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REGIONAL MARKET, INDUSTRY, AND TRANSPORTATION IMPACTS OF WATERWAY USER CHARGES

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16. Abstract

The objective of the report is to analyze the impacts on water-served economic markets and water transportation of the imposition of user charges designed to recover Federal outlays for the operation, maintenance, and repair of the U.S. waterways and ports (OM&R). The report describes the development of a preliminary impact model based on an analysis of waterway network operations and a stage-of-processing analysis of markets dependent on water carriage. Initial results from the models are based on the assumption that 100 percent of the operations and maintenance costs of waterways and ports will be recovered. The models calculate the differential impacts between segment-specific and uniform-fuel tax-collection options for a variety of commodity groups and markets, using 1972 waterway traffic data.

In general, user charge impacts on regional market prices for commodities shipped by water were found to be not substantial. Delivered commodity price impacts rarely exceeded one or two percent for 100 percent recovery of OM&R on the Mississippi River System. The major impacts, if any, due to cost recovery are expected to occur in the transportation sector. Existing water right-of-way subsidies and substantial fixed investment in water-oriented shipping facilities insulate much barge traffic from other-mode competition. It is likely that, for present, waterways can retain existing traffic under user charges, but over ten to twenty years may stand to lose new traffic to other modes as plant location decisions reflect cost recovery considerations.

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PREFACE

The U.S. Department of Transportation initiated an analysis of the impact 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 to 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 on determining their impact on both waterborne commodity movements and alternative distribution systems. Ongoing analysis is evaluating alternative deep-draft navigation user charge options and investigating their impact on both foreign and domestic traffic, including both coastal and Great Lakes trades.

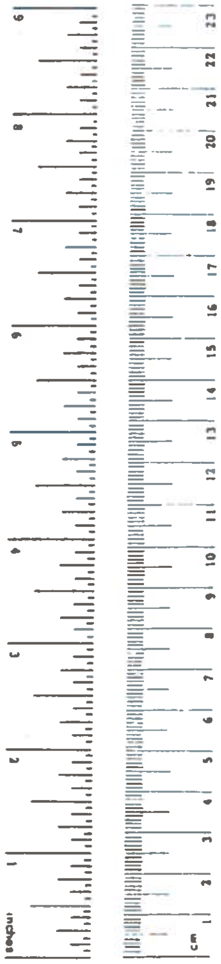
This report was prepared by the National Transportation Research Division of the U.S. Department of Transportation (DOT), Transportation Systems Center (TSC) in Cambridge MA. The study was sponsored by Dr. Philip E. Franklin, Chief, Special Projects Division (TPI-34) in the Office of the Secretary, Washington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

Major contributors to the research and model development in the report include John Witten, Cynthia Greves, Ted Glickman, Lucy Ferguson, and Rene Smith. Programming of the impacts models was accomplished by Bob Mandl. The cooperation and assistance of the Army Corps of Engineers, Office, Chief of Engineers, Planning Division, and CACI, Inc., Arlington VA, are gratefully acknowledged.

METRIC CONVERSION FACTORS

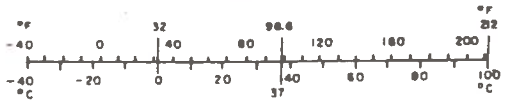
Approximate Conversions to Metric Measures

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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1. INTRODUCTION

The report presents results from an ongoing Department of Transportation analysis into the regional market, industry, and transportation impacts of imposing waterway user charges to recover Federal navigation expenditures. In recent months, several proposals to initiate phased navagation cost recovery have been given serious consideration. In the Presidential FY77 budget document, the Office of Management and Budget (OMB) proposed levying a $80 million tax via river segment tolls and lockage fees on the shallow-draft navigation system of the U.S. to recover almost one-half of the Federal operations, maintenance and repair (OM&R) expenditures in 1977. By 1979, the recovery level would be increased to 100% of OM&R.

The U.S. Department of Transportation has recommended an alternative approach involving fuel and tonnage taxes designed to recover ten percent of annual Federal OM&R as well as new construction costs for the entire (shallow and deep draft) navigation system. The fuel tax would be set to recover $65 million in addition to $10 million already collected in tonnage duties on foreign trade. A study would be conducted during the next three years to assess the impacts of a phased recovery program for user charges aimed at eventual total recovery of Federal navigation expenditures.

1.1 BACKGROUND

Federal Government support of commercial navigation activities includes channel dredging in rivers, oceans, and

Great Lakes ports by the U.S. Army Corps of Engineers(ACoE); construction, operation, and maintenance of the locks and dams in the system(ACoE); riverbank stabilization (ACoE); and maintenance of a system of aids to navigation by the U.S. Coast Guard (USCG). The multipurpose nature (e.g. hydroelectric , recreation, commercial navigation, and irrigation) of many water resource projects makes specific cost allocation to functions difficult. However, it has been estimated that the Federal Government spent $660 million in FY 74 for the navigable waterway system-- $385 million on the shallow-draft system and $275 million on deep-draft operations--including operations and maintenance as well as new construction.

Due to a perceived imbalance among transportation modes with regard to Federal subsidy of systems operation, it has frequently been proposed that the Federal Government should tax the private users of Federally provided navigation rights of way to recover these expenditures. Currently, navigation system expenditures are funded from general revenues with the only direct cost recovery being the tonnage tax and light money collected from U.S. flag and foreign flag carriers operating in U.S. trade with other nations.

Navigation cost recovery is alternatively justified on the basis of equity or economic efficiency arguments. The equity argument points out that the benefits of Federal provision of navigation facilities accrue to a single mode which competes with other private carriers, and to particular regions and groups of shippers who compete in private markets with others not so favored; yet general tax revenues support the construction and operation. The result is an income redistribution in favor of water carriers and water-served shippers and regions. In light of the current financial difficulties of rail carriers competitive with water transportation, such a subsidy should be closely examined.

The efficiency argument states that the subsidy of operations of one mode may encourage private resources to flow into economic activities that are unjustified from the point of view of the efficiency of the economy as a whole, and thus, may reduce national income. Since the superiority of water transportation in present commodity movements and in regions served has not been established, a general subsidy from public revenues may act to encourage overdevelopment of certain activities at the expense of more rational use of resources.

Several alternative recovery schemes are available including vessel license fees, bunker fuel taxes, segment tolls (ton-mile taxes), and lockage fees. Each option has unique characteristics and impacts, with combinations a possibility. License fees on ships, towboats, and barges (invariant with navigation activity) have some justification (from the efficiency side) in recovery of purely fixed or sunk investments in facilities. Segment tolls would tax each waterways operation for the amount of Federal expenditure on that section of river or port alone. Such a toll would penalize high cost rivers and benefit low expenditure segments such as the Lower Mississippi River. Uniform fuel taxes across all river segments would act to subsidize high-expenditure, low-traffic rivers by imposing additional taxes on more efficient rivers. The choice among recovery strategies must balance equity and efficiency considerations to avoid major disruptions in traffic or rapid disinvestment in existing water-oriented facilities.

The timing of cost recovery is another important issue, particularly with respect to the construction costs of new facilities. For developing waterways with growing traffic, constant (over time) cost recovery schemes would discourage traffic and inhibit expected growth. Staggered cost recovery linked to traffic potentials would not discourage such growth.

1.2 OVERVIEW OF REPORT

The report develops and exercises a User Charge Traffic and Market Impact Model to size the effects on shippers and carriers of an eventual 100% OM&R cost recovery for navigation expenditures. Because no agreement on type of recovery, percent recovery, or time-phasing of recovery exists, the methodology is sufficiently general to evaluate most recovery schemes and all recovery levels proposed for the shallow-draft system. For Phase I of the study, the models were set to look at full (100%) recovery to determine if and where serious impacts on markets, industries, or carriers would occur to help direct Phase II research. Further, a pilot study (performed two months ago) which considered the effects of a 10% recovery via fuel or segment tolls on transportation and product prices revealed impacts to be so small that intelligent analysis was not possible. For example, it was difficult to discuss product market effects or modal diversion with a user charge impact on grain prices of less than 0.1% generated by 10% recovery levels. The analysis in the report should be considered "worst-case" impacts, and an effort to identify problem areas rather than precisely to quantify impacts. The results must be considered preliminary, given that the report completes the first part of a two-part program. The second will firm up quantitative impact estimates on transportation and market prices, examine modal diversion issues, and determine financial impacts on carriers of various user charge options.

The report employs a stage-of-processing approach in analyzing the major sectors of the economy most affected by cost recovery in navagation; grains, fertilizer, energy, steel products, mining, and construction aggregates. The report is organized as follows: Section 2 describes the user charge impact methodologies developed for the study. Sections 3 through 10 detail market and industry impacts in major sectors of the economy from 100% OM&R navagation cost recovery. Section 11 examines the impact on main river segments of reduced traffic levels on smaller, high public cost rivers due to user charges. Section 12 contains some preliminary conclusions.

2, USER CHARGE IMPACT METHODOLOGY

The user charge impact methodology has as a basic objective the study of regional market, industry, and transportation impacts due to the implementation of cost recovery mechanisms for Federal navigation expenditures. The initial phase of the effort has involved developing a procedure for (a) calculating the effects of various user charge options (both type and level of recovery) on specific waterborne commodity flows and regional market areas, and (b) translating user charge-induced increases in water carriage costs into final product price and demand effects via a stage-of-processing analysis[1] of impacted markets and industries.

In this section, we describe in detail the structure and content of both aspects of the impact methodology. Section 2.1 examines the waterway traffic impact model; and section 2.2 outlines the general form of the market and industry stage-of-processing analysis. Both models are used extensively in subsequent sections to determine impacts on specific river segments and producers operating on these segments of user charge options.

2.1 WATERWAY TRAFFIC IMPACT MODEL

In brief, the waterway traffic impact model combines data concerning the network, commodity flows, carrier rates, and proposed user charges to calculate changes in traffic

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[1] Stage-of-processing analysis uses input/output (I/O) coefficients to weight relative effects of input price changes on final product prices. For example, user charge-induced increases in price of coking coal would be translated via I/O coefficients into final steel price impacts.

density and cost to shippers due to various cost recovery schemes. Individual model components and data bases will be described below, and then integrated into the overall impact model structure.

The waterways network is the basis upon which subsequent model components are developed. The network is an adaptation of the waterway traffic network developed for the Inland Navigation Systems Analysis (INSA) program of the Army Corps of Engineers (ACoE). The ACoE network divides the Mississippi River system (including all contiguous waterways) into 256 Port Equivalents (PE). The set of PE's covers the entire inland waterway system as described in the ACoE publication River Point Directory. Each PE consists of two endpoints and a centroid. Each endpoint and the centroid have a river mile establishing their position on the river system. A complete description of the PE concept is found in the INSA final report series, currently being published by the ACoE.

PE's can be a mile or a hundred miles in length, depending on the density of traffic on the river segment. TSC has converted the ACoE network into a flow simulation model, capable of handling alternative traffic loadings and of routing traffic among all points on the inland waterway system. The TSC model preserves segment distances for river sectors involved in a movement within the system. For example, a movement from Savage, Minnesota to New Orleans, Louisiana would have two segment distances preserved in the network; mileage from Savage to Cairo, Illinois (Upper Mississippi River sector) and from Cairo to New Orleans (Lower Mississippi River sector).

To evaluate the impact of segment-specific tolls on waterways commerce, it is crucial to preserve these sector distances. Segment tolls vary widely among river segments, and individual segment mileages are necessary to calculate the total origin-to-destination (O/D) segment toll for a commodity flow that involves a number of specific river sectors. At present, the complete network flow model is resident on the TSC computer, eventually to be integrated into a multi-mode network model for traffic diversion analyses.

The second importatnt component of the model is the commodity flow data base. Again, the ACoE provided DOT with complete 1972 PE to PE waterborne commodity flows for 48 commodity groups. To reduce analysis requirements, TSC has condensed the ACoE commodity groups to 24 as shown in Table 2-1. Substantial reprogramming of the tape was necessary since flows that have origins or destinations outside the Mississippi system or Gulf Intercoastal Waterway (GIWW) are included. In these cases, unless both origin and destination were outside the Mississippi River system, the origin or destination PE coding had to be altered to reflect where the commodity flow entered or left the Mississippi River system. In this manner, portions of the shipment using part of the Mississippi or GIWW system are included in ton-mile traffic density calculations for the network, and subsequently can be charged a toll for the portion of the "taxable" river system the shipment traverses. The traffic flows were then loaded on the network to calculate segment (PE) traffic density for individual commodities and total flows.

The initial and primary impact of user charges will be on rates charged by water carriers for commodity shipments. Under either a segment toll or uniform fuel tax, the carrier

TABLE 2-1
TSC AGGREGATION CODES - USER CHARGE STUDY

TSC CODE	COMMODITY	ACoE CODE
1	Coal	1
2	Lube Oil/Coke/Crude	2,8,3
4	Gasoline	4
5	Jet Fuel/Kerosene	5
6	Distillate Fuel Oil	6
7	Residual Oil	7
8	Chemicals, Drugs, etc.	9, 10, 12, 13
11	Synthetics	11
12	Fertilizer	14, 15, 16, 17
13	Other Dry Bulk	18, 19, 24, 25
14	Primary Iron and Steel	20, 21, 22
15	Waste/Scrap	23
16	Sand/Gravel	26
17	Salt	29
18	Lime/Bldg. Cement/Stone Clay	31, 32, 30
19	Agricultural Products/barley, rye, oats	35, 39, 40
20	Flour, processed agricultural goods	42, 46
21	Corn	36
22	Wheat	37
23	Soybean	38
24	Forest Products/Lumber	43, 44
25	Paper/Pulp	45
26	Phosphate Rock	27
27	Miscellaneous	28, 33, 34, 47, 48

incurs additional fixed or variable costs of operations that must be amortized among existing commodity shipments. Given that carriers and shippers have varying degrees of market power, the amount of user charge passed on by the carrier may vary across commodities and regional markets. One major factor is whether railroads respond with comparable rate increases. Lacking specific information on patterns of price discrimination by waterways carriers, we have assumed that carriers will (a) pass 100% of user charges through to shippers, and (b) each commodity shipment will bear its full toll with no discrimination between large or small shipments, among shippers and regions, or between peak and off-peak periods.

The unrealistic nature of these assumptions is recognized, but no firm empirical evidence has been available which allowed any other procedure.

Because only limited information concerning water traffic rates by commodity or O/D exists (due to the unregulated nature of most of the barge industry traffic), it was necessary to develop predictive econometric equations for a broad cross section of commodities and O/D patterns. The analysis must be considered preliminary, and we do not recommend the use of the equations to predict barge rates in general since the models were developed for the specific purpose of evaluating user charge options.

Problems in existing barge rate data include limited geographic coverage (Donley Rate Study of Locks and Dam 26 traffic), limited commodity coverage (Barge Mixing Rate Study - dry bulks only), and obsolescence (Barge Mixing Rule Study - 1970 rates). The Barge Mixing Rule rate data base was received too late for extensive use at this stage of work and so was utilized only to extend rate estimation procedures to areas not covered by the Donley Study, the most current, large-scale barge rate data base available.

The size of the Donley rate data base (231 rates for 44 commodities and commodity groups) and the need for analytical simplification made some aggregation across commodities necessary. To the extent possible, this was done on the basis of commodity homogeneity with respect to handling characteristics and distribution patterns. The major commodity groups modeled are shown in Table 2-2.

Several functional forms were tested, with the basic double log specification,

$$LN\ (RATE) = a + b\ LN\ (MILES),$$

finally chosen. In addition to mileage, several other factors which might be expected to affect barge rates were tested to improve the fit of the estimating equation. Chief among these are O/D patterns which can affect rates from the cost side because of extra fleeting or higher operating costs, and value, which can affect rates from the demand side. Other factors, such as shipment size or annual volumes, are not testable with existing rate data.

2.2 GRAINS

The available data for barge grain rates consists most heavily of moves from the upper Mississippi and Illinois Rivers to the export elevators between Baton Rouge and New Orleans. Other destinations include Guntersville on the Tennessee River and the export port of Pascagoula, Miss. on the GIWW (East). An examination of the residuals (actual rates minus predicted values) reveals that the simple double log equation systematically underestimates rates for non-Mississippi River destinations and Minnesota River (Savage) originations. With dummy variables to account for these geographic effects the result for the rate estimating equation for grains is as follows:

TABLE 2-2

COMMODITY AGGREGATION FOR RATE ANALYSIS

COMMODITY	
Grains	Corn, wheat, aggregate soybeans, oats, barley and rye
Coal	Bituminous and lignite
Petroleum Products	Gasoline, jet fuel, kerosene, gas oil, fuel oil, residual fuel oil, lubricating oils, grease, aliphatic naphtha, petroleum asphalt, and other petroleum products
Other Dry Bulks	Sand-gravel-rock, building cement, dry sulfur, iron-ore concentrates, manganese, phosphate rock, fertilizer and fertilizer materials, nitrogeneous fertilizer, superphosphate, fertilizers--NEC, lime, and non-metallic minerals
Industrial Chemicals	Industrial chemicals, sodium hydroxide, coal tar, alcohols, sulphuric acid, benzol, and benzene
Iron and Steel Products	Iron and steel scrap, castings and forgings, steel mill products and pig iron

$$\text{LN (RATE)} = \underset{(.221)}{2.87} - \underset{(.021)}{.068} \times \text{CWS} + \underset{(.019)}{.048} \times \text{UMISS}$$

$$+ \underset{(.027)}{.133} \times \text{TENN} + \underset{(.023)}{.105} \times \text{GULF} + \underset{(.032)}{.461} \times \text{LN (MILES)}$$

$$\text{corr. } R^2 = .901,$$

where CWS = dummy variable = 1 for corn, wheat, and soybeans, = 0 for oats, barley, and rye.

UMISS = dummy variable for originations in the Minneapolis-St. Paul and Savage, Minnesota, areas.

TENN = dummy variable for Tennessee River destinations.

GULF = dummy variable for destinations at ports on the GIWW.

MILES = length of haul in miles as reported in the Donley Study.

One major grain shipping area not covered by the rate data base is the Missouri River. The Barge Mixing Rule sample suggests that this is a very expensive river for barge shippers, so it was necessary to develope a rate adjustment factor for originations on this river. The procedure was as follows:

1) Rates for barge movements of grain on the Missouri River are available for 1970 from the Mixing Rule Study.

2) Rates of 1974 for grain from Peoria to New Orleans (Donley) were compared with 1970 rates to generate an inflation factor.

3) This factor was applied to the 1970 Missouri River to New Orleans barge rate to produce a "1974" rate.

4) The Missouri River to New Orleans rate was estimated using the rate model. The difference between the predicted and "actual" rate was used to calculate a dummy coefficient for Missouri River originations. (For the Kansas City to New Orleans move, it represents an increment

of $1.50 over the rate predicted for a movement of the same distance from the Illinois or Upper Mississippi River.)

As a test, the adjustment factor was inserted in the equation, and a rate for grain from Kansas City to Guntersville, Alabama was estimated. The estimated rate came within one cent of the inflated 1970 rate for the same move.

Other O/D patterns were not explored because of the relative insignificance of their flows.

2.3 COAL

Coal is represented by only fourteen rates in the Donley Study, in large part because it is not an especially important move for Locks and Dam 26. A second small sample of coal barge transport costs is found in a U.S. Bureau of Mines Circular, Coal Transportation Practices and Equipment Requirements to 1985 (IC 8706). Our strategy was to pool the two samples with the inclusion of a time variable to represent any inflationary shift in rates between the two samples. The results for the pooled regression are as follows:

$$\text{LN (RATE)} = \underset{(.270)}{1.940} - \underset{(.063)}{.308}\ \text{TIME} + \underset{(.040)}{.587}\ \text{LN (MILES)}$$

$$R^2 = .92,$$

where TIME = dummy variable with value 1 for BOM (1973) data and 0 for Donley observations. The lack of O/D identification for moves in the U.S. Bureau of Mines Study makes testing of geographic variables impossible. There is no evidence of systematic misestimation based on O/D patterns in the cases for which this information is available.

2.4 PETROLEUM PRODUCTS

The petroleum products found in the Donley Rate Study consist of nine different products ranging from lubricating oils and greases to jet fuel and gasoline. Although the basic mileage-based equation had high "explanatory power" ($R^2 = .95$), a pattern in the residuals suggested that the equation systematically underestimated rates for the heavy petroleum products, and overestimated rates for the lighter, refined products. Two groups were formed: the heavy products consisting of aliphatic naphtha, petroleum asphalt, lubricating oils and greases, residual fuel oil, and "other petroleum products", and the light group consisting of gasoline, gas oil and fuel oil, jet fuel, and kerosene. The final form and results are as follows:

$$\mathrm{LN\ (RATE)} = \underset{(.101)}{1.55} \times \mathrm{HEAVY} + \underset{(.110)}{1.44} \times \mathrm{LIGHT} + \underset{(.016)}{.770} \times \mathrm{LN\ (MILES)}$$

$$R^2 = .96,$$

where HEAVY = dummy variable which equals 1 for heavy products defined above and 0 for others.

LIGHT = dummy variable which equals 1 for light distillates and 0 for others.

2.5 OTHER DRY BULKS

The dry bulks (other than grain and coal) were divided into three groups for analysis; low value, consisting of sand-gravel-and crushed rock, cement, and lime; salt; and others (mostly agricultural chemicals and ores). A dummy variable for non-Mississippi/Illinois River O/D patterns was also tested because of observed tendencies in the residuals. The final form of the estimated rate equation is:

$$\text{LN (RATE)} = \underset{(.152)}{2.09} - \underset{(.033)}{.104} \text{ X LOW VALUE} - \underset{(.030)}{0.61} \text{ X SALT}$$

$$+ \underset{(.029)}{.221} \text{ X NON MAIN} + \underset{(.022)}{.576} \text{ X LN (MILES)}$$

$$R^2 = .985$$

where LOW VALUE = dummy variable with value equal 1 for sand - gravel - crushed rock, lime, and cement.

SALT = dummy variable with value equal 1 for salt movement

NON MAIN = dummy variable for O/D off of Mississippi and Illinois Rivers.

2.6 IRON AND STEEL PRODUCTS

There are only eleven observations for this product group, which consists of scrap, castings and forgings, steel mill products, iron and steel products, and pig iron. This limited any possibilities of experimentation with additional variables. The form chosen was the basic form:

$$\text{LN (RATE)} = \underset{(.419)}{1.74} + \underset{(.063)}{.703} \text{ LN (MILES)}$$

$$R^2 = .926.$$

2.7 INDUSTRIAL CHEMICALS

The industrial chemicals are an extremely heterogeneous commodity group. The pattern of the residuals suggests a slight downward shift in rates for alcohols and benzene, but the size of the sample makes disaggregation of the group questionable. Some success was achieved with a dummy variable for moves traversing the GIWW West (across all chemicals), so the geographic adjustment was retained. The final equation is as follows:

$$\text{Rate} = \text{EXP } [\underset{(.335)}{2.278} + \underset{(.050)}{.107} \text{ GIWW} + \underset{(.050)}{.599} \text{ LN (MILES)}]$$

$$R^2 = .93,$$

where GIWW = 1 if O/D on GIWW (West), 0 otherwise.

The final model component, user charge tolls for river segments, involved (a) the definition of homogeneous river segments with respect to expenditure of navigation funds and (b) the computation of user charges per ton-mile of traffic for 100% recovery of Federal OM&R expenditures on those segments.

The Water Resources Council (WRC) provided DOT with a computer printout which listed 1974 Federal expenditures for commercial navigation classified by expenditure type (OM&R, Implementation, Services, Unallocated), waterway type (inland waterway, coastal ports, and harbors) and Water Resource Region. Because project names - e.g., "water hyacinth control" or "dredging" - do not always indicate the location of a project, significant research was required to allocate some projects properly. Other expenditures were presented by CoE District (General Regulatory Functions, i.e., CoE overhead) or by Water Resource Region (USCG Aids to Navigation) and had to be allocated to individual rivers segments. CoE General Regulatory Functions were allocated to individual river segments in proportion to the direct project expenditures on each segment. This effectively assumed that CoE District administration activity is distributed roughly equally to field (project) activity. USCG expenditures for aids to navigation, which were presented for multi-segment WRC regions, were allocated to individual segments on the basis of ton-mile traffic densities. In total, only a small percentage of CoE and other waterways expenditures had to be allocated to river segments using arbitrary procedures.

Table 2-3 contains the final allocations of Federal navigation expenditures to river segments and 1974 traffic ton-miles by the same segments. Table 2-4 lists both 100% and 50% OM&R recovery ton-mile tolls for each river segment. In the absence of fuel consumption data by towboat size or river segment at the time of the study, uniform fuel consumption per ton-mile was assumed for all river segments, with the toll calculated as the ratio of 145 million dollars of Federal expenditure and 172-billion ton-miles (see bottom of Table 2-4). With an estimated 650 million gallons of fuel consumed on the river system in 1974, the per gallon fuel charge for 100% OM&R recovery is 22.4 cents per gallon.

Figure 2-1 outlines the waterways traffic model structure that contains the previously described components and data bases. The modified CoE network translates existing PE to PE commodity flows and econometric barge rate equations into traffic density and shipment cost data that preserve all river segments over which any commodity moves from origin to final destination. Using segment toll and/or fuel tax data, the correct user charge (assuming 100% recovery levels) is computed for each move. Comparative analyses of the effects of different recovery methods and levels can then be performed for selected industries, markets, commodities, and regions. For example, the impacts of user charges on utilities in the Upper Mississippi River region using Appalachian and Illinois coal can easily be isolated and all tolls displayed individually by specific move or as a weighted average for the region (collection of PE areas). Finally, by aggregating old and new (under user charge) shipment cost data for all commodities and flows, the aggregate change in waterways traffic and shipping costs can be calculated.

TABLE 2-3

1974 RIVER SECTOR EXPENDITURE AND TON-MILE DATA

Code	Sector	Total OM&R and Coast Guard Navigation Expenses[1]	1974 Ton-Miles (000)[2]
1	Lower Mississippi Baton Rouge-Gulf	0	10,976,502
2, 3	Mississippi Cairo-Baton Rouge	28645.5	65,417,419
4, 5	Upper Mississippi	22427.7	23,169,330
6	Arkansas River	16008.9	451,109
7	White River	422.9	70,161
8	Ohio River	16285.1	31,929,319
9*	Monongahela River	2723.0	1,641,720
10	Allegheny River	1505.3	87,302
11	Tennessee River	2900.5	3,578,809
12	Cumberland River	2234.5	982,503
13	Kanawha River	1442.0	713,681
14	Green and Barren Rivers	1069.7	1,426,247
15	Kentucky River	1402.2	43,238
16	Illinois Waterway	5630.7	8,191,628
17,18	GIWW West from Mississippi River	11329.6	14,941,505[3]
19	Houston Ship Channel	0	-
20	GIWW East	2577.8	2,857,186
21	Pearl River-Pool's Bluff	198.5	17,500
22	Alabama - Coosa	1617.4	157,813
23	Warrior-Tombigbee-Mobile Rivers	8178.0	4,247,424
24	Missouri River	10105.0	1,227,525
25	Apalachicola-Chattahoochee-Flint	2634.0	103,371
26	Atchafalaya River	2336.5	531,918
27	Morgan City-Port Allen Route	-	-
28	Red River	33.9	31,566
29	Black and Ouachita Rivers	3692.5	111,890
	*Improved Portion	145401.2	171,861,085

[1] Source: Water Resources Council printout.

[2] Source: Waterborne Commerce of the U.S. Corps of Engineers, 1974.

[3] If including Morgan City-Port Allen Route.

TABLE 2-4

SEGMENT AND FUEL TOLLS UNDER VARYING RECOVERY LEVELS

Code	Sector	TOLL/TON-MILE (100% OMR RECOVERY)	TOLL/TON-MILE (50% OMR RECOVERY)
1	Lower Mississippi Baton Rouge - Gulf	$ -	$ -
2, 3	Mississippi Cairo - Baton Rouge	.000438	.000219
4, 5	Upper Mississippi	.000964	.000484
6	Arkansas River	.035488	.017744
7	White River	.006028	.003014
8	Ohio River	.000510	.000255
9*	Monongahela River	.001658	.000829
10	Allegheny River	.017242	.008621
11	Tennessee River	.000810	.000405
12	Cumberland River	.002274	.001137
13	Kanawha River	.002021	.00101
14	Green and Barren Rivers	.00075	.000375
15	Kentucky River	.03243	.016215
16	Illinois Waterway	.000693	.000347
17,18	GIWW West from Mississippi River	.000811	.000405
	(Alternative)	(.000758)	(.000379)
19	Houston Ship Channel	-	-
20	GIWW East	.000902	.000451
21	Pearl River-Pool's Bluff	.011343	.005671
22	Alabama - Coosa	.010249	.005124
23	Warrior-Tombigbee-Mobile Rivers	.001925	.00963
24	Missouri River	.008232	.004116
25	Apalachicola-Chattahoochee Flint	.025481	.012741
26	Atchafalaya River	.004393	.002197
27	Morgan City-Port Allen Route	-	-
	(Alternative)	(.000758)	(.000379)
28	Red River	.001074	.000537
29	Black and Ouachita Rivers	.033001	.016501

*Improved Portion

		(100% OM&R)	(50% OM&R)
Uniform Ton-mile toll (100% OMR Recovery)	toll	.000843	.000422
	per gallon diesel fuel	22.4¢	11.2¢

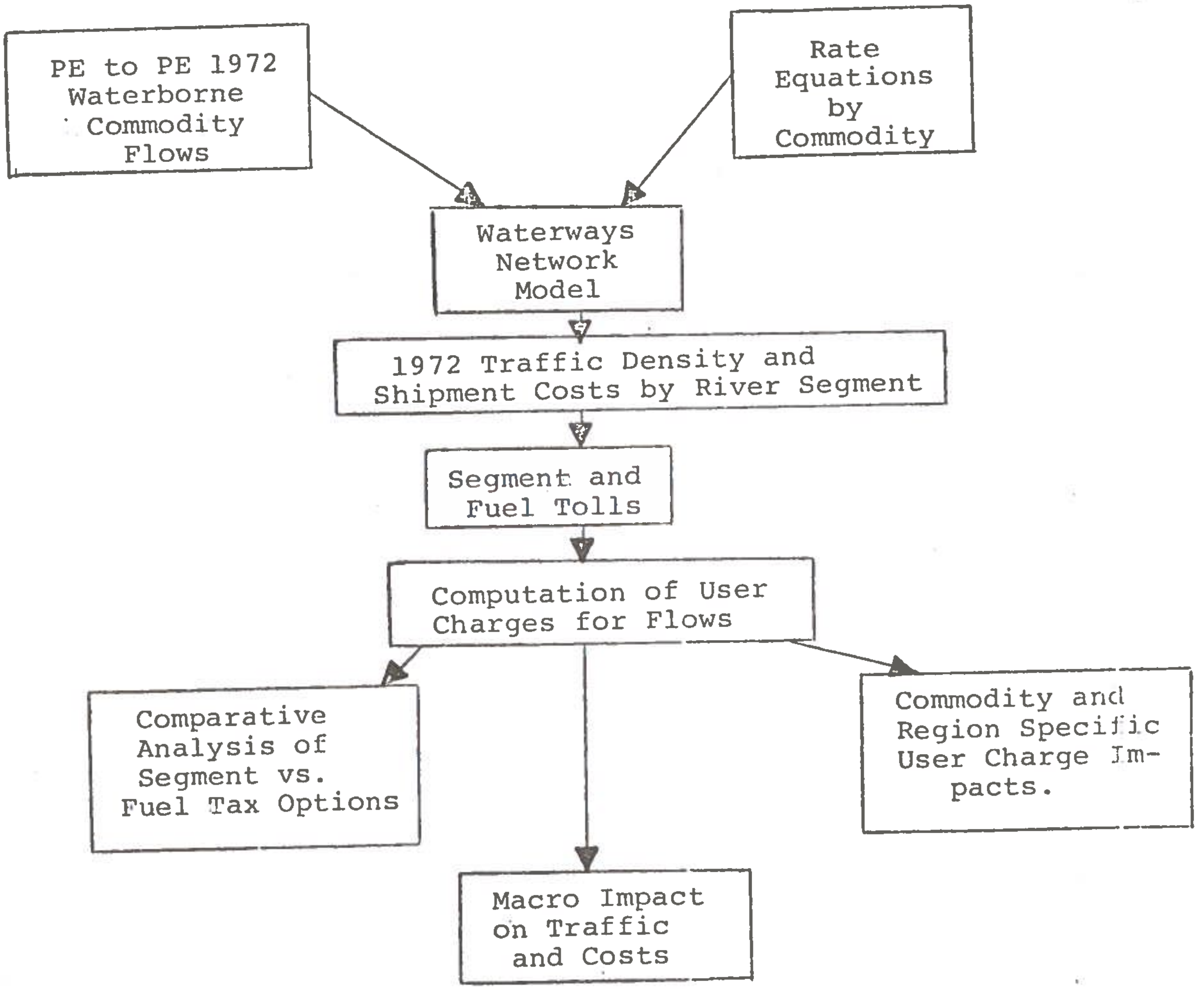

FIGURE 2-1. WATERWAYS TRAFFIC IMPACT MODEL

2.8 MARKET AND INDUSTRY IMPACT ANALYSIS

Changes in waterways shipment costs and rates will ultimately be transferred, at least in part, to those industries using the river for transportation. Increases in transportation costs may impact product prices directly (in the movement of final products to market) or indirectly through the delivered costs of inputs to the production process. Since the waterways are relatively more important in the movement of raw materials and intermediate products, a stage-of-processing approach which allows the impact of changes in input prices on total production costs has been adopted for this report.

The major emphasis of this report is on the impacts of user charge-induced barge cost increases on industries and markets served by water transportation. This is important both for identifying potential effects on the economy (commodity price inflation, regional competitive disadvantages, etc.), and for locating key areas of inquiry for follow-on analysis. For example, normal price instability in a given industry may swamp the small increases in costs caused by user charges, implying that the transportation market may be most worthy of further analysis. Further, analysis of commodity flows in the context of regional production processes provides useful insights into regional product and transportation demand elasticities and institutional factors which may influence the modal pattern of deliveries - the key focus of the follow-on analysis.

In the following Sections, a stage-of-processing approach is used to analyze important industries using the waterways, with only limited effects on input mix allowed. The preliminary nature of these models generally allows for only first-order impacts of changes in transportation costs on an industry. The models are disaggregate in nature, and attempt to consider the structural nature of operations by major industry group, such as utilties or steel manufacturers. A more complete version of these models would allow full cost feedback effects and substitution among factors in a firm's production process as relative input prices changed.

3. COAL TRAFFIC IMPACTS

3.1 INTRODUCTION

The evaluation of the impact of user charges on waterways coal traffic is complicated by the continuing adjustment of the U.S. energy sector to higher energy prices. Fuel shortages, lower growth rates for electricity, the uncertainty of nuclear power, and the availability of western coal further complicate the analysis. This section will consider the effects of a 100% OM&R segment or uniform fuel tax on waterways traffic in the context of ongoing changes within the energy sector and determine the relative impact for specific utility market areas.

In theory, a utility purchases fuel from a variety of sources, depending on regional market prices (as well as spot vs. contract markets) and burn-mix requirements. Faced with an increase in the delivered price of fuel from at least some sources (due to user charges), a utility may reoptimize fuel purchase patterns and transportation in an effort to reduce operating expenses. This may involve purchasing similar coal supplies from sources closer to the utility or, when possible, changing modes of transportation. For larger utilities (burning 1 million tons per year or more), changing modes may not be feasible due to heavy investment in rapid unloading facilities oriented toward a particular mode. It is expected that the principal impact from user charges will be to reoptimize flow patterns of coal with modal diversion a distinct possibility. This will be true in those utilities located nearest to a cheaper, alternative source of fuel such as western strip mined coal. Movement to fuels other than coal appears highly unlikely at this time, given that relative prices of oil or gas are in many cases double existing coal prices at utilities.

3.2 METHODOLOGY

As stated above, a utility may burn a variety of fuel types from several (sometimes diverse) origins that are transported to the plant by more than one mode. To calculate the impact of a change in one transport rate (barge via user charges), a methodology must be developed that correctly weights the effect of the toll on intermediate (cost per ton of fuel f.o.b. plant) and final (cents per kilowatt-hour) utility expenses and output. Figure 3-1 outlines methodology used in the analysis.

First, for a particular river segment or group of utilities in the same fuel marketing region, all waterborne coal flows are identified using 1972 CoE Waterborne Commerce movements among PE areas.[1] Using the DOT multi-mode commodity flow data base and various Bureau of Mines and National Coal Association Publications (such as Coal Traffic Annual), the modal mix and transportation rates to a particular utility are determined. Given assumptions about user charge methods and recovery levels, the effects on cost per ton of coal f.o.b. plant weighted by river origin and modal mix of shipment of user charges can be calculated. Costs per ton f.o.b. plant are drawn from the National Coal Association Steam Electric Plant Factors/1975 Edition. Weighting the impact by percent fuel usage (coal vs. oil vs. gas) at a utility and by fuel costs as an average percentage of utility operating expenses allows calculation of impact on final electricity

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[1] The CoE divides the Mississippi and related rivers into approximately 256 PE's and calculates flows by year and commodity group among them.

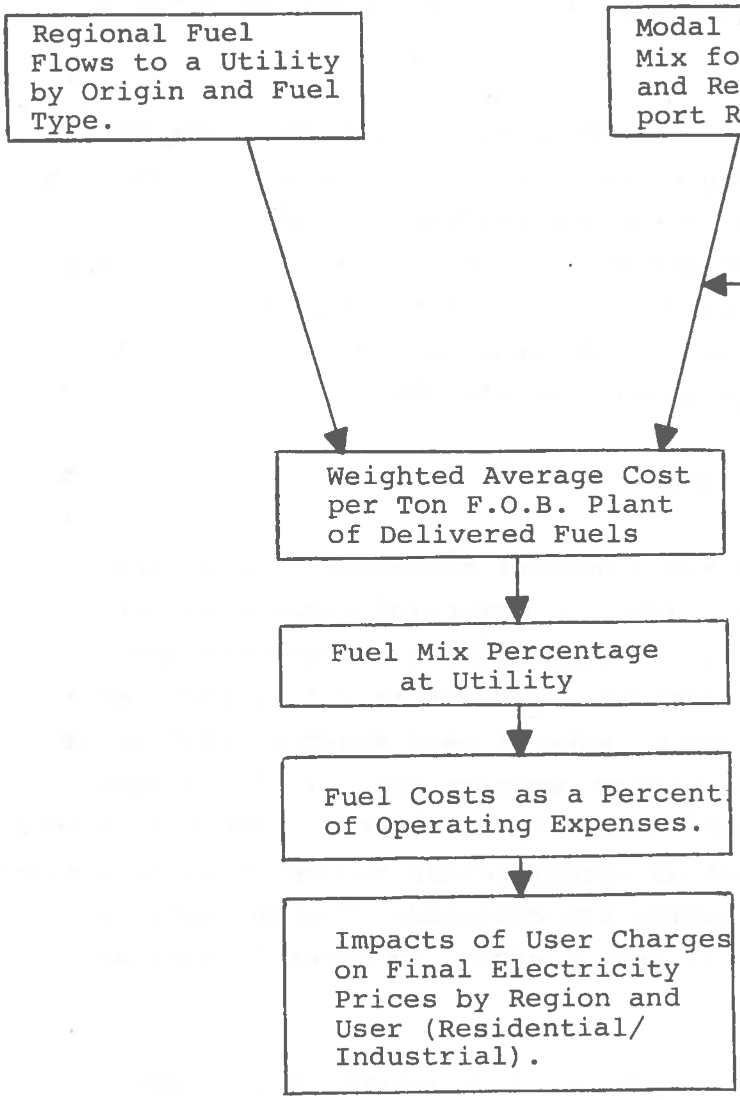

FIGURE 3-1. USER CHARGE IMPACTS ON UTILITY COSTS AND OUTPUTS

prices by region and type of user. The utility's contributions to regional production of electricity is considered in making the final calculation. The result is the percent passthrough of user charges into electricity costs for a region by user.

A sample computation for a major utility on the Ohio River is found in Table 3-1. For all major U.S. coalburning utilities receiving waterborne traffic, a similar set of computations was performed. The following impact analysis is based on these calculations. Due to time and space limitations, individual plant analyses are not published although results are available from TSC.

3.3 USER CHARGE IMPACTS

For each major river segment containing coalburning utilities, four major areas of potential impacts of user charges were examined. First, effects of user charges on market prices (transportation and electricity costs) are examined. Second, the effects of user charges relative to other market forces (energy, western coal, world demands) on utility coal demands are evaluated. Third, impacts of technology advances such as percipitators and new burn technologies on coal and water traffic are explored. Fourth, potential modal diversion due to user charges and other factors are determined.

The major river segments are examined in geographical order beginning with the eastern rivers such as the Monongahela and working west.

TABLE 3-1

SAMPLE COMPUTATION: USER CHARGE IMPACT ANALYSIS

Company: Dayton Power and Light
Plant: J. M. Stuart, Ohio River, Mile 404
Port Equivalent: PE242
1972 Consumption: Coal 4 million tons (100% of fuel burned)
Modes to Plant: Water only

Coal Flows					¢/ton	
Origin PE[1]	Dest. PE	(Million) Tonnage	% of Total	Miles	Segment Toll*	Fuel Toll**
810	242	1.3	31	214	8.5	18
246	242	1.25	30	100	5.1	8
266	242	1.00	24	300	15.3	25.2
244	242	.42	10	189	8	15.9
805	242	.18	4	226	8.7	19
		4.0				

*100% OM&R recovery

**Uniform fuel tax - entire system 100% OM&R

[1] PE 800's - Kanawha River Origins
PE 200's - Ohio River origins

weighted average fuel tax 15.3¢/ton
weighted average segment toll 7.5¢/ton

I. If cost/ton (1974 f.o.b. plant) of coal was $19.96/ton then fuel tax impact = .8%; segment = .4% increase in cost per ton.

II. Assuming fuel costs are 1/3 of operating expenses and 1974 residential electricity prices in Ohio were 2.77¢ per kilowatt hour, then prices would rise from between .13 and .26% or less than a hundreth of one cent per Kwh.

3.4 MONONGAHELA RIVER

The 132 mile Monongahela River originated almost twice the coal traffic (27 million tons) than the next largest river segment during 1974. The coal traffic was almost evenly divided between coking coal for industrial use and steam coal for utilities. Over 18 million tons remained on the Monongahela, moving a (weighted) average of 35 miles. If a 100% OM&R segments toll were charged for these moves, an increase of between one cent and twelve cents per ton of coal would result. A fuel tax (uniform) would have about one-half the impact of the segment toll.

The major coalburning utility on the Monongahela in its West Virginia portion is the Ft. Martin plant of Monongahela Power Co. With a consumption of 2.5-million tons of coal in 1972, it received a substantial portion by barge with an average length of haul of less than ten miles. A segment toll (100% OM&R) would raise delivered price per ton of coal by one cent per ton; a fuel tax by less than one cent. Impact on final electricity prices would be negligible, and the plant is committed to water transportation.

The West Penn Power Co. Hatfield Ferry plant on river mile 78.5 of the Monongahela burned 3.4 million tons of coal in 1972 using 100% coal and 100% water transport. A segment toll on major coal flows to the plant would mean an increase in the delivered price of between 2.4¢ and 6.7¢ per ton. The weighted average user charge impact on 1972 cost per ton f.o.b. plant calculated at .3% (three-tenths of one percent). Fuel taxes would imply a smaller impact. The impact on final prices is negligible, and the plant is committed to water transportation.

In sum, it is unlikely that user charges would affect existing coal transportation patterns on the river. A separate analysis for coking coal price impacts of user charges is included in the iron and steel section. The utilities have substantial investment in coal facilities for barge traffic and user charges will increase delivered coal costs by less than one percent.

3.5 ALLEGHENY RIVER

The Allegheny River runs north from Pittsburgh for 67 (improved) miles. The river is expensive to maintain and has a 100% OM&R recovery rate of 1.7 cents per ton-mile of traffic (compared with .2 cent per ton-mile on the Monogahela). In 1974, the Allegheny originated 1.2 million tons of coal traffic out of a total of 5 million tons of traffic.

The Duquesne Light Co. plant in Springdale PA (river mile 15) consumed 3.1 million tons of coal in 1974, 40% of which arrived by barge. The average segment toll on these flows (originating in West Virginia on the Monongahela) would be 46 to 49 cents per ton (compared to 8¢ per ton under a system-wide uniform fuel tax). The delivered price of waterways coal would rise by at least two percent. Since substantial coal moves to the plant by truck, reoptimization of coal flows may occur at the plant due to user charges, especially segment tolls. The fuel toll impact would be substantially lower. Coking plants which receive the majority of coal moving on the Allegheny would be impacted less, given that the delivered price of coking coal is substantially higher than that of steam coal.

3.6 KANAWHA RIVER

The Kanawha, which flows 90.6 (improved) miles through West Virginia to the Ohio River, carried 5.6 million tons of coal in 1974 out of 12.8 million tons of traffic. Two major utilities operate along the river, receiving coal from mines located in close proximity to the river. Appalachian Power Co. operated the Amos and Kanawha River plants which burned 4.3 million tons of coal in 1972. The average length of haul for Kanawha coal traffic was between ten and twenty miles. Segment tolls for these moves are calculated at two to four cents per ton. The impact on delivered coal price at the plants ranged from .90% to .2%, based on 1974 fuel cost data. The plants receive almost 100% of their coal via water, and potential diversion appears negligible. Final electricity prices would increase less than one-one hundred of a cent per kilowatt hour. The impact is minimal because the cost of coal to the Amos plant is $30.68 per ton compared to an average in the region of between $15.00 and $20.00 per ton.

3.7 OHIO RIVER

3.7.1 Pittsburgh District

In 1974, 11.3-million tons of coal originated within the Pittsburgh Engineers District of the Ohio River. The Ohio River officially begins at Pittsburgh, at the junction of the Monongahela and Allegheny Rivers. Approximately eight major coalburning utilities operate on the river between Pittsburgh and the Kanawha River mouth (265 miles downstream). Dependence on barge traffic for coal supplies ranges from about 25% to over 80%. These figures are tentative because of the difficulty in separating coking and steam coal flows in the existing waterborne data. The plants consume between one and six million tons of coal per year. Many are located in the same PE region, making identification of flows to a particular plant difficult.

Since the Ohio River is less expensive than average to operate, the uniform fuel tax would exceed a segment toll (.08¢ vs. .05¢ per ton mile respectively). Impacts of a fuel tax on cost per delivered ton of coal range from .05¢ at the Ohio Power Mitchell Plant and the Ohio Edison Burger Plant to 1% at the Duquesne Light Phillips Plant or the Ohio Edison Sammis facility. The majority of coal burned along this segment originates on the Ohio or Monongahela Rivers and may move up to 250 miles to a plant. Impacts are low due to lower costs of river operations and fewer longer flows of coal.

For flows to a given plant, a higher toll may mean changes in source of supply and/or modal diversion. For example, the Cardinal Plant of American Electric Power Corp. at river mile (Ohio) 77 has some fairly expensive tolls (21¢ per ton) on movements out of the Allegheny and Kanawha-served coal regions. If these flows are necessary to maintain optimal burn-mix to meet EPA clean air restrictions, no change in supply region may occur. However, shifts in mode may occur if the extra transportation charge (almost $175,000 per year) were considered excessive and non-competitive relative to other supplies or modes available.

In sum, it is difficult to evaluate market and mode impacts along this river segment due to the mixing in the data of steam and coking coal. However, the largest tonnage flows average less than 50 miles, which would carry a segment toll of 2.5¢ per ton (or a fuel tax of 4¢ per ton). Given less than total dependence on the river for coal supplies, utilities with higher than average length of haul may consider alternative modes or coal sources in the long run.

3.7.2 Huntington and Louisville Districts

The two remaining districts of the Ohio River originated 25 million tons of coal traffic in 1974. These districts contain the largest concentration of coalburning/water served utilities in the U.S. In all, ten major plants, consuming almost 25 million tons of coal are situated between the mouth of Kanawha (river mile 404) and the terminus of the Ohio at the Mississippi (river mile 951). These plants draw their coal from fields served by the Green, Kanawha, and Ohio Rivers. The Green and Kanawha Rivers flow into major coal producing areas and originate the majority of coal consumed in these districts.

Given that fuel tolls on the Ohio would exceed segment tolls by 40%, the impact of fuel-based user charges on cost per delivered ton of coal for utilities in these districts is between one and two percent. This translates into a cost increase of between .5 and .7% in producing electricity (per kilowatt hour).

The Joppa Plant of Electric Energy Inc., Ohio, is located near the junction of the Ohio and the Mississippi. In 1974, the plant relies on the river for about 25% of its coal, the remainder coming via rail. The fuel tax on a major move to the plant from Green River origins is almost 21¢ per ton, or an additional cost per year by barge of $300,000 out of a total fuel bill (delivered) in 1974 of almost $50 million (.06%). Conversation with utilities have led us to conclude that such a small impact will not cause major modal or supply realignment. Market electricity price impacts are even smaller.

3.8 TENNESSEE RIVER

The Tennessee River has been improved for 650 miles and carried 5.2 million tons of coal traffic in 1974, mostly to Tennessee Valley Authority (TVA) Plants situated in Tennessee and Alabama. The two major plants are the Colbert Steam Plant (1.8 million tons of coal in 1974) and the Johnsonville Plant (2.33 million tons). Since the Tennessee River segment toll is roughly equal to the average, the impacts of segment tolls and fuel taxes are approximately the same for coal traffic.

For the Colbert Plant (100% water transport and 100% coal use) the segment toll would average 4 to 8¢/ton or a .4 to .8% increase in the delivered price of coal. With a 100% passthrough to the consumer, electricity prices for the plant would rise by less than one-one hundred of one cent from 3.56¢/kw-h. The results were similar for the Johnsonville Plant. Conversation with TVA indicate that no changes in delivery patterns or modes would result from the imposition of these tolls in that TVA was committed to river transportation for these plants.

3.9 ILLINOIS RIVER

The Illinois River originated 5.1 million tons of coal in 1974, while water dependent coalburning utilities consumed over 7 million tons, mainly western coal from Wyoming and Southern Illinois coal originating on the Illinois and Mississippi Rivers. A major multi-modal movement involving trans-shipping Wyoming coal via the BN railroad to Havana, Illinois for a barge movement to final consumption points has been growing rapidly in the past few years.

At least four major utilities are located on the Illinois River outside the Chicago area. Two of these have ended coal deliveries by water since 1972; one due to a switch to 100% oil, the other for an unknown reason. The two remaining utilities - the R.S. Wallace Plant of Central Illinois Power and the Hennepin Plant of Illinois Power - would experience a weighted average impact of a fuel-based user charge (higher on the Illinois than a segment toll) of between eight and nine cents per ton. This implies an impact on cost per delivered ton of between .4 and .5% (corrected due to the less than 100% water share of coal to the plants).

Continued competition from western coal could result in further inroads into Illinois utility coal use, and user charges may accelerate this change depending on where the coal enters the river system. For example, if western coal is transferred to barges on the Illinois Waterway, user charge impacts would be substantially lower than if coal moved from an Upper Mississippi River origin. The user charge would make Southern Illinois coal even less competitive due to an additional 100 miles of river movement required compared to western coal via Havana, Illinois. If Southern Illinois coal moves under long-term contracts, user charges and diversion may be a non-issue.

The Chicago Commonwealth Edison plants also consumes a substantial amount of western coal. A fuel tax recovering 100% OM&R would increase the average barge cost per ton delivered to Chicago area plants 19 cents or 1.2% f.o.b. plant price. Given western strip mined coal is less expensive to mine than Southern Illinois coal, increases in relative regional transportation costs in favor of western coal may continue to increase its market share in Illinois, unless long-term coal contracts restrict such changes.

In sum, a user charge could further act to make Southern Illinois coal more expensive and lead Illinois utilities to switch to western coal at a <u>more rapid pace</u>. Modal diversion appears unlikely, although the western coal may enter the river system at a place other than Havana in the future.

3.10 UPPER MISSISSIPPI

Wisconsin and Minnesota utilities will be the most heavily impacted of any utilities studied in this analysis. Dairyland Power Cooperative plants at Alma, Genoa, and Cassville, Wisconsin, rely heavily on Illinois/Kentucky coal fields for a majority of their coal via water. On average, these plants may expect a 7% increase in the delivered cost per ton of coal (almost $1.00 per ton on some large moves) - slightly less under a fuel tax - due mostly to an exceptionally long length of haul for coal to these utilities, over 500 miles from Illinois fields. Such an increase in the delivered price of coal would translate into an almost 2% increase in electricity prices for the region.

A similar situation exists for Northern States Power Co. of Minnesota, except that they have increased their use of western coal substantially over the last five years. The Allan S. King and High Bridge Plants face segment tolls that average 65 to 75 cents per ton for non-western coal flows by river. In 1972, only 9% of total coal consumed by these plants came from western sources, with an average toll of 2 cents per ton (the western coal is put on the river at Minneapolis for a 25 mile movement to the utilities to take advantage of river coal unloading facilities). Increases projected to add five to seven percent to delivered coal prices will certainly accelerate the search for alternative coal supplies. If western fields are price competitive, then modal diversion will certainly also occur, reducing the 4.6 million ton per year coal flows from Southern Illinois fields by a substantial amount - and substituting a shorter water haul from Minneapolis.

3.11 WARRIOR RIVER SYSTEM

Under a segment toll, Warrior River utilities such as the Alabama Power Barry Plant and the Greene County Plant face increases in cost per delivered ton of coal of between 30 and 68 cents (two to four percent of delivered price). The impact under a fuel tax would be approximately one-half of the segment toll impact. Final electricity prices for the region may rise between one and two percent. Both plants are committed to water delivery of coal, and the impact would be substantial. The utilities are quite large, consuming well over 4 million tons of coal per year. The potential for modal diversion is not known at present although alternative supply sources may not be feasible due to length of haul from other coal fields. The potential development of the Tennessee-Tombigbee River system could have substantial effects on traffic as well as tolls.

3.12 EXPORT COAL

New Orleans, Mobile Harbor, and Houston are the three major Gulf ports that export coal. Much of this coal travels by barge and would be subject to fuel or segment cost recovery tolls.

New Orleans coal export traffic originates on the Green, Tennessee and Ohio Rivers. For these movements, segment tolls range between 35 and 113 cents per ton; fuel based tolls range from 62 to 109 cents. Japan receives much of the coal exported via New Orleans, at prices f.a.s. ship in New Orleans, ranging from $15 to $20 per ton in 1973. Price impacts range from 2% to 6% depending on the tax approach and origin.

Mobile Harbor exports Warrior River system coal to Europe and Japan. The export price of Mobile coal ranges (1974) from $25.00 to $30.00 per ton. Depending on the upriver origin of the coal, f.a.s. ship prices of coal exports would increase by three to four percent per ton.

A major consideration to be investigated in the second phase of the study is the impact on the relative competiveness of the Gulf versus the East coast coal export ports.

In summary, 100% OM&R waterways cost recovery would most directly impact utilities on the Upper Mississippi and Illinois River. Given that Southern Illinois coal fields are already non-competitive in many utility markets due to the high sulfur content and cost per ton of the coal, a waterways user charge aimed at full cost recovery of OM&R would further reduce the market area of the region. Illinois, Wisconsin, and Minnesota utilities that are currently heavy users of Southern Illinois coal may accelerate their conversion to low-sulfur western coals. However, the market for Southern Illinois coal may not entirely disappear due to the requirements of burn-mix that result in utilities using a variety of coal from diverse sources although not all in large tonnages. The Warrior River System utilities may also be adverseley affected by a user charge although not as many alternatives exist for these plants as those described above. Further study of the economic impacts of user charges on coal markets should be concentrated in the existing markets for Southern Illinois coal. Utilities may invest in new transfer facilities (for all rail or multi-mode operations) to avoid increased fuel charges due to user charges although more research is necessary to validate this conclusion.

4. CRUDE OIL AND PETROLEUM PRODUCT IMPACTS

4.1 INTRODUCTION

Each year in the United States over six-hundred forty million tons of crude oil and over one billion tons of petroleum products are transported. Crude oil moves primarily in pipelines, and secondarily, by water carrier-- both barge and tanker.

The pipeline share of traffic has been virtually constant over time; the absolute amount of crude oil moved in pipelines has risen fairly steadily since 1958. Since 1970, both the absolute amount carried by and the relative share of traffic of water carriers have fallen. (1974 waterborne tonnage was only seventy-two percent of the 1970 tonnage). Although small in absolute terms, truck and railroad transport of crude oil rose dramatically over the same period as shown in Table 4-1.

Over eighty percent of the decrease in water traffic is attributable to the drastic decline in shipments from the Gulf Coast to the East Coast. In 1975, tanker and barge movements of crude oil from the Gulf Coast to the East Coast were only ten percent of 1970 tonnage. Table 4-2 shows water traffic on this route for the first half of this decade. If the East Coast shift from domestic to imported crude oil continues, this traffic will continue to decline with or without user charges.

Coastwise oil traffic on the Pacific Coast was almost 20 million tons in 1972 and slightly larger in 1974. Tanker traffic in this region will increase markedly with the opening of the Alaskan pipeline.

TABLE 4-1
TRANSPORTATION OF CRUDE OIL[1]

	Pipelines		Water Carriers		Trucks[2]		Railroads		Total
	Tons (000's)	%	Tons (000's)	%	Tons (000's)	%	Tons (000's)	%	Tons (000's)
1970	457,157	74.3	116,301	18.9	40,900	6.7	916	0.2	615,274
1971	459,860	74.6	114,721	18.6	40,800	6.6	876	0.1	616,257
1972	487,607	75.8	103,673	16.1	51,000	7.9	1,495	0.2	643,739
1973	492,382	76.9	90,519	14.1	55,540	8.7	1,901	0.3	640,392
1974	464,272	74.8	85,350	13.5	70,043	11.3	2,704	0.4	620,605
1974 as % of 1971	1.02		1.72		1.72		3.09		1.01

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[1] Numbers may not add due to rounding.

[2] Estimated.

Source: Association of Oil Pipelines, "Shifts in Petroleum Transportation", annual issues.

TABLE 4-2
WATERBORNE CRUDE OIL TRAFFIC, GULF TO EAST COAST

Tons (000's)

1970	1971	1972	1973	1974	1975
34,839	30,487	15,789	8,362	7,731	3,515

Source: U.S. Department of the Interior, Bureau of Mines, "Mineral Industry Surveys."

No single mode dominates the transportation of refined petroleum products as Table 4-3 shows. The large share of trucks is attributable primarily to short-haul local distribution movements. Pipeline transport has grown over time to its current third of the total market. Even in 1974, when total tons carried decreased, pipeline tonnage and share increased. Waterborne tonnage decreased slightly, but the water carrier share increased. The strong time trends in the transportation of crude oil are lacking in petroleum product movements, but the direction of the trend is the same -- waterborne traffic has grown more slowly than pipeline traffic. Over the past decade, the proportion of total tonnage moved by pipeline has generally increased while that of water carriers has generally declined.

Crude oil traffic on the inland and Gulf intercoastal system totalled 75 million tons in 1972, or twelve percent of total Mississippi River system traffic. Other petroleum products (gasoline, jet fuel, distillate fuel oil) comprised 12.1 million tons of traffic in 1972 (two percent of total traffic). Petroleum products have a substantially longer length of haul than crude oil on the inland river system and tend to travel over higher cost segments. As a result, impacts on petroleum products of 100% OM&R user charges are expected to be more substantial than on crude oil, with toll costs attributed to crude oil movements probably in part being shifted to product prices.

4.2 CRUDE OIL

Crude oil traffic on the inland waterways tends to be short haul transfer operations, occurring mainly along the Gulf Intercoastal Waterway. In 1972, the GIWW (West) shipped

TABLE 4-3

TRANSPORTATION OF PETROLEUM PRODUCTS[1]

Year	Pipelines		Water Carriers		Trucks[2]		Railroads		
	Tons (000's)	%	Tons (000's)	%	Tons (000's)	%	Tons (000's)	%	Total
1970	333,085	31.1	286,367	26.8	425,200	39.7	25,816	2.4	1,070,468
1971	346,811	31.4	302,071	27.4	429,900	39.0	24,774	2.2	1,103,556
1972	388,641	32.4	322,930	26.9	462,500	38.6	25,639	2.2	1,199,711
1973	419,828	31.8	330,687	25.1	540,177	41.0	27,835	2.1	1,318,527
1974	420,376	33.5	323,868	25.8	481,993	38.5	27,226	2.2	1,253,463
1974 as % of 1970									

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[1] Numbers may not add due to rounding.

[2] Estimated.

Source: Association of Oil Pipelines, "Shifts in Petroleum Transportation."

38.4 million tons of crude and received 31.2 million tons of crude oil, mostly in flows of under 25 miles.[1] A movement of 25 miles would incur a toll of two cents per ton, with the maximum toll for an existing major move on that waterway (Houston, Texas to New Orleans) being 36 cents per ton. A ten to twenty cent per ton toll along the GIWW (West) would increase domestic (Gulf Coast) crude oil prices per ton by .2% in 1975 dollars.

There are also major tanker flows of domestic crude oil from the Gulf to the Atlantic Coast, although they have been largely displaced by imports in recent years. This crude, along with imported crude, is frequently distributed to refineries -- short haul -- by barge or small tanker. Finally, there are heavy tanker flows between Pacific ports, principally from Southern California and Alaska. These flows are difficult to treat because they frequently utilize non-project ports--ports not constructed and maintained by the ACoE.

4.3 TANKER FUEL USER CHARGES

Most of the long distance water movements of petroleum and petroleum products are tanker movements. In this section, estimation of the impacts on petroleum and petroleum products of a $1.00 per barrel tax on tanker fuel will be discussed. The impact of a fuel tax of any other magnitude would, of course, be proportionate.

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[1] In 1972, 7.5 million tons of crude also originated and terminated on the Ohio River, but this flow virtually disappeared in 1974, with total terminations falling to 640-thousand tons-- about 2/3 from the Lower Mississippi and the remainder from Ohio River origins.

Due to the shallow depth of Gulf and East Coast ports, most tankers in use now are fairly small. Reliable sources estimate the average size of coastwise tankers to be 36,000 - 37,500 deadweight tons (dwt). North Slope oil will probably be transported in larger tankers.

To suggest the range of impacts of a fuel tax, four sizes of tankers and eleven O/D pairs were used in the estimation. Given the operating characteristics of tankers built in 1974 as estimated by the U.S. Maritime Administration[2], and assuming that the fuel tax will be fully passed on to the price of the delivered product, the increase in prices at a given destination can be calculated as shown below.

$$\text{\$ per delivered barrel of oil} = \frac{\text{Tanker fuel consumption X toll per barrel (tanker fuel)}}{\text{Barrels carried (assumed equal to tanker capacity)}}$$

$$\text{Fuel Consumption} = \frac{\text{2 X Fuel used per day at sea X Miles between O/D}}{\text{Miles per day (speed)}} + \text{3 X Fuel used per day in port.}$$

The assumption of three days in port per trip is based on the opinions of Government and industry experts.

Using the above formulas, estimations of the increase in petroleum or petroleum product prices from a $1 per barrel tax on "bunker C" range from one to three cents a barrel. The highest estimate is for oil carried in 25,000 DWT tankers from Anchorage to Los Angeles - probably high because of the small size of the shipment for this move. Estimates of the prices are shown in Table 4-4.

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[2] Estimated Vessel Operating Expenses, 1974, U.S. Department of Commerce, Maritime Administration.

TABLE 4-4

DOLLARS PER DELIVERED BARREL

O/D	25,000 DWT	37,500 DWT	50,000 DWT	80,000 DWT
New Orleans - New York	.02	.02	.01	.01
Houston - New York	.02	.02	.02	.01
Anchorage - Seattle	.02	.01	.01	.01
Anchorage - Los Angeles	.03	.02	.02	.01

The impact of the tanker fuel tax on the delivered price of crude oil and products is negligible, even at considerably higher per barrel tax levels. In fact, it would frequently be no larger than the user charge for prior water movement of the crude from the point of extraction to the tanker terminal. The total user charge to East Coast tanker terminal would typically equal 4-6¢ per ton bbl compared to a price of crude in excess of $10 and product prices 2-3 times as large. This is not large enough to impact fuel prices significantly in the Northeast, especially in light of the subordinate role of domestic vs. foreign oil. Whether it is significant enough to cause further import substitution or modal shift remains to be explored.

4.4 RESIDUAL FUEL OIL

Residual (No. 6 fuel oil) is produced as a lower distillate by refineries located primarily along the Gulf Coast (Texas, Louisiana) but also in the Midwest and in Ohio. Due to high viscosity, the fuel cannot be distributed by pipeline, and is either consumed close to source of production or moved by barge, tanker, or rail to users. Basic uses of the fuel include electric generation, industrial heating, and metallurgical production. Residual is consumed in volume by steel plants in Western Pennsylvania (discussed in the iron and steel section), for industrial purposes along the Ohio River, and by utilities in Chicago, Lower Mississippi Valley and the Gulf Coast, especially Florida, also Atlantic and Pacific Coasts. A significant amount of the residual flows on inland waterways is longhaul (over 500 miles). Residual traffic comprises eight percent of total domestic internal tonnage.

The Commonwealth Edison Ridgeland Plant in Chicago consumed 1.745 million tons of No. 6 residual oil in 1972, most imported via New Orleans or originating along the GIWW. A

100% OM&R segment toll would increase the cost per ton of delivered oil by 75¢. A 100% OM&R uniform fuel tax would increase the cost by $1.07 per ton. In 1974, the utility paid an average of $40.94 per ton for No. 6 oil, making the impact of full recovery user charges about 3% on delivered price. Since the utility burns 100% oil, all from Gulf Coast origins, the increase in cost per ton of fuel translates into about a 1% rise in electricity prices for this plant, although cost increases would be spread over all consumers in the Commonwealth Edison System.

A second large consumer of No. 6 residual oil on the Illinois River is the Havana Power Plant of the Illinois Power Company. In 1972, the utility consumed 291,000 tons of oil. The burn-mix was 29% coal and 71% oil, with a delivered cost per ton for oil in 1974 of $75.63. The user charges on oil moving by barge to Havana would be larger in absolute terms because the major flow originates 684 miles down the GIWW in Texas. The 100% OM&R segment toll per ton is $1.14, and the fuel tax (higher because it taxes the Lower Mississippi segment at a rate double its segment toll) is $1.45. The impact on delivered price per ton of oil ranges between 1.5 and 1.9 percent. The weighted by fuel type impact on electricity costs ranged from .35 to .94%. The utility is committed to barge delivery of residual and the price increase would be passed along to residential and industrial users.

The Robert Richie Plant of Arkansas Power and Light in Helena consumed 258,720 tons of oil in 1972, receiving the majority of the fuel from the New Orleans region and GIWW

(West). The average segment toll per ton from origin was 20¢; the average fuel tax was 37¢. In 1974, the utility paid $63.84 per ton of oil delivered via barge. The user charges would increase delivered price by .2% to .4%. Since oil was 40% of fuel used in 1974, average impacts on electricity costs are in the range of .03% to .06%.

In 1974, Florida utilities consumed over 62 million barrels of oil (both No. 2 and No. 6 fuel oils), accounting for 56% of total BTU production in the state. Over 90% of the residual fuel oil is imported and reshipped very short distances by barge or small tanker to utilities. For example, 1.41 million tons of residual were imported at Canaveral Harbor in 1974, with 1.3 million tons transshipped by barge to the Cocoa Plant involving a haul of less than 20 miles on the GIWW. The impact on electric generating costs of a user charge on these local distribution moves would be negligible, and modal diversion unlikely.

That residual which does come from domestic sources (5-10% of Florida consumption) is received by Gulf Coast utilities from Texas, representing 10-15% of their total oil consumption. Tolls for these moves would be about 66¢ per ton (by fuel or segment toll) from Texas (Houston) if via the GIWW. Although this would not impact fuel costs and electric rates significantly, it might be sufficient to encourage import substitution for the remaining domestic fuel. If, on the other hand, the coastwise move is by the deep water route, there would be no toll - and no impact - under a segment toll, with fuel tax impacts dependent on whether the move is by tanker or barge (residual and distillate users, respectively), and what fuel tax level is set for each fuel. Further study of these questions is underway.

4.5 GASOLINE

Gasoline flows on the inland waterways tend to move from Gulf Coast and Ohio River origins to population concentrations located on or near rivers. Cincinnati, Ohio received the majority of its gasoline from Huntington, West Virginia, and New Orleans by water in 1974. The segment toll from Huntington was 8 cents per ton-(the fuel tax 14 cents per ton - compared to barge costs of about \$2.50[3]. Segment tolls from New Orleans are 52 cents per ton; fuel tax \$1.00 per ton - compared to barge costs of 6-7 dollars. The cost per ton (delivered) of retail gasoline in Cincinnati in 1972 was \$190.58. Impacts of user charges on gasoline retail prices range from .04% for a segment toll from Ohio River origins to .5% for a fuel tax from New Orleans origins.

St. Louis, on the other hand, receives the majority of its gasoline via water from New Orleans and Texas. For New Orleans origins, the segment toll is 32 cents/ton versus a 52 cent fuel tax. From Texas, the segment toll is 54 cents per ton, and the fuel tax 84 cents. Barge transportation costs of gasoline to St. Louis would increase between eight and twelve percent, if carriers practiced full passthrough of the user charges. In 1972, the retail (delivered) cost/ton of gasoline in St. Louis average \$186.97. The weighted fuel tax impact on retail gasoline prices would be .3 or .4%.

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[3] All rates used here are estimates based on 1974 Donley Study rates.

Given that pipelines are quite competitive in this region, increases in transportation costs that average over ten percent could induce modal diversion. Pipelines are beginning to experience excess capacity problems from the Gulf states as domestic production peaks and begins to decline. Imported oil and products for the East tend to be moved to the port nearest the point of consumption rather than to the Gulf. Pipelines may further reduce transportation charges in an effort to encourage new business. Combined with user charges on the waterways, losses in waterways traffic may occur.

Finally, a substantial traffic in intra-GIWW transfer of gasoline exists. A 100% segment or fuel toll on the GIWW would increase barge costs by up to 50 cents per ton, depending on the distance traveled although most moves are considerably shorter. Further study of the petroleum distribution system is necessary before these impacts can be combined into total market effects of user charge imposition.

4.6 JET FUEL

Consumption of jet fuel is localized around major population centers and military air bases. Waterways flows of jet fuel move basically to large cities located on rivers having jet port facilities. Cincinnati receives 250,000 tons of jet fuel from Ohio River origins with an average length of haul of just over 200 miles. The average segment toll is approximately ten cents per ton; the fuel tax averages 20 cents. Given a transportation charge of $2 - $2.50 per ton, barge costs would increase by 4 to 10%. In 1975, jet fuel averaged just over $89.00 per ton. A segment toll would increase the delivered price by .1% the fuel tax by .2% per ton.

St. Paul, Minnesota receives almost 120,000 tons of jet fuel equally from Texas and St. Louis river origins. The segment toll from Texas averages $1.38 per ton; the fuel tax averages $1.83, which would increase barge costs by about 20% over current rates. The toll from the St. Louis region averages 75 cents per ton and would increase barge costs by 17 percent. The weighted (by origin of flow) impact of user charges on delivered price of jet fuel in the Minneapolis area will average between one and two percent.

Again, given the close competition between pipelines and water carriers for middle and high distillate traffic, a 100% OM&R user charge may accelerate the trend away from barge transportation to pipelines for petroleum product moves. By altering relative prices, traffic diversion could occur. Further study is necessary to validate this point.

4.7 DISTILLATE FUEL OIL

Distillate (No. 2 fuel oil) tends to have destinations similar to those of fuel oil and gasoline, given that it is used extensively in home heating and electricity generation. The preliminary impacts calculations and conclusions formulated for those fuels are equally applicable here. As with the other products, significant volumes of distillate fuel oil also move in the coastwise tanker trade.

5. IRON AND STEEL PRODUCTS

The iron and steel industry is a potential heavy user of water transportation because of its consumption of large quantities of bulk raw materials (ores, coal, flux), its location on or adjacent to the inland waterways (Pittsburgh, Birmingham, East Chicago Gary), and the relatively low value of its output (primary and semi-finished iron and steel products and byproducts such as slag).[1]

Figure 5-1 shows the relationship of major inputs to the steel-making process. The numbers in parentheses show the (national average) number of tons of each input required for one ton of output at each stage of production.[2] For example, 1.463 tons of coal are needed to produce 1 ton of coke, and .576 ton of coke is used in the production of 1 ton of pig iron, .63 ton of which is used in the production of 1 ton of raw steel.

Although it is conceivable that each stage of processing could occur at a geographically separated spot - with each arrow in Figure 5-1 representing transportation of intermediate goods - in practice, they tend to be located at a common site, with coking by-product gases often being used to fuel the iron blast furnace, and pig iron moving to the steel production stage in molten form to avoid remelting. Raw steel

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[1] Requirements of large amounts of water for cooling ingots strongly rival transportation requirements as a justification for the waterside location of major steel producing complexes.

[2] Inputs vary widely between the three basic steel-making processes with the electric furnace process using 96% scrap for metallic input, and the basic oxygen and open hearth processes using more balanced inputs of pig iron and metal scrap. Since little scrap moves by waterway, but pig iron production requires large amounts of coking coal and ores (which frequently move by waterway), the precise production mix is a potentially important factor.

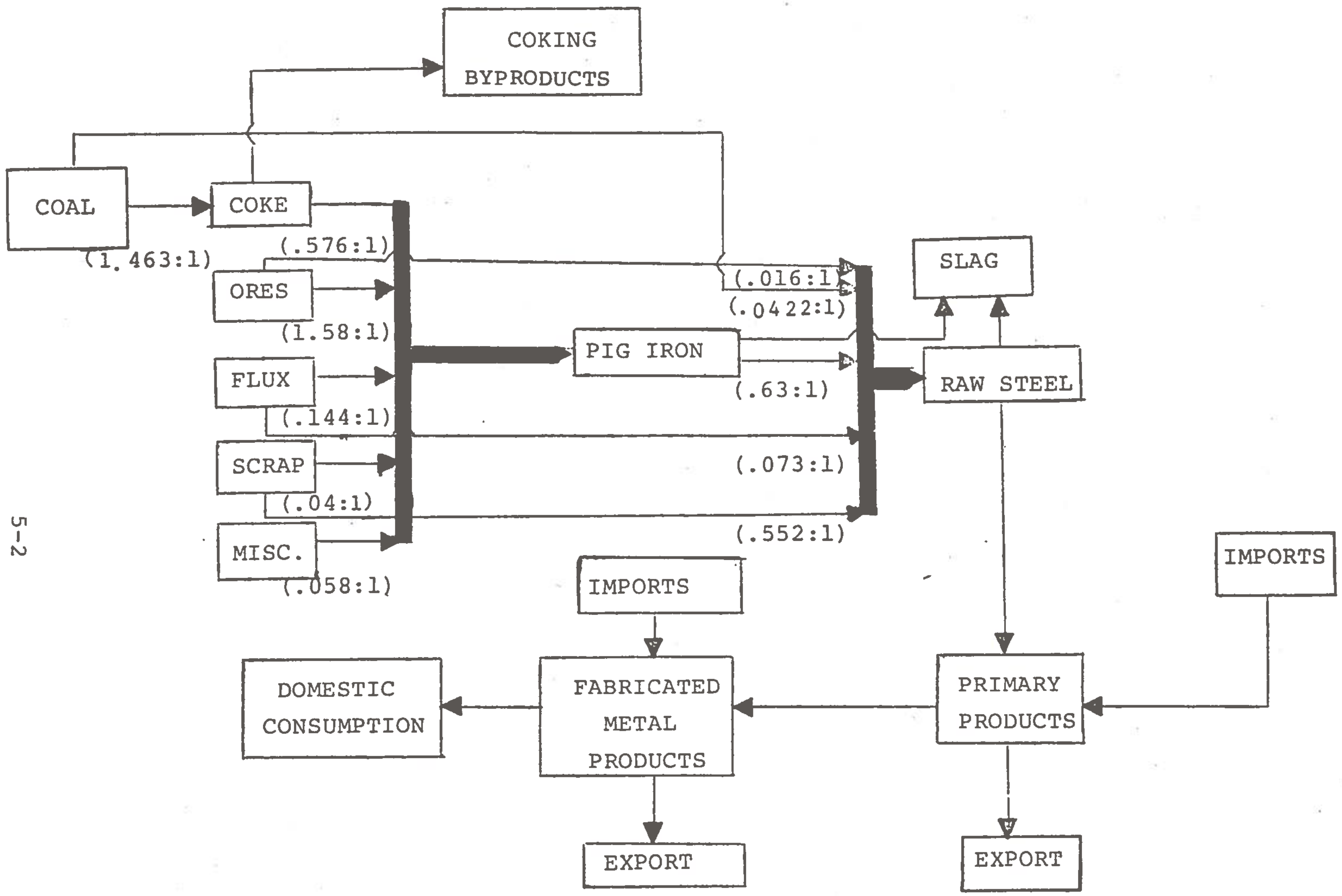

FIGURE 5-1.

INPUT/OUTPUT RELATIONSHIPS IN THE IRON AND STEEL INDUSTRY ingots may also move to on-site rolling mills for primary fabrication to sheet, tube, rods, etc.

There is also strong vertical integration back through the raw material extraction and transportation process. Steel corporations control coal and iron ore mines, and the railroads and water transportation lines which transport the raw materials, and they may even maintain the Lakes ports used in ore transportation.

To assess the impact of waterway user charges on this industry, it is necessary to identify the distribution system (geographic and modal) for iron and steel inputs and outputs for producing areas on or near the waterways. Each move which is touched by user charges can then be assessed with respect to the impact on the total production process and the probability of modal shift or alternative shipping patterns. The case of the Pittsburgh iron and steel complex on the Monongahela River is presented below.

Table 5-1 lists the Monongahela River flows directly related to the iron and steel production process either as an input or output. Indirectly related flows such as diesel fuel, which may be partially destined to fuel highway trucks for the distribution of finished products, are not included.

5.1 ORES

As indicated in Figure 5-1, the production of one ton of steel consumes approximately 1 ton of iron and manganese ores and concentrates (.016 ton directly, and .995 ton indirectly in the pig-iron-production process). The bulk of iron ore comes to Pittsburgh from the Lake Superior area via a multimodal move involving rail to the Lake Superior port, a

TABLE 5-1

BARGE MOVEMENTS ON THE MONONGAHELA RIVER OF COMMODITIES RELATED TO THE IRON AND STEEL INDUSTRY (TONS X 10^3)

Commodity	1972			1973			1974		
	WI	OB	IB	WI	OB	IB	WI	OB	IB
Iron Ore	-	-	399	-	-	287	-	-	309
Manganese Ore	-	7	424	-	28	207	-	262	89
Coal	19217	8000	3300	18081	8200	3400	18100	8800	2800
Limestone	-	462	-	-	519	-	-	447	-
Crude Tar, Oil, Gas (Coking By-products)	-	139	17	-	107	28	-	208	34
Benzene and Toluene (Coking Byproducts)	-	75	-	-	70	2	-	118	3
Residual Fuel Oil	-	-	254	-	-	499	-	-	904
Coke	-	107	2	-	175	6	-	163	5
Slag	14	53	-	4	37	-	-	40	-
Scrap	-	24	37	-	8	84	-	19	153
Ferroalloys (Intermediate Manganese)	-	12	20	-	14	22	-	11	17
Pig Iron	-	-	-	-	-	-	-	5	-
Iron and Steel									
Primary Forms	931	5	3	818	25	12	259	23	32
Shapes except Sheets	-	199	12	-	212	16	36	297	29
Sheets	25	249	11	19	332	10	9	358	7
Pipes and Tubes	-	422	4	-	319	7	6	384	2
Misc.	-	78	16	21	103	3	57	47	2
	956	953	46	858	991	48	338	1109	72

Legend

WI - moves entirely within the Monongahela River.
OB - moves originating on river and terminating elsewhere.
IB - moves orginating elsewhere and terminating on river.

trans-Lakes move to a Lake Erie port, and another rail move to the Pittsburgh area. The only alternative source for iron ore to Pittsburgh is imported ore. In 1972, Pittsburgh received foreign ore via rail from the ports of Philadelphia, Baltimore, and Lake Erie (mostly iron) as well as by barge from New Orleans (about half iron and half manganese in 1972). As much as 25% of the ores reaching Pittsburgh are import-generated, the bulk from Atlantic and Great Lakes ports by rail.

Manganese ore utilized in U.S. steel production is dominated by foreign imports - 1 million (62%) at Lower Mississippi River ports in 1972 and most of the remainder at Baltimore, Philadelphia, and Norfolk (302 thousand, 101 thousand, and 60 thousand tons, respectively).

Inland waterway segment tolls would have little impact on domestically produced iron ore which moves almost entirely on the Great Lakes and rail network. A bunker fuel tax ($1 per barrel on residual bunker C) on domestic water transportation, however, would increase the cost of the cross-Lakes leg by 4.6¢ per ton[3] on top of the base water rate (in 1973) of $2 to $2.50, depending on mine and port and a delivered price of $15 to $20. Given an estimated ratio of 1 ton of ore (direct and indirect input) to 1 ton of raw steel, this would have added 4.6¢ (.02%) to an average price of finished steel of $189 (December 1973).

A toll of this magnitude would have no significant modal shift impact on Great Lakes ore traffic because of wide, existing transport cost differentials - see Table 5-2. The

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[3] This is based on output of the ARCTEC model of the CoE North Central District as follows:

For a representative Great Lakes ore carrying fleet operating between Duluth and Cleveland.
Annual tons carried - 6.70 million
Fuel consumed - 12.9 million gallons
- 307.2 thousand bbl.

Fuel tax paid $307.2
Average tax per ton (cents) 4.59¢

TABLE 5-2
1973 ORE SHIPPING COSTS BY RAIL FROM LAKE SUPERIOR REGION TO PITTSBURGH
(DOLLARS/TON)

Rail

From	To	Rate
Mesabi and Cuyana Ranges MN	Two harbors, MN and Superior WI	$1.92
McKinley and Mt. Iron MN	Duluth	$1.70
Marquette Range WI	Escanaba MI	$ .95
Lake Erie Ports OH	Pittsburgh, Wheeling	$3.69
Mesabi Range MN	Pittsburgh, Wheeling	$13.91

Lakes

Head of Lakes	Lower Lake Ports	$2.20
Escanaba MI	Lake Erie Ports	$1.84

Source: Minerals Yearbook, U.S. Department of Interior, Vol. I, pg. 613, 1973.

rail-Lakes-rail cost of $6.50 - $8.00 per ton in early 1973 (depending on mine and port) is $6 to $7 cheaper than the all rail move. It is also unlikely that a toll of this amount would bring about a significant import substitution, but this issue is being explored further.

It is possible, however, that the iron and manganese ore barge movements from the Lower Mississippi would be subject to modal and/or port of importation rerouting given tolls to the Monongahela from Baton Rouge of 81.4¢ under a segment toll or $1.38 under a fuel tax. The vice president for purchasing for a major steel producer volunteered, however, that tolls of these magnitudes would have minimal impact on the routing of relatively high-valued manganese ore and concentrates. If this is the case, steel production costs would increase an average of .5 to .9¢ per ton (for the segment toll and fuel tax, respectively) based on a manganese ore consumption of 12.9 lb per ton of steel produced.

5.2 COKE

Most coke consumed in the Pittsburgh steel complex is produced from coal barged in from the Monongahela River, and secondly, from the Upper Ohio River. These coking plants located on the river receive all of their coal by barge, with inland ovens accounting for small residual production. Little coke is transported into or out of the region. The discussion of coal traffic impacts will focus entirely on passthrough to final steel production costs because the riverside facilities are generally totally captive to the river. For example, the U.S. Steel Clairton Coking facility (the largest in the world), which receives from 10 to 12 million tons of coal per year, has no rail or truck facilities, with the entire production process reliant on direct transfer of coal from barges.

About 50% of the coal at the Clairton Works (River Mile 20) originates on the Monongahela between miles 60 and 80, and the remainder at Huntington, West Virginia. This implies a weighted average toll of 13.6¢ per ton under a segment toll and 15.8¢ under a fuel tax - approximately .35% of the delivered price of coal at Clairton. Given coal input (direct and indirect) of .57 ton per ton of finished steel, this would add between 7.8 and 9.1¢ to the cost of a ton of finished steel.

Byproducts of the coking process per ton of coke produced include coke oven gas (10,500 cu. ft.), coal tar (90 lb), light oil (20 lb), and ammonia (5 lb). Some of them -- especially the coke oven gas -- are used locally, while others are sold and may move on the river as may the coke itself. Their relatively small volumes put them outside of the scope of this study.

5.3 SCRAP

In addition to "home" scrap retained in the steel-production process, the Pittsburgh area receives large volumes of metal scrap from as far away as Texas and California. Barge receipts of 269 thousand tons mostly from Ohio River origins accounted for only 2.9% estimated of scrap consumption in 1972. Given their relatively short haul and the volatility of the scrap market (the average price of #1 heavy composite fell from $74.39 to $68.33 per short ton between November and December 1973), these moves are not likely candidates for diversion, or are they very important in volume terms to the iron and steel industry.

5.4 FLUX

Each ton of raw steel produced requires approximately

328 lb of flux (148 directly and 180 indirectly in the pig iron). Pittsburgh receives most of its limestone flux from Pennsylvania quarries (mostly by rail), and receives no limestone by barge at the Monongahela River plants. Nearly 1/2 million tons of limestone are shipped from the Monongahela River to other locations however -- moves which will be analyzed later from their point of destination.

5.5 SLAG

Slag is a low value byproduct of the iron and steel processes which is generally sold locally (as a sand-and-gravel substitute) or "wasted" as landfill. Little slag moves on the river in the Pittsburgh area.

5.6 RESIDUAL FUEL OIL

Curtailments of natural gas supplies and EPA burn mix requirements for steel corporation steam plants has led to a growing inflow of barge-carried residual fuel oil. These uses are minor enough in the total picture to have a negligible impact on final production costs, even for tolls on long-haul flows from the Lower Mississippi and Gulf. Redistribution of purchasing patterns may become a factor at a later date, with a shortening of the barge haul wherever possible, but this move is not analyzed further at this point.

5.7 STEEL PRODUCTS

Of total production of 25 million tons of steel in the Pittsburgh area (BEA66) in 1972, about 2.1 million tons moved by water, the remainder moving by truck or rail (most to the north and east), or going to local consumption. (This excludes almost 1 million ton of primary products moving less than 6 miles between facilities on the Monongahela River -- a move which has since declined substantially.)

More than half of these moves go to the Lower Mississippi and Gulf. The 80¢ to $1.50 tolls for such moves (0.5 to 1.0 percent of product price) might be enough to encourage the destination areas to seek out shorter-haul supply points. Spread over all tons shipped, this represents a maximum increase in distribution costs of between six and ten cents per ton.

5.8 CONCLUSIONS

Waterway user charges for the recovery of 100% of OM&R expenditures on the inland waterways leads to a production-cost increase of 20-25¢ per ton (Table 5-3). This would hold even under the most pessimistic scenario (e.g., assignment of a 4.6¢ Great Lakes ore transportation premium on all iron-ore inputs in the fuel-tax scenario although a significant share of iron ore is imported via the Atlantic and would not be impacted). Adding as much as 10¢ per ton for final product shipment and byproduct shipment effects leaves the total impact with an upper bound of 25¢ before any distribution or production reoptimization which might mitigate the effects. This amounts to an impact of .05 - .1% of final produce price, based on a price of $250 per ton for primary steel products.

TABLE 5-3

IMPACTS OF WATERWAY USER CHARGES ON THE PRODUCTION COSTS AND DELIVERED PRICE OF STEEL IN THE PITTSBURGH COMPLEX

(¢/ton)

Commodity	Segment Toll	Fuel Tax
Iron Ore	-	4.6
Coal	7.8	9.1
Manganese Ore	.5	.9
	8.3	14.6
Final Product Distribution, Byproducts, and Minor Factors Possibly Excluded	7-10	7-10
TOTAL	15.3-18.3	21.6-24.6

6. GRAIN IMPACTS

Waterway transportation of grains is oriented almost entirely toward the export market (Table 6-1). For example, of 15.8 million tons of corn moving on the Mississippi River System, 14.3 million tons (90.2 percent) were destined for port elevators at or below Baton Rouge - almost entirely for export. Although this barge volume accounted for 58 percent of total exports (24.4 million tons), the remaining 1.5 million tons in the Mississippi River System accounted for only 2.5 percent of corn sales from farms for domestic use, and about 1.5 percent of total corn produced (including on farm consumption). Inland waterway soybean traffic was equally export-intensive, with 7.9 (88.7 percent) of 8.9 million Mississippi System barge tons destined for export points. Wheat is slightly less export directed, with 5.1 (82.8 percent) of 6.2 million tons of internal barge movements going to export points (2.9 of 3.8 million tons on the Mississippi System, but virtually all of the 2.3 million tons on the Columbia River).

The importance of the above observations is that waterway user charges would have little direct impact on domestic grain markets, which are served overwhelmingly by other modes, but would in the first instance impact export prices in the Baton Rouge to Mobile port range, with secondary impacts filtering down through the entire grain distribution systems.

The question of the grain market reaction to waterway user charges is a complex one because of the wide geographic dispersion of farms and country elevators (actually or potentially) feeding each river elevator, and because of the different distribution alternatives (export and domestic) available

TABLE 6-1

ROLE OF INLAND WATERWAY GRAIN TRAFFIC IN GRAIN DISTRIBUTION - 1972

No.	Activity	Corn	Wheat	Soybeans
(1)	Total Production Sold Off Farms (10^6 short tons)	90.0	43.9	37.4
(2)	Exports (10^6 short tons)	24.4	23.2	13.2
(3)	Inland Waterway Traffic to Export Points (10^6 short tons)	14.3	5.1	7.9
(4)	Total Inland Waterway movements (10^6 short tons)	15.9	6.2	8.9
(5)	Inland Waterway Share of Non-Expert Moves ((4)-(3))/((1)-(2))	.024	.013	.028
(6)	Export Intensiveness of Inland Waterway Traffic (3)/(4)	.902	.828	.887
(7)	% Exports ex-River (3)/(2)	.583	.222	.662

Source: Waterborne Commerce of U.S., 1972; DOT Multi-Mode Commodity Flow Data Base.

to each growing area. Further, the impact of any level of toll on farmer, exporter, or barge operator is very heavily dependent on the strength of the world and domestic grain markets, which in turn are a function of many unpredictable factors such as weather in different areas of the world, governmental agricultural and trade policies here and abroad, ocean shipping economics, etc. Industry dynamics make any market analysis for grains akin to shooting at a rapidly moving target.

In addition to reoptimization of distribution patterns, responses to river tolls also include possible reoptimization of cropping patterns at each producing site as farmers may put more or less acreage into cash grains, switch between grains, or alter the intensiveness of cultivation in response to changing product prices.

6.1 METHODOLOGY

Because of the complexity of the grain distribution impacts, the analysis below is compartmentalized into three parts:

1) Impacts on export grain prices assuming full pass-through of tolls to final purchaser--potential purchaser impacts.

2) Impacts on on-the-farm grain prices in different growing areas, assuming full passback of tolls to farmers -- potential producer impacts.

3) Impacts on market and modal distribution patterns for major growing areas -- the diversion question.

This final impact question is the most complex, including as it does the ultimate balancing of the first two groups of impacts, and is addressed only briefly at this point.

6.2 EXPORT PRICE IMPACTS

As indicated above, movements to export dominate barge grain traffic (see Table 6-1). Tolls per ton for the movement of grain from the Upper Midwest to the Lower Mississippi ports range from 33.8 cents for traffic originating in the vicinity of Cairo, Illinois, to $1.16 from the St. Paul area on a segment toll basic (64.9 cents and $1.37, respectively for a fuel tax).

The weighted average toll (for a segment toll and fuel tax, respectively) for barge receipts in the Baton Rouge, New Orleans, complex -- assuming 1972 origination patterns -- is 76.8 cents ($1.01) for corn, 95.0 cents (89.6 cents)[1] for wheat, and 74.9 cents (79.4 cents) for soybeans (see Table 6-2). (Up to 12 cents must be added to the fuel tax for destinations below Baton Rouge since a fuel tax would be collected for barge transportation within the deepwater port area even though no segment charge would apply within that range.)

Although the main wheat growing areas in the Central United States include the Northern Great Plains (Minnesota and the Dakotas), corn, as reflected in the mileage based fuel tax,

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[1] The figures for wheat are 73 and 74.5 cents for a segment toll and fuel tax, respectively, if high-cost Missouri River originations are excluded.

TABLE 6-2

WEIGHTED AVERAGE PRICE IMPACTS OF USER CHARGES ON GRAIN FOR EXPORT

Corn at Lower Mississippi Ports

Weighted average toll for barge terminations.	segment toll 76.8¢ fuel tax $1.01
estimated other mode receipts and local production	$1152X10^3$ tons (7.6%)
Weighted average toll impact on total terminations (toll X % tons terminated by barge).	segment toll 71.0¢ fuel tax 93.3¢

Wheat at Lower Mississippi Ports

Weighted average toll on barge terminations	segment toll 95¢ (excluding Missouri originations 73¢ fuel tax 89.6¢ (excluding Missouri originations) 74.5¢
estimated other mode receipts and local production	1018×10^3 T (33.0%)
Weighted toll impact (toll X % tons terminated by barge)	segment toll 64¢ excluding Missouri River 49¢ fuel tax 60¢ excluding Missouri River 50¢

Wheat at Columbia River Ports

Weighted average toll	90.1¢ (only segment toll applicable).
estimated other mode receipts and local production	4239×10^3 T (65.1%)

TABLE 6-2 (Continued)

Weight toll impact (toll X % tons terminated by barge)	31.4¢

Soybeans at New Orleans

Weighted average toll:	segment change 74.9¢ fuel tax 79.4¢
estimated other mode receipts and local production.	826 X 10^3 Tons (10.1%)
Weighted toll impact (toll X % barge)	segment change 66.6¢ fuel tax 70.6¢

Add $0.00084 per mile transmitted below Baton Rouge for ports downriver for fuel taxes. No segment toll would be changed in that segment however.

is the long-haul grain traffic on the Mississippi River System. This is because the greatest wheat densities occur west and north of the Upper Mississippi, where rail traffic and alternative ports (Texas-Gulf, Pacific, and Duluth) are highly competitive. Soybeans which originate along the entire length of the river have the shortest average length of haul.

Because of the greater average length of haul (from the Illinois and Upper Mississippi Rivers), corn for export at Lower Mississippi ports is especially hard hit by a fuel tax as opposed to a segment charge. Corn moving to export from the Illinois River (50 percent of Lower Mississippi corn exports in 1972) moves between 770 and 1140 miles -- depending on point of origin on the Illinois and port on the Lower Mississippi -- on the low-toll Illinois and Lower Mississippi Rivers and 220 miles on the Upper Mississippi. Under a fuel tax, these moves pay a substantial premium -- between 24 and 36 cents on average -- which subsidizes traffic moving on higher toll rivers.

The average toll for barge-delivered wheat at the Columbia River ports is roughly 90.1 cents on a segment toll basis. (Fuel taxes for the Columbia River System were not calculated due to a current lack of information about the water carrier industry there.) The impact of this toll on the competitiveness of Columbia River ports for grain export is somewhat mitigated by the fact that two thirds of wheat receipts in that area are by rail from western Washington, Idaho, Montana, and even the Dakotas and Western Minnesota.

For the segment toll case, these tolls represent .725 percent of the 1975 export price of corn, .72 percent for wheat

(.55 percent if Missouri River origins -- eight percent of total Lower Mississippi wheat receipts -- are excluded), and .40 percent for soybeans.[2]

The question of whether such increases could be passed on to foreign buyers, causing foreign consumers to pay for a share of the costs of the river system which provides efficient transportation for their grain imports, whether port reallocations would occur, or whether the farmer or barge operator would bear the burden of such cost changes cannot be answered outside of the context of the entire grain marketing-and-distributing system. These questions are being addressed in follow-on work.

6.3 FARM PRICE IMPACTS

The potential impact of user charges on grain prices at the point of production varies widely by river segment and toll option as do the production-and-distribution options available to the farmer. This is true not only because toll levels differ between the major producing areas, but also because costs of production and transportation vary over the grain growing area.

Any river draws its grain from a band on either side of river which may extend as far as 75 miles in some locations at harvest time.[3] The width of the band is determined by the costs of reaching the Lower Mississippi ports via truck barge from different inland points and the strength of demand from alternative sources (domestic processing or unit train to the same or alternative ports). The band is particularly narrow along some rivers such as the Upper Missouri, where barge costs

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[2] Export prices were calculated on the basis of farm prices per bushel of $2.70, $3.68, and $5.25 for corn, wheat, and soybeans, respectively, and total distribution costs to port of $10 per ton.

[3] Much of the discussion which follows is a result of conversations with grain marketing corporation distribution executives.

are relatively high even without user charges, and where domestic demand and unit train competition to the Texas-Gulf ports are both strong. The band is probably wider along the lower Upper Mississippi where barge vs. unit train economics are relatively stronger in favor of water shipment.

A current grain industry rule of thumb states that truck transportation of grain costs approximately 1 cent per bushel per 10 miles or 3.6 cents per ton mile. The implication of this is that a toll on the river of 10 cents from any given point would decrease the reach of the river terminal by about three miles. The impact of such a charge on river traffic would depend on the interaction of several factors including the share of river traffic coming from that portion of the hinterland, the response of elevator and barge operators to any potential losses of traffic, and the response (decline) of prices in alternative demand centers to any potential increases in supply. Such a detailed, but necessary, analysis is not carried out in this stage of work.

6.4 ILLINOIS RIVER

Illinois River points originated more than 50% (7.74 million short tons) of the corn received by barge at Lower Mississippi River ports in 1972. They also shipped 1.27 million tons to other points, primarily for processing for domestic use (540 thousand tons for the Tennessee River, 251 thousand tons to Vicksburg, and the remainder to domestic markets such as Memphis, St. Louis, and Chicago). In 1972, 2.13-million tons of soybeans also were originated at Illinois river points, 1.76-million (83%) of which were destined for Lower Mississippi River export ports, 121-thousand (5.6%) for ports between New Orleans and Mobile, and the remainder predominately to river points on Lower Mississippi and Tennessee Rivers. Illinois is not a prime wheat production area, and so, only

204-thousand tons of wheat originate on the River, 164-thousand of which were destined for the Baton Rouge-New Orleans complex of ports.

Specimen tolls for Peoria--the center of the Illinois River grain shipping area--are presented in Table 6-3. Under a fuel tax option, grain from Peoria pays a premium of 50 to 65 percent over the segment toll level of 68.1¢ per ton for movements to export points on the Lower Mississippi River. The phenomenon does not occur for the less important Tennessee River distinations because they do not utilize the long, inexpensive Lower Mississippi Segment.

Based on a national average farm price per bushel of \$2.70, \$3.68, and \$5.25 per bushel for corn, wheat, and soybeans, respectively, farm revenue per bushel along the Illinois River would fall 0.71, 0.56, and 0.39%, respectively, for the three crops under a segment toll.[4] This assumes full passback of user charges and no mitigating actions by the farmer. Such options would, of course, decrease impacts on farm income.

6.5 UPPER MISSISSIPPI RIVER

The Mississippi River north of St. Louis (including the Minnesota River) originated 5.73 million tons of corn, 2.5 million tons of soybeans, and 1.48 million tons of wheat in 1972. The destination pattern for all three grains was quite similar to that of the Illinois. Estimated tolls of \$1.16 (segment) to \$1.48 (fuel-based) represent 1.2-1.5%, .95-1.2%, and .66-.85% of the farm price of corn, wheat, and soybeans respectively.

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[4] Fuel tax price impacts would, of course, be 50-65% higher in this area.

TABLE 6-3

USER CHARGES FOR SELECTED HIGH-VOLUME GRAIN MOVES (TONNAGE INDICATED) ON THE MISSISSIPPI RIVER SYSTEM

From Origin	To Destination PE400,405,410,415 Baton Rouge-New Orleans	 PE1320,13330,1345 Tennessee River
PE510 - Illinois River, Peoria		
Segment Toll (¢/ton)	68.1	70.7
Fuel Tax[1] (¢/ton)	99.6 (111.4)	72.2
1972 Tonnage[2] (000)	3,940	197
PE354,356 - Upper Mississippi, St. Paul Area		
Segment Toll (¢/ton)	115.6	118.1
Fuel Tax (¢/ton)	136.6 (148.4)	109.1
1972 Tonnage (000)	2,892	364
PE105 - Missouri River, Kansas City		
Segment Toll (¢/ton)	353.8	366.0
Fuel Tax (¢/ton)	112.2 (124.0)	84.7
1972 Tonnage (000)	155	216
PE1700 - Lower White River		
Segment Toll (¢/ton)	22.2	
Fuel Tax (¢/ton)	40.5 (52.3)	
1972 Tonnage (000)	335	

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[1] Fuel tax is calculated on the basis of distance of Baton Rouge. Numbers in parentheses represent costs to New Orleans.

[2] Tons of corn, wheat, and soybeans.

Grain traffic in this region clearly represents a crucial area for follow-on analysis of possible modal diversion.

6.6 MISSOURI RIVER

One million tons of grain originated on the Missouri River in 1972. Three quarters of the traffic was wheat, of which a surprising 46% was destined for the Tennessee. It is extremely unlikely that the grain traffic, most of which originates at Kansas City or above, could bear the segment tolls of \$3 to \$4 which would arise on this river. It is also possible that even the lower toll generated by the fuel tax option could drive the remainder of barge grain traffic into other distribution channels. Existing shipping patterns from the Upper Missouri River region (Kansas City and above) are heavily rail-oriented, and there are indications that future growth in that region will be similarly directed even without user charges. Corn and soybean exports ex-rail at Houston have been growing extremely rapidly in recent years, and the possibility of unit trains to Seattle for loading on super bulkers has been discussed.

6.7 CONCLUSIONS

Grain traffic appears to be one of the more critical areas for follow-on analysis. Rail unit train operations to alternative ports (or to the Lower Mississippi Ports) are highly competitive with barge along a broad geographic front. Thus, it is vital to understand which traffic (how much and where) now on the rivers is most sensitive to reoptimization, and how the interaction within the grain-distribution system of farmers, elevator operators, transportation operators, and end users of grain would develop.

7. FERTILIZER IMPACTS

Fertilizer materials travel long distances from the originating site of raw materials to the final consuming area. A great majority of phosphates are obtained in Florida, while New Mexico and Saskatchewan are responsible for almost all potash production. Nitrogenous fertilizers originate primarily in regions in the periphery of the U.S., such as Louisiana and the Southwest, although the distinction is not as pronounced as in the case of phosphates and potash. The Midwest (defined as Illinois, Iowa, Indiana, Minnesota, Ohio, Michigan, and Wisconsin) consumes one-third of the fertilizer products. These O/D patterns result in commodity flows that demand cheap bulk transportation. Rail, water, and pipeline handle practically all of the long-distance carriage.

In 1972, approximately 41 million tons of commercial fertilizers were consumed in the U.S. These commercial fertilizers consisted roughly equally of direct application materials (anhydrous ammonia, urea, superphosphates, ammonium nitrate, etc.) and mixtures (18-46-0, 5-10-10, 10-10-10, etc.). See Table 3-1. The fertilizer applications contained roughly 17.1 million tons of nutrient content, of which 8.1 million tons (47%) were nitrogenous, 4.8 million tons (28%) phosphatic, and 4.5 million tons (25%) potassic.

7.1 PHOSPHATES

In 1972, over 40 million tons of marketable phoshpate rock were produced in the U.S. Of this total, 81% is attributable to Florida and North Carolina, with the Western

States producing only 12%. There is a continuing trend toward shipping rock which has already been processed (super-phosphates) instead of moving the matrix material. Processing at plants near the mining areas involves washing with sulfuric- and/or -phosphoric acid treatment for reduction to more concentrated materials, which leads to reduced transportation costs.

Water traffic generated by phosphate rock from Florida was on the order of 21.7 million tons in 1972, about 60% of which was bound for foreign countries, with the remaining 7.5 million tons moving coastwise-almost entirely to the New Orleans area (5.6 million) and Houston (1.1 million). The domestic shipments utilize 20 - 25,000 ton deepwater barges - river barges are unable to cross the open waters of the Gulf (with some exceptions), and ships face high unloading costs. That rock which is carried by ship is usually destined for Houston.

Only about one-fifth of the rock arriving in New Orleans continues up the river in that form (most often destined for Illinois) for processing at country plants. Large plants in the New Orleans area process the rock into direct application materials (superphosphates) and mixed fertilizers. It usually takes 2.5 tons of crude rock to produce 1 ton of product. This means about 1.6 million tons of product will be generated for shipment. Most is distributed to points along the river system by barge although rail may be a viable option at this point. All of the phosphate rock received in Houston leaves by rail after processing.

The imposition of a user charge on the Mississippi River System may cause some change in the current system of phosphatic fertilizer distribution. In some areas, however, transportation requirements are actually dictated by the nature of the material involved at each shipping stage. Crude rock generally moves by water, and in many cases, plants have located at the river and are set up to receive phosphate rock in this manner. It may be virtually impossible for some of these plants to convert to using rail. Ground phosphate rock, on the other hand, is a powdery substance that should be handled and transferred as infrequently as possible, thus requiring transport by rail. Competition between water and rail exists, therefore, for the superphosphates and ammonium phosphate. The major impact may occur in the phosphate rock distribution system. Profit margins in the fertilizer business have been declining in recent years, and several plants in the Midwest have been forced to close. Others are facing similar problems, and a charge may put them at a disadvantage due to the fact that a toll imposed on crude rock is in effect 2 to 2.5 times greater than on superphosphates and ammonium phosphate. Thus, one may see a shifting to expanded plant capacity at minesite and reduced processing at points along the upper river system. Because of the design of plants in the Lower Mississippi area, it is questionable whether the demand for superphosphates and ammonium phosphate by water is so elastic as to induce diversion to rail.

An important question is whether the particular user charge mechanism implemented impacts the cross-Gulf leg. A segment toll would leave most of this routing untouched, while a fuel tax would not.

7.2 POTASH

Potash accounts for 25% of the input into commercial fertilizers, but the waterway system does not play a significant role in its movement--83% of the U.S.-produced potash is mined in New Mexico with the remainder coming from Utah and California. The location of the originating mines dictates the need for shipment by rail.

Some potash does move on the Gulf. It is received by rail in the Houston area and shipped to plants along the Gulf Intracoastal Waterway East for processing. This allows shippers to take advantage of a reduced rail rate from Carlsbad NM to Houston that is applicable only for cargo if the ultimate destination does not involve points along the Mississippi River System. The agricultural demand for potassic fertilizers has a negligible effect on Mississippi River traffic; thus user charges are not a concern in this area.

7.3 NITROGEN

The nitrogenous fertilizers (anhydrous ammonia, nitrogen solutions, and ammonium nitrate) rely on the input of natural gas. The major production areas are located near the source of this raw material, generally in the Southwest (Louisiana, Texas, Oklahoma, and Arkansas) although plants which receive natural gas by pipeline have also been extensively built in the Midwest close to the consumption areas. Origins and destinations thus form a much more complex distribution pattern than in the case of either phosphate or potash.

Nitrogen products are commonly in a liquid state (anhydrous ammonia and nitrogen solutions) and are thus able to utilize three modes of transport - water, rail, and pipeline. Water and pipeline dominate the shipments of these products on economic grounds however. Pipelines pose the strongest threat to water traffic, and expansion of national ammonia pipeline capacity has recently been announced.

At the present time, there is doubt that a user charge would create a major diversion of existing traffic for two reasons. First, nearly all plants producing nitrogen products in the Southwest are located on the river system. They have been built and designed to utilize the waterways for the shipment of final products. Special equipment and terminal facilities are expensive, and will not readily be abandoned if faced with an increased cost in water transportation. The demand for nitrogen products from the Southwest is not nearly so elastic. Second, most moves on the river system are handled by dedicated tows that are subject to long-term contracts. Shippers are bound to continue the use of this system.

If the user charge is passed on without any traffic diversion (which seems likely for the nitrogenous products), the additional cost will ultimately be borne by the farmer or consumer. An analysis of final demand is necessary to determine the impact of such a situation.

7.4 FINAL REPORT

This section analyzes the effects of a user charge designed for 100% OM&R recovery on farm grain prices through its impact on the price of fertilizer inputs. Three O/D pairs for fertilizer shipments have been examined: New Orleans to Minneapolis-St. Paul, New Orleans to Chicago, and New Orleans to St. Louis. In each receiving area, the fertilizer has been assumed to be used for each of three grains -- corn, wheat, and soybeans.

A ratio of fertilizer and lime cost to the farm price of each grain has been calculated. These ratios are national aggregate figures, and do not take into account the variation of application rates in different regions of the country. The cost of fertilizer and lime accounts for 15.4% of the final value of the product for corn; 5.7% for wheat; and 1.0% for soybeans.

The second step is to calculate the user charge for each shipment and divide this by the delivered price of fertilizer to establish the percent increase in fertilizer costs. For New Orleans to Minneapolis-St. Paul, the toll is $1.43/ton by the fuel tax method and $1.16 by the segment toll method. The fuel tax adds a cost of $1.13/ton to fertilizer going to Chicago and the segment toll adds $.73/ton. The New Orleans to St. Louis shipment costs an additional $.88/ton (fuel tax) or an additional $.53/ton (segment toll). The delivered price of fertilizer is assumed for this analysis to be $100/ton -- a conservative estimate of the average cost of all types of fertilizers, especially with the inclusion of lime.

Multiplying the percentage of fertilizer and lime cost for each grain by the percentage increase in fertilizer price yields the percent increase in the cost of producing each grain at the farm. The following results have been calculated:

TABLE 7-1
PERCENTAGE INCREASES IN FARM PRODUCTION COSTS DUE TO USER CHARGES ON WATERBORNE FERTILIZER MOVEMENTS

Commodity	New Orleans to		
	Minneapolis-St. Paul	Chicago	St. Louis
Corn			
Fuel Tax	.22	.17	.14
Segment Toll	.18	.11	.08
Wheat			
Fuel Tax	.08	.06	.05
Segment Toll	.07	.04	.03
Soybeans			
Fuel Tax	.014	.011	.009
Segment Toll	.012	.007	.005

The increment in the price of corn due to a user charge (if the entire toll is passed on to the consumer) is in the range of one-tenth to two-tenths of one percent. The increase in the price of soybeans is negligible since fertilizer is a smaller factor in this grain. It should be noted that even this small impact is a very conservative estimate. First, these calculations assume that all fertilizer is shipped to the consuming area by water. In fact, practically 100% of the potash moves by rail, and phosphate products rely heavily on direct shipment by rail. Also, a large portion of nitrogenous fertilizer moves by pipeline. A more accurate calculation of fertilizer shipments would see only about 25% of fertilizer shipments moving on the inland waterway system. Second, lime is included in the development of ratios of cost of fertilizer inputs to grain output. Lime accounted for almost 40% of fertilizer materials by weight in 1972. The calculated impacts might be considered the impact on the worst-placed farmer.

7.5 SUMMARY

The analysis of final demand indicates that impacts as large as one-tenth of one percent of final grain price are unlikely. The real issue involved in the effect of user charges on fertilizer distribution is the possibility of traffic diversion in the shipping of phosphates and nitrogen products. An important consideration in the phosphate industry is the hastening of the trend of processing rock near to where it is being mined rather than at some point along the river system. A major concern in the area of nitrogenous fertilizers is the diversion of shipments from barge to pipeline. Such problems must be subject to more rigorous and detailed analysis.

8. AGRICULTURE MODEL SIMULATIONS

The Data Resources, Inc. (DRI), Agriculture Service consists of a large-scale, econometric model of prices and quantities of the major agricultural commodities produced and consumed in the U.S. The core of the model is a set of quarterly predictive equations of domestic supply and demand for 26 agricultural commodities. Price, quantity, and inventory forecasts for these commodities are supplemented by an international trade flow model, an analysis of farm operating expenses, and farm income statements.

The model is used by DRI to produce baseline and alternative forecasts of prices, output, trade flows, and farm income and expenses for each major commodity. By altering future market prices, foreign demands, or Government policies, various sensitivity analyses on model reactions to alternative futures can be performed.

Any alternative scenario such as user charge impacts on agriculture is compared with the DRI baseline forecast through 1978. To compare and understand the results of the user charge impact simulation, a brief description of the existing baseline forecast follows.

The DRI baseline agriculture forecast predicts that grain prices will soften and fall substantially (9-10%) by the end of 1976. As a result, livestock production will increase due to reduced feed costs. The forecast assumes that world production of feedgrains will rise above 1975 levels although major producers (especially the Soviet Union) will not meet target production levels. Thus, exports are forecast to experience moderate increases compared to the 1973 to 1975 period. The model predicts continued production increases through 1977 and 1978, indicating that prices will remain at profitable levels for farmers. Assuming normal weather conditions, a three-year period of record crop production should occur. Since much of this increase is destined for export markets, the demands on transportation by agriculture will remain high. Waterways, which handle a substantial amount of total U.S. grain exports will be especially affected. Farm income by 1977 is forecast to decline by 3%, although a rebound in prices by 1978 should produce a net income gain of 2%. The major uncertainty in the forecast is world weather conditions. Reduced precipitation trends over time and droughts in large areas of the world may alter both U.S. production and foreign demands.

To capture the immediate effects of the imposition of a 100% OM&R waterway user charge on agriculture, it was decided to impose a full 100% recovery scenario on the model beginning in the first quarter of 1976. Major grain prices were reduced by amounts in Table 8-1 and weighted by the waterways share in domestic traffic. The price reductions (assumed to be a market response that reduced prices across the board to all farmers) were calculated by averaging tolls on major grain flows by water. Further, since 41 percent of fertilizer shipments move by water to farms, the price of fertilizer was increased, using a weighted average of tolls on existing fertilizer flows from the Gulf to the Midwest producing areas. The price of fertilizer was increased by .4% per ton in response to the imposition of 100% cost recovery on waterways.

TABLE 8-1

USER CHARGE INDUCED CHANGES IN DRI AGRICULTURE MODEL INPUTS

Commodity	Percent by Water	Change in Market Price Due to User Charge
Corn	17.2	-.0038
Wheat	14	-.0054
Soybeans	24	-.0042
Barley	--	-.0043
Rye	--	-.0050
Oats	--	-.0029
Grain Sorghum	--	-.0050
Fertilizer	41	+.0040

An alternative approach would have been to pass the price increase caused by user charges into the international market instead of reducing the price received by farmers directly. The question of whether the export price of grain at a given port sustains such a penalty is being explored in ongoing work.

Given the relatively small price changes that would result from full 100% user charge imposition, the alternative (user charge) simulation of the model forecasts miminal impacts on agriculture. This does not imply that certain regional impacts on water-served production areas such as the Upper Missouri and Mississippi Rivers will not be substantial. Increase in barge rates to New Orleans from these regions of over $1.00 per ton will certainly impact modal traffic and perhaps port choice. However, the DRI model does not presently recognize regional differences in agricultural markets, so price changes are reflected in total U.S. markets for grain. Therefore, the model understates the impact on the worst-placed farmer and overstates the impact on the favorably placed (rail exporting) farmer, who may, in fact, gain income after user charges. A summary of the impacts on agriculture under the user charge scenario for the DRI model are found in Table 8-2.

Although relative price and production changes are difficult to explain without careful reading of the complete model output, some macroconclusions are possible. If a 100% user charge (OM&R) were introduced in the first quarter of 1976 that reduced grain prices to farmers by amounts stated in Table 8-1 and raised delivered price of fertilizer to farms by 0.4% per ton, reaction of acres planted and production in U.S. agriculture through 1978 is forecasted to be generally less than one percent (either way) for any crop. Again, regional impacts such as in the Upper Misouri and

TABLE 8-2

FORECAST AGRICULTURE IMPACTS FROM USER CHARGES USING THE DRI MODEL: 1978

Commodity Group	Acres Planted	Production	Price Change 1976-1978
	Percent Difference DRI Baseline Vs. User Charge Scenario		
Wheat	-.02	-0.1	-13
Corn	-.03	-.03	-2.7
Soybeans	+.03	-.01	+9
Barley	+.4	+.1	-6.8
Oats	-.1	-.2	-14
Grain Sorghum	-.02	-.02	-6

Mississippi Rivers-served production areas may be severe. However, time limits did not allow us to address the questions at this time.

In summary, the DRI agriculture model predicts almost no difference between its baseline and a 100% user charge for grain and fertilizer traffic scenario. Although the conclusion that impacts on U.S. agriculture are minimal is premature, total U.S. agriculture may not be dramatically impacted by the imposition of user charges. The grain traffic impact (Section 6) discusses the changes in traffic patterns that may occur in grains under user charges and regional impacts of such changes.

* *

The material which appears in this section has been based in large part on the DRI Agricultural Forecasting Model. However, all responsibility for the use of the model, and its interpretation herein, is that of DOT/TSC. Access to the model was purchased by DOT/TSC under contract DOT-TSC-1341 to DRI.

9. CONSTRUCTION AGGREGATES

9.1 SAND, GRAVEL, AND CRUSHED STONE

Construction aggregates (sand, gravel, and crushed stone) accounted for 58 million tons of traffic on the inland waterways in 1974, and are the second largest commodities moving. Construction aggregates have three basic markets - highway construction, general construction, and miscellaneous uses such as snow and ice removal, fill and decorative use. Highway and general construction are the largest markets by far. Highway construction is generally a function of state and Federal programs. As such, it is not succeptible to "normal" economic conditions (highway construction has frequently been used to generate economic activity during times of business slowdowns). General construction--primarily, commercial, industrial, and residential building--is a "lead indicator" of overall economic conditions, and has shown relatively little sensitivity to any single factor (such as the cost of materials). As a result, both highway and general construction would probably feel negligible impacts from a user charge on construction aggregates transported by water since the potential increase in the cost of a building or highway would be miniscule.

In all three markets, sales are generally on a bid basis; that is, contractors accept bids for given quantities of specific types and grades of aggregate fob producers plant. Transportation is generally provided by the buyer in his own vehicle, or occasionally, in a producer's vehicle. Due to the nature of use, most aggregates move short distances (100 miles is a frequently used limit) by truck. In cases of aggregates moving to stationary concrete plants or to distribution centers (frequently owned by the producing firm), other modes, rail or water, may be used.

Due to the highly competitive nature of the industry and the very low value per ton of the commodity ($1.50 to $2.50), construction aggregates have generally been considered the commodity most easily diverted from water transport to alternative modes by the imposition of user charges. However, analysis of the industry on several rivers in the system indicates that this is not always the case. The Kentucky River is unique since sand, gravel, and stone are the only commodities moving, and they are all received by one customer who competes with truck delivered aggregates. A user charge would probably cause a modal shift as this one firm would bear the cost of the entire river, and a competitive supply exists. The other major rivers with a large proportion of the total traffic in aggregates are the Arkansas, Missouri, Tennessee, Allegheny, Kanawha, and Ohio Rivers.

Aggregates traffic on the Missouri River was 3.3 million tons in 1974 about 40% of total tonnage. Inquiries of industry sources in the area and the Kansas City ACoE District office reveal that the Missouri River is not used for transportation of aggregates but as a source. The sand and gravel firms dredge sand from the river, barge it to their dock, and distribute it by truck. Most operators dredge in the vicinity of their plant. Thus, sand moves from mid-river to shore, and would be unaffected by user charges even in the extreme case that all other traffic ceased and maintenance by the Army was stopped.

The Illinois River is the only major river which was found to have substantial transportation of aggregates.

Aggregates traffic was 2.3 million tons out of total traffic of 41 million tons in 1974. Of this traffic, some is dredged from the river and shipped to Chicago. Other firms mine on land and ship by water. The proportions which are mined and dredged cannot be identified at this time. The toll for the Illinois River is approximately .07¢ per ton-mile. The average fob plant price of aggregates is $1.50-$2.50 per ton with an estimated barge transportation cost of $1.50 per ton (100 miles): the increase from the user charge is 1.75-2.3% of selling price fob buyer's dock. The inclusion of buyer's transport from dock to use site would decrease the overall impact further.

The general conclusion which must be drawn from the evidence supplied by industry and Army sources is that user charges would have a negligible effect on aggregates traffic on several of the rivers, where this commodity represents a substantial proportion of traffic. The Kentucky River and Illinois Waterway are the only identifiable locations where modal diversion might occur. In the case of the Kentucky, competition to the waterborne aggregate is sand and gravel transported by truck as backhaul business for coal carriers. If the waterborne aggregates traffic ceased, the trucks would be free to raise their rates in the face of increased demand; possibly allowing the reentry of water transport. The aggregate hauled by water to Chicago may be susceptible to diversion or loss of market if sufficient alternative sources exist or if other transport factors; i.e., highway limits or congestion, do not preclude such a shift. In no case is the potential for a serious "domino" effect likely to occur, burdening remaining traffic with excessive tolls.

9.2 MARINE SHELLS

Marine shells are used in the same primary markets as aggregates, where stone is not readily available. In 1974, approximately 4 million tons were carried on the Mississippi River system, all in the Gulf area. Since the shells are dredged and no segment toll is contemplated for the Mississippi River below Baton Rouge, this commodity would be largely unaffected. A fuel tax would impact the cost of shells, but the amount of impact is unknown due to the lack of information on fuel used for dredging, the length of haul, and the availability of alternative sources of supply for this commodity.

10. INDUSTRIAL CHEMICAL IMPACTS

The primary flows of industrial chemicals by water are concentrated in five regions of the U.S.; Houston, New Orleans, Atlantic Coast, Upper Ohio River and Chicago. Other significant flows terminate in Tennessee and Indiana. Of the 20 million tons traversing the waterways system, almost 8 million moved among Gulf ports, primarily Houston and New Orleans. The Atlantic Coast received 3 million tons as did the Upper Ohio River, and Chicago received 1.5 million tons. The remaining 5 million tons move to scattered destinations within the system, frequently to river-served manufacturers.

The Army Corps of Engineers does not differentiate between many of the chemicals moving on the waterways, except for sodium hydroxide, sulfuric acid, and a general category of alcohols. Given that chemical use is very specialized in industry production processes, the examination of impacts via user charges on waterways chemical flows is severely hindered. For example, prices of chemicals included in the general category, "Industrial Chemical," range from $150 to $300 per ton in 1975 prices. Further, market forces have driven chemical prices in general up almost 36% during 1975. Such an increase would swamp a one or two per cent increase in price via user charges to a receiver. Although a general increase in demand for chemicals has occurred in the last few years, the waterways share of the market has remained approximately the same, or decreased slightly since 1972 (with the exception of sodium hydroxide).

Another market force that hinders analysis of the impact of user charges on chemical markets is the requirement for special services, such as heating or cooling and the hazardous nature of the process. Discussions with industry groups indicate that double bottom barges may eventually be required to transport chemicals and other hazardous products to minimize environmental damage due to accidents. If required, significant capital cost increases for new tanker barges would drive liquid-bulk transportation rates well above present levels, certainly more than rate increases due to user charges.

Major shifts have also been occurring in the chemical industry that could alter future distribution patterns and affect water carriers of chemicals. New sources of basic chemicals, including fertilizer materials, resulting from the sale of byproducts may prove significant. Shortages of natural gas may create a shortfall in anhydrous ammonia, causing farmers to seek alternative sources for nitrogenous fertilizers. Closing of certain supply plants due to EPA regulations has also occurred. Finally, industrial process changes that alter relative demands for certain chemicals is constantly occurring, and will continue as synthetics play an increasingly important role in production.

Unfortunately, the ACoE data are aggregated in such a manner that investigation of the majority of these impacts is impossible. Preliminary analysis of two moves of industrial chemicals; one to Chicago and one to Pittsburgh (both originating in New Orleans), gives some order of magnitude impacts. The New Orleans to Chicago move would pay a segment toll of 75¢ per ton or a fuel tax of $1.07 per ton. Given an average transportation cost by water of sodium hydroxide of $7.10 per ton to Chicago, barge rates would increase between 11 and 15% depending on the type of toll. For the Pittsburgh from New Orleans move, the transportation price impact ranges from 9 to 17%. If sodium hydroxide is valued at $200 per ton, the impact of user charges on delivered prices would be a .4 or .5 percent increase.

11. RIVER SEGMENT ANALYSIS

The argument has often been made that a segment toll might lead to the shutdown of certain high-cost rivers which will lead to serious traffic impacts on other segments because of the multisegment nature of much traffic. The Missouri, Arkansas, and Kentucky Rivers are the most likely candidates for a shutdown of this sort under a segment toll. These rivers would carry relatively high segment tolls; in addition, rail and truck rates in these regions are relatively competitive with barge rates for major, identified moves, increasing the potential for shifts away from water transportation.

The effects of such a shift are examined in this Section, using the complete shutdown of the segments as the worst possible case. Using PE to PE movements, commodity flows with origins or destinations on these rivers were traced through the river system, and the losses in traffic were calculated for each segment. The losses were then compared to total traffic on the affected rivers to determine the resulting impact on remaining traffic and toll levels (see Table 11-1).

Only one river segment, the Tennessee, shows a deficit greater than 3% - mostly from Missouri River grain traffic. The Upper and Lower Mississippi Rivers lose by far the most traffic in absolute terms under this scenario, reflecting the fact that all traffic entering or leaving the Missouri and Arkansas Rivers must transit one or both of these main stems. The loss of this traffic (2.3-2.5% of their total traffic) would lead to approximately equivalent increases in their tolls. This would be an added hardship, but certainly

TABLE 11-1

TRAFFIC LOSSES IN REMAINDER OF WATERWAY SYSTEM RESULTING FROM COMPLETE CLOSURE OF MISSOURI AND ARKANSAS RIVERS

(TON-MILES)

TRAFFIC ORIGINATING OR TERMINATING ON:

	Missouri		Arkansas		Total	
Impacted River	10^6	Percent	10^6	Percent	10^6	Percent
Lower Mississippi	958.1	1.59	568.6	.94	1526.7	2.52
Upper Mississippi	391.6	1.76	118.2	.53	509.8	2.29
Ohio	56.8	.18	127.9	.40	184.7	.58
Illinois	5.9	.08	28.3	.37	34.2	.45
GIWW East	15.1	-	106.0	-	121.1	-
GIWW West	25.7	.18	80.6	.55	106.3	.73
Tennessee	150.4	3.93	6.5	.17	156.9	4.1
Monongahela	-	-	.6	.04	.6	.04
Allegheny	.4	.40	.1	.10	.5	.63
Kanawha	-	-	112.7	.01	112.7	.01
White	-	-	.2	.27	.2	.27

not of such a magnitude as would lead to serious secondary, "snowballing" impacts. No other segment suffers as much as a 1% loss. It should be noted that any tendency for shippers and receivers to replace the Missouri and Arkansas River markets with other barge served markets would mitigate these effects.

On the Kentucky River, 99% of all traffic is sand and gravel. These flows are internal to the river, and a shutdown would have negligible effect on the rest of the waterway system.

The nature of the Federal expenditure data requires analysis of the segment toll on a river by river basis. Thus, although commercial traffic utilizes only four of the fourteen locks and dams on the Kentucky River, the impact of a segment toll for recovery of expenditure on the subsegment is not possible. Similarly, we are unable to assess the viability of a shorter Missouri River or Arkansas River navigation project. This tends to increase the likelihood of "disaster" scenarios, involving complete river shutdowns under a segment toll.

It is also interesting to analyze the impact of "rationalizing" the river under a fuel tax. It is probable that, if faced with a systemwide, uniform fuel tax, barge operators would seek to "rationalize" the waterway network -- i.e., remove high cost, low traffic projects. If this were the case, traffic would be lost from the projects in question as well as from connecting projects as shown above, but the expenditure to be recovered would also fall, leading to new fuel tax levels.

For example, while the Missouri, Arkansas, and Kentucky Rivers "accounted for" only 2 1/2 percent of traffic in 1974 on the Mississippi River-GIWW system (1.72 billion ton-miles internally and another 2.62 billion ton-miles on other rivers), they received 18.9% of Federal OM&R expenditures in that same system -- see Table 11-2. Removal of these rivers from the taxed system would lower the uniform fuel tax by 17%, even ignoring the fact that much of the sand and gravel traffic on the Missouri and Arkansas would continue to exist.

TABLE 11-2

TRAFFIC AND EXPENDITURE STATISTICS, 1974

Impacted River		Ton-Miles (millions)	Outlay Federal OM&R (thousands)
Mississippi River System including GIWW		171,861.1	$ 145,401.2
		(fuel tax = .000846)	
Missouri River			10,105.0
	direct	1,227.5	
	indirect	1,468.8	
		2,696.3	
Arkansas River			16,008.9
	direct	451.1	
	indirect	1,153.0	
		1,604.1	
Kentucky River			1,402.2
	direct	43.2	
Mississippi River System Including GIWW Net of Traffic Outlays from Three Rivers above		167,517.5	117,885.1
		(fuel tax = .000704)	

12. CONCLUSIONS

A fuel tax could penalize water traffic on low-expenditure rivers (Lower Mississippi) at the expense of maintaining high-expenditure rivers (Arkansas) that generate minimal system traffic. Fuel taxes for longhaul movements could act to divert as much traffic as segment tolls on short movements on high-cost rivers.

User charge impacts on barge transportation rates range between five and fifteen percent, depending on the commodity group and O/D patterns. In many cases, especially in short-haul flows over low-cost river segments or high-value commodities, impacts are relatively small; i.e., less than five percent increases.

User charge impacts on regional market prices rarely exceed one or two percent of delivered value per ton -- significantly less than water-carrier rate impacts. In general, price increases in commodity markets are in the range of .1 to .5%. Therefore, any significant impacts will tend to be isolated in the transportation sector and not necessarily in water-served industries.

Major disruptions due to the imposition of user charges appear unlikely in most industries at least for the next five to ten years. Many river-oriented plants, such as utilities and steel manufacturers, are locked into water transportation either by long-term supply contracts or fixed investment in water-unloading facilities. Relative carrier price changes (rail vs. barge) during the next ten years will determine modal shares as firms are able to disinvest or alter contracts, and as new capacity investment decisions are made. Therefore, greatest impacts are to be expected on future (potential), not existing, traffic.

Predictions of substantial, generalized impacts on water carriers as the result of user charges appear unsupported by preliminary results. However, localized impacts may be severe in distant or high-cost increase market areas. If railroads raise rates in response to barge-rate increases due to user charges, modal impacts would be reduced or eliminated.

Future studies should focus on those markets where modal reallocation is most probable, especially grain, and should continue and expand on a market impact approach, which recognizes the interactions within the entire distribution system.

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