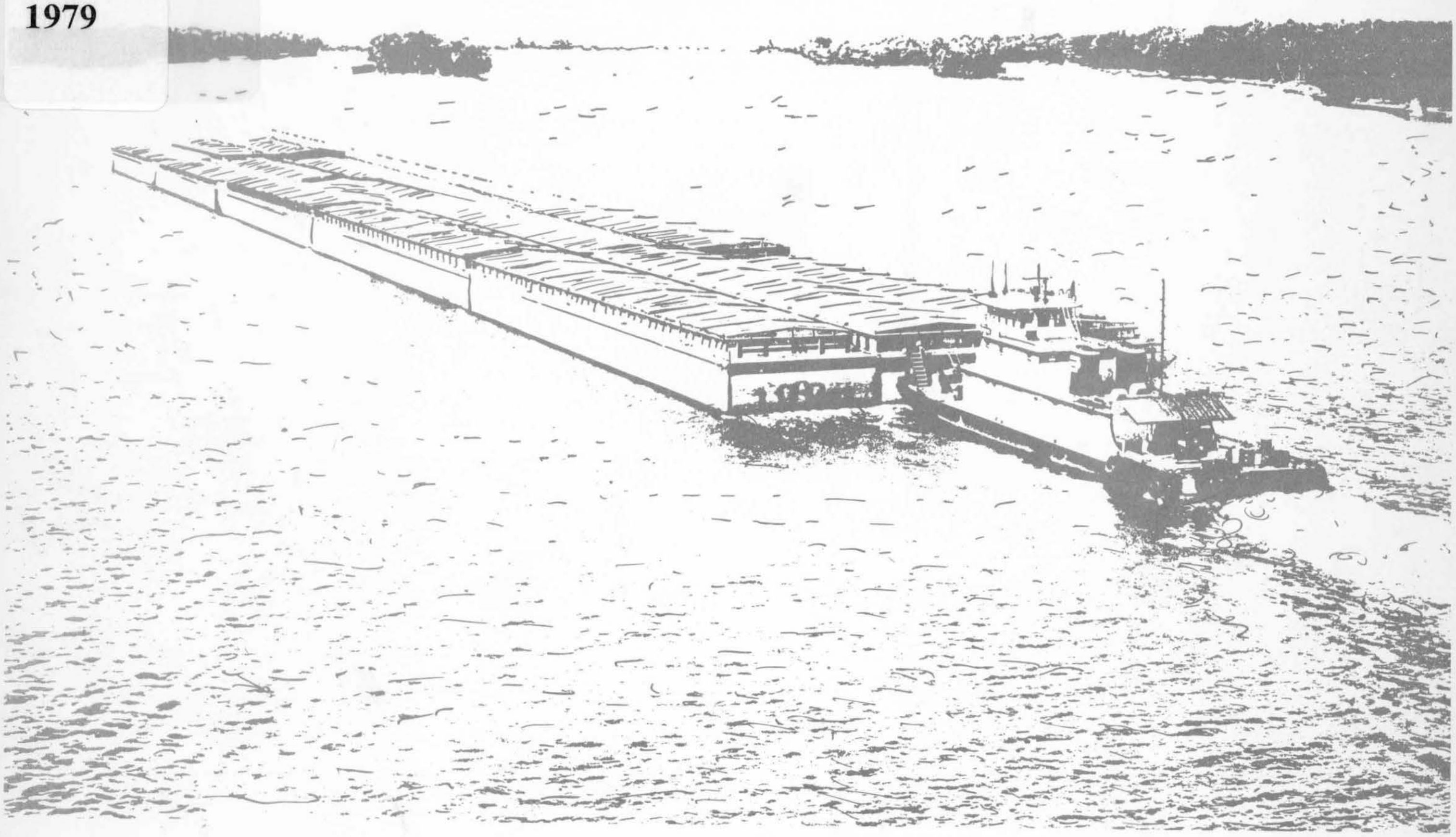


River Transportation in Iowa

DEPARTMENT OF TRANSPORTATION IOWA

May, 1978

COMPARE

CARGO CAPACITY

BARGE
1500 TON
52,500 BUSHELS
453,600 GALLONS

15 BARGE TOW
22,500 TON
787,500 BUSHELS
6,804,000 GALLONS

JUMBO HOPPER CAR
100 TON
3,500 BUSHELS
30,240 GALLONS

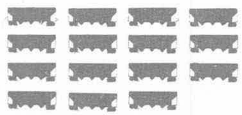
100 CAR UNIT TRAIN (GRAIN)
10,000 TON
350,000 BUSHELS
3,024,000 GALLONS

LARGE SEMI
25 TON
875 BUSHELS
7,560 GALLONS

EQUIVALENT UNITS

1 BARGE

=

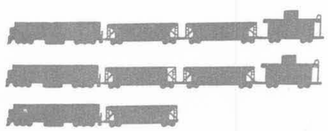


15 JUMBO HOPPERS

=

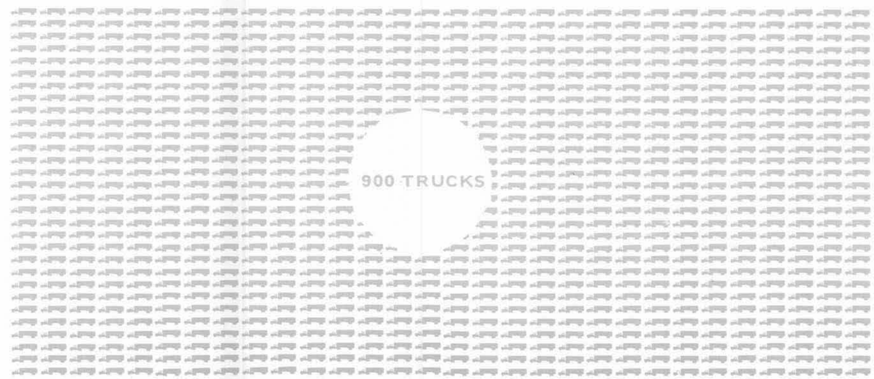
1 TOW

=



2¼ UNIT TRAINS

=



EQUIVALENT LENGTHS

¼ MILE

15 BARGE TOW

2¾ MILES

2¼ UNIT TRAINS

36 MILES
ASSUMING 150 FT.
BETWEEN TRUCKS

Prepared by:
Planning and Research Division
Iowa Department of Transportation

RIVER TRANSPORTATION IN IOWA

Prepared by:
Office of Advance Planning
Planning and Research Division
Iowa Department of Transportation
Ames, Iowa 50010
515-296-1669

May, 1978

Revised January 1979

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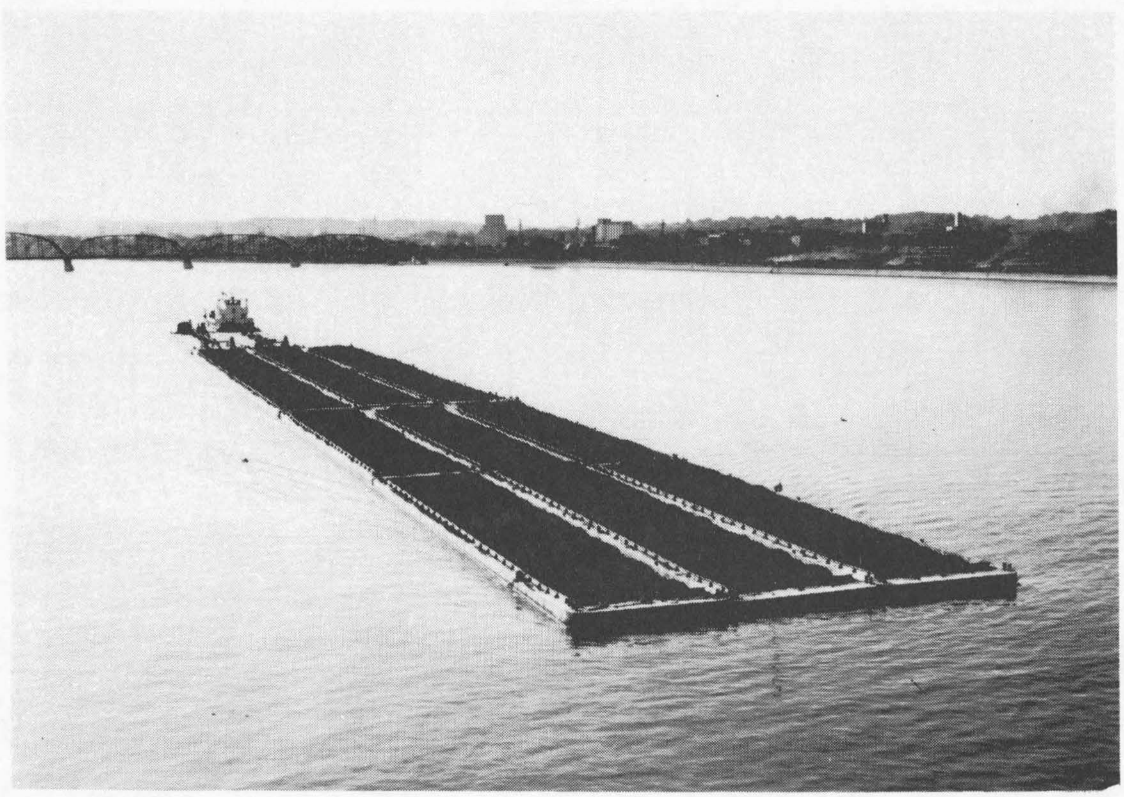
ABSTRACT

The inland waterway system, consisting of 25,000 miles of natural and artificial waterways, transports about 16% of the nations commerce. The navigational development of the Upper Mississippi and Missouri Rivers was important for Iowa and the Midwest. Navigation channels provide Iowans with a low-cost transportation system for moving bulk commodities in addition to providing areas for outdoor recreation and fish and wildlife habitat. Future commercial development and waterway improvements must take into account opportunities to enhance the fish and wildlife resources of the river system.

This report identifies current issues in commercial navigation which affect Iowa and the Midwest. Bottlenecks in the river system, such as imposed by Locks and Dam 26, are discussed in detail. Solving conflicts between developmental and environmental values are also discussed, e.g., dredging methods and dredge material disposal practices. Current Mississippi River planning considerations such as extension of the navigation season and conflicts between commercial and recreation river users are also explained.

One major concern to Missouri River navigation interests is future water supply to support the navigation season. A major factor which may limit using the Missouri River for navigation is the continued growth of upstream consumptive use of water for irrigation, domestic, municipal, mining, and industrial purposes.



13,500 Ton of Coal - Mississippi River

THE INLAND WATERWAY SYSTEM

HISTORY

The United States has the most extensive waterway system in the world. For a long time our rivers were avenues for economic development and expansion, but railroad and highway transportation soon overshadowed their role.

Due to federal interest, water transportation was revived during the early 1900's. There was a need to develop a mode of transportation that would be competetive with existing rail rates. The 1902 Rivers and Harbors Act established the "Board of Engineers for Rivers and Harbors". Responsibility was, and still is, to investigate the engineering and economic feasibility of Corps of Engineers proposed waterway projects. The Inland Waterways Commission was formed in 1907 to prepare a National plan for improving inland waterways. Its successor, the National Waterways Commission, was created in 1909 to recommend legislation for water transportation development (Ref. 10).

TODAY'S WATERWAY SYSTEM

The inland waterway system, which consists of natural and artificial waterways, is 25,543 miles long (Figure 1). Iowa is bordered on two sides by navigable waterways.

The Mississippi River and its major tributaries--the Illinois, Ohio, Missouri, Tennessee, and Arkansas Rivers--forms the heart of our waterway system. The Gulf Intracoastal Waterway stretches west approximately 1,800 miles from St. Marks, Florida to Brownsville, Texas and is linked to the Mississippi System.

The Atlantic Intracoastal Waterway extends from New York, New York to Miami, Florida for navigation. The St. Lawrence Seaway, opened in 1959, provides ocean going vessels inland access to the Great Lakes System. The New York State Barge Canal is part of the Great Lakes System connecting Lake Erie and Ontario with the Hudson River and the Atlantic Ocean. The Illinois Waterway connects the Great Lakes with the Mississippi River System.

By 1990 or earlier, new expansion and improvements to the system will include the Tennessee-Tombigbee Waterway, the Kaskaskia River waterway, and the Smithland Locks and Dam on the Ohio River.

FIGURE 1

WATERWAYS OF THE UNITED STATES

Note: This map excludes commercially navigable waterways in the States of Alaska, California, Oregon and Washington.

UPPER MISSISSIPPI RIVER

CHANNEL HISTORY

Before river improvement and development began the Upper Mississippi River, (from St. Paul, Minnesota to the mouth of the Ohio River) was swift, shallow, and rock-obstructed. During stages of low flow, depths of 3 feet were common. The river was navigable to St. Paul only at high stages.

In 1824 Congress authorized the Corps of Engineers to remove snags, sandbars, and wrecks from the Mississippi. In the 1830's rocks were dynamited and excavated to clear a passage through several reaches of rapids. Meandering sloughs and backwaters were closed off to confine flows to the main channel.

The first comprehensive project for improving the Upper Mississippi began in 1878 when a depth of 4.5 feet was authorized between St. Paul, Minnesota and the mouth of the Missouri River. This project included bypassing several of the worst rapids by constructing short lateral canals with locks. In 1907, a 6-foot channel was authorized. The increased depth was achieved by construction of hundreds of "wing dams"* extending radially from the shore to varying distances into the river. The wing dams were designed to further constrict low-water flows (Ref. 21).

LOCKS AND DAMS

In 1930, Congress authorized construction of a 9-foot channel on the Upper Mississippi. Construction of the channel from the mouth of the Ohio River to Minneapolis, Minnesota was completed in 1940. The 9-foot project was achieved by construction of locks and dams, wingdams, levees, and dredging of shallow or silted areas. Principal features are a series of 29 locks and dams, spaced at 9.6- to 46.3-mile intervals. These provide the stairstep effect illustrated in Figure 2. The dams, equipped with gates, provide a series of lakes (slack water pools) which insure adequate depth for navigation during low flow. During extremely high flow the gates are opened to allow the entire flow to pass as if the dam were not there.

The navigational channel on the Upper Mississippi is maintained to minimum widths of 300 feet up to Lock and Dam No. 2, 200 feet to the St. Anthony Falls Lock and Dam, and 100 feet the rest of the way.

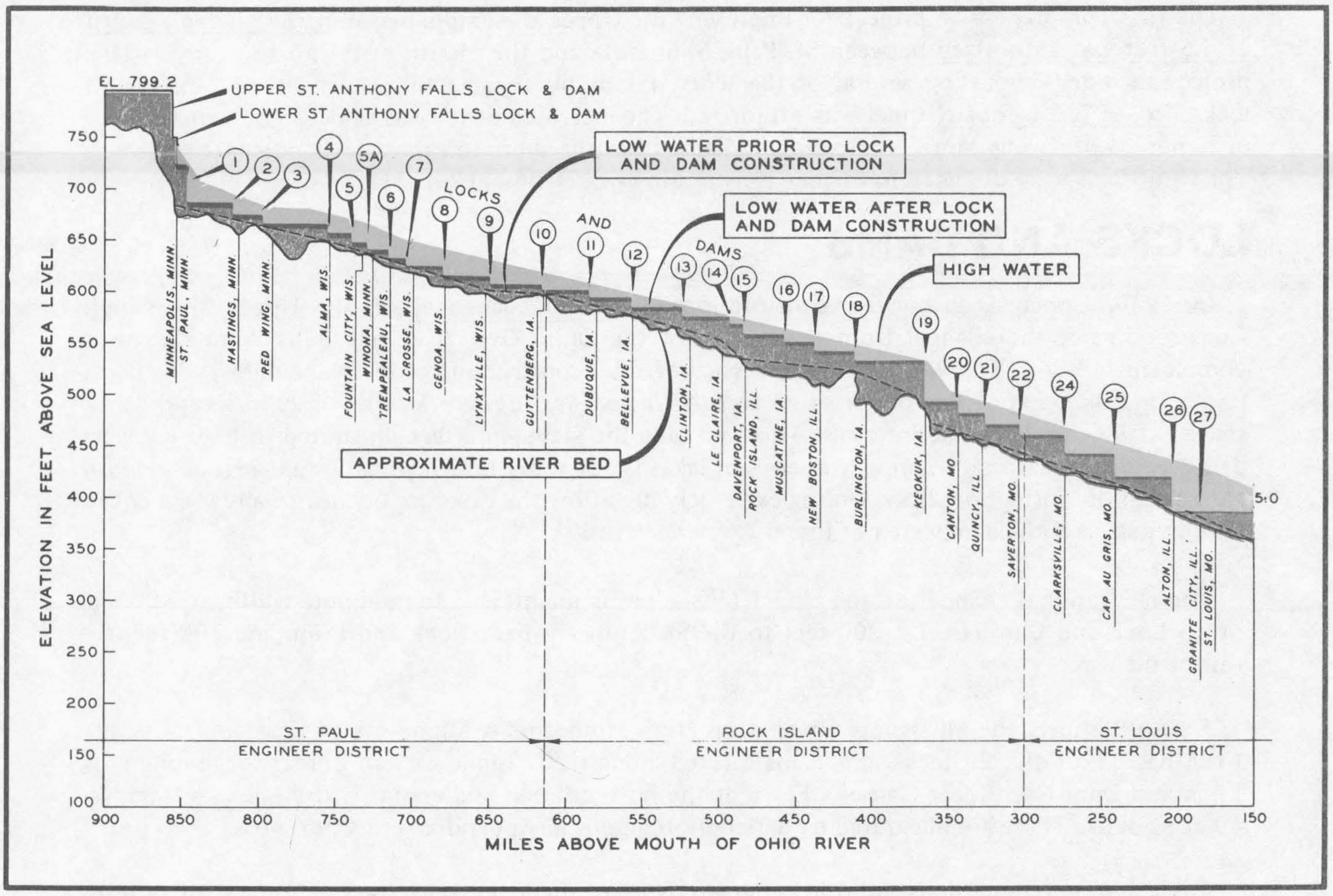
Figure 3 shows the Mississippi River dams from Minneapolis, Minnesota to St. Louis, Missouri. Iowa has 11 of the 29 locks and dams located along its 312-mile eastern border, beginning with Lock and Dam No. 9 near Harper's Ferry at the northern end and ending with Lock and Dam No. 19 at Keokuk. These are illustrated by aerial photographs in Appendix A of this report.

Table 1 shows dimensions and other characteristics of the locks. With the exceptions noted in the table, a majority of the locks are 110 feet wide by 600 feet long. The standard lock dimensions are based on permitting the passage of a tow made up of 175-foot by 26-foot barges, four abreast and three long, or of 195-foot by 35-foot barges, three abreast and three long.

*See Appendix for definition of terms

FIGURE 2

MISSISSIPPI - STAIRWAY OF WATER



Source: U.S. Army Corps of Engineers

FIGURE 3

UPPER MISSISSIPPI RIVER

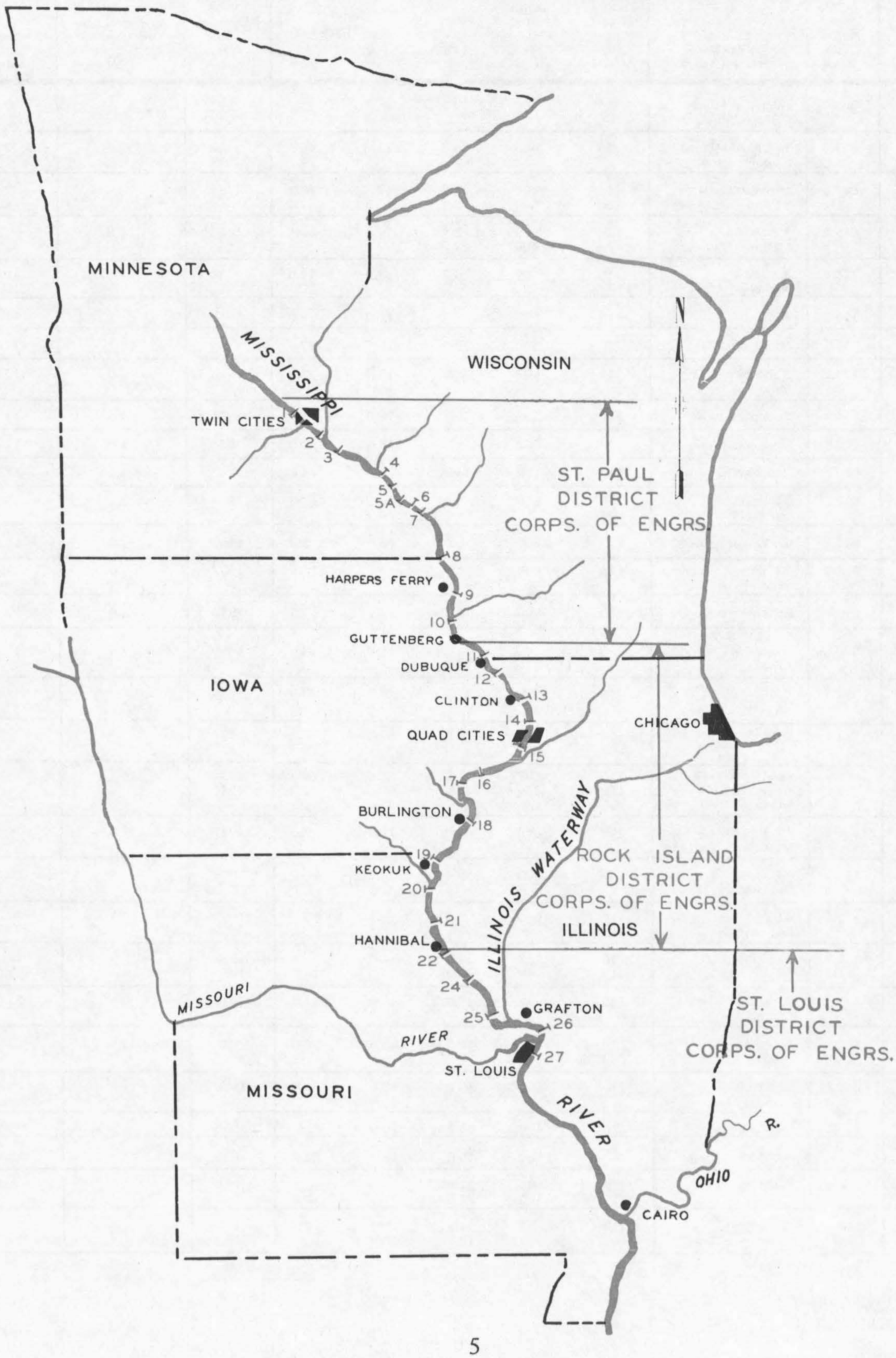


TABLE 1

LOCKS AND DAMS - UPPER MISSISSIPPI RIVER

Lock and Dam	Miles Above Ohio River	Miles from Nearest Town	Lock Dimensions: Width of Chamber (feet)	Length of Chamber (feet)	Lift (feet)	Depth On Miter Sill: Upper (feet)	Lower (feet)	Year Opened to Navigation	Estimated Cost (Millions) of Each Lock and Dam Including Work in Pool	1977 Tonnage (millions)
USAF	853.9	In city of Minneapolis, Minn.	56	400	49.2	15.7	13.7	1963	18.2	2.1
LSAF	853.3	In city of Minneapolis, Minn.	56	400	26.9	13.7	10.3	1963	12.4	2.8
No. 1	847.6	Minneapolis-St. Paul	56 56	400 400	35.9 35.9	13.5 12.5	10.1 7.6	1917	2.4	2.9
No. 2	815.2	1.3 above Hastings, Minn.	110 110	500 600	12.2 12.2	16.0 22.2	15.1 13.0	1930 1948	6.5	11.0
No. 3	796.9	6.1 above Red Wing, Minn.	110	600	8.0	17.0	14.0	1938	7.5	10.5
No. 4	752.8	Alma, Wis.	110	600	7.0	17.0	13.0	1935	4.9	11.0
No. 5	738.1	Minneiska, Minn.	110	600	9.0	18.0	12.0	1935	5.1	11.0
No. 5A	728.5	3 above Winona, Minn.	110	600	5.5	18.0	12.5	1936	7.0	11.0
No. 6	714.3	Trempealcau, Wis.	110	600	6.5	17.0	12.5	1936	4.9	11.6
No. 7	702.5	Dresbach, Minn.	110	600	8.0	18.0	12.0	1937	5.6	11.6
No. 8	679.2	Genoa, Wis.	110	600	11.0	22.0	14.0	1937	6.1	11.9
No. 9	647.9	3.3 below Lynxville, Wis.	110	600	9.0	16.0	13.0	1938	6.5	13.0
No. 10	615.1	Guttenberg, Iowa	110	600	8.0	15.0	12.0	1937	4.8	13.7
No. 11	583.0	3.7 above Dubuque, Iowa	110	600	11.0	18.5	12.5	1937	7.4	14.7
No. 12	556.7	Bellevue, Iowa	110	600	9.0	17.0	13.0	1938	5.6	15.1
No. 13	522.5	4.3 above Clinton, Iowa	110	600	11.0	19.0	13.0	1939	7.5	15.2
No. 14	493.3	3.7 below Le Claire, Iowa	110	600	11.0	20.5	13.5	1939	6.3	17.4
Le Claire lock(Canal)	493.1	3.9 below Le Claire, Iowa	80	320	11.0	17.6	10.9	1922		
No. 15	482.9	Foot of Arsenal Island, Rock Island, Ill.	110 110	600 360	16.0 16.0	24.0 17.0	11.0 11.0	1934 1934	10.5	18.0
No. 16	457.2	1.8 above Muscatine, Iowa	110	600	9.0	17.0	12.0	1937	9.8	19.8
No. 17	437.1	4.2 above New Boston, Ill.	110	600	8.0	16.0	13.0	1939	5.8	20.2
No. 18	410.5	6.5 above Burlington, Iowa	110	600	9.8	16.5	13.7	1937	10.3	20.8
No. 19	364.2	Keokuk, Iowa	110 110	358 1,200	38.2 38.2	14.0 15.0	9.2 13.0	1913 1957	14.8	21.0
No. 20	343.2	0.9 above Canton, Mo.	110	600	10.0	15.0	12.0	1936	6.3	23.0
No. 21	324.9	2.1 below Qunicy, Ill.	110	600	10.5	16.5	12.0	1938	8.1	23.9
No. 22	301.2	1.5 below Saverton, Mo.	110	600	10.2	18.0	13.8	1938	5.3	24.3
No. 24	273.4	Clarksville, Mo.	110	600	15.0	19.0	12.0	1940	8.3	25.1
No. 25	241.4	Cap Au Gris, Mo.	110	600	15.0	19.0	12.0	1939	10.9	25.1
No. 26	202.9	Alton, Ill.	110 110	600 360	24.0 24.0	19.0 16.0	10.0 10.0	1938 1938	12.8	58.4
No. 27	185.4	Granite City Ill.	110 110	1,200 600	10.5 10.5	15.0 15.0	16.0 16.0	1953 1953	63.9	64.3

*Inoperable

Source: U.S. Army Corps of Engineers

Tows of 1-8 barges require one operation of the lock chamber and can lock through in about 1/2 hour. It takes two operations of the lock chamber to pass larger tows (9-15 barges) and requires 1-1½ hours. Figure 4 shows a 15-barge tow engaged in a double locking operation. To execute the lockage: (a) The first 9 barges (first cut) are pushed into the lock chamber and disconnected, (b) the towboat and remaining 6 barges are backed free of the lock chamber, (c) after operation of the chamber the first cut is pulled out and secured to the lock guide wall by means of a winch operated cable, (d) the remaining six barges and towboat are locked through and connected to the first cut. Figure 5 shows the operation of the lock chamber.

The lift at the locks on the Mississippi varies from 5.5 feet to 49.2 feet, with an average lift of 12.9 feet. The lock at Keokuk has the highest lift along Iowa, 38.2 feet.

FIGURE 4

DOUBLE LOCKING OPERATION, LOCK & DAM 16, NEAR MUSCATINE, IOWA

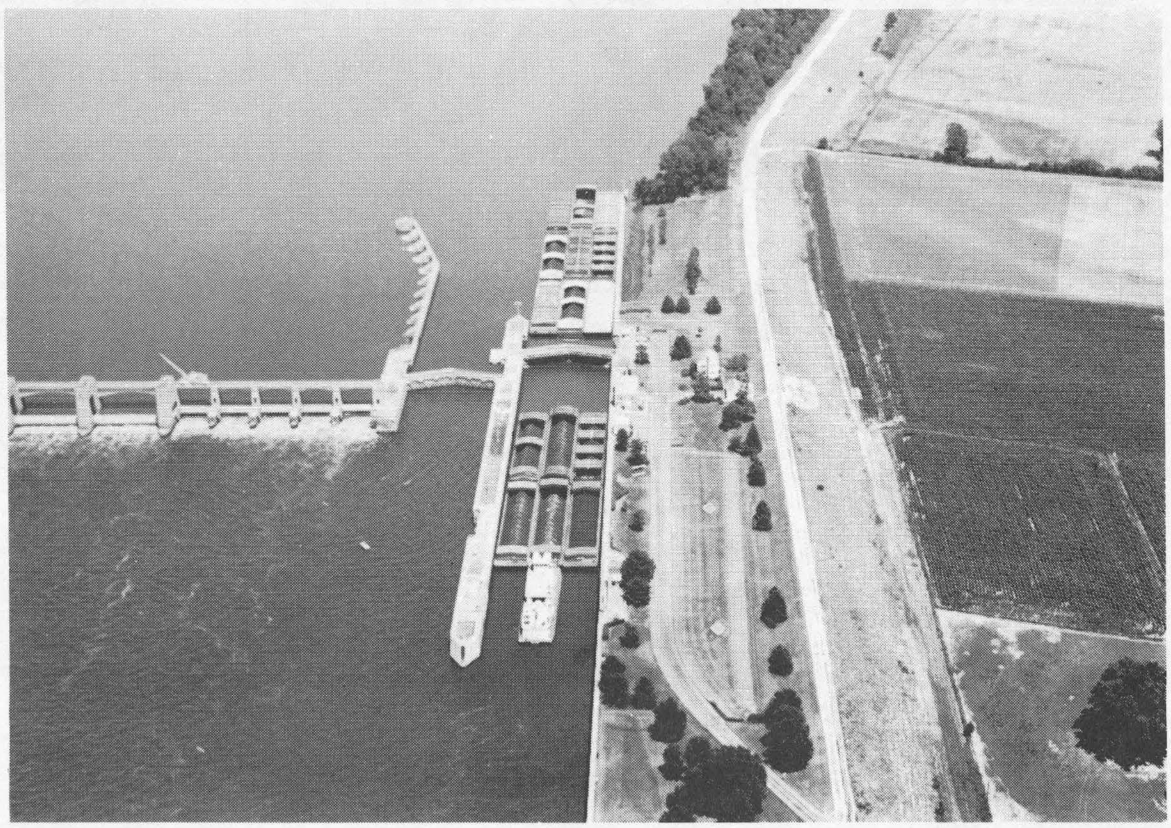


FIGURE 5

HOW NAVIGATION LOCKS OPERATE

WHY NAVIGATION LOCKS AND DAMS ARE NECESSARY

Winter cold, spring flooding, and summer heat produce wide variations in the depth of a natural river. A series of dams in such a river helps to maintain a more constant depth to permit year around use by river traffic. Navigation locks are the means by which river traffic is passed from one level to another created by the dam. This action can either be up or down. Follow the towboat in the diagrams as it passes from the upper level to the lower level.

HOW NAVIGATION LOCKS OPERATE

Diagram 1

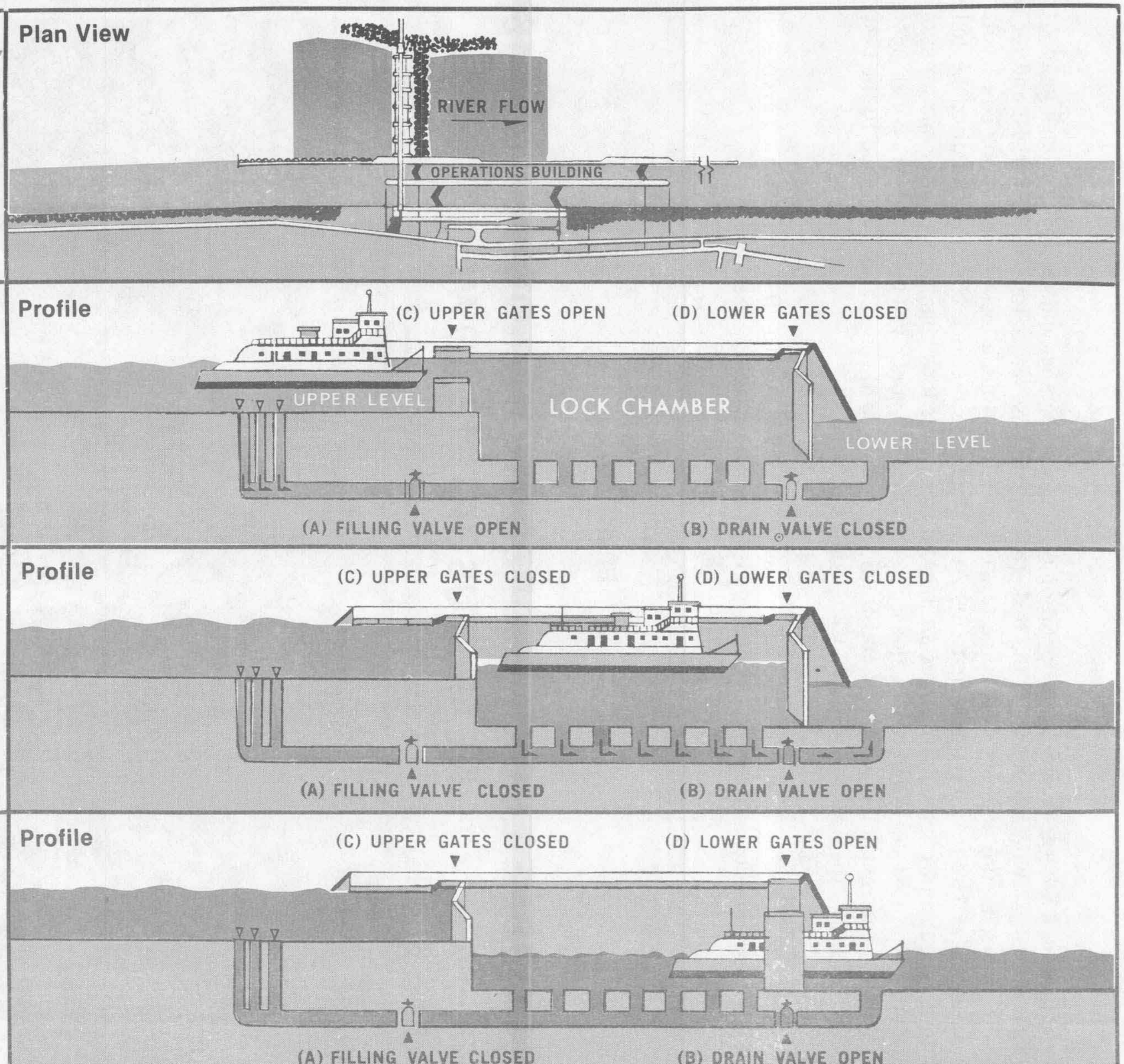
The lower gates (D) are closed; the drain valve (B) is closed; the filling valve (A) is open allowing the lock chamber to fill to the upper level; and the upper gates (C) have been opened allowing the towboat to enter the lock chamber.

Diagram 2

Now the towboat is in the lock chamber; the upper gates (C) are closed; the filling valve (A) is closed; the drain valve (B) is open allowing water to drain out into the lower level. The towboat is lowered as the water level lowers.

Diagram 3

When the water reaches the lower level, the lower gates (D) are opened allowing the towboat to leave the lock chamber and proceed on down the river to the next lock and dam where it will go through the same procedure.

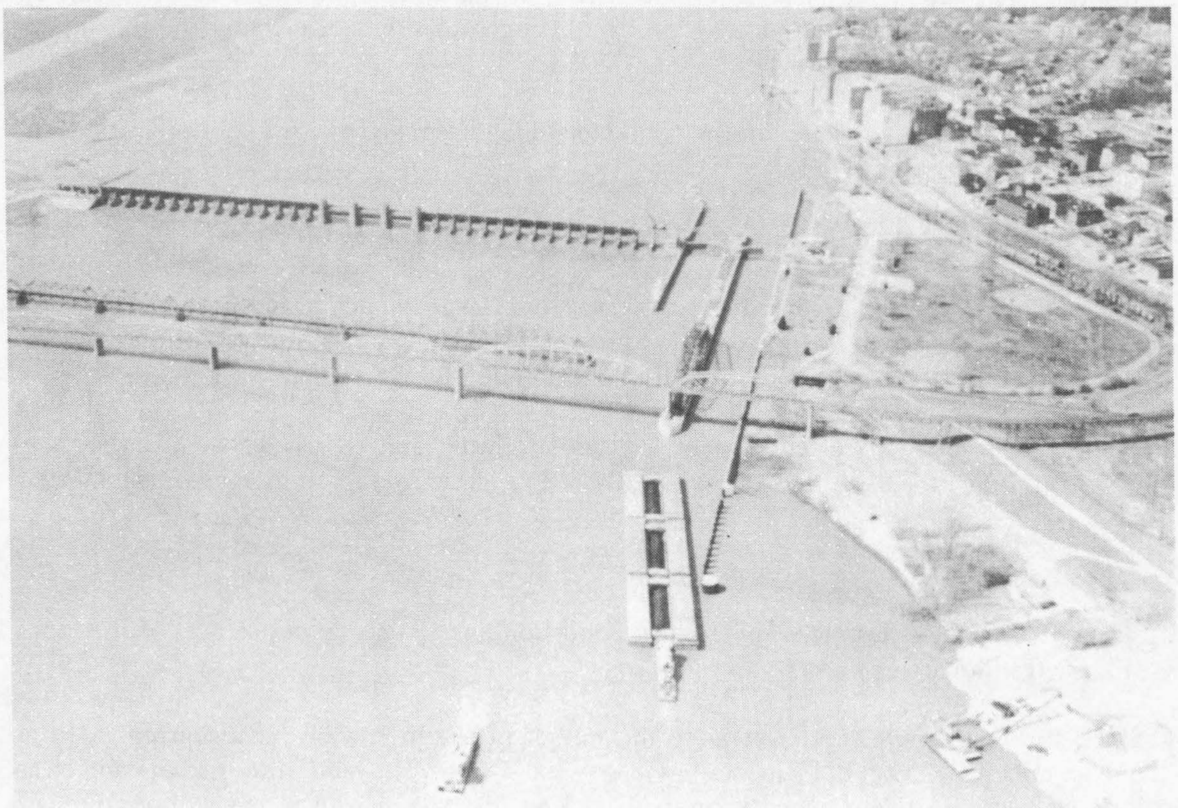


Source: The American Waterways Operators, Inc., Arlington, Virginia.

Locks and Dam No. 26

Of the 29 Locks and Dams on the Upper Mississippi, Locks and Dam 26 located at Alton, Illinois represent the only bottleneck to future water transportation. Locks and Dam 26 needs to be replaced due to severe structural problems and a lack of capacity to handle growing traffic.

Locks and Dam 26 was completed in 1938 with a design capacity of 46 million tons per year and a design life of 50 years. Deterioration has since occurred, due to ice passage, bad weather, hydraulic loading, and routine operations.



Locks & Dam No. 26 · Alton, Illinois

The dam extends 1,725 feet across the river and uses 3 roller gates and 30 tainter gates to control pool depth (Figure 6). A stilling basin, consisting of a concrete apron with two rows of baffle blocks, reduces energy from water released through the gates. The river bed is protected from erosion downstream from the stilling basin by a blanket of riprap. The 33 concrete dam piers are T-shaped and rest on timber friction piles driven into sand.

River traffic can use two locks--a 110-foot-by-600-foot main lock and a 110-foot-by-360-foot auxiliary lock. Three parallel concrete walls, with miter gates at each end, form the two lock chambers. The three walls rest on vertical wood and concrete friction piles. Both lock floors were paved with concrete to protect the foundation against sand erosion but they serve no structural support purpose.

Structural Deficiencies

Dam

The Corps of Engineers describes the general condition and structural deficiencies of the dam as follows. Figure 6 summarizes these findings.

1. The design of the pile foundations was based on an allowable lateral movement and vertical settlement of 0.25 inch. However, a 2-inch permanent downstream horizontal movement of the dam occurred during the early life of the structure. Accompanying rotation caused settlement of 0.75 inch and uplift of 0.2 inch at the heel and tow of the structure, respectively. A 1-inch variance exists in the upstream-downstream position of the dam between the minimum hydraulic loading (open-river flow) and the maximum hydraulic loading (gates closed).

2. Holes 3 feet deep have eroded in the concrete stilling basin and twisted reinforcing steel is exposed.

3. Borings indicate that voids exist under the dam piers, sills and apron.

4. Deep scour holes have developed downstream from the apron and around the railroad and highway bridge piers. Immediately downstream of the stilling basin the scourholes extend as deep as 9 feet below the top of the foundation pile tips (See Figure 6).

5. Mechanical and electrical equipment have deteriorated and require repair. The service bridge on top of the dam piers needs to be raised to allow for larger opening of the tainter gates.

Locks

The Corps of Engineers describes the general condition and structural deficiences of the locks as follows. Figure 6 summarizes these findings.

6. Since the facility opened a riverward movement of the lock walls has occurred. A total movement of 4½, 6 and 10 inches has been measured for the land, intermediate and river lock walls, respectively. A rock berm placed against the river wall has stopped further riverward movement.

7. Neither lock can be safely dewatered for inspection or repair because it is difficult to stop the water flow beneath the lock walls and sills. Any attempt to dewater a lock for inspection could cause additional loss of foundation materials and possible failure.

8. The floor of the main lock has buckled and settled up to 1 foot.

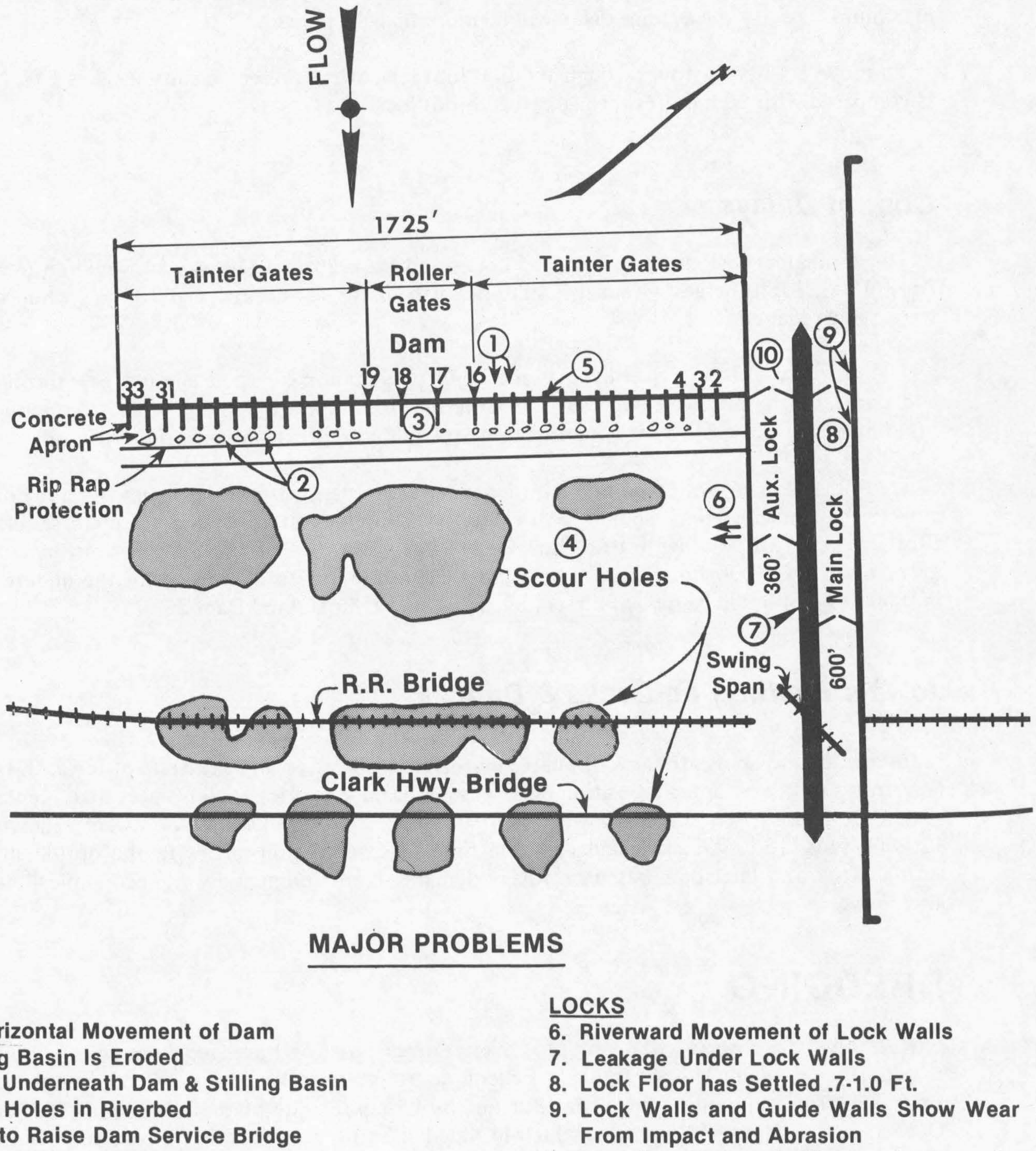
9. The lock walls and approach guide walls show deterioration from impact and abrasion as evidenced by damaged or missing wall armor, and longitudinal and vertical cracks on concrete wall monoliths.

10. General deterioration of gates, mechanical and electrical equipment has been observed. This will require maintenance, repair and/or replacement.

FIGURE 6

STRUCTURAL CONDITIONS AND MAIN PROBLEM AREAS

LOCKS AND DAM 26



MAJOR PROBLEMS

DAM

1. 2" Horizontal Movement of Dam
2. Stilling Basin Is Eroded
3. Voids Underneath Dam & Stilling Basin
4. Scour Holes in Riverbed
5. Need to Raise Dam Service Bridge

LOCKS

6. Riverward Movement of Lock Walls
7. Leakage Under Lock Walls
8. Lock Floor has Settled .7-1.0 Ft.
9. Lock Walls and Guide Walls Show Wear From Impact and Abrasion
10. Deterioration of Mechanical and Electrical Equipment Lock Gates and Dam Gates

Traffic Delays

Commerce shipped through Locks 26 has increased from 1.4 million tons in 1938 to 58.4 million tons in 1977. The present 73 million ton maximum capacity of the locks will be reached in the early 1980's. The average delay for tows waiting to lock through was 7.2 hours in 1977. At maximum capacity the average delay will be more than 12 hours.

To move a 15-barge tow through the 600-foot lock at the present facility it takes 1 to 1½ hours, as compared with 30 minutes through a 1200-foot lock.

Cost of Delays

The estimated cost of tow delays at Locks and Dam 26 in 1974 was $4.5 million (Ref. 2). In April 1976, 1,000 barges with $225 million worth of cargo were delayed 10 days while the locks were being repaired (Ref. 4).

The majority of Iowa's river exports and imports (9 million tons a year) must pass through Locks and Dam 26. The physical failure of this structure, forcing the shipment of these commodities by other modes would cost Iowans an estimated $60 million more per year in transportation costs.

Transportation is almost completely dependent on energy from petroleum. As a major energy consumer, transportation should participate in conservation programs to increase efficiency. Bottlenecks which hamper traffic flow waste large quantities of fuel. With an estimated annual delay of over 36,000 hours, and a delay fuel use rate of 15 to 20 percent of the underway rate, 950,000 to 1,300,000 gallons of diesel fuel are wasted at Locks and Dam 26.

Iowa's Position on Locks & Dam 26

In view of the above, the Iowa Department of Transportation and the State of Iowa, through the Governor's Office, adopted a position on Locks and Dam 26. This position states that a replacement structure about two miles downstream of the existing Locks and Dam 26--with one 1200-foot-by-110-foot lock installed at the time of construction and with the option of adding another lock at a later date based on future demand--is environmentally and economically the best alternative.

DREDGING

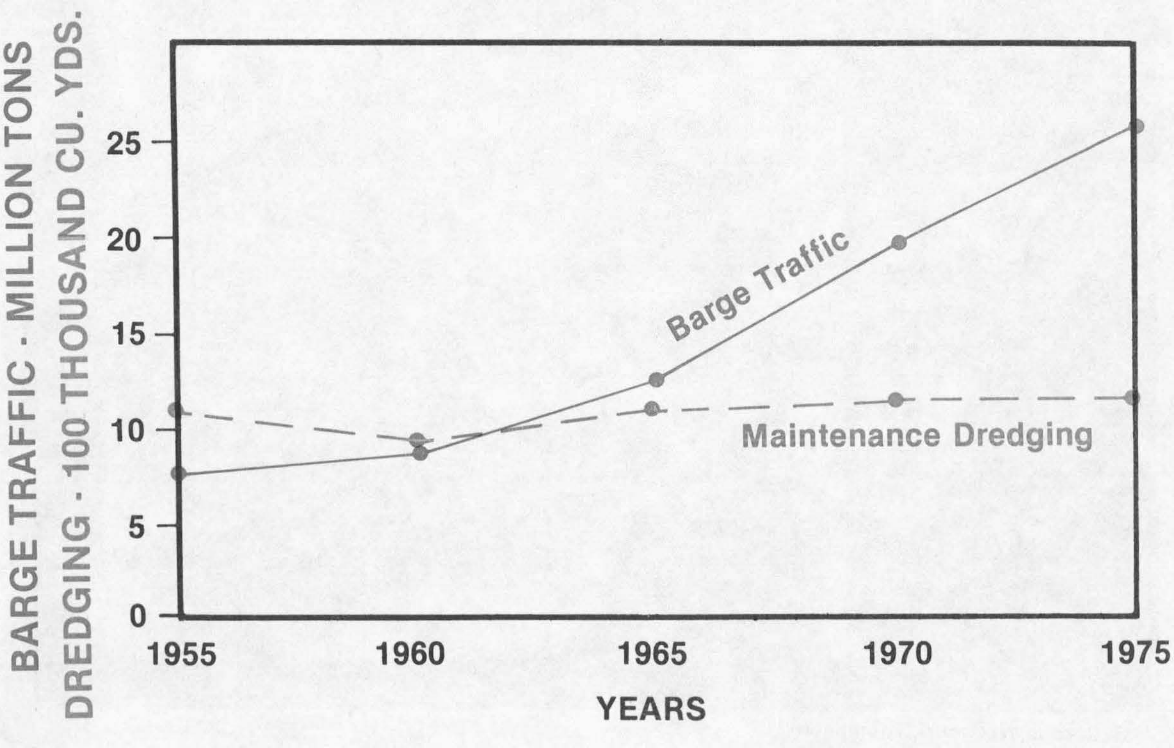
Recently controversy has erupted over the disposal of dredged material from channel maintenance dredging. For example, a Federal court action in Wisconsin has stopped the Corps of Engineers from dumping dredge material on the Wisconsin side of the Mississippi. The Wisconsin Department of Natural Resources, which initiated the suit, contends that the lawsuit is not to shut down barge traffic, but to prevent dumping of dredge material in fragile wildlife and waterfowl areas.

Dredging Practices

In accordance with the Congressional mandate to maintain the authorized 9-foot navigation channel, the Corps routinely conducts maintenance dredging in some areas of the Upper Mississippi. In other areas dredging is required on a more irregular basis to remove shoals developed during low flow. To provide authorized channel dimensions, each year approximately 1.6 million cubic yards of material in the St. Paul District and 1.2 million cubic yards in the Rock Island District were removed. Approximately 28 locations, about 1% of total river miles, were dredged in the two districts during a typical season. Figure 7 shows no apparent relationship between the amount of commercial barge traffic and the amount of maintenance dredging required.

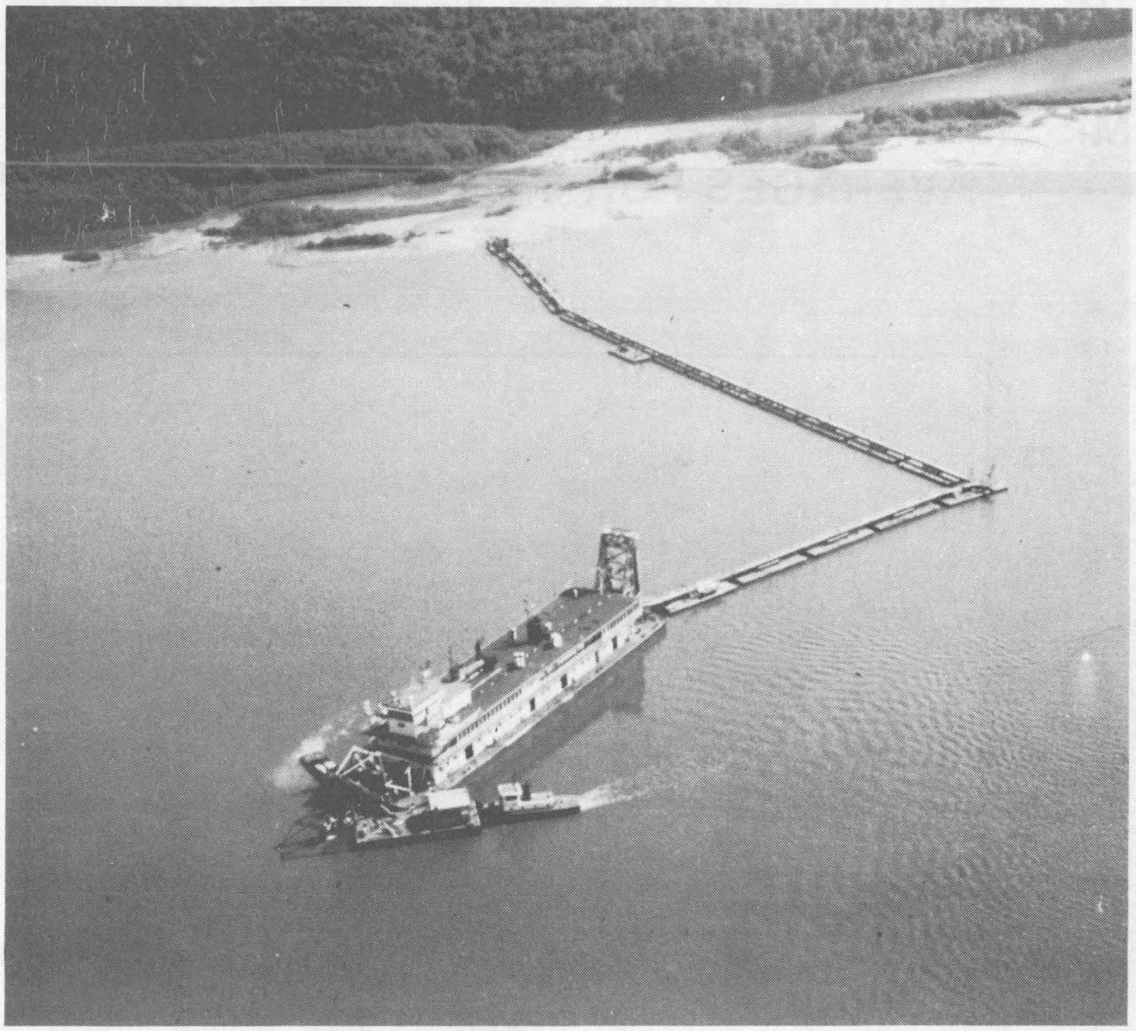
FIGURE 7

RELATION OF MAINTENANCE DREDGING TO COMMERCIAL BARGE TRAFFIC MISSISSIPPI RIVER — ROCK ISLAND DISTRICT AVERAGES FOR 5-YEAR PERIODS

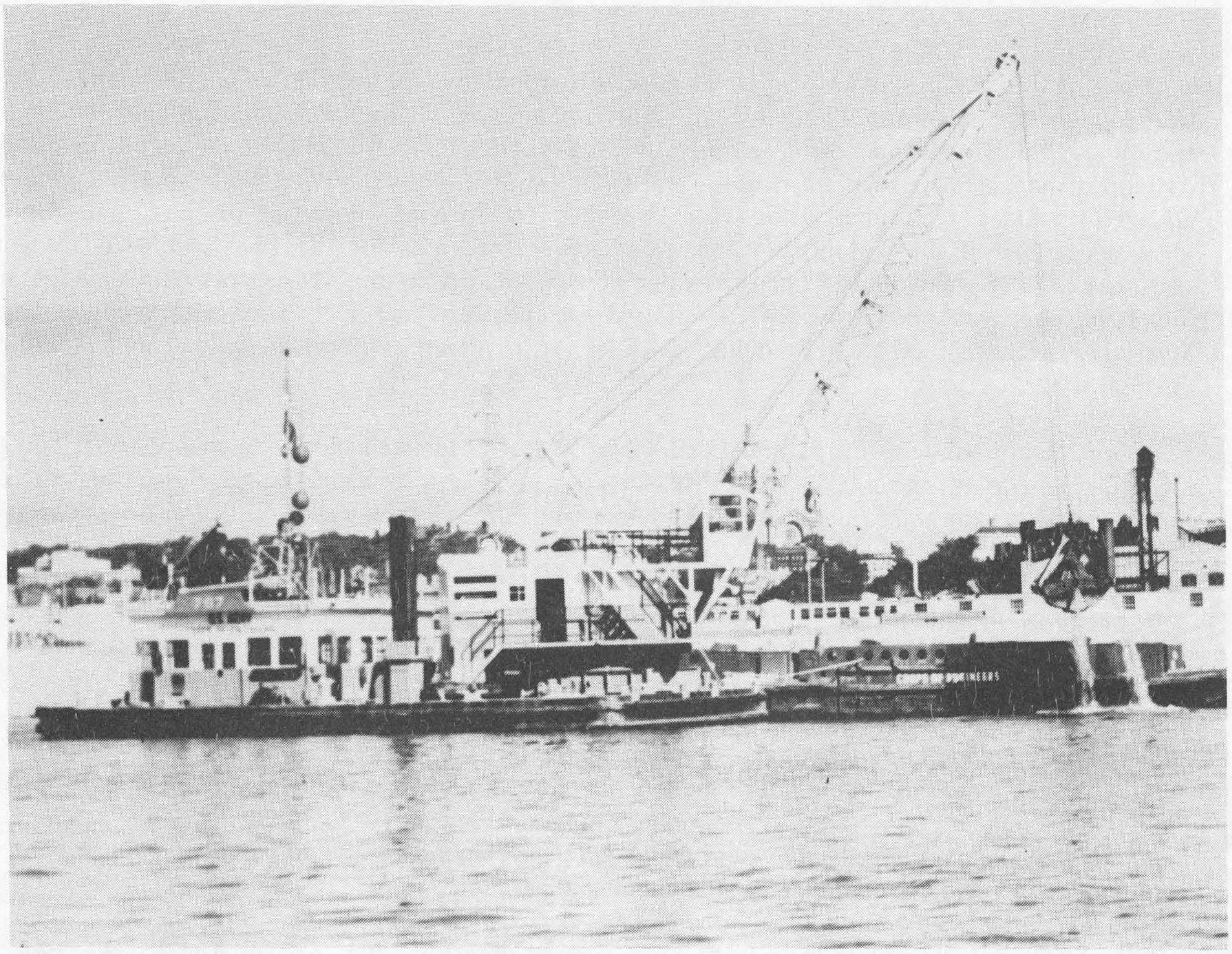


The dredging operation is not particularly damaging to the environment, except for a temporary increase in turbidity. However, disposal of the dredged material may damage the environment, particularly when it reduces fresh water flow to back water channels. This causes stagnation, eutrophication, and reduced productivity of fish habitat.

The Corps has two primary dredges on the Mississippi. The U.S. Dredge William A. Thompson is a 20-inch hydraulic unit with 4750 feet of floating pipe and 2000 feet of shore pipe. The U.S. Dredge Hauser is a 4-cubic-yard clam shell unit which places the material in open water or on land. A hydraulic dredge momentarily suspends the shoaled material with a cutter head, draws it into a centrifugal pump and pumps it through a combination of floating pipe and shore pipe to a placement site. A clam shell dredge collects the shoaled material in a clam shell bucket and casts it into a barge or dumpscow. The dumpscow then leaves the material at a placement site. The Corps has a 12-inch cutter head pipeline dredge to perform smaller scale dredging.



U.S. Dredge William A. Thompson



U.S. Dredge Hauser

Normally critical sites from Winona, Minnesota, upstream to Minneapolis, Minnesota, are dredged with the William A. Thompson during May and June. During June, July, and August, the dredge works in the Rock Island District. The Dredge Thompson returns to the St. Paul District in October and dredges any sites that have shoaled during the navigation season. The Hauser dredges in the Minneapolis-St. Paul, Minnesota area from May through September and performs structural maintenance and miscellaneous dredging thereafter. All dredging normally ends by the end of November, due to bad weather.

In the past, dredging has normally been accomplished to 9 feet plus 4 feet of overdepth. Overdepth dredging insures the integrity of the channel for a longer period in areas troubled by shoaling.

Dredging depth is a subject of a Great River Environmental Action Team (GREAT) pilot study. GREAT is a partnership of Federal, State, and local agencies (with management responsibilities for the Mississippi River) and concerned private citizens. GREAT will study the river's problems and develop a management plan to include total river resource requirements. Short range planning by GREAT includes recommendations for dredging and dredged material disposal. The Upper Mississippi River Basin Commission approved recommendations for the 1975 and 1976 dredging seasons and sent them to the Corps of Engineers. The Corps made every effort within budgetary limits and plant capability, to use GREAT's recommendations on the environmental considerations associated with maintenance dredging. GREAT team members provided guidance in selecting disposal sites.

Beginning in 1975 the Corps and GREAT invited all interested parties to make a boat trip to inventory and assess potential dredge disposal sites. Such on-site inspections are made just before the dredging season starts; all concerned Federal and State agencies, as well as the private sector, have participated.

In cooperation with GREAT, the Corps made many changes in their dredging program. Beginning with the 1975 dredging season they decided to assume much higher risks in maintaining the integrity of the navigation channel than ever before.

1. Many questionable sites, that would normally have been dredged to reduce the possibility of channel closure, were not dredged.

2. Detailed survey sheets were sent to the US Coast Guard for aids to navigation adjustment to effect using all available natural channel alignment.

3. Research is being conducted at several sites to determine if the channel will seek a new alignment that might require less maintenance.

4. Research is being conducted in the area of reduced overdredge depth, i.e., 2 feet rather than 4 feet.

During the 1975 navigation season, 586,478 cubic yards of material were dredged in the Rock Island District compared to an average annual cubic yardage of 1,200,000. This yardage was further reduced to 266,000 cubic yards in 1976. The large reduction is due to the above management decisions. Similar reductions in dredge quantities were made in the St. Paul District. Although the Corps hopes to maintain this reduction of yardage, abnormal events could produce more dredged yardage in the future.

Disposal Methods

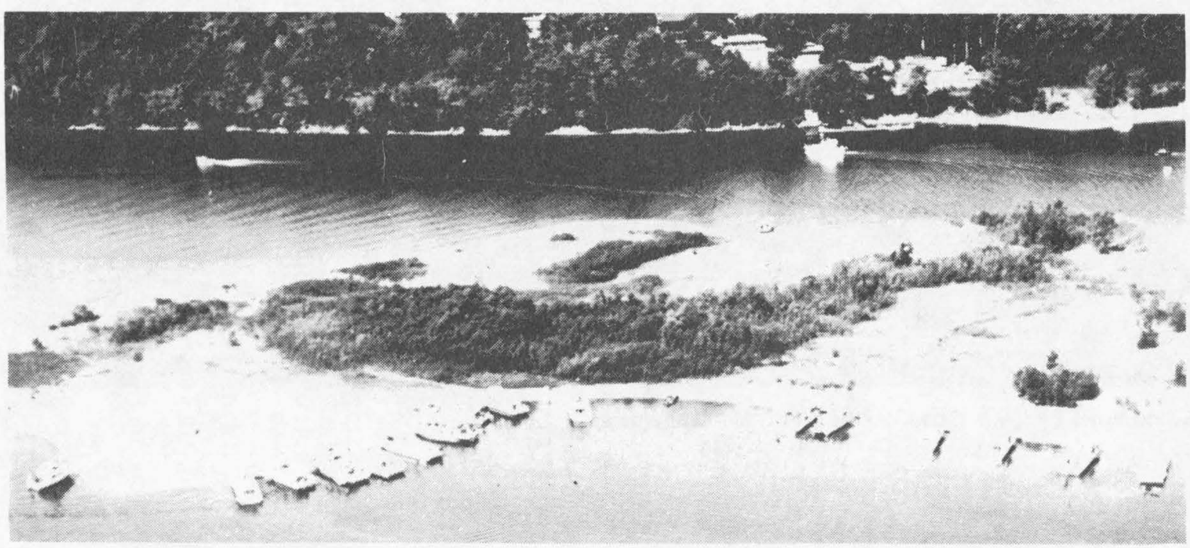
Since maintenance dredging is needed to continue commercial river transportation, disposal methods must be compatible with the environment, yet reasonable in cost. GREAT is studying dredge material soil properties and looking for possible alternative uses for it e.g., landfill, street and highway sanding, and construction. Use of the material for these purposes depends largely on the gradation which, in turn, depends on the reach of the river where dredged. For example, Buffalo County, Wisconsin regularly uses dredge material for ice control in the winter. The material in the river adjacent to Buffalo County is moderately coarse as most of it comes from the Chippewa River. Minneapolis, Minnesota used dredged material for ice control (from another section of the river) but found that the sand grains were so round that they caused more skidding than the ice itself.

Use of dredged material for fill also depends on the reach of the river where it is obtained. Certain areas of the river contain sediment which is so fine that it is difficult to dewater. Other river reaches produce material which is excellent for fill. Generally, material dredged from the main channel is more coarse than that from backwater areas.

A research project is underway to determine if dredged sand can be used, either by itself or with other materials, as a soil conditioner or additive. One such study involved composting digested sewage sludge and sawdust and blending in fly ash and dredge material. Another study involved mixing dredged material that is rich in organics with native material considered to be relatively unproductive. One pending study will determine whether the material can be used in manufacturing glass.

Other proven uses of dredged material include subbase material for road construction, and fine aggregate for asphalt.

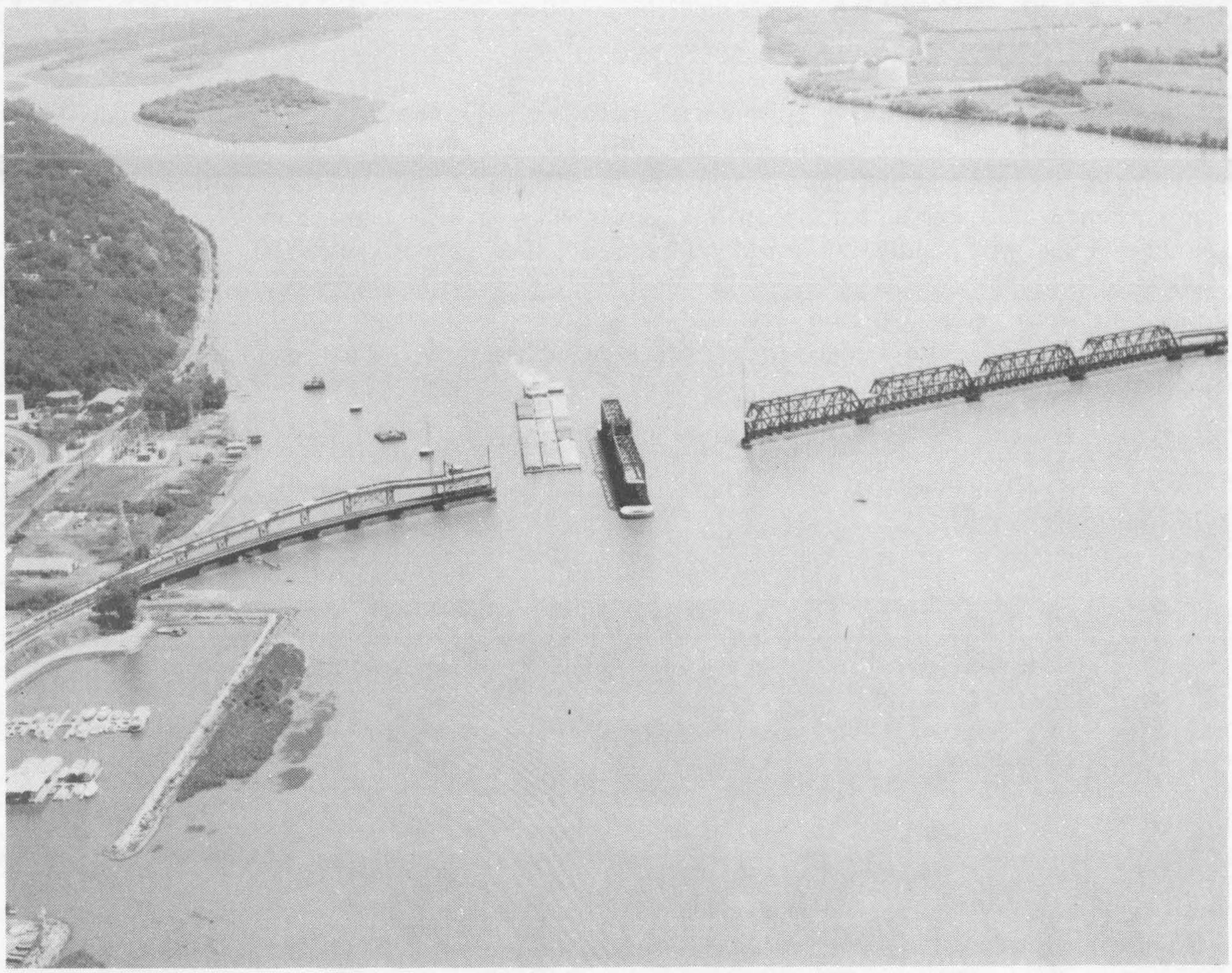
The Corps of Engineers uses large amounts of the dredged sand to establish and replenish beaches along many stretches of the river. This practice should continue, as thousands of vacationers use the beaches each summer.



Recreational Beach Built With Dredged Material

RESTRICTIVE BRIDGES

There are 105 bridges which service rail and highway traffic across the Upper Mississippi. Twenty-one of these which have inadequate vertical clearance (less than 42 feet at highwater) to allow the passing of tows, are constructed with one "swing span" or "vertical lift span". Table 2 shows the location of drawbridges and the transportation mode served. River tows have the right-of-way at drawbridges; therefore they do not present bottlenecks to waterway traffic. However, horizontal clearance is sometimes restrictive, as shown in Table 2. Because of currents which cause drifting, a typical 15-barge tow 105 feet wide by 1120 feet long can have problems passing through these structures. Horizontal clearances on the fixed-span structures range from 276 to 1487 feet except in the Minneapolis-St. Paul area, where clearances are as restrictive as 48 feet.



Swing Span Bridge in Open Position, Fort Madison, Iowa

TABLE 2

DRAW BRIDGES - UPPER MISSISSIPPI RIVER

City	River Mile**	Type Structure	Horizontal Clearance	Usage
St. Paul, MN	841.4	Swing Span	160'	C.&N.W. RR
St. Paul, MN	839.2	Vertical Lift	158'	C.&G.W. RR
St. Paul, MN	835.7	Swing Span	180'	C.&G.W. RR
*St. Paul, MN	830.3	Swing Span	195'	C. R.I.&P. RR Minnesota Highway 38
Hastings, MN	813.7	Swing Span	106'	C. M. St.P.&P. RR
Winona, MN	725.8	Swing Span	151'	C.&N.W. RR
Winona, MN	723.8	Swing Span	200'	C. B.&Q. RR
LaCrosse, WI	699.8	Swing Span	150'	C. M. St.P.&P. RR
Dubuque, IA	579.9	Swing Span	146'	I.C.G. RR
Sabula, IA	534.9	Swing Span	158'	C. M. St. P.&P. RR
Clinton, IA	518.0	Swing Span	202'	C.&N.W. RR
*Rock Island, IL	482.9	Swing Span	110'	C. R.I.&P. RR & R.I. Arsenal Bridge
Rock Island, IL	481.4	Swing Span	197'	D. R.I.&N.W. RR
Keithburg, IL	428.0	Vertical Lift	224'	C.&N.W. RR
Burlington, IA	403.1	Swing Span	153'	C. B. &Q. RR
*Ft. Madison, IA	383.9	Swing Span	200'	A. T&SF. RR - US 61 & Iowa 96
*Keokuk, IA	364.0	Swing Span	158'	T. P. & W. RR - US 136
Quincy, IL	327.9	Swing Span	300'	C. B. & Q. RR
Hannibal, MO	309.9	Swing Span	159'	N.&W. RR
Louisiana, MO	282.1	Swing Span	195'	G. M.&O. RR
Alton, IL	202.7	Swing Span	200'	C. B.&Q. RR

*Structure carries both rail and highway traffic.
**Miles above Ohio River

NAVIGATION SEASON

The Mississippi is normally navigated year-round from Cairo, Illinois to the mouth of the Illinois River at Grafton, Illinois. The Illinois Waterway is also open to commercial traffic during the winter. However, ice presents a serious risk to tows operating on the Mississippi above Grafton. Generally tows have been able to operate year-round as far north as Lock No. 19 at Keokuk, Iowa. The navigation season above Keokuk ends around December 15, and opens again around March 15. Table 3 lists closing and opening dates at selected locks. The opening of navigation to the Twin Cities depends to large extent on conditions in Pool No. 4 where ice is normally 6 to 8 inches thicker than on other pools in the river.

YEAR-ROUND NAVIGATION

Industrial, commercial, and agricultural interests have advocated year-round navigation on the Upper Mississippi River. Benefits include: a) a more orderly marketing pattern for agricultural products, b) full-time use of investment in equipment, terminals, and loading facilities, c) the avoidance of costly winter stock piling of coal, and agricultural commodities.

During the winter when the river is frozen, local shippers and receivers must either turn to rail or truck, or store and stockpile until navigation opens in the spring. Both alternatives bring higher materials handling costs and greater capital investment. Although the Illinois Waterway can carry grain during the winter, the added truck cost from Iowa to Illinois River terminals (13 to 18c/bu.) may eat up the profits (Ref. 18).

At the request of Congress the U.S. Army Corps of Engineers conducted a study entitled, MISSISSIPPI RIVER YEAR-ROUND NAVIGATION - PHASE I REPORT, published in September, 1973. The study investigated the feasibility of a 12-month navigational season between the mouth of the Ohio River at Cairo, Illinois, and the head of navigation at Minneapolis, Minnesota. The report identified several problems with year-round navigation, as described on the following pages.

TABLE 3

UPPER MISSIPPI RIVER NAVIGATION SEASON

(length of navigation season by year) [1]

Year	LOCK NO. 2 Above Hastings, Minnesota Up (Date)	Down (Date)	Season (Weeks)	LOCK NO. 5 Above Winona, Minnesota Up (Date)	Down (Date)	Season (Weeks)
1963	Apr 1	Dec 4	35	Mar 31	Dec 4	37
1964	Mar 3	Dec 4	40	Mar 1	Dec 6	36
1965	May 8	Dec 3	30	Apr 2	Dec 5	36
1966	Mar 15	Dec 4	38	Mar 14	Dec 7	39
1967	Mar 24	Dec 10	37	Mar 22	Dec 10	35
1968	Mar 20	Dec 9	38	Mar 18	Dec 11	38
1969	Mar 17	Dec 5	38	Mar 15	Dec 8	37
1970	Mar 9	Dec 4	39	Mar 8	Dec 6	39
1971	Mar 20	Dec 7	38	Mar 18	Dec 7	38
1972	Mar 23	Dec 9	38	Mar 25	Dec 5	36
1973	Mar 18	Dec 6	38	Mar 17	Dec 5	37
1974	Mar 15	Dec 11	39	Mar 14	Dec 12	39
1975	Mar 22	Dec 14	38	Mar 20	Dec 14	38
1976	Mar 5	Dec 4	39	Mar 4	Dec 5	39
AVERAGE [2]			37.4			37.4

Year	LOCK NO. 11 Above Dubuque, Iowa Up (Date)	Down (Date)	Season (Weeks)	LOCK NO. 15 At Quad-Cities Up (Date)	Down (Date)	Season (Weeks)	LOCK NO. 22 Near Hannibal, Missouri Up (Date)	Down (Date)	Season (Weeks)
1963	Mar 28	Dec 14	37	Mar 19	Dec 15	39	Jan 3	Dec 21	50
1964	Feb 27	Dec 10	41	Feb 22	Dec 12	42	Jan 28	Dec 18	46
1965	Mar 12	Dec 6	38	Mar 8	Dec 11	40	Mar 3	Dec 31	43
1966	Mar 11	Dec 9	39	Mar 9	Dec 10	39	Jan 2	Dec 31	52
1967	Mar 17	Dec 17	39	Mar 11	Dec 27	41	Mar 1	Dec 31	43
1968	Mar 6	Dec 13	40	Jan 5	Dec 30	51	Jan 1	Dec 31	52
1969	Mar 3	Dec 18	41	Jan 1	Dec 25	51	Jan 6	Dec 28	51
1970	Mar 5	Dec 12	40	Feb 28	Dec 23	42	Jan 1	Dec 29	52
1971	Mar 10	Dec 19	40	Mar 3	Dec 30	43	Feb 25	Dec 31	48
1972	Mar 11	Dec 18	40	Jan 1	Dec 31	52	Jan 1	Dec 31	52
1973	Mar 7	Dec 15	40	Feb 7	Dec 21	45	Jan 1	Dec 31	52
1974	Mar 12	Dec 14	40	Jan 22	Dec 31	49	Jan 19	Dec 31	49
1975	Mar 1	Dec 15	41	Jan 1	Dec 31	52	Jan 1	Dec 31	52
1976	Feb 26	Dec 19	42	Jan 1	Dec 20	50	Jan 1	Dec 31	52
AVERAGE [2]			39.9			45.4			49.5

1/ The "up" date listed is that of the first unbound tow passing through the lock.
The "down" date listed is that of the last downbound tow passing through the lock.

2/ Average length of season for 1963-1976

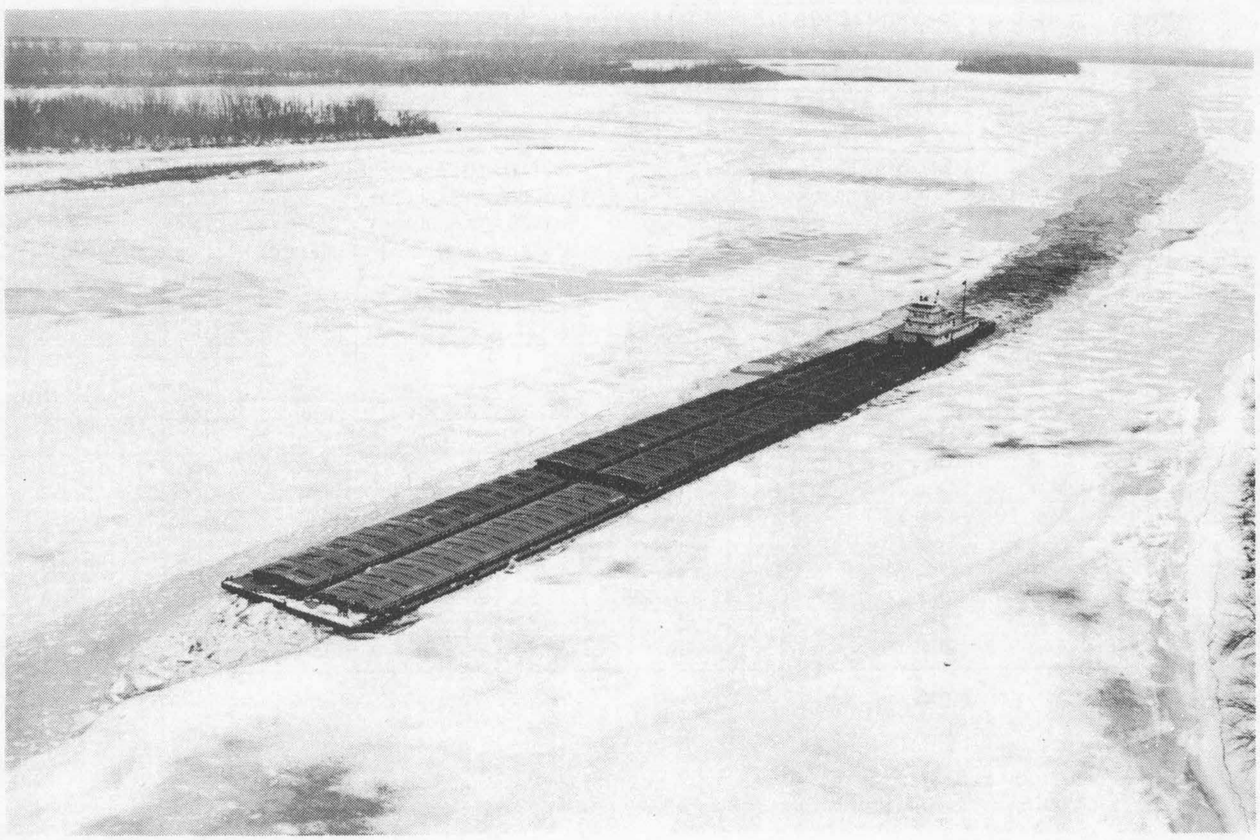
Source: Mississippi River Year Round Navigation, Phase I Report; U.S. Army Corps of Engineers, North Central Division, Chicago, Illinois, September 1973.

Ice Conditions

Eight inches of solid ice does not materially hamper towboat movement. Ten inches presents a barrier to towboats in the 2000-5000 horsepower range. Ice field and gorges which may extend to the bottom of the channel are impossible to navigate.

Winter Towing Practices

When the river has ice cover, tows are reduced in size and barges are arranged in single file, to present less ice resistance. Sometimes a "mule train" is formed by placing one barge in front of the towboat and the rest of the barges hooked on by bridle line in tandem behind the towboat. This configuration is more flexible and eases navigation on river bends. Under extreme conditions, the towboat will push one barge to break through the ice, and then return for the remaining barges.



Upbound Tow Breaking Ice, Pool 20
Photo · Courtesy of Corps of Engineers

At the Locks and Dams

Although navigation extends into the winter as long as possible, the locks were not designed for winter operation. Locking is hampered by: a) broken ice in the lock chamber interfering with operation of the lock gates, b) build-up of ice on the lock walls, gates, and the bottom of tows, c) freezing of lock valves. Normally a double lockage takes 1-1½ hours. During winter operation a double lockage may take 3 or 4 hours, and sometimes as long as 8 hours.

Locking Through Under Icy Conditions, Lock 16
Photo - Courtesy of Corps of Engineers

Maintenance of Locks and Swing-Span Bridges

Major maintenance of the locks and railroad swing-span bridges is performed during the winter. A lock must be completely closed down to perform the overhaul.

The railroads claim it is impracticable to maintain a moveable bridge in service to both rail and river traffic during repairs. The Association of Western Railways has stated that many of the swing-span bridges were constructed with cast iron turn-tables that must be lubricated with grease rather than oil. As a result the swing-spans are inoperable in extremely cold weather. They indicate that if navigation is expected to continue during subzero temperatures, the turn-tables and machinery would have to be replaced at a cost of around $250,000 per bridge. However, a Corps review of railroad bridge operation during extreme cold weather in the Twin-Cities area did not reveal any major difficulties.

Access to Docks

Docks could be damaged by broken ice pushed around by tows maneuvering into position.

Navigation Aids

Existing buoy markers are not designed for winter operation as they are covered, moved, and damaged by ice action. The U.S. Coast Guard removes these markers before the river freezes.

Ice Action on Bridge Piers

The force required to break ice would be transmitted to bridge piers and other structures in the river. Such a force could damage these structures.

Environmental Problems

A maze of channels, sloughs, marshlands, and river bottom lakes were created by the Upper Mississippi River navigation project. Commercial and sport fishing activities vary seasonally according to species and are carried on from St. Louis to Pool No. 2 above Hastings.

Disruption of the winter ice cover would cause the following problems to fishermen:

1. Loss of fishing equipment and increased hazards caused by open channel ice flow and unsafe shelf ice conditions.
2. Limited access to fishing areas where fishermen are required to cross the river channel.
3. Decline of the fishery caused by increased turbulence inherent with the operation of a tow in ice and changing water levels inherent in the operation of the navigation pools.

Potential problems related to winter navigation concerning wildlife habitat and populations include:

1. Water level fluctuations of six inches or more, during the winter, could freeze fur-bearers out of their dens. Increased potential for ice jams caused by navigation could cause these fluctuations.
2. The movements of deer and other wildlife across the frozen river would be prohibited. The open channel would also inhibit hunter access to wildlife areas.
3. Wildlife managers improve habitat areas and perform maintenance at the refuges during the winter when navigation pools are lowered for short periods. The pools would have to be maintained at a higher level to support winter navigation; this would increase refuge maintenance costs.

Alternatives for Extending the Navigation Season

The Corps considered five alternative proposals for extending the navigation season:

(A) 52-week navigation season to the Twin-Cities, all terminals would be serviced on a 12-month basis.
(B) 52-week season to Alma, Wisconsin, and a 38-week season to the Twin-Cities;
(C) 52-week season to Genoa, Wisconsin, with 46 weeks through La Crosse, Wisconsin, and a 38-week season to Alma;
(D) 52-week season to Burlington, with 46 weeks through the Quad-Cities, and a 38-week season to Genoa;
(E) Maintain the existing navigation season throughout the Upper Mississippi River.

Alternatives (A) through (D) would involve modification to the lock gates, replacement of upstream lock gates, and modification to lock approach channels. Table 4 summarizes the engineering costs and economic benefits of each alternative. Economic benefits are based on: a) the price and demand for grain at export market, b) price, storage costs, and consumption requirements of coal, salt, fertilizer, c) regional employment as affected by the close of the navigation season, and d) alternative use of barges and towing equipment during the winter months. Petroleum was not included as a potential winter commodity because of the risk of puncture to barge hulls during icy conditions. Also the benefit-cost ratios do not include an assessment of environmental costs.

Further breakdown of alternative (D) shows that the 38-week extension to Genoa is not justified on an incremental basis. Consequently this alternative was altered to a 52-week season to Burlington, Iowa, and 40-weeks to Cassville, Wisconsin (near Guttenberg, Iowa). This brought the B/C ratio for alternative (D) to 1.9 with annual economic benefits estimated at $4.79 million and annual engineering costs at $2.55 million.

Conclusions

Based on preliminary estimates of economic benefits and engineering costs, an extension of the navigational season to 52 weeks to Burlington, Iowa, and to 40 weeks to Cassville, Wisconsin, warrants further study, but extension of the navigational season between Cassville and Minneapolis lacked economic justification at the time the study was undertaken.

TABLE 4

SUMMARY OF COSTS AND BENEFITS
OF EXTENDING THE NAVIGATION SEASON

First Costs (million dollars)				
Alternative	A	B	C	D
Federal	$160.49	$140.77	$100.85	$36.70
Non-Federal	2.25	1.69	1.35	0.68
Total	$162.74	$142.46	$102.20	$37.38
Annual Costs (million dollars)				
Alternative	A	B	C	D
Federal	$ 12.03	$ 10.79	$ 7.61	$ 2.35
Non-Federal	0.66	0.50	0.39	0.20
Total	$ 12.69	$ 11.29	$ 8.00	$ 2.55
Annual Benefits (million dollars)				
Alternative	A	B	C	D
Total	$ 10.45	$ 8.48	$ 7.14	$ 4.79
Benefit/Cost Ratio	Annual Benefits divided by Annual Costs.			
Alternative	A	B	C	D
B/C Ratio	0.8	0.7	0.9	1.9

Source: Mississippi River Year Round Navigation, Phase I Report, U.S. Army Corps of Engineers, North Central Division, Chicago, Illinois, September 1973, p. 47.

RECREATIONAL BENEFITS

Each year vacationers are drawn to the Upper Mississippi to fish, swim, boat, hunt, or picnic. Forty-three public use areas, ranging in size from one to twelve acres are located along the river. The degree of development varies from simple parking lots for fishermen to areas with boat launching ramps, picnic areas, and camping facilities.

The number of small pleasure craft on the river increase every summer. This growth has created a need for additional smallboat harbors in Iowa. The Corps of Engineers has built small boat harbors in Lansing, Lindsay Park in Davenport, Muscatine and Fort Madison. Similar harbors have been authorized by Congress at Bellevue, Clinton, Credit Island at Davenport, and Keokuk.

The total number of registered boats in the Upper Mississippi River Basin is projected to increase from 521,000 in 1966 to 2.5 million in the year 2020, provided recreational facilities are available. However, opportunities for recreational development of the reservoirs is limited. The greatest single deterrent to full use of the Mississippi River for recreation is the lack of public access. Access is cut off by highways and railroad tracks which follow both shores of the river. Also, many tracts of public land along the river are separated from public roads and access by intervening private ownerships. In consequence, facilities to accommodate water-based activities are generally lacking in areas where they are in demand (Ref. 21).

SMALL CRAFT LOCKS

The locks and dams were originally built to aid navigation. The slack water pools have also provided excellent recreational facilities for pleasure boaters. Small craft lockages have increased recently at most locks on the Upper Mississippi except at those locks where commercial traffic is approaching its practical capacity. At locks with relatively low traffic, pleasure craft can be readily locked through. However, where commercial traffic is near its practical capacity, recreational boaters are discouraged from using the locks because of delays, and possible dangers involved. Table 5 gives the relationship between commercial and recreational traffic through the locks in 1966 and 1976. The heaviest concentration of recreational lockages occur between Hastings, Minnesota (L&D 2) and Davenport, Iowa (L&D 15). Locks and Dam 26 and 27 have the lowest recreational use.

Present locking regulations give preference to commercial traffic over recreational traffic. "Regulations Prescribed by the Secretary of the Army for the Ohio River, Mississippi River Above Cairo, Illinois, and their tributaries; Use, Administration, and Navigation" established the order of preference for lockage of craft as follows:

1 - U.S. Military Vessels
2 - Vessels Carrying U.S. Mails
3 - Commercial Passenger Craft
4 - Commercial Tows
5 - Commercial Fishing Craft
6 - Pleasure Craft

TABLE 5

COMMERCIAL AND RECREATIONAL LOCKAGES (1966 and 1976)

Lock	Location	Total Commercial & Recreational Lockages 1966	% Recreational Lockages 1966	Total Commercial & Recreational Lockages 1976	% Recreational Lockages 1976
USAF	St. Paul, Minn.	1,009	42	3,657	25
LSAF	St. Paul, Minn.	1,780	33	4,254	21
1	St. Paul, Minn.	2,767	38	4,934	30
2	Hastings, Minn.	3,801	58	5,085	49
3	Red Wing, Minn.	3,945	60	6,048	61
4	Alma, Wis.	4,181	49	4,502	48
5	Fountain City, Wis.	3,808	55	4,771	52
5A	Winona, Minn.	5,352	69	5,913	61
6	Trempealeau, Wis.	4,313	62	5,388	55
7	La Crosse, Wis.	6,190	68	6,192	58
8	Genoa, Wis.	4,026	59	4,839	51
9	Harper's Ferry, Ia.	4,358	60	4,769	51
10	Guttenberg, Ia.	4,959	53	6,214	58
11	Dubuque, Ia.	3,754	61	5,390	49
12	Bellevue, Ia.	4,328	50	4,989	42
13	Clinton, Ia.	4,099	47	4,737	46
14	Le Claire, Ia.	6,135	43	6,801	47
15	Davenport, Ia.	5,361	52	7,170	41
16	Muscatine, Ia.	4,292	34	5,150	26
17	Toolesboro, Ia.	3,927	28	5,459	23
18	Burlington, Ia.	4,983	43	5,326	27
19	Keokuk, Ia.	3,068	25	3,430	21
20	Canton, Mo.	4,673	15	4,972	14
21	Quincy, Ill.	4,115	23	5,299	17
22	Saverton, Mo.	3,875	20	5,207	16
24	Clarksville, Mo.	4,078	21	5,385	17
25	Cap Au Gris, Mo.	4,803	32	5,707	21
26	Alton, Ill.	11,209	11	14,533	3
27	Granite City, Ill.	10,257	11	12,577	4

Source: U.S. Army Corps of Engineers, North Central Division, Chicago, Illinois

Small Craft Locks Study

A congressional resolution adopted in April 1974, authorized the "Upper Mississippi River Small Craft Locks Study" to be completed by the Corps of Engineers. This study will investigate feasibility of modifying the existing locks and dams to permit independent passage of recreational craft. Independent passage would eliminate most competition between commercial and recreational traffic at the locks. The study will examine the feasibility of providing separate locks and other possible methods, both structural and nonstructural alternatives, to provide more efficient recreational lockages (Ref. 19).

Recreational Craft Leaving Lock Chamber, Lock & Dam II, Dubuque, Iowa

Structural Alternatives

Possible structural alternatives would include:

1. Completion of the auxiliary locks where they exist.
2. Construction of small recreational locks.
3. Construction of mechanical boat-lift devices.
4. Secluded tie-up facilities.

Completion of Auxiliary Locks

Partial provisions exist for a 100 by 360-foot auxiliary lock at 20 of the 29 lock sites. These include an upper gate sill with miter gate, upper portion of the riverwall and recesses in the intermediate wall for the lower miter gate and gate machinery. A 360-foot auxiliary lock was completed as part of the original construction at Locks 15 and 26.

The 110 by 360-foot locks are more than adequate for recreational craft but marginal in handling any overflow of commercial traffic—Barges were smaller (175x26 foot) in the 1930's when these locks were designed. A 110 by 360-foot lock can accommodate 8 of these barges. The same lock can accommodate only 3 of the 195 by 35-foot barges of today.

The possibility of adding a 110 by 400-foot auxiliary lock was also investigated. This lock could allow passage of six 195x35-foot barges. The cost would be more than the 360-foot lock but the capacity would be doubled.

Construction of Small Recreational Locks

Steel Lock - The Steel Lock, 25 by 80 feet, would be a double-wall, steel structure constructed of 3/8 inch plate. The upper gate bay would include a vertical lift gate and a filling system. The lower gate bay would include a miter gate and an emptying system.

Concrete Lock - The 25-foot by 80-foot concrete and sheet pile lock would be a U-frame structure on a sand foundation. The structure would include concrete upper and lower gate bay monoliths, and a lock chamber consisting of sheet pile walls with revetment floor.

Mobile Floating Lock - This would be a self-contained, fully operational lock structure which can be positioned behind the existing upper miter gates to form the auxiliary chamber. The device would be about 105 by 200 feet in size.

Mechanical Boat-Lift Devices

Five methods of lifting or moving pleasure craft over the dams were considered. Four of these devices, a steel lift crane, a mobile boat carrier, a steel tank with inclined rails, and an elevator were considered too slow and had insufficient capacity. Variations of these devices will be studied to determine their feasibility.

The fifth device, a differential railway lift, could handle four to six pleasure craft in one operation. This system consists of a steel tank (pan) being carried up an inclined plane, over a crest, and down a reverse plane without being tilted. The pan is rigidly suspended from a carriage equipped with wheels, and travels on a system of tracks elevated over the earth dike.

Secluded Tie-Up Facilities

Tie-up facilities could be provided, away from the immediate lock approach area, where boaters could wait without losing their locking priority.

Cost of Structural Alternatives

The approximate first cost (based on September 1977 prices) of the alternatives are given below:

360-foot auxiliary lock	$14,240,000
400-foot auxiliary lock	$29,000,000
Small-boat steel lock	$ 6,240,000
Small-boat concrete lock	$ 5,470,000
Mobil floating lock	$ 3,770,000
Differential railway lift	$ 2,000,000
Secluded tie-up facilities	$ 15,000

Nonstructural Alternatives

Possible nonstructural alternatives would include:

1. Establishment of recreational lockage times.
2. Changing of locking priorities under certain conditions.
3. Educating the boaters on lockage procedure.
4. Better communication (i.e., having radio stations announce the conditions at the locks).

The majority of pleasure boaters use the locks on weekends from Friday evening through Sunday evening and on holidays. During the 1976 season, the Corps conducted tests concerning the establishment of special pleasure craft locking periods at Lock and Dam 2 and Lock and Dam 7. The effectiveness of the above trial program will be monitored and will provide valuable data for the "Upper Mississippi River Small-Craft Locks Study".

FISH AND WILDLIFE HABITAT

The fish and wildlife habitat in the Upper Mississippi River Valley has been greatly improved by the more stabilized reservoirs resulting from the 9-foot channel commercial navigation project. This project created a maze of channels, sloughs, marshlands, and backwater lakes. Sport fishermen find most of these areas attractive. Commercial fishing is also a profitable undertaking; it contributes substantially to the economy of the valley. Commercial fishing along Iowa's border in 1974 netted 3,362,055 pounds of fish worth $522,135.

The Mississippi River is one of the great continental waterfowl flyways. Most of the lands acquired for the 9-foot channel navigation project above St. Louis have been made available to the Bureau of Sport Fisheries and Wildlife for waterfowl management purposes as part of the National Wildlife Refuge System. These lands have been incorporated into two major refuges: The 285-mile "Upper Mississippi River Wildlife and Fish Refuge", reaching from Wabasha, Minnesota to Rock Island, Illinois and the "Mark Twain National Wildlife Refuge" which is comprised of seven units between Muscatine, Iowa and St. Louis, Missouri. These two refuges, about 145,782 acres, comprise almost one-third of the Federally owned lands along the river. The existence of the refuges show that scenic recreational and wildlife values can survive in competition with a highly industrial society, providing there are safeguards to protect environmental values (Ref. 16).

In spite of the existence of excellent wildlife habitat and a productive fishery, major problems exist concerning water quality and sedimentation. Large volumes of noxious effluents are poured into the river from the Minneapolis-St. Paul metropolitan area. The navigation pool created by Lock and Dam 2 at Hastings, Minnesota, is the most affected. A breakdown of pollutants takes place in the pool, followed by an aeration process as the waters pass through the gates of the dam. This process takes place in each downstream pool as pollution is introduced into the river from smaller cities, agricultural lands, polluted water tables, and tributary streams (Ref. 16).

Water quality improves gradually downstream from Hastings. Both numbers and species of fish increase notably between Dams No. 2 and No. 4 at Alma, Wisconsin. The river also becomes cleaner bacteriologically. Pollution is less of a problem except locally below the larger cities.

Some reaches of the navigation pools are filling with sand and silt as tributary streams transport their loads to the main river. The result is the formation of a delta at the mouths of most tributaries and the gradual filling of the pools. Materials deposited in the navigational channel must be removed by dredging.

HYDROELECTRIC POWER

Electric power requirements of the Upper Mississippi River Basin are estimated to increase from 66.2 billion kwh in 1960 to 278.1 and 1,660 billion in 1980 and 2020 respectively (Ref. 21).

Although the production of hydroelectric power on the Mississippi River would be beneficial, the river does not lend itself to such production. The construction of high dams is impractical due to the flat slopes, low banks, and wide bottom lands flanking the river. Water power has been developed at a few favorable sites. The largest of these plants is located at Lock and Dam 19, Keokuk, Iowa with an installed capacity of 124,800 kw. The four generators at Locks and Dam 1 (St. Paul) have a total rated capacity of 18,000 kw. Locks and Dam 15 (Davenport) is the site of the smallest unit, rated at 312 kw.

MISSOURI RIVER

CHANNEL HISTORY

The Missouri River Navigation and Bank Stabilization Project, authorized in 1912, called for a channel 6 feet deep and 200 feet wide from Kansas City, Missouri to the mouth near St. Louis, Missouri. In 1927, Congress authorized an extension of the 6-foot channel to Sioux City, Iowa (Ref. 9).

PRESENT CHANNEL DESIGN

The present project, authorized in 1945, calls for a navigable channel 9 feet deep and 300 feet wide between Sioux City, Iowa and the mouth.

The project is designed as a free flowing waterway with a navigation channel having no locks or dams within the project limits. The river is aligned in a winding course of reversed bends which are generally from 2 to 2½ miles in length. The overall width of the river is held to specific dimensions by construction along both sides. This design uses the washing action of the river to maintain the desired channel depth.

The authorized channel dimensions now exist for 90 percent of the entire project; completion is scheduled for 1982. The remaining deficiencies are confined to crossing areas (where the channel crosses between bends of the river) and the long, flat reaches within some bends where the deep channel still meanders.

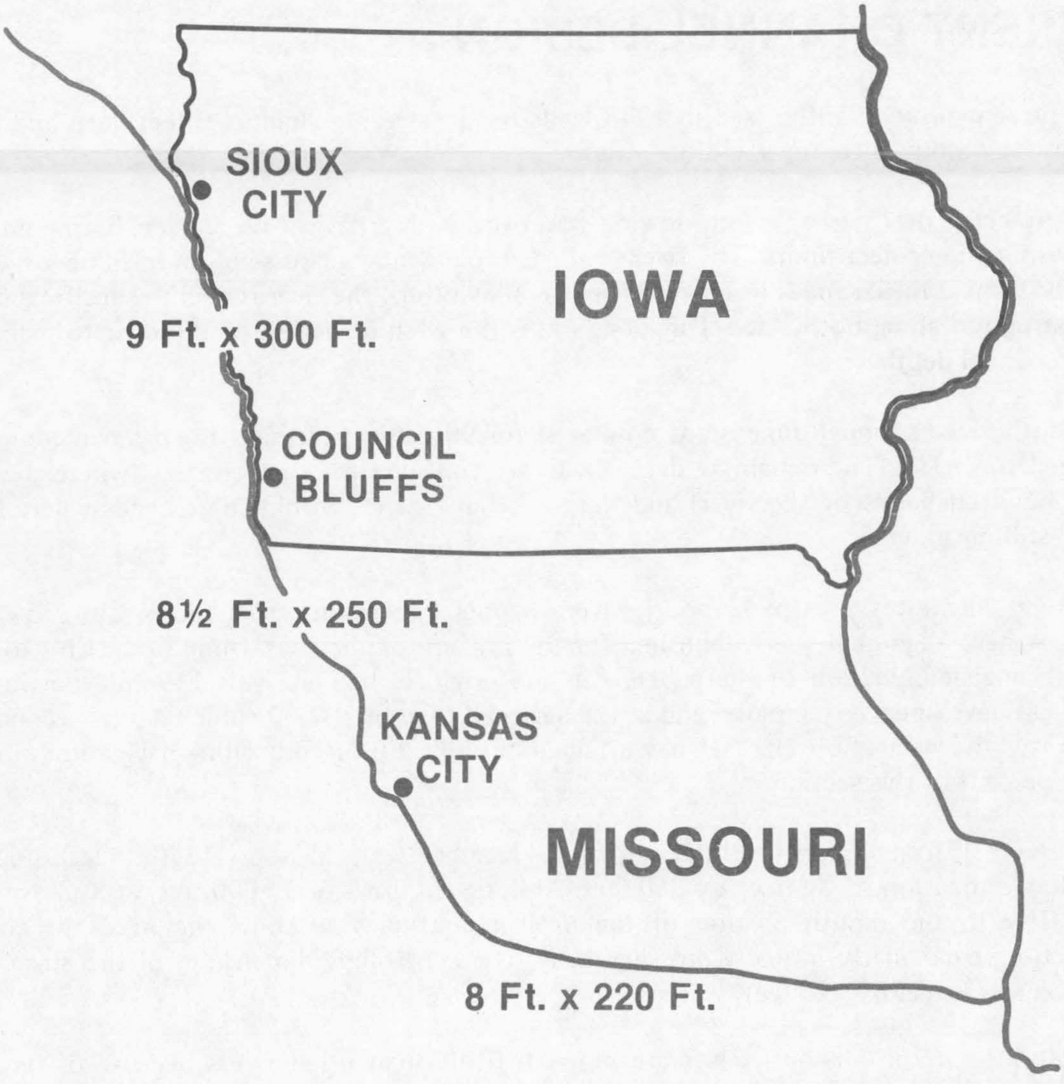
Figure 8 illustrates present Missouri River channel dimensions from Sioux City, Iowa to the mouth. A new alignment was established for the portion of the river from Sioux City to Council Bluffs through elimination of sharp bends in the original channel. This 119-mile portion of the project has developed very rapidly; and at the designed flow of 30,000 cubic feet per second (cfs) at Sioux City, the navigation channel has attained the full 9-foot controlling navigation dimensions over 99 percent of this section.

The channel from Council Bluffs, Iowa to Kansas City, Missouri (250 miles) now has a controlling dimension of 8½ feet by 250 feet. At designed flows of 35,000 (cfs) at Kansas City, the Kansas City to the mouth portion of the project continues to show the need for continued construction, particularly in many crossing areas. The controlling dimensions of this stretch of the river remain at 8 feet by 220 feet.

Operations on the Missouri River are more difficult than other rivers because of its stronger current (5 mph). The Upper Mississippi has a current of 2-3 mph.

FIGURE 8

MISSOURI RIVER CHANNEL DIMENSIONS



MAIN STEM RESERVOIR SYSTEM

Water supply for navigation is regulated by releases from six main stem reservoirs in Montana, North and South Dakota, and Nebraska (Figure 9). The reservoir system is operated according to a repetitive annual cycle by the Reservoir Control Center, Missouri River Division of the U.S. Army Corps of Engineers. The years water supply is produced by snow and rain which result in increased storage, maximum storage is 74.6 million acre-feet (maf). Storage reaches a peak in July or August, then begins a decline lasting until late in the winter when the cycle begins anew. A like pattern may be found in rates of releases from the system. The high levels of flow required for navigation or reducing reservoir flood storage are followed by low rates of winter discharge from late November until late March, then navigation levels are resumed (Ref. 13).

Effects of Water Supply on Navigation

Under present operating criteria, average Sioux City flows, as regulated to serve navigation, have a maximum target of 31,000 cfs; any flow in excess of that is to make up for deficient lower-basin inflow or to reduce flood storage. The minimum flow is 25,000 cfs; when main stem storage drops too low, water is conserved by shortening the navigation season rather than by cutting stream flow below 25,000 cfs. The first effect of growing main stem water use upon navigation is a reduction in rate of flow; the next effect is a shortening of season, and finally navigation releases are stopped.

Future Water Supply

Although there is enough water supply for Missouri River navigation today, competition for water is increasing rapidly in the Missouri River Basin. Continued growth of upstream consumptive use of water for irrigation, domestic, municipal, mining, and industrial purposes may some day limit the use of the Missouri River for navigation.

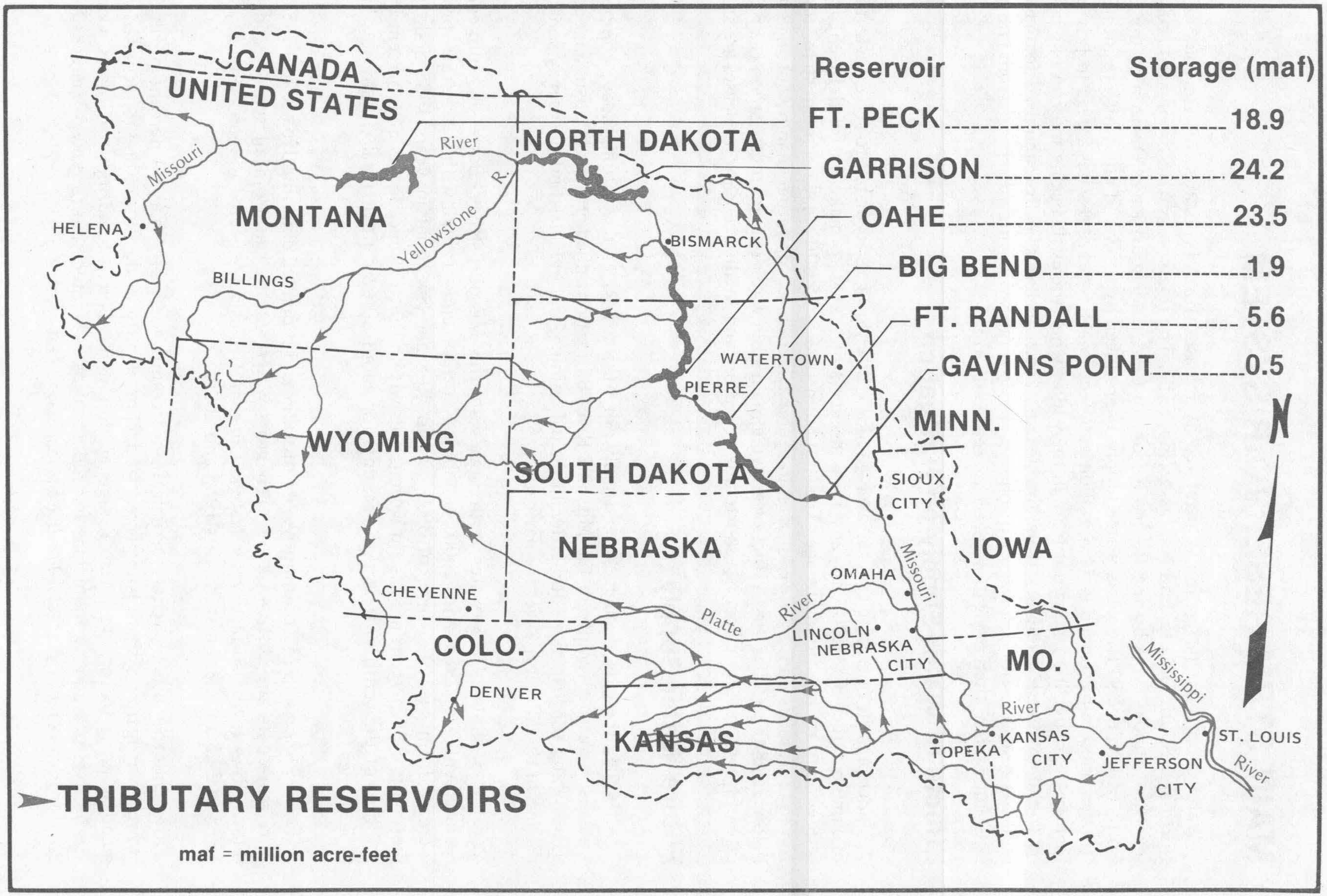
Table 6 shows 1975 water withdrawals in the Missouri River Basin and projected water requirements to 1985 and 2000. Combined surface and ground withdrawals are projected to increase from the 1975 level of 39.9 maf to 49.8 and 54.2 maf in years 1985 and 2000. This represents a 25 percent increase in withdrawals within the next decade and a 36 percent increase by the turn of the century. Irrigation accounts for about 80 percent of total withdrawals in all three time frames (Ref. 8).

Table 7 shows 1975 consumptive use of water and projected consumptive use to 1985 and 2000. This represents the difference between gross water withdrawals from all sources and estimated return flows to the surface water system. Consumptive use is expected to increase from 17.6 maf in 1975 to 22.5 and 28.4 maf in years 1985 and 2000.

Consumptive use of water for irrigation accounts for more than 90 percent of all 1975 use. However, irrigation's share is expected to decline slightly in the future due to increased use by the manufacturing sector, steam electric generation, and municipal and industrial users. Consumptive use by livestock and by municipal and industrial users is forecasted to grow 50 percent by the year 2000 from a combined total 1975 use of nearly one maf (Ref. 8).

FIGURE 9

MISSOURI RIVER BASIN



Reservoir	Storage (maf)
FT. PECK	18.9
GARRISON	24.2
OAHE	23.5
BIG BEND	1.9
FT. RANDALL	5.6
GAVINS POINT	0.5

TABLE 6

MISSOURI RIVER BASIN
1975 WATER USE AND PROJECTED WATER REQUIREMENTS, 1985-2000
WITHDRAWALS

FUNCTIONAL USE	Water Use 1975		Water Requirements			
	Ground (1,000 AF)	Surface (1,000 AF)	1985 (1,000 AF)	1985/ 1975	2000 (1,000 AF)	2000/ 1975
Municipal & Industrial (Central Systems)	399.1	823.5	1668.0	1.36	2107.4	1.72
Rural Domestic	148.0	40.4	203.8	1.04	201.9	1.05
Manufacturing (Self-Supplied)	298.6	428.8	1020.4	1.40	1308.2	1.80
Mining	141.6	209.3	361.7	1.09	446.3	1.33
Irrigation	8479.6	22909.7	37688.3	1.20	43226.4	1.38
Livestock	272.8	215.5	652.6	1.33	825.6	1.67
Steam Electric	21.4	5539.0	8189.7	1.47	6098.3	1.10
TOTAL	9761.1	30166.2	49784.5	1.25	54214.1	1.36

AF = Acre-feet per year

Source: Water And Related Land Resources In The Missouri River Basin, Technical Memorandum No. 2, 1975 National Water Assessment, Missouri River Basin Commission, August 1976.

TABLE 7

MISSOURI RIVER BASIN
1975 WATER USE AND PROJECTED WATER REQUIREMENTS, 1985-2000
CONSUMPTIVE USE

FUNCTIONAL USE	Water Use	Water Requirements			
	1975 (1,000 AF)	1985 (1,000 AF)	1985/ 1975	2000 (1,000 AF)	2000/ 1975
Municipal & Industrial (Central Systems)	479.1	651.4	1.36	808.5	1.69
Rural Domestic	122.3	126.5	1.03	122.4	1.00
Manufacturing (Self-Supplied)	217.3	376.1	1.73	567.6	2.61
Mining	126.6	131.4	1.04	153.9	1.22
Irrigation	16053.0	20351.1	1.27	25331.2	1.58
Livestock	480.3	643.0	1.34	814.7	1.70
Steam Electric	74.6	242.4	3.25	645.0	8.65
TOTAL	17553.2	22521.9	1.28	28443.3	1.62

AF = Acre-feet per year

Source: Water And Related Land Resources In The Missouri River Basin, Technical Memorandum No. 2, 1975 National Water Assessment, Missouri River Basin Commission, August 1976.

Table 8 shows year 1975 and projected flow rates of the Missouri River at Sioux City, Iowa. The 1975 flow rate of 18.5 maf annually is projected to decrease to 16.4 and 13.6 maf by 1985 and 2000. Figure 10 shows how the percentage of full and near-full length navigation seasons decline as depletions above Sioux City increase. At the 1975 flow rate of 18.5 maf, a navigation season of 4 months or more could be expected for 9.6 years out of 10, however, a navigation season of 8 months could be expected in only 6.7 years out of 10. As upstream depletions further reduce the flow rate to 13.6 maf projected by year 2000, a navigation season of 4 months or more could be expected for 5.7 years out of 10; a season of 8 months could be expected 2.2 years out of 10.

TABLE 8

WATER SUPPLIES/DEPLETIONS AT SIOUX CITY 1975-2000

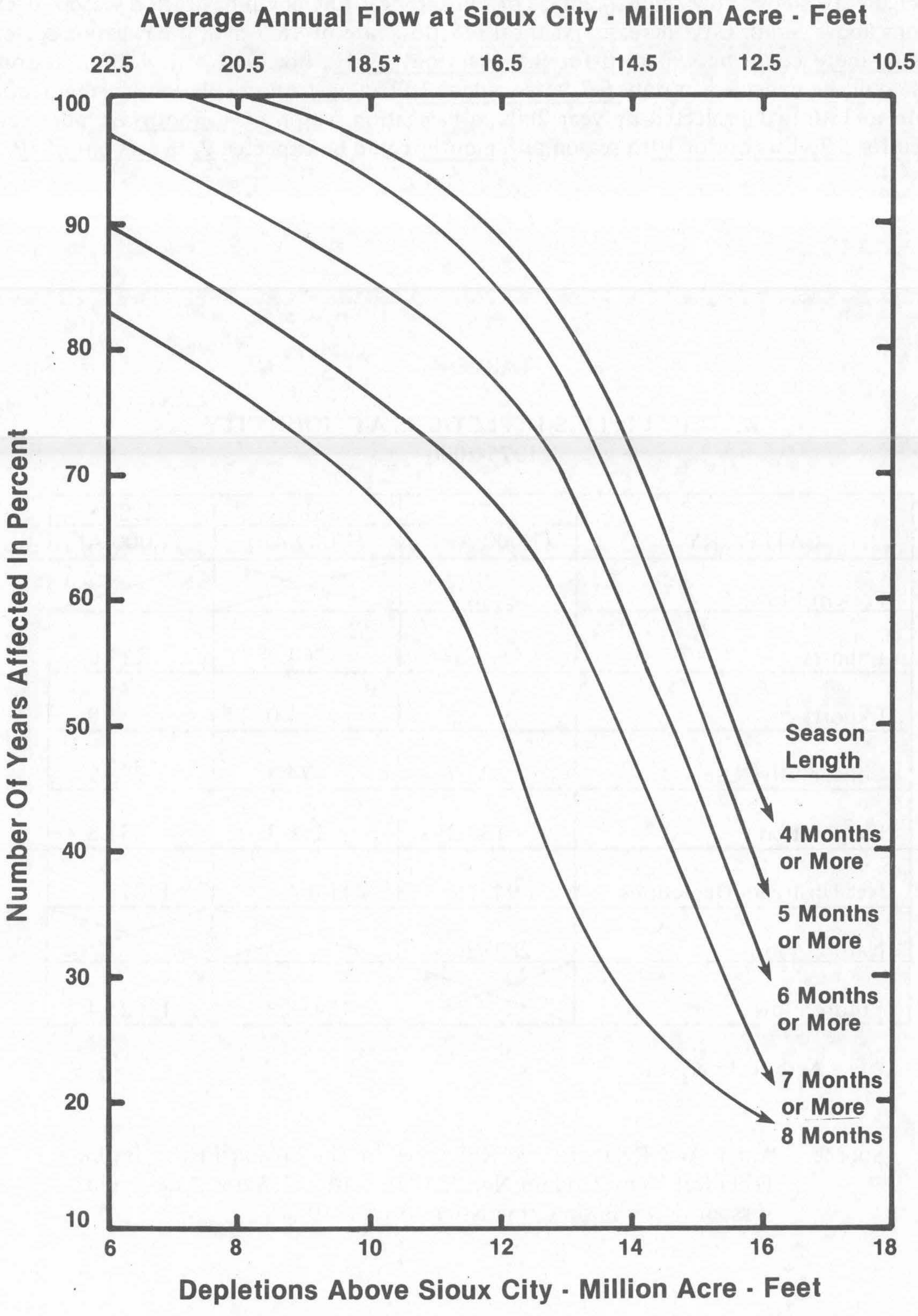
CATEGORY	1975 (1,000 AF)	1985 (1,000 AF)	2000 (1,000 AF)
Present Flow	18458.4		
Imports	0	104.2	233.0
Exports	0	0	0
Consumptive Use	303.7	474.3	786.2
Evaporation	138.3	138.3	138.3
Net Upstream Depletions	9431.6	11404.8	14015.1
Natural Flow	28332.0		
Future Flow		16418.8	13625.4

AF = Acre-feet per year

Source: Water And Related Land Resources In The Missouri River Basin, Technical Memorandum No. 2, 1975 National Water Assessment, Missouri River Basin Commission, August 1976.

FIGURE 10

NAVIGATION SEASON CURTAILMENT CAUSED BY STREAM DEPLETION



* 1975 Average Annual Flow

CHANNEL BED DEGRADATION

The swift current caused by shortening the channel in the upper reaches of the Missouri River has led to channel degradation. This has been occurring since the completion of Gavins Point Dam in 1955. Channel bed degradation has resulted in lower water surface elevation at given discharges as illustrated in Table 9.

TABLE 9

CHANNEL BED DEGRADATION - MISSOURI RIVER

Location Downstream From Gavins Point Dam	Stage Reduction At Reference Discharge of 30,000 cfs
Gavins Point Tailwater	- 7.5 ft
5 mi downstream	- 3.0 ft
57 mi downstream	- 4.0 ft
79 mi downstream (Sioux City, IA)	- 7.0 ft
120 mi downstream (Decatur, NE)	- 5.0 ft
163 mi downstream (Blair, NE)	- 2.0 ft
196 mi downstream (Council Bluffs, IA)	+1.0 ft

Channel bed degradation can be viewed as a benefit or a problem only in respect to the interests affected. Positive aspects of channel bed degradation include:

1. Reduced flooding because of additional channel capacity.
2. More riparian land is suitable for farming by reductions in drainage problems of bottom lands.

Problems or potential problems caused by channel bed degradation include:

1. Potential damage to the foundations of the highway and railroad bridges in the affected area.
2. Operational problems at terminal facilities (low draft, high docks), and undermining of channel stabilization structures.
3. Further degradation combined with low flows could leave power plant intakes higher than the flow line.
4. The stagnation and/or drying up of many of the oxbow lakes through a process of reliction.
5. The Iowa Geological Survey is concerned about possible effects of a lowered Missouri River water surface on the regional water table.

DREDGING

Dredging is required at locations on the Missouri River where the wash of the river, in combination with channel structures, does not provide the desired channel dimensions. Twenty-four sites were dredged in 1974 and dredging was not necessary in 1975. Dredging has not been required above Rulo, Nebraska since 1965. The avoidance of dredging is a design objective and future need for dredging is expected to decrease. Areas more likely to schoal include reaches downstream of tributary mouths, unusual channel alignments, and bridge crossings. Future dredging will be performed either by Government forces or by contract on an as-needed basis.

In past years, dredged material has been placed in river areas between or behind project structures. This practice destroys aquatic habitat and was objected to by agencies primarily concerned with fish and wildlife. Beginning in 1974, the dredge material was deposited in the main channel at two dredging sites on a trial basis. This method is being studied to determine the conditions under which it can be used without shoaling the downstream channel.

The Corps of Engineers issues a public notice under the provisions of Title 33 CFR 209: 145, advising interested parties of the proposed dredging. The public notice provides interested agencies and individuals 30 days to submit written comments on the proposed action; public hearings may also be requested. In the future, selection of dredge material disposal sites will be in accordance with EPA guidelines in accordance with Public Law 92-500.

RESTRICTIVE BRIDGES

Sixty bridges carry rail and highway traffic over the navigable portion of the Missouri River. Nine of these structures have either a "swing span" or "vertical lift" span to allow for the passage of river tows (see Table 10). Tows have the right-of-way at draw bridges and consequently they do not hamper waterway traffic. The fixed structures have adequate vertical clearance to allow passage of tows and range from 238 feet to 620 feet in horizontal clearance.

NAVIGATION SEASON

The commercial navigation season is limited to the ice-free period of the year which generally runs from the 1st of April through November. When weather and storage water availability permit, the navigation season is extended by earlier opening and later closing dates.

It is expected that release from the upstream reservoirs will maintain levels above the normal navigation requirements for the next few years, and this will reduce operational difficulties in the areas that are still lacking the necessary channel control structures.

TABLE 10

DRAW BRIDGES - MISSOURI RIVER

City	River Mile*	Type Structure	Horizontal Clearance	Usage
Sioux City, IA	732.3	Swing Span	215'	I-29
Council Bluffs, IA	618.3	Swing Span	236'	I.C.G. RR
St. Joseph, MO	448.2	Swing Span	200'	U.P. RR
Atchison, KS	422.5	Swing Span	160'	A.T.&S.F. RR
Leavenworth, KS	396.7	Swing Span	202'	C.&N.W. RR
Kansas City, MO	366.1	Swing Span	200'	C.B.&Q. RR
Kansas City, MO	365.6	Vertical Lift	395'	US 169-71-69
Kansas City, MO	359.4	Vertical Lift	403'	C.M.St.P.&P. RR C.R.I.&P. RR
Boonville, MO	197.1	Vertical Lift	400'	M.K.&T. RR

*Miles above Ohio River

RECREATIONAL BENEFITS

In 1965 plans were started for 60 public recreational sites along both banks of the Missouri River from Sioux City to the mouth. The overall plan calls for eight recreational areas along Iowa's border, of which three are now complete (Ref. 22).

Recreational facilities have also been developed at several of the oxbow lakes (cut-offs resulting from the elimination of sharp bends during development of the navigation project). This development has been only moderately successful because Missouri River bed degradation makes it difficult to keep a fresh flow of water to the oxbows. The Corps of Engineers has recently been authorized to create six more oxbow cutoff lakes. Alternatives are presently being studied to develop these into more viable water related recreational areas.

Recreational activities include boating, fishing, hunting, camping, picnicking, and hiking. However, the lack of access because of private lands adjoining the river is a barrier to more public use than is occurring today. There are 14 public boating access sites along Iowa's 182 Missouri River miles. Recreational boating and water skiing is often restricted by high river stages which carry hazardous floating debris. River speed is also a frequent deterent to these activities. Two large marinas exist at Sioux City, Iowa for use by recreational boaters.

Fishing as an economic pursuit has decreased during the last 30 years on the Missouri River. The reported catch for 1973 was 335,022 pounds, excluding the main stem reservoirs. The total commercial value of the catch was estimated to be about $52,000 (Ref. 17).

TRANSPORTATION EQUIPMENT

TOWBOATS

In the early days of river transportation, the freight-carrying vessels were pulled or towed. The modern practice is to push the barges, but the traditional term "towboat" is still used for the modern barge pushers.

The most striking feature of the modern towboat is its power. In 1940, the average towboat used for long-haul operations generated about 350 horsepower; 1200 HP in 1955; and 3,200 HP in 1966. Towboats of 5,000 horsepower or more are common today, and vessels of 7,200 to 10,000 horsepower operate on the Lower Mississippi River. Lock sizes and channel conditions make the use of towboats with more than 7,200 horsepower uneconomical above St. Louis (Ref. 14).

While the number of towboats operating on the Mississippi River System and Gulf Intercoastal Waterway increased by only 3 percent during the years 1971-1974, the average horsepower increased by 37 percent (Ref. 11). The trend of increasing size and power of towboats will theoretically increase system capacity. However, increased size (draft) can also restrict boats from operating over the entire river system, thereby reducing the flexibility of water operators. Fig. 11 shows typical towboats used in inland water transportation. Practically all towboats are diesel powered and carry a crew of 6 to 15 persons depending on the size of the tow and operating area.

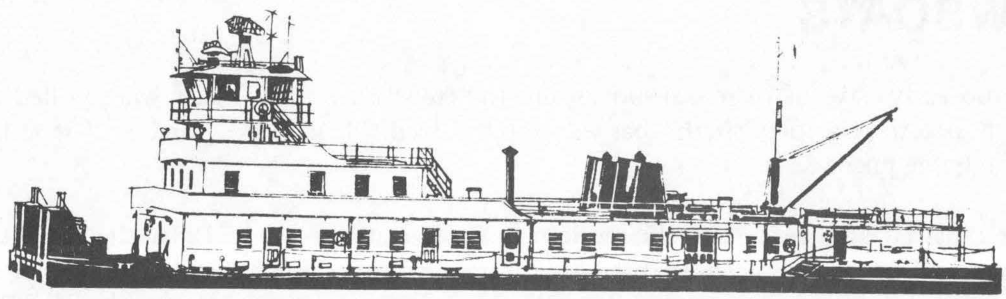
BARGES

Modern barges differ in several respects from those used during the earlier years of the inland waterways. The most striking change has been in capacity. A half century ago, barges were limited to a freight capacity of 200 to 800 tons. Most of the barges being built today have a freight capacity ranging from 1000 to 3000 tons. The most common types of barges used today are hopper barges for dry cargoes and tank barges for liquid cargoes.

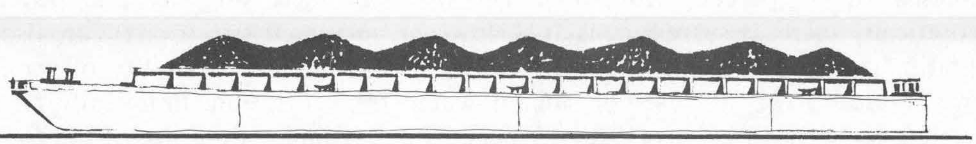
During the years 1971-1974, the number of dry cargo barges increased by 30 percent, from 13,318 to 17,345 barges. During the same period the total dry cargo capacity has increased by 42 percent, from 14.8 million tons to 21 million tons (Ref. 11). As dry cargo barges can be used for a number of different commodities, competition for barges may limit the number available for a given commodity such as grain, coal or fertilizer. The number of tank barges increased to 2,903 (12 percent) from 1971 to 1974 while total liquid cargo capacity increased by 29 percent. Fig. 11 shows common barges used in inland water transportation.

FIGURE 11

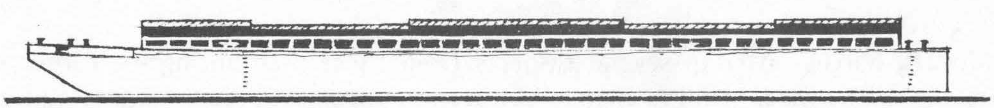
TYPICAL TOWBOATS AND BARGES



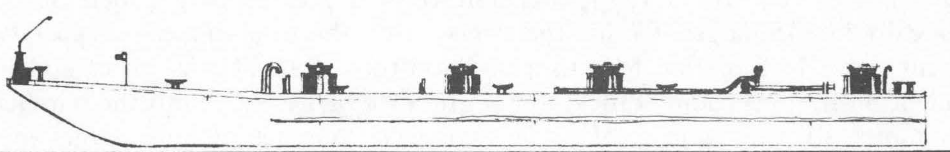
TOWBOATS	Length Feet	Breadth Feet	Draft Feet	Horsepower
	117	30	7.6	1000 to 2000
	142	34	8	2000 to 4000
	160	40	8.6	4000 to 6000



OPEN HOPPER BARGES	Length Feet	Breadth Feet	Draft Feet	Capacity Tons
	175	26	9	1000
	195	35	9	1500
	290	50	9	3000



COVERED DRY CARGO BARGES	Length Feet	Breadth Feet	Draft Feet	Capacity Tons
	175	26	9	1000
	195	35	9	1500



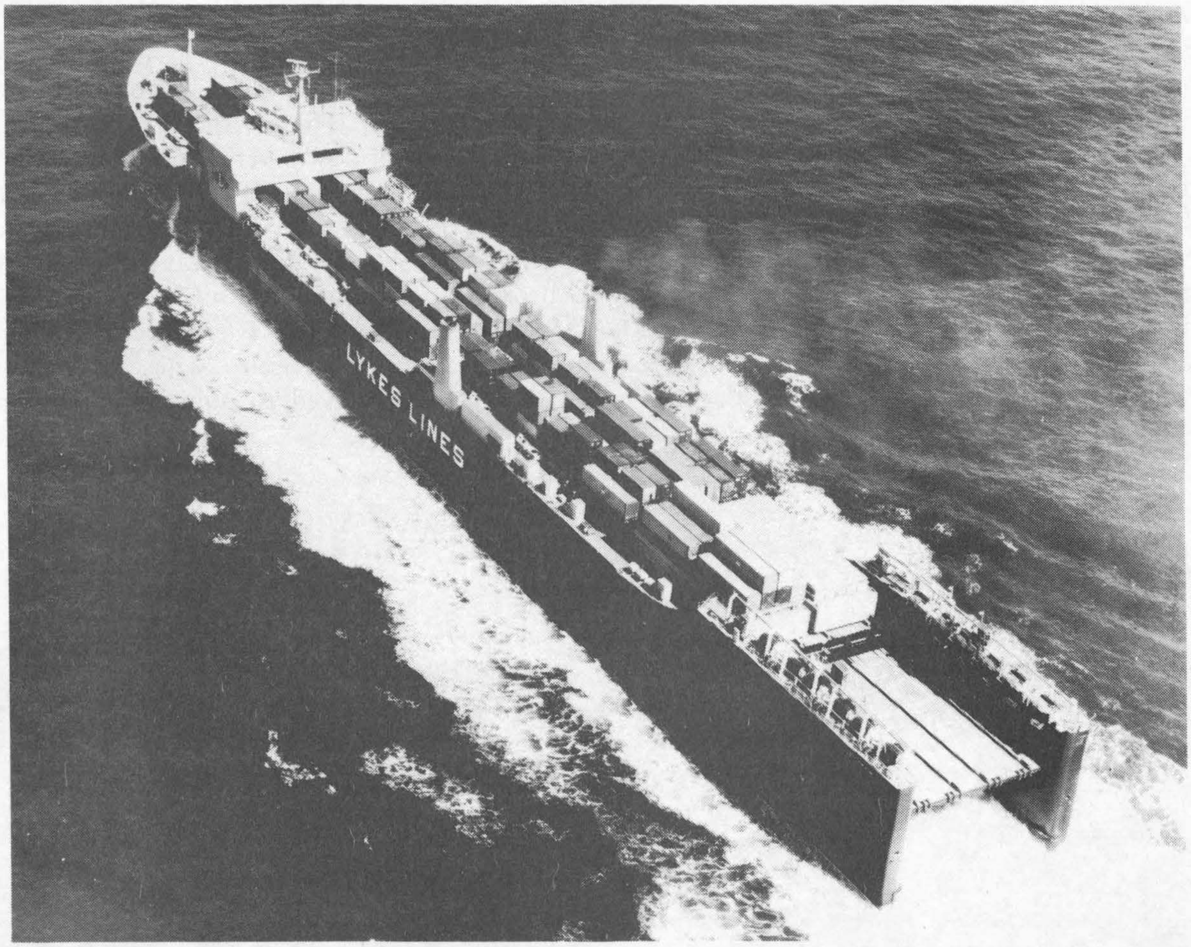
LIQUID CARGO (TANK) BARGES	Length Feet	Breadth Feet	Draft Feet	Capacity Tons	Capacity Gallons*
	175	26	9	1000	302,000
	195	35	9	1500	454,000
	290	50	9	3000	907,200

* Based on an average of 7.2 barrels per ton and 42 gallons per barrel.

Source: The American Waterways Operators, Inc., Arlington, Virginia.

SEABEE AND LASH SYSTEMS

The Seabee and LASH Systems are a recent inovation in water transportation. These systems employ specially built barge carrying ships for oceangoing transport. The barges are unloaded from the mother ship and formed into a tow for movement over inland waterways.



Seabee Barge Container Ship

Seabee barges have a 750-ton cargo capacity. They are 97 feet 6 inches long by 35 feet wide, with a draft of 9 feet (one half the size of standard river barges). This feature allows them to be integrated into any tow. LASH barges have a 400-ton cargo capacity. They are 61 feet 6 inches long by 31 feet 2 inches wide, with a draft of 13 feet. It is more difficult to use this size barge in typical tows on the inland waterway system.

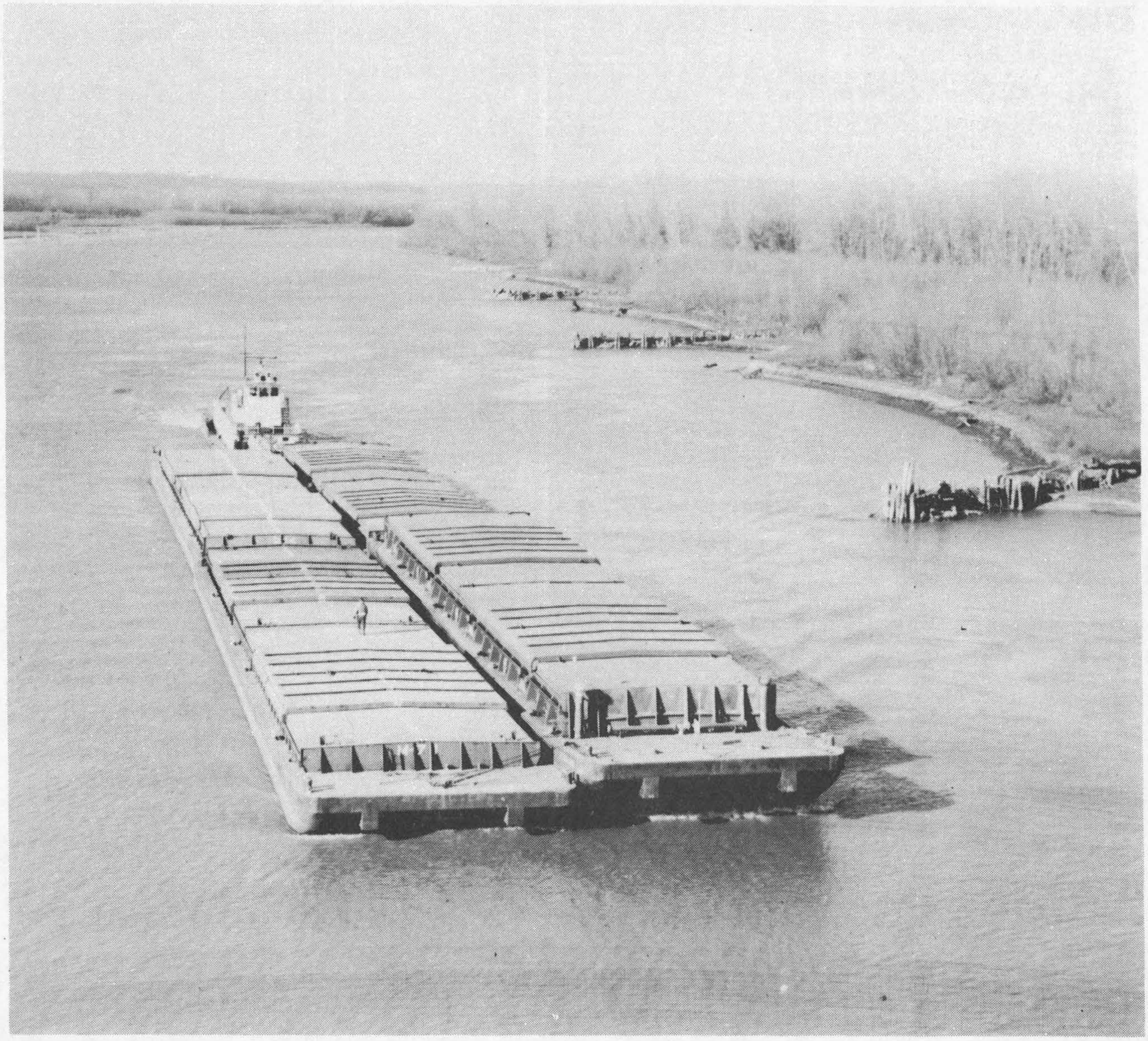
TOWS

Dedicated tows (single commodity tows) are moved from origin to destination by the same towboat without picking up or dropping off other barges. These are often used in the movement of grain, coal, and bulk liquids.

Many operations involve movement of several commodities in a single tow. Linehaul towboats involved in these operations continually pick up and drop off barges at fleeting areas; these are similar in purpose to rail classification yards. A 3,000-5,000 HP towboat may be used to collect loaded barges along the Illinois or Upper Mississippi Waterways and carry them south to St. Louis. Then that towboat may return upstream to repeat this operation. The tows delivered to the St. Louis fleeting area may be integrated with others and then moved downriver to Cario, Illinois. At Cario, the tow may be delivered to a still larger towboat for southbound movements, and the delivering towboat returns to St. Louis with barges originating at Cairo. The southbound tow pushed by a 7,000-10,000 HP towboat may consist of forty barges all the way south to New Orleans. At the New Orleans terminal, the tow is broken up into smaller units for shipment to unloading docks, or for movement along the Gulf Intercoastal Waterway. The delivering towboat will pick up a northbound tow at New Orleans for the return trip to Cairo. These northbound barges will then be broken into smaller units (8-15 barges) and moved to points on the Upper Mississippi, Ohio, or Illinois Rivers (Ref. 15).

Tow of 15 Grain Barges Near Burlington, Iowa

On the Missouri River current tow sizes average three barges above Kansas City and five barges below Kansas City. The average towboat size is 2400 horsepower.



Tow of 4 Barges - Missouri River

Navigation equipment on the inland waterways has benefited from several new technical advances. Radar has made foul weather operation possible, and can save many hours and even days of trip time from origin to destination. Communication systems have become more advanced and can put operational problems and subsequent decisions on an almost immediate basis.

COMMERCIAL TRAFFIC

INLAND WATERWAYS OF THE U.S.

Inland water transportation is ideally suited for the low cost, high volume movement of bulk commodities. Table 11 shows tonnage and ton-miles generated on inland waterways of the United States for selected years.

TABLE 11

COMMERCIAL TRAFFIC ON INLAND WATERWAYS OF THE U.S. EXCLUSIVE OF GREAT LAKES

Year	Tons (Millions)*	Ton-Miles (Billions)*	Average Length of Haul (Miles)
1947	150	35	233
1950	191	52	272
1960	291	121	416
1970	472	205	434
1975	504	243	482

*Source: Transportation Facts and Trends, Thirteenth Edition -- 1977.

During the 29-year period from 1947 to 1975, tonnage transported on inland waterways increased 3.4 times while ton-miles increased 7 times. The large growth in ton-miles is attributable to the increased length of haul for water carriers, 233 miles in 1947 to 482 miles in 1975.

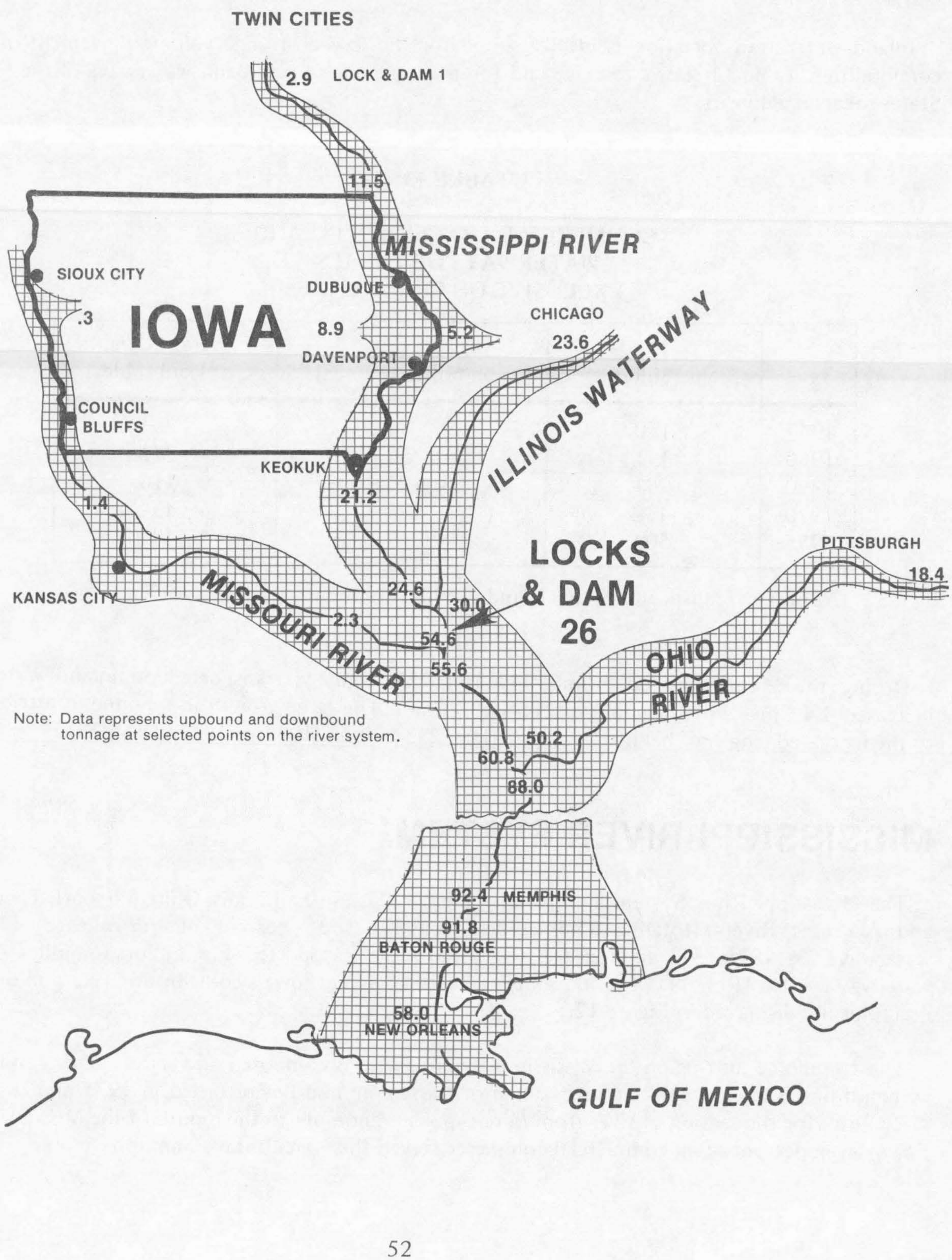
MISSISSIPPI RIVER SYSTEM

The Mississippi River System and its navigable tributaries, the Illinois, Ohio, Missouri, Tennessee, and Arkansas Rivers (totaling 8,954 miles) constitutes 35 percent of the mileage of inland waterways. In 1975, 311 million tons of cargo were transported 119 billion ton-miles on this waterway system (Ref. 11). The movement of this cargo and Iowa's contribution (9.2 million tons) is graphically displayed in Figure 12.

The commerce moving on the Mississippi River System is composed of a variety of dry and liquid commodities. Table 12 shows a breakdown of those commodities recorded in 1975 and totals for prior years for the section of river from Minneapolis, Minnesota to the mouth of the Missouri River. Forty-seven percent of all commercial commerce served the agricultural community.

FIGURE 12

MISSISSIPPI RIVER SYSTEM TONS OF CARGO (MILLIONS) 1975



Note: Data represents upbound and downbound tonnage at selected points on the river system.

TABLE 12

COMMERCIAL TONNAGE
UPPER MISSISSIPPI RIVER

From Minneapolis, Minnesota, to the mouth
of the Missouri River - 663 miles

TOTAL ANNUAL TRAFFIC

Year	Inland Waterway Net Tons	Inland Waterway Ton-Miles	Oceangoing Net Tons	Oceangoing Ton-Miles
1968	45,846,463	7,633,761,774	328,466	9,678,436
1969	49,424,746	8,766,811,590	225,585	20,205,854
1970	53,770,490	10,427,616,808	252,259	6,886,461
1971	52,479,538	10,203,254,162	293,559	12,761,720
1972	60,417,136	11,596,809,502	329,249	18,897,955
1973	57,818,045	10,873,575,077	246,153	5,626,401
1974	61,747,186	11,700,427,879	266,458	7,122,004
1975	63,080,102	11,293,894,600	158,565	8,620,861

PRINCIPAL COMMODITIES FOR
CALENDAR YEAR 1975

Commodity	Net Tons Oceangoing	Net Tons Inland Waterway
Grain and Grain Products	39,785	26,435,889
Petroleum Products		12,580,296
Coal and Lignite		8,806,384
Chemicals		3,111,865
Fertilizer	112,343	3,225,442
Iron and Steel Products	6,437	2,307,341
Sand, Gravel, Crushed Rock		2,163,080
Nonmetallic Minerals		1,729,566
Building Cement		1,262,420
Food Products		659,207
Miscellaneous		768,612
Total	158,565	63,080,102

Source: 1975 Inland Waterborne Commerce Statistics, The American Waterways Operators, Inc.

Figure 13 shows the growth of waterborne tonnage from 1950 through 1977 on the Mississippi River - Rock Island District (Guttenberg, Iowa to Hannibal, Missouri). This tonnage grew at an average annual rate of 6.9 percent during the period 1965-1977. This compares with a 4.4 percent growth rate on the entire Mississippi River System and 3 percent on all the nations waterway systems during this same period (Ref. 14). Table 13 shows tonnage by lock within the Rock Island District.

TABLE 13

COMMERCIAL TONNAGE
THROUGH LOCKS (MILLIONS)
ROCK ISLAND DISTRICT

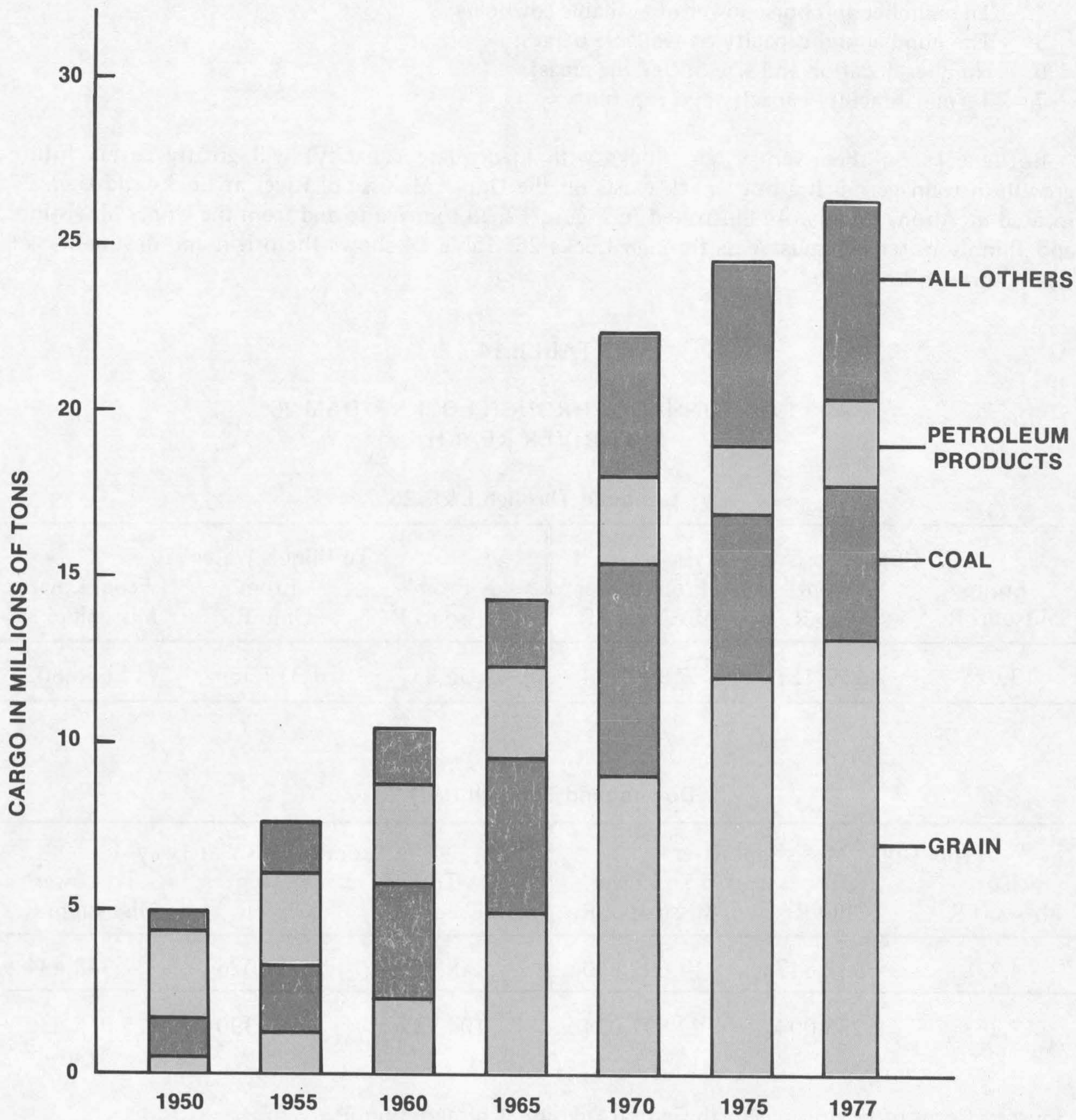
Lock	1960	1965	1970	1975	1977
11	7.0	8.3	13.6	13.3	14.7
12	7.4	8.9	14.1	14.7	15.1
13	7.4	9.0	14.1	14.7	15.2
14	7.9	9.7	15.8	15.9	17.4
15	8.4	10.3	16.7	16.6	18.0
16	8.7	10.7	17.6	18.3	19.8
17	8.7	11.1	18.4	19.1	20.2
18	8.8	11.6	18.7	19.5	20.8
19	8.9	12.3	20.0	21.2	21.0
20	9.3	12.6	20.4	21.7	23.0
21	9.5	12.9	20.9	22.3	23.9
22	9.5	13.3	21.3	23.0	24.3

One Tow in Lock Chamber and Another Waiting at Lock 16

FIGURE 13

COMMERCIAL TRAFFIC ON MISSISSIPPI RIVER

Rock Island District



Projected Commerce

Several studies have been made concerning projected waterborne commerce. Most waterway commerce projections to date assume that traffic growth will not be constrained by limitations in the system. However the actual capacity of a waterway is a function of such variables as:

1. The physical constraints of the river system, e.g., locks and dams, bridges, and channel dimensions;
2. Variations in the river due to seasonal conditions, e.g., low water and ice;
3. The availability of compatible backhauls;
4. The number and horsepower of available towboats;
5. The number and capacity of available barges;
6. Number, location and size of fleeting areas;
7. Terminal facility capacity and capability

Bottlenecks on the river system (locks with inadequate capacity) will greatly curtail future growth in tonnage. Such a bottleneck exists on the Upper Mississippi River at Locks and Dam 26 located at Alton, Illinois. As illustrated in Figure 12, all tonnage to and from the Upper Mississippi and Illinois Waterway must pass through Locks 26. Table 14 shows the origin and destination of traffic through Locks 26.

TABLE 14

1974 TONNAGE THROUGH LOCKS & DAM 26
BY RIVER REACH

Upbound Through L&D 26

To Upper Mississippi River			To Illinois Waterway		
From Missouri R.	From Ohio R.	From Lower Mississippi R.	From Missouri R.	From Ohio R.	From Lower Mississippi R.
13,025	1,297,157	7,904,174	55,837	1,317,364	12,666,802

Downbound Through L&D 26

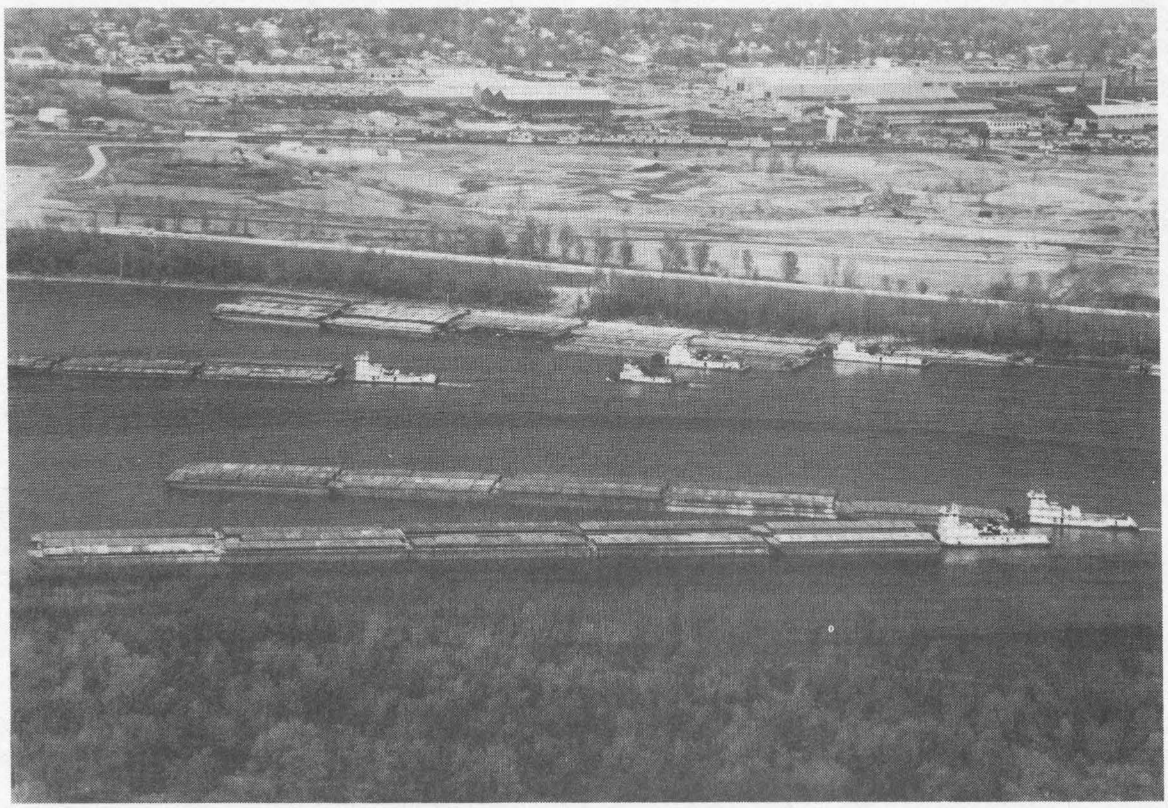
	From Upper Mississippi River			From Illinois Waterway		
	To Missouri R.	To Ohio R.	To Lower Mississippi R.	To Missouri R.	To Ohio R.	To Lower Mississippi R.
	4,238	937,847	14,692,850	48,915	1,339,026	12,348,434
Totals	17,263	2,235,004	22,597,024	104,752	2,656,390	25,015,236

Source: Corps of Engineers, North Central Division, Chicago, Illinois.

Locks and Dam 26 consists of one 110' x 600' lock and one 110' x 360' lock. Most "feeder" locks on both the Upper Mississippi and the Illinois Waterway were designed to allow passage of approximately the same annual tonnage as Locks 26. Only Locks and Dam 27, below Alton, must handle the same load as Locks 26. Locks and Dam 27 consists of one 110' x 1200' lock and one 110' x 600' lock. From Locks and Dam 27 to New Orleans there are no locks on the Mississippi River.

Locks 26 reached their 46-million-ton design capacity in 1970. Traffic has increased to 58.4 million tons in 1977; there are delays up to 40 hours for tows waiting to lock through. Therefore, future growth in commerce on the Upper Mississippi is relative to Locks and Dam 26. Upstream traffic is limited to that passing through Locks 26 plus internal traffic which does not utilize Locks 26.

Table 15 shows existing and projected commerce to 2000-2020 at selected locks on the Upper Mississippi based on various alternatives at Locks and Dam 26. The table illustrates how locks and dams located on the waterway system restrict upstream growth in tonnages as compared to maximum growth assuming an unconstrained system. Locks 26 are expected to reach their maximum capacity of 73 million tons by 1981. This will restrict the volume of tonnage through the remaining Upper Mississippi locks.



Tows Awaiting Lockage Through Locks & Dam 26

TABLE 15

EXISTING AND PROJECTED COMMERCE
UPPER MISSISSIPPI RIVER
BASED ON TWO ALTERNATIVES FOR LOCKS AND DAM 26
Millions of Tons/Yr.

		Year 2000			Year 2020		
Location	1977 Tonnage	Uncontrained System 1/	Existing Structure- One 110'x600' Lock One 110'x360' Lock	One 110'x1200' Lock New Site 2/	Unconstrained System 1/	Existing Structure- One 110'x600' Lock One 110'x360' Lock	One 110'x1200' Lock New Site 2/
Locks 1	2.9	13.9	10.7	12.0	19.4	10.6	13.3
Lock 6	11.6	21.0	15.4	17.6	28.4	14.4	19.0
Lock 11	14.7	28.1	20.9	23.9	38.4	20.0	26.0
Lock 16	19.8	37.0	27.8	31.7	50.0	26.5	34.4
Lock 20	23.0	42.1	29.8	35.3	56.1	28.5	38.0
Lock 25	25.1	47.6	33.9	39.0	63.2	31.6	42.0
Locks 26	58.4	106.2	73.0	86.0	134.8	73.0	86.0
Locks 27	64.3	115.0	84.4	97.4	145.0	86.2	99.2

1/ Assumes:
Traffic growth will not be constrained by any limitations in the system.
The modal share will remain constant over the projection period.

2/ Assumes:
1. Only nonstructural and minor structural measures will be applied to the system (except for the alternative under consideration) where necessary to maximize locking capacity.
2. Current tonnage per tow.

Source: Locks and Dam 26 (Replacement) Supplemental Economic Data, Part I, U.S. Army Corps of Engineers, January 1977.

Example: 19.8 million tons passed through Lock 16 near Muscatine, Iowa in 1977; 37 million tons are projected to pass through Lock 16 by the year 2000 considering an unconstrained system of locks downstream. However, tonnage through Lock 16 will not exceed 27.8 million tons if Locks 26 are constrained to 73 million tons. Tonnage through Lock 16 could reach 31.7 million tons if Locks 26 capacity is increased to 86 million tons (one 110' x 1200' lock).

It is the opinion of the Iowa DOT that the above projection represents the most likely future traffic level on the Upper Mississippi.

Other Waterway Commerce Projections

The Upper Mississippi River Comprehensive Basin Study shows low, medium, and high range projections to years 1980, 2000, and 2020, (see Table 16). The projections include the section of the Mississippi from Cairo, Illinois to Minneapolis, Minnesota.

TABLE 16

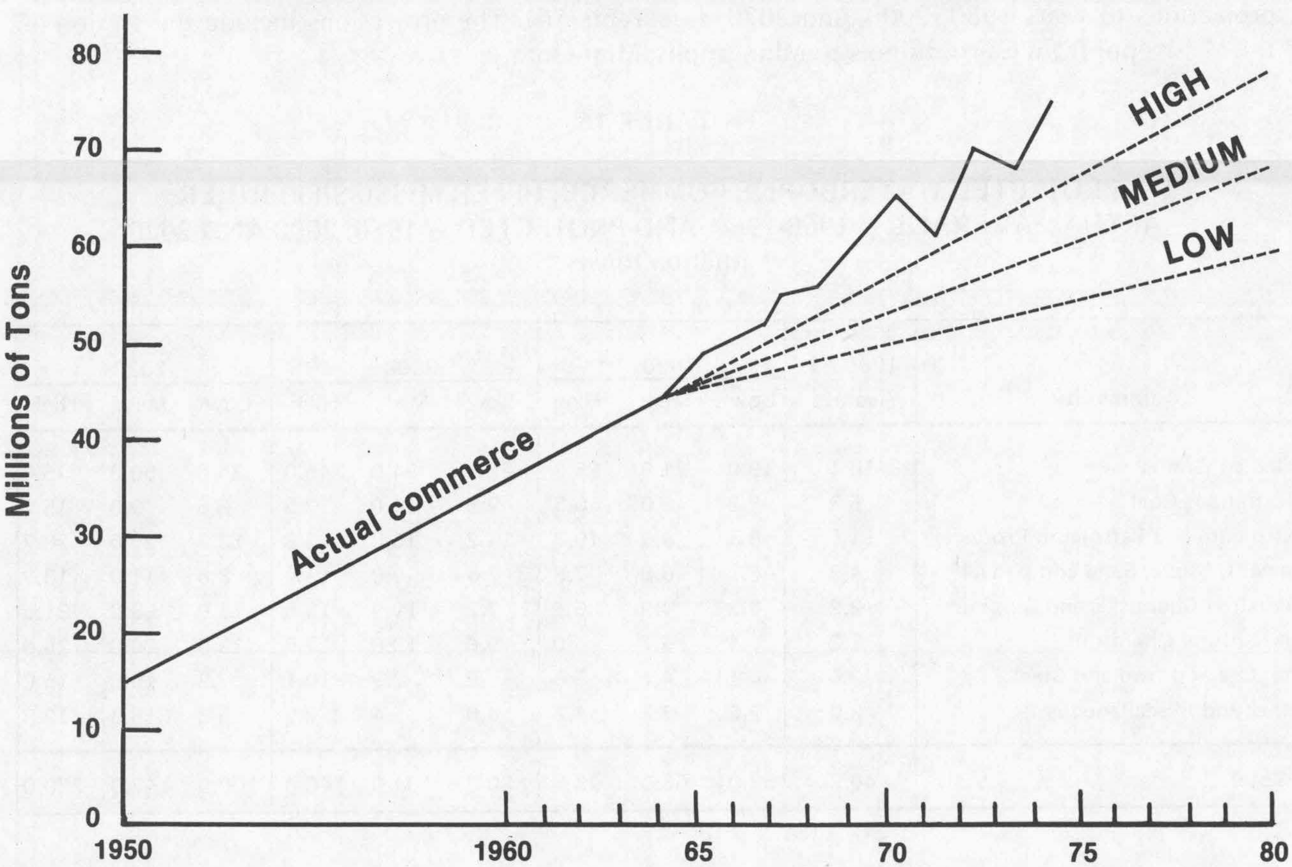
PROJECTED WATERBORNE COMMERCE, UPPER MISSISSIPPI RIVER, ACTUAL AVERAGE – 1960-1964, AND PROJECTED – 1980, 2000 AND 2020 (million tons)

Commodity	1960-64 Average	1980 Low	1980 Med.	1980 High	2000 Low	2000 Med.	2000 High	2020 Low	2020 Med.	2020 High
Selected Grains	10.1	19.0	21.0	25.0	28.0	34.0	45.0	34.0	50.0	75.0
Bituminous Coal	6.3	8.2	9.0	10.5	7.5	10.0	13.5	6.5	9.0	15.0
Petroleum and Petroleum Products	11.6	8.3	9.6	10.7	11.2	15.0	19.3	13.7	20.0	28.7
Cement, Stone, Sand and Gravel	4.2	6.1	6.8	7.6	7.6	9.0	11.2	8.6	11.0	13.9
Industrial Chemicals and Sulphur	2.2	4.3	4.9	6.3	7.2	10.3	15.5	11.0	18.2	31.5
Agricultural Chemicals	1.2	5.4	6.7	8.0	9.6	13.0	17.5	13.6	20.0	28.0
Iron Ore and Iron and Steel	2.6	4.1	4.7	5.6	5.9	7.3	10.1	7.3	10.0	15.0
Other and Miscellaneous	2.0	2.6	3.3	4.3	4.0	5.4	7.9	6.3	8.8	12.9
Total	40.2	58.0	66.0	78.0	80.0	104.0	140.0	100.0	147.0	220.0

This study projects commerce from the 1960-1964 average of 40.2 million tons to a medium level of 66.0, 104.0, and 147.0 million tons in 1980, 2000, and 2020, respectively. This represents a compound average annual increase of 2.8 percent in 1962-1980, 2.5 percent in 1980-2000 and 1.8 percent in 2000-2020 (Ref. 21). As illustrated in Figure 14 actual commerce on the Upper Mississippi has exceeded even the high growth range projected by the UMRCB Study.

FIGURE 14

ACTUAL AND PROJECTED COMMERCE UPPER MISSISSIPPI RIVER



Source: Upper Mississippi River Basin Commission. 1975. Decision Oriented Information Base.

The publication "Bulk Commodity Transportation in the Upper Mississippi River Valley" summarizes projections of the "UMRCB Study" (Ref. 21), the "Kearney Inc. Report" (Ref. 1), and the "Adjusted MarAd" projections. These projections are shown in Table 17. "In making comparisons, the reader must keep in mind that the projections may differ because of differences in underlying assumptions. The projections may also differ because of classifying commodities. Finally, the River Basin projections may differ from the other two because the former are based on Upper Mississippi commerce, whereas the latter two are based on all commerce going through Locks 26".

"In some instances, the projections from the separate studies are very close in the near term but differ considerably in the longer term, and in some instances the opposite occurs. In other instances, the projections are very close over all future years.

"For grain, projections for 1980 range between 20 and 30 million tons and for 2020 between 44 and 50 million tons.

"For coal, the 1980 projections vary between 8.5 and 10.64 million tons and for 2020 between 9.0 and 24.57 million tons.

"For petroleum, the projections range from 8.19 to 9.6 million tons in 1980 and from 8.91 to 20.00 in 2020.

"Because of the uncertainty with respect to future energy policy and energy developments, longer term projections can be expected to vary considerably. The longer term projections for both coal and petroleum show considerable variation relative to the near-term projections.

"For chemicals, 1980 projections vary from 7.93 to 11.6 million tons, while 2020 projections range from 26.22 to 39.40 million tons. All three projections suggest large growth" (Ref. 7).

TABLE 17

COMPARISONS OF PROJECTED WATERBORNE COMMERCE UPPER MISSISSIPPI RIVER
(Mill. of tons)

Year in Future	Comprehensive River Basin Study 1/			Kearney, Inc. Report 2/			Adjusted MarAd 2/
	Low	Medium	High	Low	Most Likely	High	
	Selected Grains 3/				Grains 4/		Grains 4/
1980	19.0	21.0	25.0	26.00	30.20	33.25	20.32
2000	28.0	34.0	45.0	32.00	42.90	45.10	29.24
2020	34.0	50.0	75.0	40.75	47.50	61.00	43.99
	Bituminous Coal & Coke				Coal		Coal
1980	8.2	9.0	10.5	7.0	8.5	8.9	10.64
2000	7.5	10.0	13.5	12.10	14.0	16.2	16.95
2020	6.5	9.0	15.0	14.00	16.25	18.20	24.57
	Petroleum & Petroleum Products 5/				Petroleum Products 6/		Petroleum Products 6/
1980	8.3	9.6	10.7	8.70	9.00	9.10	8.19
2000	11.2	15.0	19.3	11.15	13.30	20.00	8.55
2020	13.7	20.0	28.7	13.70	19.30	24.25	8.91
	Chemicals 7/				Chemicals 8/		Chemicals 8/
1980	9.7	11.6	14.3	7.60	8.10	9.00	7.93
2000	16.8	23.3	33.3	17.00	20.30	22.00	13.88
2020	24.6	38.2	59.5	37.30	39.40	48.00	26.22

1/ Commerce on Upper Mississippi River -- the section of the river from Cairo, Illinois at the mouth of the Ohio River to Minneapolis, Minnesota.

2/ Commerce going through Locks 26.

3/ Principally corn, wheat, soybeans, but includes rye, barley, oats, inedible vegetable oils.

4/ Corn, soybeans, wheat.

5/ Gasoline, gas oil, dist. fuel oil, crude petroleum, jet fuel, kerosene, resid. fuel oil, petroleum asphalt, lub. oils and grease, naphitha, other.

6/ Residual fuel oil, gasoline, distillate fuel oil, other.

7/ Industrial: Coal tar, benzol, sulphuric acid, alcohols, sodium hydroxide, pigments, paints, varnishes. Agriculture: Nitrogeneous fertilizer, phosphate rock, superphosphate, potash fertilizer materials.

8/ Industrial: Alcohols, sodium hydroxide, crude coal tar, gas products. Agriculture: Nitrogeneous fertilizer and superphosphates.

MISSOURI RIVER

Figure 15 shows the history of waterborne commerce from 1954 through 1977 on the Missouri River. The movement of commercial freight during 1977 totaled 3,259,900 tons. This represents a 5% increase over 1976 tonnage.

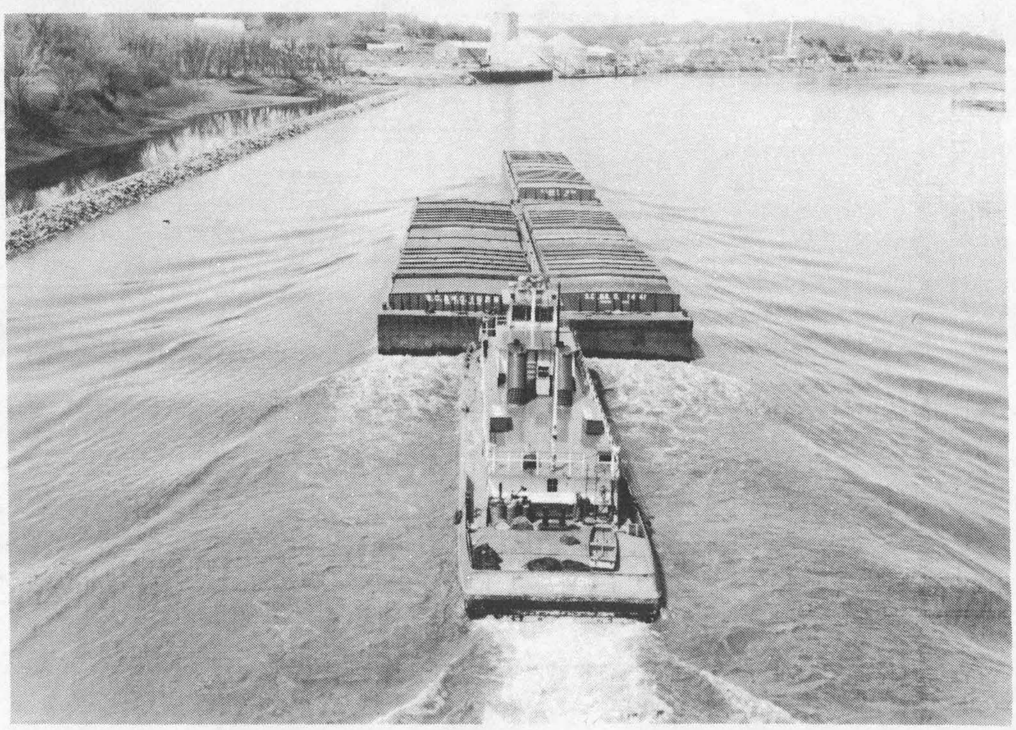
The Missouri River is principally oriented to serving agricultural and related food processing sectors of the river basin. Table 18 shows a summary of tonnage by major categories for the 1977 season.

The average length of haul on the Missouri River is about 480 miles. The total navigable length is 732 miles -- 182 miles along Iowa. On a ton-mile basis, about 71 percent takes place between Kansas City, Missouri and the mouth, 26 percent between Kansas City, Missouri and Omaha, Nebraska, and only 3 percent between Sioux City, Iowa, and Omaha, Nebraska (Ref. 17). Although this 3 percent ton-mile figure is often used, it is somewhat misleading as the distance between Sioux City and Omaha is only 107 miles. During 1977, 514,345 ton of commerce was moved on this river segment, representing 15.8 percent of the total Missouri River tonnage.

Projected Commerce

Commercial tonnage is expected to increase with the completion of the navigation project (about 1982) and the development of port facilities and shipping patterns. The Corps estimates that the present capacity of the project is about 12 million tons per year.

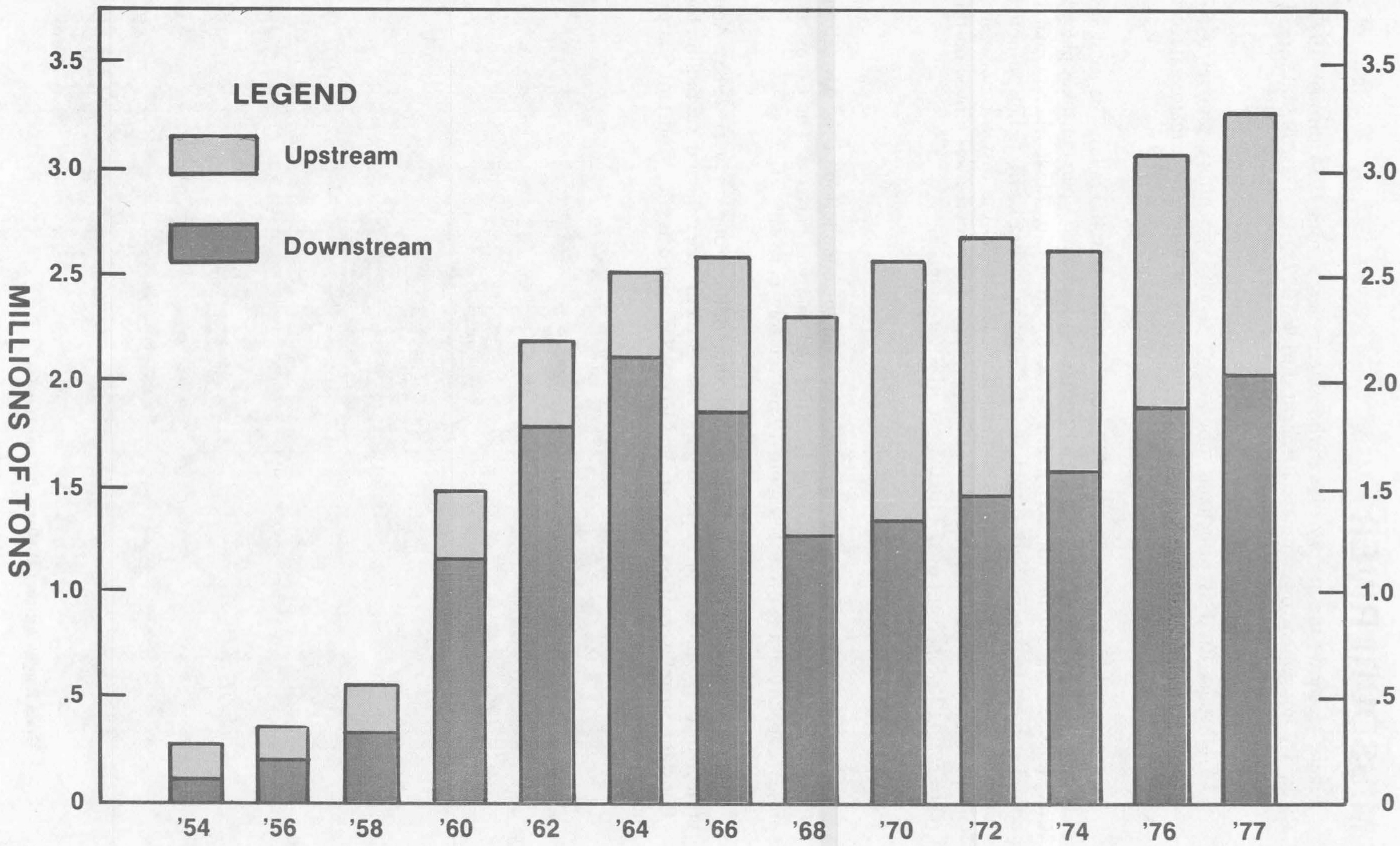
Table 19 shows projected tonnage by commodity group to year 1985. Annual tonnage is projected to 2.7 million tons assuming the "No-Growth" scenario and 3.6 million tons assuming the "Constant Share" scenario (Ref. 9). The Iowa DOT supports the "Constant Share" scenario as the most likely projection.



Grain Barges Arriving at Missouri River Terminal

FIGURE 15

COMMERCIAL TRAFFIC ON MISSOURI RIVER
SIOUX CITY TO MOUTH



Source: U.S. Army Corps of Engineers.

TABLE 18

1977 COMMERCIAL TONNAGE
MISSOURI RIVER

Commodity	Sioux City to Mouth Upstream	Sioux City to Mouth Downstream	Sioux City to Mouth Total	Sioux City to Kansas City Upstream	Sioux City to Kansas City Downstream	Sioux City to Kansas City Total
Farm Products	6,825	1,317,419	1,324,244	5,691	740,161	745,852
Nonmetallic Minerals	141,176	9,728	150,904	104,363	9,728	114,091
Food & Kindred Products	178,997	408,492	587,489	166,089	393,821	559,910
Paper & Allied Products	5,136	0	5,136	5,136	0	5,136
Chemicals & Fertilizer	416,755	129,852	546,607	287,790	106,312	394,102
Petroleum Products	232,505	139,414	371,919	1,030	0	1,030
Stone Products	148,037	0	148,037	146,769	0	146,769
Primary Metal Products	105,113	18,371	123,484	51,571	1,158	52,729
Machinery	2,050	30	2,080	100	0	100
Totals	1,236,594	2,023,306	3,259,900	768,539	1,251,180	2,019,719
1976 Comparison	1,174,623	1,931,254	3,105,877	776,098	1,308,048	2,084,146

TABLE 19

MISSOURI RIVER - 1985 COMMODITY FLOWS

(1,000 tons)

Community Group	No Growth 1/	Constant Share 2/
Farm products	1190	1540
Non-metallic minerals (other than sand & gravel)	175	220
Food and kindred	460	530
Pulp and paper	15	30
Chemicals	510	850
Petroleum	75	100
Stone, clay, and glass	170	210
Primary metals	60	100
All other freight	20	30
TOTAL	2675	3610

1/ "No-Growth" Scenario. In this scenario it is assumed that on the average, through 1985 commodity flows would not exceed the average flows experienced on the waterway between 1971 and 1974 (excluding 1973). The historical record since 1965 lends some credence to this possibility. The assumption that is being made is that the waterway would be attracting a decreasing share of future flows and that its competitive advantage does not improve.

2/ "Constant Share" Scenario. In this scenario, it is assumed that on the average through 1985 the waterway's share of future flows will remain constant at the highest level estimated for 1969 and 1974. This implies that the competitive position improves somewhat to capture some of the increase expected in future overall flows.

Source: RMG Associates, Inc., Alexandria, Virginia, Missouri River Navigation and Bank Stabilization Project, Analysis of Commodity Flows and Navigation Benefits, January, 1976.

IOWA RIVER TERMINALS

Figure 16 shows the location of Iowa river terminals and commercial tonnage handled. In 1977, 63 terminals were located on the Iowa side of the Mississippi River and 9 on the Iowa side of the Missouri River. Bulk exports from Iowa are primarily grain and major bulk imports are coal, petroleum and fertilizer.

To take advantage of this low cost means of transportation, shippers must transport freight to and from the waterfront. These movements must be accomplished by some other mode such as rail, truck or pipeline. Thirty-four of the 63 Mississippi River terminals have both road and rail access although the vast majority of the interfacing is with trucks rather than rail. Seven of the 9 Missouri River terminals have both road and rail access. Railroads and waterborne carriers compete for the movement of bulk commodities into and out of the Upper Mississippi and Missouri River regions. These two competing modes also act as a commodity interchange service for each other. The IOWA BARGE TERMINAL STUDY (Ref. 5), conducted during the summer of 1975 and updated in 1976, supplies insight into these interfacing movements. Appendix B of this report contains more information on Iowa barge terminals.

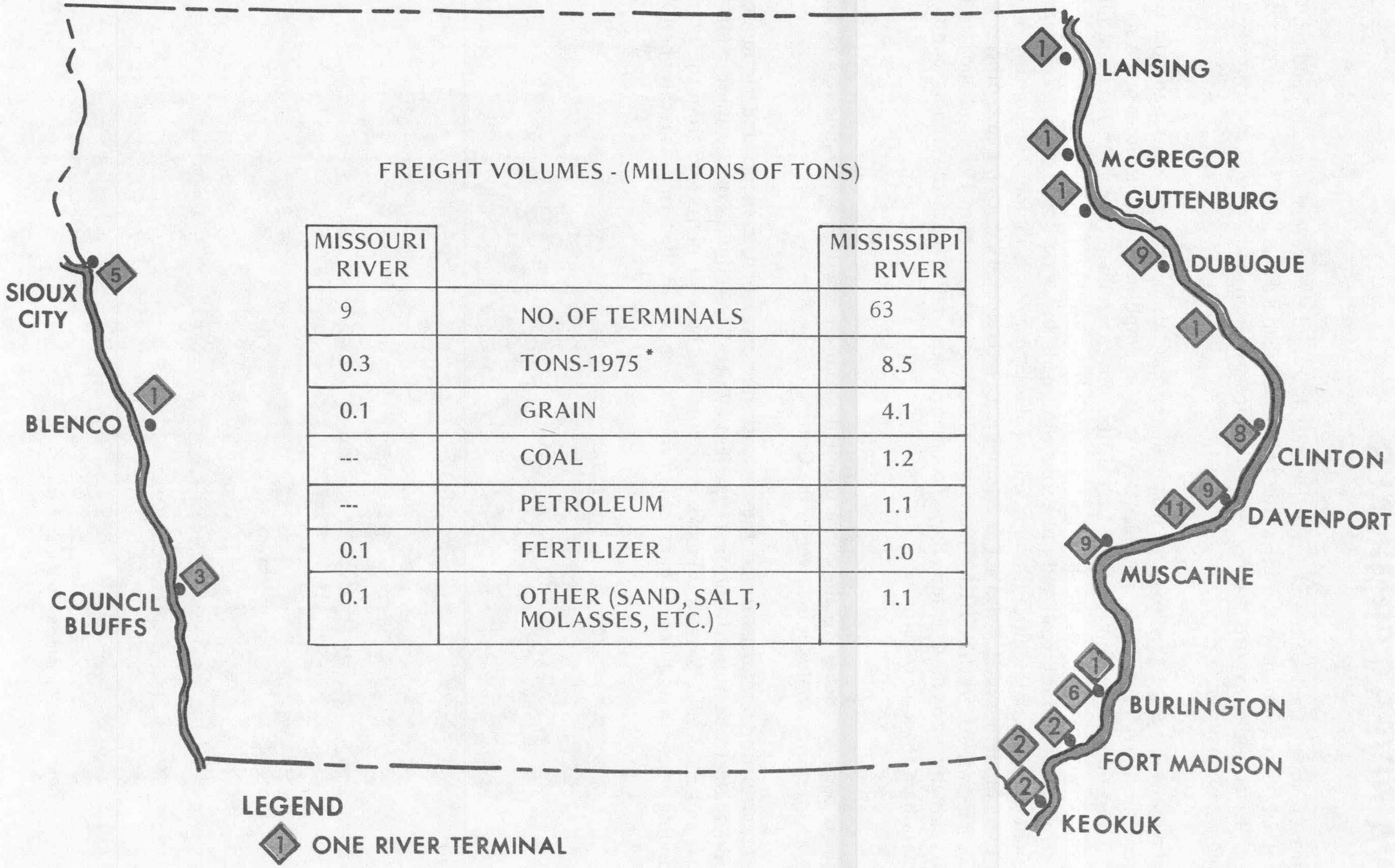
Grain is usually trucked to the barge terminals from areas within a 100-mile radius, loaded on barges, and transported down the river to the Gulf.

Most petroleum terminals are in the metropolitan areas of Bettendorf and Dubuque. Barges transport the petroleum up river from refineries in Wood River, Illinois; Joliet, Illinois; Mt. Vernon, Indiana; and St. Louis, Missouri. Trucks distribute the bulk of petroleum from the terminals to surrounding areas. In addition to barge shipments, a number of the terminals receive petroleum by pipeline.

Petroleum Terminals - Bettendorf, Iowa

FIGURE 16

IOWA RIVER TERMINALS
1977



FREIGHT VOLUMES - (MILLIONS OF TONS)

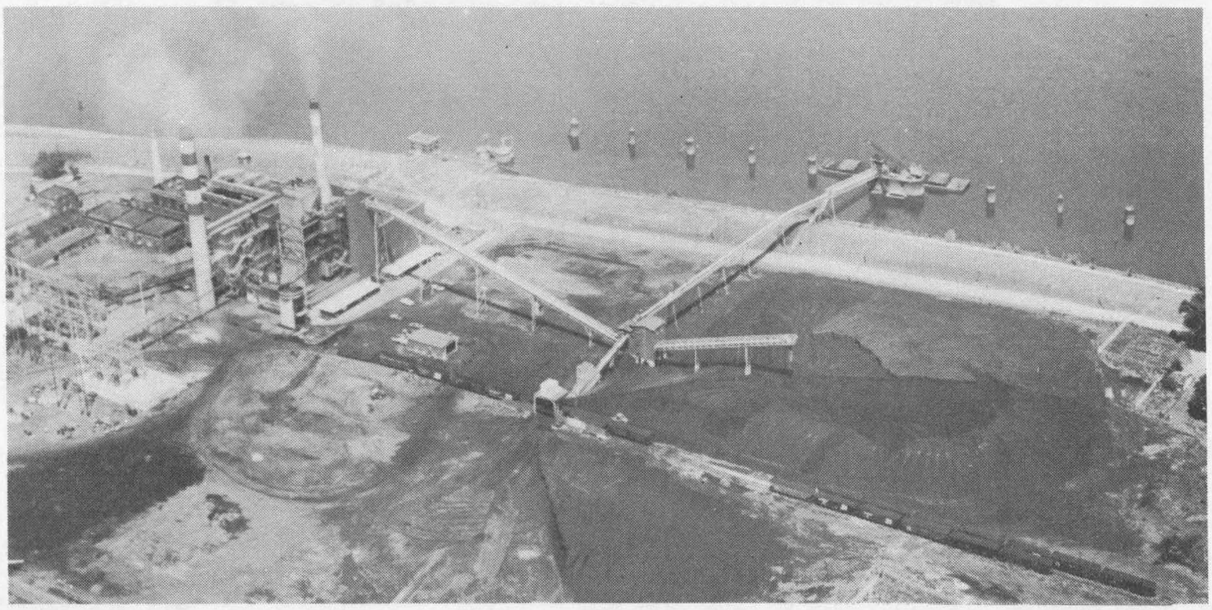
MISSOURI RIVER		MISSISSIPPI RIVER
9	NO. OF TERMINALS	63
0.3	TONS-1975 *	8.5
0.1	GRAIN	4.1
---	COAL	1.2
---	PETROLEUM	1.1
0.1	FERTILIZER	1.0
0.1	OTHER (SAND, SALT, MOLASSES, ETC.)	1.1

* 1975 data excludes tonnage handled by 5 Mississippi River terminals and 2 Missouri River terminals that have been developed since 1975.

Power plants near the river are the principal receivers of coal. Barges move the coal to the plants, which use it to produce electrical energy. The bulk of coal comes up river from Southern Illinois and Kentucky. Some Western coal from Wyoming and Montana is also received. Railroads transport the Western coal to Minneapolis, and then, down the Mississippi to the power plants.

Other principal commodities handled at Iowa barge terminals include industrial salt, road salt, liquid fertilizer, bulk fertilizer, and phosphate rock.

Very few of the companies operating in Iowa own barges or towboats. Most barges are leased from large companies located in the South.



Off-Loading Coal From Barge and Rail **Muscatine Power and Water Company**

Storage Facilities

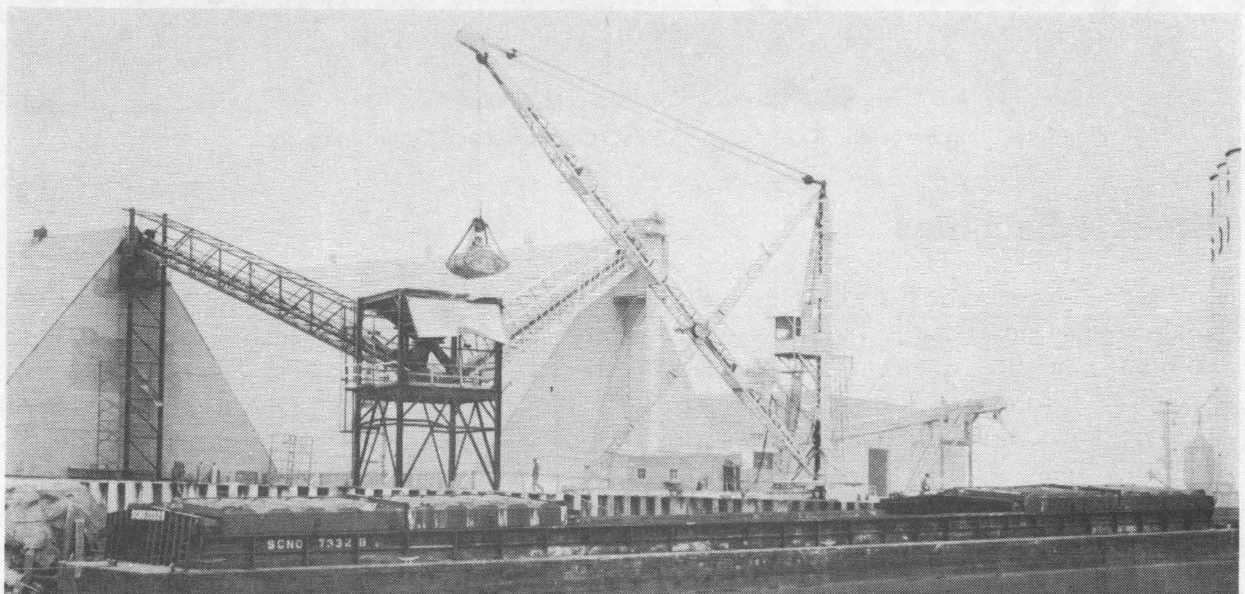
Warehouses, elevators, tanks, bins and open storage areas provide storage for 4.6 million tons of commerce at Iowa barge terminals. The majority of the open storage is used for coal to be consumed on site by electric power plants. The storage capability of 17 Mississippi River grain terminals in Iowa ranges from .2 million to 1.5 million bushels with a total capacity of 11.1 million bushels. Four Missouri River terminals which handle Iowa grain have a total storage capacity of 5.2 million bushels.

Handling Facilities

Handling systems for the transfer of bulk commodities to and from barges consist of conveyor belts, overhead chutes, augers, cranes and pumping systems.

A 1,400-ton grain barge can be loaded by a conveyor system in 4-12 hours. Petroleum products are pumped from a 1,400-ton barge in 8 hours. Commodities such as coal, salt and sand can be unloaded by clamshell bucket at a rate of 150 to 200 tons per hour. Grain arriving at river terminals can be unloaded by a truck hoist in 3 minutes. It takes 15 minutes to pipe 24 tons of petroleum from a storage tank to a truck.

Truck Hoist at Mississippi River Grain Terminal



Off-Loading Fertilizer at Missouri River Terminal

Ownership and Operations

Iowa barge terminals are owned by Midwest Co-ops, grain companies, petroleum companies, river-front industries, and small transportation companies. The cities of Clinton and Dubuque each own one barge terminal and operate them on a lease arrangement.

The cities of Council Bluffs and Davenport are presently involved in planning for public port development. The proposed terminal at Council Bluffs estimated to cost about $4.3 million consists of an alongside bank facility of 22.5 acres with 1,060 feet of frontage for barge service. An additional 73 acres are available for storage facilities, etc. The facility is planned for year-round operation. It will be served by I-29/80, the Union Pacific Railroad and the Missouri River.

The Davenport Levee Improvement Commission has applied for a grant from the U.S. Economic Development Administration to study the economic feasibility of constructing a public port near Enchanted Island (south of I-280). Preliminary engineering studies put the cost of this facility at $13 million.

City Owned Commercial Harbor, Dubuque, Iowa

Future Port Planning

The Iowa DOT, along with 17 other states bordering on the Mississippi River System is participating in the "Mid America Port Study" conducted by the Maritime Administration. Data will be collected to allow a comprehensive analysis of the existing and planned transportation system's capability to meet the region's future cargo movement demands. The study will identify the extent, type and general location of port and terminal facilities required to handle cargo movements for the next 25 years. Iowa's share in this $400,000 study is $3,125.

THE COST OF BARGE SERVICE

The cost of barge line-haul service to shippers averages 0.50¢ per ton mile. For purposes of comparison, the average ton-mile rates for the remaining modes are: air-25.92¢, truck-9.00¢, rail-1.85¢ and pipeline 0.32¢. The pipeline is the only mode which can generally match the line-haul economy of barge transportation.

LINE-HAUL COSTS

The low line-haul costs of the waterway mode compared with its chief competitor, the railroad, is its major competitive advantage. Figure 17 shows the line-haul costs of barge versus rail service under various circumstances.

Tow size and speed have a dramatic effect on the barge line-haul costs curves. Barge ton-mile cost decreases rapidly as the number of barges and the speed of the tow are increased. Marine line-haul cost exceed the rail cost only when the tow size is small and/or the tow speed is very slow (Ref. 1).

WATER CARRIAGE RATES

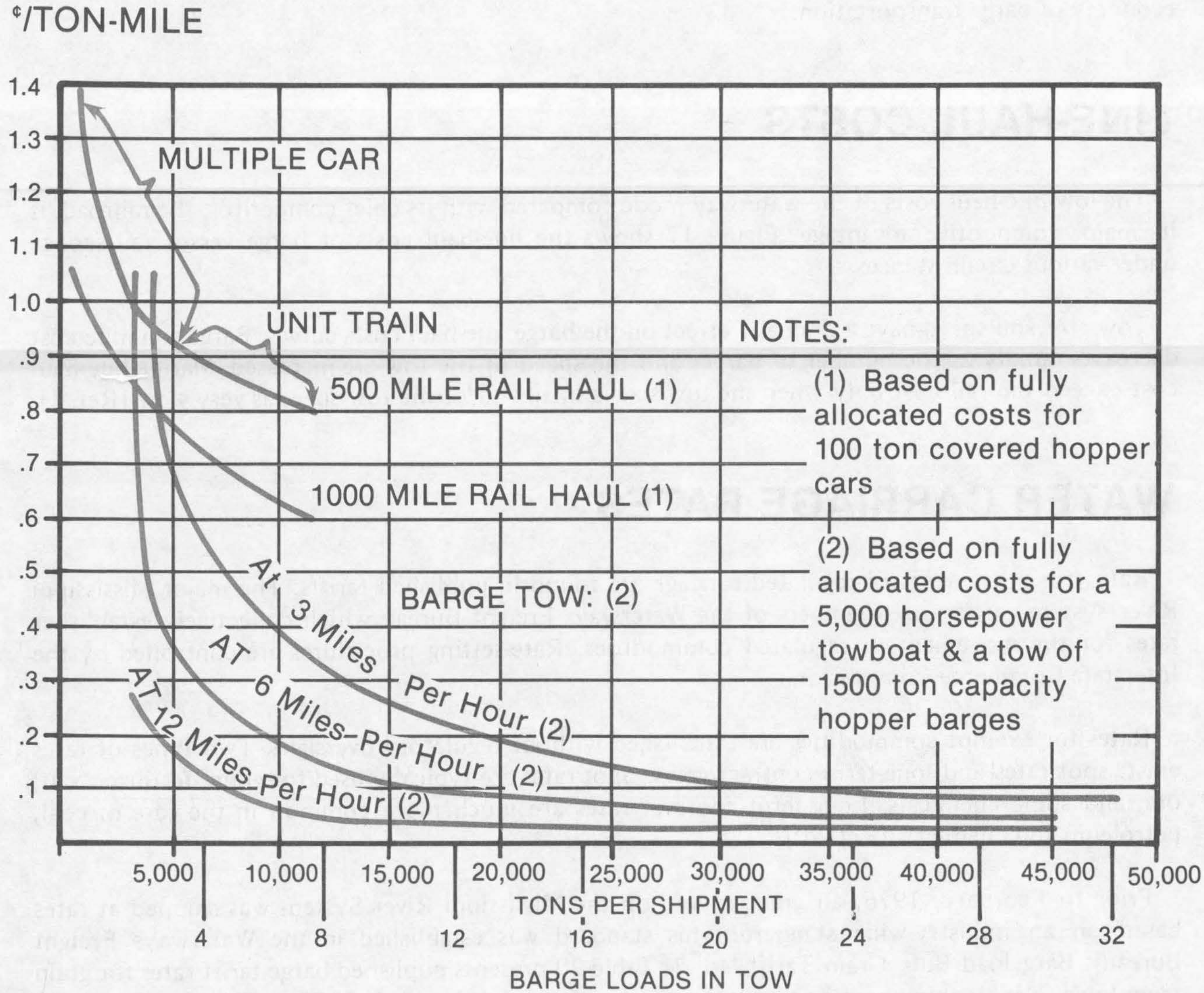
Rates for movements of regulated carriage are found in published tariffs. The major Mississippi River system carriers are members of the Waterways Freight Bureau which collectively establishes rates for the movement of regulated commodities. Rate-setting procedures are controlled by the Interstate Commerce Commission.

Rates for exempt commodities are established without regulatory oversight. Two types of rates exist: spot rates and long-term contract rates. Spot rates are typically used for grain, fertilizer, salt, ore, and some chemicals. Long-term contract rates are much more common in the case of coal, petroleum and chemicals (Ref. 20).

Prior to February, 1976, all grain moved on the Mississippi River System was shipped at rates based on an industry-wide standard. This standard was established in the Waterways Freight Bureau's Bargeload Bulk Grain Tariff No. 7. Table 20 presents published barge tariff rates for grain from Iowa river shipping points to New Orleans for the period March 1, 1975 to February 24, 1976.

FIGURE 17

LINE-HAUL COST RELATIONSHIPS RAIL VERSUS BARGE



Source: DOMESTIC WATERBORNE SHIPPING MARKET ANALYSIS, February 1974, A.T. Kearney, Inc.

TABLE 20

BARGE GRAIN RATES - MISSISSIPPI AND MISSOURI RIVERS
IOWA SHIPPING POINTS TO NEW ORLEANS
MARCH 1, 1975 TO FEBRUARY 24, 1976

City	Miles	Cost/Ton	Cost/Bu.	Cost/Ton-Mile
Keokuk	1346	$5.08	14.2¢	0.38¢
Galland	1355	5.08	14.2	0.38
Montrose	1358	5.08	14.2	0.37
Fort Madison	1373	5.08	14.2	0.37
Burlington	1389	5.08	14.2	0.37
Muscatine	1437	5.32	14.9	0.37
Davenport	1467	5.32	14.9	0.36
Clinton	1501	5.32	14.9	0.35
Dubuque	1564	6.00	16.8	0.38
McGregor	1617	6.00	16.8	0.37
Council Bluffs	1598	7.96	22.3	0.50
Sioux City	1712	9.25	25.9	0.54

Tariff No. 7 served only as a rate base for non-regulated traffic. Rates actually charged were the result of agreement between shippers and barge companies and were quoted as discounts or premiums on the tariff rates. Actual rates charged to shippers ranged from 60 to 300 percent of the published tariff. This practice allows waterway carriers to adjust their rates according to the day-to-day supply of and demand for barges. Also the above rates do not reflect shipment cost to the river terminals, loadout costs (2.4¢ per bu.) and receiving costs (3.1¢ per bu.) which must be associated with waterway transportation costs. Tariff No. 7 was determined to be no longer needed and was cancelled by the ICC as of February 24, 1976.

An Iowa State University Study, AN ECONOMIC ANALYSIS OF UPGRADING RAIL BRANCHLINES, (Ref. 3) provides insight into the cost of grain shipments by both rail and water. It is important to note that the study assumes new barge costs and new rail car costs. The existing barge fleet is a mixture of old barges purchased at lower prices than present new barge prices.

Table 21 shows intermodal rate comparisons for shipping grain from Fort Dodge and Manchester, Iowa to New Orleans. From Fort Dodge, rail is cheaper than either rail-barge or truck-barge. However, this advantage lessens when origins are closer to the river and barge rates are reduced. From Manchester, truck-barge is always cheaper than rail; from July to September rail-barge is cheaper than all rail rates. (Ref. 3)

Figure 18 shows approximate areas within Iowa where truck-barge shipments of grain to New Orleans is competative with 50-car rail rates. The study assumes:

TABLE 21

RATE COMPARISON
FORT DODGE AND MANCHESTER TO NEW ORLEANS

Mode	Shipping Period	Cents per bushel * From Fort Dodge	From Manchester
Rail			
Single-car		35.8	35.0
3-car		33.6	33.6
25-car		32.8	--[a]
50-car		30.0	--[a]
Rail[b]-barge[c]	October-December[f]	40.9	37.8
Rail[b]-barge[d]	April-June[f]	39.1	36.1
Rail[b]-barge[e]	July-September[f]	36.2	33.2
Truck-barge[c]	October-December[g]	43.7	29.6
Truck-barge[d]	April-June[g]	41.9	27.8
Truck-barge[e]	July-September[g]	39.6	24.9

*To convert to dollars per ton, multiply figures by 35.71

[a] Not available.

[b] Rail rate is for shipper-owned or leased jumbo hopper cars. An average of 8.5 cents per hundredweight was added to the rail rate to reflect the cost of shipper-leased cars for this short trip.

[c] Barge rates at 130 percent of tariff.

[d] Barge rates at 118.75 percent of tariff.

[e] Barge rates at 100 percent of tariff.

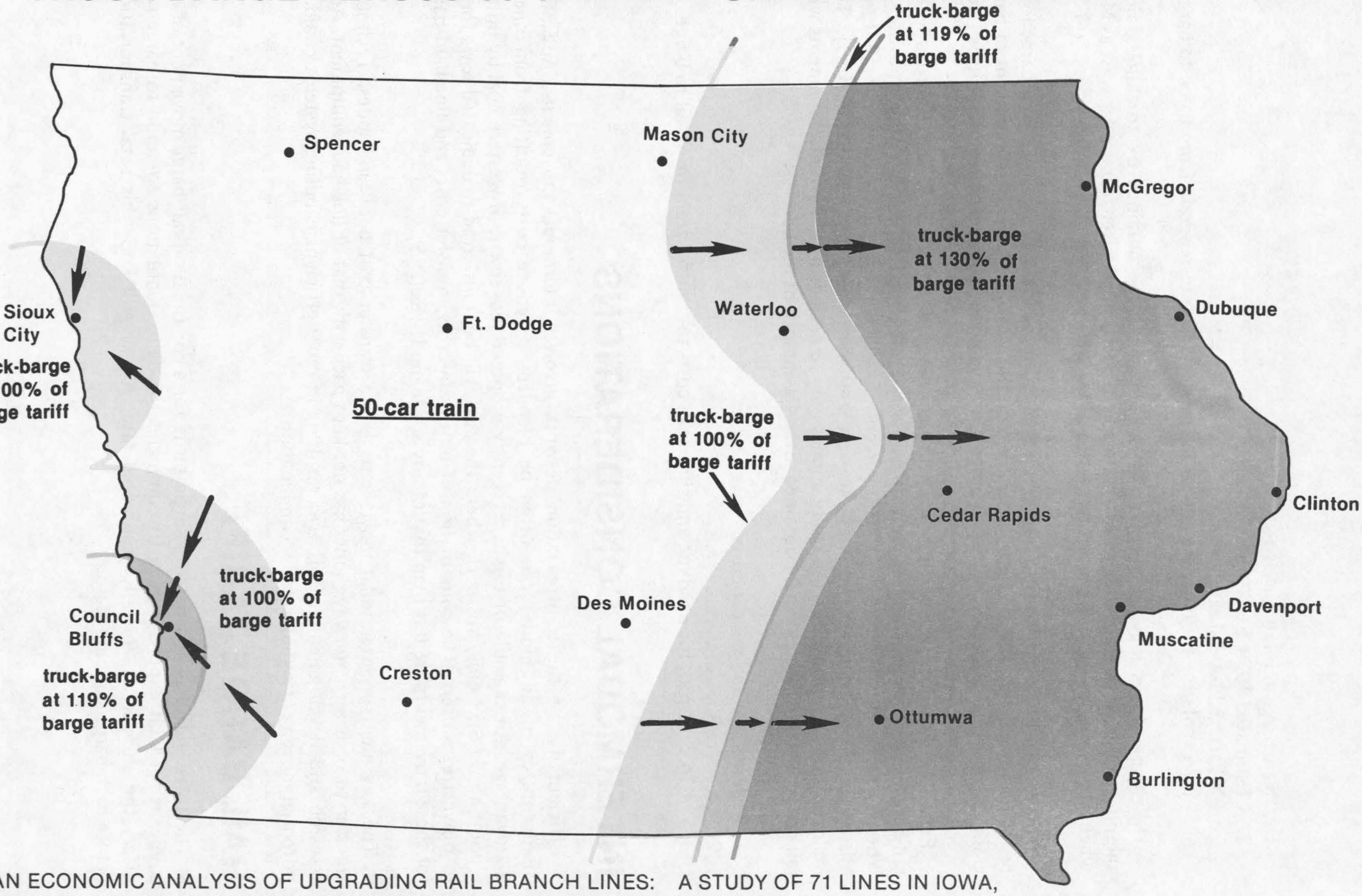
[f] Includes 4.14 cents per bushel for handling and shrinkage of transferring grain from rail to barge.

[g] Includes 3.74 cents per bushel for handling and shrinkage of transferring grain from truck to barge.

Source: AN ECONOMIC ANALYSIS OF UPGRADING RAIL BRANCH LINES: A STUDY OF 71 LINES IN IOWA, March, 1976, C. Phillip Baumel, John J. Miller and Thomas P. Drinka.

FIGURE 18

REGIONS OF COMPETETIVE ADVANTAGE TRUCK-BARGE VERSUS 50-CAR RAIL SHIPMENTS FOR GRAIN



Source: AN ECONOMIC ANALYSIS OF UPGRADING RAIL BRANCH LINES: A STUDY OF 71 LINES IN IOWA, March 1976. C. Phillip Baumel, John J. Miller, and Thomas P. Drinka.

1. New barge and rail car costs.
2. Estimated 1974 truck costs.
3. X-Parte 305-A rail rate levels.
4. 3.74 cents/bu. for handling and shrinkage costs to transfer grain from truck to barge.

The figure shows regions where a cost advantage can be obtained by trucking grain to river shipping points. It is feasible to truck grain to the Mississippi River from as far west as Mason City when barge rates are 100 percent of tariff (Ref. 3).

The area of truck-barge cost advantage is smaller on the Missouri River. Lighter barge loading and fewer barges per tow cause higher barge rates on the Missouri River. At 100 percent of barge tariff, grain can be trucked about 25 miles to Sioux City and about 30 miles to Council Bluffs (Ref. 3).

Figure 19 shows an area surrounding two main lines of the C.M.St.P. & P. Railroad where 5-car rail-barge shipments are competative with 50-car rail rates for the shipment of grain to New Orleans. When barge rates are obtainable at 100 percent of tariff it is feasible to send 5-car rail shipments to Mississippi River terminals from as far west as Emmetsburg and Manilla (Ref. 3). The study indicates that the above situation really applies only to periods of low volume shipments when rapid rail car turn around times can be obtained. Study assumptions include:

1. New barge and rail car costs.
2. X-Parte 305-A rail rate levels.
3. 4.14 cents/bu. for handling and shrinkage costs to transfer grain from rail to barge.

INTERMODAL CONSIDERATIONS

Efficient use of the transportation network involves intermodal movements. Advantages and disadvantages of all modes can often be blended to reduce costs resulting from one mode's disadvantage. An example of this is a recently proposed movement of Western coal by unit train to a point above St. Louis, Missouri, where the coal will be transferred to dedicated tows for delivery to downstream users. The combination of unit train costs, transfer costs and line-haul barge costs for these movements are less than that of any single mode (Ref. 15).

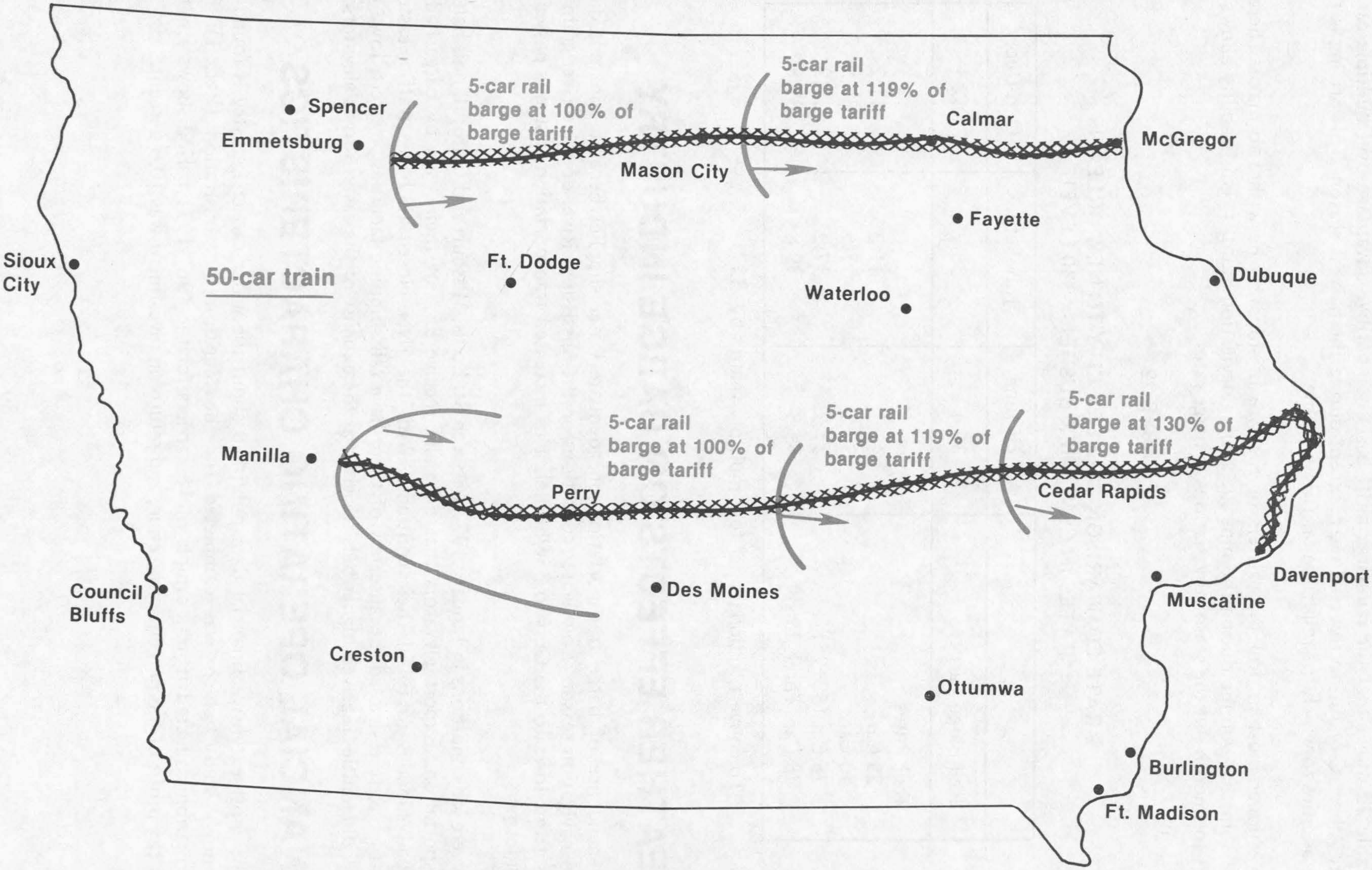
The key item in intermodal movements is the transfer cost between modes. Technology for transfer to or from waterway modes has not kept pace with that of line-haul equipment. Additional research and development in this area resulting in more efficient handling systems could increase potential movement by intermodal combination.

RAIL-BARGE TARIFF

The Iowa DOT has negotiated a single tariff for a combination rail/barge movement of corn and soybeans for Gulf export. This tariff eliminates the daily fluctuations common to barge rates and offers the shipper an annually contracted rate. A user will know his total transportation costs before each barge shipping season.

FIGURE 19

REGIONS OF COMPETITIVE ADVANTAGE
5-CAR RAIL-BARGE VERSUS 50-CAR RAIL SHIPMENTS FOR GRAIN



Source: AN ECONOMIC ANALYSIS OF UPGRADING RAIL BRANCH LINES: A STUDY OF 71 LINES OF IOWA, March 1976, C. Phillip Baumel, John J. Miller, and Thomas P. Drinka.

Table 22 shows that the rail-barge tariff has a competitive advantage over multiple car rail rates from Albert City (in northwest Iowa), except during the harvest season. This pricing is typical of several cities to which the rail-barge tariff is available.

A shipper must inform the carriers of the size of shipment he wishes to make. Thereafter, he must ship that volume during the nine succeeding navigation months. This stability allows the joint tariff to smooth out the seasonal variations in barge rates.

TABLE 22

RATE COMPARISON - ALBERT CITY TO NEW ORLEANS
*RATES IN CENTS PER BUSHEL-x-330 LEVEL

	March-June	July-Sept.	Oct.-Dec.
Rail-Barge Tariff	36.4	36.2	42.1
Rail Rates			
25-Car	41.2	41.2	41.2
50-Car	37.5	37.5	37.5
75-Car (50+25)	37.2	37.2	37.2
75-Car (Three 25's)	39.8	39.8	39.8

*To convert to dollars per ton, multiply figures by .3571

WEATHER EFFECTS ON BARGE INDUSTRY

Dependence of barge transportation on adequate water supplies became apparent during the 1976 navigation season. Low water conditions on the Mississippi River doubled river grain shipping rates from Iowa to the Gulf to 35¢/bushel. This increased transportation cost was passed back to Iowa farmers.

Severe ice conditions in January 1977 between St. Louis, Missouri and Cairo, Illinois halted water transportation. Export elevators that normally receive 85% of their grain by barge had to seek railroad supplies to fulfill their contracts. With the river closed to barge traffic, eastern Iowa elevators were restricted, because few of them have rail shipping facilities. Western Iowa elevators with rail facilities received higher bids for grain at the expense of the eastern Iowa elevators.

FINANCIAL OPERATING CHARACTERISTICS

The most extensive financial data published about the water carrier industry is found in A. T. Kearney's study which was completed for the Maritime Administration (Ref. 1). Financial information collected from a sample of 16 carriers for the 1967-1971 period shows a net average after tax profit of 6.6 percent of revenue, and return on investment was 10.6 percent.

WATERWAY USER CHARGES

GENERAL

The U.S. inland waterway system is operated entirely at public expense. River traffic does not pay any kind of fuel tax, lockage fee, or ton-mile tax to help pay for channel maintenance or the building and repair of locks and dams. The total federal investment for construction, operation, and maintenance of navigable waterways since the early 1800's totals about $8.3 billion. Federal assistance benefiting both shallow-draft and deep-draft water carriers totaled $660 million in 1974. User charge proponents claim the free-ride enjoyed by barge companies constitutes unfair competition.

If waterway user charges are adopted, the question of, "How much should be charged?," also causes debate. Barge owners think that any kind of user charge is too much while the railroads say anything less than a 100% recovery is too little.

IOWA DOT POSITION

To evaluate the effect a waterway user charge would have on Iowa and assess the amount to be charged by an equitable user charge, the Iowa DOT staff prepared a waterway user charge proposal (Ref. 6). It is designed to recoup $75 to $100 million each year through the combination of a 3c per gallon fuel tax and a $32 lockage fee. The DOT Commission voted to adopt the staff proposal in May 1977.

ENERGY INTENSIVENESS

RAIL VERSUS WATER

Much has been written concerning the relative fuel consumption or energy efficiency of the various modes of transportation. The area of transportation efficiency subject to the largest uncertainties and argument involves the comparison of water and rail energy intensiveness values. A summary of frequently cited EI values are shown in Table 23.

This table reveals that comparisons of energy intensiveness between rail and water are inconclusive. The estimates vary over a wide range between the modes: rail from 238 to 771 BTU/ton-mile, unit trains from 226 to 359, and water from 217 to 785. Three studies show rail as more efficient while nine studies conclude that water transportation is more efficient.

At present, intermodal comparisons of energy intensiveness are inconclusive and divert attention away from the more significant intermodal economic issues. The energy consumption of each mode's service with respect to a given commodity and origin/destination would be required to more accurately determine and compare relative fuel efficiencies. Motor truck energy efficiency should also be considered, when essential to the transport movement.

TABLE 23

ENERGY INTENSIVENESS - RAIL VERSUS WATER

(in BTU/ton-mile)

Author	Source	Data Years	Rail	Unit Train	Water
Hirst, Eric	Energy Consumption for Transportation in the United States. March 1972. Oak Ridge National Laboratory, ORNL-NSF-EP-15.	Mid-1960's	680		540
Hirst, Eric	Intensiveness of Passenger and Freight Transportation Modes: 1950-1970. April 1973, Oak Ridge National Laboratory, ORNL-NSF-EP-44.	1970	670		680
Rice, Richard A.	Energy Efficiencies of the Transport System. Transportation Research Institute, Carnegie-Mellon University. Doc. no. 730066.	1967-70	680		567
Rice, Richard A.	System Energy and Future Transportation. MIT Technology Review, January 1972.	1967-70	324-567		567-618
Mooz, William E.	The Effect of Fuel Price Increases on Energy Intensiveness of Freight Transportation. December 1971, Rand, R-804-NSF.	1968-67	706		570
Peat, Marwick; and Jack Faucett Associates	Industrial Energy Studies of Ground Freight Transportation, SIC Codes 4011, 4013, 4041, 4212, 4213, 4214, 4231. July 1974.	1973	700	330	500
Sebald, Anthony V.	Energy Intensity of Barge and Rail Freight Hauling. May 1974, Center for Advanced Computation, University of Illinois at Urbana-Champaign. CAC Technical Memo. NO. 20.	1971	639-711	226-359	785
Tihansky, Dennis P.	Methods for Estimating the Volume and Energy Demand of Freight Transport. December 1972, Rand, R-988-NSF.	1965-67	750		500
Batelle Memorial Institute	Energy Required for Movement of Intercity Freight.		475-680		--
Reebie Associates	(Referenced in Peat, Marwick, Mitchell/ Jack Faucett study)		544		--
Mascy, A.C. & Paullin, R.L.	Transportation Vehicle Energy Intensities. June 1974, NASA/DOT.	1974	330-550		--
National Petroleum Council	Transportation Task Group Interim Report Phase 1.	1973	--		510
Brinegar, Claude S.	Statement before the House Appropriations Subcommittee on Transportation, March 5, 1974.	1973	771		462
Cook, Harry N.	Letter to DOT Secretary C.S. Brinegar from National Waterways Conference, Inc., February 4, 1974.	1961-68	--		217-415
A "Major" Railroad	Reported to U.S. Transportation Systems Center		314-504		--
Upper Mississippi Waterway Association	The Economic Impact of Waterborne Transportation on the Upper Mississippi River Basin. June 1975.	1972	679		331
Barloon, Marvin	Reported in Upper Mississippi Waterway Association Study.	1970	650		416
Southern Pacific Railroad	Reported in Upper Mississippi Waterway Association Study.	1973	238		--
U.S. Army Engineer District St. Louis, Missouri	Locks and Dam No. 26 (Replacement) Design Memorandum No. 11 Formulation Evaluation Report, Volume 2, Appendix F. April 1975.	1971	711		649

AGENCY RESPONSIBILITY

FEDERAL AGENCIES

Maritime Administration

In accordance with the Merchant Marine Act of 1936, MarAd is charged with the responsibility within government to promote a merchant marine "sufficient to carry its domestic waterborne commerce." To accomplish this objective MarAd administers a number of assistance programs for the industry including Title XI mortgage insurance. It also undertakes research to support the industry and represents the objective of a healthy merchant marine within the workings of government.

Interstate Commerce Commission

The ICC has the responsibility for economic regulation of water carriers in interstate commerce. This includes establishing rates that are just, reasonable and free from unjust discrimination or undue preference and prejudice. For carriers subject to regulation, the ICC approves rates, grants operating authority, approves ownership changes and financial arrangements, and establishes reporting requirements.

U.S. Army Corps of Engineers

The Corps has responsibility for planning, improving and maintaining the inland river system to provide for flood control, navigation and recreation. It operates most locks and dams on the inland waterways system. Areas of responsibility by Corps District are shown in Appendix D of this report.

United States Coast Guard

The USCG is responsible for the establishment of navigation regulations and the establishment and maintenance of physical aids to navigation. Other responsibilities include search and rescue, and enforcement of the Federal Water Pollution Control Act. The Coast Guard administers a program for recreational boating safety which includes the establishment and enforcement of minimal safety and signal equipment standards.

Federal Maritime Commission

FMC is involved in the regulation of LASH and Seabee barges entering the inland waterways system as part of an international move.

Other Agencies

Several additional governmental agencies have an influence on the inland marine industry. These include the Environmental Protection Agency (pollution controls, noise control); the Department of Labor, administrator of the Occupational Health and Safety Act (crew safety); and the Federal Communications Commission (radio communications).

STATE AGENCIES

Iowa Department of Transportation

Encourages and assists in the development of programs for proper use of river transportation. Coordinates the use of river transportation with other transportation modes, examining the potential for more efficient use of Iowa's waterways, and assists Iowa cities in the development of river terminals.

Iowa Conservation Commission

Issues permits for the construction of any pier, wharf, sluice, piling, wall, fence, building, obstruction or the erection of any kind upon or over state-owned land under the jurisdiction of the commission. Responsible for enforcement of all boating regulations including the regulation of safety zones established above and below navigation lock and dam structures

Iowa Natural Resources Council

The Natural Resources Council is charged with the establishment and enforcement of a statewide plan for the control, utilization and protection of water resources. Natural Resources Council approval is required for the construction of docks, wharfs, terminal facilities, harbor construction, major excavations and embankments, and other types of floodplain or floodway construction activities relative to all streams and rivers in the state.

Iowa Department of Environmental Quality

Administers water quality standards and provides technical assistance on incidents involving spills of hazardous or toxic materials.

INDEPENDENT ORGANIZATIONS

The American Waterways Operators, Inc.

AWO is a trade association representing the national interests of operators of towboats, tugboats, and barges who provide transport services, ship berthing, and perform harbor work on the navigable waterways of the United States. AWO also represents shipyards who build and repair equipment used by the carrier members, terminal operators who serve the carriers, and certain service companies.

National Waterways Conference, Inc.

The National Waterways Conference, Inc. is composed of representatives of industry, government, and public interests groups. The organization strives for a wider appreciation of the public value of low-cost water transportation, and for sound management of the Nation's water resources for the public good.

Inland River Ports and Terminals, Inc.

Primary membership is made up of public and private river basin port and terminal authorities, and owners and operators of river terminals. The association is concerned with terminal and port operators' practices, finances and safety, transportation rates and intermodal matters, laws and legislators, channels and harbors, and public relations and publicity.

National Committee on Locks and Dam 26

A lobby group formed for the specific purpose of influencing legislation for replacement of Lock and Dam 26. The Committee includes representatives of state government agencies, inland river barge operators and towing companies, power coops and corportations, port authorities, farmers coops and associations, and inland river terminal operators.

PLANNING ORGANIZATIONS

River Basin Commissions

Both the Upper Mississippi River Basin Commission and the Missouri River Basin Commission have planning responsibilities in Iowa. The Basin Commission is the principal agency for the coordination of Federal, State, interstate, local and nongovernmental plans for the development of water and related land resources in the area served.

Great River Environmental Action Team

The Great River Environmental Action Team (GREAT) is a multiagency planning group organized to develop a resource management plan for the Upper Mississippi River. This plan will incorporate total resource requirements e.g., commercial navigation, fish and wildlife, public recreation, water quality, etc. Emphasis will be given to the problems associated with channel maintenance dredging and dredged material disposal. GREAT operates under the auspicious of the Upper Mississippi River Basin Commission.

REGULATION

REGULATION OF WATER CARRIERS

The inland waterways industry consists of about 1,850 carrier firms, classified by the Interstate Commerce Commission, (ICC), as regulated, exempt, or private.

1. Regulated Carriers operating under jurisdiction of the ICC are either classified as "Common Carriers" or "Contract Carriers".
   A. "Common Carriers" hold themselves out for public service and must provide transportation to shippers without discrimination, including transporting marginal and unprofitable shipments. They receive operating authority from an ICC certificate of public convenience and necessity. Such a carrier must file and publish tariffs and submit annual financial reports to the ICC.
   B. "Contract Carriers" provide transportation service to shippers of large quantities of goods under specific contracts. They operate under authority of an ICC permit specifying their range of service for individual shippers. Such a carrier is not required to publish actual rates, but must publish and file minimum rates with the ICC.

2. Exempt Carriers transport freight that is free of economic regulation as identified in Part III, Section 303(b) of the Interstate Commerce Act. This applies to bulk commodities which are loaded and carried without wrappers or containers and received and delivered by the carrier without transportation mark or count e.g., grain, coal, sand. The transport of liquid cargoes is exempt from economic regulation when carried in bulk in tank vessels designed for use exclusively in such service and certified for such service.
   Rates are not published by exempt carriers but are frequently established by contract with the shipper. Although regulated carriers participate extensively in the transport of exempt commodities, some carriers handle exempt traffic only.

3. Private Carriers operate fleets primarily to transport their own products (usually grain, coal, petroleum or chemicals). Private carriers are also permitted to hire out their services for the transportation of exempt commodities.

The ICC further divides water carriers into 3 classes: Class A, those with annual gross operating revenues of more than $500,000; Class B, with revenues between $100,000 and $500,000; and Class C, those with revenues less than $100,000.

The regulation of water transportation is similar to the regulation of rail and motor carriers as developed in Parts I and II of the Interstate Commerce Act. In regulation one notable difference between land carriers and water carriers is the nature of exempt commodities. One hundred percent of rail freight is subject to regulation. Agricultural products and grain are exempt from regulation for motor carriers. Water carriers, however, can transport any bulk commodity that is loaded and carried without wrappers or containers, without economic regulation. This distinction is extremely important when one realizes that approximately 85% of all barge traffic is of bulk commodities.

Water carriers wishing to enter the transportation field must file a statement of public convenience and necessity to show why they should be allowed to compete with existing modes or carriers. Extension of service requires similar documentation. Furthermore, tariffs must be established, published and filed with the ICC on non-exempt commodities: if, however, these rates are not "just and reasonable" in the eyes of the Commission, the ICC has the power to prescribe adequate rates, or the maximum and/or minimum rates for carriers (minimum only for contract carriers). Furthermore, the Commission has final control over pooling, divisions, and combinations of competition.

The Panama Canal Act of 1912 gave the ICC the power to require inter-connections between rail and water by establishing joint rates and through routes for shippers. In recent years, the Commission has worked to promote coordination between modes, an example of which is the "fishy-back" system of barge-truck connections. The term "fishy-back" applies to the movement of loaded truck trailers by barge.

It should be noted that the ICC has regulatory control over domestic inland water transportation only. International and intercoastal carriers are regulated by the Federal Maritime Commission, which was originally established in 1936. It's manner of regulation is similar to that of domestic carriers.

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APPENDIX A

LOCKS AND DAMS ALONG IOWA'S BORDER

MISSISSIPPI RIVER

LOCK AND DAM NO. 9

NEAR HARPERS FERRY, IOWA

MILE 647.9

BUILT - Construction Began 1931
Completed and Open 1938

ORIGINAL COST - $6,539,000

LOCK - One 600 feet long by 110 feet wide
Upper gate provided for future lock

Lift - 9.0 feet

Sill Depth
Upper 16.0 feet
Lower 13.0 feet

DAM - The complex has a total length of 10,165 feet - 1350 feet of fixed spillway, 8004 feet of earthen dike and 811 feet of movable gate section consisting of 5 roller gates and 8 tainter gates. The roller gates are operated from control towers, one housing operating machinery for each of the 5 gates. The tainter gates are operated by motor driven chains located at each end of the gates.

POOL LENGTH - 31 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	1,606	1,351	2,101	2,505	2,722
Recreational	2,677	1,984	2,259	2,053	2,599

TONNAGE -	1975	1977
	11,511,000	12,915,000

Note: Tonnage data is not available prior to 1975

LOCK AND DAM NO. 9

LOCK AND DAM NO. 10

GUTTENBERG, IOWA

MILE 615.5

BUILT - Construction Began 1934
Completed and Open 1937

ORIGINAL COST - $4,750,000

LOCK - One 600 feet long by 110 feet wide
Upper gate provided for future lock

Lift - 8.0 feet

Sill Depth
Upper 15.0 feet
Lower 12.0 feet

DAM - The complex has a total length of 6,510 feet - 1,200 feet of fixed spillway, 4,547 feet of earthen dike and 763 feet of moveable gate section consisting of 4 roller gates and 8 tainter gates. The roller gates are operated from control towers, one housing operating machinery for each of the 4 gates. The tainter gates are operated by motor driven chains located at each end of the gates.

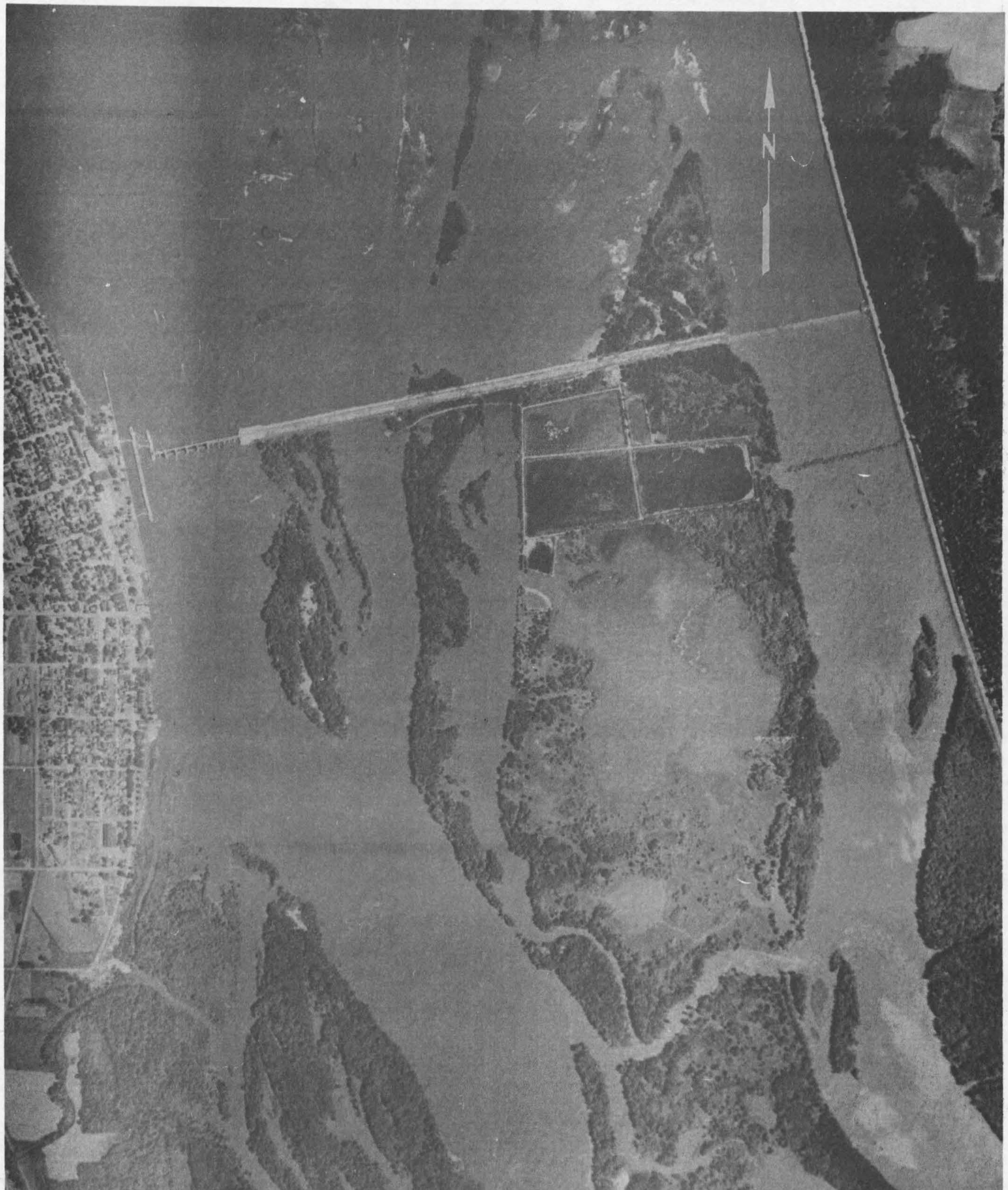
POOL LENGTH - 33 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	1,621	1,641	2,349	2,395	2,423
Recreational	2,729	2,485	3,086	2,959	4,397

TONNAGE	1975	1977
	12,092,000	13,702,000

Note: Tonnage data is not available prior to 1975

LOCK AND DAM NO. 10



LOCK AND DAM NO. 11

DUBUQUE, IOWA

MILE 583.0

BUILT - Construction Began December 11, 1933
Completed and Open September 10, 1937

ORIGINAL COST - $7,428,000

LOCK - One 600 feet long by 110 feet wide
Upper gate provided for future lock

Lift - 11.0 feet

Sill Depth
Upper 18.5 feet
Lower 12.5 feet

DAM - 1278 feet long, 16 gates (3 roller and 13 tainter)
The roller gates are operated from 3 control towers, one housing operating machinery for each of the three gates which are raised and lowered by means of a huge chain. The tainter gates are operated by motor driven chains located at each end of the gates.

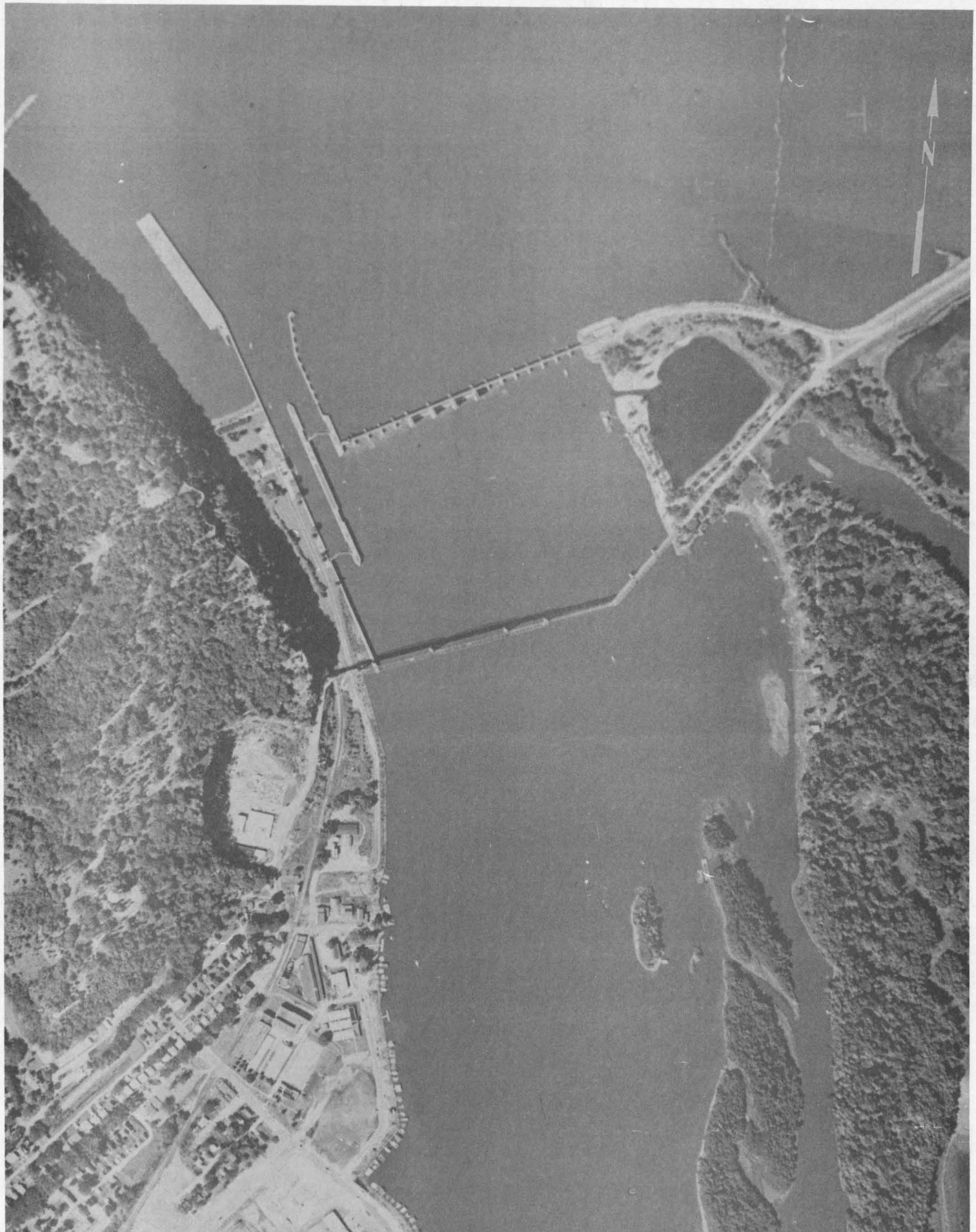
POOL LENGTH - 32 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	*	*	2,818	2,595	2,478
Recreational	2,379	1,961	2,047	2,371	2,801

TONNAGE	1960	1965	1970	1975	1977
	6,990,402	8,276,831	13,612,730	13,326,747	14,656,379

*Data not available

LOCK AND DAM NO. 11



LOCK AND DAM NO. 12

BELLEVUE, IOWA

MILE 556.7

BUILT - Construction Began December 11, 1933
Completed and Open October 10, 1938

ORIGINAL COST - $5,580,000

LOCK - One 600 feet long by 110 feet wide
Upper gate provided for future lock

Lift - 9.0 feet

Sill Depth
Upper 17.0 feet
Lower 13.0 feet

DAM - The dam is 849 feet long and consists of three roller gates and seven tainter gates. The roller gates are operated from three control towers at the dam, one housing operating machinery for each of the three gates. The tainter gates are raised and lowered by chains operated by motors located at each end of the gates.

POOL LENGTH - 26 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	*	*	2,364	2,446	2,926
Recreational	2,297	1,717	1,992	1,845	2,464

TONNAGE	1960	1965	1970	1975	1977
	7,416,676	8,920,134	14,075,865	14,680,280	15,149,142

*Data not available

LOCK AND DAM NO. 12

LOCK AND DAM NO. 13

NEAR CLINTON, IOWA

MILE 522.5

BUILT - Construction Began July 25, 1935
Completed and Open April 22, 1939

ORIGINAL COST - $7,502,000

LOCK - One 600 feet long by 110 feet wide
Upper gate provided for future lock

Lift - 11.0 feet

Sill Depth
Upper 19.0 feet
Lower 13.0 feet

DAM - The dam is 1,066 feet long and consists of 3 roller and 10 tainter gates. The roller gates are operated from control towers, one housing operating machinery for each of the three gates. The tainter gates are operated by motor driven chains located at each end of the gates.

POOL LENGTH - 34 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	*	*	2,279	2,411	2,511
Recreational	2,123	1,540	1,861	1,899	2,495

TONNAGE	1960	1965	1970	1975	1977
	7,417,076	8,954,029	14,086,660	14,735,481	15,216,550

*Data not available

LOCK AND DAM NO. 13

LOCKS AND DAM NO. 14

NEAR LE CLAIRE, IOWA

MILE 493.3

BUILT - Completed and Open July 14, 1939

ORIGINAL COST - $6,284,000

LOCKS - One lock 600 feet long by 110 feet wide
One auxiliary lock 320 feet long by 80 feet wide
The auxiliary lock (used on a standby basis) was built in the early 1900's as a part of the 6-foot channel project.

Lift - 11.0 feet

Sill Depth - Main Lock	Sill Depth - Auxiliary Lock
Upper 20.5 feet	Upper 17.6 feet
Lower 13.5 feet	Lower 10.9 feet

DAM - The dam is 1343 feet long and is composed of 4 roller gates and 13 tainter gates. The roller gates are operated from control towers, one housing operating machinery for each of the four gates. The tainter gates are operated by motor driven chains located at each end of the gates.

POOL LENGTH - 30 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	*	*	3,330	3,378	3,693
Recreational	3,895	2,205	3,114	2,774	3,263

TONNAGE	1960	1965	1970	1975	1977
	7,894,623	9,745,580	15,784,005	15,875,503	17,418,242

*Data not available

LOCK AND DAM NO. 14

LOCKS AND DAM NO. 15

DAVENPORT, IOWA

MILE 482.9

BUILT - Construction Began April, 1931
Completed and Open May, 1934

ORIGINAL COST - $10,525,000

LOCKS - One lock 600 feet long by 110 feet wide
One auxiliary lock, 360 feet long by 110 feet wide.

Lift - 16.0 feet

Sill Depth - Main Lock	Sill Depth - Auxiliary Lock
Upper 24.0 feet	Upper 17.0 feet
Lower 11.0 feet	Lower 11.0 feet

DAM - The dam is 1203 feet long and consists of 11 roller gates, 100 feet long each. Gate No. 1 and 11 are called skimmer gates, smaller in diameter (21.75 feet) in order to permit an overflow to keep the upper pool clear of debris. The remaining 9 gates are each 26 feet in diameter. There are 11 control houses at the dam, each one housing operating machinery for the roller gates. This dam was built on an angle to gain additional gates as the river is quite narrow at this point. The dam houses a small hydro electric generator which generates electricity for the Corps Clock Tower Building and the Rock Island Arsonal.

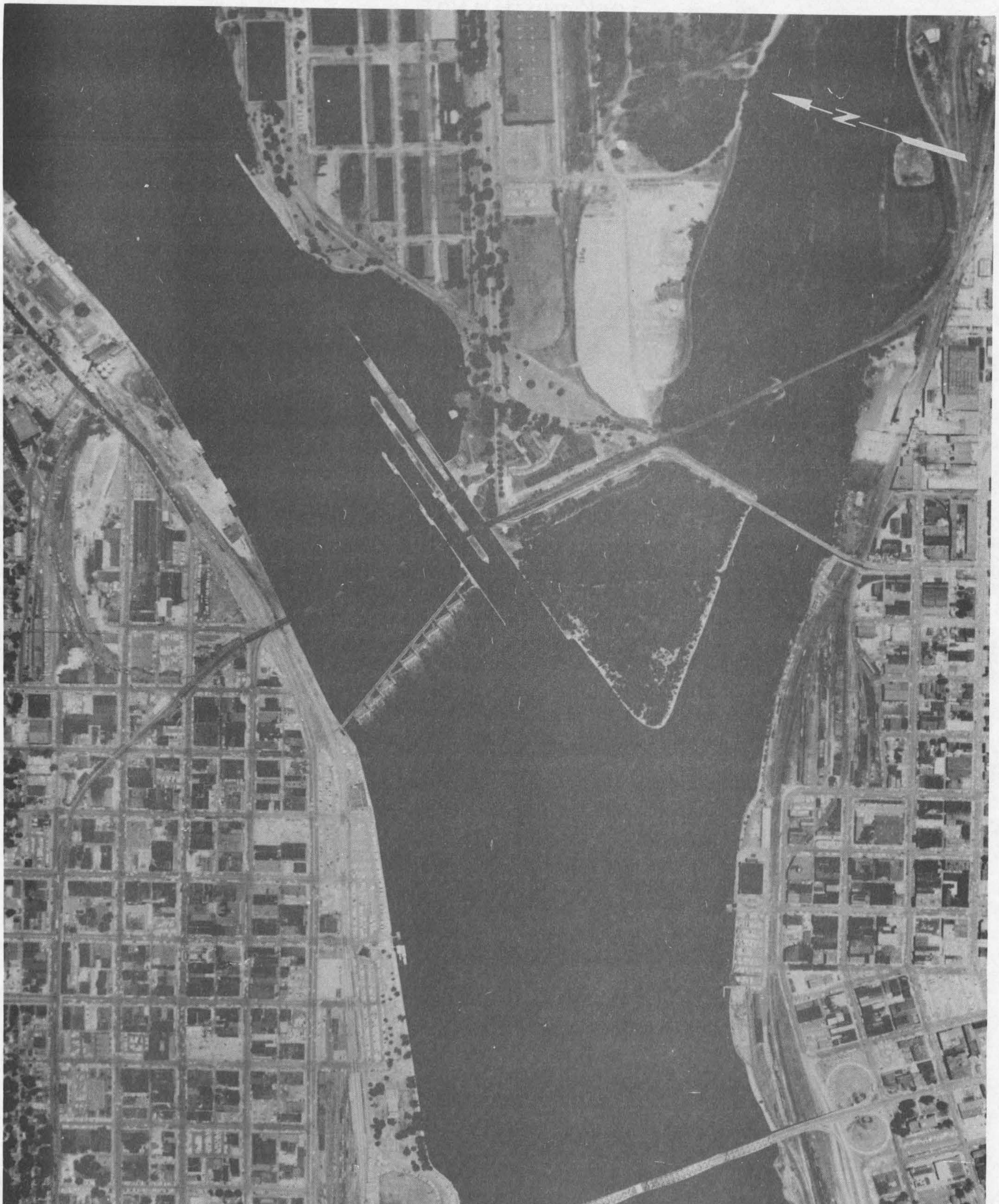
POOL LENGTH - 10 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	*	*	4,099	3,601	4,032
Recreational	3,512	2,257	2,674	2,873	2,908

TONNAGE	1960	1965	1970	1975	1977
	8,405,358	10,336,084	16,652,366	16,563,187	18,045,194

*Data not available

LOCK AND DAM NO. 15



LOCK AND DAM NO. 16

NEAR MUSCATINE, IOWA

MILE 457.2

BUILT - Construction Began December 11, 1933
Completed and Open July 11, 1937

ORIGINAL COST - $9,788,000

LOCK - One lock 600 feet long by 110 feet wide
Upper gate provided for future lock

Lift - 9.0 feet

Sill Depth
Upper 17.0 feet
Lower 12.0 feet

DAM - The dam is 1099 feet long and consists of 4 roller gates and 15 tainter gates. The roller gates are operated from control towers, one housing operating machinery for each of the four gates. The tainter gates are operated by motor driven chains located at each end of the gates.

POOL LENGTH - 26 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	*	*	3,391	3,553	3,787
Recreational	1,560	1,192	1,324	1,182	1,346

TONNAGE	1960	1965	1970	1975	1977
	8,669,087	10,695,214	17,553,860	18,341,243	19,802,196

*Data not available

LOCK AND DAM NO. 16

LOCK AND DAM NO. 17

NEAR TOOLESBORO, IOWA

MILE 437.1

BUILT - Construction Began July, 1935
Completed and Open April, 1939

ORIGINAL COST - $5,843,000

LOCK - One lock 600 feet long by 110 feet wide
Upper gate provided for future lock

Lift - 8.0 feet

Sill Depth
Upper 16.0 feet
Lower 13.0 feet

DAM - The dam is 921 feet long and contains 3 roller gates and 8 tainter gates. The roller gates are operated from control towers, one housing operating machinery for each of the three gates. The tainter gates are operated by motor driven chains located at each end of the gates.

POOL LENGTH - 20 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	*	*	3,358	3,485	3,505
Recreational	1,599	859	1,156	799	1,296

TONNAGE	1960	1965	1970	1975	1977
	8,692,694	11,146,484	18,397,510	19,107,453	20,249,573

*Data not available

LOCK AND DAM NO. 17

LOCK AND DAM NO. 18

NEAR BURLINGTON, IOWA

MILE 410.5

BUILT - Construction Began November, 1933
Completed and Open September, 1937

ORIGINAL COST - $10,308,000

LOCK - One lock 600 feet long by 110 feet wide
Upper gate provided for future lock

Lift - 9.8 feet

Sill Depth
Upper 16.5 feet
Lower 13.7 feet

DAM - The dam is 1350 feet long and contains 3 roller gates and 14 tainter gates. The roller gates are operated from control towers, one housing operating machinery for each of the three gates. The tainter gates are operated by motor driven chains, located at each end of the gates.

POOL LENGTH - 26 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	*	*	3,472	3,610	3,781
Recreational	2,976	2,002	1,812	1,490	1,422

TONNAGE	1960	1965	1970	1975	1977
	8,790,394	11,560,909	18,701,125	19,472,413	20,796,353

*Data not available

LOCK AND DAM NO. 18

LOCKS AND DAM NO. 19

KEOKUK, IOWA

MILE 364.2

BUILT - In 1905, the Mississippi River Power Company (now the Union Electric Power Company) was authorized to construct a hydroelectric plant with a dam, powerhouse, 358 foot by 110 foot lock, and drydock with several appurtenant buildings at Keokuk. These structures, with exception of the dam and powerhouse, were turned over to the United States upon their completion in 1913. In 1957, the Corps completed work on a new 1200 foot by 110 foot lock which was intergrated into the existing dam.

COST - $14,813,000 - includes cost of new 1200 foot by 110 foot lock and appurtenant work. Does not include the cost of the original 358 foot by 110 foot lock or the dam.

LOCKS - One lock 1200 feet long by 110 feet wide
One auxiliary lock 358 feet long by 110 feet wide

Lift - 38.2 feet

Sill Depth - Main Lock	Sill Depth - Auxiliary Lock
Upper 15.0 feet	Upper 14.0 feet
Lower 13.0 feet	Lower 9.2 feet

DAM - The dam is 4620 feet long and contains 119 spillways, each containing a vertical lift crest gate 32 feet long by 11 feet high. The powerhouse houses 15 main turbins (10,000 horsepower each). Maximum output is 136,000 magawatt hours annually.

POOL LENGTH - 47 miles

LOCKAGES	1960	1965	1970	1975	1977
Commercial	*	*	2,572	2,485	2,659
Recreational	903	570	671	724	675

TONNAGE	1960	1965	1970	1975	1977
	8,877,604	12,299,235	20,029,663	21,153,249	20,958,987

*Data not available

LOCK AND DAM NO. 19

APPENDIX B

IOWA BARGE TERMINALS

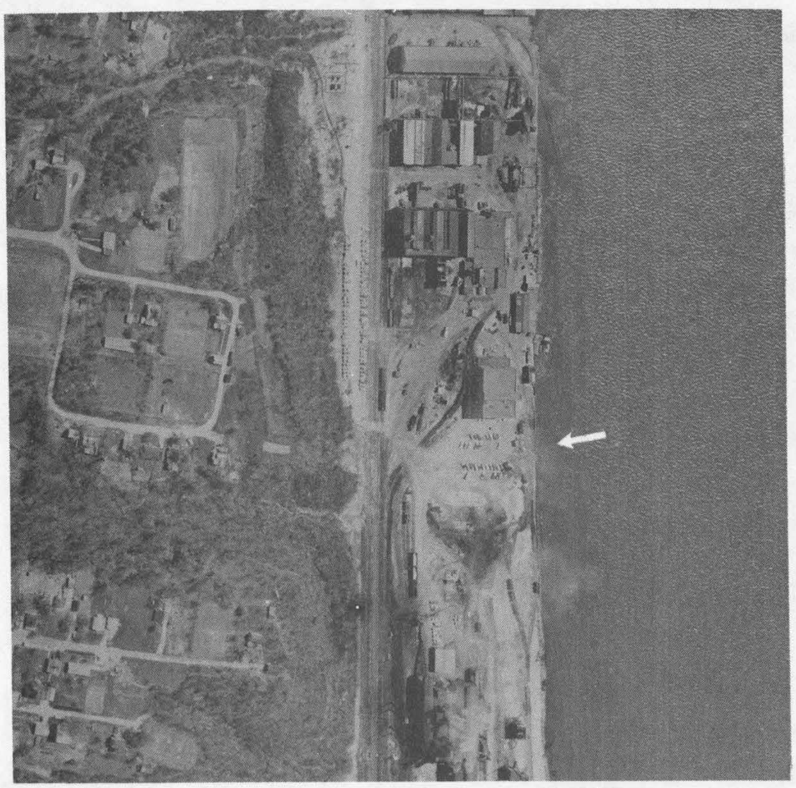
IOWA BARGE TERMINALS:
PHOTOGRAPHS AND FACTS

White arrows on the photographs **locate handling facilities** used for commodity transfer between barges and land-based facilities.

The "Map Reference No." corresponds to numbers used in "Locations of Iowa Barge Terminals", pages B-42 through B-46. The terminals are numbered from south to north along the Mississippi and Missouri Rivers.

Photograph scale: 1 inch equals 500 feet.

MISSISSIPPI RIVER TERMINALS

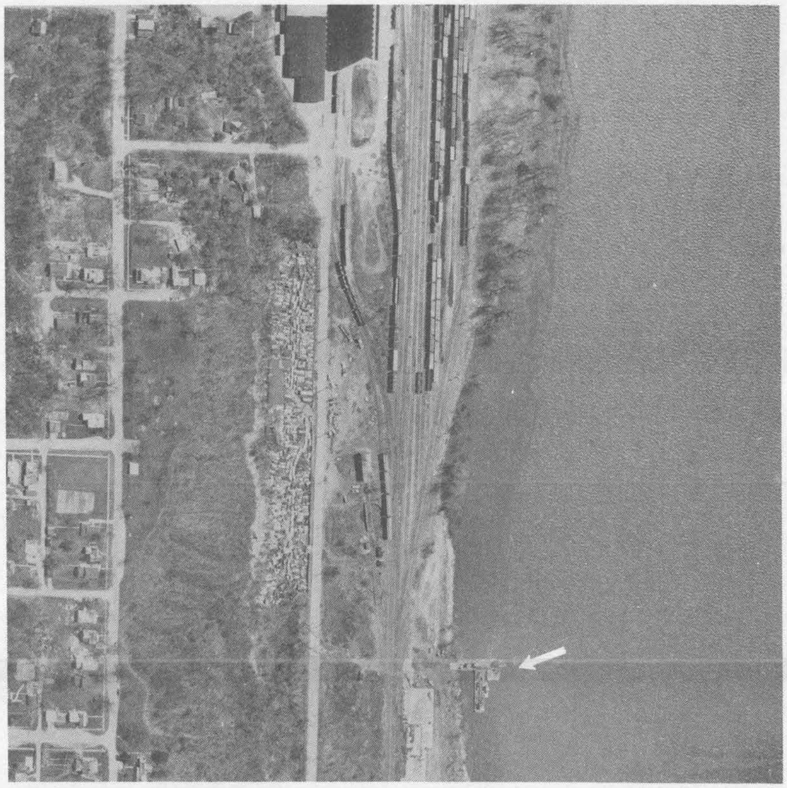


MAP REFERENCE NO.: 1
POOL NO.: 20
MILES ABOVE OHIO RIVER: 362.0
NAME: Foote Mineral Co.

ADDRESS: Ferro-Alloys Division
P.O. Box 527
Keokuk, IA 52632
PHONE: (319)524-5130
COMMODITIES HANDLED:
Manganese ore, pig iron, & construction equipment.

ACCESS:
Truck - 3½ blocks south of U.S. 136 on B St. & about 1 mile west on Commercial Street.
Rail - Burlington Northern

NOTES: Ships & receives commodities for pig iron refinery.



MAP REFERENCE NO.: 2
POOL NO.: 20
MILES ABOVE OHIO RIVER: 362.3
NAME: The Hubinger Co.

ADDRESS: (Office)
State Center Building
610 Main St., Keokuk, IA 52632
PHONE: (319)524-4151
COMMODITIES HANDLED:
Corn & corn gluten pellets, and soybeans.

ACCESS:
Truck - 3½ blocks south of U.S. 136 on B St. & about 0.5 mi. west on Commercial St. to barge facility
Rail - Chicago, Rock Island & Pacific
Burlington Northern

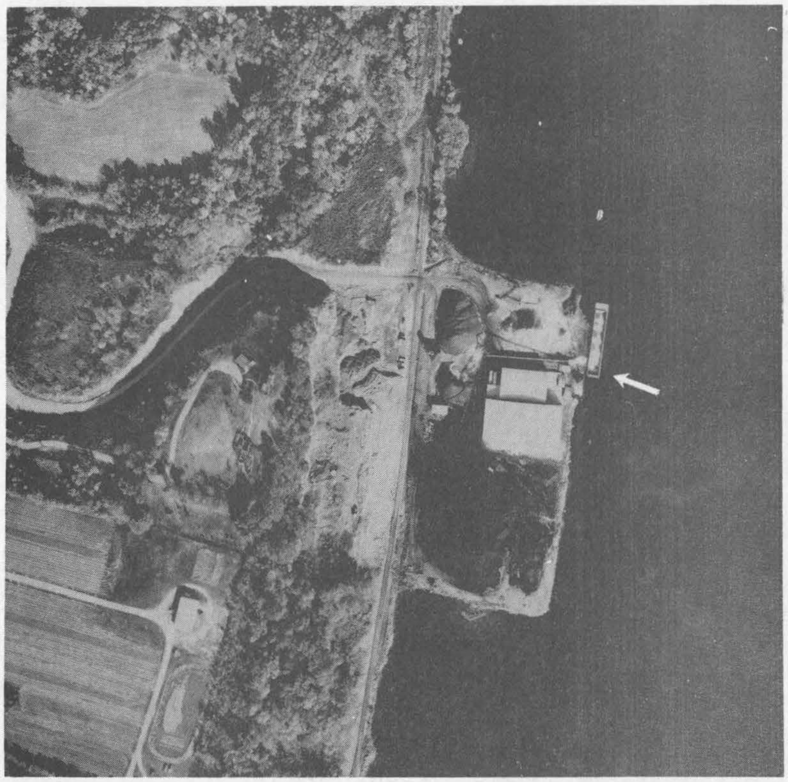
NOTES: Ships grain products from corn processing plant.

MAP REFERENCE NO.: 3
SERVICE AREA: Pools 19 and 20
MILES ABOVE OHIO RIVER: About 363.3
NAME: Iowa Marine Repair Corporation

ADDRESS:
P.O. Box 1145
Keokuk, IA 52632
PHONE: (319)524-2122
COMMODITIES HANDLED:
Barge handling services.

ACCESS: On Mississippi Drive, several blocks west of Main Street.

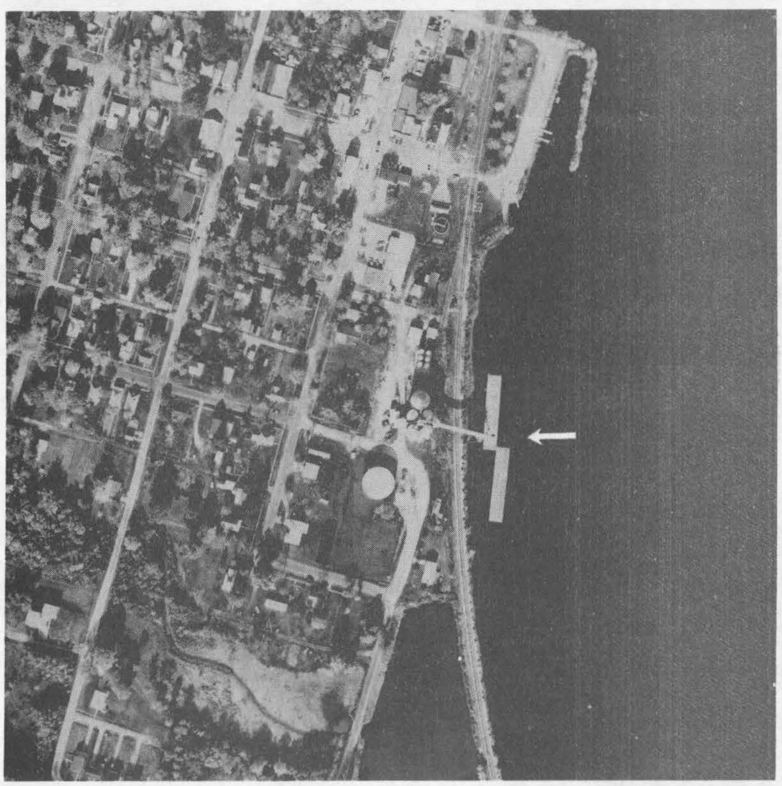
NOTES: Fleets, cleans, and repairs barges.



MAP REFERENCE NO.: 4
POOL NO.: 19
MILES ABOVE OHIO RIVER: 371.1
NAME: Iowa Gateway Terminal

ADDRESS: ATTN: W. E. Caldwell
River Road
Keokuk, IA 52632
PHONE: (319)463-5426
COMMODITIES HANDLED:
Coal, salt, newsprint, & steel products.

ACCESS:
Truck - About 3½ miles east of U.S. 218 and U.S. 61 on county rock road. No bridges and no weight restrictions.
Rail - Burlington Northern
NOTES: Shipping & receiving agent.



MAP REFERENCE NO.: 5
POOL NO.: 19
MILES ABOVE OHIO RIVER: 374.9
NAME: Hunold Elevator, Inc.

ADDRESS:
Montrose, IA 52639
PHONE: (319)463-5421
COMMODITIES HANDLED:
Corn, soybeans, wheat, and liquid fertilizer.

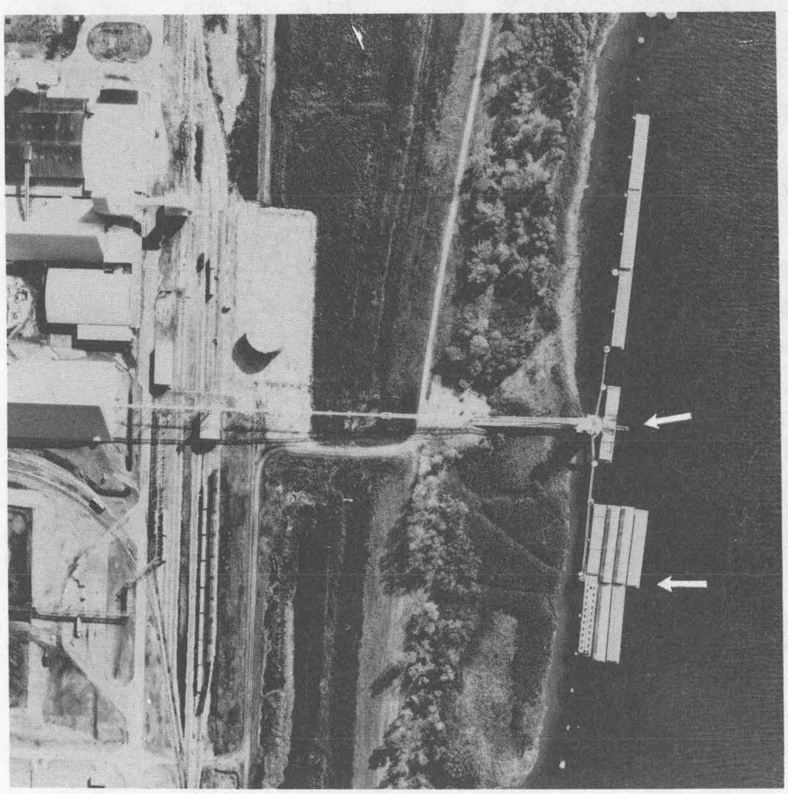
ACCESS:
Truck - On street in Montrose. A narrow paved road (IA 404) connects Montrose with U.S. 61.
Rail - Burlington Northern
NOTES: Ships grain.

MAP REFERENCE NO.: 6
SERVICE AREA: Pools 18 and 19
MILES ABOVE OHIO RIVER: 382.0
(also 390, 418)
NAME: Hall Towing, Inc.

ADDRESS:
Foot of 20th Street, P.O. 1465
Fort Madison, IA 52627
PHONE: (319)372-3078
COMMODITIES HANDLED:
Fertilizer and bulk commodities, but mainly barge handling service at present.

ACCESS:
Truck - 4½ blocks south of U.S. 61 via paved street.

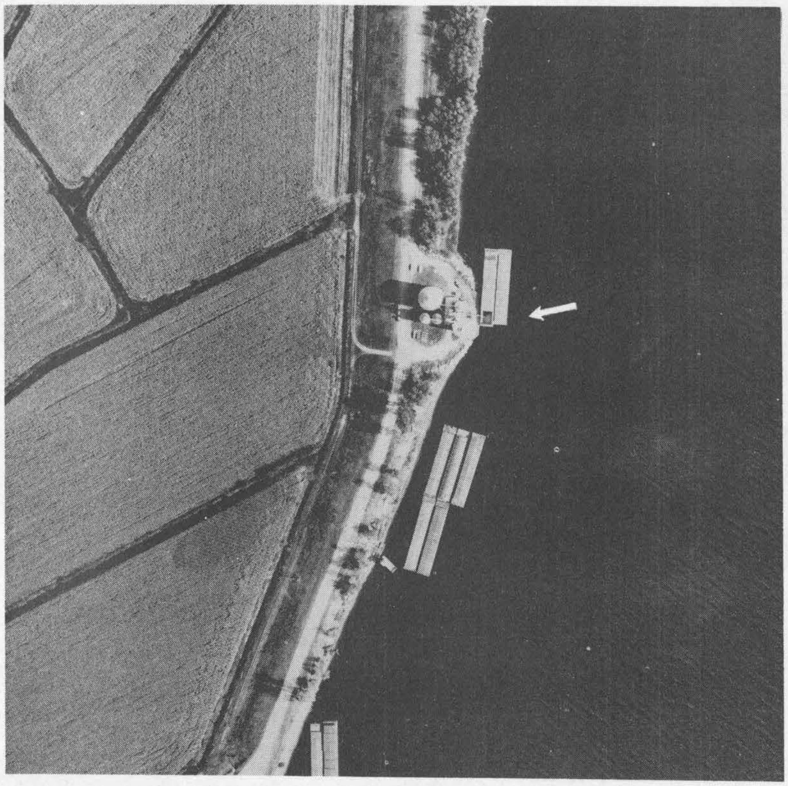
NOTES: Bulk commodity unloading at 382.0 in Ft. Madison started in 1977. Operations also include fleeting, tug service, cleaning, and repair.



MAP REFERENCE NO.: 7
POOL NO.: 19
MILES ABOVE OHIO RIVER: 389.0
NAME: FirstMiss, Inc.

ADDRESS:
P.O. Box 328
Ft. Madison, IA 52627
PHONE: (319)376-2279
COMMODITIES HANDLED:
Diammonium phosphate, phosphate rock, NH_3, & fuel oil.
ACCESS:
Truck - SE of U.S. 61 along 4.5 miles of paved and gravel roads.
Rail - Burlington Northern

NOTES: Ships fertilizer produced at the facility.

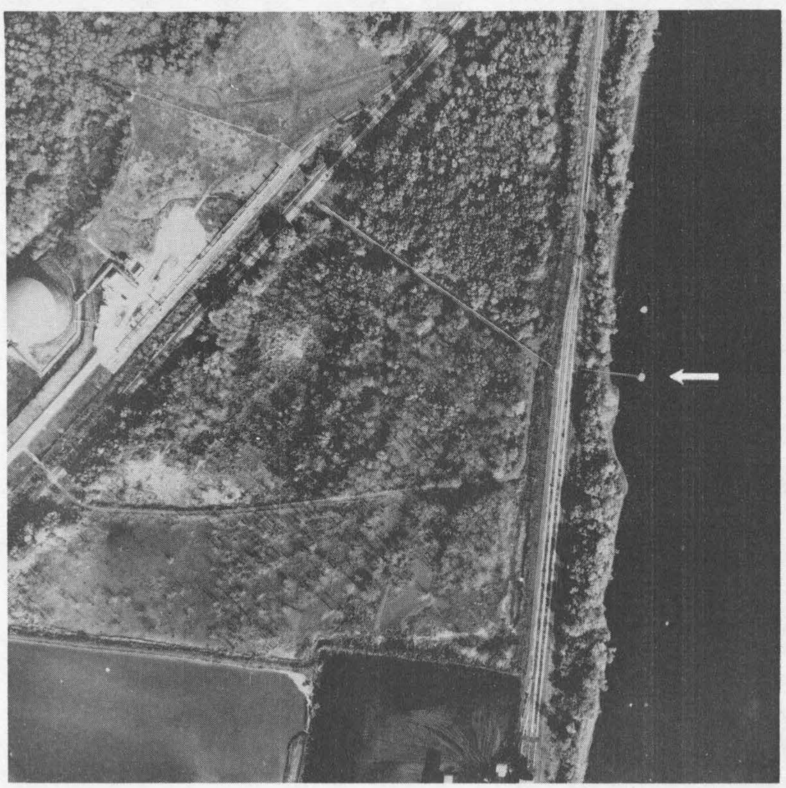


MAP REFERENCE NO.: 8
POOL NO.: 19
MILES ABOVE OHIO RIVER: 390.0
NAME: Green Bay Grain Co.

ADDRESS: (Office)
Green Bay Landing
Wever, IA 52658
PHONE: (319)372-2352
COMMODITIES HANDLED:
Corn, soybeans, & wheat.

ACCESS:
Truck - SE of U.S. 61 via 6 miles of good, gravel roads.

NOTES: Ships grain.

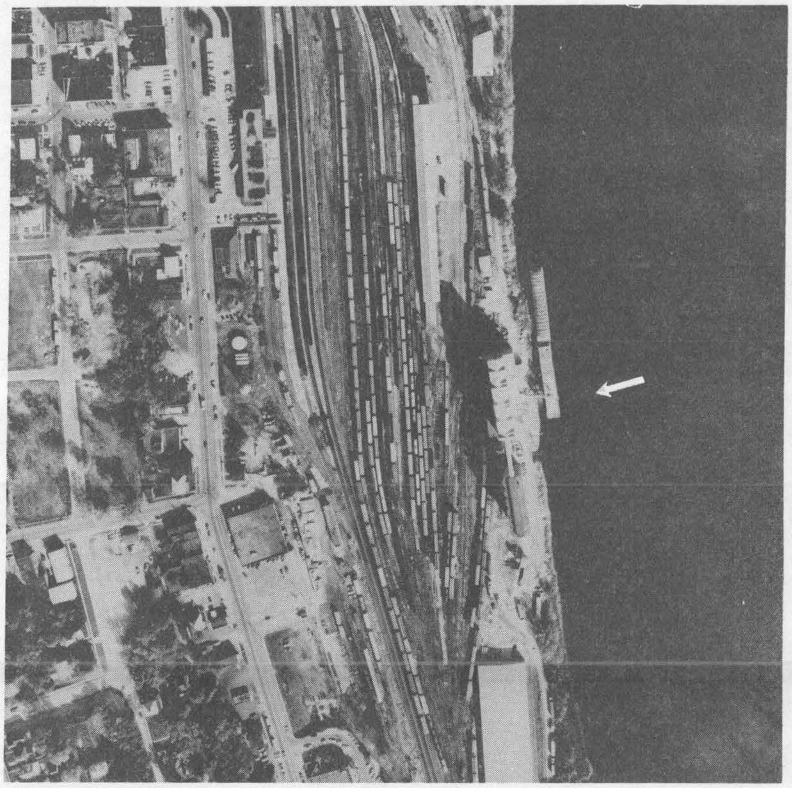


MAP REFERENCE NO.: 9
POOL NO.: 19
MILES ABOVE OHIO RIVER: 399.4
NAME: AMOCO Oil Co.

ADDRESS: Anhydrous Ammonia Term.
Old Highway 61 South
Burlington, IA 52601
PHONE: (319)752-3761
COMMODITIES HANDLED:
Anhydrous ammonia

ACCESS:
Truck - SE of paved county road via 1 mi. of good, gravel roads (1 steep incline).
Rail - Burlington Northern

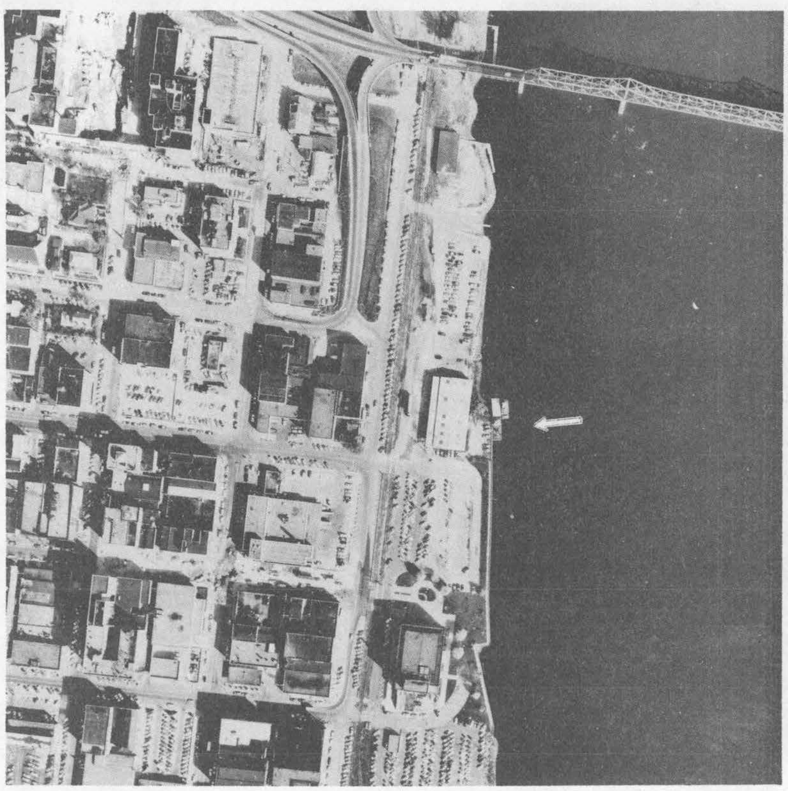
NOTES: Receives anhydrous ammonia.



MAP REFERENCE NO.: 10
POOL NO.: 19
MILES ABOVE OHIO RIVER: 403.6
NAME: Tabor & Co., Division of
Archer-Daniels-Midland Co.
ADDRESS:
Box 309
Burlington, IA 52601
PHONE: (319)752-4586
COMMODITIES HANDLED:
Grain, soybean meal, &
gluten pellets.

ACCESS:
Truck - 1 mi. east of
Burlington business district via
gravel roads with railroad
crossing and steep incline.
Rail - Burlington Northern

NOTES: Ships grain.

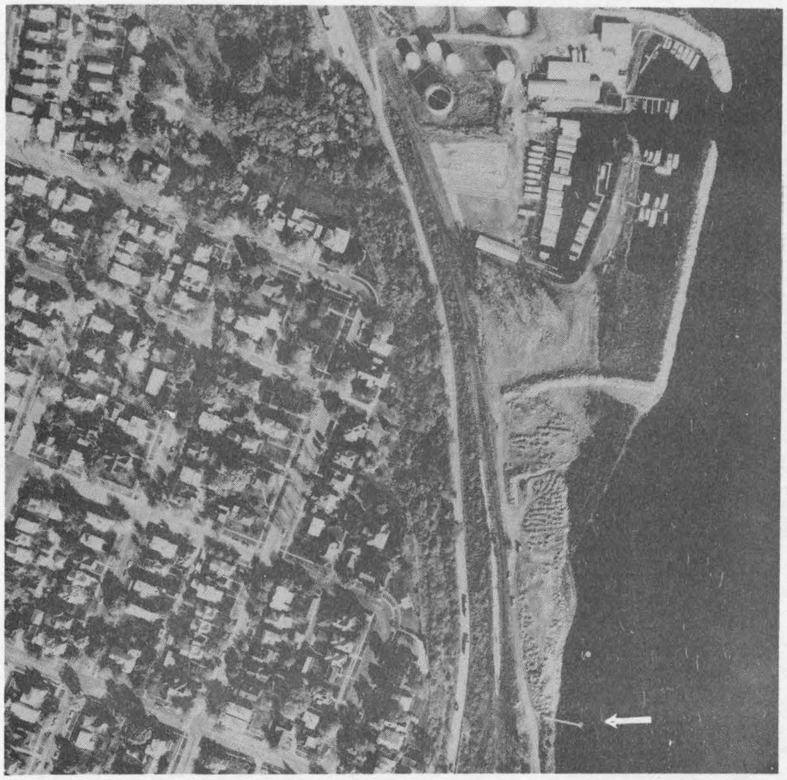


MAP REFERENCE NO.: 11
SERVICE AREA: Burlington area of Pool 19
MILES ABOVE OHIO RIVER: About 404
NAME: P-D Harbor Service Company

ADDRESS:
P.O. Box O
Argyle, IA 52619
PHONE: (319)838-2245
COMMODITIES HANDLED:
Barge handling services.

ACCESS: ½ block east of Front Street
(south of U.S. 34 bridge).

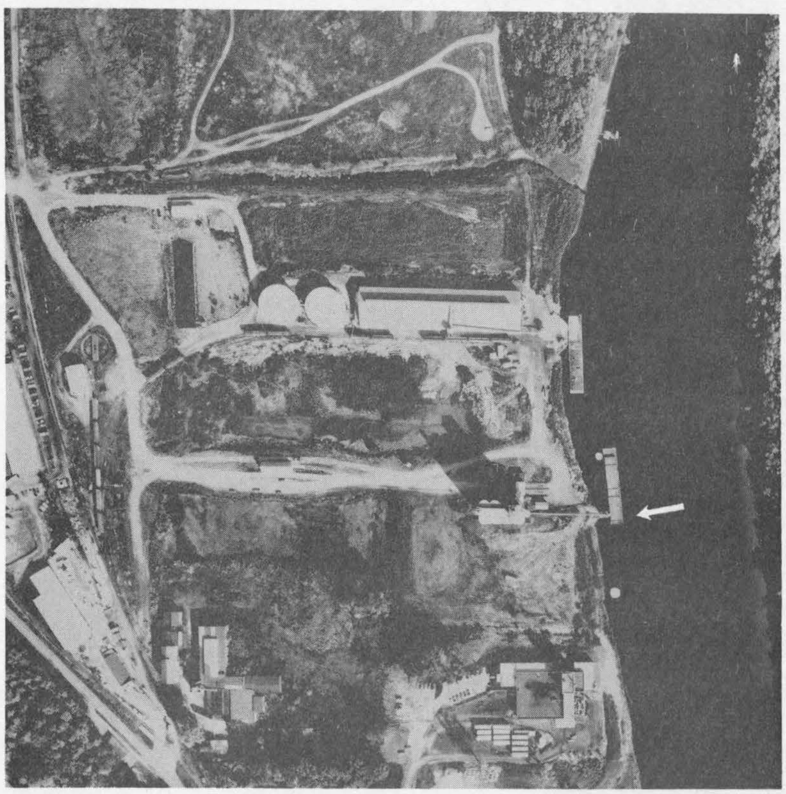
NOTES: Fleets, cleans, and
repairs barges.



MAP REFERENCE NO.: 12
POOL NO.: 19
MILES ABOVE OHIO RIVER: 404.5
NAME: Yetter Oil Company

ADDRESS:
911 Osborne Street
Burlington, IA 52601
PHONE: (319)752-6331
COMMODITIES HANDLED:
Gasoline & fuel oil.

ACCESS:
Truck - East of IA 99 via steep, gravel road. Easy access to truck loading area west of IA 99.
NOTES: Receives petroleum.

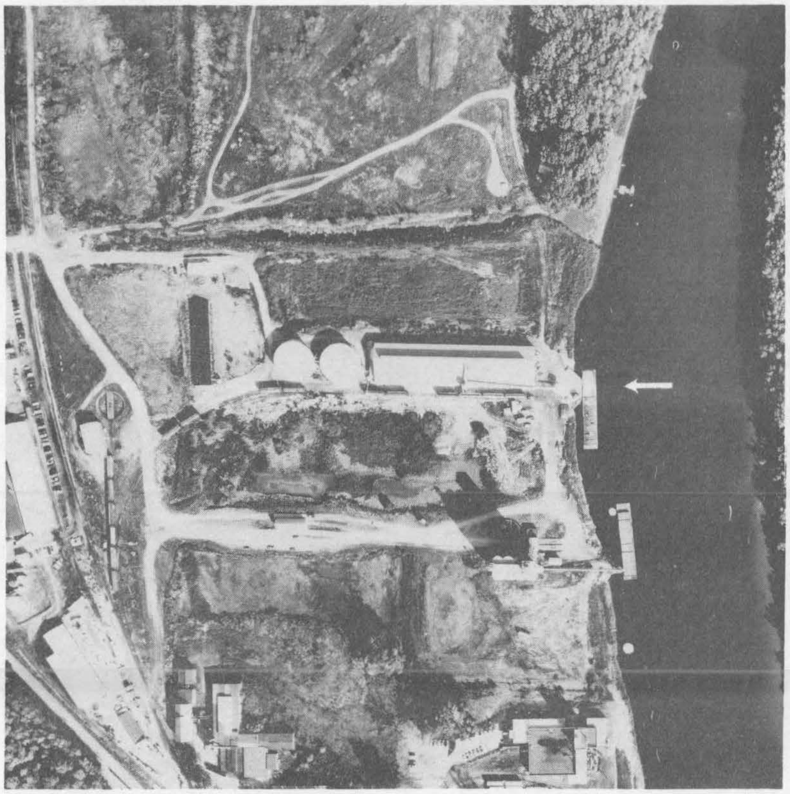


MAP REFERENCE NO.: 13
POOL NO.: 19
MILES ABOVE OHIO RIVER: 405.2
NAME: Wayne Brothers Grain Co.

ADDRESS:
P.O. Box 804
Burlington, IA 52601
PHONE: (319)753-2857
COMMODITIES HANDLED:
Corn & soybeans.

ACCESS:
Truck - About 0.3 mile east of IA 99 on good, gravel road.

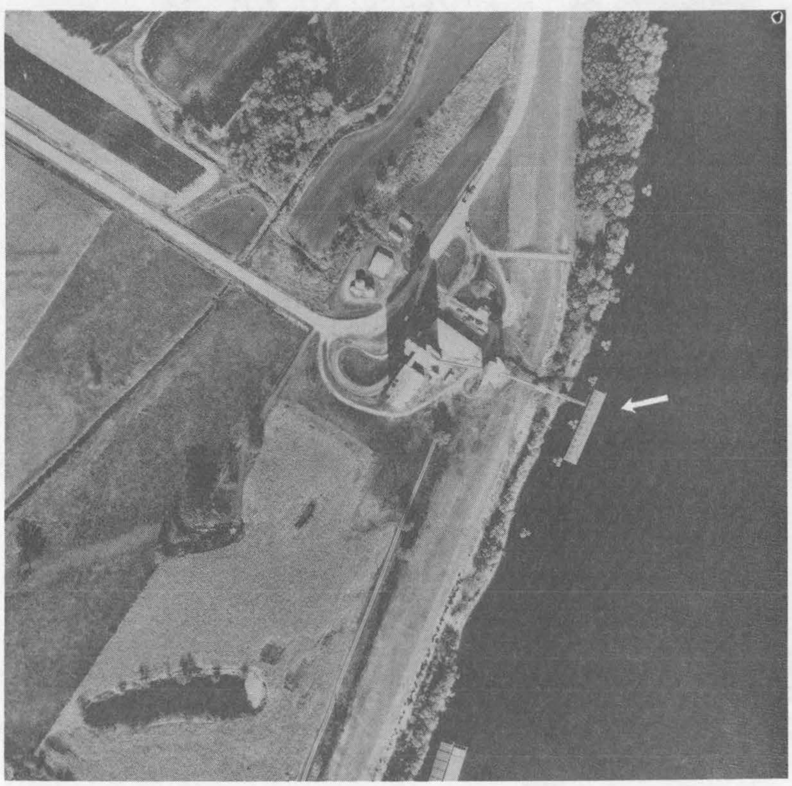
NOTES: Ships grain.



MAP REFERENCE NO.: 14
POOL NO.: 19
MILES ABOVE OHIO RIVER: 405.3
NAME: Burlington River Terminal, Inc.
ADDRESS: ATTEN: A. G. Stevenson
P.O. Box 884
Burlington, IA 52601
PHONE: (319)752-3611; 752-2802
COMMODITIES HANDLED:
Liquid & dry fertilizers, & steel.

ACCESS:
Truck - East of IA 99 via 0.3 mi. of good, gravel road; crosses 4 sets of RR tracks.
Rail - Chicago, Rock Island & Pacific

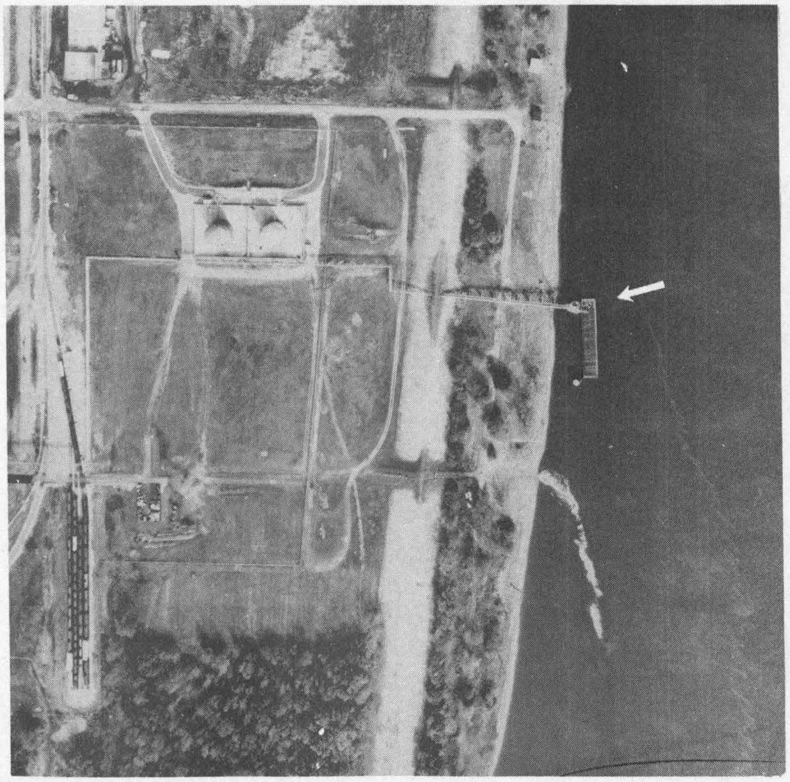
NOTES: Receives fertilizer & general commodities.



MAP REFERENCE NO.: 15
POOL NO.: 18
MILES ABOVE OHIO RIVER: 418.2
NAME: Farmers Grain Dealers, Association
ADDRESS:
Rural Route 2
Burlington, IA 52601
PHONE: (319)937-6155
COMMODITIES HANDLED:
Corn, soybeans, & wheat.

ACCESS:
Truck - East of IA 99 about 6 miles via level, good, gravel roads.

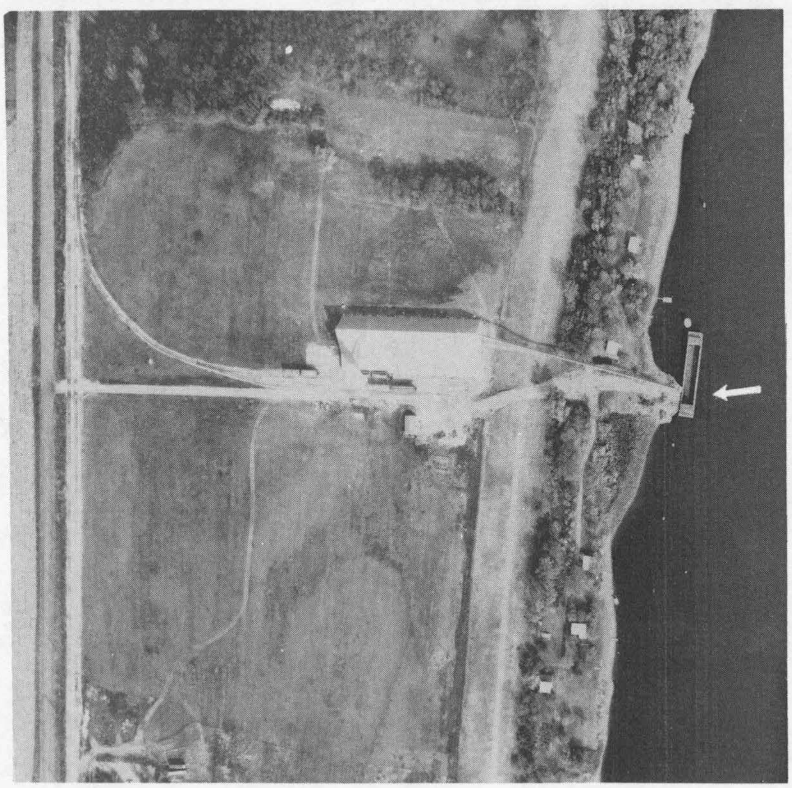
NOTES: Ships grain.



MAP REFERENCE NO.: 16
POOL NO.: 17
MILES ABOVE OHIO RIVER: 449.9
NAME: Monsanto Agricultural Products Co.
ADDRESS:
Rural Route 5
Muscatine, IA 52761
PHONE: (319)263-0093
COMMODITIES HANDLED:
Styrene & acrylonitrile.

ACCESS:
Truck - SE of IA 92 about 4 miles via good, paved & gravel roads.
Rail - Chicago, Rock Island & Pacific

NOTES: Receives chemicals for producing plastics. Barge operations started in 1976.

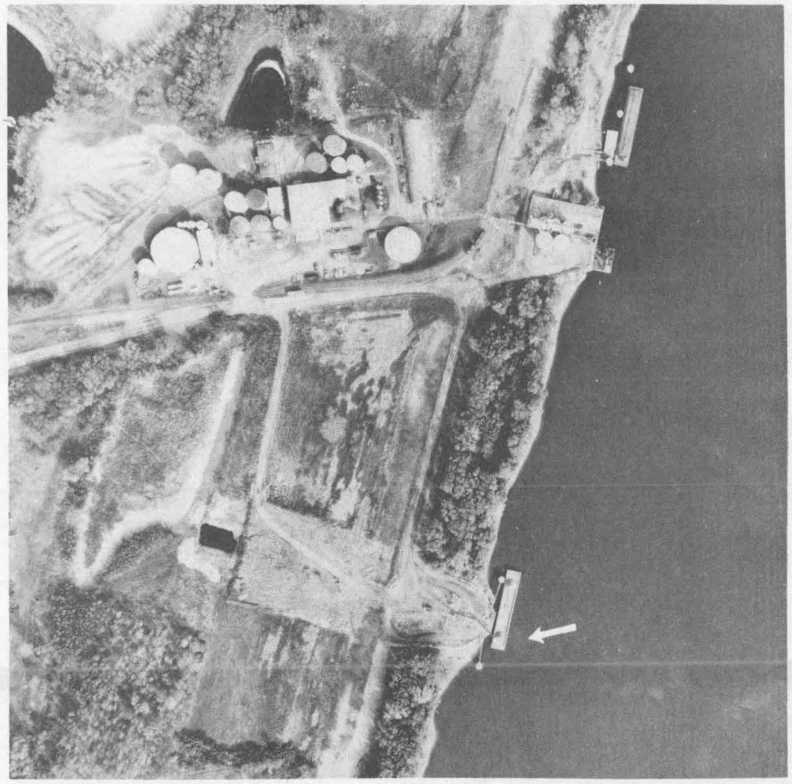


MAP REFERENCE NO.: 17
POOL NO.: 17
MILES ABOVE OHIO RIVER: 450.3
NAME: Farmland Industries

ADDRESS: Fertilizer Warehouse
Rural Route 5
Muscatine, IA 52761
PHONE: (319)264-1721
COMMODITIES HANDLED:
Dry fertilizer

ACCESS:
Truck - South of U.S. 61 about 3.5 mi. via good roads - paved & gravel.
Rail - Chicago, Rock Island & Pacific

NOTES: Receives fertilizer.

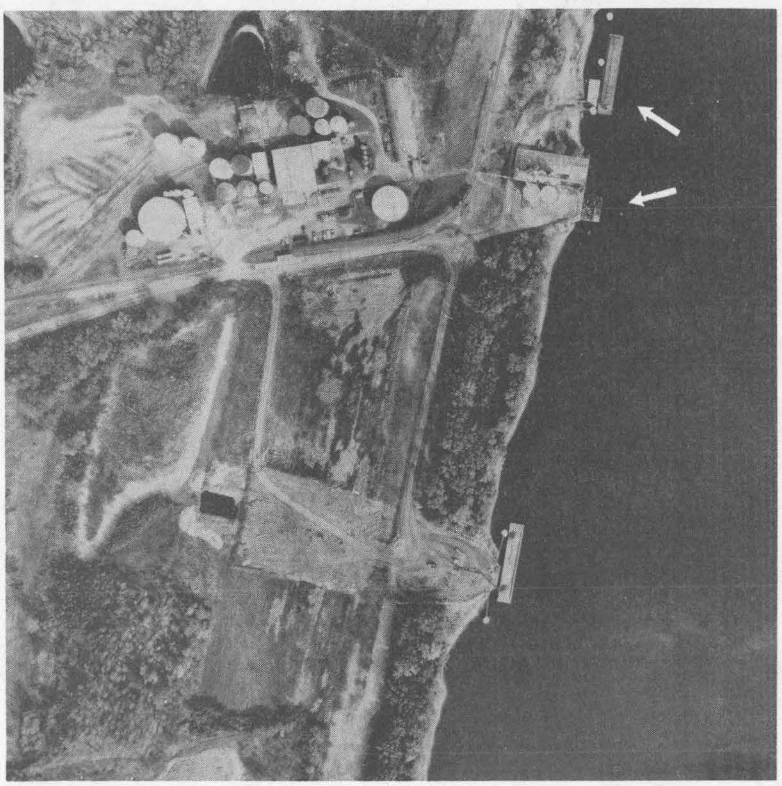


MAP REFERENCE NO.: 18
POOL NO.: 17
MILES ABOVE OHIO RIVER: 451.2
NAME: W. G. Block Co.

ADDRESS: (Office)
317 E. 4th
Davenport, IA 52808
PHONE: (319)326-1654
COMMODITIES HANDLED:
Sand, gravel, rock & stone.

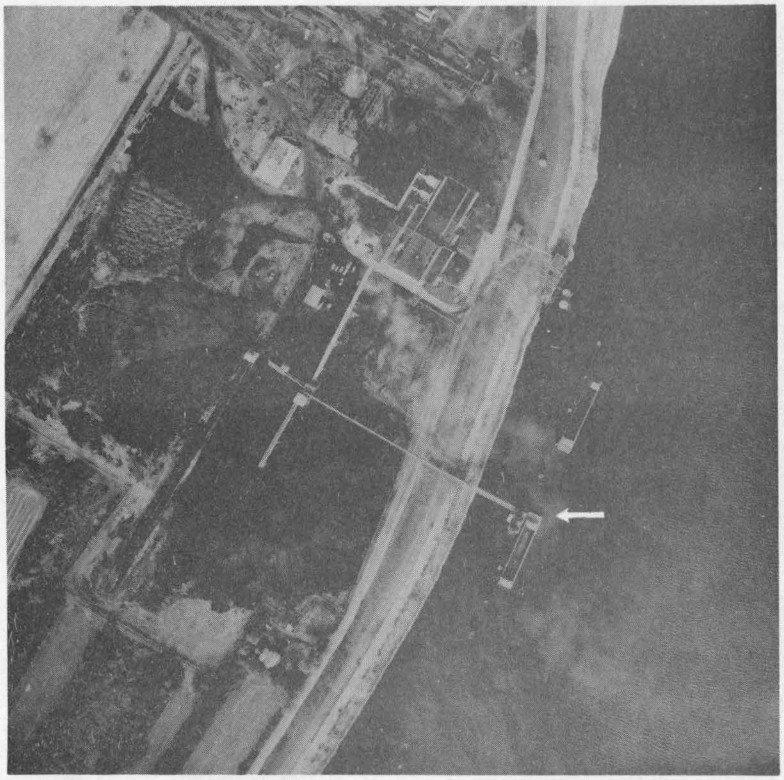
ACCESS:
Truck - SE of U.S. 61 via 3.5 mi. of good roads - paved & gravel.

NOTES: Ships commodities owned by W. G. Block Co. New terminal operating in 1976.



MAP REFERENCE NO.: 19
POOL NO.: 17
MILES ABOVE OHIO RIVER: 451.3
NAME: River Terminal Corp.

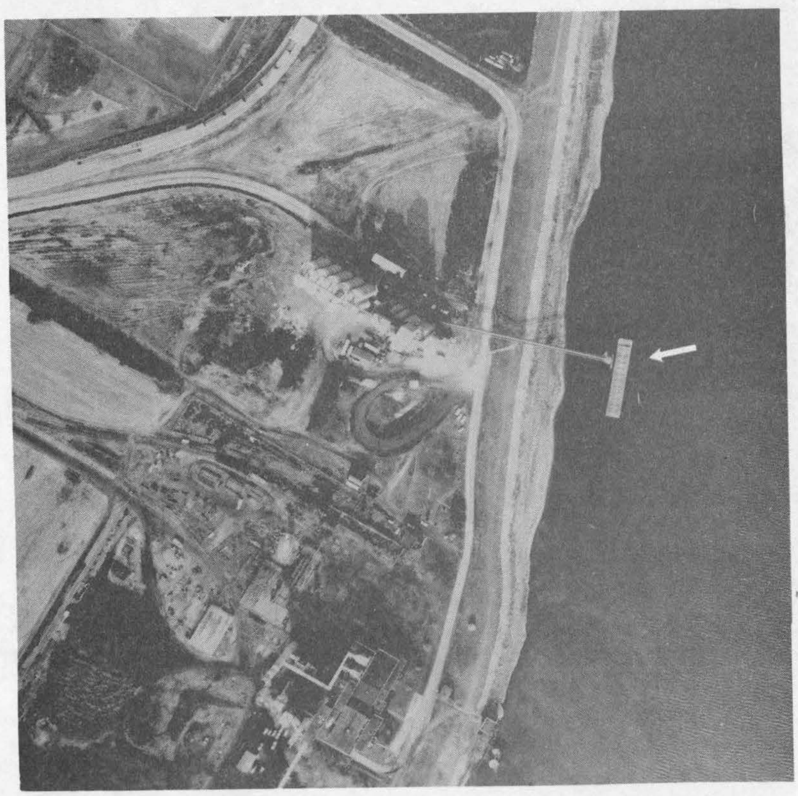
ADDRESS:
P.O. Box 1036
Muscatine, IA 52761
PHONE: (319)263-3155
COMMODITIES HANDLED:
Liquid fertilizer, molasses, condensed fish solubles, soybean oil.
ACCESS:
Truck - East of U.S. 61 about 3.5 miles via good roads - paved & gravel.
Rail - Chicago, Rock Island & Pacific
NOTES: Ships & receives general merchandise. Adjacent land & storage leased to other companies.



MAP REFERENCE NO.: 20
POOL NO.: 17
MILES ABOVE OHIO RIVER: 452.9
NAME: Muscatine Power & Water Co.
ADDRESS: (Office)
3205 Cedar
Muscatine, IA 52761
PHONE: (319)263-2631
COMMODITIES HANDLED:
Coal

ACCESS:
East of U.S. 61 about 1.5 miles via good, paved streets.
Rail - Chicago, Rock Island & Pacific

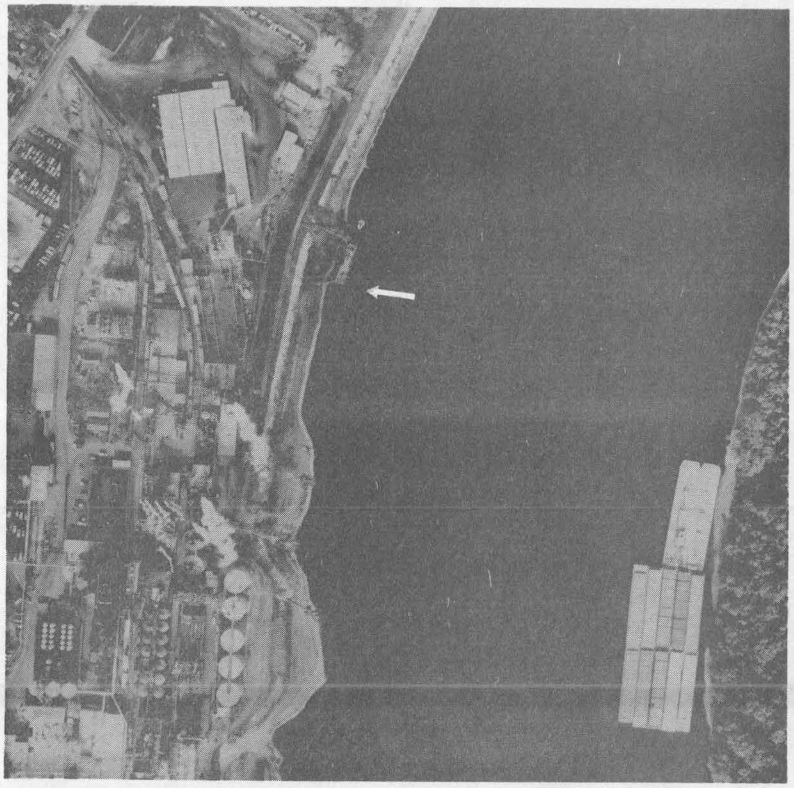
NOTES: Receives coal.
All coal used for producing electricity.



MAP REFERENCE NO.: 21
POOL NO.: 17
MILES ABOVE OHIO RIVER: 453.2
NAME: Farmers Grain Dealers Association
ADDRESS:
Rural Route 5
Muscatine, IA 52761
PHONE: (319)263-9414
COMMODITIES HANDLED:
Corn & soybeans.

ACCESS:
Truck - East of U.S. 61 about 1 mile via good, paved streets.
Rail - Chicago, Rock Island & Pacific

NOTES: Ships grain.

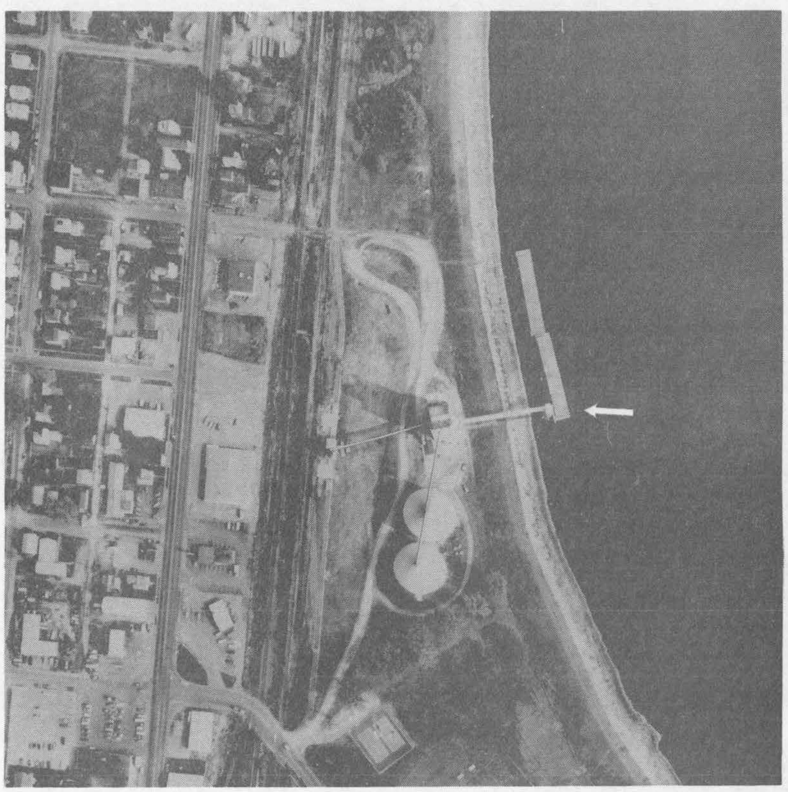


MAP REFERENCE NO.: 22
POOL NO.: 17
MILES ABOVE OHIO RIVER: 453.8
NAME: Grain Processing Corp.

ADDRESS:
1600 Oregon Avenue
Muscatine, IA 52761
PHONE: (319)264-4379
COMMODITIES HANDLED:
Alcohol

ACCESS:
Truck - SE of U.S. 61 about 6 blocks via good, paved streets.
Rail - Chicago, Rock Island & Pacific

NOTES: Ships alcohol from corn processing plant.

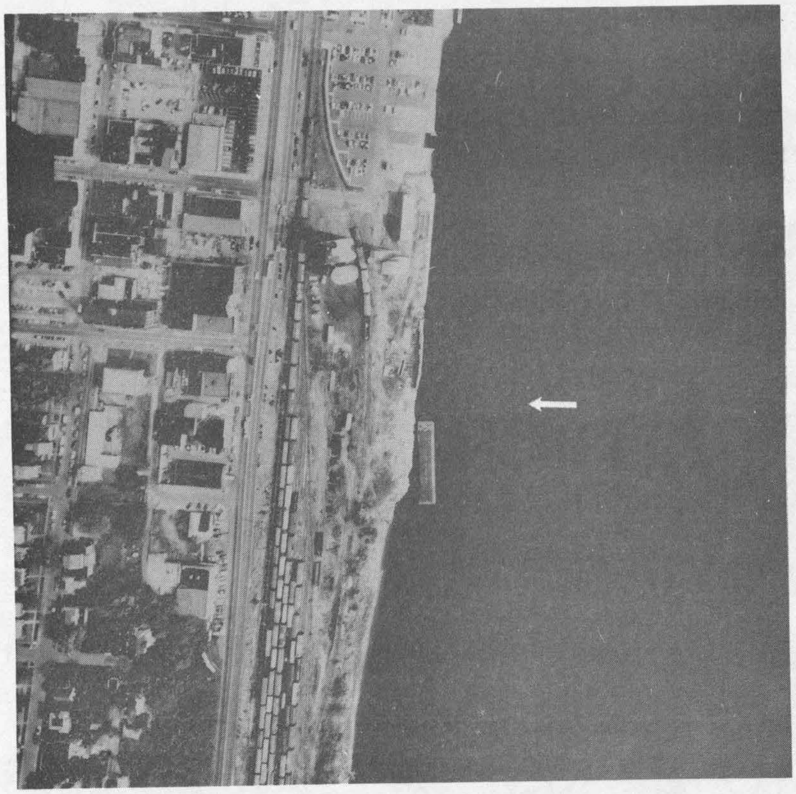


MAP REFERENCE NO.: 23
POOL NO.: 17
MILES ABOVE OHIO RIVER: 454.2
NAME: Central Soya Co.

ADDRESS:
P.O. Box 806
Muscatine, IA 52761
PHONE: (319)263-4343
COMMODITIES HANDLED:
Corn & soybeans.

ACCESS:
Truck - East of U.S. 61 about 3 blocks via paved street across rough RR tracks & short gravel road.
Rail - Chicago, Rock Island & Pacific

NOTES: Ships grain.
Operates together with Central Soya terminal 1 mile north.

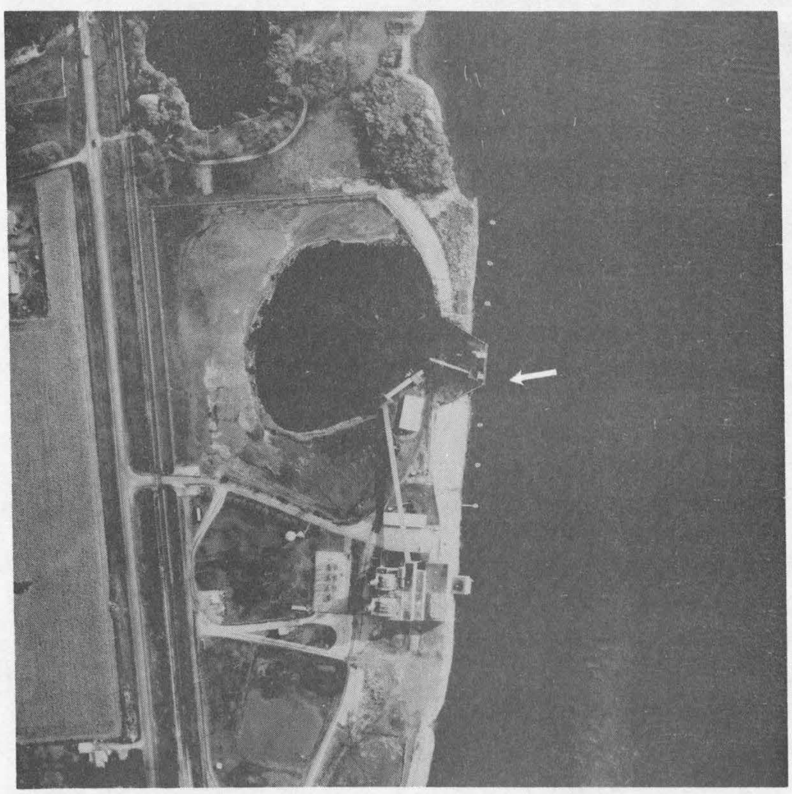


MAP REFERENCE NO.: 24
POOL NO.: 17
MILES ABOVE OHIO RIVER: 455.3
NAME: Central Soya Co.

ADDRESS:
P.O. Box 806
Muscatine, IA 52761
PHONE: (319)263-4343
COMMODITIES HANDLED:
Corn & soybeans.

ACCESS:
Truck - East of U.S. 61 via short driveway across RR tracks.
Rail - Chicago, Milwaukee, St. Paul & Pacific

NOTES: Ships grain.
Operates together with Central Soya terminal 1 mile south.

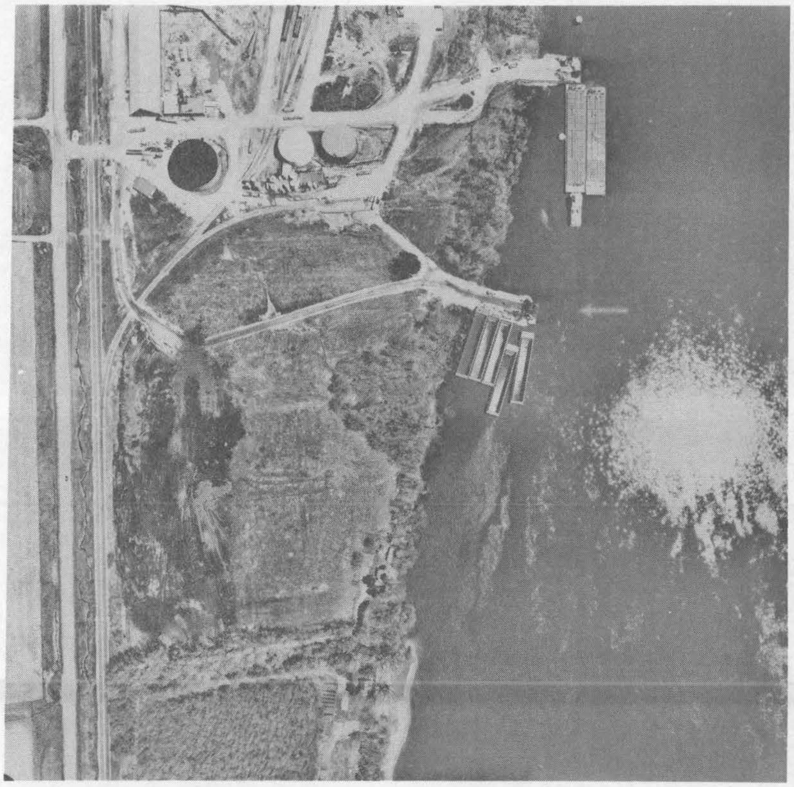


MAP REFERENCE NO.: 25
POOL NO.: 16
MILES ABOVE OHIO RIVER: 468.0
NAME: Eastern Iowa Light & Power Cooperative

ADDRESS:
P.O. Box 110
Montpelier, IA 52759
PHONE: (319)263-6898
COMMODITIES HANDLED:
Coal

ACCESS:
Truck - South of IA 22 via short, paved drivewy across rough RR tracks.

NOTES: Receives coal.
All coal used for producing electricity.

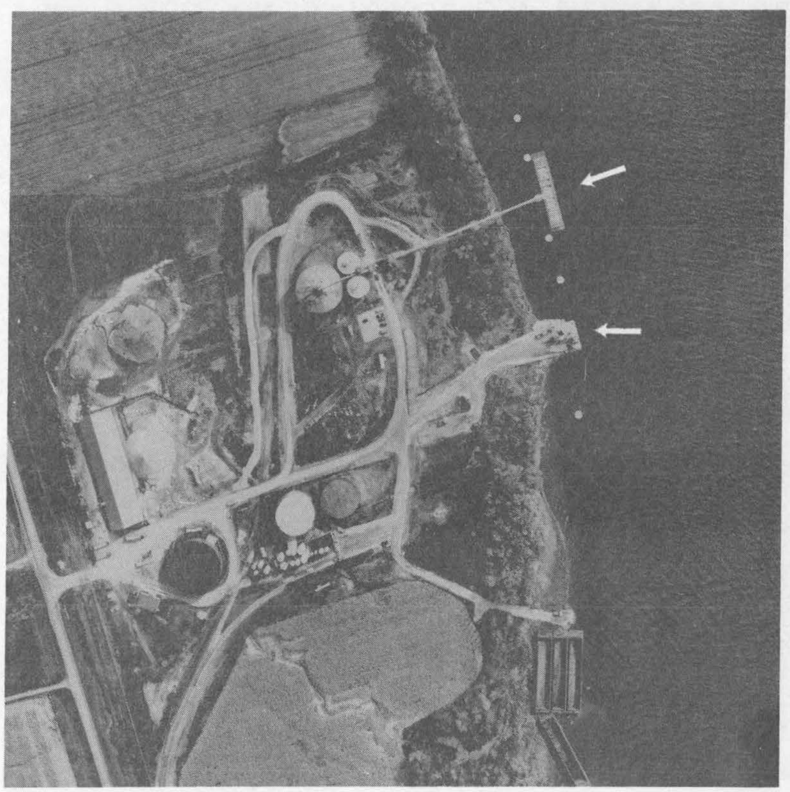


MAP REFERENCE NO.: 26
POOL NO.: 16
MILES ABOVE OHIO RIVER: 469.6
NAME: Alter Company

ADDRESS: Buffalo, Iowa
PHONE: (319)326-2561
COMMODITIES HANDLED:
Coal and steel.

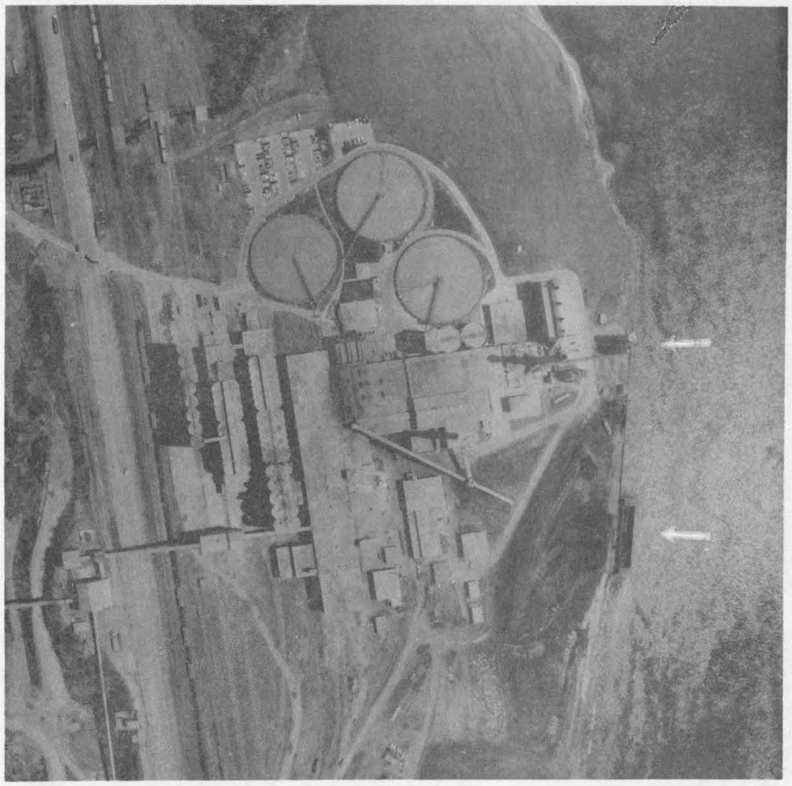
ACCESS:
Truck - Just off Iowa 22 (¾ mile from I-280)
Rail - Chicago, Rock Island & Pacific

NOTES: Mailing address:
Alter Company
2333 Rockingham Road
Davenport, IA 52808



MAP REFERENCE NO.: 27
POOL NO.: 16
MILES ABOVE OHIO RIVER: 469.8
NAME: Cargill, Inc.

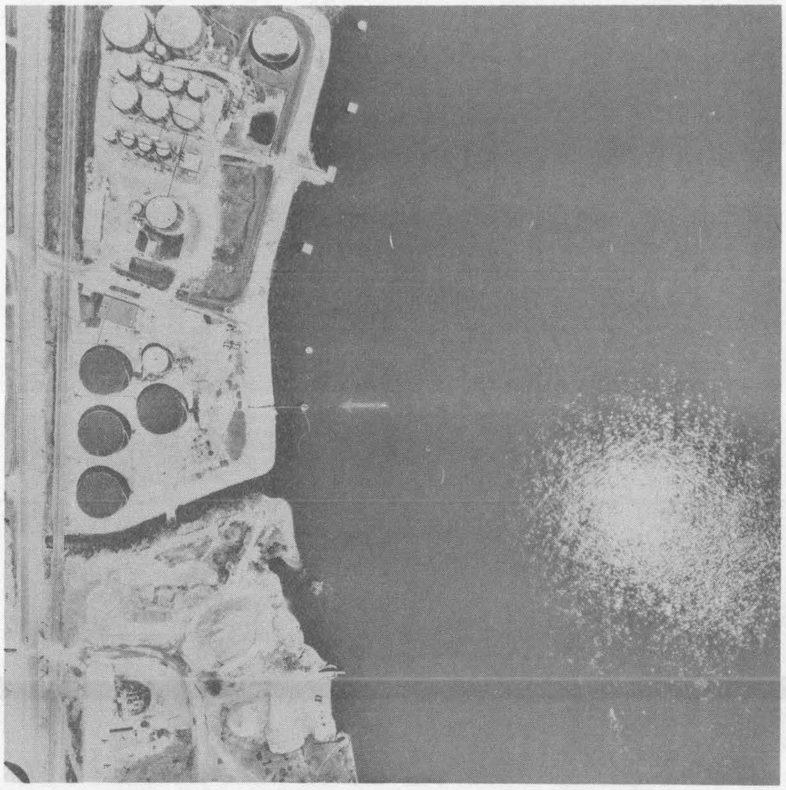
ADDRESS: Buffalo, IA 52728
PHONE: (319)381-2210 (salt)
PHONE: (319)381-2535 (molasses)
PHONE: (319)381-2323 (grain)
COMMODITIES HANDLED:
Corn, soybeans, soybean meal, industrial & road salt, molasses, vegetable oils, and caustic soda
ACCESS:
Truck - South of IA 22 via short gravel driveway across RR tracks.
Rail - Chicago, Rock Island & Pacific
- Chicago, Milwaukee, St. Paul & Pacific.
NOTES: Ships & receives a variety of commodities.



MAP REFERENCE NO.: 28
POOL NO.: 16
MILES ABOVE OHIO RIVER: 474.7
NAME: Martin Marietta Cement (Dewey Portland Cement)
ADDRESS:
606A Davenport Bank Bldg.
Davenport, IA 52808
PHONE: (319)323-2751
COMMODITIES HANDLED:
Coal, cement, coke, gypsum

ACCESS:
Truck - South of IA 22 via good, flat, paved driveway across RR tracks.
Rail - Chicago, Rock Island & Pacific
- Chicago, Milwaukee, St. Paul & Pacific
NOTES: Receives coal.
All coal is used in producing cement.

MAP REFERENCE NO.: 29
POOL NO.: 16
MILES ABOVE OHIO RIVER: 475.3
NAME: Linwood Stone Products Co., Inc.
ADDRESS:
Rural Route 2
Davenport, IA 52804
PHONE: (319)324-1931
COMMODITIES HANDLED:
Crushed stone, coal, and liquid fertilizer.
ACCESS:
Truck - South of IA 22.
Rail - Chicago, Rock Island & Pacific
- Chicago, Milwaukee, St. Paul & Pacific
NOTES: Ships crushed stone and receives coal and liquid fertilizer. The crushed stone is mined nearby and the coal is used in producing lime.

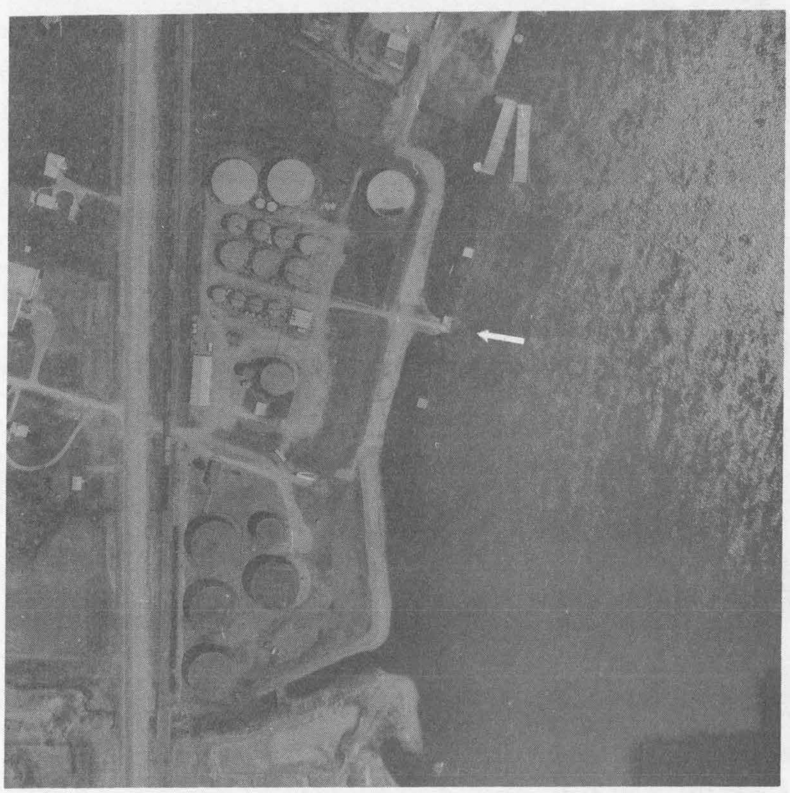


MAP REFERENCE NO.: 30
POOL NO.: 16
MILES ABOVE OHIO RIVER: 475.4
NAME: MacMillan Oil Co.

ADDRESS:
Rt. 2, Box 265
Davenport, IA 52804
PHONE: (319)383-0009
COMMODITIES HANDLED:
Fuel oil

ACCESS:
Truck - 2½ mi. south of I-280. South of IA 22 via short driveway across RR tracks

NOTES: Receives petroleum products. Barge facilities completed in 1977, including refueling equipment.

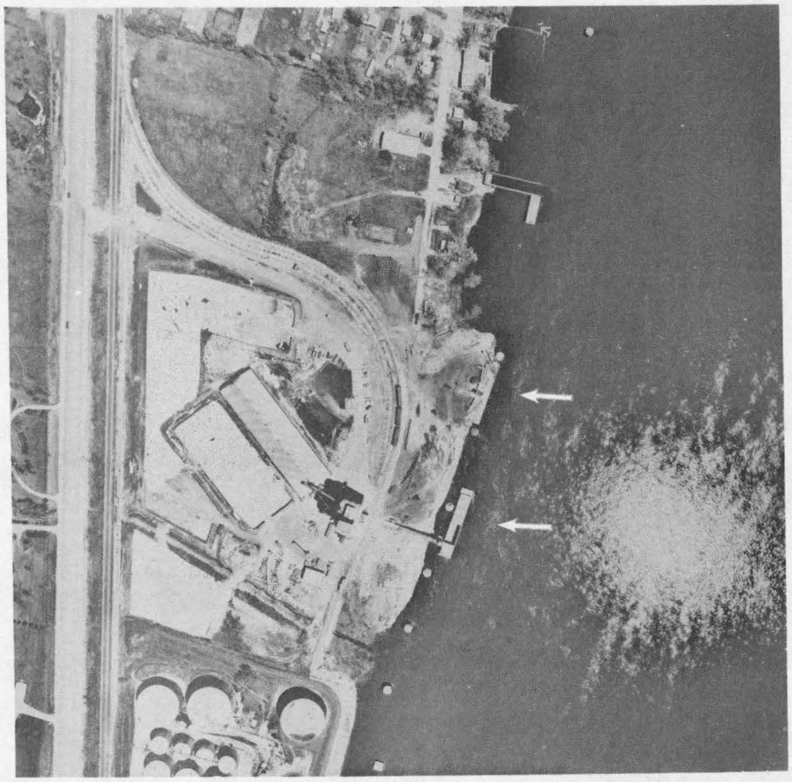


MAP REFERENCE NO.: 31
POOL NO.: 16
MILES ABOVE OHIO RIVER: 475.5
NAME: AMOCO Oil Co.

ADDRESS:
P.O. Box 3397
Davenport, IA 52808
PHONE: (319)324-5276
COMMODITIES HANDLED:
Fuel oil, asphalt road oil, and liquid fertilizer

ACCESS:
Truck - South of IA 22 via good asphalt driveway across RR tracks.

NOTES: Receives petroleum products and fertilizer.



MAP REFERENCE NO.: 32
POOL NO.: 16
MILES ABOVE OHIO RIVER: 475.7
NAME: Pillsbury Company

ADDRESS: (Office)
1600 Brady Street
Davenport, IA 52803
PHONE: (319)326-3581
COMMODITIES HANDLED:
Corn, corn screenings, corn gluten, soybeans, soybean meal, wheat, salt, oak logs, pipe, and coal

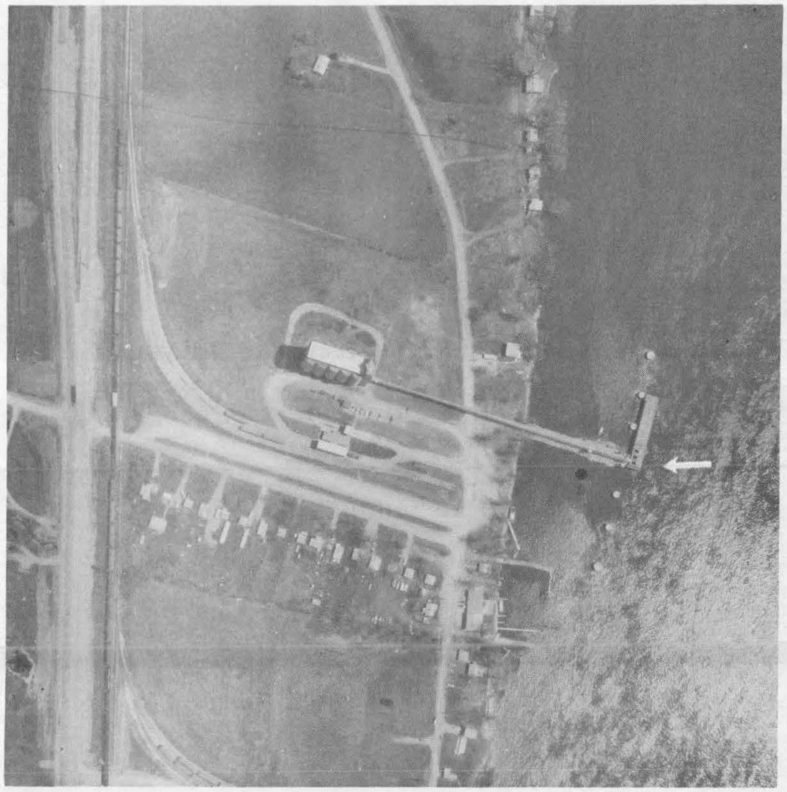
ACCESS:
Truck - South of IA 22 via good, asphalt driveway across RR tracks.
Rail - Chicago, Rock Island & Pacific
- Chicago, Milwaukee, St. Paul & Pacific -- and access to Burlington Northern
NOTES: Ships & receives commodities.

MAP REFERENCE NO.: 33
SERVICE AREA: Pools 15 and 16
MILES ABOVE OHIO RIVER: 475.85
NAME: Williams Marine Enterprise, Inc.

ADDRESS:
6725 South Concord Street
Davenport, IA 52802
PHONE: (319)324-0214
COMMODITIES HANDLED:
Barge handling services

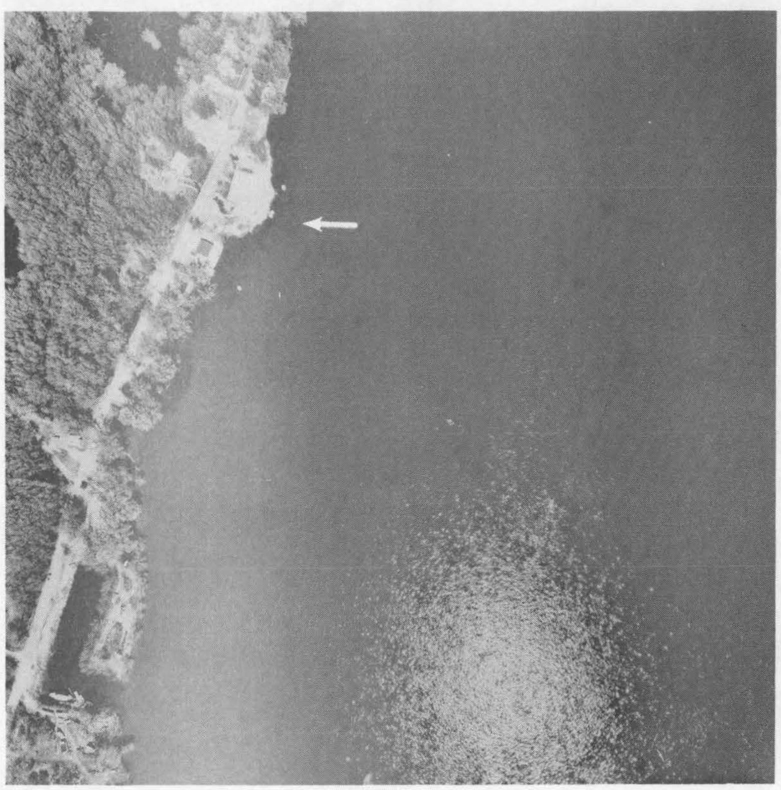
ACCESS:
South of Iowa 22 via good streets.

NOTES: Fleets, cleans, repairs, and salvages barges. Short- and medium-line towing.



MAP REFERENCE NO.: 34
POOL NO.: 16
MILES ABOVE OHIO RIVER: 476.0
NAME: Mississippi River Grain Elevator, Inc.
ADDRESS:
6603 S. Concord
Davenport, IA 52802
PHONE: (319)324-5214
COMMODITIES HANDLED:
Corn, corn products, & soybeans.

ACCESS:
Truck - South of IA 22 via good, surfaced driveway across RR tracks.
Rail - Chicago, Rock Island & Pacific
- Chicago, Milwaukee, St. Paul & Pacific
NOTES: Ships grain.

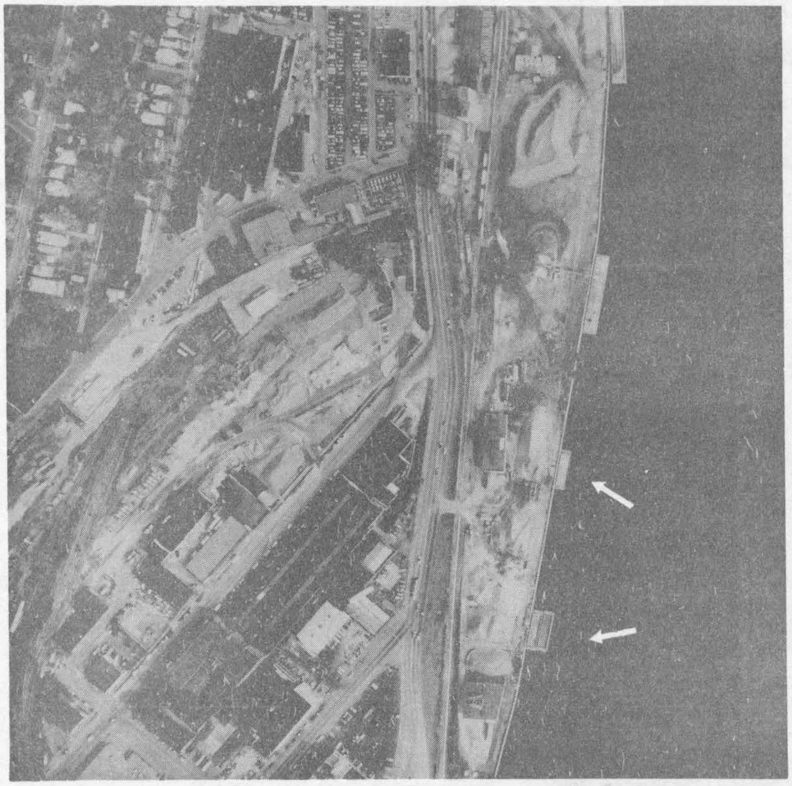


MAP REFERENCE NO.: 35
POOL NO.: 16
MILES ABOVE OHIO RIVER: 477.8
NAME: W. G. Block Co.

ADDRESS: (Terminal-S. Concord St.)
Office: 317 E. 4th, P.O. Box 3010
Davenport, IA 52808
PHONE: (319)326-1654
COMMODITIES HANDLED:
Sand, gravel, crushed rock & stone.

ACCESS:
Truck - East of IA 22 via 2 miles of hard-surfaced roads.

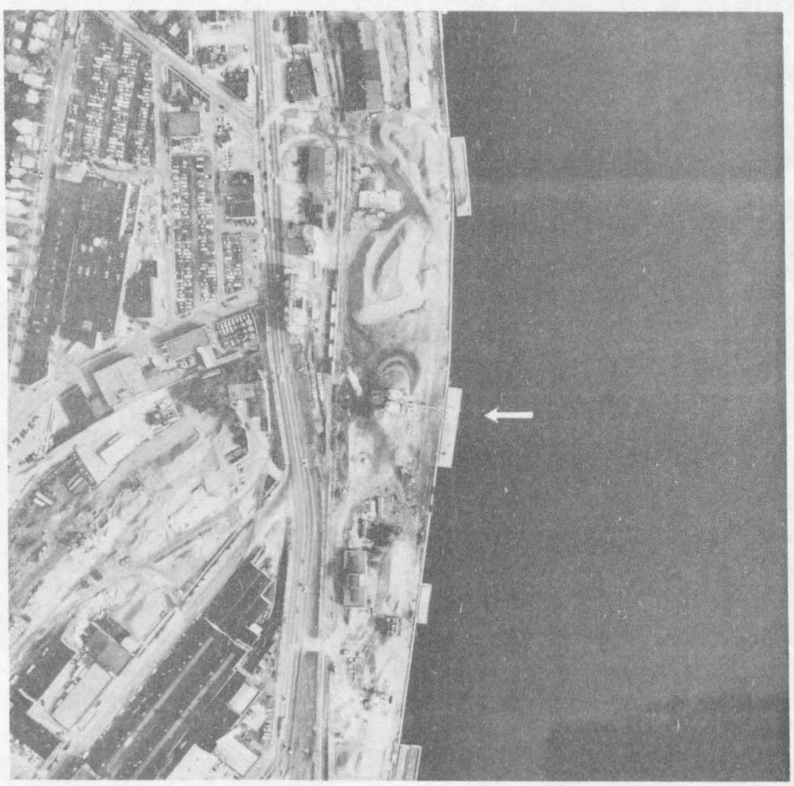
NOTES: New terminal operating in 1976.



MAP REFERENCE NO.: 36
POOL NO.: 15
MILES ABOVE OHIO RIVER: 483.2
NAME: Builders Sand & Gravel Company
ADDRESS: (Main Office)
104 Western Ave.
Davenport, IA 52801
PHONE: (319)322-1757
COMMODITIES HANDLED:
Sand & gravel.

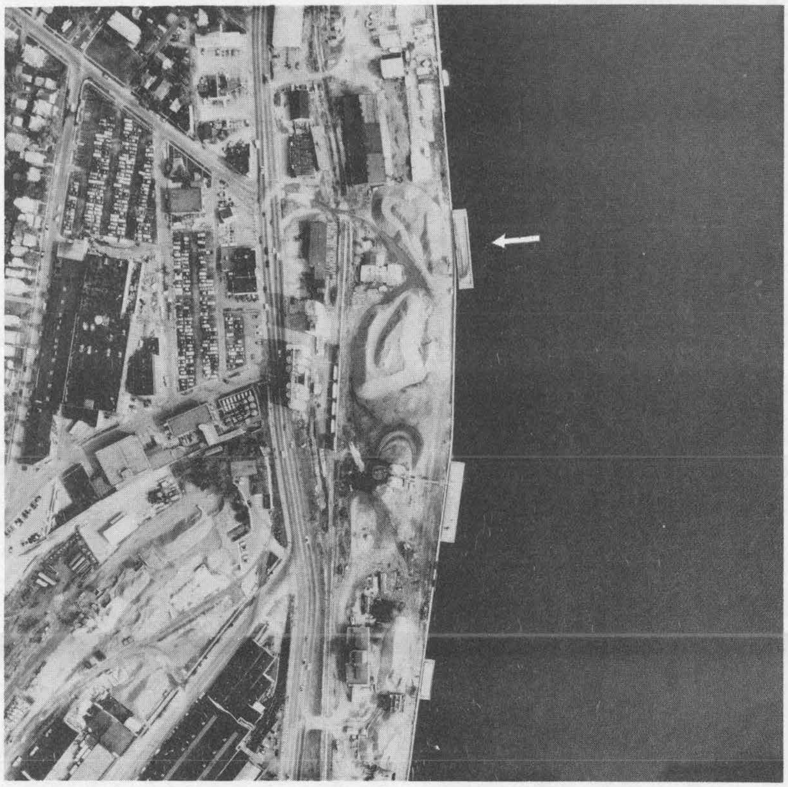
ACCESS:
Truck - South of U.S. 67 via good gravel driveway across rough RR tracks.

NOTES: Receives sand & gravel dredged from the Mississippi River.



MAP REFERENCE NO.: 37
POOL NO.: 15
MILES ABOVE OHIO RIVER: 483.3
NAME: Alter Company

ADDRESS: (Office)
2333 Rockingham Road
Davenport, IA 52808
PHONE: (319)326-2561
COMMODITIES HANDLED:
Corn, soybeans, scrap iron, car bodies, miscellaneous steel, & ingots.
ACCESS:
Truck - South of U.S. 67 via good, gravel driveway across rough RR tracks.
Rail - Chicago, Milwaukee, St. Paul & Pacific
NOTES: Ships & receives general commodities for its own operations & under contract with other companies.



MAP REFERENCE NO.: 38
POOL NO.: 15
MILES ABOVE OHIO RIVER: 483.3
NAME: W. G. Block Co.

ADDRESS: (Office)
317 E. 4th, P.O. Box 3010
Davenport, IA 52808
PHONE: (319)326-1654
COMMODITIES HANDLED:
Sand, gravel, & stone.

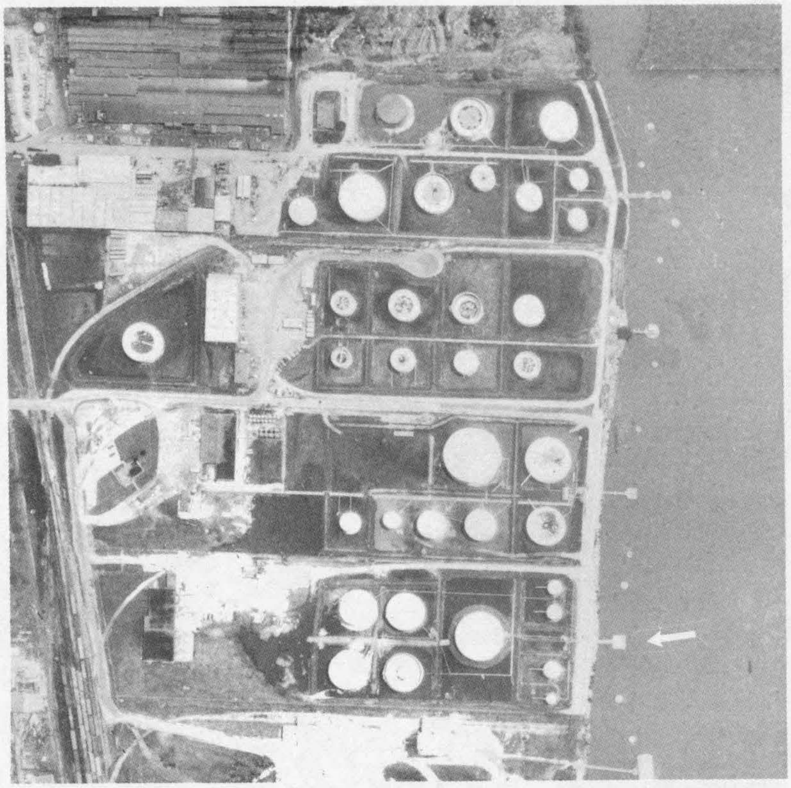
ACCESS:
Truck - South of U.S. 67 via good, gravel driveway across rough RR tracks.
Rail - Chicago, Rock Island & Pacific
- Chicago, Milwaukee St. Paul & Pacific
NOTES: Receives sand, gravel, & stone. Land area & dock purchased from International Multi-Foods Co. in 1975. New facilities used in 1976.

MAP REFERENCE NO.: 39
POOL NO.: 15
MILES ABOVE OHIO RIVER: 486.8
NAME: Universal Atlas Cement

ADDRESS:
2871 Depot
Bettendorf, IA 52722
PHONE: (319)359-8237
COMMODITIES HANDLED:
Cement

ACCESS:
Truck - South of U.S. 67 via good, level, blacktop roads.
Rail - Chicago, Milwaukee, St. Paul & Pacific

NOTES: Receives cement.

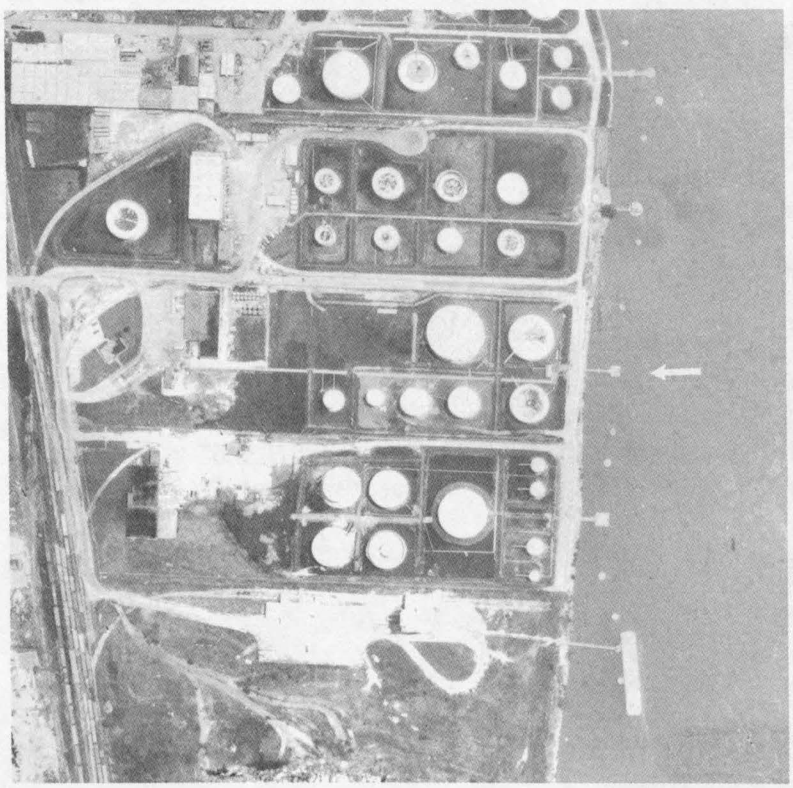


MAP REFERENCE NO.: 40
POOL NO.: 15
MILES ABOVE OHIO RIVER: 487.0
NAME: Mobil Oil Company

ADDRESS:
2925 Gilbert Street
Bettendorf, IA 52722
PHONE: (319)355-0255
COMMODITIES HANDLED:
Gasoline & fuel oil.

ACCESS:
Truck - South of U.S. 67 via good, level, blacktop roads.

NOTES: Receives petroleum products for transfer & storage.

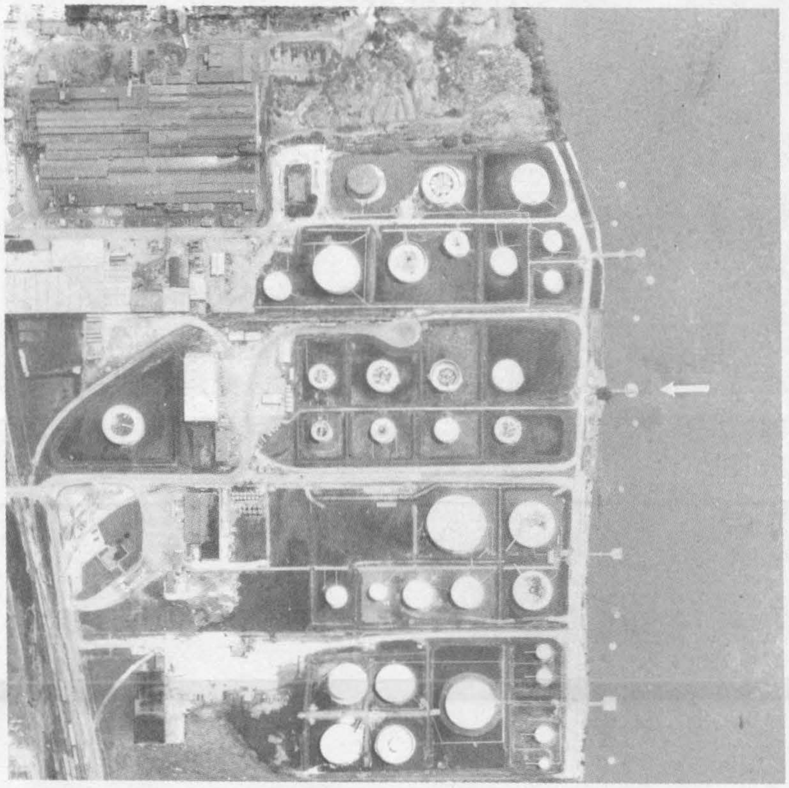


MAP REFERENCE NO.: 41
POOL NO.: 15
MILES ABOVE OHIO RIVER: 487.0
NAME: Shell Oil Company

ADDRESS:
Marine Terminal
Bettendorf, IA 52722
PHONE: (319)355-1835
COMMODITIES HANDLED:
Gasoline, furnace oil, jet fuel.

ACCESS:
Truck - South of U.S. 67 via good, flat, blacktop roads.

NOTES: Receives petroleum products for transfer & storage

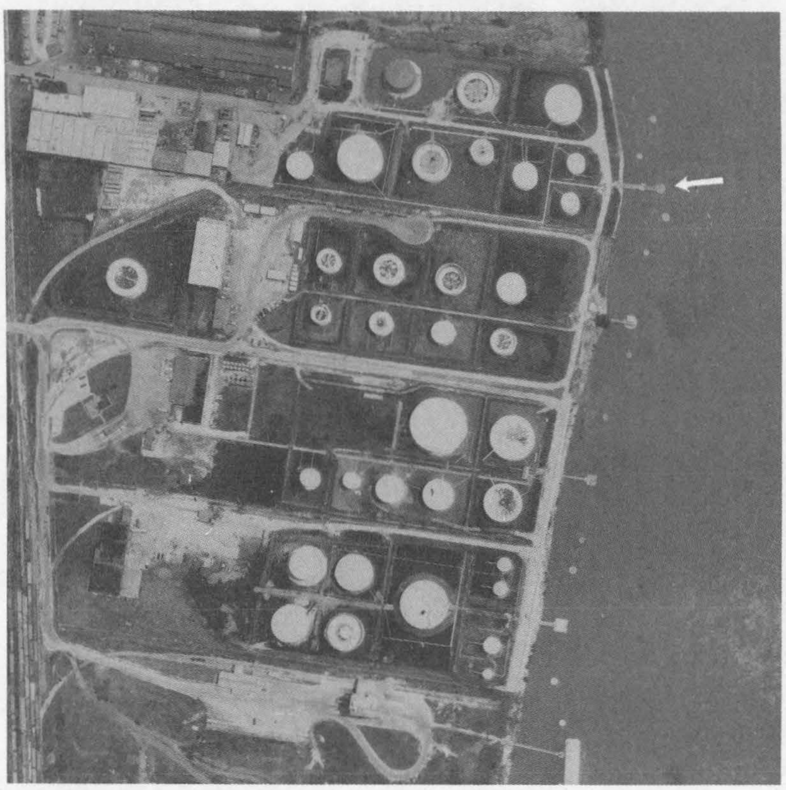


MAP REFERENCE NO.: 42
POOL NO.: 15
MILES ABOVE OHIO RIVER: 487.1
NAME: AMOCO Oil Company

ADDRESS:
S. 31st Street
Bettendorf, IA 52722
PHONE: (319)355-2686
COMMODITIES HANDLED:
Petroleum products.

ACCESS:
Truck - South of U.S. 67 via good, flat, blacktop roads.

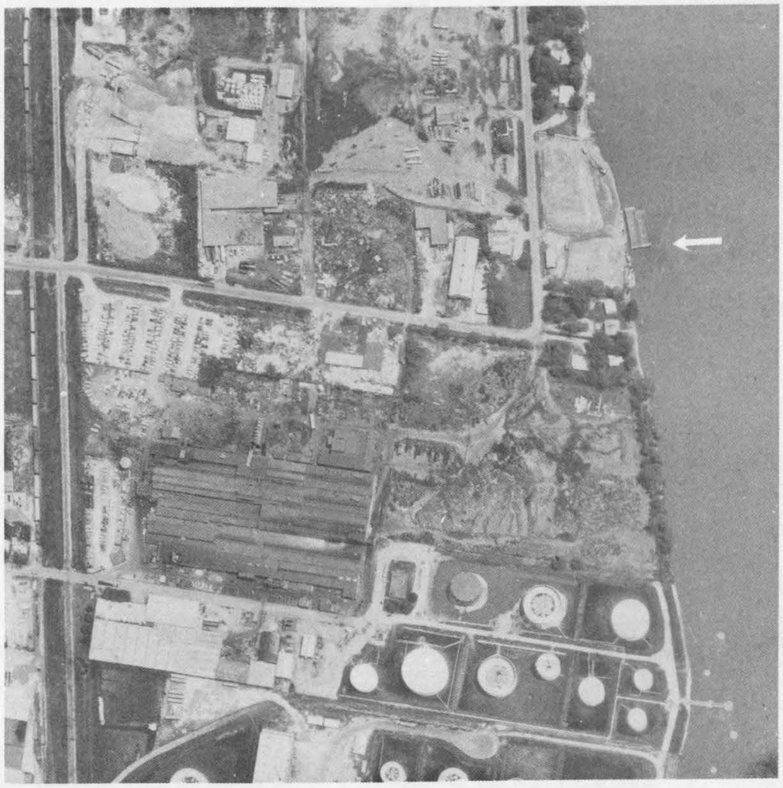
NOTES: Receives petroleum products for transfer & storage.



MAP REFERENCE NO.: 43
POOL NO.: 15
MILES ABOVE OHIO RIVER: 487.2
NAME: Phillips Petroleum Co. (Phillips 66)
ADDRESS:
Box M
Bettendorf, IA 52722
PHONE: (319)355-2654
COMMODITIES HANDLED:
Petroleum products.

ACCESS:
Truck - South of U.S. 67 via good, blacktop street.

NOTES: Receives petroleum products for transfer & storage.

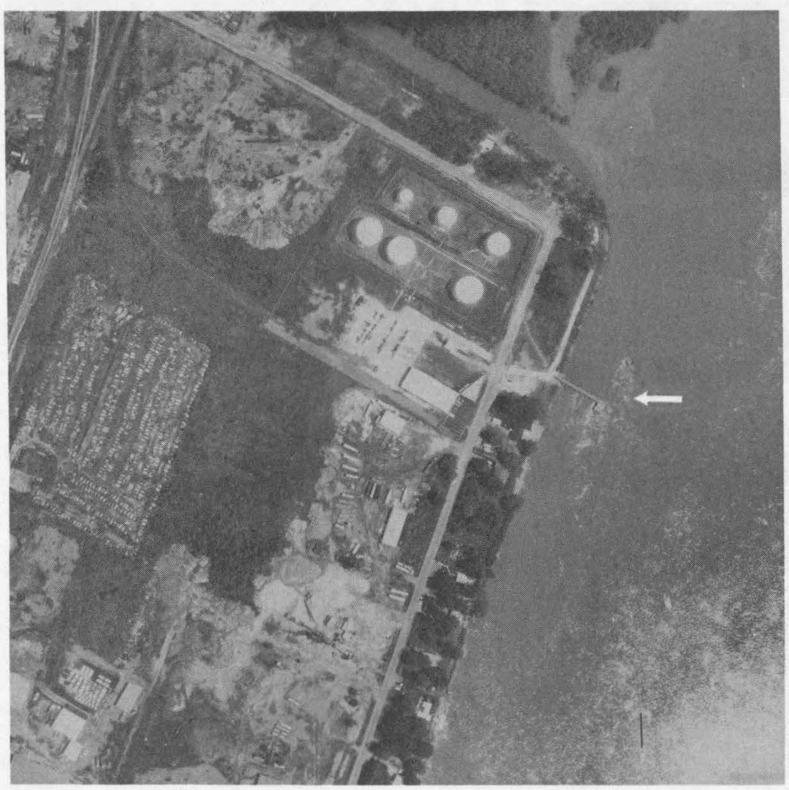


MAP REFERENCE NO.: 44
POOL NO.: 15
MILES ABOVE OHIO RIVER: 487.5
NAME: Bettendorf Terminal Co.

ADDRESS:
3623 Elm Street
Bettendorf, IA 52722
PHONE: (319)355-6223
COMMODITIES HANDLED:
Sand

ACCESS:
Truck - South of U.S. 67 via
0.4 mi. of hard-surfaced streets.

NOTES: Receives sand.
Owned & operated by LeClaire
Quarries.



MAP REFERENCE NO.: 45
POOL NO.: 15
MILES ABOVE OHIO RIVER: 487.7
NAME: The Texaco Company

ADDRESS:
Mississippi Point
Bettendorf, IA 52722
PHONE: (319)355-0271
COMMODITIES HANDLED:
Gasoline

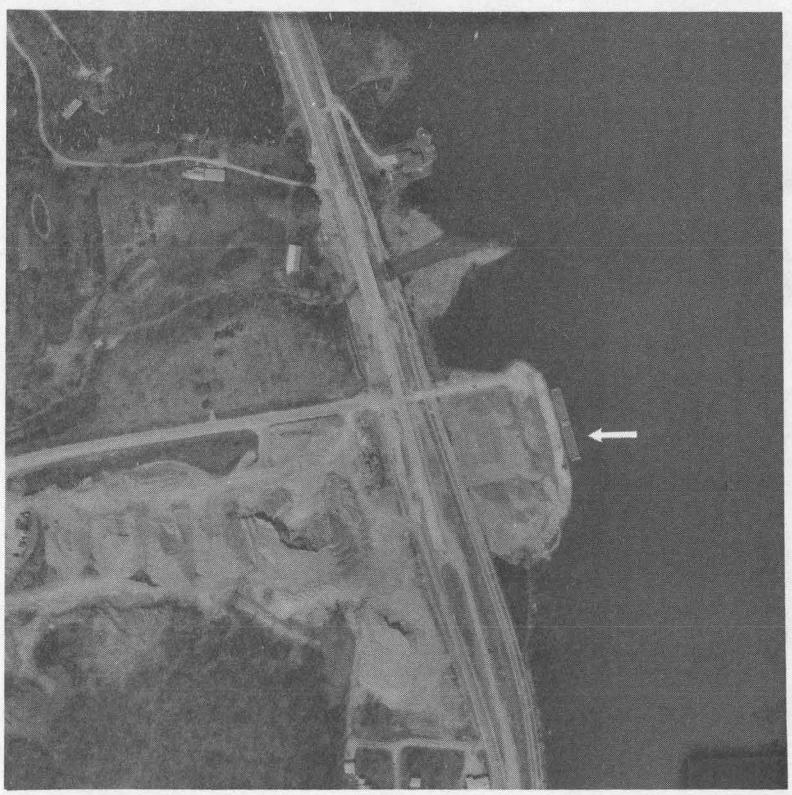
ACCESS:
Truck - South of U.S. 67 via
0.8 mile of good paved streets.

NOTES: Receives petroleum
products.

MAP REFERENCE NO.: 46
POOL NO.: 15
MILES ABOVE OHIO RIVER: 488.5
NAME: Union Oil Company
(W. H. Barber Co.)
ADDRESS:
S. Bellingham Street
Bettendorf, IA 52722
PHONE: (319)355-2931
COMMODITIES HANDLED:
Petroleum products.

ACCESS:
Truck - SE of U.S. 67 about 0.5 mile via good city streets.

NOTES: Received all petroleum by pipeline in recent years & does not use barge facility.

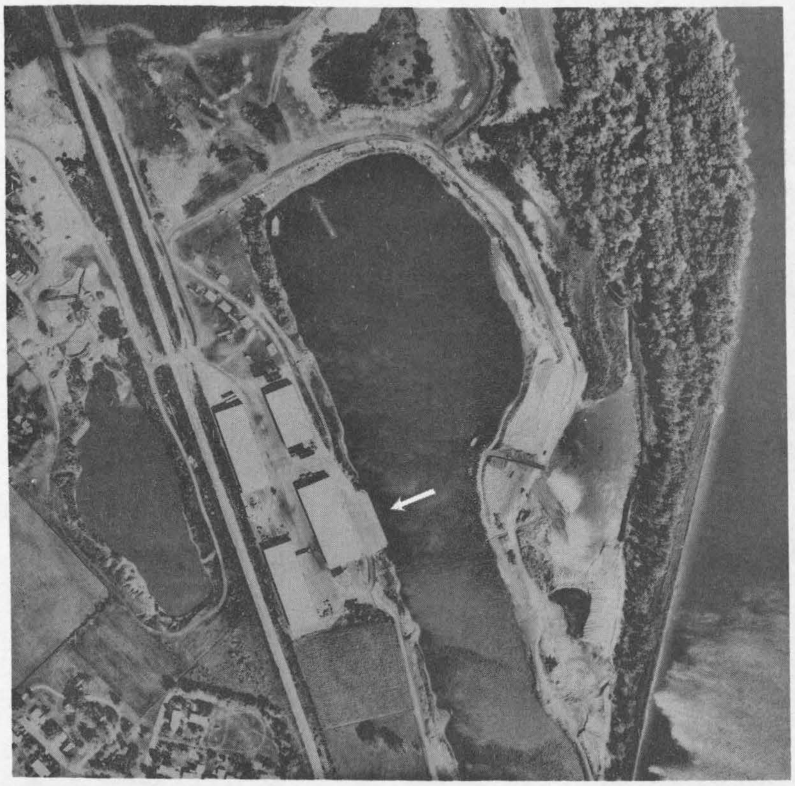


MAP REFERENCE NO.: 47
POOL NO.: 14
MILES ABOVE OHIO RIVER: 498.2
NAME: LeClaire Quarries, Inc.

ADDRESS
P.O. Box 206
LeClaire, IA 52753
PHONE: (319)289-4214
COMMODITIES HANDLED:
Sand & rock.

ACCESS:
Truck - East of U.S. 67 on good driveway across rough RR tracks.

NOTES: Ships & receives sand & rock.



MAP REFERENCE NO.: 48
POOL NO.: 14
MILES ABOVE OHIO RIVER: 512.2
NAME: Determann Industries, Inc.
ADDRESS:
1425 N. Washington
Camanche, IA 52730
PHONE: (319)259-8311
COMMODITIES HANDLED:
Aluminum, machinery, dry fertilizer, urea, coal, constr. equipment, gravel, logs, newsprint paper, pipe, salt, steel products
ACCESS:
Truck - East of U.S. 67 via good, paved driveway.
Rail - Burlington Northern
- Chicago, Milwaukee, St. Paul, & Pacific.
- Chicago & Northwestern Transportation.
- Chicago, Rock Island & Pacific
NOTES: Shipping & receiving agent. Receives coal.

MAP REFERENCE NO.: 49
POOL NO.: 14
MILES ABOVE OHIO RIVER: 513.5
NAME: W. G. Block Co.
(Acme Aggregates)
ADDRESS: (Terminal-Camanche, IA)
Office-317 E. 4th
Davenport, IA 52801
PHONE: (319)326-1651
COMMODITIES HANDLED:
Sand, gravel, & crushed rock & stone.

ACCESS:
Truck - East of U.S. 67 via 3/4 mile of gravel road.

NOTES: New facility being developed.

MAP REFERENCE NO.: 50
POOL NO.: 14
MILES ABOVE OHIO RIVER: 513.9
NAME: E.I. DuPont DeNemours, Inc.

ADDRESS:
P.O. Box 451
Clinton, IA 52732
PHONE: (319)244-4321
COMMODITIES HANDLED:
Caustic soda

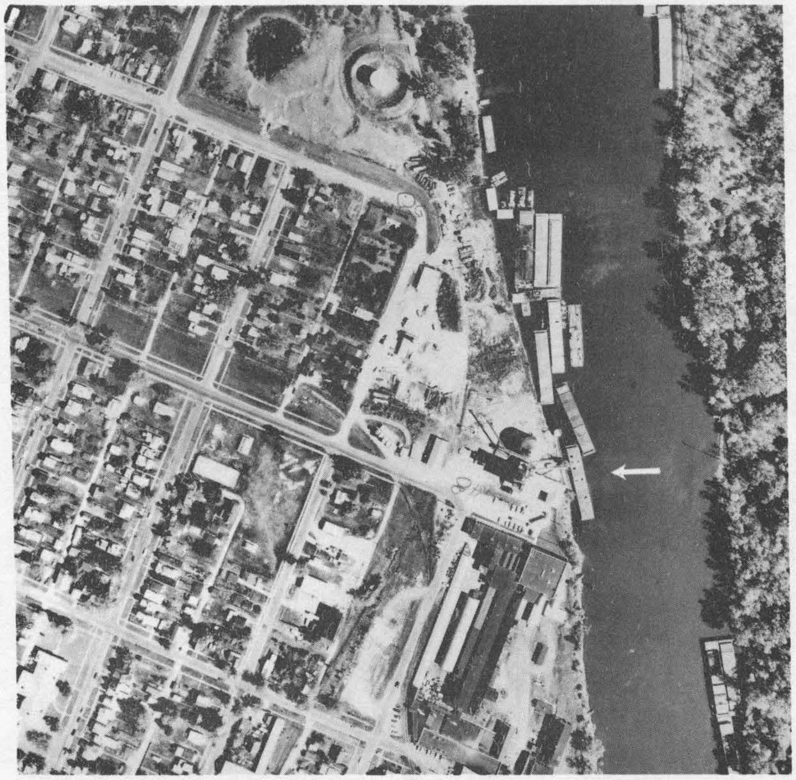
ACCESS:
East of U.S. 67 via good, paved driveway.
Rail - Davenport, Rock Island, and Northwestern
- Chicago and Northwestern Transportation
NOTES: Receives caustic soda for use in manufacturing cellophane and film materials.

MAP REFERENCE NO.: 51
POOL NO.: 14
MILES ABOVE OHIO RIVER: 514.2
NAME: Interstate Power Co.

ADDRESS: M. L. Kapp Station
2001 Beaver Channel Pkwy.
Clinton, IA 52732
PHONE: (319)243-2611
COMMODITIES HANDLED:
Coal

ACCESS:
South of U.S. 30 via very rough, gravel street.
Rail - Burlington Northern

NOTES: Receives coal.
All coal used for producing electricity.

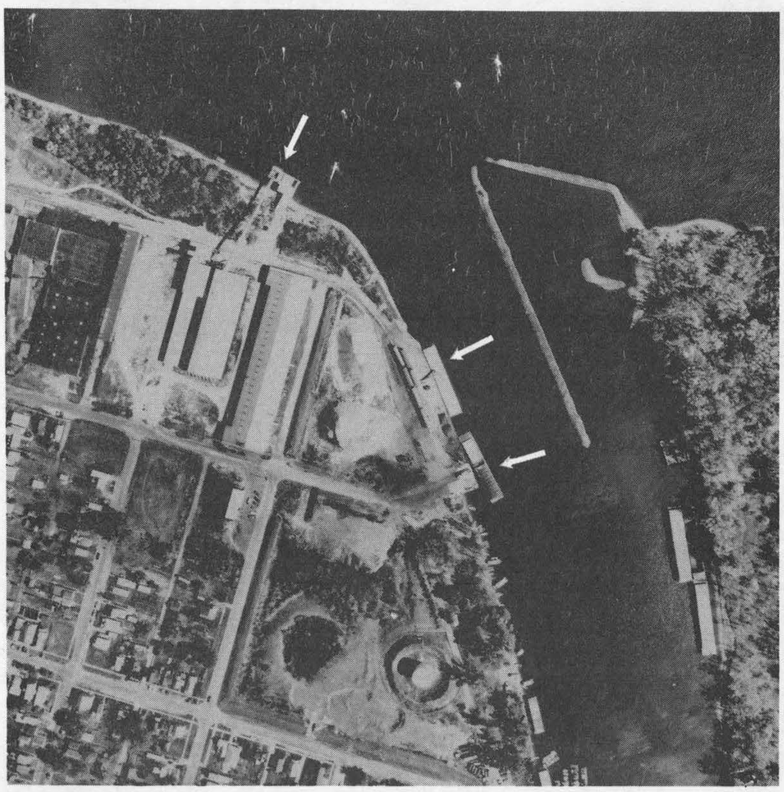


MAP REFERENCE NO.: 52
POOL NO.: 14
MILES ABOVE OHIO RIVER: 517.2
NAME: Peavy Company

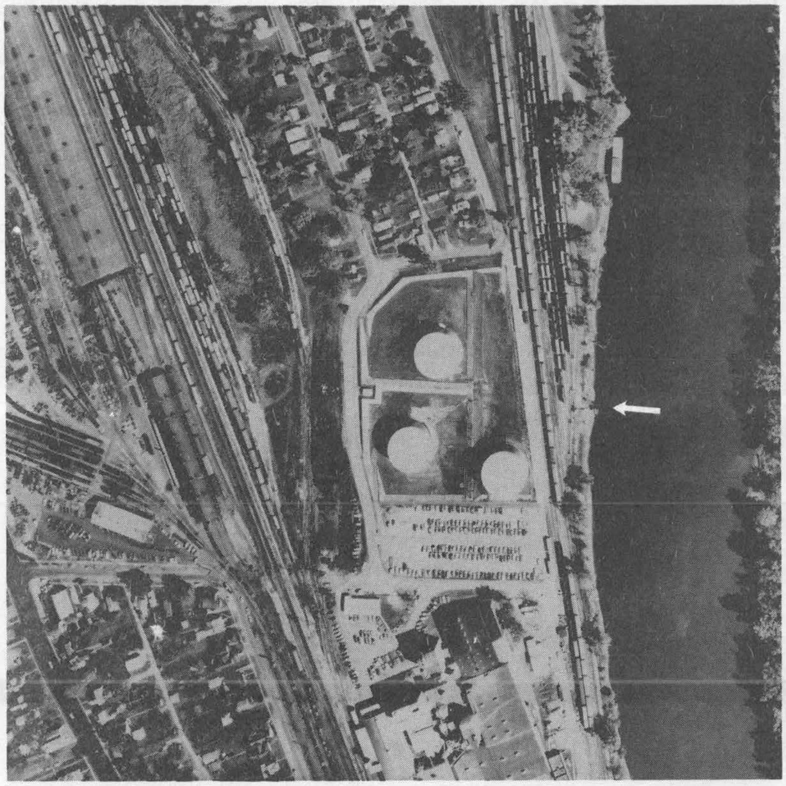
ADDRESS:
1811 S. 4th Street
Clinton, IA 52732
PHONE: (319)242-5251
COMMODITIES HANDLED:
Corn & soybeans.

ACCESS:
Truck - South of U.S. 30 via
6 blocks of good, paved, streets.

NOTES: Ships grain.
The facilities were purchased
from Fronings, Inc. in 1975.



MAP REFERENCE NO.: 53
POOL NO.: 14
MILES ABOVE OHIO RIVER: 517.5
NAME: CF Sales, Inc.
(Municipal Dock)
ADDRESS:
204-15th Ave., S.
Clinton, IA 52732
PHONE: (319)242-0962
COMMODITIES HANDLED:
Soybean meal, corn feed pellets,
beet pulp pellets, petroleum by-
products, dry fertilizer & salt.
ACCESS:
Truck - South of U.S. 30 via
7 blocks of good, paved streets.
Rail - Chicago, Milwaukee,
St. Paul & Pacific
- Chicago & Northwestern
Transportation
NOTES: Shipping & receiving
agent for all classes of commodities.
The dock facilities are leased from
the City of Clinton.

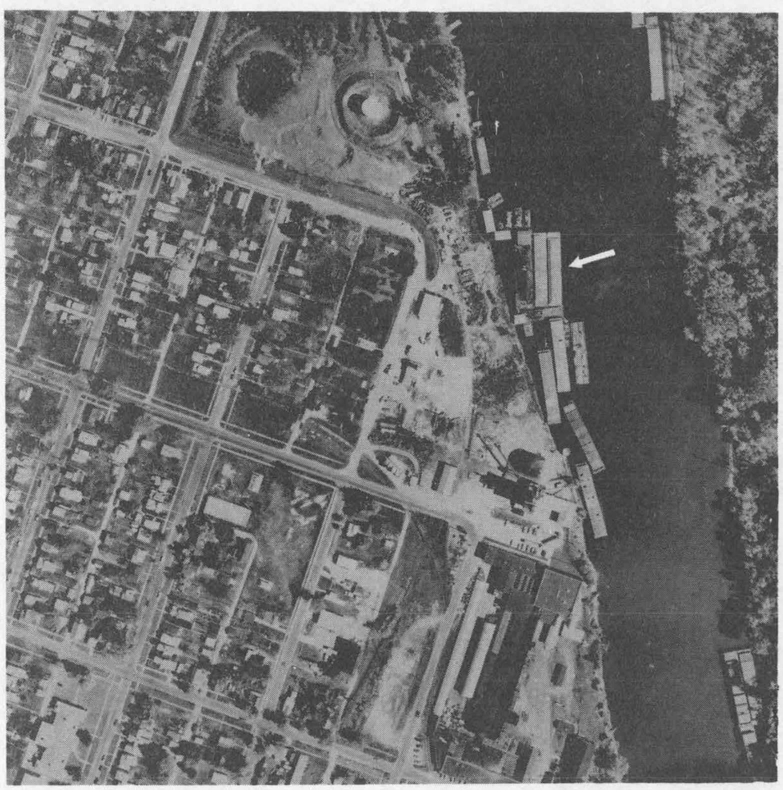


MAP REFERENCE NO.: 54
POOL NO.: 14
MILES ABOVE OHIO RIVER: 517.5
NAME: Clinton Corn Processing

ADDRESS:
P.O. Box 340
Clinton, IA 52732
PHONE: (319)242-1121
COMMODITIES HANDLED:
Fuel oil

ACCESS:
Truck - South of U.S. 30 on good, paved streets.
Rail - Chicago & Northwestern Transportation
- Chicago, Rock Island & Pacific
- Burlington Northern
- Chicago, Milwaukee, St. Paul & Pacific

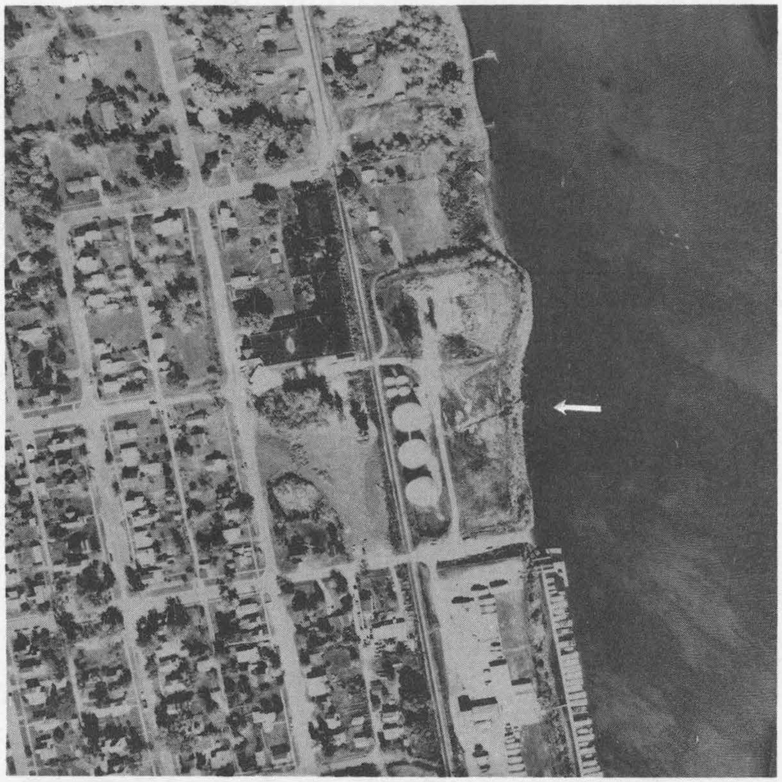
NOTES: Receives fuel oil for use at the corn processing plant.



MAP REFERENCE NO.: 55
SERVICE AREA: Pool 14
MILES ABOVE OHIO RIVER: 517.7
NAME: Lewis & Lawson Harbor Service
ADDRESS:
17th Ave. S. & River St.
Clinton, IA 52732
PHONE: (319)242-1646
COMMODITIES HANDLED:
Barge handling services.

ACCESS:
South of U.S. 30 via 6 blocks of good paved streets & 1 block on gravel street.

NOTES: Groups, moves, cleans, and repairs barges.



MAP REFERENCE NO.: 56
POOL NO.: 14
MILES ABOVE OHIO RIVER: 521.0
NAME: CF Industries, Inc.
(Carnes Oil Co.)
ADDRESS:
31st Ave., N. & River St.
Clinton, IA 52732
PHONE: (319)242-0433
COMMODITIES HANDLED:
Nitrogen

ACCESS:
Truck - East of U.S. 67 about 6 blocks via good streets (paved & gravel).
Rail - Chicago, Milwaukee, St. Paul & Pacific

NOTES: Receives nitrogen.

MAP REFERENCE NO.: 57
POOL NO.: 12
MILES ABOVE OHIO RIVER: 559.0
NAME: USS Agri-Chemicals Co.

ADDRESS:
R.F.D. 2
Bellevue, IA 52031
PHONE: (319)872-3218
COMMODITIES HANDLED:
Anhydrous ammonia.

ACCESS:
Truck - East of U.S. 51 & 67 via ¼ mile of good, asphalt road.
Rail - Chicago, Milwaukee, St. Paul & Pacific.

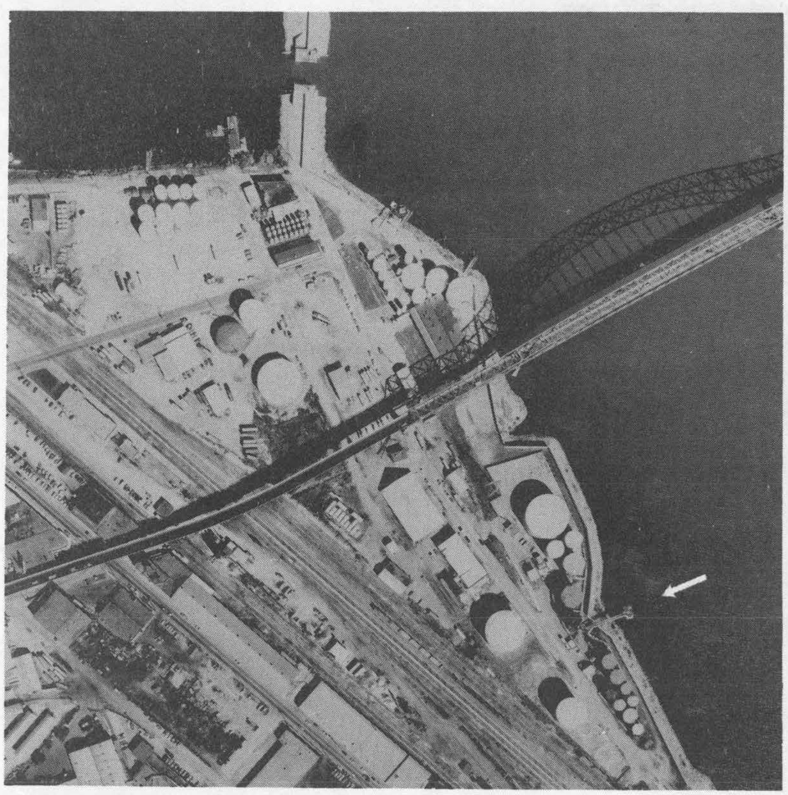
NOTES: Receives anhydrous ammonia.

NO PHOTO AVAILABLE

MAP REFERENCE NO.: 58
POOL NO.: 12
MILES ABOVE OHIO RIVER: 578.6
NAME: Wisconsin Barge Line
Fleeting & Harbor Service
ADDRESS:
P.O. Box 105
Dubuque, Iowa 52001
PHONE:608-725-5413
COMMODITIES HANDLED:
Barge handling service

ACCESS:

NOTES: Areas served:
Dubuque, Cassville, McGregor

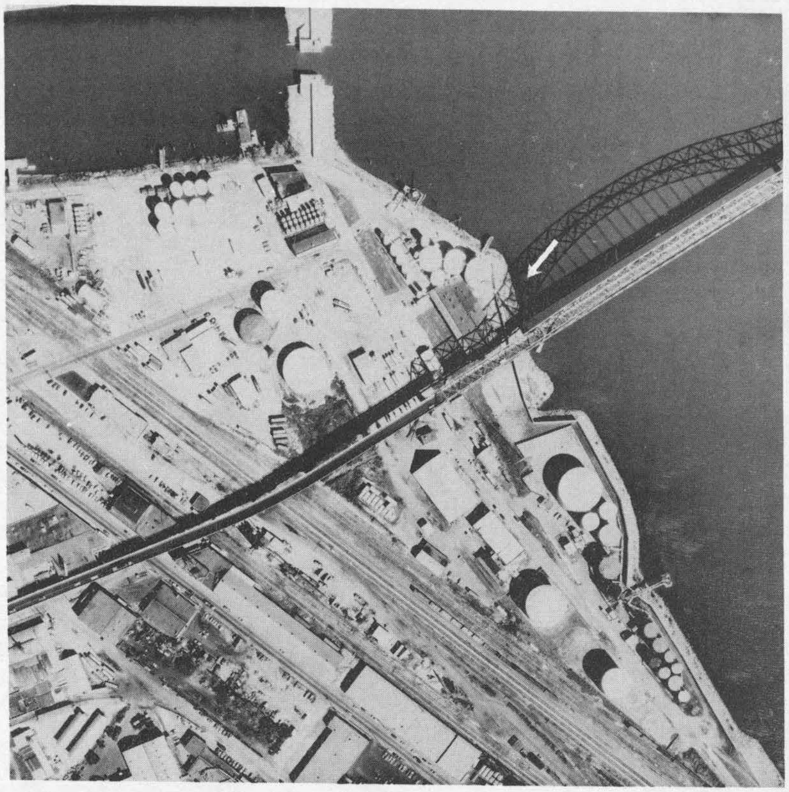


MAP REFERENCE NO.: 59
POOL NO.: 12
MILES ABOVE OHIO RIVER: 579.2
NAME: Sinclair Marketing, Inc.

ADDRESS:
200 Terminal St.
Dubuque, IA 52001
PHONE: (319)583-9718
COMMODITIES HANDLED:
Asphalt, gas, & fuel oil.

ACCESS:
Truck - East of U.S. 52 via about
6 blocks of good, paved streets.

NOTES: Receives petroleum
products.

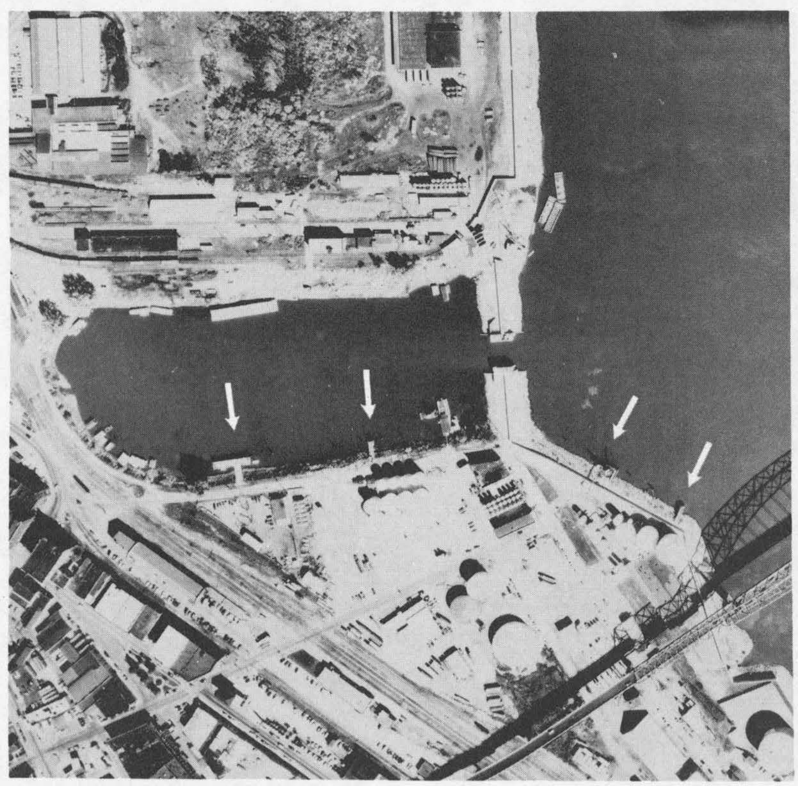


MAP REFERENCE NO.: 60
POOL NO.: 12
MILES ABOVE OHIO RIVER: 579.3
NAME: Dubuque Twine Company

ADDRESS:
Jones & Terminal St.
Dubuque, IA 52001
PHONE: (319)583-9701
COMMODITIES HANDLED:
Baler twine

ACCESS:
Truck - East of U.S. 52 via about 5 blocks of good, paved streets.
Rail - Burlington Northern
Illinois Central Gulf

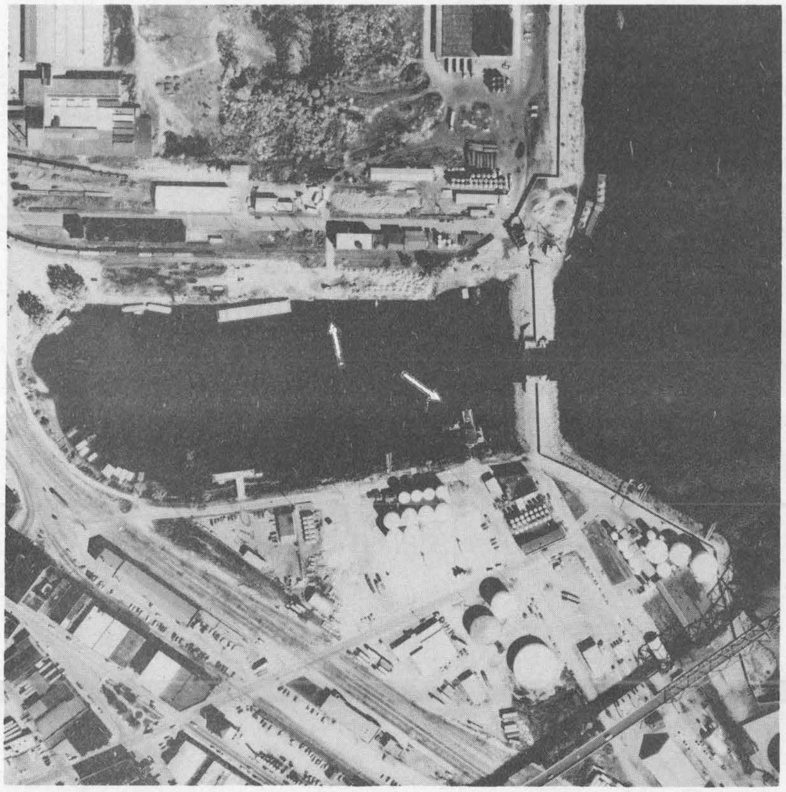
NOTES: Receives twine.
Dock and storage area owned by the City of Dubuque.



MAP REFERENCE NO.: 61
POOL NO.: 12
MILES ABOVE OHIO RIVER: 579.4
NAME: Dubuque Tank Terminal Co.

ADDRESS:
Jones & Terminal St.
Dubuque, IA 52001
PHONE: (319)583-6457
COMMODITIES HANDLED:
Lard, grease, tallow, liquid fertilizer, molasses, & salt.
ACCESS:
Truck - East of U.S. 52 via about 4 blocks of good, paved streets.
Rail - Burlington Northern
Illinois Central Gulf

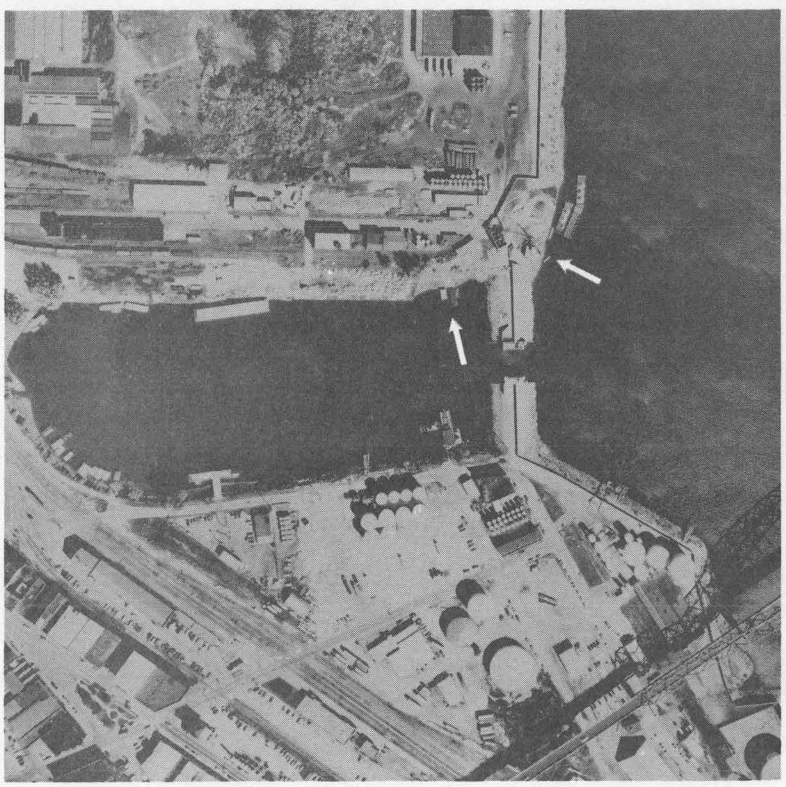
NOTES: Ships & receives a variety of commodities.



MAP REFERENCE NO.: 62
SERVICE AREA: Dubuque area of Pool 12
MILES ABOVE OHIO RIVER: 579.5
NAME: Newt Marine Service
Dubuque Barge & Fleeting Service Company
ADDRESS:
1200 Adeline
Dubuque, IA 52001
PHONE: (319)582-5633
COMMODITIES HANDLED:
Barge handling services.

ACCESS: East of U.S. 52 via about 4 blocks of good, paved streets to facilities on south side of Ice Harbor.

NOTES: Fleets, cleans, repairs and surveys barges.

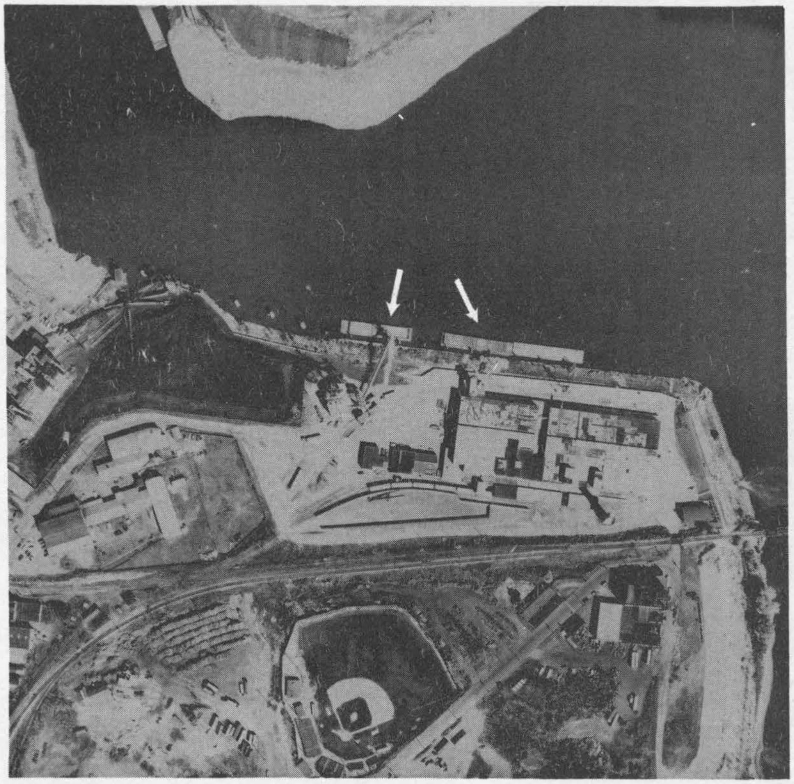


MAP REFERENCE NO.: 63
POOL NO.: 12
MILES ABOVE OHIO RIVER: 579.5
NAME: Molo Sand & Gravel Co.

ADDRESS: (Plant: end of 3rd St.)
Office: 41 Main St.
Dubuque, IA 52001
PHONE: (319)582-3611
COMMODITIES HANDLED:
Sand & gravel.

ACCESS:
Truck - East of U.S. 52 via about 4 blocks of bumpy brick streets & across 9 RR tracks.

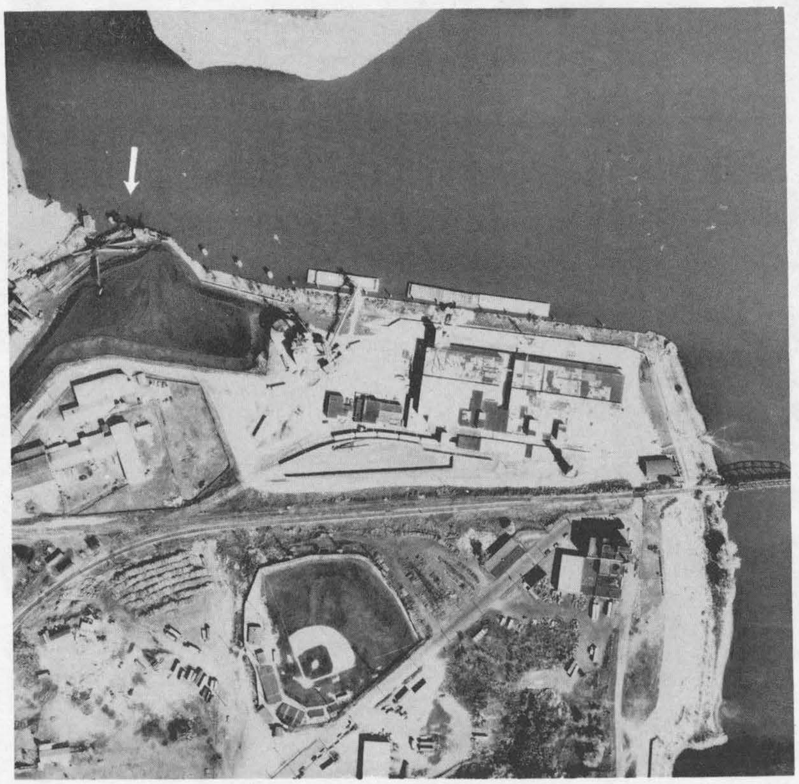
NOTES: Receives sand & gravel which is dredged from the Mississippi River.



MAP REFERENCE NO.: 64
POOL NO.: 12
MILES ABOVE OHIO RIVER: 580.0
NAME: Pillsbury Company

ADDRESS:
E. 7th & Commercial St.
Dubuque, IA 52001
PHONE: (319)556-4245
COMMODITIES HANDLED:
Corn, soybeans, dry fertilizer, and coal.

ACCESS:
Truck - East of U.S. 52 via 6 blocks of good, paved streets & 6 blocks of rough gravel & brick streets.
Rail - Illinois Central Gulf
- Chicago, Milwaukee, St. Paul & Pacific
- Burlington Northern
- Chicago & Northwestern Transportation
NOTES: Ships & receives commodities.

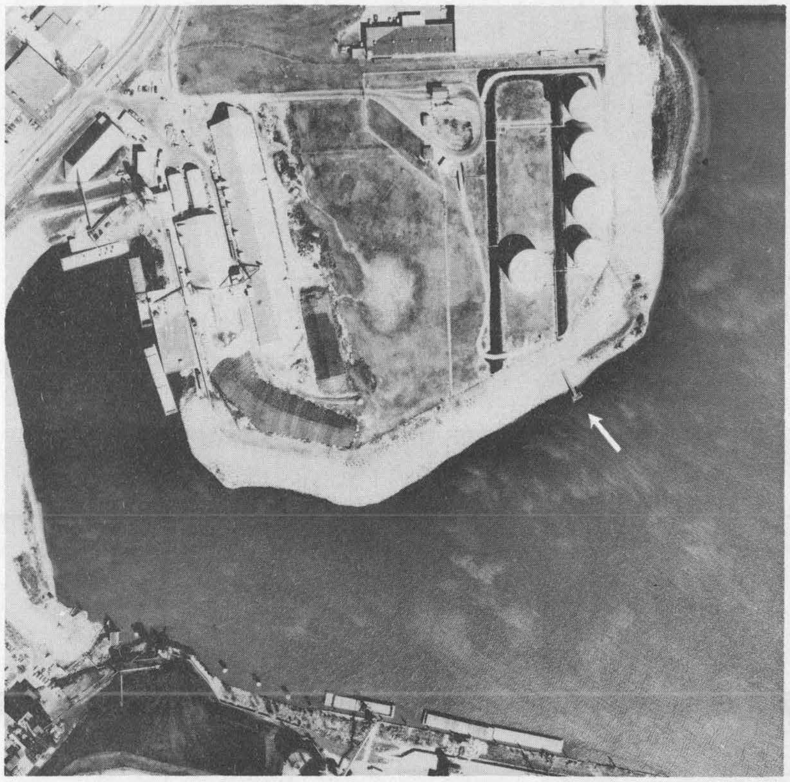


MAP REFERENCE NO.: 65
POOL NO.: 12
MILES ABOVE OHIO RIVER: 580.0
NAME: Interstate Power Co.

ADDRESS:
1000 Main St.
Dubuque, IA 52001
PHONE: (319)582-5421
COMMODITIES HANDLED:
Coal

ACCESS:
East of U.S. 52 via about 6 blocks of good paved streets.
Rail (not used) - Chicago, Milwaukee St. Paul & Pacific

NOTES: Receives coal.
All coal used for producing electricity.

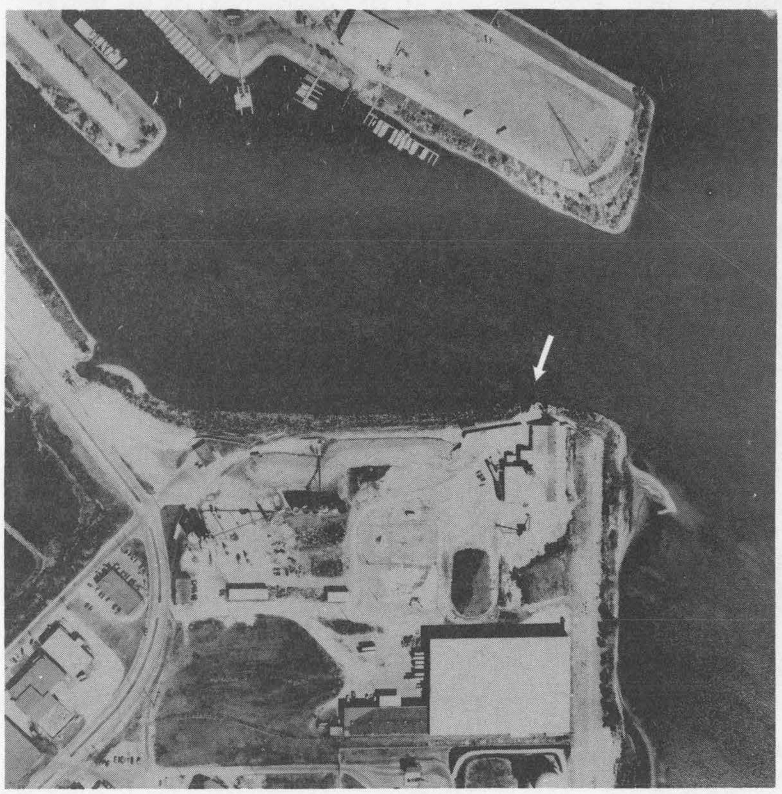


MAP REFERENCE NO.: 66
POOL NO.: 12
MILES ABOVE OHIO RIVER: 580.1
NAME: Dubuque Oil Company

ADDRESS: (12th St. Extension)
Box 921
Dubuque, IA 52001
PHONE: (319)556-1304
COMMODITIES HANDLED:
Gasoline & fuel oil.

ACCESS:
Truck - East of U.S. 51 via good, paved streets.

NOTES: Receives petroleum products. Owned by Koch Industries. Expansion now in progress.

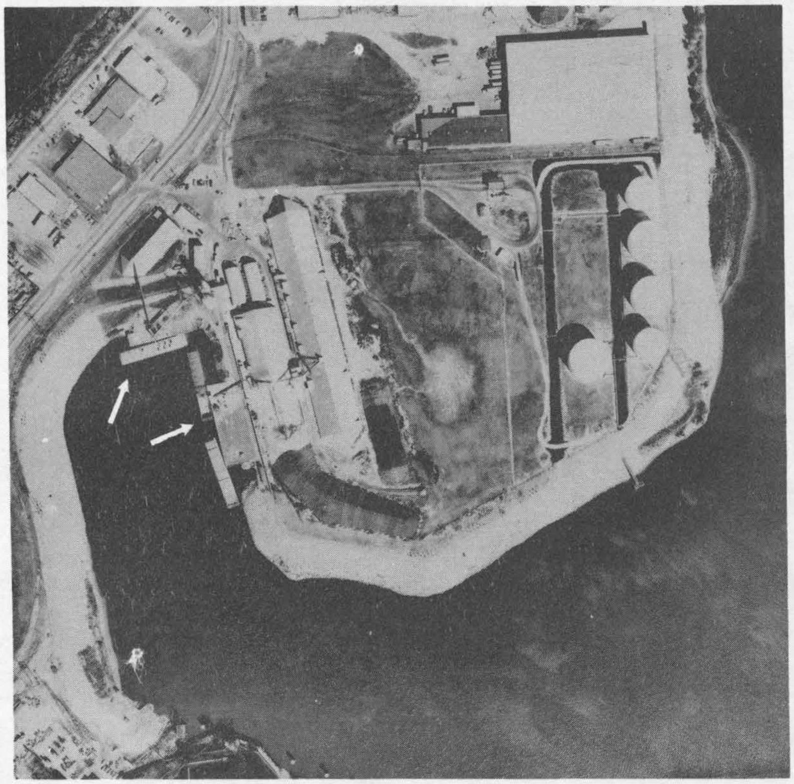


MAP REFERENCE NO.: 67
POOL NO.: 12
MILES ABOVE OHIO RIVER: 580.3
NAME: Dubuque Tank Terminal Co.

ADDRESS: (Office)
Jones & Terminal St.
Dubuque, IA 52001
PHONE: (319)583-6457
COMMODITIES HANDLED:
Salt & dry fertilizer.

ACCESS:
Truck - East of U.S. 52 via good, paved streets.
Rail - Chicago & Northwestern Transportation

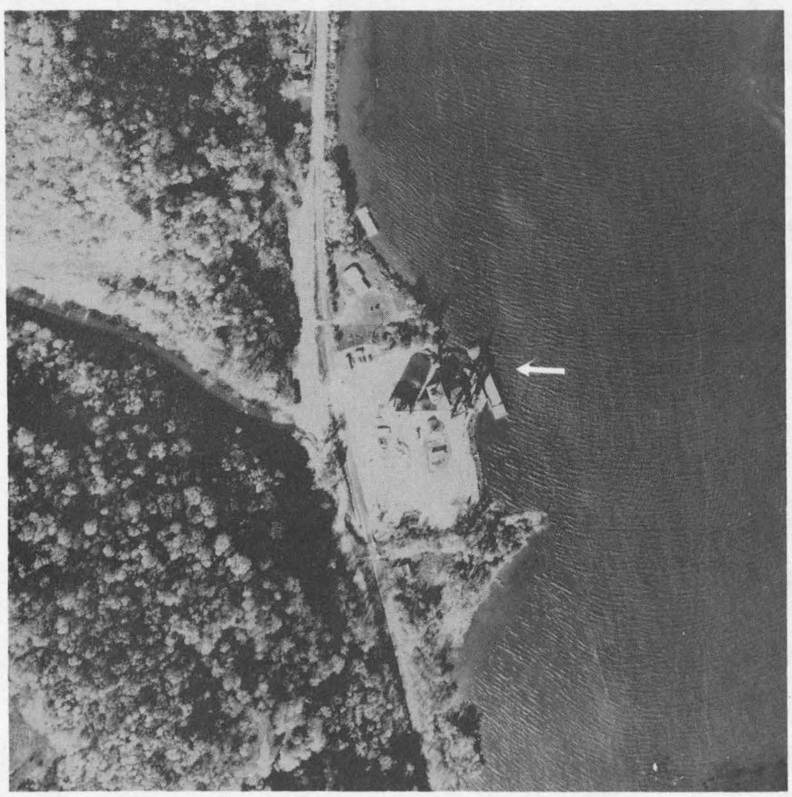
NOTES: Receives general commodities.



MAP REFERENCE NO.: 68
POOL NO.: 12
MILES ABOVE OHIO RIVER: 580.3
NAME: ContiCarriers & Terminals, Inc.

ADDRESS:
1050 Kerper Blvd.
Dubuque, IA 52001
PHONE: (319)556-4532
COMMODITIES HANDLED:
Corn, soybeans, salt, dry fertilizer, coal, steel, & pig iron.
ACCESS:
Truck - East of U.S. 52 via good, paved streets.
Rail - Chicago & Northwestern Transportation

NOTES: Ships & receives bulk commodities.



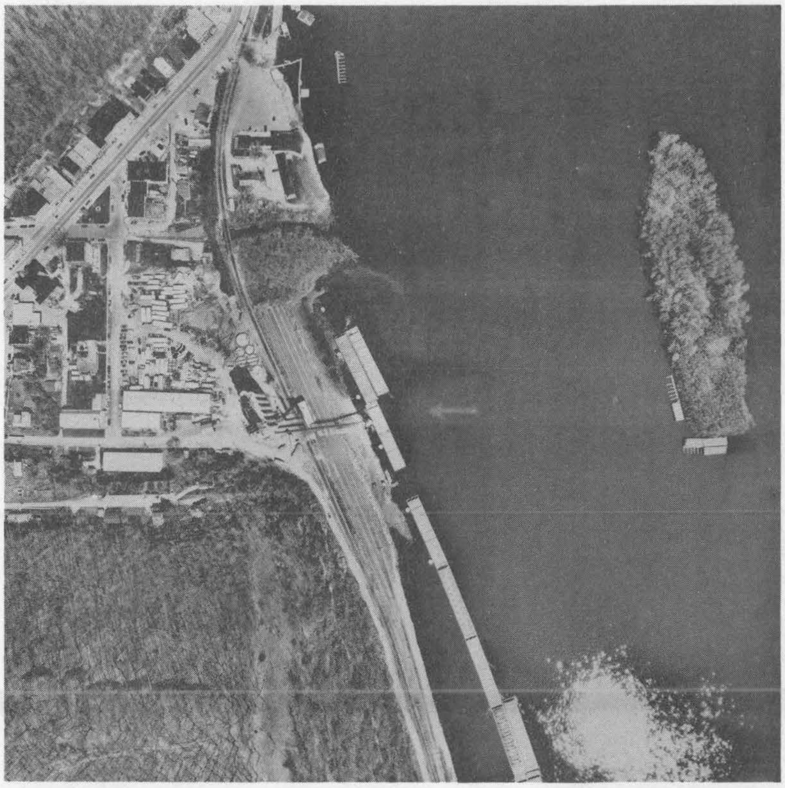
MAP REFERENCE NO.: 69
POOL NO.: 10
MILES ABOVE OHIO RIVER: 624.0
NAME: Pattison Grain Terminal

ADDRESS:
Clayton, IA 52049

PHONE: (319)964-2133
COMMODITIES HANDLED:
Corn & soybeans.

ACCESS:
Truck - East of paved county road (X-56) via a steep, winding, gravel road for 1 mile.

NOTES: Ships grain.



MAP REFERENCE NO.: 70
POOL NO.: 10
MILES ABOVE OHIO RIVER: 633.3
NAME: Farmers Grain Dealers Association
ADDRESS:
McGregor, IA 52157

PHONE: (319)873-3436
COMMODITIES HANDLED:
Corn & soybeans.

ACCESS:
Truck - East of U.S. 18 via 2 blocks of good, paved streets.
Rail - Chicago, Milwaukee, St. Paul & Pacific

NOTES: Ships grain.

MAP REFERENCE NO.: 71
POOL NO.: 9
MILES ABOVE OHIO RIVER: 660.0
NAME: Interstate Power Co.

ADDRESS:
Lansing Power Plant
Lansing, IA 52151
PHONE: (319)533-4717
COMMODITIES HANDLED:
Coal

ACCESS:
East of paved county road (X-52) via a good, gravel road for 0.7 mile.

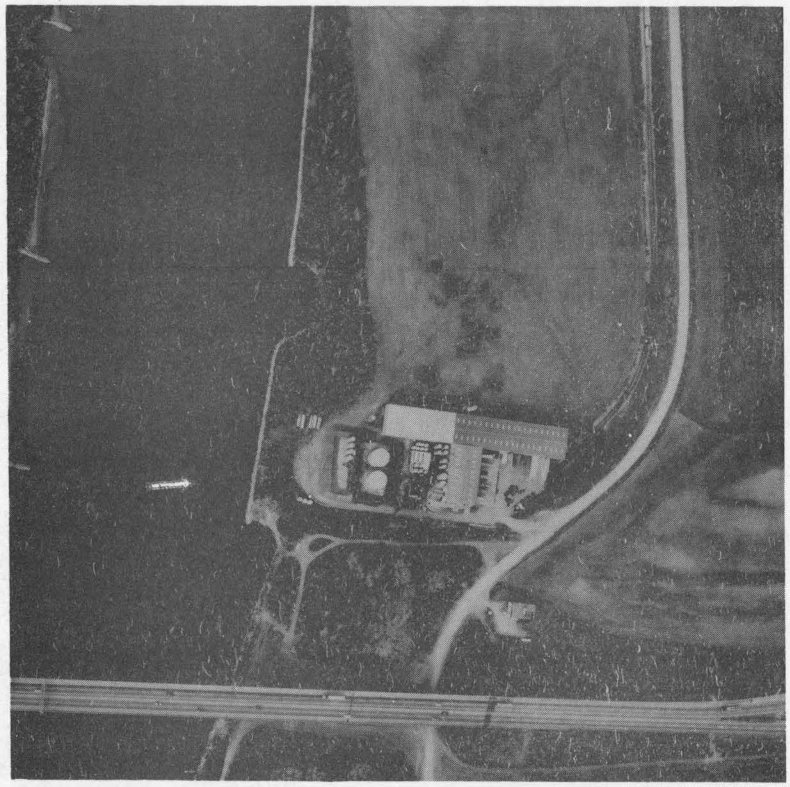
NOTES: Receives coal.
All coal used in producing electricity.

MAP REFERENCE NO.: 72
MILES ABOVE MO. RIVER MOUTH: 614.1
NAME: Terminal Packaging Corp.

ADDRESS:
2850 River Road
Council Bluffs, IA 51501
PHONE: (712)323-9802
COMMODITIES HANDLED:
Antifreeze, methanol, brake fluid, oil.

ACCESS:
Truck - West of I-29 via 1 mile of good roads - paved & gravel.
Rail - Union Pacific

NOTES: Receives antifreeze.



MAP REFERENCE NO.: 73
MILES ABOVE MO. RIVER MOUTH: 614.4
NAME: Cargill, Inc.

ADDRESS:
2401 S. 37th St.
Council Bluffs, IA 51501
PHONE: (712)323-9481
COMMODITIES HANDLED:
Corn, wheat, & dry fertilizer.

ACCESS:
Truck - West of I-29 via ½ mile of good roads - paved & gravel.
Rail - Union Pacific

NOTES: Ships grain & receives fertilizer.

MAP REFERENCE NO.: 74
MILES ABOVE MO. RIVER MOUTH: 614.45
NAME: Farmland Industries

ADDRESS:
2301 S. 37th St.
Council Bluffs, IA 51501
PHONE: (712)322-8287
COMMODITIES HANDLED:
Dry fertilizer.

ACCESS:
Truck - West of I-29 via ½ mile of good roads - paved & gravel.
Rail - Union Pacific

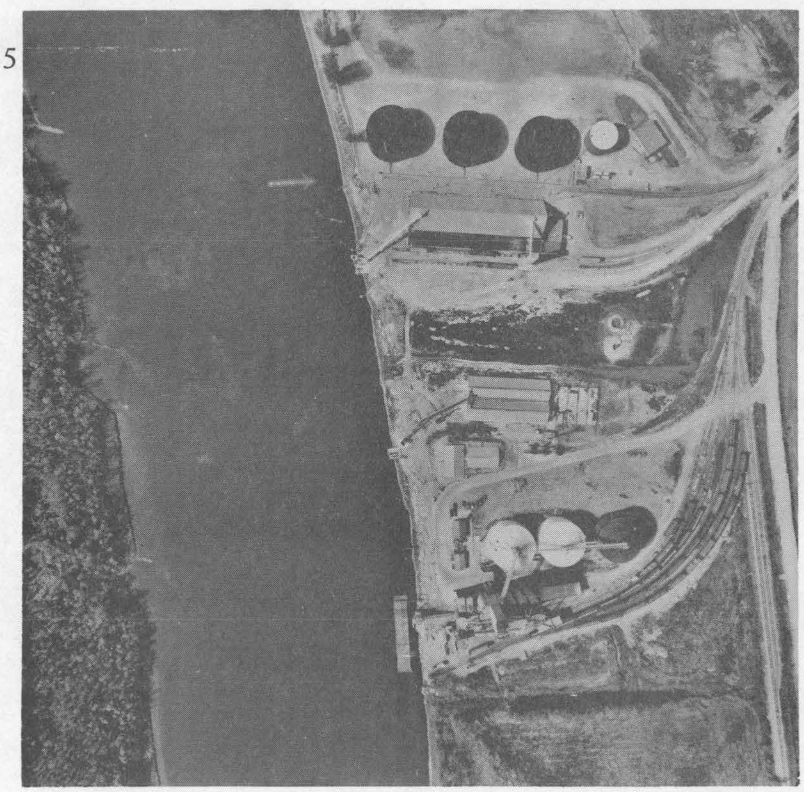
NOTES: Receives bulk fertilizer.

MAP REFERENCE NO.: 75
MILES ABOVE MO. RIVER MOUTH: 614.55
NAME: MacMillan Oil Company

ADDRESS: I-29 and Nebraska
P.O. Box 911
Council Bluffs, Iowa 51501
PHONE: (712)323-6122
COMMODITIES HANDLED:
Petroleum products

ACCESS:
Truck - West of I-29 via ½ mile of good roads - paved & gravel.
Rail - Union Pacific

NOTES:

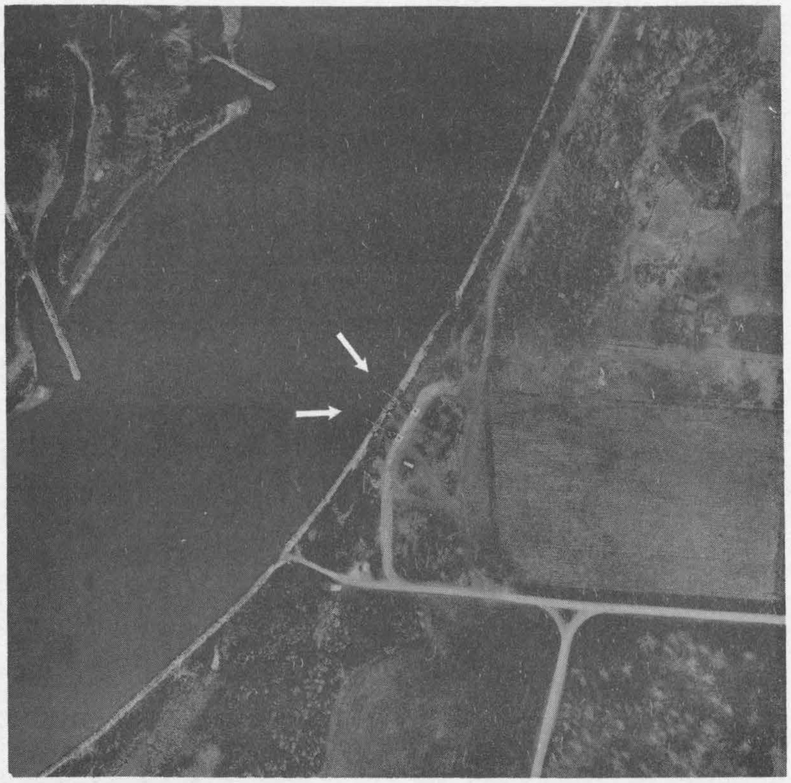


MAP REFERENCE NO.: 76
MILES ABOVE MO. RIVER MOUTH: 680.6
NAME: Pilus Transfer Point

ADDRESS:
Rural Delivery
Blencoe, IA 51523
PHONE: (712)452-2749
COMMODITIES HANDLED:
Corn & soybeans.

ACCESS:
Truck - West of I-29 via about 3 miles of good county roads - paved & gravel.

NOTES: Ships grain.

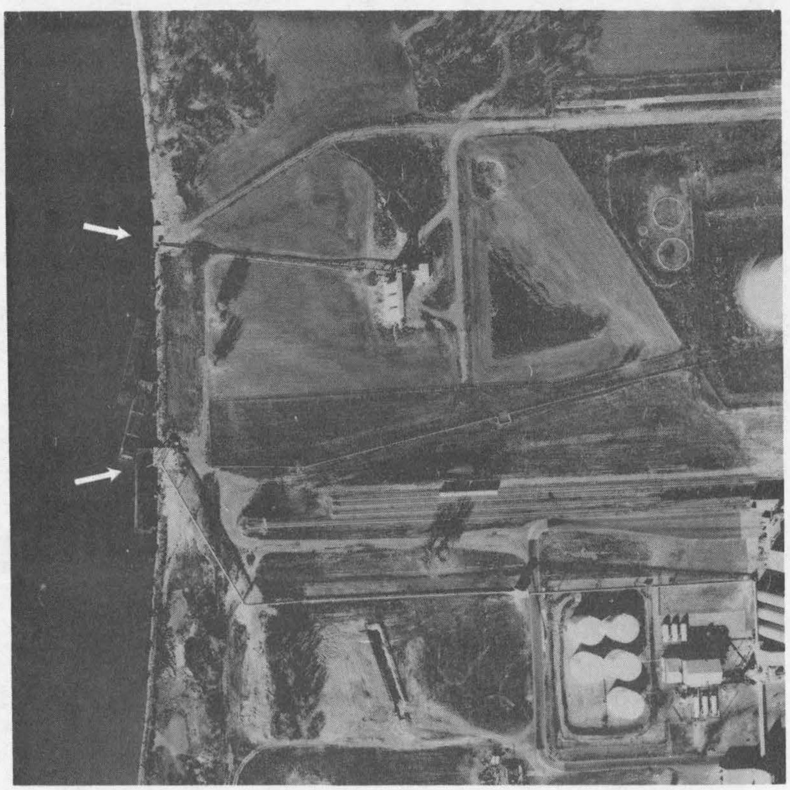


MAP REFERENCE NO.: 77
MILES ABOVE MO. RIVER MOUTH: 716.6
NAME: Farmland Soy Processing Co. (Farmland Industries, Inc.)

ADDRESS: Port Neal Ind. Area
P.O. Box 200
Sergeant Bluff, IA 51054
PHONE: (712)943-4282
COMMODITIES HANDLED:
Soybean meal & soybean oil.

ACCESS:
Truck - West of I-29 via 3 miles of good paved roads.
Rail - Chicago & Northwestern Transportation

NOTES: Ships soybean products produced at the terminal.



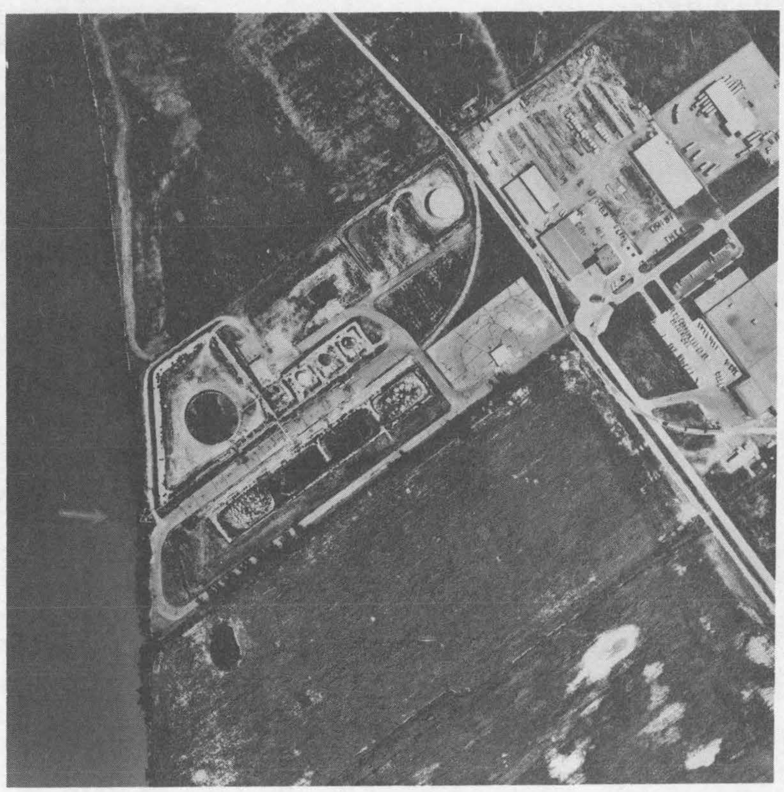
MAP REFERENCE NO.: 78
MILES ABOVE MO. RIVER MOUTH: 727.0
NAME: Flavorland By-Products

ADDRESS:
1900 Murray
Sioux City, IA
PHONE: (712)258-7524
COMMODITIES HANDLED:
Tallow

ACCESS:
Truck - West of I-29 via 1.6 miles of good paved roads.

NOTES: Tallow shipments to start upon completion of new barge facility in 1977.

MAP REFERENCE NO.: 79
MILES ABOVE MO. RIVER MOUTH: 727.5
NAME: Jebro, Inc.

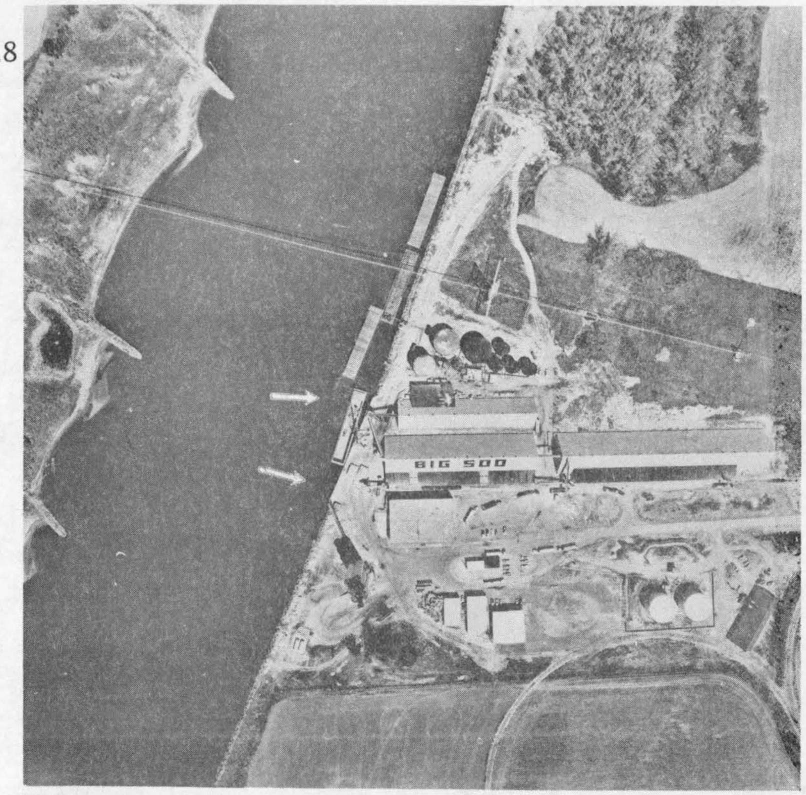


ADDRESS: (2303 Bridgeport)
P.O. Box 2813
Sioux City, IA 51106
PHONE: (712)277-8855
COMMODITIES HANDLED:
Asphalt

ACCESS:
Truck - West of I-29 via 0.8 mile of good, paved roads.
Rail - Chicago & Northwestern Transportation

NOTES: Received asphalt before 1975, but none since then.

MAP REFERENCE NO.: 80
MILES ABOVE MO. RIVER MOUTH: 727.8
NAME: Big Soo Terminal



ADDRESS:
4101 Harbor Drive
Sioux City, IA 51111
PHONE: (712)258-0537
COMMODITIES HANDLED:
Grain, soybean meal, alfalfa pellets, tallow, salt, molasses, paper, steel, dry and liquid fertilizer & pitch.
ACCESS:
Truck - West of I-29 via 0.4 mile of good gravel road.
Rail - Chicago & Northwestern Transportation

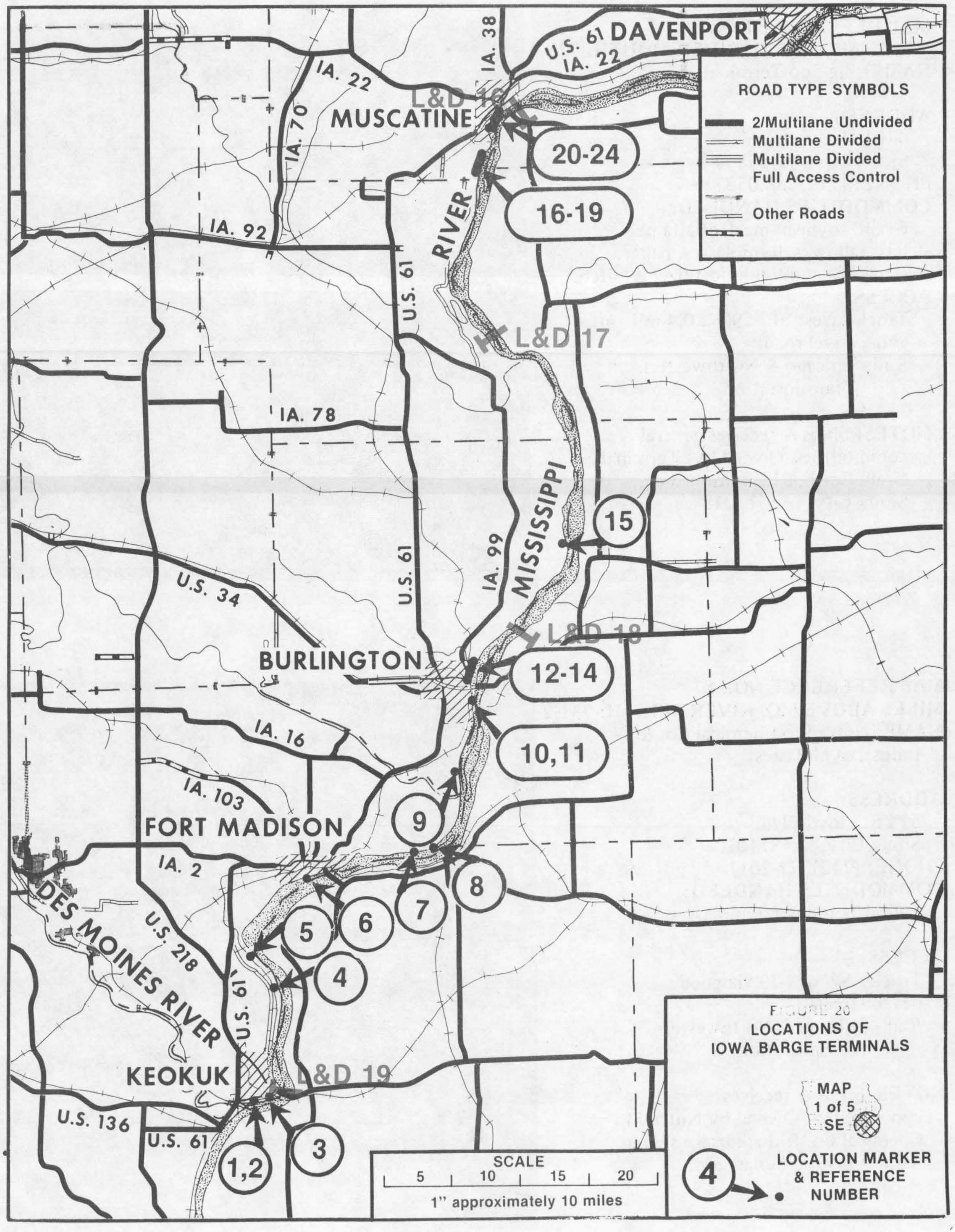
NOTES: Ships & receives general commodities. Owned by: Terminal Grain Corp., 615 Benson Bldg., Sioux City, IA 51101.

MAP REFERENCE NO.: 81
MILES ABOVE MO. RIVER MOUTH: 731.2
NAME: Nutra Flo Chemical Co. & Industrial Molasses

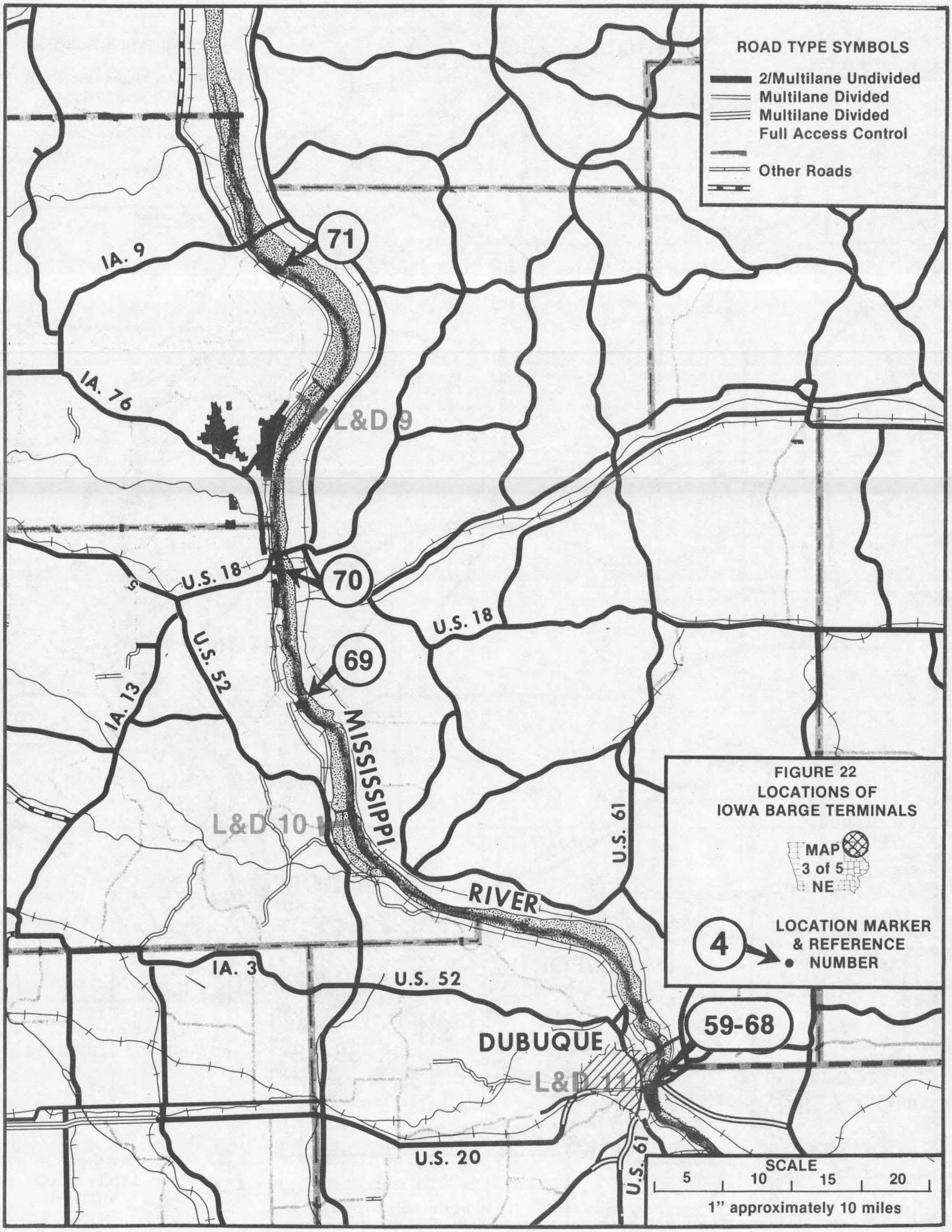
ADDRESS:
514 S. Floyd Blvd.
Sioux City, IA 51101
PHONE: (712)277-2011
COMMODITIES HANDLED:
Tallow & industrial molasses.

ACCESS:
Truck - SW of I-29 via good paved streets.
Rail - Chicago & Northwestern Transportation

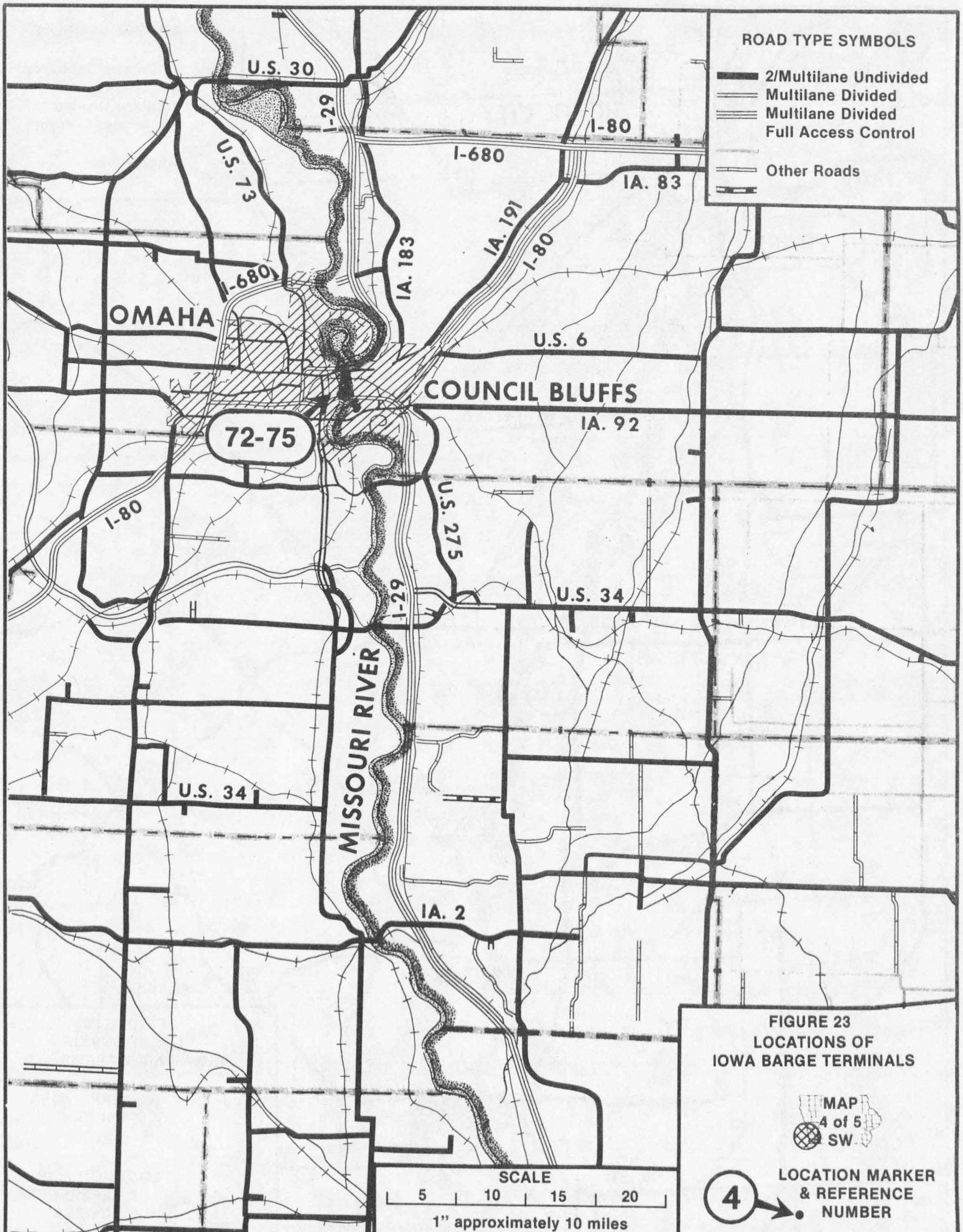
NOTES: Ships & receives commodities. Owned by Nutra Flo Chemical Co. & dock usage shared with Industrial Molasses.

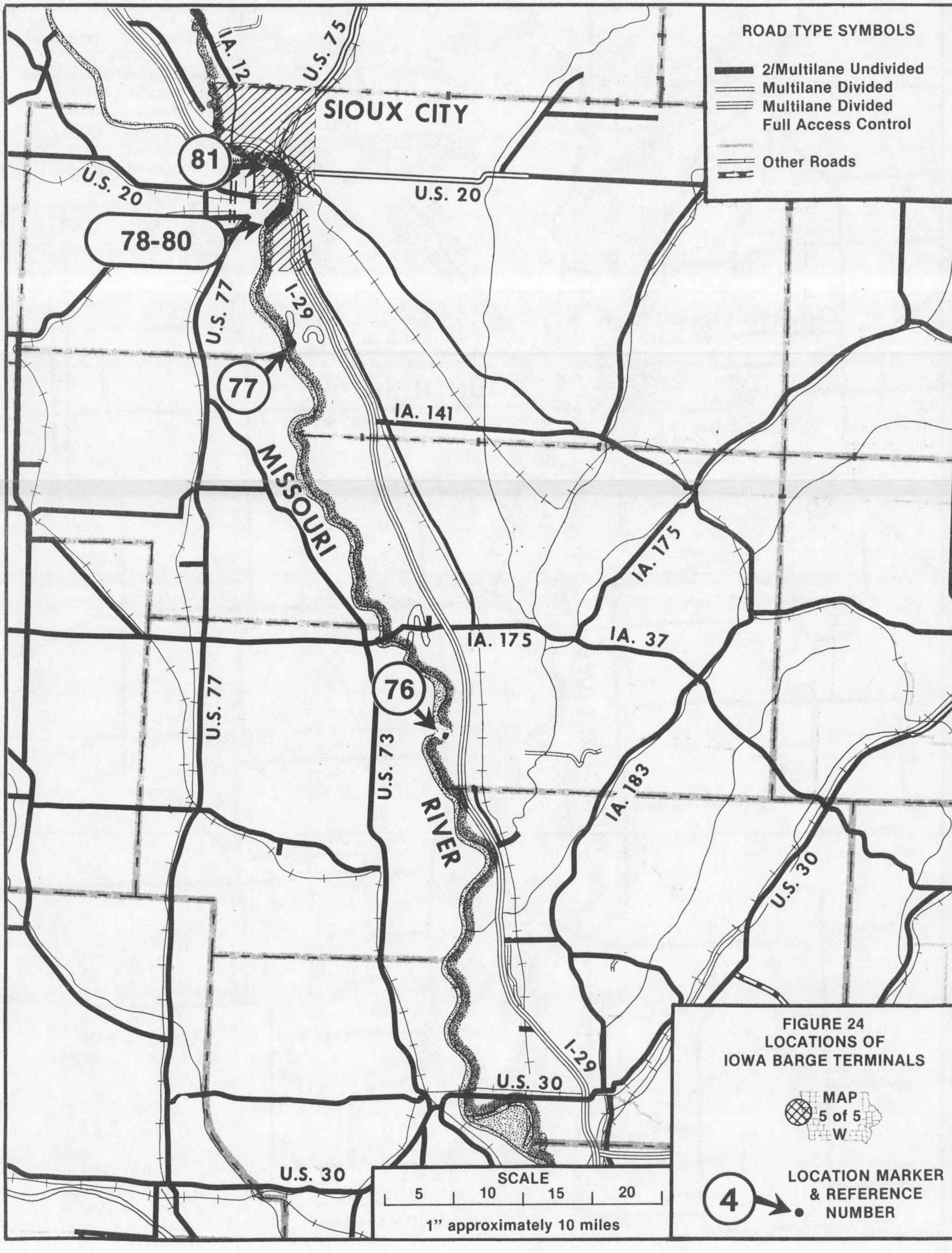

DAVENPORT
U.S. 61
IA. 22
IA. 38
L&D 16
MUSCATINE
20-24
16-19
IA. 70
IA. 92
RIVER
U.S. 61
L&D 17
IA. 78
MISSISSIPPI
IA. 99
15
U.S. 34
L&D 18
BURLINGTON
12-14
10,11
IA. 16
IA. 103
FORT MADISON
9
IA. 2
8
7
6
5
4
DES MOINES RIVER
U.S. 218
U.S. 61
KEOKUK
L&D 19
U.S. 136
U.S. 61
1,2
3
ROAD TYPE SYMBOLS
2/Multilane Undivided
Multilane Divided
Multilane Divided
Full Access Control
Other Roads
SCALE
5
10
15
20
1" approximately 10 miles
FIGURE 20
LOCATIONS OF
IOWA BARGE TERMINALS
MAP
1 of 5
SE
LOCATION MARKER
& REFERENCE
NUMBER

ROAD TYPE SYMBOLS
2/Multilane Undivided
Multilane Divided
Multilane Divided Full Access Control
Other Roads
DUBUQUE
58
57
U.S. 20
U.S. 151
U.S. 52
U.S. 61
L&D 12
IA. 62
MISSISSIPPI
RIVER
U.S. 52
IA. 64
U.S. 67
IA. 136
56
CLINTON
U.S. 30
U.S. 30
52-55
49-51
48
IA. 38
IA. 130
U.S. 61
U.S. 67
I-80
BETTENDORF
I-80
47
U.S. 6
U.S. 6
L&D 14
DAVENPORT
I-280
39-46
IA. 38
U.S. 61
IA. 22
IA. 22
36-38
35
MUSCATINE
U.S. 61
25
26
27
28-34
SCALE
5
10
15
20
1" approximately 10 miles
FIGURE 21
LOCATIONS OF
IOWA BARGE TERMINALS
MAP
2 of 5
E
4
LOCATION MARKER
& REFERENCE
NUMBER



ROAD TYPE SYMBOLS
2/Multilane Undivided
Multilane Divided
Multilane Divided
Full Access Control
Other Roads
FIGURE 22
LOCATIONS OF
IOWA BARGE TERMINALS
MAP
3 of 5
NE
4
LOCATION MARKER
& REFERENCE
NUMBER
71
70
69
59-68
IA. 9
IA. 76
L&D 9
U.S. 18
U.S. 18
U.S. 52
IA. 13
MISSISSIPPI
RIVER
L&D 10
U.S. 61
IA. 3
U.S. 52
DUBUQUE
L&D 11
U.S. 20
U.S. 61
SCALE
5
10
15
20
1" approximately 10 miles


ROAD TYPE SYMBOLS
2/Multilane Undivided
Multilane Divided
Multilane Divided
Full Access Control
Other Roads
U.S. 30
I-29
I-80
I-680
U.S. 73
IA. 83
IA. 191
I-80
IA. 183
I-680
OMAHA
U.S. 6
COUNCIL BLUFFS
72-75
IA. 92
I-80
U.S. 275
U.S. 34
I-29
MISSOURI RIVER
U.S. 34
IA. 2
FIGURE 23
LOCATIONS OF
IOWA BARGE TERMINALS
MAP
4 of 5
SW
SCALE
5 10 15 20
1" approximately 10 miles
4
LOCATION MARKER
& REFERENCE
NUMBER


ROAD TYPE SYMBOLS
2/Multilane Undivided
Multilane Divided
Multilane Divided
Full Access Control
Other Roads
SIOUX CITY
IA. 12
U.S. 75
U.S. 20
U.S. 20
81
78-80
U.S. 77
I-29
77
IA. 141
MISSOURI
IA. 175
IA. 175
IA. 37
76
U.S. 77
U.S. 73
RIVER
IA. 183
U.S. 30
I-29
U.S. 30
U.S. 30
SCALE
5
10
15
20
1" approximately 10 miles
FIGURE 24
LOCATIONS OF
IOWA BARGE TERMINALS
MAP
5 of 5
W
4
LOCATION MARKER
& REFERENCE
NUMBER

INDEX OF TERMINALS BY COMMODITIES HANDLED

COMMODITY HANDLED	MAP REFERENCE NO. OF TERMINAL
Acrylonitrile	16
Alcohol	22
Aluminum	48
Anhydrous ammonia	7, 9, 57
Antifreeze	72
Asphalt	31, 59, 79
Barge handling services	3, 6, 11, 33, 55, 58, 62
Cement	28, 39
Coal	4, 20, 25, 26, 28, 29, 32, 48, 51, 64, 65, 68, 71
Coke	28
Condensed fish solubles	19
Construction equipment	1, 48
Corn	2, 5, 8, 10, 13, 15, 21, 23, 24, 27, 32, 34, 37, 52, 64, 68, 69, 70, 73, 76, 80
Corn screenings	32
Diammonium phosphate	7
Fertilizer - dry	6, 14, 17, 48, 53, 64, 67, 68, 73, 74, 80
Fertilizer - liquid	5, 14, 19, 29, 31, 61, 80
Gravel (sand, rock, stone)	18, 29, 35, 36, 38, 44, 47, 48, 49, 63
Grease	61
Gypsum	28
Lard	61
Lumber - oak logs	32, 48
Machinery	48
Manganese ore	1
Molasses	19, 27, 61, 80, 81
Newsprint - paper	4, 48, 80
Nitrogen	56
Pellets - alfalfa	80
Pellets - beet pulp	53
Pellets - corn gluten	2, 10, 32, 53
Petroleum (fuel oil, road oil, gasoline, furnace oil, by-products, etc.)	7, 12, 30, 31, 40, 41, 42, 43, 45, 46, 53, 54, 59, 66, 72, 75
Phosphate rock	7
Pig iron	1, 68
Pipe	32, 48
Pitch	80
Salt (industrial, road)	4, 27, 32, 48, 53, 61, 67, 68, 80

COMMODITY HANDLED (CONT'D)	MAP REFERENCE NO. OF TERMINAL (CONT'D)
Scrap (iron, car bodies, misc. steel, ingots)	37, 68, 80
Soda - caustic	27, 50
Soybean meal	10, 27, 32, 53, 77, 80
Soybean oil	19, 77
Soybeans	2, 5, 8, 10, 13, 15, 21, 23, 24, 27, 32, 34, 37, 52, 64, 68, 69, 70, 76, 80
Steel products	4, 14, 26, 37, 48, 80
Styrene	16
Tallow	61, 80, 81
Twine - baler	60
Urea	48
Vegetable oils	27
Wheat	5, 8, 15, 32, 73

INDEX OF TERMINALS BY COMMODITIES HANDLED

COMMODITY HANDLED	MAP REFERENCE NO. OF TERMINAL
Acrylonitrile	16
Alcohol	22
Aluminum	48
Anhydrous ammonia	7, 9, 57
Antifreeze	72
Asphalt	31, 59, 79
Barge handling services	3, 6, 11, 33, 55, 58, 62
Cement	28, 39
Coal	4, 20, 25, 26, 28, 29, 32, 48, 51, 64, 65, 68, 71
Coke	28
Condensed fish solubles	19
Construction equipment	1, 48
Corn	2, 5, 8, 10, 13, 15, 21, 23, 24, 27, 32, 34, 37, 52, 64, 68, 69, 70, 73, 76, 80
Corn screenings	32
Diammonium phosphate	7
Fertilizer - dry	6, 14, 17, 48, 53, 64, 67, 68, 73, 74, 80
Fertilizer - liquid	5, 14, 19, 29, 31, 61, 80
Gravel (sand, rock, stone)	18, 29, 35, 36, 38, 44, 47, 48, 49, 63
Grease	61
Gypsum	28
Lard	61
Lumber - oak logs	32, 48
Machinery	48
Manganese ore	1
Molasses	19, 27, 61, 80, 81
Newsprint - paper	4, 48, 80
Nitrogen	56
Pellets - alfalfa	80
Pellets - beet pulp	53
Pellets - corn gluten	2, 10, 32, 53
Petroleum (fuel oil, road oil, gasoline, furnace oil, by-products, etc.)	7, 12, 30, 31, 40, 41, 42, 43, 45, 46, 53, 54, 59, 66, 72, 75
Phosphate rock	7
Pig iron	1, 68
Pipe	32, 48
Pitch	80
Salt (industrial, road)	4, 27, 32, 48, 53, 61, 67, 68, 80

COMMODITY HANDLED (CONT'D)	MAP REFERENCE NO. OF TERMINAL (CONT'D)
Scrap (iron, car bodies, misc. steel, ingots)	37, 68, 80
Soda - caustic	27, 50
Soybean meal	10, 27, 32, 53, 77, 80
Soybean oil	19, 77
Soybeans	2, 5, 8, 10, 13, 15, 21, 23, 24, 27, 32, 34, 37, 52, 64, 68, 69, 70, 76, 80
Steel products	4, 14, 26, 37, 48, 80
Styrene	16
Tallow	61, 80, 81
Twine - baler	60
Urea	48
Vegetable oils	27
Wheat	5, 8, 15, 32, 73

ALPHABETICAL LIST OF TERMINALS

NAME (Cont'd)	PAGE NO.

APPENDIX C

MODAL OPERATING COSTS

APPENDIX C

MODAL OPERATING COSTS

The following tables show freight cost by length of haul. All vehicle operating costs are included, e.g., fuel, oil, tires, and wages. Freight loading and handling costs and capital costs of equipment are also included.

When comparing costs among tables it must be kept in mind that costs per vehicle mile and per ton mile are dependent upon types of products being shipped.

Barge Costs*
1974

Miles** Hauled	Dollars Per Vehicle Mile***	Cents Per Ton Mile
800	137.25	0.61
1000	114.75	0.51
1200	101.25	0.45
1400	92.25	0.41
1600	83.25	0.37
1800	78.75	0.35

* Average cost for grain downstream and fertilizer upstream.

** Distance along the Mississippi River from Minneapolis, Minnesota.

*** Vehicle consists of a 4500 horsepower towboat and 15 barges.

Source (computed from data published in):

BULK COMMODITY TRANSPORTATION IN THE UPPER MISSISSIPPI RIVER VALLEY, July 1975, The Department of Agricultural and Applied Economics, University of Minnesota.

AN ECONOMIC ANALYSIS OF UPGRADING RAIL BRANCH LINES, A STUDY OF 71 LINES IN IOWA, March 1976, Iowa Department of Transportation, Iowa State University of Science and Technology.

TRUCK COSTS
1977

Length of Haul (Miles)		Tractor-Semi Trailer (48,000 pound payload)		Single-Unit Truck (27,000 pound payload)	
		Dollars Per Vehicle Mile	Cents Per Ton Mile	Dollars Per Vehicle Mile	Cents Per Ton Mile
50	Wages	0.28	2.4	0.23	3.5
	Operating	0.30	2.6	0.25	3.7
	Maintenance	0.13	1.1	0.11	1.7
	Capital*	0.11	1.0	0.09	1.4
	Load & Unload	5.92	50.4	3.33	50.5
	TOTAL	6.74	57.5	4.01	60.8
100	Wages	0.28	2.4	0.23	3.5
	Operating	0.30	2.6	0.25	3.7
	Maintenance	0.13	1.1	0.11	1.7
	Capital*	0.11	1.0	0.09	1.4
	Load & Unload	2.96	25.2	1.66	25.2
	TOTAL	3.78	32.3	2.34	35.5
200	Wages	0.28	2.4	0.23	3.5
	Operating	0.30	2.6	0.25	3.7
	Maintenance	0.13	1.1	0.11	1.7
	Capital*	0.11	1.0	0.09	1.4
	Load & Unload	1.48	12.6	0.83	12.6
	TOTAL	2.30	19.7	1.51	22.9
400	Wages	0.28	2.4	0.23	3.5
	Operating	0.30	2.6	0.25	3.7
	Maintenance	0.13	1.1	0.11	1.7
	Capital*	0.11	1.0	1.09	1.4
	Load & Unload	0.74	6.3	0.42	6.4
	TOTAL	1.56	13.4	1.10	16.7
800	Wages	0.28	2.4	0.23	3.5
	Operating	0.30	2.6	0.25	3.7
	Maintenance	0.13	1.1	0.11	1.7
	Capital*	0.11	1.0	0.09	1.4
	Load & Unload	0.37	3.1	0.21	3.2
	TOTAL	1.19	10.2	0.89	13.5
1000	Wages	0.28	2.4	0.23	3.5
	Operating	0.30	2.6	0.25	3.7
	Maintenance	0.13	1.1	0.11	1.7
	Capital*	0.11	1.0	0.09	1.4
	Load & Unload	0.30	2.6	0.17	2.6
	TOTAL	1.12	9.7	0.85	12.9

* Capital costs reflect equipment depreciation and interest costs based on annual equivalent costs at 11% interest and a 7-year life expectancy.

Source: Computations based on data from Iowa DOT Transportation Regulatory Board's 1975 Cost Study, and Bulk Commodity Transportation in the Upper Mississippi River Valley, Department of Agricultural and Applied Economics, University of Minnesota, 1975.

RAIL COSTS
1974

Length of Haul (Miles)	Conventional Train*		Unit Train**	
	Dollars Per Train Mile	Cents Per Ton Mile	Dollars Per Train Mile	Cents Per Ton Mile
100	172.00	6.75	38.40	1.50
200	104.00	4.03	29.44	1.15
500	63.00	2.18	23.81	0.93
1000	49.00	1.79	23.04	0.90
2000	42.00	1.61	22.27	0.87

* Assumed 64 car train made up of a mixture of cars averaging 40 tons of cargo per car, Average conditions and 3 - 2000 horsepower locomotives.

** Assumed 50 car unit train with 4 - 2000 horsepower locomotives.

Sources: Conventional Train,
Rail Carload Cost Scales, 1974, Interstate Commerce Commission, Bureau of Accounts, Washington, D.C., Statement No. ICI-74, August 1976.

Unit Train,
Computations based on data from U.S. Railway Association Preliminary System Plan, Volume 1, February 26, 1975.

Freight Vehicle Base Purchase Prices
(1977 Dollars)

Water	
Tow boat (4500 hp)	2,250,000
Barge	
Covered hopper (1500 ton)	195,000
Open hopper (1500 ton)	170,000
Truck	
Tractor-semi trailer	
Tractor	40,000
Hi-cube trailer	14,000
Refrigerator trailer	16,000
Single Unit truck (tandem axle)	26,000
Pickup	4,000
Rail	
Diesel locomotive (2000 hp)	400,000
Covered hopper car (100 ton)	38,000
Insulated box car	51,000
Open top hopper car	29,000

Source: Iowa Department of Transportation, Planning and Research Department.

ESTIMATED OPERATING COSTS OF TOWBOATS ON THE MISSISSIPPI RIVER SYSTEM
1976

HORSEPOWER	1800-2200	2800-3400	4000-4400	5000-6000	6100-7000
INVESTMENT (Average new cost)	$1,000,000	$1,700,000	$2,200,000	$2,600,000	$3,100,000
FIXED COSTS:					
Return on investment	$ 177,500	$ 199,700	$ 258,400	$ 305,400	$ 364,100
Administration & supervision	55,700	80,500	94,500	117,200	130,000
Sub-total	173,200	280,200	352,900	422,600	494,100
OPERATING COSTS:					
Wages & fringe benefits	250,000	325,000	325,000	350,000	350,000
Fuel	180,000	300,000	400,000	564,000	666,000
Maintenance & repairs	45,000	60,000	80,000	95,000	105,000
Supplies	25,000	34,000	38,000	42,000	44,000
Subsistence	20,000	28,000	28,000	31,000	31,000
Insurance	30,000	50,000	65,000	80,000	93,000
Other	7,000	8,000	9,000	10,000	11,000
Sub-total	557,000	805,000	945,000	1,172,000	1,300,000
TOTAL COSTS: (Annual)	730,200	1,085,200	1,297,900	1,594,600	1,809,200
HOURLY OPERATING COSTS (345 days)	$88.00	$131.00	$157.00	$193.00	$217.00

ESTIMATED OPERATING COSTS OF BARGES ON THE MISSISSIPPI RIVER SYSTEM 1976

TYPE	OPEN HOPPER	COVERED HOPPER	TANK SINGLE SKIN	TANK DOUBLE SKIN WITH COILS	CYLINDRICAL TANK PRESSURE
SIZE	195'x35'	195'x35'	290'x50'	290'x50'	195'x35'
INVESTMENT (Average new cost)	$160,000	$190,000	$570,000	$710,000	$700,000
FIXED COST:					
Return on investment	$ 18,800	$ 22,300	$ 67,000	$ 83,400	$ 77,100
Administration & supervision	500	600	2,600	3,000	2,000
Sub-total	19,300	22,900	69,600	86,400	79,100
OPERATING COST:					
Maintenance & repair	2,500	2,900	14,000	15,000	9,000
Insurance	1,900	2,400	10,000	12,400	12,000
Supplies	300	300	2,000	2,000	1,000
Sub-total	4,700	5,600	26,000	29,400	22,000
TOTAL COSTS: (Annual)	24,000	28,500	85,600	115,800	101,100
HOURLY OPERATING COSTS (355 days)	$2.80	$3.35	$10.00	$13.60	$12.00

APPENDIX D

U.S. ARMY CORPS OF ENGINEERS
DIVISION AND DISTRICT BOUNDARIES FOR CIVIL WORKS ACTIVITIES

APPENDIX D

U.S. ARMY CORPS OF ENGINEERS DIVISION AND DISTRICT BOUNDARIES FOR CIVIL WORKS ACTIVITIES

Figure 25 shows the Corps of Engineers' division and district boundaries for civil work activities in the United States. The Corps' North Central Division and Missouri River Division have jurisdiction in Iowa, (Figure 26). Division and district boundaries are defined by drainage area of major river basins.

Example: The North Central Division's Rock Island District has jurisdiction in the eastern two-thirds of Iowa which includes:

The Des Moines River Basin
The Iowa and Cedar Rivers Basin
The Skunk River Basin
The Turkey, Maquoketa, and Wapsipinicon River Basins
The Fox, Wyaconda, and Sabins River Basins
The Upper Mississippi River Basin from Guttenberg to Keokuk

The North Central Division's St. Paul District has jurisdiction in two small areas in northern Iowa.

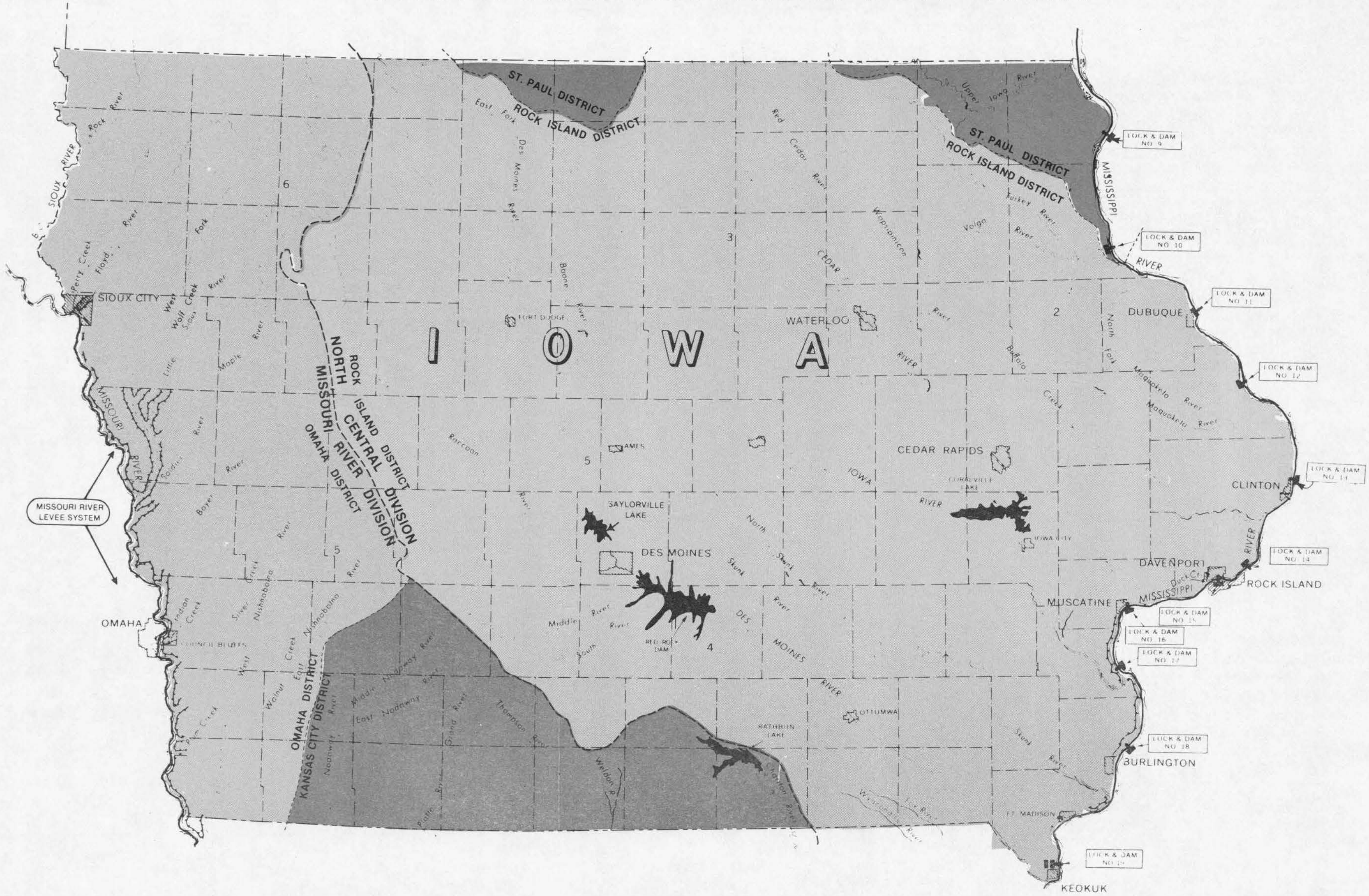
The Missouri River Division's Omaha District has jurisdiction in western Iowa, and the Kansas City District in the southwestern portion of the State.

FIGURE 25

U.S. ARMY CORPS OF ENGINEERS DIVISION AND DISTRICT BOUNDARIES FOR CIVIL WORKS ACTIVITIES UNITED STATES

FIGURE 26

U.S. ARMY CORPS OF ENGINEERS DIVISION AND DISTRICT BOUNDARIES CIVIL WORKS ACTIVITIES FOR IOWA



DEFINITION OF TERMS

accretion - The gradual or inperceptible sediment buildup by natural forces.

acre-foot - An area of one acre covered with water to a depth of one foot. One acre-foot is 43,560 cubic feet or 325,851 gallons.

apron - A floor or lining of resistant material at the toe of a dam or bottom of a spillway to prevent erosion from turbulent water flow.

basin - Drainage area of a stream; as river basin

bridle line - The wire cable used to connect a barge in trailing fashion behind the towboat.

degradation - Lowering of the river bed due to the tendency of the flowing water to pick up and transport river bed material.

double lockage - Requires two operations of the lock chamber to permit passage of one tow.

draft - The depth of water a vessel draws, especially when loaded.

eutrophication - An oxygen deficiency condition of water.

fishy back - The movement of loaded truck trailers by barge or ferry.

gradation - A term used to describe the particle size of sand or gravel.

hydraulic loading - The static and dynamic forces caused by water acting against a structure.

ice gorge - Piled up ice; the result of broken ice which moves out of one or more navigation pools and gorges in a downstream pool

levee - An earthen embankment to prevent flooding.

miter gates - Vertical gates which form the openings of navigation locks; these gates consist of two swinging leaves and close at the center.

monoliths - Large sections into which a concrete dam or other structures are divided for construction or functional reasons.

oxbow lakes - Lakes resulting from the cutting off of sharp river bends during realignment of a river channel.

reliction - The gradual recession of water leaving permanently uncovered land.

riparian land - Shoreline land adjoining a natural watercourse.

riprap - Broken stone, boulders, or other materials placed on earth surfaces for protection against the erosive action of waves or currents.

rock berm - A mound or strip of stone placed against the side of a structure near the base to act as a buttress.

roller gates - A gate designed to control the flow of water through a dam; consists of a cylindrical plate steel roller approximately as large in diameter as the height of opening to be closed and spanning between piers.

scour hole - Hole caused by the erosive action of running water.

shoals - A sandbank or sandbar formed by river currents.

sill - A horizontal beam forming the bottom of an entrance to a lock.

single lockage - Requires one operation of the lock chamber to permit passage of one tow.

stilling basin - A structure at the outlet end of a spillway to help disipate the energy of flowing water and discharge the water into the downstream channel in such a manner as to prevent damage to the dam or scour of the bed or banks of the channel.

tainter gates - A large gate used to control the flow of water through or over dams; such gates have a cylindrical surface with the convex side facing upstream.

ton-mile - One ton of freight moved over a distance of one mile.

tow - An assemblage of one or more barges propelled by a towboat.

wing dam - A wall, crib, row of pilings, or stone jetty projecting from the bank into a stream for protecting the bank from erosion, arresting sand movement, or for concentrating the flow of a stream into a smaller channel.

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