

The Economic Impact of a Chickamauga Lock Closure

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Center for Transportation Research
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Executive Summary

The Tennessee Department of Transportation (TDOT) established a grant to the University of Tennessee Center for Transportation Research to determine the impacts of a permanent closure of Chickamauga Lock. Significant findings are as follows:

1. River traffic has declined through the years at the lock to under one million tons.
2. Upon closure, transportation costs to ship those commodities via different modes would increase. In the case of salt, the capacity of overland transportation might be insufficient to meet the Olin Corporation's needs.
3. If Chickamauga Lock closed for 30 days, TDOT's cost would rise by \$1.5 million per year. Closures of 90 and 180 days would result, respectively, in annual increased costs of \$2.8 million and \$3.1 million. The majority of the cost increase is found in salt.
4. Upon a permanent closure, two of the major shippers currently using the lock would shift transportation modes to rail. This shift is to a degree due to continued uncertainty about the lock, the decline in the demand for asphalt, and improvements in the efficiency of moving asphalt by rail.
5. Given the decline in traffic and the planned shifts to rail for much of the traffic at the lock, closure would not significantly affect highway congestion around Chattanooga nor would it materially cause an increase in highway degradation.
6. Employment at the industries using the lock stands at approximately 1,000, with associated payrolls of \$54 million. A substantial number of these jobs would likely be lost in the event of a closure.
7. The U.S. Coast Guard would remove the buoys and day markers above Chickamauga Dam.
8. The U.S. Army Corps of Engineers would significantly reduce the number of hours that Watts Bar, Melton Hill, and Fort Loudon Locks are available to process recreational craft. The number of available days per year could be reduced to 12 at each lock. This is the maximum number of days presently available at Melton Hill Lock.
9. The Tennessee Valley Authority would not alter their reservoir operations policies upon lock closure.
10. If the Christensen Yacht Company did complete their plant and manufacture large yachts, they would not be able to ship them through the lock, thus this plant would never be completed. Their plan was to hire 1,200 workers.
11. Large pleasure craft would be relocated below Chickamauga Dam, and marinas would suffer significant sales losses.
12. Given no change in reservoir operations, the manufacture of small pleasure boats would most likely remain unchanged. However, maintenance would no longer be available in the Tellico Pool for large craft located below Chickamauga Dam.
13. The Tennessee Valley Authority would be forced to change its business policy concerning the movement of overweight and/or oversized equipment in to and out of the upper Tennessee River. These large and heavy devices, currently shipped by barge, would be shifted to either truck transportation or be repaired on site, necessitating the construction of manufacturing

plants upstream of the dam. Some of the devices are so large that highway shipment would be made by truck at speeds of one mph.

14. The movement of pleasure boats to University of Tennessee football games would be diminished.

The Grant

The Tennessee Department of Transportation (TDOT) established a grant to the University of Tennessee Center for Transportation Research (UTCTR) to address the impacts of a permanent closure of the navigation lock at Chickamauga Dam. The impetus for the grant lies in the possibility that lock closure would “...have various direct and indirect effects on the Grantor State Agency and the state of Tennessee, both in terms of its internal functioning and the demands a closure would create for alternative transportation capacity.”¹ The UTCTR is instructed to focus their analysis on five areas:

1. The availability and/or pricing of materials used by the Grantor State Agency to build and maintain roadways.
2. Demands for alternative roadway capacity in and around the Chattanooga area and incremental maintenance costs.
3. The economic impact on private-sector freight shippers that currently rely on Chickamauga Lock.
4. The subsequent operation of upstream locks and the maintenance of non-navigation river navigation aids.
5. The potential impact on railroad rates determined in the absence of a navigation alternative.

The draft report begins with a short history of Chickamauga Lock and dam and the problems that have led to the need to replace the navigation lock. Each focus area is then discussed in turn.

Chickamauga Lock

The Chickamauga Lock and Dam were constructed by the Tennessee Valley Authority in the late 1930's as a part of President Roosevelt's "New Deal" program². The navigation lock was opened for service in 1940. This lock, in combination with Watts Bar and Fort Loudoun Locks and Dams, allows navigation to extend up the Tennessee River from Chattanooga (RM 417) to Knoxville (RM 652), a distance of 181 miles. These three upper Tennessee River locks are sized at the very unconventional 60 x 360 feet which, at construction, was compatible with the "standard" barge in common use at the time (27 x 172

¹The Grant agreement is between the State of Tennessee, Department of Transportation and the University of Tennessee.

²Nine main stem locks and dams were constructed as part of a system that permitted navigation on the Tennessee River from Paducah, Kentucky to Knoxville, Tennessee, a distance of 652 miles.

feet in dimension)³. Increases in towboat horsepower have allowed tonnage hauled to increase from 1,000 tons in a “standard” barge to the currently standard “jumbo barge” which can carry 1,500 tons. The jumbo barge is sized at 35 x 195 feet, thus modern locks have been constructed at 110 x 600 or 110 x 1,200 feet to technically accommodate 9 or 16 jumbo barges per tow⁴. The larger of the two lock sizes have been constructed on the Ohio River system to accommodate tows hauling coal to steam power plants. This change in technology has rendered the small upper Tennessee River locks to be very inefficient because only one jumbo barge can be locked through the Chickamauga chamber at a time, thus requiring hours to pass a multi-barge tow through the lock.

In addition to this inefficiency, Chickamauga Lock was found to be moving early in its operational life. The problem was ultimately linked to “aggregate alkali reaction” which occurs as a reaction between the alkaline cement paste and non-crystalline silicon dioxide. This reaction causes expansion of the altered aggregate and loss of strength in the concrete monolith. At Chickamauga, slots have been cut in the lock walls to allow for expansion only to close as the walls expand. Post tensioning has been used to fasten the lock chamber to bed rock to minimize movement. There has been considerable spalling where large chunks of concrete have fallen off of the lock into the river. Finite Element Analysis performed at TVA beginning in the middle to late 1990’s isolated the source of the pressure caused by the expansion. It was found to be so severe in key areas of the lock⁵ that TVA began to warn the users in the middle 1990’s that a permanent closure of the lock was imminent. Closure is now a very real possibility absent construction of a new lock chamber⁶.

The current commercial users of the lock are the Olin Corporation, Chlor-Alkali Products Division; Tate and Lyle Grain, Inc.; Marathon Petroleum Company, L.P., Southern Asphalt Region; Fort Loudoun Terminal Company; Burkhart Enterprises, Inc.; Smokey Mountain Transfer Corporation; Ergon Knoxville Inc. and the TVA. Shown in Table 1, 959.3 thousand tons of commodities were shipped through

³ Four standard barges could pass through the lock in one cut, that is, one turn of the lock from one side to the other).

⁴A common tow size on the Ohio River system is 15 barges. This can be handled in two cuts at the smaller locks and one cut at the larger lock.

⁵ A key finding was the pressure found to be developing in the downstream lock approach wall’s miter gate block.

⁶ A new lock chamber was under construction, reaching the point that a coffer dam had been erected. Construction was halted due to funding problems. Currently, both the Senate and House have versions of the 2014 Water Resource Development Act that, upon reconciliation and approval by the President, would mean that construction could begin again within the next few years.

Chickamauga Lock in calendar year 2013.⁷ This tonnage volume has been fairly stable since 2010. The three dominant commodity groups handled at the lock are crude materials, farm products and

Table 1: Tonnage Data for 2013

Commodity	Calendar Year 2013	Percent
Coal, lignite and coke	7,500	0.78
All Petroleum and Petroleum products	105,010	10.95
All Chemicals and Related Products	56,226	5.86
All Crude Materials, Inedible except Fuels	575,250	59.97
All Primary Manufactured Goods	19,894	2.07
All Food and Farm Products	177,000	18.45
All Manufactured Equipment and Machinery	15,410	1.61
All Waste Material	1,500	0.16
All Unknown or Not Elsewhere Classified	1,500	0.16
All Commodities	959,290	100.00

petroleum products which respectively account for 60.0, 18.5, and 11.0 percent of total traffic. Crude products include salt moving to the Olin Corporation and salt moving on to Knoxville for distribution by government agencies as road salt. Dredged river sand, ores and scrap metal are also included in this group.

Farm products are outbound shipments of corn cellulose material (corn gluten feed) and some inbound corn. Petroleum movements are asphalt shipments to the Marathon and Ergon Corporations.

⁷ These data are sourced from the U.S. Army Corps of Engineers' Lock Performance Monitoring System which presently has posted the 2013 data to the web site of the Navigation Data Center.

Chemicals and related products account for 5.9 percent of the total. The category “All Manufactured Equipment and Machinery” includes over-dimensioned and over-weight items shipped by the federal government and government contractors. Flat and rolled steel is also included in this group.

An important function of the lock has been to allow the movement of overweight and oversized commodities needed in the construction and maintenance of power plants and other government facilities. In earlier years, traffic at the lock has included movements in support of environmental cleanups (a large containment vat), science-related project shipments, steam generators, rotors, and nuclear engines. Conversely, barge mounted cranes, boats, ships and caissons are not considered to be commodities and thus their weight is not counted in the tonnage recorded at the lock.

In addition to the industrial traffic, recreational boaters use Chickamauga Lock extensively. From 1994-2013, the number of recreational vessels transiting Chickamauga Lock have been as high as 4,944 in any given year. The number of recreation lockages have been as high as 2,338. This period of exceptionally high recreational use occurred during 2006-2007. Recreational use of the lock includes support of the Riverbend festival held annually in Chattanooga, fishing tournaments and fishing generally, University of Tennessee football game river traffic (termed the “Vol Navy”), cruises, and vessels moved for hull inspections, and “snowbirds”⁸ among others. Certain vessels operating for hire must have periodic hull inspections and dry dock facilities that are not available upstream of Chickamauga Lock. Without the lock, these vessels could not operate for hire over an extended period. The river boat “Star of Knoxville” moored in downtown Knoxville is one of these boats.

Commercial navigation would not be possible without the U.S. Coast Guard that marks the main river navigation channel. The Tennessee Valley Authority marks the secondary channels. While closure of the lock would impact the recreational boat manufacturing industry in the area, the potential loss of these channel markings would also negatively impact recreational boating. The US Coast Guard sets buoys with the cutter *Ouachita*, and TVA sets its buoys with its workboat the *Sideview*. With closure of the navigation lock, the cutter, now moored upstream of the lock⁹, would have to be moved downstream or become landlocked. High current often moves buoys off station, and without the cutter buoy setting would be very difficult due to their weight and size. And without any commercial traffic, it would be

⁸ Large boats are moved to the upper Tennessee River from the North where they are docked for extended periods as residences.

⁹ The *Ouachita* is moored at approximately RM 472, about one mile above the dam.

difficult to justify the dedication of federal resources to maintain a channel¹⁰. Discussed below, the position of the U.S. Coast Guard is that the buoys would have to be removed.

Impacts on Traffic

Of the 981 thousand tons of traffic currently being shipped on the upper Tennessee River through Chickamauga Lock, almost two-thirds of the tonnage is commodities that are generally used for either highway maintenance or highway construction¹¹. These are asphalt, sand and salt. While discussed below in some detail by commodity, those receiving asphalt and salt for winter highway maintenance or industrial use generally have enough inventories for a 30 day outage. For delays of 31-90 days, the anticipated strategy is to shift modes to rail and/or truck. This diversion accounts for 60% of the traffic at the lock. For asphalt, the shift to rail during a 91-180 day outage would be permanent.

The Loudon County corn sugar and ethanol manufacturer has the critical issue of being able to bring a supply of empty barges to the plant adequate to store their manufactured cellulose by-product. Corn arrives at the plant generally by rail as the cost of shipping by this mode is lower than by barge. During the manufacturing of corn syrup and ethanol, the cellulose material (termed corn gluten feed) is stored in empty barges. Certain of the material is transported a few feet by barge to be used by the Dupont Corporation to manufacture health care products and polymers. If the barge storage becomes totally exhausted, a domestic market has to be found for this material. It should be noted that this product does not move well by train due to its sticky nature that causes it to cling to rail cars, so surplus gluten feed is transported by barge to feedlots, is sold or given away to area farmers¹².

Non-fertilizer chemicals shippers currently using water transportation would see costs rise during an outage, but their customers could be served from supply points below Chickamauga Dam. While costs would increase, the prime fear is that inbound salt could not reach the Olin Company's Calhoun, Tennessee plant in a cost effective manner and in quantities adequate to maintain production at that plant. Discussed below, problems in securing salt could cause the Calhoun plant to be shut down.

¹⁰ The dam and locks on the Tennessee River are authorized for navigation, hydro power and flood control but not for recreation.

¹¹ Certain of the asphalt is used for parking lots and driveways.

¹² This was related to CTR by a TDOT Region One employee who hauls this product to his farm from the Lenoir City plant.

River terminals handling dredged sand, pebbles, ores and rolled steel for a fee would see these commodities shift to other modes fairly quickly after a lock closure. Without water transportation, their customers would in most cases ship directly to ultimate destinations via truck or rail depending on the circumstances. River sand does not generally move via rail. Certain ores would shift to rail while others would be routed away from shipment to export and to domestic consumption.

Generally, though, for short periods of disruption, most shippers hold enough inventories to weather a 30 day delay in barge service. For some, notice that the lock will be out of service would mean that they could ramp up inventories to last for possibly 45 days and longer. For others such as asphalt shippers, it is important to know the time of the outage. If in season, the short term impact would be greater than if demand for their product was low such as occurs in the winter months.

There would undoubtedly be some losses in traffic even in a short term closure. Some commodities do not move well by rail, and a shift to truck is not feasible due to the long haul and high cost involved. Further, some suppliers of aggregates are not rail served , and transport by truck is not feasible.

Table 2: Tons Shipped to and from the Port of Knoxville*

Commodity	Tons	Percent
Coal	1,600	0.32
Petroleum and Petroleum Products	104,400	20.91
Chemicals and Related Products		
Crude Materials	360,290	72.17
Primary Manufactured Goods	12,000	2.40
Food and Farm Products		
Manufactured Equipment	20,904	4.19
Waste Material		
Unknown		
Total	499,194	100.00

*Source: Public domain LPMS Fort Loudoun Lock data.

Cost to Build and Maintain Roads

Summary

During the Fall months of 2013, all of the shippers using Chickamauga Lock over the past three years were interviewed as to their current use of the lock and how they would respond to closures of 30, 90 and 180 days. From the information gathered in the interviews and the confidential U.S. Army Corps of Engineers Waterborne Commerce Statistical Center (WCSC) data file, shipper savings data were estimated for the conditions that exist with Chickamauga Lock open and then for each of the 30, 90 and 180 day closure alternatives. These data provide the per-ton transportation cost of losing navigation at the lock.

TDOT or its contractors use asphalt, sand and rock salt in the construction and maintenance of the roadways. This study concentrates on expenditures in Region One. The tonnage data for asphalt and salt was supplied to UTCTR by Ms. Amanda Snowden whose staff summed the tonnage of asphalt requested for Region 1 in all state contracts let for the year 2013. Asphalt purchases totaled 30,254 tons. Additionally, CTCTR studied the TDOT annual report “Average Unit Prices – 2013 Awarded Contracts” which reports the asphalt mixes purchased by TDOT in 2013. In converting pavement mixes into asphalt purchased, it is assumed in this study that the mixes are 4.0% asphalt¹³. The data show that TDOT purchased 700,623 tons of paving mixes or asphalt in 2013, and this converts to just under 30,000 tons of asphalt. As for salt, the average annual usage during the period FY08/FY09-FY13/FY14 (excluding FY11/FY12 that was a very warm winter) was 69,705 tons. As for sand, a minor part of the calculation, Snowden reported that this commodity is so expensive that only TDOT can afford to purchase it. Total sand shipped in 2012 was over 34,000 tons.

In total, TDOT’s Region One received 133,585 tons of materials shipped by barge into Knoxville. It is assumed in the cost calculations that all of the material would be consumed in the closure period. **If closed for 30 days, TDOT’s cost would rise by \$1.5 million per year. Closures of 90 and 180 days would result, respectively, in annual increased costs of \$2.8 million and \$3.1 million.** While the data used to

¹³ In a meeting with Ms. Amanda Snowden and her staff, CTR staff was told that asphalt accounts for 4.0% of the mix.

make the calculation are based on confidential Corps data¹⁴ and cannot be reproduced in this report, the majority of the cost increase is found in salt. As discussed below, the salt market to the north is different than the market to the south, and late orders to the northern salt mines can result in exorbitant prices and slow or no delivery. The material below lays out the causes for transportation costs to increase given a lock closure.

Asphalt

Two asphalt terminals currently supply this commodity to TDOT contractors, Marathon Petroleum Company and Ergon Knoxville. While both companies are served by rail, Marathon currently receives no rail shipments and Ergon receives only a limited supply by rail. Both terminals have restricted rail facilities. Marathon has side tracks that can handle two asphalt cars, and the rail tracks leading to the Ergon facility are old and in poor repair.

But in spite of the limited rail infrastructure, there has been a recent movement toward the possibility of rail transportation of asphalt into Knoxville. For a variety of reasons, this is possible at the Marathon Oil terminal but not at the Ergon terminal due to the deteriorated condition of the local railroad tracks and their limited access to rail asphalt cars. While at the Marathon facility very short term disruptions in barge service could be handled by reducing inventory and 90 day outages could be handled by trucking from a variety of sources, the ultimate solution of a permanent loss in barge services would be to shift to rail transportation. This shift became possible, first, due to the decline in the demand for asphalt that caused shipments to drop substantially from higher levels present prior to 2008¹⁵. Second, the long-term economic advantage of the barge asphalt service to Knoxville has been eroded by the rise in the price of diesel fuel used to fuel towboat engines and to heat the asphalt cargo. Third, thermal efficiency of asphalt rail cars has been improved in the last few years.

The quantity of Asphalt moved into the two Knoxville terminals is reported in the confidential WCSC data file which catalogues Vessel Operation Reports filed by towboat captains¹⁶. Since there are only two asphalt terminals in the Knoxville area, their shipments data cannot be disclosed in this report. What we can say is that the generic petroleum products category in the public release Fort Loudoun

¹⁴ It is certainly possible for TDOT to gain access to the Corps confidential files. This would have to be worked out with the Corps of Engineers, including TDOT signing a confidentiality form.

¹⁵ It would not be possible to meet the demand that existed prior to 2008 with rail service to Knoxville alone.

¹⁶ The WCSC data cannot be disclosed in this report for each commodity unless there are three shippers each of which cannot account for more than 80 percent of total shipments.

Lock LPMS data peaked in the last 20 years at 333,671 tons in the year 2000, dropped to 274,567 tons in 2007, dropped heavily in the business recession, and dropped further to 104,400 tons in 2013.

Petroleum products moving into Knoxville thus declined 69% from the year 2000 to 2013. These data are indicative of the decline in the demand for highway construction and maintenance and thus the demand for asphalt.

Marathon Petroleum has long advocated for the maintenance of barge transportation to their Knoxville terminal¹⁷. It was felt that rail transportation could not have supported the pre-recession traffic levels. But since that time, improvements in rail cars is coupled with a declining demand for asphalt. Company spokesmen feel that rail transportation can support the lower shipment level under certain conditions: that the side tracks are expanded to accommodate more rail cars at the South Knoxville terminal and a crew is hired to unload rail cars¹⁸. Marathon's facility can currently accommodate 2 cars. As noted, rail transportation is not really an option at the Ergon Knoxville terminal due to the poor condition of the tracks leading to the plant.

Salt

Currently, the most economical way to supply road salt for application in Region One is to ship it to Knoxville by barge primarily from Louisiana and to a lesser degree South America. In fact, the economies of barge shipment are so great that the rail salt loading facilities in Louisiana have been decommissioned. The delivered price from the south can be lower than from the Great Lakes ,and the supply is also more dependable during periods of high demand. With closure of Chickamauga Lock, shipment from the south would no longer be possible to Knoxville by barge. And given that shipment via a trans-load to truck from Chattanooga is a very expensive alternative, the next most economical source of road salt is by rail from the Great Lakes. Shipper interviews suggest that about a fifth of the salt would be sourced from the south by truck out of Chattanooga. These marginal truck moves would most likely occur during the cold weather season when salt to the north is difficult to get.

¹⁷ Marathon Petroleum sent their manager of communications to Knoxville to oversee an interview of their terminal manager with WATE TV news concerning the importance of Chickamauga Lock in 2006. In 2008, Marathon sent a senior manager to participate in the Transportation Research Board's Plenary session "Can the Conflict between Freight's Need for Port Access and the Gentrification of Waterfronts be Resolved" held in Baltimore Maryland.

¹⁸ Fewer people are required to unload asphalt from barges.

While the supply of salt off of the Great Lakes is massive¹⁹, some cities on occasion have not been able to acquire salt from this region or saw prices skyrocket there over what they expected to pay. Salt mined in the area is distributed locally, transported by ships all over the lakes system (before the lakes freeze over), and by trains all over the Midwest and Northeast. Demand can outpace supply, especially for those who limit their pre-winter orders and exhaust their supply. When demand is high, logistics can limit delivery when the majority of the customer base wants delivery at the same time²⁰. In Ohio the 2014 shortages were thought to possibly be due to issues stemming from the mining of the salt, but the larger problem was the unexpected long winter²¹. In that state, Morton Salt is being investigated for providing supplies in Knoxville to Ohio at a cost of \$53 per ton²². Here, a buyer in Ohio most likely could not get a timely delivery from suppliers from the Great Lakes mines and in an emergency had to shift to a southern supplier who was sourcing salt by barge from Louisiana through Knoxville. The point of this discussion is that those buyers in Tennessee accustomed to easily acquiring in-season salt deliveries might have to adjust their winter storm management plans and begin to hold a greater inventory of rock salt or face shortages as have occurred in Ohio. Of course, in that situation an alternative is to truck salt from Chattanooga at a higher price.

Demand for Alternative Roadway Capacity

Throughout the modern history of Chickamauga Lock, there has been a competitive environment where water transportation added value to commodities in spite of the inefficiencies of navigation on the upper Tennessee River. It was cost effective to bring petroleum fuels into Knoxville by barge until lower cost pipeline transportation became available. Later, wheat shipments to Knoxville's White Lily Flour Company were lost in a merger that moved soft flour manufacturing (used to make biscuit flour in Knoxville) to Chattanooga below the lock²³. Hard winter wheat was then railed to the White Lily plant in Knoxville. Bowater Southern, a major paper pulping plant in Calhoun, Tennessee, ceased using the river to transport wood pulp when their tree farm in Guntersville, Alabama (located below Chickamauga Lock) was no longer productive. Their outbound newsprint paper, once a barge commodity ceased when the technology in that industry shifted to 10 foot paper rolls. Rather than convert their facilities to accommodate the new technology, the company shifted to overland transportation due to uncertainty

¹⁹ The supply below Lake Erie is one of the largest in the world.

²⁰ <http://www.popularmechanics.com/technology/engineering/infrastructure/there-is-no-salt-shortage-theres-a-salt-bottleneck-16468141>

²¹ <http://www.vindy.com/news/2014/feb/05/odot-grapples-with-road-salt-shortage/>

²² <http://www.vindy.com/news/2014/feb/11/panel-to-pay-expert-witness-in-road-salt/>

²³ The navigation locks below Chickamauga Lock and Dam are all modern and at least sized at 600x110 feet.

about Chickamauga Lock. Their new tree farm at Royal Blue was not river served, so it became a trucking operation. The “Mad Cow” epidemic in Ireland and England eliminated the demand for corn gluten feed there and thus the market for Tate and Lyle’s by-product from high fructose corn syrup manufacturing. While this company received corn by barge in large quantities, most likely this move was not competitive with rail. The controlling factor was that the empty corn barges were used to inventory corn gluten feed that was shipped to New Orleans to be loaded on to Ocean going ships in midstream transfer and bound for Shannon Ireland. To replace the Irish market, Tate and Lyle entered into a partnership with the DuPont Corporation, named DuPont Tate & Lyle Bio Products, LLC, to produce a variety of products including personal health care products and polymers using as input the corn gluten feed once bound for Ireland. This plant is located next door to the Tate and Lyle facility. Some of the gluten feeds remains on the river for transportation to feed lots and other demand.

TVA built a coal dock at the Kingston Steam Plant but never shipped any coal there by barge due to the inefficiencies of barging on the upper Tennessee River. In Harriman, the area around the coal tipple facility became gentrified and repeated attempts to again ship coal from that site never materialized. The world market price for zinc dropped to such a low level that the zinc mines in the area were not profitable to operate on a large scale consistently from year to year.

What is left on the river is salt, asphalt, sand, bran and sharps (corn gluten feed), zinc ore, scrap metal, chlorine, potassium hydroxide, fertilizers and other minor commodities. Eight of these commodities account for 906,000 tons or 92% of total traffic. When the last Chickamauga Lock impact study was completed in the late 1990’s, Tate and Lyle was still shipping large quantities of corn gluten feed to Shannon Ireland and asphalt was being shipped at the pre-1988 recession levels. These were movements that essentially had to be shipped by barge and were planned to be trans-loaded in Chattanooga for trucking around the closed lock. These commodities would then be reloaded to barge transportation for the remainder of their trip.

The environment has changed in the last 15 years. The trans-loading of commodities will not occur in Chattanooga to the extent that it would have in the 1990’s. The traffic base is also lower. But more importantly, long term lock outages now imply a shift to rail transportation for two primary commodities and closure for the major industrial customer.

Presently, for those commodities that divert from barge to truck transportation, the tractor-semi trailers would travel on 350 highway links, a link being defined as a road between two intersection points. In mapping these links, the truck diversions do not occur with any intensity on any one line but are dispersed in a “spider web” network across a broad region that extends to Louisiana and Texas. Heavy truck traffic does not occur in the periphery or outmost edges of the diversions but is higher in proximity of river ports. In terms of ton-miles, 90.7% of the diversions are virtually all to interstate/freeway roadways with many being high speed, low congestion with no signals. For example, Interstate 64, identified in the surveys as a potential conduit for asphalt shipments into East Tennessee, would see asphalt shipped from Catlettsburg, Kentucky to the intersection with I75 in Lexington and then on to Knoxville. This is a very lightly travelled roadway with a very low traffic volume to capacity ratio. The relation between the number of links and the percent of ton-miles is shown in Table 3.

Table 3: Relation of Highway Links to Ton-miles

Number of Links	Percent of total ton-miles
40	90.7
50	92.6
60	93.9
70	95.0
350	100.0

Social Cost of Truck Traffic Diversions

To quantify the impact of lock closure on the environment, the study relies on a congestion model developed by Drs. Arun Chatterjee and Fred Wegmann²⁴. This model was used in the first study of a potential closure at Chickamauga Lock²⁵ and has been used by the UTCTR in later studies of potential waterway closures in Pittsburgh and Chicago²⁶. The model quantifies the impact per ton of diversions on delay (time), incidents, fuel consumed and air pollution.

²⁴ During the development of the model, both men were Professors of Civil Engineering at the University of Tennessee.

²⁵ Chatterjee, Arun, Wegmann, F.J., Jackson, N.M., et. al., “Effect of Increased Truck Traffic from Chickamauga Lock Closure,” Transportation Research Record, No. 173, 2001.

²⁶ Both studies were undertaken for the U.S. Army Corps of Engineers and neither study has been released to the public.

Most recently the model was used to estimate the environmental impacts of closure of the Chicago Area Waterway System (CAWS). Primarily from analyzing the results from this study, it was determined that the cost to the environment from closure is 3¢ per ton-mile. While the Chicago area roadways may typically suffer greater congestion other than that around and above Chattanooga, the overall movements as reflected in the most relevant variable, ton-miles are not very different than the situation for the movements around Chickamauga lock. For most Chicago routes, congestion is not significantly affected by the project's additional trucks, and, there, as here for the Chickamauga lock movements, ton-mile calculations are dominated by long stretches of Interstate highways, which are mostly rural and relatively low-volume. For those shippers that could be negatively impacted by potential waterway closures, field surveys have indicated that the affected companies have planned diversion routes and times of day that consciously avoid congestion to the extent possible. It has also been determined in field work interviews that traffic regulations ban heavy truck traffic on certain roads in urban areas. Further, certain urban roads are so congested at certain times of day that rational shippers would never move traffic there. For example, a lock outage at Emsworth, Dashiels, or Montgomery Locks, downstream of Pittsburgh, would see millions of tons of coal moving around the city via rail to the Allegheny River for trans-loading to standard barges for delivery to power plants. Coal delivery through the city would be prohibited.

Social Costs

For Chickamauga lock, the movements have been routed and examined, though not thoroughly detailed to the level of every minor road segment, and this indicates that the affected routes, for the most part, are unlikely to suffer significant additional congestion. Again, those routes are on the whole dominated by long stretches of Interstate. Thus the overall ton-mile costs of trucks added to the highway system for the components whose costs are estimated by the model can be expected to be quite similar to that of the Chicago project.

The base year social costs attributable to truck diversions are shown in Table 4. The costs are the summation of those estimated for four Highway Model components—delay, accident, fuel, and pollution²⁷.

Table 4: Social Costs Due to Lock Closure

	Alternative				
	Truck Hauls		30-Day Closure	90-Day Closure	180-Day Closure
	To/from All Water	Truck Line Haul			
Ton-Miles	2,053,333	32,929,504	23,285,582	12,808,325	9,835,786
@\$.03/Mile	0.03	0.03	0.03	0.03	0.03
Equals	\$61,600	\$987,885	\$698,567	\$384,250	\$295,074
Alternative % of Year			8.2%	24.7%	49.3%
Truck Line Haul			\$57,417	\$94,747	\$145,516
Water % of Year	100%	0%	91.8%	75.3%	50.7%
To/From Value			\$56,537	\$46,411	\$31,222
Total Base Year Truck Costs	\$61,600	\$987,885	\$113,953	\$141,157	\$176,738

Table 4 is laid out as follows. Column one reflects an all-water routing where the ton miles are those that occur on average²⁸ for truck moves to and from the river under current conditions. Column two is the total line haul ton-miles assuming that the lock is closed year round and the appropriate traffic is diverted to truck transportation as reflected in the field surveys²⁹. Columns three-five are the truck line haul ton-miles assuming that the lock closed for 30, 90 or 180 days. The table reflects calculations executed for 151 commodities, relating average annual tonnages to the likelihood of diversion to truck transportation as reported in the surveys discussed above. In the 30, 90 and 180 day scenarios, the line haul social costs are calculated in the model as \$57.4, \$94.7 and \$145.5 thousand respectively. The last two rows of the table reflect the percentage of year the movements would remain on the river and the social costs during closure period that would occur for truck hauls to and from the river. Total social costs are estimated to be \$114.0, \$141.2 and \$176.7

²⁷ Each component is discussed in Appendix A.

²⁸ Ton miles are averaged for the years 2009-2011.

²⁹ Certain other movements are to rail transportation. Others might cease operations.

thousand, respectively, for closure of 30, 90 and 180 days. These calculated cost numbers are so low that even a doubling of the \$0.03 cost per ton mile would still yield inconsequential results. However, it is important to note that on occasion lock closure would imply that overweight and oversized objects will move to and from TVA power plants. Highway movements of these objects could mean significant delays for short periods of time. These possible TVA highway shipments are discussed below.

Road Maintenance Costs

The data reported above are the social costs of lock closure. Following below is a discussion of the cost of road maintenance associated with lock closure. In the late 1990's, TVA funded Dr. N. Mike Jackson, Professor of Civil Engineering at the University of Tennessee, to estimate how a closure of Chickamauga Lock would impact highway road maintenance. Even at the higher traffic level existing at that time and a more limited diversion to rail transportation, Dr. Jackson found "minor" pavement damage that could be attributable to a 180 day closure. Dr. Jackson concluded that

This low impact is due to the relatively small addition of ESALs³⁰ to the pavement with respect to the design traffic (background ESALs). It should be noted that this observation is a function of the design capacity of the roadway network surrounding the Chickamauga lock³¹.

In discussions with Dr. Jackson, the reasons for the small maintenance impacts was that either the lock outages were far too brief (the 30 day scenario), the resident traffic in combination with the diverted traffic was too small to cause a problem, the diversions were spread out over a too wide area (the "spider web" phenomenon), or routine maintenance and repaving addressed the problem before any significant damage could occur. While this finding seemed counter-intuitive, UTCTR found the same spider web traffic pattern in the Pittsburgh and Chicago studies.

Given the expense associated with the determination of highway damage in combination with the findings of Dr. Jackson's study, the UTCTR, in combination with the U.S. Army Corps of Engineers, ignored pavement damage in the Pittsburgh and Chicago studies. And given that traffic has actually

³⁰ ESALs is an engineering acronym for the term Equivalent Single Axle Loads. The concept is used to relate the load that the diverted trucks would place on the design capacity of the various roads where this capacity is also measured also in ESALs.

³¹ Chatterjee, page 11.

fallen at Chickamauga Lock since the first study was completed, this study assumes that the Dr. Jackson’s findings remain valid. Thus, a 180 day closure of Chickamauga Lock would not be expected to place any additional strain on highway maintenance budgets.

Economic Impact on Shippers and Leisure Boat Manufacturing

Employment estimates for those firms shipping commodities through the lock and those that manufacture leisure boats are shown in Tables 5. In order of magnitude, leisure boat manufacturing employment stands at 1,948 while the Olin Corporation and Tate and Lyle employ 550 and 275 people respectively. Christensen Yachts is not presently operating but local planners expect the plant to be completed and production to begin. This company has said in the past that it expects to hire 1,200 workers. Four companies account for the majority of leisure boat manufacturing employment on area reservoirs.

Table 5: Estimated Employment of Firms Directly Affected by Lock Closure

Company	Employment*
Burkhart Terminal	35
Ergon Petroleum	5
Fort Loudoun Terminal	15
Marathon Petroleum	4
Nystar Zinc Coy Mine	80
Olin	550
PSC Metals	7
Smoky Mountain Transfer	Not publically available
Tate and Lyle	275
Subtotal	971
Leisure Boat manufacturing	1948
Christensen Yachts	1200
Grand Total	4199

*Estimated through and internet search

While the closure of Chickamauga Lock will have broad range impacts on the Tennessee Valley, certain employers could be more severely impacted than others. The non-governmental firm most likely impacted will be the Olin Corporation. Olin’s outbound chemical shipments will be negatively affected, but its primary impact will be an inability to secure a dependable inbound salt supply necessary to maintain operations. While the company will not say publically that the plant would close upon lock closure, you get the feeling in talking to managers off-line that they will not be able to keep the plant open³². Olin has stated publically that they have 350 high paying jobs and 200 contractors at the Charleston, Tennessee plant. There are six plants that use or reprocess Olin outputs. These companies are Lanza Microbial Control; Resolute Forest Products; United Hydrogen of Tennessee; Wacker Chemie AG, Polysilicon Division; and Smokey Mountain Transfer. The decisions these companies would make in regard to a lock closure would be heavily influenced by how Olin would react.

Certain of the shippers have indicated that in the event of a closure they would shift to rail transportation. Marathon Petroleum, for example, would have to construct the necessary rail facilities and hire and train the employees necessary to handle and unload rail cars.

As shown in Table 5, the non-governmental shippers currently using Chickamauga Lock are estimated to employ approximately 1,000 people. The wages and salaries³³ consistent with this employment level are shown in Table 6. Total wages and salaries, \$54.7 million, is dominated by the manufacturing plants that have payrolls estimated to be \$45.5 million.

Table 6: Total and Industry Estimated Wages and Salaries

Industry	Employment	Industry-Specific Wage Rates	Total Wages
Manufacturing	832	\$54,725	\$45,531,200

³²TVA prepared the transportation analysis for the Corps of Engineers in the circa year 2000 analysis necessary for preparation of a Chief’s Report-The Chickamauga Lock feasibility study. When TVA interviewed the Olin Corporation concerning their response to a potential lock closure, the company indicated that they could not remain open in the event of a permanent closure. The Chief’s Report was signed in May of 2002.

³³ The Wages and Salary rates data are sourced from the Bureau of Economic Analysis. They are 2012 annual average wages and salaries rates per employee for the State of Tennessee unadjusted for inflation.

Mining	80	64,396	5,151,680
Transportation and Warehousing	59	68,536	4,043,624
Total	971		\$54,726,504

In addition to the firms shipping goods through the lock, the boat manufacturing and maintenance industry is to a degree also dependent on the lock remaining open. One of the first manufacturers to locate on Tellico Reservoir brought deep draft yachts up the Tennessee River through Chickamauga Lock for maintenance and once repaired repositioned them downstream to the Gulf of Mexico or Atlantic Ocean. Boat maintenance, with the potential for servicing very large vessels, still continues in the Tellico pool. This is discussed below.

In 2013 there were 1,948 employees in pleasure and houseboat manufacturing in the counties of Blount, Campbell, Knox, Loudon, and Monroe. Employment by firm is shown in Table 7. The link between the location of these firms and lock closure is a knowledgeable and productive labor force, a beautiful setting in which to market their products, and the fact that commercial barge transportation is an authorized purpose of the lock and dam and, as such, TVA maintains an 11 foot draft in all of the navigable channels³⁴. While TVA has stated that the river system would continue to be operated as though the lock remained operational, it is certainly possible that elevations could fluctuate. Below some channel depth, a potential lowering of the channel would certainly negatively affect leisure boat manufacturing, especially since the channel markers would have been removed³⁵.

According the census publication *County Business Patterns*, the average annual payroll rate for ship and boat building (NAICS 3366) in Tennessee in 2012 was \$37,856. When that rate is applied to employment in the boat building industry, the annual payroll is estimated to be \$73.7 million.

³⁴ This is not completely possible in the dry summer months. Siltation, in combination with low rainfall, sometimes requires dredging to maintain the deep channel.

³⁵It is certainly possible that, if the current model of reservoir operation is challenged, TVA would undertake another reservoir operations study such as was done in 2006 in response to challenges from LOUD and other lobbying individuals.

Table 7: Boat Manufacturing in East Tennessee

Company	County	Employees	Product
Brunswick Boat Group & Sea Ray Boats	Knox/Monroe	745	Pleasure boats
Mastercraft Boats Co.	Monroe	370	Pleasure boats
Yamaha-Tennessee Watercraft Inc.	Monroe	300	Sports boats
Malibu Boats Inc.	Loudon	300	Pleasure boats
Skier's Choice	Blount	140	Ski boats
Bryant Boats Inc.	Monroe	45	Pleasure boats
Bullet boats Inc.	Knox	21	Pleasure boats
Allison Boats	Blount	12	Pleasure boats
Sailabration Houseboats Inc.	Knox	9	Houseboats
Norris Craft Boat Co. Inc.	Campbell	5	Pleasure boats

*Book of Lists, 2013; Community Data Sheets, State of Tennessee. Reprinted by East Tennessee Economic Development Agency

One leisure boat manufacturer, Christensen Shipyards, is not presently in operation at its Loudoun County, Tennessee location. This plant, fully constructed on the exterior in 2009, was originally expected to cost \$20 million, encompass 450,000 square feet, and hire 1,200 workers. The plant was designed to produce very large yachts ranging in size from 170 to 225 feet and costing in a range of \$40 to \$70 million. Since yachts of this size cannot be moved via highway transportation, they must leave the area via water and thus are dependent on the navigation channel to allow transport to deep water. Christensen chose the Loudon County because it was "...closer to European markets, good interstate access, a deep harbor to launch its boats, low taxes and a highly skilled labor force."³⁶ While construction is now on hold, local government officials and economic development personnel report (see the *Continuing Disclosure Document* referenced below) that plans remain positive for boat construction to begin. Calls to local economic development professions confirm this opinion. Clayton Pangle³⁷ of the Loudon County Chamber of Commerce has seen no information to the contrary. Valued at the local payroll rate for boat manufacturing in the area, \$37,856 in 2012, Christensen Yachts would have a payroll of \$45.4 million per year.

³⁶ *Continuing Disclosure Document For Fiscal Year-Ending June 30, 2011*, Knox County, Tennessee CUSIP 499512, March 13, 2012, page 21. (This document fulfills the continuing disclosure requirement of the Securities and Exchange Commission, Securities Act of 1934, Rule 15c-12 (b) (5).

³⁷ Contacted by telephone on June 19, 2014.

Those industries that utilize Chickamauga Lock or the navigation channel include manufacturing, mining leisure boat manufacturing and, potentially, the Christensen Yacht Company. Those industries presently in operation have an estimated payroll of \$128.4 million. Adding the Christensen Yacht Company, the payroll would rise to \$173.8 million.

Secondary Impacts

A measure of the importance of the lock is the impact of the industries either using the lock or the navigation channel maintained to support commercial barge transportation. This impact is estimated by multiplying the estimated wages and salaries by an output multiplier which captures both the indirect and induced effects of the activities keyed to the lock remaining open. For this exercise, it is felt that a wage and salary multiplier value of 2.75 is appropriate. This value is an implicit output multiplier embedded in the well-known REMI (Regional Economic Models Inc.) forecasting-simulation model³⁸. Excluding Christensen Yachts which is currently not in operation, the total impact of the lock and the navigation channel is \$353.1 million annually. If Christensen Yachts was completed and operational, the total impact value would rise to \$477.95 million per year. This estimate is conservative in that it excludes the value of the navigation channel for water supply and the maintenance of discharge (NPDES) permits.

Upon closure, it is very difficult to determine the number of jobs and wages that would be lost. Based on interview responses, at least one major manufacturer would most likely close and, of course, Christensen Yachts would not complete their plant. If TVA is able to continue to operate the upper Tennessee as if commercial navigation continued to exist, there would probably be very little loss in small-craft leisure boat manufacturing, though the loss of channel markings could decrease the local demand for these boats. But as discussed below, the manufacture of larger boats needing the lock to move out of the upper Tennessee River would not be possible. However, if TVA drastically modifies its

³⁸ This multiplier value is estimated by running a control solution and then “shocking” the model by adding one billion dollars to output or sales. The response of wages and salaries is assumed to be proportional to a given change in sales given regularities in the relation of employees in each industry to the dollar value of sales. This of course assumes no change in the wage rates.

operational model such that the upper Tennessee River is no longer operated to support an 11 foot navigation channel, then the demand for pleasure boats could diminish, especially in this region due to the prevalence of fixed docks at residences on the main channel.

One final impact of closure is the effect on marinas that would be brought about by the geographic relocation of large yachts due to lock closure. Closure of the lock would suggest that most of the large yachts currently moored above the lock in the pools of Chickamauga, Watts Bar, Fort Loudoun and Melton Hill would be relocated downstream of Chickamauga Dam. One common theme among those who buy pleasure boats of moderate to large size is that the owners ultimately plan to circumnavigate Eastern North America by water, in trips varying in length from 5,000 to 7,500 miles and called the great loop or the Great Circle Route. Those making this trip are called “loopers.” Many or most of the upper-Tennessee River yachts would be relocated because they cannot be trucked and if not relocated would be landlocked with greatly diminished value. Boats over 12 feet wide, over 30-40 feet in length, or are too tall for bridge clearances fall into the this category. Second, larger yachts can draft six feet or more; and navigation would be hazardous without navigation aids.

Second, marinas would be negatively affected from the loss of business brought about by reduced locking hours at the upstream locks, those that would have attended sporting events by water from below Chickamauga Lock, fishing tournaments that have operated on more than one reservoir, snowbirds, the “loopers,” and local boaters that would not be able to move around on the upper Tennessee River as they now currently do.

NPDES

Certain of the firms operating above Chickamauga Lock expressed concern about how the reservoirs above Chickamauga Lock would be operated given a closure. Both have NPDES (National Pollutant Discharge Elimination System) permits that are tied to the volume of water into which they discharge waste water. Their thinking is that, if Chickamauga Lock closes permanently, TVA will come under pressure to accommodate the needs of other potential water users. Loss of the NPDES permits could drastically impact their facilities. And while not part of the study, many other firms have NPDES permits and could also be negatively impacted given a change in TVA policy. But, as noted, TVA has no plans to modify its reservoir operations policy.

TVA

The TVA, a federal corporation, also uses the river upstream of the lock to ship heavy equipment and to position barge mounted cranes for use in plant maintenance³⁹. The agency maintains a state-of-the art power service shop at Muscle Shoals, Alabama, located downstream of the lock. The shop spans 750,000 square feet with a workforce of 500. Hydraulic cranes used for plant maintenance are housed and maintained at the Muscle Shoals facility⁴⁰. As heat exchangers, rotors, generators and other equipment need maintenance⁴¹, they are barged to the Muscle Shoals plant and returned by barge after repairs are made. Rotors are balanced at the Muscle Shoals plant. And due to the economies of shipping heavy equipment by barge, coal steam and nuclear power plants are designed to be maintained via the water side. It would be very difficult to operate on these massive power plants from the land side, assuming that these massive components could even be shipped to the plant via overland modes.

Generator rotors are dimensioned approximately 20 feet tall and 40 feet wide and are configured at their smallest size for transportation. Other components, nuclear generator rotors for example, are barged due to their weight which can be 250 tons. These items are 30 feet in length and can be moved by either rail or truck in special trailers (shown in figure 1) which would cause major highway disruptions. Low pressure (LP) turbines weigh only 150 tons but would stand 25 feet tall on a trailer and probably would not move overland. Most likely these turbines would remain on site and be machined there. Whatever the case, the cost of lock closure in both transportation and manufacturing is estimated to be in the millions of dollars. The cost to society in traffic delays would also be high too as these massive pieces of equipment move at a very slow speed⁴² as hauled between the maintenance plant at Muscle Shoals and the power plants.

³⁹While coal does not presently move to any of the coal steam plants located upstream of Chickamauga Lock, TVA is presently examining the potential to ship coal to the Bull Run steam plant located upstream on the Clinch River. This plant, currently served by rail transportation, is apparently having trouble getting adequate coal deliveries due to a locomotive shortage.

⁴⁰ www.tva.com/power/hequip01.htm and www.tva.com/power/servicecenter.htm

⁴¹ For certain components, maintenance is planned over a multiyear cycle.

⁴² The piece shown in Figure is estimated by a TVA engineer to move on the highway at one mph.

Figure 1: 250 Ton Nuclear Steam Generator Moving on a Special Flatcar after Unloading from a Deck Barge



- Photograph from Edwards Moving and Rigging

Recently, during a maintenance outage at the Kingston Steam plant, an inspection determined that the stator, the stationary component of an electric generator, was determined to be damaged beyond repair. A compatible unit was shipped by barge from the TVA Shawnee coal steam plant located on the Ohio River near Paducah, Kentucky. Weighing 200 tons, the generator could not be moved easily over land, thus the barge transportation was an ideal transportation alternative.

([http://oakridgetoday.com/2014/12/23/generator-part-weighing -200-tons](http://oakridgetoday.com/2014/12/23/generator-part-weighing-200-tons))



Picture taken from an article in Oakridge today.com (reproduced there from a TVA photograph)

U.S. Coast Guard

In emails of August 7, 2014 and August 11, 2014, Mr. Mike M. Sollosi, Office of Navigation Systems of the USCG, wrote that if closure of the lock became imminent, the USCG would no longer maintain the buoys above Chickamauga Lock. Before removing their cutter (the Ouachita), the buoys would have to be removed due to their eventually going off station and “misleading the mariner.”

U.S. Army Corps of Engineers

As laid out in the TVA Act, the U.S. Army Corps of Engineers (USACE) is given responsibility for maintaining and operating the system of navigation locks on the Tennessee River. The Corps is provided a budget to fulfill this task. Under the assumption that Chickamauga Lock fails and virtually all commercial traffic ceases to move on the upper Tennessee River and upper River tributaries, this budget (executed for the Tennessee River) will most likely be reduced; and the decision as to where to make cuts in expenditures will be left to the Nashville District of the USACE.

The Inland Marine Transportation System study team, made up of representatives of industry and the USACE, has identified six levels of service for operational locks and caretaker status for locks currently not in operation. The service levels are shown in Table 9⁴³.

Table 8: IMTS Levels of Service

Level	Title	Description
1	Full 24/7/365	24 hours per day, 7 days a week, 365 days a year
2	Two Shifts per Day	16-20 hours per day, 7 days a week, 365 days a year (two shifts of either 8 or 10 hours)
3	Single Shift	8-12 hours per day, 7 days a week, 365 days a year
4	Set Times per Day	Lockages (including recreational craft) at set times per day.
5	Weekends & Holidays	Lockages on weekends and holidays only
6	Appointment	Commercial Lockages by appointment

It is difficult to say with any certainty into what category the locks on the upper Tennessee River would fall into given the absence of any knowledge of the budget cuts that would result from a closure of Chickamauga Lock. In a meeting with the USACE on October 20, 2014, it was inferred that no policy has been developed regarding how the Corps would react to a closure of Chickamauga Lock but stated that a lock closure would result in significantly reduced hours of operation for the locks at Watts Bar and Fort Loudon Dams. However, in a conversation with Mr. Jeff Ross of the Nashville District of the Corps of Engineers, it was stated that the current policy at the Clinch River's Melton Hill Lock is 12 days per year. While no tonnage passed through Melton Hill Lock in 2012 and 2013, it is available to pass shipments destined to or originating from the DOE facilities at Oak Ridge, Tennessee. It is certainly possible that closure of Chickamauga Lock would imply that the recreational users of Fort Loudon and Watts Bar Locks would also receive 12 days of lockage time per year. It is assumed in this policy that no major

⁴³ www.iwr.usace.army.mil/Portals/70/docs/IWUB-Meeting-69-Level-of-Service-Update-jeff-mckee-081313.pdf.

maintenance problems would occur at any of these locks because any major issue would most certainly result in a lock being permanently closed.

Another possibility is to transfer the upstream locks to the state of Tennessee. As of 2012, the USACE has divested 24 locks to states and municipalities. In Kentucky, the state closed most of the locks on the Kentucky River due to deterioration and no funds for repair and maintenance⁴⁴. The principal difference between locks on most of the inland river system and those on the Tennessee River is the height of the lift, project multipurpose functions, and maintenance and operation costs. It is relatively safe to open and close gates on low lift locks but it is inherently dangerous to operate the locks when the lift is 60 feet (watts bar and Fort Loudoun) or 58 feet at Melton Hill. For example, something as simple as tying off a pleasure boat to a ladder and not a floating mooring bit could cause death and property damage. Thus, any transfer in ownership is highly unlikely.

WATER-COMPELLED RAIL RATE EFFECTS

Prior to regulatory reform in the late 1970s and 1980s, the Interstate Commerce Commission (ICC) routinely sheltered navigation from railroad competition by holding rail rates unnecessarily high in instances where there was a navigation alternative . These prices were called “umbrella rates”. When railroads were freed of this constraint in the early 1980s, their response was to aggressively target waterborne traffic by offering lower rates than were available to similar shippers who did not have a navigation alternative. The outcome, known now as *water-compelled rail rates*, was carefully documented across an array of commodities and inland waterway segments during the early 1990s.

By 1995, however, rail traffic in most corridors had grown to the point where discussions of excess capacity had given way to expressions of concern over network adequacy. Then, and since, as rail traffic has continued to grow, rail pricing sensitivity to available navigation has diminished so that it is minimal in most rail-served markets. Today, in an era where railroad capacity is at a premium in nearly all regions, water-compelled rates are no longer an issue. Whether or not the current trend is sustained over the long-run is almost purely a function of the alternative demands for railroad capacity and the corresponding desire of the railroads to capture traffic that may be appropriately moved by water.

⁴⁴ Ibid., p 4.

Within this context, TVA has periodically assessed the relationship between available navigation on the Tennessee and Cumberland Rivers and regional railroad rates. The two most recent exercises were in 1999 and 2003. Results from estimations for those years are provided in Table 9.

Table 9: Water-Compelled Rate Effects

COMMODITY	Effective Competitive Distance	Aggregate Effect (\$X 1 Million)
1999 Estimates		
Coal	10	\$37.50
Corn and Other Grain Products	90	\$5.90
Metallic Minerals		
Non-Metallic Minerals	30	\$2.60
Grain Milling Products	45	\$3.00
Wood Products	45	\$3.40
Chemicals		
Primary Metal Products	50	\$6.00
Metal Scrap	20	\$3.60
AVERAGE / TOTAL	38	\$62.00
TOTAL NON-COAL		\$24.50
2003 Estimates		
Coal	NA	\$423.50
Corn and Other Grain Products	75	\$2.80
Metallic Minerals	30	\$2.00
Non-Metallic Minerals		
Grain Milling Products	30	\$0.20
Wood Products	30	\$0.10
Chemicals	40	\$6.00
Primary Metal Products		
Metal Scrap	25	\$1.50
AVERAGE / TOTAL	31	\$436.10
TOTAL NON-COAL		\$12.60

The sum dollar amount for the 2003 estimates is seven times larger than the same total for 1999. However, a closer examination of the results indicates that this change is exclusively the result in changed coal effects. Water-compelled impacts for other commodities fell by roughly half between 1999 and 2003 and the effective distance over which this influence was exercised declined by more than 20 percent during the same period. TVA has not undertaken a water-compelled rate analysis for more than

a decade. However, if for no other reason, the diminished role of coal as a generating fuel within the TVA service area suggest this impact would be measurably less at the current time.⁴⁵

In the 35 years since the passage of the Staggers Rail Act of 1980, the number of Class I railroads has fallen from roughly 20 to the current level of six. Direct rail-to-rail competition is rarely evidenced. In the case of higher-valued commodities truck-load and rail / truck intermodal service can often provide effective competition to rail carriers. However, in the case of bulk commodities, where shipment volumes often exceed the practical limits of motor carriage, commercial navigation routinely provides the only possible competitive relief for rail shippers. When rail capacity is abundant, navigation can have a pronounced effect. However, when rail network capacity is scarce as it is currently, rail pricing is generally insensitive to the navigation alternative.

⁴⁵ Anecdotal evidence, combined with industry-level discussions, suggests that coal and grains are the only commodities for which a water-compelled rail rate impact is currently evident and, even in the cases of these two commodities, impacts are highly idiosyncratic.

