The Declining Reliability of the U.S. Inland Waterway System

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Introduction

The roughly 12,000-mile U.S. inland and intracoastal waterway system is an integral, albeit largely unnoticed, part of our nation's freight transportation system (see Figure 1). This network handles about 600 million tons, and 300 billion ton-miles, of domestic cargo movements annually -- principally raw materials and liquid and bulk primary products, like coal, petroleum, chemicals, grain, processed metals, cement, sand and gravel.[1] It is the primary artery for more than half of the nation's grain and oilseed exports, for about 20 percent of the coal for utility plants, and for about 22 percent of domestic petroleum movements. From a national transportation perspective it is a "quiet" mode, largely unnoticed by a general public used to dodging trucks on the highways or stopping for freight trains at suburban crossings. However, the infrastructure that supports this quiet mode is starting to show its age, and a major failure at one of its component locks and dams could have serious economic consequences that would give the quiet mode some very loud public attention.

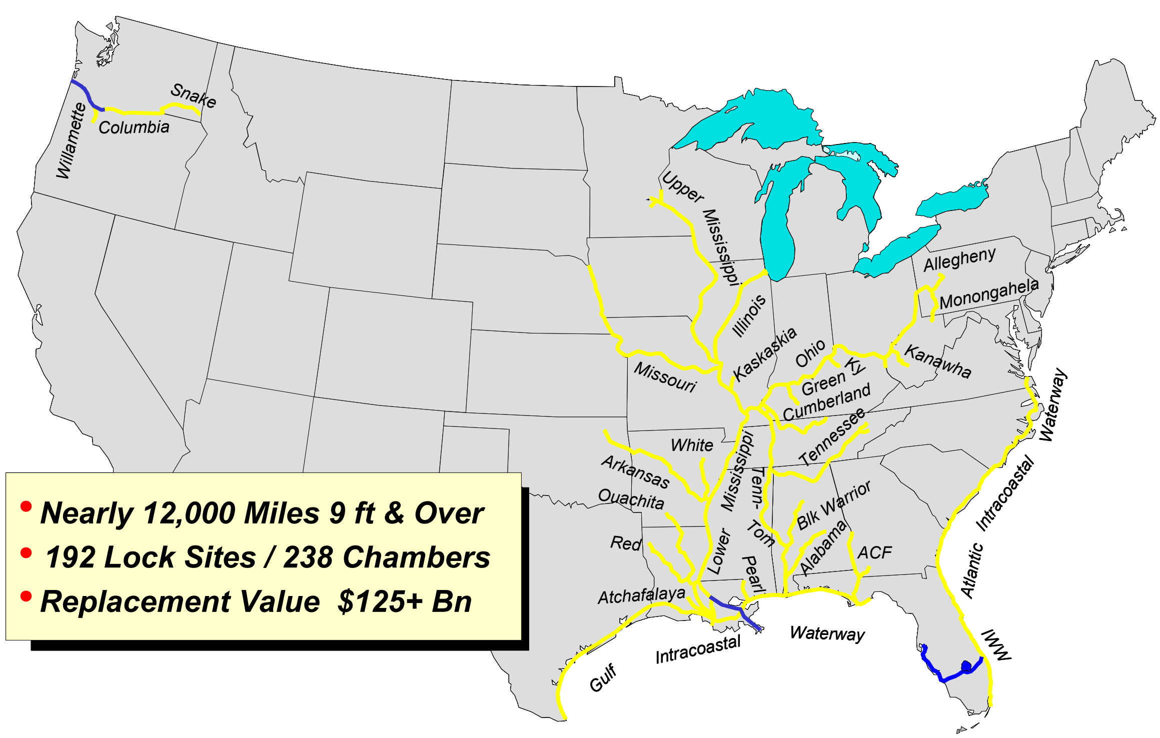

Figure 1: U.S. inland and intracoastal waterway system.

Meanwhile, our nation's demand for freight transportation continues to grow. The Department of Transportation's "Freight Analysis Framework" is forecasting a 70 percent increase in freight traffic by 2020.[2] Such dramatic growth will tax the capabilities of all our domestic modes of transport – highways primarily, but rail and water will also be impacted. At the same time, age, wear and tear, and lack of maintenance is reducing the reliability – and ultimately the capacity – of an inland waterway infrastructure that, until recently, was the envy of the world.

Inland Waterway System

The inland waterway system has been developed gradually throughout the nation's history. Early canals were followed by river improvements, such as clearing obstructions and dredging, which provided a safer channel for commercial navigation but were still subject to extreme variations in water levels. Locks and dams were constructed to raise water levels and provide a more reliable channel on rivers such as the Ohio, the Illinois, the Upper Mississippi, the Tennessee and many other tributaries. Today a system of 192 commercially active lock sites, with 238 lock chambers (multiple chambers at some sites), provides a minimum nine-foot navigation channel on nearly 12,000 miles of inland and intracoastal waterways.[3] This system is operated and maintained by the U.S. Army Corps of Engineers (the Corps) as part of its civil works program. This waterway network is plied by commercial towboats, which push barges lashed together as tows, with each barge capable of holding 1400-1800 tons of cargo. A single tow of 15 barges carries the freight cargo equivalent of 870 tractor trailer trucks, making this a low-cost and fuel-efficient freight mode that is especially suited to bulk cargo that is not time-sensitive (see Figure 2).

Figure 2: 15-barge grain tow, hauling approximately 22,500 tons of export grain, exits Lock & Dam 13, Upper Mississippi River.

Aging Inland Waterways Infrastructure

But this system is showing its age. The average age of the 192 commercially active locks in the U.S. now exceeds 50 years old. Many of the locks and dams in operation today were constructed during the 1930s, including most of the locks on such major systems as the Upper Mississippi, Illinois, and Tennessee Rivers. Even many "second generation" higher-lift locks and dams on the Ohio River were built largely in the 1950s and are now around 50 years of age themselves.

An aging inland waterways infrastructure is not necessarily a concern as long as timely investments are made in maintenance and major rehabilitations, with some capacity and modernization improvements where needed. Just as we faithfully preserve and maintain aging iconic bridges, like the Brooklyn and the Golden Gate, with proper care and attention we can maintain our inland waterways infrastructure for decades to come. However, in constant dollar terms, operations and maintenance funding for the Corps' civil works infrastructure has been largely flat or declining for decades, even as facilities have suffered the wear and tear of many years of constant use, and as requirements for other activities, such as environmental mitigation, have increased (see Figure 3).[4] Long-established programs for advance maintenance of principal lock components have essentially given way to a fix-as-fail policy, and even then the fix may take weeks or months to complete. Depending on the nature of the lock malfunction, this protracted repair time can have major consequences for barge traffic that depends on the facility, and for shippers and manufacturers depending on timely delivery of their cargo.

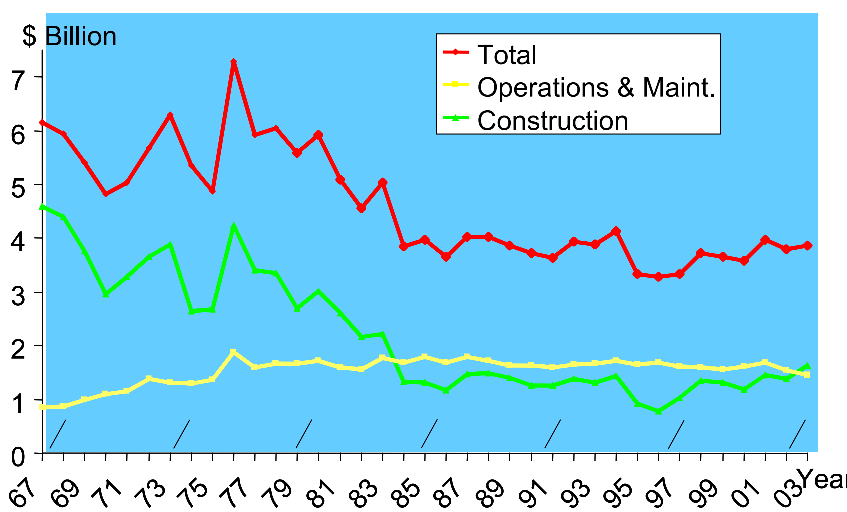

Figure 3: Annual Corps civil works appropriations in constant 1995 dollars (billions).

Coupled with this decline in civil works investment is a corresponding increase in the backlog of needed maintenance and repair at individual projects. As funding has become increasingly constrained, only the most urgent maintenance and repair needs can be addressed while other items are postponed for another day. The Corps estimates its most urgent operations and maintenance (O&M) backlog for fiscal year 2004 is now about $1.01 billion, an increase of $127 million from the previous year and up from less than $200 million in 1998. About $623 million (62 percent) is navigation related, including coastal harbors and the inland and intracoastal waterways. In addition to this, the Corps has identified about $1.9 billion of unfunded work that needs to be addressed, but is not as time-sensitive as the critical backlog.[5]

System-Wide Trends in Lock "Unavailability"

Available data suggests that our aging inland waterways infrastructure, coupled with constrained funds and the backlog for maintenance and major rehabilitation, is resulting in more frequent closures for repairs. One indicator of this trend is national lock "unavailability" time, as captured by the Corps' Lock Performance Monitoring System (LPMS) database. Lock unavailability time throughout the inland waterways system has been trending upward over the past decade. Lock unavailability time is the cumulative periods over a year during which a locking facility was unable to pass traffic. There can be a myriad of reasons, including weather, river levels or ice, mechanical problems with the lock, mechanical problems with the tow being passed, accidents, etc. One might reasonably expect that unavailability time due to weather and river conditions would average out about the same over time, or perhaps even decrease as improvements in technology permit continued navigation under adverse conditions. That suggests that increasing downtime for maintenance and repairs, both scheduled and unscheduled, is a principal factor in increasing unavailability time at locks (see Figure 4).[6]

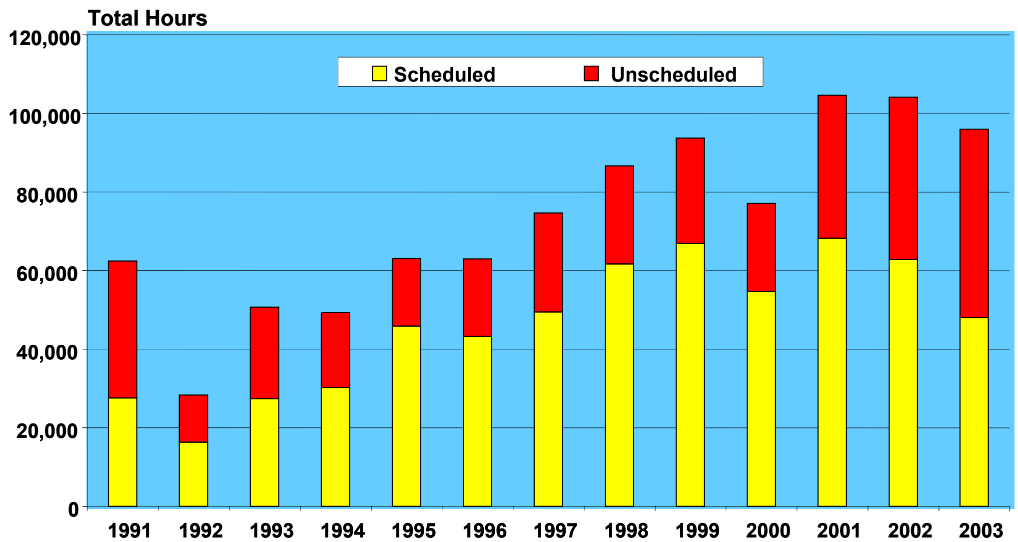

Figure 4: Navigation lock unavailability, scheduled and unscheduled, all locks.

The LPMS data displayed in Figure 4 suggest a worrisome growth in lock unavailability hours over the past decade. Such downtime at locks more than doubled in the 1990s to an annual average of over 100,000 hours system-wide between 2001-03 (the equivalent of over 4,100 days, or 11.4 years, of lost service). Two trends seem to be happening: Scheduled maintenance and repairs are occurring more often, at more locations, and/or are taking longer to complete; and unscheduled closures due to failure of a lock component, or some other incident, are occurring more often, at more locations, and are likewise taking longer to fix. Such trends, if true, have serious implications for perceived reliability – the confidence of shippers and carriers in committing to use the waterway mode – and for the physical capacity of the system in terms of its ability to accommodate future freight traffic growth.

Regional Focus: Upper Mississippi River

The supposition that increasing lock unavailability time is due to increasing downtime for maintenance and repairs is borne out by regional LPMS data for the Upper Mississippi River. This includes data for the 29 locks and dams on the 663-mile reach of the Upper Mississippi River between St. Louis and the head of navigation at Minneapolis. Figure 5 shows the hours of unavailability due just to maintenance or hardware failure for locks on the Upper Mississippi, from 1991 through 2003.

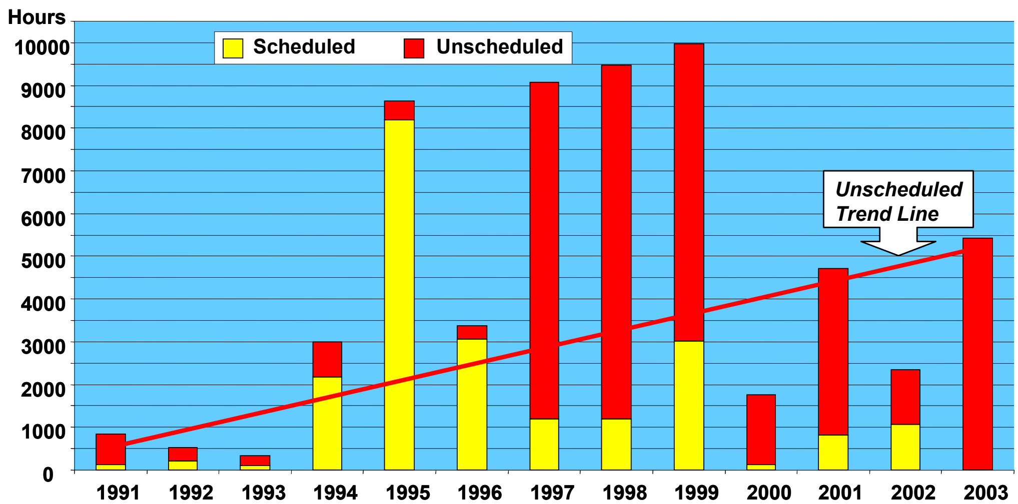

Figure 5: Upper Mississippi River lock unavailability time due to scheduled or unscheduled maintenance or hardware malfunction.

While the mid and late 1990s seem to have been periods of excessive unavailability due to maintenance or hardware malfunction, the linear trend for unscheduled closures through 2003 (the line on the graph) is clearly upward – at a rate of over nine percent annually. The generally declining trend in scheduled maintenance may reflect the declining availability of O&M funds and the consequent shift towards “fix-as-fail” with respect to lock maintenance.

A consequence of this trend would be perceived and real decreasing service levels to Upper Mississippi River shippers and carriers, and a trend toward decreasing system capacity to handle current (and future) volumes of traffic. This implies that traditional estimates of lock capacities may not necessarily be a fixed, static number. As maintenance interruptions at locks increase, the effective capacity of the system diminishes over time.

Recent Lock Disruption Examples

Several recent unanticipated lock disruptions highlight the challenge to maintain the system under the fix-as-fail approach and the dilemma this poses to users of the inland waterways. Each seems an isolated event, but the increasing frequency and magnitude of these disruptions are giving waterway operators pause.

John Day Lock & Dam, Columbia River: November 2002, the upstream lock gate failed, temporarily halting all through river traffic (no auxiliary lock). The lock was returned to partial service by manually positioning a bulkhead into position for each lockage. This was a cumbersome and time-consuming process, but it did permit navigation to resume. Gate repairs took eight months and well over $1 million in funds were diverted from other priority projects. In the meantime, leaking under the dam foundation and several cracked lock monoliths were discovered. Periodic work to anchor walls and foundation and replace damaged concrete resulted in repeated lock closures over the next several months. In addition, a contract was awarded in December 2003 to repair two cracked lock monoliths, resulting in additional lock closures through the first six months of 2004, including a one-month closure in March and daily 12-hour closures for two months thereafter. Elsewhere on the Columbia and Snake Rivers, gate rehabilitations or replacements will be needed over the next few years at McNary, Ice Harbor, Little Goose and Lower Monumental Locks & Dams, and a full major rehabilitation of Lower Monumental is being assessed.[7]

Greenup Locks & Dam, Ohio River: September 2003, a planned three-week maintenance closure of the 1200-foot main chamber was extended to eight weeks when inspections showed unanticipated gate deterioration and a clear risk of a failure. The Corps and waterway shippers and carriers were caught off-guard by the need for the extended closure. All tows had to be processed through the adjacent, smaller, 600-foot auxiliary chamber (a common feature on the Ohio River, but less so on other waterways). Use of the smaller lock requires much longer tow processing times, as each tow has to be broken up and reassembled after passing through the lock in sections. Queue delays approached 40 hours at one point and caused an estimated $14 million in direct tow-operating costs to industry just sitting idle in back-ups.[8]

Shippers dependent upon rapid delivery of cargo through Greenup had to draw on supplies on-hand or rely upon other, higher cost modes of transport resulting in $10-$15 million in increased transport costs. Reportedly, some utilities came within a few days of exhausting coal supplies and would have had to shut down. Any shutdown would have put added stress on the regional utility grid, which was still reeling from the impact August 2003 blackout across the Midwest and the Northeast. The Corps' Huntington District repair fleet had to focus on lock gate repairs rather than on high priority repairs at other projects. If the lower gate had failed, the main chamber might have been closed six months with delays to the waterway industry costing in the range of $75 million.

McAlpine Lock & Dam, Ohio River: August 2004, anticipated two-week closure of the 1200-foot main chamber to perform emergency lock miter gate repairs, at an estimated cost of $0.7 million. The gate is considered to be at risk of a catastrophic failure, which would greatly prolong any closure. The lock would normally handle about 2.1 million tons of cargo over this period. The shutdown is considered "unscheduled" because of the short nine-week notice provided to industry and the emergency nature of the repairs. This closure is problematic for the waterways industry because the auxiliary lock chamber at McAlpine has been demolished to make way for a second 1200-foot chamber (see Figure 6). So through traffic on the Ohio River must be completely halted for the duration of the repairs. The main chamber at McAlpine had undergone major maintenance before the auxiliary chamber was taken out of service in 1999, however construction of the second 1200-foot lock replacement project is years behind schedule due to funding shortfalls. Consequently, any prolonged closure of the only operating chamber halts traffic entirely. A survey by the National Waterways Council identified more than 70 companies that depend on waterborne transport through McAlpine.[9] Impacts to these companies range from "no effect" to "severe," where severe includes curtailed production and laying off employees. In all, over 60 percent of the companies surveyed, representing nearly 1.9 million tons of cargo over a typical two-week period, anticipated moderate to severe impacts to their business from the lock closure. Affected industries include utilities, petrochemical processors, aluminum producers, an integrated steel manufacturer, and the Delta Queen Steamboat Company, among others.

Figure 6: Construction of second 1200-foot lock chamber at McAlpine, July 2004. The existing 1200-foot lock at right is being closed for gate repairs, halting all through traffic.

<u>Lock & Dam 27 Main Chamber, Upper Mississippi River</u>: August 2004, anticipated two-week closure of the 1200-foot main chamber in order to perform gate repairs.[10] The 600-foot auxiliary chamber continues to pass traffic, but with significant delays of up to 40 hours per tow. Concerns were expressed that high water, or the need for additional repairs, could stretch the closure period to three weeks or more.

<u>Emsworth Locks & Dam, Ohio River</u>: Plans are underway for emergency repairs to the dam at Emsworth, downstream from Pittsburgh. The date has yet to be determined, but the work is considered urgent, with the structural integrity of the dam at risk. A dam failure risks loss of the upstream pool, the potential for downstream flooding, as well as interruption of navigation to Pittsburgh, the nation's 13th largest port complex handling over 52 million tons of cargo annually.

Major Rehabilitations in the Queue

Like highways and railways, inland waterway infrastructure requires routine maintenance and the occasional major rehabilitation, modernization or replacement. And despite the most diligent efforts of those responsible for infrastructure operation, any system will likely suffer the occasional mishap and shut down. However, the recent series of service disruptions on the inland waterways highlights an alarming trend toward an ever-larger O&M backlog, delayed completion of the ongoing construction of replacement projects or major rehabilitations of existing projects, and the repeated postponement of new starts of projects in the queue.

In its 2004 Annual Report, the Inland Waterways Users Board expressed deep concern about the integrity of waterway infrastructure, the need for timely maintenance and major rehabilitations, and an end to delays in completing ongoing construction projects.[11] The board noted that projects under construction face a cumulative delay of 31 years that has so far resulted in more than $4.3 billion in economic benefits foregone that can no longer be recovered (based on the economic benefits these projects would have produced if completed on schedule). The board also expressed alarm about the potential for a catastrophic failure of inland waterway infrastructure and called for a $100 million increase in O&M funds to address maintenance priorities and to begin to reduce the backlog.

A number of projects underway or planned might have reduced or avoided the impacts of the recent navigation disruptions previously highlighted (see Figure 7). Most significantly, a second 1200-foot chamber at McAlpine was originally scheduled for completion in 2002. Had this project been in place, the system-wide impacts of a total shut down of the Ohio River could have been avoided.

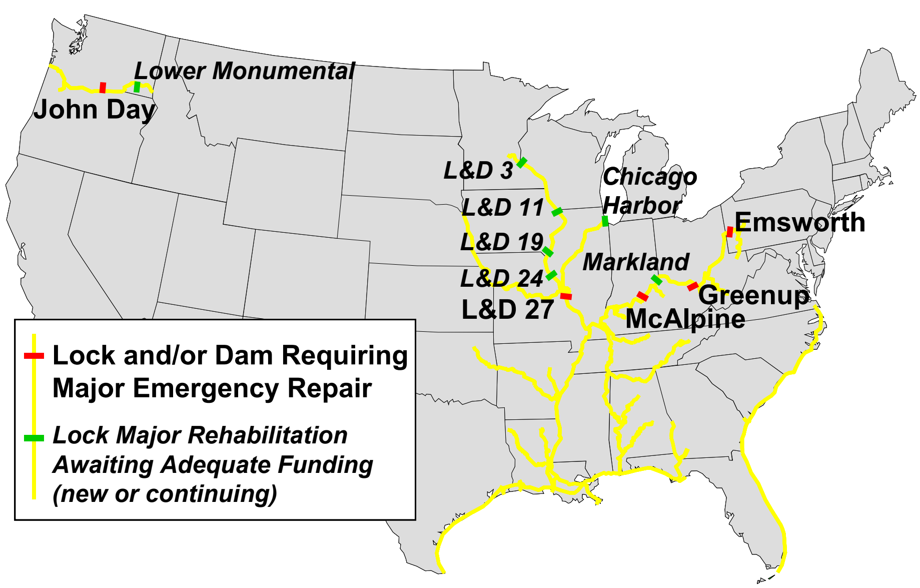

Figure 7: Major locks and dams requiring emergency repairs, November 2002 through August 2004, and pending major rehabilitations.

A number of major rehabilitations continue to await new start funds, including Locks & Dam 27 on the Upper Mississippi (to include gate replacements), Emsworth, Markland, and the Chicago Harbor Lock. A major rehabilitation at Lock & Dam 19 on the Upper Mississippi is proposed to receive initial funding in fiscal year 2005. Rehabilitation of Lock & Dam 24 is continuing but not fully funded, while rehabilitations at Locks & Dams 3 and 11 have been underway for some years but have been eliminated from the fiscal year 2005 budget request.[12] The emergency work planned or underway for Lock & Dam 27 and Emsworth will be addressing some of the problems that would have been corrected under a major rehabilitation, but these critical repairs are no substitute for a major rehabilitation itself.

Conclusions

The Corps of Engineers' Lock Performance Monitoring System data indicate that lock unavailability time has more than doubled over the past decade. While a more detailed look at the causes of the unavailability time is needed (lock malfunction versus other reasons), data for locks on the Upper Mississippi River suggest that increasing durations of unscheduled lock maintenance and mechanical malfunctions are a primary cause. This has serious implications for the future of the inland waterway system as a viable freight transportation mode. Concerns over increasing lock unavailability time, lock unreliability, and system integrity may be leading some shippers toward a modal shift to rail or highway. Considering that on a system-wide basis, waterways are generally more energy efficient and produce fewer air emissions than other freight modes, perhaps there needs to be a discussion of what transportation policies and goals best serve the long-run national interest. As noted earlier in this paper, the Department of Transportation's Freight Analysis Framework (FAF) is projecting freight traffic to increase 70 percent by 2020. The brunt of this growth will be borne by highways, which are already at capacity in many locations. The FAF assumption is that rail and water modes can help meet the freight demand that cannot be handled by the highway system. But if lack of investment and perceived unreliability are already steering shippers away from water, this mode may not be able to play the future role for which it is needed. Indeed, with increasing lock unavailability across the system, the practical capacity of the inland waterway mode diminishes over time, pushing more cargo off the system and perhaps stressing other freight modes even sooner than suggested in the recent FAF study.

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[2] U.S. Department of Transportation, Office of Freight Management and Operations, Freight News, "Freight Analysis Framework," October 2002.
[3] U.S. Army Corps of Engineers, Institute for Water Resources, "Inland Waterway Navigation, Value to the Nation," brochure, December 2000.
[4] National Waterways Conference, 2004 Budget Summit, presentation by Robert F. Vining, "The U.S. Army Corps' Budget: A Navigation Program in Crisis?," March 9, 2004, Washington, D.C.
[5] Ibid.
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[7] U.S. Army Corps of Engineers, Portland District, New Releases (periodic) and the Pacific Northwest Waterways Association, “Issues,” http://www.pnwa.net/.

[8] National Waterways Council, Legislative Workshop, presentation by Mike White, “Operations & Maintenance Needs on America’s Inland Navigation System,” January 28, 2004.

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[11] U.S. Army Corps of Engineers, Institute for Water Resources, “Inland Waterways Users Board 18th Annual Report to the Secretary of the Army and the United States Congress,” March 2004.

[12] Department of the Army, Office of the Assistant Secretary of the Army (Civil Works), “Fiscal Year 2005, Civil Works Budget for the U.S. Army Corps of Engineers,” February 2004.