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MODAL TRAFFIC IMPACTS OF WATERWAY USER CHARGES
Volume I: Recovery Options And Impacts Summary

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16. Abstract

This report has considered waterway user charges, which have been proposed as a method of cost recovery of Federal expenditures. The report has examined possible modal carrier and traffic impacts due to user charges on the inland river system, and potential differential effects of various cost recovery options. It has found that waterway ton-miles may be reduced by as much as ten percent by the recovery of 100 percent of annual Federal operating, maintenance, and rehabilitation expenditures on rivers through a segment-specific toll. Adjustments to the changes in transportation prices by economic agents such as shippers, carriers, and producers should act to lower these traffic impacts over the long term. The report is divided into three volumes.

This volume serves as an introduction to and summary of the Department of Transportation inland waterway user charge analysis. Alternative recovery options are discussed, sample tolls are calculated, and potential impacts of cost recovery on waterway traffic and carrier finances are summarized.

Volume II contains in-depth analyses of modal traffic impacts under user charge imposition by major commodity distribution system. Volume III contains data appendices that summarize segment toll versus fuel tax impacts on barge rates by commodity and river.

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PREFACE

The U.S. Department of Transportation initiated an analysis of the impacts of Federal navigation cost recovery during May 1975. This study is one of a series conducted to examine the modal traffic and carrier impacts of imposing waterway user charges on the U.S. shallow- and deep-draft navigation system. The information provided by these studies will be used by Government and industry to help shape future transportation policies and aid in public resource allocation decisions across programs.

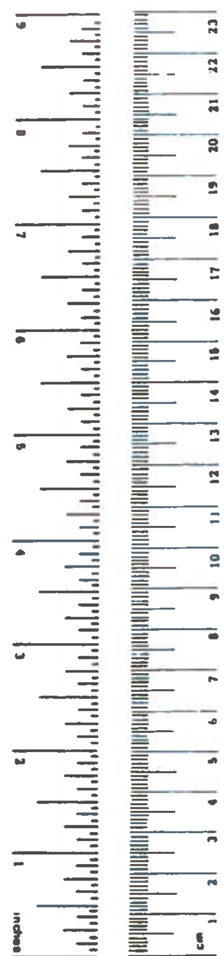
Work to date has focused on the evaluation of various cost recovery options, such as fuel taxes, segment tolls, and lockage and license fees, and determining their relative impact on both waterborne commodity movements and alternative distribution systems. Ongoing analysis is evaluating alternative deep-draft navigation user charge options and investigating their impacts on both foreign and domestic traffic, including both coastal and Great Lakes trades.

The report was prepared by the National Transportation Research Division of the U.S. Department of Transportation, Transportation Systems Center in Cambridge MA. The study was sponsored by Dr. Philip E. Franklin, Chief, Special Projects Division (TPI-34) in the Office of the Secretary, Washington DC. Cooperation of the U.S. Coast Guard and the U.S. Army Corps of Engineers is acknowledged and appreciated.

METRIC CONVERSION FACTORS

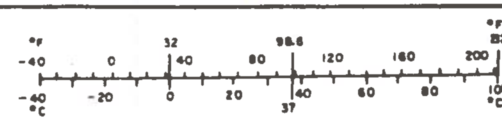
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

Waterway user charge legislation has been introduced in Congress by every administration since the 1930's. Heralded by some as necessary for equity in modal competition and by others as unfairly taxing the efficient performance of the barge industry, cost recovery of Federal navigation expenditures has continually been surrounded by controversy. A major concern of all interested parties are the resultant effects on waterway carriers and their operations as well as on shippers and regional economies of cost recovery programs. A further complication is that user charges imply changes in public investment criteria for transportation if payback of waterway facility capital costs is required.

The major purpose of the study is to determine modal carrier and traffic impacts due to waterway user charges and to examine potential differential effects of various cost recovery options. In brief, it was found that inland waterway ton-miles may be reduced as much as 10 percent by the recovery of 100 percent of annual Federal operating expenditures on on rivers via a segment-specific toll. Adjustments by economic agents such as shippers, carriers, and producers to the changes in transportation prices should act to lower these traffic impacts in the long term. The results are based on analysis performed at a fair level of detail; for example, the utility plant for coal and petroleum traffic impacts.

To analyze consistently waterborne traffic impacts from user charges across various distribution systems, a waterways traffic impact model was developed. The model combines data on the inland waterways network, 1972 system commodity flows, estimated barge rates, and proposed user charge options (segment tolls and fuel taxes) to calculate changes in barge transportation costs to shippers under each cost recovery method and various levels of payback. The resultant changes in relative modal rates due to user charge imposition are then used to determine traffic impacts by major commodity distribution systems; grains, coal, petroleum, iron and steel, fertilizer, sand and gravel, chemicals, and other products. Individual commodity impacts are then aggregated to produce systemwide effects as well as by product class and individual river.

Fuel taxes or segment tolls set to recover 100 percent of the Federal operations, maintenance, and repair (OM&R) expenditures on inland waterways are the major user charge options analyzed in the study. The calculated fuel taxes and segment tolls are based on a five-year average of Army Corps of Engineers and U.S.

Coast Guard inland river system OM&R expenditure data (fiscal years 1971 to 1975) corrected when necessary to apportion costs to complementary deep-draft operations in ports and channels. The fuel tax option is assumed to be a uniform system-wide charge, based on total OM&R expenditures and total system ton-miles in any year (variations in fuel use - gallons per ton-mile -by river sector were not available). The segment toll would charge all traffic moving on a particular river sector its share (per ton-mile) of total Federal OM&R expenditures on the sector. In all, 29 river sectors are examined for user charge impacts. Alternative recovery mechanisms such as vessel license fees and lockage charges are also examined.

A number of related questions and issues are also explored. System-wide effects of discontinuing maintenance on all or part of so-called high cost rivers is detailed. The capability of other modes to handle waterway traffic diverted by user charges is examined. When possible, barge carrier financial impacts are determined. A comparative study of traffic impacts under different user charge options and recovery levels is performed. Finally, recent user charge studies are reviewed and the results compared with this study.

The study is divided into three volumes. Volume I describes the basic methodologies used in the analyses, summarizes the findings of the distribution system studies, determines overall waterway traffic impacts from user charges, details effects by major commodity and river, and explores issues related to the type of expenditure and payback level in navigation cost recovery. Volume II contains the in-depth analyses of modal traffic impacts under user charge imposition by major commodity distribution system. Each chapter explains the basic approach and carries out the analysis at the required level of detail. Volume III is a set of data appendixes that summarize segment toll versus fuel tax impacts on barge rates by commodity and river. Commodity traffic densities by river segment are also computed so that correct ton-mile diversions can be calculated. Since the primary results of the last two volumes form the basis of Volume I analyses, the remainder of the summary will concentrate on Volume I results.

Volume I begins by discussing some of the previous and ongoing DOT studies on waterway user charges and related issues. In particular, a recent TSC study on regional industry and market price impacts due to user charges is reviewed. It was found that delivered commodity price impacts rarely exceeded 1 or 2 percent for 100-percent recovery of Federal

OM&R expenditures and were more commonly only a fraction of one percent. Projected market forces other than user charges were generally found to have a more substantial impact than navigation cost recovery.

Procedures for and problems of developing a consistent data base of Federal (Army CoE and CG) OM&R and implementation (new construction) expenditures by river were then described. Using the expenditure and system ton-mile data for the years 1971 to 1975, various user charges were calculated for 29 rivers and waterways of the inland system. In particular, segment tolls for each of the five years and average over all years were presented. The system-wide (uniform) fuel tax was also calculated. Tolls by segment to recover implementation as well as OM&R expenditures were also calculated although the study dealt only with the impacts of OM&R cost recovery. The development of the waterways traffic impact model is then described in detail. Waterways network construction procedures, derivation of inter-port distance matrixes, traffic assignment algorithms, and user charge impact calculation methods are discussed. Sample model output for various runs is presented.

Alternative cost recovery options in the form of vessel license fees and lockage/segment-dredging tolls are next examined. The analysis suggests that possible public goals such as efficiency of resource allocation and navigation cost recovery might not be simultaneously achievable with a user charge option based on a single, per use price on navigation facilities (such as a lockage fee or a segment toll). Rather, separate user charges to recover the fixed and variable portions of Federal navigation expenditures may be necessary. For example, vessel license fees could be set to recover the fixed portion (dredging, etc.) of Federal costs while a lockage fee may be used to collect any variable costs associated with waterways operation. Using the amount of traffic diversion as the measure of inefficiency in resource allocation under an option, those recovery mechanisms with the least diversion and highest payback levels would be preferred. Preliminary analysis reveals that the vessel license fee may best meet these criteria.

If registration fees on towboats and barges are used as a recovery mechanism, a number of different collection options exist. Assuming 59 percent of Federal navigation costs are recovered from barges and 41 percent from towboats (the 59:41 ratio reflects the relative investment levels in towboat and barge fleets for the inland river system), an annual barge fee would be $3.13 per-ton of load capacity and the annual towboat fee would be $18.40 per horsepower. A typical barge tow (involving a 5000 HP towboat and nine 195' x 35' dry cargo barges) would pay a registration fee of $134,000 per year, or about 10 percent of current operating costs for that tow. It was found that license fees would tend to minimize overall traffic impacts because carriers could spread them over traffic most able to bear the burden, unlike other options where carriers may not be able to lessen the impact on divertable traffic.

Lockage fees are an option proposed to recover Federal outlays for navigation-related locks and dams (63 percent of Army CoE OM&R) as well as other variable system costs. For 100 percent recovery of lock related costs, a uniform fee of $171.20 (at 1972 traffic levels) per system lockage would be required. A national uniform lockage fee would have a prejudicial effect on low-traffic rivers or small-chambered locks in that uniform fees would be spread over fewer tons per lockage. Variable (by river) lockage fees range from $31.09 on the Kentucky to $3510.90 on the Arkansas. If fuel taxes are used to recover dredging costs, the uniform charge per system ton-mile would be 0.32 mil (compared with the fuel tax of 0.80 mil per ton-mile for full OM&R recovery). Certain rivers such as the Arkansas, Kentucky, and Appalachicola/Chattahoochee/Flint would have segment-specific dredging tolls in excess of three cents per ton-mile. System impacts of the combination lockage fee and segment-dredging toll were outside the scope of the study.

Differential impacts of major user charge options (fuel taxes and segment tolls) and recovery levels were also discussed. An in-depth commodity and river sector analysis revealed that uniform fuel taxes may have a more substantial impact on barge rates and perhaps future waterway traffic levels than segment tolls. The key difference between the two approaches is that for segment tolls, impacts are concentrated on traffic which uses the higher cost rivers, while for fuel taxes, the geographic distribution of impacts will probably be more uniform. Similarly, impacts would tend to be concentrated in the early phases of implementation under a river-specific segment toll as opposed to more gradually under a system-wide tax.

The potentially higher traffic impacts under the fuel tax option assumes the preservation of the entire inland river system after user charge imposition. Discontinuing Federal OM&R expenditures on the seven highest cost rivers in the inland system (Arkansas, Allegheny, Kentucky, Pearl, Missouri, Appalachicola/Chattahoochee/Flint, and the Ouachita/Black Rivers) would result in the loss of 4.4 percent of total system ton-miles but reduce the uniform fuel tax by almost 24 percent. A reduced fuel tax would diminish commodity traffic losses on major rivers by improving the relative competitiveness of waterway transportation (after user charges).

Several major issues associated with the recovery of waterway facility capital costs are examined. The conflict between the use of average cost pricing to recover fully facility capital costs and the resultant inefficiencies due to the exclusion of traffic capable of paying only incremental use costs is discussed. The impact of required cost payback on public investment decision in transportation is briefly explored.

A summarization of the detailed distribution system analyses by commodity in Volume II indicates that as much as 10 percent of inland waterway traffic (from 1972 levels) may be displaced to other modes during the period of segment toll imposition. Unfortunately, both user charge and market forces contribute to the final diversion estimate. Further, carrier and shipper responses that could act to reduce traffic impacts are not included. TSC analysts consider a range of five to ten percent traffic loss under segment tolls an acceptable estimate.

A uniform system-wide fuel tax that recovers 100 percent of existing OM&R expenditures may result in diversions twenty-five to fifty percent higher than under segment tolls. Under both options, major commodities affected include corn, soybeans, fertilizer, petroleum products (excluding residual oil), crude oil, and sand and gravel traffic. Long-haul movements of petroleum and grains experience substantially higher barge rate increases under a fuel tax. Predicted major ton-mile losses on the inland waterways are due to petroleum and grain traffic diversion, with sand and gravel a distant third.

A summary of impacts by river sector indicates that the major rivers such as the Lower Mississippi, Ohio, Gulf Intercoastal Waterway, and to a lesser extent the Illinois River, account for about 90 percent of total system ton-miles and have segment tolls averaging only 25 to 75 percent of the uniform system-wide fuel tax. Any user charge option based on recovering average system expenditures per ton-mile, vessel, etc., would cause traffic on these rivers to pay part of the operating costs for traffic on the remainder of the system. If the seven highest cost rivers are excluded from the expenditure base, the difference between the uniform fuel tax and segment tolls is minimized. Thus, under a rationalized river system, traffic impacts under a fuel tax may be no greater than under segment tolls. The dilemma associated with choosing among the two options is apparent. Main-stem rivers (such as the Ohio, Mississippi (lower), GIWW and Illinois) would be more affected by a uniform system fuel tax while tributary rivers (generally highest Federal cost projects) may lose all commercial traffic under a segment toll. Further study may reveal an alternative option such as license fees to be preferable to either segment tolls or a fuel tax.

The analysis also revealed two types of high (Federal) cost rivers. The first type (Kanawha, Allegheny for example) have longer subsequent hauls on other rivers than on the rivers themselves. Even under a segment toll, these rivers may not experience loss of traffic along their entire length. For example, if major moves on these rivers use only the first 10 miles of the project, Federal expenditures may be continued only on the commercially viable portion of the river. The second type is the high-cost rivers with substantial internal ton-miles such as the Missouri, Arkansas, and Kentucky Rivers. These rivers may not remain commercially viable under either fuel tax or segment toll options. Under the fuel tax, the continued maintenance expenses for operations on these rivers may be opposed by certain waterway interests in that they raise uniform fuel taxes by 20 percent for the entire system.

Estimated traffic diversion of about 10-percent of system ton-miles via a 100-percent OM&R user charge would not necessarily have adverse financial impacts on the average barge carrier. Assuming barge operators were able to reduce operating costs by at least 50 percent of an overall 10-percent drop in revenues, less than normal returns on equity would result but still cover a substantial dividend, if desired. Debt repayment and equipment financing probably still could be carried out at adequate levels with unallocated cash flow. True carrier impacts would depend on examination of actual firm financial statements.

Other mode impacts are also summarized. In general, excess rail line-haul capacity on north to south lines paralleling waterways would facilitate the movement of any traffic diverted from the river system although rolling stock availability is questionable. Pipeline capacity for Gulf to Midwest crude and product movements is becoming more available as domestic oil reserves and production decline over time. Final diversion estimates from waterways will depend on the rate increases by competitive modes in response to user charges. If, for example, railroads raise grain rates by an equal amount (to user charges), corn and soybean traffic diversion from waterways will be lessened.

Finally, a review of recent user charge studies is undertaken. Similarities and differences among the Army Corps of Engineers, Department of Interior, and Maritime Administration studies in comparison with the DOT study are discussed in detail. In spite of the differences in approach and findings, some common conclusions of the recent user charge studies can be drawn:

1. Recovery of 100 percent of the Federal OM&R expenditures on the inland river system of the U.S. is unlikely to result in traffic losses in excess of 10 percent of system ton-miles under either a fuel tax or segment toll. Action by carriers and shippers to minimize impacts could lead to even lower waterway traffic diversion. Initial recovery of 10 percent of these expenditures would have considerably smaller effects, perhaps less than one percent of system ton-miles.

2. While traffic impacts on system ton-miles will be similar under the two collection approaches, there are likely to be differences in the regional and commodity mix of diversion. Under a segment toll, traffic impacts should tend to be isolated on commodity flows involving highest cost rivers, with main stem rivers experiencing some traffic loss due to their interactions with the high cost segments. Under a fuel tax, traffic impacts would be more dispersed geographically, with greater impacts on long-haul grain and petroleum traffic moving on the main stem system and reduced impacts on high-cost river traffic.

3. Pass-through of user charges to shippers or receivers of waterway traffic will lead to higher costs of production, reduced income levels for those dependent on waterway transportation and higher prices for consumers. In general, these price and income effects were measured in fractions of one percent, although certain commodities may experience slightly larger increases.

4. Future user charge impact studies should continue to be performed at substantially disaggregate levels. For major waterway receivers such as utilities, analysis at the plant level is appropriate. Originators of waterway traffic such as grain should be analyzed from true inland rather than river traffic origins. Finally, alternative distribution systems and market shifts for existing waterborne flows due to transportation price changes must be considered.

1. INTRODUCTION

The following three-volume study on the modal traffic impacts of waterway user charges completes the second phase of a U.S. Department of Transportation (DOT) study on navigation cost recovery options and impacts. The first phase analyzed the regional market price impacts and costs to consumers of user charge introduction. The final phase will examine procedures for recovering Federal deep-draft navigation expenditures as well as impacts on U.S. coastwise and foreign trade. A corollary study analyzes existing public investment decisions in transportation in the context of eventual navigation cost recovery.

The first phase study, "Regional Market, Industry and Transportation Impacts of Waterway User Charges," analyzed the impacts on water-served economic markets of the imposition of user charges on the inland river system of the U.S. In general, regional market and price impacts were found to be minimal compared to other long-term market forces. Delivered commodity price impacts rarely exceeded 1 or 2 percent for 100-percent recovery of Federal operations, maintenance, and repair (OM&R) costs on inland and coastal waterways, and were more commonly only a fraction of 1 percent. Any major potential impacts due to user charges were predicted to occur in the transportation sector, where 6-to-15 percent barge rate increases would result. However, it was argued that water-oriented fixed facility investments made rapid or widespread modal diversion from water unlikely in the short term. In that plant location decisions may be altered if the Federal subsidy for water transportation is discontinued, future waterways traffic growth could be affected. It is expected that such changes would occur over a 10 to 20 year period.

The following concentrates on the transportation system and carrier impacts from waterway user charges via fuel or segment taxes. Substantial improvements in both Federal waterways expenditure and modal traffic data since the previous study allowed an expanded micro-level impact analysis to be performed. The basic approach was to analyze major commodity distribution systems that use waterways and to determine traffic effects of user charge-induced relative modal price shifts. Extensive consideration was given to regional and commodity class variations in impacts. Differential impacts of alternative cost recovery options were evaluated from a systems and commodity perspective. Finally, carrier financial impacts under various scenarios were examined.

1.1 BACKGROUND

Traffic impacts resulting from imposition of waterway user charges are considered a major policy issue but have only been superficially analysed in the past. Although water carrier revenues and capital are most directly affected, water-oriented facilities and agricultural land located on or near subsidized waterways would also be impacted. Analysis at the regional and commodity level has been hindered by the absence of consistent modal data on inter-regional commodity flows, transportation rates, and network capacity data. Difficulties in defining competitive modal flows, markets, and distribution patterns also reduce confidence in the results. Further, previous studies have tended to use aggregate (cross-commodity and markets) national price elasticities to determine traffic diversion estimates. For example, a price elasticity of -1 has commonly been assumed, so that a 10-percent increase in barge rates would result in a 10-percent traffic loss by water carriers. In reality, regional market and carrier conditions often vary substantially from national conditions but minimal work on output response to price changes is done at the regional level. Little, if any, empirical justification exists for using an aggregate price elasticity for all potential diversion situations.

To understand potential impacts due to new taxes to recover Federal expenditures on naviation, an approach that considers the markets, distribution systems, and modal networks within which various commodities move must be employed. Interregional commodity flows are the result of spatial market interactions based on delivered prices and quality considerations at a consuming point. Altering relative delivered prices via user charges changes the ability of markets to compete, affecting commodity flows. Distribution systems are also modified by user charges. Existing distribution patterns are designed to take maximum advantage (in cost terms) of transportation systems, especially (when possible) subsidized waterways. Increasing operating costs on one portion of a distribution system may alter the entire pattern. For example, grain formerly moving via barge to New Orleans for export may change to all-rail flows to east coast ports after user charges. Finally, transportation networks (including transfer, load/unload facilities) constrain (for a time) commodity movements to patterns established by prior fixed facility investment decisions. Existing entry/exit points in a modal network restrict flows to certain modes unless relative price changes result in new facility investments to enable use of alternative modes. For example, a utility receiving all coal via water with no unloading facility for railcars would have to face a substantial shift (say two dollars per ton increase on barge coal) in relative modal prices to justify construction of a rotary car dumper and sidings. For the majority of bulk commodities moving on the inland waterway system, receiving facility constraints inhibit modal shift. At present, only ten percent of water-served electric utilities have rail facilities capable of volume coal receipts. The concept of modal diversion due to relative price changes has little meaning in these cases. Rather, market diversion due to changes in delivered prices is a more realistic way of viewing user charge impacts.

The above section argues that traffic impact analysis due to Government policy actions should be done in the context of the relevant commodity market and distribution systems that determine interregional commodity movements. Only when correct shipping patterns and overall systems constraints are incorporated into the analysis process can meaningful results be obtained. The detailed technical analyses implied by these considerations requires substantial knowledge of alternative distribution systems available to waterway shippers in diverse markets and commodities. Since time constraints on the analysis were severe, the following embodies these concepts in a structural and organization framework for the study rather than in a rigorously empirical manner.

1.2 GLOSSARY OF TERMS

Although every administration since President F.D. Roosevelt has introduced some form of waterway user charge legislation into Congress, much of the terminology associated with the analysis of cost recovery options and impacts is not widely understood. The following section explains some of the more common terms associated with types of Federal navigation expenditures, user charge options, barge carrier operations, and commodity distribution systems.

For this study, Federal navigation expenditures fall into three major categories. U.S. Army Corps of Engineers' expenditures consist of operations, maintenance and rehabilitation (OM&R) costs and implementation (IMP) costs. OM&R expenditures refer to the annual costs of keeping the inland waterway system open and includes dredging as well as maintenance costs on locks and dams. Army CoE implementation expenditures refer to capital costs associated with new construction concerned with expanding or improving the existing system, such as channel development, lock and dam construction, etc. The other major Federal expenditure on inland waterways is associated with U.S. Coast Guard programs. CG aids to navigation (ATN) and search and rescue (SAR) are annual costs related to upkeep of navigation marks and safety in commercial waterway operations. The data base includes U.S. Army CoE OM&R and IMP data, CG OM&R data (ATN and SAR), but not CG IMP costs (cutters, buoy tenders, district headquarters, etc.). A waterway of the United States is defined as any Federally improved waterway, harbor or navigation channel, except the Saint Lawrence Seaway. Only inland waterways and the Gulf Intercoastal waterways are examined in this study.

Navigation cost recovery is the payback by commercial users of some percent of various combinations of Federal OM&R and/or IMP expenditures. User charge options are methods of recovering these expenditures. The most commonly discussed option is the fuel tax, a charge levied on fuel use by carriers on the inland waterways set to recover some percent of Federal expenditures. The fuel tax can be either system-wide (uniform) or segment-specific (variable by river). At present, the uniform approach is preferred because little is known about variations in fuel use (gallons per ton-mile) by river segment.

The segment toll would charge barge carriers for their operations on river-specific segments. For example, a waterborne movement originating on the Ohio River and terminating in New Orleans would pay a toll per ton-mile on each sector (Ohio, Lower Mississippi) that varied with sector Federal costs and recovery level. The total fee charged a movement under a segment toll would be the sum of the tolls paid on each segment of the river system involved in the movement.

The license fee would apply a fixed operating charge on towboats, barges, etc., in the inland system, set to recover a certain percent of Federal expenditures. The fee would grant operating rights on either a system-wide or river-specific basis, depending on the option chosen.

A lockage fee would establish a charge for each use of a lock by a commercial carrier. Again, the charge could be either uniform across the system or lock-specific. They would generally be used with a segment toll or fuel tax to collect back dredging costs.

Finally, congestion tolls are specific taxes aimed at relieving excess demands for waterway facilities at certain constraint points in the system. They may be used in conjunction with other recovery options to substitute for construction or rehabilitation projects with marginal cost-benefit justification.

Barge carrier operation (towing) on the inland waterway system are activities associated with moving commodities from river point to river point. These include barge pickup, fleeting operations (adding barges to a tow), lock passage, and line-haul movements. Towboats are self-propelled ships that actually push barges. Switchboats are small tugboats that add or subtract barges from moving tows (a set of barges and a towboat) or during fleeting operations. Towboats are rated by horsepower (HP) from 300 to 9000. Barge types include dry cargo, tanker, and covered hopper, and are of variable size (195' x 35' is the most common).

Distribution systems refer to the total activitiy surrounding the movement of freight between true origin and final destination, including pickup, line-haul via transfer terminal, and delivery. Delivered prices are the total costs associated with the distribution system and the markets served, including original market base price, pickup and delivery, line-haul, handling, and inventory costs. Terms associated with specific commodity distribution systems are explained in the relevant sections.

1.3 OVERVIEW OF REPORT

The study, divided into three volumes, estimates the potential carrier and traffic impacts from the imposition of waterway user charges on the inland river system of the United States. Volume I calculates cost recovery tolls and examines differential impacts of various recovery options, summarizes carrier and traffic effects by major commodity and river, details other mode impacts, and reviews recent user charge studies. Volume II contains the full-scale commodity distribution system analysis for each of the major waterborne commodities.

grains, fertilizer, coal, petroleum, iron and steel, chemicals, and sand and gravel. For each commodity group carrier and traffic impacts of 100-percent OM&R cost recovery via either fuel taxes or segment tolls are estimated and discussed. Volume III is the data appendix to the report, containing various forms of output from the Waterways Traffic Impact Model (described in Volume I, Chapter 3). Included are cost recovery impacts by originations and terminations for each major commodity and river. Finally, ton-mile traffic densities by commodity and river sector are developed by originating traffic.

Volume I is organized as follows: Chapter 2 explains the Federal navigation expenditure data development and recovery toll calculations. Chapter 3 describes the Waterways Traffic Impact Model, a network simulation model that is used to evaluate carrier rate and traffic impacts due to user charges. Chapter 4 examines two alternative recovery options: vessel license fees and lockage charges. Chapter 5 presents differential traffic impacts from various user charges and recovery levels. High-cost river sectors are examined in detail in Chapter 6. Chapter 7 explores some of the issues related to the recovery of implementation expenditures. A summary of traffic impacts by commodity and river are presented in Chapter 8. Chapter 9 examines carrier financial impacts. Alternative modal impacts are estimated in Chapter 10. Finally, Chapter 11 compares the results of recent user charge studies to those of the DOT study.

2. NAVIGATION COST RECOVERY: TOLL CALCULATION

The waterway user charge impact analysis is based on recovery of 100 percent of Federal expenditures on operations, maintenance, and repair (or rehabilitation) - OM&R - in support of commercial navigation. Data on OM&R expenditures for the years 1971 through 1975 were provided by the Army Corps of Engineers and the Coast Guard for the inland waterway sectors listed in Table 1. Wherever possible, expenditures in support of deep-draft navigation are excluded - e.g., no ACoE expenditures for the Mississippi River south of Baton Rouge are allocated to the shallow-draft system because of the magnitude of project depths in that area.

Similarly, expenditures on major rehabilitation or replacement projects is excluded when identifiable because of the non-recurring nature of this expenditure. It is reasoned that a five year history is too short a time frame on which to base a toll for an individual river, if a single project which will not recur for 40 or 50 years is allowed to dominate the expenditures. In particular, this led to the exclusion of expenditures for the rehabilitation of the Bankhead Lock and Dam on the Warrior River from the expenditure data.

This same logic led to the exclusion of implementation (new construction) expenditures from the analysis. To analyze this body of expenditure, estimates of expected annualized costs for each project - including replacement or rehabilitation would have to be made. Although data on past expenditures would be useful in estimating these costs, five years is not long enough to capture the long-term patterns, since projects which received the heaviest attention in the early seventies would not need major rehabilitation until the end of the century. No serious proposal to collect back past expenditures has been forwarded.

In that several cost recovery proposals include payback of some percentage of new federal implementation expenditures, FY 1971 to 1975 Army Corps new construction costs were tabulated for inland river sectors. Coast guard implementation data for the inland system is not currently available. Due to the theoretical difficulties described above, implementation recovery impacts are not considered in the user charge analysis. However, sample toll calculations for various implementation recovery levels and comparisons to existing toll structures are contained in this chapter.

2.1 ARMY CORPS OF ENGINEERS OM&R

Army Corps of Engineer expenditures for inland waterway OM&R are listed in Table 2 (see Table 1 for sector name abbreviations).* The data are used as received from the Corps except: expenditures from the Port of Memphis are included in CAIROBR, the Port of St. Louis and the Minnesota and St. Croix Rivers are included in MINCAIRO, and the Bankhead L&D rehabilitation is excluded from the WARTOMMO.

The data provided by the Corps do not include such categories of expenditure as general regulatory functions, aquatic plant control, and project condition surveys, nor do they include OM&R expenditures for inland water (shallow-draft) ports other than Memphis and St. Louis. Army Corps expenditures within deep-draft ports (Lower Mississippi,

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*OM&R expenditures on Tennessee River locks and dams were provided by the Tennessee Valley Authority.

TABLE 1

U.S. RIVER SECTORS FOR THE USER CHARGE STUDY

Sector Number	Name	Sector Name Abbreviation
1	Mississippi River - Cairo to Baton Rouge	CAIROBR
2	Mississippi River - Minneapolis to Cairo	MINCAIRO
3	Arkansas River	ARK
4	White River	WHITE
5	Ohio River	OHIO
6	Monongahela River	MON
7	Allegheny River	ALL
8	Tennessee River	TENN
9	Cumberland River	CUMB
10	Kanawha River	KAN
11	Green and Barren River	GRBAR
12	Kentucky River	KENT
13	Illinois Waterway	ILL
14	Gulf Intercoastal Waterway - West	GIWWW
15	Morgan City-Port Allen Route	MORGPA
16	Gulf Intercoastal Waterway - East	GIWWE
17	Pearl River	PEARL
18	Alabama-Coosa River	ALA
19	Warrior-Tombigbee-Mobile River	WARTOMMO
20	Missouri River	MO
21	Apalachicola-Chattahoochee River	APCHAPFL
22	Atchafalaya River	ATCH
23	Red River	RED
24	Black and Ouachita River	OUACHBLK
25	Atlantic Intercoastal Waterway	AIWW
26	Columbia and Snake Rivers	COLSNAKE
27	Kaskaskia Waterway	KASK
28	Willamette River	WILL
29	Mississippi River - Baton Rouge to Mouth of Passes	BRMOP

TABLE 2

ARMY CORPS OF ENGINEERS OM&R EXPENDITURES:
FY 1971 TO 1975 BY RIVER SECTOR
(Thousands of Dollars)
(Totals Row in Hundreds of Thousands)

ARMYCORP	1971	1972	1973	1974	1975
CAIROBR	8518.8	7830.4	7133.8	10401.9	12374.5
MINCAIRO	20700.8	20784.8	21589.0	28487.0	28327.0
ARK	9627.7	11964.8	12524.2	18252.5	11703.2
WHITE	266.8	272.9	311.9	273.8	656.6
OHIO	12084.1	11348.5	14290.7	16264.0	15196.4
MON	2179.8	2071.1	2314.2	2532.8	3618.7
ALL	878.8	809.6	1001.5	1584.8	1706.0
TENN	1991.5	2204.2	2536.3	2680.6	2959.0
CUMB	1479.0	1669.3	1712.9	1881.6	2328.8
KAN	1158.2	1414.2	1645.6	1349.7	1783.8
GRBAR	1181.5	709.5	1148.6	921.8	589.4
KENT	907.6	1001.8	1160.7	1506.4	1745.7
ILL	3778.4	4401.2	6978.0	6251.6	9246.5
GIWWW	7763.4	7457.3	8305.7	10832.1	10759.3
MORGPA	147.9	120.0	54.9	257.5	274.9
GIWWE	2011.8	583.7	811.4	1698.9	1923.1
PEARL	293.7	186.1	390.5	376.2	131.5
ALA	860.5	891.5	1036.1	1712.0	1435.2
WARTOMMO	2780.1	2386.5	2919.0	2957.2	4303.5
MO	13242.0	18108.2	12024.3	13820.6	12881.1
APCHAPEL	3213.5	3539.8	3247.9	3648.7	4082.7
ATCH	637.4	459.6	623.3	854.1	1631.5
RED	5.3	22.6	21.3	12.1	8.8
OUACHBLK	1225.7	1401.1	1289.4	3708.5	1681.0
ATWW	4139.4	3666.7	5949.3	5614.7	6062.8
COLSNAKE	2087.1	2050.7	2633.3	2796.8	2953.9
KASK	0.0	56.5	147.3	415.8	536.0
WILL	932.9	813.0	825.3	648.3	449.3
BRMOP	0.0	0.0	0.0	0.0	0.0
TOTAL	1040.93	1082.25	1146.26	1417.42	1413.50

Lower Columbia and Wilamette, and Houston Ship Channel) are assumed to be for the benefit of deep-draft navigation only and are, therefore, not included in the Corps data submission.

2.2 COAST GUARD OM&R

The Coast Guard provided data concerning its expenditures for the operation and maintenance of aids to navigation (ATN) in the inland waterway system Table 3). The expenditure data do not include the costs of other programs such as Port and Waterway Safety and Search and Rescue.

Since Coast Guard accounting procedures do not generally recognize individual river sectors (the same buoy tender may serve several sectors) and become both shallow- and deep-draft navigation benefit from ATN systems in jointly used areas, the data submitted by the Coast Guard result from the allocation of expenditures from larger geographic areas into our river segments. After lengthy discussion, it was agreed that these allocations should be performed on the basis of traffic densities as measured by ton-miles from the Waterborne Commerce of the United States. The final figures also include an allocation of Coast Guard ATN expenditures not allocated to any particular sector in the data. These unallocated expenditures, which account for about 20-25% of the total are allocated to each sector on the basis of its share of allocable expenditures.

2.3 ARMY CORPS IMPLEMENTATION

Allotments of Construction, General Funds during fiscal years 1971 to 1975 for inland river sectors are summarized in Table 4. Corps implementation expenditures are defined as that percent of a project benefitting navigation on inland waterways. In a single fiscal year, allotments would generally not equal actual expenditures. Over a five-year time period,

TABLE 3

U.S. COAST GUARD OM&R EXPENDITURES:
FY 1971 TO 1975 BY RIVER SECTOR
(Thousands of Dollars

COASTGRD	1971	1972	1973	1974	1975
CAIROBR	1067.77	1154.62	1173.65	1349.74	1515.40
MINCAIRO	2117.94	2331.68	2265.84	2668.09	2983.55
ARK	274.39	325.41	309.19	369.89	417.86
WHITE	61.38	41.13	54.86	57.53	59.31
OHIO	1990.20	1104.74	1055.51	1213.57	1396.63
MON	45.45	52.60	52.66	62.42	66.51
ALL	2.60	2.79	2.95	3.36	3.70
TENN	616.08	686.70	669.42	768.05	875.55
CUMB	21.71	30.37	37.19	37.37	47.40
KAN	26.23	28.08	28.11	27.15	28.44
GRBAR	43.19	50.57	49.22	54.16	62.18
KENT	1.13	1.40	1.84	1.68	1.77
ILL	793.99	869.06	894.75	1012.19	1154.44
GIWWW	1449.24	1452.85	1409.88	1620.80	1701.07
MORGPA	81.86	112.06	88.31	110.07	137.93
GIWWE	281.47	320.64	298.00	350.74	412.81
PEARL	0.07	0.01	0.00	0.01	0.07
ALA	11.74	11.20	15.59	18.22	25.76
WARTOMMO	299.89	378.60	384.14	490.31	578.32
MO	533.60	609.82	579.64	649.68	758.33
APCHAPFL	9.54	10.73	12.79	11.93	11.64
ATCH	95.35	65.71	39.98	61.40	24.76
RED	0.28	0.42	0.44	0.65	1.35
OUACHBLK	1.13	1.94	2.15	2.31	2.74
AIWW	0.00	0.00	0.00	0.00	0.00
COLSNAKE	642.56	697.24	697.21	821.76	913.18
KASK	0.00	0.00	0.04	0.25	0.31
WILL	22.43	24.58	23.31	29.69	31.87
BRMOP	906.15	1088.78	1151.66	1337.05	1585.01
TOTAL	11397.3	11453.7	11298.3	13130.0	14797.8

TABLE 4

ARMY CORPS OF ENGINEERS IMPLEMENTATION EXPENDITURES;
FY 1971 TO 1975 BY RIVER SECTOR
(THOUSANDS OF DOLLARS)
(TOTALS ROW IN HUNDREDS OF THOUSANDS)

IMPLEMEN	1971	1972	1973	1974	1975
CAIROBR	7750.0	8000.0	9250.0	17750.0	9450.0
MINCAIRO	2096.0	3710.0	10320.0	9939.0	11075.0
ARK	39505.0	20729.0	18877.0	13377.0	6556.0
WHITE	0.0	0.0	0.0	0.0	0.0
OHIO	51857.0	73030.0	78933.0	86876.0	69695.0
MON	0.0	0.0	0.0	0.0	175.0
ALL	0.0	0.0	0.0	0.0	0.0
TENN	0.0	0.0	0.0	0.0	0.0
CUMB	1663.0	910.0	813.0	540.0	170.0
KAN	0.0	0.0	0.0	0.0	0.0
GRBAR	0.0	0.0	0.0	0.0	0.0
KENT	0.0	0.0	0.0	0.0	0.0
ILL	4495.0	5646.0	1079.0	1477.0	503.0
GIWWW	100.0	128.0	0.0	200.0	100.0
MORGPA	0.0	0.0	0.0	0.0	0.0
GIWWE	629.0	199.0	298.0	816.0	473.0
PEARL	0.0	0.0	0.0	0.0	0.0
ALA	6624.0	1682.0	6612.0	5143.0	2400.0
WARTOMMO	4400.0	3639.0	9000.0	15550.0	8100.0
MO	6214.0	3677.0	10979.0	2518.0	3920.0
APCHAPFL	285.0	252.0	571.0	345.0	189.0
ATCH	70.0	874.0	1130.0	2800.0	1075.0
RED	3500.0	4227.0	5820.0	9890.0	14680.0
OUACHBLK	6456.0	5246.0	8050.0	8095.0	8000.0
AIWW	15042.0	8810.0	11863.0	14429.0	14318.0
COLSNAKE	9063.0	19187.0	14482.0	17421.0	15547.0
KASK	13532.0	25184.0	12791.0	9081.0	4700.0
WILL	0.0	0.0	0.0	0.0	0.0
BRMOP	0.0	0.0	0.0	0.0	0.0
TOTAL	1732.81	1851.30	2008.68	2162.47	1711.26

allotments would be expected to closely coincide with expenditures. In some cases, the implementation data for a specific project on a river sector contained de-obligated funds in a particular year. When this occurs, the reduction in construction fund allotments were subtracted from the original allotment. The source of the data is CoE Work Allowance Files (DAEN-CWS-S).

2.4 USER CHARGE CALCULATIONS: OM&R COST RECOVERY

Segment tolls (Table 7) are calculated for each river sector by dividing total OM&R expenditure (CG plus ACoE; Table 6) for each river by the ton-miles on the river as reported in the Waterborne Commerce of the United States (ACoE) (Table 5). Obviously, tolls for recovery of less than 100 percent would be proportionately smaller, while tolls to collect implementation as well as OM&R expenditures would be significantly larger. A simple 5-year average of the toll for each sector (Table 8) is used for the impact analysis in this report.

A systemwide "ton-mile tax" was calculated as a proxy for a fuel tax. While fuel efficiency per ton-mile and the ability of carriers to reduce their tax liability through changes in operating procedures may vary from river to river, the state-of-the-art in modelling barge operations does not allow these effects to be captured at this time. The surrogate calculation, which calculates the "fuel tax" as the ratio of total system expenditures for OM&R divided by total system ton-miles, shares many of the attributes of a fuel tax -- especially cross-subsidization of high cost sectors by lower cost sectors. Table 9 contains fuel tax calculations for Fiscal Years 1971 to 1975 and a simple 5-year average.

TABLE 5

U.S. ARMY CORPS OF ENGINEERS SHALLOW-DRAFT WATERBORNE TON-MILES BY RIVER SECTOR; CY 1971 TO 1975*
(TENS OF MILLIONS OF TON-MILES)

TONMILE/10000	1971	1972	1973	1974	1975
CAIROBR	5274.89	6056.38	5925.62	6541.74	6509.75
MINCAIRO	1950.51	2240.40	2140.04	2326.61	2323.90
ARK	25.69	52.09	33.86	45.11	43.10
WHITE	5.75	6.58	6.01	7.02	6.12
OHIO	3090.55	3206.65	2994.22	3194.51	3232.04
MON	142.02	152.79	149.48	164.17	153.89
ALL	8.06	8.00	8.31	8.73	8.58
TENN	396.05	375.59	392.85	357.88	391.58
CUMB	67.73	88.20	105.48	98.25	109.86
KAN	81.79	81.53	79.62	71.37	65.73
GRBAR	134.82	146.72	139.55	142.62	143.91
KENT	3.47	3.97	5.23	4.32	3.94
ILL	731.22	835.04	845.07	882.58	899.20
GIWWW	1487.79	1464.68	1368.55	1404.05	1254.92
MORGPA	85.42	115.63	87.11	97.06	104.95
GIWWE	288.96	323.25	289.26	303.84	304.54
PEARL	0.07	0.01	0.00	0.01	0.05
ALA	12.05	11.30	15.13	15.78	19.01
WARTOMMO	307.87	381.69	372.87	424.74	426.64
MO	132.99	128.04	88.44	122.75	110.58
APCHAPFL	9.80	10.82	12.42	10.34	8.59
ATCH	97.88	66.25	38.80	53.19	18.27
RED	1.38	2.20	2.24	3.16	5.72
OUACHBLK	5.59	10.19	10.86	11.19	11.78
AIWW	57.09	69.19	58.11	53.19	47.46
COLSNAKE	52.34	80.10	76.77	79.81	NA
KASK	NA	NA	0.04	0.22	0.24
WILL	2.32	2.06	2.02	2.72	NA
BRMOP	930.25	1097.65	1117.90	1158.25	1169.30
TOTAL	15384.3	17017.0	16365.8	17585.2	17373.6

*Source: U.S. Army Corps of Engineers, Waterborne Commerce of the United States. 1971 to 1974, 1975 direct from ACoE Headquarters. Calendar year (CY) data.

TABLE 6

SUM OF ARMY CORPS AND COAST GUARD OM&R EXPENDITURES:
FY 1971 TO 1975 BY RIVER SECTOR
(THOUSANDS OF DOLLARS)
(TOTALS ROW IN HUNDREDS OF THOUSANDS)

ACCG	1971	1972	1973	1974	1975
CAIROBR	9586.6	8985.0	8307.4	11751.6	13889.9
MINCAIRO	22818.7	23116.5	23854.8	31155.1	31310.5
ARK	9902.1	12290.2	12833.4	18622.4	12121.1
WHITE	328.2	314.0	366.8	331.3	715.9
OHIO	14074.3	12453.2	15346.2	17477.6	16593.0
MON	2225.2	2123.7	2366.9	2595.2	3685.2
ALL	881.4	812.4	1004.4	1588.2	1709.7
TENN	2607.6	2890.9	3205.7	3448.6	3834.6
CUMB	1500.7	1699.7	1750.1	1919.0	2376.2
KAN	1184.4	1442.3	1673.7	1376.9	1812.2
GRBAR	1224.7	760.1	1197.8	976.0	651.6
KENT	908.7	1003.2	1162.5	1508.1	1747.5
ILL	4572.4	5270.3	7872.7	7263.8	10400.9
GIWWW	9212.6	8910.1	9715.6	12452.9	12460.4
MORGPA	229.8	232.1	143.2	367.6	412.8
GIWWE	2293.3	904.3	1109.4	2049.6	2335.9
PEARL	293.8	186.1	390.5	376.2	131.6
ALA	872.2	902.7	1051.7	1730.2	1461.0
WARTOMMO	3080.0	2765.1	3303.1	3447.5	4881.8
MO	13775.6	18718.0	12603.9	14470.3	13639.4
APCHAPFL	3223.0	3550.5	3260.7	3660.6	4094.3
ATCH	732.7	525.3	663.3	915.5	1656.3
RED	5.6	23.0	21.7	12.8	10.2
OUACHBLK	1226.8	1403.0	1291.6	3710.8	1683.7
AIWW	4139.4	3666.7	5949.3	5614.7	6062.8
COLSNAKE	2729.7	2747.9	3330.5	3618.6	3867.1
KASK	0.0	56.5	147.3	416.1	536.3
WILL	955.3	837.6	848.6	678.0	481.2
BRMOP	906.1	1088.8	1151.7	1337.1	1585.0
TOTAL	1154.91	1196.79	1259.24	1548.72	1561.48

TABLE 7

SHALLOW-DRAFT SYSTEM OM&R RECOVERY SEGMENT TOLLS; 1971 TO 1975

(DOLLARS PER TON-MILE)

SEGTOLL1	1971	1972	1973	1974	1975
CAIROBR	0.00018	0.00015	0.00014	0.00018	0.00021
MINCAIRO	0.00117	0.00103	0.00111	0.00134	0.00135
ARK	0.03855	0.02359	0.03790	0.04128	0.02812
WHITE	0.00571	0.00477	0.00611	0.00472	0.01170
OHIO	0.00046	0.00039	0.00051	0.00055	0.00051
MON	0.00157	0.00139	0.00158	0.00158	0.00239
ALL	0.01093	0.01015	0.01209	0.01819	0.01993
TENN	0.00066	0.00077	0.00082	0.00096	0.00098
CUMB	0.00222	0.00193	0.00166	0.00195	0.00216
KAN	0.00145	0.00177	0.00210	0.00193	0.00276
GRBAR	0.00091	0.00052	0.00086	0.00068	0.00045
KENT	0.02618	0.02524	0.02224	0.03488	0.04433
ILL	0.00063	0.00063	0.00093	0.00082	0.00116
GIWWW	0.00062	0.00061	0.00071	0.00089	0.00099
MORGPA	0.00027	0.00020	0.00016	0.00038	0.00039
GIWWE	0.00079	0.00028	0.00038	0.00067	0.00077
PEARL	0.40464	1.24909	7.96949	3.48344	0.27072
ALA	0.00724	0.00799	0.00695	0.01096	0.00769
WARTOMMO	0.00100	0.00072	0.00089	0.00081	0.00114
MO	0.01036	0.01462	0.01425	0.01179	0.01233
APCHAPFL	0.03290	0.03281	0.02626	0.03541	0.04766
ATCH	0.00075	0.00079	0.00171	0.00172	0.00907
RED	0.00040	0.00105	0.00097	0.00040	0.00018
OUACHBLK	0.02195	0.01376	0.01190	0.03316	0.01430
AIWW	0.00725	0.00530	0.01024	0.01056	0.01278
COLSNAKE	0.00522	0.00343	0.00434	0.00453	NA
KASK	NA	NA	0.37587	0.19235	0.22553
WILL	0.04109	0.04058	0.04195	0.02489	NA
BRMOP	0.00010	0.00010	0.00010	0.00012	0.00014

TABLE 8

SHALLOW-DRAFT SYSTEM OM&R RECOVERY SEGMENT TOLLS:
SIMPLE 5-YEAR AVERAGE
(DOLLARS PER TON-MILE)

SECTOR	SEGMENT TOLL
CAIROBR	0.00017
MINCAIRO	0.00120
ARK	0.03291
WHITE	0.00653
OHIO	0.00048
MON	0.00170
ALL	0.01438
TENN	0.00084
CUMB	0.00197
KAN	0.00197
GRBAR	0.00068
KENT	0.03023
ILL	0.00084
GIWWW	0.00076
MORGPA	0.00028
GIWWE	0.00058
PEARL	0.90789
ALA	0.00821
WARTOMMO	0.00091
MO	0.01256
APCHAPFL	0.03423
ATCH	0.00164
RED	0.00050
OUACHBLK	0.01878
AIWW	0.00892
COLSNAKE	0.00564
KASK	0.23438
WILL	0.04160
BRMOP	0.00011

TABLE 9

SHALLOW-DRAFT OM&R COST RECOVERY FUEL TAX:
1971 TO 1975 AND 5-YEAR AVERAGE
(DOLLARS PER TON-MILE)

	1971	1972	1973	1974	1975
Fuel Tax	0.00075	0.00070	0.00077	0.00088	0.00090
	5-Year Average (Simple)				
Fuel Tax	0.00080				

Although a definite upward trend exists in the uniform ton-mile (fuel) tax over the last five years due to increasing OM&R expenditures (largely inflation), the simple five-year average was chosen for the impact analysis. This reflects an assumption that inflation will remain moderate and barge traffic will resume normal growth in a recovering economy. Otherwise, the higher toll estimates of 1974 and 1975 would be more appropriate.

2.5 USER CHARGE CALCULATIONS: OM&R PLUS IMPLEMENTATION

As previously mentioned, the impact analysis does not include implementation expenditures in cost recovery options at present. To examine the magnitude of total federal navigation cost recovery by sector, implementation costs were included in a set of sample toll calculations. Table 10 is a summation of Tables 3 and 4, representing 100 percent of federal navigation expenditures (excluding Coast Guard implementation) for fiscal years 1971 to 1975. In general, total federal cost recovery would involve payback of two to three times more than OM&R recovery only. Table 11 calculates 5-year average segment totals under a number of proposed cost recovery options. Column 1 (ACCG) is the basis for analysis in the following report. Column 2 (IMP) indicates sector tolls under recovery of Corps implementation costs only. On some low-maintenance rivers such as the Ohio, implementation costs are high. Implementation tolls are almost five times higher than OM&R tolls for this river. Column 3 (ACCGIM) indicates full cost recovery tolls for 100 percent of federal navigation expenditures. Column 4 (HALFALL) calculates tolls at 50 percent recovery levels for all federal navigation costs.

TABLE 10

TOTAL FEDERAL NAVIGATION EXPENDITURES
(OM&R PLUS IMPLEMENTATION)
BY RIVER SECTOR;
FISCAL YEARS 1971 TO 1975
(THOUSANDS OF DOLLARS)
(TOTALS ROW IN HUNDREDS OF THOUSANDS)

ACCGIM	1971	1972	1973	1974	1975
CAIROBR	17336.6	16985.0	17557.4	29501.6	23339.9
MINCAIRO	24914.7	26826.5	34174.8	41094.1	42385.5
ARK	49407.1	33019.2	31710.4	31999.4	18677.1
WHITE	328.2	314.0	366.8	331.3	715.9
OHIO	65931.2	85483.2	94279.2	1.0E+05	86288.0
MON	2225.2	2123.7	2366.9	2595.2	3860.2
ALL	881.4	812.4	1004.4	1588.2	1709.7
TENN	2607.6	2890.9	3205.7	3448.6	3834.6
CUMB	3163.7	2609.7	2563.1	2459.0	2546.2
KAN	1184.4	1442.3	1673.7	1376.9	1812.2
GRBAR	1224.7	760.1	1197.8	976.0	651.6
KENT	908.7	1003.2	1162.5	1508.1	1747.5
ILL	9067.4	10916.3	8951.7	8740.8	10903.9
GIWWW	9312.6	9038.1	9715.6	12652.9	12560.4
MORGPA	229.8	232.1	143.2	367.6	412.8
GIWWE	2922.3	1103.3	1407.4	2865.6	2808.9
PEARL	293.8	186.1	390.5	376.2	131.6
ALA	7496.2	2584.7	7663.7	6873.2	3861.0
WARTOMMO	7480.0	6404.1	12303.1	18997.5	12981.8
MO	19989.6	22395.0	23582.9	16988.3	17559.4
APCHAPFL	3508.0	3802.5	3831.7	4005.6	4283.3
ATCH	802.7	1399.3	1793.3	3715.5	2731.3
RED	3505.6	4250.0	5841.7	9902.7	14690.1
OUACHBLK	7682.8	6649.0	9341.6	11805.8	9683.7
AIWW	19181.4	12476.7	17812.3	20043.7	20380.8
COLSNAKE	11792.7	21934.9	17812.5	21039.6	19414.1
KASK	13532.0	25240.5	12938.3	9497.1	5236.3
WILL	955.3	837.6	848.6	678.0	481.2
BRMOP	906.1	1088.8	1151.7	1337.1	1585.0
TOTAL	2887.72	3048.09	3267.92	3711.19	3272.74

TABLE 11

RIVER SYSTEM SEGMENT TOLLS
UNDER VARIOUS RECOVERY OPTIONS
(DOLLARS PER TON-MILE)

Options:

ACCG = 100% Recovery Corps and Coast Guard OM&R
IMP = 100% Recovery Corps Implementation Only
ACCGIM = ACCG & IMP
HALFALL= 50% Recovery of ACCGIM

SEGAVE	ACCG	IMP	ACCGIM	HALFALL
CAIROBR	0.00017	0.00017	0.00035	0.00017
MINCAIRO	0.00120	0.00034	0.00154	0.00077
ARK	0.03291	0.04956	0.08247	0.04123
WHITE	0.00653	0.00000	0.00653	0.00327
OHIO	0.00048	0.00229	0.00278	0.00139
MON	0.00170	0.00002	0.00173	0.00086
ALL	0.01438	0.00000	0.01438	0.00719
TENN	0.00084	0.00000	0.00084	0.00042
CUMB	0.00197	0.00087	0.00284	0.00142
KAN	0.00197	0.00000	0.00197	0.00099
GRBAR	0.00068	0.00000	0.00068	0.00034
KENT	0.03023	0.00000	0.03023	0.01511
ILL	0.00084	0.00031	0.00116	0.00058
GIWWW	0.00076	0.00001	0.00076	0.00038
MORGPA	0.00028	0.00000	0.00028	0.00014
GIWWE	0.00058	0.00016	0.00074	0.00037
PEARL	0.90789	0.00000	0.90789	0.45394
ALA	0.00821	0.03066	0.03887	0.01944
WARTOMMO	0.00091	0.00213	0.00304	0.00152
MO	0.01256	0.00469	0.01725	0.00862
APCHAPFL	0.03423	0.00316	0.03739	0.01870
ATCH	0.00164	0.00217	0.00381	0.00190
RED	0.00050	0.25944	0.25994	0.12997
OUACHBLK	0.01878	0.07226	0.09104	0.04552
AIWW	0.00892	0.02262	0.03154	0.01577
COLSNAKE	0.00564	0.02619	0.03183	0.01591
KASK	0.23438	1.3E+01	1.3E+01	6.73466
WILL	0.04160	0.00000	0.04160	0.02080
BRMOP	0.00011	0.00000	0.00011	0.00006

Relative expenditure levels of implementation versus total navigation costs are compared in Table 12. Implementation costs generally exceed OM&R costs on new rivers such as the Alabama-Coosa, Warrior and Red. However, major rebuilding programs on the Ohio River are also evident.

Finally, Table 13 calculates uniform ton-mile (fuel) taxes for the various recovery options. Although OM&R expenditures (and toll recovery levels) have risen over time, implementation expenditures are more variable. If 50 percent of all Federal navigation costs were chosen as a recovery option (HALFALL), the average (uniform) toll per ton-mile would be one versus 0.8 mil per ton-mile under 100 percent OM&R recovery only.

The above examination of implementation expenditures by river sector is intended to be descriptive only and should not be used to analyze impacts of new construction cost recovery. The data represent <u>total</u> (not annualized) construction expenditures in any one year and would overstate the effects on segment tolls of recovering implementation costs. Recovery options for new construction costs must involve the use of annualized project costs, given that typical waterway facility lifespans are 30 years or more. The CoE did not provide sufficient information to allow calculation of annualized costs. Serious consideration of new construction cost recovery would require a substantially more complex data base than is currently available. For example, project life, interest rates by project, and other data would be required in addition to construction cost estimates by facility.

TABLE 12

CORPS IMPLEMENTATION EXPENDITURES AS A PERCENT OF FEDERAL NAVIGATION COSTS (PERCENT)

IMP = 100 percent Implementation
ACCG = 100 percent Corps plus Coast Guard OM&R
TOTAL = IMP & ACCG

CC	IMP/ACCG	IMP/TOTAL
CAIROBR	0.994	0.498
MINCAIRO	0.281	0.219
ARK	1.506	0.601
WHITE	0.000	0.000
OHIO	4.745	0.826
MON	0.013	0.013
ALL	0.000	0.000
TENN	0.000	0.000
CUMB	0.443	0.307
KAN	0.000	0.000
GRBAR	0.000	0.000
KENT	0.000	0.000
ILL	0.373	0.272
GIWWW	0.010	0.010
MORGPA	0.000	0.000
GIWWE	0.278	0.217
PEARL	0.000	0.000
ALA	3.732	0.789
WARTOMMO	2.328	0.700
MO	0.373	0.272
APCHAPFL	0.092	0.085
ATCH	1.324	0.570
RED	520.404	0.998
OUACHBLK	3.848	0.794
AIWW	2.535	0.717
COLSNAKE	4.646	0.823
KASK	56.468	0.983
WILL	0.000	0.000
BRMOP	0.000	0.000

TABLE 13

UNIFORM TON-MILE (FUEL) TAXES FOR VARIOUS RECOVERY OPTIONS; FY 1971 TO 1975 AND SIMPLE 5-YEAR AVERAGE (DOLLARS PER TON-MILE)

FUELTX	1971	1972	1973	1974	1975
ACCG	0.00075	0.00070	0.00077	0.00088	0.00090
IMP	0.00113	0.00109	0.00123	0.00123	0.00098
ACCGIM	0.00188	0.00179	0.00200	0.00211	0.00188
HALFALL	0.00094	0.00090	0.00100	0.00106	0.00094

FUELAVE	5YEARAVE
ACCG	0.00080
IMP	0.00113
ACCGIM	0.00193
HALFALL	0.00097

3. WATERWAYS TRAFFIC IMPACT MODEL

The model essentially combines data concerning the geographical features of the waterways system, commodity flows on the system, estimated carrier rates and proposed user charges for the purpose of calculating the cost to shippers of the various cost recovery schemes and, ultimately, the systems effects of changes in traffic density. A network representation enables a simulated distribution of flows to be generated from O-D information, to which unit user charges can be applied in turn. Because these charges may vary widely among river segments, it is crucial to identify and preserve the many possible distances that various shipments travel through any segment.

The model is capable of analyzing waterway carrier rate and traffic impacts of a variety of proposed navigation cost recovery options and levels. When exogenous data or models indicate sector traffic impacts due to toll imposition, resulting effects on river ton-mile densities and segment payback tolls can be calculated by commodity. Revised traffic forecasts due to market or other non-user charge factors can also be analyzed on the network. In order to reduce analysis requirements to a manageable level, the Corps waterborne commodity flow data for 1972 is aggregated to 24 commodity groups. Waterway network analysis is conducted at the 29 major river sector level, although all calculations occur at the more micro port-equivalent level. Carrier rates are estimated by TSC, which employed a regression analysis relating the rate for a commodity to such factors as length of haul, origin-destination patterns and value of shipments.* User charges were calculated in accordance with procedures described in Section 2.

The following section describes the development of the model and examines some sample output. Alternative applications of the model system are also explored.

3.1 NETWORK REPRESENTATION

The waterway network used in the model is a modification of the Army Corps of Engineers network developed for the Inland Navigation Systems Analysis program (INSA). Complete network documentation is found in Reference (1). The network is composed of a set of hierarchically arranged components; river systems, sectors, ports, locks, and river reaches. The ports and locks represent network nodes while river systems and reaches are the links among nodes. River sectors or links are represented as aggregates of port-equivalents (PE). Each PE is a collection of river docks and ports to reduce the number of river origins and destinations to a manageable level for analysis. At present, the inland river system and Gulf Intercoastal Waterway of the U.S. are divided into 246 port equivalents.

In the TSC version of the network, port equivalent centroids only were used as nodes for a total of 246. With the exception of the areas around Mouth of Passes in New Orleans and the Barkley Canal between the Tennessee and Cumberland Rivers, the network is a "tree" with unique routings from

*The rate model, which is based on the Donley rates collected from the ACoE L&D 26 Study, performs creditably on major long-haul moves, but must be used cautiously for short-haul moves or flows which are uncharacteristic of those in the Donley Study. Where it is available, outside information concerning barge rates is used in place of regression estimates. A complete description of the derivation and estimation of the barge rate equations can be obtained from the authors upon request.

any node to another. Link distances were calculated from node to node as the differences between centroid locations of adjacent PE's. For analysis and reporting purposes, the network was aggregated into the twenty-nine river sectors listed in Table 1. The sectors correspond to available data on Corps and Coast Guard navigation expenditures as reported in Section 2, Volume I.

3.2 COMMODITY FLOWS

TSC obtained the 1972 Waterborne Commodity Flow data among PE's from the Corps of Engineers. The data were originally developed for the INSA program. The PE commodity flows consist of tonnage movements of 47 INSA commodity classes. To reduce analysis requirements to a manageable level, TSC aggregated the 47 INSA commodity groups into 24 related commodities. Table 14 lists the basic commodities analyzed in the model and in the user charge impact study. Certain recoding of commodities originating or terminating outside the inland river system and the Gulf Intracoastal Waterway was necessary to account correctly for all ton-miles in the U.S. river system. In that the data may not completely mask certain shippers at the PE level, the commodity flow data base can only be obtained through the Corps of Engineers (DAEN-CWO-M).

3.3 DISTANCE MATRICES

The computation of the ton-miles and user charges within each sector required the generation of twenty-nine 264x264 matrices of distances between nodes. Entry (i,j) of matrix K is the distance traversed within section k by a shipment originating in P_{E_i} and terminating in P_{E_j}. The more remote a sector, the sparser is its distance matrix. Initially, diagonal elements were taken to be zero; the incorporation of intra-PE flows was done independently and will be described later.

TABLE 14

COMMODITY GROUPS: USER CHARGE STUDY

TSC CODE	COMMODITY
1	Coal
2	Lube Oil/Coke/Crude
4	Gasoline
5	Jet Fuel/Kerosene
6	Distillate Fuel Oil
7	Residual Oil
8	Chemicals, Drugs, etc.
11	Synthetics
12	Fertilizer
13	Other Dry Bulk
14	Primary Iron & Steel
15	Waste/Scrap
16	Sand/Gravel
17	Salt
18	Lime/Bldg. Cement/Stone, Clay
19	Agricultural Products/barley, rye,oats
20	Flour, processed agricultural goods
21	Corn
22	Wheat
23	Soybeans
24	Forest Products/Lumber
25	Paper/Pulp
26	Phosphate Rock
27	Miscellaneous

To prepare for the construction of these matricies, the two regions without unique routings were isolated for analysis. In the New Orleans region, sectors 1, 14, 22, and 29 (see Table 1) were combined into one "supersector" and in the Cairo, Illinois Region, sectors 5, 8, and 9 were combined into another. These "supersectors" are important to the internal logic of the model but are transparent in the output reports.

The "gateway" nodes in each supersector were then identified according to the following rule: for any shipment from a node in one supersector to a node in another, the gateway node is the last node encountered in the originating supersector. There is a unique gateway for every such shipment. By this decomposition approach, we first obtained all distances for shipments wholly within supersectors, and then used the gateways to reconstruct shipments involving more than one supersector in order to obtain all other distances.

To describe the approach in detail, consider first the generation of distance matrices for supersectors 3 to 23 (supersectors 1 and 2 are more complicated and will be discussed afterward). The subnetwork contained in each of these supersectors has the property that there is a unique routing between nodes. Using an available path-building program the total distance was computed between every such O-D pair. For the remaining distances, either the origin or the destination or both are outside of the supersector of interest. In this case, using the pre-established gateway information, the distance is set to zero if the current supersector is not between the origin and destination nodes, or it is set to the appropriate already-computed distance within that supersector otherwise.

For supersectors 1 and 2, the distance matrices are three-dimensional because each element is associated not only with an origin and a destination, but a constituent sector as well. Again, we focused first on the O-D pairs within the supersector, employing the results of a CACI, Inc. analysis* of the 1972 PE-to-PE flows which derived the percentage of the total tonnage of all commodities flowing along each possible alternative route. The lengths of these routes were weighted by their respective percentages to arrive at the respective percentages to arrive at the average distance within each sector of the supersector. For example, from node 232 to 199 in supersector 1, there are three alternative routings, with 0% flowing via the Atchafalaya, 20% via the Port Allen Route, and 70% via New Orleans and other routes. The mileages of the routes in each constituent sector, and the computed average distances found by weighting these lengths by the given percentages. The remaining distances within these two supersectors were found in the same way as their counterparts in supersectors 3 to 23, except that it was necessary to keep track of the portion of each distance attributable to the various sectors within the supersector.

3.4 DIAGONAL DISTANCES

The elements of the distance matrices on the diagonals are the lengths of local movements wholly within PE's. For most cases, it was assumed that the average such distance would be half of the total PE length. The only exceptions were for those PE's were the principal commodity is sand and gravel, which typically moves short distances. In those

*CACI, Inc. of Arlington, VA developed the INSA models for the CoE.

instances, the distance was set to 15 miles. This rule was derived primarily to protect the integrity of traffic density estimates on rivers such as the Missouri and Arkansas which have large volumes (very short-haul) intra-PE movements.

3.5 USER CHARGE COMPUTATIONS

A battery of computer programs was developed to compute and print out the results of applying user charges to the various sectors. Based on unit charges, O-D flows, and the distance matrices obtained as described above, the following algebraic relationships were employed for this purpose:

(1) Total Distance $$D_{ij} = \Sigma d_{ijk} ,$$

(2) Rate $$R^c_{ij} = e^{B^c_{ij}}(D_{ij})^{b^c_z} ,$$

(3) Toll $$T_{ij} = \Sigma d_{ijk} t_k ,$$

(4) Fuel Tax $$F^c_{ij} = f_c D_{ij} .$$

Where:

d_{ijk} = distance from PI i to PI j in sector k ,

B^c_{ij} and b^c_z = rate parameters,*

t_k = unit toll in sector k,

f_c = unit fuel charge.

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* $B^c_{ij} = b^c_i + \Sigma X^{ij}_l + \Sigma B^c_l Y^c_l$, where X and Y are dummy variables in the regression equation $lN R^c_{ij} = B^c_{ij} + b^c_z \ln D_{ij}$.

3.6 OUTPUT

For each commodity and river sector, the model generates output reports as illustrated by Tables 15 and 16. The accompanying tables are classified by terminating traffic, although the same information is available by PE of origination. For example, Table 15 reports the origination pattern of corn received at PE 410 (the Lower Mississippi River port area between river miles 106.0 and 167.8). From origin PE 100 (Lower Mississippi River), average length of haul to PE 410 is 1195 miles. In 1972, 5000 tons of traffic move between these PE's at an average barge rate of $4.32 per ton. The segment toll for 100% OM&R recovery is $2.61 per ton and the uniform system fuel tax is $.95 per ton. The segment toll is 60 percent of the rate and the fuel tax would represent an increase of 22 percent. The segment toll is about 37 percent higher than the fuel tax.

The model also provides a weighted (by tonnage) average of each of the above variables for total receipts (or shipments, if summation is by origin) of each commodity at each destination (or origin). Table 16 presents the weighted average data for receipts of corn at PE 410, corresponding to Table 15 terminations.

3.7 APPLICATIONS

In addition to providing consistent and accurate origin-to-destination tolls, comparing them to estimates rates and then calculating weighted averages by origin and destination (first order shipper impacts), the model can perform other useful functions. Key among these is its ability to calculate ton-mile densities on each river segment (including originating, terminating, and through traffic) given the origin-

TABLE 15

1972 CORN TRAFFIC FLOWS TERMINATING IN PE 410
(LOWER MISSISSIPPI RIVER):
WATERWAYS TRAFFIC IMPACT MODEL OUTPUT

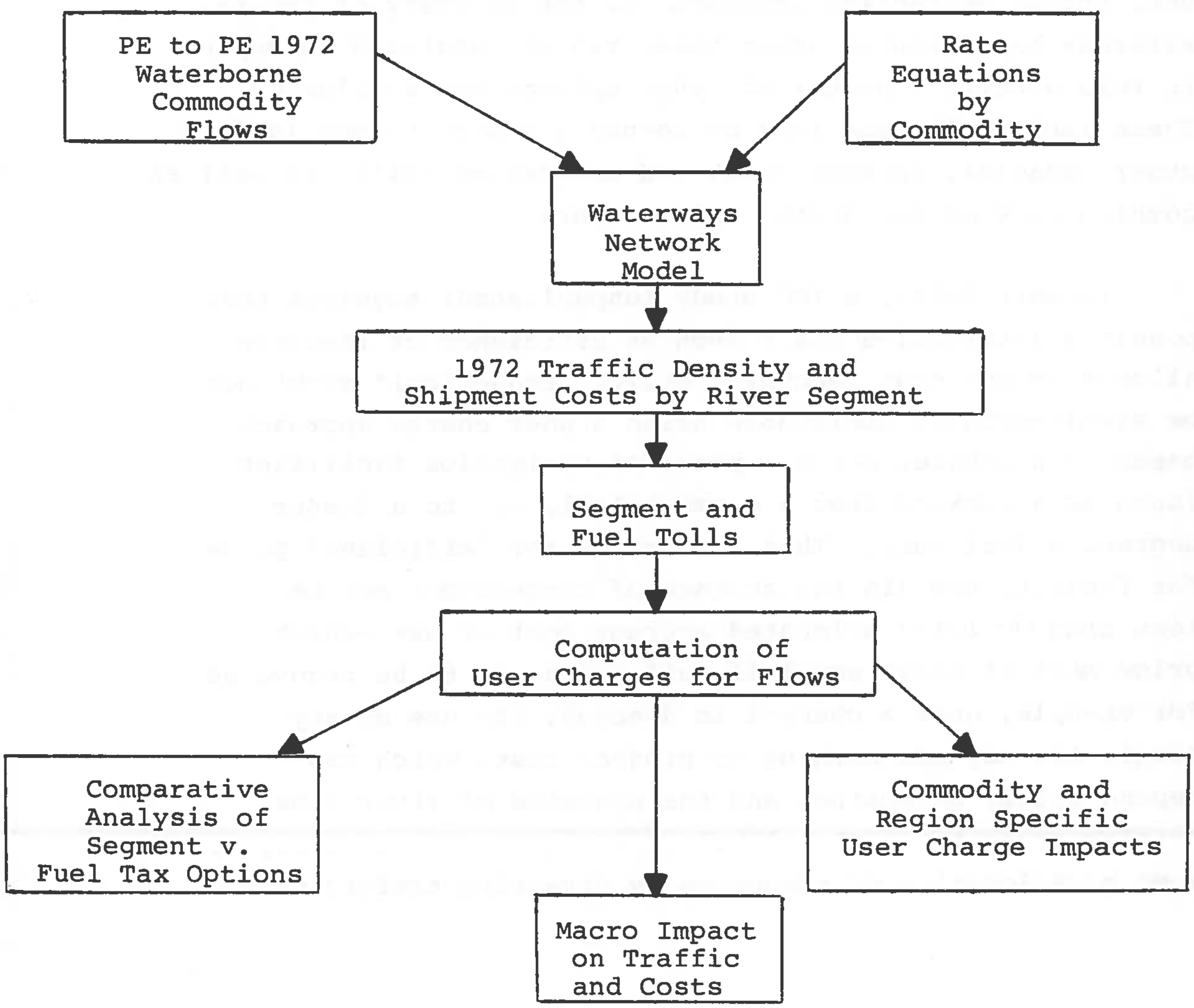
Orig. PE	(1) Mileage	(2) Tonnage (000's)	(3) Rate (c/ton)	(4) Toll (c/ton)	(5) Fuel tax (c/ton)	(6) (4)/(3) (%)	(7) (5)/(3) (%)	(8) (5)/(4) (%)
100	1195.0	5	432.076	261.062	95.481	60.420	22.098	36.574
105	1384.0	1	462.335	500.525	110.582	108.260	23.918	22.093
110	1642.0	4	500.242	827.411	131.196	165.402	26.226	15.856
200	826.0	4	364.436	13.547	65.997	3.717	18.109	487.174
210	954.0	16	389.462	19.691	76.225	5.056	19.572	387.104
216	976.0	3	393.577	20.747	77.982	5.271	19.814	375.873
220	1020.0	20	401.659	22.859	81.498	5.691	20.290	356.525
226	1066.0	1	409.911	25.067	85.173	6.115	20.779	339.783
238	1333.0	5	454.402	37.883	106.507	8.337	23.439	281.146
300	892.0	13	377.582	21.683	71.271	5.743	18.876	328.694
301	998.0	5	397.642	34.403	79.740	8.652	20.053	231.783
302	1018.0	170	401.296	36.803	81.338	9.171	20.269	221.010
304	1027.0	17	402.928	37.883	82.057	9.402	20.365	216.607
306	1041.0	3	405.451	39.563	83.176	9.758	20.514	210.237
310	1110.0	15	417.626	47.843	88.689	11.456	21.236	185.375
312	1133.0	42	421.593	50.603	90.527	12.003	21.473	178.896
314	1159.0	9	426.026	53.723	92.604	12.610	21.737	172.373
316	1182.0	105	429.902	56.483	94.442	13.139	21.968	167.204
318	1227.0	378	437.372	61.883	98.037	14.149	22.415	158.424
320	1246.0	215	440.481	64.163	99.555	14.567	22.602	155.160
322	1276.0	231	445.339	67.763	101.952	15.216	22.893	150.454
324	1304.0	95	449.817	71.123	104.190	15.812	23.163	146.492
326	1310.0	43	450.770	71.843	104.669	15.938	23.220	145.691
328	1337.0	129	455.030	75.083	106.826	16.501	23.477	142.278
332	1403.0	26	465.250	83.003	112.100	17.841	24.094	135.055
336	1458.0	238	473.571	89.603	116.494	18.921	24.599	130.011
340	1521.0	7	482.897	97.163	121.528	20.121	25.166	125.076
344	1548.0	73	486.830	100.403	123.685	20.624	25.406	123.189
350	1614.0	98	496.291	108.323	128.959	21.826	25.984	119.050
354	1646.0	350	500.803	112.163	131.515	22.397	26.261	117.254
356	1661.0	166	502.902	113.963	132.714	22.661	26.390	116.453
358	1673.0	53	504.574	115.403	133.673	22.871	26.492	115.831
360	1678.0	1	505.269	116.003	134.072	22.959	26.535	115.576
435	266.0	3	216.154	3.934	21.253	1.820	9.833	540.249
460	407.0	1	262.976	6.331	32.519	2.407	12.366	513.652
480	606.0	4	315.946	9.714	48.419	3.075	15.325	498.450
485	823.0	24	363.825	13.403	65.758	3.684	18.074	490.619
500	1101.0	145	416.061	44.543	87.970	10.706	21.144	197.494
505	1176.0	975	428.895	50.768	93.962	11.837	21.908	185.082
510	1235.0	1738	438.684	55.665	98.677	12.689	22.494	177.268
515	1278.0	222	445.660	59.234	102.112	13.291	22.913	172.388
520	1299.0	338	449.021	60.977	103.790	13.580	23.115	170.212
530	1329.0	143	453.772	63.467	106.187	13.987	23.401	167.311
535	1345.0	4	456.283	64.795	107.466	14.201	23.552	165.855
540	1366.0	31	459.553	66.538	109.143	14.479	23.750	164.032
1585	904.0	1	379.915	1484.972	72.230	390.869	19.012	4.864

TABLE 16

SUMMARY DATA BY TERMINATING PE;
1972 CORN FLOWS TO PE 410: SAMPLE MODEL OUTPUT

Weighted Mileage	Total Tonnage (000's)	Weighted Rate (¢/ton)	Weighted Toll (¢/ton)	Weighted Fuel Tax (¢/ton)	(4)/(3) %	(5)/(3) %	(5)/(4) %
1279.8	6171	445.102	65.221	102.259	14.653	22.974	156.788

destination pattern of waterway traffic. This allows analysis of river segment interactions and the secondary impacts of traffic diversion on ramining traffic. In Chapter 6, for example, the contribution of the traffic of selected high cost rivers to the rest of the system is analyzed, and the effects of the shutdown of each river on the remaining rivers are estimated. Figure 1 summarizes and links major model components and specifies typical outputs.



<u>FIGURE 1.</u> WATERWAYS TRAFFIC IMPACT MODEL FLOW CHART

4. ALTERNATIVE RECOVERY OPTIONS

4.1 BACKGROUND

Although fuel taxes and segment tolls have been the major user charge mechanisms proposed for the recovery of Federal waterway expenditures (only these two are analyzed in depth in this study), a number of other options are available. These include license fees on towboats and/or barges (and other vessels), lockage fees, and congestion tolls, as well as combinations of the above, among others.

In particular, a TSC study (unpublished) suggests that possible alternative goals such as efficiency of resource allocation and cost recovery (deficit reduction)* might not be simultaneously achievable using a user charge approach based on a single, per use price on navigation facilities (such as a lockage fee, a segment toll, or, to a lesser degree, a fuel tax). This is because the "efficient" price for facility use (in the absence of congestion) may be less than the fully allocated average cost of use--which price must at least equal if full costs are to be recovered. For example, once a channel is dredged, its use by any single tow may add nothing to project cost, which may depend solely on weather and the dynamics of river flow. Pricing project use at a level equal to average cost may create some misallocation of resources by diverting traffic which

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* Other goals might include equity between modes, equity between regions, administrative feasibility of the recovery program, etc.

could return its incremental costs, but not its "full share" of costs.*

Simultaneous achievement of both goals - efficiency and cost recovery - in the face of a significant fixed (i.e., non-variable with use) component of Federal navigation outlays is possible through the recovery of that component of costs via a fixed-fee (unrelated to system use) approach. Annual vessel license fees are the most feasible fixed fee option, with the possibility of implementing them in conjunction with use-related tolls to recover any costs which are variable with system use.

A more detailed analysis of the theoretical issues behind these alternative recovery options is found in the previously cited TSC study. This chapter initiates an exploration of alternative recovery options. The following sections calculate the necessary toll and fee levels under the alternative options based on expenditure data developed in Chapter 2 and briefly discusses some potential impacts. It is intended to be suggestive of levels of recovery and impacts rather than a complete study as in the case of fuel taxes and segment tolls.

4.2 VESSEL LICENSE FEES

License fees in the form of vessel registration taxes would be a relatively simple option for the collection of Federal navigation expenditures - especially for project costs which are insensitive to incremental navigation activity (most Army dredging, Coast Guard aids to navigation, new facility construction or time and weather-related maintenance). Such registration taxes could be imposed on towboats and/or barges on the basis of any number of vessel attributes including horsepower or registered

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*Questions of the economics of the second best and definition of variable versus fixed costs obviously make this analysis more complex than can be represented here. Further, an average (fully allocated) cost-based user charge which created little or no traffic dislocation could impose only a low level of resource misallocation, making the question of efficiency somewhat hypothetical.

tonnage for the former, and cargo capacity or fully loaded draft for the latter. The proportions of total costs to be collected from each vessel group (towboats, barges, fishing vessels, private dredges, etc.) would also have to be determined.

In this section, annual registration fees are calculated on the assumption that barge registration fees will recover 59% of the 1972 level of government costs ($67.3 million) and towboat fees will recover the remaining 41% ($46.0 million). [The 59:41 ratio reflects one estimate of the relative levels of private investment in the barge and towboat fleets, with no recovery from other vessel classes.]* Further, registration fees are calculated on the basis of HP for towboats and cargo capacity (in tonnage) for barges - a decision founded as much on data availability as on any other criteria.

These assumptions lead to an annual towboat registration fee of $18.40 per rated (towboat) horsepower and a barge registration fee of $3.13 per ton of load capacity (based on the 1972 Mississippi system and GIWW fleet).** Table 17 presents the annual registration fees for barge and towboat classes based on these per-unit fees. A typical barge tow

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* The estimate was provided by CACI, Inc., of Arlington, VA under contract to DOT for support tasks in the user charge study. An alternative estimate, based on average now towboat investment ratio (in $ value), is 70:21.

** Much of this analysis is derived from calculations provided by CACI, Inc. Detailed technical reports are available on request to TSC. Expenditures to be recovered are 1972 ACoE and CG OM&R expenditures less the AIWW and COLSNAKE sectors (see Chapter 2 , Table 6). Calculations for other years yield similar results.

TABLE 17

ANNUAL EQUIPMENT REGISTRATION FEES: 100% RECOVERY OF FEDERAL OM&R EXPENDITURES*

Barge Size	Annual Fee**	Towboat Class (HP)	Annual Fee***
100 x 26	$1,095	300	$5,520
120 x 30	1,252	600	11,040
150 x 32	1,565	1,200	22,080
175 x 26	3,129	1,800	33,120
135 x 40	3,136	2,500	46,000
195 x 35	4,694	3,300	53,033
200 x 50	5,650	4,300	79,120
185 x 54	6,568	5,000	92,000
245 x 35	7,509	5,700	104,880
240 x 50	8,606	7,000	105,800
290 x 53	9,390	8,400	154,560
		9,000	165,600

*1972 Federal (ACoE & CG) expenditure data.

**Based on $3.13/ton.

***Based on $18.40/horsepower.

(involving a 5000 HP towboat and nine 195 x 35 dry cargo barges) would pay a registration fee of $134 thousand per year. Using information from a recent MARAD study found in Table 18, the annual operating cost of such a tow would be approximately $925,000. Adding appropriate company overhead expenses, the fee would increase annual operating costs by slightly over ten percent (well within the range predicted under fuel taxes or segment tolls).

The impacts of license fees on waterway traffic are more difficult to assess than impacts of segment tolls or fuel taxes because the taxed unit (an annual operating right) is more distinct from the traffic metric (a ton or ton-mile). Thus, the composition of a given tow will normally change as it moves through the system, and any single consignment of goods may be moved by several different towboats in the course of a single origin/destination flow.*

The immediate impact of a vessel license fee would be in the form of an addition to carrier fixed costs - equivalent in carrier accounts and pricing strategy to overhead, insurance, or capital cost items. Because the tax would not be attached to specific shipments (except where equipment is in fully dedicated service or under annual contract), carriers will distribute the burden of the registration fee according to what "the traffic will bear." Spot barge grain rates which fluctuate 100-300 percent between peak and slack shipping seasons (see grain analysis in Chapter 3, Volume II) are an indication that carriers currently cover their private fixed

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* This is also a problem associated with a fuel tax recovery option, but only if a user charge is not viewed as a purely overhead cost by the industry.

TABLE 18

ANNUAL COSTS FOR TYPICAL INLAND WATERWAY VESSELS

TOWBOAT (5,000 HORSEPOWER/12 MAN CREW)

VESSEL RELATED	
Fuels and Lubricants	$264,000
Maintenance and Repairs	60,000
Insurance	48,000
Depreciation	132,000
Supplies	21,600
Telephone and Radar	1,200
Subtotal	$526,800
CREW RELATED	
Wages and Fringe	$254,760
Transportation	9,000
Food and Staples	19,200
Miscellaneous	2,640
Subtotal	$285,600
TOTAL	$812,400
BARGE (JUMBO-COVERED)	
Depreciation	$ 8,275
Repairs and Maintenance	2,500
Insurance	1,650
TOTAL	$12,425

Source: Domestic Waterborne Shipping Market Analysis: Inland Waterways Trade Area, A.T. Kearney for MARAD, NTIS Doc. COM-74-10412. (1973)

costs differentially over the year in response to market conditions. Fixing the rate at one level for the whole year would result in too little traffic in the off-season, and excess demand at harvest. Carriers maximize traffic and revenues by letting the varying market determine their rate.

While these comments would not apply to many commodity movements - e.g. private petroleum haulage or sand and gravel in conjunction with dredging operations - it is likely that traffic diversion in the aggregate could be minimized under a vessel registration tax approach.* It cannot, however, be deduced that the traffic impact differential would be great, or that some commodity flows might not be impacted to a greater degree under this approach. Particularly, any activities which imply greater than average idle time for equipment would suffer relative to fully utilized operations.

Another factor mitigating diversion in the short run is the tax avoidance would be scrapping or selling unprofitable equipment. Carriers would absorb profit losses in the short run rather than let traffic go as long as revenues were more than covering variable operating costs. In the case of a ton-mile tax, no ton would move which did not pay its share of variable costs plus the segment toll, while under the fuel tax, each ton would have to pay at least its share of increased variable costs.

In summary, although license fees may involve a more complex collection procedure than fuel taxes or segment tolls, initial investigations reveal several factors that could mitigate long-run carrier and traffic impacts of user charges. First, unlike segment tolls or fuel taxes, license fees would

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* Further comparative study among options would be needed to verify this presumption.

not be associated with any specific oommodity traffic (except previously mentioned dedicated tows). Carriers could use variations on value-of-service pricing to spread the impacts over traffic they determined as most able to bear user charge burdens. Second, since license fees would not be associated with a specific unit of service (such as tons or ton-miles), shippers would be less likely to know their true "share" of navigation cost recovery as determined by the carriers. They would not be able to use their market power to have carriers reduce rate increases as easily as under other recovery options. Third, since carriers with similar equipment would pay similar license fees, inter-carrier rivalry for traffic under user charge-induced market changes would be less than under other options. In all, these reasons imply that a license fee approach may cause fewer disruptions in the barge industry and act to minimize traffic impacts within the system. Further analysis would be required to validate these conclusions.

Lockage Fees

It has been suggested that a lockage fee (a charge for each operation at a lock) might be a reasonable options for recovery Federal outlays on locks (estimated at 63% of COE OM&R). Under such a proposal, traffic which does not use any locks would not be required to support their operation and maintenance. Obviously such an approach would have to be supplemented by a second procedure (fuel tax, segment toll, license fee, etc.) for recovery of dredging and other non-lock related expenditures. In addition to the basic equity argument for a lockage fee - only facility users pay - there is a related efficiency argument - toll payments are more closely ties to actual project use.* The following

* Any efficiency argument requires establishment of cost-use relationships at each lock.

section calculates the average lockage fees and corollary segment toll/fuel taxes necessary for recovery of 1972 federal navigation expenditures.

There are several ways of structuring a lockage fee. For example, a uniform lockage fee could be changed for a locking operation anywhere in the system - the estimated change would have been $171.20 at 1972 traffic levels and estimated lock OM&R expenditures* - or the fee could be calculated on the basis of the traffic volume and expenditure at each individual lock (the only approach which would capture the purported equity and efficiency characteristics of the lockage fee option). A national uniform lockage fee would have prejudicial impacts on small rivers - or, more particularly, small-chambered locks - for which uniform fees would be spread over fewer tons/lockage. A lockage fee which is uniform for all lockages on a river (i.e., not based on each individual lock's expenditure and traffic) would imply vastly different fee levels on each river (Table 19).

Among the various proposals for recovery under lockage fees, the lock-specific charge is the most appealing from a variety of perspectives. Although it is not possible to calculate lock-specific fees at present (due to data problems), certain observations on their overall impacts can be made. First, rivers such as the Allegheny and Kentucky, which have most of their commercial traffic activity on only small portions of the entire project would have lower user charge impacts under a lock-specific change, than under a river-specific lockage fee or a segment toll. This is because the significant government expenditures on little used locks would

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*The share of expenditures attributable to locks and the number of lockages performed on the system was developed from limited CoE data by CACI, Inc.

TABLE 19

LOCKAGE FEE CALCULATIONS

River Sector	# Locks	Lockages (Est. 1972)	Lock O&M (1971-1975 Avg.) (000's)	Lockage Fee
Upper Mississippi	28	69,377	$14,667.1	$211.41
Arkansas	17	3,438	12,070.5	3510.90
White	1	0	179.4	∞
Ohio	27	122,202	11,755.2	96.19
Monongahela	9	41,378	2,510.3	60.66
Allegheny	8	7,022	1,192.1	169.77
Tennessee	10	8,838	2,435.3	275.55
Cumberland	4	1,980	1,790.3	904.19
Kanawha	3	12,041	1,470.3	122.11
Green/Barren	3	29,240	909.2	31.09
Kentucky	14	9,980	1,258.4	126.09
Illinois	7	24,446	5,928.1	242.50
GIWW, West	8	56,326	5,029.3	89.29
GIWW, East	1	6,509	986.8	151.61
Alabama	3	1,261	831.1	659.08
Black Warrior/Tombigbee	6	12,693	2,669.3	210.30
Apalachicola/Chattahoochee/ Flint	3	1,136	3,541.5	3117.52
Atchafalaya	1	6,586	300.0	45.55
Black/Ouachita	4	963	1,593.1	1654.31
TOTAL	157	415,416	$71,117.3	$171.20

not be charged to the commerce using only more heavily used portions. For example, 100 percent of Kentucky River traffic has used only the first three of fourteen locks, and the bulk of lockages on the Allegheny use only the first three or four of 9 locks. Thus, the unused locks (and their Federal expenditures would atrophy with little system impact. Second, inordinate burdens would not be placed on the traffic at small-chambered locks to the benefit of larger locks whose tons per lockage is potentially greater. Finally, the role of individual locks in system operations would be more apparent to users of the river. Rebuilding or expansion plans by the Corp would be subject to greater scrutincy by those who had to bear the costs of the project.

Table 20 presents the results of a CACI, Inc. analysis of estimated dredging costs by river sector. The expenditure data is averaged over a 5 year period (1971-1975) to provide a longer term estimate of sectoral dredging requirements. Using sector ton-mile data, segment tolls required to collect back COE dredging plus CG expenditures are also calculated. On newer rivers (Arkansas, Ouachita/Black, for example) and heavily locked rivers (Kentucky, Allegheny), full cost recovery (final column of Table 20) via segment tolls substantially exceeds recovery costs for dredging and CG costs only. On a system-wide basis, the uniform fuel tax for dredging and CG costs only is forty percent of the total expenditure recovery fuel tax (final row of Table 20).

Traffic impacts of a lockage fee in combination with another option for non-lock federal costs cannot be assessed outside the context of a full system simulation. Origin to destination tolls would have to be estimated for all waterway traffic and potential impacts assessed in light of existing market relationships and distribution systems - as is done

TABLE 20

SEGMENT TOLLS REQUIRED TO RECOVER CoE DREDGING AND CG EXPENDITURES (BASED ON AVERAGE 1971 TO 1975 SYSTEM COSTS)*

(Mills/Ton-Mile)

Sector	Average COE Dredging Costs (000's)	Average CG (M&R Costs (000's)	Total Costs (000's)	Segment Toll (Dredging and CG)	Segment Toll (all OM&R costs)**
Lower Mississippi	$9,096.6	$1,252.2	$10,348.8	.158	0.17
Upper Mississippi	9,332.9	2,473.4	11,806.3	.550	1.20
Arkansas	855.0	340.8	1,195.8	2.539	32.90
White	177.0	55.1	232.1	4.145	6.50
Ohio	1,844.8	1,155.3	3,000.1	.098	0.48
Monongahela	13.0	56.1	69.1	.046	1.70
Allegheny	4.0	3.1	7.1	.085	14.38
Tennessee	39.0	725.3	764.3	.233	0.84
Cumberland	24.0	34.8	58.8	.071	1.97
Kanawha	0.0	27.7	27.7	.034	1.97
Green/Barren	1.0	52.0	53.0	.039	0.68
Kentucky	6.0	1.6	7.6	.173	30.23
Illinois	203.0	944.9	1,147.9	.141	0.84
GIWW, West	3,847.0	1,636.0	5,483.0	.324	0.76
GIWW, East***	694.6	333.4	1,028.0	.356	0.58
Pearl***	(275.6)	0.0	0.0	--	--
Alabama	356.0	36.5	392.5	3.115	8.21
Black Warrior/Tombigbee	400.0	427.1	827.1	.186	0.91
Missouri	14,000.0	627.4	14,627.4	11.132	12.56
Apalachicola/Chatta-Hoochee/Flint	5.0	11.4	16.4	.161	34.23
Atchafalaya	541.2	57.6	598.8	.244	1.64
Red	14.0	.6	14.6	.408	0.50
Black/Ouachita	268.0	2.1	270.1	2.178	18.78
TOTAL	$41,722.1	$10,254.4	$51,976.5	.319****	0.80****

*Some variation between these expenditures and those reported in Chapter 2 exist in that CACI had preliminary rather than final data for this work.

**Source: Chapter 2, Table 8.

***Pearl River included with GIWW, East.

****Uniform fuel tax, system basis.

in this study for segment tolls and fuel taxes. In conjunction with a fuel tax for recovery of non-lock expenditures, the lockage fee would remove the major cross-subsidy element of the fuel tax, while at the same time insulating the most commercially viable portions of projects like the Allegheny and Kentucky from their under-used portions, but little more can be said about their precise impacts. (One possibility is that they may encourage operations cost-cutting at low traffic locks by reducing operations hours.)

In summary, lockage fees and requisite segment/fuel charges for dredging and CG costs cannot be evaluated on the same terms as previously examined options. Serious consideration of this approach would require a full-system study as described in the preceding paragraph.

5. DIFFERENTIAL IMPACTS OF USER CHARGE OPTIONS AND RECOVERY LEVELS

5.1 BACKGROUND

In connection with user charge impacts on the waterways system, two major and interrelated issues require further examination. First, what are the relative waterborne traffic impacts of the two primary recovery options (fuel taxes and segment tolls) in a system-wide context. In other words, does the choice of recovery option affect the eventual traffic impacts of user charges. Second, if user charges are phased-in over time (for example, beginning at 10 percent of OM&R expenditures and cumulating to 100 percent recovery over ten years at 10 percent yearly increments), at what rate will traffic impacts occur during this period. It is expected that at different levels of recovery, impacts on certain traffic will be greater than other levels due to crucial changes in modal rate differentials.

The following chapter examines both questions in detail, using data and information developed in Volumes II and III.

5.2 DIFFERENCE IN RECOVERY OPTIONS

A common theme of Volume II chapters is that, for major waterborne commodity flows, fuel taxes would raise barge rates by a larger percentage than segment tolls. An implication is that fuel taxes could, in the long-run, be responsible for potentially greater traffic losses on waterways, especially in the long-haul/high traffic volume categories. The reason is that an uniform system fuel tax would require "main stem" (Lower Mississippi, Illinois, and Ohio) traffic to support barge operations on less utilized and more expensive (in terms of federal costs) rivers such as the Arkansas, Allegheny, Missouri and Ouachita/Black. The implicit subsidy for these rivers under the fuel tax would reduce the cost advantage waterways have over other modes on long-haul, high volume bulk movements. In some cases, diversion to alternate distribution systems or patterns may occur.

The purpose of this section is to analyze the differential effects of the subsidy on commodity movements and individual rivers. The analysis is based on appendices A to D of Volume III, which detail fuel tax versus segment toll impacts on barge rates by major commodity groups and rivers.

Coal traffic on the Upper Mississippi River (Cairo to Minneapolis) would be most affected by a segment toll given that federal expenditure per ton-mile is higher than the system average. For Illinois River utilities segment and fuel taxes were about equal in their impact on barge rates. Tennessee River utilities tend to be more affected by fuel taxes, although the evidence is mixed and dependent on the coal source(s) for each utility. Similar results exist for Ohio River utilities. For Allegheny, Monongehela and Kanawha River utilities, the fuel tax is only fifty to seventy-five percent of segment tolls. In sum, concentrating on high volume coal rivers, the fuel tax more severely impacts rates when hauls exceed 100 miles (average haul on the Ohio is 290 miles). If western coal and EPA Clean Air Act requirements result in longer lengths of haul on the waterway (as predicted), the fuel tax is less desirable than a segment toll for coal traffic in the long-run.

For grain traffic, shippers (with the exception of Missouri River wheat traffic) would substantially subsidize the high cost rivers under a fuel tax. As discussed in Chapter 3 of Volume II extra user charge payments on shipments to the Gulf under a fuel tax amount to 12 cents per ton (from Minneapolis) to 71 cents per ton (from Cincinnati). For Missouri River grains, segment tolls average six times higher than a fuel tax but only a fraction of total waterborne grain originates on the river (less than five percent). In the long term, a uniform system fuel tax could result in higher potential diversion of waterborne grain traffic than a segment toll. The situation is quite similar for fertilizer products. With the exception of Missouri River destinations, the fuel tax would tend to increase barge rates 1.5 to 3 times more than a segment toll. However, the Missouri River fuel tax is (on average) only eight percent of the segment toll.

For petroleum traffic, fuel taxes tend to result in larger rate increases than segment tolls, with the differential increasing as length of haul increases. Short-haul crude oil flows along the GIWW tend to be slightly worse off under a uniform fuel tax (twenty-five percent higher than segment tolls). In residual oils similar conclusions hold, with fuel taxes averaging 25 to 50 percent higher. Lower Mississippi residual flows would bear a fuel tax 2.9 times the corresponding segment tolls. Distillate oils, gasoline and jet fuel have longer lengths of haul and higher differentials. On a weighted tonnage average, fuel taxes are from 1.5 to 3 times segment tolls. In sum, fuel taxes on petroleum products would result in significantly higher barge rates in relation to segment tolls and could potentially have greater traffic impacts.

Iron and steel production would be affected on both the input and output stages. Metallurgical coal traffic would be most affected by a segment toll (but diversion is unlikely as shown). Residual oil flows would be most affected by fuel taxes as would waste and scrap inputs. Product shipments would face barge rate increases of twenty to eighty percent more under a fuel tax than a segment toll. In sum, fuel taxes appear less beneficial than segment tolls to this industry.

Most sand and gravel moves tend to be short-haul operations on high cost rivers. In general, fuel taxes would heavily subsidize these operations, averaging as little as 6 percent of corresponding segment tolls. For the Cumberland River, the segment toll is 3.4 times fuel taxes due to longer average length of haul (325 miles). Alternately, Ohio River sand and gravel traffic would be seriously affected by fuel taxes 50 percent higher than segment tolls. Regardless of recovery option, sand and gravel traffic would be substantially affected by waterway user charges.

In summary, a commodity and river sector analysis has borne out the original conclusion that uniform fuel taxes aimed at recovery of system-wide expenditures may have a more substantial impact on barge rates and perhaps future waterways traffic levels than segment tolls. The major exception is the Upper Mississippi River (Minneapolis to Cairo) which, due to high federal expenditures, has overall segment toll impacts that are slightly higher for major commodities than the fuel tax.*

5.3 DIFFERENCE DUE TO RECOVERY LEVELS

The major user charge proposals incorporate a phased approach to reach payback goals for federal navigation expenditures. For example, user charges would be set to recover some

*Petroleum products moving to Upper Mississippi destinations do, however, have a higher increase in barge rates due to fuel taxes. See Appendix Table B-24, Volume III.

percentage of total expenditures in the first year with increasing levels of recovery in future years. The DOT proposal originally proposed a fuel tax to recovery 10 percent of all future costs with an automatic increase to 20 percent after 3 years (unless the DOT Secretary intervened). The OMB proposal would collect back 50 percent of OM&R costs, phased in over five years. Additionally, 50 percent of new construction costs for projects not underway would be collected from commercial users.

The phasing-in of user charge collections is an attempt by federal decision-makers to minimize carrier traffic disruptions during cost recovery introduction. The assumption is that smaller (yearly) rate increases over time would give the barge industry a longer period of adjustment to progressively higher rates due to user charges. However, the impact of any level of user charge recovery on waterborne traffic depends import on the modal and inter-barge firm rate differentials by commodity group and market.

The implication is that each increase in navigation cost recovery would lead certain shippers (in diverse commodities and markets) to reconsider their shipments via waterways. It could be argued, for example, that even within a specific traffic category, impacts could vary substantially under different recovery levels. Highly (modal) competitive traffic would be most affected by initial levels of recovery. The real question is what factors determine the rate of traffic loss under phased user charges.

In general, traffic impacts would be determined by the distribution of commodity traffic by modal rate differentials and the ability of a shipper to change modes (or sources) over time. Here, the concept of rate differentials refers to the costs of alternative distribution systems, not just a line-haul mode comparison. Depending on how the user charge impact is allocated by carriers, rate differentials will fall and shippers will reconsider existing waterway delivery systems over time. Such changes will vary by markets as well as commodities. For example, commodities such as grains and sand/gravel with apparently low overall modal rate differentials would be affected immmediately upon user charge imposition. Other commodities such as residual fuel oil and coal may be affected only by substantially higher federal cost recovery levels.

Traffic impacts would manifest themselves sooner (i.e. lower recovery levels) under a river-specific recovery option such as the segment toll than under a uniform system-wide tax. This is true because traffic impacts are heavily concentrated on traffic involving high cost rivers where segment tolls are adequate to divert significant traffic even at the lower recovery levels. Thus, even at 10% recovery levels average segment tolls are 63¢ for Missouri River wheat shipments and over one dollar per ton for iron and steel received on the Arkansas. Clearly, significant diversion, especially given secondary "snowballing" effects, would occur at less than full recovery under a segment toll, with rivers like the Pearl, Arkansas, and Missouri in danger of shut-down at evwn 50% (or lower) recovery levels. Fuel taxes, on the other hand, would probably face a temporal diversion pattern similar to the pattern of recovery phase-in. Certain traffic such as the grains would face some immediate impacts which would increase roughly proportionately with toll levels, while other flows would be impacted at different points as the cost-advantage of particular existing delivery systems was challenged.

The precise dynamics of traffic impacts cannot be detailed beyond these observations. The "inevitability" of higher tolls may lead some shippers to alter their logistic systems in advance of higher tolls - causing more rapid (but not necessarily greater) systems loss than pure analysis might suggest - but the existence of such capital in barges, transfer facilities, etc., would have a countervailing impact.

In summary, the key difference between the impacts of the two approaches - river-specific (segment tolls) versus systemwide (fuel taxes) - is that in the former case, impacts are concentrated on traffic which originates and/or terminates on the high cost rivers, while in the latter case the geographic distribution of impacts is more uniform. Similarly, impacts would probably be concentrated in the early phases of implementation under a river-specific segment toll, but more gradual under a systemwide tax.

6. TRAFFIC AND EXPENDITURE CONTRIBUTIONS OF HIGH-COST RIVERS

6.1 BACKGROUND

The continuing development of the inland river system coupled with varying maintenance requirements among rivers results in substantial differences in federal expenditures across river sectors. Table 7 in Chapter 2 indicates the variations in Federal OM&R expenditures per ton-mile of traffic on each river segment. In general, newer rivers (Pearl, Arkansas, for example) and rivers serving as "branch-lines" for main stem segments (such as the Allegheny, Missouri, and Kentucky) have higher costs than the major rivers (Illinois, Ohio, and Mississippi). This chapter examines the role of so-called high-cost rivers in system traffic patterns and the impacts on user charges of the continued maintenance of these sectors.

6.2 ANALYSIS

A user charge in the form of a fuel tax would cause movements involving relatively high-cost rivers to receive an implicit subsidy from movements on relatively inexpensive rivers - such as the Ohio and Lower Mississippi Rivers. For example, Federal operations and maintenace expenditures on the Arkansas, Missouri, Allegheny, Kentucky, Pearl, Kaskaskia, Appalachicola-Chattahoochee-Flint, and Ouachita-Black Rivers exceeded 1 cent per ton-mile of traffic for the period 1971 to 1975*, while the Federal expenditure on the Ohio and Lower Mississippi Rivers was only .05 cent per ton-mile and .02

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*Actual toll levels are as follows (¢/ton-mile): Missouri 1.0; Arkansas 3.9; Allegheny 1.1; Ouachita-Black 2.3; Kentucky 2.3; Pearl 40.5; and Appalachicola-Chatahoochee-Flint 3.3.

cent per ton-mile respectively. This high expenditure per ton-mile exerts a significant influence on the level of the uniform ton-mile tax (fuel tax). Were these rivers no longer maintained by the Corps of Engineers, the cost of using the remainder of the inland river system would be substantially reduced. The purpose of this section is to quantify the cross-subsidy implicit in a uniform recovery approach (system-wide fuel tax or license fee).*

Table 21 identifies the ton-mile contribution of each of the selected high-cost rivers to inland waterway system traffic in 1972. For example, traffic originating and/or terminating on the Arkansas River contributes 1.639 billion ton-miles of system traffic - 535.9 million of which take place on the Arkansas River itself, 625.9 million on the Cairo-Baton Rouge portion of the Lower Mississippi River, 115.2 million on the Upper Mississippi, etc. While the seven high-cost rivers contributed over 7.6 billion ton-miles of total system traffic (4.5% of system traffic) in 1972, they accounted for $36.1 million of annual Federal expenditure (26.9% of system expenditure) from 1971 to 1975. A system-wide fuel tax without either the traffic or federal expenditures on these seven rivers would be only .06 cent per ton-mile or 23.4 percent lower than a fuel tax on the river system in its current configuration. This 23.4 percent represents the average cross-subsidy penalty on traffic which does not utilize the high-cost rivers.

Because traffic volumes on lower cost rivers would be impacted by a shutdown (or significant traffic loss) on the high-cost rivers, segment tolls on the remaining rivers would

*This analysis is not intended as a policy recommendation. It does, however, indicate that there might be pressures from within the industry - barge operators <u>and</u> users - to press for the elimination of certain projects which drive up tolls on the system as a whole.

TABLE 21

SYSTEMS TRAFFIC CONTRIBUTIONS OF HIGH COST RIVERS - 1972 TON-MILES

	ARK	ALLEGH	KY	PEARL	MO	ACF	OB	TOTAL
BR-MOP	97021557	22930212	324740	117920	130831445	8427292	43100556	302753722
CAIRO-BR	625852016	465858165	1811050	107200	222522199	4934038	72280338	2393365006
MIN-CAIRO	115222689	13135200	0	0	440050950	0	1868260	570277099
ARK	535,901,405	349629	0	0	0	0	0	536251034
WHITE	637840	0	0	0	0	0	0	637840
OHIO	142240368	905326851	1347392	0	72230820	0	1752338	1122897769
MON	656354	128116015	0	0	70087	0	0	128842456
ALL	85158	86967591	0	0	464854	0	0	87517603
TENN	6482745	2581504	0	0	162693635	0	499450	172257334
CUMB	0	400149	0	0	0	0	0	400149
KAN	115154	3155305	0	0	289790	0	0	3560249
G&B	0	0	0	0	0	0	0	0
KENT	0	0	43888370	0	0	0	0	43888370
ILL	25447518	0	0	0	15277912	0	2211060	42936490
GIWWW	73608188	90875082	0	0	36463299	12915707	123798651	337660927
MORGPA	7311368	12168578	0	0	8474264	0	17493490	45447700
GIWWE	4120329	638750	146300	298655	7969358	110917138	550690	124641220
PEARL	0	0	0	639375	0	0	0	639375
ALA	0	0	0	0	0	0	0	0
WAR-TOM	121307	0	521400	0	71804	2435826	0	3150337
MO	0	14455476	0	0	1421406900	0	0	1435862376
APCHAPFL	0	0	0	0	0	113157397	0	113157397
RED	0	0	0	0	0	0	0	0
OUACHBLK	0	0	0	0	0	0	127870820	127870820
ATCH	3917441	7128161	0	0	4828692	0	28797752	44672046
	1,638,741,437	1754086668	48039252	1163150	3523646009	252787398	420223405	7638687319

be affected. Table 22 shows estimates of segment toll impacts on the remaining rivers from elimination of the traffic of the seven selected high-cost rivers. While the effects range as high as 10% increase in the Monongahela River segment toll, the average (weighted) effect on the system would be only about a 3 percent increase in segment tolls.

6.3 SUMMARY

In summary, it appears that the secondary impacts from loss of traffic on the high-cost rivers are not a significant factor in segment toll levels on other rivers. The expenditures on high cost rivers, on the other hand, exert a strong impact on the level of uniform system-wide tolls - increasing them by more than 20 percent.

Several observations should be introduced at this point.

a. Traffic losses on low-cost rivers due to the shutdown of high-cost rivers are probably exaggerated somewhat in this analysis. Some traffic with an origin or destination on a high-cost river might well still move by barge for a portion of its route, with subsequent haul by another mode. Similarly, that diverted traffic might be replaced by an alternative source (or market outlet) which utilizes barge transportation without using the high-cost river.

b. Some of the adverse impact that the high Federal outlays on the high-cost rivers exert on system-wide tolls - and their own high segment tolls as well - might be avoidable by a redefinition of projects. For example, the Allegheny River has 9 locks and dams and a project length of 72 miles, yet little traffic uses more than the first four locks, and traffic which represents at least 75 percent of this river's ton-miles (and a greater share of its contribution to total system traffic) uses only the first three. [The

TABLE 22

TRAFFIC AND SEGMENT TOLL IMPACTS OF HIGH-COST RIVER TRAFFIC
(TON-MILE IN MILLIONS)

Code	Ton-Miles - 1972	Ton-Miles Without High-Cost River Contributions	Percentage Increase in Traffic	% Increase In Segment Toll
BR-MOP	11095.6	10792.9	-2.81	2.89
CAIRO-BR	60873.5	58480.1	-4.09	4.26
MIN-CAIRO	22249.2	21678.9	-2.52	2.59
WHITE	62.5	61.9	-1.03	1.01
OHIO	31965.0	30842.1	-3.64	3.78
MON	1546.1	1417.2	-9.09	10.00
TENN	3624.5	3452.3	-4.99	5.25
CUMB	760.0	759.6	- .05	.05
KAN	821.8	818.3	- .44	.44
G&B	1354.2	1354.2	-	-
ILL	8189.0	8146.1	- .53	.53
GIWW	20711.5	20373.8	-1.66	1.69
MORPA	949.7	904.2	-5.03	5.30
GIWWE	3364.7	3240.0	-3.85	4.00
ALA	135.1	135.1	-	-
WAR-TOM	4511.4	4508.2	.07	.07
RED } *	2.3	2.3	} *	} *
ATCH	363.8	319.1		
TOTAL	172579.7	167286.2		

*An accounting problem in the TSC model tabulates the traffic on the section of the Red River between the Ouachita-Black and the Old River as if it were occurring on the Atchafalaya River. This traffic accounts for the bulk of Red River traffic. Thus, the impact of closing the Ouachita-Black would be to effectively eliminate Red River traffic and leave the Atchafalaya relatively untouched (2-5%).

steam coal traffic, which may be pivotal to the river's survival under user charges, uses only the first sixteen miles of the project, and much of the long-haul petroleum traffic from the Gulf uses less.] Shortening the project would clearly minimize the user charge impacts on this river.

c. Some commerce on high-cost rivers, particularly in dredged sand and gravel would continue and even be facilitated by a shutdown of Corps of Engineers activity on the project. There are numerous non-project rivers in the United States which serve as sand and gravel sources -- e.g., the Kansas River.

7. COST RECOVERY OF IMPLEMENTATION EXPENDITURES

7.1 BACKGROUND

The Office of Management and Budget (OMB) user charge legislation proposal (January 1977) contains a section requiring 50 percent recovery of capital (new project) costs from commercial users (not states or localities) effective immediately for all facilities not yet under construction. The so-called "joint-venture" approach would require beneficiaries (presumably barge carriers) to pay one-half of any new project costs (initiated after legislative enactment). Cost payback would begin after the new project becomes operational. Recovery of these capital costs would be based on estimated annual charges necessary to recover, over project life, the required portion of capital costs (including interest charges during construction and operational periods). In reality, actual methods of capital cost recovery for new inland waterway projects have yet to be determined. The Secretary of the Army, responsible for collecting user charges, must determine optimal payback methods for both capital and OM&R expenditures under the OMB proposal.

The main purpose of this chapter is to examine some of the issues and problems associated with recovering sunk capital costs, The impacts of eventual (partial) cost recovery on initial investment decisions for waterway facilities involving public funds will also be briefly examined.

7.2 RECOVERY OF SUNK INVESTMENTS

The OMB proposal recommends the recovery of capital costs (50 percent) of new construction beginning after the project is operational. In general, economists consider the recovery of sunk and irretrievable costs associated with a facility investment a violation of efficient, short-run pricing policies for facility use. Traffic which could pay incremental-use costs of a facility would be denied access to a facility if it could not pay average cost (including capital expenses) required in capital payback schemes. The result is the classical user charge dilemma: the inability to simultaneously meet efficiency and payback goals under per-use prices on navigation facilities.

Regardless of the option or level of recovery chosen for capital costs, the recovery pricing structure should be based on an annualized cost over the operational lifetime of the facility. Implementation expenditures provide benefits over a number of years. The costs of constructing waterway facilities should be amortized over full project lifetime to determine correct recovery costs.

In essence, the recovery of average use costs (including capital charges) from present commercial users may be the correct social*price for system use even though it excludes certain traffic from the system. Under average cost pricing, any traffic unable to pay its share of fully allocated costs would move by an alternative distribution system. An average cost pricing strategy guarantees full cost recovery (in this case, 50 percent of capital costs), unless cost payback drives all users off the systems. Given that the fixed costs would be spread over smaller numbers of users, traffic loss could accelerate as recovery costs rose. The situation is similar to present conditions on many railroads where declining traffic volumes coupled with high fixed costs of operation have produced bankruptcy.* Such a pricing structure does provide an on-going economic test of the original and operations investment costs. Maintenance of a facility could be decreased or ended if users chose not to pay its costs.

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*Although it should not be inferred that user charges will bankrupt barge carriers in large numbers.

In summary, recovery of Federal capital costs of waterway facilities reflects a less desirable pricing policy with respect to sunk investments in that it may violate optimal short-run facility pricing strategies. However, decisions on capital cost recovery are inexorably linked to initial public facility investment decisions. The next section examines the question in more detail.

7.3 INVESTMENT CRITERIA AND USER CHARGES

If user charges (including some portion of capital costs) are legislated, facility investment decisions must be modified to include the market and carrier impacts of cost recovery. Resultant increases in overall transportation costs due to user charges may alter future distribution patterns and reduce the present economic vaibility of the investment in a facility. Imposing average-cost pricing on existing benefits evaluation procedures used by the CoE to justify facility rehabilitation or construction would alter decisions on many projects currently under consideration. The CoE would be required to develop new investment criteria, incorporating payback as a major component of the transportation pricing under the improved system.

A potential result of user charge imposition may be improved consideration of the optimal timing of facility rehabilitation or new construction. Phased upgrading in response to incremental changes in the required economic capacity of a facility would reduce overbuilding biases present in existing decision methodologies. In this manner, using correct pricing structures would result in socially optimal decisions over the long term. If user charges are implemented, consideration of cost recovery schemes in public investment analysis is essential to the efficient use of public resources within transportation.

A potential problem associated with user charges aimed at collecting new project capital costs is the divergence between traffic levels and available system capacity, especially on new river systems. Facilities built for traffic levels 50 years hence may have minimal traffic flows in initial years. If beginning traffic levels are low, the OMB would tax early users of the system at an annualized cost recovery rate (i.e., equal in all years of project life). An effect would be to discourage traffic growth or drive existing flows off the project. A capital cost recovery approach that initially collects much less than annualized capital costs and grows as traffic increase would allow a new project to develop traffic flows. Collection rates could be set to recover back the required 50 percent of capital, but would be phased in relation to traffic growth. Given that investment decisions depend on the projected traffic levels for initial justification, consideration of these factors must occur early in the decision process.

In summary, the effects of navigation cost recovery on investment decisions for public waterway facilities have yet to be determined. An ongoing DOT study in investment criteria within the transportation sector is investigating the above and other relevant issues.

8. TRAFFIC IMPACTS BY MAJOR COMMODITY GROUP AND RIVER

8.1 INTRODUCTION

Chapter 8 summarizes modal traffic impacts due to waterway user charges from two perspectives; by commodity class and by river sector. When relevant, traffic loss on all rivers from the diversion of commodity flows is presented. For example, if Illinois River corn exports are diverted to rail, the lower Mississippi River will also lose ton-miles.

The summary results lack many of the in-depth qualifications found in the distribution system analyses of Volume II. As such, they should be viewed as overall perspectives of maximum potential traffic losses under user charges. Correct citation of individual traffic impact data should reference relevant qualifications from Volume II.

In general, the traffic loss summaries reflect the interaction of ongoing market forces with potential user charges and their joint impacts on commodity distribution systems. Due to the dynamic nature of commodity market adjustment, differentiation of impacts among causal factors is frequently impossible. User charge impacts are generally segregated in the summaries, although certain traffic effects (such as on petroleum flows) may occur only in the presence of particular market conditions (e.g., excess pipeline capacity).

Further, the dynamic carrier and market responses triggered by the imposition of user charges cannot be summarized in a single set of commodity traffic diversion statistics. Acting in basic self-interest, shippers, carriers, producers, and consumers of waterborne traffic will act to minimize impacts on their operations. As a result, secondary impacts will begin almost immediately after user charge imposition. The simultaneous attempts by various economic agents to adjust to new waterway transportation price levels will have a significant effect on final traffic impacts. Any estimates of traffic diversion from waterways after user charges should be considered as a maximum effect, prior to bargaining among concerned parties to reduce overall impacts.

Finally, given that carrier, regional, and national income levels, market prices, and public investment strategies in transportation will also be impacted by user charges, traffic diversion represent only one metric in deciding on whether user charges should be imposed. In particular, effects on long-term plant investment and location decisions should also be investigated.

8.2 SUMMARY BY COMMODITY GROUP

Commodity traffic impacts summaries are drawn from the findings in Volume II: Distribution System Analyses. In general, major qualifications associated with a diversion estimate are mentioned, although detailed discussions are left to chapter summaries in Volume II.

Table 23 summarizes the basic findings on traffic impacts due to user charges. Column titles refer to the percent diversion predicted for each commodity (e.g., 10% corn - 10% of corn generated system ton-miles diverted). The impacts represent the effects of 100-percent OM&R segment toll imposed on a system-wide basis. Segment toll impacts are generally less than corresponding fuel tax impacts on commodity flows and should be considered as minimum system impacts due to full OM&R recovery user charges. An initial examination of Table 23 reveals that not all commodities analyzed in Volume II are represented. Coal, for example, was found to have little potential diversion due to user charges and was not included. Other commodities such as processed fertilizer, chemicals, and other dry bulks were deemed too difficult to analyze at present for user charge impacts. The following commodity summaries, however, will mention commodities excluded from the final diversion estimates in Table 23.

8.3 COAL

Detailed analysis of user charge impacts on waterways coal traffic has revealed that even 100-percent OM&R recovery would not seriously affect existing flows or hinder coal traffic growth over time. Some ton-mile changes may occur due to changes in utility coal purchase patterns but these have been predicted to increase coal length of haul over time. In general, the cost of a water-served utility to shift to delivery of coal by rail exceeds the additional costs user charges impose on water transportation. Further, potential energy market factors such as strip mining restrictions and Clean Air Act requirements will substantially exceed the cost impacts of user charges on the delivered price of coal. In summary, waterways coal traffic level and patterns are generally independent of user charge impacts, although some moves may be affected.

8.4 CORN

Barge corn traffic accounts for almost 20-billion ton-miles -- over 12 percent of total Mississippi River system traffic -- with over 95 percent of the ton-miles originating on the Upper Mississippi and Illinois River. Our analysis, which focuses on the dominant export trade, estimated potential diversion of about ten percent (2 billion ton-miles) under a segment toll and perhaps double that under a fuel tax. This traffic loss would be concentrated on the originating rivers and the Lower Mississippi which carries the long-haul to the Gulf ports (see Table 23). The Illinois, Upper Mississippi, and Lower Mississippi Rivers would lose 172.9-

million ton-miles (2.11%), 560.1-million ton-miles (2.52%), and 1.1-billion ton-miles (1.77%), respectively, under the segment toll. Impacts on other river segments would be significantly smaller. Impacts would be roughly doubled under a fuel tax.

As indicated in the grains analysis, potential traffic losses probably exaggerate the most probable impacts. To the extent that rail rates and processor and feeder bid respond to barge rate increases, traffic loss will be reduced (and farm income impacts increased).

8.5 SOYBEANS

Soybeans accounted for 8.65 billion ton-miles (5.3%) of Mississippi River System traffic in 1972, with almost 60 percent of the ton-miles concentrated on the Cairo-Baton Rouge segment of the Mississippi River. (The percentage on this segment is somewhat higher than for corn because of soybeans shipped from the Southern growing area (the Delta Region). while we estimate potential traffic loss of approximately ten percent under a segment toll and twenty to twenty-five percent under a fuel tax for Upper Mississippi River and Illinois River export traffic, these estimates probably overstate diversion potential for soybean originating below Cairo. Ten-percent diversion of all river soybean traffic would mean a ton-mile loss of 0.53 percent of system ton-miles, with impacts slightly higher on the Upper and Lower Mississippi Rivers (0.88% and 0.84%, respectively.) The percentage traffic loss on the Illinois River (0.5%) would be about the system average. A fuel tax would have correspondingly higher potential traffic impacts. As in the case of corn, traffic impacts would be mitigated to the extent that railroad rates and processor bids were responsive to increase barge costs.

8.6 PHOSPHATE ROCK

Because shipment of phosphate rock to Northern plants would bear a particularly large toll per unit of phosphate content (relative to fertilizer product) and because current distribution economics already favor the processing of rock in the South, we factor in a high diversion potential (50%) for barge traffic in this commodity. (See Table 23.) The sole exception to this is the Lower Mississippi River below Baton Rouge, where upward of eighty percent of the traffic in rock is to processors in that area. Thus, we only divert 10 percent of traffic in this segment (50% x 20%) to represent diversion of through traffic. As in the case of grain traffic greatest losses in absolute terms occur on the main stems, (Upper and Lower Mississippi and Illinois Rivers) with losses in each case accounting for less than one percent of segment traffic. Clearly impacts would be somewhat lower under the segment toll than under the fuel tax because of the indicated traffic pattern.

8.7 IRON AND STEEL PRODUCTS

Although it was not possible to be very precise in analyzing this traffic because of over-aggregation in the data, we put a ceiling on diversion of ten percent, with considerably lower diversion expected, particularly under a segment toll because of the heavy concentration of iron and steel ton-miles on the low-cost Ohio and Lower Mississippi Rivers (70%). Ten percent diversion would cost these rivers 0.82 percent and 0.39 percent of their respective ton-miles. Smaller impacts would be felt on most other rivers.

8.8 SAND AND GRAVEL

Table 23 reviews the impact of sand and gravel traffic diversion on the waterway system under two scenarios - for total diversion(1) and for expected diversion(2). On only a few rivers is sand-and-gravel traffic of sufficient importance to create a "snowballing" situation in which losses of this transportation sensitive commodity lead to higher tolls and more traffic losses in a spiral that leads to segment non-viability. These include the Kentucky (sand and gravel equals approximately 100% of ton-miles), the Alabama (88%), and, to a lesser extent, the Cumberland (33.5%), the Allegheny (32.9%), and the Apalachicola, Chattahoochee, Flint (19.5%), most of which are high cost rivers.

In most cases, expected sand and gravel diversion, though higher than for other commodity groups because of its relatively low value and ubiquity, is considerably less than total. Effects are normally isolated on individual segments, with little system interaction, and, therefore, little main stem river impacts.

8.9 CRUDE OIL

The analysis of crude oil traffic impacts due to user charges did not specify a potential diversion percentage. Based on a study of future pipeline requirements, substantial crude oil capacity will not become available. User charge-induced barge rate changes may affect a maximum of 10 percent of long-haul waterborne crude oil traffic from Gulf Coast origins. Total system ton-mile loss would be .8 percent, with the GIWW-West and Baton Rouge to Gulf sectors losing about 3 percent each of their ton-miles. Only part of the shift can be directly attributed to user charges.

8.10 PETROLEUM PRODUCTS

Petroleum products traffic on inland waterways has fallen substantially in the past five years, due partially to a stagnant economy and partly to pipeline competition. The analysis predicted increasing pipeline competition for waterborne petroleum product flows since domestic Gulf refinery production is falling. User charges will accelerate (mostly) and cause (somewhat) increased diversion of traffic from water to pipeline. A predicted maximum of 25 percent products traffic loss would be associated with the combined market and user charge changes in the next ten years. Again, only a portion (unknown) of the traffic loss can be attributed directly to user charges. In total, system ton-mile loss from a twenty-five percent fall in products traffic would be about 2 percent, with Gulf Coast waterways losing the greatest amount of ton-miles. Table 23 details the results for both crude oil and petroleum products.

8.11 CHEMICALS

The nature of data aggregation makes ton-mile diversion analysis relatively meaningless for this group since commodities with different diversion properties are combined in the data. The separate chapters - fertilizers for anhydrous ammonia, and chemicals for petrochemicals and sulfur - should be referenced for insights into this group.

8.12 CONCLUSION (COMMODITY SUMMARIES)

The information presented in Table 23 indicates that approximately 10 percent of waterborne traffic may be displaced to other modes during the period of segment toll imposition. Unfortunatley, both market and user charge impacts are contained in the results. TSC analysts consider a range of five to ten percent traffic loss under segment tolls an acceptable figure. Diversion under a fuel tax eventually collecting 100% OM&R may run twenty-five to fifty percent higher than segment toll impacts.

Table 23 also indicates that if high-cost rivers were rationalized out of the system, maximum ton-mile loss would be only 4.4 percent. With longer pre-river hauls, much of this traffic could be put directly or main stem rivers so that 4.4 percent is an upper bound. The "cost" of maintaining these rivers is diversion of main stem traffic under a fuel tax. As reported in Chapter 6, rationalizing the seven high-cost segments would reduce the uniform system fuel tax by about twenty-five percent. Further study would be necessary to determine if the net system benefits associated with system rationalization outweigh potential costs. Clearly, ton-miles per Federal OM&R dollar are substantially higher on main stem rivers. By maintaining marginal rivers, overall system efficiency and viability may be threatened by navigation cost recovery schemes that subsidize high cost, low-volume rivers.

Finally, certain river sectors lose substantial internal ton-miles due to segment toll imposition. For example, the Cumberland and Kentucky Rivers, among others, experience a dramatic reduction in ton-miles due to sand-and-gravel traffic diversion (see Table 23, last column). The Lower Mississippi sectors (CAIROBR and BRMOP) have their ton-miles reduced ten to twelve percent due to segment toll impacts on long-haul grain and petroleum traffic. The Upper Mississippi and Illinois waterways experience slightly lower ton-mile losses than the Lower Mississippi for the same reason. Gulf Inter-coastal waterway ton-miles decline primarily because of the reduced petroleum traffic, a phenomena already occurring due to market forces. In summary, major ton-mile diversions are due to losses in sand and gravel traffic as well as grain and petroleum movements.

TABLE 23
WATERBORNE TRAFFIC IMPACTS DUE TO MARKET AND USER CHARGE FACTORS BY COMMODITY AND RIVER (MILLIONS OF TON-MILES)

Sector	Baseline Ton-Miles (10^6)	High Cost Rivers Ton-Miles	%[e]	10% Corn Traffic Loss Ton-Miles	%[e]	10% Soybeans Ton-Miles	%[e]	Sand & Gravel Ton-Miles Scenario 1	%[e]
CAIROBR	60113.0	2392.1	3.98	1061.9	1.77	503.6	.84		
MINCAIRO	22249.2	565.6	2.54	560.1	2.52	195.2	.88	15.4-18.4	.06-.08
ARKANSAS	540.1	540.1	a	1.0*	0.19	1.6	.30	3.9-5.9	.72-1.09
WHITE	62.5	.6		.02	0.03	5.0	.08	c	
OHIO	31965.0	1096.0	3.43	9.9	0.03	15.0	.05	262.1-314.5	.82-.98
MONON	1546.1	12.9	0.96	0	-	0	-	16.9	1.09
ALLEGH	87.0	87.0	a	0	-	0	-	14.3	16.44
TENN	3624.5	17.2	0.47	30.4	0.84	5.7	.16	140.0	3.98
CUMB	760.0	.4	0.05	0	0	0	-	127.4	16.76
KAN	821.8	3.6	0.44	0	0	0	-	8.9-13.4	1.08-1.63
G&B	1354.2	0	-	.02	n	3.4	.41	c	
KENT	43.9	43.9	a	0	0	0	-	43.5	99.09
ILL	8189.0	42.9	0.52	172.9	2.11	41.1	.5	92.0	1.12
GIWW-W	20711.5	337.7	1.63	.6	n	4.7	.02	c	
MORGPA	949.7	45.4	4.78	.1	0.01	.2	.02	c	
GIWW-E	3364.7	124.6	3.70	2.3	0.07	3.3	.1	c	
PEARL	.6	.6	a	0	0	0	-	0	0
ALA	135.1	0	0	0	0	.2	.1	59.2	43.82
WAR-TOM	4511.4	3.2	0.07	.2		1.9	.04	c	
MO	1421.4	1421.4	a	1.0	0.07	3.4	.24	48.7[d]	3.43
AP/CHA/FL	113.2	113.2	a	.03	0.03	.03	.03	c	
RED	2.3	0*	0	0	0	0	-	0	0
OUACH/BL	127.9	127.9	a	0	0	1.0	.78	c	
ATCH	363.8	44.7*	12.3	n	n	.5	.14	c	
BRMOP	11095.6	302.8	2.73*	149.8	1.35*	79.7	.72	c	
TOTAL	163057.9	7323.8	(4.4)[b]	1990.3	(1.22)	865.5	(.53)	853.3	(.05)

[a]High cost rivers lose 100% of traffic - except that which can remain in unmaintained river (e.g., dredged sand and gravel).

[b]A large share of phosphate rock tonnage of BRMOP is to processors along that segment and will not be diverted. The figure here is based on 50 percent diversion of through traffic only. Since this traffic is roughly 20% of phosphate rock traffic in BPMOP, 10% (.5 x .2) is calculated

[c]Not separately analyzed.

TABLE 23 (CONT.)

Sector	Sand & Gravel Ton-Miles Scenario 2	%[e]	Phosphate Rock 50% Ton-Miles	%[e]	Iron & Steel Ton-Miles	%[e]	Crude Oil 10% Ton-Miles	%[e]	Petroleum 25% Products Ton-Miles	%[e]	TOTAL % sector Ton-Miles diverted
CAIROBR	450.5	.74	456.2	.75	236.4	.39	338.4	.5	1355.5	2.3	10.53
MINCAIRO	61.4	.28	187.7	.84	41.2	.19	19.2	.1	48.4	.3	7.44
ARKANSAS	38.8	7.18	n	n	9.7	1.79	0	-	0	-	3.28
WHITE	3.4	5.50	n	n	.02	.03	0	-	0	-	.14
OHIO	1048.3	3.28	0	0	260.7	.82	92.9	.2	457.5	1.5	6.83
MONON	33.8	2.19	0	0	3.2	.21	.2	-	1.0	.3	2.56
ALLEGH	28.6	32.91	0	0	.2	.28	0	-	0	0	16.72
TENN	280.0	7.73	0	0	11.7	.32	8.9	.2	14.8	.5	6.47
CUMB	254.7	33.51	0	0	3.9	.52	1.6	.2	28.8	3.8	21.33
KAN	[illegible]	10.86	0	0	.2	.02	.4	0	7.3	1.0	2.96
G&B	.25	0.02	0	0	.02	n	0	-	0	-	.41
KENT	43.5	99.09	0	0	.04	.08	0	-	0	-	99.17
ILL	184.0	2.29	70.5	.86	30.1	.37	20.1	.2	32.8	.5	6.18
GIWW-W	408.0	1.76	13.8	.07	61.4	.27	693.9	2.9	604.0	2.8	7.69
MORGPA	4.9	0.51	0	0	4.1	.44	10.6	.7	35.5	3.5	9.45
GIWW-E	43.3	1.29	10.3	.31	6.1	.18	18.0	.5	80.3	2.3	7.16
PEARL	0	0	0	0	0	0	0	-	0	-	-
ALA	118.4	87.67	0	0		n	0	-	0	-	43.82
WAR-TOM	53.4	1.18	2.7	.06	61.1	.36	9.5	.2	0	-	.73
MO	97.4[d]	6.85	.8	.06	2.0	.14	0	-	0	-	3.94
AP/CHA/FL	21.0	18.52	0	0	0	0	0	-	0	-	.06
RED	0	0	0	0	0	0	0	-	0	-	-
OUACH/BL	2.0	1.60	0	0	.03	.02	.2	.1	0	-	.90
ATCH	2.1	0.59	0	0	.7	.19	9.3	2.4	17.0	5.0	20.03
BRMOP	17.7	0.16	42.6[b]	.39	30.2	.27	168.0	2.7	332.0	3.3	11.46
TOTAL	3284.7	(2.01)	784.8	(.48)	718.5	(.44)	1385.9	(.8)	3015.4	(2.0)	

9.9% system traffic loss due to segment tolls.

[d]This is based on average haul of 15 miles, probably a bit long for operations on this river.

[e]Percent of sector ton-miles.

[n]Negligible.

*Network routing problems misallocate small amounts of traffic among these sectors.

8.13 SUMMARY OF RIVER IMPACTS

The following section examines user charge impacts on major commodity traffic by river sector. Each river (see Chapter 2, Table 1 for a list of river sectors studied) is first characterized by major traffic flows and then in terms of commodities most sensitive to user charge imposition. Regional price and income effects are not discussed in detail although they can be inferred from predicted barge rate increases under user charges. These summaries should be read in conjunction with the summaries by commodity class in the previous section.

In general, these river summaries are not intended to duplicate the detailed technical analyses of Volume II. The results do not mention many of the qualifying factors that influence the variability in impact levels by river. They are intended to give a broad systems perspective to user charge impacts and do not represent conclusions in the general sense of the term. Traffic impacts and/or diversion from user charges should not be the only metric used to judge whether or not navigation cost recovery should be implemented.

8.14 UPPER MISSISSIPPI RIVER -- MINNEAPOLIS TO CAIRO

Because of expenditure data limitations, we are forced to analyze this river as a single project - i.e., with a single toll for its entire length. This makes the segment toll for the portion of the river north of Locks and Dam 26 somewhat lower than it would be (it is 50% higher than the system average already) because the heavy through traffic moving between the Illinois River and Cairo subsidizes the first 25 locks and dams on the segment. More properly, tolls should be assessed with this river split at least in two - at the Illinois River - and probably again isolating the Iowa area (frequently called the Middle Upper Mississippi) from the Minnesota area.

Forty-three percent of the ton-miles on this river are accounted for by grain -- about one-fourth of which are from Illinois River through traffic -- most of it destined for Gulf ports. Coal is the next largest component, with 21.2 percent of segment ton-miles (mostly in the form of deliveries to Minneapolis-St. Paul area utilities), followed by petroleum products with 10.2 percent. The remaining traffic (25%) is spread rather evenly over our remaining commodity classes - e.g., chemicals (4.7 percent), fertilizer (3.4 percent), and sand and gravel (2.7 percent).

The grains, which produce more than 16 billion ton-miles on the system (not including the Illinois River through-traffic) are clearly the most important, and probably the most sensitive major commodity flow on this river. Existing dynamic factors in this transportation market made precise estimates of grain diversion impossible. Relatively new unit train-to-barge terminal gathering rates are tending to make barge line-haul more competitive (gathering grain all the way from Western Iowa at certain times of year) at the same time that other railroads are providing improved unit train options for direct rail export. In light of this uncertainty, we place an upper bound on grain diversion of 10% under the segment toll and 15% under a fuel tax, with potential diversion under either approach increasing at the upper end of the project. As in the case of the Illinois River, however, rail rate and market response could offset much of this traffic loss, meaning that more of the burden would impact regional incomes.

Up to 10 percent of coal ton-miles (but no tonnage) might be diverted as Upper Mississippi utilities would shift some of their receipts from Illinois coal to rail/barge western coal with shorter river hauls. Because of the high segment toll on this river, this factor might be somewhat greater under that option.

For the remainder of traffic, the relative burden of the segment toll and fuel tax tends to favor the segment toll, with inflows of petroleum products, chemicals, fertilizers, and "other dry bulks" generally having lower origin/destination segment tolls by as much as 50 percent - higher for Gulf-Upper Mississippi moves. Flows - other than grains - originating on the Upper Mississippi tend to favor the fuel tax slightly because they remain (to a greater extent) on this relatively high-cost river for most of their journey.

8.15 ILLINOIS WATERWAY

The Illinois Waterway carries over 8 billion ton-miles of traffic and generates significantly more than that on the remainder of the system. Illinois River corn shipments alone contribute almost 11 billion ton-miles throughout the system, and petroleum product receipts an additional 4.8 billion ton-miles. Grain account for 26.7 percent of ton-miles on the Illinois River, followed by petroleum products (17.7 percent), coal (14.5 percent), and chemicals (9.5). The remainder of traffic is spread over a wide variety of commodities.

Because of its traffic pattern, segment tolls tend to favor Illinois Waterway traffic. Almost 90 percent of Illinois Waterway grain traffic is destined for export ports in the New Orleans area. This traffic pattern reflected in the fact that the average fuel tax on grains from this area exceeds the segment toll by 55-65 percent (the difference is greater for export-bound traffic alone) even though the Illinois is a slightly higher-than-average-cost river. Diversion of up to 10 percent of this grain traffic under the segment toll and 20 percent under the fuel tax is possible although it could be substantially mitigated by rail rate increases for export grain or price responses in competing domestic grain outlets. In lieu of diversion, the burden of segment tolls (or higher fuel taxes) would be more completely passed back to farm prices of grain.

Because of the presence of long-haul flows from the Gulf, petroleum and product traffic is also least impacted under the segment toll - especially crude oil and residual fuel oil - which suffer a 50% penalty under the fuel tax. To the extent that pipeable volumes are adequate to justify pipeline capacity expansion, a significant share of petroleum flows are potentially divertible, with user charges providing an added economic incentive. Diversion of the non-pipeable residual fuel oil to another mode is less likely, nor is fuel conversion in the short-run.

Coal traffic to Illinois Waterway utilities will not be significantly impacted by user charges. The bulk of the traffic is rail/barge western coal entering the river at Havana. Some shortening of haul length is possible, with some of the traffic now entering the river at E. St. Louis being transshipped at Havana, but overall tonnage will be unaffected. Segment tolls and fuel taxes would have comparable impacts, if any.

Sand and gravel traffic (roughly 2-3% of total ton-miles) would face significant diversion potential in spite of low tolls (4-5¢ per ton) because of good supplies from land based quarries in the area. Urban road congestion in the Chicago area might help preserve half or more of the waterway tonnage however.

8.16 OHIO RIVER

With more than 30-billion ton-miles, the Ohio River accounts for almost twenty percent of Mississippi River system traffic. Coal makes up the largest volume flow with almost 30 percent of Ohio River ton-miles, followed by petroleum products (16.4%), crude petroleum (12.2%) - this flow has since been virtually replaced by a new pipeline in the Ohio River Valley, chemicals (11.7%), iron and steel (7.6%), "other dry bulks" (7.3%), sand and gravel (3.1%), and all other commodities (11%).

About 3.5% of Ohio River ton-miles come from traffic on rivers with segment tolls greater than 1 cent per ton-mile, with 80 percent of that amount accounted for by interaction with the Allegheny. While it might be presumed that this component of traffic could be highly susceptible to a segment toll - as opposed to a fuel tax - it should be recalled that overall origin/destination tolls on for the traffic interaction with the Allegheny actually favor the fuel tax because of relatively long-hauls on lower cost rivers. [No such phenomenon can make up for segment tolls paid on the Arkansas, Kentucky, and Missouri Rivers, but these contribute less than 1 percent of Ohio River.]

Coal traffic along the Ohio moves to major utilities committed to barge delivery systems via long-term facilities investment. Diversion to alternative distribution patterns is unlikely given that average user charges on coal traffic are only eleven cents per ton at 100 percent recovery levels. Impacts of EPA Clean Air Act controls on utility stack gas emissions may alter coal movements on the Ohio much more than user charges. Some diversion of petroleum and products is possible, as exemplified by a 35 million barrel crude oil flow which left the Ohio River in 1974 after completion of a pipeline from Western Kentucky to the Huntington, W. VA area. User charges may encourage the economics of further diversion of this sort. With the average origin-to-destination user charge under a fuel tax 100% higher than the corresponding segment toll for petroleum traffic terminating on the Ohio, this incentive for such change would obviously higher under that option -- the fuel tax is generally about 30-40 percent greater for petroleum moves within the Ohio Valley region, and 200 percent (or more) greater for receipts from the Gulf.

The greatest flows of iron and steel on the Ohio River move from the Pittsburgh area to points on the Ohio River and tributaries (42%) and Gulf of Mexico (25%). [Of the lower volume of shipments from the mid-Ohio Valley, over half are destined for points in the vicinity of the Gulf.] As such, these flows are more heavily burdened by fuel taxes than segment tolls - the sole exception being barge shipments to the Arkansas, which would probably be diverted from all-barge delivery although barge-rail shipments via a lower Mississippi port would possibly leave the Ohio River portion of those flows intact. Diversion of as much as ten percent of Ohio River iron and steel traffic would not be anticipated.

"Other dry bulks," including ores and fluxes for steel-making among others, is another commodity group which moves into the Ohio River area with long hauls on the Lower Mississippi and Ohio River causing segment tolls to fall generally below fuel taxes for full origin-destination movements. Diversion of some of this traffic (much of which is imported through the New Orleans area) to rail delivery from Atlantic ports is a possibility although rail congestion in that area may constrain this somewhat.

Finally, the analysis indicates that 25-30 percent of Ohio River sand and gravel traffic might be diverted under a user charge (however collected). This would account for only about 1 percent of ton-miles, and thus, would have no significant secondary impacts on other traffic or rivers.

8.17 ALLEGHENY RIVER

Allegheny River traffic is composed of coal (44% of ton-miles), sand and gravel (33%), petroleum and products (10.5%), and other commodities including chemicals, steel, and "other dry bulks" (12.5%). Most of the coal traffic is relatively short-haul in the Pittsburgh area, with a total length of haul of 45 miles for originating coal and 76 miles for coal destined for points on the Allegheny (only a fraction of the total haul occurs on this river - about 15 miles for inbound traffic). The sand and gravel traffic is mostly dredged from the river and moves an average of 20-25 miles for unloading. The remainder of the traffic is dominated by long-haul moves from the Gulf area (petroleum, chemicals, and unidentified dry bulks), with an average length of haul of almost 1500 miles, only the last 10-20 of which occur on the Allegheny.

Most of the traffic on this river uses only the first four locks (of nine) and most of the non-sand and gravel traffic uses only the first three. This is one factor in the high segment toll imposed - 14 mil per ton-mile. A shortened project length would relieve the toll burden significantly.

The coal traffic appears pivotal to the viability of this river. While half or more of the sand and gravel traffic would leave the river under a segment toll, this would still leave the long-haul traffic in petroleum, chemicals, and steel somewhat better off than under a fuel tax. The heavy coal flows are thought to be relatively insensitive to user charges, even at the 30-40 cents per ton added by the segment toll (compared to 6¢ under the fuel tax). If, however, the coal flows proved susceptible to diversion, a snowballing effect of higher taxes causing more diversion causing higher taxes might shut down the river (recall that a shortening of the project would minimize the probability of this scenario).

Under a fuel tax diversion of traffic on the Allegheny would be lessened because more sand and gravel and possibly coal, would be preserved at the risk of losing more of the long-haul traffic due to higher tolls. This underlines the dilemma of the choice between the two tax approaches, because while coal and construction aggregates together account for over 75% of ton-miles <u>on the Allegheny River itself</u>, they account for less than 15% of total system ton-miles generated by that river's traffic. [The rest is made up of the long-haul commodities whose ton-miles occur chiefly on other rivers.]

8.18 MONONGAHELA RIVER TRAFFIC

Coal traffic, mostly for Pittsburgh area coke ovens, but also to utilities in the same area, dominates Monongahela River traffic with 86% of the ton-miles (1.3 billion). The overall average length of haul for Monongahela River coal traffic is between 50 and 75 miles. The remaining traffic - consisting mostly of inbound petroleum products and "other dry bulks" (iron & manganese ores, fluxes, etc.) and outbound iron and steel products - is generally long-haul traffic (1796 miles for the 1.1 million tons of dry bulks).

Because of the relatively short hauls (and thus low tolls) involved, and the fixity of capital in barge-receiving facilities, the Monongahela River coal traffic should be relatively untouched by user charges. While the segment toll on this river is twice as high as the system average, most of its traffic (except for coal) travels long distances on other rivers (especially the low cost Ohio and Lower Mississippi Rivers) prior or subsequent to moving a relatively short-haul on the Monongahela. As a result, "other dry bulks" (mostly ores) destined for the Monongahela - accounting for 2.0 billion <u>system</u> ton-miles compared to 1.6 billion ton-miles for the much larger tonnage coal traffic terminating there - would face an average toll of $1.41 per ton under a fuel tax compared to 68¢ under a segment toll. Similar results are found for this river's other non-coal traffic.

8.19 KANAWHA RIVER

Over half the traffic activity on the Kanawha River (measured in ton-miles) is accounted for by coal shipments from West Virginia mines. While Kanawha coal moves as far as New Orleans and the Illinois River, most of it is destined for the Ohio River Valley. Chemicals, both shipments and receipts, make up the second largest commodity group with 27.6% (226 million ton-miles) of Kanawha River traffic. Sand and gravel, coming off the Ohio River, is another 10.6 percent.

Because it interacts with relatively low-cost rivers, fuel taxes generally exceed segment tolls for Kanawha traffic on an origin-to-destination basis, even though the segment toll per ton-mile on the Kanawha itself is 2 mils per ton-mile - more than twice the system average fuel tax. Thus, while Kanawha coal tolls would be slightly higher under a segment toll approach (16¢ per ton versus 12¢ per ton), average fuel taxes exceed segment tolls for most other commodities (e.g., 50¢ versus 36¢ for chemicals, which provide more system ton-miles than the coal, and 85¢ versus 50¢ for gasoline receipts).

Most Kanawha River coal traffic will be unaffected by user charges at levels discussed in this study (see Volume II, Chapter 2 and 5). Whatever coal diversion might occur - considered small due in part to lack of adequate rail facilities at many river-served utilities - would probably be carried to Ohio River loading facilities for subsequent barge shipment - as in the case for a significant volume of West Virginia coal already - implying that much of the traffic impact would be localized. Because of poor substitute sources, minimal diversion (up to 10%) is anticipated in the sand-and-gravel traffic. Whatever small traffic loss is expected in other commodity classes would be greater under a fuel tax approach as is indicated by the relative magnitude of tolls discussed above.

8.20 GREEN AND BARREN RIVERS

Coal accounts for over 99 percent of the traffic (in ton-mile terms) on the Green and Barren Rivers. At 1972 traffic patterns, user charges would add 24 cents per ton to the delivered price of coal from this river under a segment toll approach, and almost twice that amount under a fuel tax - in part because of this river's relatively low toll

(0.68 mil compared to the system average 0.8 mil) and in part because significant amounts of Green and Barren River coal went as far as New Orleans for cross-Gulf shipment to Florida. Changes in coal purchasing patterns of utilities due to EPA or other restrictions (strip mining) will probably have a greater impact on the Green/Barren River traffic than user charges.

8.21 KENTUCKY RIVER

Virtually all traffic on the Kentucky River is sand and gravel coming in from the Ohio River to a single receiver at Frankfort, Kentucky. A segment toll applied to this very costly river (3 cents of Federal OM&R per ton-mile) would drive all this traffic from the waterways, with negligible impact on the rest of the system. Elimination of the 11 locks which have served no commercial traffic in recent years would dramatically reduce the segment toll, it is unlikely that even this lower toll (perhaps 50 cents per ton) would permit continuation of the sand-and-gravel traffic. In light of the fact that barge accounts for less than 100 percent of this area's supply of this commodity makes it uncertain how much of the traffic would remain in the long run even under a uniform fuel tax (6-10 cents per ton).

8.22 CUMBERLAND RIVER

Petroleum and petroleum products - from the Gulf area and to a lesser degree the Ohio River - accounted for 34.2 percent of Cumberland River ton-miles in 1972, while sand and gravel (25%) was dredged mostly from the Tennessee and Ohio Rivers and hauled to Nashville. The remainder of the traffic base includes inbound chemicals (10.0%), coal (8.4%), iron and steel products (5.2%), and lime (5.1%).

The most sensitive commodity flow on this river would appear to be sand and gravel which moves 150-200 miles to Cumberland River destinations. While it is difficult to pinpoint diversion levels because substitution of lower grade local products is involved, a loss of fifty percent of sand-and gravel-traffic is not unreasonable - only product quality standards would preserve remaining traffic. This would, of course, raise tolls on remaining traffic. A smaller (by two-thirds) toll on sand and gravel under a fuel tax would also encourage some traffic loss in sand and gravel, but probably not as large.

For most other Cumberland River flows, fuel taxes exceed segment tolls because of significant prior haulage of low cost rivers, especially the Ohio and Lower Mississippi Rivers - although not by as much as on the other tributaries of the Ohio because the average haul up the Cumberland is relatively longer. While greater sand and gravel loss under a segment toll would decrease the gap between the two approaches, this factor would not be fully offsetting.

Diversion of the petroleum traffic, on occurrence which would depend on traffic volumes justifying pipeline investment, would be equally likely under either user charge approach. Coal traffic, which is unlikely to be altered significantly at the low tolls levels involved (10 cents per ton), is equally indifferent between approaches.

8.23 TENNESSEE RIVER

Tennessee River traffic (over 3.5-billion ton-miles overall in 1972) consists of coal (34 percent), grain (18.2 percent), petroleum and products (14.7 percent), chemicals

(9.4 percent), and sand and gravel (7.7 percent), with the remaining 18 percent spread evenly over the other commodity groups. Coal is received from the Tennessee River and Green and Barren River (and to a much lesser degree, from the Ohio River). Receipts of petroleum and petroleum productts, chemicals, other dry bulks, iron and steel, and fertilizer reach the Tennessee after long hauls from the Gulf area or Pittsburgh. The Tennessee shows a higher-than-expected interaction with the Missouri River, receiving a significant share of its grains and grain products from that river, and shipping back fertilizer, chemicals, and pulp and paper. One can only guess that the potential for a relatively balanced two-directional flow pattern accounts for this phenomenon, which accounts for only 4.5 percent Tennessee River ton-miles.

Because its own segment toll (0.84 mils per ton-mile) approximates the system average, and its traffic distribution is similar in many ways to the system as a whole (except for the larger role of coal), much of the commodity analyses of Volume II is appropriate for this river. The utility coal anlaysis in that volume estimates that no significant amount of coal traffic will be diverted from the Tennessee River because of user charges although some changes in origin/destination patterns are expected due to exogenous market factors. Grain traffic diversion in the range of 10 percent might be expected if user charge-induced barge rate increases are not offset by countervailing factors such as rail rate changes or domestic price shifts, with little difference in impact between a segment toll and a fuel tax. [Missouri River origins for this traffic will be replaced by less distant sources -- especially the Ohio River.] Sand and gravel will suffer some diversion to lower quality substitutes produced from limestone, but this will be limited by product standards to perhaps 50 percent under either taxing approach. Petroleum product receipts, with average length of haul of between 650 and 1300 miles on the Lower Mississippi and Ohio Rivers face some risk of diversion to pipeline for at least part of their journey, especially under fuel taxes, which exceed segment tolls by 20-100 percent. Overall traffic losses on this river higher than 10 percent in the long run would be surprising

8.24 MISSOURI RIVER

Traffic to or from Missouri River points accounts for about 3.5 billion ton-miles, with about 40 percent of those ton-miles occurring on the Missouri itself and most of the remainder coming from prior or subsequent hauls on the Upper and Lower Mississippi River. While sand-and-gravel and waterway improvement materials provide over 60 percent of the tonnage on the river, they account for well under 10 percent of ton-miles, with lengths of haul seldom in excess of 15 miles from dredging points to yards. Grains, on the other hand, which move long distances from Kansas City and above to Lower Mississippi River ports and the Tennessee River, account for 36.4 percent of Missouri River ton-miles, with processed agricultural products making up another 21.2 percent. Fertilizer, which moves into the region predominately from the Gulf area, adds another 15 percent.

Because of draft restrictions and a short shipping season, the Missouri is one of the least economical rivers for commercial navigation, even in the absence of user charges. Alternative marketing channels and even direct modal competition to existing markets are quite strong relative to the rest of the system. Segment tolls would, without a doubt, close this river to commercial navigation (current OM&R costs are about $15 million - about 10% of the system total - annually). A segment toll of $4.64 per ton just for the portion of the haul from Kansas City to St. Louis is clearly prohibitive. The sand-and-gravel traffic makes limited use of project facilities, and might even benefit by shutdown of the river, but it would not be able to support the existing project if the long-haul traffic left the river.

It is not clear how this shutdown would affect the traffic on other rivers. Some of the traffic - particularly in the grains - would undoubtedly find its way to the Mississippi River by rail - and alternative river sources and/or outlets would be found for some, thus softening the impact on the rest of the system. The river would also continue to serve as a major sand and gravel source.

Because it is a relatively uneconomical transportation outlet, much of the long-haul traffic on this river would be threatened by a fuel tax as well. It would not be surprising to see as much as 25 to 50 percent of the agriculture related traffic (grains, products, fertilizer) leave the river under that option for example. Action for discontinuation of this project would almost certainly be initiated by carriers under a uniform systemwide tax approach (fuel tax, license fee) when it was realized that this waterway accounted for almost 10 percent of the magnitude of the toll level.

8.25 THE KERR-McCLELLAND WATERWAY (ARKANSAS RIVER)

Traffic on the Arkansas River in the study base year - 1972 - was 541-million ton-miles, consisting of coal (35.1 percent), iron and steel (17.9 percent), miscellaneous products (10.4 percent - mostly non-commercial waterway improvement materials), fertilizer (7.5 percent), sand and gravel (7.2 percent), grains (5.1 percent), and all other (16.7 percent). Since that time, 75% of the coal traffic has disappeared, bauxite flows have increased up to 10-20 percent of a somewhat reduced traffic base, sand and gravel traffic has grown (as waterway improvement materials have declined), with the remainder of traffic growing slightly.

Segment tolls on the order of $4 to Little Rock (mile 120) and $12 to the major coal loading areas would obviously lead to a shutdown of this project, which costs $12-15 million annually to maintain -- a subsidy of $2-3 dollars per ton of traffic, even including the very short-haul sand and gravel dredged from the river bed. Some of this traffic would continue to move by barge, with prior or subsequent rail or truck movement to or from the Arkansas River area (Little Rock, for example, is only about 100-120 miles from the Lower Mississippi River).

A fuel tax would have only marginal impact on major traffic flows on this river, but there might be some pressure exerted on the part of carriers for a shutdown of this project which contributes more than 5 percent to any systemwide uniform tax. Finally, no analysis was made of the feasibility of discontinuing maintenance on certain up-river portions of the waterway although this would reduce annual operating costs if traffic levels were low on that part of the system.

8.26 THE WHITE RIVER

No special analysis was performed of the traffic on this relatively high cost river (6.6 mils per ton-mile under a segment toll). Its small traffic base consists of grain (over

60 percent) inbound fertilizer (19.4 percent), and sand and gravel (11.9 percent). If grain from this river did not have to pay McClelland-Kerr segment tolls for the 10 miles of that waterway it must traverse to reach the Mississippi, segment tolls would still approach $1.00 per ton for the grain traffic to New Orleans, compared to 50¢ under the fuel tax.

Because of its proximity to the Lower Mississippi - encouraging possible truck/barge substitution - significant diversion is possible under either taxing approach although the higher toll level and potential snowballing effects would probably close it to commercial navigation under the segment toll.

8.27 OUACHITA/BLACK RIVERS

At least eighty-five percent of the small ton-mile base on this river consists of crude petroleum, petroleum products, and petrochemicals. Outbound soybeans contribute another 8 percent.

The segment toll on this river is almost 2¢ per ton-mile, meaning most traffic on the river would pay tolls of $2-3 per ton under this approach. At these levels, significant traffic would be diverted, with total shutdown of commercial navigation a likelihood due to snowballing traffic loss and segment toll increases. Since Ouachita/Black traffic currently accounts most of the current Red River traffic, this project would follow. A fuel tax would probably preserve most of the traffic on this river, with traffic on the rest of the system paying most of the $1.5 million annual OM&R expenditures. Once again, this might give rise to political pressure for abandonment of this Federal project.

8.28 ATCHAFALAYA RIVER AND GIWW -- MORGAN CITY -- PORT ARTHUR ROUTE

The traffic on these waterways is dominated by petroleum, petroleum products, and petrochemical traffic - about 70 percent of ton-miles - most of it in the form of through traffic moving between the GIWW-West and points at or above Baton Rouge. Dry bulks (mostly salt and other non-metallic minerals - fluxes, etc.) make up another 14 percent, again mostly long-haul through traffic.

The low segment toll on the Morgan City-Port Allen (MCPA) (0.28 mils per ton-mile) favors this route over the Atchafalaya (1.6 mils and rising in recent years), so that traffic on the Atchafalaya (which has declined dramatically in recent years) would probably tend toward the alternative route or even a third possibility, the longer route through New Orleans. A fuel tax approach would favor neither facility over the other to any great extent - although it clearly works to the absolute disbenefit of the higher volume MCPA route.

Because these waterways serve as connecting waterways between the relatively inexpensive GIWW-West and Lower Mississippi Rivers and because long-haul petroleum, chemicals, and dry bulks comprise a significant share of their traffic, the fuel tax would impact their traffic to a considerably greater extent than a segment toll - in terms of delivered prices as well as traffic loss. This toll differential would be substantial for all traffic, and would tend to increase with the length of haul. For example, a ton moving from the Houston Ship Channel to Pittsburgh would pay about $1.60 under a uniform fuel tax, but only 80¢ under a segment toll. The tolls from Houston to Memphis on the other hand would be 64 and 30 cents, respectively. In sum, segment tolls may lead carriers to use the least expensive of connecting channels to and from the Gulf. Whether the MCPA bypass has the capacity to handle all the traffic is a serious question. One option to avoid over crowding any one access channel would be a uniform toll across all channels to the Gulf.

8.29 GULF INTRACOASTAL WATERWAY -- WEST

Crude petroleum and petroleum products dominate this waterway's traffic with over sixty percent of its approximately 12-15 billion ton-miles. Shipments of these commodities from the GIWW-West generate another 5.5 billion throughout the rest of the system, especially on the Lower Mississippi River. Another 15 percent of the traffic consists of chemical ton-miles - flows whose movements generate more than 2.5 billion ton-miles on other rivers. Finally, while unidentified dry bulks (mostly salt and other non-metallic minerals - fluxes, etc.) contribute only about 3-1/2% of ton-miles on this segment, each ton in this group moves about 9 miles elsewhere for every mile it moves on the GIWW-West with 6 billion system ton-miles involving these shipments, including a billion ton-miles on the Lower Mississippi, 1 billion on the Ohio, 800 million on the Upper Mississippi. "Miscellaneous products," consisting mostly of marine shells, account for 16.3 million tons and add an estimated 2 billion ton-miles to traffic on the GIWW-W. Limited commodity flow and expenditure data prevent an analysis of traffic and tolls in individual projects in the Gulf area - e.g., the Atchafalaya River south of Morgan City, or the various bayous in the area.

The flows on this waterway which contribute the most to total barge commerce (measured in ton-miles) - the long-haul flows of petroleum and products, chemicals, dry bulks, and iron and steel - are disproportionately impacted by a fuel tax because they traverse long sections of low toll waterways, especially the Lower Mississippi and Ohio Rivers. [The sample tolls discussed in the previous section are equally appropriate here.]

A long-term decline in petroleum traffic in the GIWW-West sector is highly probable, due to changing petroleum market conditions and user charge imposition (as discussed in Chapter 5, Volume II). Declining demand for products, depletion of crude petroleum reserves, and competition from pipelines could reduce petroleum ton-miles by as much as twenty five percent. Crude oil flows may fall by a lesser amount (ten percent) due to the continued inaccessibility of many wells and drilling platforms to pipeline transportation.

8.30 PEARL RIVER

While the Corps of Engineers have reported annual navigation expenditures on this river averaging $275,000 over the last five years, the best year for traffic was only about 700 thousand ton-miles in 1971, with the five year average at about 300 thousand. This implies a segment toll of almost <u>$1 per ton-mile</u> on traffic which consisted of mostly logs in 1972 and all marine shells in 1975. The implicit subsidy on marine shells receipts in 1975 was $18.30 per ton if CoE data are correct. Clearly, this river, which interacts little with the rest of the system, would shutdown under a segment toll. Continued operation under a fuel tax is probable.

8.31 WARRIOR RIVER

The biggest traffic groups on the Black Warrior-Tombigbee Rivers are coal (45% of ton-miles in 1972) and "other dry bulks" (primarily iron ore to Birmingham - 31%). Crude oil traffic, which has since been reduced, accounted for 8.7 percent, while iron and steel (about equal volume to Mobile and the western Gulf) was 3.6 percent of this segment's traffic.

If anyone of the big three traffic components diverts from the river - imported iron ore to Birmingham from Mobile, internal coal flows to Warrior River utilities, and export coal through Mobile - the impact under a segment toll might snowball to eliminate much of the remaining traffic. This is not only because segment tolls would increase significantly, but also because the upbound ore and downbound coal provide an unusually good traffic balance - helping keep private towing costs down.

As indicated in the commodity analyses, we consider this scenario unlikely because the non-water options to the utilities are not competitive with barge at the toll levels being discussed, and because we doubt that U.S. Steel - the only ore shipper - will abandon this distribution system for what appears to be a competitive all-rail one.

Fuel tax impacts on this river's traffic would be comparable to segment toll impacts, except that there would be no potential for shutdown via "snowballing."

8.32 ALABAMA-COOSA RIVERS

Sand and gravel comprises about 85% of the tonnage on this river, and a similar 85-90 percent of total ton-miles, with about one-third of the traffic internal to the river, and most of the remainder bound for markets in Mobile (1.3-million tons).

This sand-and-gravel flow to Mobile, which is obviously the key to the commercial survival of this river, would bear a toll of 12 cents under a fuel tax and 75-85 cents under a segment toll - the difference resulting from the 8-mil-per-ton-mile toll on the Alabama-Coosa (approximately 10 times the system average).

Although a detailed study of the sand and gravel market was not conducted, we would expect significant ton-mile diversion of this traffic, especially with possible snowballing effects as the least economic flows leave the river or shorten their haul. Eventual closure to commercial traffic is likely although the river would probably continue as a source for sand, particularly in the Montgomery area. Fuel taxes would have relatively small impacts on this traffic.

No anlaysis of whether a shorter project would be more viable was performed.

8.33 APALACHICOLA -- CHATTAHOOCHE -- FLINT RIVERS

Petroleum products - originated mostly on the GIWW-East - of which they use an average of about 250 miles - comprise about 54 percent of ton-miles on this river system, with chemicals (predominately petrochemicals) accounting for another 15 percent. Internal sand-and-gravel shipments account for almost 40 percent of tonnage, but only about 15-20 percent of ton-mileage. Remaining traffic consists of logs, fertilizers, and a small amount of grain.

Annual Federal OM&R expenditures of 3.5 to 4 million dollars for a traffic base of 800 thousand to 1 million tons and to 108 million ton-miles - declining in recent years - lead to segment tolls of almost 3.5 cents per ton-mile. This implies tolls on the petroleum traffic ranging from $4.23 per ton for residual fuel oil receipts to $7.08 for gasoline (which moves farther up the river). Chemicals traffic would bear similar origin/destination tolls, while the average toll on sand and gravel would be $1.86 per ton. Fuel taxes for these moves would range from 4 cents per ton on the sand and gravel to 40 cents on the petroleum traffic.

It is difficult to imagine that commercial traffic would not come to a halt on this river under a segment toll for full recovery of Federal OM&R expenditures although a detailed study of alternative sand-and-gravel and petroleum distribution systems was not performed. A fuel tax would leave traffic relatively untouched although some pressure might be forthcoming from shippers and carriers elsewhere to eliminate this project to lower the system toll level -- a 1500 ton barge shipment anywhere on the system would pay an additional $32 dollars in fuel taxes for each 1000 miles moves because of the A/C/F being in the calculation base.

8.34 GULF INTRACOASTAL WATERWAY - EAST

Traffic on the GIWW-East totaled over 3 billion ton-miles in 1972 (the busiest year in the last five), with 2.2 billion ton-miles on the 134 mile segment between Mobile and New Orleans, 364 million between Mobile and Pensacola (46 miles), 452 million between Pensacola and Panama City (110 miles), and 209 million between Panama City and Apalachee Bay (135 miles). This traffic was composed of petroleum and products (41% - mostly from within the eastern Gulf area), coal (20% from the Ohio and Tennessee), chemicals (mostly petro - 9.5%), miscellaneous products (mostly marine shells - 10%), and all other commodities (almost 20 percent).

Full origin-to-destination tolls for traffic involving this waterway are almost always higher under the fuel tax approach than under a segment toll, except for movements involving high cost segments, which accounted for less than 4 percent of GIWW-East ton-miles in 1972. However, both absolute toll levels and the difference between the approaches are relatively small for the petroleum and chemical movements, and so little tonnage diversion would be expected here under either approach.

The coal traffic on this segment - with the heaviest single flow moving from the Ohio River to an Escambia River utility east of Mobile - is probably insensitive to user charges under either approach. The fuel tax approach, which adds $1 to transport costs from the Ohio River and only 30-35 cents to Warrior River coal, might encourage some source shifting, but not a decline in this segment's coal traffic. A segment toll would add 30-40 cents to the cost of both flows. No significant impact is expected on marine shell traffic although price impacts will be somewhat greater if fuel consumed in dredging operations is taxed.

8.35 THE LOWER MISSISSIPPI -- CAIRO TO BATON ROUGE

This river segment handles over 60 billion ton-miles in 1972 - more than one-third of shallow-draft ton-miles on the Mississippi River/Gulf system. Out of a total of 102 million tons, 76.6 million are through traffic - i.e., with both origin and destination on other segments. The overall average length of haul on this 720 mile long segment is almost 600 miles, showing that most of this through traffic (a minimum of 90 percent) - travels the entire length, between the Gulf area (including the Lower Mississippi port complex and the Ohio and Upper Mississippi River systems).

Through traffic accounts for between 85 and 90 percent of total ton-miles on this segment. The most important commodity class on this segment (see Table 24) is grain mostly for export from the Illinois and Upper Mississippi Rivers, with about thirty percent of segment ton-miles. Next in importance are petroleum products - mostly northbound - with 22.5 percent of ton-miles (16.1% in the form of products and 6.5% as crude oil, tars, etc.). About 25 percent of this flow involves non-pipeable products. Coal traffic (7.2 billion ton-miles - 11.8 percent) includes large flows from the Ohio River system to New Orleans for subsequent cross-Gulf shipment to Florida utilities (3-3 1/2 million tons), and to Mobile export facilities and utilities in the eastern-Gulf area (3 1/2 - 4 million tons). Chemicals, including a large but unidentifiable component of pipeable anhydrous ammonia, account for 11.1 percent of ton-miles. This commodity moves heavily from the Gulf area to the Ohio River area and, especially for anhydrous ammonia, the Upper Mississippi River. "Other dry bulks," predominately road salt (over 4 million of about 6 million tons) and ores, add another 4.5 billion ton-miles (7.3 percent).

The ton-mile tax on this segment is only 0.17 mils per ton-mile, meaning that each ton traversing the entire segment pays a premium of 45 cents under a uniform fuel tax for that portion of its trip. The origin-destination toll per ton will be greater under the uniform tax unless higher segment toll payments on other portions of the trip offset this penalty. In general, this does not occur - except for relatively small flows to and from the Missouri and Arkansas Rivers - with prior or subsequent movement on the Ohio River, Morgan City-Port Allen route, and GIWW, normally increasing the margin between the two approaches.

Table 24

ESTIMATED 1972 TON-MILES BY COMMODITY ON THE LOWER MISSISSIPPI RIVER - CAIRO TO BATON ROUGE

	Ton-Miles (Millions)	%	
Coal	7190.3	11.8	
Crude Oil	3912.3	6.4	
Gasoline	4941.6	8.1	
Jet Fuel	685.6	1.1	
Distillate Oil	1537.3	2.5	16.1
Residual Oil	2682.6	4.4	
Chemicals	6729.2	11.1	
Synthetics	58.2	-	
Fertilizer	1678.3	2.8	
"Other Dry Bulks"	4437.3	7.3	
Iron & Steel	2364.5	3.9	
Waste & Scrap	191.1	.3	
Sand & Gravel	450.5	.7	
Lime, etc.	507.4	.8	
Corn	10618.9	17.4	
Wheat	1881.9	3.1	30.0
Soybeans	5036.4	8.3	
Other Grains	733.6	1.2	
Processed Agriculture Goods	2880.9	4.7	
Forest Products	136.8	.2	
Paper and Pulp	161.9	.3	
Phosphate Rock	912.6	1.5	
Miscellaneous	1144.8	1.9	
TOTAL	60873.8	100	

Potential diversion of barge traffic using the Cairo-Baton Rouge segment of the Lower Mississippi River is concentrated in several traffic classes. In the first place, 3.5-4 percent of the ton-miles on this river are in conjunction with flows involving rivers which would, in all probability, shutdown under a segment toll. Most of this interaction is with the Arkansas and Missouri Rivers. While this traffic loss would have a negligible impact on the remaining traffic on the segment, it is improbable that even this amount would leave the waterways entirely. Recall from earlier comments that political, rather than economic, pressure might shut down these very same rivers under a fuel tax.

Grain traffic is perhaps the next most sensitive traffic class. Losses of up to 10 percent of the grain traffic under a segment toll and 15-20 percent under higher fuel taxes are possible. The exact amount of traffic diversion in the commodity group will depend on the rate response of railroads and the ability of the domestic market to absorb increased supplies.

Petroleum traffic - for all but the non-pipeable products - will generally move by pipeline rather than barge in head to head competition as long as volumes are adequate to justify capacity, terrain is favorable, and institutional barriers (e.g., environmental or regulatory controls) are not prohibitive. User charges of any level will obviously make the pipeline option more economically viable than it is already, and higher uniform tolls will provide a greater pressure for diversion. Thus, while a 12 cent segment toll for 720 miles on the Lower Mississippi would provide only limited incentive for pipeline expansion, the 58 cent fuel tax for the same move would obviously increase consideration of such an action.

Little probability is seen for diversion of either chemicals or coal traffic under either appraoch, with the possible exception of anhydrous ammonia diverting to a greater pipeline share.

Significant diversion of other product groups on this river segment is not likely. Some shifting of iron and steel products and imported iron ore and manganese are possible (more so under a fuel tax).

8.36 CONCLUSION (RIVER SUMMARIES)

The impact summaries by river highlight a major dilemma in the choice among user charge options. The fuel tax tends to divert long-haul, high revenue traffic in grains and petroleum products on main stem rivers. Alternatively, the segment toll affects shorter-haul, local movements of sand/ gravel and other dry bulks on tributary (higher Federal cost) rivers.

A fuel tax based on main stem river Federal expenditures only would reduce overall system impacts to the level of segment toll impacts or below, depending on whether diverted high-cost river traffic is transported to main stem terminals for barge movement.

9. FINANCIAL IMPACTS ON WATERWAY CARRIERS

9.1 BACKGROUND

Waterborne freight carriers will bear the initial burden of navigation cost recovery activities. Segment or fuel taxes will be directly assessed on barge companies and cost pass-through to shippers will tend to vary with markets and commodities served. For example, carriers may tend to raise barge rates in those transportation markets where modal competition is negligible more than in markets where substitute carriers operate successfully. Further, carriers will experience a reduction in capitalized equipment values used in inland towing operations. If reduced revenues (due to increased costs and/or traffic losses) result, market value of existing capital stock will fall proportionately. Secondary impacts on the capital value of water-served facilities and agricultural land near subsidized waterways will also occur. Finally, industries serving water carriers such as equipment suppliers, shipyards, and other suppliers will be affected if traffic falls off. Maintenance schedules may be extended and new equipment orders may lag behind current rates.

The following section constructs a hypothetical river freight carrier (since no consistent financial data are directly reported for unregulated carriers), and examines the impact of a uniform ton-mile tax on major financial variables such as return on equity, cash flow, and debt repayment capabilities. It should be emphasized that the construct is a fair representation of current financial conditions for a composite of river carriers and is not indicative of individual behavior of any one firm.

9.2 FINANCIAL ANALYSIS

To provide a rough quantification of the financial impact of a possible uniform per-ton-mile toll on an individual commercial river freight carrier, TSC set up a hypothetical company, whose financial structure was taken from various sources. (See Section 9.4.) Using as a baseline the financial performance of this company from the beginning of 1973 through the first six months of 1975 (the latter annualized to a full year), TSC designated some simplified scenarios to "bracket" a range of possible toll impacts, and applied these scenarios to the best year of the three, 1974, and to the worst, 1975. (Note that 1975 is particularly poor for the hypothetical company because its performance is based on revenue-expense-investment relationships for the first half of 1975, whereas traffic apparently picked up for many commercial carriers only in the second half of that year.) Of course, the hypothetical company is basically a composite, to a great extent derived, as Section 9.4 points out, from a pooling by the Waterways Freight Bureau of the accounts of six prominent commercial carriers which possess some ICC operating authority (although do not necessarily derive their revenue from regulated traffic). Thus, there is probably some tendency for individual company financial fluctuations to have been already dampened out in the baseline scenario.

Table 25 shows a financial recapitulation for the TSC composite for years 1973-75, and Table 26 shows the change in the 1974 or 1975 performance which would have occurred, given various assumptions, if the composite earning power were to have been suddenly impacted by a toll of 0.8 mils per ton-mile in one year or the other. (This in itself is a simplication, of course, since any toll would most likely be applied gradually.)

TABLE 25

COMPOSITE RIVER FREIGHT LINES FINANCES: 1973-75

	1972*	1973	1974	1975
Total revenues	$10,000 thous.	$10,410	$13,778	$12,998
Revenue per ton-mile**	3.3 mill/ton-mile	3.6	4.6	4.8
Depreciation allowances		$920 thous.	1,033	1,079
Other operating expenses		7,474	9,810	9.826
Total operating expenses		8,394	10,843	10,905
Miscellaneous income		110	99	66
Income before interest and taxes		2,126	3,034	2,159
Interest on long-term debt		735	795	990
Income taxes (federal)		392	619	192
Provision for deferred federal income tax		133	324	232
Provision for deferred income tax investment credits		10	66	75
Net income		856	1,230	670
Dividends		265	291	342
Total long-term investment (net of depreciation reserves)	$14,815 thous.	16,117	19,184	19,430
Portion financed by deferred tax reserves	1,259	1,392	1,716	1,948
Portion financed by deferred investment tax credit reserves	222	335	401	476
Portion financed by other reserves and liabilities	74	81	96	97
Portion financed by long-term debt	7,956	8,414	10,137	9,747

*As a baseline for traffic, investment and elements of capitalization.

**No attempt has been made to separate line freight revenues (on which ton-mile freight would be earned) from other revenues, such as terminal charges. If all revenue were converted to ton-miles on the basis of the revenue yields shown above, ton-mileage for each year would be:

1972	1973	1974	1975
3,030 million	2,892	2,995	2.708

We have calculated the toll impacts assuming that tolls affect all types of revenue equally although the traffic diversions envisioned are derived from the relationship of the toll to revenue yield per ton-mile, which was in turn derived from the line freight revenue reported to the ICC by the six prominent carriers mentioned above. (Line freight revenue, excluding towing for other ICC authority-holding carriers, amounted to 90% of the total revenue they reported in 1975.) We have calculated cost-reduction scenarios two ways, one by an "optimistic" method whereby all expenses (and associated investment) are reduced in the same proportion, and another whereby depreciation and interest expense (plus associated investment and debt outstanding) remain steady while the other expenses decline. The more optimistic method implies that the company has been able to cut back immediately its new equipment ordering (or conceivably, sell off some existing equipment) sufficiently to achieve the presumed capital cost reductions.

Table 26 explains the eight scenarios calculated and gives five key performance measures of the company before and after the "sudden impact." Scenarios 2 and 3 are supposed to represent the most drastic imaginable impact, either the carrier completely absorbing a substantial toll or suffering a proportional traffic diversion without being able to reduce any expenses at all. Scenarios 4 and 5 modify 3 by assuming a half proportional cutback in all expenses (4), or in all expenses except depreciation and interest (5). Scenario 6 starts over again by assuming only a half-proportional traffic diversion (again with no expense adjustment), and Scenarios 7 and 8 modify 6 by assuming a one-quarter (or half of one-half) proportional expense cutback. Any scenarios in which revenue losses and (total) expense

TABLE 26

IMPACT OF .8 MIL/TON-MILE TOLL IMPOSED
ON 1974 COMPOSITE CARRIER BALANCE SHEET

Balance Sheet Effects	Scenarios*						
	(1)	(2&3)	(4)	(5)	(6)	(7)	(8)
Revenue Reduction	-	$2396 thous.	$2396	$2396	$1198	$1198	$1198
Net income after reduction**	$1230	(157)	469	376	572	850	806
Return on equity at baseline scenario debt-equity ratio	18.0%	NMF	7.5%	5.5%	8.4%	13.0%	11.8%
Income before interest taxes as % of total capitalization	17.8%	3.8%	10.2%	8.8%	10.8%	14.2%	13.3%
Cash flow as percent of long-term debt at baseline scenario debt-equity ratio[1]	26.2%	8.6%	18.8%	17.1%	19.5%	22.8%	22.0%
Cash flow as a percent of depreciation allowance	257%	84%	185%	167%	192%	224%	216%

*(1) Baseline.
(2) Company absorbs tolls - no traffic diversion.
(3) Company does not absorb tolls - traffic diversion in proportion to toll/revenue yield (17.4% in 1974 - 16.7% in 1975).
(4) Same as (3) except with 1/2 proportional reduction in all operating and capital cost elements (8.7% in 1974, 8.3% in 1975).
(5) Same as (3), but with 1/2 proportional reduction in operating cost elements only.
(6) Same as (3), but with only 1/2 proportional traffic diversion.
(7) Same as (6), but with 1/4 proportional reduction in cost elements (4.35% in 1974, 4.167% in 1975).
(8) Same as (6), but with 1/4 proportional reduction in operating cost elements only.

**Without consideration of impact of income tax or investment tax credit carry-forward or carry-back.

TABLE 26 (CONT.)

IMPACT OF .8 MIL/TON-MILE TOLL IMPOSED ON 1975 COMPOSITE CARRIER BALANCE SHEET

Balance Sheet Effects	Scenarios*						
	(1)	(2&3)	(4)	(5)	(6)	(7)	(8)
Revenue Reduction	-	$2166	$2166	$2166	$1083	$1083	$1083
Net income after reduction**	$670	(997)	(9)	(142)	49	349	320
Return on equity at baseline scenario debt-equity ratio	9.4%	NMF	NMF	NMF	7%	5.1%	4.5%
Income before interest taxes as % of total capitalization	12.8%	NMF	5.8%	5.0%	6.4%	9.5%	8.8%
Cash flow as percent of long-term debt at baseline scenario debt-equity ratio1	21.1%	.9%	11.0%	9.6%	12.0%	17.3%	16.6%
Cash flow as a percent of depreciation allowance	190%	8%	99%	88%	108%	156%	150%

*(1) Baseline.
(2) Company absorbs tolls - no traffic diversion.
(3) Company does not absorb tolls - traffic diversion in proportion to toll/revenue yield (17.4% in 1974 - 16.7% in 1975).
(4) Same as (3) except with 1/2 proportional reduction in all operating and capital cost elements (8.7% in 1974, 8.3% in 1975).
(5) Same as (3), but with 1/2 proportional reduction in operating cost elements only.
(6) Same as (3), but with only 1/2 proportional traffic diversion.
(7) Same as (6), but with 1/4 proportional reduction in cost elements (4.35% in 1974, 4.167% in 1975).
(8) Same as (6), but with 1/4 proportional reduction in operating cost elements only.

**Without consideration of impact of income tax or investment tax credit carry-forward or carry-back.

cutbacks were in the <u>same</u> proportion would, of course, return us to the revenue-expense-investment relationships of the baseline although reported net income would decline.

Return on equity has been shown in Table 26 because it is probably the single most important statistic by which to evaluate the long-run financial condition of an enterprise. We can see that in 1974 the composite carrier had an ROE which compares very favorably with that of American industry, and that even in the poor year, 1975, ROE did not fall too far. For 1973-1975, it averaged about 14% in the baseline scenario. This would seem to be adequate to finance the degree of long-term growth which companies in this industry are facing, even if, say, a third of it were paid out to owners and parent companies as dividends. Of course, it might be claimed that TSC has driven up the hypothetical ROE of the baseline (and all other scenarios) by assuming too extensive use of debt to finance long-term investment. (The Waterways Freight Bureau presentations from which the TSC composite's revenue-expense-investment relationships were derived did not specify the form of long-term liabilities, so TSC hypothesized debt, equity, and reserve relationships which seemed reasonable on the basis of prior investigations.) We do not feel there is gross over-statement, however, because the "opening" debt/equity ratio which we used was a reasonable 60%-40%, our average interest rate estimates did not include any reductions due to the Title XI mortgage insurance program, and the debt-equity ratio for the three years never went above 60%, according to the assumptions of the baseline scenario.* The need for debt was, of course,

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*At the end of 1975, it stood at 57.6%.

reduced by the deferral of Federal income taxes, but the extent of these deferrals compared to investment was taken directly from Waterways Freight Bureau material.* In any case, we have also shown in Table 26 the relationship of earnings before interest and taxes to the total debt and equity. For the three years 1973-75 this gross return-on-total capitalization averaged 15.2% in the baseline scenario.

The last two lines of Table 26 contain two measurements of (after tax) cash flow. We are interested in cash flow as well as profitability (measured by ROE and ROTC), perhaps even more interested, because we need to think about how easily a company could avoid insolvency during any "adjustment" period which might be required to get back to "normal" profitability. We have measured cash flow in terms of two potential, mutually exclusive, requirements for cash: repayment of long-term debt and replacement of equipment as it comes to the end of its economic life. Our estimates of cash flow under the different scenarios is conservative in that it does not allow for any refunds of taxes such as might occur under scenarios 2, 3, 4, 5, and 6 calculated on year 1975.**

Reviewing the scenarios in terms of the resulting measurements of profitability and cash flow, we can see that the "worse case" does seem likely to cause trouble if it were to coincide with a poor year. Without new proceeds from sale of equipment, or tax refunds, the composite company would have just barely enough cash in 1975 to operate under scenarios 2, and 3, let alone reduce outstanding debt. Proceeds from new debt issues would not be coming in,

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*If at the end of 1972 all reserves had remained at the same 10% of total investment that they had been at the beginning of 1972, and debt has taken up the deficit, the debt/equity ratio would still only have been 59.0%.

**It is conceivable even that the Congress might desire to accord the river operators some temporary extension or tax benefits in order to cushion the impact of a new toll system.

because, presumably, no new mortgagable equipment purchases would be being made. While replacement of equipment would, we assume, not be necessary for two or three years, there would be no significant cash flow from operations to provide any flexibility in changing types of equipment or modernizing the fleet during the early part of this readjustment "period." A company with a poorer operating margin, a lower ratio of revenue to investment, or a higher relative amount of debt than the composite could be in even more difficulty. Also, some companies might have more debt outstanding on shorter term than others, making their needs for cash to service debt greater. For example, one company might have a five-year secured bank term loan coming due which required refinancing of a substantial un-amortized balance, whereas another might have all of its debt safely placed with insurance companies on a 15 or 20 year basis. (In fact, some companies in the future might even have substantial financing through 25-year U.S. Government-guaranteed bonds or notes, and many companies today may have had substantial funds advanced to them by large parent companies, thus making it less necessary for them to deal with outside creditors.)

On the other hand, the financial impact of the most optimistic of our (non-baseline) scenarios (#7) does not seem too drastic, even when it is imposed on 1975, the "bad" year. Earnings on equity, while obviously sub-normal (5.1%), are high enough to cover a fairly generous dividend compared to book value (equity) per share if that were considered very important by management. (It probably would not be so considered since public ownership of river freight carriers is not uncommon except through ownership of the shares in industrial companies to whose earnings river freight operations are a contributor.) The restated 1975 cash flow of the composite company under scenario #7 amounts to 17.3% of the debt which would have been outstanding under the baseline debt ratio after the assumed investment reductions of scenario #7 had taken place. Even if the company had to absorb a further 10% net reduction in debt, and wanted to pay a dividend amounting to its entire reported net income, it would still have unallocated cash flow amounting to about $330 thousand. Assuming (which is reasonable) that equipment could be financed at 75% of cost, this residual cash would support any necessary equipment purchases during the first "re-adjustment year" amounting to as high as 130% of depreciation allowances or 7.1% of total investment. As far as the "most optimistic" scenario being imposed in the "good year" is concerned, the impact consists only of reducing ROE to 13.0% and cash flow to 2.24 times depreciation allowances. This reduced performance seems good enough to support the composite company through almost any possible problems which might be met before final re-adjustment is achieved.

9.3 CONCLUSION

Estimated traffic diversion of under 10 percent of system ton-miles implies that financial scenarios 6, 7, and 8 would most closely represent carrier impacts from a 100% OM&R uniform system fuel tax of .8 mil per ton-mile. Assuming barge operators were able to reduce operating costs by at least 50 percent of the overall revenue reduction (scenario #7), less than normal returns on equity would result but still allow a 5 percent dividend if desired. Debt repayment and equipment financing could still probably be carried out at adequate levels with unallocated cash flow. Obviously, carrier impacts depend on the actual financial health of individual firms, but requisite data by company are not available for analysis.

9.4 CONSTRUCTION OF "COMPOSITE RIVER FREIGHT LINES" FINANCIAL RECAP 1973-75

a. All year-to-year and internal relationships of:

revenues
expenses other than interest and taxes, and
total investment

were taken directly from the "consolidated comparitive industry statement" prepared by the Waterways Freight Bureau in support of the general rate increase filed with the ICC on behalf of its members on December 1, 1975. (Note that this statement only ran from 1974 through the first 6 months of 1975, so that the last year of the TSC composite does not reflect improved traffic conditions which may have occurred in the latter half of 1975.)

b. Freight revenue yields were taken from the 1972-1975 ICC-filed reports of the six carriers which had provided information for the WFB statement:

American Commercial Barge Lines
Valley Line
Sioux City & New Orleans Barge Lines
Federal Barge Lines
Union-Mechling Lines
Ohio River Co.

(1975 yield was adjusted downward, so that it would produce a year-to-year ton-mile drop for the composite no greater than was reported to the ICC by the six carriers combined, if all revenues were converted directly to ton-miles by use of the revenue yields. See note on a above.)

c. Total investment was broken down by sources of financing as follows for the beginning of the three-year period (i.e., end of 1972):

Deferred tax reserves	8.5%	
Deferred investment tax credit reserves	1.5%	
Other libabilities and reserves	.5%	
	10.5%	TOTAL
Long-term debt (due after one year)	60% of remainder	
Equity	40% of remainder.	

Tax and investment tax credit reserves were increased each year by the amounts allowed for these reserves as expenses.

Equity was increased by earnings retained after payment of a dividend amounting to 5% of prior year equity. Long-term debt was whatever residual was required to finance total long-term investment.

d. Interest was calculated at the Moody's Baa industrial bond rate (five-year moving average):

1973	1974	1975
8.3%	8.5%	8.8%

plus .5% extra debt expense, to allow for limited access by company to public debt issue markets, with 5% extra debt allowed to represent amounts due to be repaid during the year.

e. Taxes were calculated on income after interest based on the effective tax percentage reported in the WFB composite statement, holding the deferred tax and deferred investment credit allowances to the same percent of revenue as shown in the WFB composite and treating the tax accrual account as a residual. (Note that in any case where the resuting investment tax credit allowance, increased by 10% to cover credits actually taken against tax expense for the year, appeared to be greater than 1/2 of the tax accrual for the year, the investment tax credit allowance was adjusted down and the tax accrual adjusted up by the same amount. This was to guard against the possibility of deriving tax credits in excess of the statutory limit of 1/2 tax liability.) The effect of tax carry-forwards and carry-backs was not estimated.

10. OTHER MODE IMPACTS

10.1 INTRODUCTION

A major consideration of user charge impacts is the effects of potentially diverted waterway traffic on alternative distribution systems such as all-rail, truck, pipeline or coastwise flows. In many cases, a shipper would alter its entire distribution process, affecting not only waterway flows but also complementary modes serving river transshipment points. For example, grain flows from the Dakotas may move via all-rail connections to Houston or Duluth after user charges instead of by truck or rail to Minneapolis for shipment by barge to New Orleans. In this manner, more than waterway traffic will be affected if diversion results from user charges.

This chapter considers potential changes on other modes as the result of user charge imposition. It further examines the impacts of modal technology changes on future shipment patterns in the context of user charge introduction. The purpose is to assess potential traffic gains or losses by certain modes and whether mode operations and technology changes could act to mitigate adverse effects of navigation cost recovery.

10.2 RAIL

Railroad traffic increases due to user charges could occur from diversion of grain shipments from the waterways with some partially offsetting traffic losses on rail lines serving river points for trans-shipment via barge. For example, our grain analysis indicates potential waterway losses of corn and soybean export traffic of up to 2.5-3.0 million tons under a segment toll, and 50-100% more under a fuel tax. If all of this traffic were to move to the Gulf by rail, it would add this same tonnage, and 2.5-3.0 billion ton-miles, to rail activity assuming a trip length to the Gulf of 1000 miles. This compares to estimated 1975 rail originations of these two commodities (in the Western and Official rail regions) of 32.7 million tons and 15.1 billion ton-miles. An increase of this magnitude would require the installation of 5 to 7 new 100 car trains and maintenance of 7-8 day turn-arounds to Gulf export. In all probability, however, this overestimates the likely gains to rail activity. Rail flows of grain that might replace waterway shipments may not be long-haul flows to Gulf export ports. Changing market conditions and bid price variations between processors and modal terminals may shift grain to processing plants near growing areas (by truck or rail) and subsequent shipment of products to final markets. Additionally, losses in barge terminal gathering traffic and the fact of lower rail circuitry means that increases in rail ton-miles will certainly be less than diverted waterborne grain ton-miles. Rails may increase grain products shipments if user charges make processor markets more favorable than export markets.

Potential diversions of iron and steel products from waterways would probably move to destination by truck or rail in the Ohio Valley region and by rail to Gulf receivers. Mode diversion of Gulf-bound iron and steel traffic may be restricted by the necessity to deliver primary iron and steel products and steel pipe to offshore or bayou drilling sites not served by rail.

Imported iron ore movements that flow via the inland river system from New Orleans to Pittsburgh could divert to east coast ports (Philadelphia) under user charges with final delivery to Pennsylvania steel plants via rail - currently the dominant delivery system for such moves.

Finally, export coal traffic moving from Tennessee and Green River origins to the Gulf could switch to all-rail flows via Norfolk VA coal piers under 100% OM&R cost recovery. Only small amounts of petroleum traffic may shift from water to rail under user charges due to significantly lower pipeline transport costs. Some gains in processed phosphate rock traffic from Gulf Coast nutrient processors via rail may also occur.

Examination of the recent Federal Railroad Administration study on rail capacity* provides some information on the ability of railroads to carry potential traffic increases due to user charges. For grain traffic, the study reveals that the major North-South rail corridors west of the Mississippi River (i.e., Kansas City to Dallas/Ft. Worth) could handle over fifty percent more traffic than at present. Similar excess capacity exists in the Dallas/Ft. Worth to Houston corridor. Grain carriers in North-South corridors (Illinois to Mobile) also report excess capacity but at lesser levels than western roads.

However, rail lines from and to east coast ports are not listed as having substantial excess capacity available for new traffic. In the case of imported iron ore or exported coal flows via east coast ports, the requirements to move significant amounts of bulk traffic in congested Eastern corridors may necessitate new investment in rail facilities (although more study is required on this point). [For example, introduction of unit train service for ore in these corridors might improve the capacity situation.]

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*U.S. Department of Transportation. Preliminary Standards, Classification, and Designation of Lines of Class I Railroads of the U.S. U.S. Government Printing Office. August, 1976.

In summary, railroads appear capable of absorbing potential diversions of grain traffic from waterways under user charges. Shifts of imported or exported bulk flows from Gulf to Eastern ports may create problems for railroads serving these potential flows and hinder a switch to that distribution channel.

10.3 PIPELINES

As discussed in Chapter 5 (Petroleum Traffic Impacts) of Volume II, substantial market and distribution system changes would have to occur in pipeline transportation for user charge-induced waterborne petroleum diversion to occur. Declining domestic reserves of crude oil and lessened refinery ouput along the Gulf Coast imply increased pipeline capacity available for petroleum movements to destinations presently served by the river system. If pipeline companies accept smaller shipment sizes and arrange for distribution to previously water-served points from existing pipeline termini, present waterway shipments of petroleum would divert to pipeline regardless of user charge imposition. For example, there was a barge flow of crude oil from the Louisville, KY area to the Huntington WV area of between 3.5 to 6.0 million tons from 1968 to 1973. Construction of a lower cost pipeline had totally displaced this flow by 1974 even without the influence of user charges.

User charge imposition would apparently only accelerate diversion to pipeline from water. Pipelines directly affected include product and crude lines with Gulf Coast originations and Upper Midwest/Ohio Valley destinations. Alternatively, residual fuel oil flows to Upper Ohio Valley industrial plants, steel mills and utilities via inland rivers may divert to coastwise tanker and rail/truck distribution from east coast ports. Market diversion to imported residual fuels via east coast ports could also occur. In the longer term, pipeline shipment of crude coupled with local product refining is another real possibility.

Alternative delivery schemes may include pipeline flows to St. Louis or Cincinnati or other Ohio River points and trans-shipment via barge to final destination. The impact on barge rate increases on long-haul petroleum traffic would be significantly reduced by the pipeline shipments.

10.4 TRUCKS

Trucks generally serve as a complementary mode to waterborne traffic, providing overland service to and from the river. Any diversion of traffic away from the rivers due to user charges would affect truck ton-miles although truck gathering to rail terminals would be partially offsetting.

The substantial reduction in waterways sand and gravel traffic under 100% OM&R user charges could actually benefit truck traffic in that inland quarries would substitute for river-dredged sand due to relative market price shifts.* Rivers might still serve as the major source of dredged sand in any area, with shorter barge hauls to yards. Some major tonnage flows of dredged sand move only 60 to 300 feet by barge. This phenomenon would probably also increase truck hauls.

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*In the situation where inferior quality mines are utilized rather than expansion of existing quarry capacity, the shipment distance by truck will not necessarily increase.

Trucks would become the major mode of sand and gravel delivery with generally longer hauls because river dredging could not compete over as long distances with land quarries. Thus, since dredging is more expensive than land mining, trucking of river sand must be over shorter distances to compete with land quarries. In summary, total truck ton-miles of sand and gravel should increase after user charges are imposed unless reduced tolls are negotiated to compensate for navigation-related dredging by sand and gravel companies.

If double and/or triple bottoms are allowed in interstate and intrastate trucking, substantial economies of haul would result. In grains traffic, the river hinterland could increase due to lower trucking costs (as much as fifteen percent over single trailer operations). Although more analysis is necessary to verify the actual impacts, the simultaneous introduction of increased weight limits for trucks on the interstate system and waterway user charges could act to offset each other with regard to grains traffic.* Studies recently initiated by FHWA to investigate the energy-savings/highway safety and wear implications of double and triple trailers on interstate highways will provide additional data to analyze further these considerations.

10.5 HIGH-COST RIVERS

If segment tolls lead to the phasing-out of high-cost river segments (examined in Chapter 6 of Volume I), alternative distribution systems may have to be established for crucial flows currently using these sectors. For example, imported bauxite flows from the Gulf to aluminum plants on

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*This factor could also shift the balance away from dredged to quarried sand and gravel even without user charges.

the Arkansas River may have to move via rail. Similarly, grain traffic originating on the Missouri River may have to move via rail to the Gulf or via rail or truck to main stem Mississippi River ports for shipment via barge to New Orleans. Although actual alternative distribution system costs to a shipper may exceed existing (subsidized) rates, true social costs of using the high-cost rivers exceeds the alternative mode costs under most circumstances. The decision should be made on existing resource use considerations rather than on preserving sunk capital expenditures on low-traffic waterways.

10.6 MODAL RATE INCREASES

Relative changes in transportation rates among regions by mode and commodity class will significantly influence the long-run impact of waterway user charges. Detailed discussions in Volume II revealed that the response of competing modes to potential barge rate increases under user charges would be a primary determinant of ultimate diversion from waterways. Two major points merit examination. First, can value-of-service pricing policies by modes be used to minimize waterway traffic impacts. Second, to what extent will other modes adjust pricing structures in response to changes in barge rates.

Depending on the market power of a waterway carrier, certain shippers and/or markets may be more able than others to absorb rate increases from user charges. Under an activity-based tax (fuel or ton-mile), carriers may find it difficult to impose on a larger share of the user charge burden on these shippers than implied by the amount of traffic they move on the system. If the fixed-fee approach (vessel fees) were chosen to recover Federal navigation costs, a carrier would have an increased possibility of spreading the new overhead charges differentially among its traffic base. In either case, the degree to which carriers are successful in charging-off the new costs in a manner that maintains as much of their existing and potential traffic as possible will determine long-run impacts. Barge firms compete with each other as well as with other modes for traffic, so that the success of one waterway carrier in minimizing rate increases to shippers could affect other barge firms. In some cases, this inter-barge firm competition could be as significant as competition from other modes. In summary, qualitative factors indigenous to the operation of a (barge) company such as management skills, negotiation conditions and existing goodwill will aid the firm in determining an appropriate market response to user charge imposition.

A priori, we would expect peak-load traffic to bear a greater-than-proportional share of the user-charge burden within any commodity group than off-peak traffic (a phenomenon suggested by existing seasonal fluctuations in grain rates), and back-haul traffic to bear a lighter burden than major "front-haul" flows under a fixed-fee license approach. Cross-subsidization between commodity groups except where explainable in terms of peaking and backhaul concepts is probably less likely due to actual and potential competition between carriers and the possibility of private carriage.

The degree to which other modes alter existing rate structures relative to waterway rates after user charges will also influence the amount of traffic diversion from the river system. Depending on the perceived market demand response to rate changes in a region and by shippers, other modes may or may not alter "competitive" (to waterway) rates. Frequently, demand elasticities may imply that changes in relative rates in favor of one mode will mean traffic increases. Grain shipments out of the Midwest are an example of these types of markets, where competition among modes and carriers is keen in particular areas and diversion potentials high. Again, depending on the comparisons between before and

and after traffic revenues, rails may choose to withhold any ad hoc increases in their rates if barge rates increase due to user charges. Their intent would be to attract new traffic to rail. Alternatively, the profit maximizing rail response might be to raise rates on all grain traffic in the competitive area to capture additional revenues from existing traffic. Obviously, an intermediate marketing straegy of partially offsetting rate increases is also possible - and perhaps probable. Exogenous factors such as the total level of grain shipments and rail car availability would play a key role in the decision. In summary, other-mode rate responses due to user charges will vary by market and commodity. A detailed analysis of such changes and their effects on the final diversion estimates of waterway traffic is beyond the scope of this study.

11. A REVIEW OF RECENT USER CHARGE STUDIES

11.1 BACKGROUND

The issue of waterway user charges has stimulated a number of studies - both theoretical and empirical - in recent years. In many ways, the studies tend to complement each other as well as analyzing similar impacts. In this chapter, the most recent of these studies* are discussed briefly, to explain how they differ from the TSC study and what conclusions, if any, they share in spite of data and methodology differences.

11.1.1 Shabman Study

The Shabman study is primarily a literature review, with little original research into the impacts of waterway user charges. It treats extensively many of the theoretical issues involved in a user charge policy decision and critically reviews previous studies on waterway demand and barge industry structure. In a brief impact analysis, Shabman concludes that traffic in major bulk commodities on most major rivers will be unaffected by user charges under either a fuel tax or a segment toll, and that any traffic losses which occur will involve; (1) significant losses of traffic on high cost rivers under a segment toll approach, (2) significant (50-100%)

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*Shabman, Leonard A., User Charges for Inland Waterways: A Review of the Issues in Policy and Economic Impacts. Virginia Polytechnic Water Resources Research Center. Bulletin 91 (May 1976).

CACI, Inc. - Federal. Potential Impacts of Selected Inland Waterway User Charges - Final Report. Prepared for Office, Chief of Engineers. U.S. Army Corps of Engineers, Washington, DC (December 1976).

Ernst and Ernst, Inc. Impact of User Charges Applied to Inland Waterways. Prepared for the Maritime Administration, U.S. Department of Commerce. Washington DC (December 1976).

losses of sand and gravel traffic on all rivers under a fuel tax.

These conclusions are derived from generalities concerning the competitive advantage of barge transportation (as unearthed in the literature review). Little reference is made to the context in which particular movements occur (river origin-destination versus actual origin-destination, alternative sources and supplies, actual modal competition, etc.). Thus, coal arriving at New Orleans is assumed to be consumed at dockside, when in fact it is ultimately destined for Florida on a cross Gulf of Mexico move. Similarly, coal moving on the Kanawha is assumed sensitive to diversion because of that river's high toll even though the haul on that river may involve only the initial leg of a very long haul on low-toll rivers.

Because Shabman does not treat barge flows on an origin-destination basis, his study apparently misses the differential impacts of alternative recovery schemes on long-haul traffic on the major rivers, and understates potential impacts on such traffic both under schemes.* Tolls which appear small in terms of mil/ton-mile are capable of causing traffic disruptions when applied over 1000-1500 miles, especially in conjunction with considerations of accessorial costs (e.g., costs of trucking grain to river terminals) and alternative sources (e.g., movement of imported iron ore over land from Atlantic ports instead of the long, circuitous barge route

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*This is exaggerated somewhat by user charge estimates 25-35% lower than those calculated in the TSC study.

from New Orleans). Such long-haul moves provide a significant share of total waterway commerce.* Also Shabman does not consider pipeline competition to barge on long-haul petroleum traffic.

In summary, the Shabman study does not consider the market and distribution system factors that generate and control waterborne commodity flows. Instead, the analysis focuses on examining impacts of user charges on traffic originations by river rather than on the total origin/destination movement. Finally, the Shabman study addresses traffic impacts, leaving price and market impacts relatively untouched.

11.1.2 Ernst and Ernst Study

The Ernst and Ernst study does not attempt to analyze the impacts of waterway user charges, but rather is intended as a "think-piece" concerning what factors should be considered in such an analysis. It applies elementary economic tools to identify what parties might be impacted by such a policy (i.e., producers, consumers, barge firms, railroads, etc.), and lists the generic information requirements for an impact analysis. It suggests a highly disaggregated approach with a close accounting of burden impact at the individual firm level. Apparently, the scope of the study did not allow for the suggestions to be implemented in any extensive analyses, and only an example of their potential application is provided.

In a brief case study performed on Ohio River coal movements, it was found that electric rates will rise in that region if the delivered price of coal to utilities rises

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*One-half million tons of iron ore from New Orleans to Pittsburgh contributes more to system ton-miles than 20-million tons of coking coal moved 45 miles on the Monongahela.

as a result of user charges.* It further suggests that total increases in prices will exceed total toll collections if utilities (or electricity-consuming industries) impose a price markup in excess of transport cost increases. The actual results of the limited analysis cannot be used because of some questionable assumptions concerning industry pricing policy and because no real data concerning coal flows and tolls are used. For example, similar assumptions are made concerning the pricing practices of manufacturers purchasing electricity. Product price markups are assumed to be proportional to the electricity share of materials costs, not to its share of total costs (including labor, overhead, etc.). The interaction of these two assumptions exaggerates the impact of markup pricing drastically. Impacts are further exaggerated by assumptions of 100% delivery of coal by barge, failure to account for decreases in purchases of electricity in calculated total dollar impacts, and neglect of questions of supply elasticities for coal, electricity, or consumer durables. Finally, no comparison is made between the impacts of alternative collection schemes, and no estimate is made of traffic impacts.

11.1.3 CACI Study

The CACI study provides the only extensive empirical analysis among the three studies reviewed. Using the INSA (Inland Navigation Systems Analysis) models they developed

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*The case study is not performed at the disaggregated level suggested by the theoretical sections, but uses a variety of national and regional parameters derived from different sources.

for the Corps of Engineers, CACI examines the towing industry cost impacts and modal traffic share impacts of waterway user charges. Potential impacts on industry structure. shippers, consumers, and export markets are not included due to resource limitations.

CACI's approach is first to estimate the impacts of user charges on barge transportation costs, and then to examine existing (1972) intercity traffic patterns - with fixed origins and destinations - in the context of a multi-mode (rail and barge) network to identify barge flows for which the transportation cost by barge after user charges exceeds the transportation cost by rail, and thus, indicates a potential mode shift.

CACI's basic conclusions are that traffic diversion under a user charge would amount to 7.1 percent of total system ton-miles under a fuel tax and 9.5 percent under a segment toll. It further concludes that traffic losses would be greater on every river but two (the Green and Barren, and the Atchafalaya) under the segment toll, presumably because large traffic losses on high-cost rivers would lead to traffic losses on low-cost mainstem rivers due to modal diversion of flows which move between high-cost and main-stem rivers.

The TSC study, while it estimates total potential* diversion in roughly the same range - about ten percent of total system ton-miles under each collection approach - suggests a somewhat different commodity and regional mix for traffic impacts. Particularly, while the two studies agree that traffic losses will be relatively localized to movements with high-cost river origins and/or destinations, the TSC

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*While potential traffic losses are identified in terms of exist flows which appear to have reasonable transportation or source alternatives, the TSC study also identifies institutional facto (fixed facilities, rail rate responses, etc.) which may tend to mitigate such traffic effects, passing a greater share of burde through to users of barge transportation.

study sees more potential diversion of traffic which moves long distances on the main stem rivers - traffic normally identified as "best suited" for barge transport - under a fuel tax. Although it is difficult to compare TSC results with those in the CACI report because diverted flows are not identified on a commodity-by-river basis, certain observations are possible.*

First, TSC shows more potential diversion of grain from the waterways than CACI, particularly from the Illinois and Upper Mississippi shipping areas. This is primarily because the TSC analysis considers the effect of trucking costs to river terminals, much of which occurs within too narrow a geographic band to be captured by the CACI analysis. This leads to their underestimate being significantly greater under the fuel tax which is biased against long-haul export flows.

Secondly, the CACI analysis does not treat pipeline competition to waterway movements of petroleum and products. This mode provides the strongest competition to barge for pipeline products and may take significant traffic from the river, especially long-haul flows, and more so under a fuel tax.

Thirdly, CACI does not extensively consider potential market or port shifts. For example, competition on the Upper Ohio River for barged ores imported through New Orleans comes not from a parallel rail move, but from rail delivery from Atlantic ports. This tends to underestimate diversion potentials for such moves, a bias which is again strengthened under the relatively higher fuel tax on long-haul main stem moves.

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*The fact that CACI aggregates vastly different products into single commodity groups (e.g., ore with waste and scrap; sand and gravel with phosphate rock, fluxes, and sulfur; anhydrous ammonia and benzene with ground phosphate rock and sodium hydroxide) would make comparisons difficult even if impacts were identified more explicitly.

Finally, the TSC study recognizes that institutional considerations would often serve to impare (at least in the short run) diversion indicated by a simple transportation cost analysis. Such factors, which include fixed capital facilities, competitive ratemaking behavior, private distribution systems, and environmental regulations on utilities, play a role in our assessment of expected traffic impacts, but are not considered by CACI.

None of the "shortcomings" discussed above are due to oversight on the part of CACI. The assumptions and limitations are carefully documented in the study. Because of these differences, however, it appears that the similarity of results between the CACI and TSC reports at the systemwide level may include a significant element of coincidence, with the major common element being the traffic impacts on the high-cost river segments.

11.2 SUMMARY

In spite of differences in approach and findings, some common conclusions of the recent user charge studies can be drawn:

a. Recovery of 100% of the Federal OM&R expenditures on the Mississippi River (and tributaries) waterway system is unlikely to result in traffic losses in excess of 10% of systemwide ton-miles under either a fuel tax or segment toll. Obviously, initial recovery of 10% of these outlays would have considerably smaller impacts, perhaps less than one percent of system ton-miles.

b. While traffic impacts in the aggregate (system ton-miles) will be similar under the two collection approaches, there are differences in the regional and commodity mix. Under a segment toll, traffic impacts will be relatively isolated on traffic involving high-cost rivers, with main stem rivers losing some traffic because of interactions with high-cost segments. Under a fuel tax, traffic impacts would be more dispersed, with greater impacts on traffic (especially longhaul) wholly within the low-cost main-stem system and reduced impacts on traffic involving high-cost rivers.

c. Pass-through of user charges to shippers or receivers will lead to higher prices or costs of production and/or reduced income for those dependent on waterway transportation. (These factors are examined in some detail in this study and an earlier one, and found to be relatively small - most price and income effects were measured in fractions of one percent.)

d. Future user charge impact studies should be performed at substantially disaggregate levels. For major waterway receivers such as utilities, analysis at the firm level is appropriate. Originators of waterway traffic such as grain must be analyzed from true inland rather than river origins. Finally, alternative distribution systems and market shifts for existing waterborne flows must be examined.

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