature that examined funding for port infrastructure projects in the state (*5*). This research expands upon TTI's previous efforts by further examining the current unpredictable and piecemeal approach to funding the nation's locks and dams.

Background

The current approach the Corps uses to fund the nation's lock and dam infrastructure typically requires the *authorization* (i.e., establishment, continuation, or modification of an activity) and *appropriations* (i.e., provision of budget authority to an agency for specified purposes) by Congress (*6*). Authorization of a project can occur years before funds are appropriated. Furthermore, when appropriations do occur they may only allocate funds for a portion of an authorized project (*10*). As noted previously, the Corps is responsible for maintaining much of the nation's federal navigable water resources and for the construction and maintenance of more than 241 locks managed by the Corps at 195 sites around the U.S. (*7*). The Corps receives authorization by Congress to construct specific projects through the federal

Water Resources Development Act (WRDA) and separate appropriations from Congress to fund projects, usually annually.

Federal law also dictates what funding can be made available depending on the nature of the project (e.g., new construction, rehabilitation, maintenance, etc.) New construction and major rehabilitation projects are financed at 50 percent by the Inland Waterways Trust Fund (IWTF) and 50 percent through general appropriations by Congress. It is worth noting, however, that there was an exception made for Olmsted Lock and Dam project--85% of the project was funded through general appropriations and 15% through the IWTF in the Water Resources Reform and Development Act of 2014 (*8*). Operations and maintenance (O&M) funding comes entirely through general appropriations by Congress (*2*). For additional context, Figure 3 below provides a summary of the standard construction and operations and maintenance cost-sharing requirements for Corps projects.

Project Purpose	Maximum Federal Share of Construction	Maximum Federal Share of O&M
Navigation		
Coastal Ports—		
<20 ft. harbor	80%[a]	100%[b]
20 ft.-50 ft. harbor	65%[a]	100%[b]
>50 ft. harbor	40%[a]	50%[b]
Inland Waterways	100%[c]	100%
Flood and Hurricane Damage Reduction		
Inland Flood Control	65%	0%
Coastal Hurricane and Storm Damage Reduction	65%	0%
except Periodic Beach Renourishment	50%	0%
Aquatic Ecosystem Restoration	65%	0%
Multi-Purpose Project Components		
Hydroelectric Power	0%[d]	0%
Municipal and Industrial Water Supply Storage	0%	0%
Agricultural Water Supply Storage	65%[e]	0%
Recreation at Corps Facilities	50%	0%
Aquatic Plant Control	Not Applicable	50%

Source: 33 U.S.C. §§2211-2215, unless otherwise specified below.

a. Percentages reflect that nonfederal sponsors pay 10%, 25%, or 50% during construction and 10% over a period not to exceed 30 years.

b. Appropriations from the Harbor Maintenance Trust Fund, which is funded by collections on commercial cargo imports at federally maintained ports, are used for 100% of these costs.

c. Appropriations from the Inland Waterway Trust Fund, which is funded by a fuel tax on vessels engaged in commercial transport on designated waterways, are used for 50% of these costs.

d. Capital costs initially are federally funded and are repaid by fees collected from power customers.

e. For the 17 western states where reclamation law applies, irrigation costs initially are federally funded, then repaid by nonfederal water users.

Figure 3: Standard Construction and O&M Cost-Sharing Requirements for U.S. Army Corps Projects.
Source: (9)

The process of appropriating money annually based on a current project list typically results in piecemeal, unpredictable, and unreliable funding. Perhaps one of the most notable examples of rising project cost escalation is the Olmsted Locks and Dams project near the confluence of the Ohio and Mississippi Rivers. The Corps was responsible for the planning and construction of the Olmsted Locks and Dam project. In 1988, Congress passed the Water Resources Development Act. At that time, the Act authorized the Olmsted project at a cost of $775 million, with construction expected to take seven years. At the time of publication, the Olmsted project is currently slated to open in October 2018 and be fully functional—30 years after construction first began (*10*).

While this was likely due to many causes, the lack of a reliable funding source may have served as one contributing factor. A post-hoc analysis by the U.S. Government Accountability Office (GAO) on the Olmsted Lock project noted that while the Corps' decision to use a cost-reimbursement contract contributed to project delays, "the Corps and consultant reports also identified other contributing factors, including limited funding; market condition changes, such as unexpected and significant increases in the price of construction materials; and design changes during the dam construction in response to soil conditions and other issues (*11*)." (Additional information concerning the price of construction materials and the calculation methods to cover those costs can be found in Appendix 2.)

This GAO report also noted the challenges posed to the Olmsted project attributed to inconsistent funding levels available in the IWTF. Notably, this report pointed to the unpredictable, "incremental" nature of IWTF funding:

> *According to a Corps headquarters official, in fiscal year 2003, the balance of the Inland Waterways Trust Fund, which generally pays half of the construction costs of navigation and rehabilitation projects, started to decline because so many projects were under construction. The official said that from fiscal years 2005 to 2009, there was a sharp decrease in the balance of the trust fund as fuel tax revenues started to decline, and that by fiscal year 2009, the fund was nearly depleted. As a result, the expenditures from the fund were limited to the amount of annual fuel tax revenues collected for that particular year. According to the 2012 consultant report and the headquarters official, the Olmsted project was funded on a monthly basis, and this incremental funding also contributed to delays and increased costs (11).*

Many different analyses developed in the past have proposed policy solutions addressing challenges faced in projects such as Olmsted. One such solution involves changing federal lock and dam cost-sharing requirements. For example, in 2010, the Inland Marine Transportation System (ITMS) published its Capital Project Business Model report. This report was prepared by the Inland Marine Transportation System Capital Investment Strategy Team and represented a collaborative effort between navigation industry representatives and Corps inland navigation experts (but does not represent the official Corps agency position.) This report, as part of its larger analysis of options for reducing Corps project costs and schedule delays, proposed a number of different cost-sharing methods. As shown in Table 1 below, a number of cost-sharing options to increase the reliability of lock and dam projects were considered (*12*).

Table 1: IMTS Capital Projects Business Model Lock and Dam Cost-Sharing Options Considered.
Source: (12)

Description
Baseline Option—50% Federal and 50% IWTF
50/50 for New Construction, 100% Federal for Major Rehabilitation
50/50 for New Construction and Major Rehabilitation above $50 million, 100% for Major Rehabilitation below $50 million
50/50 for Locks, 100% Federal for Dams
50/50 for New Construction, and 75/25 for Major Rehabilitation
60% Federal, 40% IWTF
65% Federal, 35% IWTF
75% Federal, 25% IWTF
50% Federal, 50% IWTF on all projects

Ultimately, the Capital Project Business Model report recommended that all new lock construction projects be funded under a cost-share model consisting of 50 percent from general appropriations and 50 percent from the Inland Waterways Trust Fund. Furthermore, this report recommended new construction and major rehabilitation dam projects and major rehabilitation lock projects below $100 million be funded entirely through general appropriations (*12*).

Study Approach

This report aims to analyze and highlight the inefficiencies and cost escalations resulting from the current unpredictable and piecemeal approach to funding the nation's lock and dam infrastructure. It is intended to provide policymakers and the public with a practical assessment of these different funding approaches. This research effort was divided into four tasks: 1) describe current lock and dam prioritization process, 2) describe current funding structure, 3) conduct a funding scenario analysis, and 4) summarize these conclusions and provide a list of best practices. First, TTI conducted a literature review that assessed the current lock and dam prioritization process. As part of this effort, TTI reviewed literature, published reports, and other information collected from relevant federal, state, and local stakeholder agencies. After the relevant literature were compiled, researchers then reviewed the current Corps cost estimation process. As part of this review, researchers examined how cost estimates for the rehabilitation and replacement of locks and dams are performed and an examination of how the Corps prioritizes its infrastructure needs (and estimates costs associated with them.)

Once those tasks were complete, researchers then conducted a funding scenario analysis. This assessment involved a cost comparison of the same lock project that was funded through current levels compared to a more "predictable and reliable" funding scenario.

This report is organized into the following sections:

1. current U.S. Lock and Dam Prioritization and Selection Process;

2. current U.S. Lock and Dam Funding Structure;

3. results from the Funding Scenario Analysis; and

4. conclusions and best practices.

Because of the time frame for the delivery of this research, TTI has relied primarily on publicly available data and has supplemented it with interviews of officials from key agencies, such as the Army Corps of Engineers, and the Inland Waterways Users Board. Most of the publicly available data reside within the Corps[1], but other sources were assessed as needed (U.S. Department of Agriculture, port authorities, and studies performed by other parties).

[1] In March 2016, the Corps released "Inland and Intracoastal Waterways: 20-Year Capital Investment Strategy."

CHAPTER 2 – CURRENT LOCK AND DAM PRIORITIZATION AND SELECTION PROCESS

The U.S. Army Corps of Engineers utilizes a process for prioritizing potential lock and dam projects once a need has been determined. According to the IMTS, the Corps' current project selection process consists of the following six steps: 1) identifying problems and opportunities, 2) inventorying and forecasting conditions, 3) formulating alternative plans, 4) evaluating alternative plans, 5) comparing alternative plans, and 6) selecting a plan. Corps decision making is generally based on completing and documenting these steps (*12*).

In order to identify which needs should be priorities, the Army Corps of Engineers performs an Operational Condition Assessment (OCA) – a formula that incorporates condition ratings, probability of failure, and the consequences of such a failure (*13*). Employing the OCA approach, the Corps assigns condition ratings of each lock and dam using an A through F scale. These are used to construct a statistical model to help predict the probability that the asset will fail in the future. The Corps then uses a tool, which takes into consideration the importance of the component to the Corps' mission, public safety, and the economy, to calculate the economic consequence of such a failure. The result of this calculation is then used to rank potential projects. The Corps selects as priority projects those that have the "greatest net economic and environmental returns per dollar expended" (*14*).

After identifying and prioritizing needs, the Corps must perform benefit-cost analyses (BCA) to assess the feasibility of lock and dam improvement and/or replacement projects. In executing such analyses, the Corps attempts to incorporate all costs and benefits thought to influence net economic efficiency. Costs include elements such as construction management, planning, materials acquisition, and inflation expected to occur during the construction process. Benefits represent net efficiency gains, which exclude basic economic transfers between actors (*15*). These gains are generally expressed as tonnage multiplied by the savings per ton anticipated after the completion of the project. In addition to prioritizing projects and demonstrating their feasibility, the Corps must determine whether a deficiency at a lock and dam should be repaired, rehabilitated, or replaced. According to a 2011 TTI study, the Army Corps of Engineers typically consider the Dam Safety Action Classifications and Condition Index (i.e., index that summarizes characteristics associated with structural and operational risk of dam infrastructure) when making these decisions (*3*).

The Corps and other relevant agencies must develop cost estimates for projects to inform Congress of anticipated needs before seeking funds. The project costs are computed during the feasibility stage and, as stated previously, include all construction and associated costs (*16*). Additionally, the Corps is required to post all proposed plans to receive public commentary and often communicate to stakeholders through open meetings (*17*). However, the burden is placed on stakeholders to seek out and attend such meetings; thus, some of the information regarding proposed projects may not be easily accessible. The development of cost estimates and performance of the benefit-cost analyses typically can take two to three years to complete. After this period, feasibility studies are reviewed by the Office of Management and Budget (OMB) before being forwarded to Congress to begin the appropriations process (*18*).

The Army Corps of Engineers states that considering needs and resources concurrently can help the organization uphold a common objective (*13*). Thus, the needs—and costs associated with them—of other locks and dams can affect whether a project is designated for replacement or rehabilitation. In prioritizing the needs of the entire system, the following reasoning is sometimes practiced: *If we had unlimited financial resources, we would recommend **replacing** ____ lock and dam. However, given the needs of other locks and dams and the scarcity of resources, we recommend **rehabilitating** ____ lock and dam.* Additionally, as projects are authorized, they add to the backlog of projects awaiting appropriations, so the Corps must attempt to allocate their resources strategically (*14*).

U.S. Army Corps of Engineers (Economic Principles and Guidelines)

The Corps structures its BCAs in accordance with *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, often referred to as Principles and Guidelines, or P&G. While the P&G was most recently updated in 2013, limited funding has resulted in the Corps still using the 1983 P&G (*19*).[2] Detailed Corps guidance can be found in the Planning Guidance Notebook (PGN, formally listed as ER 1105-2-100). The P&G relies heavily upon predictive models and monetization techniques as the basis for water resources investment decisions.

The P&G established four accounts to evaluate and present effects of alternative plans (*20*):

- National Economic Development (NED): displays changes in the economic value of the national output of goods and services.
- Regional Economic Development (RED): displays changes in the distribution of regional economic activity from each alternative plan. This includes income, employment, and population projections.
- Environmental Quality (EQ): displays non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of ecosystem restoration plans.
- Other Societal Effects (OSE): displays plan effects focused on social issues that are not covered in the other accounts, such as urban and community impacts; life, health, and safety factors; displacement; long-term productivity; and energy requirements and energy conservation.

The P&G does not place equal weight on the four accounts. The NED account is the most important of the accounts, as it is the only required account for federal water projects. Components of the other three accounts are often included in the NED account when they are monetized, but they are not considered as equally important objectives in the final analysis (*20*). The Corps is required to choose the NED-maximizing alternative unless "there are overriding reasons for recommending another plan, which can be based on federal, state, local or international concerns (20)." The P&G requires the plan that maximizes net national economic benefits consistent with protecting the nation's environment be selected unless an exception is

[2] The Water Resources Development Act of 2007 required the Army to modernize the 1983 P&G. While attempts have been made to revise the P&G and implement those guidelines across all Corps functions, subsequent appropriations bills prohibited the Corps from spending any money to implement the new P&G. Consequently, the Corps is still using the 1983 P&G.

granted. Therefore, the Corps' project recommendation rests on whether the project's benefits outweigh the costs detailed in the NED account.

The base economic benefit of a navigation project is the reduction in the value of resources required to transport commodities. This could be accomplished in the following ways:

- cost reduction benefits for commodities for the same origin and destination and the same mode of transit, thus increasing the efficiency of current users;
- shift of mode benefits for commodities for the same origin and destination providing efficiency in waterway or harbor traversed;
- shift in origin and destinations that would provide benefits by either reducing the cost of transport, if a new origin is used or by increasing net revenue of the producer, if a change in destination is realized (this benefit cannot exceed the reduction in transportation costs achieved by the project);
- new movement benefits when there are additional movements in a commodity or there are new commodities transported due to decreased transportation costs; and
- induced movement benefits, which are the value of a delivered commodity less production and transportation costs when a commodity or additional quantities of a commodity, are produced and consumed due to lower transportation costs.

By definition, NED benefits are the direct and indirect increases in production and employment attributable to a plan[3] (*20*). The NED is the only required alternative by the P&G; however, other alternative plans may be identified. The community or local sponsor decides on which plan to choose, and they may decide not to use the NED alternative. The Corps utilizes the NED to determine whether a community is going beyond the necessary requirements, such as constructing a higher levee, if they do so, the community will be responsible for some or all of the additional costs.

[3] Note: The 1983 Principles and Guidelines requires at least one water and related land resources plan to be developed for a water resources project that is pursuant to applicable national environmental statutes, applicable executive orders, and other Federal requirements.

CHAPTER 3 – CURRENT LOCK AND DAM FUNDING STRUCTURE

The Corps follows a comprehensive authorization and appropriation process. This chapter will explore the process in which those projects move from recommendation, to funding through an examination of 1) the process in which projects are moved up the districts and eventually to Congress, 2) the authorization of projects through the Water Resource Development Act (WRDA), and 3) an overview of the appropriations process.

Authorization Process

How the Corps made its project infrastructure investment decisions underwent significant changes in fiscal year 2006. Prior to the change, the process involved recommendations from the districts to their respective divisions, which would submit a division-wide portfolio of projects to headquarters. All projects were required to fall within set funding amounts for each division, and would be allocated to projects that met administration priorities and had an equal benefit-cost ratio (BCR). Following this submittal, Corps headquarters would then consolidate division portfolios into a single, agency-wide portfolio (*21*). In fiscal year 2006, the shift from a relatively decentralized approach to a centralized performance-based budgeting process occurred. Following the prioritization process, selected projects, which are those receiving a minimum benefit-to-cost ratio of 2.5, must be authorized to receive appropriations. Customary practice is for the Office of Management and Budget (OMB) to set a minimum benefit-cost threshold to be included in the President's annual budget request. Although the project BCR must exceed 1.0, thresholds used by the administration can vary. In recent years, more stringent criteria have been used: for example, for the FY 2015 budget, a BCR of 2.5 was required for construction projects (*2*). Projects are authorized through WRDA, which are authorization bills that add, or remove, activities to a pool of existing authorized activities. WRDA legislation typically originates in the House Transportation and Infrastructure Committee and must pass through both chambers of Congress. This committee, historically, has been a place of intense debate over the planning, construction, and operation of Corps projects.

Authorizations can be project-specific, programmatic, or general (*9*). Authorizations consist of project studies, construction, and modification of existing authorizations. It is important to note that WRDA authorizations do not appropriate funds to projects, but rather make them eligible to be included in funding requests.

Budget Requests

Once projects are authorized, they must then be presented in the President's budget request to receive appropriations. There is no timeline for project appropriations following authorization; however, legislation in the Water Resources Reform and Development Act of 2014 establishes a seven-year timeframe that if no federal funds were appropriated the project would be automatically de-authorized. The budget formulation process includes the districts, divisions, and the Corps headquarters. Two years before desired construction, projects meeting certain performance standards outlined in the prioritization process are compiled into a portfolio at each of the 38 districts. Each district submits their project portfolio to their respective division. In this step, the divisions will review and edit each portfolio before sending it to Corps headquarters for review. This process continues as the list moves up to the Assistant

Secretary of the Army for Civil Works (ASA), the OMB, and then to the President's budget (refer to Figure 4).

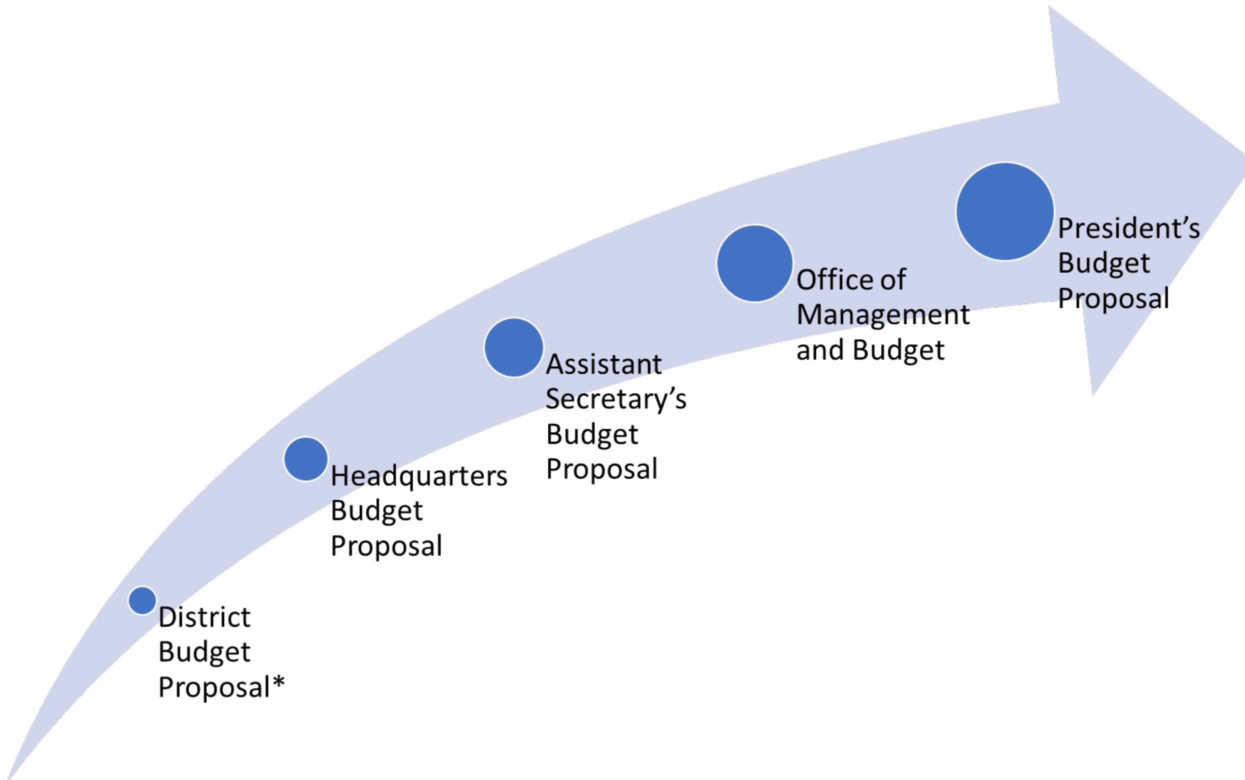


Figure 4: Typical Budget Request Process.
Source: (22)

*Note: The District Budget Proposal is reviewed by their respective Corps division before being submitted to Corps headquarters for review.

Appropriations Process

Congress appropriates funding to authorized Corps civil works projects through the Energy and Water Development Appropriations Act. The President's budget request is reviewed by the Appropriations Committee's Subcommittee on Energy and Water Development. During this review, the subcommittee will hold hearings and alter the bill. Following this review, the bill moves to the whole Appropriations Committee for further changes. Following these changes, the bill moves to the House for a vote, then to the Senate for a second vote. During both of these hearings, amendments can be added to change the contents of the bill. Congressional actions typically include either an alteration in the amount of funding requested by the President, or the provision of "additional funding" for any activity deemed to be not included or underfunded in the budget request (22). If any changes are made by the Senate, the bill will move back to the

House for reconciliation. Following reconciliation, passage by both chambers of Congress, it will move back to the President for enactment.

By the time the final appropriations bill is enacted, the request that was originally made at the Corps district level will have been reviewed and altered nearly ten times. However, the rate at which the Corps authorizes projects exceeds the rate at which appropriations are made by Congress. Given limited budgets, projects that move through the authorization process may not receive funding for several years, receive funding in a piecemeal manner, or not receive funding at all. This has led to a growing backlog of projects, as well as competition between projects.

Those projects meeting both the Administration's and Congress's goals and direction will be kept in the funding request and be appropriated funds. However, those not being presented as a "priority" project for the administration will be removed from the budget request. As the Congressional Research Service (CRS) notes, the Bush and Obama administrations focused on flood and storm damage reduction, navigation, and aquatic ecosystem restoration. Projects identified to be included in the annual budget request must be reviewed by the Administration before being submitted to Congress, as the Corps is part of the Administration. As such, there are no situations where the Corps sends budget requests directly to Congress without the Administration's approval. This is further enforced by the removal of "earmarking" projects to bypass the formal authorization and appropriations process in 2011. It is worth noting, however, that some Congressional members have discussed removing this ban in future infrastructure legislation (*23*).

Funding

Once a budget request is submitted by the President, Congress will begin to review and revise the request. Historically, Congress has provided additional funding for specific projects. Following the elimination of earmarking, Congress still has appropriated additional funding for use on specific types of projects, rather than specific projects. Following this increase, it is then the responsibility of the Administration to work with Corps offices to develop a list of projects that will receive these funds. Historically, the Corps has requested between $4.5 billion to $6.0 billion. These appropriations are summarized in Figure 5.

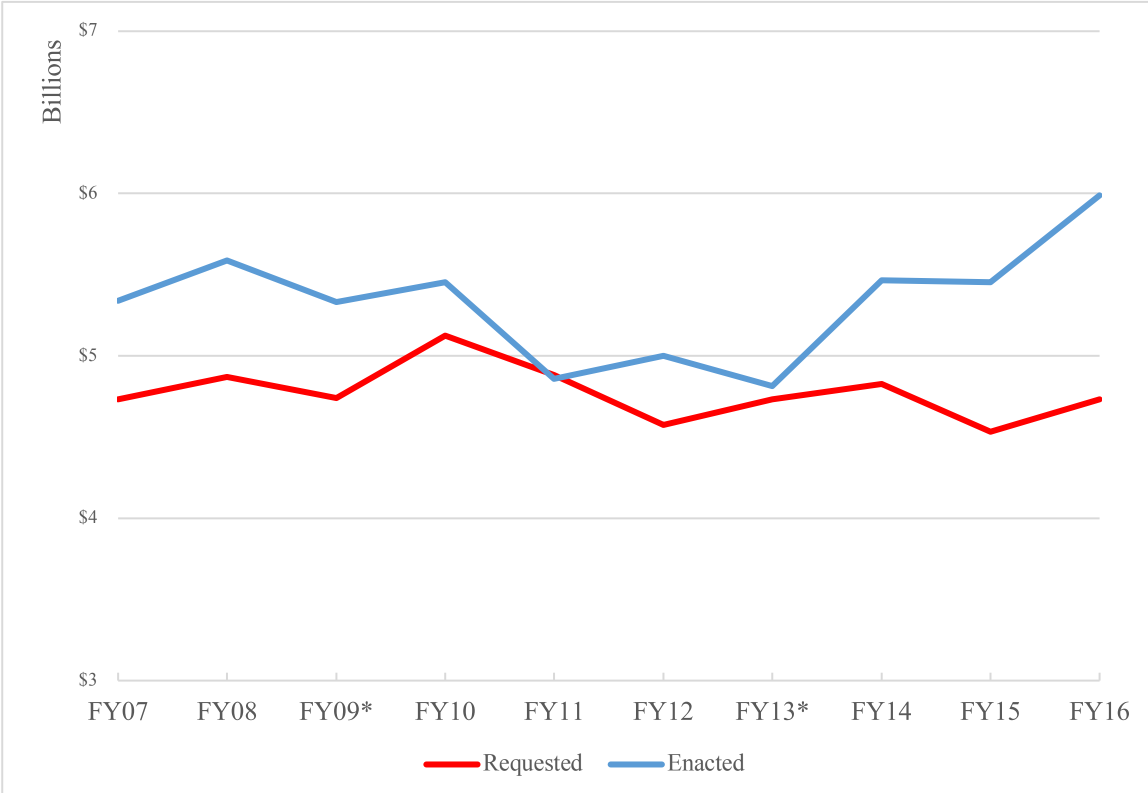


Figure 5: FY 2007 to FY 2016 Army Corps Civil Works Budget Request and Enacted Appropriations.
Source: (24)

The appropriated funds are directed into several separate budget accounts based on their use. Two of these accounts, Operations & Maintenance (O&M) and Construction, receive part of their funding through existing trusts.

The Harbor Maintenance Trust Fund (HMTF) was created by Congress in 1986 to provide funding for maintenance dredging for federally maintained harbors and channels. Funds generated by the Harbor Maintenance Tax (a 0.125% ad valorem tax on imports) are deposited into the HMTF.

The Inland Waterways Trust Fund was established to help underwrite the costs of construction and major rehabilitation of the nation's inland waterway system. Funds are generated via the Inland Waterways Tax – a $0.29 per gallon assessment on diesel fuel used on 27 stretches of the country's inland waterway system. The 12,000 miles of fuel-taxed waters include most of the nation's largest rivers: the Mississippi, Ohio, Illinois, the lower Missouri, and the Gulf and Atlantic Intracoastal waterways. The fund annually generates approximately $110 - $120 million per year via the Inland Waterways Tax. These funds are, in turn, matched with revenue from the U.S. Treasury. The total $220 - $240 million is directed toward construction and major rehabilitation projects. The U.S. Treasury assumes 100 percent of the costs of operations and maintenance.

As discussed previously, amendments made to the Corps project priority list can result in projects receiving partial funding, or no funding at all. In the case of new inland waterway construction and major rehabilitation projects, these issues are exacerbated, as projects are financed 50 percent through the IWTF, and the other 50 percent from general appropriations. In recent years, the IWTF has suffered from a revenue shortfall. Signed into law by the President in 2014, H.R. 5771 (known as the Tax Increase Prevention Act of 2014) extended expired tax provisions that ultimately led to a 9-cent increase in the Inland Waterways Diesel Fuel User Fee. This increase, from 20 cents to 29 cents per gallon of diesel fuel, has provided additional funds to the Inland Waterways Trust Fund for inland waterway modernization construction funding (*25*).

In a recent analysis on the cost of project delays, HDR reviewed the projects listed in Table 2.

Table 2: Construction and Rehabilitation Projects that Experienced Delays.
Source: (26)

Project Type	Name	Location	Original Investment (in 2011 $M)	Original Completion Date Anticipated	Actual Completion Date (or Recent Estimate)
Construction	Olmsted	Olmsted	$775	2006	2018
	Lower Monongahela	Allegheny, Washington and Wetemoreland 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

Note: *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 this completion date has not been revised. Therefore, the project team assumed this project has no delay in the mode.

Case Study: Lower Monongahela River Locks and Dams Project

The Lower Monongahela River Locks and Dams Project is an example of a project that experienced cost and schedule overruns due to unpredictable and unreliable funding. The project was initially authorized in 1992. Located in southwestern Pennsylvania, it would replace a fixed-crest dam with a gated dam at Braddock Locks and Dam, remove Locks and Dam 3 in Elizabeth, and construct two new locks in Charleroi. The project was expected to be complete by 2004 at with an authorized project cost of $750 million (*27*). As of 2018, work was still ongoing for this project (*28*).

The project costs are shared 50/50 between the IWTF and General Treasury funds (*29*). $556 million was originally invested in the project, and as of 2014, $629 million had been allocated to the project, despite an initial authorized cost of $750 million. In 2017, an additional $82 million was allocated. The expected cost of the project is now $1.2 billion, not including Land Chamber or Port Perry Bridge. As of 2018, the Corps expected the project to be operational by 2027 and completed by 2029, if proper funding is allocated (*28*). Table 3 below shows the past and remaining work on the project as of 2018.

Table 3: Lower Monongahela Project Schedule.
Source: (28)

Schedule of Remaining Work	Design Initiated	Contract Award	Construction Complete
Charleroi River Wall	Oct. 1995	Sept. 2004	Sept. 2014
Charleroi Emptying Basin	Oct. 1995	Sept. 2013	Sept. 2015
Charleroi River Chamber (M22-27)	Oct. 1995	Sept. 2014	FY 2019
Charleroi Dam Stilling Basin Ext.	Oct. 1995	Planned Oct. 2018	FY 2021
Charleroi River Chamber Completion	Oct. 1995	Aug. 2017	FY 2023
L/D 3 Removal	Oct. 1995	Planned FY 2021	FY 2023
Dredging	Oct. 1995	Aug. 2017	FY 2022
Municipal Relocations	Oct. 1995	Not awarded	Variable
Port Perry Bridge Relocation	Oct. 1995	Not awarded	Variable

In addition to cost overruns, the project delay also reduced benefits. In 2013, benefits for the Monongahela River Locks and Dams project were estimated at more than $220 million per year. These benefits include transportation cost savings that are passed on to the end consumer, reduced facility maintenance costs, as well as reduced truck traffic and congestion on roadways. However, 80 to 90 percent of these benefits will not be realized until the removal of Lock and Dam 3. The removal of Lock and Dam 3 is still outstanding and dependent upon future funding availability. These benefits, initially expected to be realized by 2004 are still pending 13 years later at a loss of more than $2.8 billion in economic impacts (29).

CHAPTER 4 – FUNDING SCENARIO ANALYSIS RESULTS

In this chapter, TTI researchers use data collected to conduct a comparison of hypothetical lock and dam projects under an ideal predictable and reliable funding scenario versus an unpredictable and unreliable funding scenario.

The US Army Corps of Engineers maintains a Civil Works Construction Cost Index System (CWCCIS) that tracks the cost to construct 19 different types of projects categorized by the Civil Works Breakdown Structure Feature Code (CWBS). Not only does the cost index track historic construction costs, it forecasts future cost indexes based on the Office of Management and Budget's inflation projections. Two of the CWBS categories included in the index are Dams and Locks. All of the categories are weighted and included in the composite index as a weighted average. Dams represent 15 percent and locks represent 2 percent of the composite weighted average index. For the purposes of this report, researchers created a composite weighted average index consisting of only lock and dam construction components. This composite index varied less than 0.01 percent from the composite index reported in the CWCCIS.

Using the CWCCIS, researchers calculated the growth in construction costs over time. Construction costs are estimated to increase 2 percent each year into the future. For example, costs will increase $20,000 for every $1,000,000 of construction after the first year of delay. If there are two years of delay, that same $1,000,000 of estimated construction costs will now cost an additional $40,000. If there are three years of delay, there will be an additional $60,000 for every $1,000,000 of construction costs estimated, and so on.

If funding is predictable and reliable, contractors can often make advance purchases of needed materials potentially at significant savings. However, if funding is provided in increments, with no guarantee as to when the remaining increments will be received, the contractors are at the mercy of market prices at that particular time. This is often the difference between participating in a buyer's market (where demand is low) or a seller's market (where demand is high). In addition to changing market impacts, large volume purchases can include bulk discounts of 5 to 10 percent of the price of materials, though the contractor must have a place to store the materials, which may incur additional costs. If contractors were to ramp up their purchases of materials, machinery, and labor and then experience multiple years of delay in between funding allocations on a particular project, they would have to secure a long-term location to store any pre-purchased materials and possibly continue making payments on machinery that could sit idle. Additionally, they could be forced to sustain a volatile business model that exists in a perpetual state of flux to provide contingent work and income should the next increment of funding not be provided. Furthermore, if the contract is only for a small portion of the project, there is no guarantee that the same contractor will perform the remainder of the project when funds become available. This eliminates any incentive for a single contractor to pre-purchase materials or machinery. Constructing projects as funds become available through multiple contracts increases the need for costly mobilization and demobilization.

For example, a contractor could purchase $100,000,000 of materials and equipment for a five year project in year one. These goods are expended over the five years. However, if the contractor made incremental purchases of material and equipment annually over the same five years it will cost significantly more. Though not usually the case, let us assume all annual purchases are the same for each of the five years. At the end of the five years, the contractor in the second scenario will have spent an additional $4 million due to inflation. Moreover, fluctuations or seasonality in the market, as well as small, incremental purchases can further increase costs. For example, a five percent increase in the cost of materials, could cost an additional $5 million in the unpredictable and unreliable scenario (see Table 4).

Table 4: Construction Cost Comparison.

Year	Reliable and Predictable Scenario	Unreliable and Unpredictable Scenario (Base Cost)	Unreliable and Unpredictable Scenario (Inflation)	Unreliable and Unpredictable Scenario (Material Cost 5% Increase)	Unreliable and Unpredictable Scenario (Total Cost)
1	$100,000,000	$20,000,000		$1,000,000	$21,000,000
2		$20,000,000	$397,000	$1,019,846	$21,416,766
3		$20,000,000	$805,000	$1,040,234	$21,844,919
4		$20,000,000	$1,221,000	$1,061,044	$22,281,929
5		$20,000,000	$1,645,000	$1,082,264	$22,727,542
Total	**$100,000,000**	**$100,000,000**	**$4,068,000**	**$5,203,388**	**$109,271,156**

Even if a contractor does not purchase in bulk at the beginning of a project, they can account for cost inflation and possible market seasonality in the budget if there is a predictable and reliable construction schedule to follow.

Example Scenario

For example, assume identical projects with identical costs. Both projects are divided into four phases with cost structures as follows:

- Phase 1: $250,000,000
- Phase 2: $150,000,000
- Phase 3: $75,000,000
- Phase 4: $25,000,000

Project A is allocated all $500,000,000 at the time of authorization and is able to follow a five-year construction schedule on time.

- Phase 1: 1 year
- Phase 2: 1.5 years
- Phase 3: 1.5 year
- Phase 4: 1 year

Project B is allocated funds in increments that delay completion of the phases.

- Phase 1: Allocated $150 million in the first month of year 2. The one-year delay will cost the project $3 million in inflation and will still have a funding gap of $103 million to complete Phase 1. In the first month of year 3, an additional $140 million is allocated.

Due to the original delay of funds, the project was halted and will now be mobilized at an additional cost of $7 million and will cost an additional $5.6 million in inflation. Furthermore, changes to the market caused the price of materials to rise and will cost an added $7 million. This leaves $120.4 million available for construction. Phase 1 will take 2.5 years to complete. This is 1.5 years longer than Project A. There is $17.4 million remaining to begin Phase 2.

- Phase 2: Begins directly after Phase 1 with funds from the second allocation. A third allocation of $180 million is made in the first month of year 5. Due to delay, there are $9 million in mobilization costs, $14.4 million in inflation, and $9 million in increased material costs leaving $147.6 million for construction. Phase 2 will be completed within the planned time of 1.5 years. Phase 3 can begin with the remaining $15 million.
- Phase 3: Begins directly after Phase 2 with funds from the third allocation. A fourth allocation of $70.6 million is made in the last month of year 5. After inflation and increased material costs, there is $60 million for construction. Due to the time in which the funds were received, no mobilization was needed. Phase 3 will take 1.5 years to complete. There are no funds remaining to begin Phase 4.
- Phase 4: $32.7 million is allocated in the tenth month of year 7. After subtracting $4.4 million for inflation, $1.6 million to mobilize, and $1.6 million for price increases, there is $25 million remaining to complete Phase 4 in the eleventh month of year 8.

Due to the delay of Phase 1 funding and unreliable incremental funding for phases 2 through 4, Project B experiences nearly three years of additional construction and after inflation, additional mobilization, and changes to the market price of materials has cost overruns of $73.3 million (see Table 5).

Table 5: Hypothetical Project B Funding Allocations (in $millions).

Time	Allocation	Inflation	Mobilization Costs	Cost of Market Changes	Available for Construction
Year 2 Month 1	$150.0	$3.0			$147.0
Year 3 Month 1	$140.0	$5.6	$7.0	$7.0	$120.4
Year 5 Month 1	$180.0	$14.4	$9.0	$9.0	$147.6
Year 5 Month 12	$70.6	$7.1		$3.5	$60.0
Year 7 Month 11	$32.7	$4.4	$1.6	$1.6	$25.0
Total	**$573.3**	**$34.5**	**$17.6**	**$21.2**	**$500.0**

Note: Totals may differ due to rounding.

Project A will begin to amass benefits nearly three years before Project B's benefits will begin to be realized. Benefits will vary depending on the nature and size of the project. In a 2012 analysis of foregone benefits conducted for the National Waterways Foundation, HDR found that when a construction project is delayed, it 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 (*26*)."

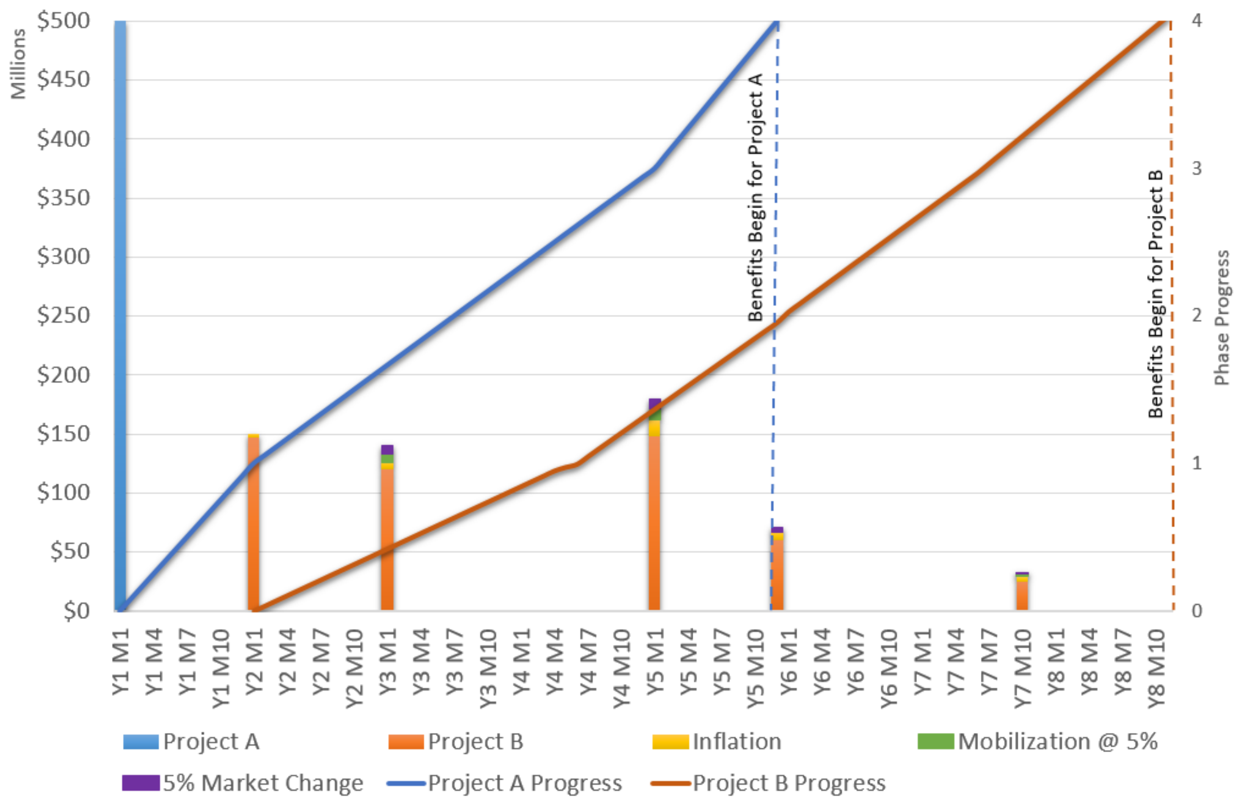


Figure 6: Example of Predictable and Reliable Funding vs. Unpredictable and Unreliable Funding Scenario.
***Source: (30,31)*[4]**

Other considerations include the additional projects programmed for construction. As the priorities and benefit- cost ratios (BCR) change from year to year, the funding for other projects is imperiled by unreliable and unpredictable funding as well. As the costs increase over time due to inflation and repeatable mobilization efforts, the BCR is reduced which in turn can affect the projects prioritization and likelihood of receiving adequate funding.

[4] Researchers examined several USACE reports and found that mobilization costs of 5 percent were frequently used and based on historical rates. For more information, see referenced footnotes.

CHAPTER 5 – CONCLUSIONS AND BEST PRACTICES

This research sought to highlight the inefficiencies and cost escalations resulting from the current unpredictable approach to funding the U.S. lock and dam infrastructure. This system, which includes more than 241 locks managed by the Corps at 195 sites around the U.S., is facing pressure in two important ways. First, much of the infrastructure is aging and faces increased needs for either full rehabilitation or reconstruction of key projects. In order to meet these construction demands, the system needs significant funding to keep the system going. However, as documented by associations such as the Inland Waterways Users Board, the funding necessary to meet these challenges is failing to meet this growing need. In subsequent studies, such as the Inland Waterways Users Board, several projects (such as the Olmsted Locks) were even featured as examples of significant cost and schedule overruns, resulting in large portions of funding dedicated to a handful of inland waterway projects.

Following this submittal, Corps headquarters would then consolidate division portfolios into a single, agency-wide portfolio. In fiscal year 2006, for example, the shift from a relatively decentralized approach to a centralized performance-based budgeting process occurred. In the October 8, 2015 edition of Capitol Currents, a publication of Waterways Council, Inc., Major General John Peabody (retired) noted, "the most striking observation about the capabilities of the Corps can be derived from a simple comparison between the Olmsted Locks and Dam project, and the Greater New Orleans' Hurricane Storm Damage Risk Reduction System (HSDRRS) (*32*)." The former has been inefficiently funded for almost all of its nearly thirty years. Cost growth from inefficient funding alone exceeds over $500 million.
In contrast, the HSDRRS project was fully funded, had the benefit of lessons from four decades of construction plus an in-depth analysis after Hurricane Katrina, and had all regulatory permits streamlined. Just seven years after Katrina, the HSDRRS withstood similar storm surge from Hurricane Isaac, yet no flooding occurred inside that system.

It is for this reason that researchers focused on options the Corps could consider to maximize existing funding that's available to better plan for and deliver transportation projects more efficiently on-time and within budget. Using data provided by the U.S. Army Corps Civil Works Construction Cost Index System (CWCCIS), researchers found that if funding is predictable and reliable, contractors could plan for these cost inflations over the scheduled construction period and arrange for the purchases of materials and machinery within a confined budget. Overall, researchers found that a "reliable and predictable" scenario would result in a savings of approximately $9.3 million on an example $100 million project.

In addition to conducting a scenario, researchers also further examined the Monogahela River Locks and Dams project. Benefits for this project were estimated at $220 million per year. These benefits included transportation cost savings that are passed on to the end consumer, reduced facility maintenance costs, as well as reduced truck traffic and congestion on roadways. However, 80 to 90 percent of these benefits will not be realized until the removal of Lock and Dam 3. The removal of Lock and Dam 3 is still outstanding and dependent upon future funding availability. These benefits, initially expected to be realized by 2004 are still pending 14 years later at a loss of more than $2.8 billion in economic impact.

Based on our interviews with inland waterway subject matter experts, it is worth noting that another key factor in cost growth is related not only to a specific project but also to "ripple" effects for other projects that may be in the construction queue. For example, if inefficient funding is a result of the lack of available inland waterway trust funds and/or match dollars from the General Treasury, then all other projects in the queue are "pushed out" an additional year or more. It is conceivable, then, that such a "rippling" effect could in turn lead to changes in the benefit-cost scores of some projects. In other words, if the project denominator, or cost, increases and the benefits stay the same, this will cause some projects to no longer receive funding.

Finally, as part of this review of the literature and scenario analysis, researchers also sought out examples of approaches to strategically prioritize which projects receive funding. Specifically, while some have noted that project prioritization and selection typically occurred in a decentralized process, more recent efforts by the Corps have sought to take a more centralized, asset-focused approach. For example, in response to increased funding constraints, the Corps is in the process of developing asset management strategies, assessment tools and processes, and funding initiatives that will help prioritize the future of the United States' civil works infrastructure investments "to achieve long-term sustainability and reliability (*33*)". As a specific part of the overall improvement in funding initiatives, the Corps has been recently working to develop an asset-focused value model to improve lifecycle investment decisions. Using this new asset-focused approach, the Corps will be able to better anticipate the possibility of asset failure and the consequences of that failure.

This report analyzed the inefficiencies and cost escalations resulting from the current funding approach by examining a hypothetical lock and dam project scenario under an ideal, predictable, and reliable funding scenario as well as under an unpredictable and unreliable funding scenario. The predictable and reliable funding scenario is one example of how changes in funding levels can result in overall project cost and time-savings. Overall, reliable and predictable funding, coupled with integrated asset-focused approaches to improve lifecycle investment decisions, can help to improve the useful life of the nation's inland waterway system.

In addition to the work presented here, researchers also identified a few areas for future research. These areas could include the following:

- Comprehensive examination of different funding scenarios and the likelihood those different scenarios might impact the ability to complete more inland water projects on-time and within budget;

- Potential opportunities (both project time and cost-savings benefits) for private participation in the project financing, delivery of the construction and/or operations of lock and dam infrastructure;

- Effective tools that help communicate the importance of inland waterway infrastructure, the need to revisit current federal legislation governing how projects are prioritized and funded, and legislative changes that can help make the current funding process more efficient;

- Comprehensive case study analysis of international examples, especially funding systems in The Netherlands, and how the prioritization process in other countries can inform how the U.S. prioritizes its lock and dam infrastructure; and

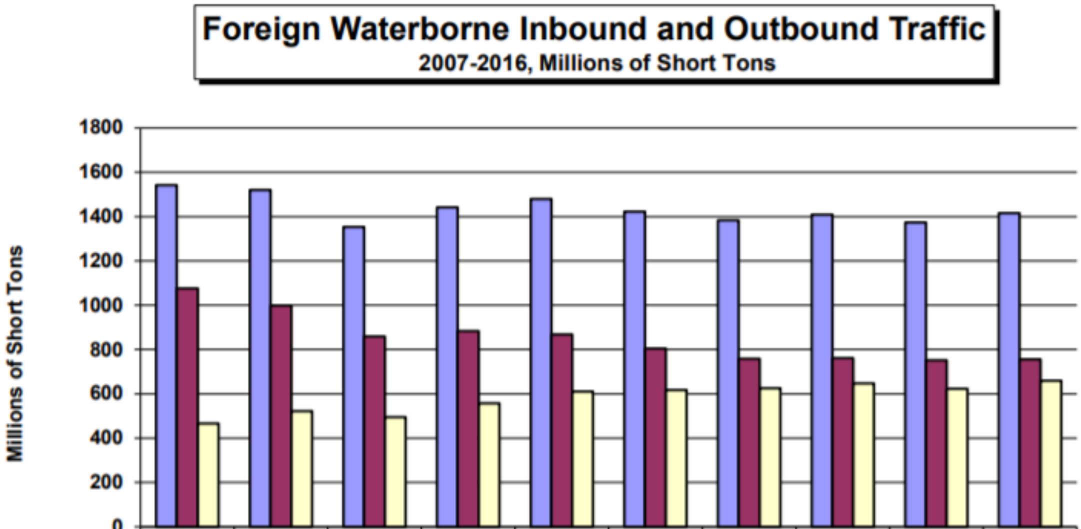
- Comprehensive analysis of multiple projects, both past and present, comparing the proposed schedules and funding needs to the actual schedules and funding received to determine project performances as well as cost savings and losses.

APPENDIX 1: WATERBORNE COMMERCE STATISTICS

The data presented in the Figures and Tables below were obtained from the Waterborne Commerce Statistics Center (WCSC). The figures and tables below show domestic tonnages (short tons). Data presented in Table 7 include all internal tonnage, which is tonnage moving exclusively on waterways within the boundaries of the United States. The deep-draft sections of the Mississippi, the Columbia and the Gulf Intracoastal Waterway include domestic coastwise data as well. This coastwise tonnage travels on these internal waterways and also Coastwise (the oceans or the Gulf of Mexico). Note that rounding may result in commodity tonnages that do not add up to the totals for a waterway. (Table 6 below provides a summary of the commodity groups presented in Table 7.)

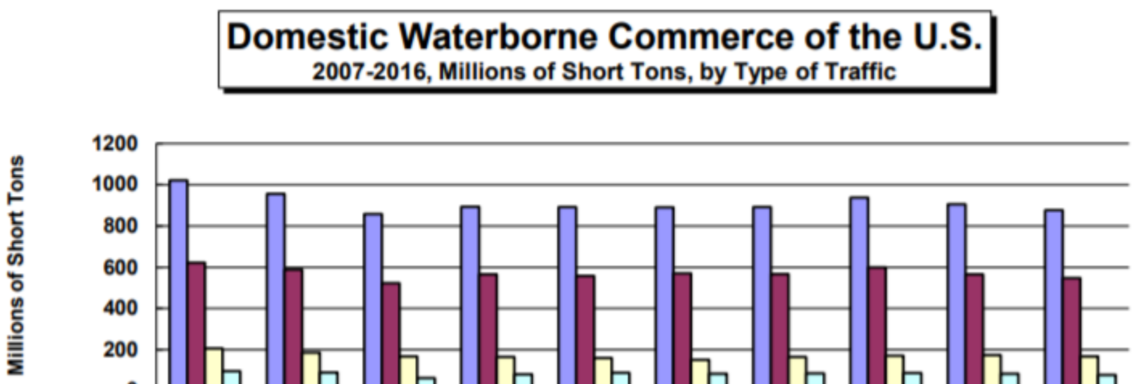
Table 6: Explanation of Commodity Groups.
*Source: (*34*)*

Type	Description
Coal	Coal, lignite, and coke
Petro & Petro Products	Petroleum and Petroleum Products
Chemicals	Chemicals and fertilizers
Crude materials	Crude materials, inedible, such as: forest products, pulp, sand, gravel, stone, iron ore, marine shells, nonferrous metallic ores, and sulphur
Manufactured Goods	Primary manufactured goods, such as: paper and allied products, concrete, iron, steel, non-ferrous metals, and wood products
Food and Farm	Food, grain, and farm products
Manufactured Equipment	All manufactured equipment
Water material	Waste material, such as: garbage, landfill, sewage sludge, and waste water
Other	Commodity group not specifically listed in a table. (This will differ from table to table)



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total	1542.5	1520.8	1353.7	1440.9	1479.6	1421.9	1383.6	1408.7	1374.2	1415.5
Inbound	1075.7	998.7	858.9	883.1	869.1	804.5	758.7	760.9	751.6	755.6
Outbound	466.8	522.1	494.8	557.8	610.4	617.4	624.9	647.8	622.5	659.8

Figure 7: Foreign Waterborne Inbound and Outbound Traffic, 2007-2016.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total**	1021.7	956.4	858.4	893.7	892.4	890.0	891.4	937.2	904.8	876.6
Internal***	622.0	588.6	523.8	565.8	557.7	570.0	567.0	599.6	565.9	548.1
Coastwise	205.8	186.3	167.8	164.5	161.0	152.2	164.9	172.0	175.1	168.7
Lakewise	95.6	90.4	63.2	80.5	88.1	84.4	85.4	87.9	83.9	78.2

**Total also includes Intraport and Intra-territory traffic.
***Total Internal excludes waterway improvement materials.

Figure 8: Domestic Waterborne Commerce of the U.S., 2007-2016.

Table 7: Domestic Waterborne Traffic, 2016 vs. 2015.

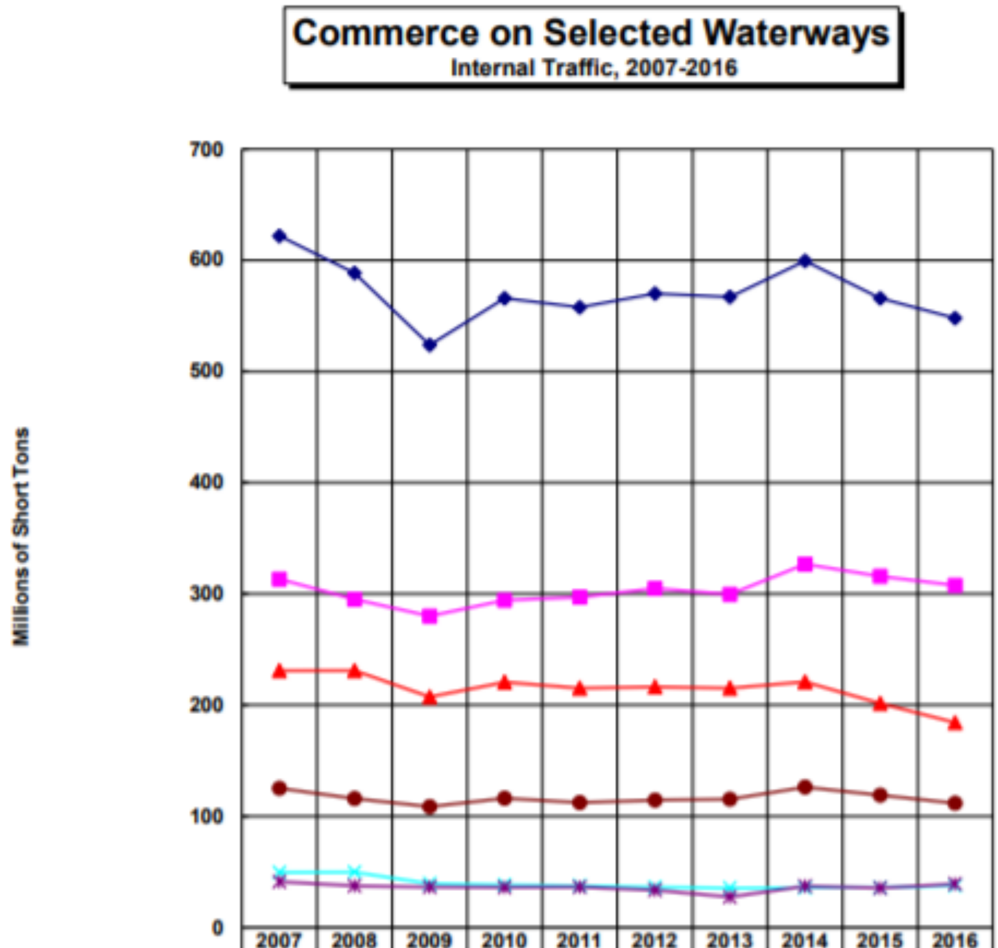
Domestic U.S. Waterborne Traffic

Annual Tonnage Comparisons: 2016 VS 2015
Millions of Short Tons

National Totals**	CY15	CY16	Percent Change
Domestic	904.8	876.6	-3.12%
Lakewise	83.9	78.2	-6.80%
Coastwise	175.1	168.7	-3.63%
Intraport	78.3	80.1	2.24%
Intra-territory	1.6	1.5	-6.12%
Internal	565.9	548.1	-3.15%
National Internal Commodities			
Coal	126.2	109.8	-13.00%
Petroleum	162.8	157.6	-3.16%
Chemicals	50.9	52.3	2.80%
Crude Materials	100.0	96.7	-3.37%
Manufactured Goods	28.6	26.8	-6.08%
Food and Farm	89.7	97.2	8.37%
Manufactured Equipment	6.8	6.8	-0.10%
Other	1.0	0.9	-8.08%
Waterways			
Allegheny River	0.7	0.7	-1.03%
Atchafalaya River (Upper)	10.9	9.1	-15.73%
Atlantic Intracoastal	2.6	2.2	-12.84%
Big Sandy	6.1	5.3	-12.76%
Black Warrior River	18.4	17.7	-3.69%
Columbia River***	13.5	13.8	2.03%
Cumberland River	21.8	22.5	2.92%
Gulf Intracoastal***	118.9	111.7	-6.10%
Illinois Waterway	35.5	39.0	9.86%
Kanawha River	13.9	11.7	-15.60%
McClellan-Kerr Wtwy	10.2	11.6	13.61%
Mississippi River***	315.8	307.6	-2.58%
Missouri River	4.4	4.7	5.78%
Monongahela River	16.3	14.5	-11.27%
Ohio River	201.4	184.2	-8.53%
Snake River	3.6	3.4	-6.41%
Tennessee River	35.8	37.7	5.24%
Tennessee Tombigbee	8.1	7.9	-1.71%

**All National Totals exclude waterway improvement materials.

***Includes domestic coastwise tonnage.



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total Internal**	622.03	588.56	523.84	565.83	557.71	570.05	567.02	599.56	565.93	548.09
Mississippi***	313.31	295.18	280.00	294.31	297.17	304.96	299.68	326.75	315.77	307.63
Ohio	230.84	230.80	207.45	220.59	215.25	216.51	215.15	220.84	201.40	184.21
Tennessee	49.45	49.67	39.23	38.20	37.36	36.29	35.34	35.68	35.85	37.73
Illinois	41.12	37.28	36.41	36.12	36.36	33.41	27.39	37.06	35.47	38.97
GIWW***	125.06	115.88	108.55	116.23	112.09	114.37	115.36	126.12	118.91	111.65

**Total Internal excludes waterway improvement materials.
***Includes domestic coastwise tonnage.

Figure 9: Commerce on Selected Waterways, 2007-2016.

APPENDIX 2: EXAMPLE PROJECT COST COMPUTATIONS

Figure 10, Figure 11, and Figure 12 were obtained from the March 2017 report of the U.S. Army Corps of Engineers Civil Works Construction Cost Index System (CWCCIS) and are prepared by fiscal year (beginning October 2nd, ending September 30th/October 1st) with the indexes based on the first day of each quarter. These figures illustrate how existing project costs are updated. More information regarding these project cost indices can be found by visiting the latest report of the CWCCIS at http://www.publications.usace.army.mil/.

EXAMPLE COMPUTATION
USING TABLE A-1,
Quarterly Cost Indexes by CWBS Feature Code

The following formula is used for the purpose of updating/escalating an existing project cost.

$$\frac{\text{Cost Index: Quarter A}}{\text{Cost Index: Quarter B}} \times \text{Cost in Quarter B (Known)} = \text{Cost in Quarter A (Unknown)}$$

Cost Index A is the cost index for the Quarter the project costs are updated to.
Cost Index B is the cost index for the Quarter the project costs are updated from.

Note: Both cost indexes must be from the same Table and Feature Code.

EXAMPLE – Assume the following:

You have a project cost of $500,000
Date of the project cost is 1 Nov 2014 (1st QTR FY15)
Feature Code is 04, Dams – Cost Index is **807.10**

You want to escalate the project cost to 1 Mar 2017 (2nd QTR FY17)
Feature Code is 04, Dams – Cost Index is **832.51**

$$\frac{\text{FY17 QTR 2: } \mathbf{832.51} \text{ (Feature Code 04)}}{\text{FY15 QTR 1: } \mathbf{807.10} \text{ (Feature Code 04)}} \times \$500{,}000 \text{ (1st QTR FY15)} = \text{Cost in 2nd QTR FY17}$$

1.031 X $500,000 = $515,500

Figure 10: Quarterly Cost Index Computation Example.

EXAMPLE COMPUTATION
USING TABLE A-2,
Yearly Cost Indexes by CWBS Feature Code

The following formula is used for the purpose of updating/escalating an existing project cost.

$$\frac{\text{Cost Index: Year A}}{\text{Cost Index: Year B}} \times \text{Cost in Year B (Known)} = \text{Cost in Year A (Unknown)}$$

Cost Index A is the cost index for the Year the project costs are updated to.
Cost Index B is the cost index for the Year the project costs are updated from.

Note: Both cost indexes must be from the same Table and Feature Code.

EXAMPLE – Assume the following:

You have a project cost of $500,000
Date of the project cost is 1 Oct 2012 (FY13)
Feature Code is 04, Dams – Cost Index is **778.54**

You want to escalate the project cost to 1 Oct 2017 (FY18)
Feature Code is 04, Dams – Cost Index is **850.93**

$$\frac{\text{FY18: } \mathbf{850.93} \text{ (Feature Code 04)}}{\text{FY13: } \mathbf{778.54} \text{ (Feature Code 04)}} \times \$500{,}000 \text{ (FY13)} = \text{Cost in FY18}$$

1.093 X $500,000 = $546,500

Figure 11: Yearly Cost Index Computation Example.

EXAMPLE COMPUTATION
USING TABLE A-3,
State Adjustment Factors

The following formula is used to adjust or compare project costs from one state to another.

$$\frac{\text{State Factor for State A}}{\text{State Factor for State B}} \times \text{Cost in State B (Known)} = \text{Cost in State A (Unknown)}$$

State Factor for State A is the factor for the State where the project costs are needed.

State Factor for State B is the factor for the State where project costs were developed.

Note: First, update project costs to the desired year by using Table A-1 or A-2. Then use the state adjustment factor to change the cost to another state. In addition, use Figures A-1 or Figure A-2 for methods to compute the escalation.

EXAMPLE – Assume the following:

You have a project cost of $500,000 developed in the State of Washington,
Dated or escalated to current FY
Location of the project: Washington State (State B)
State Adjustment Factor for Washington State is **1.06**

Location of the State for adjustment or comparison: Pennsylvania (State A)
State Factor for Pennsylvania is **1.09**

$$\frac{\text{PA State: } \mathbf{1.09}}{\text{WA State: } \mathbf{1.06}} \times \text{\$500,000 (WA)} = \text{Cost in State A (Pennsylvania)}$$

1.028 X $500,000 = $514,000

Figure 12: State Adjustment Factor Example.

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