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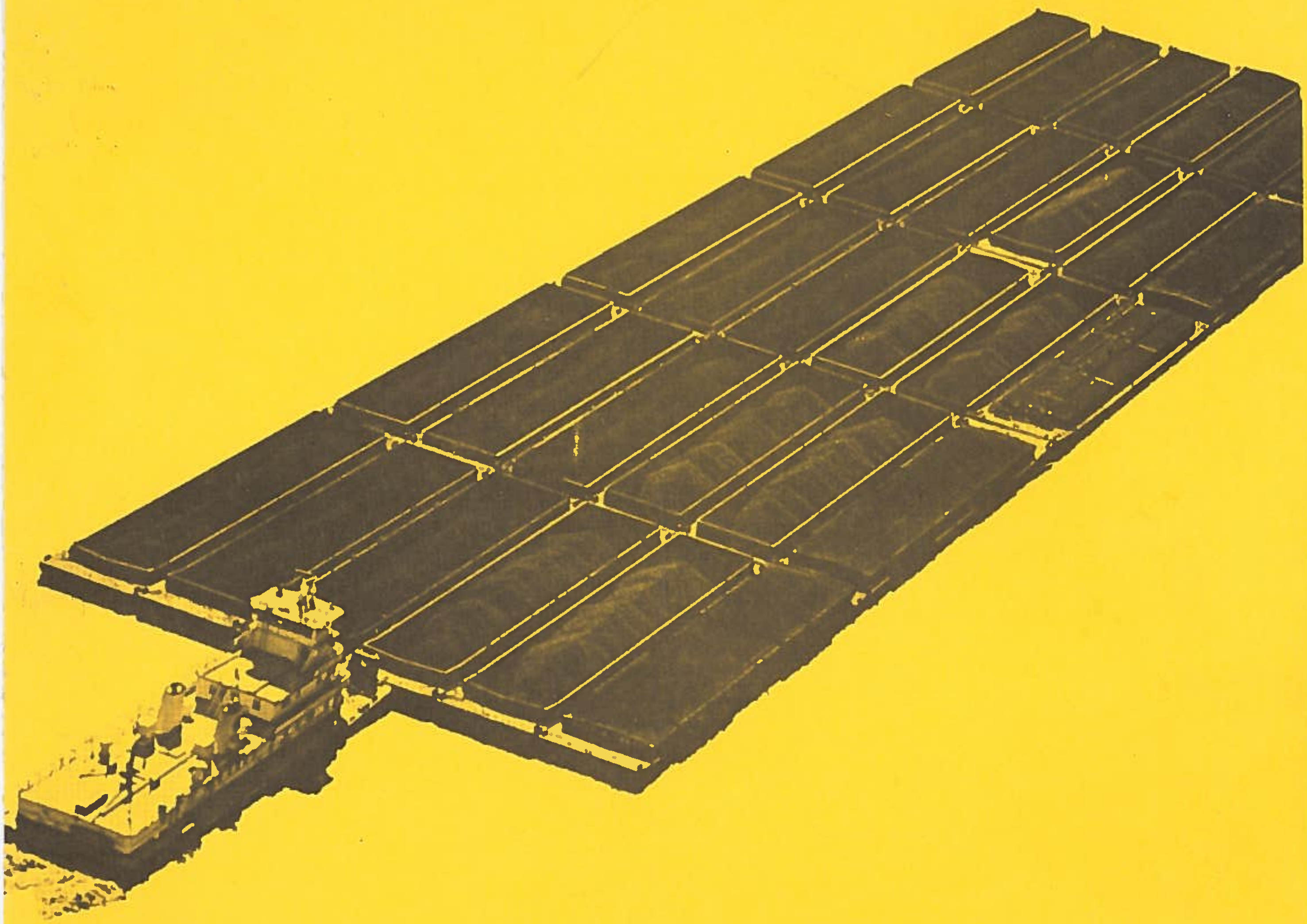
WATER TRANSPORTATION REQUIREMENTS FOR COAL MOVEMENT IN THE 1980's



APRIL 1976

FINAL REPORT

Prepared for

U. S. DEPARTMENT OF TRANSPORTATION
OFFICE OF TRANSPORTATION ENERGY POLICY
AND
TRANSPORTATION SYSTEMS CENTER
RESEARCH DIVISION
KENDALL SQUARE
CAMBRIDGE, MASSACHUSETTS 02142

Prepared by

INPUT OUTPUT COMPUTER SERVICES, INC.
689 CONCORD AVENUE
CAMBRIDGE, MASSACHUSETTS 02138

WATER TRANSPORTATION REQUIREMENTS FOR COAL MOVEMENT IN THE 1980's

SAMIR A. DESAI

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Document is available to the public through the
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16. Abstract

This water-oriented coal transportation study is one of a series conducted by the Department of Transportation to identify and quantify transportation requirements for energy materials. Information provided by these studies will be used by government and industry to examine and shape present and future transportation policies and related resources allocation decisions.

The primary objectives of this study are to develop and present barge industry estimates of the additional equipment and facilities required to handle a projected doubling of coal traffic. Other key report objectives are to describe present coal flows, associated operational policies and practices, and the interfaces with connecting or continuing modes of transportation.

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Ammerican Waterways Operators, Inc (AWO)
American Commercial Barge Line Co.
The Ohio River Company
Army Corps of Engineers (Washington, D.C.)

The officials within the barge industry and AWO provided valuable insight into outstanding issues. In this connection we would like to thank Mr. F. H. Blasked, Mr. H. J. Bubzien, Jr., Mr. David Mortenson, Mr. Neil Schuster, Mr. James R. Smith, and Mr. Jack D. Woffard. Our thanks are also due to Mr. DuWayne Koch, of Systems Analysis Applications Branch, Army Corps of Engineers, Washington, D.C.

Much inspiration and knowledge has come from Dr. David L. Anderson, Chief, Industry and Policy Analysis Branch, Transportation Systems Center and Technical Monitor for the project. He provided continuous advice and guidance to the project. Without the environment that he created this project would not have been completed.

Finally, the authors wish to express their gratitudes to the many others whose considerable effort helped to bring this project to a successful conclusion.

Executive Summary

Study Purpose and Objectives

This water-oriented coal transportation study is one of a series conducted by the Department of Transportation to identify and quantify transportation requirements for energy materials. Information provided by these studies will be used by government and industry to examine and shape present and future transportation policies and related resources allocation decisions.

The primary objectives of this study are to develop and present barge industry estimates of the additional equipment and facilities required to handle a projected doubling of coal traffic. Other key report objectives are to describe present coal flows, associated operational policies and practices, and the interfaces with connecting or continuing modes of transportation.

Study Approach

Recognizing the sensitive nature of the information requested and the need to maintain the confidentiality of data submitted, the study approach adopted called for contacting barge operators through their affiliations in the American Waterways Operators, Inc. When contacted, the association agreed to distribute, collect, consolidate, and clarify member firm responses to a contractor-prepared questionnaire.

In order to better understand the type, capacity, and cost of barge equipment, interviews were held with barge manufacturer.

Industry Structure

The barge and towing industry is composed of about 1,850 companies ranging in size from smaller operations to quite large companies. Of these, about 185 companies are certified as regular route common carriers, about 30 companies hold ICC permits to provide services under contracts with shippers, over 1,600 companies are engaged in the transportation of commodities which are exempt from regulation under provisions of the Interstate Commercial Act, and about 400 companies are engaged in private transportation of their own commodities.

These 1,850 companies operate on 25,543 miles of commercially navigable waterways in the United States. They utilize 4,100 tow boats and tugs with a combined horsepower in excess of 5 million to move 25,410 barges of various types with a total capacity of 33.7 million net tons.

Detailed data on future coal flows, equipment requirements, dock facilities, maintenance facilities, etc. could not be obtained from barge companies.

Barge coal traffic is exempt from ICC regulations and is highly competitive. The companies move the coal under contractual agreements with shippers and consumers. They compete not only with other modes of transportation, but also with each other for some coal movement. As a result, the majority of the companies were reluctant to provide data on future operations.

Coal transportation requires not only barge and towing equipment but also dock and receiving facilities, fleeting and harbor services, terminals, etc. The small and medium size companies which form a major portion of the industry are only involved in some aspects of coal transportation and

cannot predict the needs for a total transportation network to move future demands for coal. Army engineers operate and maintain all locks and dams on inland waterways. Some companies just provide harbor and fleet services, some just operate terminals either leased or owned by them. The majority of docks and loading facilities are owned and operated by shippers or receivers or sometimes independent companies. Some companies engage in contractual relationships with shippers and other carriers, providing freighting or towing services but who do not maintain daily operational control over their vessels. Also, small and medium size companies do not maintain planning staff to continually project requirements in the future.

Study Findings

Seven out of twenty barge companies responded to our questionnaire. Together these companies carried over 60 million tons or approximately 50 percent of the total coal carried by waterway carriers in 1975. The participating barge companies were asked to estimate their equipment and plant requirements to double the coal traffic by the 1980's. Study findings are summarized below.

- Coal transportation by water requires not only barge and towing equipment but also dock and receiving facilities, fleeting, harbor services, and terminals among other things. The small and medium size companies which form a major portion of the industry are involved in some aspects of coal transportation. It is difficult for them to predict requirements for a total water transportation network to move coal for the fulfilment of future demands.

- Coal is moved principally in open hopper barges, however, covered hopper barges with their covers off are also

employed in coal service. The two most commonly used sizes of hopper barges in coal service are:

Length feet	Breadth feet	Draft feet	Capacity feet
175	26	9	1,000
195	35	9	1,500

According to a study made by a major barge manufacturing company, the total industry's hopper barge fleet is estimated to be over 15,000 barges in 1985.

- Participating barge companies have approximately 3,500 barges in coal service. They have planned or ordered some 200 barges and estimate additional requirements for some 1,900 barges to accommodate coal traffic increases.

- Industry structure did not permit accurate estimates of equipment maintenance and dock facilities required to double the coal traffic. The responding companies estimated capital expenditure of over $16 million for equipment maintenance facilities and some $6 million for dock facilities.

- Interviews and surveys revealed that barge operators do not have major research and development programs to revolumnize or change substantially the present barge operation. The physical constraints of the waterways system such as channel depth, width, and lock size limit the technological developments.

.0 INTRODUCTION

Under Project Independence, the U. S. government set a goal of self-sufficiency in energy by 1985. As the U. S. has some 48% of known world-wide coal reserves, a dramatic increase in the use of coal is expected.

This water-oriented coal transportation study is one of a series conducted by the Department of Transportation to identify and quantify transportation requirements for energy materials. Information provided by these studies will be used by government and industry to examine and shape present and future transportation policies and related resources allocation decisions.

1 Study Purposes and Objectives

The primary objectives of this study are to develop and present barge industry estimates of the additional equipment and facilities required to handle a projected doubling of coal traffic. Other key report objectives are to describe present coal flows, associated operational policies and practices, and the interfaces with connecting or continuing modes of transportation.

Further report objectives are to obtain and report barge industry comments about new technological and operational changes in coal water movements.

Study Approach

Revenues earned from transporting coal are important to the economic health of the barge industry. To protect and expand these revenues barge operators must compete against other barge operators within the same or different waterway systems, other modes of transportation, and other energy sources.

To maintain and improve the competitive position of coal against other energy materials, barge operators must also cooperate and work with the same competitors identified above. However, fierce competition still exists in this area as various "teams" often contend for the same tonnage.

Recognizing the sensitive nature of information requested and the need to maintain the confidentiality of data submitted, the study approach adopted called for contacting barge operators through their affiliations in the American Waterways Operators, Inc. When contacted, the association agreed to distribute, collect, consolidate, and clarify member firm responses to a contractor-prepared questionnaire.

In order to better understand the type, capacity, and cost of barge equipment, interviews were held with barge manufacturers.

1.3 Industry Structure

The barge and towing industry is composed of about 1,850 companies ranging in size from smaller operations to quite large companies. Of these, about 185 companies are certified as regular route common carriers, about 30 companies hold ICC permits to provide services under contracts with shippers, over 1,600 companies are engaged in the transportation of commodities which are exempt from regulation under provisions of the Interstate Commerce Act, and about 400 companies are engaged in private transportation of their own commodities.

These 1,850 companies operate on 25,543 miles of commercially navigable waterways in the United States. They utilize 4,100 tow boats and tugs with a combined horsepower in excess of 5 million to move 25,410 barges of various types with a total capacity of 33.7 million net tons.

Detailed data on future coal flows, equipment requirements, dock facilities, maintenance facilities, etc. could not

Group	Length in Miles of Waterways					
	Under 6 ft.	6 to 9 ft.	9 to 12 ft.	12 to 14 ft.	14 ft. and up	Total
Atlantic Coast Waterways (exclusive of Atlantic Intracoastal Waterway from Norfolk, Va. to Key West, Fla.)	1,426	1,241	584	938	1,581	5,770
Atlantic Intracoastal Waterway from Norfolk, Va. to Key West, Fla.	-	65	65	1,104	-	1,234
Gulf Coast Waterways (exclusive of the Gulf Intracoastal Waterway)	2,055	647	1,133	79	378	4,292
Gulf Intracoastal Waterway from St. Marks, Fla to the Mexican border, including Port Allen-Morgan City Alternate route	-	-	-	1,137	-	1,137
Mississippi River System	2,020	969	4,957	740	268	8,954
Pacific Coast Waterways	730	498	237	26	2,084	3,575
Great Lakes	45	89	-	8	348	490
All Other Waterways	76	7	-	1	7	91
GRAND TOTAL	6,352	3,516	6.976	4,033	4,666	25,543

Note: 1. The mileages in this table represent the lengths of all navigable channels of the United States, including those improved by the Federal Government, other agencies, and those which have not been improved but are usable for commercial navigation.

2. Source: 1973 Inalnd Waterborne Commerce Statistics.

Table 2.1 Commercially Navigable Waterways of the United States by Lengths and Depths

be obtained from barge companies.

Barge coal traffic is exempt from ICC regulations and is highly competitive. The companies move the coal under contractual agreements with shippers and consumers. They compete not only with other modes of transportation, but also with each other for some coal movement. As a result, the majority of the companies were reluctant to provide data on future operations.

Coal transportation requires not only barge and towing equipment but also dock and receiving facilities, fleeting and harbor services, terminals, etc. The small and medium size companies which form a major portion of the industry are only involved in some aspects of coal transportation and cannot predict the needs for a total transportation network to move future demands for coal. Army engineers operate and maintain all locks and dams on inland waterways. Some companies just provide harbor and fleet services, some just operate terminals either leased or owned by them. The majority of docks and loading facilities are owned and operated by shippers or receivers or sometimes independent companies. Some companies engage in contractual relationships with shippers and other carriers, providing freighting or towing services but who do not maintain daily operational control over their vessels. Also, small and medium size companies do not maintain planning staff to continually project requirements in the future.

Seven out of twenty companies responded to our questionnaire. The responses were not very detailed, and are summarized in subsequent chapters.

2.0 U. S. Waterways

2.1 Overview

The U. S. waterways system is a network of over 25,000 miles of navigable waterways. These waterways include coastal waterways, inland rivers, and canals and Great Lakes.

Table 2.1 summarizes the navigable lengths and depths of the various waterways mentioned above. Note that the majority - some 60 percent - have a channel depth of 9 feet or more. The Mississippi River and Gulf intracoastal system form one continuous system and account for some 58 percent of the mileage of navigable waterways. These waterways can be grouped under four categories.

- Inland waterways (including Gulf-Intracoastal canals).
- Atlantic inter and intra coastal waterways.
- Pacific coast waterways.
- The Great Lakes.

Coal moves primarily on inland waterways and the Great Lakes.

2.2 Inland Waterways

The inland waterway system consists of:

- Upper and lower Mississippi River.
- Illinois River.

- Ohio River.
- Missouri River.
- Tennessee River.
- Arkansas River.
- Alabama River.

The Gulf Intracoastal Waterway is linked directly to the Mississippi system and stretches eastward 1,800 miles from Brownsville, Texas to St. Marks's, Florida.

Other commercially active inland waterways include the Atlantic Intracoastal Waterway, the Hudson River/New York State Barge Canal System, the Columbia River, and the Sacramento River.

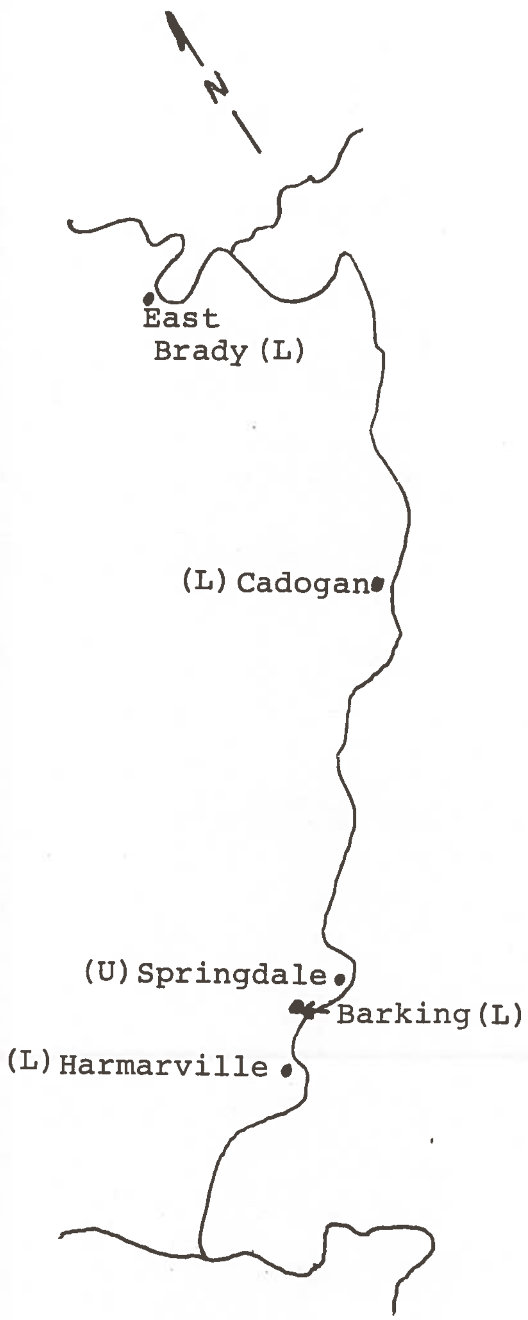
Figures 2.1 through 2.9 present the principal waterways along with total mileage, depths, coal traffic volumes, average maximum tow sizes, and, whenever possible, coal transfer facilities. "U" and "L" along with a town denote unloading and loading facilities, respectively. Some facilities have both unloading and loading services and are designated by (U,L). A number in front of a U or L denotes the number of facilities in or near the town.

2.3 Great Lakes

The Great Lakes form an important transportation link for transshipping various commodities to destinations in the northern U. S. and Canada.

Coal moves to the lower Great Lakes ports for transshipment by water from both the Appalachian fields and Illinois-Indiana-western Kentucky fields. Some of the coal transfer facilities located on these lakes, along with the railroads serving them, are shown in Figure 2.10.

ALLEGHENY RIVER



Navigation on the Allegheny River begins at East Brady, Pennsylvania southwestward to Pittsburgh and its confluence with the Monongahela River to form the Ohio River.

Total Mileage--72

Project Depth--9 feet

Project Width--200 Feet

Lock Dimensions--56' by 360'
(9 locks)

Navigation Season--12 months

1973 Coal Traffic:
(000's of net tons)

Ocean Going:	-
Inland Waterways:	2,351
Total:	2,351
% of Total Traffic	42.8

Average Maximum Tow Size: 11 barges

Information Sources:

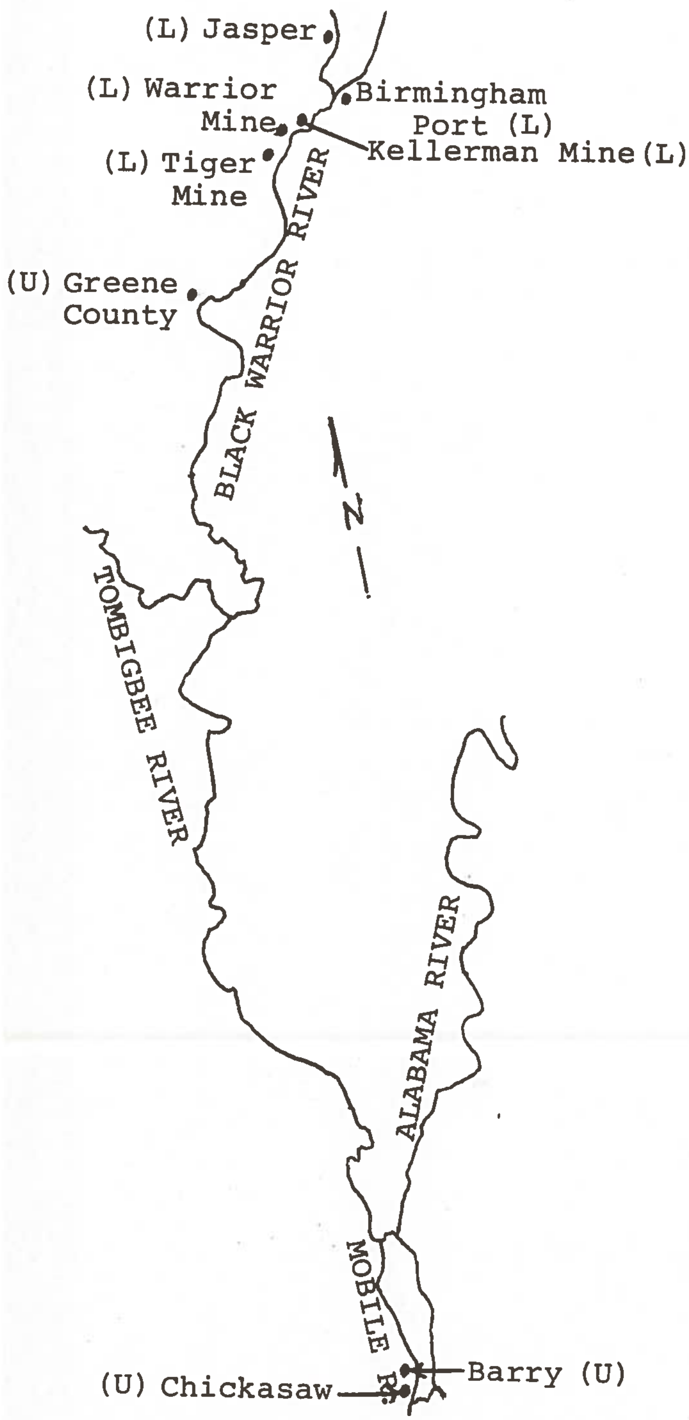
1973 Inland Waterborne Commerce Statistics (American Waterways Operators, Inc.)

Big Load Afloat--U. S. Domestic Water Transportation Resources (American Waterways Operators, Inc.)

1974 Keystone Coal Industry Manual (McGraw-Hill, Inc.)

Figure 2.1

BLACK WARRIOR, WARRIOR AND TOMBIGBEE RIVER SYSTEM



The Black Warrior-Tombigbee Waterway lies wholly within the State of Alabama and is made up of the Black Warrior, Warrior, and Tombigbee Rivers, including the Sipsey, Mulberry, and Locust Forks of the Black Warrior River.

Total Mileage--466

Project Depth--9 feet

Project Width--200 feet

Lock Dimensions--

Coffeeville	110' by 600'
Demopolis	110' by 600'
Warrior	110' by 600'
Wm. Bacon Oliver	95' by 460'
Holt	110' by 600'
John Hollis Bankhead	52' by 286'

Navigation Season--12 months

Average Max. Tow Size--6 barges

1973 Coal Traffic:
(000's of net tons)

Ocean Going:	-
Inland Waterways:	5,509
Total:	5,509
% of Total Traffic	39.1

Information Sources:

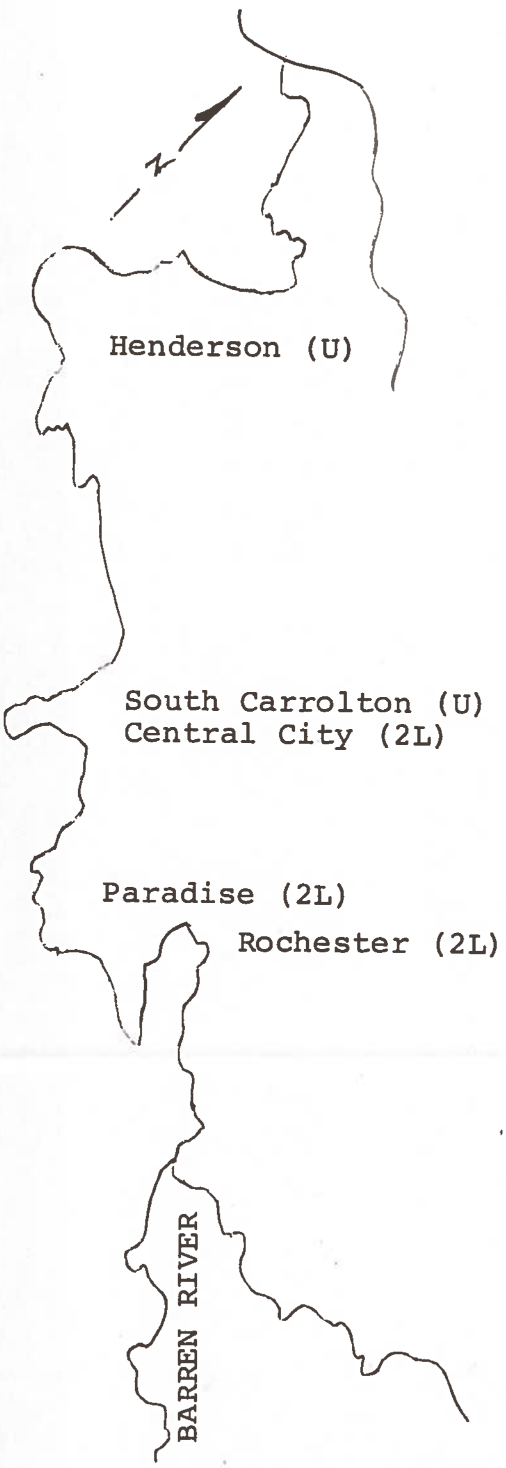
1973 Inland Waterborne Commerce Statistics (American Waterways Operators, Inc.)

Big Load Afloat--U. S. Domestic Water Transportation Resources (American Waterways Operators, Inc.)

1974 Keystone Coal Industry Manual (McGraw-Hill, Inc.)

Figure 2.2

GREEN RIVER



The Barren River flows northwesterly from Bowling Green, Kentucky to its confluence with the Green River at Woodbury for a distance of 30 miles. The Green River flows northwesterly for a distance of 150 miles where it empties into the Ohio River eight miles above Evansville, Indiana.

Total Mileage--180

Project Depth--5.5 to 9 feet

Project Width--100 to 200 feet

Lock Dimensions--

No. 1 Green River	84' by 600'
No. 2 Green River	84' by 600'
No. 3 Green River	35.8' by 137.5'
No. 4 Green River	35.8' by 138'
No. 1 Barren River	56' by 360'

Navigation Season--12 months

Average Maximum Tow Size: 9 barges

1973 Coal Traffic:
(000's of net tons)

Ocean Going:	-
Inland Waterways:	15,458
Total:	15,458
% of Total Traffic:	99.6

Information Sources:

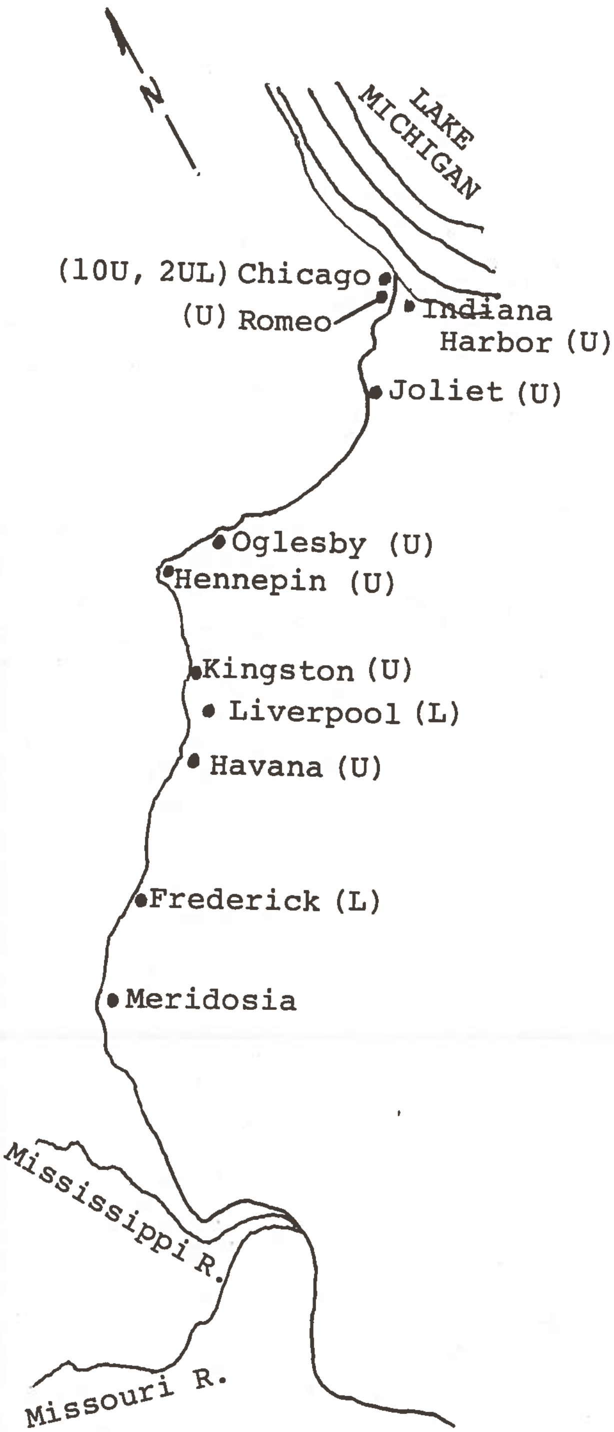
1973 Inland Waterborne Commerce Statistics (American Waterways Operators, Inc.)

Big Load Afloat--U. S. Domestic Water Transportation Resources (American Waterways Operators, Inc.)

1974 Keystone Coal Industry Manual (McGraw-Hill, Inc.)

Figure 2.3

ILLINOIS WATERWAY



The Illinois Waterway extends from Chicago Harbor at Lake Michigan to Grafton, Ill. and its confluence with the Mississippi River. In the Chicago area it includes the Calumet-Sag Channel and the Chicago Sanitary and Ship Canal.

Total Mileage--353.6

Project Depth--9 feet

Project Width--225 feet

Lock Dimensions--

Lockport	110' by 600'
Brandon Road	110' by 600'
Dresden Island	110' by 600'
Marseilles	110' by 600'
Starved Rock	110' by 600'
Peoria	110' by 600'
LaGrange	110' by 600'

Note: The 1962 Authorization Bill provides for two new locks 110' by 1,000', and the modification of the project to provide for construction of supplemental locks, 110' by 1,200', of the seven existing lock sites.

Navigation Season--12 months

1973 Coal Traffic:
(000's of net tons)

Ocean Going:	-
Inland Waterways:	7,144
Total:	7,144
% of Total Traffic	16.0

Information Sources:

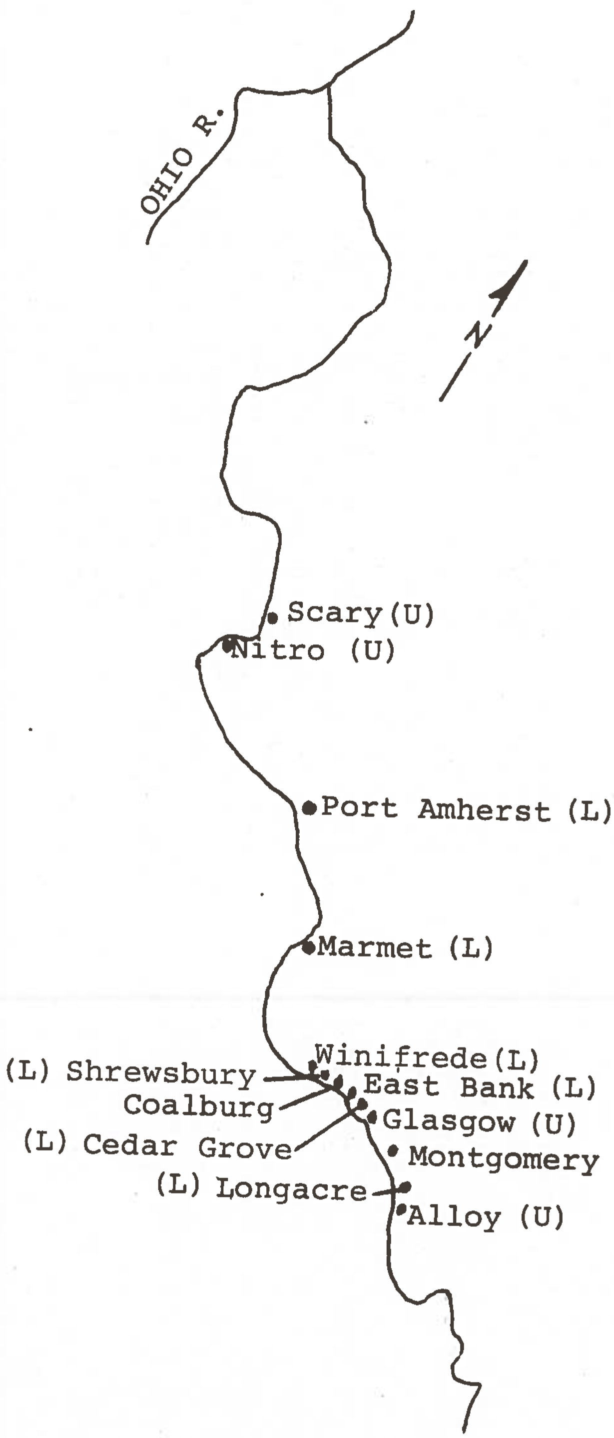
1973 Inland Waterborne Commerce Statistics (American Waterways Operators, Inc.)

Big Load Afloat--U. S. Domestic Water Transportation Resources (Amer. Waterways Operators, Inc.)

1974 Keystone Coal Industry Manual (McGraw-Hill, Inc.

Figure 2.4

KANAWHA RIVER



Navigation on the Kanawha River begins at Deepwater, West Virginia and flows northward to Point Pleasant, West Virginia and its confluence with the Ohio River.

Total Mileage--91

Project Depth--9 feet

Project Width--300 feet

Lock Dimensions--

London	56' by 360'
Marmet	56' by 360'
Winfield	56' by 360'

Average Maximum Tow Size: 4 barges

1973 Coal Traffic:
(000's of net tons)

Ocean Going:	-
Inland Waterways:	7,325
Total:	7,325
% of Total Traffic	51.7

Information Sources:

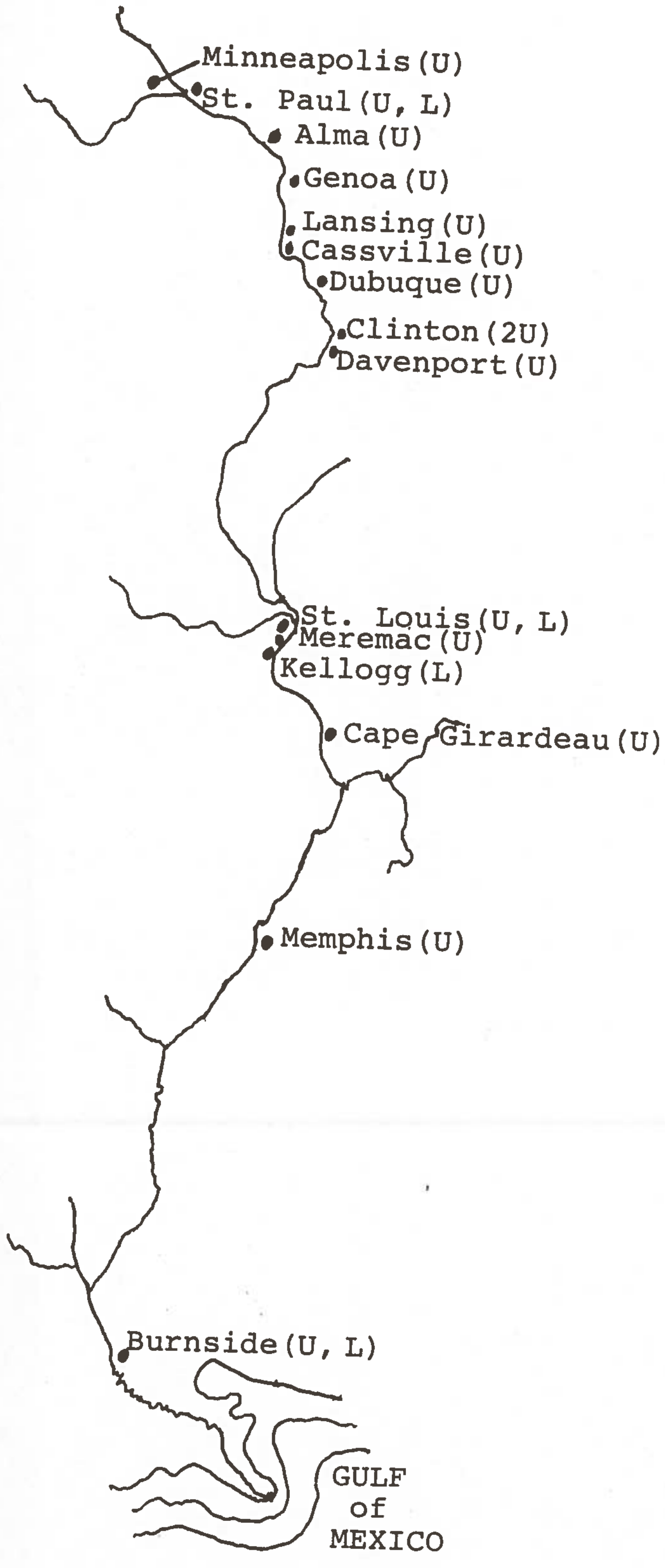
1973 Inland Waterborne Commerce Statistics (American Waterways Operators, Inc.)

Big Load Afloat--U. S. Domestic Water Transportation Resources (American Waterways Operators, Inc.)

1974 Keystone Coal Industry Manual (McGraw-Hill, Inc.)

Figure 2.5

MISSISSIPPI RIVER



The Mississippi River rises in northern Minnesota and flows in a southerly direction to the Gulf of Mexico. Navigation extends from Minneapolis, Minn. to the mouth of the Passes.

Total Mileage--2,360

Navigation Mileage--1,837

Project Depth--9 feet to 40 feet

Project Width--300 to 1,100 feet

Lock Dimensions--56' by 400', 110' by 600', 110' by 1,200 feet (30 locks and dams)

Navigation Season--Minneapolis to mouth of Missouri: end of March through first week of December; mouth of Missouri to Head of Passes, 12 months

Average Max. Tow Size:
Upper Mississippi: 15 barges
Lower Mississippi: 40 barges

1973 Coal Traffic:
(000's of net tons)

Ocean-going:	4,129
Inland Waterways:	19,426
Total:	23,555
% of Total Traffic	8.5

Information Sources:

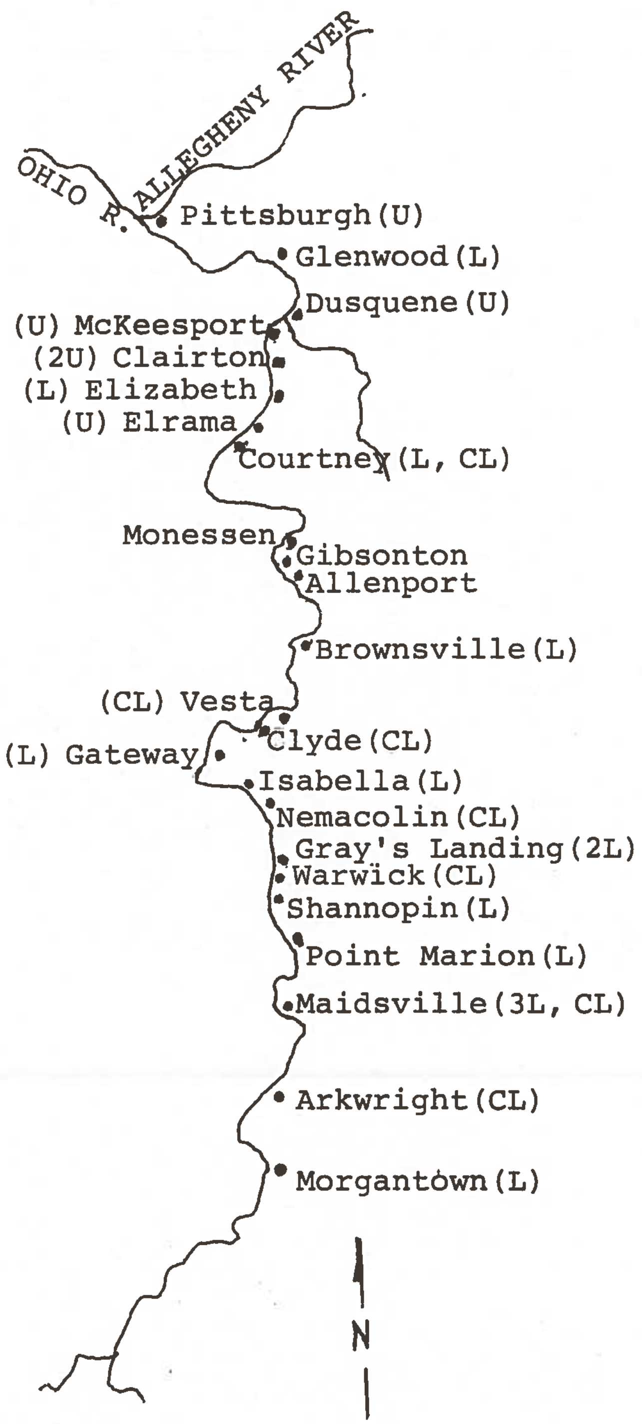
1973 Inland Waterborne Commerce Statistics (American Waterways Operators, Inc.)

Big Load Afloat--U. S. Domestic Water Transportation Resources (American Waterways Operators, Inc)

1974 Keystone Coal Industry Manual (McGraw-Hill, Inc.)

Figure 2.6

MONONGAHELA RIVER



The Monongahela River flows northwesterly from Fairmont, West Virginia to its confluence at Pittsburgh with the Allegheny River to form the Ohio River.

Total Mileage--129

Project Depth--7 to 9 feet

Project Width--300 feet

Lock Dimensions--

No. 2 (2 chambers)	56' by 360'
	110' by 720'
No. 3 (2 chambers)	56' by 360'
	56' by 720'
No. 4 (2 chambers)	56' by 360'
	56' by 720'
No. 5 (2 chambers)	56' by 360'
No. 6 (2 chambers)	56' by 360'
No. 7	56' by 360'
No. 8	56' by 360'
No. 14	56' by 182'
No. 15	56' by 182'
Maxwell (to replace No. 4)	84' by 720'
Morgantown	84' by 600'
Hildebrand	84' by 600'
Opeskiska (to replace Nos. 14 and 15)	84' by 600'

Navigation Season--12 months

1973 Coal Traffic:
(000's of net tons)

Ocean Going:	-
Inland Waterways:	29,635
Total:	29,635
% of Total Traffic	78.8

Average Maximum Tow Size: 15 barges

Information Sources:

1973 Inland Waterborne Commerce Statistics (American Waterways Operators, Inc.)

Big Load Afloat--U. S. Domestic Water Transportation Resources (American Waterways Operators, Inc.)

1974 Keystone Coal Industry Manual (McGraw-Hill, Inc.)

Figure 2.7

OHIO RIVER

The Ohio River is formed at Pittsburgh by the junction of the Allegheny and the Monongahela Rivers and flows southwesterly to Cairo, Illinois, and its confluence with the Mississippi River.

Total Mileage--981

Project Depth--9 feet

Project Width--100 to 600 feet

Lock Dimensions--
  43 existing--110' by 600' to be replaced by 19 locks--110' by 1,200'

Average Max. Tow Size: 20 barges

1973 Coal Traffic:
  (000's of net tons)

Ocean Going:	-
Inland Waterways:	65,137
Total:	65,137
% of Total Traffic	48.2

Information Sources:

1973 Inland Waterborne Commerce Statistics (American Waterways Operators, Inc.)

Big Load Afloat--U. S. Domestic Water Transportation Resources (American Waterways Operators, Inc.)

1974 Keystone Coal Industry Manual (McGraw-Hill, Inc.)

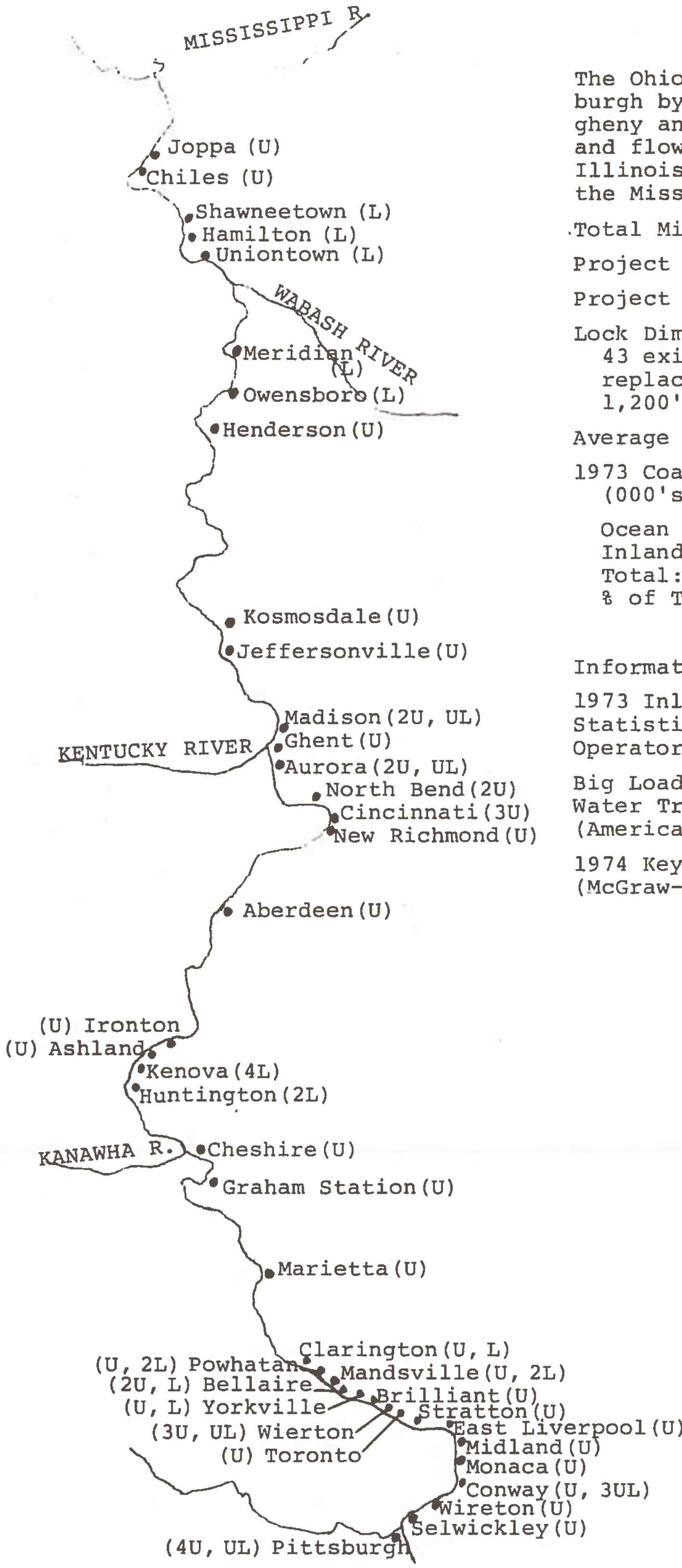
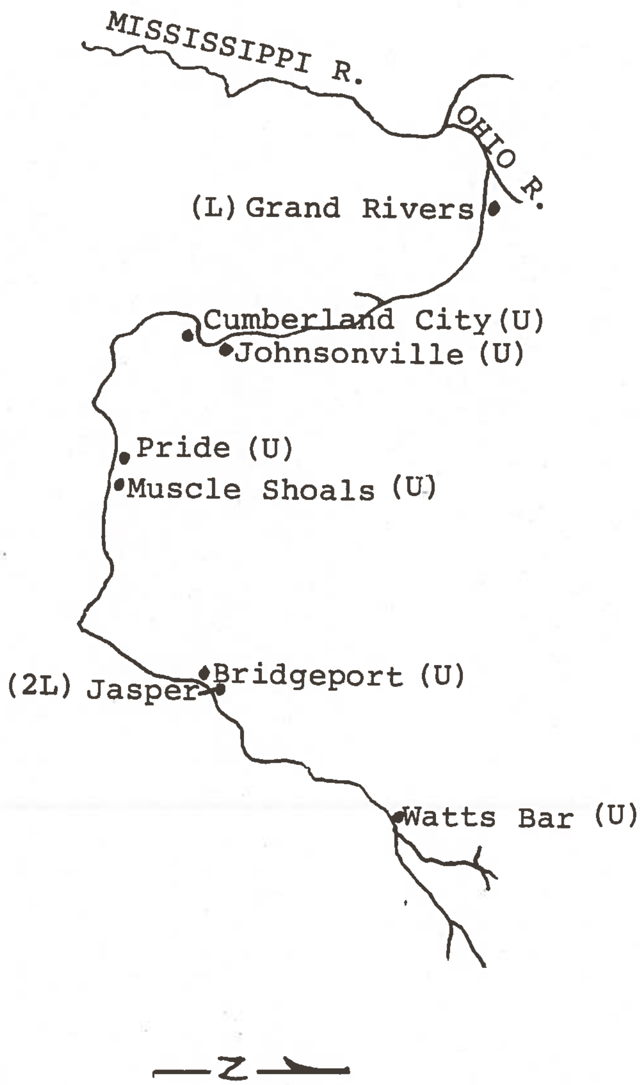


Figure 2.8

TENNESSEE RIVER



The Tennessee River is formed at Knoxville, Tennessee by the junction of the Holston and French Rivers, flowing south and southwest to its confluence with the Ohio River at Paducah, Kentucky.

Total Mileage--652

Project Depth--9 feet

Project Width--300 to 500 feet

Lock Dimensions--

Kentucky	110' by 600'
Pickwick	110' by 600'
Wilson:	
Auxiliary	60' by 292'
Main	110' by 600'
Wheeler	60' by 400'
Guntersville	60' by 360'
Hales Bar	60' by 265'
Chickamauga	60' by 360'
Watts Bar	60' by 360'
Fort Loudon	60' by 360'

Navigation Season--12 months

Average Max. Tow Size--4 barges

1973 Coal Traffic:
(000's of net tons)

Ocean Going:	-
Inland Waterways:	11,592
Total:	11,592
% of Total Traffic	41.1

Information Sources:

1973 Inland Waterborne Commerce Statistics (American Waterways Operators, Inc.)

Big Load Afloat--U. S. Domestic Water Transportation Resources (American Waterways Operators, Inc.)

1974 Keystone Coal Industry Manual (McGraw-Hill, Inc.)

Figure 2.9

Lake Port Coal Loading Facility	Railroad Serving
Chicago	Belt
Toledo*	C&O, PC
Sandusky	N&W
Lorain	B&O
Ashtabula	PC
Conneant	B&LE

* several docks

Figure 2.10 Great Lakes and Coal Transfer Facilities.

3.0 Coal Traffic

3.1 Overview

The principal commodities best suited to movement by inland waterway transportation are those which are required in large quantities, can be economically moved in bulk, and do not require rapid transit. Of all inland waterway shipments (exclusive of the Great Lakes) during the year 1973, the tonnage of only fourteen commodities exceeded one percent of the total. These fourteen, with their percentages of the total of over 596 million tons, are listed below:

Commodity	(000 tons) 1973 Tonnage (1)	% of Total
Grain and grain products	26,844	4.5
Soyabeans	8,560	1.4
Marine shells, unmanufactured	18,633	3.1
Bituminous coal and lignite	117,164	19.6
Crude petroleum	55,650	9.3
Sand, gravel, and crushed rock	74,876	12.6
Rafted logs	14,599	2.5
Basic chemicals and products	12,441	2.1
Fertilizer & fertilizer materials	6,466	1.1
Gasoline	41,580	7.0
Distillate fuel oil	38,258	6.4
Residual fuel oil	70,936	11.9
Iron and steel products	7,241	1.2
Subtotal	493,288	82.7
All other commodities	103,172	17.3
Grand Total	596,460	100.0

Note: 1. Source: Inland Waterborne Commerce Statistics, 1973.

Note that coal is the largest single commodity, some 20% of the total tonnage moving over the U. S. Inland Waterways. In 1974, water carriers transported 18.4% or 102,507,000 tons of coal. Coal is a principal item of traffic along

the Ohio River and its tributaries. Coal is also moved down the Mississippi River, and large tonnage is transferred near the river mouth to ocean-going barges which cross the Gulf of Mexico to power plants in Florida. The Great Lakes are another waterway for coal. In 1974, 5.9% or 32,654,000 tons of coal moved over the Great Lakes. Figure 3.1 shows major eastern waterways over which coal moves and their proximity to the coal mines.

3.2 Coal Traffic--Inland Waterways

Domestic inland water movements of bituminous coal, by shipping area, rose from 101,679,673 tons in 1969 to 108,885,275 tons in 1973, the latest year for which data is available. The inland coal water movements generally are concentrated in the eastern U. S. A.

Table 3.1 summarizes major coal water movements. Only those rivers or waterways which had more than a million tons of coal traffic per year are listed. Note that the Ohio River has more coal traffic than any other waterway. In 1973, over 65 million tons of coal moved on the Ohio River. This is about 48% of the total traffic on that river.

Although the Ohio River ranks high in its commercial importance, its greatness must be considered in relation to its major "contributors", the Tennessee, the Cumberland, the Green, the Kentucky, the Kanawha, the Monongahela, and the Allegheny. Out of the total 41 million tons of coal unloaded on the Ohio River, over 31 million tons originated on the above tributaries.

Specific coal movements from origin to destination within and in and out of the Ohio River basin are shown in Figures 3.2, 3.3, and 3.4 The width of the arrows indicate the approximate volumes, where 1/8 of an inch is equivalent to four million tons. To protect confidentiality of the specific private hauls, the curves have been rounded.

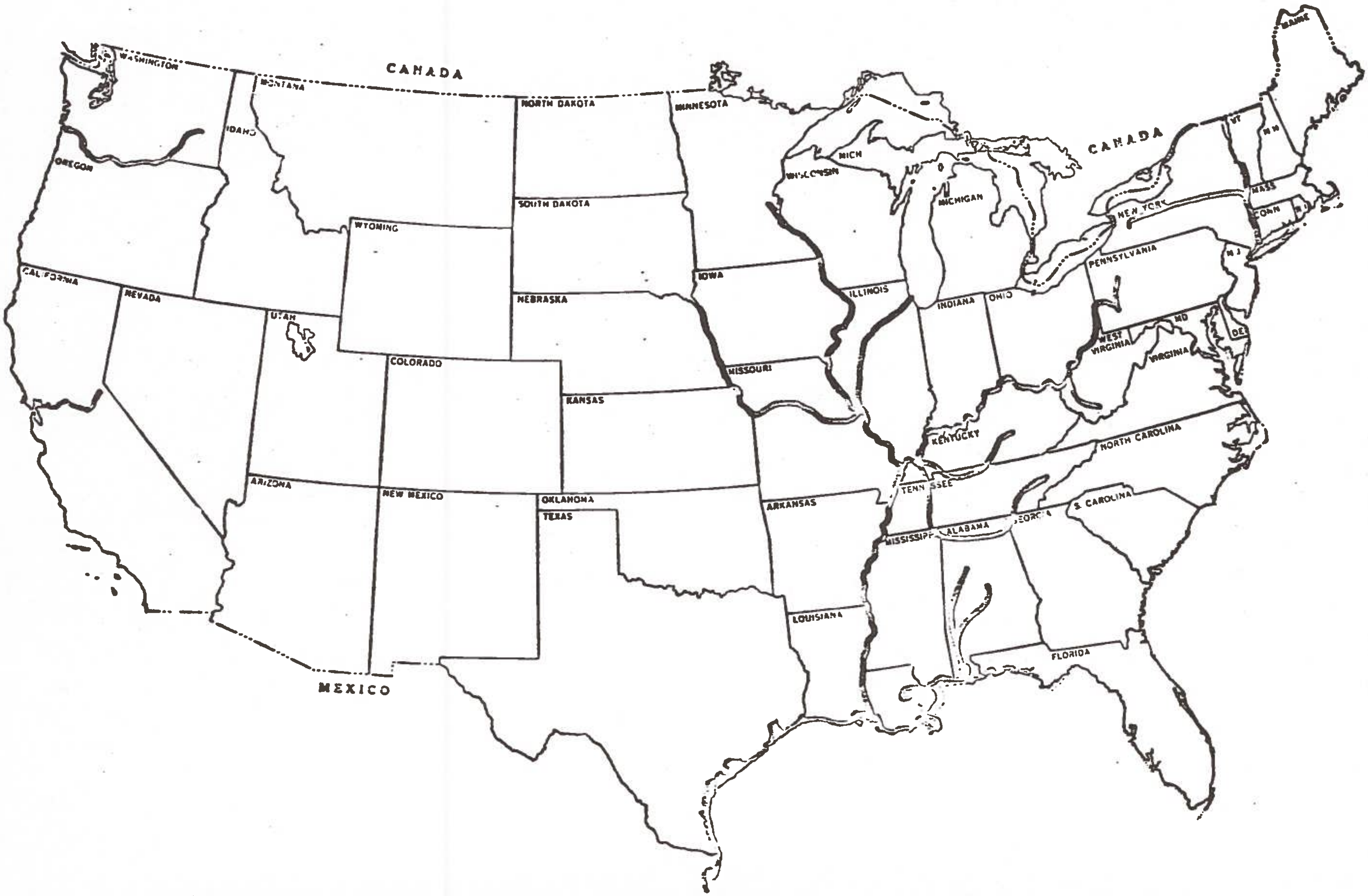
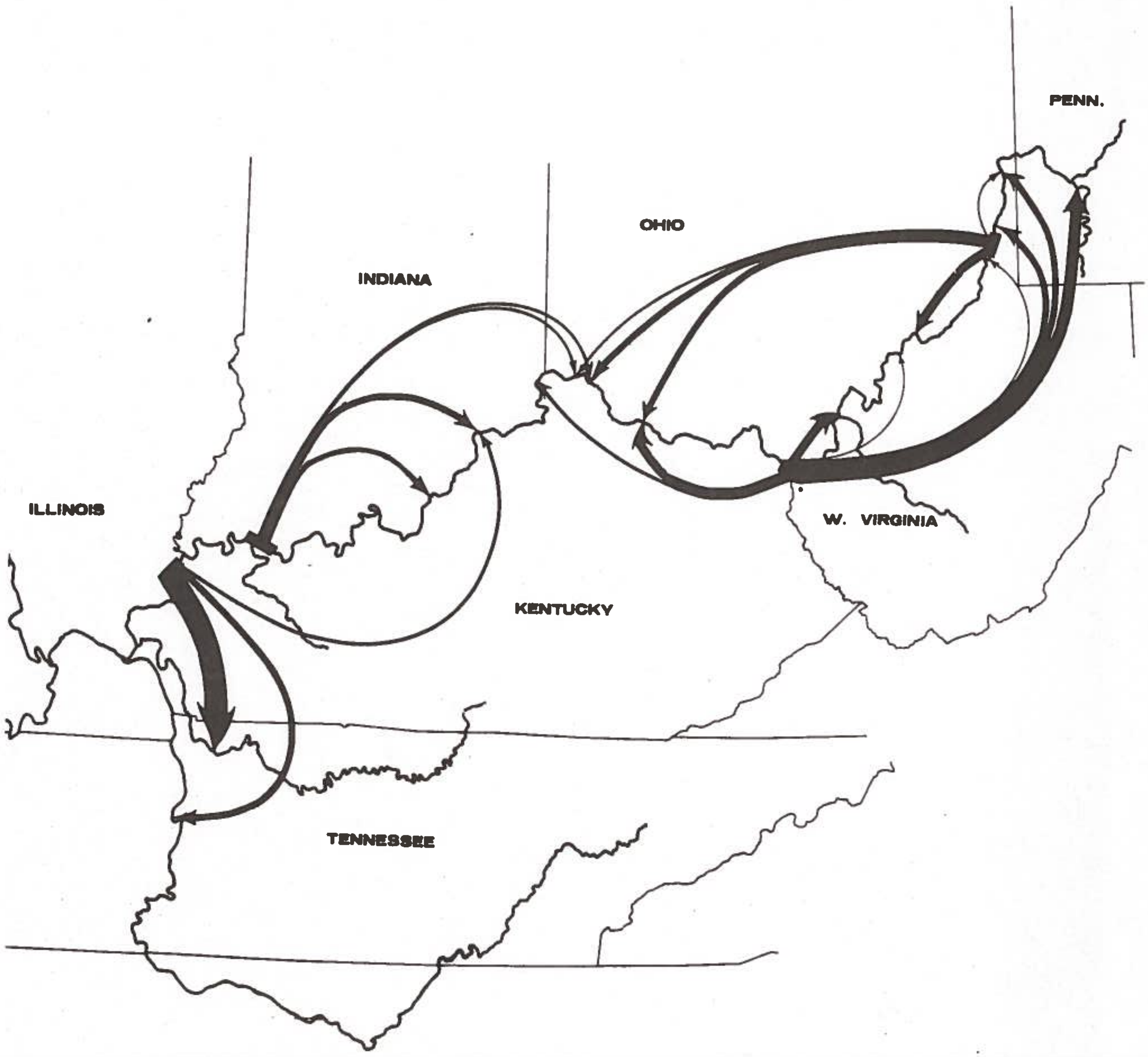


Figure 3.1 Major Eastern Waterways and Their Proximity to the Coal Mines

Shipping Area	Tonnage Loaded	Tonnage Unloaded: Local	Tonnage Unloaded: From Other Rivers	Total Coal Traffic
Allegheny River	1,214,818	497,134	1,136,232	2,351,050
Baltimore Harbor & Channels	2,555,525	1,928,968	3,645,751	6,201,276
Cumberland River	56,735	56,735	4,301,001	4,357,736
Delaware River	101,078	101,078	1,634,951	1,736,029
Escambia & Conecub Rivers	-	-	1,538,299	1,538,299
Green & Barren Rivers	15,458,181	377,610	-	15,458,181
Gulf Intracoastal Waterway	-	-	1,614,301	1,614,301
Illinois River	5,836,152	853,557	854,923	6,691,075
Kanawha River	6,675,576	1,972,165	649,414	7,324,990
Mississippi River	8,084,640	4,577,898	6,662,467	14,747,107
Monongahela River	26,281,271	18,122,728	3,353,254	29,634,525
Ohio River--Huntington Dist.	10,575,405	4,071,827	6,576,947	17,152,352
Ohio River--Louisville Dist.	12,727,277	3,552,880	10,803,610	23,710,887
Ohio River--Pittsburgh Dist.	10,490,390	6,422,040	9,780,734	20,271,124
Tennessee River	6,436,607	3,612,235	4,408,124	10,844,731
Warrior River System	4,797,199	4,377,924	762,808	5,560,007

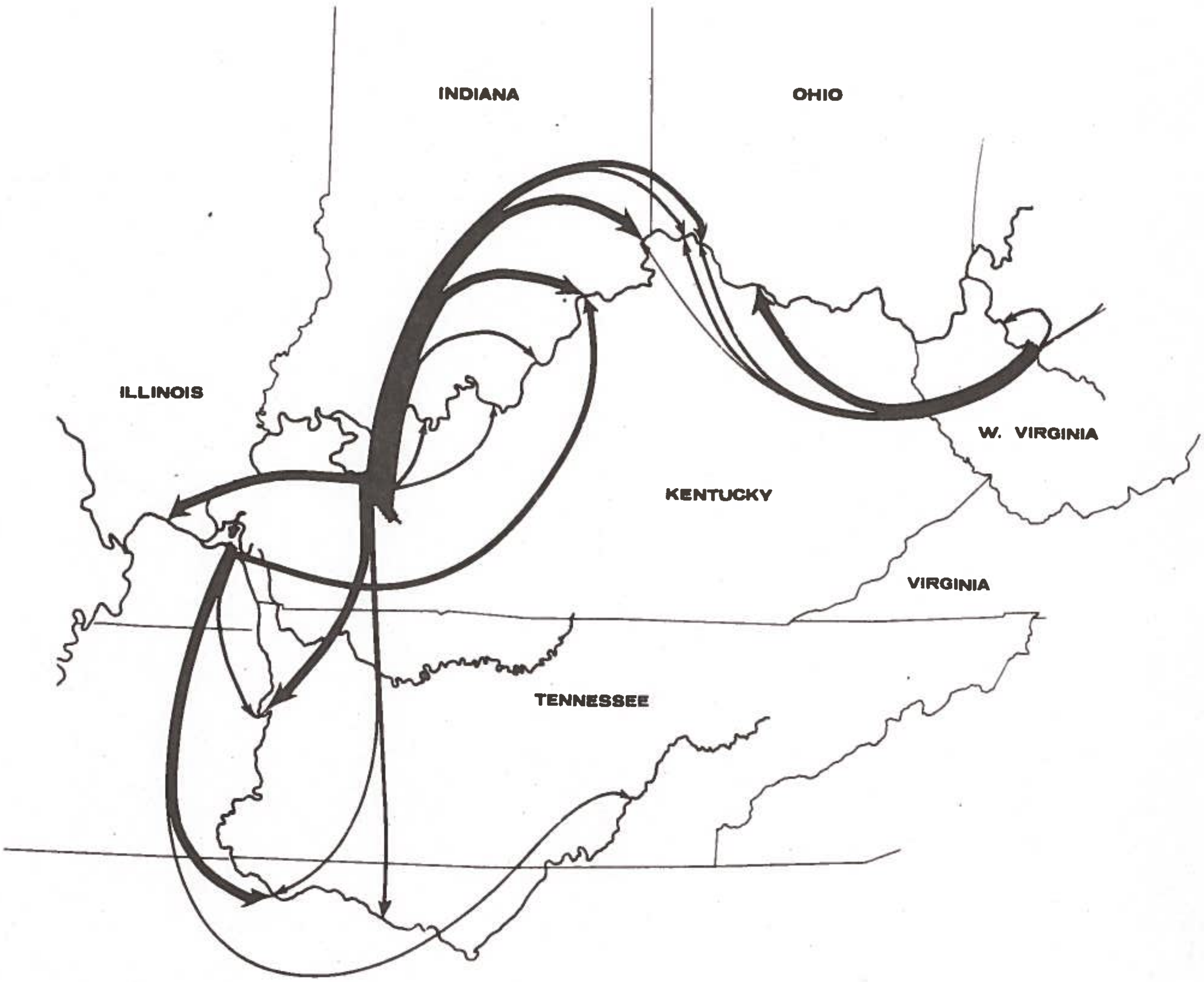
Source: Coal Traffic Annual, 1975

Table 3.1 Domestic Inland Water Movements of Bituminous Coal, 1973



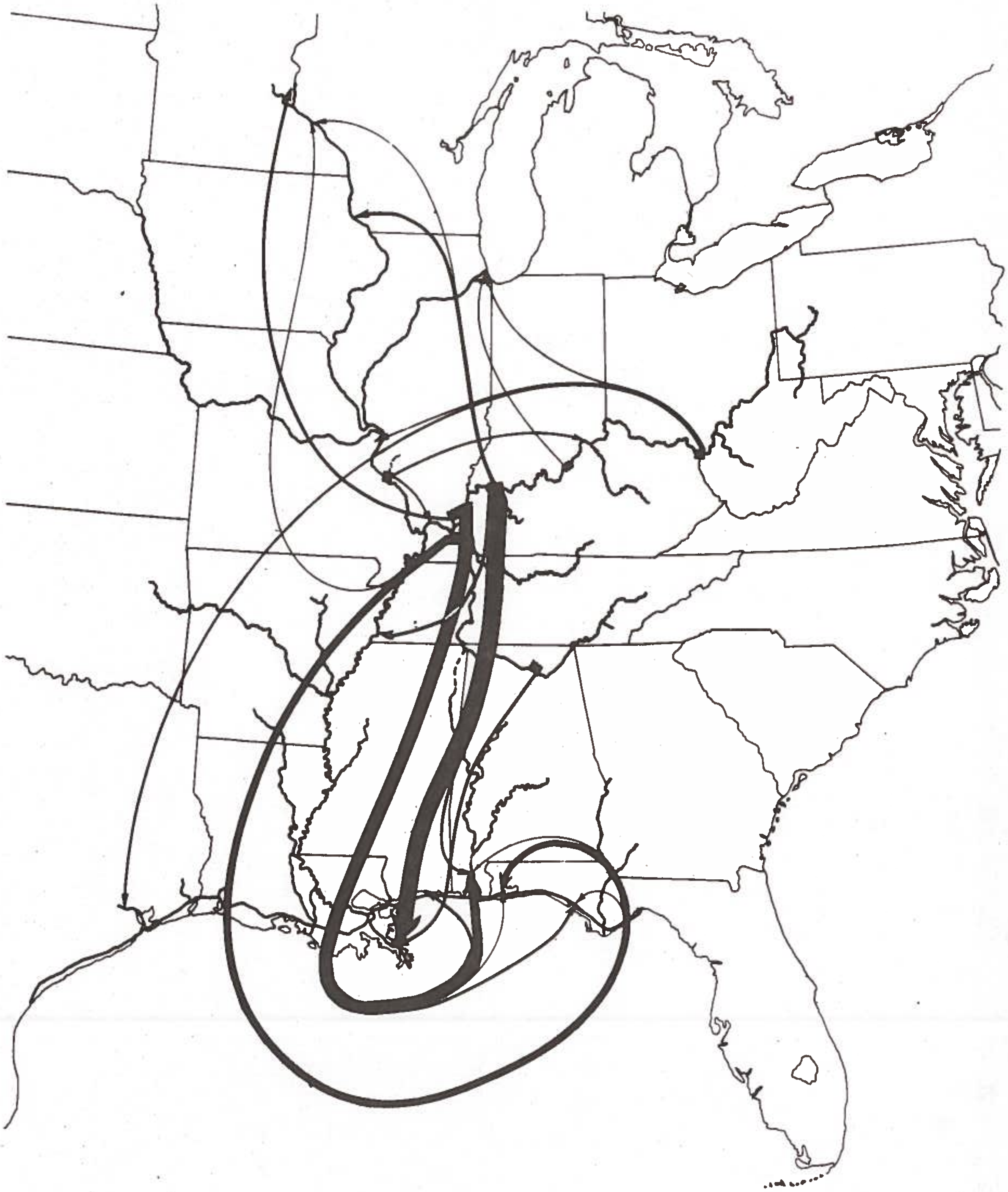
Source: U. S. Army Engineering Division, Ohio River Division, Cincinnati, Ohio in Kentucky's Coal Transportation, State of Kentucky.

Figure 3.2 Inland Waterway Coal Movements on the Ohio River Basin from Ohio River Docks, 1972.



Source: U. S. Army Engineering Division, Ohio River Division, Cincinnati, Ohio in Kentucky Coal Transportation, State of Kentucky.

Figure 3.3 Inland Waterway Coal Movements, 1972.



Source: U. S. Army Engineering Division, Ohio River Division, Cincinnati, Ohio in Kentucky Coal Transportation, State of Kentucky.

Figure 3.4 Inland Waterway Coal Movements on the Ohio River Basin from Docks on Tributaries, 1972.

3.3 Lake Coal Traffic

The Great Lakes are an important waterway for coal movements. Coal from origins in eastern Kentucky, Maryland, Ohio, Pennsylvania, Virginia, West Virginia, and Tennessee is transshipped at various ports on Lake Erie for further movement to destination ports on the Great Lakes. The transshipping facilities on Lake Erie are located at Toledo, Sandusky, Lorain, Astabula, and Conneant, Ohio. Coal originating in Illinois, Indiana, and western Kentucky is also marketed on the Great Lakes through the port of Chicago, Illinois. These facilities are shown in Figure 2.11. Lake Erie ports like Toledo and Sandusky and also the port of Chicago on Lake Michigan receive coal mostly by rail and load it into freighters. Some coal flows and specific movements to these ports are presented in subsequent chapters.

Table 3.2 presents bituminous coal shipments to Canadian and U. S. ports from Lake Erie and Michigan.

3.4 Coal Export

The U. S. is a major exporter of coal. The majority of exported coal is of metallurgical type. The cyclical nature of demand for this type of coal is made more volatile by changes in shipping rates, import restrictions, and foreign exchange restrictions.

Total export shipments hit a peak of over 76 million tons in 1957, but dropped sharply thereafter. The trend in shipments was upwards in the 1960's, with 70.9 million tons shipped in 1970.

In 1974, the declining trend in coal exports overseas has been arrested and coal exports are expected to increase steadily for the next few years. Table 3.3 presents exports of bituminous coal by continent group. Japan has surpassed Canada as the largest single foreign market for U. S. coal.

Lake	Loading Port	Thousands of Net Tons: Destination: Canada	Thousands of Net Tons: Destination: U. S.	Thousands of Net Tons: Total
Erie	Ashtabula, Ohio	3,076	1,180	4,256
Erie	Conneant, Ohio	4,675	2,050	6,725
Erie	Lorain, Ohio	-	2,030	2,030
Erie	Sandusky, Ohio	2,353	1,729	4,082
Erie	Toledo, Ohio	2,853	9,845	12,698
SUBTOTAL		12,957	16,834	29,791
Michigan	Chicago, Illinois	(1)	(1)	4,044
TOTAL		12,957	16,834	33,835

Notes: 1. Not available

2. Source: Coal Traffic Annual, 1975

Table 3.2 Bituminous Coal Shipments to Canadian and U. S. Ports

Continent Group	1970	1971	1972	1973	1974(1)
North & Central America	18,849	17,852	18,629	16,539	14,117
South America	2,920	2,672	2,651	2,655	2,351
Europe	21,504	16,403	16,678	14,252	15,855
Asia	27,647	19,706	18,039	19,381	27,603
Oceania	22	-	-	43	-
Africa	-	-	-	-	-
TOTAL	70,932	56,633	55,997	52,870	59,926

Notes: 1. Preliminary

2. Source: Coal Data, 1974

Table 3.3 Exports of Bituminous Coal by Continent Group

The majority of coal exported overseas is transshipped through Atlantic ports. In 1974, bituminous coal dumping at Atlantic ports by U. S. railroads totaled 50,542,924 tons. Over 79% of that amount was terminated by the Norfolk and Western and the Chesapeake and Ohio Railroads. Slightly over 43 million tons, or about 86%, were destined for export, over 4 million tons had marine termination, and over 2 million tons had other domestic termination. Table 3.4 summarizes the tidewater traffic by carrier, port, and marine destination for the year 1974.

Some N&W coal flows to Atlantic ports, and transshipment operations are described in subsequent sections.

Railroad & Port	Destinations: New England	Foreign(1)	Other	Inside Capes	Total
Penn Central					
Philadelphia	-	339,833	-	75,690	415,523
Baltimore	-	403,791	-	622,236	1,026,027
TOTAL	-	743,624	-	697,926	1,441,550
Baltimore & Ohio					
Baltimore	-	5,534,135	-	1,487,736	7,021,871
Reading Company					
New York	24,832	-	712,207	-	737,039
Philadelphia	-	955,494	-	19,532	975,026
TOTAL	-	955,494	712,207	19,532	1,712,065
Western Maryland					
Baltimore	-	1.786	-	-	1,786
Chesapeake & Ohio					
Hampton Roads	257,767	10,246,842	2,815,274	5,972	13,324,855
Norfolk & Western					
Hampton Roads	220,175	24,713,358	1,107,264	-	27,040,797
GRAND TOTAL	502,774	43,195,239	4,634,745	2,210,166	50,542,924

Notes: 1. Includes shipments to U. S. military forces; excludes shipment to Canada.
2. Excludes bunker fuel.

Source: Coal, Coke, and Iron Ore Committee, Coal Traffic Annual, 1975

Table 3.4 Bituminous Coal Dumpings at Atlantic Ports, 1974 (2)

4.0 EQUIPMENT IN COAL SERVICE

Practically all river coal is moved in hopper barges. Hopper barges are also most versatile, least costly, and most numerous in the U. S. barge fleet.

The hopper barge is basically a simple double skinned, open-top box, the inner shell forming a large hopper or cargo hold. The bottom, sides, and ends of the hold are free of appendages and adapt ideally to unloading with clam shell buckets, hooks, grabs, continuous belt buckets, or other devices.

Principally, there are two types of hopper barges--open hopper barges and covered hopper barges. Covered hopper barges differ from the open hopper barges in that they are equipped with water-tight covers over the entire cargo hold.

Coal is moved principally in open hopper barges; however, covered hopper barges with their covers off are also employed in coal service. The two most commonly used sizes of hopper barges in coal service are listed below.

Length Feet	Breadth Feet	Draft Feet	Capacity Tons
175	26	9	1000
195	35	9	1500

Present open and covered hopper barges and their size distributions are presented in Tables 4.1 and 4.2.

A major barge manufacturing company conducted a study in 1975 covering a large majority of the equipment on the river in the way of dry cargo barges. The study indicated what replacement and growth could not only be expected, but is probable, particularly if coal requirements follow the pattern expected by most in the energy field. Results of this study are presented in Table 4.3.

Representative Barge Size	Other Included Barge Sizes	Barge Units	Draft Empty	Draft Loaded	Nominal Tons/Barge	Number of Barges	Total Tons
352 x 76		3.92	4.0	18.0	5500	1	5,500
250 x 80	240 x 72, 275 x 80	2.93	5.0	12.0	4625	8	37,000
265 x 53	250 x 50, 250 x 53	2.06	1.6	9.0	3000	11	33,000
280 x 50	295 x 50	2.05	1.4	8.0	2730	42	114,660
180 x 70	180 x 60	1.85	3.0	10.5	3000	10	30,000
200 x 50	192 x 50, 180 x 53	1.47	1.0	10.5	2150	35	75,250
245 x 35	220 x 50, 220 x 45, 230 x 40, 250 x 35, 225 x 45, 240 x 45	1.26	1.5	11.0	2400	81	194,400
150 x 50	165 x 56	1.10	1.5	9.0	1620	6	9,720
175 x 42	180 x 40, 184 x 35, 175 x 36	1.08	3.5	7.5	2500	30	75,000
195 x 35	200 x 35, 200 x 40	1.00	1.5	9.0	1500	4520	6,780,000
210 x 26	200 x 26, 195 x 26	0.80	1.2	9.0	1100	42	46,200
155 x 35	150 x 32, 160 x 36, 158 x 26, 142 x 27	0.79	2.0	9.0	725	115	83,375
175 x 26	175 x 30	0.67	2.0	9.0	1000	2278	2,278,000
120 x 30	140 ft. and less	0.53	1.0	7.0	400	977	390,800
TOTAL						8156	10,152,905

Source: U. S. Army Corps of Engineers Waterborne Commerce Statistics Center, Transportation Lines on the Mississippi River System and the Gulf Intracoastal Waterway (Transportation Series 4)

Table 4.1 Barge Size Distribution, Open Hopper

Representative Barge Size	Other Included Barge Sizes	Barge Units	Draft Empty	Draft Loaded	Nominal Tons/Barge	Number of Barges	Total Tons
420 x 80		4.92	5.0	25.2	19200	5	96,000
350 x 69		3.54	4.6	19.3	10000	1	10,000
220 x 46	245 x 45	1.48	2.0	12.5	3200	6	19,200
180 x 42	170 x 44	1.11	1.5	8.5	1100	3	3,300
195 x 35	200 x 35	1.00	1.5	9.0	1500	3671	5,506,500
175 x 26		0.67	2.0	9.0	1000	133	133,000
140 x 25	140 ft. and less	0.51	1.7	7.5	585	40	23,400
TOTAL						3859	5,791,400

Source: U. S. Army Corps of Engineers Waterborne Commerce Statistics Center, Transportation Lines on the Mississippi River System and the Gulf Intracoastal Waterway (Transportation Series 4)

Table 4.2 Barge Size Distribution, Covered Hopper

Year	(1) Est. Size Industry H.B. Fleet	(2) No. of Barges 20 yrs. Old	(3) % O.H.	(3) % C.H.	No. of Barges Replacement	(4) Unit Replacement Cost	(5) Open Hopper ($000's)	Covered Hopper ($000's)	Total Replacement Cost ($000's)	Barges	New Construction 5% Compounded Annual Growth Rate % O.H.	% C.H.	($000's) O.H.	($000's) C.H.	($000's) Growth
1975	9,250	247	63	37	247	$ 190,000	$ 24,200	$ 17,400	$ 41,600	-	-	-	$ -	$ -	$ -
1976	9,712	265	51	49	265	199,000	22,100	27,000	49,100	462	60	40	45,300	37,000	82,300
1977	10,198	201	36	64	201	220,000	13,100	28,300	41,400	486	60	40	52,600	42,800	95,400
1978	10,708	508	36	64	508	242,000	36,300	78,700	115,000	510	60	40	60,800	49,400	110,200
1979	11,243	421	18	82	421	266,200	16,600	92,000	108,600	535	60	40	70,100	57,000	127,100
1980	11,805	223	41	59	223	292,820	22,000	38,500	60,500	562	60	40	81,000	65,900	146,900
1981	12,395	141	19	81	141	322,102	7,100	36,800	43,900	590	60	40	93,500	76,000	169,500
1982	13,015	307	48	52	307	354,312	43,000	56,600	99,600	620	60	40	108,000	88,000	196,000
1983	13,666	328	20	80	328	389,743	21,000	102,300	123,300	651	60	40	125,000	101,500	226,500
1984	14,350	459	20	80	459	428,717	32,300	157,500	189,800	684	60	40	144,300	117,300	261,600
1985	15,068	430	8	92	430	471,589	13,300	187,000	200,300	718	60	40	166,600	135,500	302,100
Total					3,530		251,000	822,100	1,073,100	5,818			947,200	770,400	1,717,600
							(389)	(388)							
Older than 20 yrs.		777	50	50		190,000	73,910	73,720	147,630						
							324,910	895,820	1,220,730						

Notes:
1. Estimated hopper barge fleet growth of 5% compound rate.
2. Assumes replacement in kind when reaching 20 year age, i. e. covered for covered, open for open.
3. No distinction made between Rake and Box type barge.
4. Hopper Barge Unit Cost--Increased cost calculated at a 10% compound rate.
   a. Open Hopper=82% of cost of covered barge.
   b. Hatchcover=18% of cost of covered barge.
5. All barge unit costs are sales prices.
6. O.H. = Open Hopper, C.H. = Closed Hopper

Table 4.3 Hopper Barge Construction Projection, 1975 - 1985

5.0 SURVEY FINDINGS

Seven out of twenty barge companies responded to our questionnaire. They are:

- American Commercial Barge Company
- Campbell Barge Line, Inc.
- Crounse Corporation
- Mid-America Transportation Company
- Ohio River Company
- Upper Mississippi Towing Company
- Twin City Barge Line, Inc.

Together, these companies carried over 60 million tons or approximately 50% of the total coal carried by inland waterway carriers in 1975.

5.1 Equipment Fleet

Participating barge companies were asked to estimate their equipment requirements to double the water coal traffic by the 1980's. Barges and tow boats required to transport the increased coal traffic were reported. Consolidated requirements for these categories are presented in Tables 5.1 and 5.2.

5.2 Equipment Maintenance Facilities

Participating barge companies also reported the additional barge and tow boat maintenance facilities required to accommodate an increased equipment fleet. Results of our survey are presented in Table 5.3.

Only three companies responded to this question with estimated dollars. Together, they carried 31 million tons of coal in 1975, some 52% of the total coal tonnage carried by the surveyed companies.

Several companies reported no additional facility requirements.

Barge Size and Type	Existing Fleet	Planned/ On Order	Additional Required	Total
175' x 25' std open	304 (1)	12	40	356
175' x 25' std covered	-	-	-	-
195' x 35' Jumbo open	1697	104	1806	3607
195' x 35' Jumbo covered	1297	75	30	1402
140' x 26'	8	-	-	8
210' x 26'	19	-	-	19
195' x 26'	-	56	-	56
Other	128	-	-	128
TOTAL	3453	247	1876	5576

Notes: 1. Includes some 175' x 26' barges
2. Includes totals for seven surveyed barge companies.

Table 5.1 Projected Barge Fleet for Doubling Coal Traffic: Selected Barge Companies

Tow Boat Size	Existing Fleet	Planned/ On Order	Additional Required	Total
Under 2000 hp	55	4	27	86
2000-2999 hp	2	0	1	3
3000-4999 hp	29	2	17	48
5000-7999 hp	26	1	36	63
Over 7000 hp	9	1	(1)	10
TOTAL	121	8	81	210

Notes: 1. Unknown.

2. Includes totals for seven surveyed barge companies.

Table 5.2 Projected Tow Boat Requirements for Doubling Coal Traffic: Selected Barge Companies

Maintenance Facility for	Estimated Cost (1975 $)
Tow Boats	$ 2,150,000
Barges	2,100,000
Tow & Barges	12,000,000
TOTAL	$ 16,250,000

Table 5.3 Estimated Maintenance Facility Costs: Selected Barge Companies

Some of these companies indicated that their equipment fleets are maintained by shipyard facilities owned and operated by outside organizations and they have no way of estimating the amount or cost of these facilities.

3 Dock Facilities

Participating companies also reported estimated dock facility costs to double the coal traffic. Only three companies reported costs in this category. Together, these companies transported approximately 15.8 million tons of coal in 1975. The survey results are presented in Table 5.4. Several companies reported that more facilities will be needed or present facilities will have to be expanded in order to handle more coal traffic. However, they did not report any costs associated with the work.

4 Technological and Operational Changes

Respondents found it difficult to predict technological and operational changes that would make coal movements more efficient. Interviews and surveys revealed that barge operators do not have major research and development programs to revolumnize or change substantially the present barge operations. Also, the physical constraints of the waterway system, such as channel depth, width, and lock size limit the technological developments. The following paragraphs summarize comments during our interviews and survey.

Additional Dock Facilities	Estimated Costs
3	$ 6,000,000
1	200,000
1 (1)	50,000
TOTAL	$ 6,250,000

Notes: 1. Present dock facilities will be expanded.

Table 5.4 Estimated Dock Facilities: Selected Barge Companies

Barge Lashing

Barge lashing is an area that requires improvement. Tows have been getting bigger, sometimes consisting of about forty jumbo barges, but essentially the lashing and hook-up facilities have not changed. Development of a flexible lashing can reduce the operational costs in barge movements.

Equipment

Refinements, but no major changes will characterize equipment technology for the barge industry. The most common barge size is a length of 195 feet and breadth of 35 feet with an average 9 foot draft. The barge carries about 1550 tons of coal. The size is not expected to increase substantially; however, draft may go up to 10 feet, thus increasing the barge coal carrying capacity.

Scheduling and Utilization

Presently, computer systems are not commonly employed to schedule barges. But as the number of barges in the fleet continues to climb,and barge prices rapidly rise, there will be pressure to use more sophisticated scheduling and controlling techniques involving use of computers.

No major impact on barge utilization is expected from the improvement in average speed of the barge movements. Table 5.5 summarizes responses to present and anticipated barge movements by river.

Communication

Communications from ship to ship and ship to shore will continue to improve.

River	Average Present	Speed Anticipated
Ohio		
Upstream	5	5.5
Downstream	8	8
Tennessee		
Upstream	6	6
Downstream	9	9
Green		
Upstream	7	7
Downstream	6	6
Upper Mississippi		
Upstream	5	6
Downstream	7	8
Lower Mississippi		
Upstream	5.5	5.5
Downstream	11	11

Table 5.5 Average Barge Speeds

6.0 MOVEMENT DESCRIPTIONS

6.1 Overview

Coal water movements are limited to existing rivers and canals. Whenever coal consumers and producers are located near a waterway, barge operations can handle the total move from origin to destination and do not get involved with other modes of transportation. However, there are several intermodal--water to rail or rail to water--moves that bring coal from producers to consumers. With the increased distance at which coal is becoming competitive with other forms of energy, greater cooperation and interaction is expected among various modes, especially rail and water.

For example, American Commercial Barge Co. has announced an agreement with Burlington Northern, Inc. to build a rail-barge facility near St. Louis, Missouri. Most of the engineering design work is completed. This facility will enable these companies to bring low-sulfur Western coal to electric generating facilities located on the waterways.

The following sections present descriptions of some coal river and inter-modal movements.

6.2 River Coal Movement

The coal from western Kentucky mines is moved on the Ohio and Cumberland Rivers to a TVA plant in Cumberland City, Tennessee. Two mines in Morganfield, Kentucky supply the coal for this movement. One mine is located about nine miles from the Ohio River while the other mine is approximately 13 miles from the Ohio River. A single flight, cable belt conveyor system brings the coal from the mines to Union Town, Kentucky which is on the Ohio River. The conveyor system feeds to an open stockpile near the riverside and can also be used to load the barges directly.

A fleet of sixty barges and three tow boats is employed for this coal movement. Three sizes of barges, as listed below, are used in the fleet.

Size	Net Capacity
195' x 35'	1,400 tons
200' x 35'	1,600 tons
245' x 35'	1,800 tons

The coal is loaded into the barges from the stockpile or the conveyor system. It takes about eight to ten hours to load all 15 barges which are used to form a tow (Figure 6.1). After the last barge is loaded, it takes between one and two hours to form a tow. The total length and width of the tow are 1,040' and 105' respectively.

A specially designed 5,600-hp tow boat pushes the tow along the Ohio River. The tow must pass through the following locks:

Mile Post	Name	Size	Location
846.0	Union Town Lock	1200' x 110'	Union Town, Ky.
876.8	Lock 50	600' x 110'	Marion, Ky.
903.1	Lock 51	600' x 110'	Golconda, Ill.

The tow moves at an average speed of six miles per hour. Locks 50 and 51 are not used when the river is high. If the river is low, however, these locks must be used and the tow is broken in order to maneuver the barges through the locks.

Movement of the tow from the Ohio River to the Cumberland River is tricky and requires special operational planning and skills.

Figures 6.2 and 6.3 show a schematic of the area where the

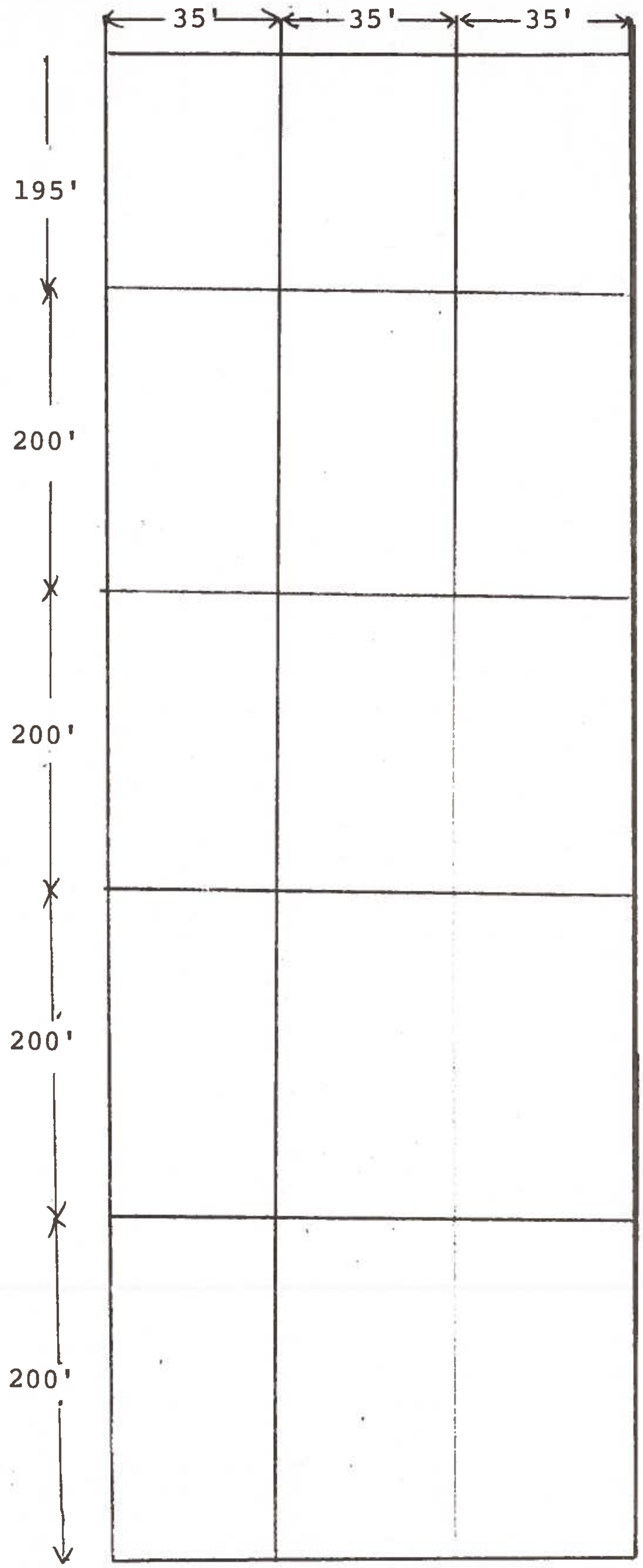


Figure 6.1 Tow Moving Coal on Ohio and Cumberland Rivers

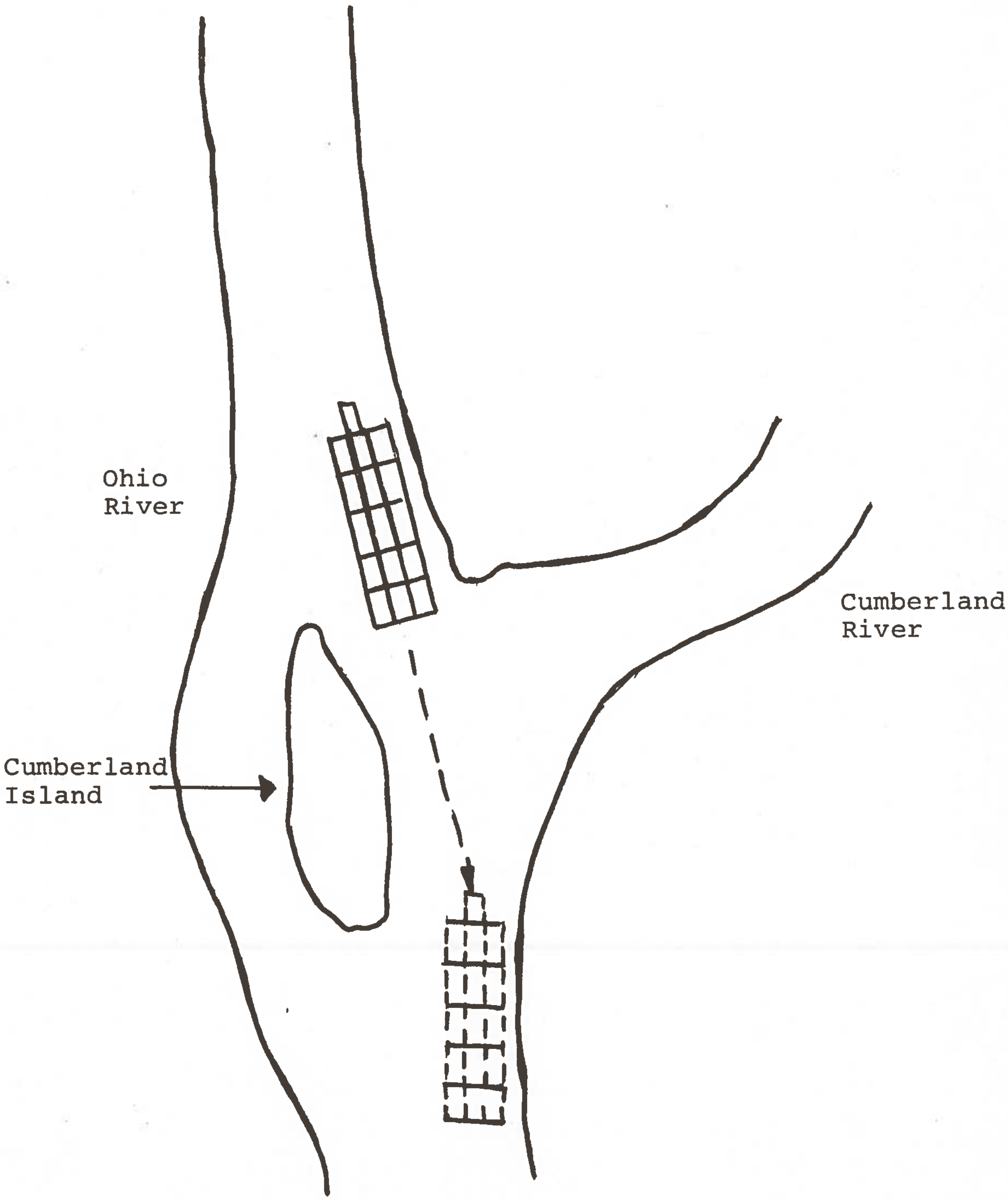


Figure 6.2 Tow Maneuvering at Ohio and Cumberland Rivers

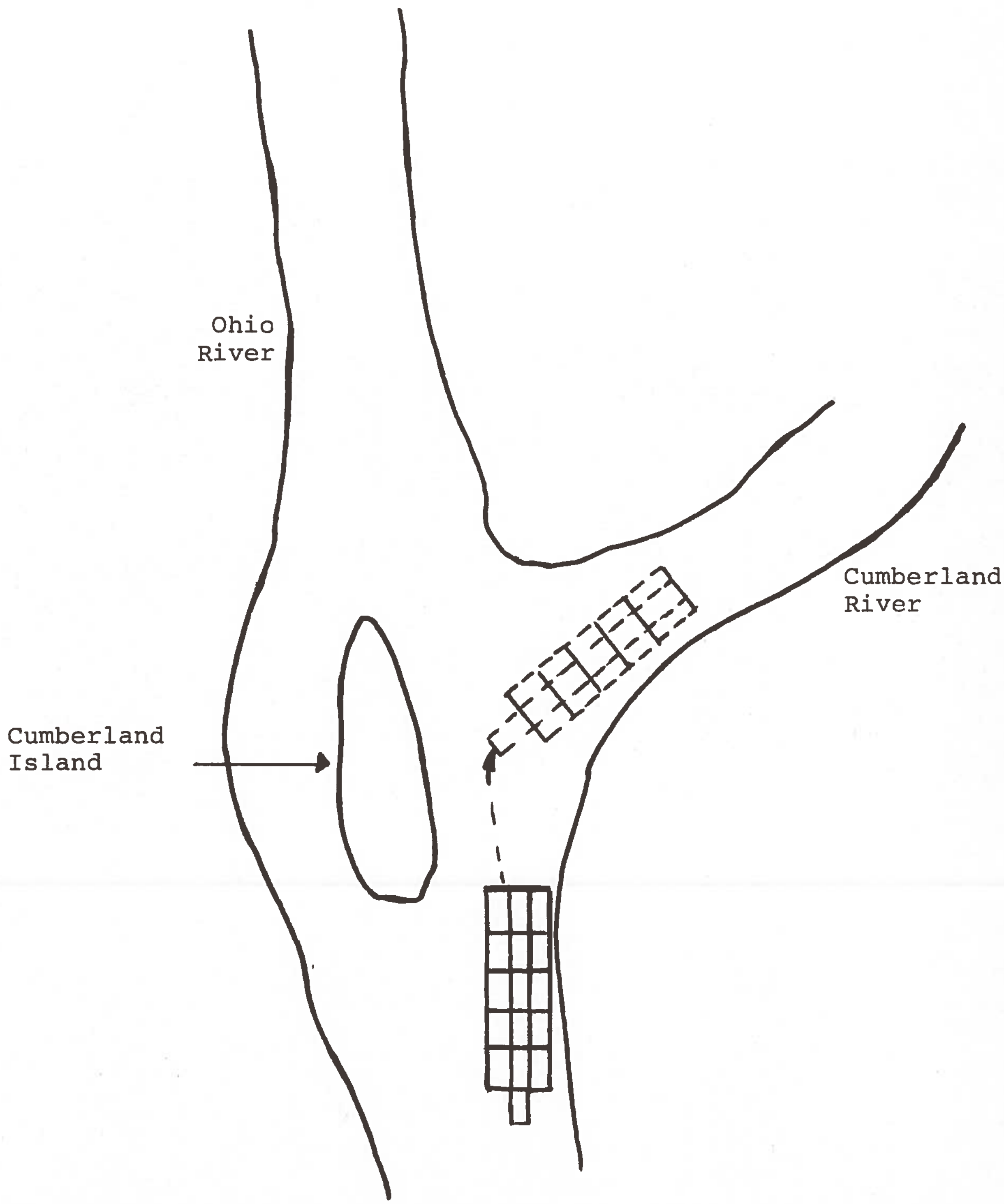


Figure 6.3 Tow Maneuvering at Ohio and Cumberland Rivers (2)

Ohio and Cumberland Rivers meet. Operationally it is not possible to turn the whole tow around for entrance into the Cumberland River. The tow is pushed along the side of the river. The tow boat is separated and taken around to the other end of the tow. Then the towboat pushes the tow from the other side. Moving along the Cumberland River, the tow passes through Barkley Lock. The lock size is 800' by 110' and hence the tow is broken at the third barge. Two tows are now pushed through the lock one by one.

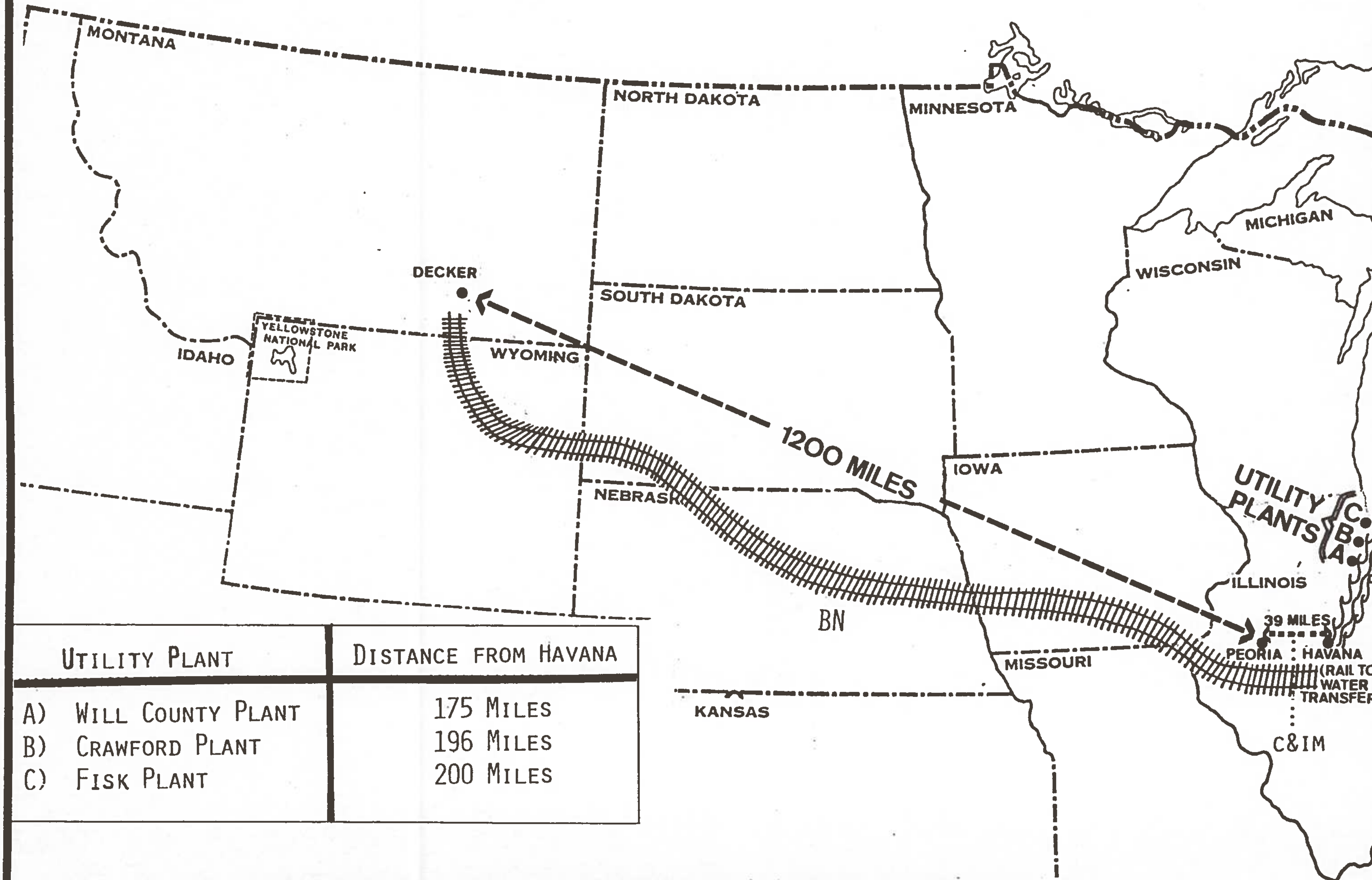
Before the tow enters into the Cumberland River, a bow thruster is put in front of the tow. It is a steering device and primarily helps the empty tow in windy situations and in sharp curves.

At the TVA plant in Cumberland City, Tennessee, the crew leaves the barges near dockside. The crew then picks up the empty barges and begins its return trip. The crew wait is minimal and involves only the time required to form a tow out of waiting empty barges. Thus maximum utilization of crew and towboats is made. The loaded barges left behind are unloaded by a wheel unloader. The wheel with continuous bucket goes into the barge, digs the coal, and unloads it into its center to be carried away by conveyor.

The total return trip, if the Ohio River is high, is approximately 62 hours. If, however, the river is low, the trip takes an additional 24 hours. Part of this additional time is the result of the breaking and reforming of the tow at Locks 50 and 51 on the Ohio River.

6.3 Rail-Barge Movement

A complex rail-barge movement involving the Burlington Northern and Chicago & Illinois Midland railroads and the Valley Line (barge) Company is bringing Decker, Montana coal to Commonwealth Edison Company's three electric power generating facilities in the Chicago area (see Figure 6.4).



UTILITY PLANT	DISTANCE FROM HAVANA
A) WILL COUNTY PLANT	175 MILES
B) CRAWFORD PLANT	196 MILES
C) FISK PLANT	200 MILES

FIGURE 6.4 RAIL-WATER COAL MOVEMENT: BURLINGTON NORTHERN, INC.

Annually, about five million tons of coal are brought to Havana, Illinois by rail, transferred to barges, and towed to three utility plants on the Illinois River.

The C&IM road crew brings the loaded unit train to Havana and spots it on a yard track. A switch crew breaks the train into two 50-car cuts and brings them to unloading facilities.

At the dockside, a single car rotary dumper unloads the cars. Cars are pulled up to the rotary dumper by a hydraulically operated mechanism called a "barney mule". Rotary dumper design does not permit unloading without uncoupling each individual car from the unit train. The train can be unloaded in approximately 24 hours.

Coal can either be dumped to open storage or conveyed directly to the barge on dockside. The open storage method is used to stack about fifteen trainloads, or 150,000 tons of coal.

Valley Line Company has deployed two hundred 1200-ton barges to move this coal from Havana to the three Edison plants. Barges can be loaded directly from the rotary dumper or from the stockpile. Loading from the stockpile involves a rotary wheel travelling along the pile. It reclaims the coal from the pile and dumps it on a conveyor. The conveyor carries the coal to a hopper feeding the barge. After the loading is completed, a tow is formed with fifteen barges. A tow boat pushed the barges to the three plants located on the Illinois River. Approximate distances to these plants from the Havana docks are given below:

Plant	Distance in Miles
Will County	175
Crawford	196
Fisk	200

The docks at each of the plants are owned by the utility company. Barges are unloaded by a crane travelling along the tracks along dockside. The crane is a gantry type, and is equipped with a clam shell bucket. The crane dumps coal into a hopper which either feeds the conveyor leading to the stockpile or the plant directly. River freezing during the winter does not permit smooth scheduling of barge movements. However, mild winters in the last two or three years have prevented any major problems.

Unlike eastern coal, western coal is not washed. Its moisture content is inherent rather than on the surface. Hence coal freezing in cars or barges is not a major problem.

6.4 Lake Coal Movement

The majority of coal transshipped at lower Great Lakes ports is brought to the Lakes by rail. The transshipping facilities (Section 2.3) are maintained by various railroads, sometimes through affiliations with terminal operating companies.

The Norfolk & Western Railroad terminated over 4 million tons of Lake coal in 1974. These N&W Lake coal flows are illustrated in Figure 6.5.

Lake coal from midwestern mines moves to Chicago by rail for transshipment to Upper Great Lakes destinations. Coal moving via Chicago docks normally moves by boat to destinations in Wisconsin, Michigan, and Minnesota as far north as the city of Duluth. Much of the coal traffic from midwestern mines moves under annual volume or trainload rates. One such move from western Kentucky to a Wisconsin power plant is described below.

Four of five large producing mines in western Kentucky supply coal to a Wisconsin power plant located on Lake

t Sandusky coal is transferred to vessels
or water movement to:

Steel Companies

River Rouge, Mi:higan

Ecorse, Michigan

Hamilton, Ontario

Hamilton, Ontario

Utilities

Montreal, Quebec

Marquette, Michigan

ote: Coal for Sandusky is also received at Norton
from the SOU and CRR at St. Paul.

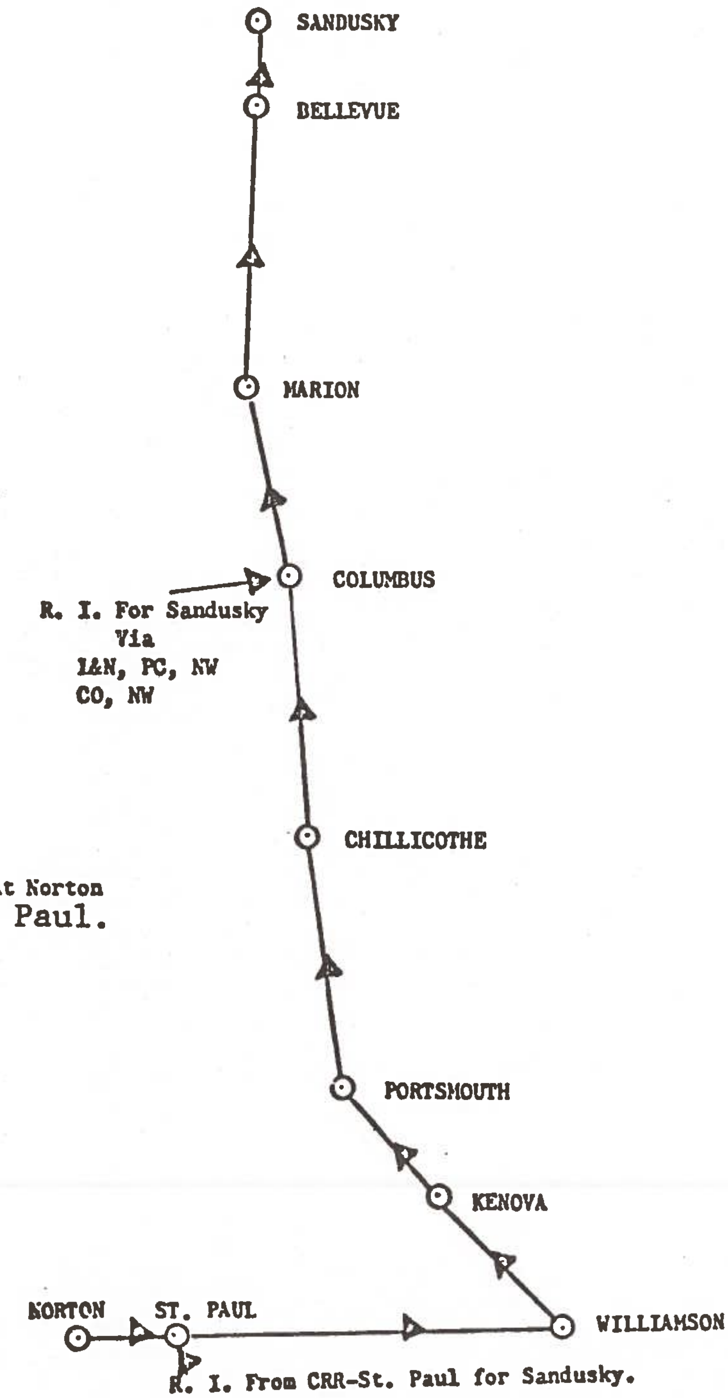


Figure 6.5 Lake Coal Flows

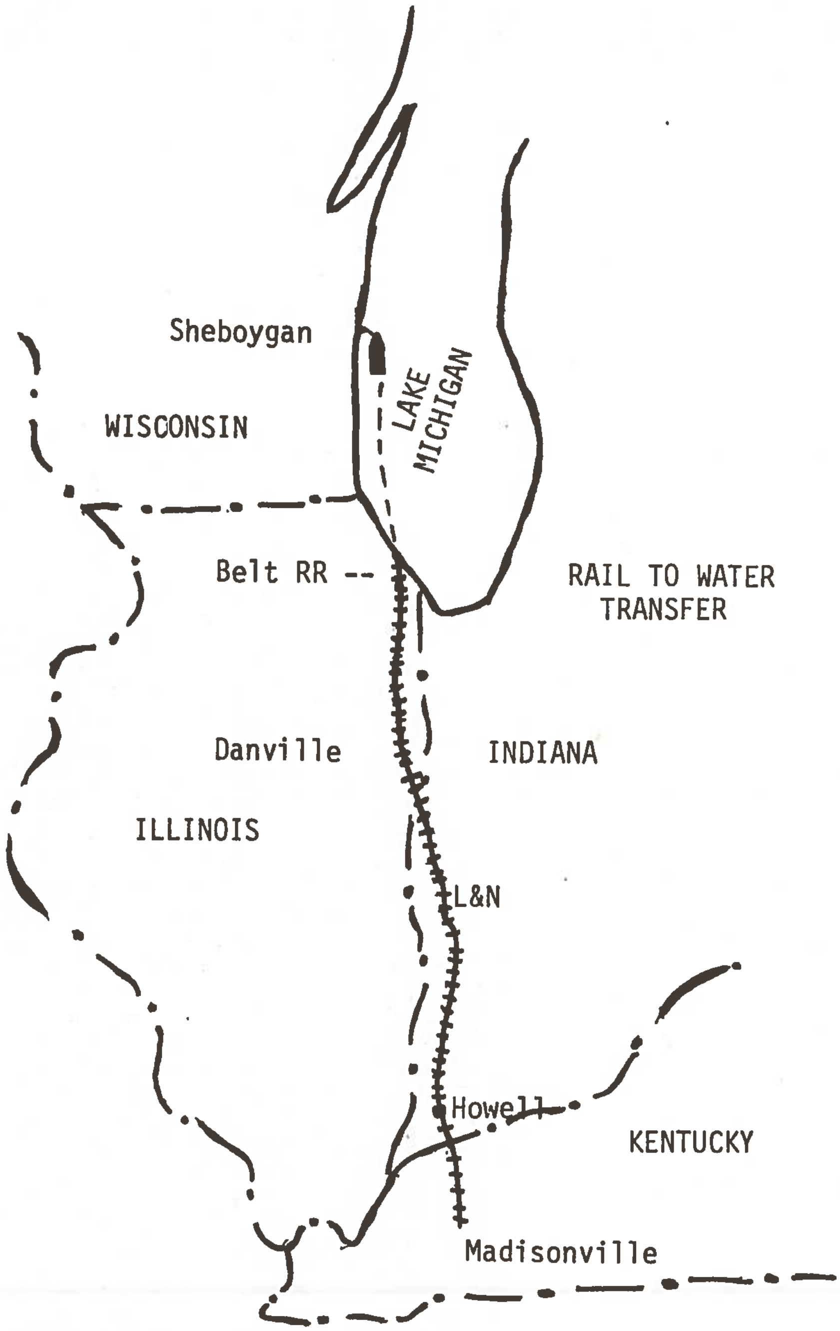
Michigan. Coal moves over rail via L&N and Belt (BRC) railroads to Chicago and then over water by boat to Sheboygan, Wisconsin. This movement is illustrated by Figure 6.6. The movement is very complex and requires close coordination among several organizations. The organizations include the utility plant, rail-water transfer facility operators, and origin and destination railroads and mines. The coordination of the various elements--boat schedules, car unloading, train movements, car loading, coal production, etc.--is accomplished by a permit system. A permit, based on vessel arrivals, is issued to an originating carrier (L&N) and mines for car loading and movement. The permit is issued by the Rail-to-Water Transfer Corporation, the transloading facility operators. The permit system helps prevent accumulation of unmanageable numbers of cars on destination railroad and facilities and insures better equipment utilization.

Coal is recovered from deep and strip mines and is brought to the tipple near a railhead by trucks. Trucks are large, heavy duty, with 50-ton capacity and travel distances of 2 to 3 miles over private roads.

Cars in this service are unassigned and drawn from a 50-to-80-ton hopper car pool in the area. Based on permits and mine track holding capacity, cars are dropped at mines by mine crews. Mines are allowed 24 hours to load these cars.

L&N mine crews pick up the loaded cars and marshall them at Atkinson Yard, near Madisonville, Kentucky. Depending on the number of cars and coal volumes, L&N consists one or two trains for Chicago. The train size varies depending on coal volume and car sizes. Each train usually carries between 7,000 and 10,000 tons of coal.

A road crew with four six-axle locomotives operates the train from Atkinson Yard to Howell, Indiana. Another crew moves the train to Danville, Illinois where a crew change



Location	Distance from Madisonville, KY	Remarks
Howell	65 miles	crew change
Danville	230 miles	crew change
Chicago	347 miles	rail-water transfer
Chicago (87th St.)	350 miles	interchange with BRC
Sheboygan	493 miles	water movement

Figure 6.6 Lake Cargo Coal Movement

is made. The last crew then delivers the train to BRC. A BRC crew and motive power then move the train to transloading facilities located on the Calumet River near Chicago.

The transloading facility is operated by the Rail-to-Water Transfer Corporation. The facility, due to space limitations, has no ground storage area for its coal. Coal is transported directly from rail cars to vessel or barges. Coal is bottom dumped from cars into a hopper. The hopper feeds the coal to a conveyor leading into a vessel. The facility owns a locomotive to switch cars as required. The facility can store up to 220 railroad cars on its tracks. Vessel sizes calling on the facility vary from 10,000 to 30,000 tons. A new vessel about to be commissioned into this service will have a capacity of 40,000 tons. The facility also loads jumbo barges with 1500-ton capacity. Pertinent information on the facility is provided in Table 6.1.

On the average, it takes two days for rail cars to unload. Total turnaround time between mines and transloading facility is about six days. Empty cars follow the same route in reverse and can be diverted to other movements depending on the need at the time. Inspection is performed at Atkinson Yard.

Frozen water during the winter season inhibits the vessel operations and hence facilities and rail movements are usually stopped between December 15 and March 15. This period varies from year to year, depending upon the weather conditions. The utility plant builds up a large stock of coal during the summer months. In case of emergencies in the winter, coal is shipped all the way to the plant via alternate rail routes.

The vessel takes about twelve hours to go from Chicago to Sheboygan, Wisconsin. Vessels used in this service are

Location: Mile 1.8 on the Calumet River--Chicago, Illinois

Served By: The Belt Railway Co. of Chicago

Storage: Yards for holding 2,200 railroad cars

Berths: North Berth 735 Feet--South Berth 726 Feet

Draft: Water depth at dock--27 Feet LWD.

Loading Mechanisms: Two moveable loading towers with telescopic chutes

Product Handling Equipment: 72 inch conveyor belts

Loading Capacity: 3,000 TPH each dock

Special Equipment: High speed trimming machine for stowing meals and foods

Rail Equipment: Bottom dump, open top or covered, hopper cars--no size limitation

Services Available: Trimming--Separations--Documentation

Operating Season: March 15 through December 15

Ground Storage: none

Number of boats that can be loaded at a time: 2

Boat sizes: 27,000 to 60,000 tons

Table 6.1 Pertinent Operational Parameters
Rail to Water Transfer Facility
Chicago, Ill.

self-unloading and have their own boom and cranes to unload the coal. Depending on the size, it takes about 6 to 8 hours to unload the vessel. Coal is sometimes shipped from Sheboygan via rail or water to other Wisconsin power plants.

6.5 Tidewater Movement

The shipments of coal to tidewater refers to the transportation of coal mined in the Appalachian Region and moved to Atlantic ports for further transshipment by water. Subsequent shipments may terminate locally, domestically, but outside the port locale, or at a foreign destination.

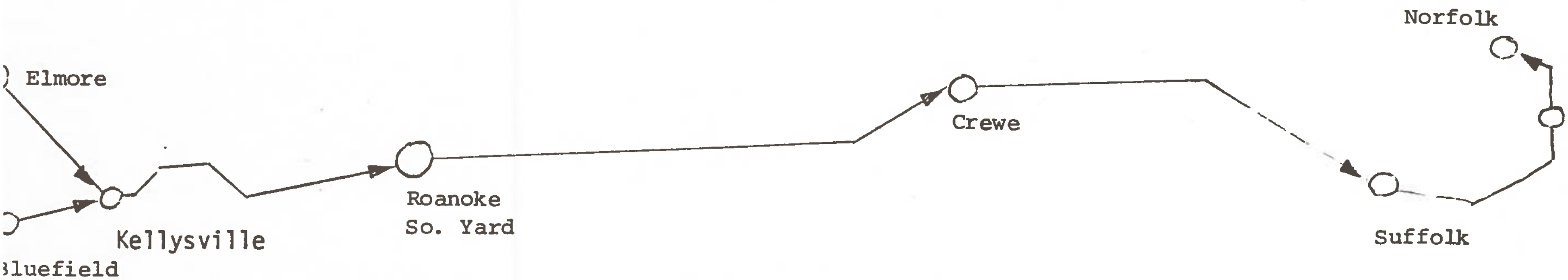
The Hampton Roads ports of the Norfolk and Western Railroad at Lambert's Point, Virginia handled over 27 million tons of coal in 1974. Some of the coal districts this coal originates from are listed below:

- Pocahantas
- Tug River
- Clinch Valley, No. 1
- Clinch Valley, No. 2
- Upper Powhatan
- Virginia
- Thakar
- Kenova

Tidewater coal flows over N&W are illustrated in Figure 6.7.

N&W Pier 6 is located at Lambert's Point Virginia, and is one of the world's largest and fastest coal mixing and loading facilities. The mild, ice-free climate and the deep, wide channels of Hampton Roads permits year round operations and easy, direct access to the Atlantic Ocean, which is some 20 miles distant.

This advanced, $25 million facility operates one to three



Line Segment	Trains	Cars/Trains	Total Cars	Remarks
Elmore To Kellysville	2	130	260	Includes some 20 misc cars
Bluefield To Kellysville	4	160	640	
Kellyville To Roanoke	6	130-160	900	
Roanoke To Crewe	5	170-180	875	
Crewe To Norfolk	4	220-225	890	Includes Received Interchange At Altavista and Secoast

Notes: 1. Five locomotives are used between the departure yards and Roanoke, with pushers assigned between Kellyville and Roanoke. Three locomotives are used on segments between Roanoke and Norfolk.

2. Empties are returned from Norfolk to Roanoke on five 180 car trains powered by three locomotives. From Roanoke 180 car trains powered by three locomotives are returned to Bluefield and Elmore for placement at mines.

Figure 6.7 Representative Daily Tidewater Volumes And Locomotive Assignments

shifts per day, 364 days per year. The pier has a loading speed of some 16,000 tons per hour and can load at a rate of 20,000 tons per hour for 30-minute periods. The entire system, including support for marshalling coal cars can readily support an annual through-put volume of some 36 million tons of export coal. this yearly tonnage translates to an average of some 1164 85-ton cars or 98,901 tons of coal being processed through the facility on a typical day. However, daily loading rates can vary substantially due to unusual conditions such as strikes, ship delays, and weather. Sufficient flexibility exists in both operating policies, practices, and equipment systems to meet resulting variations in operating requirements. For example, during periods of low car dumpings, second and third shifts may be suspended. During periods of peak demand, daily car dumpings have averaged 1500 cars over a three month period. Two records for handling vessels are summarized below:

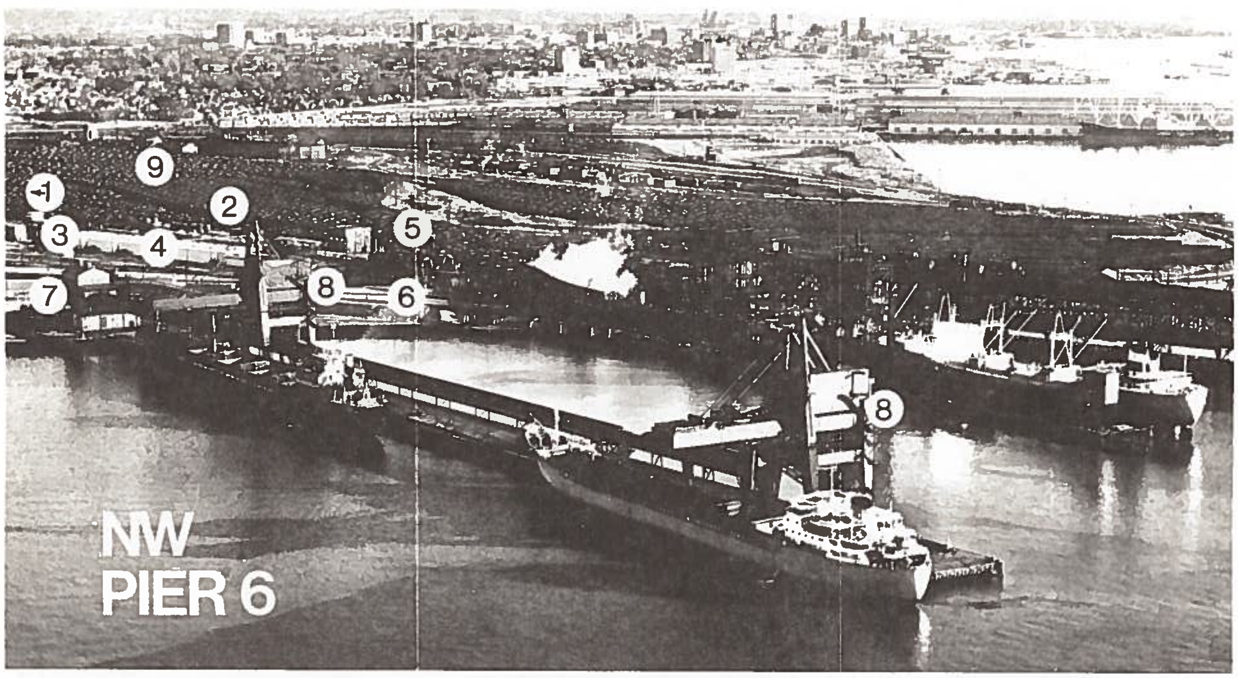
John A. Essberger: Sailed from Hampton Roads February 8, 1974, taking 1,457 cars, 119,087 net tons; registered 12:15 PM January 29, 1974; Docked at Pier Six 4:30 AM February 6; started loading 7:25 AM February 6; finished 6:55 AM, February 8; Total time, 47 hours and 30 minutes.

Tyne Bridge: Established a new record for tonnage taken by a single ship at Hampton Roads; 1,464 cars, 119,386 net tons; registered 11:20 PM, February 20, 1974; docked 10:30 PM, February 22; started loading, 10:50 PM, February 22; finished 6:50 PM, February 24; undocked 8:30 PM, February 24; total time 44 hours.

Other principal operating features include docking of four 45,000-ton colliers at the 1600-foot-long, 82-foot-wide pier, two giant, self-propelled loading towers, with 120-foot loading booms that traverse the pier, custom blending of four types of coal simultaneously, eight foot conveyor belts, and coal mixed three times between blending and

loading. Figures 6.8 and 6.9 show the location and describe the work and processes performed at the system stations.

Present pier capacity is sufficient to support estimated 1980 operating requirements. The continued increase in average capacity per car, which has moved from 75 tons in 1965 to 85 in 1975, will continue to simplify and improve the efficiency of pier-side car movement operations. As the average capacity approaches 100 tons, the annual throughput capacity of the facility will increase by some 20% without need of significant capital expenditures.



1. Barney Yard. This switching yard is where loaded coal cars are assembled before dumping. NW sorts cars containing various classes of coal as the first step in blending exactly the right coal mixture for each customer.

2. Scale Retarders. These retarders slow each car rolling toward the weighing station so it will pass over the scales at not more than 5 mph. Car speed is determined by radar, which relays data to the retarder which then slows the car to the proper speed.

3. Scale Office. Two Fairbanks-Morse mechanical scales, each with a capacity of 400 tons, weighs each car and records its weight automatically.

The scales are accurate within 0.2 per cent, or within 400 pounds, on a 100-ton coal load.

4. Thawing Shed. The car leaves the weighing station and rolls down to the thawing sheds. In the winter, frozen coal is thawed here so it can be dumped easily.

Electrically-powered infra-red heating elements, operating at 1550° F, are grouped on each side and beneath the cars. Cars pass through the sheds in six to nine minutes.

5. Tandem Rotary Dumpers. Together these high-speed dumpers can empty 252 cars per hour. The dumper mechanism pushes each car into position with an automatic chain drive, locks it in position, rotates it 165°, then turns it upright and releases it. The dumped coal falls into blending bins.

6. Custom Blending Station. This is where coal from various mines is precision blended electronically to customer specifications.

Blending ratios of up to 7-to-1 can be preset at each of three blending points. Coal falls from two bins at rates that are automatically varied. The coal falls onto the moving shuttle conveyors. A third control further varies blend proportions by presetting the relative speed at which the two shuttle conveyors deposit coal on the main transfer conveyor belt.

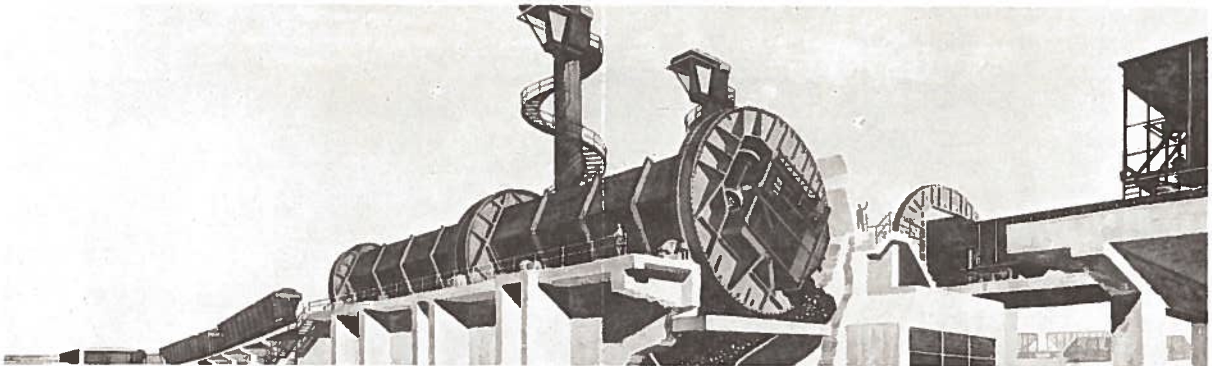
7. Transfer House. Here coal is transferred to the pier conveyor belts. As the coal falls onto the pier conveyor belts it is mixed, increasing the homogeneity of the blend. More mixing is also accomplished at three other transfer points.

8. Loading Towers. Each of these massive towers weighs 2,800 tons and stands 192 feet above the water. They travel the length of the pier on 90 wheels. The towers can load two ships at once or both can concentrate on a single ship. Retractable booms reach down 120 feet and telescopic chutes with mechanical trimmers distribute the coal rapidly and evenly into the ship's hold.

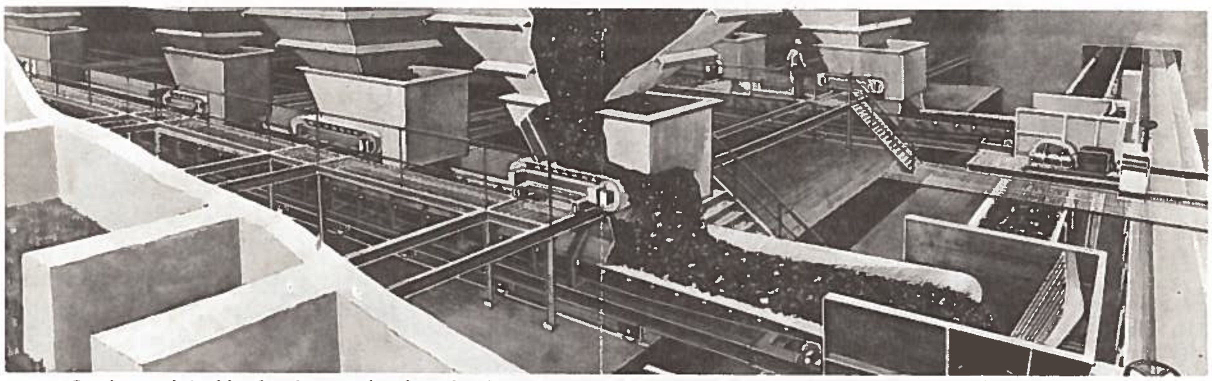
9. Empty Yard. Empty cars leaving the dumpers move to the kickback, reverse direction and continue to the empty yard. From the retarder tower, cars are classified for return to the railroad that owns them. Cars needing repairs are switched to the modern repair shop.

The empty yard has 38 tracks with a total capacity of 2,330 cars.

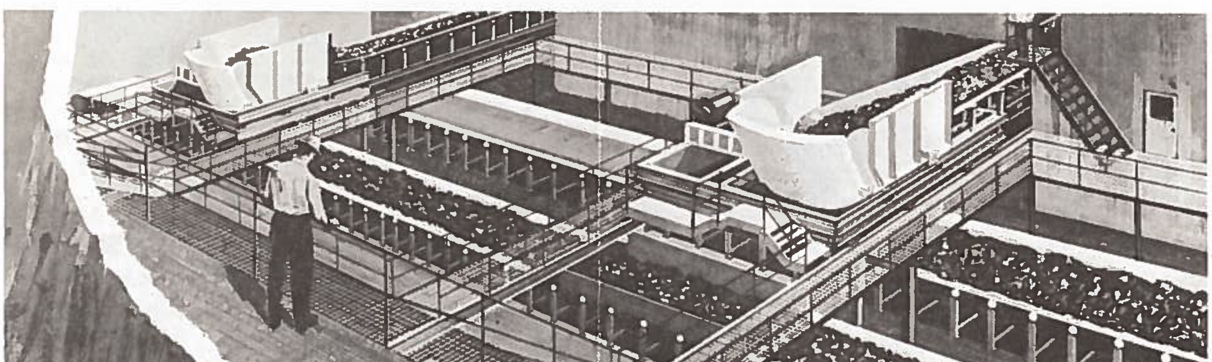
Figure 6.8 Work and Processes Performed at System Stations.



Rotary dumpers at Custom Blending Station empty four coal cars into transfer bins.



Coal, regulated by feeder mechanism, is placed on variable-speed shuttle conveyors.



Blended coal is mixed at the transfer house when it is transferred to pier conveyors.

Coal is mixed for a third time at the loading towers, and is deposited aboard ship.

Figure 6.9 Work and Processes Performed at System Stations.