PROJECTED AND ACTUAL TRAFFIC ON INLAND WATERWAYS

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AUGUST 2000

PROJECTED AND ACTUAL TRAFFIC
ON INLAND WATERWAYS

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EXECUTIVE SUMMARY

Purpose of Study

The U.S. Army Corps of Engineers (USACE) was asked by the House Energy and Water Appropriations Subcommittee to provide a comparison of actual traffic on inland waterways against the earliest available traffic forecasts when navigation improvements were first proposed on these waterways. In response to this request the USACE Headquarters tasked the USACE Institute for Water Resources (IWR) to coordinate with Corps field offices to compile the requested information and prepare a summary.

Five division offices provided detailed information on 15 traffic projections that were prepared for ten waterways between 1943 and 1989. The inputs from the five USACE divisions are included in this report as attachments which describe the ten waterways, their traffic forecasts, and the actual traffic realized. The ten waterways for which traffic forecasts were provided (and the year of the forecasts) are:

Ohio River (1968,1980)
Tennessee River (1969,1989)
Lower Mississippi River (1974)
J. Bennett Johnston (Red River) Waterway (1983)
Gulf Intracoastal Waterway (1978)
Columbia-Snake Waterway (1958, 1977)
Missouri River (1950, 1953)
Tennessee-Tombigbee Waterway (1945, 1986)
Black Warrior-Tombigbee Navigation System (1983)
McClellan-Kerr Arkansas River Navigation System (1943/1954)

Types of Waterways

Seven traffic forecasts, provided for five waterways (the Arkansas, Tennessee-Tombigbee, Missouri, Columbia, and Red), represented projections for proposed "new" navigation systems, meaning that the waterway had not yet been developed for commercial navigation with at least a 9-foot depth at the time the forecasts were prepared. Eight traffic forecasts, provided for six waterways (the Ohio, Tennessee, Lower Mississippi, Gulf Intracoastal, Black-Warrior, and Columbia), were for improvements to "existing" navigation systems (waterways that had at least a 9-foot depth and a significant amount of commercial traffic when the projections were prepared). The Columbia-Snake forecasts included one when it was a "new" waterway (1958) and a subsequent forecast (1977) after the system was “existing” (i.e. fully operational) in 1975.

Projection Methods

Each waterway study and traffic forecast was in some way unique, because each involved a different mix of waterway physical features, geographic locations, traffic compositions, types of movements and economic hinterlands that had to be addressed. The complexity of the methods employed in the development of the various forecasts varied widely, as did the time, effort, and expense invested in each overall study. The projection methods utilized to formulate these 15 projections included:

- The application of independently derived commodity-specific annual growth rates to base year traffic levels.

- Shipper surveys of existing and potential waterway users to estimate the future demand for barge shipments.

- Statistical analysis using regression and correlation to predict future waterborne traffic based on independent economic variables.

- A detailed long-range commodity supply-demand and modal split analysis incorporating the production and consumption patterns of individual economic regions within the waterway hinterland.

Some of the more accurate projections used national level forecasts of economic growth combined with regional economic and traffic studies, including surveys of shippers. Short-term phenomena, such as a rapid increase in energy prices, unduly influenced some long-term projections.

Study Results

The overall results indicate that a meaningful comparison of projected and actual traffic could be made for 13 of the 15 forecasts (Table ES-1). Several of these forecasts involved traffic comparisons that were difficult to characterize, as reflected in the footnotes in Table ES-1 and supporting discussions in the attachments to this report.

- Eleven of the 15 projections that could be readily compared against actual traffic either forecast total traffic to within a reasonable degree of actual total tonnage in 1998, or underestimated future traffic growth by more than 15%, meaning actual total traffic exceeded what was forecast to occur.

  - Traffic forecasts for seven of the 11 projections were within plus or minus 15% of actual traffic recorded in 1998. The age of the projection was unrelated to its accuracy since four projections were prepared more than 20 years before 1998 and three were less than 20 years old. Although total actual traffic tracked closely with the forecasted levels, the actual traffic composition of specific commodities varied considerably from what was forecast in some cases. In such

TABLE ES-1
SUMMARY OF PROJECTED AND ACTUAL 1998 TRAFFIC ON INLAND WATERWAYS

New Waterways (1)	**Projection Year**	**Actual Traffic Close to Projected Traffic**	**Actual Traffic Significantly Above Projected Traffic** (2)	**Actual Traffic Significantly Below Projected Traffic** (2)
MK Arkansas	1943/1954	X		
Tenn-Tom	1945		X	
Tenn-Tom	1986			X
Missouri (3)	1950		X (4)	
Missouri	1953		X (4)	
Columbia (5)	1958		X	
J. Bennett Johnston (Red)	1983	X		
Existing Waterway (6)				
Ohio	1968	X		
Ohio	1980	X		
Tennessee	1969	X		
Tennessee	1989	X		
Lower Mississippi	1974	X		
Columbia (5)	1977			X
Black Warrior-Tombigbee	1983			X
GIWW	1978			X

Source: Input from five USACE divisions. Refer to the attachments in this report for the waterway details.

(1) Waterways that had not been developed for commercial navigation with at least 9-foot depth when traffic projections were prepared.
(2) Significant difference between actual and projected traffic was more than plus or minus 15%.
(3) The 1950 projection modified a 12 million-ton estimate contained in the 1939 authorization documentation (HD 214). The 12 million-ton figure combined estimates of 7 million tons from 1933 for the middle river and 4.8 million tons from 1929 for the lower river provided to the Corps by an organization of barge owners. The Missouri River had not been developed to its current dimensions at the time of the projections.
(4) Current navigation on the Missouri River is distinctly different from that forecasted by either of the projections. Missouri River navigation is exceeding the total forecasted traffic levels prepared in 1950 and 1953, but the actual commodity traffic contrasts sharply with these forecasts.
(5) The Columbia River had an early projection prepared in 1958 when it was a " new" waterway, and another prepared later in 1977 when it was an "existing" waterway.
(6) Waterways that had at least a 9-foot depth and a significant amount of existing commercial traffic when traffic projections were prepared.

cases some commodity traffic was overestimated or underestimated. In some cases it turned out there were commodity movements that were not even considered at the time of the original forecast.

- Four of the 11 traffic projections, all prepared in the 1940s and 1950s, underestimated future traffic growth by more than 15%. Explanations for these underestimates include the projections being based on the assumed continuation of generally slower economic growth patterns that were in effect at the time the forecasts were prepared; stronger than predicted growth rates in the movement of selected commodities, such as coal, grain, sand and gravel, and forest products; and the development of new patterns of waterway movements which were unforeseen at the time the projections were developed.

- Two of these latter forecasts (the Missouri River projections, 1950 and 1953) projected a particularly different commodity mix than actually realized. Although the Missouri's 1998 actual total traffic has significantly exceeded these two forecasts, this is largely due to the internal movement of sand/gravel (about 6.5 million tons in 1998), which was not considered in the original projections. Without the sand/gravel component, the remaining traffic represents about 35 percent of the 1950 projection and 83 percent of the 1953 projection. The Missouri River tonnage without sand/gravel and waterway material peaked in the late 1970's and exceeded or approached levels predicted by the two forecasts. However, by 1998 Missouri River traffic without sand/gravel and waterway material movements was significantly lower than projected.

- Traffic projections for the remaining four of the 15 forecasts exceeded actual total traffic by more than 15%. All four forecasts were made in the post 1973 time period. This timeframe was characterized by a rapid increase in the price of oil, which resulted in what turned out to be highly optimistic national forecasts of future movements of coal, petroleum and petroleum products. An expected continuation of strong economic growth patterns was another factor likely affecting these projections. (To the contrary, the significant increase in the price of petroleum actually resulted in increased inflation, a slowdown in general economic conditions, and significant economic recession in 1981-82). In addition, sand and gravel traffic turned out to be less than anticipated on a couple of waterways.

Additional tables in the **Summary** section of this report provide a more detailed comparison of projected versus actual traffic based on 1998 traffic (Table S-2) and over the time horizons of the various forecasts (Table S-3). Complete information on the specific forecasts is included in the **Attachments** of this report.

Conclusions

As a result of this review the following conclusions can be drawn:

- About three-fourths of the projections either closely estimated or underestimated the overall level of future waterway traffic. Forecasts of total traffic proved to track more closely with actual navigation than component projections for individual commodities. Where the total traffic was about right, the specific commodities may have varied from what was forecast.

- The state-of-the-art practice of projecting future waterway traffic has evolved over time. Historically, even the time horizon used for the forecasts has varied, with some projections being one-year point estimates, others being projections of traffic at year 10 and year 20 of a project, and some projections looking 50 years into the future.

- Some of the more accurate projections used national level forecasts of economic growth combined with regional economic and traffic studies, including surveys of shippers.

- Several region wide studies, such as the Ohio River Basin projections, have stood the test of time reasonably well, and there may be value to be gained by using the techniques applied in those earlier studies to future projections.

- Short-term phenomena, such as market shocks in energy prices, may unduly influence long term projections if not recognized as short term events. Care should be taken when forecasting long-term trends to compensate for such short-term events in the formulation of the projections.

PROJECTED AND ACTUAL TRAFFIC ON INLAND WATERWAYS

SUMMARY

1. Introduction

Attention to the Upper Mississippi River-Illinois Waterway navigation system has stimulated interest in waterway traffic forecasts for other segments of the Nation's inland waterway system. During the recent budget testimony before the House Energy and Water Appropriations Subcommittee, the U. S. Army Corps of Engineers (USACE) was asked to provide for the record a comparison of the original waterway traffic projection for other inland waterways across the Nation versus the actual traffic realized for these waterways.

In particular, the subcommittee asked the USACE to show the traffic projected for waterways at the time navigation improvements were first proposed for authorization or the earliest projections available. The subcommittee requested data on projected and actual traffic for the waterways rather than for individual locks.

Subsequent to the hearing HQUSACE tasked the USACE Institute for Water Resources (IWR) to gather the requested waterway forecast and actual traffic and related explanatory information from the USACE field offices and prepare a summary of the data.

IWR received input from five divisions for the ten waterways indicated below:

- **Great Lakes and Ohio River Division (LRD):**
  Ohio River
  Tennessee River

- **Mississippi Valley Division (MVD):**
  Lower Mississippi River, Cairo to Baton Rouge
  J. Bennett Johnston (Red River) Waterway, Mississippi River to Shreveport, LA.
  Gulf Intracoastal Waterway, Leland Bowman Lock

- **Northwestern Division (NWD):**
  Columbia-Snake Waterway (Columbia Portion)
  Missouri River

- **South Atlantic Division (SAD):**
  Tennessee-Tombigbee Waterway
  Black Warrior-Tombigbee Navigation System

- **Southwestern Division (SWD):**
  McClellan-Kerr Arkansas River Navigation System

The inputs from the five USACE divisions are included in this report as attachments that describe the ten waterways, their traffic forecasts, and actual traffic. This summary provides comparative highlights of the ten waterways, which are highlighted in the figure below.

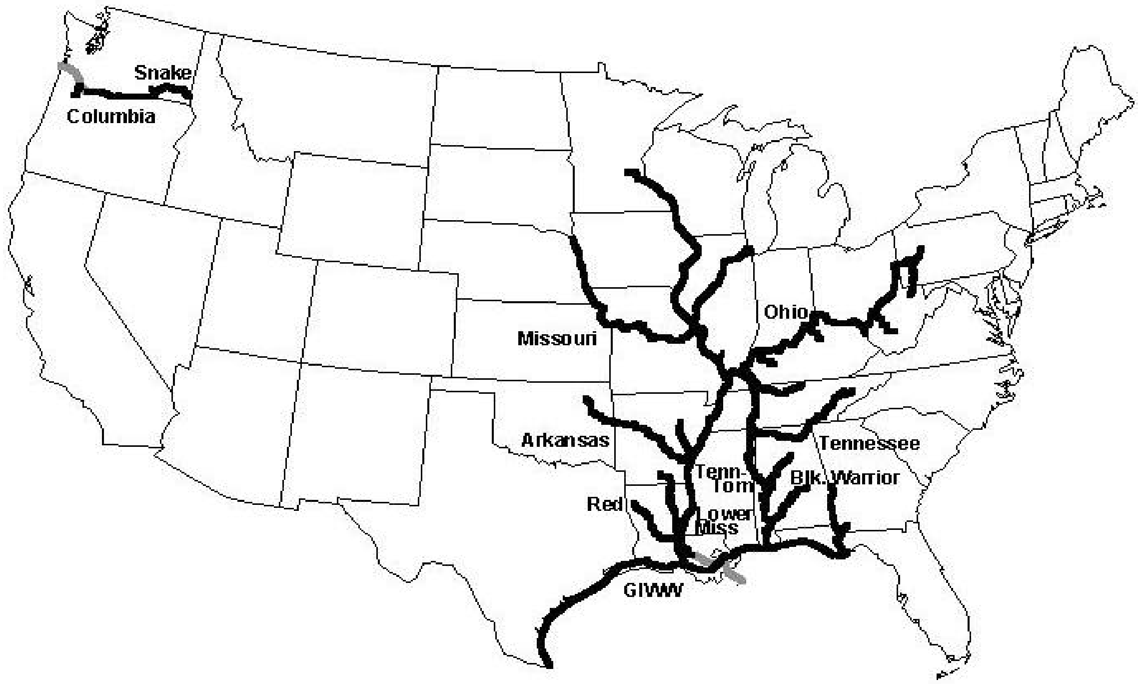


Figure 1 -- Major Inland and Intracoastal Waterway Segments

2. Types Of Waterways

The ten waterways for which information on projected and actual traffic was readily available include five **"new"** waterways. The "new" waterways were the McClellan-Kerr Arkansas Navigation System (MKARNS), Missouri River, J. Bennett Johnston (Red River) Waterway, the Tennessee-Tombigbee Waterway, and Columbia-Snake Waterway. These "new" waterways had not yet been developed for commercial navigation with at least a 9-foot depth at the time when projections were first prepared. Consequently, these waterways carried little or no waterborne commerce on which to base the initial traffic forecasts.

The six **"existing"** waterways include older and more established elements of the inland navigation system with at least a 9-foot depth, including the Lower Mississippi River, Ohio River, Gulf Intracoastal Waterway, Tennessee River, Black Warrior and Tombigbee Navigation System, and the Columbia-Snake Waterway (only fully operational since 1975). These waterways possessed historic traffic records upon which to base the traffic forecasts that were associated with further project improvements. The Columbia-Snake Waterway actually was the subject of an early projection prepared in 1958 when it was a "new" waterway and another forecast prepared later in 1977 when it was then an "existing" waterway.

3. Projection Methods

a. Overview

IWR published a report in 1992 that reviewed and assessed traffic forecasting methodologies previously employed by sixteen project level and national level USACE inland waterway studies. (David Grier and Leigh Skaggs, A Review of 16 Planning and Forecast Methodologies Used in the U.S. Army Corps of Engineers Inland Navigation Studies, June 1992, Institute for Water Resources, Alexandria, VA.) Inherent in that effort was the identification of data sources for economic, transportation, and commodity supply and demand forecasts. That publication did not examine projected and actual traffic. The effort was part of a larger R&D effort to develop procedures and guidelines for making consistent and systematic inland waterway traffic projections.

Each inland waterway study is in some way unique, because individual waterway projects have unique physical features, geographic locations, traffic mixes and patterns, economic hinterlands, etc. that have to be addressed. The complexity of the methods employed in the development of the forecasts for the ten subject waterways varied widely, as did the time, effort, and expense invested in each overall study. The projection methods utilized to formulate these 15 projections included:

- The application of independently derived commodity-specific annual growth rates to base year traffic levels,
- Shipper surveys of existing and potential waterway users to estimate the future demand for barge shipments,
- Statistical analysis using regression and correlation to predict future waterborne traffic based on independent economic variables,
- A detailed long-range commodity supply-demand and modal split analysis incorporating the production and consumption patterns of individual economic regions within the waterway hinterland.

The forecasting of waterway traffic is a difficult task due to the dynamic nature of transportation and the challenges inherent in estimating the spatial and temporal characteristics of freight demand. In particular, the existence of alternative and competing modes of transportation for the same commodity and the opportunity for other nations to supply the same types of commodities as the United States (i.e., coal and grain) to the same overseas markets provide added levels of uncertainty to whatever forecasting technique or model is employed.

The projection methods employed should not be judged solely on the basis of forecasting accuracy for the simple reason that every forecast contains some degree of error. A rigorous methodology does not necessarily ensure an accurate forecast. The soundness of the underlying macroeconomic and political assumptions used in the analysis is of paramount importance. Unfortunately, sometimes macroeconomic changes or unpredictable political, fiscal, or other unforeseen events can defy all the presumptions of "conventional wisdom."

b. Methods in the Studies

The forecasts discussed in the attachments to this report utilized a combination of the above projection methods as summarized here and in Table S-1. The projections of waterborne commerce were performed between 1943 and 1958 for "new" waterway projects – the Arkansas, Columbia-Snake, Missouri, and Tennessee-Tombigbee. The focus of these projections was on the entire waterway to be developed. Except for the forecast for the Columbia-Snake Waterway, the time period for projections was considerably less than the 50-year design lives of the projects. In a few cases the initial traffic projection was aimed primarily at a single year, the initial year traffic (Missouri) or for the ultimate traffic (Arkansas and Tenn-Tom). For the Missouri traffic was also forecasted for two years, the 10th and 20th years after project opening. In one case the traffic projection was also done for multiple years, but only for the first 15 years after opening (Arkansas).

In the early traffic projections prepared for "new" waterways, shipper decisions, economic conditions and forecasts, and waterway traffic were based on slow growth that occurred in the 1930s and 1940s. These early projections were limited to a few commodities, perhaps in part due to the limited number of commodities likely to move in significant tonnages and the uncertainty associated with forecasting for new waterways. The base traffic was determined either through a survey of potential shippers by barge in the waterway's region (Missouri River) or a comprehensive analysis of commodity traffic and growth rates on other waterways (Arkansas River). Diversion of traffic from other modes (Missouri River and Tenn-Tom Waterway) and other waterways (Tenn-Tom Waterway) were considered by analyzing railroad shipment waybill records in the region and calculating transportation savings by a shift to the project waterway. Traffic projections were developed based on current and expected national economic conditions and adjusting for regional variations in different industry sectors (Missouri River).

Later projections of waterborne commerce were conducted between 1968 and 1989 for two new waterways (Red River and Tenn-Tom Waterway), five existing waterways in conjunction with individual lock improvement projects (Black Warrior-Tombigbee, Columbia-Snake Waterway, GIWW, Ohio River, and Tennessee River), and one comprehensive study (Lower Mississippi River). These projections were developed twenty years or more after those done for new waterways in the post-World War II period. These forecasts were based on 20 to 40 years of rapidly expanding waterway

TABLE S-1
SUMMARY OF PROJECTION METHODOLOGIES
ON INLAND WATERWAYS

Name of Waterway **(Projection Year)**	**Projection Methodology**	**Source of Projection**
New Waterways		
McClellan – Kerr Arkansas River Navigation System (1943/54)	Review of existing waterways including the Ohio River, the Illinois River, the Kanawha River, the Allegheny River, and the Upper Mississippi River. Growth rates for specific commodities (petroleum products, coal, iron and steel) were calculated and adjusted to reflect regional differences for the Arkansas River System.	1943 District Survey Report which served as the basis for project authorization. 1954 update of earlier commodity forecasts.
Tennessee – Tombigbee Waterway (1945)	Single point estimate based on estimates of traffic that would shift from rail to the waterway and the Mississippi River to the waterway.	Authorizing document for the Tennessee – Tombigbee Waterway, House Document 486, 79th Congress, 2nd Session, dated 29 September 1945.
Tennessee – Tombigbee Waterway (1986)	Single point estimate of future waterway traffic.	Consulting report entitled "Operational Forecast for Initial Traffic on the Tennessee – Tombigbee Waterway" dated August 1986.
Missouri River (1950)	Estimates of traffic at years 10 and 20 of project operation. Projection of waterway traffic was based on extensive research and field surveys of shippers of more than 40 commodities.	Projections were presented in a Missouri River Division report prepared in 1950. The 1950 projection modified a 12-million ton estimate contained in the 1939 authorization documentation (HD 214). The 12-million ton figure combined estimates of 7 million tons from 1933 for the middle river and 4.8 million tons from 1929 for the lower river provided to the Corps by an organization of barge owners.
Missouri River (1953)	Single point estimate. Projection of waterway traffic based on analysis of waybill shipments from and into the region surrounding the river, interviews with prospective users of barge traffic, and other information.	Projections were presented in a report prepared by the Missouri Basin Survey Commission dated 1953.
Columbia-Snake Waterway (1958)	Projection of traffic through the year 2025 for each of the eight projects on the Columbia – Snake River System	Projections were presented in document entitled "Water Resource Document of the Columbia River Basin" dated June 1958.
J. Bennett Johnston (Red River) Waterway (1983)	Projections were based on national economic forecasts (OBERS) and a comprehensive survey of shippers.	Projections were presented in the report entitled "Red River Waterway General Reevaluation Report and Environmental Impact Statement No. 2" dated August 1983.

TABLE S-1 SUMMARY OF PROJECTION METHODOLOGIES ON INLAND WATERWAYS (cont'd.)		
Existing Waterways	**Projection Methodology**	**Source of Projection**
Ohio River (1968)	Projections were based on economic growth forecasts for key waterway industries. Industry growth rates were based on economic forecasts and information derived from shipper surveys.	Projections were presented in the report entitled "Report on Replacement, Gallipolis Locks and Dam" dated July 1969.
Ohio River (1980)	Projections were based on report entitled "Projections for Waterborne Transportation, Ohio River Basin, 1980 –2040" dated December 1980, supplemented by economic growth forecasts for key waterway industries. Industry growth rates were based on economic forecasts and information derived from shipper surveys.	Projections were presented in report entitled "Gallipolis Locks and Dam Replacement, Ohio River, Phase I, Advanced Engineering and Design Study, General Design Memorandum, Appendix L" dated 1980.
Tennessee River (1969)	Projections were based on forecasts of industry employment and average waterway tons per employee, and new shipments based on shipper survey.	Traffic projections were presented in a Tennessee Valley Authority report on improvements at Pickwick Lock, dated 1969.
Tennessee River (1989)	Traffic projections were based on report entitled "Forecast of Future Ohio River Basin Waterway Traffic, 1986 – 2050, Part II: Commodity Traffic Demand Forecasts" dated May 1986. Short-term projections relied on user surveys and plant and company level forecasts. Long term projections relied upon industry and geographic specific earnings projections.	Traffic projections were presented in "Lower Cumberland and Tennessee River Navigation Feasibility Report, Kentucky Lock Addition, Appendix D" dated December 1991.
Lower Mississippi River (1974)	Traffic projections were based on national economic forecasts (OBERS) and included inputs such as population, employment, earnings, income, and production of goods and services at the national level.	Traffic projections were presented in report entitled "Lower Mississippi River Region Comprehensive Study," dated 1974.
Columbia-Snake Waterway (1977)	Projection of waterway traffic through the year 2000.	Traffic projections were presented in feasibility report entitled "Bonneville Lock and Dam, Feasibility Study for Modifying Lock" dated January 1977.
Black Warrior – Tombigbee Waterway (1983)	Projections were based on origin and destination data for historical movements and applying national economic forecast growth rates (based on 1980 OBERS projections), and additional tonnage added due to movements on the Tennessee Tombigbee Waterway.	Traffic projections were presented in feasibility report entitled "Interim Feasibility Report and Environmental Impact Statement for Oliver Lock Replacement" dated December 1983.
Gulf Intracoastal Waterway (1978)	Traffic projections were made for the period from 1980 to 2030. Projected commodity growth was based on the weighted average of growth rates for seven commodity groups.	Traffic projections were developed in association with the evaluation of the Vermilion Lock, authorized for replacement by the Water Resources Development Act of 1976.

Source: Input from five USACE divisions. Refer to the attachments in this report for the waterway details.

traffic since World War II. These later forecasts reflected a more sophisticated modeling capability of regional, national, and international economic conditions and industry sectors, along with advances in computer capabilities.

In these later forecasts the projection time period usually encompassed multiple decades up to 50 years, but projections were also prepared for the anticipated initial year after project opening (Tenn-Tom Waterway). Such projections applied to the full range of anticipated commodities. Development of estimates for the traffic base and short-term forecasts employed trends from historic traffic (GIWW and Ohio River), surveys of potential shippers (Red, Ohio, and Tennessee Rivers), and plant and company level forecasts (Tennessee River). Estimates were also made of traffic likely to be diverted from railway and highway movements (Ohio and Tennessee Rivers). Longer-term projections of waterway traffic utilized a variety of economic forecasts for waterway-related industries and commodities (BWT, GIWW, Ohio, Red, and Tennessee Rivers) and for geographic areas (BWT, Red, and Tennessee Rivers). Traffic was also estimated based on industry employment forecasts and calculation of waterway tons per employee (Tennessee River).

4. Projected and Actual Traffic

a. Waterways

The overall results indicate that a meaningful comparison of projected and actual traffic could be made for 15 forecasts (Table S-2). Several of these projections involved traffic comparisons that were difficult to characterize, as reflected in the Table S-2 footnotes and attachments of this report.

For 11 of the 15 traffic projections that could be readily compared, total traffic in 1998 was at least 85 percent of the forecast traffic (Table S-2). For five "new" waterways the actual traffic in 1998 represented at least 85 percent of the original projected traffic in six of the seven projections. For six "existing" waterways the actual traffic in 1998 represented at least 85 percent of the original projected traffic in five of the eight projections. The age of the projection was unrelated to how closely the forecast tracked with actual traffic since four "accurate" traffic forecasts (actual traffic being 85 to 115 percent of forecast traffic) were prepared 20 to 40 years prior to 1998 and three were prepared less than twenty years earlier.

If the forecasts are evaluated by the extent actual total traffic met or exceeded projected traffic, then many of the "new" waterways (Arkansas, Columbia, J. Bennett Johnston, and Tennessee-Tombigbee) achieved better results than some of the "existing" waterways (Black Warrior-Tombigbee, Columbia, and GIWW). On the "new" waterways the actual traffic in 1998 ranged between about 90 to 150 percent of the projected traffic for four forecasts and was 59 percent for the most recent of the forecasts (Tenn-Tom, 1986).

TABLE S-2
PROJECTED AND ACTUAL 1998 TRAFFIC
ON INLAND WATERWAYS
(Tons in 000s)

New Waterways (1)	**Projection Year**	**Years Since Projection**	**Year Opera-tional** (3)	**Projected Traffic For 1998**	**Actual Traffic In 1998**	**Actual Traffic As % 0f Projected**
MK Arkansas	1943/1954	55/44	1971	12,720	12,036	95
Tenn-Tom	1945	53	1985	5,764	8,509	148
Tenn-Tom	1986	12	1985	14,453	8,509	59
Missouri (5)	1950	48	1981	5,000	(6) 8,378	(6)168
Missouri (5)	1953	45	1981	2,100	(6) 8,378	(6)399
Columbia (4)	1958	40	1975	7,872	10,850	139
J. Bennett Johnston (Red)	1983	15	1994	3,993	3,727	93
Existing Waterways (2)						
Ohio	1968	30	1993	264,700	241,900	91
Ohio	1980	18	1993	241,600	241,900	100
Tennessee	1969	29	1983	61,400	52,000	85
Tennessee	1989	9	NO	51,900	52,000	100
Lower Mississippi	1974	24	NA	185,733	195,840	105
Columbia (4)	1977	21	1993	15,121	10,850	72
Black Warrior-Tombigbee	1983	15	1991	56,020	24,169	43
GIWW	1978	20	1985	82,700	37,644	46

Source: Input from five USACE divisions. Refer to the attachments in this report for the waterway details.

(1) Waterways that had not been developed for commercial navigation with at least a 9-foot depth when traffic projections were prepared.
(2) Waterways that had at least a 9-foot depth and a significant amount of existing commercial traffic when traffic projections were prepared.
(3) Year when project under study or restudy became operational. Includes new and replacement locks.
(4) The Columbia River had an early projection prepared in 1958 when it was a " new" waterway, and another prepared later in 1977 when it was an "existing" waterway.
(5) The 1950 projection modified a 12 million-ton estimate contained in the 1939 authorization documentation (HD 214). The 12 million- ton figure combined estimates of 7 million tons from 1933 estimate for the middle river and 4.8 million tons from 1929 estimate for the lower river provided to the Corps by an organization of barge owners. The Missouri River had not been developed to its current dimensions at the time of projections.
(6) Current navigation on the Missouri River is distinctly different from that forecasted by either of the projections. Missouri River navigation is exceeding the total forecasted traffic levels prepared in 1950 and 1953, but the actual commodity traffic contrasts sharply with these forecasts.

Abbreviations: NO - Not operational. NA – Not Applicable.

The results of the comparison of the two Missouri River projections (1950 and 1953) against actual traffic are more difficult to characterize. Although the Missouri's 1998 actual total traffic was 168 and 399 percent of its two forecasts, this was largely due to the internal movements of sand/gravel (about 6.5 million tons in 1998), which were not considered in the original projections. Without the sand/gravel component, the remaining traffic would have been 35 percent of the 1950 projection and 83 percent of the 1953 projection. The Missouri River tonnage without sand/gravel and waterway material peaked in the late 1970's and exceeded or approached levels predicted by the two forecasts. However, by 1998 Missouri River traffic without sand/gravel and waterway material movements was significantly lower than projected.

By contrast, actual traffic in 1998 on "existing" waterways ranged between 85 to 105 percent of the projected traffic for five forecasts and below 85 percent for three of the projections (Columbia River (1977) GIWW and BWT). In a general sense, projections tended to underestimate the traffic that actually developed on "new" waterways, while tracking more closely with actual traffic on "existing" waterways, except for the Black Warrior-Tombigbee and GIWW.

The actual and projected total traffic were also compared for years before 1998 (Table S-3). In these earlier years the traffic increases due to new waterways or improvements on existing waterways were not as great as in 1998. As with the latest traffic in 1998, actual traffic in the startup years on "new" waterways tended to be much higher than projected traffic compared to results on "existing" waterways. Actual startup traffic on new waterways was 91 to 307 percent of traffic in five forecasts compared to 95 to 118 percent of traffic in six forecasts on existing waterways. On the Missouri River sand and gravel tonnage has increased, as has its share of total traffic (46 percent for 1980 to 52 percent for 1985, 73 percent for 1990, 76 percent for 1995 and 78 percent for 1998). Without the sand and gravel tonnages the remaining commercial traffic as a percent of projected traffic would fall well below 100 percent.

Actual startup traffic was less than 85 percent of that projected in four instances – the new Tenn-Tom Waterway (9 and 24 percent) and the existing BWT (44 percent), Columbia (62 percent), and GIWW (73 percent). In subsequent years until 1998 on these waterways the percentage rose to 59 and 148 for the Tenn-Tom Waterway, remained steady (43 percent) for the BWT, rose to 72 percent for the Columbia, and declined to 46 percent for the GIWW.

The trend over the early years of the forecasts for nearly all the ten waterway projects was that actual traffic was increasing as a percent of the projected traffic or showing no significant change. It was rising on the TTW and Columbia (one forecast) since project opening and rising as part of a traffic recovery on the Arkansas, Missouri, and Tennessee (one forecast). Early year percentages were either close to those in 1998 (BWT, Ohio, Red, and Tennessee) or fluctuating (Ohio and one Columbia forecast).

TABLE S-3
PROJECTED AND ACTUAL TRAFFIC
ON INLAND WATERWAYS, 1960 – 1998

New Waterways	**Projection Year**	**Actual Traffic As % of Projected Traffic**							
		1960	**1970**	**1975**	**1980**	**1985**	**1990**	**1995**	**1998**
MK Arkansas	1943/54	_	(1) 307	140	127	83	83	86	95
Tenn-Tom	1945	_	_	_	_	24	77	141	148
Tenn-Tom	1986	_	_	_	_	9	31	56	59
Missouri (4)	1950	_	_	_	(2)197	(2)185	(2)146	(2)153	168
Missouri (4)	1953	_	_	_	282	308	278	328	399
Columbia	1958	102	83	_	169	_	121	_	139
J. Bennett Johnston (Red)	1983	_	_	_	_	_	_	91	93
Existing Waterways									
Ohio	1968	_	108	101	98	94	103	95	91
Ohio	1980	_	_	_	95	92	102	101	100
Tennessee	1969	_	100	85	73	79	85	80	85
Tennessee	1989	_	_	_	_	_	102	95	100
Lower Mississippi	1974	_	118	_	146	_	174	_	105
Columbia	1977	_	_	_	_	_	62	_	72
Black Warrior-Tombigbee	1983	_	_	_	_	_	44	46	43
GIWW	1978	_	_	_	_	(3)73	71	56	46

Source: Input from five USACE divisions. Refer to the attachments in this report for the details.

(1) Projected and actual traffic are for 1971.
(2) Projected traffic is assumed to be 3.0, 3.5, and 4.5 million tons in 1980, 1985, and 1995, respectively. Projected traffic for the 10th year (1991) is used for 1990.
(3) Projected and actual traffic are for 1986.
(4) Actual total traffic includes sand and gravel (46% of actual traffic for 1980, 52 % for 1985, 73% for 1990, 76% for 1995 and 78% for 1998). Without the sand and gravel tonnages the remaining commercial traffic as a percent of projected traffic would fall well below 100 percent. Also see footnotes (5) and (6) of Table S-2.

The explanation for “new” waterways generally having actual total traffic substantially above projected traffic is probably due in large part to the historic context in which the projections were made (Table S-4). In the early traffic projections prepared for “new” waterways, shipper decisions, economic conditions and forecasts, and waterway traffic were based on slow growth that occurred in the 1930s and 1940s. This was followed by strong waterway traffic with a 4.3 percent average annual growth from 1947 to 1977. By contrast, the more recent traffic projections prepared for “existing” waterways reflected the shipper decisions, economic conditions and forecasts, and waterway traffic that were based on the 35 years of strong growth after World War II. Thereafter came an economic slowdown, particularly for waterways, whose traffic slumped to an average annual growth rate of less than one percent from 1977 to 1998.

Several of the initial traffic forecasts for “new” waterways were prepared in the first half of the twentieth century, when the methods for developing traffic projections were much less sophisticated than in the latter half of the century, particularly subsequent to 1975. In several cases a very long time elapsed between preparation of the initial traffic projection and when the waterway project was fully operational. The development period for these waterways generally lasted about 40 to 50 years --- 38 years for the Arkansas, 17 for the Columbia-Snake, 53 for the Missouri, 48 for the Red and 40 for the Tennessee-Tombigbee. Generally, “new” waterways start operating with low traffic levels (less than 10 million tons) in early years of operation, making forecasts more susceptible to deviations that reflect small, but relatively significant shifts in actual traffic within major commodity groups due to a variety of short term macro and micro economic factors. Finally, the “new” waterways generally serve developing regions and areas that historically have a smaller population base and a less developed industrial and agricultural infrastructure.

Traffic forecasts for improvements on “existing” waterways generally were developed in the last half or third of the twentieth century and tended to be based on more sophisticated methods of economic analysis. In most cases there was a relatively short development time (about 15 years) between preparation of waterway traffic forecasts and completion of the related improvement that would benefit system traffic by replacing an older, smaller lock with a new larger chamber or by constructing an additional chamber. These “existing” waterways generally have high (over 25 million tons per year) or moderate (10 to 25 million tons per year) levels of waterborne commerce. Thus, because their total and key commodity group traffic are higher, traffic forecasts tend to be less sensitive to macro and micro economic events, and a shift in actual traffic for one commodity can be offset by changes in actual traffic for other commodities carried on the waterway. These waterways also tend to serve regions with larger population bases and a developed industrial and agricultural infrastructure.

TABLE S-4
WATERWAY TRAFFIC GROWTH, 1947 – 1998
(Tons in 000)

Year	Tons	Change	Percent Change	Compound Annual Percent
1947	149,614			
1957	182,150	32,536	21.75	2.0
1967	398,593	216,443	118.83	8.1
1977	528,705	130,112	32.64	2.9
1987	569,827	41,122	7.78	0.8
1998	625,028	55,201	9.69	0.8
1947-1977		379,091	253.38	4.3
1977-1998		96,323	18.22	0.8

Source: Waterborne Commerce of the United States, USACE Waterborne Commerce Statistics Center, annual.

b. Commodities

Although commodity level forecast components were not available across all waterways, Table S-5 displays those that were provided at a level of detail that allowed for a meaningful comparison against 1998 traffic data. Table S-5 confirms that projecting commodity level traffic proved more difficult than forecasting total traffic. Actual commodity traffic exceeded the projected commodity traffic in about one-half of the forecasts displayed.

Coal traffic, important to the Lower Mississippi, Ohio, Tennessee, BWT, and Tenn-Tom, has continued to grow, but more slowly than anticipated for a variety of reasons. Anticipated domestic coal movements have not kept pace with traffic projections made prior to the Clean Air Act and its amendments and subsequent implementation of emission standards. Coal traffic has also been impacted by increased government regulations of mining practices. Exports of steam and metallurgical coal through Lower Mississippi River ports and Mobile (served by the Tenn-Tom and BWT) declined due to lower worldwide demand than expected and competition from foreign countries that expanded production of lower cost coal. There has been a geographic shift from higher priced and higher sulfur eastern coal to lower priced low sulfur western coal for use in domestic electric utility plants. However, low cost unit train operations resulted in a loss of some existing and potential rail-barge and all barge movements of coal to all-rail traffic (Tennessee). So far the shift in traffic, particularly for coal, from the Mississippi to the Tenn-Tom and BWT has been somewhat less than forecast.

TABLE S-5
PROJECTED AND ACTUAL 1998 TRAFFIC
FOR SELECTED INLAND WATERWAY
COMMODITY FORECAST COMPONENTS [1]

Waterway	Forecast Year	Commodity Group	Projected Traffic (Tons in 000s)	Actual Traffic (Tons in 000s)
Ohio	1980 [2]	Coal	148,000	132,700
Tennessee	1969	Coal	45,500	20,500
Tennessee	1989	Coal	24,500	20,500
Tenn-Tom	1945	Forest Products	302	3,614
		Agricultural Products	377	70
Tenn-Tom	1986	Forest Products	2,500	3,614
		Agricultural Products	203	70
		Coal	7,125	2,601
MK Arkansas	1943/54	Petroleum & Petro Products[3]	4,961	1,104
		Chemicals[4]	1,018	1,981
		Farm Products	1,010	2,762
		Manufacturing Products[5]	3,786	1,349
		Crude Materials[6]	1,388	4,828
Johnston (Red)	1983	Iron & Steel	1,246	9
		Energy Products[7]	471	1,061
		Chemicals[8]	1,024	201
		Grain	62	142
		Sand & Gravel	Not included	2,334
Missouri	1950	Farm Products	3,166	705
		Sand & Gravel	Not included	6,478
Missouri	1953	Farm Products	1,270	705
		Sand & Gravel	Not included	6,478
Columbia	1977	Grain[9]	5,417	6,578
		Lumber, Wood & Paper[10]	1,422	1,354
		Petroleum & Petro Products	622	2,051
		Sand & Gravel	7,020	314

Source: IWR based on USACE Division inputs. Refer to the attachments for waterway details.

[1] Commodity data extracted from USACE Division attachments for individual inland waterways and included above only where level of detail allowed a consistent comparison. Specific commodity level forecasts not readily available for BWT, GIWW and Lower Mississippi River segments.
[2] Proj80 is the only Ohio River forecast for which individual commodity group projections were available.
[3] Petroleum products category includes coke from coal, coke from petroleum, and coal.
[4] Chemicals include agricultural fertilizers, which comprise largest % of this category in most years.
[5] Iron & steel products constitute major commodities within manufactured good category in a typical year.
[6] Crude materials include various ores, sand, gravel, rock, logs and waterway improvement materials.
[7] Energy products category includes petroleum, coal and coke from coal and petroleum.
[8] Chemical category includes industrial and agricultural chemicals and related chemical products.
[9] Grain category includes other agricultural goods.
[10] Lumber, wood & paper category also includes paper products, logs, woodchips and pulp.

Agricultural products have moved in large volumes on the Lower Mississippi from the Upper Mississippi River and Illinois Waterway, mostly bound for export markets. Agricultural products traffic has been greater than projected on the Columbia-Snake and lower than projected on the Missouri because of the higher than expected demand for wheat in the Far East and the introduction of lower cost unit trains to transport grain from the upper Great Plains to states in the Pacific Northwest for shipment to the Far East. Grain traffic on the Missouri, which had tracked with forecasted levels until the early 1980's, has also suffered because of the growth of local and regional consumption, especially for processing and animal feeds. By contrast, grain traffic from the lower Great Plains on the Arkansas bound for export from Louisiana's ports exceeds the amounts forecast.

Other commodities may be either significant in offsetting losses in coal, grain, or other traffic or be disappointing when compared with the projections. Non-metallic minerals, especially sand, gravel, and stone, have surpassed their traffic projections on the Missouri and Arkansas, while not tracking as well with the forecasts on the Columbia, BWT, and Tenn-Tom. Petroleum product traffic has far exceeded projected levels on the Red and on the Columbia where a pipeline was not constructed. However, movements of petroleum products and crude petroleum on the GIWW and MK Arkansas have been below the projected levels. Domestic and export markets have boosted forest product traffic on the BWT and Tenn-Tom above forecast levels.

ATTACHMENTS

ATTACHMENT 1: Great Lakes and Ohio River Division

Introduction

The existing Ohio River can be generally characterized as a system of high-lift dams breached by 110'x1200' main chambers and 110'x600' auxiliary chambers, opened between 1959 and 1975. Notable legacy projects from previous investment programs remain (LD52, LD53, Emsworth, Dashields, and Montgomery, in particular). The Tennessee River projects are legacies of several investment programs, though the majority of the main lock chambers are 110'x600' chambers brought on-line in the 1960s. Notable exceptions are the 110'x600' Kentucky Lock which began operation in 1942, the three small-chamber projects on the upper Tennessee (Chickamauga, Watts Bar, and Fort Loudoun each have a single 60'x360' chamber), and the large main chamber project at Pickwick Lock opened in 1984 (the main chamber is 110'x1000' and the auxiliary is 110'x600').

A number of challenges presented themselves in this analysis. Traffic projections that supported the improvements that resulted in the existing Ohio and Tennessee River infrastructure were made between the 1960s and 1980s. Not surprisingly, the older reports supporting these investments are not readily available. Compounding the research difficulty is the nature of these studies; their purpose being to evaluate a specific lock and dam project investment, rather than investments in a river system. For that reason, lock-specific projections were generally presented in much more detail than river projections. And finally, at the time these studies were underway, responsibility for making traffic projections rested outside the district offices. In the case of the Ohio River, the division office, rather than the district office, made the traffic projections, and in the case of the Tennessee River, the Tennessee Valley Authority (TVA), rather than the Corps of Engineers, made the traffic projections. In the final analysis, there is sufficient information to make the requested comparisons, but the older projection sets are not as rich an information source as they may have been when first developed. Full and complete projection details may exist outside of the reports referenced for this paper, but time and resources precluded an exhaustive search for this material.

Projection Sources

The projections selected for presentation in this paper come from a number of sources. The three Ohio River projections presented below are referred to as Proj65, Proj68, and Proj80. Proj65 projections appeared in the September 1965 *Willow Island General Design Memorandum*. The Proj68 set appeared in the July 1969 *Report on Replacement, Gallipolis Locks and Dam* (an intended decision document supplanted by the Gallipolis feasibility report). Proj80 projections appeared in Appendix L of the 1980 *Gallipolis Locks and Dam Replacement, Ohio River, Phase 1, Advanced Engineering and Design Study, General Design Memorandum*. Projections presented in the later two studies reference predecessor traffic projection studies, one of which, *Projections of Demand for Waterborne Transportation, Ohio River Basin, 1980 – 2040,* was readily available.

The two Tennessee River projection sets presented below are referred to as Proj69 and Proj89. The Proj69 set was drawn from excerpts of the Main Lock at Pickwick Landing Dam, Planning Report 4-100-2, Tennessee Valley Authority, September 1970. Though the new lock came on-line in 1984, study results were based upon waterway traffic projections prepared in the 1960s. These projections relied upon industry employment forecasts presented in *Resources for America's Future* published by Resources for the Future in 1963. A more recent waterway study, the December 1991 *Lower Cumberland and Tennessee River Navigation Feasibility Report, Kentucky Lock Addition, Appendix D*, presents the most recent set of Tennessee River projections used in a decision document. This last report draws upon projections presented in *Forecast of Future Ohio River Basin Waterway Traffic, 1986 – 2050, Part II: Commodity Traffic Demand Forecasts (Proj89).*

1A: Ohio River

1. Projection Methodology

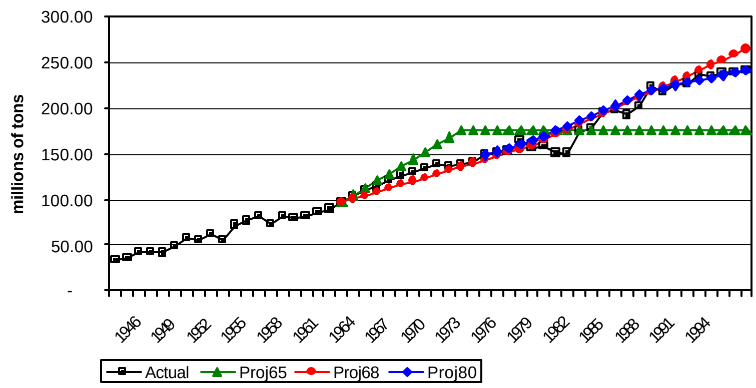
Methodologies used in projecting waterway traffic have evolved over time. Proj65 relied heavily on historic waterway traffic growth, which was used in extrapolating from the 1964 base year out to 1974. Traffic diversions were estimated and formed the basis for additional capacity need. Benefits accruing to capacity expansion were estimated for these ten years and then assumed to remain constant throughout the study period. In essence, traffic demands were held constant after 1974. So while the Proj65 set may have overestimated growth in the first 10 years, it grossly underestimated traffic growth between 1974 and 2000.

Proj68 and Proj80 relied upon growth expectations for key waterway industries. In both instances these expectations were based upon economic forecasts and shipper surveys. As can be seen in Figure 1 below, this method proved to yield better predictions of the future.

2. Results

Figure 1 summarizes the performance of the three Ohio River traffic projection sets. Proj65, the oldest projection set, deviated the most from actual traffic, while the other two sets performed quite well.

FIGURE 1
Ohio River Traffic
Actual vs. Projected



Numeric results for each of the projection sets are displayed in Table 1. Again, Proj65 did not perform as well as the other two projection sets. Proj68 tracked actual traffic very well for 30 years, and projected traffic never exceeded actual traffic by more than 9 percent. The performance of Proj80 projections was remarkable over its first 18 years.

TABLE 1
Ohio River Traffic Demand Projections -- All Commodities
Modernization Studies for the Existing System
(millions of tons)

Year	Actual	Projection Set: Proj65 1/	Projection Set: Proj68 2/	Projection Set: Proj80 3/
1950	48.6			
1960	79.5			
1970	129.6	144.1	119.9	
1975	140.1	175.9	139.4	
1980	155.9	N/A	159.0	164.2
1985	177.5	N/A	188.4	192.0
1990	224.7	N/A	217.8	219.7
1995	235.8	N/A	247.0	233.4
1996	239.0	N/A	253.0	236.2
1997	239.8	N/A	258.8	238.9
1998	241.9	N/A	264.7	241.6

Source:

1/ 1965 Projections taken from the Willow Island Locks and Dam General Design Memo. - Design Memo. No. 1, Huntington District, September 1965. No projections were presented for years beyond 1975. The economic analysis implicitly assumed no traffic growth.

2/ 1968 Projections taken from Report on Replacement, Gallipolis Locks and Dam, Main Report, Huntington District, July 1969.

3/ 1980 Projections taken from Gallipolis Locks and Dam Replacement, Ohio River, Phase 1, Advanced Engineering and Design Study, General Design Memorandum, Appendix L, Study Area Economics Base and Commodity Flow Analysis, Huntington, District, 1980.

In fact, Proj80 projections were generally lower than actual traffic throughout the 1990s.

As can be seen in Table 2, projecting total traffic proved to be less difficult than projecting traffic by commodity. Proj80 is the only set for which individual commodity group projections are available. Coal projections performed very well between 1980 and 1990, before consistently overstating coal traffic. Projected traffic frequently exceeded actual traffic by 10 percent from 1995 on. While early provisions of the Clean Air Act were in effect when these projections were made, increasingly more stringent laws and rules became effective in subsequent years. These stricter requirements, especially with regard to sulfur and nitrous oxide emissions, along with other government actions affecting coal mining practices, have acted to dampen coal growth, while not halting growth altogether. The necessary corollary to this situation is that other commodities have performed better than expected allowing total traffic projections to track actual Ohio River traffic.

TABLE 2
Ohio River Traffic Demand Projections -- Coal
Modernization Studies for the Existing System
(millions of tons)

Year	Actual	Projection Set		
		Proj65 1/	Proj68 2/	Proj80 3/
1950	23.9			
1960	40.0			
1970	59.0			
1975	73.3			
1980	99.9			96.5
1985	98.2			116.1
1990	136.7			135.8
1995	130.0			143.4
1996	134.8			145.0
1997	135.1			146.5
1998	132.7			148.0

Source:

1/ 1965 Projections taken from the Willow Island Locks and Dam General Design Memo. - Design Memo. No. 1, Huntington District, September 1965. No projections were presented for years beyond 1975. The economic analysis implicitly assumed no traffic growth.

2/ 1968 Projections taken from Report on Replacement, Gallipolis Locks and Dam, Main Report, Huntington District, July 1969. This report was supplanted by the 1980 Gallipolis GDM as a decision making document. No commodity-specific projections for the Ohio River were presented.

3/ 1980 Projections taken from Gallipolis Locks and Dam Replacement, Ohio River, Phase 1, Advanced Engineering and Design Study, General Design Memorandum, Appendix L, Study Area Economics Base and Commodity Flow Analysis, Huntington, District, 1980.

Note: Commodity specific projections were not available for Proj65 and Proj68.

1B: Tennessee River

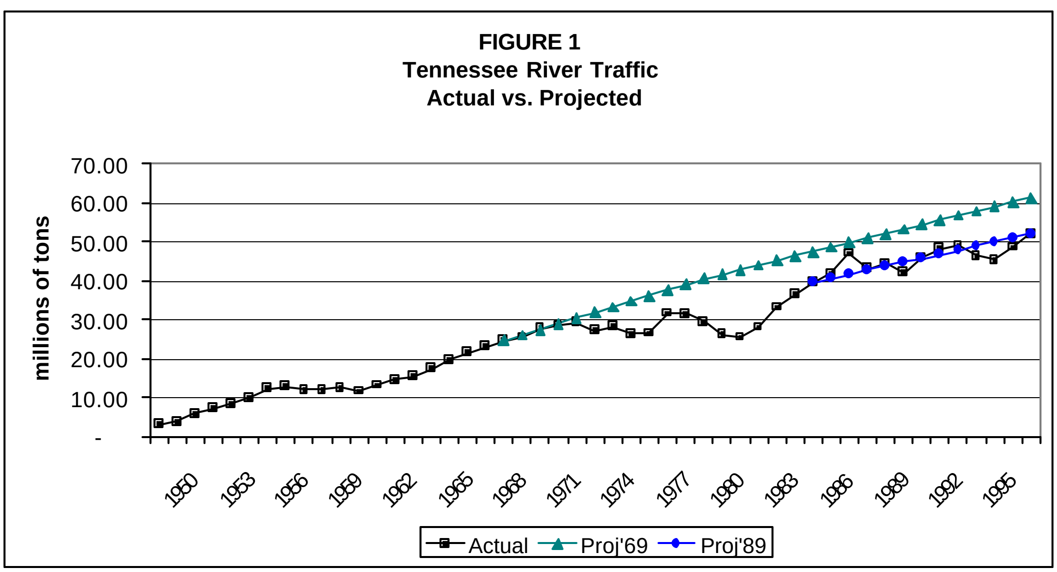
1. Projections Methodology

Methodologies used in projecting waterway traffic on the Tennessee River are of two characters. Proj69, which supported the decision to build a 110'x1000' main chamber at Pickwick, relied upon key waterway dependent industry employment forecasts and the calculation of an average waterway tons per employee. Adjustments were made to the resulting projection based upon information about potential new movements as provided by Tennessee Valley shippers. Proj89, which supported the decision to replace Kentucky Lock with a 110'x1200' chamber, recognized separate short-term and long-term forecast horizons. Short-term projections relied upon extensive user surveys and plant/company level forecasts. Long-term projections relied upon industry and geographic-specific earnings projections.

2. Results

Proj69 consistently overestimated actual traffic beginning in the early 1970s when the Tennessee River entered a decade long pause in significant traffic growth (see Figure 1). The 1970s oil shocks, coal strikes, general economic slowdown, and TVA's focus on nuclear generation acted to dampen growth on the Tennessee. Ironically, some of these very factors led to a resurgence in traffic when TVA re-focused on electrical generation with coal. In the 1980s traffic began to rebound, nearly reaching levels in 1986 predicted by Proj69. However, a major coal transfer terminal closed shortly afterward, causing 6-9 million tons of coal to be lost to Tennessee River towing companies. Had this tonnage remained, it is possible that the Proj69 projection set would have performed quite well in the late 1980s and 1990s.

Proj89, with this history behind it, has performed remarkably well. Actual traffic has held close to the projection line, moving both slightly above and below.



Macro-economic forces caused Tennessee River traffic to flatten in the 1970s and the return to coal-fired electric generation led to re-newed growth in the 1980s. Traffic in the 1990s continued to grow, but at a slower pace dictated by the loss of a major coal shipper. Proj69 projections remained consistently higher than actual traffic, exceeding 1998 actual traffic by 18 percent. Over the last 10 years Proj89 has ranged between 2 percent too low to 10 percent too high. In 1998 the difference between actual and projected traffic was 100 thousands tons out of a total of 52 million tons.

TABLE 1
Tennessee River
Tennessee River Traffic Demand Projections -- All Commodities
Modernization Studies for the Existing System
(millions of tons)

Year	Actual	Projection Set	
		Proj69 1/	Proj89 2/
1950	3.1		
1955	10.0		
1960	12.4		
1965	17.4		
1970	25.5	25.5	
1975	28.3	33.2	
1980	29.4	40.5	
1985	36.5	46.3	
1990	44.5	52.1	43.7
1995	46.3	57.9	48.9
1996	45.4	59.1	49.9
1997	48.6	60.2	50.9
1998	52.0	61.4	51.9

Source:

1/ Main Lock at Pickwick Landing Dam, Planning Report 4-100-2, Tennessee Valley Authority, September 1970.

2/ Lower Cumberland and Tennessee River Navigation Feasiblity Report, Kentucky Lock Addition, Appendix D, Systems Analysis, prepared for the Nashville District by the Huntington District, December 1991.

A similar performance pattern between these projection sets carries through when looking at individual commodities. Proj69 grossly overstated coal traffic, while Proj89 tracked actual coal traffic fairly well. As mentioned above, some of Proj69's poor performance can be traced directly to the loss of a major coal transfer terminal on the Tennessee River. Proj69 overestimated coal traffic by as much as 136 %; Proj89 by as much as 30%.

TABLE 2
Tennessee River
Tennessee River Traffic Demand Projections -- Coal Modernization Studies for the Existing System
(millions of tons)

Year	Actual	Projection Set	
		Proj69 1/	Proj89 2/
1950	0.2		
1955	5.7		
1960	5.2		
1965	7.3		
1970	9.7	9.7	
1975	12.1	19.7	
1980	15.1	27.1	
1985	19.1	32.2	
1990	22.2	37.3	23.6
1995	18.8	42.4	23.8
1996	18.4	43.4	24.0
1997	19.5	44.4	24.3
1998	20.5	45.5	24.5

Source:

1/ Main Lock at Pickwick Landing Dam, Planning Report 4-100-2, Tennessee Valley Authority, September 1970.

2/ Final Report, Forecast of Future Ohio River Basin Waterway Traffic, 1986-2050, Part II: Commodity Forecasts, Huntington District, May 1990 and Commodity Traffic and Benefit Study for Navigation Improvements on the Upper Tennessee River, prepared for Nashville District by Huntington District, March 1988.

ATTACHMENT 2: Mississippi Valley Division

2A: Lower Mississippi River; Cairo to Baton Rouge

1. Introduction

Channel improvement is an integral part of the Mississippi River and Tributaries (MRT) Project authorized by the Flood Control Act of 1928 and its later amendments. Involved, in addition to the project's flood control features, are provisions for the construction and maintenance of a navigable channel from Cairo, Illinois, to Baton Rouge. In 1896 Congress authorized a navigation channel 9 feet deep and 250 wide at low water between Cairo and Head of Passes near the Mississippi River's mouth. A width of 300 feet was authorized in 1928. In 1944 the authorized depth from Cairo to Baton Rouge was increased to 12 feet at low water. Width remained 300 feet. Along this 725-mile segment a minimum low water navigation channel 9 feet deep and 300 feet wide is maintained through dredging and other control measures. Modern improvements designed to facilitate navigation on the Mississippi River below Cairo, Illinois have also provided flood control benefits.

The shallow draft Lower Mississippi River between Cairo and Baton Rouge connects with the Ohio River and Middle Mississippi River in the north at Cairo and the deep draft Mississippi River at Baton Rouge. The deep draft Mississippi River, including four of the Nation's largest ports at Baton Rouge, South Louisiana, New Orleans, and Plaquemines, provides the intermodal connection between inland waterway and coastal and foreign traffic. Other waterways directly or indirectly connect with the Lower Mississippi along its course and originate or terminate traffic that moves on the Mississippi. These waterways include the Arkansas, White, Ouachita-Black, Red, Atchafalaya, Yazoo and Gulf Intracoastal Waterway. Ports along the Lower Mississippi that provide intermodal connections via railways and highways or direct links to individual docks include Memphis, Tennessee, Vicksburg, Greenville, Natchez, and Rosedale, Mississippi, Helena, Arkansas, and Lake Providence, Louisiana.

2. Projected and Actual Traffic

Actual tonnage moving on the Lower Mississippi has outstripped projected movements because one out of every seven tons of waterborne commerce in the United States since 1970 has moved on waterways and through ports in the Lower Mississippi Region. Most of this activity occurred on the Mississippi River and the Gulf Intracoastal Waterway and the four deep draft ports along the Mississippi River in Southern Louisiana. Important commodities moved were petroleum and petroleum products, iron and steel products, nonmetallic minerals, unprocessed marine shells, grain and grain products.

The Lower Mississippi Region Comprehensive Study was conducted to obtain basic information for functional studies and plan formulation. It described the present and past population and employment trends of the region and the Nation. Inputs to the economic study element were obtained primarily from national economic projections by the Bureau of Economic Analysis and the Economic Research Service (OBERS). The inputs included projections of population, employment, earnings, income, and production of goods and services at the national level.

Table 1

Lower Mississippi River Projected and Actual Tonnage, 1970-2000

(1,000 Tons)

Year	Projected Tons [1]	Actual Tons [2]
1970	72,453	85,558
1980	99,799	146,159
1990	108,392	188,540
1998	185,733	195,840
2000	185,733	NA

[1] Source: Lower Mississippi Region Comprehensive Study, 1974, Appendix J, Navigation

Note: Projected traffic is inland only, but includes coastwise and foreign traffic moving on the Mississippi River. Data for 1998 is interpolated.

[2] Source: Waterborne Commerce of the United States, Part 2 for Mississippi River, Mouth of Ohio to Baton Rouge, LA, USACE, annual.

Note: Actual traffic is internal only, and excludes coastwise and foreign traffic. Data for 2000 is not available.

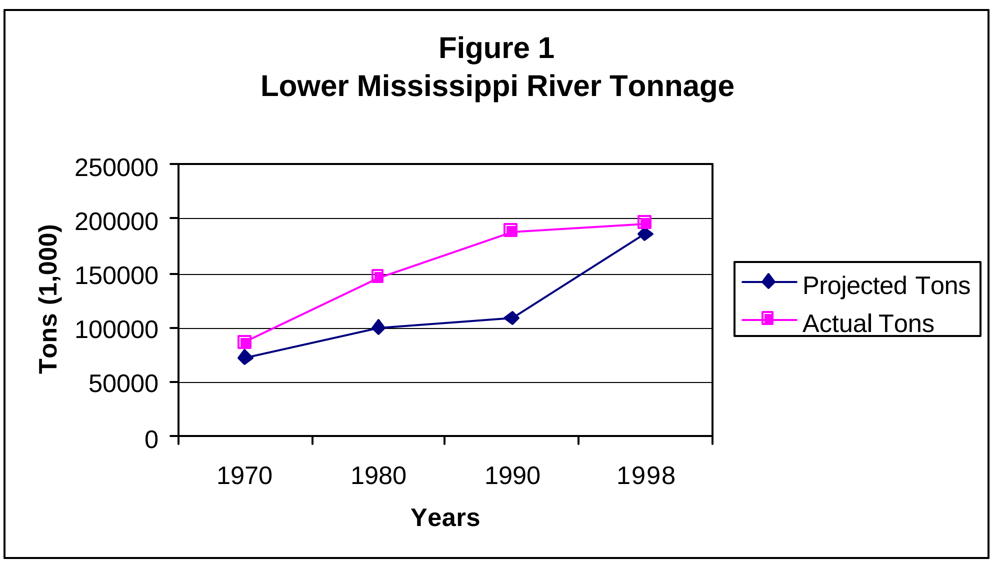


Table 2
Lower Mississippi River Traffic
by Commodity, 1980, 1990, and 1998
(Million Tons)

Commodity	1980	1990	1998
Farm Products	64.1	76.1	69.7
Metals	6.8	13.0	22.9
Coal	17.1	40.0	28.4
Crude Petroleum	5.2	1.7	2.2
Nonmetallic Minerals	9.7	21.5	31.6
Forest Products	0.7	0.6	1.3
Industrial Chem	11.5	10.1	10.9
Agricultural Chem	5.9	7.7	8.5
Petroleum Products	20.6	17.9	19.8
Other	4.5	0.1	0.3
Total	146.2	188.5	195.9

Source: Waterborne Commerce of the United States, Part 2 for Mississippi River, Mouth of Ohio to Baton Rouge , LA, USACE, annual.

2B: J. Bennett Johnston (Red River) Waterway
Mississippi River to Shreveport, Louisiana

1. Introduction

Previous work for the improvement of the Red River below Fulton, Arkansas was authorized first in 1828 and in subsequent years through 1890. The existing project was authorized by the River and Harbor Act of 13 July 1892. A 35-mile link between the Ouachita and Black Rivers navigation project and the Mississippi River is included in the project.

The Overton-Red River Waterway project was authorized in 1946 as a modification of the project "Red River Below Fulton, Arkansas." Under the modification a 9 by 100-foot navigation channel was to be constructed from the Mississippi River via the Old and Red Rivers for a distance of 31 miles and then through a new land cut to Shreveport. The 205-mile long project would have included nine locks. Surveys and preliminary studies were suspended in 1961 due to a lack of local cooperation. Planning was resumed for the lower 31 miles of the waterway in 1965, and construction of the project was initiated in 1968. Authorization of the Red River project eliminated the need for the Overton-Red River Waterway above Mile 31. Completion of the lower 31 miles of the project occurred in 1982. The lower 31 miles was subsequently incorporated into the Red River Waterway, Mississippi River to Shreveport, Louisiana, project.

The River and Harbor Act of 1968 authorized as a modification of the project, "Red River Below Fulton, Arkansas, and Louisiana," a plan for navigation on the Red River from the Mississippi River to Shreveport, consisting of a channel 9 feet deep and 200 feet wide and utilizing five navigation locks and dams. Construction of the 236-mile long Mississippi River to Shreveport reach was initiated in 1973. The entire waterway was opened to navigation in December 1994.

2. Information Sources

Two sources of information and data provided a comparison of forecast and actual traffic on the Mississippi River to Shreveport reach of the Red River Waterway. Forecasts were obtained from General Reevaluation Report and Environmental Impact Statement No. 2, New Orleans District USACE, August 1983. Actual traffic was obtained from the Waterborne Commerce of the United States, USACE, annual.

3. Projection Methods

Detailed analyses of potential navigation benefits for the proposed waterway were presented in the Phase I – General Design Memorandum (DM No. 2) published in May 1976. A comprehensive field canvass of potential shippers was conducted during the period November 1971 to June 1972. The area covered by the survey included 10 parishes in Louisiana, 22 counties in Texas, and 5 counties in Arkansas.

Commodity forecasts were based on 1972 OBERS Projections, Economic Activity in the United States by Economic Area, Water Areas, Historical and Projected – 1929-2020. (April 1974). The bulk of the commodity movements originates or terminates within the Alexandria or Shreveport, Louisiana, Standard Metropolitan Statistical Areas (SMSA). Data for these SMSAs were utilized in the traffic forecast.

4. Projected and Actual Traffic

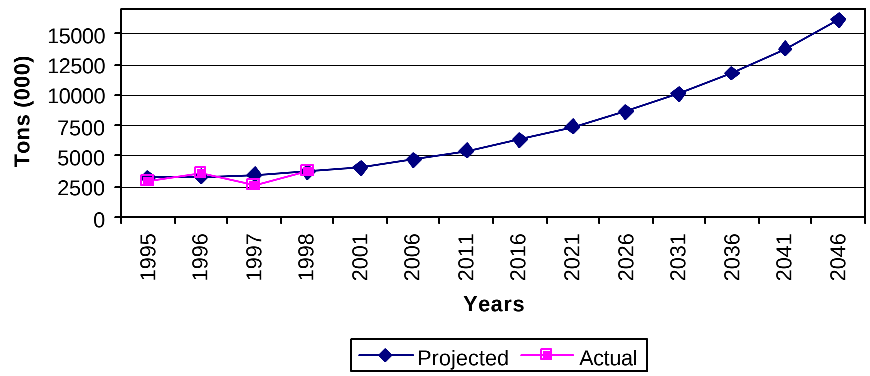
Actual traffic movements on the waterway have been very close to forecast levels. Traffic was forecast to increase from 3.3 million tons in 1996 to 3.99 million tons in 2001. Actual movements increased from 3.6 million in 1996 to 3.7 million in 1998. There was a decrease in 1997 to 2.6 million tons (Table 1 and Figure 1).

Table 1
J. Bennett Johnston (Red River) Waterway
Projected and Actual Total Tonnage (000), 1995-2046

Year	Projected	Actual
1995	3,222	2,938
1996	3,327	3,619
1997	3,460	2,608
1998	3,727	3,749
2001	3,993	
2006	4,651	
2011	5,426	
2016	6,332	
2021	7,390	
2026	8,629	
2031	10,080	
2036	11,779	
2041	13,769	
2046	16,106	

Sources: 1. General Reevaluation Report and Environmental Impact Statement Supplement No. 2, USACE, New Orleans District, August 1983.
2. Waterborne Commerce of the United States, USACE Waterborne Commerce Statistics Center, annual.

Figure 1
J. Bennett Johnston (Red River) Waterway
Projected and Actual Total Tonnage, 1995-2046



Commodity types moving on the system, primarily sand, gravel, and stone, petroleum products, chemicals, and grain, are very similar to those projected to move. However, the tonnages for sand, gravel, and stone, petroleum products, and grain have exceeded projected levels, while tonnages for iron and steel, chemicals, and paper and allied products have not reached forecast levels. Since the waterway has been open only a short time and a solid traffic base has not been established, the mix of goods moving will probably vary during these early years (Tables 2 and 3).

Table 2
J. Bennett Johnston (Red River) Waterway
Projected Tonnage by Commodity, 1996-2046
(000s)

Year	Iron & Steel	Other Metals & Ores	Industrial Chemicals	Agricultural Chemicals	Sulphur	Energy Products	Paper & Allied Products	Grain	Misc.	Total Tonnage
1996	1,150	58	933	19	147	436	408	60	116	3,327
2001	1,390	65	1,112	20	177	523	508	65	133	3,993
2006	1,627	68	1,290	21	212	612	606	67	148	4,651
2011	1,905	71	1,495	22	255	716	724	69	169	5,426
2016	2,230	75	1,733	23	307	839	864	73	188	6,332
2021	2,610	79	2,009	24	369	982	1,031	76	210	7,390
2026	3,055	83	2,329	25	443	1,150	1,231	79	234	8,629
2031	3,576	87	2,700	26	533	1,346	1,469	82	261	10,080
2036	4,186	92	3,130	27	640	1,576	1,753	84	291	11,779
2041	4,900	97	3,628	28	770	1,844	2,092	86	324	13,769
2046	5,736	102	4,206	29	926	2,159	2,497	89	362	16,106

Source : General Reevaluation Report and Environmental Impact Satement Supplement No. 2, New Orleans District, Aug. '83.

Table 3
J. Bennett Johnston (Red River) Waterway
Actual Tonnage by Commodity, 1995-1998
(000s)

Year	Iron and Steel Products	Chemicals and Related Products	Petroleum Products	Grain	Sand Gravel and Stone	Lime	Manufactured Equipment & Machinery	Coal	Total Tonnage
1995	1	268	675	419	1559	10	6		2,938
1996	2	221	575	197	2601		23		3,619
1997		163	696	200	1549				2,608
1998	9	201	1039	142	2334		2	22	3,749

Source: Waterborne Commerce of the United States, Waterborne Commerce Statistics Center, annual.

2C: Gulf Intracoastal Waterway
Leland Bowman Lock

1. Introduction

The Vermilion Lock, Louisiana, on the Gulf Intracoastal Waterway (GIWW) was authorized for replacement by the Water Resources Development Act of 1976. The project was located on the Louisiana section of the GIWW near Abbeville, Vermilion Parish, Louisiana (about midway between Lake Charles and Morgan City). The purpose of the authorized improvement was to replace the lock, which was 1,182 feet long, 56 feet wide, and had a sill depth of 11.3 feet, with a larger lock that would provide adequate facilities for existing and projected navigation requirements. The Vermilion Lock represented a bottleneck within a system of five adjacent locks located along the GIWW. The original analysis prepared in 1973 assumed deepening of the GIWW from 12 to 16 feet. A reanalysis was conducted in 1978 after local assurances were not furnished. Construction of the Leland Bowman Lock was begun in 1981 and completed in 1985. The new lock dimensions are 110 feet wide and 1,200 feet long with a sill at 15 feet below mean low Gulf datum.

2. Projection Method

Projected growth rates for Vermilion Lock traffic were prepared in the original 1973 report. The subsequent 1978 economic justification utilized 1976 traffic through Vermilion Lock as a base upon which growth rates for commodity groupings were applied. A weighted average of original report growth rates for seven major commodity groups, based on the percent of tons in each group that traveled through the lock, was calculated in 5-year increments over the period 1980-2030. No projections of traffic were made for the GIWW segment from the Mississippi River to Sabine River.

3. Projected and Actual Traffic

Table 1 and Figure 1 present projected and actual tonnage, as reported by the Lock Performance Monitoring System, for Bowman Lock after its opening for the years 1986, 1990, 1995 and 1998. Traffic at Bowman Lock rose from 41.5 million tons in 1986 to a record 46.0 million tons in 1988 and 45.9 million tons in 1990. Thereafter traffic declined to 42.2 million tons in 1995 and 37.6 million tons in 1998. Traffic through Bowman Lock in 1990 represented 68 percent of that on the GIWW, Mississippi River to Sabine River segment, but it was 61 to 64 percent in 1986, 1995, and 1998. The major commodities on that GIWW segment in 1998 were petroleum products (18.2 million tons and 30 percent of the total) crude materials (13.5 million tons and 22 percent), chemicals (12.2 million tons and 20 percent), and crude petroleum (10.3 million tons and 17 percent).

In 1986 and 1990 actual traffic was 73 and 71 percent respectively of projected traffic, but it dropped to 56 percent in 1995 and down further to 46 percent in 1998. At the time of the project study in 1976 the two major commodity groups were petroleum and petroleum products (60 and 20 percent, respectively). In the late 1960s and early 1970s, there were expectations that these industries would continue growing throughout the 1980s and 1990s. Thus, the growth rates were 3 percent for both industries until the year 2000 and then constant tonnage thereafter. These growth rates proved reasonable only in the short term, resulting in the actual traffic being about 46 percent of the projected.

Table 1
LELAND BOWMAN LOCK TONNAGE
(Tons in 000)

Year	Projected Traffic	Actual Traffic	Difference	Actual % of Projected
1986	57,120	41,550	15,570	72.74
1990	64,400	45,887	18,513	71.25
1995	75,200	42,212	32,988	56.13
1998	82,700	37,645	45,055	45.52

*Projections for 1986 and 1998 are interpolated from report projections.

Source: Vermilion Lock, Louisiana Replacement Design Memorandum No. 1, Supplement No. 1 and Lock Performance Monitoring System

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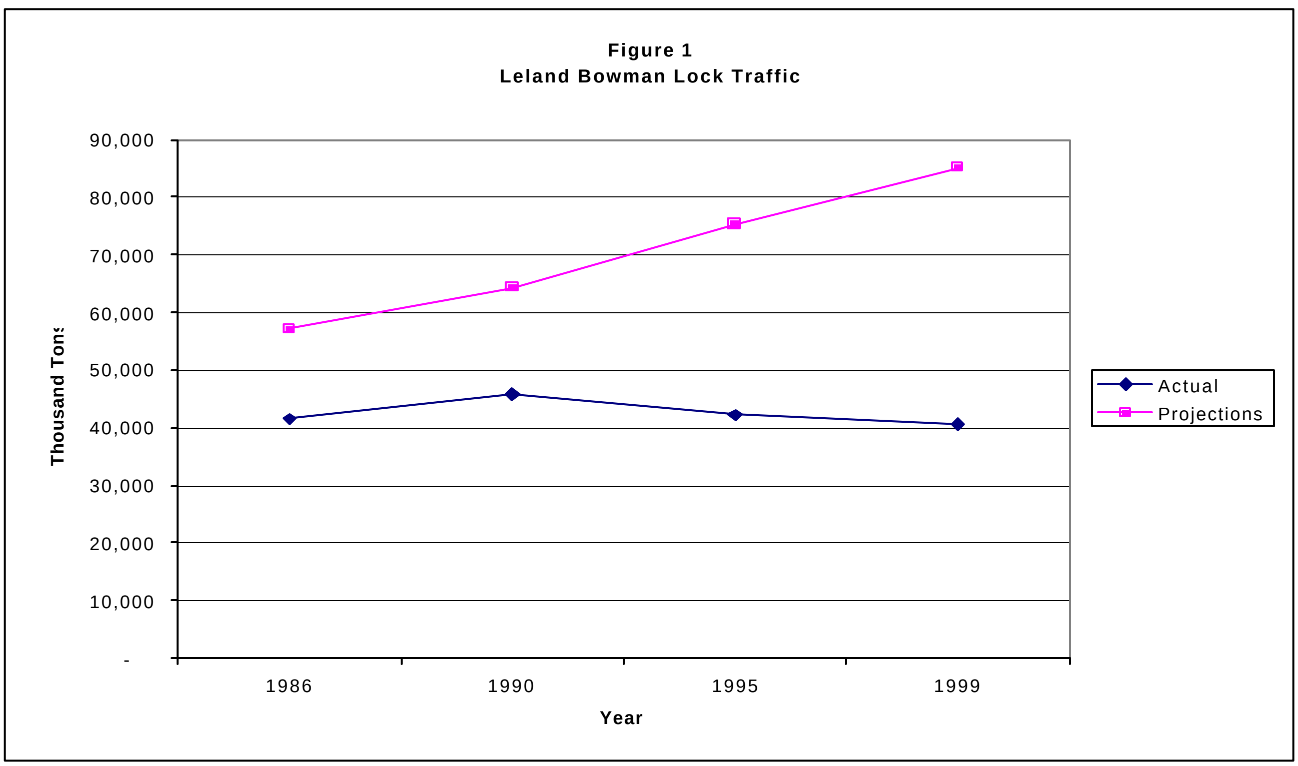


ATTACHMENT 3: Northwestern Division

3A: Columbia - Snake Waterway (Columbia Portion)

1. Introduction

This paper is to compare the actual navigation traffic on the Columbia - Snake Waterway to the tonnage projections made in studies for project authorization. This study was done using readily available data and appropriate references are made to data sources. This examination concentrates on the movement of commodities in the Columbia River section of the waterway. This was done by utilizing commodity tonnages through the Bonneville Lock and Dam. Bonneville is the furthest downstream lock of the eight locks that constitute the Columbia - Snake Waterway. Other locks in the waterway that provide shallow draft navigation upstream to Lewiston, Idaho are: The Dalles, John Day, McNary on the Columbia, and Ice Harbor, Lower Monumental, Little Goose, and Lower Granite on the Snake River.

Almost all the commodities that move on the Columbia - Snake Waterway either pass downstream or upstream through Bonneville Lock and Dam. There are very few commodity shipments that originate and terminate within the reservoirs in the waterway. For this reason, only the tonnages at the Bonneville Lock and Dam are examined in this paper.

2. Original Projections

The original Bonneville Lock was put into operation in 1938. The studies done for authorization of this lock were not very extensive and did not envision the complete, eight-dam waterway system. The earliest thorough economic study of the Columbia - Snake Waterway was done in House Document 531 - 81st Congress (1949/1950). This study was the first to define tonnage projections and economic benefits for the waterway as it is currently developed. In June 1958 a review of the HD 531-81 was done and made long-term commodity projections for each of the eight projects through year 2025. Table 1 provides the commodity movement projections through the Bonneville Lock by decade from 1960 to 2000 from the 1958 review. This table also provides the average annual projections for the period of 1975 to 2025 by commodity type.

3. Projections for Bonneville New Lock

In 1977 a Feasibility Study was done for adding a second lock at Bonneville Lock and Dam. The size of the original lock was only 56' by 500', which was smaller than the other locks in the system. The study recommended construction of a new lock that would be 86' by 675', which would be the same size as the seven other locks in the Columbia - Snake Waterway. The study provided projections of commodity movements over time. The second lock was operational in 1993.

Table 1
Columbia - Snake Inland Waterway Navigation Projections
Measured At Bonneville Lock and Dam

	Tons of Traffic (1,000)				
	1960	1970	1980	1990	2000
Total Annual Tonnage Projected for Bonneville Lock [1/]	2,266	3,781	5,296	6,811	8,326

Commodities Projected For Period 1975 to 2025 [2/]	**Downbound**	**Upbound**	**Total**	**Percent**
Aluminum and related products	200	480	680	7.40
Ammonia		139	139	1.50
Cement	200	70	270	2.90
Chemical Products	45		45	0.50
Grain	1,612		1,612	17.60
Industrial Chemicals		78	78	0.80
Limestone	1,400		1,400	15.20
Logs rafted	262		262	2.90
Lumber and poles	410		410	4.50
Paper products	96		96	1.00
Petroleum coke	555	254	809	8.80
Petroleum products		2,519	2,519	27.40
Sawdust, chips, etc	162		162	1.80
Woodpulp and products	158		158	1.70
Miscellaneous	155	390	545	5.90
Total	5,255	3,930	9,185	100.00

Source: Review of H.D. 531, 81st Congress, 2nd Session: "Water Resource Development of the Columbia River Basin", June 1958, Appendix B, North Pacific Division

Notes: [1/] Taken from Appendix B, part 3.
[2/] No year by year projections were developed by commodity, this reflects the annual average over period of 1975 to 2025.

Table 2 provides the projected tonnages of movement through the Bonneville project for the years of 1990 and 2000, as presented in the Feasibility Study (FS). Slight modifications were made in these projections for the General Design Memorandum (GDM) and a Post Authorization Study, but the FS projections are presented here because they represent the estimates from which authorization was provided. The table also shows the projections by commodity type.

Table 2
Columbia - Snake Inland Waterway Navigation Projections
Measured At Bonneville Lock and Dam

	Tons of Traffic (1,000)		
	1972	**1990**	**2000**
Bonneville Lock Tonnages	4,527	13,391	15,862

Commodities	**1972**	**1990**	**2000**	**Percent in 2000**
Grain	2,705	4,784	5,575	35.1
Petroleum	880	985	531	3.3
Sand and Gravel	58	5,500	7,400	46.7
Fertilizer	135	395	403	2.5
General Cargo	25	27	28	0.2
Wood Chips	425	900	1,000	6.3
Paper and Wood Products	4	95	101	0.6
Logs rafted	221	342	342	2.2
Miscelaneous	75	364	482	3.0
Total	4,528	13,392	15,862	100.0

Source: "Bonneville Lock & Dam, Feasibility Study for Modifying Lock," Portland District Corps of Engineers, January 1977

4. Comparison to Actual Traffic

The actual navigation traffic through Bonneville Lock was taken from the data compiled for the two studies mentioned above and the Lock Performance Monitoring System. Table 3 provides the actual total tonnages for selected years and shows the tonnages projected in the original studies. Figure 1 graphically presents this same data.

The actual total tonnages at Bonneville Lock exceeded those projected in the original system-wide study as can be seen from Table 3 and Figure 1. However, the actual tonnages were considerably less than those projected to occur in the 1977 FS with the new lock. To explain these differences, an examination by commodity category was done. Table 4 shows the actual 1998 tonnages by general commodity type. These commodity categories are slightly different than those presented in Tables 1 and 2, but do provide a general basis for comparison. By comparing Table 4 with Table 1 it can be seen that the actual tonnages at Bonneville for grain were much higher than projected in the H.D. 531-81 review analysis (actual = 6.2 million tons, projected = 1.6). The 1958 analysis projected movements of limestone of about 1.4 million tons through the Columbia - Snake Waterway, which did not materialize.

The major difference in the projections from the Bonneville 2nd Lock analysis and the existing tonnages was primarily because movement of sand and gravel through the lock did not grow as rapidly as projected in the 1977 study. From Table 2 it can be seen that sand and gravel movements were projected to be 7.4 million tons by year 2000.

However, movement in 1998 was only about 0.3 million tons. Sand and gravel movements through Bonneville Lock have grown steadily in the past five years, but not at the high rate and volume projected in the 1977 FS. Actual tonnages of petroleum and related products in 1998 were considerably higher than projected in the Bonneville 2nd Lock FS. Traffic in 1998 was over 2 million tons, but the 1977 study projected that petroleum would move primarily by pipeline and that only 0.5 million tons were projected for the lock in year 2000.

TABLE 3

BONNEVILLE LOCK: ACTUAL TRAFFIC VS. PROJECTIONS

(1,000 Tons)

Year	Actual	Projections in H.D. 531-81 Review (1958)	Projections in 2nd Lock Feasibility Report (1977)
1940	707		
1950	1,144		
1960	2,316	2,266	
1970	3,120	3,781	
1980	8,932	5,296	
1990	8,260	6,811	13,391
1998	10,850	7,872	15,121
2000		8,326	15,862

For HD 531-81 Review and Feasibility Report, 1998 was Interpolated.

Figure 1
Columbia Inland Waterway - Actual vs. Projected Tonnage

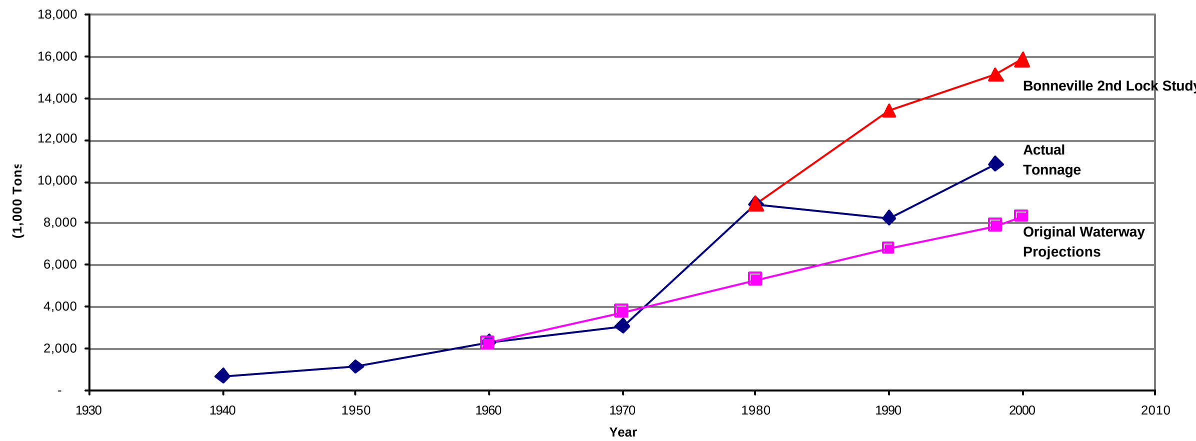


TABLE 4
Bonneville Lock Actual Tonnage for 1998

Commodities Type:	Tons (1,000)
Aluminum & Related Products	133
Chemical Products	140
Grain	6,231
Other Agricultural Goods	347
Lumber, logs, woodchips, pulp	1,151
Paper Products	203
Petroleum & Related Products	2,051
Sand & Gravel	314
Other Miscellaneous	281
Totals	**10,850**

3B: Missouri River

1. Introduction

The current Missouri River Bank Stabilization and Navigation Project, providing for a nine foot navigation channel, Sioux City to the mouth, was authorized by the River and Harbor Act of 1945 in accordance with House Document (HD) 214. This authorization expanded earlier authorizations which provided for a six-foot channel and initially provided for a navigation channel from Kansas City to the mouth. The following discussion provides a comparison between actual Missouri River traffic as reported by Waterborne Commerce of the United States and projections and estimates in HD 214 and other studies developed shortly after authorization.

2. Summary of Traffic Projections

HD 214 identifies several Missouri River tonnage estimates, two of which apply to the entire reach of the 1945 authorization, Sioux City to the mouth.

a. The earliest, a report by the United State Department of Commerce, March 1928, identifies 8,445,355 tons as available for transportation on the Missouri River, Sioux City to the mouth.

b. Two estimates by the Kansas City District Engineer, a 1929 report estimating tonnage between Kansas City and the mouth, and a 1933 estimate of tonnage between Kansas City and Sioux City, were combined in HD 214 to arrive at an estimate for the Missouri River of 12 million tons annually.

The Missouri River Division completed a report in 1950 including an extensive economic evaluation of both the navigation and bank stabilization impacts of the 1945 authorization. This report identifies 4 million tons as a reasonable estimate of probable commerce that could be assigned to the Missouri River between Sioux City and the mouth under present economic conditions. The report goes on to note that with industrial expansion in the region, navigation tonnage is estimated to increase by 25 percent to 5 million tons 20 years after project completion.

The Missouri Basin Survey Commission (MBSC), in compliance with Executive Order No. 10318, dated 3 January 1952 and modified on 9 February 1952, presented a report with an estimate of expected Missouri River tonnage. These studies identified 1,930,000 tons that could be shipped economically by barge and after adjustment for other commodities not specifically analyzed, the total volume would not exceed 2,100,000 tons.

Summary of Initial Missouri River Navigation Traffic Projections

Source	Date(s)	Projected Tonnage
U.S. Department of Commerce (HD 214)	1928	8,445,355
Corps of Engineers (HD 214)	1939 (1929,1933)	12,000,000
Corps (Missouri River Division) Report 1950	1950	4,000,000*/5,000,000**
Missouri River Basin Survey Commission (MBSC)	1953	2,100,000

10*, 20** years after project completion

3. Consideration of Alternative Projections

Of the various projections, the estimate of 12 million tons from HD 214 and the 4-5 million ton estimate from the Corps 1950 study are the two which have been quoted repeatedly. The 12 million-tonnage estimate gains its legitimacy because it is the primary projection in the authorizing document. In reality however, the Corps never seems to have been comfortable with that number as evidenced by the extensive economic evaluation conducted in 1950, only five years after authorization of a project not expected at the time to be completed until 1960. Further, it has also been determined, after research by the division historian, that the 12 million-ton figure was not based on a Corps study, but was given to the Corps by an organization of private barge owners. In contrast, the Corps 1950 study is based on extensive research and analysis including nearly 1500 field contacts encompassing over 40 commodities. The MBSC 1953 projection of tonnage to be reached by 1970 was derived from studies of waybill rail shipments from and into the region surrounding the river, interviews with prospective users of barge transportation, and information on prospective savings by waterway use.

4. Actual Tonnage

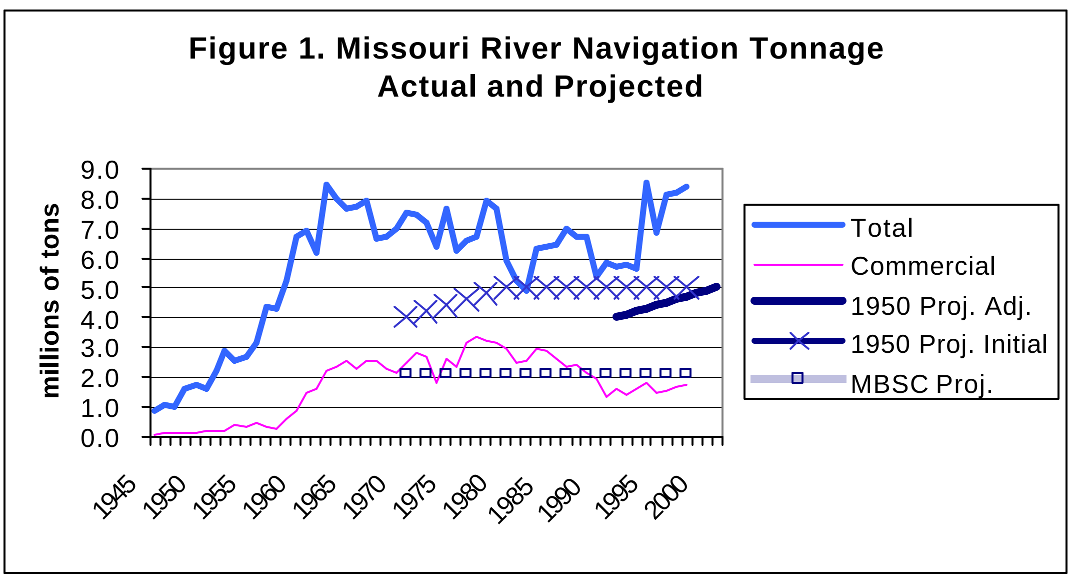
Actual Missouri River tonnage is provided below including major products, total tonnage, and what is identified as "commercial" tonnage, which is total tonnage excluding sand and gravel and waterway material. On the Missouri River sand and gravel movements are largely a local activity consisting of mining sand from the river bed and transporting the sand by shallow draft barges to a nearby storage location on the bank, generally within 1-3 miles. Therefore while sand movements currently account for most of the Missouri River tonnage, they contribute little to ton-miles or benefits and were not included in historical projections.

Table 1 Missouri River Tonnage, 1945-1998 (thousands)						
Year	Farm & Food	Chemicals	Sand/Gravel	Waterway Material	Commercial*	Total
1945	64	0	155	645	70	870
1950	80	1	283	1,130	197	1,610
1955	119	2	414	2,291	435	3,140
1960	1,197	21	1,462	4,046	1,441	6,949
1965	1,771	80	2,449	3,006	2,271	7,726
1970	1,429	526	2,678	2,377	2,463	7,519
1975	1,291	461	2,744	1,147	2,317	6,208
1980	1,671	502	2,715	290	2,909	5,915
1985	1,139	688	3,393	472	2,607	6,472
1990	432	345	4,240	272	1,329	5,841
1995	443	452	5,222	224	1,439	6,884
1998	705	472	6,478	167	1,733	8,378

* Commercial: Total tonnage excluding sand, gravel, and waterway material

3. Comparison of Projections and Actual Tonnage

Actual tonnage and the projections from the 1950 Corps study and the 1953 MBSC study are combined and provided in Figure 1. The projected tonnages in the 1950 report, originally estimated to occur in 1970 and 1980, 10 and 20 years respectively after project completion, have been adjusted to 10 and 20 years after the actual completion date of 1981. Total tonnage peaked to date in 1994 at 8.5 million tons and commercial tonnage peaked in 1977 at 3.3 million tons.



Commercial: Excludes sand/waterway material.
Adj. Projection: Per 1950 study adjusted for actual project completion.
Initial Projection: Per 1950 study expected project completion.

Although total tonnage for the Missouri River has exceeded the projections in the 1950 Corps report and the 1953 MBSC report and approached within about 70 percent of the 12 million tons estimated in the authorizing document, the product mix is dramatically different than foreseen. Neither the Corps 1950 report nor the MBSC study includes sand/gravel or waterway material in their estimates. The dramatic differences in the product mix is illustrated in Table 2 comparing tonnage for several major products from the most recent estimate as provided by Waterborne Commerce of the United States with tonnage forecasted by the Corps 1950 report and the MBSC 1953 study.

Table 2
Missouri River Actual and Projected Tonnage (thousands) - Major Products

	1998 Actual	Corps 1950 Report*	MBSC 1953 Study
Farm and Food Products	705	3,166	1,270
Chemicals	472	120	75
Coal	0	90	200
Sand/Gravel	6,478	0	0
Waterway Material	167	0	0
Other	556	698	555
TOTAL	8,378	4,074	2,100

*10 years following project completion

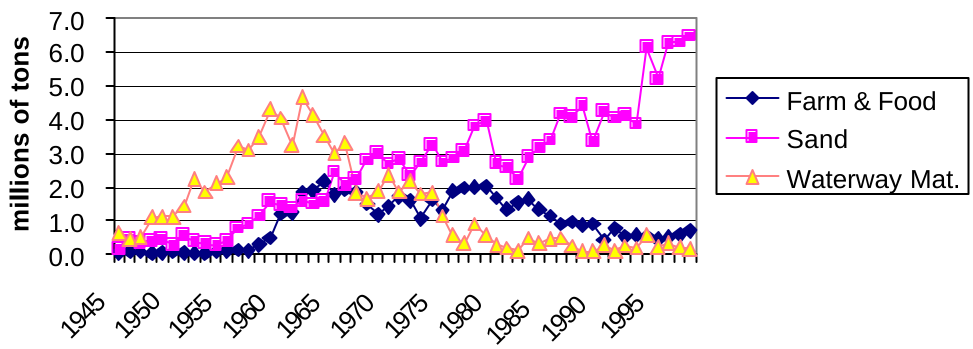
A historical perspective on actual movements provides further insight for comparing forecasted and actual tonnage (Figure 2). Until about the early 1980's, with farm and food product movements frequently approximating 2 million tons, actual tonnage generally seemed to be validating the forecasts, particularly those from 1950 and 1953. However, since then farm and food product movements have declined along with total "commercial" tonnage.

Farm product tonnage has declined in recent years for a variety of reasons. These include introduction of low-cost unit train rates to high capacity Pacific Northwest ports in the late 1970's, decline in agricultural exports in the early 1980's, growth in local consumption including the feed and processing markets, and the drought of the late 1980's and early 1990's, which shortened the Missouri River navigation season by 5 weeks for 4 years in a row. The most dramatic reduction has been in wheat tonnage. Until the introduction of the unit train rates to the Pacific Northwest ports, the Missouri River often moved over one million tons of wheat, peaking at over 1.7 million tons. In contrast, in 1998 the Missouri River moved 64,000 tons of wheat. The bottom line is that agriculture remains the primary industry over much of the Missouri River Basin and although the Missouri River moves a variety of other commodities, farm products remain the dominant regional output. For farm products navigation primarily serves the export market and the Missouri River Basin is in an unfavorable competitive position as measured by both distance and cost relative to other production regions. The risk and uncertainties of this position likely will continue to constrain Missouri River navigation tonnage.

Sand and gravel movements now increasingly dominate Missouri River navigation tonnage, producing traffic levels exceeding most historical traffic forecasts and even approaching the undocumented 12 million ton figure in the authorizing document.

Current navigation on the Missouri River is distinctly different from that forecasted by any of the early projections. Missouri River navigation is exceeding the total forecasted traffic levels prepared in 1928, 1950, and 1953, but the actual commodity traffic contrasts with the 1950 and 1953 forecasts.

Figure 2
Missouri River Tonnage
for Major Commodities, 1945-1998



ATTACHMENT 4: South Atlantic Division

4A: Tennessee-Tombigbee Waterway

1. Introduction. The Tennessee-Tombigbee Watwerway extends from the Demopolis Lock and Dam on the Black Warrior-Tombigbee Waterway, 213 miles above Mobile, to the Pickwick Reservoir on the Tennessee River, a distance of 234 miles. The river section is 9 feet deep and the canal and divide sections 12 feet deep. The bottom width is 300 feet, except in the actual divide cut, where it is 280 feet. The project was authorized in the Rivers and Harbor Act of 1946. Construction was initiated at the Gainesville Lock and Dam in the fall of 1972. The Tennessee-Tombigbee Waterway was opened to navigation in January 1985.

Joining the Black Warrior-Tombigbee system and the Tennessee River creates an entirely new transportation artery connecting much of the interior of the United States with the Gulf Coast. In addition to making the benefits of water transportation available to local trade areas in Alabama and Mississippi, it provides a more direct barge route for through traffic between Gulf Coast points and points on the Ohio, upper Mississippi, Missouri, and Illinois River systems.

2. Projected Traffic. The authorizing document for the Tennessee- Tombigbee Waterway is House Document No. 486, 79th Congress, 2nd Session, submitted 29 September 1945. This document is in the form of a letter report from the Secretary of War to the House of Representatives, Committee on Rivers and Harbors. This document provided only a single point forecast of 5,764,000 tons. This included 3,999,000 tons of commerce shifting to the waterway from other transportation modes (primarily rail), and 1,764,000 tons of unspecified commodities shifting from the Mississippi River to the Tennessee-Tombigbee Waterway. Table 1 displays the commodity forecast by commodity type and Table 4 compares the total traffic forecast with actual traffic.

Table 1: Tennessee Tombigbee Waterway 1945 Commodity Forecast[11] (1,000 Tons)

Commodity	Commerce
Agricultural Products	377
Mine Products	1,542
Forest Products	302
Manufactures, Etc.	1,778
Sub-Total, Modal Transfers	3,999
Mississippi River Transfers	1,765
Total	5,764

[11] Waterway Connecting the Tombigbee and Tennessee Rivers, Secretary of War, House Document No. 486, 79th Congress, 2nd Session, Government Printing Office, 1946.

Since the original authorizing document was prepared a variety of other documents have been prepared to document changes to the originally authorized navigation system. One document of this type was the A.T. Kearney Report prepared in 1976[12]. This document forecasted over 28 million tons of commerce beginning in 1986 and increasing to 33.5 million tons through the end of the study period of 2035. This forecast included a large volume of coal (18.4 million tons in 1986 and increasing thereafter). During this time, the price of petroleum increased dramatically due to the impact of OPEC. Many researchers believed petroleum prices would continue to increase, and that coal would be transported on the waterway to export markets as an energy substitute. Later the price of petroleum declined and the large volume of coal shipments did not materialize.

Another commodity forecast was prepared for the Tennessee-Tombigbee Waterway in August 1986 by the consulting firm B.H.S. Economic Research under a contract with Mobile District. This forecast was entitled “Operational Forecast for Initial Traffic on the Tennessee-Tombigbee Waterway.” It was a single point forecast of 14.5 million tons, including about 7.1 million tons of coal. Table 2 displays this forecast by commodity type and Table 4 compares the total traffic forecast with actual traffic.

Table 2
Tennessee Tombigbee Waterway
1986 Commodity Forecast[13]

Commodity	Commerce (Tons x 1,000)
Agricultural Products	203
Metal Mining	211
Coal	7,125
Non-Metallic Minerals	1,303
Food and Kindred	87
Lumber and Wood Products	2,232
Paper Products	268
Chemical Products	927
Petroleum	217
Stone, Clay, Glass and Concrete	55
Primary Metals	501
Wholesale Trade	10
Contingency Amount (10%)	1,314
Total	14,453

[12] An Evaluation of the Transportation Economics of the Tennessee-Tombigbee Waterway, Kearney Management Consultants under contract to the U.S. Army Corps of Engineers, February 1976.

[13] Operational Forecast for Initial Traffic on the Tennessee-Tombigbee Waterway, Mobile District, U.S. Army Corps of Engineers, August 1986.

3. Actual Traffic. The most recent information regarding actual commerce shipped on the Tennessee-Tombigbee Waterway is provided in Waterborne Commerce of the United States 1998, Part 2, Gulf Coast, Mississippi River System and Antilles. In that year 8,506,000 tons of commerce were transported. Table 3 displays 1998 commerce by commodity type.

Total traffic on the Tenn-Tom Waterway grew rapidly from 1985 to 1988. In the first four startup years total tons increased 220 percent from 1,358,000 tons in 1985 to 4,347,000 tons in 1989. During the 1990s waterborne commerce nearly doubled, steadily rising 96 percent to 8,509,000 tons in 1998. Total traffic thirteen years after the opening of the waterway was 48 percent greater than the 5,764,000 tons projected for the waterway in 1945 at the time of its authorization. Total traffic in 1998 was 41 percent less than the 14,453,000 tons projected as initial traffic by B.H.S. Economic research for the Corps in 1986. However, the B.H.S. projections contained a 10 percent contingency amount of 1,314,000 tons, which, if omitted, would have resulted in total projected traffic based on specific commodities of 13,139,000 tons. The actual total traffic in 1998 would then have been only 35% less than the 1985 B.H.S. projection without the contingency. Thus, the actual total traffic 13 years after the project became operational greatly surpassed traffic projections made 40 years before the opening and was about 60 percent of the amount projected at the time of the opening.

Table 4 provides a comparison of the 1945 and 1986 total forecasted shipments with the actual total shipments that have occurred since 1989.

Figure 1 provides this same information in graphical format.

Table 3
Tennessee Tombigbee Waterway
1998 Actual Commodity Shipments[14]
(Tons x 1,000)

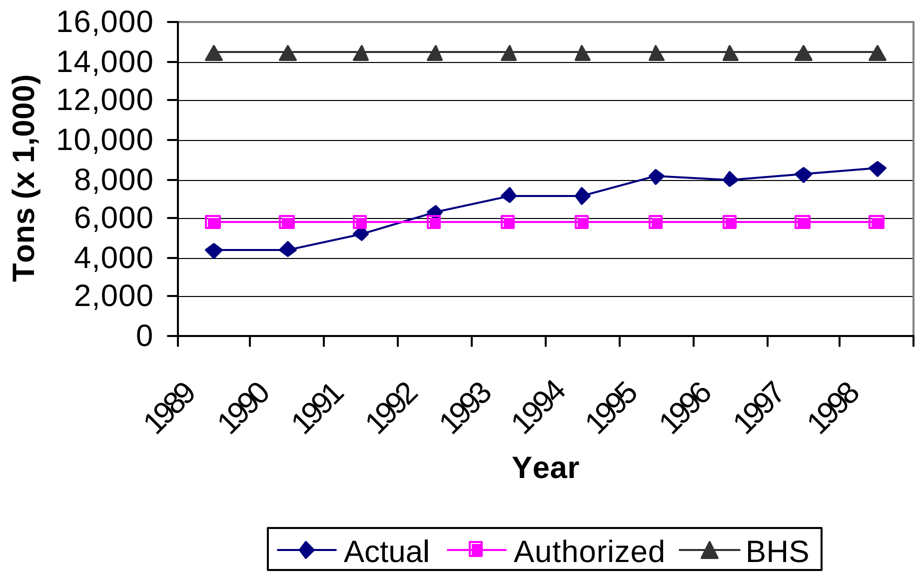
Commodity	Commerce
Coal	2,601
Petroleum	546
Chemicals	248
Forest Products	3,614
Sand and Gravel	592
Manufactured goods	552
Farm Products	70
All Other Commodities	283
Total	8,506

[14] Waterborne Commerce of the United States 1998, Part 2, Gulf Coast, Mississippi River System and Antilles, Water Resources Support Center, Navigation Data Center, 1998.

Table 4
Tennessee-Tombigbee Waterway
Comparison of Actual vs. Forecasted Commerce
(Tons x 1,000)

Year	Actual	Authorizing	B.H.S
1989	4,347	5,764	14,453
1990	4,410	5,764	14,453
1991	5,199	5,764	14,453
1992	6,287	5,764	14,453
1993	7,133	5,764	14,453
1994	7,123	5,764	14,453
1995	8,116	5,764	14,453
1996	7,991	5,764	14,453
1997	8,223	5,764	14,453
1998	8,509	5,764	14,453

Figure 1
Tennessee-Tombigbee Waterway
Actual vs. Forecasted Commerce



4B: Black Warrior and Tombigbee Navigation System

1. Introduction. The first Federal appropriation for improving the Black Warrior River was provided on 5 July 1884 and the Secretary of War authorized the original project on 19 April 1887. The project originally had 19 locks. Over the years the project was modernized and the number of locks was eventually reduced to six. The project took its present form with the completion of the new Oliver Lock and Dam, which was authorized in 1985 and constructed in 1992.

2. Projection Methods and Traffic. A feasibility report was prepared entitled "Interim Feasibility Report and Environmental Impact Statement for Oliver Lock Replacement" in December 1983. Commodity forecasts for the entire Black Warrior and Tombigbee navigation system were prepared for this report. "With" project system commerce was estimated to be 50.1 million tons in 1990 and 57.5 million tons by the year 2000 (Table 5 and Figure 1).

The forecast methodology for the Oliver Lock replacement began with a shipment list derived from detailed dock-to-dock Waterborne Commerce Statistics Center (WCSC) records. Each record was encoded with the origin and destination Port Equivalent (PE) and Business Economic Area (BEA) code. Using the BEA and commodity codes each movement was assigned projection rates for forecast years. The projection factors were based on the 1980 OBERS projections developed by the Office of Business Economics. The movements projected to move on the Tennessee-Tombigbee Waterway (TTW) in the 1976 Economic Reanalysis of the TTW were then added to these movements. Since the TTW forecasts contained the expectations of large coal shipments, the forecasts for the Black Warrior Tombigbee (BWT) estimates reflected these expectations.

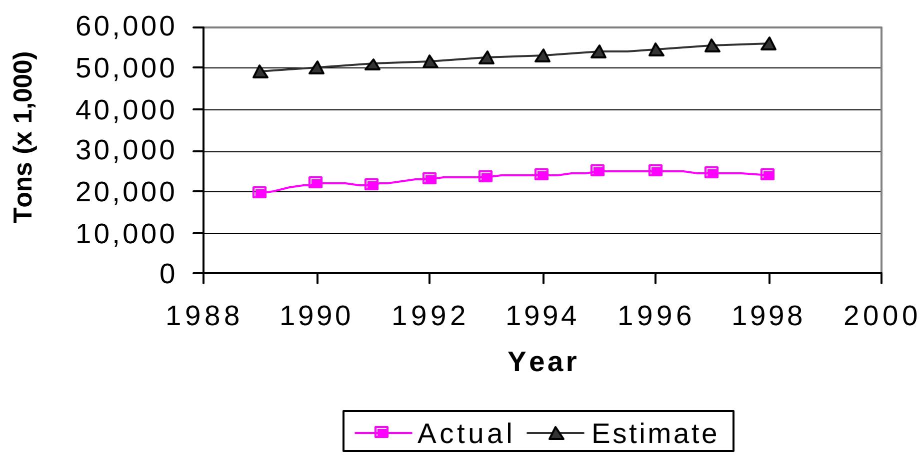
A breakdown by commodity for the Oliver Lock replacement forecast is not easily extractable. The analysis conducted was a systems analysis, as such the commodity forecasts included traffic for the Gulf Intracoastal Waterway (GIWW), and river traffic moving on the Tennessee, Ohio, and Cumberland Rivers.

3. Actual Traffic. Actual commerce was 21,844,000 tons in 1990, and it had increased by 11 percent to 24,169,000 tons in 1998 (Table 1 and Figure 1). In 1998 coal was the most important commodity with 11.5 million tons and 46 percent of the waterways traffic (Table 2). Forest products accounted for less than half of coal's traffic with 5.3 million tons and a 22 percent share. The other three commodities with over one million tons each together comprised about one-fourth of the BWT traffic. They were iron ore and scrap (2.4 million tons and 10 percent), petroleum (2.3 million tons and 9 percent), and primary manufactured goods (1.1 million tons and 5 percent). The leading growth commodities between 1990 and 1998 were primary manufactured goods (up 57 percent), petroleum (up 27 percent) and forest products (up 17 percent). Coal and iron ore and scrap traffic grew at slower paces of 10 and 9 percent, respectively.

Table 1
Black Warrior and Tombigbee River
Comparison of Actual vs. Forecasted Commerce

Year	Actual[15] (Tons x 1,000)	Estimate[16] (Tons x 1,000)
1989	19,570	49,360
1990	21,844	50,100
1991	21,633	50,840
1992	23,205	51,580
1993	23,674	52,320
1994	23,782	53,060
1995	24,674	53,800
1996	24,910	54,540
1997	24,390	55,280
1998	24,169	56,020

Figure 1
Black Warrior and Tombigbee River
Actual vs. Forecasted Commerce



[15] Waterborne Commerce of the United States 1998, Part 2, Gulf Coast, Mississippi River System and Antilles, Water Resources Support Center, Navigation Data Center, 1998.

[16] Black Warrior and Tombigbee Rivers, Alabama, Interim Feasibility Report and Environmental Impact Statement for Oliver Lock Replacement, Mobile District, U.S. Army Corps of Engineers, December 1983.

Table 2
Black Warrior and Tombigbee Rivers
Waterborne Commerce by Commodity – 1998

Commodity	Commerce (tons x 1,000)
Coal	11,514
Petroleum	2,182
Chemicals	617
Forest Products	5,254
Sand Gravel and Rock	610
Iron Ore and Scrap	2,416
Other Crude Materials	367
Primary Manufactured Goods	1,121
Food and Farm Products	64
Manufactured Equipment and Machinery	12
Total	24,157

ATTACHMENT 5: Southwestern Division

5A: McClellan-Kerr Arkansas River Navigation System

1. Projection Methods and Traffic

The following paragraphs provide a comparison between traffic projections and actual traffic on the McClellan-Kerr Arkansas River Navigation System (MKARNS). The December 1943 Little Rock District Survey Report contained the initial projections of waterway traffic, and was the basis for project authorization in 1946. In 1949 prospective tonnage movements were reevaluated and a revised set of projections were developed. In 1954 the 1949 estimates were reviewed and updated to reflect conditions in that year.

The original set (1943) of projections that were the basis for MKARNS authorization showed total annual movements of 9,015,000 tons. It was estimated that about one million tons would use the system during the first year of operation, and would rise to the nine million-ton figure in approximately 15 years. The estimates in the 1943 Survey Report were developed by reviewing traffic on already developed waterway systems. Waterways selected for comparative purposes included the Ohio, Illinois, Kanawha, Allegheny, and Upper Mississippi. These systems were selected because they carried petroleum products, coal, and iron and steel products in large quantities. These commodities were estimated to comprise 55 percent of the prospective tonnage for the Arkansas River. Growth rates on the comparative systems by specific commodities were plotted, and after adjustments for regional differences, used to develop the MKARNS projections.

The 1954 revision of the 1943 Report projected annual traffic of 13,220,000 tons, and assumed that the waterway had been in operation long enough to attain a state of economic maturity. The time required for the system to reach maturity was estimated at about 20 to 25 years. The projections shown in Table 1 represent a merging of the 1943 and 1954 estimates into a single set of figures which are reasonably comparable and consistent. Figure 1 "M-K Traffic Volume" is a graphic representation of the data in Table 1.

2. Projected and Actual Traffic

Tables 2 and 3 show traffic totals by commodity groups. These groupings are the major categories that are listed in Waterborne Commerce Statistics Center reports, and include petroleum products, chemicals, crude materials (various ores and sand, gravel and rock), manufactured products, and farm products. Table 3 provides a comparison of actual and projected tonnage movements within these categories. Figures 1 through 5 are graphical representations of the data in Table 3.

Actual traffic in petroleum and coal products tracked projections quite closely until the early 1980s (Figure 2). At that time, changes in international market conditions for crude oil adversely affected refineries in Oklahoma, reducing the tonnage of residual fuel oil being shipped to Lower Mississippi ports. Also, changes in environmental regulations adversely affected coal operations in both Arkansas and Oklahoma.

Since the original projections were made in the 1940s and 1950s, there has been a significant increase in the use of agricultural fertilizers, greatly exceeding the initial expectations (Figure 3). Principally for that reason, actual tonnages of chemicals moved on the MKARNS have exceeded projected levels.

Actual shipments of crude materials have exceeded projected levels throughout the history of MKARNS due to the large quantities of sand, gravel, and waterway improvement materials that have moved on the system (Figure 4). Typically, about one-half of the movements of aggregates are internal movements within the system.

Current movements of manufactured products have fallen well below projected totals throughout the life of the system, although there has been a significant upturn in the 1990s, a trend that likely reflects the overall performance of the national economy (Figure 5). The initial forecasts included significant tonnages of primary metal products, which, due to changes in inventory management and other structural developments, have not materialized.

Shipments of farm products have shifted to the waterway to a much larger extent that was envisioned in the original projections (Figure 6). This shift has been due largely to changes in government farm programs, especially the commodity storage programs.

Table 1. McClellan-Kerr Arkansas River Navigation System Actual and Projected Tonnages, 1971-2000[1]

Year	Actual Tonnage	Projected Tonnage
1971	4,294,048	1,400,000
1972	5,337,370	1,960,000
1973	4,955,789	2,530,000
1974	6,000,443	3,110,000
1975	5,156,562	3,690,000
1976	6,536,434	4,270,000
1977	9,145,956	4,860,000
1978	9,851,932	5,450,000
1979	8,411,173	6,040,000
1980	8,461,411	6,640,000
1981	7,674,431	7,230,000
1982	7,823,228	7,820,000
1983	7,567,986	8,400,000
1984	8,521,310	9,000,000
1985	7,725,486	9,270,000
1986	8,395,856	9,540,000
1987	7,915,037	9,810,000
1988	6,678,244	10,080,000
1989	7,926,783	10,350,000
1990	8,785,000	10,620,000
1991	9,014,000	10,890,000
1992	8,526,000	11,160,000
1993	9,382,000	11,430,000
1994	10,706,000	11,700,000
1995	10,348,000	11,970,000
1996	10,551,000	12,220,000
1997	11,154,000	12,470,000
1998	12,036,000	12,720,000
1999	N/A	12,970,000
2000	N/A	13,220,000

Source: Actual tonnages from Waterborne Commerce Statistics Center. Projected data compiled from 1943 Little Rock District Survey Report and a 1954 Reevaluation Study. Projected data represent the year of operation after completion of the waterway.

[1] Published data on tonnages are not available for years 1999 and 2000.

Table 2. McClellan-Kerr Arkansas River Navigation System, Tonnages by Major Commodity Group, Selected Years, In Thousands of Tons

Year	Petroleum Products	Chemicals	Crude Materials	Mfg. Products	Farm Products	Products NEC	Total
1971	67	299	3,142	266	488	32	4,294
1975	594	446	3,041	299	747	26	5,155
1980	2,509	1,071	2,441	640	1,789	10	8,461
1985	1,705	949	2,686	547	1,800	38	7,725
1990	872	1,736	3,589	542	2,041	6	8,786
1998	1,104	1,981	4,828	1,349	2,762	10	12,034

Source: Waterborne Commerce of the United States, Part 2, years cited. U.S. Army Corps of Engineers, Water Resources Support Center

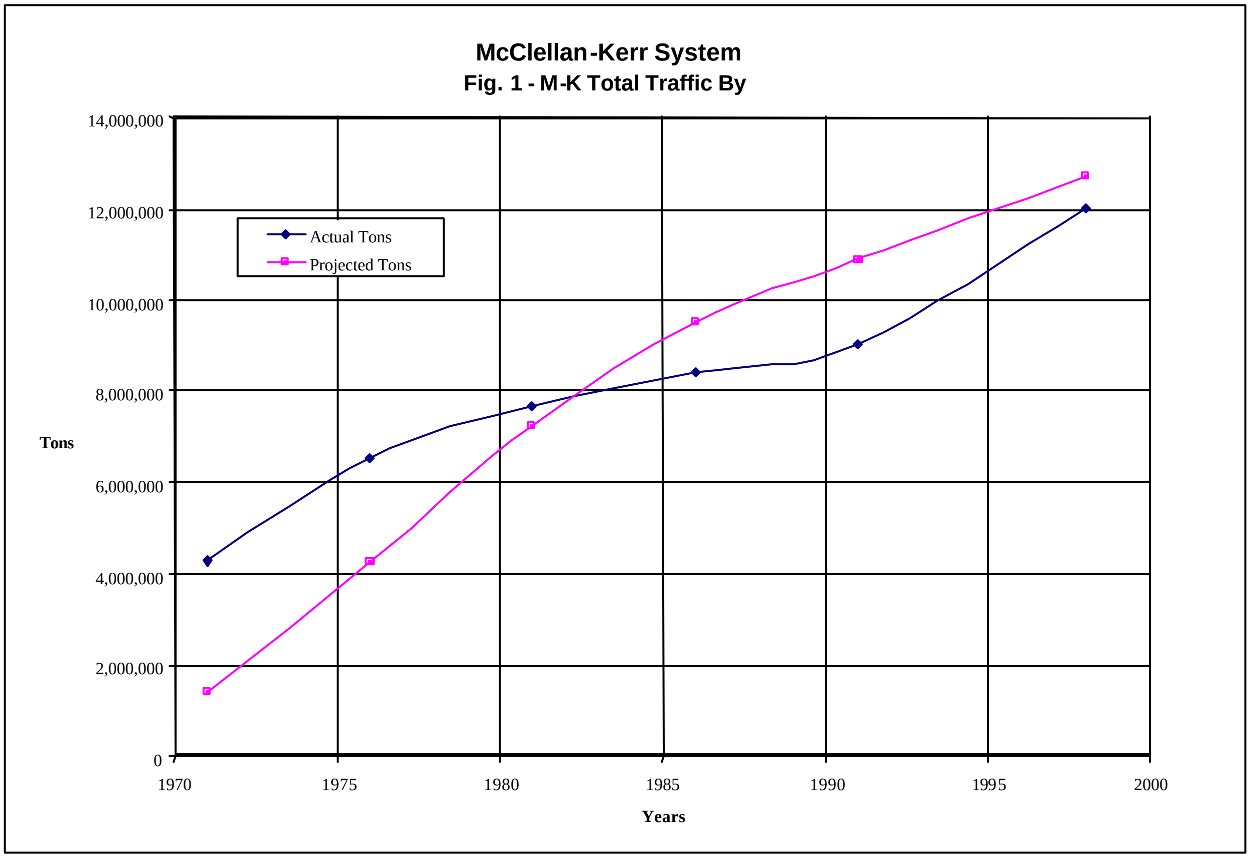
Notes:
1. Petroleum Products category includes coke from coal, coke from petroleum, and coal.
2. Chemicals category includes agricultural fertlizers, which comprise the largest percentage of this category in most years.
3. Crude materials include various ores, sand, gravel, rock, logs, and waterway improvement materials.
4. Iron and steel products constitute the major commodities within the manufactured goods category in a typical year.

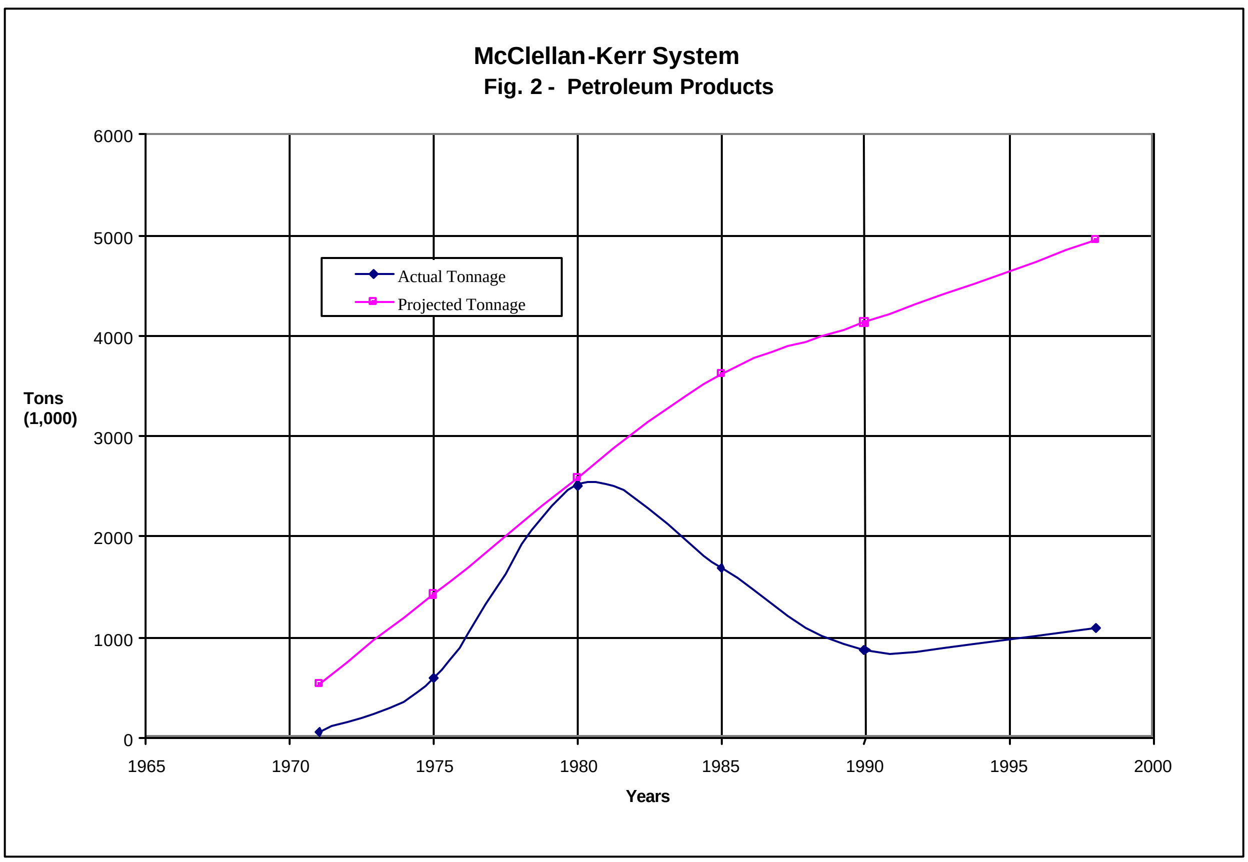
Table 3. McClellan-Kerr Arkansas River Navigation System, Tonnages by Major Commodity Group, Actual and Projected, Selected Years, In Thousands of Tons

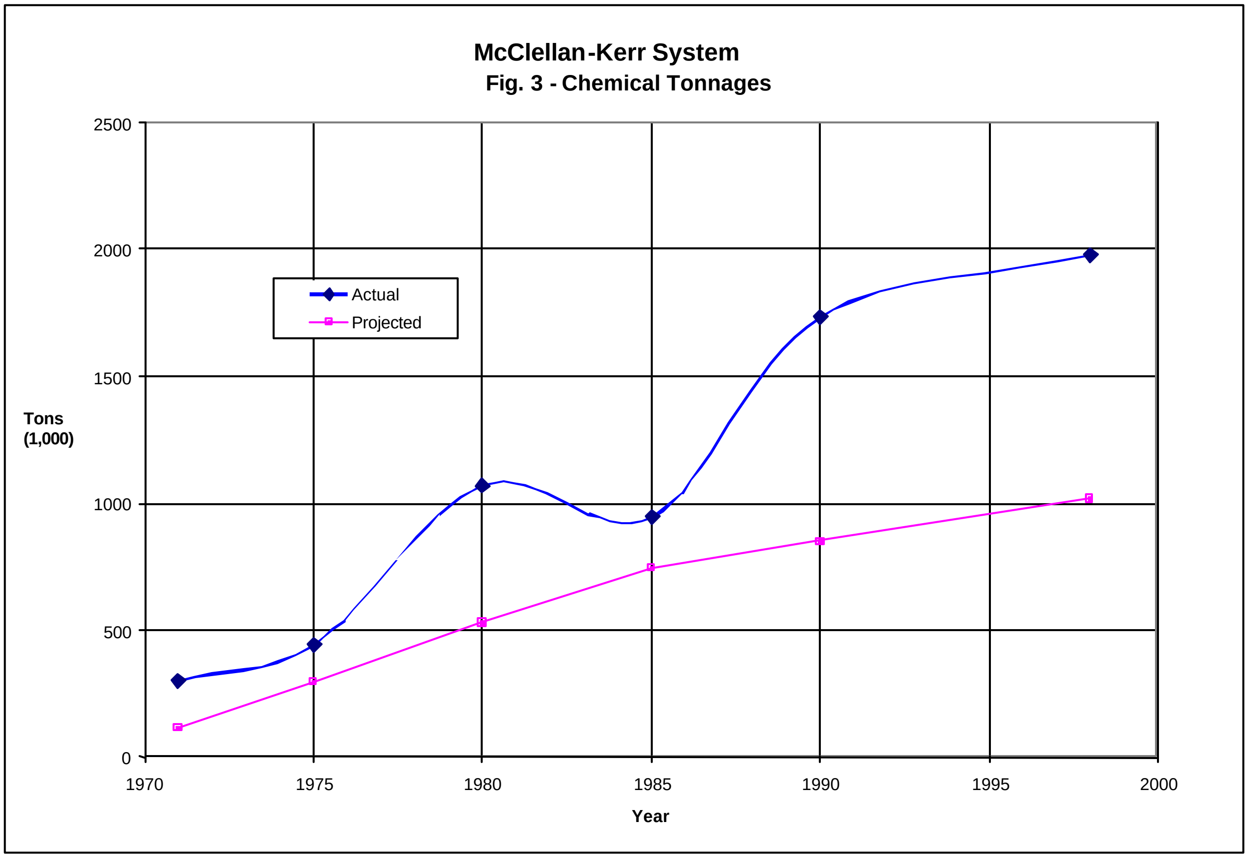
Year	Petroleum Products		Chemicals		Crude Materials		Mfg. Products		Farm Products	
	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected	Actual	Projected
1971	67	546	299	112	3,142	154	266	420	488	112
1975	594	1,439	446	295	3,041	406	299	1,107	747	295
1980	2,509	2,590	1,071	531	2,441	730	640	1,992	1,789	531
1985	1,705	3,615	949	742	2,686	1,020	547	2,781	1,800	742
1990	872	4,142	1,736	850	3,589	1,168	542	3,186	2,041	850
1998	1,104	4,961	1,981	1,018	4,828	1,388	1,349	3,786	2,762	1,010

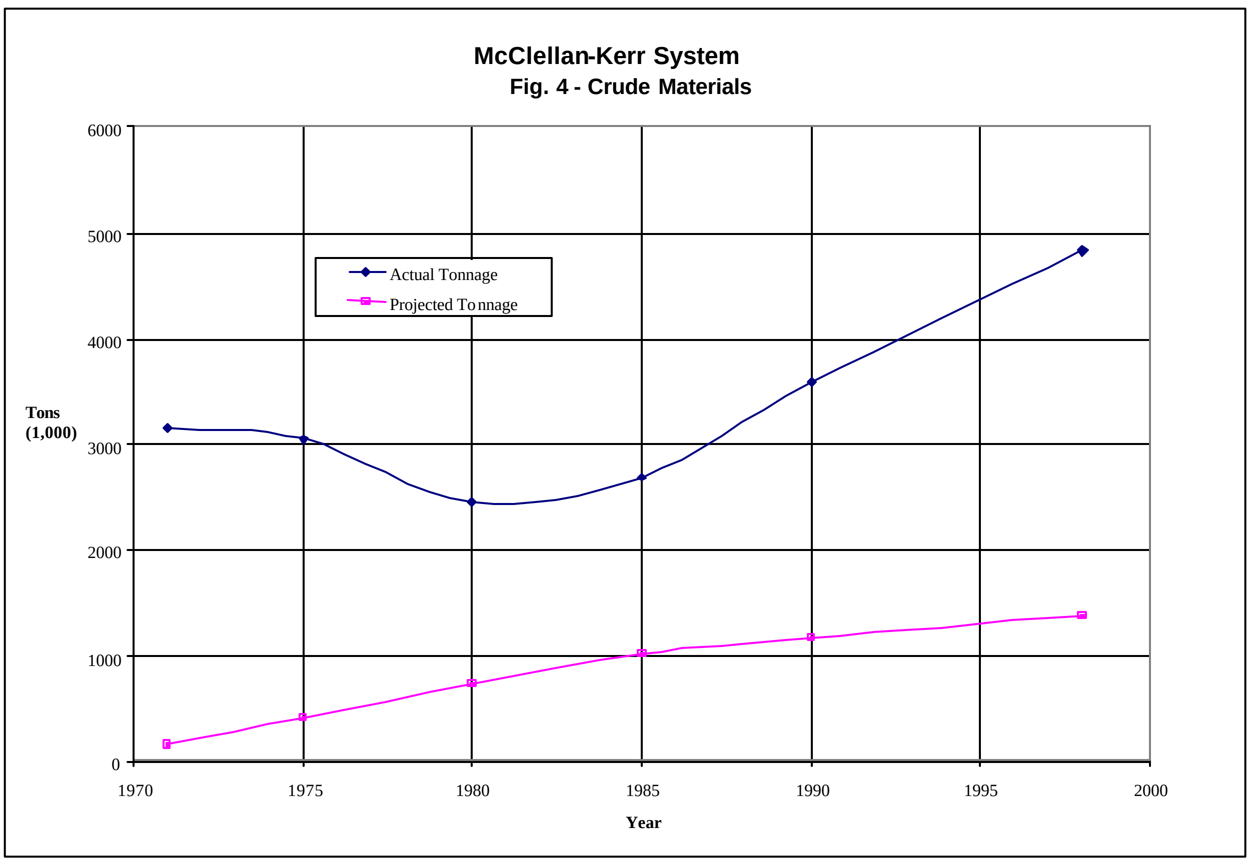
Source: Actual tonnage from Waterborne Commerce of the United States, Part 2, years cited. U.S. Army Corps of Engineers, Water Resources Support Center

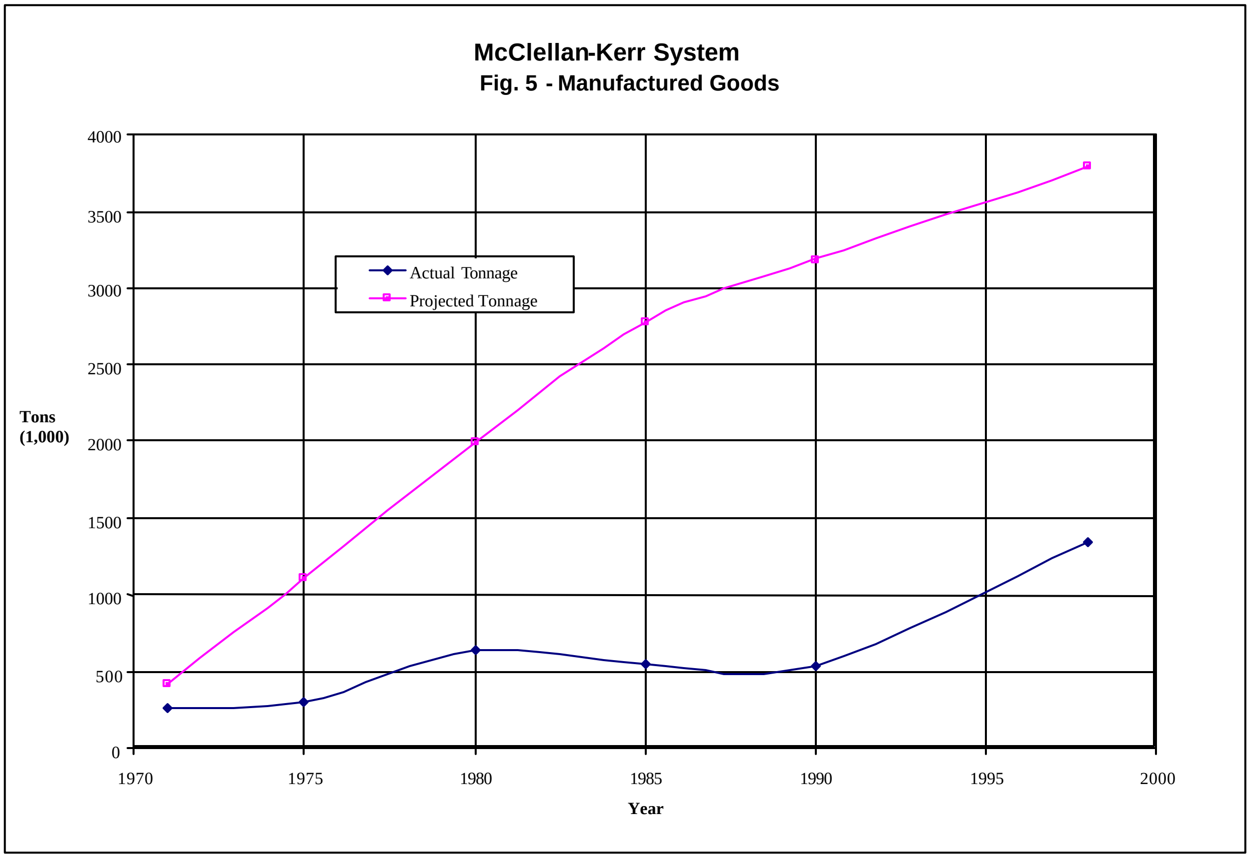
Notes:
1. Petroleum Products category includes coke from coal, coke from petroleum, and coal.
2. Chemicals category includes agricultural fertlizers, which comprise the largest percentage of this category in most years.
3. Crude materials include various ores, sand, gravel, rock, logs, and waterway improvement materials.
4. Iron and steel products constitute the major commodities within the manufactured goods category in a typical year.

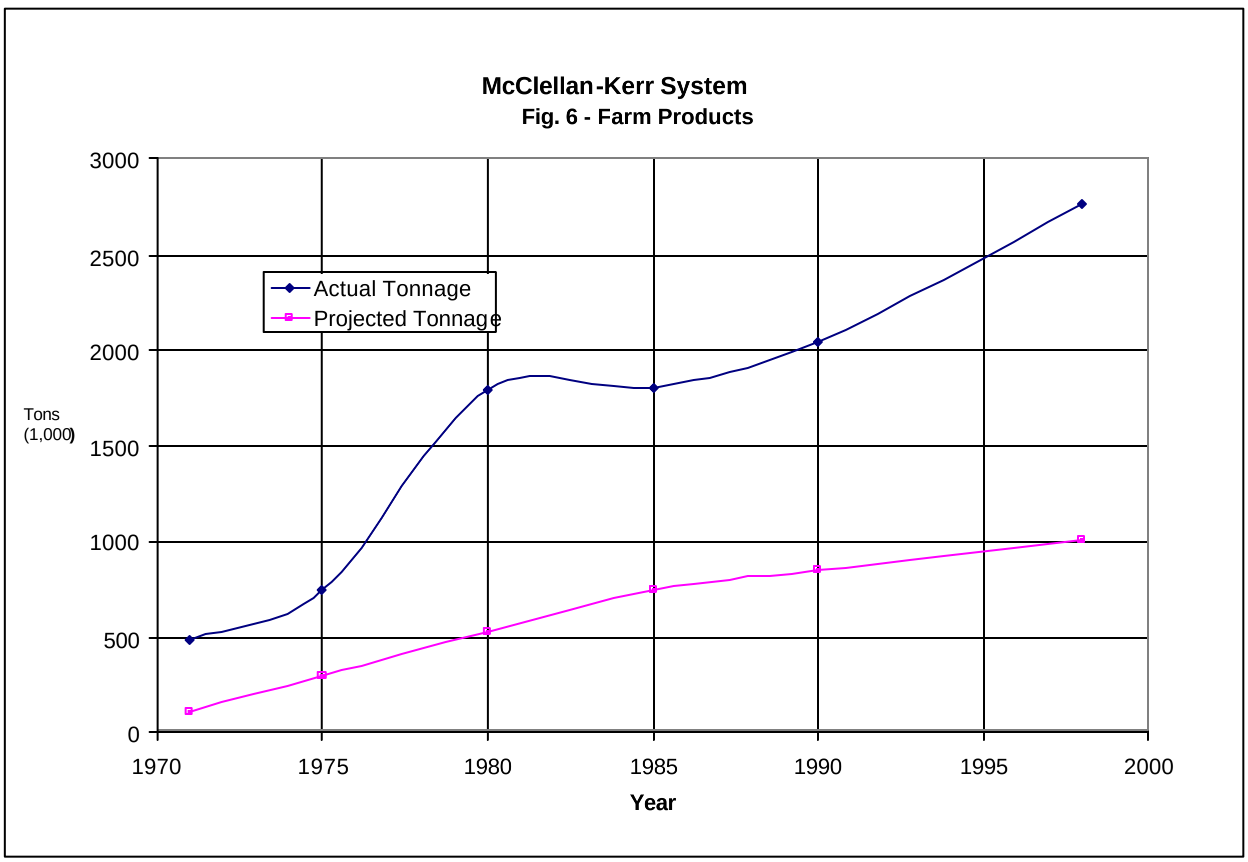

McClellan-Kerr System
Fig. 1 - M-K Total Traffic By
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
Tons
Actual Tons
Projected Tons
1970
1975
1980
1985
1990
1995
2000
Years


McClellan-Kerr System
Fig. 2 - Petroleum Products
6000
5000
4000
3000
2000
1000
0
Tons
(1,000)
Actual Tonnage
Projected Tonnage
1965
1970
1975
1980
1985
1990
1995
2000
Years


McClellan-Kerr System
Fig. 3 - Chemical Tonnages
Actual
Projected
Tons
(1,000)
2500
2000
1500
1000
500
0
1970
1975
1980
1985
1990
1995
2000
Year


McClellan-Kerr System
Fig. 4 - Crude Materials
Actual Tonnage
Projected Tonnage
Tons
(1,000)
6000
5000
4000
3000
2000
1000
0
1970
1975
1980
1985
1990
1995
2000
Year


McClellan-Kerr System
Fig. 5 - Manufactured Goods
4000
3500
3000
2500
2000
1500
1000
500
0
Tons
(1,000)
Actual Tonnage
Projected Tonnage
1970
1975
1980
1985
1990
1995
2000
Year


McClellan-Kerr System
Fig. 6 - Farm Products
3000
2500
2000
1500
1000
500
0
Tons
(1,000)
Actual Tonnage
Projected Tonnage
1970
1975
1980
1985
1990
1995
2000
Year