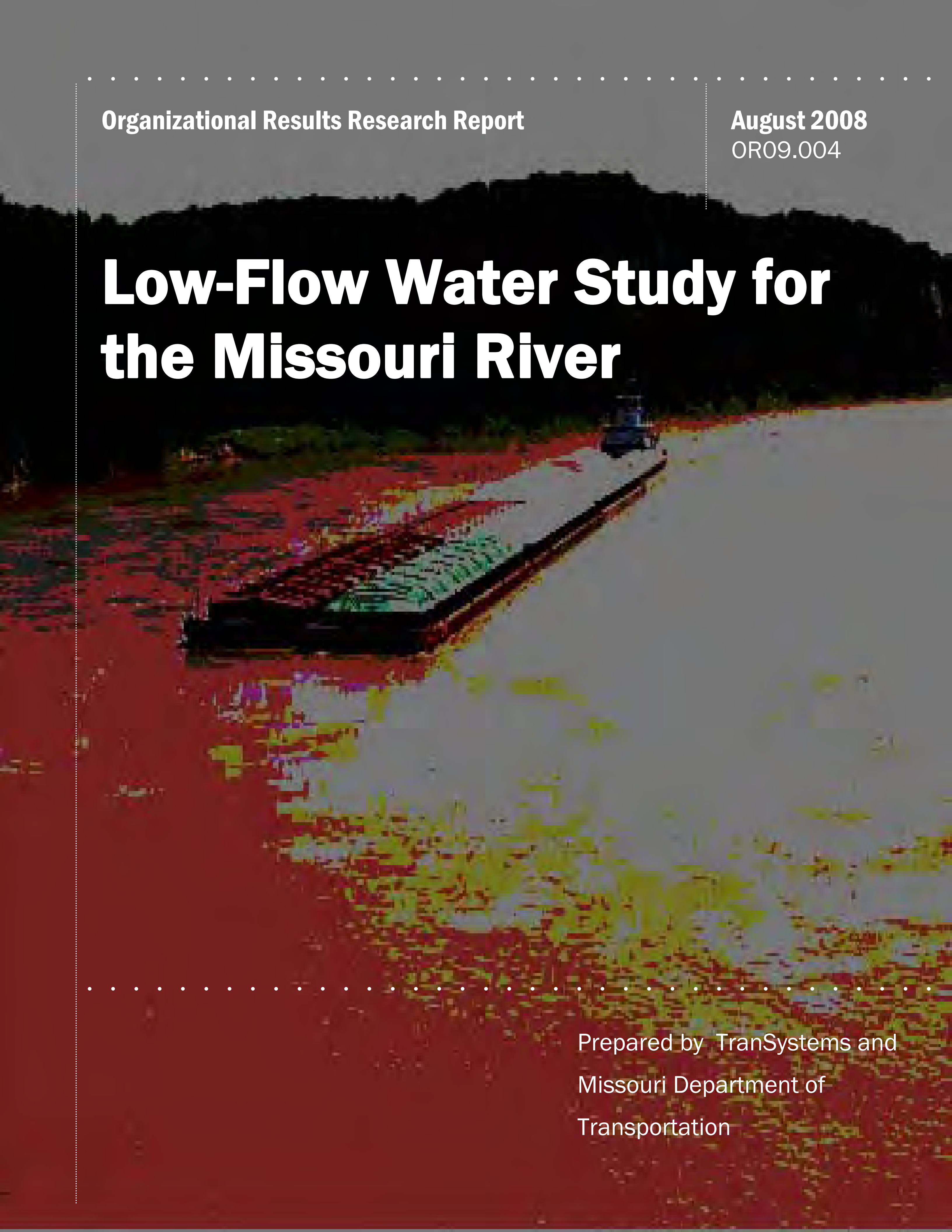

Organizational Results Research Report

August 2008
OR09.004

Low-Flow Water Study for the Missouri River

Prepared by TranSystems and

Missouri Department of

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The Missouri Department of Transportation (MoDOT) retained TranSystems to identify and review low-flow industry trends, equipment and strategies used in inland navigation settings throughout the United States and worldwide which may be transferable to the Missouri River and which could support an increase in barge activity on the Missouri River. TranSystems undertook several tasks to accomplish the study objectives, as follows:

- Low-Flow Issues of the Missouri River – an evaluation of current challenges faced by tugs and barges operating on the Missouri River.
- Interview Survey – a survey to determine challenges of moving cargo on the Missouri River and potential solutions to support expansion of cargo activity. Organizations interviewed include shippers of cargo, terminal operators, tug and barge operators, and government agencies.
- Market Analysis and Trends –a review of historical trends in cargo activity on the Missouri River and developments in the barge industry.
- Best Practice Identification – an evaluation of low-flow technologies used on other river systems in the U.S. and Europe.
- Potential Technology Solutions – based on the interview survey and technology evaluation, the identification of potential solutions that could support cargo activity on the Missouri River.
- Public Sector Benefits and Costs – proposed policy actions for MoDOT, and their impacts.

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Final Report

Missouri Department of Transportation – Low-Flow Water Study for the Missouri River

Submitted to:

Missouri Department of Transportation

TranSystems

August, 2008

Table of Contents

1. Executive Summary

1.1 Background and Scope

The Missouri Department of Transportation (MoDOT) retained TranSystems to identify and review low-flow industry trends, equipment and strategies used in inland navigation settings throughout the United States and worldwide which may be transferable to the Missouri River and which could support an increase in barge activity on the Missouri River. TranSystems undertook several tasks to accomplish the study objectives, as follows:

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- Potential Technology Solutions – based on the interview survey and technology evaluation, the identification of potential solutions that could support cargo activity on the Missouri River.
- Public Sector Benefits and Costs – proposed policy actions for MoDOT, and their impacts.

1.2 Findings and Conclusions

1.2.1 Low-Flow Issues of the Missouri River

Research on Missouri River navigational conditions has identified competing opinions from stakeholder groups. Today it seems the demands of environmentalists and their concern for endangered species outweighs the demand for river transportation, although the United States Army Corps of Engineers (USACE) operating plan states transportation on the lower Missouri is still one of its major criteria. Private interests maintain the timing of releases of upstream dams do not fit with tourist or fishing seasons and impact potential development to support those industries. The following developments were considered during the execution of subsequent tasks:

- The 2008 Annual Operating Plan (AOP) for the Missouri River continues to emphasize conservation efforts.
- The AOP anticipates releasing only enough water to provide minimum navigation flows for the entire season and shortening the season by 17 to 60 days. It was shortened by 35 days in 2007.

The USACE announced March 27, 2008, that it would be adjusting releases from five tributary dams in Missouri and Kansas. The USACE will be able to raise water levels in the reach above Kansas City, while not increasing the amount of water that flows below that point. This plan is designed to mimic the natural flow of the river before the six large upstream dams and reservoirs were built. It is hoped the plan will improve habitat for the pallid sturgeon, a federally protected endangered species. Releases are regulated in late spring through the summer to protect the nests and chicks of the least tern and piping plover, both protected by the Endangered Species Act.

1.2.2 *Interview Survey*

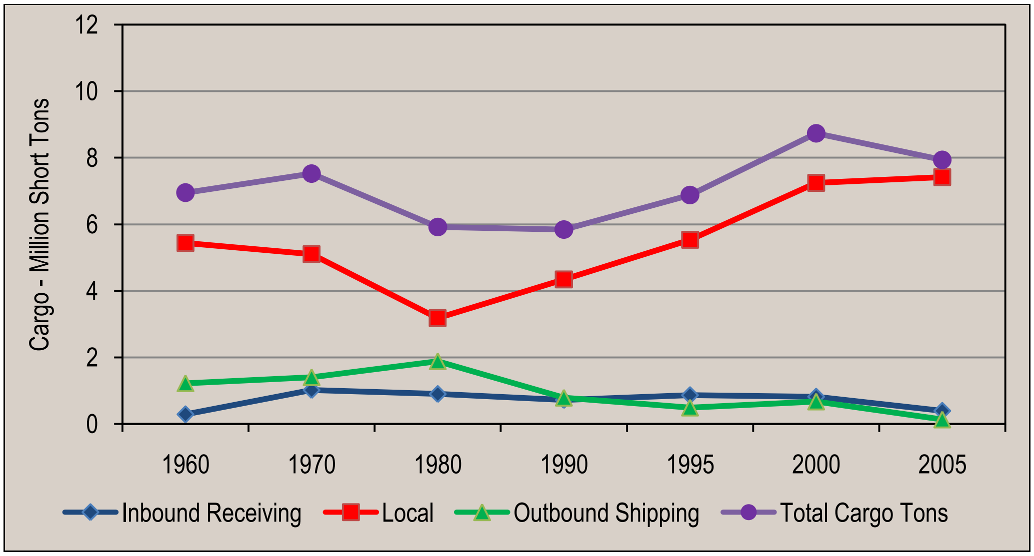
The interview survey provides guidance on potential actions required to support the renewal and growth of barge traffic on the Missouri River. The following items should be considered for further evaluation by the Missouri Department of Transportation:

- Support the development of barge service on the Missouri River by identifying funds to assist with the construction of shallow draft tugs
- Explore the potential for USACE to invest in shallow draft equipment, which could be consistent with its Missouri Navigation mission. Increased river traffic will aid in keeping river channels clear.
- Support new fleeting operations by funding the start-up of new fleeting services.
- Encourage a program for channel maintenance and monitoring.
- Establish river tug crew training program. Many tug crews are reaching retirement age. Training programs will also promote safety on the Missouri River, as crews are made aware of local navigational issues.
- Create strategic partnerships with Louisiana Lower Mississippi River ports to market use of inland waterways for emerging cargos (e.g. ethanol and DDGS).
- Market and promote environmental benefits of barge service. Identify government supported environmental funds for attainment of clean air and water.

1.2.3 *Market Analysis and Trends*

The historical trend in Missouri River cargo volume is shown Figure 1-1. Cargo volume is currently at a higher level than in the 1960s, 1970s and 1980s due to expansion of local cargo (largely sand and gravel). Outbound cargo has declined compared to the earlier decades, which reflects a variety of factors including competition for grain shipments from the Arkansas River, drought in the 1988 to 1993 period and poor service reliability.

Figure 1-1: Historical Missouri River Cargo Tons



Source: US Army Corp of Engineers, Waterborne Commerce Statistics

1.2.4 Best Practice Identification

The most common practice today on U.S. inland waterway systems for accommodating freight barge traffic during low-flow conditions is barge light loading. This practice is quite common today and is currently employed not only on the Missouri River but also on the McClellan/Kerr waterway in Arkansas, and the Tennessee-Tombigbee waterway in Alabama.

Inland waterway systems of Europe best represent navigation patterns matched to varying channel dimensions. The systems vary in traffic and cargo concentrations depending on the depth and width of each particular channel.

Research on existing and proposed technologies and operating practices on low-flow rivers has identified the following issues:

- Barge light loading is an acceptable practice although its use restricts expansion of river traffic and cargo volumes on the Missouri River.
- European inland waterway transportation and the supporting freight transportation market is much more dynamic than any U.S. inland waterway system.
- Standardization of lock dimensions on the Mississippi and connecting river systems is not conducive to new barge and work boat designs.

1.2.5 Potential Technology Solutions

- The following conclusions have been developed concerning potential technology solutions to increased barge traffic on the Missouri River: The availability of shallow draft tugs for performing line haul and fleeting operations on the river is of greater importance than a supply of shallow draft barges.
- Shallow draft tugs would be expected to improve service reliability.
- Purpose built self-propelled shallow draft tugs could be used for intra Missouri River freight traffic.
- A vessel with a maximum draft of six feet could operate at under minimum service flow conditions throughout the Missouri River's regular navigational season.

1.2.6 Costs and Benefits of Construction Subsidy for Shallow Draft Tugs

An analysis of the costs and benefits for the deployment of shallow draft tugs by replacing rail with barge to move cargo between St. Joseph, MO and St. Louis, MO provided the following:

During a normal navigation season, from April 1 to December 1, the transport cost savings to shippers from replacing rail with barge are greater than the construction subsidy for a fleet of two shallow draft tugs at $1.1 million. For a single season, the total transport cost savings of replacing rail and barge is over $2.4 million.

Barge transportation generates 39 percent lower air emissions per cargo ton-mile than rail transportation. In this analysis, barge transportation would generate an 11 percent reduction in total emissions, based on the distance between St. Joseph and St. Louis, and the cargo tons shipped per season. The barge advantage comes from its greater fuel efficiency per cargo-ton mile:

Estimated Air Pollutants per Season

	Barge	Rail[1]
Air Pollutants	**Total Emissions per Season**	
Hydrocarbons (HC)	3,929,011	4,365,587
Carbon Monoxide (CO)	10,452,480	11,612,137
Nitrogen Oxides (NOx)	106,101,382	117,874,451
Particulate Matter (PM)	2,632,912	2,920,601
Fuel Consumption per Season (Gallons)	392,700	436,254

Barge transportation is a safer transportation mode than rail, generating fewer fatalities and injuries per cargo ton-mile. Fatalities and injuries per billion ton-miles for barge are 0.28 and 0.045, respectively. Barge is significantly lower than the estimated 0.649 and 5.814 fatalities and injuries per billion ton-miles on rail.

1.2.7 *Public Sector Benefits and Costs*

The interviews with shippers, barge operators, and government agencies, and the review of other technologies identified a number of preferred solutions to support the development of new cargo activity on the Missouri River. MoDOT could undertake the following actions:

- Provision of support for the construction and deployment of shallow draft tugs for fleeting and line haul operations
- Provision of support for new fleeting operations to improve operational performance on the river
- Provision of support for river crew training program
- Other policy actions
    - Enhance program for channel maintenance and monitoring to address shipper and operator concerns about channel reliability.
    - Create strategic partnerships with Louisiana, Lower Mississippi River ports to market use of inland waterways for emerging cargos (for example, ethanol and DDGS).
    - Promote environmental benefits of barge service.

These actions all have similar benefits and costs:

- Potential Public Sector Benefit:
    - Increased use of Missouri River assets (ports, etc.) with potential higher employment, tax revenues, etc.
    - Potential increased use of barge, which has a lower environmental footprint than other transport modes
    - Increased traffic aids channel maintenance, supporting river reliability
- Potential Public Sector Cost:
    - Financial support for incentive programs

- Potential Private Sector Benefit:
  - Increased transport options for shippers
  - Service reliability for shippers
  - Lower cost transport option (barge less expensive than rail and truck)
  - Increased cargo tonnage for terminal operators
  - Greater operational reliability for barge operators
- Potential Private Sector Cost:
  - Risks from increased use of Missouri River. For example, can water levels be maintained so shippers have confidence in long term service reliability?
  - Transfer of equipment from potentially more reliable and higher revenue/profit rivers to the Missouri River

2. Low-Flow Issues of the Missouri River

2.1 Introduction

The primary objective of this study is to identify and review low-flow industry trends, equipment, and strategies used in inland navigation settings throughout the United States and worldwide that may be transferable to the Missouri River. This section of the study describes current navigation and low-flow challenges on the Missouri River to provide a baseline for research into alternative strategies for cargo movement by river.

2.2 Missouri River Navigation

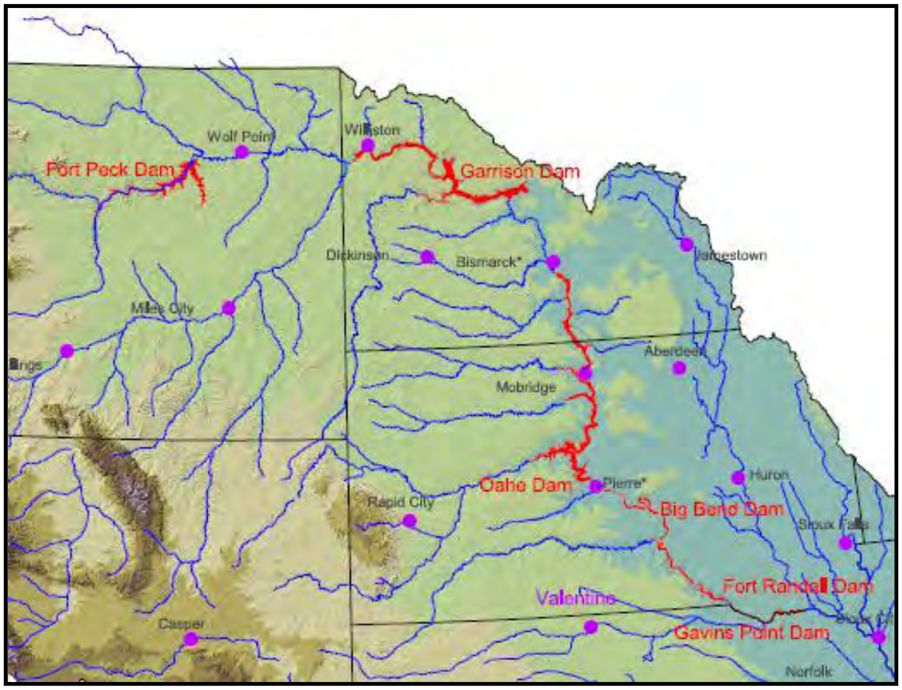
Navigation, freight, and commodity shipping on the Missouri River are chronically constrained due to low-flow water conditions. The standards, equipment and strategies in the barge industry increasingly do not work on the Missouri River. As a result, the low-flow conditions not only shorten the overall navigation season but also constrain the future development of barge activity on the Missouri River.

The Missouri River Bank Stabilization and Navigation Project (BSNP) initiated efforts to supply reliable commercial transportation while minimizing bank erosion and channel meandering on the Missouri River. The project, authorized by the Rivers and Harbor Act of 1945, was designed to provide a secure, continuous channel with a depth of nine feet and a width of at least 300 feet for a distance of 735 miles stretching from Sioux City, Iowa to the mouth of the river near St. Louis, Missouri. As a result of the BSNP, the Current Water Control Plan (CWCP) was developed. The purpose of the CWCP is to serve the needs of the river basin and the geographic area of the river including congressionally authorized project purposes, federally recognized Native American Tribes, and endangered species.

2.3 Dam Locations and Descriptions

Water levels on the Missouri River are regulated by a system of releases from dams at strategic times. The six dams located on the Missouri River that serve the function of discharge regulation, as mandated through the CWCP, are shown in Figure 2-1.

Figure 2-1: Missouri River Basin Dam Locations



Source: US Army Corp of Engineers

The Missouri River Basin Dam system is the single source of water level regulation on the Missouri River and the most significant source of water for the Missouri River beyond local precipitation and tributaries below Sioux City. The characteristics of the six dams are described below.

Fort Peck - Fort Peck Lake

The Fort Peck Dam serves primarily as a collecting point for plains snowmelt and localized rainfall runoff. It reduces the risk of flood damages that would occur from unregulated flows from the Fort Peck Dam to Lake Sakakawea.

Garrison Dam – Lake Sakakawea

The Garrison Dam serves as the largest reservoir in the US Army Corp of Engineers (USACE) system for collection of snowmelt and localized rainfall runoff. The Garrison Dam helps to prevent flood damage to the areas between the Garrison Dam and Lake Oahe, especially the urban Bismarck area.

Oahe Dam – Lake Oahe

The primary function of the Oahe Dam is to capture snowmelt and localized rainfall runoffs through controlled releases into the system. Controlled releases minimize possibility of flood conditions between the Oahe Dam and the Big Bend Reach, especially the urban areas of Pierre and Fort Pierre. Releases from the Oahe and Big Bend Dams supply power generation needs and navigation discharge back-up for Fort Randall and Gavins Point Dams.

Big Bend Dam-Lake Sharpe

Big Bend Dam is located on Lake Sharpe 80 miles upstream from the Oahe Dam. Big Bend has two MAF of total storage and is primarily used for day to day and week to week power generation. It discharges directly into Lake Francis Case, negating the need for winter release restrictions.

Fort Randall – Lake Francis Case

The primary purpose of Fort Randall is to collect and control runoff from plains snowmelt and localized rainfall through metered releases further into Gavins Point Dam.

Gavins Point Dam – Lewis and Clark Lake

The Gavins Point Dam is farthest downstream of the Missouri River dams and has the primary function of re-regulating releases from upper system dams. The total storage capacity of Gavins Point is 500,000 acre-feet, making it the smallest of the dams in the system. Because it has low storage capacity, releases from Gavins Point must be coupled with other releases from dams upriver.

2.4 Navigational Season Determinants

Navigational seasons are determined from levels of precipitation, the existence of drought conditions, and the intensity of snowfall runoff in a given period. Human elements that play a significant part in navigational conditions include recreational requirements to support tourism and fishing, as well as environmental issues such as support for wildlife habitat or lack thereof. The existence of capacity and predicted strength of runoff levels lead to the determination of the system service level for a particular navigation season.

System Service Level

The system service level acts as a numeric indication of the water volume necessary to achieve a normal eight-month navigation season with average tributary contributions. "Full-service" occurs if there is a 35,000 cubic feet per second (cfs) of flow and "minimum-service" occurs if there is 29,000 cfs of flow. Full-service downstream flows support nine-foot depth and minimum-service of downstream flows support eight-foot depth in the Missouri River navigation channel. System service levels are determined from flow target discharges at four predetermined control point locations. The locations and their respective flow target discharge deviations are shown in Table 2-1.

A full-service level of 35,000 cfs results in a target discharge of 31,000 cfs for Sioux City and 41,000 cfs for Kansas City. A minimum-service level of 29,000 cfs is required to maintain a target flow of 25,000 for Omaha and 31,000 for Nebraska City. Determination of the appropriate service level is a result of the amount of water-in-storage within the system.

Table 2-1: Control Point Location and Deviation from Service Level

Control Point Location	Flow Target Discharge Deviation from Service Level (Cubic Feet per Second)
Sioux City	-4,000
Omaha	-4,000
Nebraska City	+2,000
Kansas City	+6,000

Source: US Army Corp of Engineers

Service Level System Water-in-Storage Checks

System water-in-storage checks are performed every year on March 15 and July 1. Service levels are verified against past performance of the system during times of extreme drought and times of overproduction of discharge flows. The relation of system service level to water in system storage checks is given in Table 2-2.

Table 2-2: Service Level and Volume of Water in System Storage

Date	Service Level (Cubic Feet per Second)	Water in System Storage (Million Acre-Feet)
March 15	35,000 (full-service)	54.5 or more
March 15	29,000 (minimum-service)	49.0 to 31.0
March 15	No service	31.0 or less
July 1	35,000 (full-service)	57.0 or more
July 1	29,000 (minimum-service)	50.5 or less

Source: US Army Corp of Engineers

Full-service level is characterized by a discharge rate of 35,000 cfs and water-in-storage of 54.5 million acre-feet (MAF) or more. During periods of extreme drought when the system's water-in-storage level is not above 31 MAF, a navigation season cannot be supported.[1]

System water-in-storage levels also determine the length of the navigation season. The correlation between system storage levels and season duration are shown in Table 2-3.

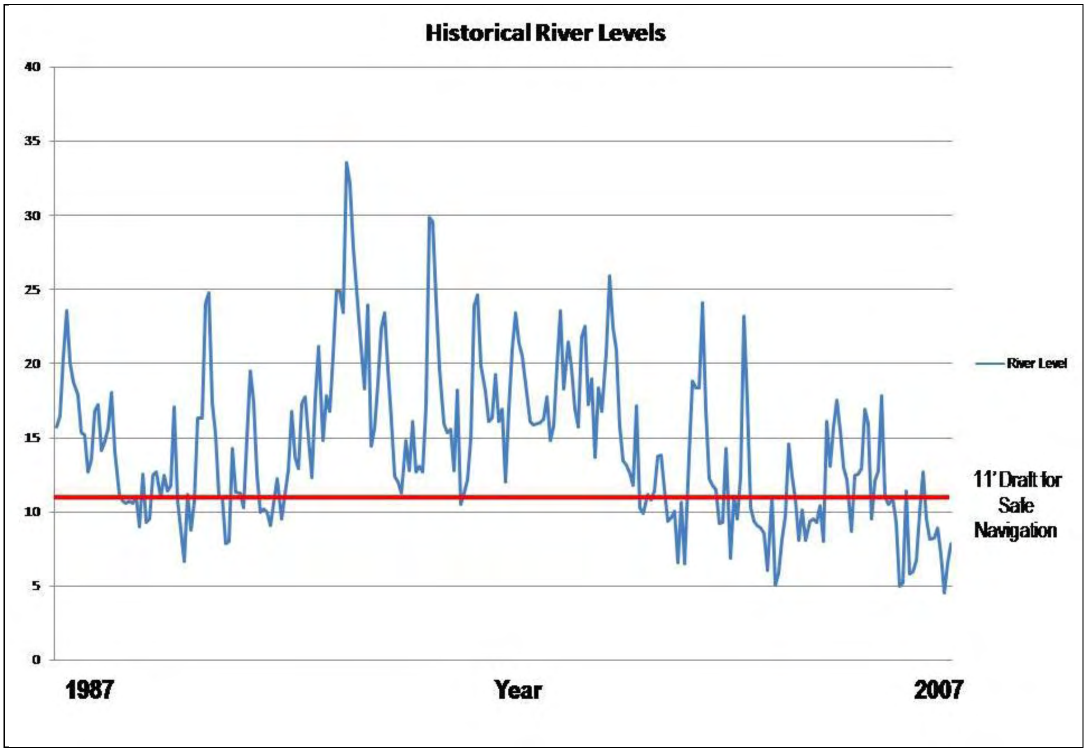
Table 2-3: Navigation Season Length Relative to Volume of Water in System Storage

Date	System Storage (Million Acre-Feet)	Season Closure Date at Mouth of the Missouri River
March 15	31.0 or less	No season
July 1	51.5 or more	December 1 8-month season
July 1	46.8 through 41.0	November 1 7-month season
July 1	36.5 or less	October 1 – 6-month season

Source: US Army Corp of Engineers

[1] US Army Corp of Engineers "Missouri River Mainstem Reservoir System Master Water Control Manual Missouri River Basin" Revised March 2006.

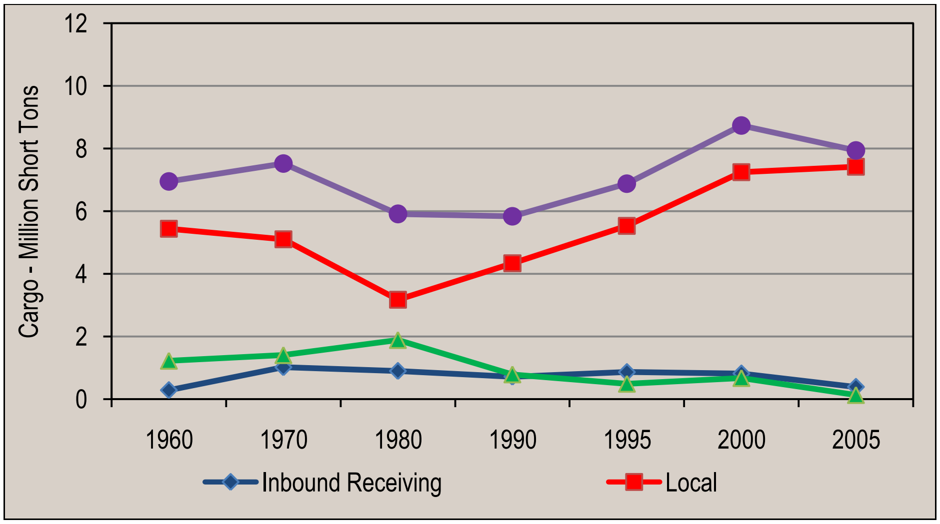
Figure 2-2: Missouri River Navigation Constraints at Kansas City Gage



Source: US Army Corp of Engineers

The historical trend in Missouri River cargo volume is shown in Figure 2-3. Cargo volume is currently at a higher level than in the 1960s, 1970s and 1980s due to expansion of local cargo (largely sand and gravel). Inbound and outbound cargo flows have declined compared to peak activity in the 1970s and 1980s.

Figure 2-3: Historical Missouri River Cargo Tons



Source: US Army Corp of Engineers, Waterborne Commerce Statistics

2.5 Conclusions

Research on Missouri River navigational conditions has identified competing opinions from stakeholder groups. Today it seems the demands of environmentalists and their concern for endangered species outweighs the demand for river transportation, although the USACE operating plan states transportation on the lower Missouri is still one of its major criteria. Private interests maintain that the timing of releases of upstream dams do not fit with tourist or fishing seasons and impact potential development to support those industries. The following developments were considered during the execution of subsequent tasks:

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3. Interview Survey

3.1 Introduction

In support of the research into river conditions, low-flow technologies, cargo movements, and modal competition, TranSystems undertook interviews with companies involved in cargo traffic on the Missouri River. An initial survey was conducted in December 2007, primarily with barge operators, to explore Missouri River operations and ideas about overcoming low-flow restrictions. A second survey was conducted in February 2008 with shippers, terminal operators, and the U.S. Army Corps of Engineers to obtain further information on low-flow and other issues faced by users of the Missouri River. Table 3-1 provides a list of interviewees. The remainder of Section 3 discusses the main topics raised in the interviews. The key points from the interviews are:

- Shippers are not confident in the Missouri River as a transportation option. Rainfall and water levels are the main concerns.
- The USACE Master Plan, which sets the barge season and water levels on the Missouri, will require a number of years of successful implementation before shippers and tugboat operators can rely on it.
- More shallow draft tugs, not necessarily new barge designs, are viewed as being required on the Missouri. Existing barges can be light loaded and remain competitive with rail.
- Tugboat and barge operators currently favor deployment of their assets on other water systems because they can achieve higher utilization, return on investment, and profitability.

Table 3-1: Interviewees

Name	Type	Market Segment
	Interviewed December 2007	
ACL	Barge/Tug Operator	Linehaul towing
Agri-Service of Brunswick	Terminal Operator	Agricultural Products (also involved in transportation)
Ingram Barge Lines	Barge/Tug Operator	Linehaul towing
Kirby	Barge/Tug Operator	Linehaul towing
Lewis & Clark Marine	Barge/Tug Operator	Fleeting and switching
Mid-West Terminals	Terminal Operator	Bulk Commodities
Missouri Dept. Of Natural Resources	Government Agency	-
	Interviewed February 2008	
US Army Corps of Engineers	Government Agency	-
Agri Services of Brunswick	Terminal Operator	Agricultural Products (also involved in transportation)
Jebro, Inc.	Shipper	Asphalt
MidWest Terminals	Terminal Operator	Bulk Commodities
Kock Industries	Shipper	Fertilizer (also involved in transportation)
LeFarge	Shipper	Cement (also involved in transportation)
Trans-Ammonia	Shipper	Fertilizer (also involved in transportation)
Anonymous	Shipper	Grain (also involved in transportation)
Holcim Group	Shipper	Sand and Gravel

Source: TranSystems

3.2 Origin/Destination Pairs and Terminal Infrastructure

Approximately 90 percent of barge traffic originating from the Missouri River and continuing on to the Mississippi River is bound for ports on the Lower Mississippi River (New Orleans, Baton Rouge, and South Louisiana). The remaining ten percent is bound for St. Louis and ports along the river system. The primary origin points on the Missouri River include Sioux City, Omaha, St. Joseph, Kansas City, Brunswick, Jefferson City, and Booneville. There is excess terminal capacity along the Missouri River and the majority of terminal infrastructure is in good condition.

3.3 Cargo Types

The vast majority of cargo is outbound movements of grain and the main inbound cargo is fertilizer. Grain shipments peak in the fall and fertilizer shipments peak in the spring. A small percentage of the total barge traffic on the entire Missouri River is local and consists of sand and gravel dredged from the river for local construction material. One company transports small volumes of asphalt from St. Louis to Kansas City for Conoco Philips and cement from St. Louis to Jefferson City for LaFarge.

Survey responses provided the following specific commodity comments:

- Sand and gravel dredged from the Missouri River bed are the principal cargo that moves intra Missouri River.
- Grain moves on the Missouri River if water level and production availability coincide. Lead time and reliability are requirements if barge service is to be considered by shippers. New facilities on the Arkansas River diverted some grain cargoes from the Missouri River.

- Corn production (for ethanol) production has increased sharply but most ethanol facilities are located near rail lines. Increased corn production (for ethanol) does not appear to be an opportunity for Missouri barge service unless the facility is located near a terminal on the Missouri.

- Identity Preserved (IP) Grains move in small quantities and are more appropriate for containerized service. The Missouri is not currently set up with a container on barge infrastructure. IP exports in the area are a small percentage of total grain exports.

3.4 Rate, Transit Times, and Modal Competition

The current rate for dry bulk cargo is approximately $30 per ton to the Lower Mississippi River; this includes costs for cargo loading and discharge. Transit times are:

Origin / Destination	Downbound	Upbound
Kansas City / St. Louis	Two Days	Three Days
Kansas City / Sioux City	Two Days	Two Days

Cost is the biggest competitive advantage for barge over rail and truck modes. Bulk cargoes (grains and fertilizers) are seasonal and are moved during the Missouri River's open months. Barge operators and shippers adapt to low-flow conditions by light loading barges and still remaining competitive on a cost per ton basis with other modes. Light loading is discussed in further detail in Section 5.2. During the four months closure, no grain cargo is shipped. Some grain is stored until the Missouri River opens again; however, it is not a significant amount.

Barge is the most competitive option for most port to port shipments of bulk cargo because rail costs have continued to rise over the past few years. However, cargo that is currently transported by rail is expected to continue to move by rail because the origin/destination pairs suit this transport mode.

Bulk cargoes will continue to be transported on the river because of the cost advantage and because of the prevalence of destination ports along the Mississippi River for those cargo types. Dried distillers grains (DDGS) and specialty grains are currently moving in smaller volumes. They are mostly containerized and transported by rail to West Coast or other ports, or they move by rail hopper car to West Coast and other ports and then transfer into containers. Growth in the production of DDGS may provide opportunities for barge transport.

Shippers suggest that barges are more economical than rail providing that they can be loaded to at least the 7.5-foot draft level. Barge load capacity at 7.5 feet ranges from 1,150 to 1,200 tons; at nine feet barge load capacity ranges from 1,400 to 1,500 tons.

Respondents suggest that existing barge design is sufficient, as it enables barges to remain competitive to rail, even light loaded to a draft of 7.5 feet. One respondent suggested that the real issue is the decreased availability of barges. Older barges are being retired at a faster rate than new barges are being placed into service.

3.5 Barge Operations and On-Time Performance

The smaller market and variable water conditions dissuade new operators from placing assets on the Missouri River. A further challenge is the absence of fleeting companies on the Missouri River, which results in line haul barges performing the fleeting on arrival or departure. There were two fleeting companies on the Missouri River four to five years ago, but these family run companies retired from the business and their tugs were sold off and deployed elsewhere by the new owners. The absence of fleeting companies deters new line haul operators from operating on the Missouri River because turnaround of the line haul tugs is slower.

Current barge construction and operating costs are:

- $550,000 for a hopper barge
- $1,000,000 for a tank barge
- $20,000 to $30,000 per year for maintenance and certification costs

Current tug costs are:

- Daily lease rate of $5,500
- Operating costs vary depending on fuel costs but a general guide is $1,500 per day plus fuel, maintenance and repair, supplies and insurance

Typical barge tows have a maximum of six barges (two wide). Typical barge capacity is measured in draft feet and the maximum draft for U.S. inland waterway barges is nine feet. On the Missouri River, the average draft is 7.5 feet for inbound barges and eight feet for outbound barges. Barges are typically loaded 80 percent to 90 percent of maximum capacity on the Missouri River, and for hopper barges this equates to an average load of 1,200 tons, and for tank barges 8,500 barrels. Some barges may be topped off in St. Louis before proceeding down river to Lower Mississippi ports.

Respondents stated that when cargo does move by barge, the on-time performance is fairly reliable due to close monitoring of river conditions, good communication practices between barge operators and terminals, and predictability of peak seasonal cargo requirements.

3.6 Tug Boat Operator Strategies and Tug Boat Availability

Tugboat operations and strategies have a significant influence on Missouri barge activity, perhaps more so than the shipper demand to move cargo by barge. The types of tugs purchased (standard instead of shallow draft), or the decision to position tugs on other higher profit, lower risk rivers reduces the amount of equipment available to handle cargo on the Missouri River.

Tug boat operator respondents suggest that shallow draft tugs would be necessary to restore barge traffic on the Missouri. The often shallow draft conditions on the Missouri prevent tugboat operators from sending in standard river tugs due to the concern that a fully fueled tug has a draft of roughly nine feet - exceeding the 7.5-foot maintained river depth. Respondents said that shallow draft tugs are in short supply. One operator noted that only five percent of his fleet can operate in shallow draft conditions. Tug draft, not barge draft is the limiting factor when considering low water levels. As previously observed the barges can be light loaded to 7.5 feet and remain competitive with rail rates.

A barrier to tug availability on the Missouri River is the reluctance of tugboat operators to position assets on low profit margin, high-risk rivers. Tug owners assess the entire North American river system as they determine where to position their assets. A river is attractive if it has few navigational concerns and a high demand for barge capacity. The Mississippi, Ohio, and Arkansas Rivers were mentioned in the survey as being far more attractive than the Missouri river based on navigation and cargo availability criteria. Two companies that formerly provided regular service on the Missouri were purchased by a larger tug operator that subsequently discontinued service on the Missouri and repositioned the tugs elsewhere.

The lack of tug traffic causes safety concerns. One tug operator mentioned that he is reluctant to send his tugs up the Missouri because the nearest tug may be too far away to assist in an emergency situation. Ironically, one tug operator suggested that easy navigation on the Missouri depends on regular barge traffic because channels will be better maintained. He also commented that the terminal network could decline due to falling revenues from barges, and the resulting unlikely future investment needed to maintain terminals. Finally, tug service is also driven by the availability of tugboat crews. A former barge service operator suggested that tug crew training programs would be required to address an aging tug crew work force.

3.7 Water Level

Water level is the primary issue that affects barge traffic on the Missouri River, according to respondents. Many factors influence the decision to arrange barge service, yet if rainfall returned to normal levels in the region that feeds the Missouri River, responses to this survey suggest that barge traffic would return.

3.8 Factors that Influence Water Level on the Missouri River

Drought in the region that feeds the Missouri River is at the heart of the barge issue. The lack of rainfall, especially in recent years, has raised concerns about water usage from special interest groups concerned with sustaining wildlife, providing irrigation for farms, and land preservation. These interests are often at odds with the objective of providing reliable and safe barge service on the Missouri River. Shortened barge seasons and abrupt barge service interruptions have occurred as regional disputes and lawsuits ensued over the amount of water released, or not released, into the Missouri. These service interruptions and fluctuating barge seasons have made the Missouri River very unattractive to shippers and barge operators. The following information was provided by the USACE and lists the major events that have affected barge traffic on the Missouri river:

- The Russian grain embargo during the Carter administration
- The completion of the Arkansas River and terminal facilities in the early 1980s - Grain such as wheat was diverted away from the Missouri River.
- The drought of 1988-1993 - Lighter drafts and shortened seasons reduced profits.
- The flood of 1993, 1995 and the high water of 1997 - These flood events made for a rocky rebound from the previous 1988 tonnage.
- The USACE Missouri River Master Plan - The process took 14.5 years and was completed in 2004. During this period the Missouri became less reliable and shippers protected themselves by using more surface transportation options.
- The Missouri River Biological Opinion of 2000 and the 2003 update - The outbreak of lawsuits over river operations caused additional reliability issues.
- The drought of 2000 to present (2008). - Again lighter drafts and shortened season have greatly impacted the ability for a robust navigation industry to stay and to return to the Missouri River.
- Competition - The Mississippi, Ohio, and Illinois Rivers offer better employment and profit opportunities for barge operators.
- Missouri River basin shipper apathy - Many shippers are not even looking at a barge transport because they have developed strong relationships with surface transportation, view the Missouri River as unreliable, and are removed from the potential benefits of barge transport.
- Recreation - Water levels and cargo activity on the river have been influenced by upstream recreational demand, including the tourism sector.

The USACE has the responsibility of maintaining water level and, by extension, the barge season on the Missouri River. Water levels are maintained by releasing water from six dams, starting with the Gavin's Point

Dam located at mile 811 on the Missouri (mile zero is where the Missouri meets the Mississippi). To address when and how water is to be released, the USACE published the Missouri River Master Plan in 2004; it was over fourteen years in the making. The Master Plan establishes guidelines that set the river depth to 7.5-foot throughout the Missouri River barge season, which usually lasts from April to November. The USACE manages water level on the Missouri from Gavin's Point to Kansas City; however, the Missouri River depends on tributaries below Kansas City to maintain river depth. River navigation below Kansas City may be problematic during drought years even with the Master Plan in place. Shipper interviews suggest that the Missouri river is navigable up to Sioux City, IA nine months out of the year, although "water is a problem all along the 800 miles" according to one respondent. The Master Plan has been challenged and upheld in court. Therefore, the USACE indicated that they are confident that future water disputes are unlikely, and the Missouri will prove to be reliable in the coming years. The USACE states that it has maintained a 7.5-foot draft for the past two years during drought conditions, which they say demonstrates the reliability of both the Master Plan and the Missouri River.

3.9 Shipper Reaction

Shippers who move product near the Missouri River have turned to rail, which is viewed as a more reliable option. Barge is normally considered to be more reliable than rail if the river itself is dependable. Given that respondents indicate that the cost per ton of rail is roughly 15 percent to 30 percent higher than barge cost per ton from points on the Missouri River to the Gulf, shippers would return to barge service if they are convinced that the Missouri River can provide reliable service. Uncertainty over the barge season and water levels from year to year eliminate barge as an option, especially for shippers that schedule transportation logistics a year in advance. One shipper who did move a small amount of grain via barge last year noted that his cargo availability coincided with sufficient water; however, he cannot count on the barge season duration, so he is not planning to make a similar move this year. He additionally stated the USACE's determination of the Missouri barge season does not coincide with shippers needs for scheduling future shipments. Barge shipments for the summer months are arranged in January of the same year, but USACE only sets the Missouri River barge season in March, and this creates uncertainty for the shipper.

Two respondents felt that rainfall will be the key to increased use of the Missouri:

> *"We can't keep taking water from reservoirs that don't have it. If we see water come back, I see traffic coming back, at least for that year. People have not left for good, but we are at all time lows in the reservoirs…. It will take a couple of years to make [chartering their own tugs] workable." – Shipper*

A few shippers who believe that the cost savings realized through barge transportation outweigh the risks of Missouri barge operations have chartered low-flow tugs and leased their own barges. One respondent participated in the start-up of one such shipper directed tug operation. They indicated that it was not clear if taking matters into their own hands actually saved money over rail, due to unforeseen operational, scheduling and administrative expenses.

> *"To improve the situation, water reliability (rain) has to be there. You also need public tow service on the river – we just have chartered tugs today. We used to have regular tug service, but no longer. Chartered tugs involve a lot more work from the shipper, so chartering is much more of a hassle." - Terminal Operator*

3.10 Conclusions

The interview survey provides guidance on potential actions required to support the renewal and growth of barge traffic on the Missouri River. The following items should be considered for further evaluation by the Missouri Department of Transportation:

- Support the development of barge service on the Missouri River by identifying funds to assist with the construction of shallow draft tugs

- Explore the potential for USACE to invest in shallow draft equipment, which could be consistent with its Missouri Navigation mission. Increased river traffic will aid in keeping river channels clear.

- Support new fleeting operations by funding the start-up of new fleeting services.

- Encourage a program for channel maintenance and monitoring.

- Establish river tug crew training program. Many tug crews are reaching retirement age. Training programs will also promote safety on the Missouri River, as crews are made aware of local navigational issues.

- Create strategic partnerships with Louisiana Lower Mississippi River ports to market use of inland waterways for emerging cargos (e.g. ethanol and DDGS).

- Market and promote environmental benefits of barge service. Identify government supported environmental funds for attainment of clean air and water.

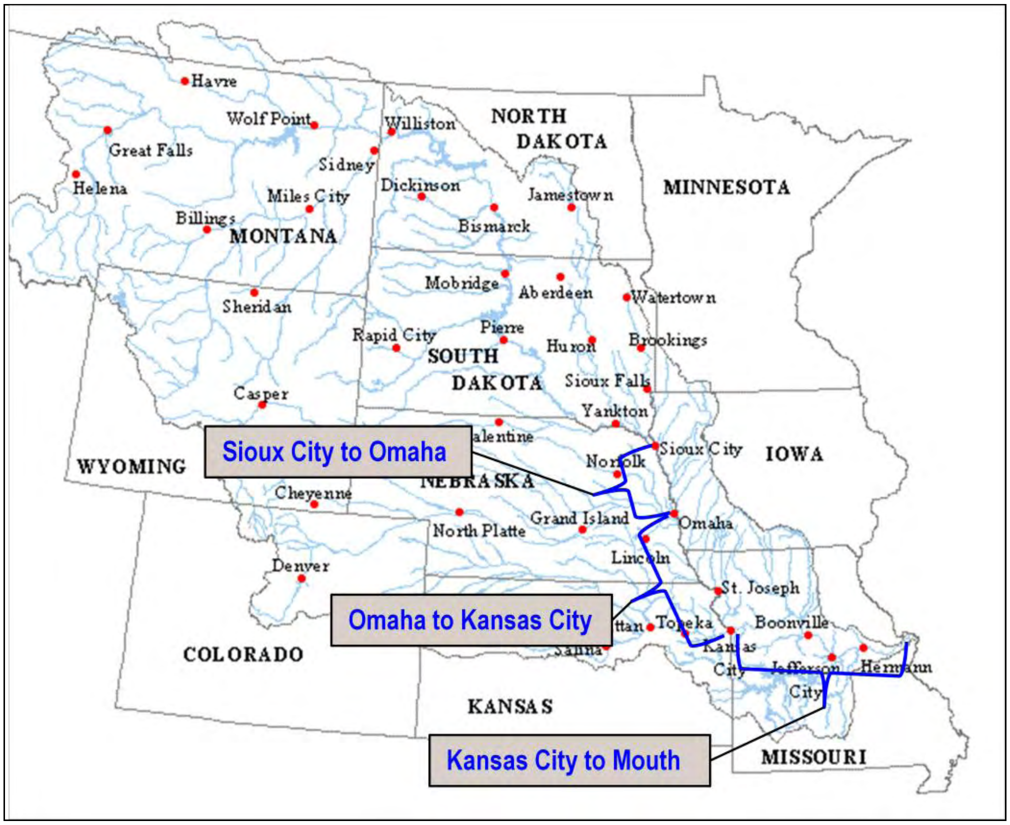
4. Market Analysis and Trends

4.1 Introduction

As background to the discussion on low-flow issues and solutions, this section of the study addresses cargo movements on the Missouri River, barge industry trends, and developments in other transport modes. The analysis is based on the Waterborne Commerce Statistics obtained from the U.S. Army Corps of Engineers, the interview results presented in Section three, several additional interviews with companies involved in the rail industry, and research into barge and rail industry trends. Limited emphasis is placed on the trucking industry because the interview survey and research showed that rail is the primary alternative mode to long distance barge movements.

The Waterborne Commerce Statistics are published annually by USACE. In Section 4, data are presented for 2005 and for selected prior years to provide perspective on historical cargo activity since 1960. For reporting purposes, USACE presents data for the full river from Fort Benton, MT to the Mouth and for three regions of the river: Sioux City to Omaha (116 miles), Omaha to Kansas City (250 miles), and Kansas City to the Mouth (375 miles). The three regions are illustrated in Figure 4-1. Nearly all cargo activity takes place on the lower two regions, from Omaha to the confluence with the Mississippi River. The review also considers cargo flow type: inbound receiving, outbound shipping, local (intra-Missouri cargo) and through (cargo passing through a river segment). It is important to note that the sum of the statistics for the three regions is greater than for the full river due to double counting of some cargo movements. For example, some of the outbound shipping from the Omaha to Kansas City region appears as inbound receiving into the Kansas City to Mouth region, but would only be counted once as local cargo (intra-Missouri cargo) when looking at the complete river (Fort Benton to Mouth).

Figure 4-1: Missouri River Regions for USACE Waterborne Commerce Statistics

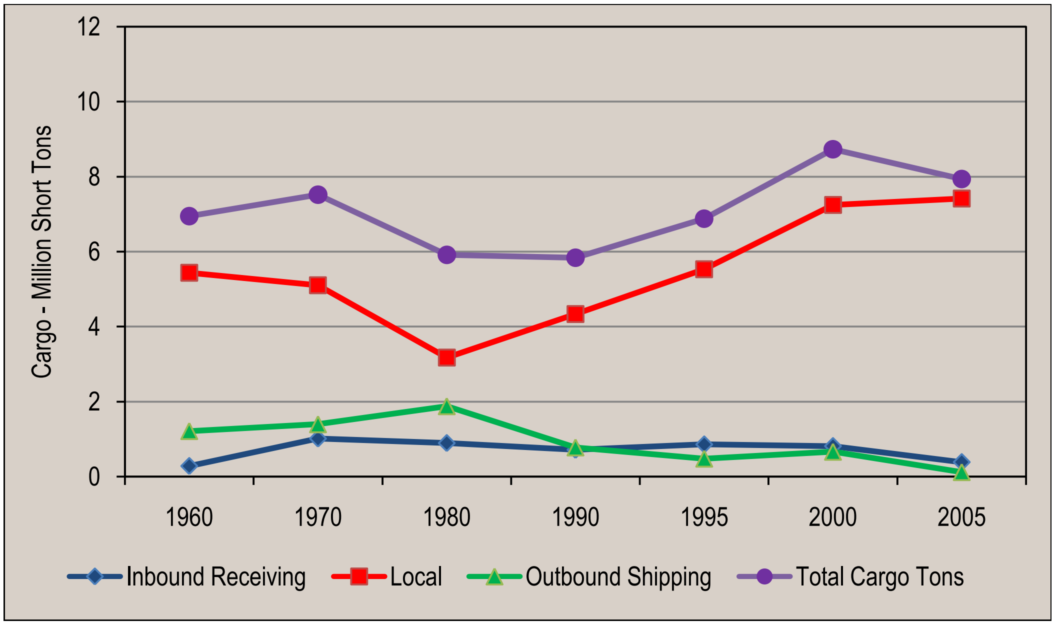


Source: TranSystems and US Geological Survey (map of Missouri River Basin)

4.2 Historical Missouri River Cargo Trends, 1960 to 2005

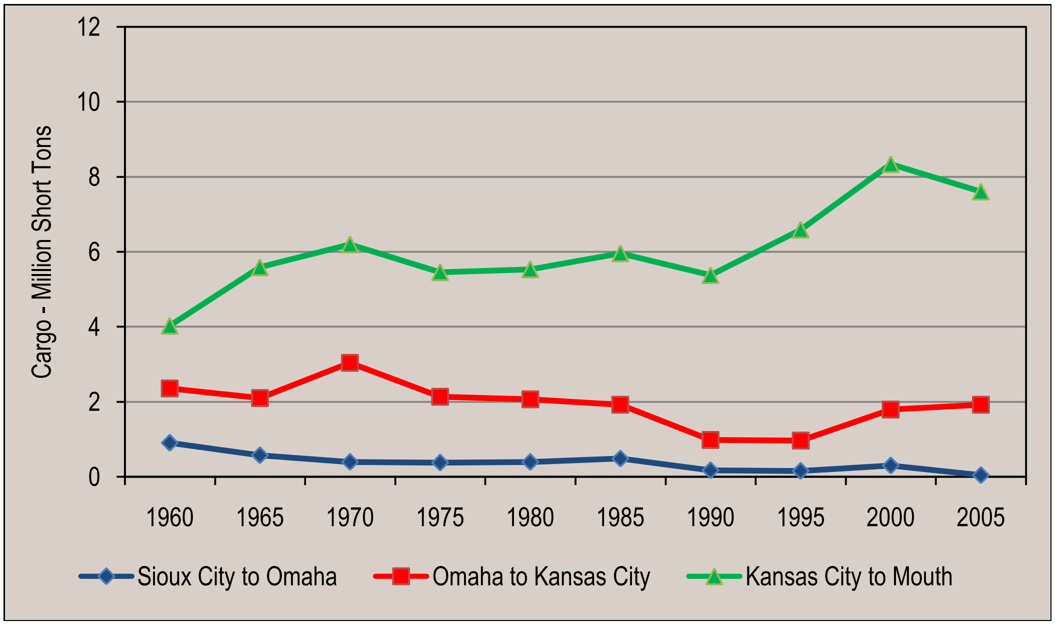
The historical trend in Missouri River cargo volume is shown in Figures 4-2 and 4-3. Cargo volume is currently at a higher level than in the 1960s, 1970s and 1980s due to expansion of local cargo (largely sand and gravel). Outbound cargo has declined compared to the earlier decades, which reflects a variety of factors described in Section 3 including competition for grain shipments from the Arkansas River and drought in the 1988 to 1993 period. These and other factors were discussed in Section 3.

Figure 4-2: Historical Missouri River Cargo Tons – Fort Benton to Mouth



Source: US Army Corp of Engineers, Waterborne Commerce Statistics

Figure 4-3: Historical Total Cargo Tons by River Segment



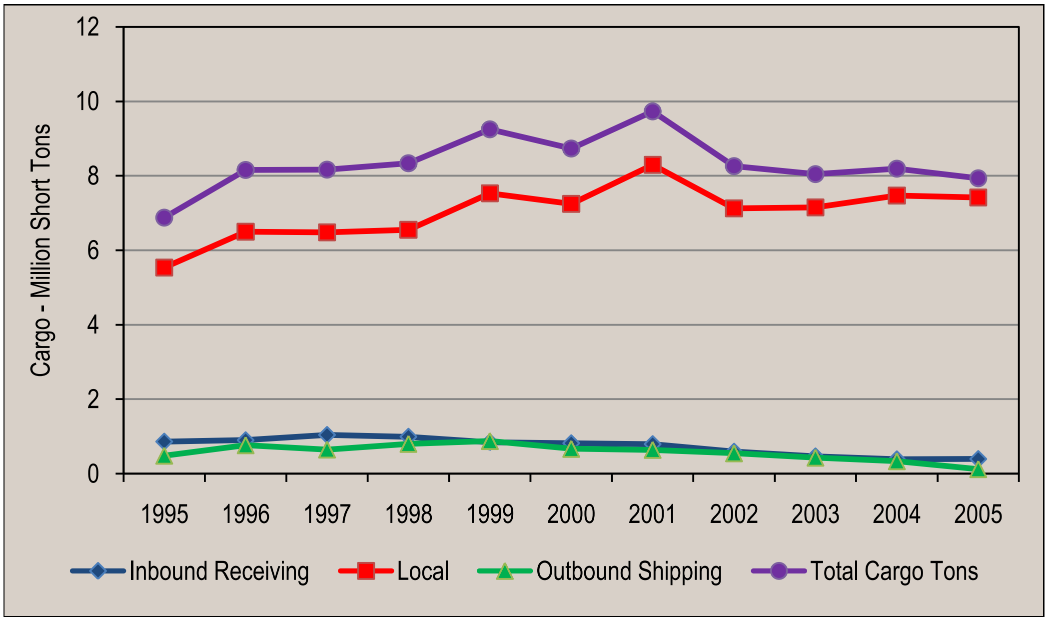
Source: US Army Corp of Engineers, Waterborne Commerce Statistics

4.3 Recent Missouri River Cargo Trends, 1995 to 2005

The detailed cargo statistics for the years 1995 to 2005 are presented in Tables 4-1 to 4-4 in Section 4.4, and summarized in the following discussion.

Figure 4-4 shows the trend in cargo flows on the Missouri River. Cargo peaked at nearly 10 million short tons in 2001 and then declined to around eight million short tons per year. Local traffic (intra-Missouri and nearly all sand and gravel) is the dominant cargo, accounting for 95 percent plus of local Missouri River cargo movements. Local shipments peaked in 2001 and then declined to around 7.5 million short tons per year.

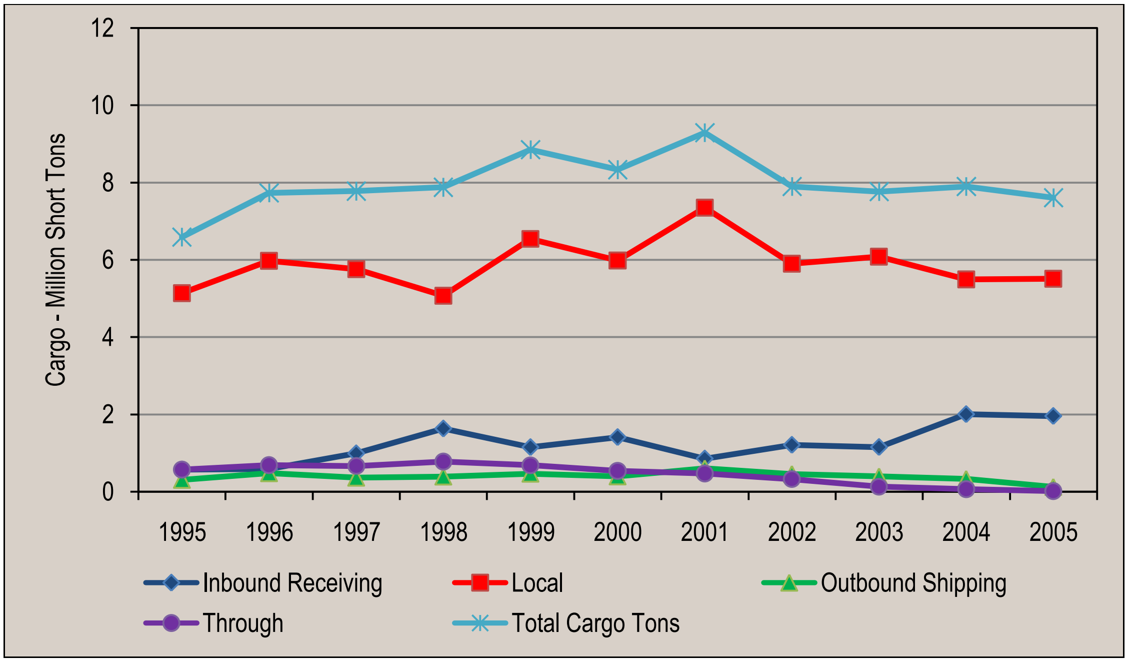
Figure 4-4: Missouri River Cargo Tons – Fort Benton to Mouth



Source: US Army Corp of Engineers, Waterborne Commerce Statistics

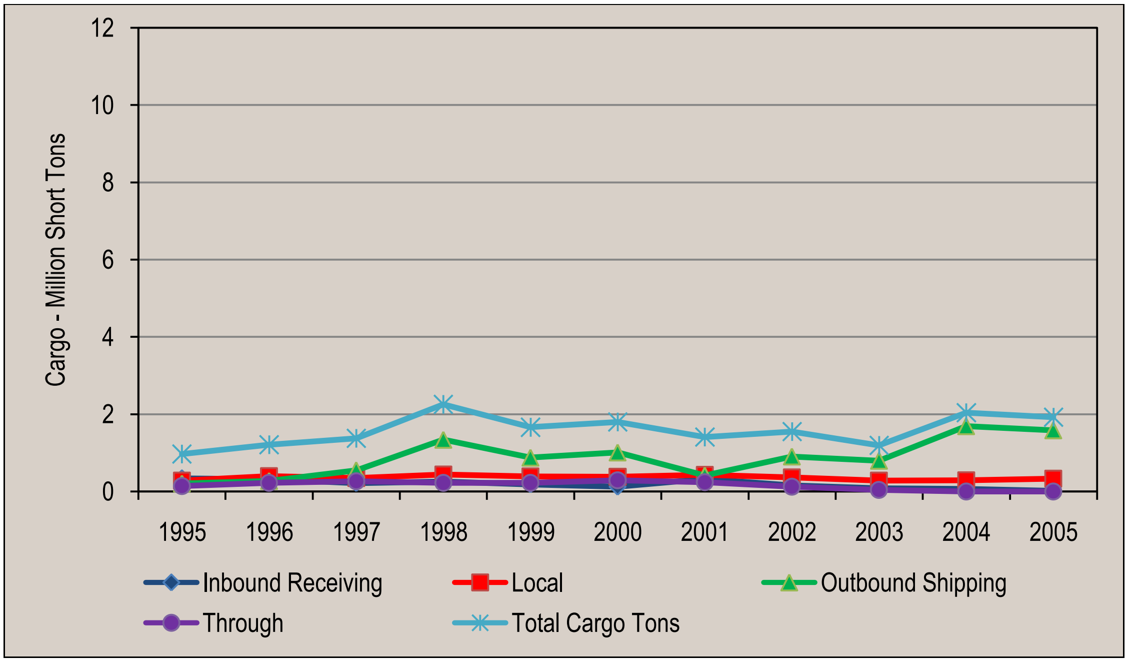
Figure 4-5 shows trends on the Kansas City to Mouth river segment. This river segment accounts for the majority of cargo movements on the Missouri River. Inbound receiving is the dominant cargo movement, primarily sand and gravel. Figure 4-6 shows the cargo trends on the Omaha to Kansas City segment of the Missouri River. Along this river segment, outbound shipping accounts for the majority of cargo flows and crude materials is the dominant commodity type. The Sioux City to Omaha river segment had no recorded cargo movements in 2004 and 2005.

Figure 4-5: Missouri River Cargo Tons – Kansas City to the Mouth



Source: US Army Corp of Engineers, Waterborne Commerce Statistics

Figure 4-6: Missouri River Cargo Tons – Omaha to Kansas City



Source: US Army Corp of Engineers, Waterborne Commerce Statistics

4.4 Missouri River Cargo Statistics

Tables 4-1 through 4-4 provide the commodity detail for traffic moving on the Missouri River. The statistics are broken into four types of movements – inbound receiving, outbound shipping, local, and through. As stated in the introduction to Section 4, data is presented for the full river from Fort Benton, MT to the Mouth and for three regions of the river: Sioux City to Omaha (116 miles), Omaha to Kansas City (250 miles), and Kansas City to the Mouth (375 miles). It is important to note that the sum of the statistics for the three regions is greater than for the full river due to double counting of some cargo movements. For example, some of the outbound shipping from the Omaha to Kansas City region appears as inbound receiving into the Kansas City to Mouth region, but would only be counted once as local cargo (intra-Missouri cargo) when looking at the complete river (Fort Benton to Mouth).

Table 4-1: Missouri River Cargo by Commodity Group – Fort Benton to Mouth

000 Short Tons	Commodity Group	1995	2000	2001	2002	2003	2004	2005
Inbound Receiving	Chemicals and Related	399	289	331	247	118	48	7
	Crude Material	31	34	42	17	10	5	118
	Food and Farm Products	15	4	8	6	0	0	0
	Machinery	2	1	0	0	0	0	0
	Petroleum and Petroleum Products	277	257	217	173	213	216	180
	Primary Manufactured Goods	138	233	197	148	123	117	88
	Inbound Receiving Total	***862***	***818***	***795***	***591***	***464***	***386***	***393***
Local	Chemicals and Related	48	0	2	0	0	0	0
	Crude Material	5,388	7,245	8,292	7,072	7,154	7,469	7,417
	Food and Farm Products	3	0	0	0	0	0	0
	Primary Manufactured Goods	94	0	0	54	0	0	0
	Local Total	***5,533***	***7,245***	***8,294***	***7,126***	***7,154***	***7,469***	***7,417***
Outbound Shipping	Chemicals and Related	5	0	0	0	0	0	0
	Crude Material	56	144	142	168	222	192	117
	Food and Farm Products	425	525	500	382	128	41	10
	Machinery	0	0	0	0	0	0	0
	Primary Manufactured Goods	0	0	0	0	83	105	0
	Outbound Shipping Total	***486***	***669***	***642***	***550***	***433***	***338***	***127***
Grand Total (Inbound Receiving + Local + Outbound Shipping)		**6,881**	**8,732**	**9,731**	**8,267**	**8,051**	**8,193**	**7,937**

Source: US Army Corp of Engineers, Waterborne Commerce Statistics

Table 4-2: Missouri River Cargo by Commodity Group – Sioux City to Omaha

000 Short Tons									
Type	**Direction**	**Commodity Group**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Inbound Receiving	Up or East or North Bound	Chemicals and Related	58	97	115	74	13	0	0
		Crude Material	0	4	5	0	0	0	0
		Food and Farm Products	1	0	0	0	0	0	0
		Petroleum and Petroleum Products	6	49	0	4	5	0	5
		Primary Manufactured Goods	1	12	1	4	1	0	0
		Up or East or North Bound Total	*66*	*162*	*121*	*82*	*19*	*0*	*0*
		Inbound Receiving Total	***66***	***162***	***121***	***82***	***19***	***0***	***0***
Local	Up or East or North Bound	Crude Material	0	0	2	0	0	0	0
		Up or East or North Bound Total	*0*	*0*	*2*	*0*	*0*	*0*	*0*
		Local Total	***0***	***0***	***2***	***0***	***0***	***0***	***0***
Outbound Shipping	Down or West or South Bound	Crude Material	2	12	10	0	0	0	0
		Food and Farm Products	82	126	118	43	23	0	0
		Down or West or South Bound Total	*84*	*138*	*128*	*43*	*23*	*0*	*0*
	Up or East or North Bound	Crude Material	5	0	0	0	0	0	0
		Up or East or North Bound Total	*5*	*0*	*0*	*0*	*0*	*0*	*0*
		Outbound Shipping Total	***89***	***138***	***128***	***43***	***23***	***0***	***0***
		Grand Total (Inbound Receiving + Local + Outbound Shipping)	**155**	**300**	**251**	**125**	**42**	**0**	**0**

Source: US Army Corp of Engineers, Waterborne Commerce Statistics

Table 4-3: Missouri River Cargo by Commodity Group – Omaha to Kansas City

000 Short Tons									
Type	**Direction**	**Commodity Group**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Inbound Receiving	Down or West or South Bound	Crude Material	2	12	10	0	0	0	0
		Down or West or South Bound Total	*2*	*12*	*10*	*0*	*0*	*0*	*0*
	Up or East or North Bound	Chemicals and Related	127	70	78	48	26	7	3
		Crude Material	20	14	223	7	36	0	0
		Food and Farm Products	2	0	1	0	0	0	0
		Machinery	2	1	0	0	0	0	0
		Petroleum and Petroleum Products	84	10	12	37	14	56	10
		Primary Manufactured Goods	105	14	5	63	1	0	0
		Up or East or North Bound Total	*340*	*109*	*319*	*155*	*77*	*63*	*13*
		Inbound Receiving Total	***342***	***121***	***329***	***155***	***77***	***63***	***13***
Local	Down or West or South Bound	Chemicals and Related	29	0	0	0	0	0	0
		Crude Material	235	198	156	285	180	284	244
		Down or West or South Bound Total	*264*	*198*	*156*	*285*	*180*	*284*	*244*
	Up or East or North Bound	Chemicals and Related	2	0	0	0	0	0	0
		Crude Material	12	183	268	80	101	5	84
		Up or East or North Bound Total	*14*	*183*	*268*	*80*	*101*	*5*	*84*
		Local Total	***278***	***381***	***424***	***365***	***281***	***289***	***328***
Outbound Shipping	Down or West or South Bound	Chemicals and Related	17	0	1	0	0	0	0
		Crude Material	0	866	286	807	751	1,686	1,581
		Food and Farm Products	185	143	130	98	45	2	0
		Primary Manufactured Goods	0	0	0	0	0	0	0
		Down or West or South Bound Total	*202*	*1,009*	*417*	*905*	*796*	*1,688*	*1,581*
	Up or East or North Bound	Chemicals and Related	5	0	0	0	0	0	0
		Food and Farm Products	1	0	0	0	0	0	0
		Up or East or North Bound Total	*6*	*0*	*0*	*0*	*0*	*0*	*0*
		Outbound Shipping Total	***208***	***1,009***	***417***	***905***	***796***	***1,688***	***1,581***
Through	Down or West or South Bound	Food and Farm Products	82	126	118	43	23	0	0
		Down or West or South Bound Total	*82*	*126*	*118*	*43*	*23*	*0*	*0*
	Up or East or North Bound	Chemicals and Related	53	97	115	74	13	0	0
		Crude Material	0	4	5	0	0	0	0
		Petroleum and Petroleum Products	6	49	0	4	5	0	0
		Primary Manufactured Goods	1	12	1	4	1	0	0
		Up or East or North Bound Total	*60*	*162*	*121*	*82*	*19*	*0*	*0*
		Through Total	***142***	***288***	***239***	***125***	***42***	***0***	***0***
		Grand Total (Inbound Receiving + Local + Outbound Shipping + Through)	**970**	**1,799**	**1,409**	**1,550**	**1,196**	**2,040**	**1,922**

Source: US Army Corp of Engineers, Waterborne Commerce Statistics

Table 4-4: Missouri River Cargo by Commodity Group – Kansas City to Mouth

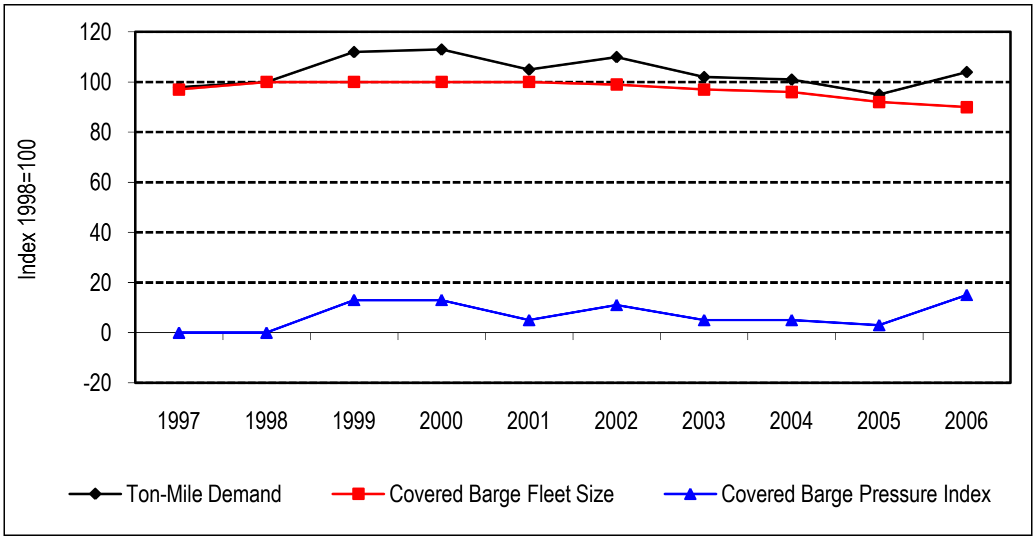
000 Short Tons									
Type	**Direction**	**Commodity Group**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Inbound Receiving	Down or West or South Bound	Chemicals and Related	12	0	1	0	0	0	0
		Crude Material	5	866	286	807	751	1,686	1,581
		Down or West or South Bound Total	*17*	*866*	*287*	*807*	*751*	*1,686*	*1,581*
	Up or East or North Bound	Chemicals and Related	220	122	141	124	79	41	4
		Crude Material	6	16	26	10	10	5	118
		Food and Farm Products	15	4	7	6	0	0	0
		Machinery	0	0	0	0	0	0	0
		Petroleum and Petroleum Products	187	198	205	131	195	159	170
		Primary Manufactured Goods	126	207	191	135	121	117	88
		Up or East or North Bound Total	*554*	*547*	*570*	*406*	*405*	*322*	*380*
		Inbound Receiving Total	***571***	***1,413***	***857***	***1,213***	***1,156***	***2,008***	***1,961***
Local	Down or West or South Bound	Crude Material	1,875	3,205	2,451	1,970	1,723	2,087	1,460
		Down or West or South Bound Total	*1,875*	*3,205*	*2,451*	*1,970*	*1,723*	*2,087*	*1,460*
	Up or East or North Bound	Crude Material	3,261	2,780	4,904	3,929	4,363	3,407	4,047
		Up or East or North Bound Total	*3,261*	*2,780*	*4,904*	*3,929*	*4,363*	*3,407*	*4,047*
		Local Total	***5,136***	***5,985***	***7,355***	***5,899***	***6,086***	***5,494***	***5,507***
Outbound Shipping	Down or West or South Bound	Crude Material	56	144	142	168	222	192	117
		Food and Farm Products	158	255	252	240	59	39	10
		Primary Manufactured Goods	0	0	0	0	83	105	0
		Down or West or South Bound Total	*214*	*399*	*394*	*408*	*364*	*336*	*127*
	Up or East or North Bound	Chemicals and Related	0	0	1	0	0	0	0
		Crude Material	0	0	213	0	36	0	0
		Food and Farm Products	2	0	0	0	0	0	0
		Primary Manufactured Goods	94	0	0	54	0	0	0
		Up or East or North Bound Total	*96*	*0*	*214*	*54*	*36*	*0*	*0*
		Outbound Shipping Total	***310***	***399***	***608***	***462***	***400***	***336***	***127***
Through	Down or West or South Bound	Chemicals and Related	5	0	0	0	0	0	0
		Food and Farm Products	267	269	247	142	68	2	0
		Primary Manufactured Goods	0	0	0	0	0	0	0
		Down or West or South Bound Total	*272*	*269*	*247*	*142*	*68*	*2*	*0*
	Up or East or North Bound	Chemicals and Related	179	167	191	122	39	7	3
		Crude Material	20	18	16	7	0	0	0
		Food and Farm Products	0	0	1	0	0	0	0
		Machinery	2	1	0	0	0	0	0
		Petroleum and Petroleum Products	90	59	12	42	18	56	10
		Primary Manufactured Goods	12	26	6	13	2	0	0
		Up or East or North Bound Total	*303*	*271*	*226*	*184*	*59*	*63*	*13*
		Through Total	***575***	***540***	***473***	***326***	***127***	***65***	***13***
		Grand Total (Inbound Receiving + Local + Outbound Shipping + Through)	**6,592**	**8,337**	**9,293**	**7,900**	**7,769**	**7,903**	**7,608**

Source: US Army Corp of Engineers, Waterborne Commerce Statistics

4.5 Barge Industry Trends

An indication of the overall demand and supply in the barge industry is provided by the Barge Pressure Index (BPI) published annually by Informa Economics. The BPI is the difference between an index of ton-mile demand and an index of barge fleet size. A rising BPI indicates that fleet supply is not keeping up with demand. The BPI for the covered (hopper) barge fleet is shown in Figure 4-7. The BPI was reasonably stable from 2002 through most of 2005 as both demand and fleet size moved in the same direction. The BPI spiked in 2006 due to growth in demand and the continued contraction in fleet size; this led to higher barge freight rates during 2006. The barge market remained strong during 2007.

Figure 4-7: Covered Barge Pressure Index



Source: TranSystems derived from Informa Economics

The covered (hopper) barge fleet has declined over the past few years and is approximately 800 plus units smaller than in 2004. New building activity was more than offset by retirements despite the substantial increase in new barges delivered in recent years. High rates of retirements in the hopper and the tank barge fleets are due to an aging fleet profile. Standard operating life is 25 to 30 years for a hopper barge and 30 to 40 years for a tank barge. The small tank barge fleet (10,000 barrels or less) has increased slightly in recent years; however, the jumbo fleet (over 10,000 barrels) has fallen in number due to fewer deliveries than retirements. The tank barge fleet is heavily concentrated; the top ten operators control 85 percent plus of the fleet and the two largest operators, Kirby Corporation and American Commercial Lines, control approximately 50 percent of the fleet.

Table 4-5: Barge Fleet by Type

Number of Barges	2004	2005	2006
Jumbo 195' & 200' x 35' Covered Barges	11,805	11,271	11,015
Small Tank Barges (10,000 barrels or less)	177	208	211
Jumbo 195' & 200' x 35' Tank Barges (10,001 to 20,000 barrels)	1,321	1,320	1,297
Semi-Integrated Unit Tow Tank Barges (20,001 or More Barrels)	935	954	957
Other Barge Types [1]	6,719	6,818	7,214
Total Fleet	**20,957**	**20,571**	**20,694**

Source: TranSystems derived from Informa's "Barge Fleet Profile"
[1] Open hoppers and specialty barges

In recent years, the level of vessel newbuilds has accelerated due to growing demand for double hull tank barges as replacement for the phasing out of single hull vessels by 2015 under the 1990 Oil Pollution Act (OPA). Other factors are the more stringent quality requirements of major shippers and replacement needs due to an aging fleet. Replacement demand caused by an aging fleet is driving new orders of hopper barges. The large number of hopper barges nearing or at retirement age reflects these earlier spikes in newbuild activity that responded to the early 1970s grain export boom to Russia, strong grain exports and freight rates in the 1996/97 period, and investment tax credits of 1979/81. It is projected that tanker and hopper barge newbuilding will remain strong over the next four to five years. However, an oversupply of tonnage is not expected because the high prices associated with vessel newbuilds are curtailing speculative orders.

4.6 Rail Industry Trends

The operational cost savings advantage of bulk-cargo unit trains has caused railroads to consider commodities that would also be appropriate for barge transportation. However, reliable river barging continues to be advantageous due to rising rail prices and the higher cargo handling costs of rail. The use of unit trains for grain transportation is on the rise, making up 55 percent of all bulk grain movement train configurations in 2005, up from 34 percent in 1985. Grain unit trains typically carry 50+ cars, all having the same origin and destination. The attraction of the larger unit trains lies in their lower operating costs compared to smaller car-length trains and their ability to absorb the growth of shipments.

Railroads are also offering better service, according to one shipper:

> *"The [railroad] trend is that they now offer better service… The BN is delivering cars when we need them, and [they are] even moving cars more than once a day if we ask them to."*

Bulk commodity rates have been on the rise due to rail infrastructure improvements in recent years. Railroads have spent $10 billion in upgrades since 2000 and plan an additional $12 billion in the future.[2] Most of the improvements involved projects to increase the rail network's capacity to handle Asian containerized cargo; however, rail shippers across the country are likely paying much of these improvements through rate increases.

A general trend is considering ways to move cargo away from trucking and onto rail. This helps address environmental and traffic congestion issues of trucking. However, barge operators may also be in the position to divert truck traffic providing that shipper transit and service requirements can be accommodated using the barge transportation mode.

[2] "New Era for Rail Building", Wall Street Journal, February 13, 2008

5. Best Practice Identification

5.1 Introduction

Low-flow conditions in the Columbia/Snake River system, the Ohio River system, and the 244-mile Upper Mississippi River, have resulted in reduced traffic and diversion of traffic to other modes. In some cases, river operators and shippers have developed “work around” techniques and have transferred to surface modes in order to accommodate periods of low-flow. However, once cargo moves to a competing mode, it seldom returns to its original mode of distribution without significant economic incentives. This section identifies and reviews best practices in the U.S. and worldwide for accommodating low-flow conditions in river trade.

5.2 Other US Inland Waterway Systems

The most common practice today on U.S. inland waterway systems for accommodating freight barge traffic during low-flow conditions is barge light loading. In this procedure a barge is only loaded to the point where the resulting loaded draft of the barge will safely navigate the applicable river draft. This practice is quite common today and is currently employed not only on the Missouri River but also on the McClellan/Kerr waterway in Arkansas (Figure 5-1) and the Tennessee-Tombigbee waterway in Alabama (Figure 5-2). Knowledge of historical low-flow patterns has served as the benchmark for determining when channel availability is more likely to be impacted (i.e. during the summer and early fall). This helps operators to minimize light loading of barges. If shippers and operators perceive water transport as undependable, they will elect alternate modes even if the former offers transportation cost savings.

Figure 5-1: McClellan-Kerr Waterway

Source: www.tenntom.org

Figure 5-2: Tennessee-Tombigbee Waterway

Source: www.tenntom.org

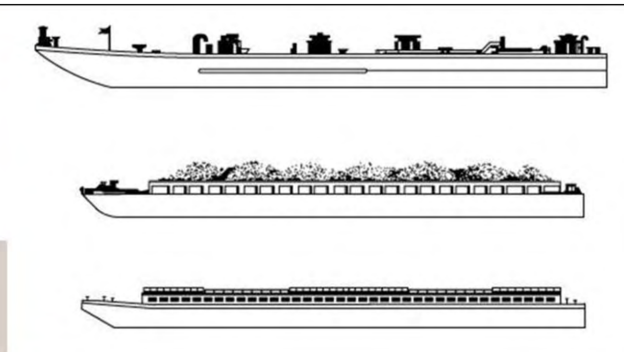
Barge types are relatively standardized on the U.S. inland waterway system. Figure 5-3 provides a summary of the most common barge types in use today.

Figure 5-3: U.S. Inland Waterway Barge Types

Inland Liquid Cargo Tank Barge
297 Feet Long / 1,000,000 Gallon Capacity
Carries: Petroleum Products, Petroleum Fertilizer, Chemicals, Orange Juice

Open Dry Cargo Barge
195 Feet Long / 1,530 Ton Capacity
Carries: Coal, Steel, Ore, Sand, Gravel, Lumber

Covered Dry Cargo Barge
195 Feet Long / 1,500 Ton Capacity
Carries: Grain, Soy, Beans, Coffee, Salt, Sugar, Paper Products, Packaged Goods



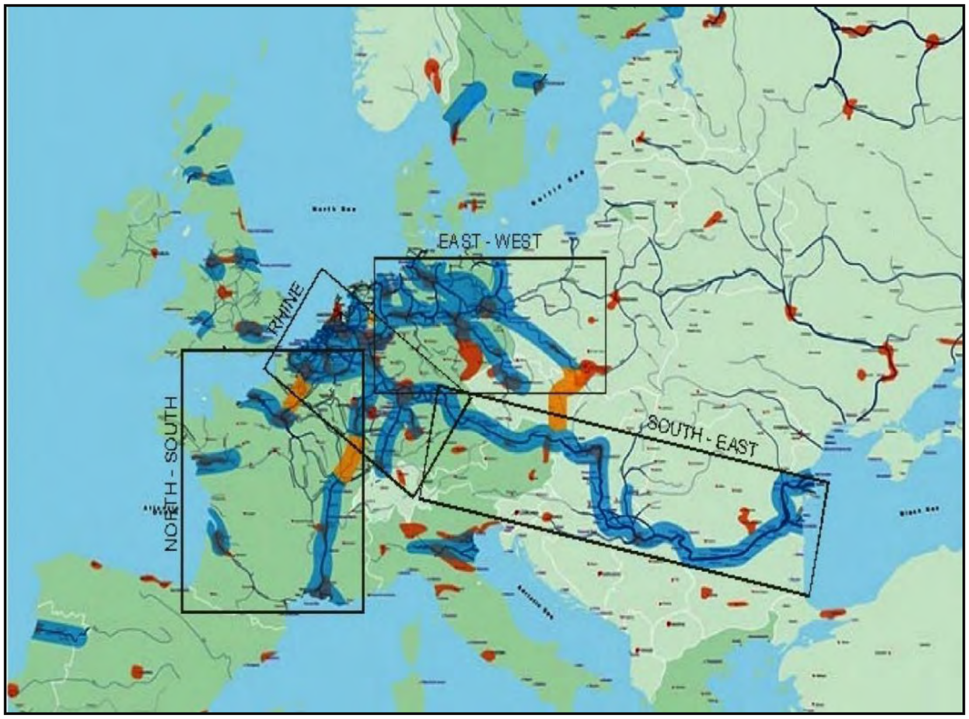
Source: www.tenntom.org

5.3 European Inland Corridor System

Inland waterways of Europe best represent navigation patterns matched to varying channel dimensions. The European Inland Corridor System is made up of four corridors: the Rhine Corridor, the Danube (South East) Corridor, the East-West Corridor, and the North-South Corridor. Each of the corridors is characterized by a system of primary waterways, ancillary waterways, canals, and locks that connect the hinterlands of Europe to the seas. The system varies in traffic and cargo concentrations depending on the depth and width of each particular channel. The system's 22,990 miles of waterways, alignment of the corridors, and their general locations are shown in Figure 5-4.[3]

[3] Freddy Wens, Civ. Eng. Managing Director Flanders Hydraulics, Secretary CoCom PIANC / COPEDEC IOC. Inland "Waterway Transport in Belgium/Flanders and the European Union." March 2007

Figure 5-4: European Inland Corridor System



Source: Buck Consultants International; PINE Report

The corridors cover the following areas:

- The Rhine Corridor is comprised of the Rhine River and its canals in the western part of Germany, Belgium, the Netherlands, Switzerland, the eastern part of France, and in Luxembourg. The Rhine Corridor has a total length of 8,638 miles.

- The Danube (South East) Corridor includes the Danube River, its tributaries, and its navigable canals as well as the Main-Danube Canal. The Danube Corridor has a total length of 8,120 miles.

- The East-West Corridor includes the Elbe, Oder, and Wisla Rivers as well as the Mittelland Canal (MLK) in northern Germany. The East-West Corridor has a total length of 7,036 miles.

- The North-South Corridor is comprised of the major rivers, navigable tributaries, and linking canals between the lower Rhine area and the Mediterranean. This network also includes France and links to the Belgian/Dutch network. The North-South Corridor has a total length of 4,455 miles.[4]

There is some overlap in the corridors as the total length of the system is approximately 22,990 miles.

5.3.1 Inland Corridor Classifications

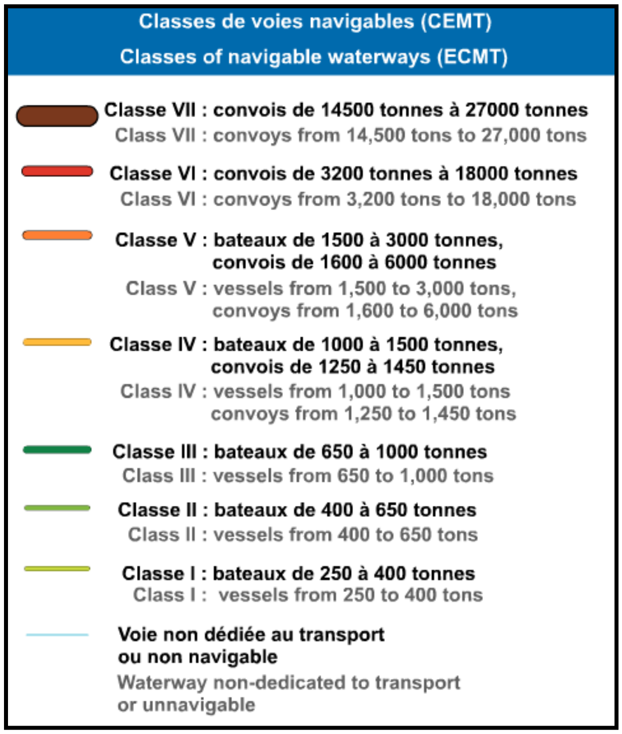
"Resolution 92/2 on New Classification of Inland Waterways", European Conference of Ministers of Transport, established a system to be used in classifying the types of ships permissible to transverse through a particular inland waterway. The vessel classification was designed to be used as a planning tool and a precautionary measure. Waterways slated for improvement would be modified to a certain class not to go below acceptable

[4] Ibid.

draft and beam of other portions of connecting waterways. Figure 5-5 shows the classes of waterways by tonnage and maximum convoy capacity. The classifications of the inland waterways are shown in Figure 5-6.

As depicted, the Danube is one of the few waterways with the ability to carry Class VII convoys while many other portions of the waterways can carry up to Class VI vessels.[5]

Figure 5-5: Classes of Navigable Waterways (ECMT)



Source: www.binnenvaart.be/en_html/pbv/index

Figure 5-6: Inland Waterways of Europe with Classifications

[5] http://www.binnenvaart.be/en_html/iedereen/index.asp?./klanten/waterwegen.asp

Source: www.binnenvaart.be/en_html/pbv/index

5.3.2 Self-Propelled and Push Barge Fleet Characteristics

The fleet characteristics vary greatly with the Rhine having consistently deeper draft while the Danube has some of the deepest drafts, allowing vessels of the Class VII type. This is in contrast to the fleet of the Elbe and Odra waterways with typical drafts as low as 5.2 feet (1.6 meters).

5.3.3 Self-Propelled Vessels

The ECMT 92/2 Classification of Inland Waterways (Figure 5-7) categorizes acceptable vessels by maximum beam, width, draft, tonnage, and height under bridges. The ECMT 92/2 Classification of Inland Waterways provides homogenous requirements for all inland waterways in Europe.

Figure 5-7: ECMT 92/2 Vessel Classifications

Type of Inland Waterway	Class	Designation	Maximum Length		Maximum Beam		Draft		Tonnage	Minimum of Height Under Bridges	
			Meters	Feet	Meters	Feet	Meters	Feet	Tons	Meters	Feet
Regional Importance West of Elbe	I	Barge	38.5	126.3	5.1	16.6	1.8-2.2	5.9-7.2	250-400	4.0	13.1
	II	Kampine-Barge	50-55	164.8-180.5	6.6	21.7	2.5	8.2	400-650	4.0-5.0	13.1-16.4
	III	Gustav Koenigs	67-80	219.8-262.5	8.2	26.9	2.5	8.2	650-1,000	4.0-5.0	13.1-16.4
Regional Importance East of Elbe	I	Gross Finow	41	134.5	4.7	15.4	1.4	4.6	180.0	3.0	9.8
	II	BM-500	57	187.0	7.5-9.0	24.6-29.5	1.6	5.3	500-630	3.0	9.8
	III	---	67-70	219.8-262.5	8.2-9.0	26.9	2.5	8.2	650-1,000	4.0-5.0	13.1
International Importance	IV	Johann Welker	80-85	262.5-278.9	9.5	31.2	2.5	8.2	1,000-1,5000	5.25 or 7	17.2 or 22.9
	Va	Large Rhine Vessels	95-110	311.7-360.9	11.4	37.4	2.5-2.8	8.2-9.2	1,500-3,000	5.25 or 7	17.2 or 22.9 or 29.9
	VIb	---	140	459.3	15.0	49.2	3.9	12.8	---	7 or 9.1	22.9 or 29.9

Source: Adapted from Buck Consultants International; PINE Report

5.3.4 Rhine Corridor

Waterways of the Rhine have the largest vessels within the system. There are an estimated 5,500 self-propelled dry cargo vessels with an average capacity of 1,000 dead weight tons (dwt) that travel on the Rhine. There are as many as 1,100 push barges being used, often joined in convoys of four to six barges with a total capacity up to 16,000 tons.

5.3.5 Danube (South-East) Corridor

The Danube had a total of 2,650 tow and push barges in use in 2000. Push barges differ in size because the fleet consists mostly of re-equipped tow barges. After the mid 1970's, push barges of the Danube-Europe Elbe type, became the preferred size. They have a capacity between 1,350-1,500 tons and a draft of 7.5-8 feet (2.3-2.5 meters). Convoys on the Danube are often four to six barges.

The typical design draft of a vessel on the Danube is 8.2-11.5 feet (2.5-3.5 meters). Due to seasonal draft restrictions along most of the Danube, self-propelled twin screw vessels are employed over single screw vessels. This allows for partial loading of the vessel without compromising stability. Extremely low water, depths of 5.6 feet (1.7 meters), often render push boats with drafts of 5.9-7.2 feet (1.8-2.2 meters) useless. When depths are this low, traditional tow boats with drafts of 5.2 feet are used to pull partially loaded barges through shallow portions of the waterway.

5.3.6 East-West Corridor

The total number of self-propelled vessels operating on the corridor totaled 172 in 2000. The average capacity of the vessels on the corridor is 450 dwt with a typical design draft of 5.2 feet (1.6 meters). Small push barges of the GSP-54 type (Figure 5-8) are the design maximum of the Elbe and Oder waterways.

5.3.7 North-South Corridor

The North-South Corridor is comprised of the Seine and Rhone/Saone waterways. Dry cargo ships and dry cargo barges on the Seine have an average of 900 tons and 1,100 tons, respectively. Dry cargo ships and dry cargo barges on the Rhone/Saone waterway have an average capacity of 1,100 tons and 2,000 tons, respectively. The fleet ranges in size from the 'Europe' class vessels and barges to much smaller ships suitable for navigating smaller portions of the waterways.[6]

5.3.8 Barge and Pushboats

Figure 5-8 provides a list of the barges used on the inland waterways as well as the maximum capacity per waterway. The barges are loaded per the depth requirements of the waterway.

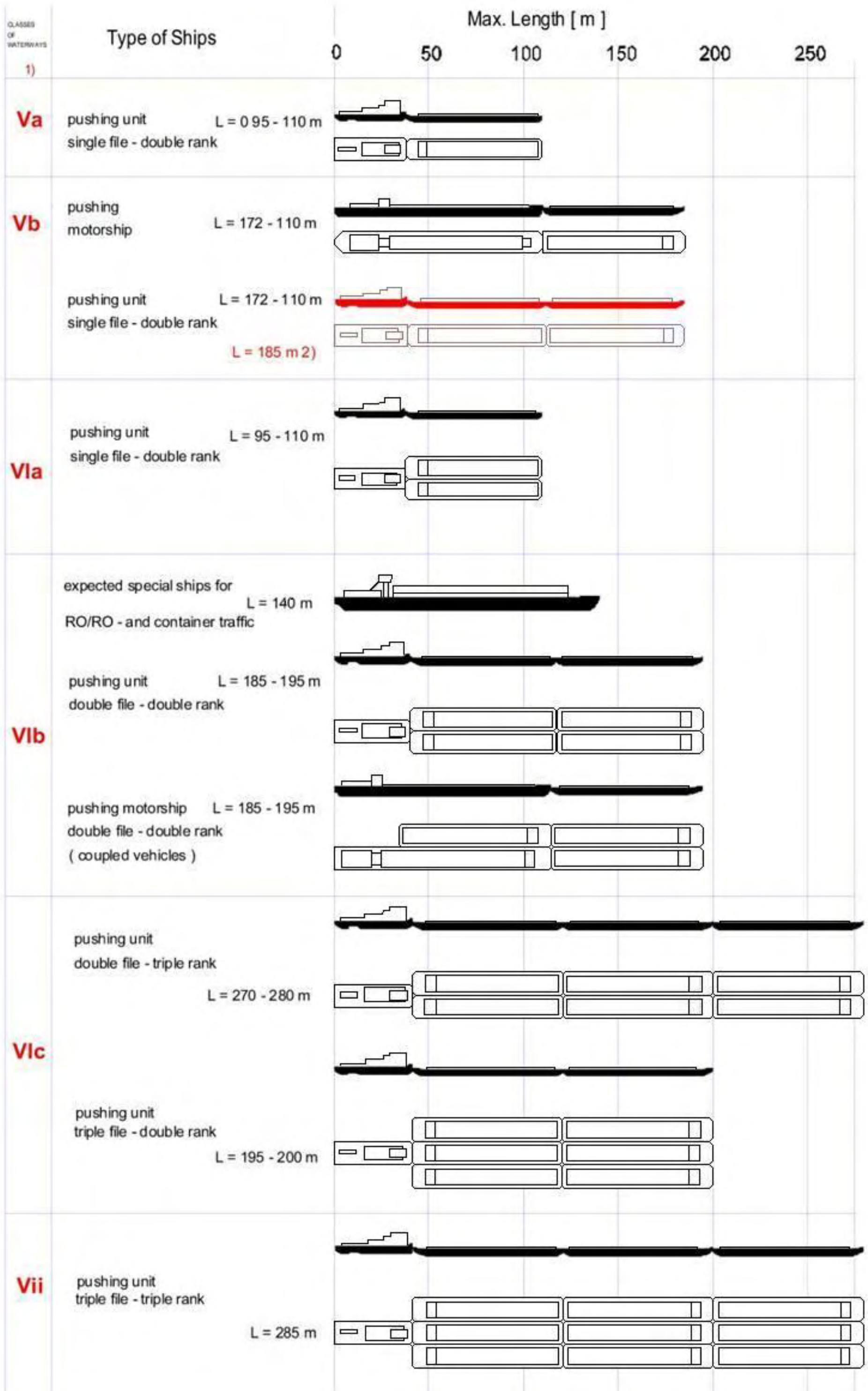
[6] Buck Consultants International (The Netherlands) ProgTrans (Switzerland) VBD European Development Centre for Inland and Coastal Navigation (Germany) via donau (Austria), Prospects of Inland Navigation
within the enlarged Europe (PINE) Full Report. 2004. Pg. 63,

Figure 5-8: Barge Dimensions and Area of Use

Barge type	Dimensions (L x B)	Tonnage capacity at a draught of				Area of use
		2,00m	*2,50m*	*2,80m*	*4,00m*	*River or corridor*
Europe Type I	70,00 m x 9,50 m	940 t	1240 t	-	-	Rhine, MLK
Europe Type II	76,50 m x 11,40 m	1250 t	1660 t	1850 t	-	Rhine, MLK, Danube
Europe Type IIa	76,50 m x 11,40 m	1140 t	1530 t	1800 t	2800 t	Rhine
Europe Type IIb	76,50 m x 11,00 m	1100 t	1500 t			Danube
GSP-54	54,00 m x 11,00 m	900 t				Elbe, Oder
SP-65	65,00 m x 8,20 m	900 t				Elbe, Oder
SP-35	32,50 m x 8,20 m	415 t				Elbe, Oder
LASH	18,70 m x 9,50 m	250 t	335 t	385 t		Weser, Rhine
See-Bee	29,75 m x 10,70 m	490 t	640 t	730 t		Weser, Rhine
Interlichter	38,25 m x 11,40 m	585 t	775 t	900 t		Danube
OBP-500	45,50 m x 9,60 m	480 t	-	-	-	Oder

Source: Buck Consultants International; PINE Report

Figure 5-9: Push Barge Configurations



Source: SPIN-TN

Push barge configurations are larger on the Rhine than any of the other corridors. Push boats are also differentiated into Long Range, Canal, and Harbor push boats. Long Range push boats are double and triple screw vessels, work primarily on the Lower and Middle Rhine, and have the following dimensions: length 98-115 feet, beam 95-99 feet, and draft 8.5-8.9 feet. Canal push boats are of twin screw construction, work on tributaries, and have the following dimensions: length 49-82 feet, beam 36 feet, and draft 4.9-6.6 feet. Harbor push boats are smaller vessels used within the harbor for shifting and have the following dimensions: length 36-66 feet, beam 36 feet, and draft 4.9-6.6 feet.

5.3.9 Lock Characteristics

In accordance with "Resolution No. 92/2 on New Classifications of inland Waterways", waterways of national importance must have a minimum rating of Class IV (Figure 5-7). Waterways of this class must accommodate vessels with the following specifications:

- Maximum length-over- all= 279 feet
- Maximum beam =31 feet
- Maximum draft=8.2 feet
- Maximum capacity=3,000 tons

The four corridors of the European Inland Corridor System are mostly Class IV and above (Figures 5-5 and 5-6). Lock chambers on fluvial stretches in the Rhine and North-South Corridors have a width of 39.4 feet (12 meters) enabling the passage of vessels with a beam up to 37.4 feet (11.4 meters). Standard Danube push barges have a beam of 36 feet (11.0 meters) which is less than the Rhine barges. West-European locks have a standard allowance of 2 feet (0.60 meters), allowing vessels with a beam of 37.6 feet (11.45 meters) to pass through chambers with a width of 39.4 feet (12 meters). The Danube allowance on the Iron Gates is 3.3 feet (1.00 meter) allowing for convoys of three barges abreast having a beam of 36 feet (11.0 meters) each to pass through the 111.5 foot (34.0 meters) wide chamber.[7]

5.3.10 Existing and Future Technology

Discussions and interviews with private ship owners and representatives of shipping companies in Germany and the Netherlands indicate that characteristics of new builds and conversions of existing vessels are strongly influenced or even determined by the cargo to be transported. This depends on its state of aggregation, its quality, and its quantity. Shipping companies concentrate more often on special purpose ships, preferring long-term contracts and point to point traffic. The majority of private ship owners stick to the so called all-round vessels, which are qualified for the transport of various kinds of goods also on the tributaries.

Common innovative targets connected with new ships or new ship types exist to minimize the risk of a purpose built new construction by private ship owners and charterers. The same applies to other fields of interest within inland navigation and its participants; that is, changes within the framework of conditions for waterborne transport (improvement and maintenance of the waterways), improvements of navigational equipment, and solving of logistic problems are desirable goals to be realized. There are also real concepts with regard to improved ships and their equipment.

[7] Buck Consultants International (The Netherlands) ProgTrans (Switzerland) VBD European Development Centre for Inland and Coastal Navigation (Germany) via donau (Austria), Prospects of Inland Navigation within the enlarged Europe (PINE) Full Report. 2004. Pg 73.

The decision of a private owner or a shipping company to put on a single motor ship, coupling or pushing trains for forthcoming transports depends to a large extent on their comprehensive economical and technical experience and the resulting business philosophy.

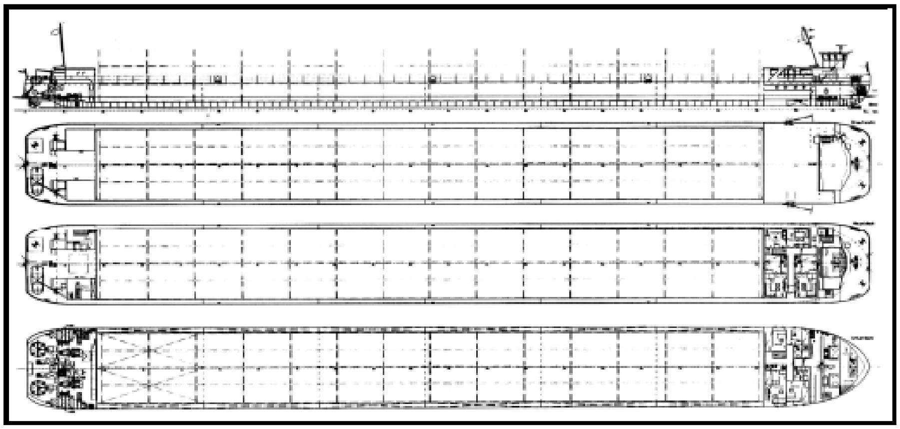
Based on the shapes of the Zentralverein für Deutsche Binnenschifffahrtin (BdZ or Central Association for German Inland Navigation) in the nineties, a cargo motor ship has been developed by the Versuchsanstalt für Binnenschiffbau Duisburg (VBD or European Development Centre for Inland and Coastal Navigation), with the following dimensions[8]:

Length	269 ft.
Beam	31 ft.
Draft	8.2 ft.
Load Capacity	1,300 tons
Container Capacity	77 TEU

These dimensions allow travel through more shallow tributaries and canals of the Rhine. A self-propelled vessel has been designed by the shipyard Roßlau and the VBD to specifically address constraints of low-flow conditions. The vessel is illustrated in Figure 5-10 and has the following dimensions:

Length	360 ft.
Beam	37.4 ft.
Max. Draft	6.56 ft.
Light Draft	2.1 ft.
Container Capacity	1,690 tons

Figure 5-10: Self-Propelled Vessels for Shallow Water

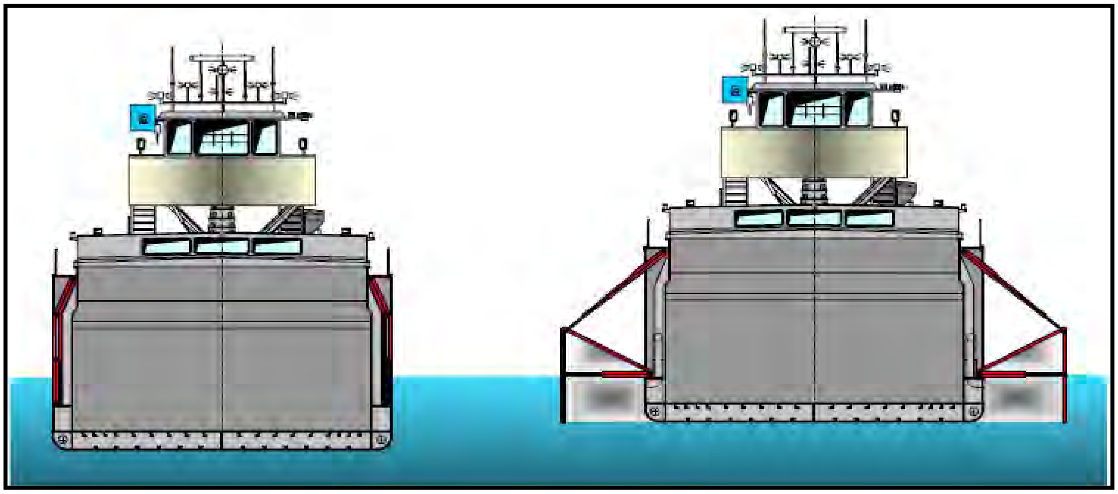


Source: SPIN-TN

[8] European Strategies to Promote Inland Navigation; Innovative Transport Vehicles-Rhine." December 2003. Pg 31

Another innovative proposal is the so called “inland ship particularly suitable to operate on shallow water” (Figure 5-11).This vessel is to represent a competitive ship type being able to run on the Rhine and Elbe rivers. It has a fixed minimal breadth of 29.5 feet and a maximal breadth of 41.3 feet. Buoyancy bodies with built in excess pressure mounted within the wing passage effect this flexibility. These bodies are moved by hydraulic cylinders and help provide additional lift by effectively increasing the vessels contact surface area. The draft of a ship can be lowered with the help of these technical features without changing the cargo quantity.[9]

Figure 5-11: Inland Ship Particularly Suitable to Operate on Shallow Water



Source: SPIN-TN

5.4 Conclusions

The most common practice today on U.S. inland waterway systems for accommodating freight barge traffic during low-flow conditions is barge light loading. This practice is quite common today and is currently employed not only on the Missouri River but also on the McClellan/Kerr waterway in Arkansas, and the Tennessee-Tombigbee waterway in Alabama.

Inland waterway systems of Europe best represent navigation patterns matched to varying channel dimensions. The systems vary in traffic and cargo concentrations depending on the depth and width of each particular channel.

Research on existing and proposed technologies and operating practices on low-flow rivers has identified the following issues:

- Barge light loading is an acceptable practice although its use restricts expansion of river traffic and cargo volumes on the Missouri River.
- European inland waterway transportation and the supporting freight transportation market is much more dynamic than any U.S. inland waterway system.
- Standardization of lock dimensions on the Mississippi and connecting river systems is not conducive to new barge and work boat designs.

[9] Ibid.

6. Potential Technology Solutions

6.1 Introduction

The interviews with shippers and others involved with the Missouri River cargo sector and the review of other waterway systems point to two technology solutions:

- Shallow draft tugs (suggested as a more important requirement than shallow draft barges)
- Shallow draft barges

Respondents stated the availability of shallow draft tugs for performing line haul and fleeting operations on the river is of greater importance than a supply of shallow draft barges. Shallow draft tugs would be expected to improve service reliability on the Missouri River. A basic analysis of the costs and benefits from the deployment of shallow draft tugs is provided in Section 7.3. Common in European inland waterways, self-propelled barges are typically employed for short-haul routes between ports. These potential solutions are reviewed in Section 6.

6.2 Shallow Draft Tugs

There are numerous work boat manufacturers in the U.S. capable of building shallow draft push boats with greater than 2,000 horsepower (HP). Reducing draft on a traditional push boat design is directly related to increasing the vessel beam. Several manufacturers were queried for cost estimates for the construction of a 1,000 to 1,500 HP push boat of 110 feet in length, a draft of 7 feet, and a beam of 36 feet. Cost ranged from $5.5 million to $6 million and varied based on the cost of construction materials and order book back log. The cost is only $250,000 to $500,000 more than a standard tug, the difference largely due to additional horsepower and twin screws.

Shipyards contacted for this analysis include:

- A&B Industries, Amelia, Louisiana
- Bollinger Shipyards, Lockport, Louisiana
- Jeffboat, Jeffersonville, Indiana
- Mariner Shipyard, Morgan City, Louisiana
- Steiner Shipyards, Bayou La Batre, Alabama

Figure 6-1: Shallow Draft Push Boat

Source: TranSystems

Table 6-1 compares typical dimensions of a modern twin screw push boat and a shallow draft push boat with similar horsepower. In general, the length-over-all (LOA) to beam ratio for shallow draft push boats is lower and the overall gross registered tonnage is less than typical tow boats. Towing service providers with shallow draft push boat technology interviewed for this analysis included Stevens Towing of Mobile, Alabama, Lewis & Clark Marine of Granite City, Illinois, and Terral River service, Lake Providence, Louisiana. Figure 6.1 depicts a Shallow Draft Push Boat in operation.

Table 6-1: Typical Push Boat Dimensions

Vessel	LOA	Beam	HP	GRT	Draft
Shallow Draft Push Boat	80'	36'	1,200'	134	7'
Standard Push Boat	110'	26'	1,000'	297	11'

Source: TranSystems

6.3 Proposed Self-Propelled Barge Design

The self-propelled barges designed for use in Europe are purpose-built for the waterway and intended cargo they will carry. The same would be true for the design of a self-propelled barge that would be used on the Missouri River. Several US barge and tug construction firms were interviewed to determine the ideal size necessary for service on the Missouri River. To maximize the utility of the proposed vessel, the study considered self-propelled barges with 12,000 ton and 2,000 ton capacities.

6.3.1 Vessel Characteristics

Both options would require the same size crew and would have a similar maximum speed of eight miles per hour. The 12,000-ton option replicates the capacity of a six super jumbo barge tow, and the 2,000-ton option represents the carrying capacity of a single super jumbo barge.

A 12,000-ton capacity self-propelled barge would have the following dimensions:

- 1,000 feet length-over-all
- 108 feet beam
- Six feet maximum draft
- Weight of 4,000 tons
- Direct drive propulsion with triple screws
- Horsepower=10,000
- Crew=Ten to 12 people
- Purchase price $50 million

The structure of the vessel would need to be heavily reinforced. A self-propelled barge of this size would require a turning radius of 1,500 feet.

The 2,000-ton capacity self-propelled barge resembles the dimensions of a super jumbo barge and would have the following dimensions:

- 400 feet length-over-all
- 54 feet beam
- Six feet maximum draft
- Weight of 700 tons
- Direct drive propulsion with twin screws
- Horsepower= 2,000
- Crew=Ten to 12 people
- Purchase price = $6 to $7 million

The smaller vessel would be easier to navigate and would not require the maneuvering area of the 12,000 ton option.

6.3.2 Operating Costs

From interviews with operators on the Missouri River, it was determined that current daily operating costs are based upon a lease rate of $5,500 per day. The cost can be broken down into $1,500 dollars per day, as a basic crew cost plus the costs of fuel, maintenance and repair, supplies, and insurance costs.

The costs for the self-propelled options (Figure 6-2) considered are not comparable to that of the existing barge and tug combinations. Both types of self-propelled vessels have different horsepower requirements, changing the daily operating costs. A metric developed by the USACE was used to determine fuel costs for the two options. Crew costs given for existing operations would remain the same.

Figure 6-2: Daily Operating Costs

Self-Propelled Barge Option	Fuel	Crew	Total	Per Trip (5 days)
12,000-ton capacity	$32,011	$1,500	$33,511	$167,553
2,000-ton capacity	$2,105	$1,500	$3,605	$18,023

Source: TranSystems

The fuel consumption and crew operating rates were the only factors used to create daily and per trip costs. Maintenance and repair, supplies, and insurance beyond this estimate cannot be determined at this phase of development.

6.3.3 Season Length Determination

It is assumed that a vessel with a maximum draft of six feet could operate at under minimum service flow conditions throughout the regular season. Water storage levels could be preserved to allow for a longer season by discharging at the minimum rate of 29,000 cfs. Greater flows could occur if required to alleviate potential flood conditions without affecting the vessel utilization. If the water-in-storage levels were sufficient to support a full season under minimum service conditions, the proposed self-propelled barges could make one trip per week between Kansas City and Saint Louis for eight months.

6.4 Conclusions

The following conclusions have been developed concerning potential technology solutions to increased barge traffic on the Missouri River:

- The availability of shallow draft tugs for performing line haul and fleeting operations on the river is of greater importance than a supply of shallow draft barges.
- Shallow draft tugs would be expected to improve service reliability.
- Purpose built self-propelled shallow draft tugs could be used for intra Missouri River freight traffic.
- A vessel with a maximum draft of six feet could operate at under minimum service flow conditions throughout the Missouri River's regular navigational season.

7. Public Sector Benefits and Costs

7.1 Introduction

The interviews with shippers, barge operators, and government agencies, and the review of other technologies identified a number of preferred solutions to support the development of new cargo activity on the Missouri River. The following discussion addresses each proposed action and provides a review of benefits and costs.

7.2 Shallow Draft Tugs

The preferred solution to support the development of new cargo activity on the Missouri River is the provision of shallow draft tugs for fleeting and line haul operations. As discussed in Section 3 (interviews), a central obstacle to the expansion of cargo is the lack of availability of tugs on the Missouri River due to the sale of assets by previous service providers (and their subsequent redeployment to other markets) and the reluctance of major tug operators to deploy assets on the Missouri River due to draft restrictions and the opportunities for stable and more profitable employment on other waterways. A further challenge, as identified in Section 6.2, is the additional cost of shallow draft tugs; $250,000 to $500,000 more than a standard tug largely due to additional horsepower and twin screws. A proposed policy approach is for MoDOT to support the construction of shallow draft tugs and their deployment on the Missouri River through:

- Financial programs to bridge the construction cost gap between shallow draft and standard tugs. Examples are grants, cost share, low interest loans and tax incentives.
- Cooperation with other agencies to fund investment in shallow draft tugs. Given that increased cargo activity could have broad benefits, including stimulation of local economic activity, mitigation of highway/rail congestion and pollution, and assistance with maintenance of river channels, then financial programs could be structured with the assistance of other local, state and federal agencies. For example USACE, local and state governments, and local and state economic development agencies.

The potential costs and benefits of supporting the construction and deployment of shallow draft tugs are shown in Table 7-1.

Table 7-1: Potential Major Benefits and Costs of Construction and Deployment of Shallow Draft Tugs

Potential Public Sector Benefit	Potential Public Sector Cost
• Increased use of Missouri River assets (ports, etc.) with potential higher employment, tax revenues, etc • Potential increased use of barge, which has a lower environmental footprint than other transport modes • Increased traffic aids channel maintenance, supporting river reliability	• Financial support to bridge the construction cost gap between for shallow draft tugs and standard tugs (low-flow tugs cost from \$5 million to \$6.5 million, about \$250,000 to \$500,000 more than a standard tugs) • Administrative cost of incentive programs
Potential Private Sector Benefit	**Potential Private Sector Cost**
• Increased transport options for shippers • Service reliability for shippers • Lower cost transport option (barge less expensive than rail and truck) • Increased cargo tonnage for terminal operators • Greater operational reliability for barge operators	• Risks from increased use of Missouri River. For example, can water levels be maintained so shippers have confidence in long term service reliability? • Transfer of equipment from potentially more reliable and higher revenue/profit rivers to the Missouri River

Source: TranSystems

7.3 Costs and Benefits of Construction Subsidy for Shallow Draft Tugs

In order to develop a basic analysis of the costs and benefits from the deployment of shallow draft tugs, estimates on freight rates to move cargo between St. Joseph, MO and St. Louis, MO were collected. In addition, literature was reviewed regarding the environmental and safety impacts of barge transportation compared to other transport modes.

Companies contacted for rate information advised the following:

- General market rates are difficult to obtain due to the inconsistency of navigational conditions on the Missouri River over the past few years, the relatively limited river use, and shippers use of chartered barges instead of commercial service. Therefore, the rates provided by companies are estimates and assume river reliability.

- Rates are based on grain and cement movements southbound, and fertilizer movements northbound.

- Respondents advised they would not use trucking between St. Joseph and St. Louis, and that the correct alternative mode is rail. Some shippers, notably of northbound fertilizers, have increased their use of rail due to the unreliability of river service. Even though rail has historically been more expensive than barge, it is more reliable.

- Barge rates are driven by the availability of both southbound and northbound cargo. If there is no northbound cargo available, then barge rates would be up to 60 percent more expensive due to the need to reposition an empty barge.

- Today's rail rates are probably higher due to the absence of a competitive and reliable barge service.

The following assumptions were made to develop estimates of the costs and benefits of investment in shallow draft tugs:

- Cargo movements between St. Joseph, MO and St. Louis, MO.
- Barge
    - A barge rate of $15 per ton, assuming balanced southbound and northbound cargo flows.
    - A normal navigation season of April 1 to December 1, allowing 244 days of navigation.
    - Transit times of 2 days southbound and 3 days northbound, plus 2 days for loading and discharge, for a total round trip transit of 7 days.
    - A total of 34 round trips per season, based on the normal navigation season and the transit time.
    - A single barge tow of six barges, loaded to a draft of 7.5 feet, provides capacity of 7,200 tons (1,200 tons per barge), which generates round trip capacity of 288,000 tons per navigation season.
- A rail rate of $20 per ton.
- Shallow draft tugs:
    - A fleet of two shallow draft tugs to provide minimum service coverage and backup.
    - A construction subsidy of $500,000 per shallow draft tug is provided by the State. An arbitrary 10 percent was added to account for program administration.

The results of the above analysis are presented in Table 7-2. Under a normal navigation season, from April 1 to December 1, the transport cost savings to shippers from replacing rail with barge are greater than the construction subsidy for a fleet of two shallow draft tugs.

Table 7-2: Cost-Benefit Analysis of Construction Subsidy for Shallow Draft Tugs

Assumptions			
Ports	St. Joseph, MO and St. Louis, MO		
Normal Navigation Season - Days	244		
Barge Round Trip Transit - Days	7		
Round Trips per Season	34		
Cargo Tons per Round Trip	14,400		
Cargo Moved per Season	489,600		
Construction Subsidy for Two Shallow Draft Tugs			$1,100,000
Transport Costs	**Barge**	**Rail**	
Rate per Ton	$15.50	$20.50	
Total Transport Cost per Round Trip	$223,200	$295,200	
Total Transport Cost per Season	$7,588,800	$10,036,800	
Transport Cost Savings per Season			**$2,448,000**

Source: TranSystems

An important issue is recovery of the construction subsidy, which could take place through a user fee per cargo ton. Estimated user fees per cargo ton are shown in Table 7-3, based on different periods of time to recover the subsidy. For example:

- A fee of $2.25 per cargo ton would be needed to recover the subsidy in a single year (or single navigation season).
- A fee of $0.22 per cargo ton would be required to recover the subsidy over a period of ten years (or ten navigation seasons).

Clearly, the longer the recovery period, the lower and more attractive the user fee would be for shippers.

Table 7-3: Example of Subsidy Recovery by User Fees

Years to Recover Construction Subsidy	Total Cargo Tons Shipped	User Fee per Cargo Ton (Construction Subsidy / Cargo Tons Shipped)	User Fee per Cargo Ton as Percent of Barge Rate
1	489,600	$2.25	14.5%
2	979,200	$1.12	7.2%
3	1,468,800	$0.75	4.8%
4	1,958,400	$0.56	3.6%
5	2,448,000	$0.45	2.9%
6	2,937,600	$0.37	2.4%
7	3,427,200	$0.32	2.1%
8	3,916,800	$0.28	1.8%
9	4,406,400	$0.25	1.6%
10	4,896,000	$0.22	1.4%

Source: TranSystems

The environmental and safety impacts of the different transport modes were briefly evaluated based on analysis contained in the study "A Modal Comparison of Domestic Freight Transportation Effects on the General Public" published in November 1997 and prepared by the Center for Ports and Waterways, Texas Transportation Institute for the MARAD and the National Waterways Foundation. The study compared the environmental footprints and safety impacts of barge and other transport modes in order to determine the benefits of moving cargo via the inland waterway system.

Barge transportation generates 39 percent lower air emissions per cargo ton-mile than rail transportation. In this analysis (Table 7-4), barge transportation would generate a 11 percent reduction in total emissions, based on the distance between St. Joseph and St. Louis, and the cargo tons shipped per season. The barge advantage comes from its greater fuel efficiency per cargo-ton mile (Table 7-5).

Table 7-4: Estimated Air Pollutants per Season

	Barge	Rail[1]
Miles between St. Joseph and St. Louis	462	368
Cargo Tons per Season	489,600	489,600
Cargo Ton-Miles per Season	226,195,200	180,172,800
Air Pollutants	**Emissions - Grams per Ton-Mile[2]**	
Hydrocarbons (HC)	0.01737	0.02423
Carbon Monoxide (CO)	0.04621	0.06445
Nitrogen Oxides (NO_x)	0.46907	0.65423
Particulate Matter (PM)	0.01164	0.01621
Air Pollutants	**Total Emissions per Season**	
Hydrocarbons (HC)	3,929,011	4,365,587
Carbon Monoxide (CO)	10,452,480	11,612,137
Nitrogen Oxides (NOx)	106,101,382	117,874,451
Particulate Matter (PM)	2,632,912	2,920,601

(1) Average of BNSF (387 miles) and UP (350 miles).

(2) Data obtained from "A Modal Comparison of Domestic Freight Transportation Effects on the General Public" published in November 1997 and prepared by the Center for Ports and Waterways, Texas Transportation Institute for the MARAD and the National Waterways Foundation.

Source: TranSystems

Table 7-5: Estimated Air Pollutants per Season

	Barge	Rail
Cargo Ton-Miles per Season	226,195,200	180,172,800
Energy Efficiency		
Cargo Ton-Miles per Gallon of Fuel [1]	576	413
Fuel Consumption per Season (Gallons)	392,700	436,254

(1) Data obtained from "A Modal Comparison of Domestic Freight Transportation Effects on the General Public" published in November 1997 and prepared by the Center for Ports and Waterways, Texas Transportation Institute for the MARAD and the National Waterways Foundation.

Source: TranSystems

Barge transportation is a safer transportation mode than rail, generating fewer fatalities and injuries per cargo ton-mile. As shown in Table 7-6, barge transportation would provide a significant reduction in fatalities and injuries per season compared to rail (based on the earlier assumptions regarding season duration, cargo volumes and distances).

Table 7-6: Estimated Safety Impacts per Season

	Barge	Rail
Cargo Ton-Miles per Season	226,195,200	180,172,800
Safety Impacts [1]		
Fatalities per Billion Ton-Miles	0.028	0.649
Injuries per Billion Ton-Miles	0.045	5.814
Safety Impacts per Season		
Fatalities per Season	0.006	0.117
Injuries per Season	0.010	1.048

(1) Data obtained from "A Modal Comparison of Domestic Freight Transportation Effects on the General Public" published in November 1997 and prepared by the Center for Ports and Waterways, Texas Transportation Institute for the MARAD and the National Waterways Foundation.

Source: TranSystems

7.4 New Fleeting Operations

The need for new fleeting operations, linked to the availability of shallow draft tugs, is important to operators and shippers (as identified in the interviews). The absence of established fleeting operations reduces the reliability and effectiveness of barge operations on the Missouri River. It requires line haul tugs to undertake the fleeting function, which reduces their productivity and profitability. A single fleeting shallow draft fleeting tug could provide coverage to a port region (which includes a number of different terminals). As with shallow draft tugs, a proposed policy approach is for MoDOT to facilitate the development of new fleeting operations through:

- Financial support to support the start-up of new fleeting services
    - Grants
    - Low interest loans
    - Tax incentives
- Cooperation with other local, state and federal agencies

The potential costs and benefits of supporting development of new fleeting operations, which are similar to those from deployment of shallow draft tugs, are shown in Table 7-7.

Table 7-7: Potential Major Benefits and Costs of New Fleeting Operations

Potential Public Sector Benefit	Potential Public Sector Cost
• Increased use of Missouri River assets (ports, etc.) with potential higher employment, tax revenues, etc • Potential increased use of barge, which has a lower environmental footprint than other transport modes • Increased traffic aids channel maintenance, supporting River reliability	• Financial support to provide new fleeting operations • Administrative cost of incentive programs
Potential Private Sector Benefit	**Potential Private Sector Cost**
• Operational reliability for tug and barge companies • Service reliability for shippers • Increased cargo tonnage for terminal operators	• Risks from increased use of Missouri River. For example, can water levels be maintained so shippers have confidence in long term service reliability? • Transfer of equipment from potentially more reliable and higher revenue/profit Rivers to the Missouri River

Source: TranSystems

7.5 River Crew Training Program

An industry concern discussed by respondents to the interview survey is the aging profile of tug crews and the impact of retirements on the availability of crews. A proposed policy solution is for MoDOT to support the training of new tug crews, as follows:

- Financial incentives to tug companies to expand training programs
  - Grants
  - Low interest loans
  - Tax incentives
- Development of training programs at the local and state level
- Cooperation with local, state and federal agencies

The potential costs and benefits of training programs are shown in Table 7-8.

Table 7-8: Potential Costs and Benefits of Shallow Draft Tugs

Potential Public Sector Benefit	Potential Public Sector Cost
• Increased employment in the local river industry. • Increased safety due to expanded crew availability and less stress on existing crews.	• Financial support to promote crew training • Administrative cost of incentive programs
Potential Private Sector Benefit	**Potential Private Sector Cost**
• Operational reliability due to expansion of crew supply • Enhanced operational safety due to less stress on existing crew supply	• Cost of expanded training activity

Source: TranSystems

7.6 Other Policy Actions

The interview survey and research of operations on the Missouri River identified a number of other policy actions that could be undertaken to support the expansion of barge activity on the Missouri River. They are:

- Enhanced program for channel maintenance and monitoring to address shipper and operator concerns about channel reliability.
- Create strategic partnerships with Louisiana, Lower Mississippi River ports to market use of inland waterways for emerging cargos (for example, ethanol and DDGS).
- Promote environmental benefits of barge service.

These policy actions would have similar benefits and costs as those identified earlier for shallow draft tugs, fleeting operations and crew training.

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