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# Technical Report

# Forecast Of Future Ohio River Basin Waterway Traffic Based On Shippers' Surveys

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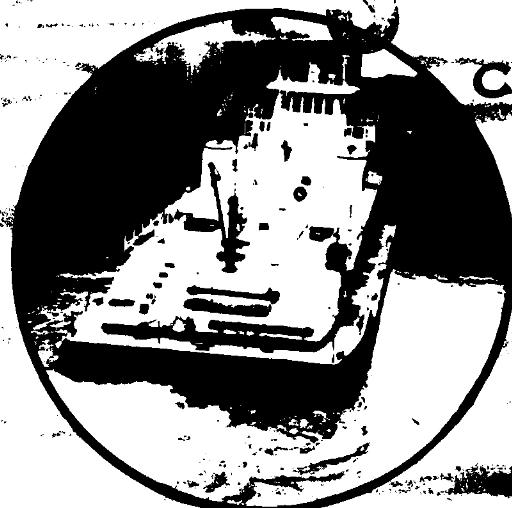

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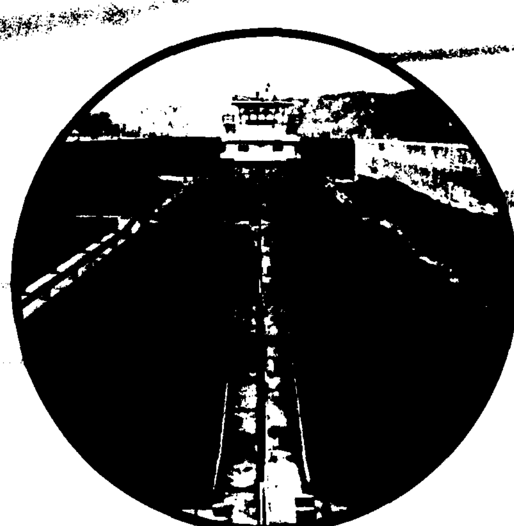

SEPT. 1979

Ohio River Division
Cincinnati, Ohio
U. S. Army
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This ~~Corps of Engineers~~ report describes one of three independent but complementary studies of future freight traffic on the Ohio River Basin Navigation System. Each of the studies considers existing waterborne commerce and develops a consistent set of projections of future traffic demands for all of t navigable waterways of the Basin. Each report contains information on past and present waterborne commerce in the Basin and projections by commodity group and origin-destination areas from 1975 to at least 1990.


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The three study projections, in conjuction with other analytical tools and system information, will be used to evaluate specific waterway improvements to meet short and long-term navigation needs. The output from these studies will serve as input to Corps' Inland Navigation Simulation Models to help analyze the performance and opportunities for improvement of the Ohio River Basin Navigation System. These data will be used in current studies relating to improvement of Gallipolis Locks, the Monongahela River, the Upper Ohio River, the Kanawha River, the Lower Ohio River, the Cumberland River and the Tennessee River, as well as other improvements.

The study and the 1975-1990 traffic projections discussed in this report were developed by surveying all waterway users in the Ohio River Basin through a combined mail survey and personal interview approach. The purpose of the survey was to obtain an estimate from each individual shipper of his future commodity movements by specified origins and destinations, as well as other associated traffic information. All identifiable waterway users were contacted and requested to provide the survey information. In addition, personal interviews were held with the major shippers. The responses were then aggregated to yield projected traffic demands for the Ohio River Navigation System.

FINAL REPORT

# FORECAST OF FUTURE OHIO RIVER BASIN WATERWAY TRAFFIC BASED ON SHIPPERS' SURVEYS

Prepared for the
U.S. Army Corps of Engineers
Huntington District Engineer
P.O. Box 2127
Huntington, WV

BY:
Battelle
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505 King Avenue
Columbus, OH 43201

Under Contract: DACW69-78-C-0059

OHIO RIVER DIVISION

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September 1979

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## PREFACE

This Corps of Engineers report describes one of three independent but complementary studies of future freight traffic on the Ohio River Basin Navigation System. Each of the studies considers existing waterborne commerce and develops a consistent set of projections of future traffic demands for all of the navigable waterways of the Basin. Each report contains information on past and present waterborne commerce in the Basin and projections by commodity group and origin-destination areas from 1975 to at least 1990.

The three projections, in conjunction with other analytical tools and system information, will be used to evaluate specific waterway improvements to meet short- and long-term navigation needs. The output from these studies will serve as input to Corps' Inland Navigation Simulation Models to help analyze the performance and opportunities for improvement of the Ohio River Basin Navigation System. These data will be used in current studies relating to improvement of Gallipolis Locks, the Monongahela River, the Upper Ohio River, the Kanawha River, the Lower Ohio River, the Cumberland River, and the Tennessee River, as well as other improvements.

This report, completed in June 1979, was prepared for the Corps by Battelle Columbus Laboratories, Columbus, Ohio. The study and the 1975-1990 traffic projections discussed in this report were developed by surveying all waterway users in the Ohio River Basin through a combined mail survey and personal interview approach. The purpose of the survey was to obtain an estimate from each individual shipper of his future commodity movements by specified origins and destinations, as well as other associated traffic information. All identifiable waterway users were contacted and requested to provide the survey information In addition, personal interviews were held with the major shippers. The responses were then aggregated to yield projected traffic demands for the Ohio River Navigation System.

A second report, completed in January 1979, was prepared for the Corps by CONSAD Research Corporation of Pittsburgh, Pennsylvania. The study and the 1975-1990 projected traffic demands discussed in that report were developed by correlating the historic waterborne commodity flows on the Ohio River Navigation System with various indicators of regional and national demands for the commodities. The demand variable(s) which appeared to best describe the historic traffic pattern for each of the commodity groups was selected for projection purposes. The historic and projected values for the demand variables are based upon the 1972 OBERS Series E Projections of National and Regional Economic Activity. The OBERS projections were developed by the Bureau of Economic Analysis of the U.S. Department of Commerce in conjunction with the Economic Research Service of the Department of Agriculture.

## PREFACE
(Continued)

A third report, to be completed in September 1979 is being prepared for the Corps by Robert R. Nathan Associates, Inc. of Washington, D.C. The study and the 1975-2040 projections to be discussed in that report are much more comprehensive in scope, and focus on a much longer time frame. The basic study approach involves placing the historic production, consumption, and net shipments (by transportation mode) of commodities which move by water in the Ohio River Basin into perspective with total national output. The production, consumption, and shipment estimates are being prepared for all geographic areas within the Basin which are either directly or indirectly (through modal transfers) served by the Ohio River Navigation System. Economic, environmental and institutional factors which have historically affected output, consumption and modal shipments are being identified and analyzed. These same variables will then be projected through the year 2040 under alternative scenarios. Detailed waterway flow projections by commodity group and origin-destination areas will then be presented for the most probable future condition.

SUMMARY REPORT

# FORECAST OF FUTURE OHIO RIVER BASIN WATERWAY TRAFFIC BASED ON SHIPPERS' SURVEYS

to

HUNTINGTON DISTRICT
U.S. ARMY CORPS OF ENGINEERS

Battelle
Columbus Laboratories

## ACKNOWLEDGEMENT

We would like to extend our gratitude to the many organizations which participated in this study and particularly to the individuals who were interviewed by us for the survey. We also extend our gratitude to those firms who responded to our survey by mail. This report would not have been possible without their willing cooperation.

This study was conducted under the direction of Charles Kimm. Harry Collis served as principal researcher. He was assisted by Loren Rosenthal and Cathy Neuberger who lent valuable assistance in preparing the final report. In addition, Homer Ball, Norman Fischer, David Nippert, and Janice Warmke also participated in this study.

Our special gratitude is extended to the U.S. Army Corps of Engineers, especially the Huntington District staff, for their support and unfailing assistance throughout this study.

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# CHAPTER I.

## SCOPE OF STUDY

# CHAPTER I. SCOPE OF STUDY

The Ohio River Basin is a nine-state region covering an area of 204,000 square miles. Much of this region's basic industry is situated on the nine navigable rivers which constitute the Ohio River System. These industries, and others further inland, use the rivers to transport bulk commodities such as coal, aggregates, and petroleum fuels. According to 1976 Waterborne Commerce of the United States Statistics, a total of 177.9 million tons of these and other commodities were moved in tows of one to fifteen barges on the main stem Ohio and its tributaries. The Basin is depicted in Figure 1.

The U.S. Army Corps of Engineers (COE) is responsible for constructing and maintaining the 71 lock and dam projects* which make the Ohio River System navigable. Other navigation related COE maintenance duties include dredging, construction of revetments and channel straightening. COE responsibilities also encompass certain regulatory functions regarding development activities in navigable waters and their tributaries.

## Purpose

COE needs reliable barge traffic projections to help guide the waterway improvement planning and management process. Such projections indicate which river segments, tributaries, and lock and dam projects are likely to experience the most future congestion. COE can then make necessary waterway improvements in anticipation of traffic problems.

COE is also interested in determining which operational and economic matters, relating to barge transportation, are of greatest concern to waterway users. And, COE needs to know user intentions regarding changes in the size and configuration of barge tows, diversion of barge traffic in response to the waterway user charges, and reductions in empty or "light" barge traffic in the Basin.

This study was designed to generate barge traffic flow projections through the year 1990 for input to COE's waterway improvements plans. It was also meant to solicit user views regarding the matters mentioned above. This information was to be obtained by surveying waterway users through questionnaires and field interviews.

## Units of Analysis

The units of analysis used in this study include rivers, lock and dam projects, commodity groups, BEA's and PE's. The last two units require some immediate explanation. BEA is an abbreviation for "Bureau of Economic Analysis". This Bureau, which is part of the Commerce Department, has subdivided the United States into 173 geographical areas; these areas, or "BEA's", are used by many federal agencies for planning purposes. PE stands for "Port Equivalent". COE has segmented all rivers

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* Currently there are 72 locks and dams including Locks & Dams 50 and 51 but Smithland will replace Locks & Dams 50 & 51.

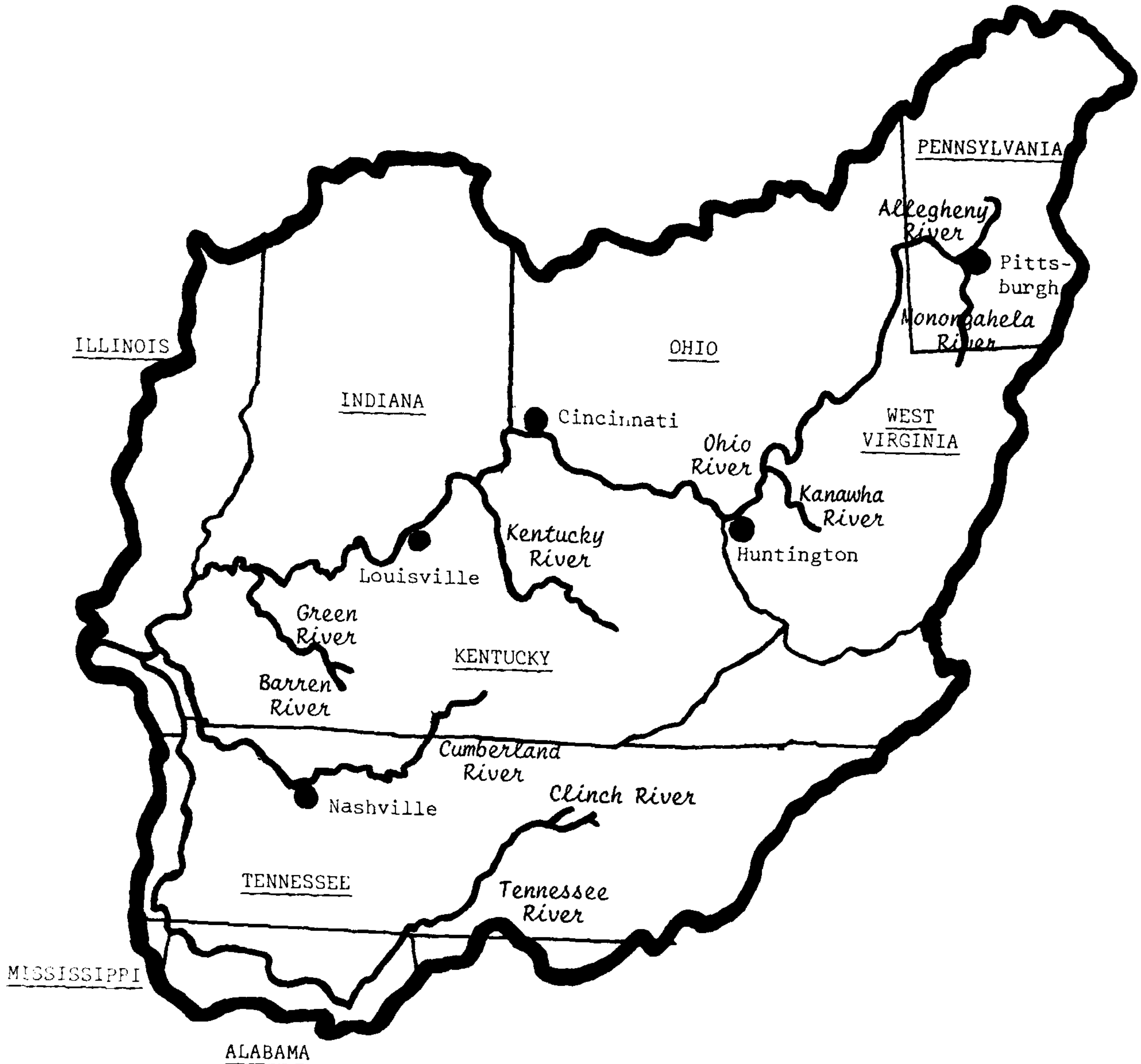


FIGURE 1. THE OHIO RIVER BASIN

into PE units for purposes of analysis and planning. These units of analysis are discussed in greater detail in succeeding paragraphs.

## Rivers, Locks and Dams, and PE's

The nine navigable rivers of the Ohio River System are listed below. The figure in parentheses after each river indicates the number of active lock and dam projects on that river.

- Ohio (main stem) (20)
- Allegheny (8)
- Monongahela (9)
- Kanawha (3)
- Kentucky (14)
- Green-Barren Rivers (3)
- Cumberland (4)
- Tennessee (9)
- Clinch (1)

The channels of these rivers are maintained at a minimum depth of nine feet.

There are 91 active PE river segments in the Ohio River System. (An active PE segment is one which shows any dock activity.) PE's are a very disaggregate unit of analysis. In fact, more than 2,700 distinct PE-to-PE movements have been identified in the Basin. Discussions of river traffic at this level are soon overwhelmed by detail. Therefore, although commodity movements were tabulated and projected on the PE level, such information is contained only in the appendices and is not analyzed in the main body of the report.

## BEA's and States

Portions of nine states are found in the Basin's navigable waterway hinterland. They are listed in the order of direction of water flow.

- Pennsylvania
- West Virginia
- Ohio
- Kentucky
- Indiana
- Illinois
- Tennessee
- Alabama
- Mississippi

Counties of the various states have been recombined into BEA areas. BEA's are labeled as the cities which are their focal points. A river segment may be included within a BEA or it may be used as its boundary. There are 15 waterside BEA's in the study area:

- Pittsburgh, PA
- Cleveland, OH
- Huntington, WV
- Columbus, OH
- Cincinnati, OH
- Louisville
- Evansville, IN
- Memphis, TN
- Paducah, KY
- Huntsville, AL
- Chattanooga, TN
- Knoxville, KY
- Nashville, TN
- Clarksburg, WV
- Lexington, KY

BEA's rather than states are used as a unit of analysis in this report. They are smaller and more homogenous in terms of industrial activities than states. The BEA boundaries are depicted in Figure 2.

## Major Commodity Groupings

The nine major commodity groups used in this study are:

- Coal & Coke
- Petroleum Fuels
- Crude Petroleum
- Aggregates
- Grains
- Chemicals & Chemical Fertilizers
- Ores & Minerals
- Iron Ore, Iron & Steel
- Miscellaneous Commodities*

These major commodity groups are further divided into "4-digit" commodity classifications. A 4-digit breakdown of each commodity group is found in Table 1. Also found in this table is the tonnage distribution of these individual commodities based on 1976 WCSC statistics.

## Brief Description of Barge Traffic Activities in the Basin

Table 1 provides a fair understanding of the industries which use the waterway because each commodity group represents a specific kind of industrial activity.

Coal & Coke. Coal clearly dominates activities on the waterway. It is mined in nearly every state in the region. A large portion of that coal is consumed by power plants, steel firms, and other heavy industry within the Basin.

Petroleum Fuels; Crude Petroleum. Petroleum fuels are transported to various distribution points along the river. In some cases the supply source is a refinery; in other cases barges act as extensions of petroleum pipelines. A relatively small quantity of crude is imported to the region.

Aggregates. Aggregates are quarried or dredged from the river, classified and taken to metropolitan areas where they are distributed principally by land modes to transportation. Or, aggregates may be barged directly from source to construction sites.

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*Includes commodities not covered under the first eight commodity groupings.

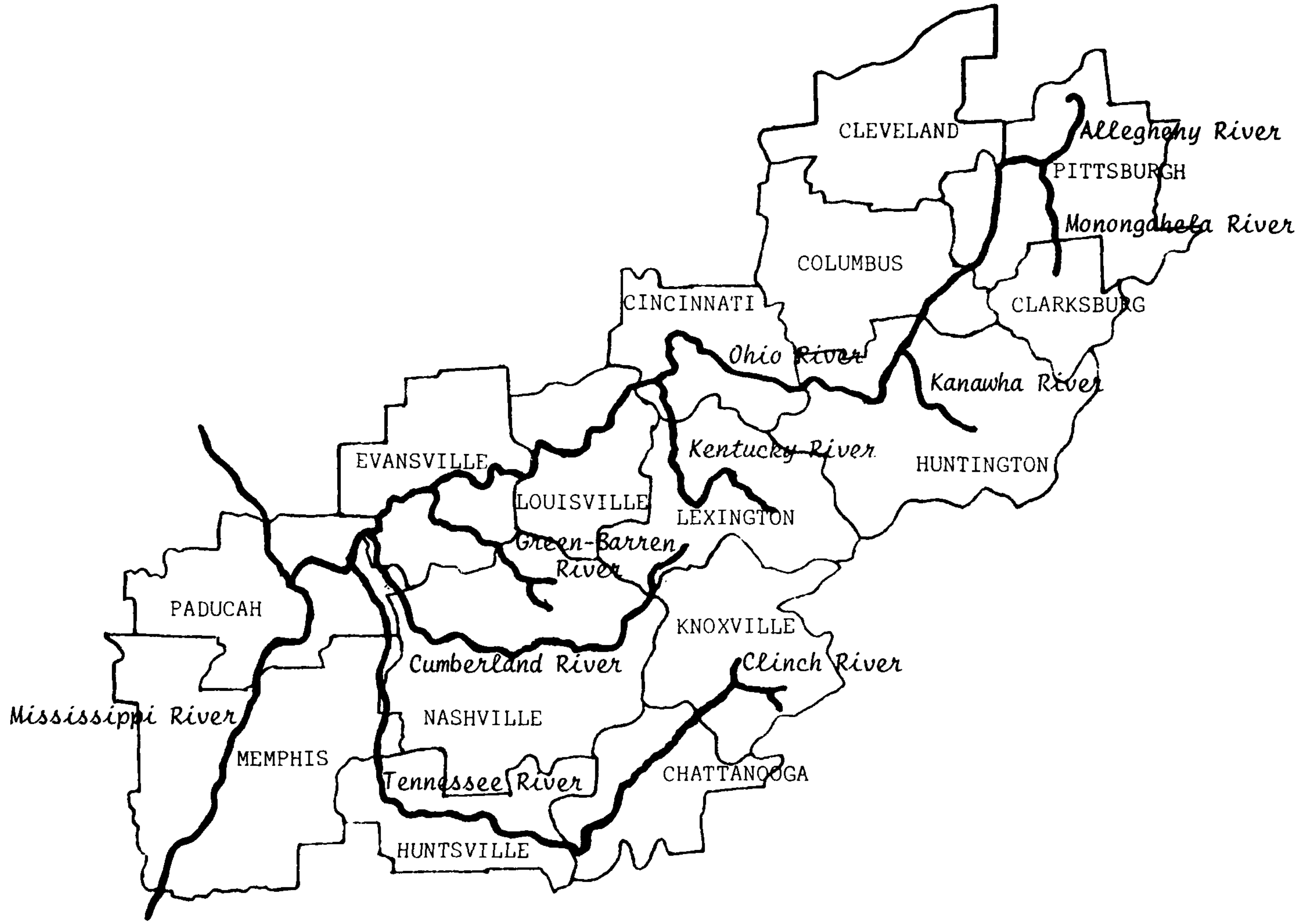


FIGURE 2. OHIO RIVER BASIN BY BEA'S

TABLE 1. 1976 OHIO RIVER BASIN WATERBORNE TRAFFIC BY COMMODITY GROUP COMPOSITION

| Commodity Group | Commodity Classification | Tonnage (in 000's) | Percent of Group | Percent of Total |
|---|---|---|---|---|
| 1. Coal & Coke | 1121 Coal & Lignite | 102,991 | 99.5 | 57.9 |
| | 2920 Coke | 480 | 0.5 | 0.3 |
| | Group Total | 103,471 | 100.0 | 58.2 |
| 2. Petroleum Fuels | 2911 Gasoline | 9,661 | 50.7 | 5.4 |
| | 2912 Jet Fuel | 863 | 4.5 | 0.5 |
| | 2913 Kerosene | 215 | 1.1 | 0.1 |
| | 2914 Distillate Fuel Oil | 4,944 | 25.9 | 2.8 |
| | 2915 Residual Fuel Oil | 3.166 | 16.6 | 1.8 |
| | 2921 LPG/LNG | 211 | 1.1 | 0.1 |
| | Group Total | 19,060 | 100.0 | 10.7 |
| 3. Crude Petroleum | 1311 Crude Petroleum | 883 | 100.0 | 0.5 |
| 4. Aggregates | 1411 Limestone | 1,305 | 6.1 | 0.7 |
| | 1442 Sand, Gravel, Crushed Rock | 19,919 | 93.6 | 11.2 |
| | Group Total | 21,224 | 100.0 | 11.9 |
| 5. Grains | 0102 Barley, Rye | 16 | 0.3 | ---* |
| | 0103 Corn | 2,481 | 46.5 | 1.4 |
| | 0104 Oats | 58 | 1.1 | ---* |
| | 0106 Sorghum Grains | 9 | 0.2 | ---* |
| | 0107 Wheat | 1,556 | 29.2 | 0.9 |
| | 0111 Soybeans | 1,213 | 22.7 | 0.7 |
| | Group Total | 5,333 | 100.0 | 3.0 |

TABLE 1. (Continued)

| Commodity Group | Commodity | Tonnage (in 000's) | Percent of Group | Percent of Total |
|---|---|---|---|---|
| 6. Chemicals & Chemical Fertilizers | 2810 Sodium Hydroxide | 641 | 6.8 | 0.4 |
| | 2811 Crude Products from Coal Tar | 1,143 | 12.1 | 0.6 |
| | 2813 Alcohols | 900 | 9.5 | 0.5 |
| | 2817 Benzene, Toluene | 480 | 5.1 | 0.3 |
| | 2818 Sulphuric Acid | 267 | 2.8 | 0.2 |
| | 2819 Basic Chemicals, NEC | 4,700 | 49.7 | 2.6 |
| | 2822 Synthetic Rubber | 23 | 0.2 | ---* |
| | 2861 Wood Chemicals | 20 | 0.2 | ---* |
| | 2871 Nitrogenous Fertilizers | 523 | 5.5 | 0.3 |
| | 2872 Potassic Fertilizers | 21 | 0.2 | ---* |
| | 2873 Phosphate Fertilizers | 41 | 0.4 | ---* |
| | 2879 Fertilizers, NEC | 447 | 4.7 | 0.3 |
| | 2891 Chemical Products, NEC | 243 | 2.6 | 0.1 |
| | Group Total | 9,449 | 100.0 | 5.3 |
| 7. Ores & Minerals | 1021 Copper Ore | 1 | 0.0 | ---* |
| | 1051 Bauxite | 4 | 0.1 | ---* |
| | 1061 Manganese Ores | 729 | 21.4 | 0.4 |
| | 1091 Non-Ferrous Ores, NEC | 415 | 12.2 | 0.2 |
| | 1451 Refractory Materials | 91 | 2.7 | 0.1 |
| | 1491 Salt | 1,733 | 50.8 | 1.0 |
| | 1493 Liquid Sulphur | 148 | 4.3 | ---* |
| | 1499 Non-Metallic Minerals, NEC | 292 | 8.6 | 0.2 |
| | Group Total | 3,413 | 100.0 | 1.9 |

TABLE 1. (Continued)

| Commodity Group | Commodity | Tonnage (in 000's) | Percent of Group | Percent of Total |
|---|---|---|---|---|
| 8. Iron Ore, Iron & Steel | 1011 Iron Ore | 792 | 18.5 | 0.4 |
| | 3311 Pig Iron | 62 | 1.4 | ---* |
| | 3314 Iron & Steel, Primary Forms | 218 | 5.1 | 0.1 |
| | 3315 Iron & Steel, Shapes | 507 | 11.8 | 0.3 |
| | 3316 Iron & Steel, Plate & Sheet | 1,219 | 28.5 | 0.7 |
| | 3317 Iron & Steel, Pipe & Tube | 475 | 11.1 | 0.3 |
| | 3318 Ferroalloys | 550 | 12.9 | 0.3 |
| | 3319 Iron & Steel, Primary Forms, NEC | 70 | 1.6 | ---* |
| | 4011 Iron & Steel Scrap | 387 | 9.0 | 0.2 |
| | Group Total | 4,280 | 100.0 | 2.4 |
| 9. Miscellaneous Commodities** | 2041 Flour | 83 | 0.8 | ---* |
| | 2042 Prepared Animal Feed | 84 | 0.8 | ---* |
| | 2049 Grain Mill Products, NEC | 704 | 6.5 | 0.4 |
| | 2062 Molasses | 69 | 0.6 | ---* |
| | 2091 Vegetable Oils | 214 | 2.0 | 0.1 |
| | 2415 Pulpwood Logs | 294 | 2.7 | 0.2 |
| | 2611 Pulp | 63 | 0.6 | ---* |
| | 2631 Paper | 92 | 0.9 | ---* |
| | 2916 Lubricants | 565 | 5.2 | 0.3 |
| | 2917 Solvents | 378 | 3.5 | 0.2 |
| | 2918 Asphalt | 1,506 | 14.0 | 0.8 |
| | 2991 Petroleum-Coal Products, NEC | 653 | 6.1 | 0.4 |
| | 3271 Lime | 452 | 4.2 | 0.3 |
| | 3312 Slag | 192 | 1.8 | 0.1 |
| | 3323 Lead & Zinc | 64 | 0.6 | ---* |
| | 3324 Aluminum | 83 | 0.8 | ---* |

TABLE 1. (Continued)

| Commodity Group | Commodity | Tonnage (in 000's) | Percent of Group | Percent of Total |
|---|---|---|---|---|
| 9. Miscellaneous Commodities** (Continued) | 3411 Fabricated Metal Products | 71 | 0.7 | ---* |
| | 3511 Machinery, Except Electrical | 144 | 1.3 | 0.1 |
| | 3731 Ships & Boats | 92 | 0.9 | ---* |
| | 4012 Non-Ferrous Metal Scrap | 110 | 1.0 | 0.1 |
| | 4118 Waterway Improvement Material | 3,668 | 34.0 | 2.1 |
| | Group Total | 10,789 | 100.0 | 6.1 |
| | Grand Total, Ohio River System | 177,902 | 100.0 | 100.0 |

* Less than 0.1% of total traffic.
** Excludes commodities with less than 0.5% of group total.

Source: 1976 COE Waterborne Commerce of the United States Statistics

Grains. Grains are collected by rail and truck from throughout the region. Most barge shipments of grain are foreign export movements which are transloaded to oceangoing vessels at Gulf Coast ports.

Chemicals & Chemical Fertilizers. A wide array of basic chemicals and chemical fertilizers are moved on the river. Very little is exported from the region. About half of the tonnage is imported from Gulf ports; the other half is originated and terminated within the Basin.

Ores & Minerals. The bulk of the metallic ores are used in steel alloy making. Most of the metallic ores are imported from outside the Basin. Salt is an important non-metallic mineral imported from the Western Gulf Coast.

Iron Ore, Iron & Steel. Only a limited amount of iron ore is being handled by barge. Mainly this group represents steel products such as sheet, plate, tubes, pipes, angles, etc. Two-thirds of this traffic originates from the headwaters of the Basin; the rest is imported from outside the region. There are also substantial exports of steel products from the Basin.

Miscellaneous Commodities. The principal 4-digit commodities in this category are asphalt and waterway improvement materials. Because of the diversity of commodities in this group, no particular pattern of movement can be sketched.

# CHAPTER II.

## STUDY APPROACH

## CHAPTER II. STUDY APPROACH

This chapter discusses the collection of survey information and the subsequent analysis of survey data. These topics include:

- Questionnaire design
- Identification of waterway users and selection of major users for interviews
- Interview procedures
- Tabulation and construction of data base
- Contrast of new with preexisting data
- Generation of traffic projections
- Analysis of operational and economic user concerns and intentions.

### Overview

All Ohio River Basin Waterway Users were surveyd by questionnaire and/or field interviews. They were asked to describe their traffic flows in the base year 1976 and to project their traffic flows for the years 1980, 1985, and 1990. They were also asked to discuss operational and economic matters relating to barge movements which were of particular concern to them. Major waterway users were identified through the use of preexisting traffic data (the Waterborne Commerce Statistics and dock listing compiled by COE). Field interviews were conducted with personnel from these firms to clarify the responses from the questionnaire.

The survey responses were tabulated and traffic flow projections were made for each of 2,488 distinct commodity movements reported. These detailed projections were summed, yielding aggregate projections for rivers, BEA's, PE's, and individual locks and dams. The 1976 data collected from survey respondents were compared with preexisting data. Finally, waterway user concerns and views were ranked and analyzed. The overall study approach is depicted in Figure 3.

### Survey Questionnaire Design

The questionnaire was designed in cooperation with COE. It had two sections, the first being quantitative, the second qualitative. The quantitative section related to traffic growth projections, modal split, and other traffic statistics; the qualitative section surveyed the economic and operational concerns and intentions of waterway users. The questionnaire is attached as Attachment I.

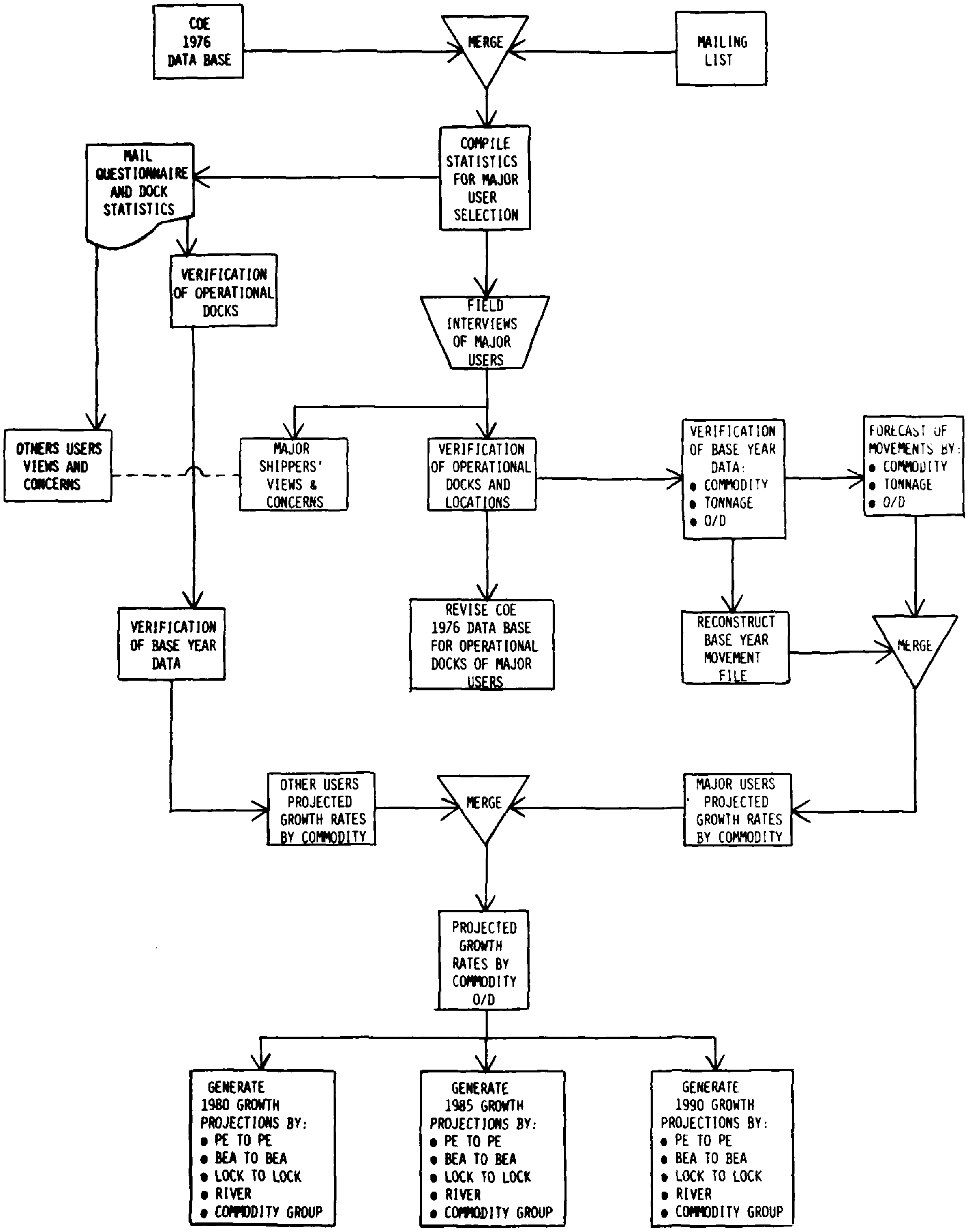


FIGURE 3. OVERVIEW OF STUDY APPROACH

Copy of WCSC Data Provided Respondents. In addition to the questionnaire, each dock(s) was sent a copy of the Waterborne Commerce Statistics (WCSC) information describing movements to and from their dock(s) in the 1976 base year. This was done to provide a common frame of reference for survey respondents. This was expected to produce more consistent and comparable survey responses.

Commodity Projections. Firms were asked to verify their 1976 traffic flows and to project their traffic movements on a point-to-point basis for each commodity they handled; projections were requested for the years 1980, 1985, and 1990.

Modal Split. It was important to determine whether regional freight traffic was susceptible to diversion either to or from barge. Respondents were asekd to describe movements that now use one mode which might be diverted to other modes. This information was requested on a point-to-point, commodity specific basis. When the same commodities were moving by both barge and rail, respondents were asked whether a change in modal split was anticipated.

New Docks and Facilities. Respondents were asked whether they planned to construct, purchase, or lease new dock or river-front facilities or to close existing ones.

Operational and Economic User Concerns and Intentions. The qualitative portion of the questionnaire solicited user views on the following issues:

- Barge costs and likely impact of cost increases
- Competition from other modes
- Navigational problems
- Planned use of the Tennessee-Tombigbee Waterway
- Equipment ownership, use, and configuration
- Reduction of light and empty barge movements.

## Identification of Waterway Users

### Questionnaire Mailings

COE supplied the research effort with WCSC data for the 1976 base year. This data described traffic flows to, from, and within the Basin on a dock-to-dock, commodity specific basis. COE also provided an address listing for each dock in the Basin. These two information sources were dovetailed. What resulted was a listing of each dock, its location, its owner, and the commodity tonnages which moved to and from it in 1976. The listing was not completely accurate, but it did provide a solid departure point for the survey. In all, 901 questionnaires with accompanying data sheets were sent to all identifiable docks in the Basin. This represents 79.7 percent of the 1976 dock listings. The breakdown by river is included as Attached II at the end of this report.

## Criteria for Major User Selection

It was known at the commencement of the study that a relatively small number of firms contributed the bulk of movements in the Basin. The WCSC data were analyzed to determine precisely which firms these were, where their docks were located and the commodity tonnages they moved. In cooperation with COE an initial set of 49 firms was chosen for in-depth field interviews. The selection process was governed by the need to estimate traffic flows for all major commodity groupings as well as the desire to interview the most intensive users of the waterway.

## Major User Sample Size by Commodity Group

The WCSC data indicated that 49 major users contributed 71.8 percent of the tonnage which moved in the Basin in 1976. Many of these firms moved several major commodities. Table 2 breaks down the major user movements by commodity group, and indicates the major user share of each commodity group.

TABLE 2. SELECTED MAJOR USERS' TRAFFIC VOLUME SHARE OF OHIO RIVER BASIN TOTAL BY COMMODITY GROUP, 1976

| Commodity Group | System Tonnage (in 000's) | Major User Tonnage (in 000's) | Major User Share |
|---|---|---|---|
| 1. Coal & Coke | 103,471 | 85,668 | 82.8 |
| 2. Petroleum Fuels | 19,060 | 16,080 | 84.4 |
| 3. Crude Petroleum | 883 | 717 | 81.2 |
| 4. Aggregates | 21,224 | 7,590 | 35.8 |
| 5. Grains | 5,333 | 3,513 | 65.9 |
| 6. Chemicals | 9,449 | 5,586 | 59.1 |
| 7. Ores & Minerals | 3,413 | 1,731 | 50.7 |
| 8. Iron Ore, Iron, & Steel | 4,280 | 3,278 | 76.6 |
| 9. Miscellaneous Commodities | 10,789 | 3,494 | 32.4 |
| Total | 177,902 | 127,657 | 71.8 |

Source: 1976 COE Waterborne Commerce Statistics

It can be seen that the major users dominated each of the commodity groups with the exception of aggregates and the miscellaneous commodities. Major user movements amount to approximately one-third of these last two commodity movements.

## Interview Procedures

Personnel Interviewed. In most cases, no single individual within a respondent firm was able to provide a complete set of answers for the survey. Accounting people provided the verification of the traffic information for the 1976 base year; marketing and strategic planning departments provided traffic projections; and traffic personnel provided information about operating problems, modal split, etc. Firms with independent operating divisions or subsidiaries posed even greater difficulties.

Because of the complexity of the organizations interviewed, it was often necessary to hold joint meetings with several company officials. Follow-up interviews were frequently necessary to obtain a complete set of survey responses. Generally, the respondent firms were quite helpful, both in terms of providing information and coordinating the responses of the various operating divisions to ease the study team's task. Of the initial 49 companies selected, three firms declined to participate and were replaced by three substitute firms. Of the final 49 firms, two firms were unable to meet the data submission deadline and two others were only able to supply partial data.

Interview Format. Each interview began with a review of the preexisting WCSC data describing that firm's barge activities in the Basin. The dock listings and commodity flows associated with each dock were varified or revised. In most interviews more time was spent on identification of the dock ownership and verification of 1976 base year traffic statistics. Thereafter, the interview proceeded along the format of the questionnaire. The structure of the questionnaire was discussed previously in this chapter and is attached as Attachment I .

The principal advantage of field interviews over mailed questionnaires is the greater detail and clarity of responses. For example, a businessman might report that he expects his traffic picture to be "stable" in the coming decade. At first hearing, this seems to be a zero-growth traffic projection. However, a bit of probing might reveal that the stable baseline which the businessman is referring to is a compounding annual growth of 1-3 percent which the firm has experienced for the last five years.

It is possible to obtain clarifying information from interviewees which gives a better understanding of the reliability of growth projections for the firm and its industry. Example: Have the projections been generated based on detailed market analysis, or are they simple extrapolations of past trends? Although this qualitative information could not be directly incorporated into growth projections, it did allow the study team to assess the degree of certainty associated with growth projections for the various commodity groups.

## Data Clarification Procedures for Respondents Not Selected for Field Interviews

From the final mailing list of 901 identifiable operating docks in the Basin, 564 docks were not selected for field interviews. While their individual tonnages were less than that reported for the major users' docks, their collective tonnage for 1976 represents 28.2 percent of the Basin traffic volume. From the 564 docks a total of 104 responses were received. These questionnaire respondents were contacted by telephone to clarify responses and to verify the 1976 WCSC statistics reported for their operations. The respondent firms contacted in this manner were generally quite helpful in supplying and clarifying any missing data for the study.

## WCSC Data Base "Reidentified"

Difficulties with WCSC Data. The field interviews suggested that there were a variety of deficiencies in the original WCSC data base. Among the most prominent difficulties was the misidentification of docks either in regard to their owners, operators, or users. It was decided that the field interviews should be used to "reidentify" movements in the original data base. It was particularly important to determine whether movements had never been reported and were therefore totally absent from the data base, or if there simply had been some misspecification of origin or destination or commodity. As it turned out, both problems did exist. The magnitude of these problems is discussed in Chapter III.

Reidentification Process. The original WCSC data base was reworked in light of the field interview data. Docks were reidentified on a user basis, i.e., the firm which shipped or received commodities across a dock as opposed to the firm which held title or once held title to the facility. In cases where more than one firm used a dock, their movements were disaggregated and were assigned different dock codes. In addition, edit checks were performed to insure consistency between and among the various data items found on each record. For example, PE codes were matched with river codes to check for consistency. As a final step, tonnages from physically adjacent docks owned by the same firm were combined when that firm had no idea as to what tonnage moved across which dock.

The reidentification process provided a better understanding of the WCSC data base regarding which movements belonged to whom in the original WCSC data and which movements were entirely unreported. As a by-product of this procedure, the portion of the WCSC data which described the movements of nonrespondents in the 1976 base year was segregated from the rest of the data.

## New Data Base Constructed to Supplant WCSC Data

Because of the discrepancies discovered between the original WCSC data and the survey responses, an entirely new file was constructed. It described not only the base year (1976) movements, but also projected movements in the years 1980, 1985, and 1990. The data received from both the field interviews and the questionnaires were incorporated into this file. Data for nonrespondents were carried over from the original WCSC file.

Calculating Growth Projections for Respondents. Growth projections for the respondent firms were calculated on the basis of their 2,488 individual commodity movements reported. This includes all of the major users and non-major user respondents. These 2,488 movements became the input to the new data base. This procedure has substantial advantages over calculating a growth rate for the Basin as a whole and then applying it to base-year traffic volumes. The latter procedure shrouds all information about relative growth expectations for rivers, PE's, BEA's, and commodity classifications on the 4-digit level.

It should be noted that not all of the 2,488 growth projections were truly independent. In some cases, a firm might provide only a blanket growth projection for an entire commodity group comprising dozens of distinct movements with some supplementary information on movements which would be notable exceptions to the general trend. Other firms discussed each movement independently and provided very disaggregate growth projections. In balance, it is believed that a large body of information pertaining to relative growth potentials of commodities and geographical areas was successfully captured by the survey.

Exclusion of Double-Counts. Both shippers and receivers of barged commodities were surveyed. This created the potential for tonnage double-counts, because the same movements might be reported twice, first from the shipper's perspective and then from the receiver's. To avoid double-counts, it was decided to include only the receiver's response in cases where a double-count was detected. It was reasoned that future transportation demand would be more accurately projected by the receivers, whose demand for transportation services actually drives the system.

For many varieties of commodity movements, double-counts did not pose a problem. For example, grain shipments are almost totally outbound for transshipment at New Orleans or other Gulf ports; salt is almost entirely inbound from Avery Island and other points in the Gulf area. In the first case the receivers were not surveyed; in the second case the shippers were not surveyed. However, coal, aggregates and a variety of other commodities were usually moved entirely within the Basin. For these commodities, special efforts were necessary to avoid double-counting the same tonnage.

Four steps were taken to eliminate double-counts. First, many commodity movements in the Basin are internal to the firm. Survey respondents were asked to identify these internal movements. Second, the original WCSC data were analyzed to determine commodity exchange relationships between firms. This was possible since COE data is dock specific on both ends of a movement. Third, survey respondents were asked to provide the names of their suppliers/customers when the potential for double-counts was thought to exist. Fourth, movements were matched on a PE-to-PE commodity specific basis. When tonnage totals were suspiciously close for parallel movements follow-up research was conducted to determine whether a double-count had been detected.

Nonrespondent Data. An excellent 69 percent response to the survey was obtained (on a reidentified tonnage basis). The future traffic volumes of the 31 percent nonrespondents were estimated via a three-step process. The first step was to carry the nonrespondent data which had been segregated in the original WCSC file over to the new file. The second step was to adjust this data for probable understatement. The survey responses resulted in an estimated 9 percent understatement in the original data. The tonnages of all nonrespondent movements were upgraded by an appropriate amount regardless of origin or destination. Finally, the growth rates evidenced by the survey data for the years 1980, 1985, and 1990 were applied to the nonrespondents' base year tonnages to yield projections for the nonrespondents in those years. Separate growth rates were calculated and applied for each major commodity group.

## Generation of Aggregate Growth Projections for PE's, Rivers, BEA's, and Locks

The new data base contained projections for 6,050 distinct movements. This total consisted of the 2,488 individual movements reported by the respondent firms (both major user and non-major user respondents) together with the 3,562 movements which represented the non-respondent firms' movements as based on the 1976 COE data. To provide a more understandable portrait of present and future traffic in the Basin, movements were aggregated on the basis of PE's, BEA's, and rivers.

In addition to the point-to-point projections, tonnage flows were calculated for each lock in the Basin, distinguishing by commodity group and direction of flow.

Tables, graphs, and discussions of these findings can be found in Chapter III and the appendices.

## Contrast of Original/Reidentified/ New Data Bases

Once the new data base was constructed, it was possible to contrast it with both the original and the reidentified WCSC data bases. Of interest were not only net changes in tonnage but also allocation errors between docks and commodity classifications. COE was also interested in determining whether the errors in the original WCSC data were largely due to misinformation regarding dock ownership, or whether they had their roots in other causes.

How the process of contrast and comparison would be carried out is obvious and will not be belabored. It is important to note that the analysis could be performed on a dock specific basis for each 4-digit commodity classification.

The WCSC reporting problems resolved themselves into a limited number of recognizable patterns. The magnitude and causes of these problems are discussed in Chapter III.

Comparisons of the WCSC data, the survey data and the degree of survey coverage by commodity group is presented as Attachment III.

## Analysis of User Concerns and Intentions

The major purpose of this survey is to develop traffic forecasts for the waterways of the Ohio Basin which reflect the overall market outlooks, development plans and strategies of the individual firms that utilize the waterway system. To the extent that the individual water users may not, or cannot, fully anticipate the strategies of other firms, nor the capabilities of the waterway system, the resultant forecasts represent demands for waterway service rather than actual traffic projections. In order to more fully understand each firm's traffic demand projection, a series of questions were designed to gauge the respondent's sensitivity to various parameters which might affect the magnitude of the individuals' forecasts as well as the economics of barge traffic. The reader is referred to pages 5 thru 9 of the questionnaire (Attachment I) which deal with waterway equipment utilization, waterway reconfiguration, navigational problems and costs, modal shifts and other matters influencing waterway use. Qualitative and/or quantitative answers to these questions aided in the identification of assumptions inherent in the traffic forecasts as well as the issues or concerns to which the forecasts are most sensitive. Responses to these questions were categorized and tabulated, with answers of each firm given equal weight. This process was a simple and straightforward procedure, because firms showed a great deal of consistency in their response pattern.

## Analytic Tool: SPSS

All of the editing, generation of tables, graphing, and other computational activities were carried out through the use of the computer language SPSS (Statistical Package for the Social Sciences).

# CHAPTER III.

## FINDINGS

# CHAPTER III. FINDINGS

This chapter unfolds the survey findings in three sections. The first discusses disparities between the WCSC data and the survey data. The second section describes traffic growth projections to the year 1990 for commodity groups, rivers, and BEA's. The final section analyzes user views and concerns regarding barge transportation in the Basin.

## Discrepancies Between WCSC Data and Survey Responses

### Nature of the Problem

When the survey was first undertaken it was thought that there might be a limited amount of erroneous information in the WCSC data. However, the first few interviews revealed some major inconsistencies between WCSC data and interview responses. This was a significant and unanticipated finding.

Errors in the WCSC data can be categorized as follows:

- Totally unreported movements
- Erroneously described commodities
- Erroneously described points of origin and destination.

It should be stated at this juncture that the WCSC data, as they currently exist, correctly portray the broad pattern of barge activities in the Basin. However, at a detailed level of analysis (dock, 4-digit commodity classification) the accuracy of the data is much more debatable. It also seems that a non-negligible percentage of commodity movements are never reported to COE.

The analysis in this section will proceed on the assumption that survey respondents correctly described their traffic flows for the year 1976, and that when these responses were inconsistent with WCSC data the latter were incorrect. There are several justifications for this assumption.

- The survey responses came directly from the firms shipping and receiving the commodities, not from an intermediary (WCSC data are collected from barge carriers)

- There was intensive cross-checking and follow-up inquiries on survey responses

- Survey respondents were made aware of COE's concerns about the accuracy of base-year reported WCSC data.

Nevertheless, there were probably a number of occasions when the WCSC data were correct and the survey responses were erroneous.

Sources of the Problem

Unreported Movements. As indicated in Chapter II, data discrepancies were analyzed in two stages. In the first stage, movements already reported in the WCSC data were "reidentified" in terms of the company of origin and destination. This was done using updated dock ownership listings gathered through the survey. The reidentified WCSC file is contrasted with the original WCSC file in Table 3.

Many of the movements which appeared to be absent in the original WCSC data came to light through the reidentification process. This suggests that much of the difficulty with the WCSC data could be resolved simply by updating COE listings of dock ownership and use.

In the second stage of analysis, survey responses were used to create an entirely new file for the 1976 base year. This file was contrasted with the reidentified WCSC data. This contrast is shown in Table 4. There are clear indications that WCSC data problems stem not only from the misidentification of docks but also unreported and erroneously reported movements.

There are a variety of circumstances which seem to promote the nonreporting of barge movements. Interestingly, some of these circumstances might also lead to duplicate reporting of the same movements.

Circumstance 1: Exchange Agreements. Exchange or swapping agreements affect mainly the petroleum fuel and coal industries. These agreements allow suppliers to serve each others' customers, thereby producing transportation cost savings. Suppose for example, a refinery in Missouri contracts for the sale of a million barrels of gasoline to a customer in Pittsburgh, while a refinery belonging to a different firm in West Virginia enters into a similar contract with a customer in Illinois; the two refineries may then execute an exchange agreement where the Missouri firm supplies the Illinois customer and the West Virginia firm supplies the Pittsburgh customer. This circumstance promotes underreporting. The firm which originally agreed to the sale will not report the delivery because it did not barge the commodity. The firm which actually made the delivery (assuming it barges its own commodities) may not report the movement because it wasn't its sale. Using the reverse logic, both firms might report the same movement.

Circumstance 2: Traffic Interlining. When traffic is interlined, Carrier One moves a barge from origin point A to interchange

TABLE 3. COMPARISON OF 1976 ORIGINAL COE WATERBORNE COMMERCE STATISTICS AND "REIDENTIFIED" WCSC DATA FOR THE SELECTED MAJOR USERS

| Commodity Group | Original(1) Tonnages (000's) | Reidentified(2) Tonnages (000's) | Percentage Difference |
|---|---|---|---|
| Coal & Coke | 67,504 | 81,233 | +20.3 |
| Petroleum Fuels | 16,035 | 15,799 | -1.5 |
| Crude Petroleum | 717 | 286 | -60.1 |
| Aggregates | 6,619 | 6,691 | +1.1 |
| Grains | 3,057 | 3,062 | +0.2 |
| Chemicals & Chemical Fertilizers | 4,986 | 5,229 | +4.9 |
| Ores & Minerals | 1,623 | 1,651 | +1.7 |
| Iron Ore, Iron & Steel | 2,584 | 2,642 | +2.2 |
| Miscellaneous Commodities | 3,371 | 3,414 | +1.3 |
| Total | 106,496 | 120,007 | +12.7 |

Source: (1) Based on original 1976 COE Data for those major users who responded.
(2) Based on adjustment made to the original COE data via Battelle survey.

TABLE 4. COMPARISON OF 1976 "REIDENTIFIED" WCSC DATA AND SURVEY RESPONSES FOR THE SELECTED MAJOR USERS

| Commodity Group | Reidentified Tonnages (000's) | Survey Responses (000's) | Percentage Difference |
|---|---|---|---|
| Coal & Coke | 81,233 | 84,643 | +4.2 |
| Petroleum Fuels | 15,799 | 17,274 | +9.3 |
| Crude Petroleum | 286 | 0 | -100.0 |
| Aggregates | 6,691 | 7,682 | +14.8 |
| Grains | 3,062 | 3,052 | -0.3 |
| Chemicals & Chemical Fertilizers | 5,229 | 6,325 | +21.0 |
| Ores & Minerals | 1,651 | 2,132 | +29.1 |
| Iron Ore, Iron & Steel | 2,642 | 3,294 | +24.7 |
| Miscellaneous Commodities | 3,414 | 2,665 | -21.9 |
| Total | 120,007 | 127,067 | +5.9 |

Source: Battelle Survey

point B; Carrier Two moves the barge from point B to the final destination C. In this situation, one, both, or neither of the carriers may report the movement. If Carrier One reports, he may describe the movement as proceeding from point A to point B; alternatively, he may describe the entire movement from point A to ultimate destination point C. The same holds true for Carrier Two. It is easy to see how this circumstance could result in erroneous WCSC data.

Circumstance Three: Contract or Chartered Carriage. Contract and chartered commodity movements were frequently unreported. These transportation arrangements blur the distinction between shipper and carrier. It may be that both parties assume that the other will report the movement. Or, the carrier may believe that contract carriers do not have the same reporting obligations as common carriers.

Circumstance Four: Transport of Dredged Materials. Each year many million of tons of material are dredged from system rivers and moved to shore for distribution as aggregates. Many of these movements are never reported. Carriers may feel no need to report these movements because they do not fit the norm. (The movement is typically short, does not transit a lock, and has no dock of origin.)

Erroneously Described Commodities. This problem is confined mainly to chemicals, ores & minerals and the miscellaneous commodity groups; the iron & steel and petroleum fuels groups also exhibit this problem, but to a lesser degree. Most of the classification errors are within commodity groups but there is some misallocation between groups.

NEC (Not Elsewhere Classified) categories are a major problem. They have become the repositories of all movements which cannot be readily assigned to one of the other commodity classes. Unfortunately, there are many cases when the technical or commercial name used to describe a commodity prevents it from being recognized and properly categorized. For example, "AMAPA" and "COMILOG" are trade names for manganese ore. But, a movement reported as "AMAPA" might end up being categorized as nonferrous ores-NEC, or nonmetallic minerals-NEC, or even chemical products-NEC.

There are also some idiosyncracies in the four-digit-commodity group classification scheme which may promote errors or ambiguities. Chief among these is commodity classification 4118 (waterway improvement materials) which is grouped with miscellaneous commodities and amounted to 4 million tons in 1976 on the basis of WCSC data. In many cases waterway improvement materials are aggregates which have been dredged from the river, thereby improving channel depth, or they may be quarried materials delivered to a lock-and-dam project. In these circumstances there is no single correct category for the materials moved.

There may also be many situations when the barge carrier simply does not know what commodity he is carrying. This is particularly true of chemicals or ores which may have "exotic" names.

It is also important to note that carriers may report their movements to federal agencies other than COE such as the Coast Guard. The commodity classifications used by these other agencies do not always coincide with WCSC classifications. This may promote a certain amount of confusion.

Erroneously Described Origins or Destinations. This problem is pervasive in the WCSC data on the dock-specific level. At higher levels of aggregation it largely disappears. This difficulty may originate in the COE dock listings mentioned earlier. Each year many docks are constructed, deactivated, leased, and traded; COE dock listings have not totally kept track of these changes.

The following example shows how this may produce errors in the WCSC data. A barge carrier may indicate that he delivered 500,000 tons of aggregates to firm A in Evansville. Unfortunately, the dock which COE lists as belonging to firm A in Evansville may now be operated by a grain shipper. It is also possible that firm A owns a half dozen docks in the vicinity of Evansville. The movement might then be arbitrarily assigned to one of those six docks.

Many firms in the Basin operate under several different trade names. When these names are based on geography or commodity, several firms may use very similar names. This creates ample opportunity for confusion.

Reconsignment enroute of grain, petroleum or coal barges may also produce reporting errors. For example, a grain barge outbound for New Orleans from Cincinnati may be reconsigned enroute to St. Paul. The movement has been diverted but underlying paperwork documenting the movement may not change, and the obsolete information eventually finds its way into WCSC files.

Erroneous origin/destination information can also result from the exchange and interlining arrangements discussed earlier.

## Ohio River Basin Traffic Growth Projections

The survey responses indicate that barge traffic will grow 74.0 percent from 1976 to 1990. Table 5 shows the estimated 1976 base-year tonnage flows and the projections for 1980, 1985, and 1990. These numbers indicate that growth will be vigorous from 1976 to 1980, moderate from 1980 to 1985, and very modest from 1985 to 1990. The shape of this growth curve is readily explainable.

TABLE 5. OHIO RIVER BASIN WATERBORNE TRAFFIC PROJECTIONS BY COMMODITY GROUP, TO 1990 (IN THOUSAND TONS)

| Commodity Group | 1976* | 1980 | 1985 | 1990 | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|
| Coal & Coke | 111,631 | 166,270 | 201,095 | 217,335 | 94.7 |
| Petroleum Fuels | 20,922 | 21,527 | 22,640 | 23,764 | 13.6 |
| Crude Petroleums | 664 | 0 | 0 | 0 | -100.0 |
| Aggregates | 25,169 | 31,194 | 34,671 | 38,339 | 52.3 |
| Grains | 5,583 | 6,921 | 7,918 | 9,004 | 61.3 |
| Chemicals & Chemical Fertilizers | 11,290 | 12,504 | 13,802 | 15,701 | 39.1 |
| Ores & Minerals | 4,435 | 4,668 | 5,151 | 5,627 | 26.9 |
| Iron Ore, Iron & Steel | 5,167 | 5,779 | 6,341 | 6,676 | 29.2 |
| Miscellaneous Commodities | 10,915 | 18,327 | 22,385 | 24,124 | 121.0 |
| Total | 195,776 | 267,190 | 314,003 | 340,570 | 74.0 |
| Increase Over Previous Period (%) | | 36.5 | 17.5 | 8.5 | |
| Overall Growth (1976-1990, %) | | | | 74.0 | |

* Based on readjusted volumes from Battelle's survey.

Traffic, particularly coal traffic, will grow strongly throughout the next decade. But, an anticipated coal strike in 1981 will produce heavy coal stockpiling in 1980. Coal traffic will surge in that year with a probably subsidance in 1981. Growth will then resume at a moderate rate, with coal traffic once again being the major growth influence. Once one gets beyond the 1985 period, business people become increasingly reluctant to make positive growth projections. Citing various uncertainties in the present economic situation, many respondents projected zero or marginal growth for those final five years.

Many respondents qualified their projections, indicating a number of factors which might prevent the projected growth from materializing. There was an almost universal expression of anxiety about environmental, regulatory, and zoning laws. Collectively, these restrictions could significantly dampen barge traffic growth.

Many traffic people also felt that substantial lock improvements might be necessary to accomodate the volume of future barge traffic. Otherwise, bottlenecks might physically limit barge activities in the Basin.

A final important consideration is the role of the railroads as competitive movers of bulk commodities within the region. Several respondents were very critical of rail carriers as bulk commodity movers. Most respondents totally discounted the potential of railroads to divert traffic from barges during the projection period. The growth factors cited earlier reflect this negative perspective.

At the same time, it is known that several of the area's railroads are discussing merger or reorganization, and that the federal government is becoming more attentive to the role railroads play in the U.S. transportation network. It is possible, therefore, that railroads will compete more successfully for bulk freight traffic in the Basin than many respondents currently assume.

## Traffic Growth Projections by Commodity Groups

The following commodity group projections (Tables 6 through 13) are all based on the 1976 readjusted tonnages as determined during the survey.

Coal. Growing coal consumption will be the most important influence on barge traffic increases. Table 6 shows the coal comprised 57 percent of commodity tonnage moving in the Basin in 1976; by 1990 coal's traffic share will have climbed to 63.8 percent.

TABLE 6. OHIO RIVER BASIN WATERBORNE TRAFFIC PROJECTIONS FOR COAL, TO 1990

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Tonnages (000's) | 111,631 | 166,270 | 201,095 | 217,335 |
| Increase Over Previous Period (%) | --- | 48.9 | 20.9 | 8.1 |
| Overall Growth (1976-1990, %) | --- | --- | --- | 94.7 |
| Coal's Share of Total Traffic (%) | 57.0 | 62.2 | 64.0 | 63.8 |

Three varieties of coal move in the Basin - metallurgical coal, coke, and steam coal. Although consumption of the first two is expected to grow moderately, consumption of steam coal (the dominant commodity in this group) is expected to grow dramatically. Most steam coal is consumed by electric power generating plants. The planning, permitting, and construction of a power plant may take as long as a decade. Because of this, electric utilities are forced to map demand for electricity (and energy inputs) well into the future. A great deal of confidence can be attached, therefore, to coal traffic forecasts. At the same time, there may be some slippage in the completion dates of planned power generating units; coal traffic growth will show a corresponding lag.

Utilities also suggested that EPA restrictions on sulphur emissions might slow the use of coal as an energy source substantially more than projections indicate.

The depletion of coal reserves and environmental restrictions on sulphur emissions will produce shifts in coal origin points but destination points will remain largely unchanged.

Petroleum Fuels. Petroleum fuels barge traffic is expected to increase slightly (under 14 percent during the projection period). Table 7 indicates that this commodity group's traffic share will decline from 10.7 percent to 7.0 percent over this period.

TABLE 7. OHIO RIVER BASIN WATERBORNE TRAFFIC PROJECTIONS FOR PETROLEUM FUELS, TO 1990

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Tonnages (000's)** | **20,922** | **21,527** | **22,640** | **23,764** |
| **Increase Over Previous Period (%)** | --- | 2.9 | 5.2 | 5.0 |
| **Overall Growth (1976-1990, %)** | --- | --- | --- | 13.6 |
| **Petroleum Fuels Share of Total Traffic (%)** | 10.7 | 8.1 | 7.2 | 7.0 |

Several factors account for the expected slow growth of petroleum fuel traffic. Oil companies expect that petroleum fuels will constitute a progressively smaller portion of the national energy mix in coming decades. At the same time, the increasing prevalence of exchange agreements will reduce the barge transportation of petroleum fuels.

Customer exchange agreements were discussed earlier in this chapter. One of their initial effects is a reduction of petroleum fuel transportation measured in ton-miles. A second effect is the consolidation of petroleum fuel distribution points, as individual firms come to dominate the distribution function in specific regions. The ultimate result is the construction of pipelines (which require large volumes to be economical) to supply the high-volume distribution points.

Petroleum fuel transportation proceeds in three stages. Crude petroleum is transported to the refineries in the first stage. Refined petroleum products are transported to distribution points in the second stage. Refined products are taken from distribution points to final consumers in the third transportation stage. Barges are involved primarily in second stage transportation activities in the Basin.

Therefore, the link between refinery and distributor will increasingly be provided by pipelines rather than barges. In some cases petroleum fuels will be transported a portion of their haul by pipeline and then transloaded to barge to complete the trip.

It is likely that prevailing petroleum fuel traffic patterns and volumes will remain fixed; traffic growth will be absorbed by pipelines.

Crude Petroleum. Crude petroleum movements have been almost totally diverted from barges to pipelines. Original WCSC data indicated that major users moved 717,000 tons of crude in 1976. The field interviews could not confirm any such movements, nor is any reversal of the diversions to pipeline expected. Some future movements of crude petroleum of an emergency "make-up" nature will probably occur in the Basin, but they will amount to only a few barges per refinery per year.

Aggregates. Table 8 indicates that traffic in aggregates will increase at a compounding rate of 3-4 percent over the projection period. This commodity group's traffic share will decline from 12.9 percent in 1976 to 11.3 percent in 1990.

TABLE 8. OHIO RIVER BASIN WATERBORNE TRAFFIC PROJECTIONS FOR AGGREGATES, TO 1990

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Tonnages (000's) | 25,169 | 31,194 | 34,671 | 38,339 |
| Increase Over Previous Period (%) | --- | 23.9 | 11.1 | 10.6 |
| Overall Growth (1976-1990, %) | --- | --- | --- | 52.3 |
| Aggregates Share of Total Traffic (%) | 12.9 | 11.7 | 11.0 | 11.3 |

The aggregates industry boomed during the interstate highway construction program. The substantial completion of this program left a demand vacuum. To a significant extent that vacuum has been filled by residential construction and road resurfacing (many roads were built decades ago at 20 year design standards and are now reaching "maturity"). It is also expected that a continued vigorous growth of the electrical utility industry will spur demand for aggregates for use in power plant construction. There are no anticipated booms corresponding to the interstate highway construction periods, but certain regions such as West Virginia and "aggregate poor" areas of Alabama may experience inordinate increases in aggregate imports from other areas of the Basin.

The extraction and waterborne transportation of aggregates in the Ohio River Basin follow a simple pattern. Aggregates such as crushed limestone, sand or gravel are extracted from quarries or dredged from the river bottom. The aggregates are then classified either as they are loaded into barges (as is the case with dredging) or as they are loaded into trucks for the movements to the barge loading dock (as is the case with quarries). They then move either directly via barge to consumption sites, or they are shipped to a major metropolitan area such as Louisville or Cincinnati. From these metropolitan areas, the aggregates are either distributed locally or they are further processed and converted into building cement, added to asphalt, or distributed locally as construction materials. In some instances the materials are shipped via barge directly to consumption sites after the conversion process.

Extraction sites are expected to remain fixed for several reasons. Many firms reported that their existing quarries would provide them with adequate supplies for several decades. Moreover, the environmental and zoning restrictions on establishing new quarry or river dredge sites are rather intimidating. The last factor will tend to eliminate "tramp" quarries, i.e., quarries mined near major construction sites for the purpose of serving that one project only. The net result will be more waterborne transportation of aggregates from established sites. It is also likely that the major users will control a bigger portion of the market in coming years. Therefore, their growth projections may differ from industry projections, and the numbers in Table 8 may be somewhat optimistic.

The destination points for aggregates will also remain fixed, with the exception of the regions mentioned earlier. There will also be temporary traffic surges to specific construction sites such as power plants.

Grains. As can be seen in Table 9, the traffic share of grain is expected to remain constant; absolute tonnage increases for the year 1990 will amount to 61 percent of the 1976 base year.

TABLE 9. OHIO RIVER BASIN WATERBORNE TRAFFIC PROJECTIONS FOR GRAINS, TO 1990

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Tonnages (000's) | 5,583 | 6,921 | 7,918 | 9,004 |
| Increase Over Previous Period (%) | --- | 24.0 | 14.4 | 13.7 |
| Overall Growth (1976-1990, %) | --- | --- | --- | 61.3 |
| Grains Share of Total Traffic (%) | 2.9 | 2.6 | 2.5 | 2.6 |

Grain is collected from throughout the western and central portions of the Basin by truck and rail. It is transloaded to barge at cities such as Cincinnati, Evansville, and Louisville. Most grain is barged to Gulf ports, transloaded to oceangoing vessels, and shipped abroad. This established pattern is not expected to change.

Grain merchants suggested that the projections they provided for Table 9 are optimistic. Advances in agricultural technology may plateau, in which case the output of regional grain-producing lands would stabilize. Moreover, the grain companies have invested heavily in rail rolling stock. It is used to ship grain via unit-trains to East Coast ports. It is the intention of the grain firms to maintain a competitive balance between the modes. The precise traffic split is uncertain.

Chemicals & Chemical Fertilizers. As can be seen in Table 10, chemical traffic in the Basin will grow only half as fast as the average. Its traffic share will decline to 4.6 percent by 1990.

TABLE 10. OHIO RIVER BASIN WATERBORNE TRAFFIC PROJECTIONS FOR CHEMICALS & CHEMICAL FERTILIZERS, TO 1990

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Tonnages (000's)** | 11,290 | 12,504 | 13,802 | 15,701 |
| **Increase Over Previous Period (%)** | --- | 10.8 | 10.4 | 13.8 |
| **Overall Growth (1976-1990, %)** | --- | --- | --- | 39.1 |
| **Chemicals Share of Total Traffic (%)** | 5.8 | 4.7 | 4.4 | 4.6 |

The growth of the chemical industry may be slowed by the enforcement of increasingly stringent air- and water-pollution standards. These environmental regulations affect chemical transportation as well as chemical production. They require safeguards against seepage and spills and mandate the purchase of equipment to contain and collect pollutants should spills occur.

Established patterns of movement are not expected to change. The major chemical producing areas of the Kanawha Valley and the Upper Tennessee will continue to ship finished products to points in the Basin while receiving feedstocks from the Lower Mississippi and Gulf Coast.

Advanced technology in containerization has introduced new methods of transporting resins, plastics, and other granular chemicals in both containers and LASH barge equipment. As a result, there may be more opportunity for consolidation of these products for barge lot-size shipments.

Ores & Minerals. As can be seen in Table 11, the absolute volume of ore & mineral traffic will increase marginally from 1976 to 1990. Their traffic share will decline to 1.7 percent.

TABLE 11. OHIO RIVER BASIN WATERBORNE TRAFFIC PROJECTIONS FOR ORES & MINERALS, TO 1990

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Tonnages (000's)** | 4,435 | 4,668 | 5,151 | 5,627 |
| **Increase Over Previous Period (%)** | --- | 5.3 | 10.3 | 9.2 |
| **Overall Growth (1976-1990, %)** | --- | --- | --- | 26.9 |
| **Ores & Minerals Share of Total Traffic (%)** | 2.3 | 1.7 | 1.6 | 1.7 |

The commodities contained in this group are mainly ores such as manganese used for alloy steel production. As such, they are highly dependent on the strength of the steel industry. The firms handling ores & minerals are very cautious in their growth projections for the Basin. This reflects the slow growth expectations of the domestic steel industry.

Over two-thirds of the ore & mineral traffic in the Basin originates in Lower Mississippi and Gulf Coast ports and terminates in the major steel-producing areas of the Basin. These inbound patterns are expected to continue in the future with little change. Outbound patterns are less certain. Manganese ores are currently being drawn from GSA stockpiles in the Basin. There is a strong possibility that these sources will be closed in the near future. As a result, more ore will be imported from Africa, Australia, and South American through Lower Mississippi and Gulf ports.

Salt is the major nonmetallic mineral in this group. It is brought into the Basin from the western Gulf Coast and has a positive growth future.

Iron Ore, Iron & Steel. Table 12 shows that traffic in iron ore, iron & steel will increase modestly over the projection period. Its traffic share will slip from 2.6 percent in 1976 to 2.0 percent in 1990.

TABLE 12. OHIO RIVER BASIN WATERBORNE TRAFFIC PROJECTIONS FOR IRON ORE, IRON & STEEL, TO 1990

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Tonnages (000's)** | 5,167 | 5,779 | 6,341 | 6,676 |
| **Increase Over Previous Period (%)** | --- | 11.8 | 9.7 | 5.3 |
| **Overall Growth (1976-1990, %)** | --- | --- | --- | 29.2 |
| **Iron & Steel's Share of Total Traffic (%)** | 2.6 | 2.2 | 2.0 | 2.0 |

Intermediate and finished iron & steel products are the most important commodities in this group. Currently, these products flow from the Upper Ohio and Monongahela Rivers to points downstream within and outside the Basin. Recent years have also witnessed a growing volume of foreign steel imported to the Basin through Gulf and Lower Mississippi ports.

Slow growth predictions for domestic steel are attributable to the threat of foreign imports and the reluctance of domestic steel producers to invest in major new facilities. The exchange value of the dollar will have a strong influence on the level of foreign steel imports.

The firms interviewed predict a continuation of the current balance between foreign and domestic steel sources, but there are many qualifications attached to this forecast.

Miscellaneous Commodities. The field interviews resulted in a reassignment of many of the movements originally thought to belong in the miscellaneous category to other commodity groups. NEC categories were particularly overburdened with misclassified movements. The field interviews identified the major commodities in this group as asphalt, lime, building cement, naptha, and lubricating oils.

TABLE 13. OHIO RIVER BASIN WATERBORNE TRAFFIC PROJECTIONS FOR MISCELLANEOUS COMMODITIES, TO 1990

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Tonnages (000's) | 10,915 | 18,327 | 22,385 | 24,124 |
| Increase Over Previous Period (%) | --- | 67.9 | 22.1 | 7.8 |
| Overall Growth (1976-1990, %) | --- | --- | --- | 121.0 |
| Miscellaneous Commodities Share of Total Traffic (%) | 5.6 | 6.9 | 7.1 | 7.1 |

Well over half the tonnage included in this group belongs to non-respondent firms. It is likely that responses from these firms would reveal further misclassifications. Because survey projections for commodities in this group are very limited, the overall growth prediction for the group is not very reliable.

Lime (for coal desulphurization) is the major commodity within this group for which projections were given. The expected high traffic growth for this commodity in effect "pulled" the traffic predictions for all commodities in the group.

## Traffic Growth Projections by Rivers

This section will discuss the commodity projections as they apply to each of the nine navigable rivers in the Ohio River Basin. Included will be descriptions of the principal commodities on each river, the direction these commodities flow, and how the rivers interact with each other in terms of these commodity flows. Also covered will be a discussion of the effect of these flows on locks.

Main Stem Ohio. The Ohio is the principal river in the Basin; all other rivers are its tributaries. Table 14 shows the projected commodity flows on the Ohio. This table includes through traffic as well as freight which originates or terminates on the river. A graphic representation of growth on the river is shown in Figure 4. Approximately 15 percent of this volume is through traffic.

TABLE 14. WATERBORNE TRAFFIC PROJECTIONS, OHIO RIVER, TO 1990 (IN THOUSAND TONS)

| Commodity Group | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Coal & Coke | 85,842 | 134,577 | 167,675 | 182,298 |
| Petroleum Fuels | 20,535 | 21,104 | 22,180 | 23,270 |
| Crude Petroleum | 664 | 0 | 0 | 0 |
| Aggregates | 20,939 | 26,091 | 29,017 | 32,088 |
| Grains | 5,568 | 6,904 | 7,897 | 8,982 |
| Chemicals & Chemical Fertilizers | 10,863 | 12,180 | 13,459 | 15,346 |
| Ores & Minerals | 4,388 | 4,644 | 5,151 | 5,627 |
| Iron Ore, Iron & Steel | 5,164 | 5,776 | 6,338 | 6,672 |
| Miscellaneous Commodities | 10,387 | 17,441 | 21,303 | 22,958 |
| Total | 164,350 | 228,717 | 273,020 | 297,241 |

Because such a large portion of the Basin's traffic flows on the main stem Ohio, its growth characteristics and its traffic mix are quite similar to the Basin overall.

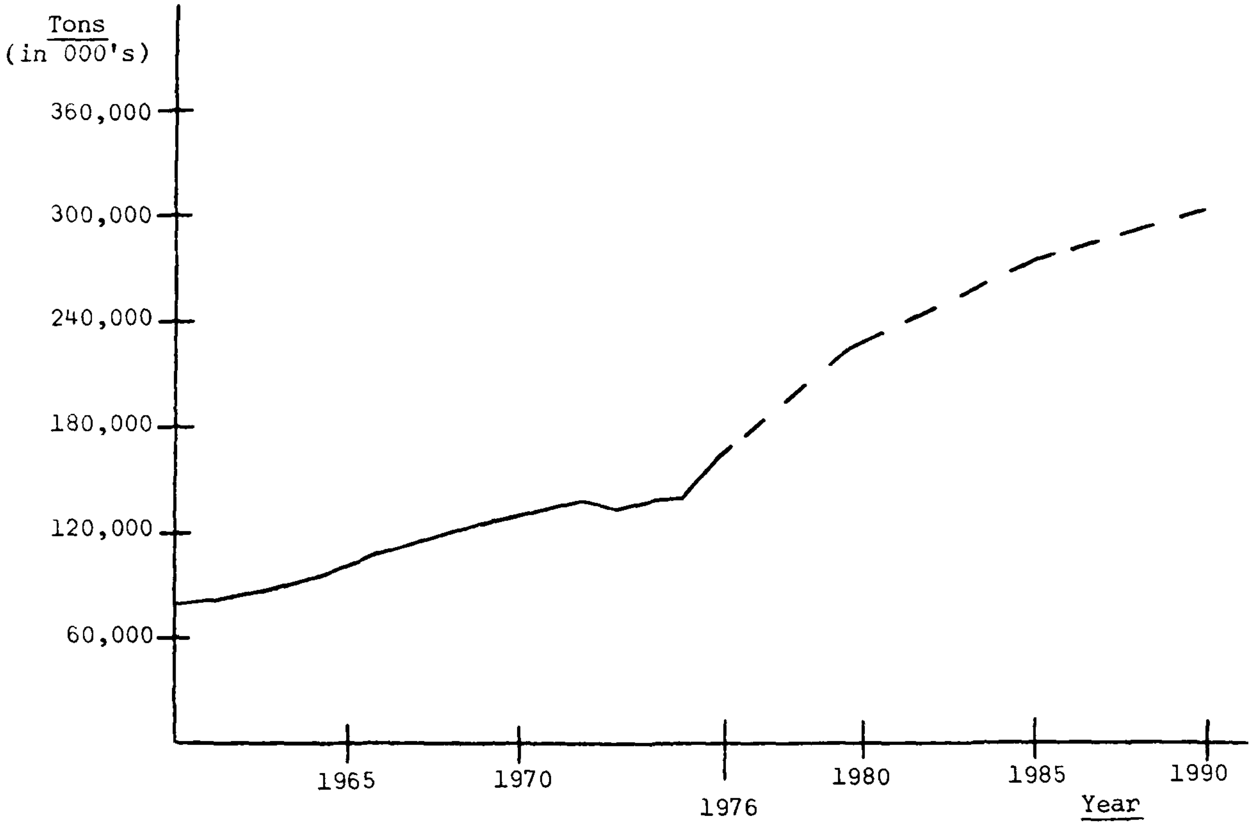


FIGURE 4. OHIO RIVER TRAFFIC GROWTH PATTERNS, 1960-1990

All locks on the Ohio will experience significant traffic increases. But some will experience greater growth than others because of anticipated changes in the traffic mix and origin/destination patterns. Estimated 1990 lock transit volumes are shown in Table 15.

TABLE 15. ESTIMATED 1990 LOCK TRANSIT VOLUMES, OHIO RIVER (IN THOUSAND TONS)

| Lock | Tonnage Estimated 1976 | Tonnage Projected 1990 | Expected Growth (%) |
|---|---|---|---|
| Emsworth | 23,954 | 38,328 | 60 |
| Dashields | 23,731 | 38,799 | 63 |
| Montgomery | 21,093 | 31,971 | 52 |
| New Cumberland | 24,695 | 39,634 | 60 |
| Pike Island | 26,458 | 41,853 | 58 |
| Hannibal | 30,798 | 50,434 | 64 |
| Willow Island | 32,233 | 50,491 | 57 |
| Belleville | 34,623 | 54,115 | 56 |
| Racine | 36,723 | 57,038 | 55 |
| Gallipolis | 42,670 | 70,215 | 65 |
| Greenup | 34,071 | 67,607 | 98 |
| Meldahl | 30,468 | 55,185 | 81 |
| Markland | 34,866 | 60,490 | 73 |
| McAlpine | 40,470 | 66,856 | 65 |
| Cannelton | 42,590 | 68,723 | 61 |
| Newburgh | 39,531 | 73,671 | 86 |
| Uniontown | 46,103 | 83,214 | 80 |
| Smithland | 51,889 | 90,913 | 75 |
| Ohio L&D 52 | 60,840 | 106,687 | 75 |
| Ohio L&D 53 | 56,181 | 87,660 | 56 |

Allegheny River. As shown in Table 16, the Allegheny River is expected to experience slower growth than the overall system, with most of the growth being generated by aggregates and the miscellaneous commodities. It is anticipated that coal from the Allegheny will experience a decreasing market share as the older mines in the region become depleted. Inbound coal will be confined to the lower reaches near the Pittsburgh area, as will most commodity flows. Figure 5 is a graphic representation of the historic and expected growth on the Allegheny for all commodities.

TABLE 16. WATERBORNE TRAFFIC PROJECTIONS, ALLEGHENY RIVER, TO 1990 (IN THOUSAND TONS)

| Commodity Group | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Coal & Coke | 2,[illegible] | 3,231 | 2,975 | 3,011 |
| Petroleum Fuels | 351 | 332 | 369 | 385 |
| Crude Petroleum | 3 | 0 | 0 | 0 |
| Aggregates | 1,656 | 1,931 | 2,083 | 2,234 |
| Chemicals & Chemical Fertilizers | 89 | 91 | 100 | 113 |
| Ores & Minerals | 316 | 368 | 429 | 434 |
| Iron Ore, Iron & Steel | 195 | 209 | 220 | 226 |
| Miscellaneous Commodities | 589 | 782 | 922 | 1,000 |
| Total | 6,057 | 6,944 | 7,098 | 7,403 |

Most traffic flows on the Allegheny are local. Some petroleum fuels, chemicals, and ores are imported to the river from the Lower Mississippi and Gulf Coast.

Because of the slow growth expectation for the river, none of its locks will experience significant traffic increases. Lock transit volumes are shown below in Table 17.

TABLE 17. ESTIMATED 1990 LOCK TRANSIT VOLUMES, ALLEGHENY RIVER (IN THOUSAND TONS)

| Lock | Tonnage | | Expected Growth (%) |
|---|---|---|---|
| | Estimated 1976 | Projected 1990 | |
| Allegheny L&D 6 | 129 | 155 | 20 |
| Allegheny L&D 5 | 1,584 | 2,126 | 34 |
| Allegheny L&D 4 | 1,934 | 2,753 | 42 |
| Allegheny L&D 3 | 3,606 | 4,227 | 17 |
| Allegheny L&D 2 | 4,057 | 5,093 | 26 |

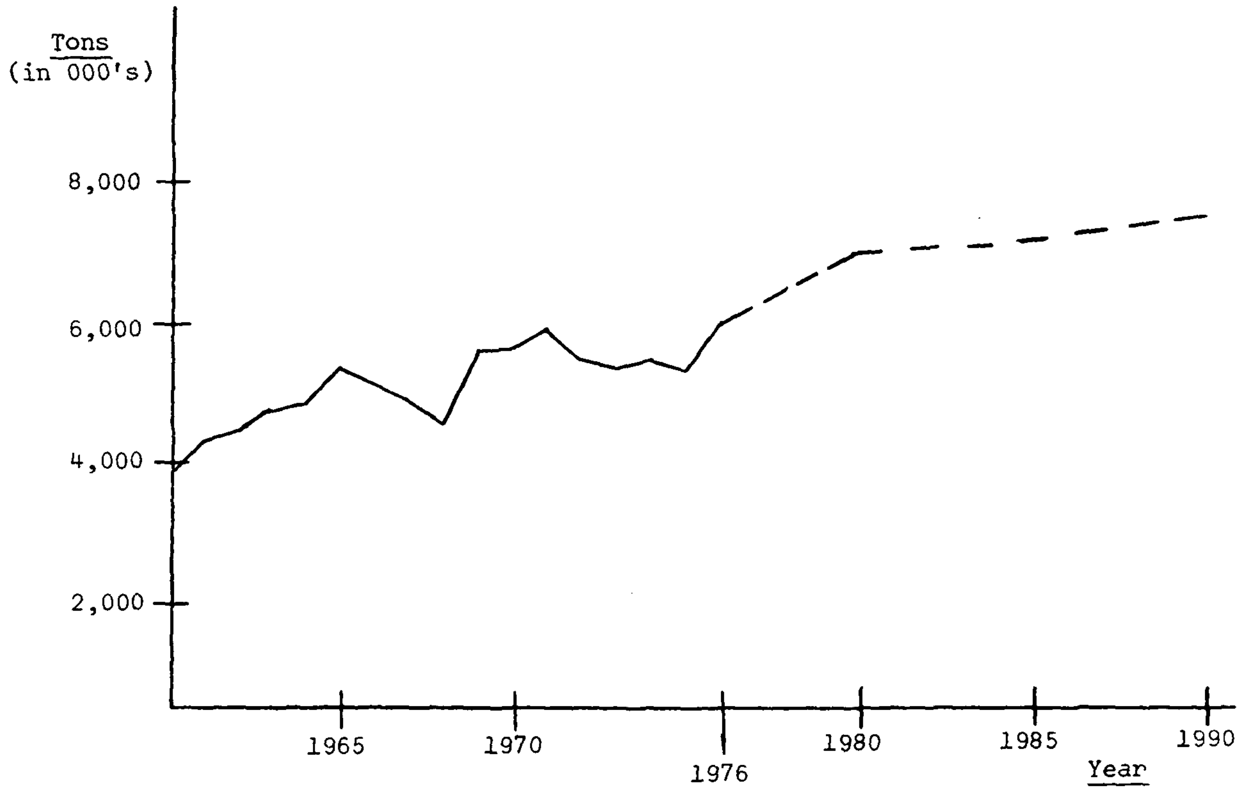


FIGURE 5. ALLEGHENY RIVER TRAFFIC GROWTH PATTERNS, 1960-1990

Monongahela River. Traffic on the Monongahela is expected to grow 57 percent from 1976 to 1990. (See Table 18.) This is appreciably slower than the Basin overall. Figure 6 depicts historic and projected traffic on the Monongahela.

TABLE 18. WATERBORNE TRAFFIC PROJECTIONS, MONONGAHELA RIVER, TO 1990 (IN THOUSAND TONS)

| Commodity Group | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Coal & Coke | 31,829 | 41,795 | 48,533 | 52,099 |
| Petroleum Fuels | 2,454 | 2,430 | 2,719 | 2,835 |
| Aggregates | 1,846 | 2,107 | 2,260 | 2,424 |
| Chemicals & Chemical Fertilizers | 339 | 400 | 482 | 549 |
| Ores & Minerals | 502 | 531 | 588 | 643 |
| Iron Ore, Iron & Steel | 1,766 | 1,919 | 2,069 | 2,198 |
| Miscellaneous Commodities | 363 | 498 | 592 | 651 |
| Total | 39,099 | 49,680 | 57,243 | 61,399 |

Lock transit volumes are an important consideration on the Monongahela. Estimated 1990 lock transit volumes are shown in Table 19.

TABLE 19. ESTIMATED 1990 LOCK TRANSIT VOLUMES, MONONGAHELA RIVER (IN THOUSAND TONS)

| Lock | Tonnage: Estimated 1976 | Tonnage: Projected 1990 | Expected Growth (%) |
|---|---|---|---|
| Opekiska | 188 | 352 | 87 |
| Hildebrand | 244 | 408 | 67 |
| Morgantown | 1,040 | 1,820 | 75 |
| Monongahela L&D 8 | 5,345 | 8,684 | 62 |
| Monongahela L&D 7 | 7,242 | 13,124 | 81 |
| Maxwell | 17,001 | 29,484 | 73 |
| Monongahela L&D 4 | 18,018 | 30,996 | 72 |
| Monongahela L&D 3 | 22,364 | 37,634 | 68 |
| Monongahela L&D 2 | 20,899 | 36,069 | 73 |

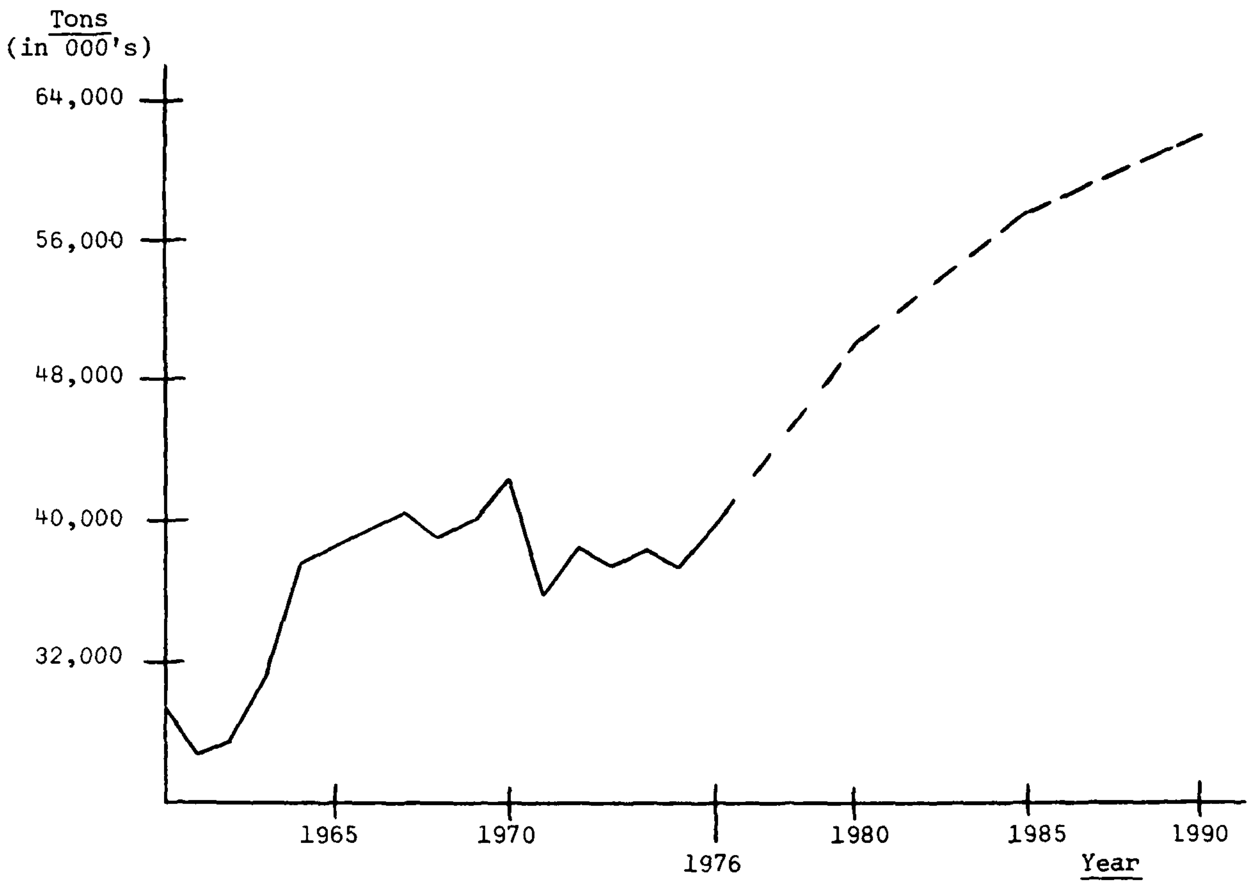


FIGURE 6. MONONGAHELA RIVER TRAFFIC GROWTH PATTERNS, 1960-1990

Kanawha River. Traffic on the Kanawha is expected to grow 57.1 percent between 1976 and 1990. Table 20 indicates that almost all of this growth will be accounted for by aggregates and coal.

TABLE 20. WATERBORNE TRAFFIC PROJECTIONS, KANAWHA RIVER, TO 1990 (IN THOUSAND TONS)

| Commodity Group | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Coal & Coke | 6,986 | 9,778 | 12,741 | 13,114 |
| Petroleum Fuels | 1,274 | 1,303 | 1,368 | 1,381 |
| Aggregates | 2,118 | 2,521 | 2,900 | 3,328 |
| Chemicals & Chemical Fertilizers | 3,588 | 3,809 | 4,076 | 4,171 |
| Ores & Minerals | 169 | 172 | 185 | 195 |
| Iron Ore, Iron & Steel | 82 | 84 | 95 | 104 |
| Miscellaneous Commodities | 220 | 305 | 359 | 380 |
| Total | 14,437 | 17,972 | 21,724 | 22,673 |

The Kanawha serves West Virginia, which is expected to be a growth area in the Basin because of its coal deposits. The projected influx of aggregate traffic is due to expected increases in road and home construction. The Kanawha Valley is also heavily laden with chemical industry, but this variety of traffic will not increase greatly.

Coal moves both upstream and downstream on the Kanawha. A significant amount of chemical feedstocks are brought to the river from Gulf Coast area. Final chemical products are distributed from the river mainly to major industrial areas within the Basin. Estimated 1990 lock transit volumes are shown in Table 21.

TABLE 21. ESTIMATED 1990 LOCK TRANSIT VOLUMES, KANAWHA RIVER, (IN THOUSAND TONS)

| Lock | Tonnage Estimated 1976 | Tonnage Projected 1990 | Expected Growth (%) |
|---|---|---|---|
| London | 1,612 | 2,531 | 57 |
| Marmet | 5,843 | 8,573 | 47 |
| Winfield | 11,418 | 20,263 | 77 |


FIGURE 7. KANAWHA RIVER TRAFFIC GROWTH PATTERNS, 1960-1990

Kentucky River. Traffic flows on the Kentucky River are of low magnitude and will continue to be so in the future. Although Table 22 indicates that the river will experience average growth, tonnage in 1990 will only amount to 2 or 3 barges per day.

TABLE 22. WATERBORNE TRAFFIC PROJECTIONS, KENTUCKY RIVER, TO 1990 (IN THOUSAND TONS)

| Commodity Group | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Petroleum Fuels | 3 | 3 | 3 | 3 |
| Aggregates | 538 | 625 | 755 | 911 |
| Total | 541 | 628 | 758 | 914 |

Aggregates constitute 99 percent of the traffic on the river. Aggregate movements ebb and rise with construction cycles and the advent and completion of major construction projects. Therefore, traffic volumes may be very erratic from year to year. But they are expected to show the trend seen in Figure 8.

Of the fourteen lock and dam projects on the Kentucky only the lower four are expected to be used for commercial barge transportation. Volumes through these locks are expected to be identical because all confirmed traffic originates and terminates in the Frankfort area, four pools upstream from the river mouth. Estimated 1990 lock transit volumes are shown in Table 23.

TABLE 23. ESTIMATED 1990 LOCK TRANSIT VOLUMES, KENTUCKY RIVER, (IN THOUSAND TONS)

| | Tonnage | | Expected |
|---|---|---|---|
| Lock | Estimated 1976 | Projected 1990 | Growth (%) |
| Kentucky L&D 4 | 541 | 914 | 69 |
| Kentucky L&D 3 | 541 | 914 | 69 |
| Kentucky L&D 2 | 541 | 914 | 69 |
| Kentucky L&D 1 | 541 | 914 | 69 |

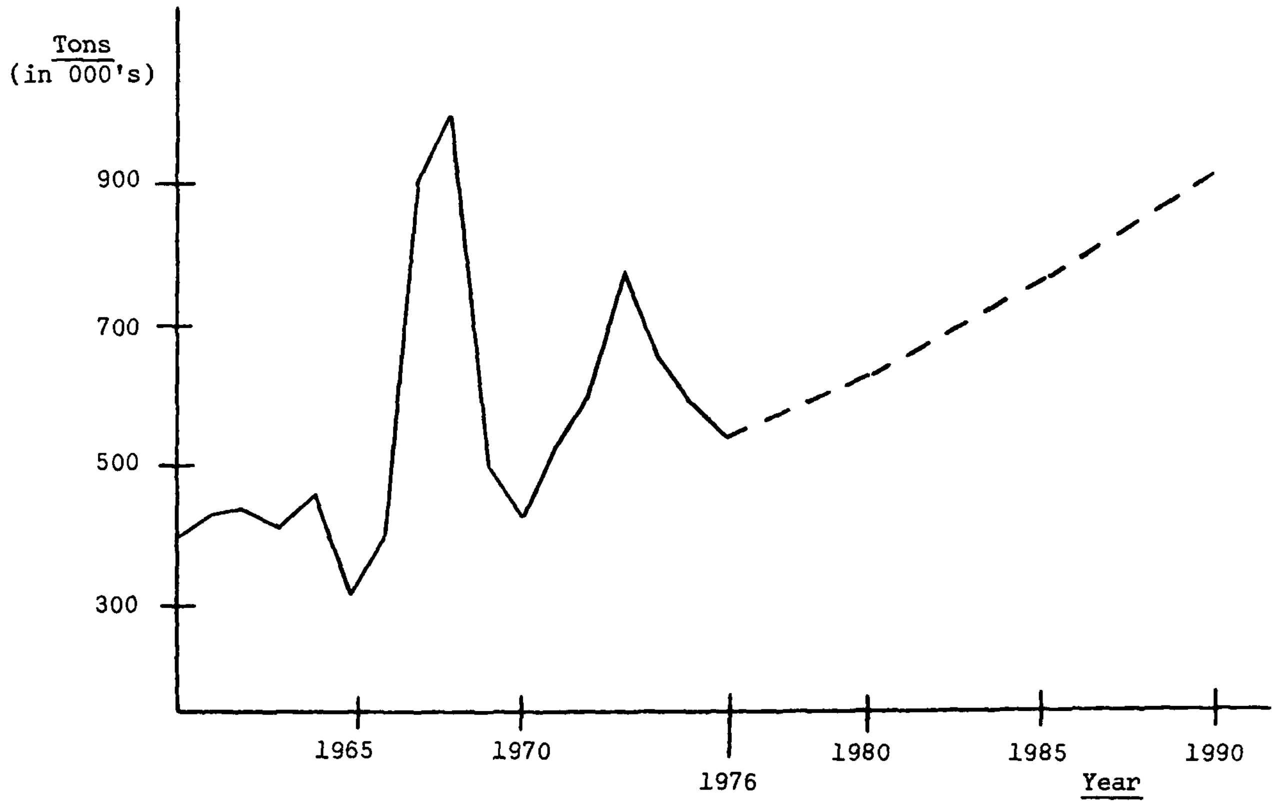


FIGURE 8. KENTUCKY RIVER TRAFFIC GROWTH PATTERNS, 1960-1990

Green-Barren Rivers. The Green-Barren Rivers are also single commodity river. (The two rivers are considered as one.) It is mainly a coal originator. No appreciable long-term growth is expected to occur in river traffic, as can be seen in Table 24. (See also Figure 9.)

TABLE 24. WATERBORNE TRAFFIC PROJECTIONS, GREEN-BARREN RIVERS, TO 1990 (IN THOUSAND TONS)

| Commodity Group | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Coal & Coke | 12,601 | 15,947 | 13,048 | 13,795 |
| Grains | 176 | 220 | 247 | 265 |
| Chemicals & Chemical Fertilizers | 3 | 4 | 4 | 5 |
| Ores & Minerals | 1 | 1 | 1 | 1 |
| Miscellaneous Commodities | 0 | 0 | 60 | 120 |
| Total | 12,782 | 16,173 | 13,361 | 14,186 |

Unlike other coal regions of the Basin, this is not expected to be a boom area. Many of the mines situated along the river are near depletion. Respondent firms have indicated an intention to open new mines as old ones are closed, but significant net growth is not planned. Green River coal mines primarily serve the lower half of the Basin, including power plants on the Tennessee and Cumberland. Grain exports, a secondary activity on the river, will increase modestly.

Estimated 1990 lock transit volumes for the Green-Barren are shown in Table 25.

TABLE 25: ESTIMATED 1990 LOCK TRANSIT VOLUMES, GREEN-BARREN RIVERS, (IN THOUSAND TONS)

| | Tonnage | | Expected |
|---|---|---|---|
| Lock | Estimated 1976 | Projected 1990 | Growth (%) |
| Green L&D 3 | 65 | 132 | 103 |
| Green L&D 2 | 11,729 | 12,674 | 8 |
| Green L&D 1 | 12,251 | 13,303 | 9 |

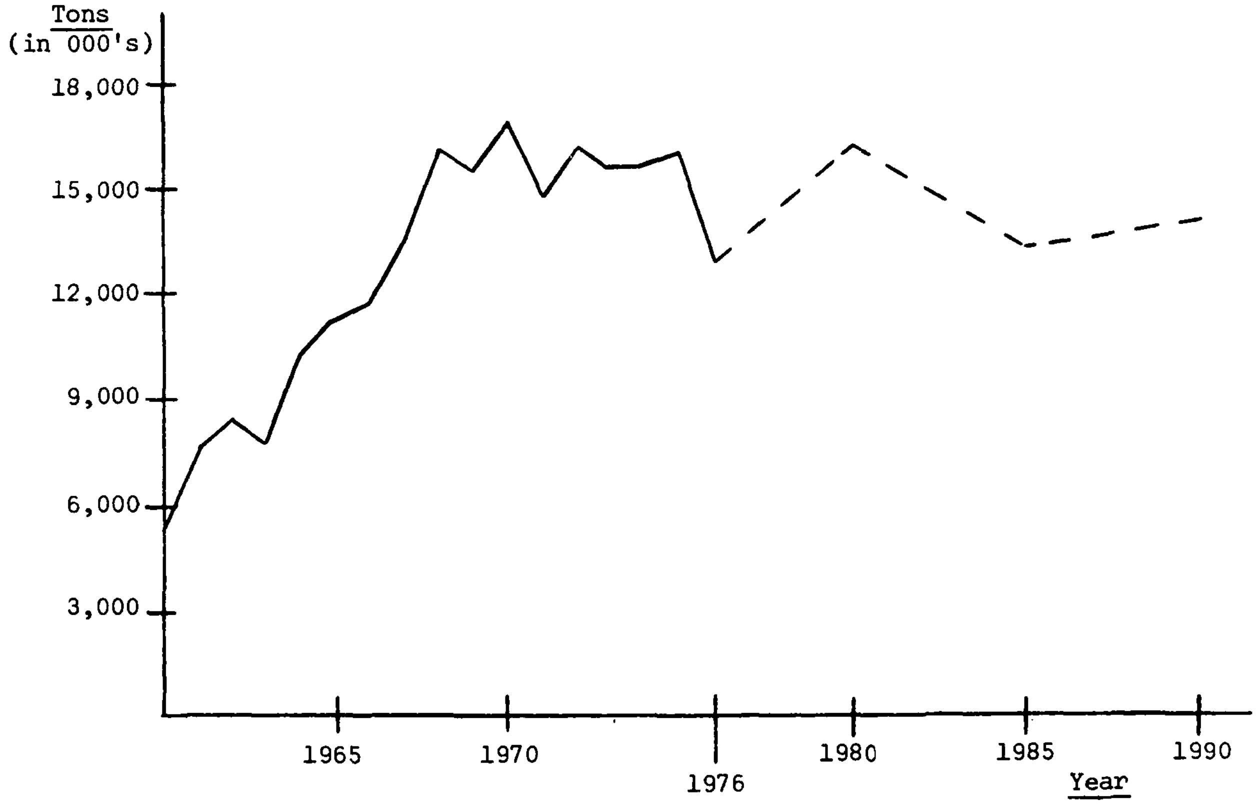


FIGURE 9. GREEN-BARREN RIVERS TRAFFIC GROWTH PATTERNS, 1960-1990

Cumberland River. A wide variety of commodities are moved on the Cumberland; unlike most of the system, coal does not dominate traffic. Table 26 indicates that after a burst of activity between 1976 and 1980, traffic growth will virtually halt on the river.

TABLE 26. WATERBORNE TRAFFIC PROJECTIONS, CUMBERLAND RIVER, TO 1990 (IN THOUSAND TONS)

| Commodity Group | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Coal & Coke | 4,315 | 6,331 | 5,260 | 5,557 |
| Petroleum Fuels | 1,322 | 972 | 1,004 | 1,032 |
| Aggregates | 2,686 | 3,304 | 3,722 | 4,183 |
| Grains | 12 | 45 | 80 | 115 |
| Chemicals & Chemical Fertilizers | 213 | 230 | 285 | 312 |
| Ores & Minerals | 62 | 68 | 78 | 92 |
| Iron Ore, Iron & Steel | 301 | 327 | 351 | 364 |
| Miscellaneous Commodities | 2,645 | 4,261 | 5,169 | 5,567 |
| Total | 11,556 | 15,538 | 15,949 | 17,222 |

A variety of interesting events should occur on the Cumberland over the projection period. Construction materials such as asphalt, building cement, and aggregates are expected to grow in traffic volume even as petroleum fuel traffic declines. Coal traffic will jump 40 percent between 1976 and 1980 and then level off. (See Figure 10.)

Overall traffic growth on the Cumberland will be modest compared to the Basin as a whole. Estimated 1990 lock volumes are shown in Table 27.

TABLE 27. ESTIMATED 1990 LOCK TRANSIT VOLUMES, CUMBERLAND RIVER, (IN THOUSAND TONS)

| Lock | Tonnage: Estimated 1976 | Tonnage: Projected 1990 | Expected Growth (%) |
|---|---|---|---|
| Old Hickory | 261 | 466 | 79 |
| Cheatham | 3,792 | 4,923 | 30 |
| Barkley | 5,974 | 8,095 | +36 |

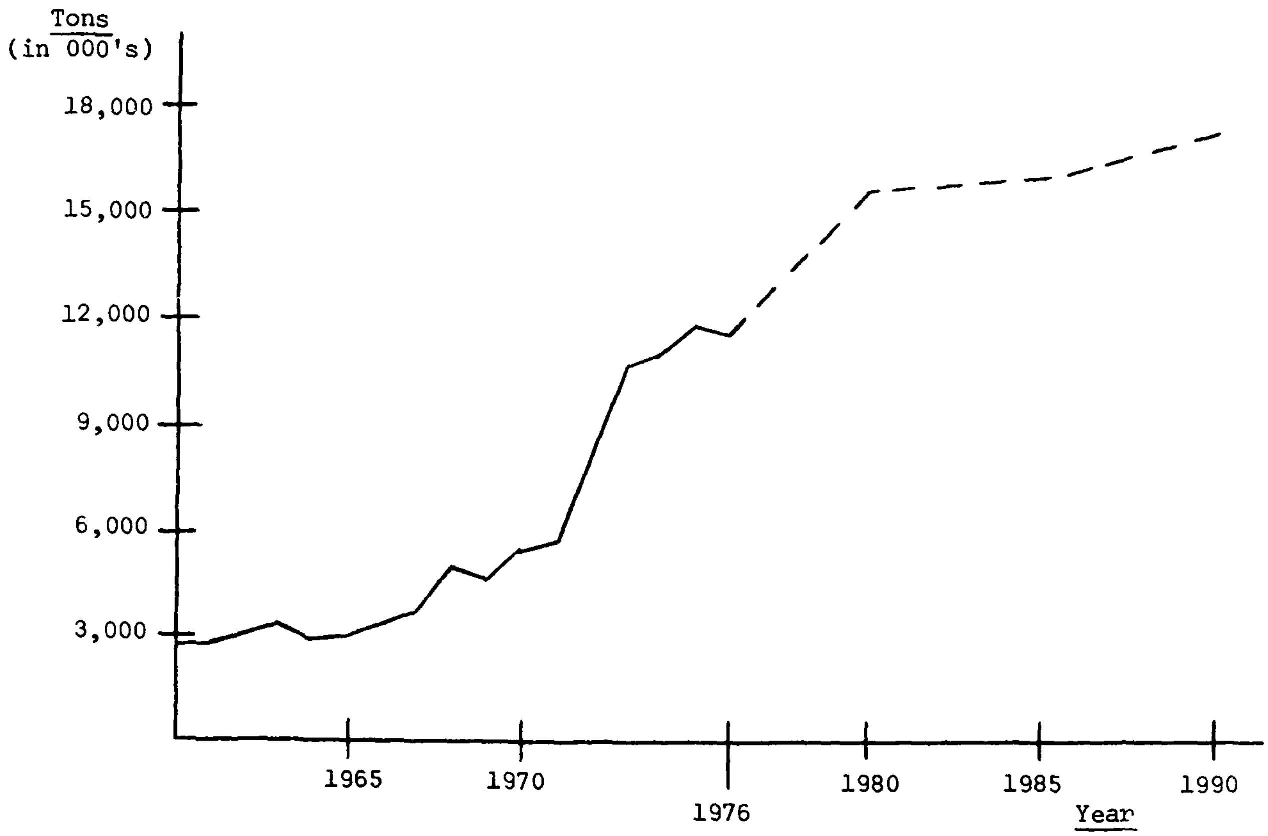


FIGURE 10. CUMBERLAND RIVER TRAFFIC GROWTH PATTERNS, 1960-1990

Tennessee River. Traffic on the Tennessee will grow 86.5 percent from 1976 to 1990. Almost all of this growth is projected to occur between 1976 and 1980. Table 28 indicates that coal traffic is expected to increase by 14 million tons over this brief period and then subside.

TABLE 28. WATERBORNE TRAFFIC PROJECTIONS, TENNESSEE RIVER, TO 1990 (IN THOUSAND TONS)

| Commodity Group | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Coal & Coke | 9,840 | 24,249 | 23,357 | 23,239 |
| Petroleum Fuels | 1,832 | 1,842 | 1,960 | 2,080 |
| Aggregates | 3,194 | 3,945 | 4,418 | 4,934 |
| Grains | 1,502 | 1,813 | 2,072 | 2,336 |
| Chemicals & Chemical Fertilizers | 2,661 | 2,861 | 3,001 | 3,210 |
| Ores & Minerals | 1,317 | 1,318 | 1,424 | 1,540 |
| Iron Ore, Iron & Steel | 703 | 748 | 793 | 816 |
| Miscellaneous Commodities | 4,040 | 6,607 | 8,032 | 8,632 |
| Total | 25,089 | 43,383 | 45,057 | 46,787 |

The peaking of coal volumes in 1980 is attributable partially to the anticipated coal strike mentioned earlier. There are also planned expansions and additions to riverside facilities by the utility companies in the Tennessee Valley and those using the Tennessee River. There may be a significant subsidance in coal traffic in 1981 followed by moderate growth to 1985; no growth is projected thereafter. The Tennessee is also a major grain-producing and aggregate-consuming region. Traffic in both of these commodities will grow vigorously. Most of the grain will be exported, but there will also be significant inbound tonnages of animal feed. The aggregates will come both from the Tennessee itself and from near reaches of the Cumberland and Ohio. (See Figure 11.)

Estimated 1990 lock transit volumes for the Tennessee are shown in Table 29. The tonnage shown for the Kentucky Lock includes that Cumberland River traffic which by-passes Barkley Lock and the mouth of the Cumberland by traversing the Barkley Canal.


FIGURE 11. TENNESSEE RIVER TRAFFIC GROWTH PATTERNS, 1960-1990

TABLE 29. ESTIMATED 1990 LOCK TRANSIT VOLUMES, TENNESSEE RIVER, (IN THOUSAND TONS)

| Lock | Tonnage: Estimated 1976 | Tonnage: Projected 1990 | Expected Growth (%) |
|---|---|---|---|
| Ft. Loudon | 228 | 409 | 79 |
| Watt's Bar | 378 | 673 | 78 |
| Chickamauga | 973 | 1,423 | 46 |
| Nickajack | 4,763 | 7,414 | 56 |
| Guntersville | 4,561 | 8,276 | 81 |
| Wheeler | 6,721 | 11,779 | 75 |
| Wilson | 7,030 | 12,220 | 74 |
| Pickwick | 7,923 | 24,159 | 205 |
| Kentucky Dam | 18,475 | 36,581 | 98 |

## Traffic Growth Projections by BEA's

BEA's are used by many federal agencies for economic analysis. They are smaller and economically more homogeneous than states. BEA's occupy an intermediate status between rivers and PE's. As such they indicate which stretches of the Basin's rivers are expected to experience the most traffic growth and whether that growth will be largely outbound or inbound. The analysis of the waterborne traffic flowing in and out of BEA's also gives insight into the economy and growth expectations of a region.

It is something of an oversimplification, but BEA's can be roughly divided into three classes. The first class includes BEA's with heavy amounts of extractive industries (coal and ore mines, oil production, etc.); these BEA's tend to have heavy outbound traffic. The second class of BEA's has a manufacturing orientation; its commodity movements are typically weighted towards inbound traffic. When a BEA shows high volumes of both outbound and inbound traffic, there is usually a large amount of waterborne traffic internal to the BEA. This third class of BEA typically has manufacturing industry situated near mineral deposits in order to minimize transportation costs.

A cautionary note is in order at this point. The traffic which is listed and analyzed for each BEA includes only that traffic which originates or terminates on a river in the Ohio Basin. If a BEA includes a stretch of river not located in the Basin its traffic is excluded from the analysis unless it is inbound or outbound from the Basin. It should also be noted that, for ease of display, intra-BEA tonnage was counted as both inbound to and outbound from the BEA's concerned. Therefore, these two columns cannot be summed to yield total net tonnage.

Due to roundings it should be noted that the following tables (Table 30 thru 44) the sums of the individual group totals may not add to the exact total figures as shown.

Pittsburgh BEA. The Pittsburgh BEA encompasses the headwaters of the Ohio, most of the Monongahela, and all of the Allegheny. It is by far the most heavily trafficked BEA in the Basin. Although the steel industry is most important, many other varieties of manufacturing occur in this area. Almost 32 million tons of this traffic moved internally to the BEA in 1976.

The Pittsburgh BEA is projected to handle the largest volumes of inbound tonnage through 1990. However, the growth rate for this inbound traffic is not expected to show the rate of growth exhibited in the overall Basin projections. Outbound traffic growth is expected to closely reflect the Basin's growth rate. Only the Huntington BEA is projected to have a greater outbound traffic volume by 1990.

TABLE 30. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, PITTSBURGH BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 36,298 | 59,856 | +65 | 38,396 | 58,605 | +53 |
| Petroleum Fuels | 672 | 691 | +3 | 4,076 | 4,410 | +8 |
| Crude Petroleum | | | | 3 | 0 | -100 |
| Aggregates | 6,224 | 9,414 | +51 | 5,806 | 8,275 | +43 |
| Chemicals & Chemical Fertilizers | 1,052 | 1,548 | +47 | 1,455 | 2,088 | +44 |
| Ores & Minerals | 145 | 236 | +63 | 833 | 1,090 | +31 |
| Iron Ore, Iron & Steel | 2,316 | 2,735 | +18 | 1,309 | 1,693 | +29 |
| Miscellaneous Commodities | 450 | 835 | +86 | 1,177 | 2,244 | +91 |
| Total | 47,157 | 75,316 | +60 | 53,056 | 78,406 | +48 |

Cleveland BEA. The Cleveland BEA includes only a ten-mile stretch of the main stem Ohio just west of the Pittsburgh BEA in the East Liverpool, Ohio, area. But, it is a very intensively used stretch of the river. Large quantities of coal are consumed in this area by steel and other manufacturing industries and power plants.

Traffic in this BEA is mainly inbound. This imbalance will become even more pronounced over the projection period as inbound traffic increases by 105 percent while outbound traffic grows by a marginal 23 percent.

TABLE 31. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, CLEVELAND BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 4 | 9 | +125 | 5,067 | 10,836 | +114 |
| Petroleum Fuels | 427 | 473 | +11 | 721 | 1,027 | +42 |
| Aggregates | 467 | 620 | +33 | 161 | 247 | +53 |
| Chemicals & Chemical Fertilizers | 60 | 64 | +7 | 19 | 26 | +37 |
| Ores & Minerals | 1 | 1 | +0 | 109 | 126 | +16 |
| Iron Ore, Iron & Steel | 31 | 37 | +19 | 361 | 371 | +3 |
| Miscellaneous Commodities | 14 | 31 | +121 | 256 | 1,060 | +314 |
| Total | 1,004 | 1,233 | +23 | 6,695 | 13,692 | +105 |

Columbus BEA. The Columbus BEA is bounded on the east by a small stretch of the main stem Ohio situated to the north of the Huntington BEA. Chemicals are the most important outbound commodity on this stretch of the river. Inbound traffic is twice as large as outbound and is composed primarily of aggregates and coal.

Outbound movements will increase moderately from this region, led by coal. Inbound commodities such as chemicals and coal will grow at a pace equal to the Basin's overall growth rate. The traffic balance will become more heavily weighted toward inbound movements.

TABLE 32. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, COLUMBUS BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 322 | 1,020 | +217 | 1,161 | 2,835 | +144 |
| Petroleum Fuels | 4 | 5 | +25 | 700 | 773 | +10 |
| Crude Petroleum | 0 | 0 | 0 | 164 | 0 | -100 |
| Aggregates | 208 | 318 | +53 | 1,458 | 2,291 | +57 |
| Grains | 2 | 4 | +100 | 0 | 0 | 0 |
| Chemicals & Chemical Fertilizers | 1,831 | 2,232 | +22 | 204 | 987 | +384 |
| Ores & Minerals | 27 | 20 | -26 | 314 | 371 | +18 |
| Iron Ore, Iron & Steel | 79 | 86 | +9 | 66 | 78 | +18 |
| Miscellaneous Commodities | 8 | 17 | +113 | 239 | 689 | +188 |
| Total | 2,482 | 3,702 | +49 | 4,306 | 8,022 | +86 |

Huntington BEA. The Huntington BEA is situated on the upper portion of the main stem Ohio. It includes portions of Kentucky, West Virginia, and Ohio and all of the Kanawha River. This is one of the major traffic originating and terminating BEA's in the Basin. Coal, petroleum fuels, chemicals, and aggregates are by far the most important commodities. In 1976, 13 million tons of these commodities moved internally to the BEA; 23 million tons were exported and 15 million tons imported.

The Huntington BEA is expected to be one of the coal boom areas in the Basin. As such, outbound coal traffic is expected to experience exemplary growth over the projection period. It is expected to surpass the Pittsburgh BEA by 1990 to become the largest coal exporting BEA in the Basin.

TABLE 33. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, HUNTINGTON BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) 1976 | Estimated Outbound Tonnage (in 000's) 1990 | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) 1976 | Estimated Inbound Tonnage (in 000's) 1990 | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| Coal & Coke | 27,430 | 66,774 | +143 | 15,347 | 28,004 | +83 |
| Petroleum Fuels | 4,974 | 5,597 | +13 | 3,094 | 3,670 | +19 |
| Aggregates | 1,987 | 3,038 | +53 | 3,575 | 5,600 | +57 |
| Grains | 1 | 2 | +100 | 0 | 0 | 0 |
| Chemicals & Chemical Fertilizers | 1,113 | 1,225 | +10 | 4,088 | 4,818 | +20 |
| Ores & Minerals | 71 | 74 | +4 | 212 | 249 | +17 |
| Iron Ore, Iron & Steel | 172 | 211 | +23 | 69 | 275 | +298 |
| Miscellaneous Commodities | 451 | 1,235 | +174 | 280 | 509 | +82 |
| Total | 36,200 | 78,156 | +116 | 26,665 | 43,226 | +62 |

Clarksburg BEA. This BEA is situated in West Virginia on the Upper Monongahela. Its traffic is almost entirely coal, outbound and inbound. Almost all of this coal is consumed within the Clarksburg and Pittsburgh BEA's.

Traffic in this area will grow modestly. Many of the mines in this area produce high-sulfur coal, which is currently at a competitive disadvantage.

TABLE 34. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, CLARKSBURG BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 3,526 | 6,366 | +81 | 2,340 | 2,949 | +26 |
| Petroleum Fuels | 0 | 0 | 0 | 295 | 350 | +19 |
| Aggregates | 672 | 673 | +0 | 0 | 0 | 0 |
| Ores & Minerals | 0 | 0 | 0 | 50 | 64 | +28 |
| Miscellaneous Commodities | 0 | 0 | 0 | 39 | 86 | +121 |
| Total | 4,199 | 7,040 | +68 | 2,724 | 3,449 | +27 |

Cincinnati BEA. The Cincinnati BEA envelopes the mid-reach of the Ohio River. It includes the Licking River, a small tributary which merges with the Ohio at Cincinnati. Inbound tonnage is more than two times the outbound tonnage for the Cincinnati BEA. This is consistent with the pattern set by other major manufacturing BEA's.

This BEA will experience twice the traffic growth of the average BEA in the Basin for both outbound and inbound traffic. The major component of these increases is a high coal growth rate. Outbound coal growth is due to the expected development of coal loading facilities in the area. The high growth rate for inbound coal can be attributed to expected industrial development in the area as well as increased consumption at existing and planned power plants on the river.

TABLE 35. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, CINCINNATI BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 2,653 | 11,699 | +341 | 15,266 | 47,326 | +210 |
| Petroleum Fuels | 1,854 | 2,476 | +34 | 2,145 | 2,354 | +10 |
| Aggregates | 2,440 | 3,022 | +24 | 2,195 | 2,993 | +36 |
| Grains | 1,437 | 2,585 | +80 | 1 | 2 | +100 |
| Chemicals & Chemical Fertilizers | 66 | 85 | +29 | 1,299 | 2,498 | +92 |
| Ores & Minerals | 0 | 0 | 0 | 670 | 1,075 | +60 |
| Iron Ore, Iron & Steel | 62 | 67 | +8 | 659 | 965 | +46 |
| Miscellaneous Commodities | 397 | 1,582 | +298 | 793 | 1,634 | +106 |
| Total | 8,909 | 21,516 | +142 | 23,027 | 58,846 | +156 |

Louisville BEA. The Louisville BEA includes the mid-reach of the Ohio River between the Cincinnati and Evansville BEA's. It is an important center of waterborne activity. The full-range of commodities are handled by the Louisville BEA, but coal, petroleum fuels, and aggregates are the most important.

Louisville will experience marginal inbound traffic growth and vigorous outbound growth. For the first time it will become a major coal-exporting BEA. Outbound and inbound traffic will come into rough balance.

TABLE 36. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, LOUISVILLE BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) 1976 | 1990 | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) 1976 | 1990 | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| Coal & Coke | 377 | 2,428 | +544 | 6,744 | 6,643 | -1 |
| Petroleum Fuels | 333 | 349 | +5 | 3,992 | 4,887 | +22 |
| Aggregates | 4,614 | 7,157 | +55 | 2,621 | 3,719 | +42 |
| Grains | 169 | 244 | +44 | 0 | 0 | 0 |
| Chemicals & Chemical Fertilizers | 18 | 22 | +22 | 292 | 368 | +26 |
| Ores & Minerals | 0 | 0 | 0 | 81 | 103 | +27 |
| Iron Ore, Iron & Steel | 86 | 92 | +7 | 348 | 397 | +14 |
| Miscellaneous Commodities | 162 | 221 | +36 | 393 | 816 | +108 |
| Total | 5,760 | 10,513 | +83 | 14,471 | 16,931 | +17 |

Evansville BEA. This BEA contains portions of the lower main stem Ohio and all active portions of the Green River. Energy commodities and aggregates dominate inbound traffic. These two commodities plus grains also constitute the bulk of outbound traffic.

The Evansville BEA will experience slow outbound traffic growth, but inbound tonnage will almost triple. This latter increase will be led by an 11-million ton jump in coal imports mainly due to new power plants in the area.

TABLE 37. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, EVANSVILLE BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 29,343 | 39,364 | +34 | 1,582 | 12,147 | +768 |
| Petroleum Fuels | 3,398 | 3,448 | +1 | 1,252 | 1,669 | +33 |
| Crude Petroleum | 0 | 0 | 0 | 497 | 0 | -100 |
| Aggregates | 1,999 | 4,039 | +102 | 1,646 | 2,172 | +32 |
| Grains | 2,206 | 3,325 | +51 | 163 | 257 | +58 |
| Chemicals & Chemical Fertilizers | 65 | 68 | +5 | 756 | 971 | +28 |
| Ores & Minerals | 53 | 74 | +40 | 660 | 745 | +13 |
| Iron Ore, Iron & Steel | 58 | 74 | +28 | 96 | 142 | +48 |
| Miscellaneous Commodities | 281 | 624 | +122 | 264 | 591 | +124 |
| Total | 37,403 | 51,017 | +36 | 6,916 | 18,693 | +170 |

Paducah BEA. The Paducah BEA includes the mouths of the Ohio, Cumberland, and Tennessee Rivers and the mid-reach of the Mississippi River above and below Cairo. The full spectrum of commodities are moved to and from this BEA. In the 1976 base its traffic volumes were substantial but less than Pittsburgh, Huntington, and Cincinnati.

By all appearances traffic will grow very vigorously in this BEA, both outbound and inbound. Paducah will become one of the most important coal-exporting BEA's partially due to coal docks in the area handling increasing amounts of western coal for barge movement up river. Also more of this BEA's existing coal mines are expected to move increasing tonnage by water to riverside power plants.

TABLE 38. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, PADUCAH BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 5,564 | 25,347 | +356 | 2,346 | 5,490 | +134 |
| Petroleum Fuels | 377 | 468 | +24 | 1,047 | 1,497 | +43 |
| Aggregates | 3,660 | 5,667 | +54 | 1,593 | 3,573 | +124 |
| Grains | 266 | 385 | +45 | 2 | 92 | +4600 |
| Chemicals & Chemical Fertilizers | 495 | 555 | +12 | 404 | 498 | +23 |
| Ores & Minerals | 60 | 53 | -12 | 572 | 536 | -6 |
| Iron Ore, Iron & Steel | 128 | 132 | +3 | 89 | 92 | +3 |
| Miscellaneous Commodities | 4,786 | 11,065 | +131 | 1,090 | 2,408 | +121 |
| Total | 15,356 | 43,672 | +184 | 7,143 | 14,187 | +99 |

<u>Lexington BEA.</u> The Lexington BEA contains the mid and upper reaches of the Kentucky River. Its profile is identical to the Kentucky River. One or two barges of aggregates are inbound daily from the main stem Ohio. A marginal quantity of petroleum fuels were exported by barge.

Growth expectations for the BEA are average, but there are no indications that this will become a major region of barge activity.

TABLE 39. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, LEXINGTON BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) 1976 | 1990 | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) 1976 | 1990 | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| Petroluem Fuels | 3 | 3 | 0 | 0 | 0 | 0 |
| Aggregates | 0 | 0 | 0 | 538 | 911 | +69 |
| Total | 3 | 3 | 0 | 538 | 911 | +69 |

Nashville BEA. The Nashville BEA contains the middle reach of the Cumberland River, a portion of the middle Tennessee River, and the headwaters of the Green-Barren Rivers. This is a low traffic volume BEA. There is a heavy traffic imbalance towards inbound movements. The only outbound commodity of consequence is aggregates. As with most BEA's a large portion of the aggregates produced by the region are consumed internally.

The projections indicate that Nashville will be a slow traffic growth BEA. Nor will any single commodity group experience dramatic growth in absolute terms.

TABLE 40. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, NASHVILLE BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 98 | 200 | +104 | 7,501 | 9,478 | +26 |
| Petroleum Fuels | 10 | 11 | +10 | 1,322 | 1,032 | -22 |
| Aggregates | 1,269 | 2,026 | +60 | 2,623 | 4,136 | +58 |
| Grains | 12 | 115 | +858 | 0 | 0 | 0 |
| Chemicals & Chemical Fertilizers | 31 | 77 | +148 | 489 | 642 | +31 |
| Ores & Minerals | 185 | 320 | +73 | 280 | 345 | +23 |
| Iron Ore, Iron & Steel | 58 | 62 | +7 | 319 | 399 | +25 |
| Miscellaneous Commodities | 119 | 263 | +121 | 654 | 1,183 | +81 |
| Total | 1,782 | 3,075 | +73 | 13,188 | 17,213 | +31 |

Huntsville BEA. This BEA straddles the mid-portion of the Tennessee River. It contains a substantial amount of industry particularly steel industry. This BEA originates and terminates a full range of commodities in roughly the same proportion as the Basin overall.

Outbound traffic is expected to decline by 33 percent from the Huntsville BEA. This is largely due to a collapse of outbound coal traffic. Inbound coal traffic will grow as outbound traffic declines. Inbound traffic overall will increase by 155 percent.

TABLE 41. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, HUNTSVILLE BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 2,863 | 400 | -86 | 3,071 | 11,859 | +286 |
| Petroleum Fuels | 56 | 56 | +0 | 447 | 348 | -22 |
| Aggregates | 146 | 223 | +53 | 292 | 446 | +53 |
| Grains | 70 | 112 | +60 | 661 | 1,030 | +56 |
| Chemicals & Chemical Fertilizers | 258 | 348 | +35 | 1,133 | 1,302 | +15 |
| Ores & Minerals | 47 | 0 | -100 | 168 | 213 | +27 |
| Iron Ore, Iron & Steel | 65 | 80 | +23 | 235 | 277 | +18 |
| Miscellaneous Commodities | 760 | 1,658 | +118 | 398 | 900 | +126 |
| Total | 4,264 | 2,876 | -33 | 6,404 | 16,377 | +155 |

Chattanooga BEA. The Chattanooga BEA contains most of the upper portion of the Tennessee (its headwaters are in the Knoxville BEA). It experiences moderate traffic volumes with a slight weighting towards inbound traffic. As with other BEA's on the Tennessee, the full spectrum of commodities is handled.

River traffic growth is expected to lag behind the Basin average. Coal and aggregates will be the most important growth commodities.

TABLE 42. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, CHATTANOOGA BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) | | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| | 1976 | 1990 | | 1976 | 1990 | |
| Coal & Coke | 1,533 | 2,343 | +53 | 835 | 2,040 | +144 |
| Petroleum Fuels | 0 | 0 | 0 | 511 | 406 | -21 |
| Aggregates | 1,345 | 2,059 | +53 | 1,275 | 1,951 | +53 |
| Grains | 8 | 12 | +50 | 707 | 1,090 | +54 |
| Chemicals & Chemical Fertilizers | 38 | 53 | +39 | 254 | 352 | +39 |
| Ores & Minerals | 1 | 1 | +0 | 154 | 195 | +27 |
| Iron Ore, Iron & Steel | 18 | 22 | +22 | 107 | 130 | +21 |
| Miscellaneous Commodities | 230 | 385 | +67 | 668 | 1,349 | +102 |
| Total | 3,174 | 4,875 | +54 | 4,509 | 7,513 | +67 |

Knoxville BEA. The headwaters of the Cumberland and the Tennessee Rivers proceed from the Knoxville BEA; it also contains the active portions of the Clinch River. Both outbound and inbound volumes in this BEA are very low, averaging only a barge or two a day. Aggregates dominate the traffic and most of these are produced and consumed internally.

Although this BEA will experience average traffic growth, there are no indications it will become a major center of barge activity.

TABLE 43. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, KNOXVILLE BEA

| Commodity Growth | Estimated Outbound Tonnage (in 000's) 1976 | 1990 | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) 1976 | 1990 | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| Petroleum Fuels | 0 | 0 | 0 | 38 | 42 | +11 |
| Aggregates | 115 | 175 | +52 | 127 | 194 | +53 |
| Grains | 0 | 0 | 0 | 14 | 22 | +57 |
| Chemicals & Chemical Fertilizers | 2 | 2 | 0 | 16 | 22 | +38 |
| Ores & Minerals | 0 | 0 | 0 | 7 | 8 | +14 |
| Iron Ore, Iron & Steel | 17 | 22 | +29 | 1 | 1 | 0 |
| Miscellaneous Commodities | 52 | 116 | +123 | 119 | 263 | +121 |
| Total | 186 | 315 | +69 | 321 | 553 | +72 |

Memphis BEA. The Memphis BEA includes a stretch of the Mississippi south of Cairo and is bounded on the east by the Lower Tennessee. This BEA experiences a heavy imbalance of inbound over outbound traffic. A wide variety of commodities are imported to this BEA, led by the energy products coal and petroleum fuels. The only outbound commodity of consequence in the BEA is petroleum fuels.

This BEA will experience average inbound traffic growth and negligible outbound growth.

TABLE 44. PROJECTED 1990 TRAFFIC GROWTH BY COMMODITY GROUP, MEMPHIS BEA

| Commodity Group | Estimated Outbound Tonnage (in 000's) 1976 | 1990 | Projected Growth 1976-1990 (%) | Estimated Inbound Tonnage (in 000's) 1976 | 1990 | Projected Growth 1976-1990 (%) |
|---|---|---|---|---|---|---|
| Coal & Coke | 0 | 0 | 0 | 1,617 | 3,231 | +100 |
| Petroleum Fuels | 705 | 779 | +10 | 509 | 509 | +0 |
| Aggregates | 0 | 0 | 0 | 450 | 688 | +53 |
| Grains | 0 | 0 | 0 | 19 | 31 | +63 |
| Chemicals & Chemical Fertilizers | 31 | 43 | +39 | 110 | 129 | +17 |
| Ores & Minerals | 0 | 0 | 0 | 1 | 1 | +0 |
| Iron Ore, Iron & Steel | 22 | 26 | +18 | 102 | 116 | +14 |
| Miscellaneous Commodities | 17 | 37 | +118 | 576 | 1,201 | +109 |
| Total | 774 | 885 | +14 | 3,384 | 5,907 | +75 |

## Ohio River Basin Waterway Users' Views and Concerns

This section highlights the information obtained in response to survey questions on pages 5 thru 9 of the questionnaire. For these issues or topics concluded to be of most concern to the current users of the waterway, interpretations are provided as directly extracted from the individual qualitative responses, or as otherwise obtained from analysis of responses in aggregate. Brief discussions are provided for the following general topics:

- The basinwide impact of the Tennessee-Tombigbee Waterway
- The sensitivity of barge rates to modal choice
- Specific operational aspects of the waterway forecasts
- Anticipated future changes in equipment.

### Impact of the Tennessee-Tombigbee Waterway

Recognizing that the Tennessee-Tombigbee Waterway will not be operational until 1986, Ohio River Basin shippers were asked about their current intentions to use the new waterway. The questionnaire and survey process were not designed to specifically estimate anticipated traffic levels for the Tennessee-Tombigbee, nor were the responses sufficient for this purpose. This study deals with the time period thru 1990 - a period in which Ohio Basin shippers might be engaged in development of markets and supply contracts for the longer-term, when the Tennessee-Tombigbee would be operational. For this reason, it is useful to know if the new waterway will significantly influence shipping decisions made during the preceding years. The survey question was developed for this purpose.

Of the 119 existing waterway users responding to the survey question, many responses indicated an unfamiliarity with the probable economics of the Tennessee-Tombigbee routing. Those most knowledgeable of the new waterway tended to comprise the larger shippers, and the smaller users operating along the lower Ohio, Cumberland, and Tennessee Rivers.

Users with operations largely concentrated in the middle and upper portions of the Ohio Basin do not expect to use the Tennessee-Tombigbee. This is not surprising, since well over two-thirds of the 196 million tons shipped on the Basin waterways is internal to the Ohio system. Thirteen firms indicated intended use of the waterway; four additional firms indicated possible use of the waterway with final decision contingent upon observed economics of the routing and/or market conditions. An additional fourteen firms responded that, at this time, they did not know if they would be using the Tennessee-Tombigbee routing in their operations. More than one-half of the seventeen respondents who express intentions to use the waterway are currently operating along the Tennessee River.

Commodities most frequently mentioned in connection with the Tennessee-Tombigbee routing include chemicals, ores and minerals, iron and steel products, and certain petroleum products. In the absence of detailed information about routing economics, existing high volume waterway shippers of coal, grain, and petroleum fuels between the Gulf Coast and the Ohio River state that the current Mississippi River route would probably continue to be used.

## Sensitivity to Unilateral Barge Rate Increases

The respondents .o this issue indicated that barge rates would have to increase unilaterall by more than 10 percent before they would contemplate diverting commodities to other modes. Most users do not feel that increased barge rates will go unanswered by the major competitor, rail. They see an almost constant differential between rail and barge rates with little or no convergence of the two rates. Even at a 15 percent unilateral rate increase, there is substantial belief by the users that traffic will remain on the rivers. The major reason cited is that the users have substantial capital invested in equipment for handling barges. The inference is that barge rates would have to surpass rail rates substantially and remain higher before the cost savings of switching to the alternate mode would justify the investment needed for the new rail equipment.

Commodities most mentioned as candidates for a modal shift are the high-value commodities such as finished and semi-finished steel products, chemical products, and the higher value petroleum products. As a result, the tonnage affected by a rate increase would not be substantial. Other bulk commodities would require barge rates to surpass the rail rate substantially and remain higher before any commodities would be shifted from the waterway.

## Planned Modal Shifts

There were very few planned modal shifts away from barge for other than economic reasons. As has been discussed previously, most waterway users in the Ohio River Basin are barge oriented because of the lower rate structure for the bulk commodities. They have constructed their facilities for this single mode of transportation. There were, however, indications that there may be shifts to barge from rail due mainly to perceived service deterioration and rising rail rates. These shifts could be affected by those firms which already have bimodal operations.

## Results of Ranking of Important Aspects of Water Transportation

The respondents were asked to rank and explain sixteen aspects of water transportation, giving specific locations of problem areas. In several cases the respondents had marked more than one item with the same ranking figure, indicating that a relationship existed among those items.

A tabulation of responses indicates the following:

- "Waterway barge rates" was marked most often as number one concern
- "Lock transit time" was marked most often as second concern
- "Availability of empty barges as needed" was marked most often as third concern.

Barge Rates

The Ohio River Basin Users are sensitive to the relationship of the different transportation modes and are particularly concerned with barge rates. The concern for barge rates was not limited to any one industry but was distributed throughout the commodity groups. Rail rates, on the other hand, although they represent the greatest competition for the bulk commodities moved in the Ohio River Basin, were of top concern to only a limited number of companies (about 20 percent), in the grain, chemical, steel, and general commodity industries.

The relative importance placed on barge rates and the lesser importance placed on other rates is indicative of several things. First, many of the utility companies have built their facilities for single mode delivery. Their concern with other rates will grow only when barge rates increase to the point of surpassing the other modes. They would then be in a position to invest the necessary capital for rail unloading facilities.

The petroleum industry's concern with barge is due to the ability of the petroleum companies to switch to pipeline. However, pipelines are expensive to construct and are not a viable alternative in all delivery cases. The petroleum industry is then in the same position as the utilities, in that they will consider the investment in other modes when the barge rates surpass the other rates resulting in added facilities that can be justified through the cost savings of the less expensive mode.

The aggregate industries which are based on the rivers of the Basin have developed themselves to be dependent upon the river with no alternative mode available to them for their bulk movements.

The grain industry is perhaps the most multimodal of all commodity industries in the Basin. Its facilities are capable of both rail and truck delivery, and rail and barge shipments. The respondents indicated that the most influential factor in the choice of mode is the location of the export outlet. A shift of outlet to the East Coast ports would have a greater effect than nearly equal transportation rates.

The chemical industry mentioned its concern with transportation rates, as these rates increasingly reflect the additional charges for more expensive equipment changes and safeguards required by the regulation of most chemical transportation.

Transportation costs are a small part of the costs of the ores & minerals category. Therefore, barge rates are not as important as other aspects of water transportation to the ores & minerals industry.

The respondents indicated that it is not just the charge per ton but rather the entire cost of barge transportation that affects them. The low volume, high density, high value of semifinished and finished iron & steel products makes these commodities sensitive to transportation rates.

The companies included in the miscellaneous group are largely public terminals. They are primarily directed toward the waterway as the interface between the barge haul and the land delivery mode. These companies indicated that they are affected by barge rates in that if their customers shift transportation modes, they are in a position to lose this business.

## Lock Transit Time

The following locks were mentioned consistently as being bottlenecks for the Ohio River Basin traffic flows:

- Ohio River:
  - Gallipolis
  - Cannelton
  - Lock 50
  - Lock 51
  - Smithland
  - Lock 52
  - Lock 53
- Kanawha - Winfield Lock
- Monongahela - Lock 3
- Tennessee - Pickwick Lock

In addition, the small locks on the Kanawha, Monongahela, and Allegheny Rivers were cited as generally causing delays severe enough to have forced some shippers to alternate modes. The respondents indicated that they would use the Basin Waterway System more extensively if these bottlenecks could be reduced.

## Availability of Empty Barges

The concern about the availability of empty barges is not limited to one industry; it is an equally important concern to all industries in the Basin. The shortage of empty barges is not limited to any one geographical region, but rather is spread throughout the system and is of concern on all rivers in the Basin.

## Equipment Related Concerns of the Ohio River Basin Users

Almost all firms expressed some concern about equipment availability. Most respondents saw the availability of barges and towboats as being a function of lock delay and the resulting tie up of both loaded and empty equipment. The respondents indicated little desire to change barge sizes in the Basin. Present facilities are able to handle both the standard and the jumbo barges. Other sizes, such as the shorter LASH barge, only cause loading and unloading difficulties. Larger barges have not been proposed for the Ohio due to the lock sizes and to facilities built for the present mix of standards and jumbos.

Except for those firms who own their own equipment, most firms in the Basin consider themselves powerless to decrease the number of empty barges moving on the Basin's waterways. The firms which own equipment indicated that they do attempt to secure backhauls for their equipment when feasible both in economics and by regulation. They indicated that the competition for backhaul is strong as the backhauls are from areas where backhaul loads are scarce.

Light boats are not seen as a problem in the Basin. The firms stated frequently that port service vessels were lacking in some areas and that this type of light boat traffic should be increased, not decreased.

## Additional User Comments

The recurring comment from users of the Basin waterways concerns communications with the Corps of Engineers. The noteworthy suggestions included:

- Publication of previous month's lockage times
- Cummunication of river conditions
- More extensive interface with users before planning lock repairs.

Communication is recognized by the firms as a two-directional action, but they indicated that their suggestions to the Corps could improve their river operations and in turn, increase efficiency in commercial river usage.

ATTACHMENT I

OHIO RIVER BASIN USERS SURVEY QUESTIONNAIRE

## OHIO RIVER BASIN USERS SURVEY QUESTIONNAIRE

The information obtained in this survey will be treated confidentially. Individual reports are for statistical purposes only. The information requested below is for follow-up purposes only, when necessary. If you have any questions, please contact the Battelle study team: Harry Collis at (614) 424-5115.

Company Name ______________________

Address ______________________

City, State, Zip Code ______________________

Person Completing This Questionnaire ______________________

Title ______________________

Telephone Number - Area Code (   ) ______________________

(1) In addition to the commodity movements listed on the separate reference sheet, what other transportation modes did you utilize for those commodities, both inbound and outbound, during 1976? (For example, if 20,000 tons of coal were brought in by barge, how much coal, if any, also came in by truck, rail, conveyor, etc.?)

(a)

| Inbound Commodity | Mode | Volume (In Tons) | Originated From* |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

* If any commodity had more than one origin/destination, please list the major origin/destinations and their respective volumes separately.

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| (b) Outbound Commodity | Mode | Volume (In Tons) | Destined To* |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

(2) When you compare the last 5 years of your operations, what has been the trend of your commodity flows moved by water transportation? (Please give the trends by individual commodities.)

| (a) Inbound Commodity | Yearly Increase (Percent) | Yearly Decrease (Percent) | No Change |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

| (b) Outbound Commodity | Yearly Increase (Percent) | Yearly Decrease (Percent) | No Change |
|---|---|---|---|
| | | | |
| | | | |

*(b) is continued on next page*

* If any commodity had more than one origin/destination, please list the major origin/destinations and their respective volumes separately.

(b) (Continued)

| Outbound Commodity | Yearly Increase (Percent) | Yearly Decrease (Percent) | No Change |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

(3) From your past operational experience and your company's plan for the future, how do you see your waterway utilization in the future?

Increasing Use ______ Decreasing Use ______ No Change ______

If you plan an increasing and/or decreasing use in the future, please fill in the following information by commodity.

(a) For inbound commodities

| Commodity | Time Period | Increase or Decrease | Volume (Tons Per Year) | Percent Change Per Year | Origin (Site Specific)* |
|---|---|---|---|---|---|
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |

*(a) is continued on next page*

* Site specific for origin/destination points. Please use dock, river, and river mile, or nearest major urban area (for example: XYZ Company, Ohio River Mile 350.0, or Portsmouth, Ohio).

(a) (Continued)

| Commodity | Time Period | Increase or Decrease | Volume (Tons Per Year) | Percent Change Per Year | Origin (Site Specific)* |
|---|---|---|---|---|---|
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |

(b) For outbound commodities

| Commodity | Time Period | Increase or Decrease | Volume (Tons Per Year) | Percent Per Year | Destination (Site Specific)* |
|---|---|---|---|---|---|
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |
| | 1977-1980 | | | | |
| | 1981-1985 | | | | |
| | 1986-1990 | | | | |

* Site specific for origin/destination points. Please use dock, river, and river mile, or nearest major urban area (for example: XYZ Company, Ohio River Mile 350.0, or Portsmouth, Ohio).



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(c) Do you expect to handle increasing commodity flows by:

(1) Using present facilities? __________

(2) Expansion of present facilities? __________

(3) Building and moving to new facilities? __________

(4) The Tennessee-Tombigbee Waterway, connecting the Tennessee River and the Tombigbee River, is scheduled for completion in the mid-1980s. Will this connecting waterway have an impact on your utilization of river transportation? Yes_______ No_______ If yes, please explain what this impact will be.

(5) If barge transportation costs were to unilaterally increase by the following levels, please check at what level would you contemplate a diversion of shipments from water to other modes of transportation.

(a)

| Percent Increase in Costs | Stay With Waterway | Divert From Waterway |
|---|---|---|
| 2 | | |
| 5 | | |
| 10 | | |
| 15 | | |

(b) At the level of barge rate increase at which you would divert shipments to another mode, indicate which commodities you would divert and what percent to which mode. Then rank the impact of the rate increase using 1 as the highest impact, 2 as next highest, etc. Please indicate whether Inbound (I) or Outbound (O) commodities and mode (i.e., rail, truck, or others).

| Commodity | I/O | Percent Diverted | Mode Diverted to | Impact Ranking |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

(6) Do you contemplate any modal shifts in the near future for any other reasons? Yes_______ No _______ If yes, please explain the shifts.

(7) Please indicate the importance of the following aspects of water transportation to your existing operations. Use a ranking scale with 1 as the most important, 2 as next important, etc.

(a) _____ Barge loading/unloading time

_____ Timely access to loading, unloading, and transfer facilities

_____ Riverfront storage and stockpiling space

_____ Use of barge for temporary commodity storage

_____ Availability of empty barges as needed

_____ Availability of towboats as needed

_____ Pool transit time

_____ Lock transit time

_____ Navigational safety

_____ Navigational obstructions (e.g., ice, bridge clearance, etc.)

_____ Security of shipment (breakage, theft, etc.)

_____ Waterway barge rates

_____ Rail rates

_____ Truck rates

_____ Pipeline rates

_____ Accessibility to alternative mode of shipment

_____ Others (please specify)

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(b) For your numbers 1, 2, and 3 choices in part (a) of this question, please provide the following information for each item individually.

(i) Why are these items important to your operation?

(ii) To what extent are you now experiencing or do you anticipate experiencing problems concerning these items, and where in the Ohio River navigational system are these problems most severe?

(8) If improvements were to be made concerning the areas in question (7), what would the impact be on your waterway utilization? Please explain.

(9) (a) Do you own and/or operate the waterway towing equipment used to transport your commodities? Yes______ No______ If yes, please check the type of equipment. (1) Barges______ (2) Towboats______

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AD-A087 193 BATTELLE COLUMBUS LABS OH F/G 5/3

FORECAST OF FUTURE OHIO RIVER BASIN, WATERWAY TRAFFIC BASED ON --ETC(U)

SEP 79 H COLLIS DACW69-78-C-0059

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(b) Do you foresee any major changes in the mix of barge types or size of towboats used in your commodity movements over the next 15 years as compared with equipment used in your 1976 commodity movements (e.g., larger barges, smaller barges, larger towboats, smaller towboats, etc.). Yes______ No______ If yes, please explain.

(c) What actions are you now taking, or do you plan to take between now and 1990 to minimize the number of empty barges and light boats moving on the Ohio River System? Please explain.

(10) Additional comments or suggestions, if any.

ATTACHMENT II

OHIO RIVER BASIN COMMERCIAL DOCKS
PROCESSED FOR STUDY QUESTIONNAIRE

ATTACHMENT II: OHIO RIVER BASIN COMMERCIAL DOCKS PROCESSED FOR STUDY QUESTIONNAIRE

| River | Total From Mailing List | Duplicate Listing Or No Address | No Traffic | Questionnaires Sent |
|---|---|---|---|---|
| Ohio | 661 | 87 | 50 | 524 |
| Little Kanawha | 6 | 0 | 1 | 5 |
| Kanawha | 81 | 4 | 6 | 71 |
| Big Sandy | 11 | 0 | 4 | 7 |
| Pocatalico | 1 | 0 | 0 | 1 |
| Elk | 7 | 1 | 3 | 4 |
| Allegheny | 49 | 3 | 20 | 26 |
| Monongahela | 130 | 5 | 19 | 106 |
| Cumberland | 41 | 3 | 4 | 34 |
| Tennessee | 113 | 2 | 12 | 99 |
| Kentucky | 4 | 0 | 3 | 1 |
| Green-Barren | 11 | 0 | 0 | 11 |
| Rough | 1 | 0 | 0 | 1 |
| Clinch | 4 | 0 | 2 | 2 |
| Hiwassee | 6 | 0 | 1 | 5 |
| Licking | 4 | 0 | 0 | 4 |
| Total | 1,130 | 106 | 125 | 901 |

# ATTACHMENT III

## COMPARISON OF WCSC DATA AND SURVEY DATA AND DEGREE OF SURVEY COVERAGE BY COMMODITY GROUP

ATTACHMENT III: COMPARISON OF 1976 "REIDENTIFIED" WCSC DATA AND SURVEY RESPONSE FOR ALL RESPONDENTS (IN THOUSAND TONS)

| Commodity Group | Reidentified (1) Tonnage (000's) | All Survey (2) Responses (000's) | Percentage Difference |
|---|---|---|---|
| Coal & Coke | 82,848 | 88,631 | + 7.0 |
| Petroleum Fuels | 15,932 | 17,543 | + 10.1 |
| Crude Petroleum | 286 | 0 | -100.0 |
| Aggregates | 7,914 | 10,349 | + 30.8 |
| Grains | 3,117 | 3,108 | - 0.3 |
| Chemicals & Chemical Fertilizers | 5,341 | 6,510 | + 21.9 |
| Ores & Minerals | 1,706 | 2,534 | + 48.5 |
| Iron Ore, Iron & Steel | 2,692 | 3,339 | + 24.0 |
| Micsellaneous Commodities | 3,475 | 2,763 | - 20.5 |
| Total | 123,311 | 134,777 | + 9.3 |

Source: (1) Based on adjustments made to the original COE data via Battelle survey

(2) Based on Battelle survey

ATTACHMENT III: COMPARISON OF ALL SURVEY RESPONSES TO TOTAL OHIO RIVER BASIN WATERWAY TONNAGE, 1976 (IN THOUSAND TONS)

| Commodity Group | Total (1) Basin Traffic | All (2) Survey Responses | Percentage Response |
|---|---|---|---|
| Coal & Coke | 111,631 | 88,631 | 79.4 |
| Petroleum Fuels | 20,922 | 17,543 | 83.8 |
| Crude Petroleum | 664 | 0 | 0.0 |
| Aggregates | 25,169 | 10,349 | 41.1 |
| Grains | 5,583 | 3,108 | 55.7 |
| Chemicals & Chemical Fertilizers | 11,290 | 6,510 | 57.7 |
| Ores & Mineral | 4,435 | 2,534 | 57.1 |
| Iron Ore, Iron & Steel | 5,167 | 3,339 | 64.6 |
| Miscellaneous Commodities | 10,915 | 2,763 | 25.3 |
| Total | 195,776 | 134,776 | 68.8 |

Source: (1) Based on readjusted volumes from Battelle's survey

(2) Battelle survey

ATTACHMENT III: COMPARISON OF TOTAL OHIO RIVER BASIN WATERWAY TRAFFIC AS DERIVED FROM WCSC AND BATTELLE SURVEY, 1976 (IN THOUSAND TONS)

| Commodity Group | WCSC (1) | Battelle Survey (2) |
|---|---|---|
| Coal & Coke | 103,471 | 111,631 |
| Petroleum Fuels | 19,060 | 20,922 |
| Crude Petroleum | 883 | 664 |
| Aggregates | 21,224 | 25,169 |
| Grains | 5,333 | 5,583 |
| Chemicals & Chemical Fertilizers | 9,449 | 11,290 |
| Ores & Minerals | 3,413 | 4,435 |
| Iron Ore, Iron & Steel | 4,280 | 5,167 |
| Miscellaneous Commodities | 10,789 | 10,915 |
| Total | 177,902 | 195,776 |

Source: (1) Waterborne Commerce Statistics, 1976

(2) Based on readjusted volumes for 1976 from Batelle's survey

APPENDIX A

VOLUME PROJECTION BY RIVER OF ORIGIN

BY RIVER OF DESTINATION BY YEAR 1976 - 1990

( IN THOUSANDS OF TONS)

VOLUME PROJECTION BY RIVER OF ORIGIN
BY RIVER OF DESTINATION BY YEAR 1976 - 1990
(IN THOUSANDS OF TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Ohio River Origin | | | | |
| To Ohio River | 60501. | 86291. | 113924. | 125156. |
| Little Kanawha | 261. | 319. | 353. | 390. |
| Kanawha | 5486. | 8185. | 8872. | 9387. |
| Big Sandy | 91. | 113. | 126. | 140. |
| Elk | 89. | 98. | 98. | 98. |
| Allegheny | 538. | 623. | 664. | 687. |
| Monongahela | 6675. | 7850. | 8545. | 9154. |
| Cumberland | 5792. | 7562. | 7310. | 7839. |
| Tennessee | 3834. | 9078. | 9279. | 9193. |
| Kentucky | 538. | 625. | 755. | 911. |
| Green-Barren | 0 | 0 | 60. | 120. |
| Upper Mississippi | 1751. | 2246. | 3351. | 3567. |
| Lower Mississippi | 5694. | 7844. | 9771. | 10847. |
| Missouri | 12. | 14. | 14. | 14. |
| Illinois | 672. | 977. | 1139. | 1190. |
| Arkansas | 56. | 61. | 65. | 68. |
| Cuachita | 1. | 1. | 1. | 1. |
| White | 1. | 2. | 2. | 2. |
| Tombigbee | 3. | 6. | 7. | 7. |
| Great Intracoastal Waterway-East | 2610. | 3129. | 3338. | 3556. |
| Great Intracoastal Waterway-West | 259. | 304. | 339. | 376. |
| Houston Ship Channel | 449. | 601. | 717. | 772. |
| Yazoo | 13. | 19. | 22. | 24. |
| Kanawha River Origin | | | | |
| To Ohio | 2754. | 4115. | 6995. | 7186. |
| Kanawha | 2970. | 2409. | 2308. | 2335. |
| Big Sandy | 4. | 3. | 4. | 4. |
| Allegheny | 20. | 22. | 24. | 26. |
| Monongahela | 886. | 978. | 1101. | 1221. |
| Cumberland | 8. | 9. | 10. | 12. |
| Tennessee | 152. | 61. | 65. | 65. |
| Upper Mississippi | 17. | 20. | 24. | 27. |
| Lower Mississippi | 59. | 60. | 67. | 71. |
| Illinois | 144. | 137. | 152. | 155. |
| Gulf Intracoastal Waterway-East | 14. | 13. | 15. | 15. |
| Gulf Intracoastal Waterway-West | 47. | 45. | 48. | 48. |
| Houston Ship Channel | 2. | 3. | 4. | 5. |
| Yazoo | 1. | 2. | 2. | 2. |

VOLUME PROJECTION BY RIVER OF ORIGIN
BY RIVER OF DESTINATION BY YEAR 1976 - 1990
(IN THOUSANDS OF TONS)
(Continued)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Big Sandy River Origin | | | | |
| To Ohio | 794. | 3642. | 4968. | 6307. |
| Kanawha | 16. | 16. | 17. | 17. |
| Monogahela | 16. | 15. | 15. | 15. |
| Cumberland | 9. | 20. | 20. | 20. |
| Tennessee | 28. | 84. | 116. | 147. |
| Upper Mississippi | 22. | 77. | 119. | 161. |
| Lower Mississippi | 150. | 10. | 10. | 10. |
| Illinois | 14. | 34. | 34. | 34. |
| Gulf Intracoastal Waterway-West | 35. | 35. | 35. | 35. |
| Elk River Origin | | | | |
| To Ohio | 5. | 5. | 5. | 5. |
| Allegheney River Origin | | | | |
| To Ohio | 1577. | 2035. | 2106. | 2138. |
| Kanawha | 1. | 1. | 1. | 1. |
| Allegheney | 1523. | 1699. | 1413. | 1523. |
| Monongahela | 303. | 358. | 400. | 432. |
| Tennessee | 0. | 18. | 18. | 18. |
| Upper Mississippi | 2. | 2. | 3. | 3. |
| Lower Mississippi | 23. | 35. | 41. | 45. |
| Illinois | 6. | 0 | 0 | 0 |
| Gulf Intracoastal Waterway-East | 8. | 12. | 15. | 16. |
| Mononghaela River Origin | | | | |
| To Ohio | 9701. | 14161. | 17321. | 18864. |
| Kanawha | 44. | 46. | 54. | 58. |
| Allegheney | 810. | 705. | 751. | 751. |
| Monongahela | 18007. | 22292. | 25087. | 26596. |
| Cumberland | 1. | 1. | 1. | 1. |
| Tennessee | 46. | 399. | 556. | 561. |
| Upper Mississippi | 38. | 39. | 39. | 41. |
| Lower Mississippi | 294. | 351. | 406. | 447. |
| Missouri | 1. | 1. | 1. | 1. |
| Illinois | 14. | 14. | 17. | 17. |
| Arkansas | 33. | 36. | 41. | 45. |
| Tombigbee | 7. | 7. | 8. | 8. |
| Gulf Intracoastal Waterway-East | 44. | 48. | 54. | 58. |
| Gulf Intracoastal Waterway-West | 279. | 315. | 353. | 388. |
| Houston Ship Channel | 24. | 28. | 32. | 34. |
| Yazoo | 1. | 1. | 1. | 1. |

VOLUME PROJECTION BY RIVER OF ORIGIN
BY RIVER OF DESTINATION BY YEAR 1976 - 1990
(IN THOUSANDS OF TONS)
(Continued)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Cumblerland River Origin | | | | |
| To Ohio | 529. | 859. | 1077. | 1155. |
| Kanawha | 26. | 29. | 32. | 35. |
| Allegheney | 2. | 2. | 2. | 2. |
| Mononghela | 3. | 3. | 3. | 3. |
| Cumberland | 323. | 409. | 499. | 577. |
| Upper Mississippi | 52. | 64. | 73. | 81. |
| Lower Mississippi | 2332. | 3495. | 4154. | 4550. |
| Illinois | 13. | 14. | 14. | 14. |
| Red | 333. | 557. | 678. | 732. |
| Gulf Intracoastal Waterway-West | 57. | 68. | 77. | 88. |
| Tennessee River Origin | | | | |
| To Ohio | 420. | 462. | 503. | 530. |
| Kanawha | 29. | 29. | 33. | 34. |
| Allegheney | 38. | 39. | 42. | 43. |
| Mononghela | 41. | 50. | 56. | 60. |
| Tennessee | 6912. | 9846. | 9667. | 10230. |
| Upper Mississippi | 365. | 512. | 624. | 680. |
| Lower Mississippi | 4530. | 6922. | 8453. | 9193. |
| Missouri | 16. | 18. | 20. | 22. |
| Illinois | 436. | 545. | 630. | 675. |
| Arkansas | 6. | 7. | 7. | 8. |
| Ouachita | 19. | 29. | 34. | 37. |
| Red | 128. | 215. | 262. | 283. |
| Tombigbee | 13. | 13. | 13. | 13. |
| Gulf Intracoastal Waterway-East | 501. | 745. | 933. | 1018. |
| Gulf Intracoastal Waterway-West | 143. | 170. | 186. | 194. |
| Houston Ship Channel | 20. | 29. | 34. | 37. |
| Yazoo | 7. | 10. | 12. | 14. |
| Other | 1. | 2. | 2. | 2. |
| Kentucky River Origin | | | | |
| To Ohio | 3. | 3. | 3. | 3. |

VOLUME PROJECTION BY RIVER OF ORIGIN
BY RIVER OF DESTINATION BY YEAR 1976 - 1990
(IN THOUSANDS OF TONS)
(Continued)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Green-Barren River Origin | | | | |
| To Ohio | 6536. | 6248. | 5889. | 6711. |
| Cumberland | 71. | 627. | 0 | 0 |
| Tenneessee | 487. | 2659. | 1610. | 1218. |
| Green-Barren | 530. | 697. | 826. | 883. |
| Upper Mississippi | 520. | 674. | 669. | 722. |
| Lower Mississippi | 4167. | 4585. | 3458. | 3607. |
| Illinois | 446. | 650. | 808. | 879. |
| Gulf Intracoastal Waterway-East | 18. | 27. | 33. | 36. |
| Clinch River Origin | | | | |
| To Monogahela | 1. | 2. | 2. | 2. |
| Tennessee | 45. | 75. | 91. | 98. |
| Tombigbee | 2. | 4. | 5. | 5. |
| Other | 1. | 2. | 2. | 2. |
| Upper Mississippi River Origin | | | | |
| To Ohio | 4514. | 4950. | 5380. | 5919. |
| Kanawha | 12. | 17. | 20. | 21. |
| Allegheney | 165. | 195. | 213. | 237. |
| Monongahela | 138. | 184. | 443. | 575. |
| Cumberland | 549. | 734. | 843. | 895. |
| Tennessee | 1732. | 5485. | 5432. | 5590. |
| Lower Mississippi River Origin | | | | |
| To Ohio | 6733. | 7245. | 8286. | 9778. |
| Little Kanawha | 120. | 120. | 121. | 123. |
| Kanawha | 699. | 687. | 710. | 727. |
| Allegheney | 442. | 440. | 509. | 538. |
| Monongahela | 1276. | 1332. | 1470. | 1597. |
| Cumberland | 1277. | 889. | 942. | 988. |
| Tennessee | 1641. | 1981. | 2226. | 2362. |
| Green-Barren | 1. | 2. | 2. | 2. |
| Missouri River Origin | | | | |
| To Ohio | 113. | 142. | 162. | 183. |
| Allegheney | 4. | 7. | 9. | 10. |
| Tennessee | 370. | 484. | 561. | 629. |

VOLUME PROJECTION BY RIVER OF ORIGIN
BY RIVER OF DESTINATION BY YEAR 1976 - 1990
(IN THOUSANDS OF TONS)
(Continued)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Illinois River Origin** | | | | |
| To Ohio | 358. | 306. | 332. | 350. |
| Kanawha | 25. | 24. | 26. | 26. |
| Monongahela | 10. | 11. | 12. | 13. |
| Cumberland | 97. | 107. | 117. | 122. |
| Tennessee | 627. | 723. | 805. | 871. |
| **Arkansas River Origin** | | | | |
| To Ohio | 85. | 112. | 137. | 161. |
| Monongahela | 3. | 4. | 5. | 5. |
| Cumberland | 1. | 2. | 2. | 2. |
| Tennessee | 89. | 109. | 126. | 143. |
| **Ouachita River Origin** | | | | |
| To Tennessee | 30. | 36. | 38. | 40. |
| **White River Origin** | | | | |
| To Tennessee | 1. | 1. | 2. | 2. |
| **Atchafalaya River Origin** | | | | |
| To Ohio | 55. | 62. | 86. | 120. |
| **Tombigbee River Origin** | | | | |
| To Ohio | 2. | 3. | 3. | 3. |
| Kanawha | 15. | 14. | 16. | 16. |
| Tennessee | 2. | 4. | 5. | 5. |
| **Gulf Intracoastal Waterway-East** | | | | |
| To Ohio | 669. | 679. | 722. | 765. |
| Allegheney | 1. | 1. | 1. | 1. |
| Monongahela | 3. | 4. | 4. | 4. |
| Cumberland | 36. | 39. | 42. | 46. |
| Tennessee | 310. | 361. | 391. | 421. |
| Green-Barren | 3. | 4. | 4. | 5. |
| **Gulf Intracoastal Waterway-West** | | | | |
| To Ohio | 2444. | 2781. | 3159. | 3561. |
| Kanawha | 791. | 796. | 871. | 916. |
| Allegheney | 478. | 577. | 682. | 710. |
| Monongahela | 399. | 415. | 441. | 409. |
| Cumberland | 26. | 27. | 29. | 31. |
| Tennessee | 1806. | 1880. | 1891. | 1981. |
| Green-Barren | 1. | 1. | 1. | 1. |

VOLUME PROJECTION BY RIVER OF ORIGIN
BY RIVER OF DESTINATION BY YEAR 1976 - 1990
(IN THOUSANDS OF TONS)
(Continued)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Houston Ship Channel Origin | | | | |
| To Ohio | 676. | 795. | 885. | 990. |
| Kanawha | 132. | 137. | 142. | 150. |
| Allegheney | 114. | 170. | 202. | 220. |
| Monongahela | 12. | 16. | 17. | 19. |
| Cumberland | 19. | 21. | 23. | 26. |
| Tennessee | 250. | 286. | 316. | 352. |
| Yazoo River Origin | | | | |
| To Kanawha | 9. | 10. | 11. | 12. |
| Allegheney | 1. | 1. | 1. | 1. |
| Monongahela | 8. | 12. | 15. | 16. |
| Tennessee | 8. | 9. | 10. | 11. |
| Other River Origin | | | | |
| To Ohio | 7. | 11. | 13. | 14. |

Source: Battelle Survey

# APPENDIX B

## TONNAGE FLOW TIME-SERIES BY LOCK BY DIRECTION

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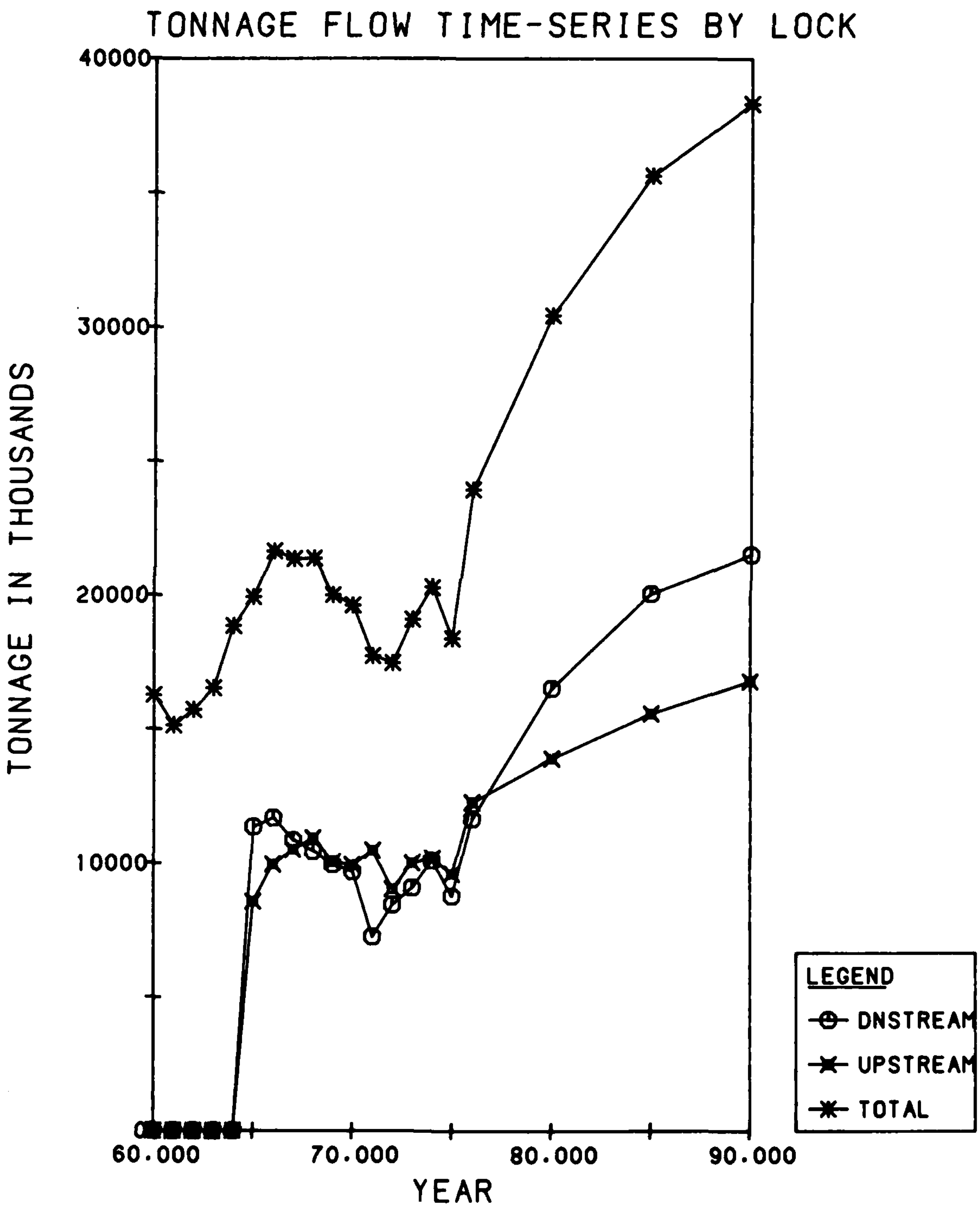


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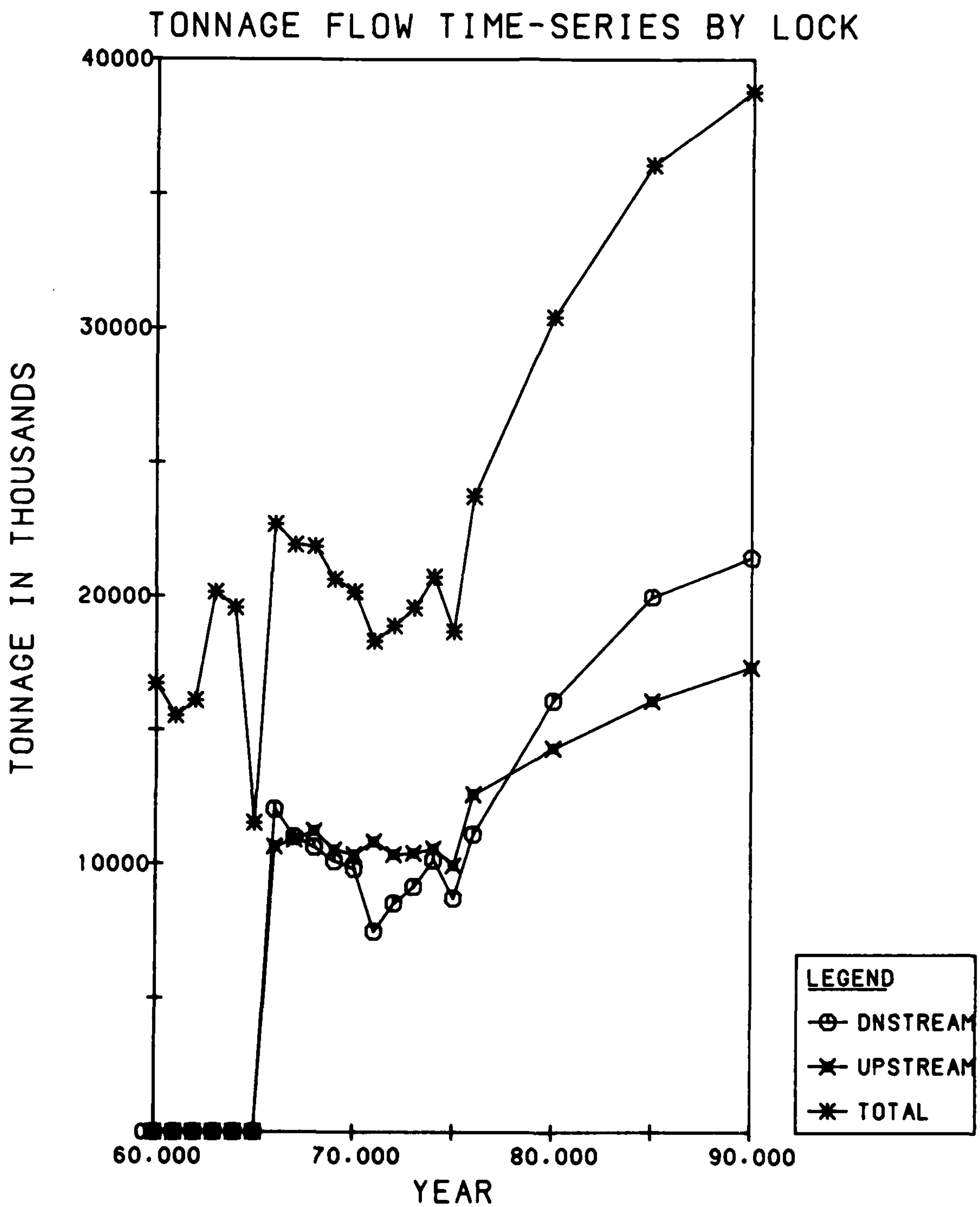


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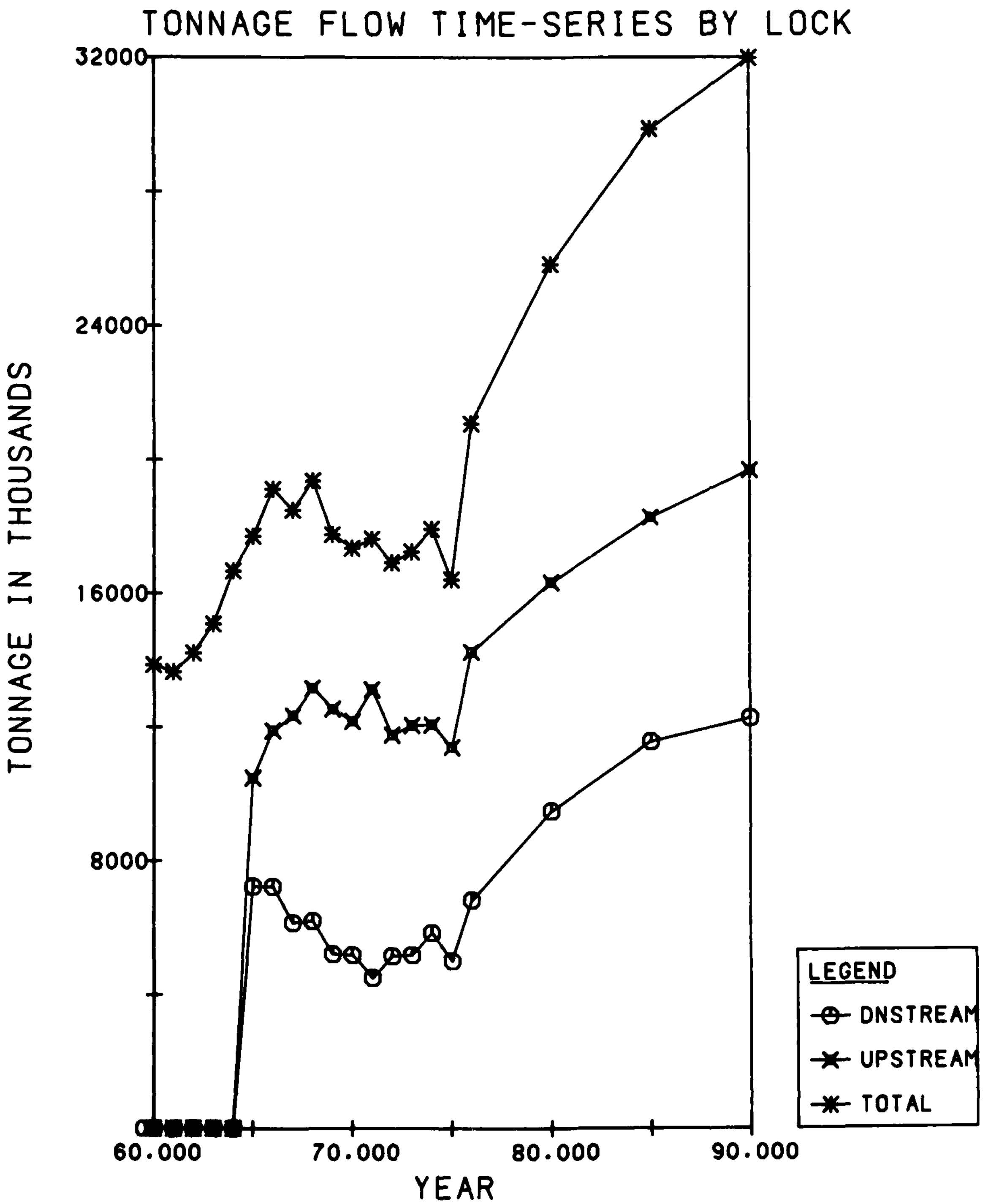


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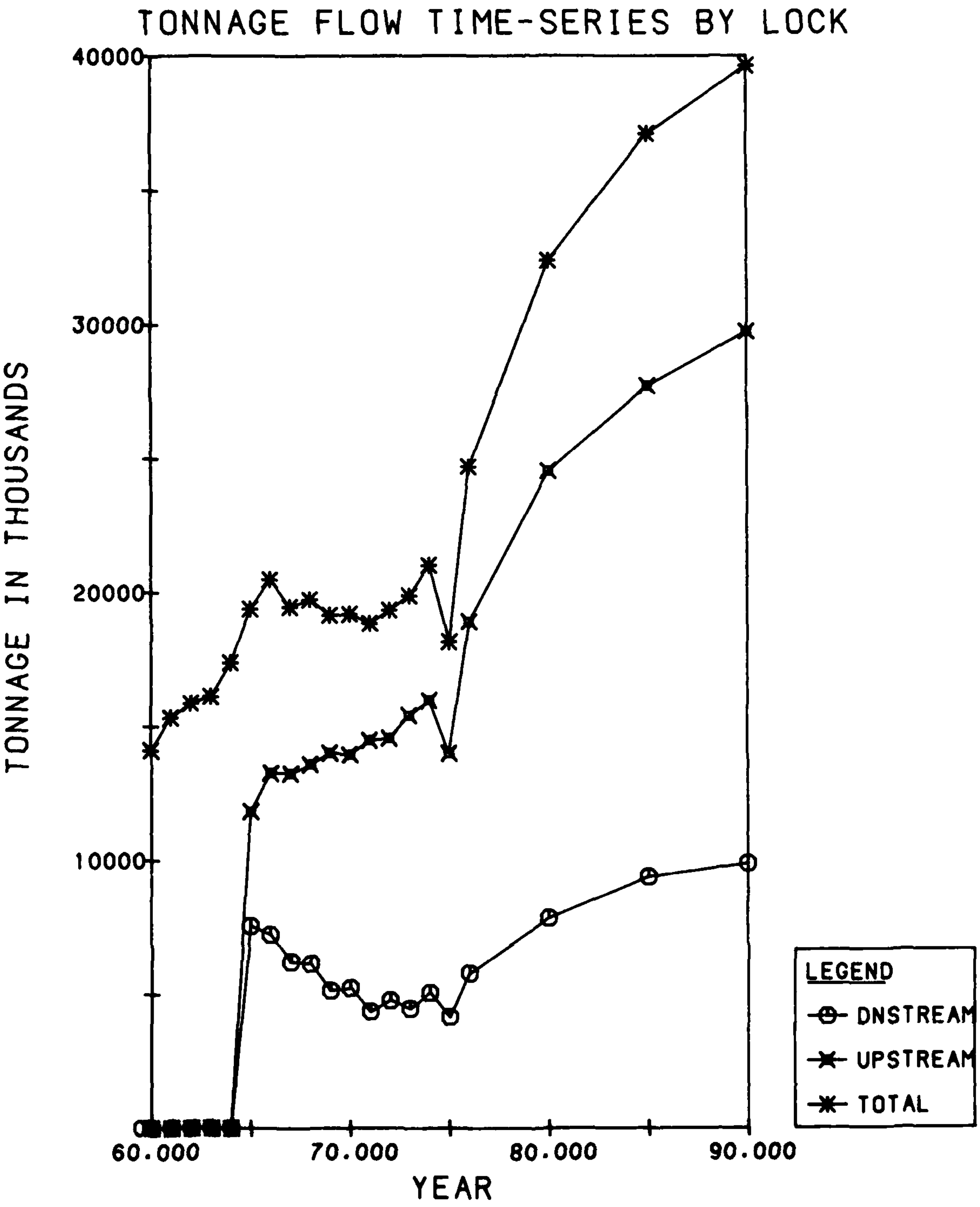


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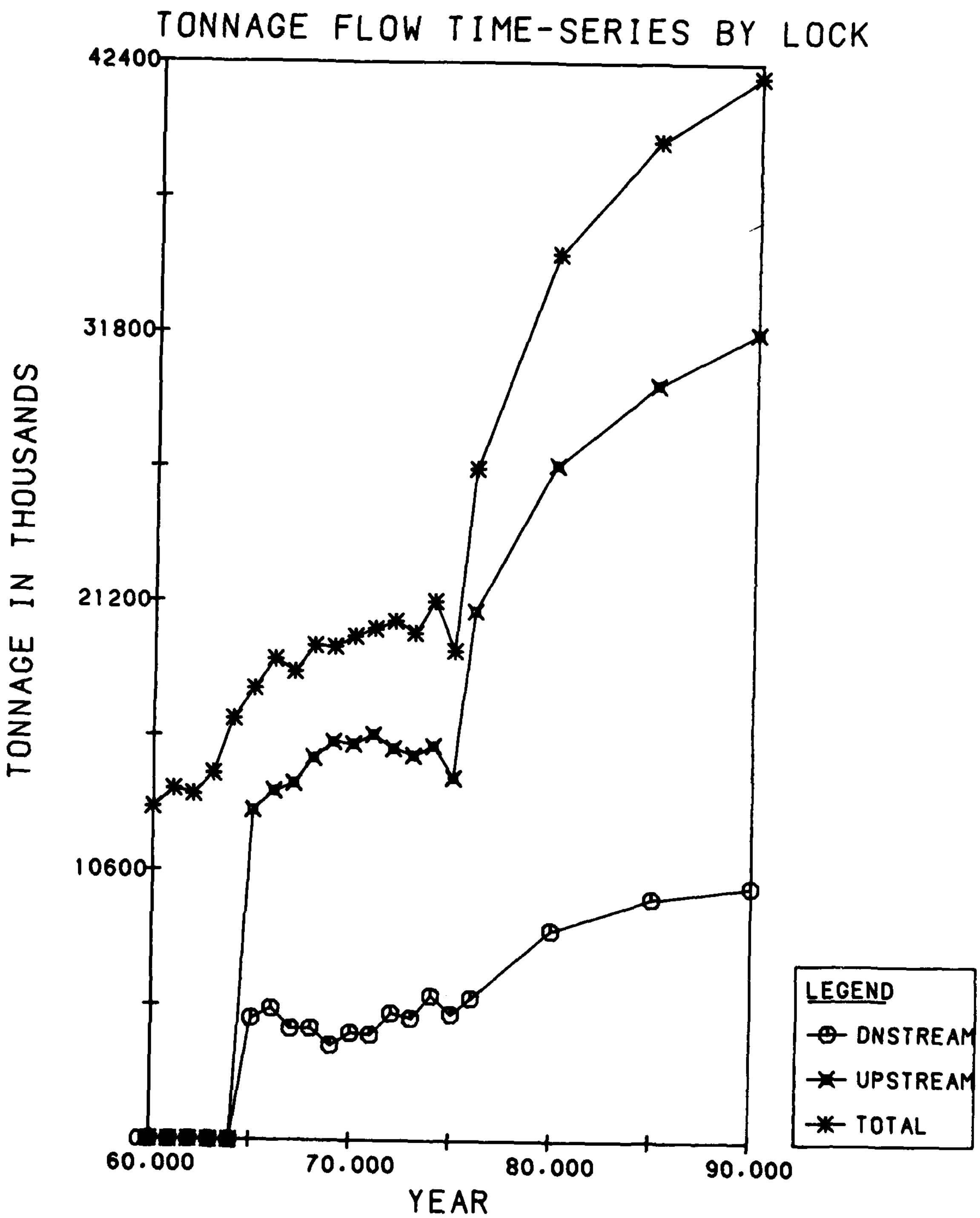


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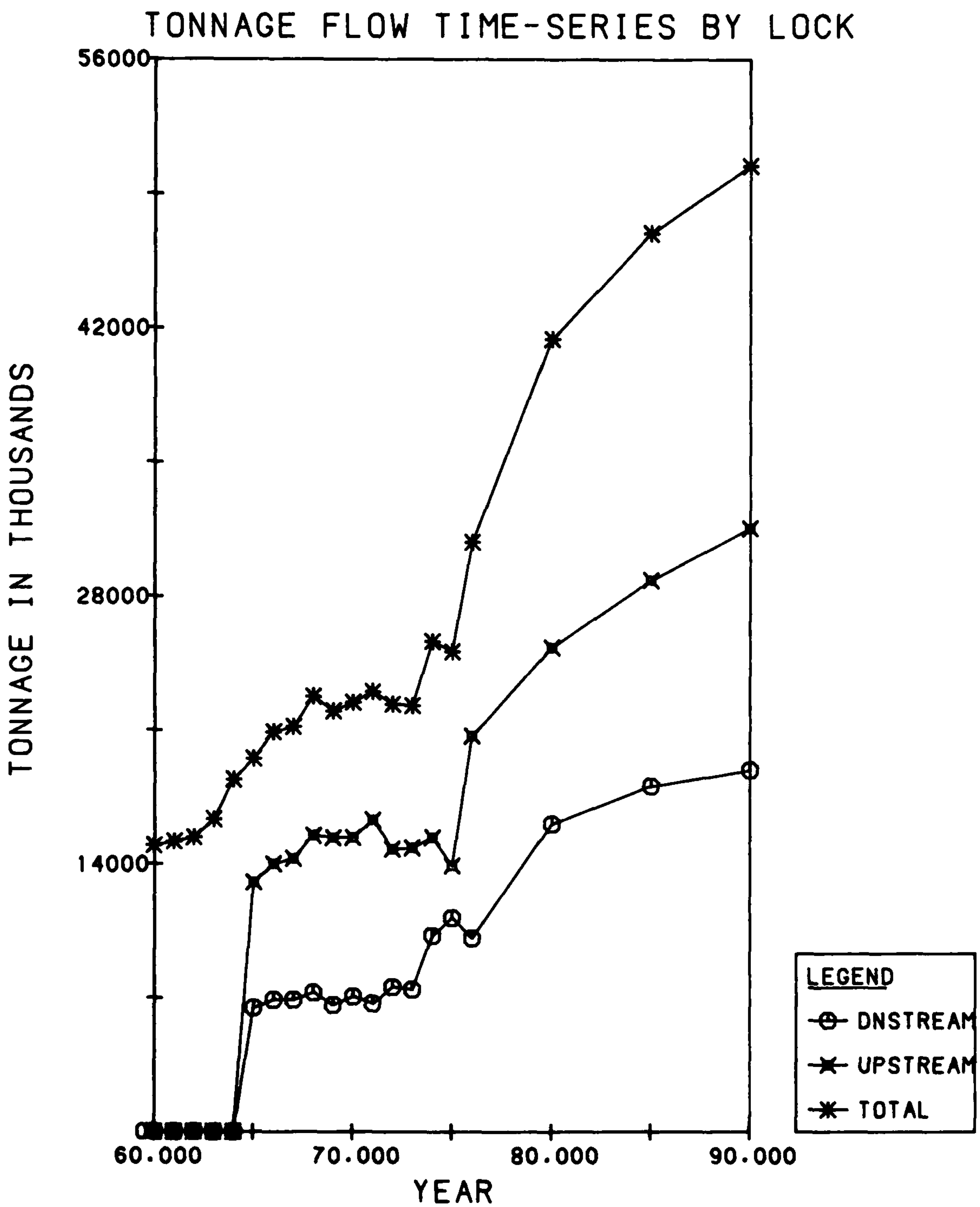


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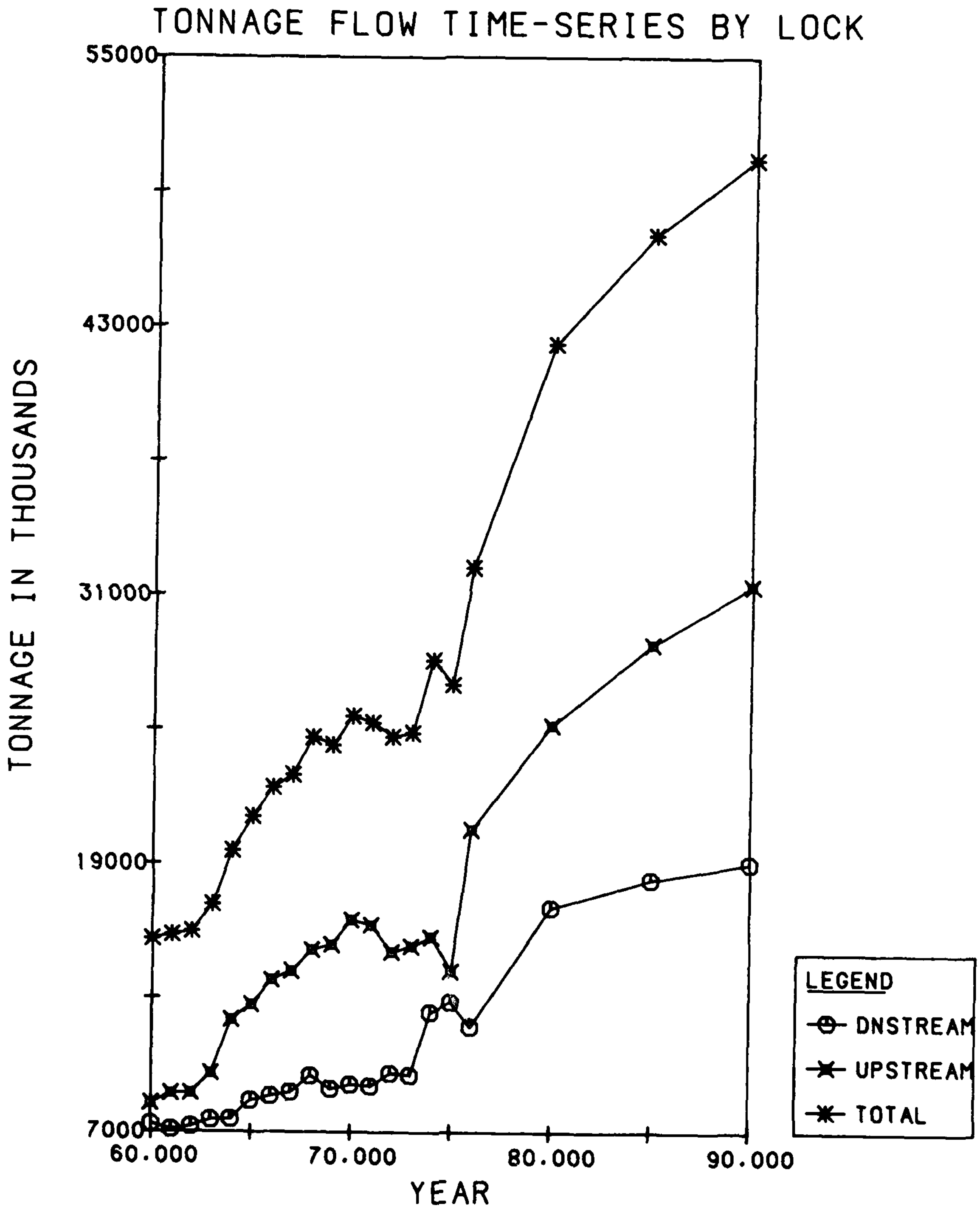


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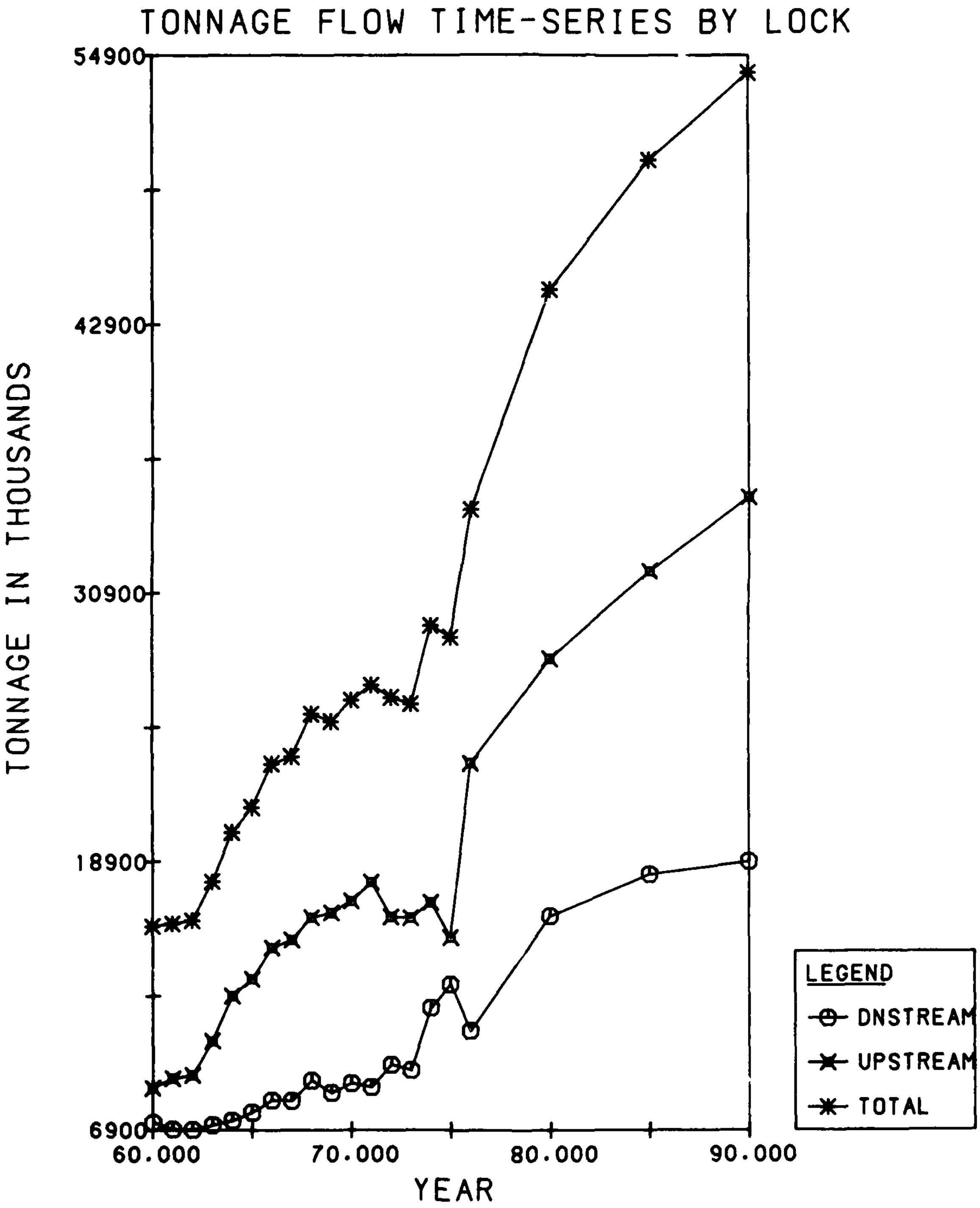


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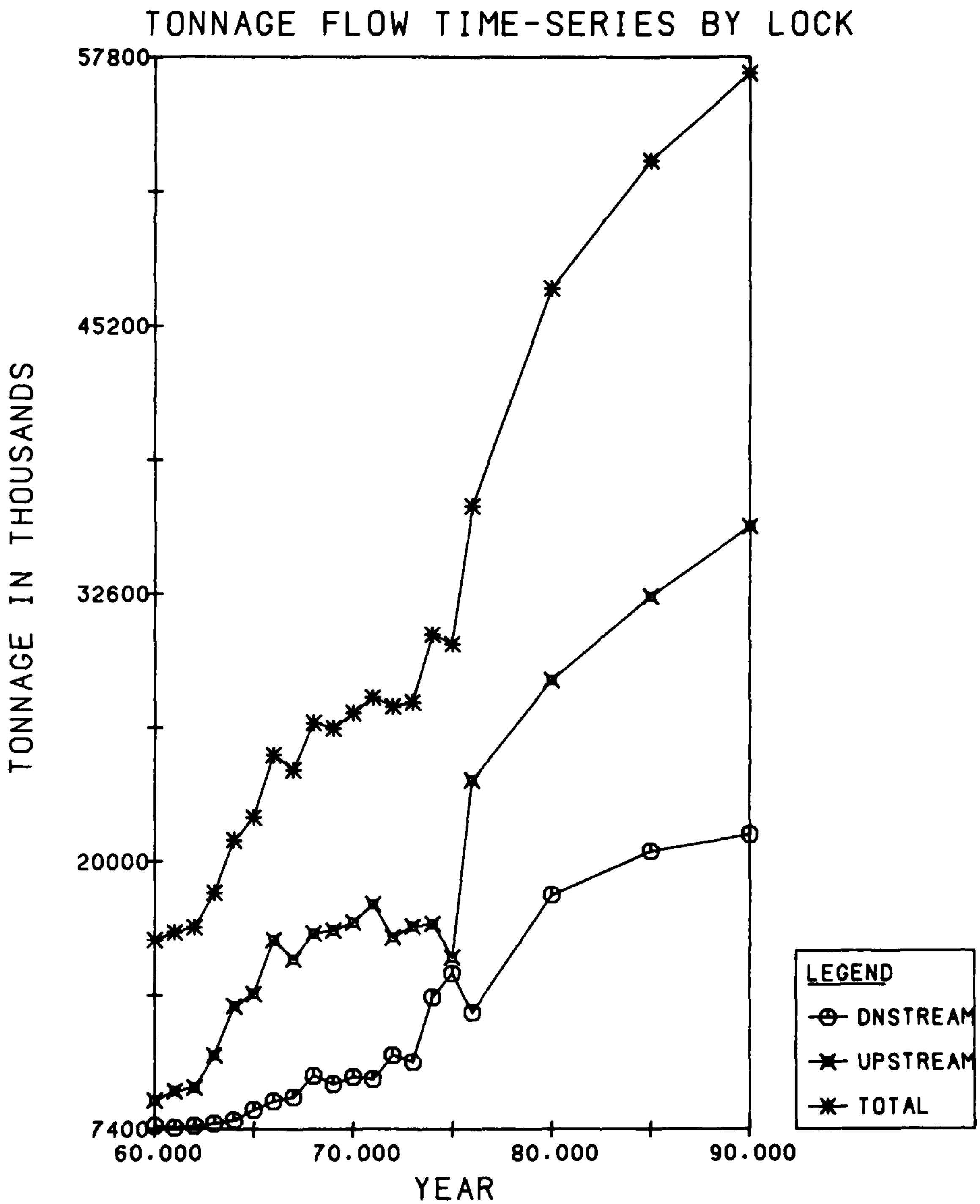


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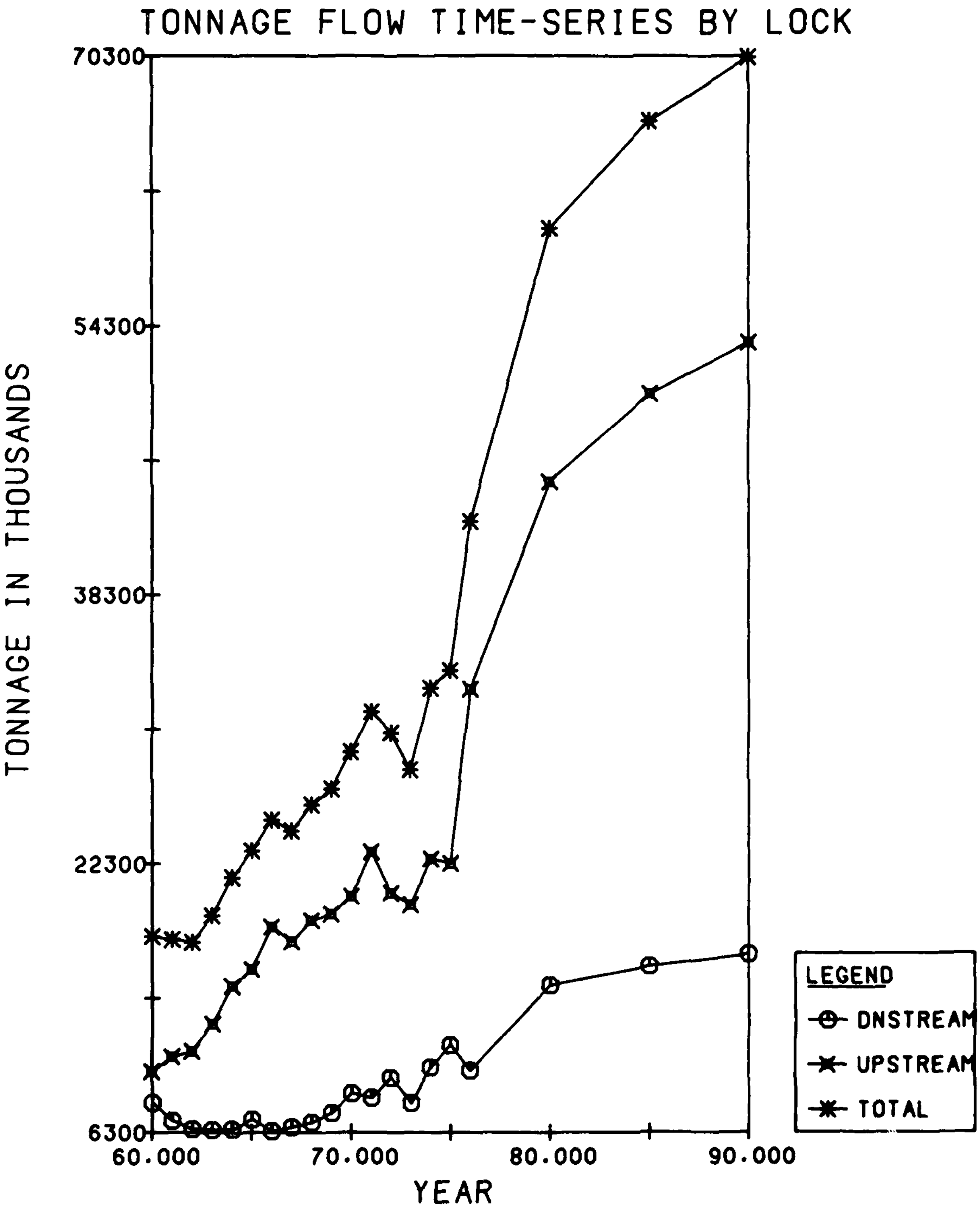


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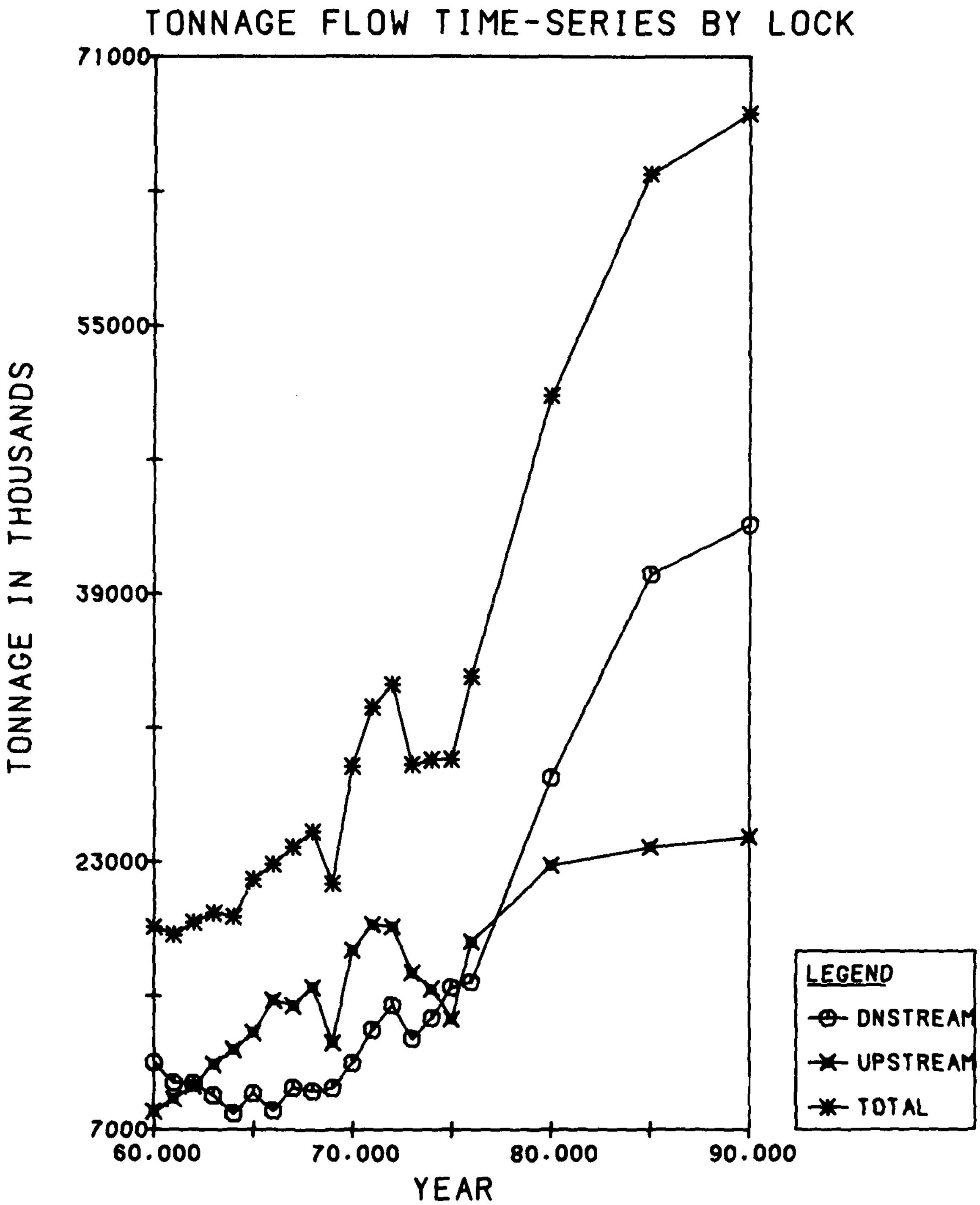


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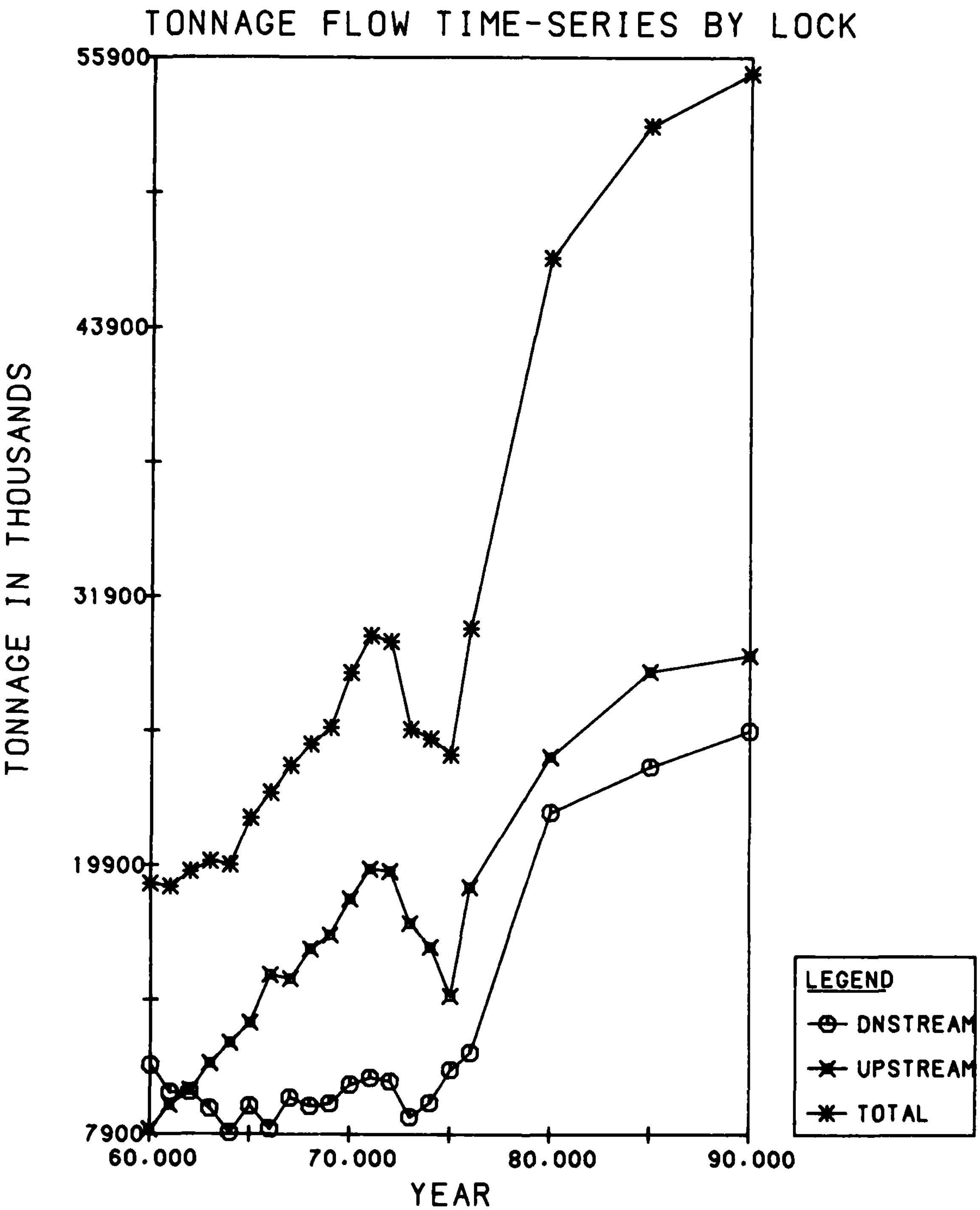


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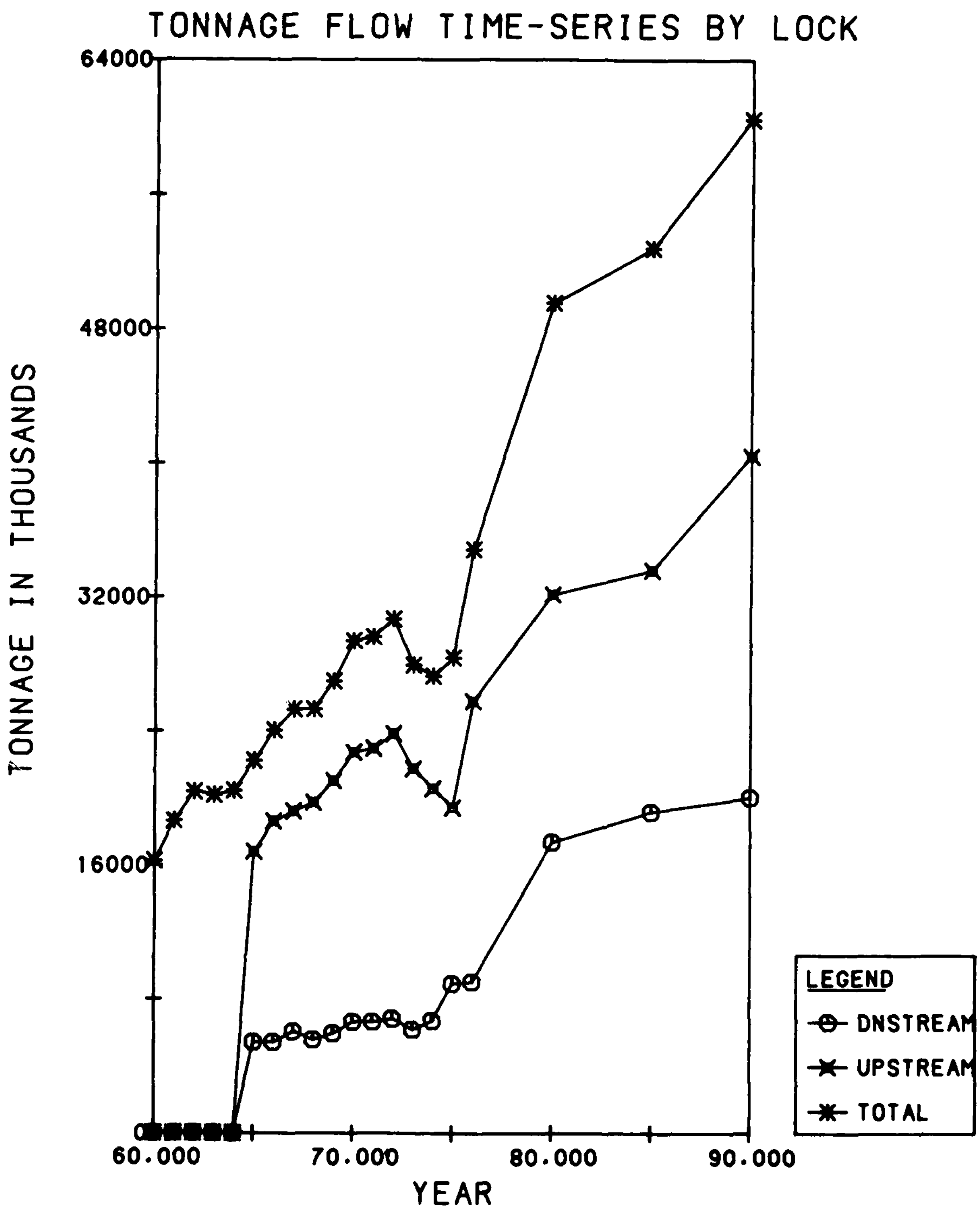


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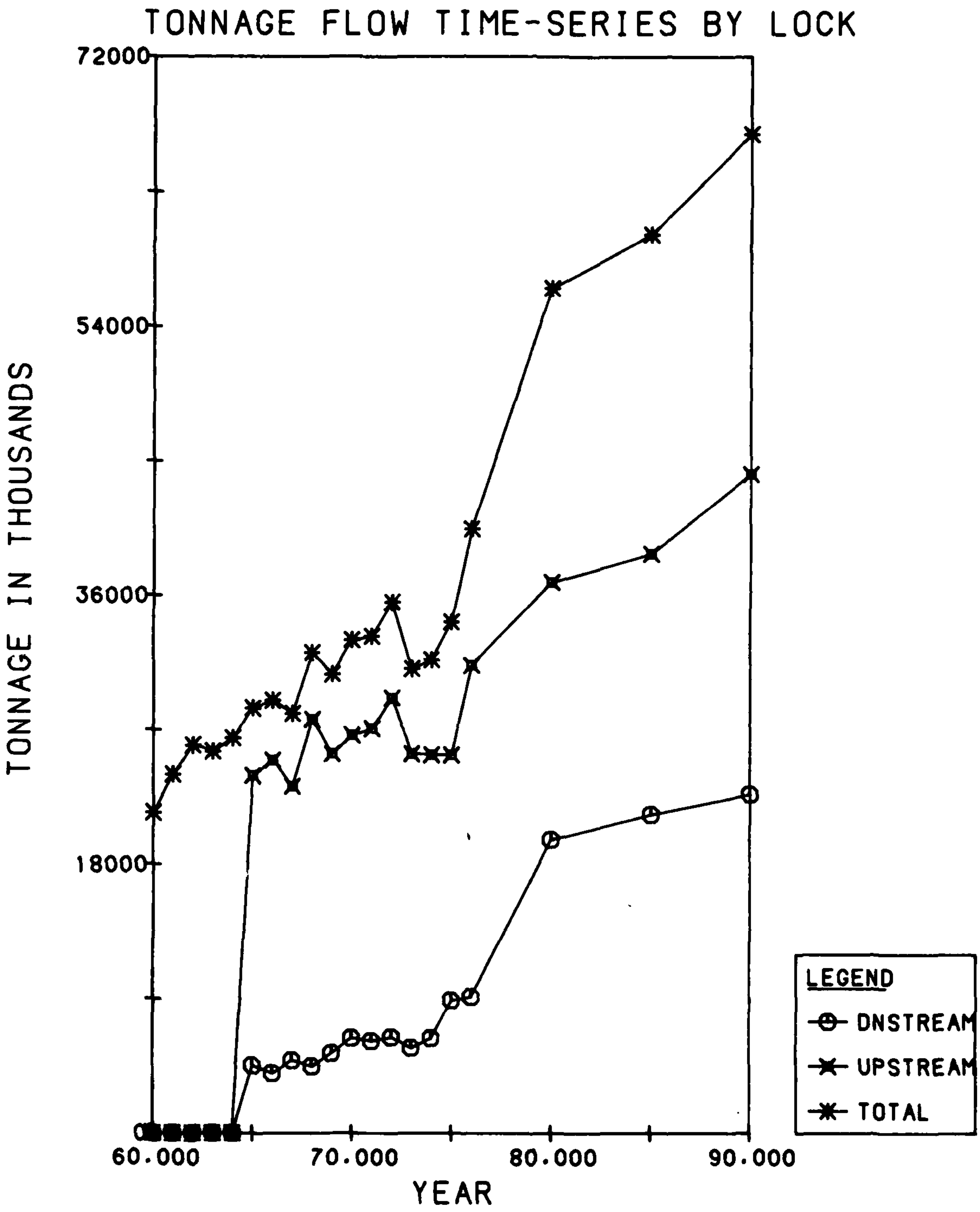


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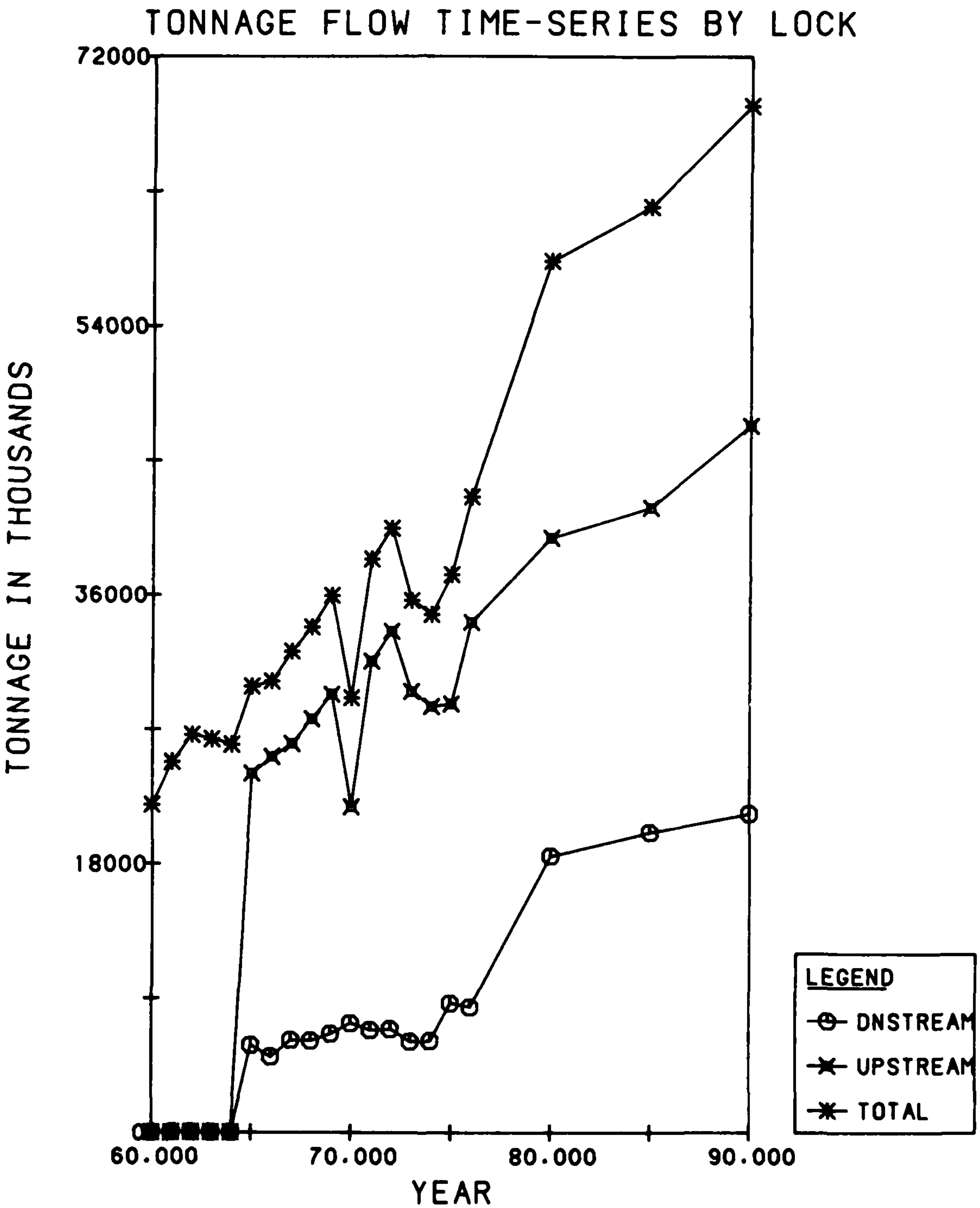
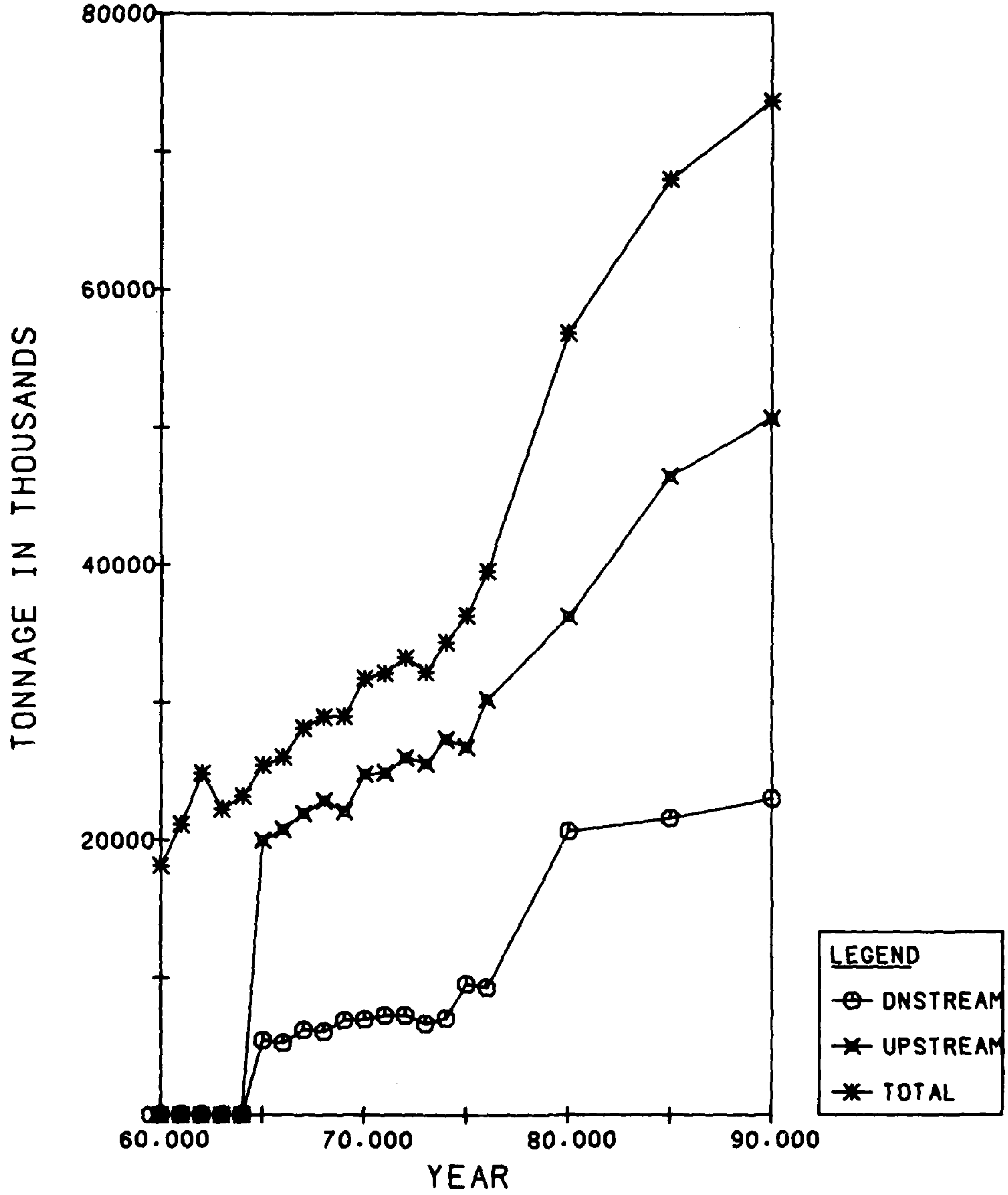



CANNELTON LOCK & DAM

TONNAGE FLOW TIME-SERIES BY LOCK

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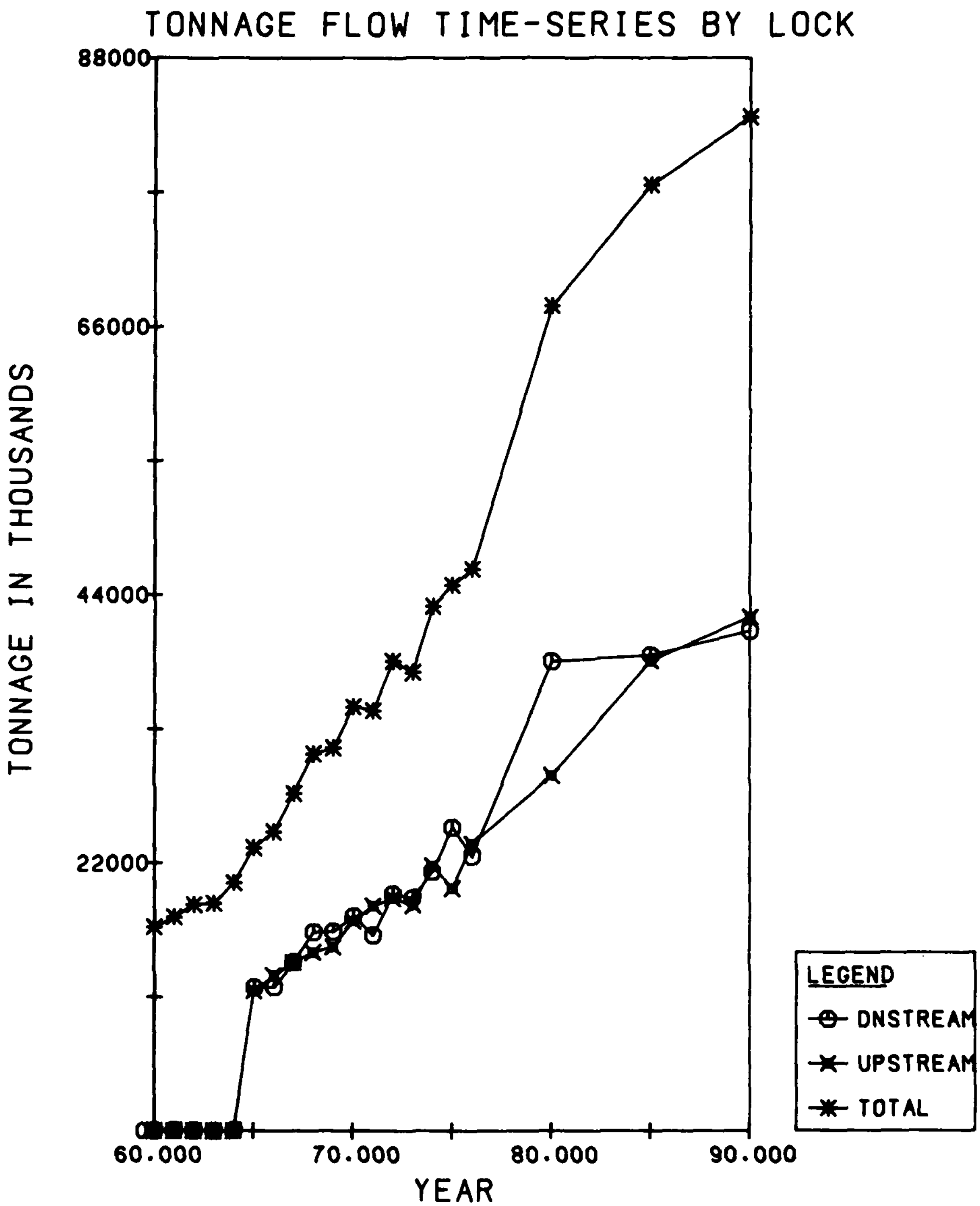


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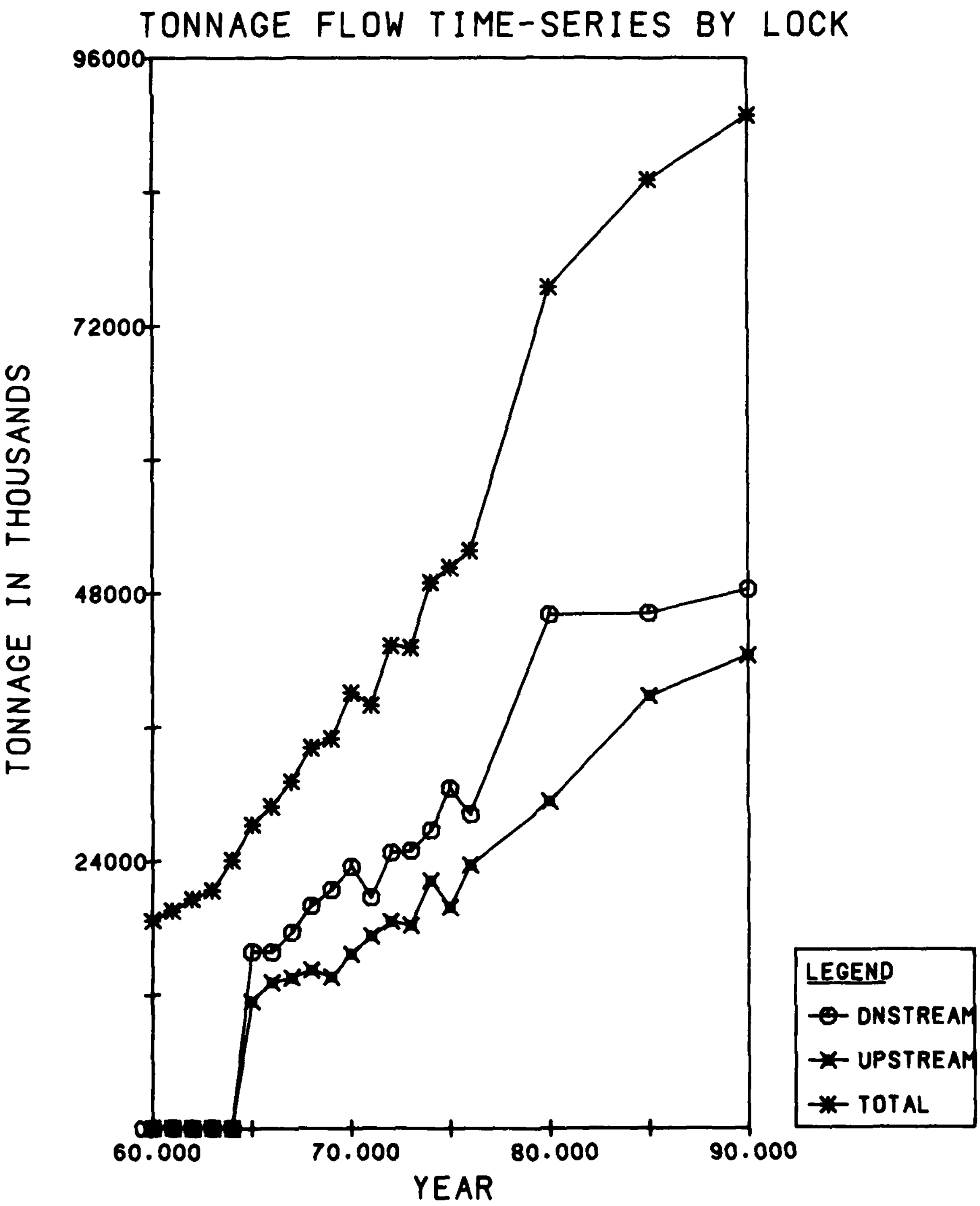


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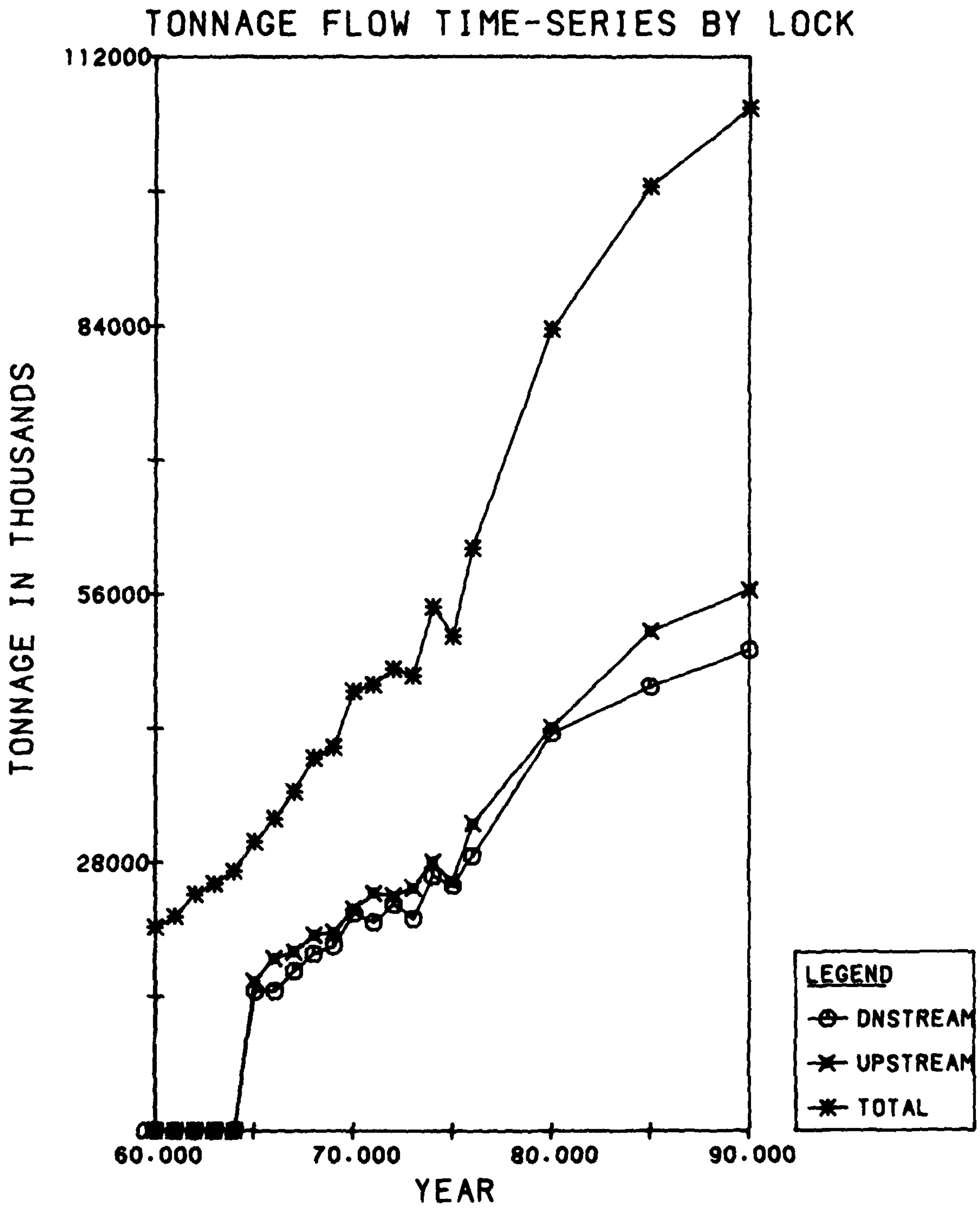
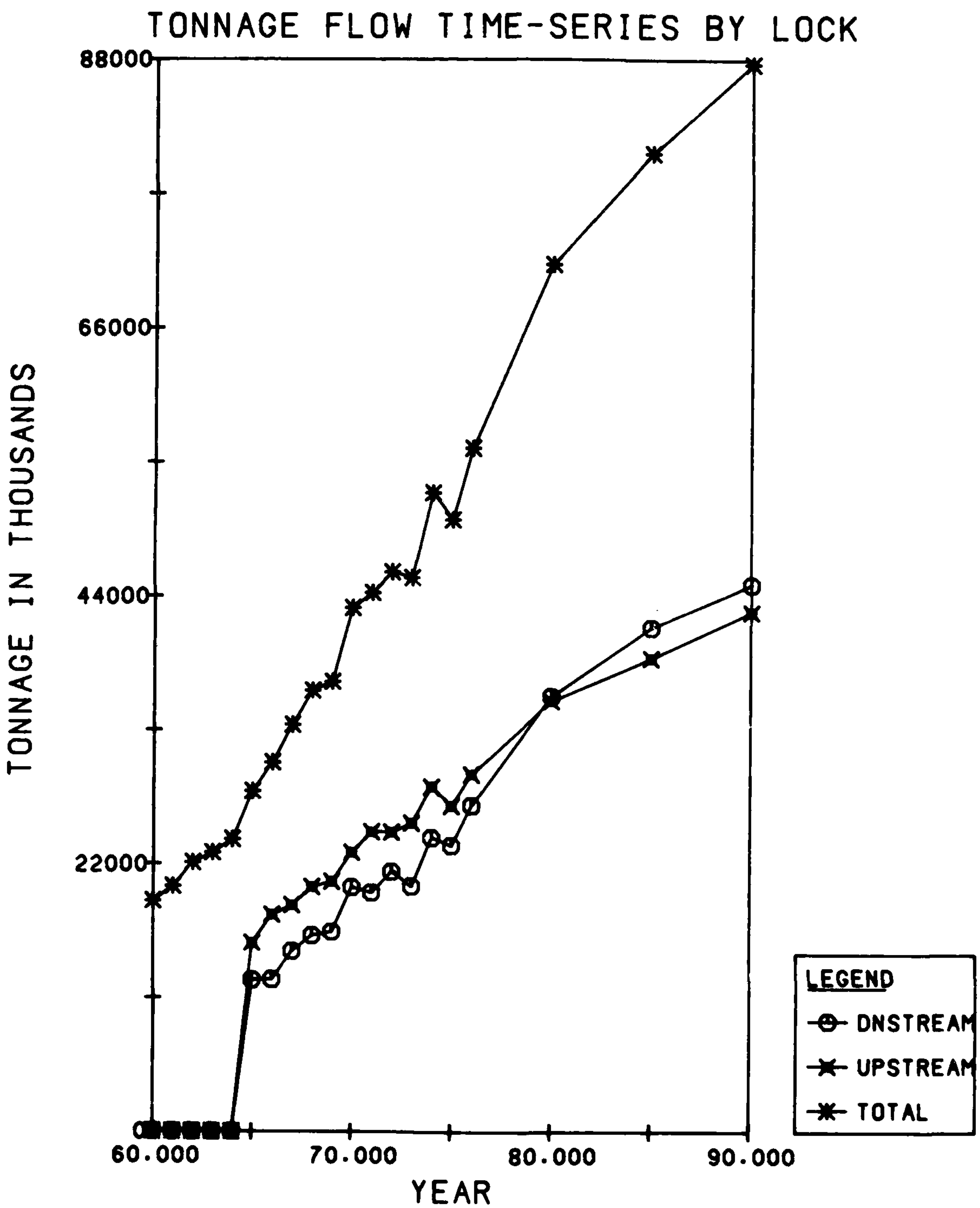



OHIO LOCK & DAM #52

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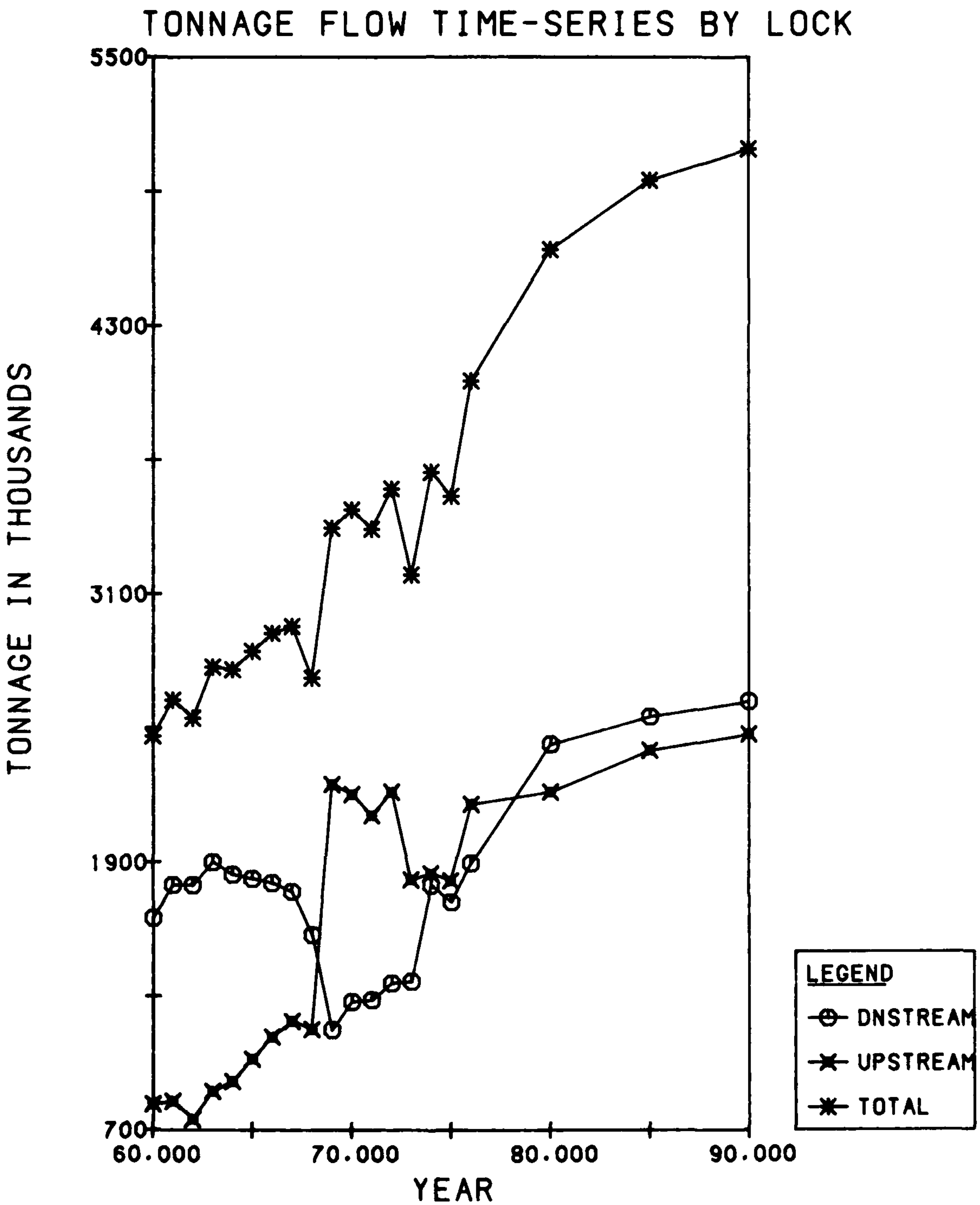


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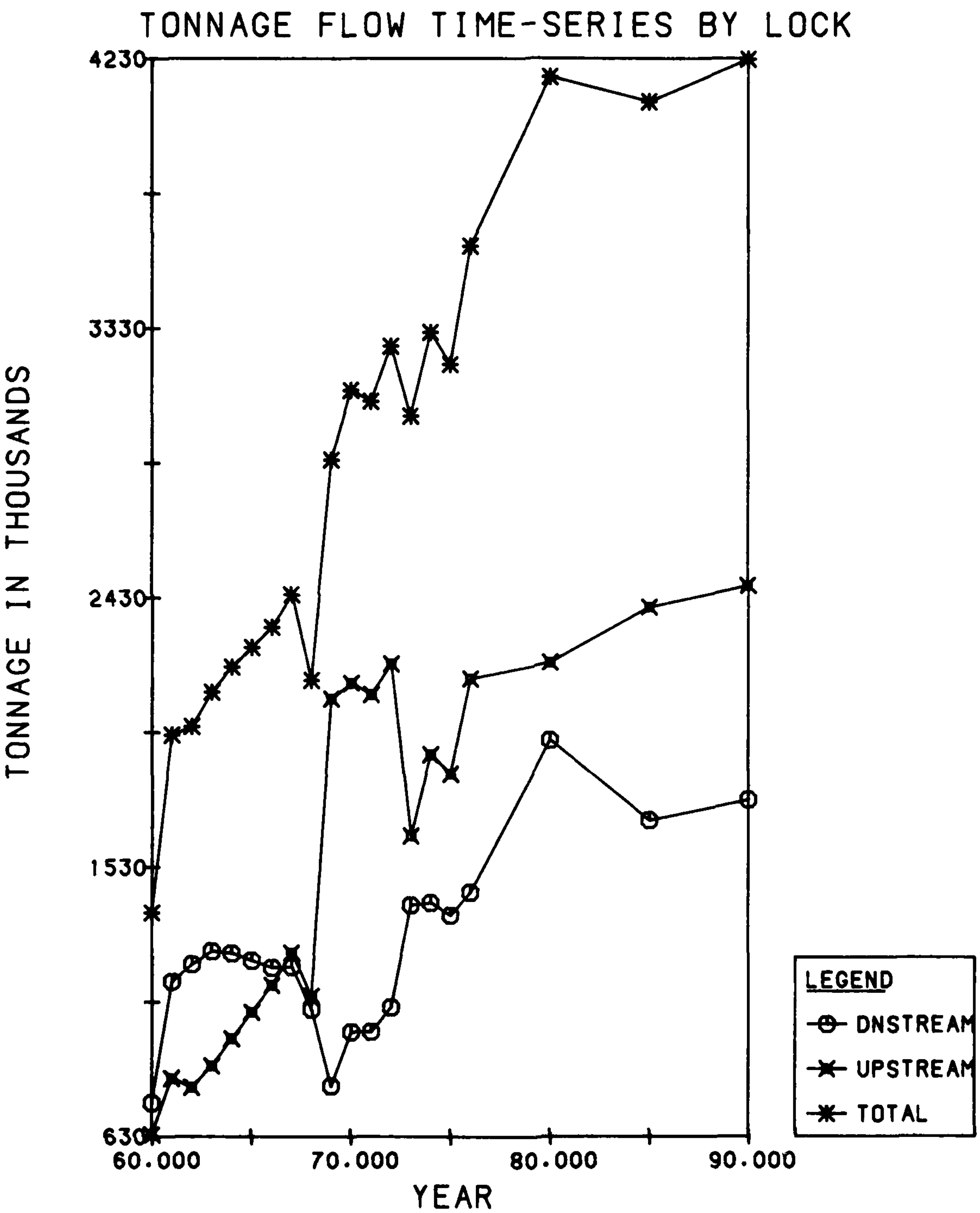


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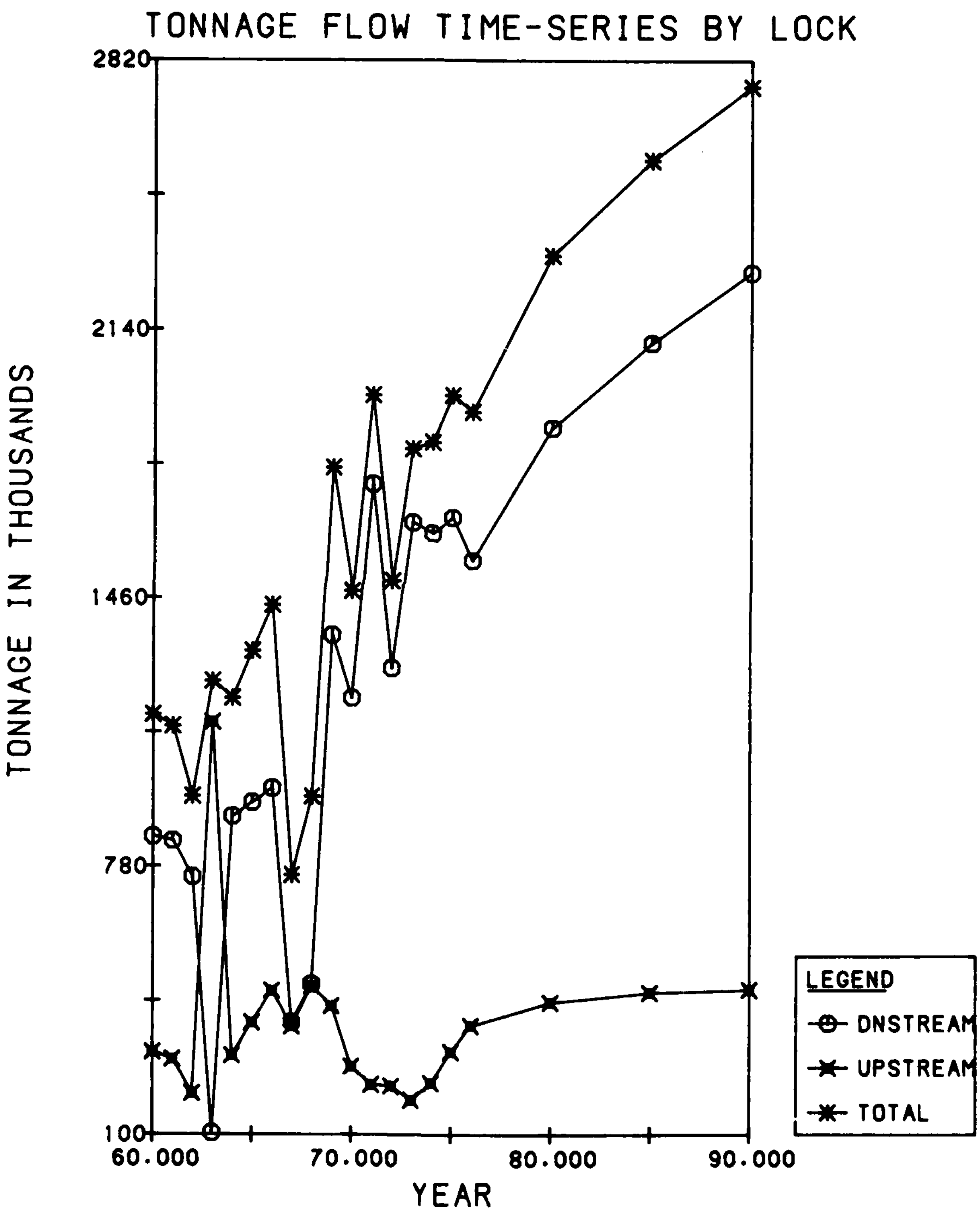


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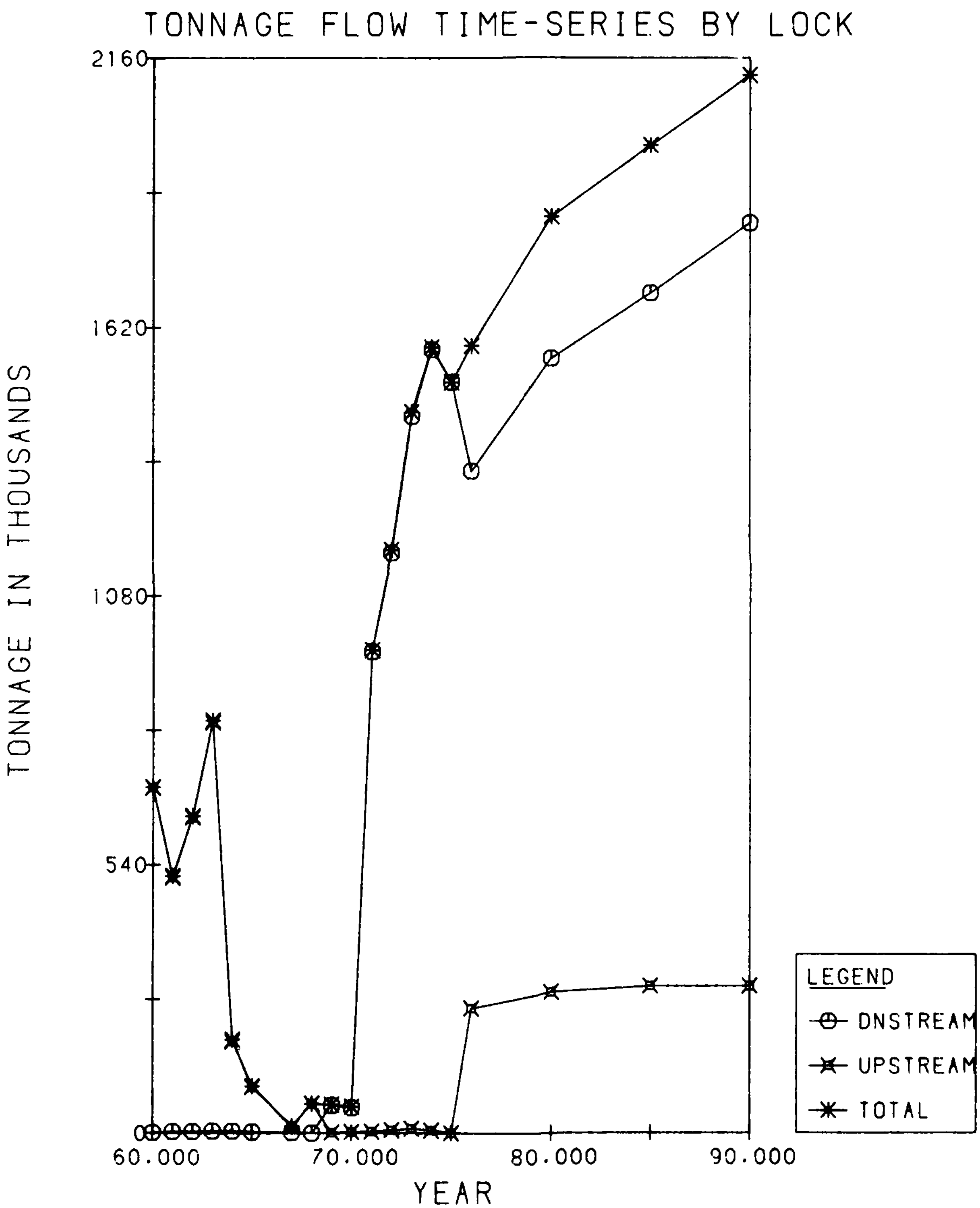


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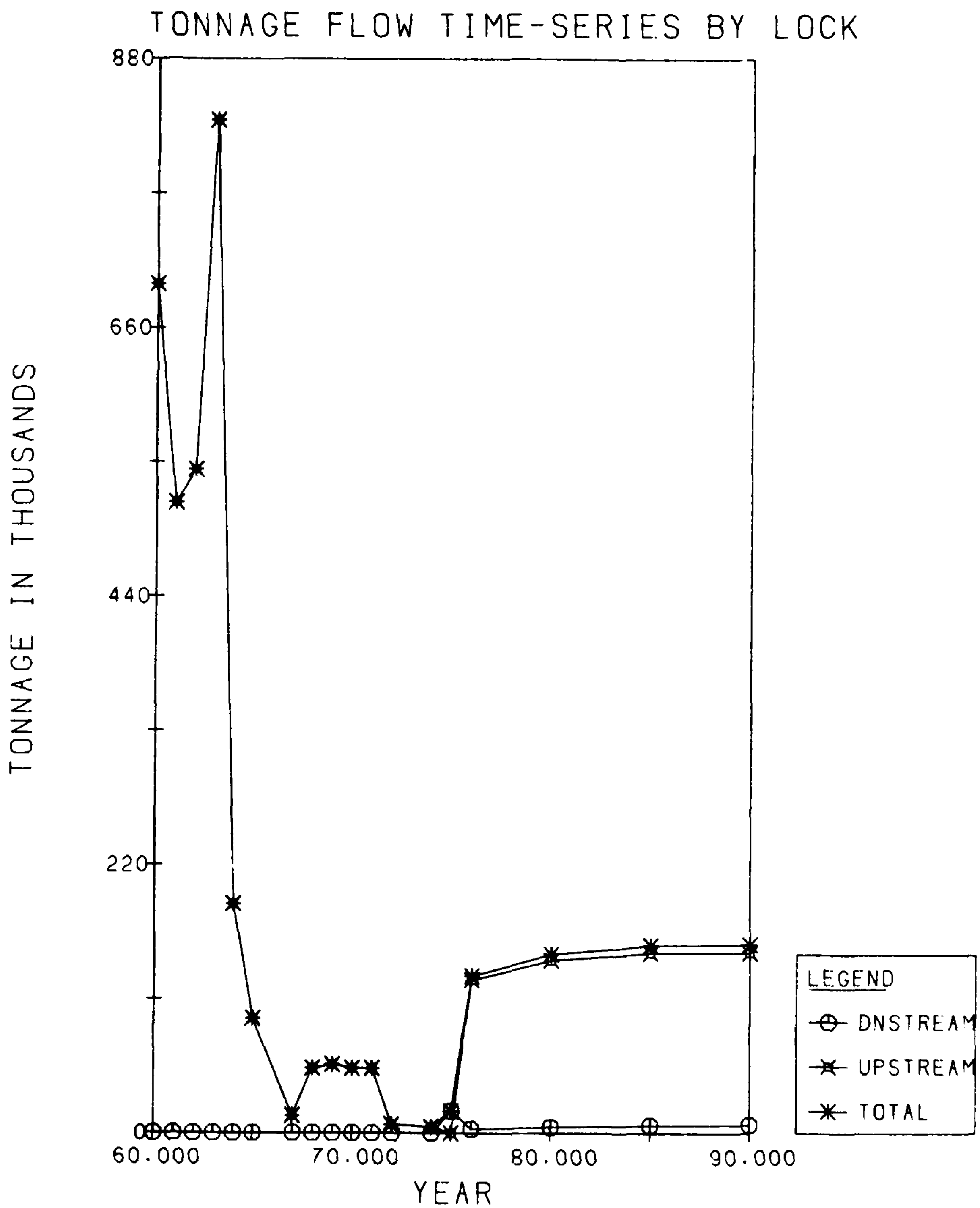
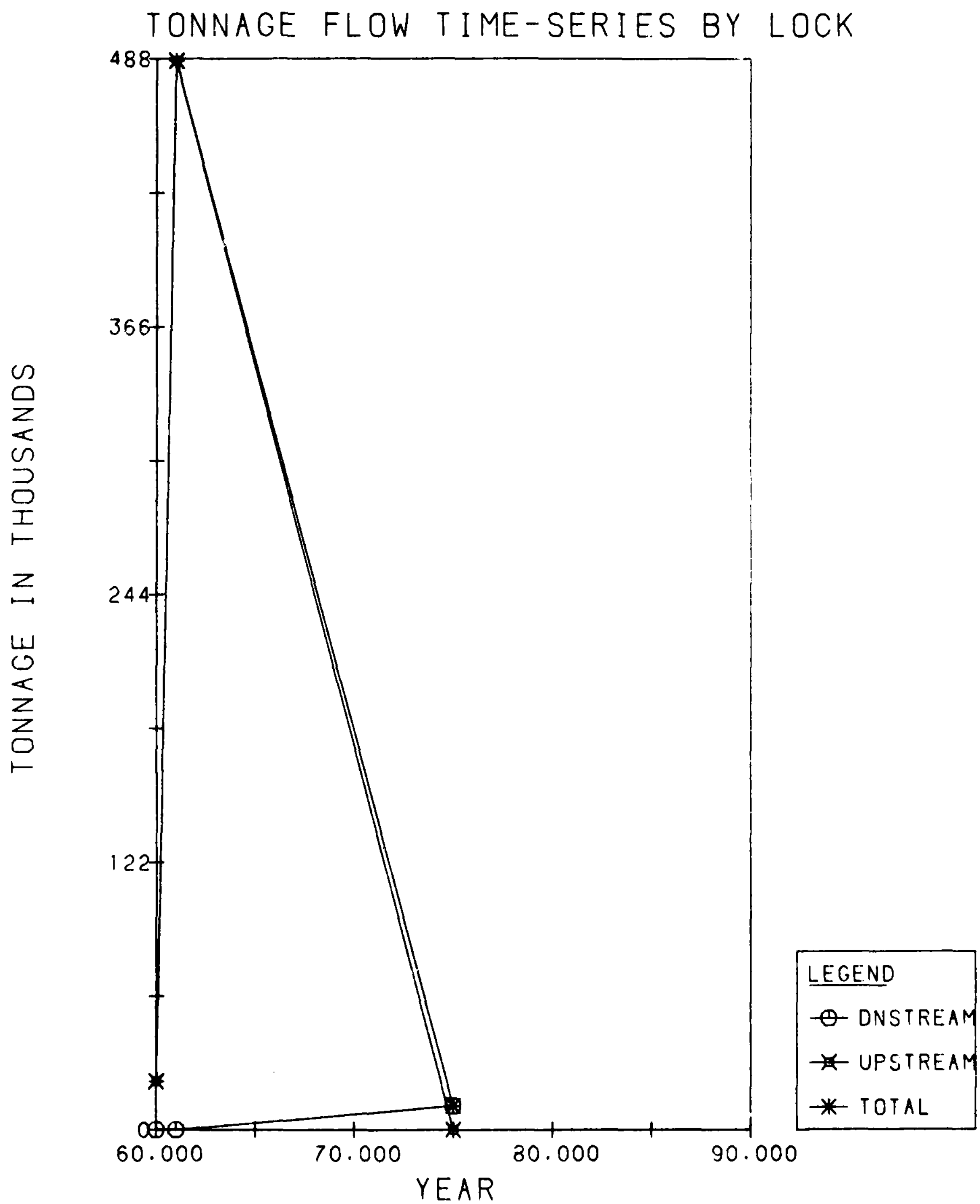



ALLEGHENY LOCK & DAM #6

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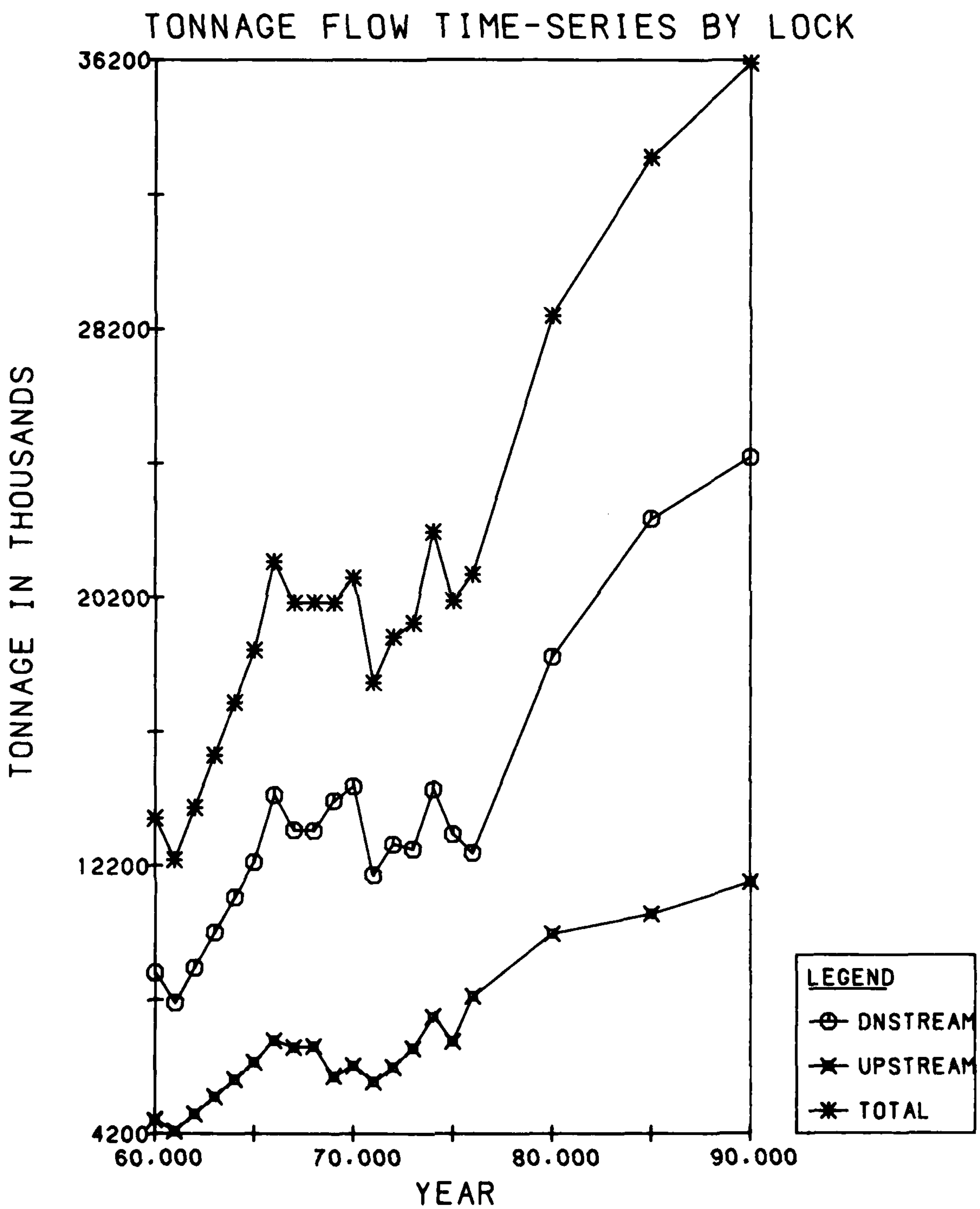
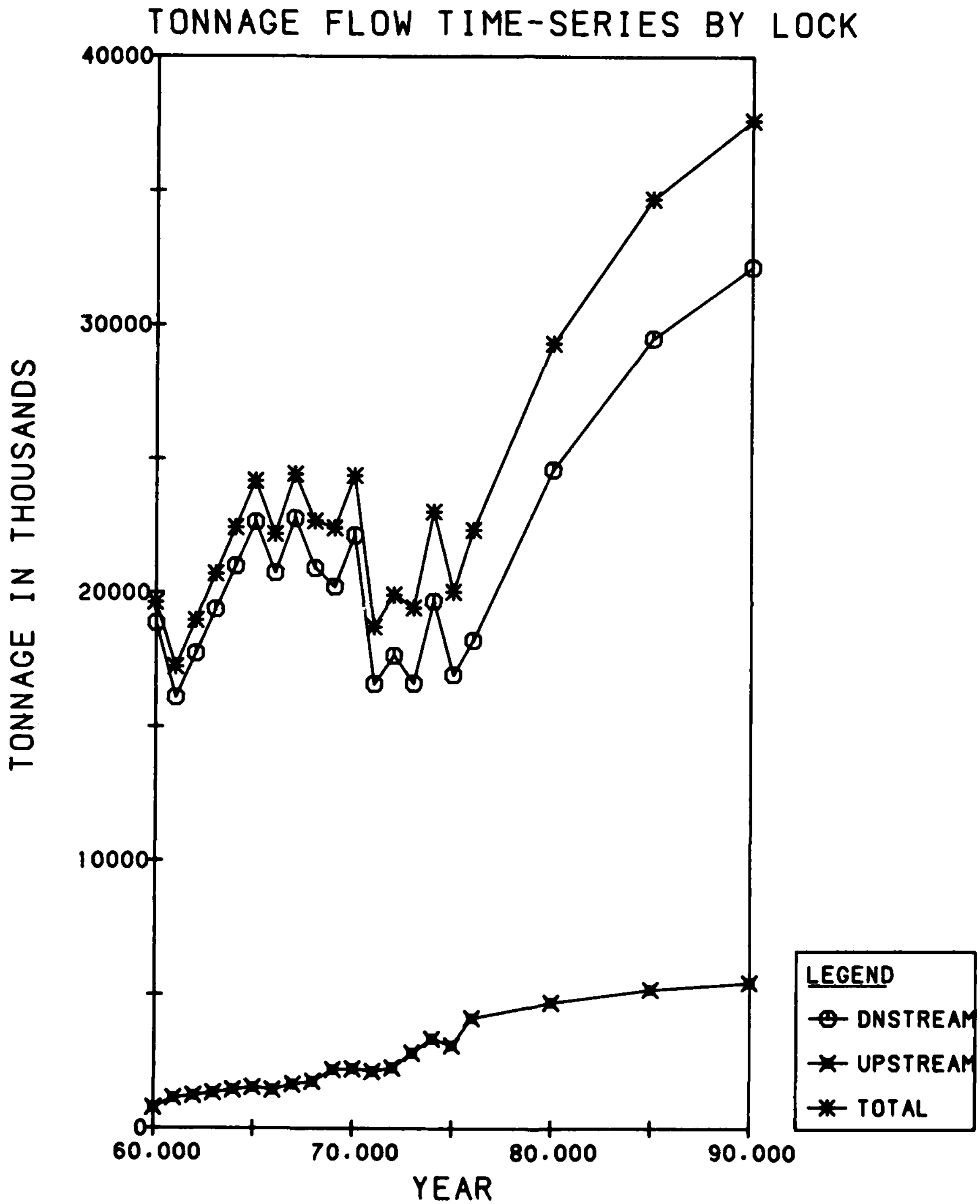



MONONGAHELA LOCK & DAM #2

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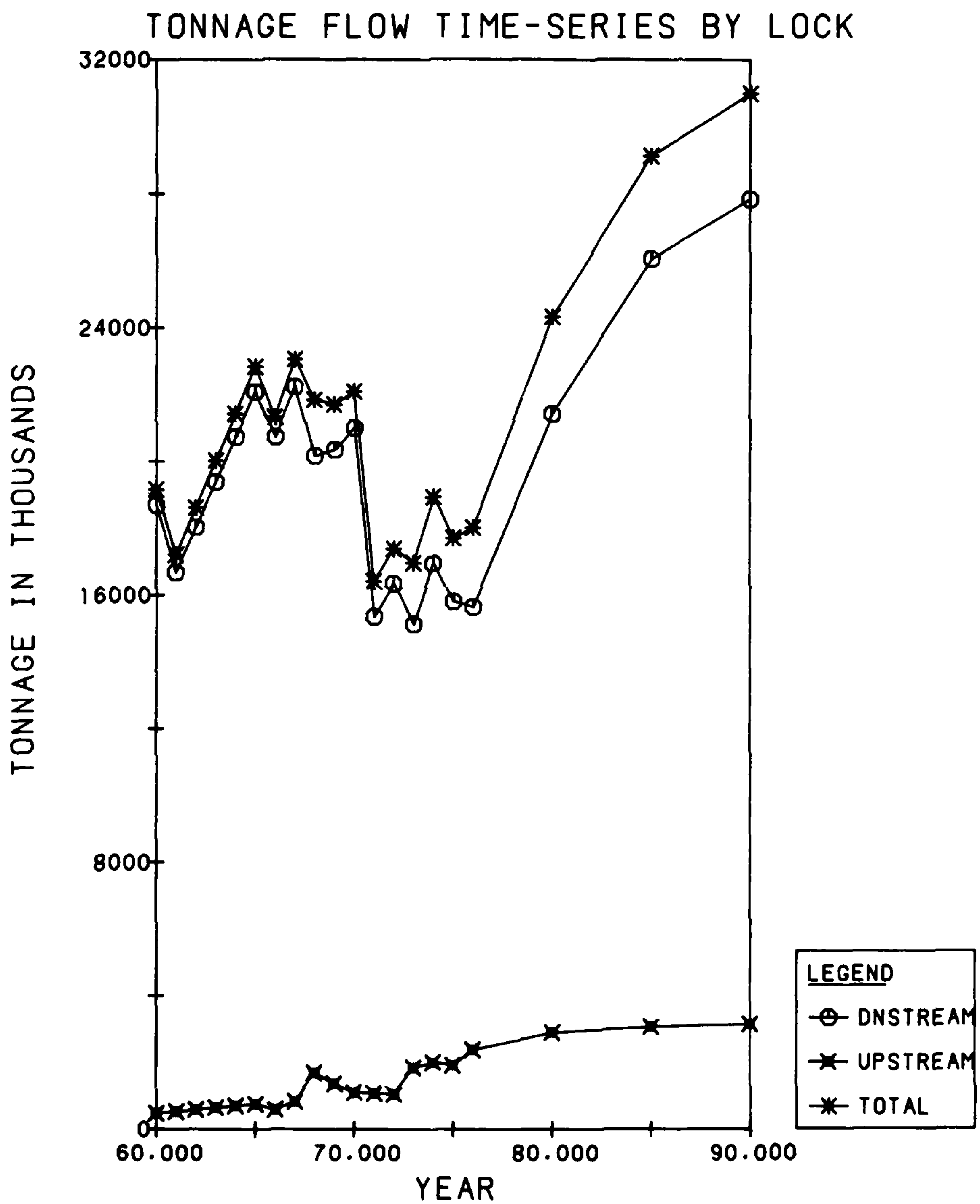


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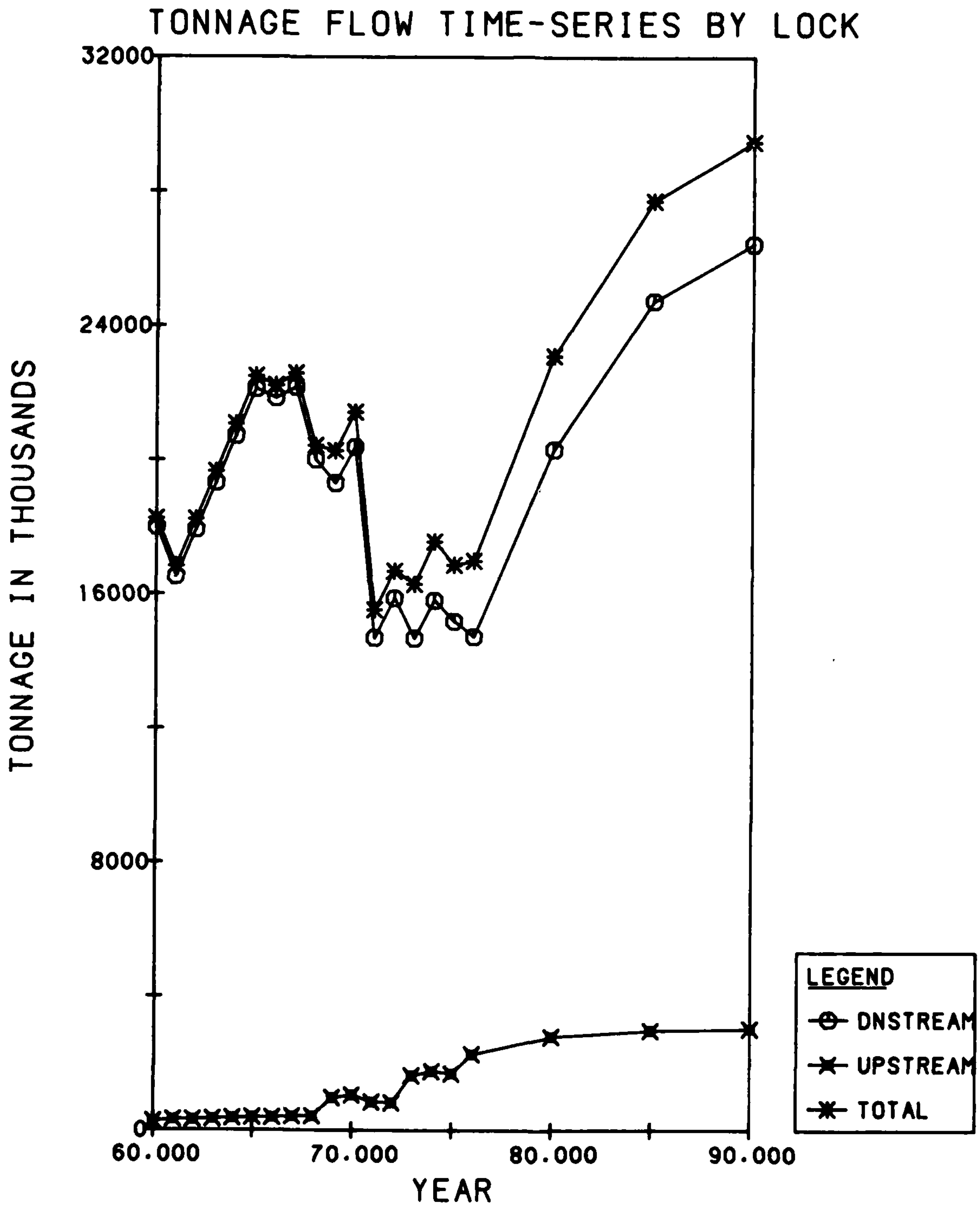


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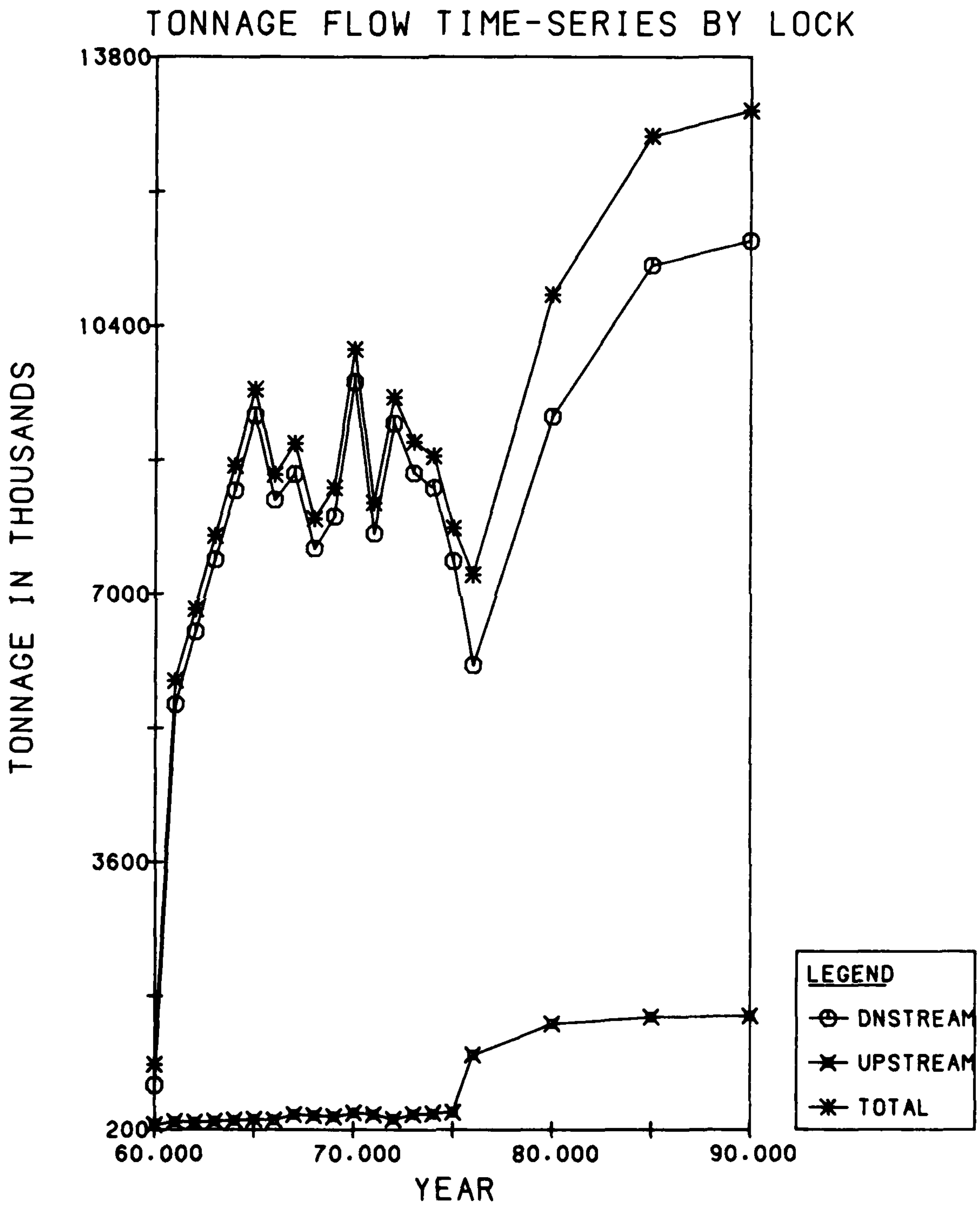


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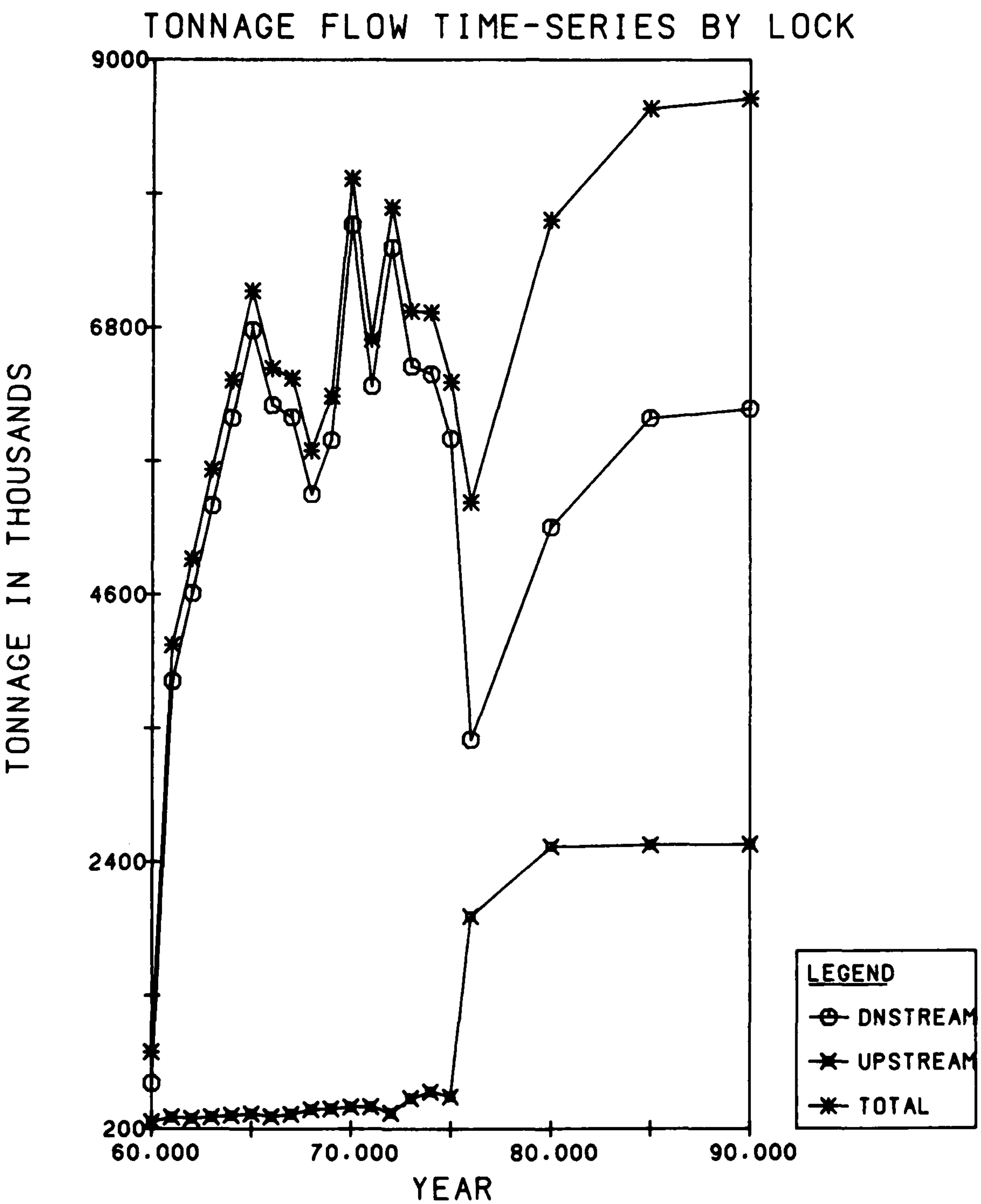


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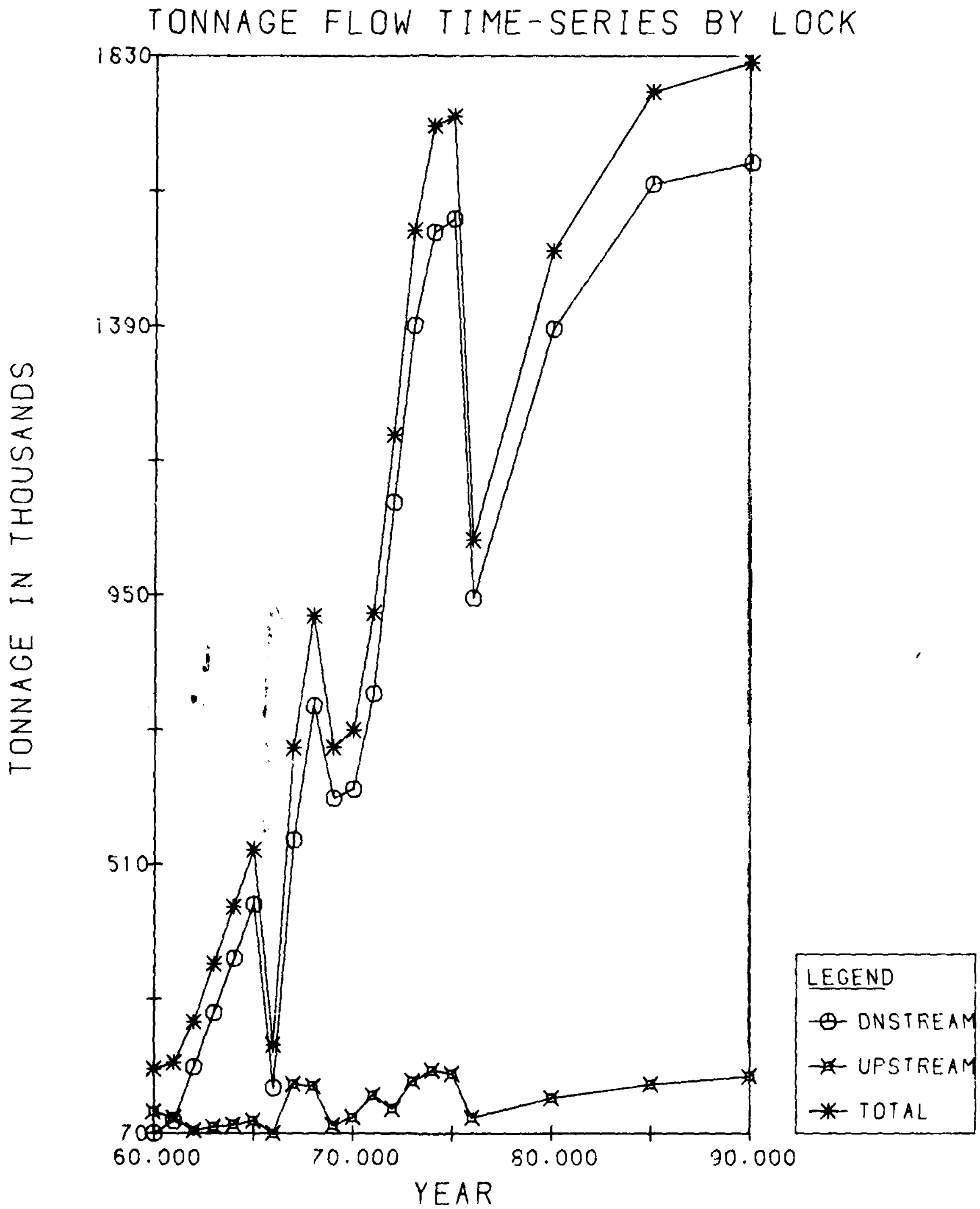
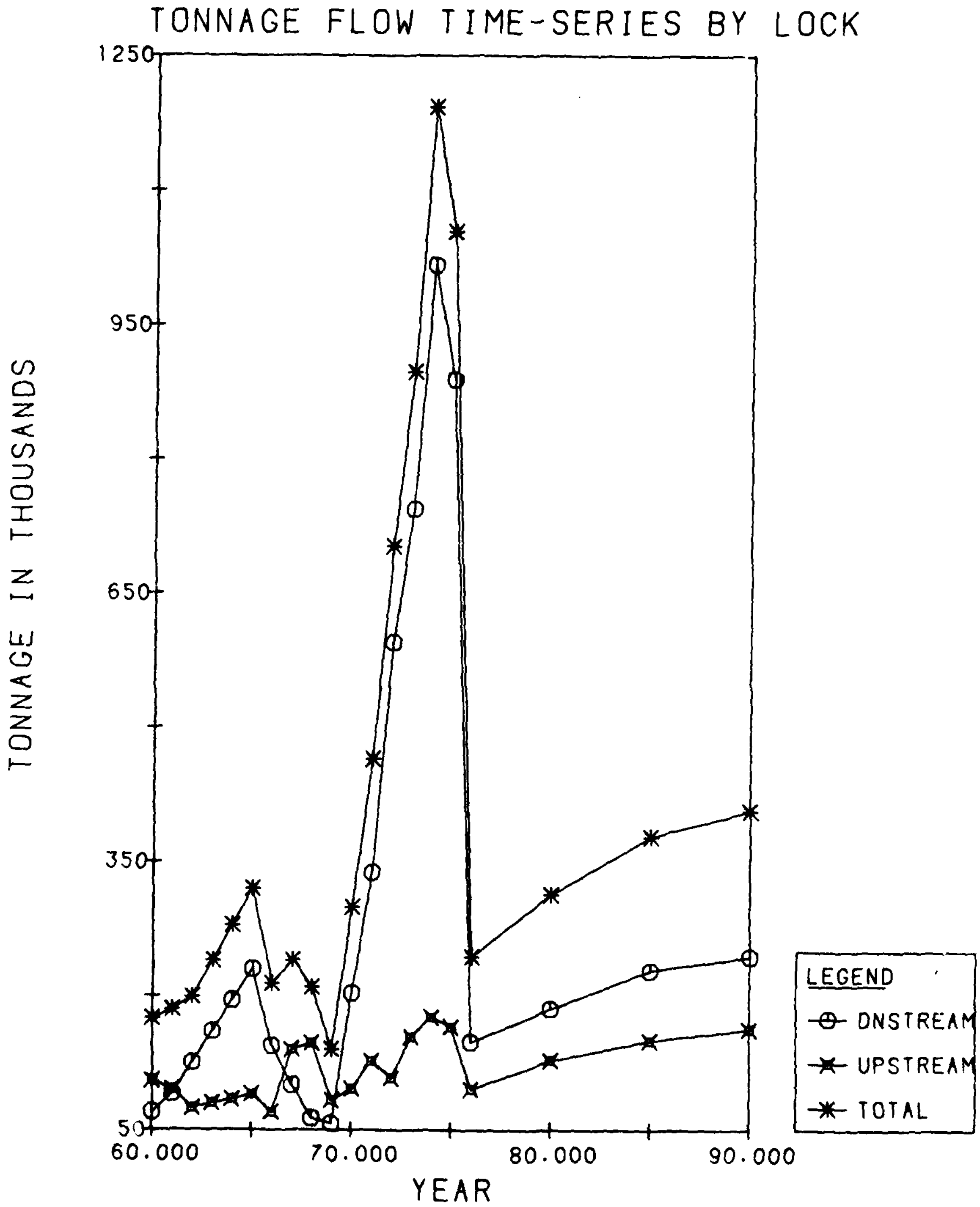
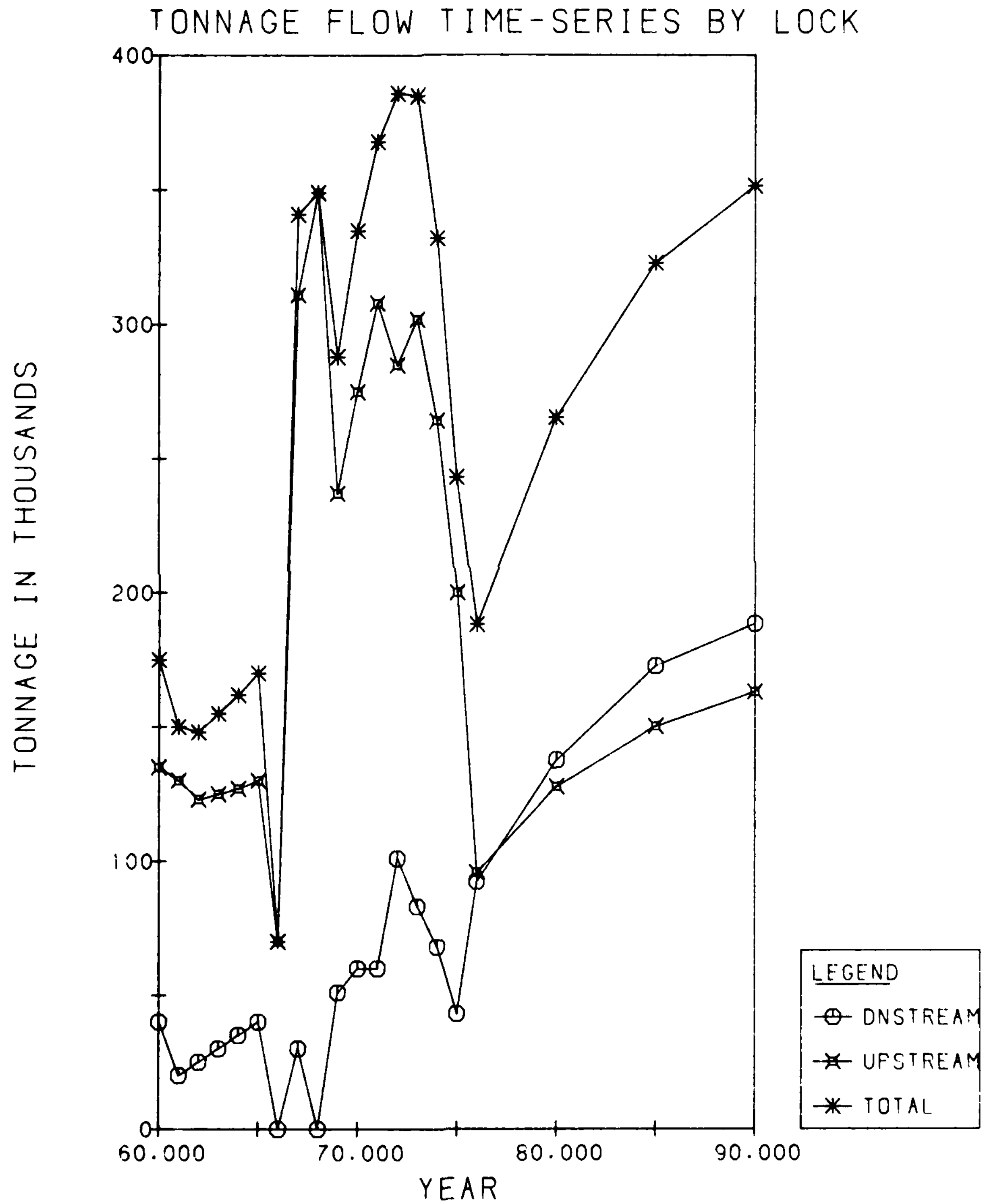


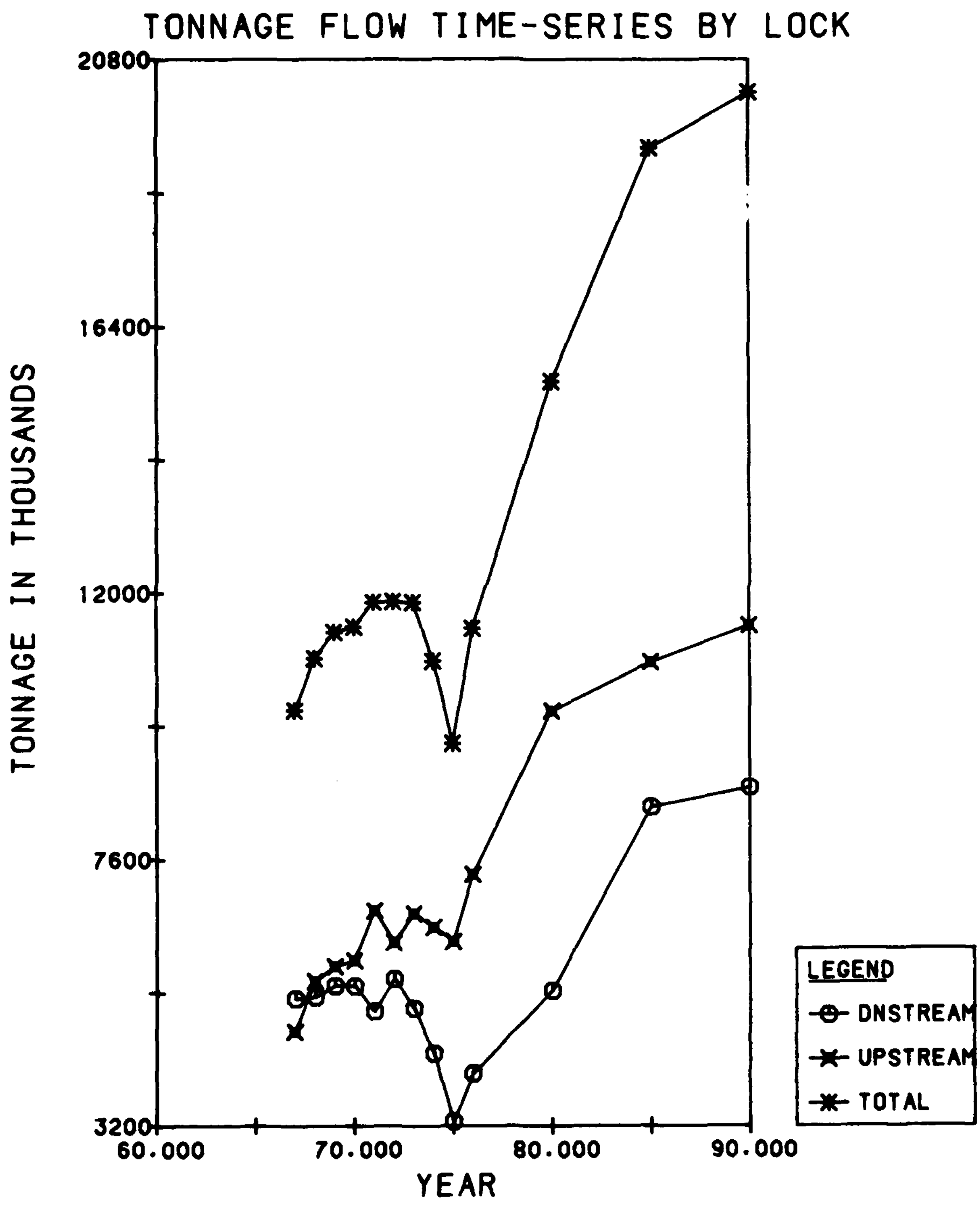

MORGANTOWN LOCK & DAM




HILDEBRAND LOCK & DAM




OPEKISKA LOCK & DAM

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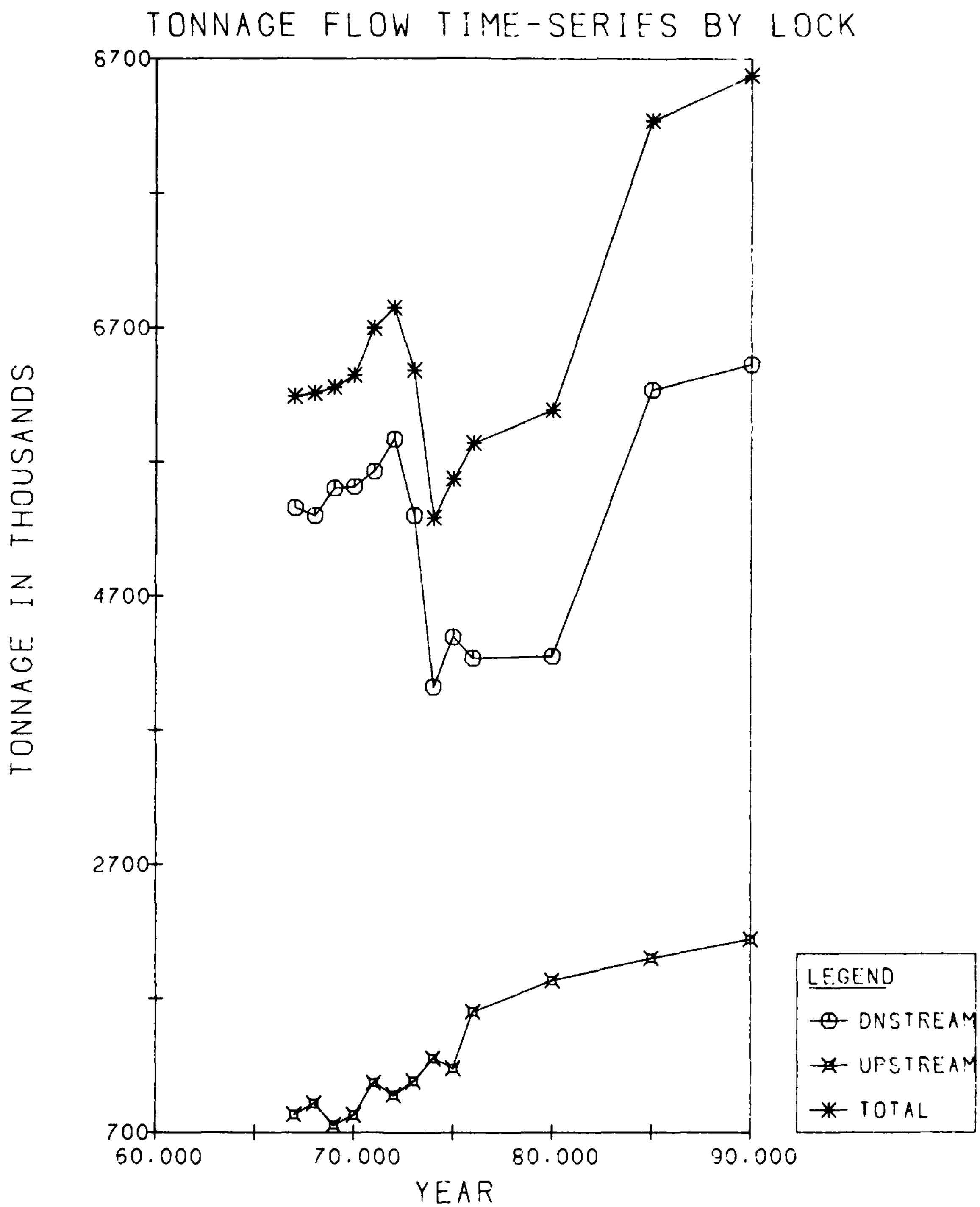
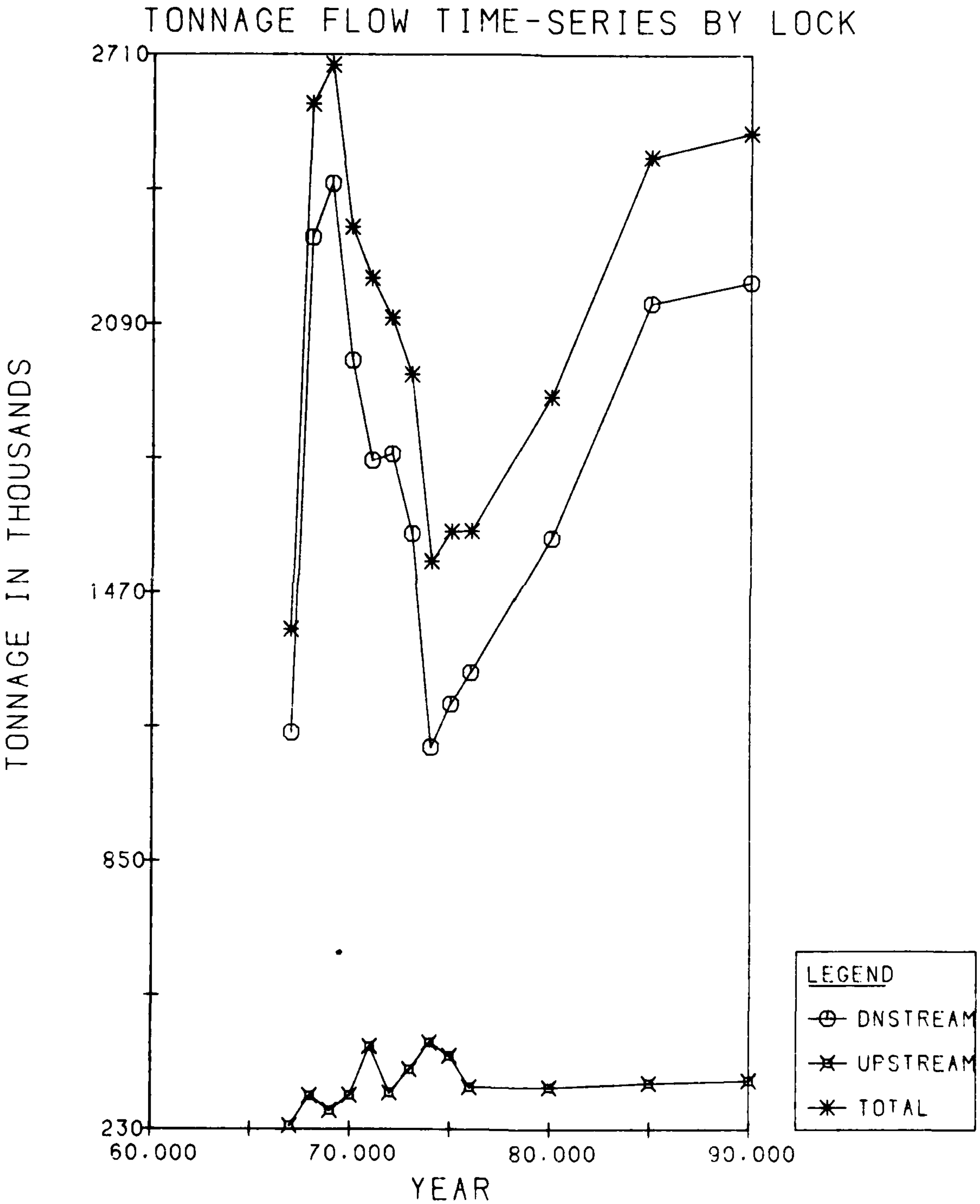
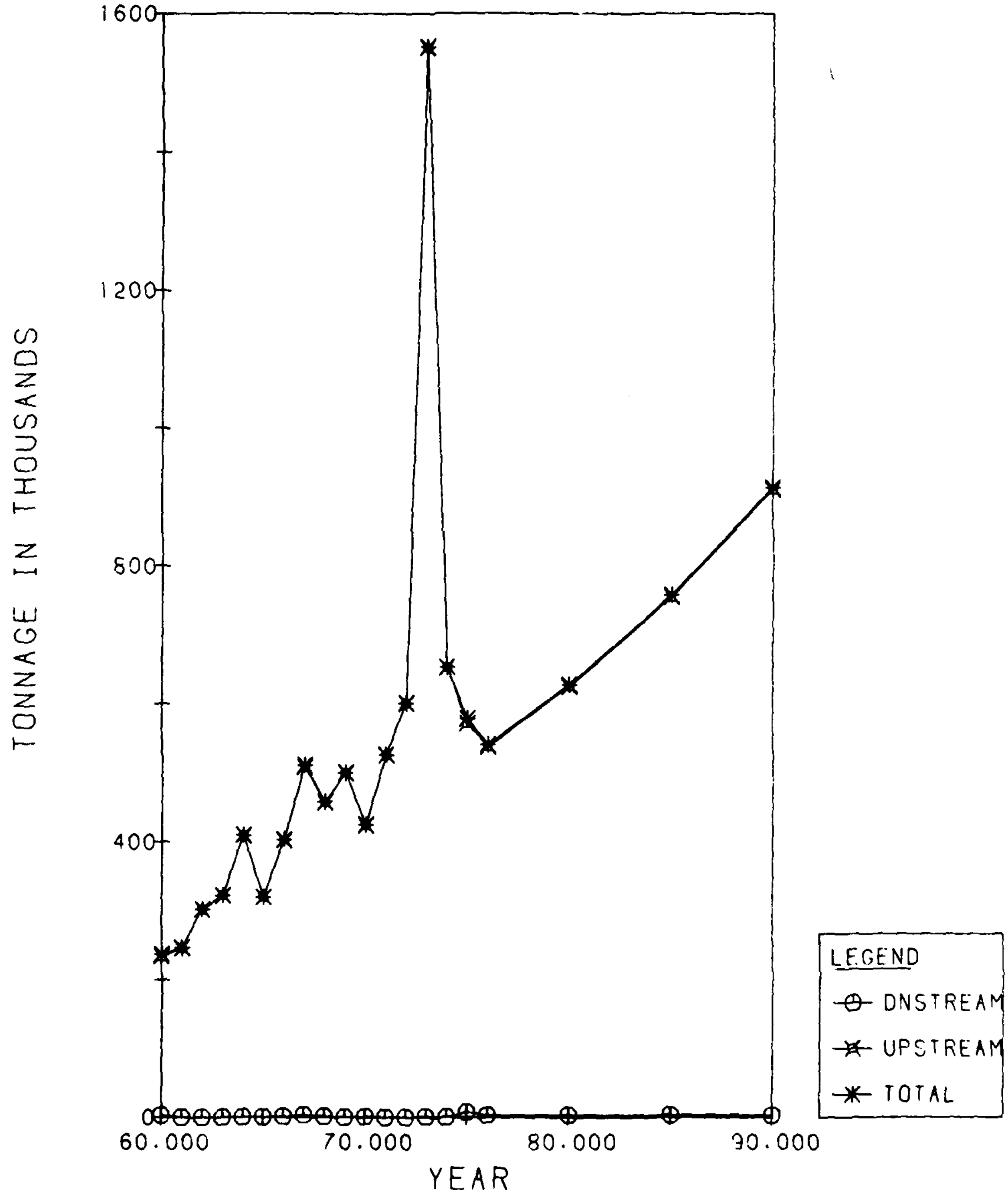



MARMET LOCK & DAM

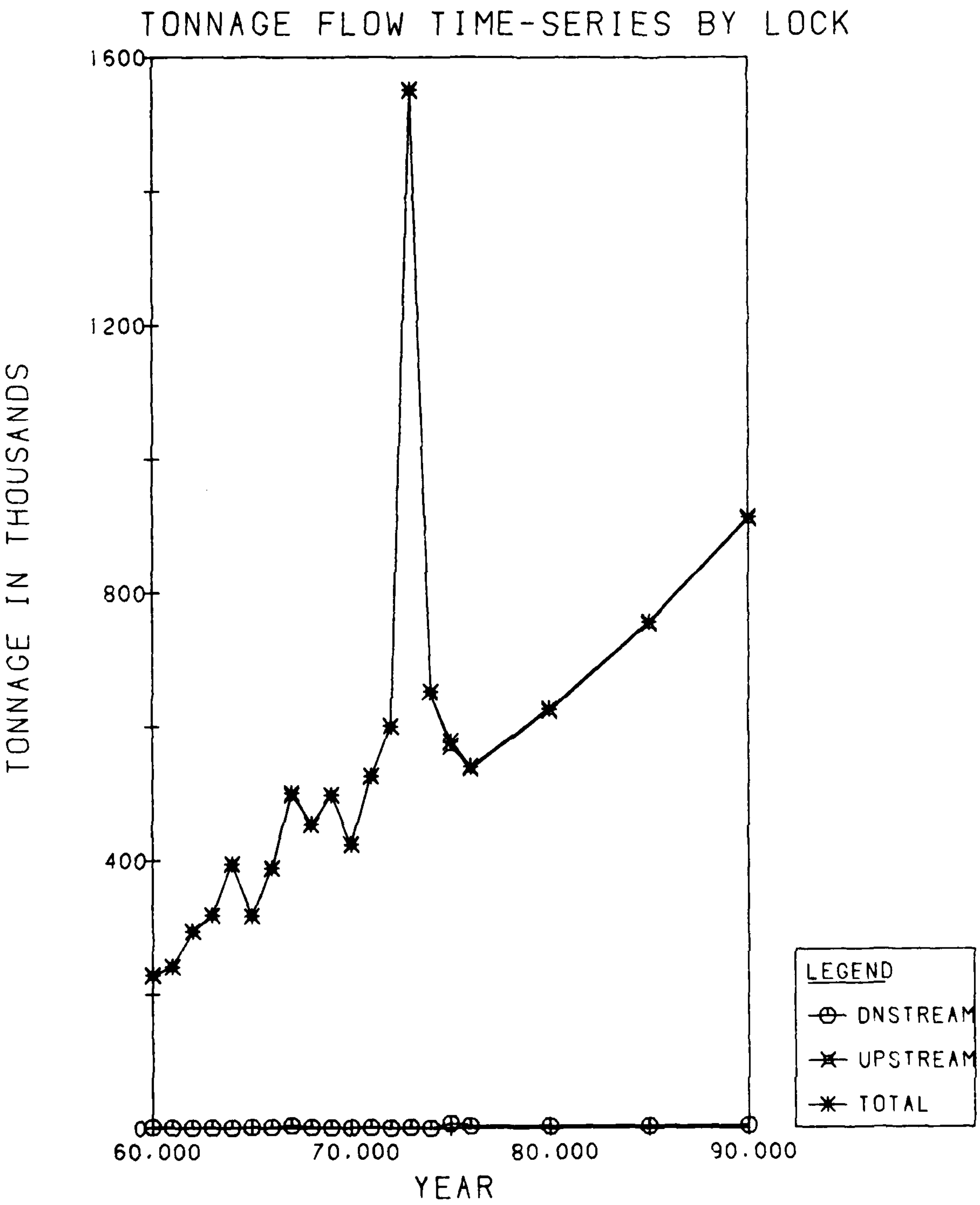



LONDON LOCK & DAM

TONNAGE FLOW TIME-SERIES BY LOCK




KENTUCKY LOCK & DAM #1

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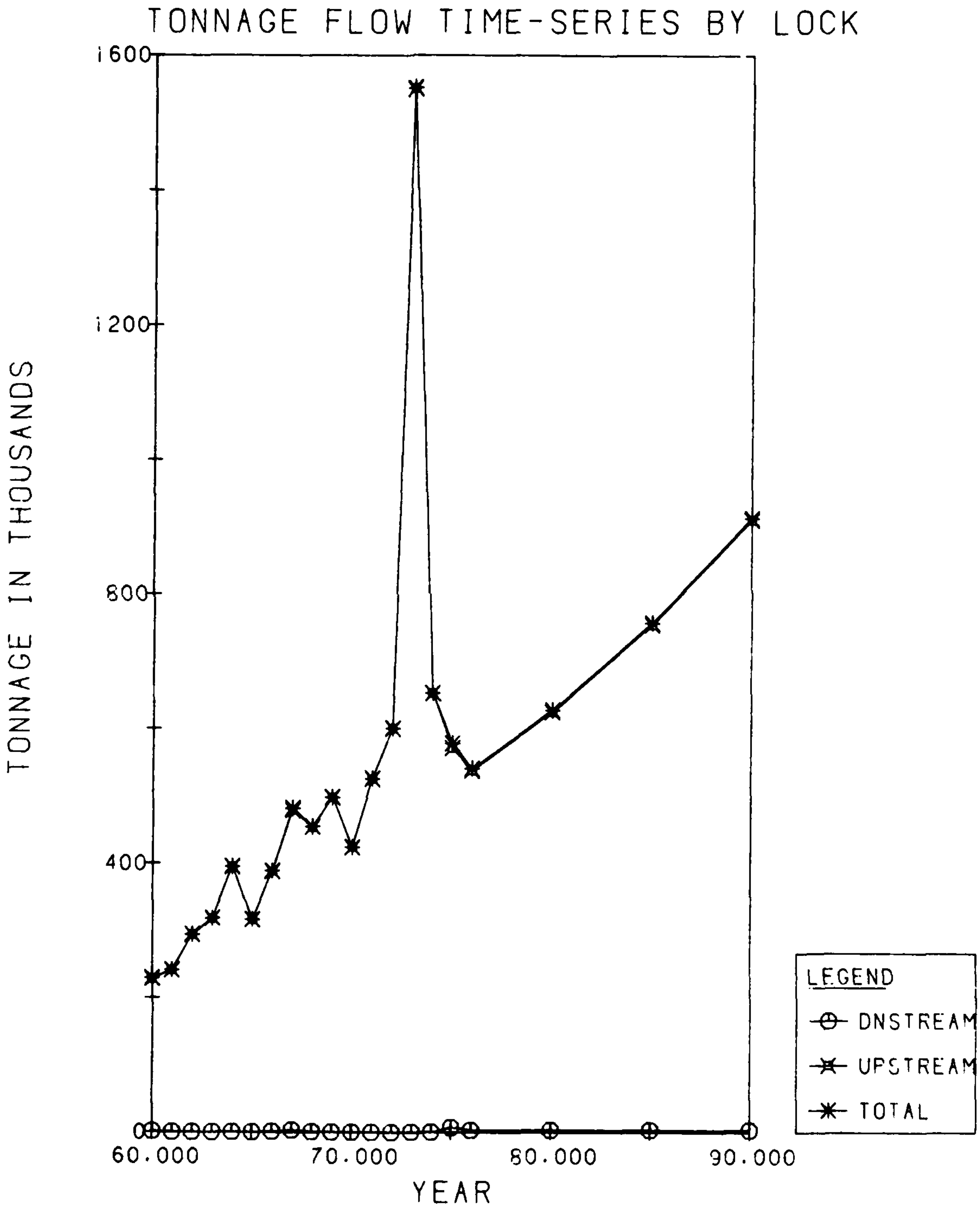


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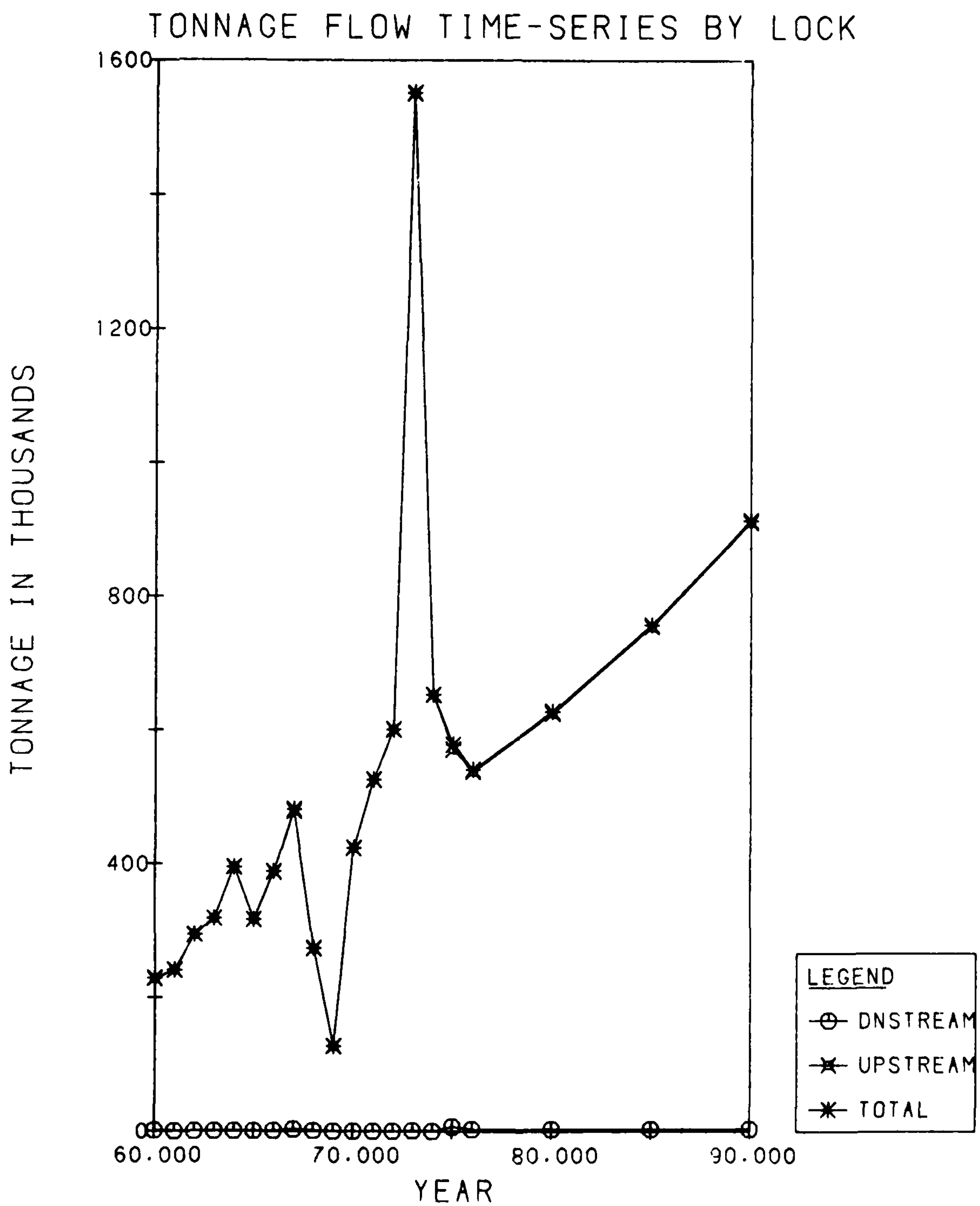


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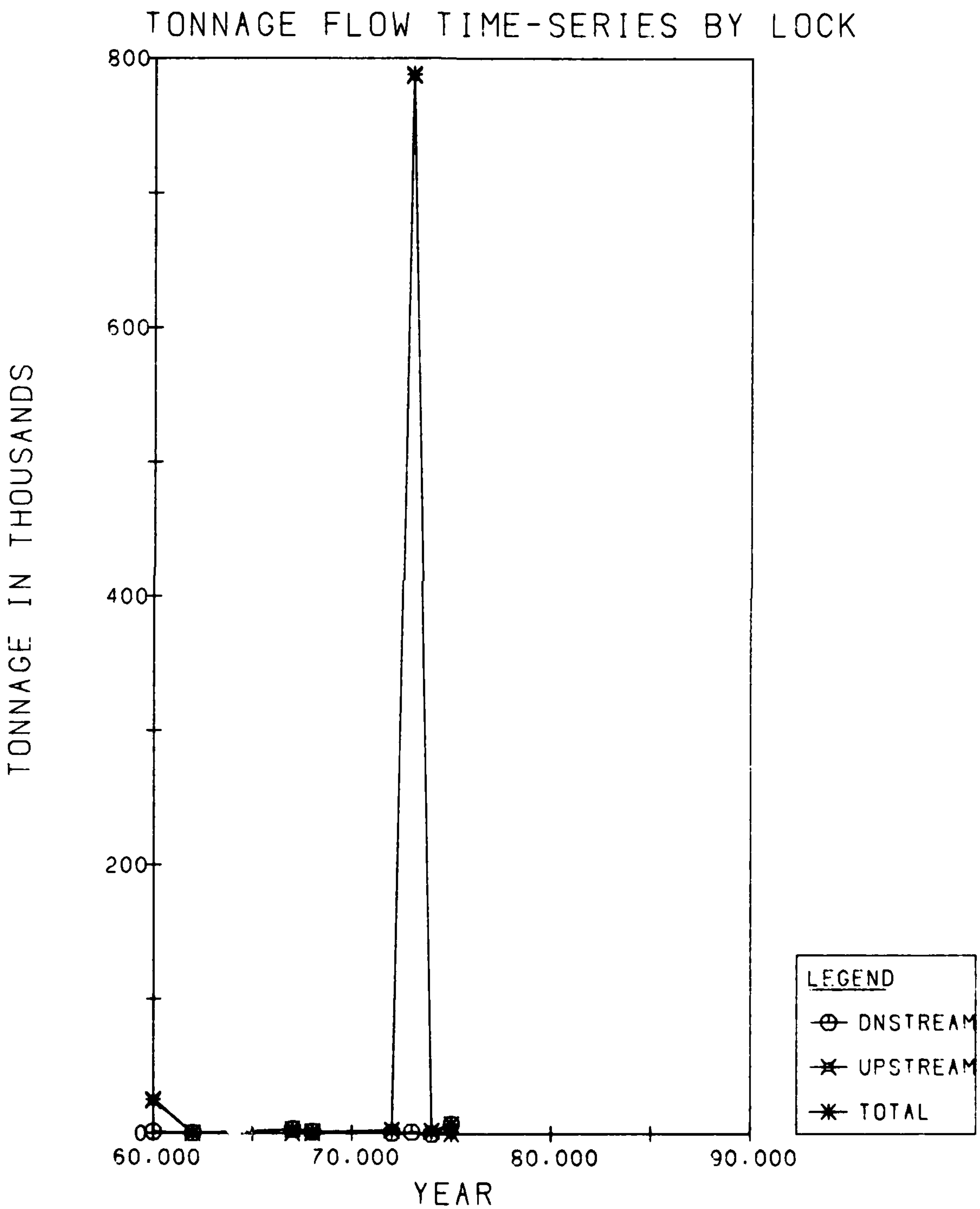


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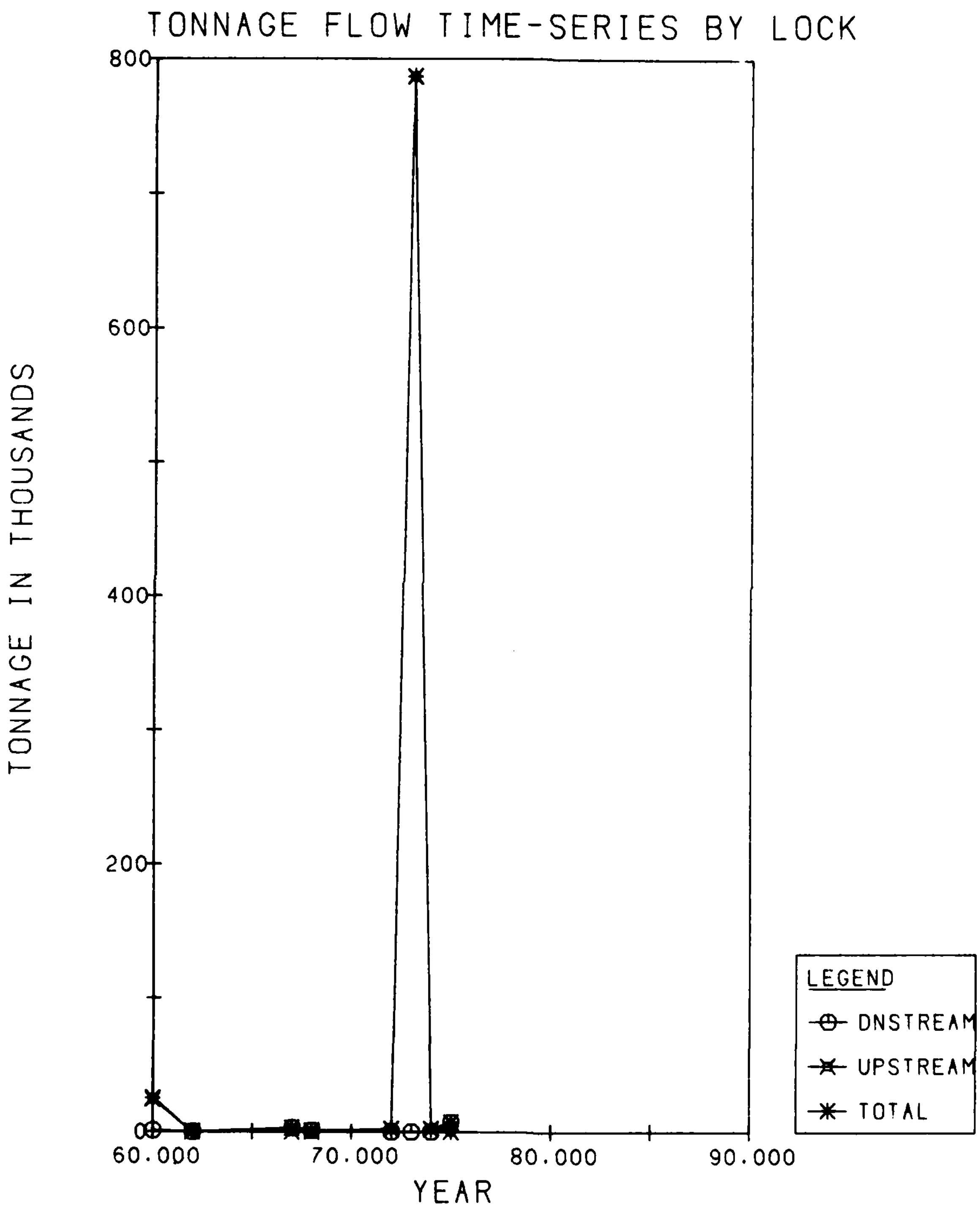
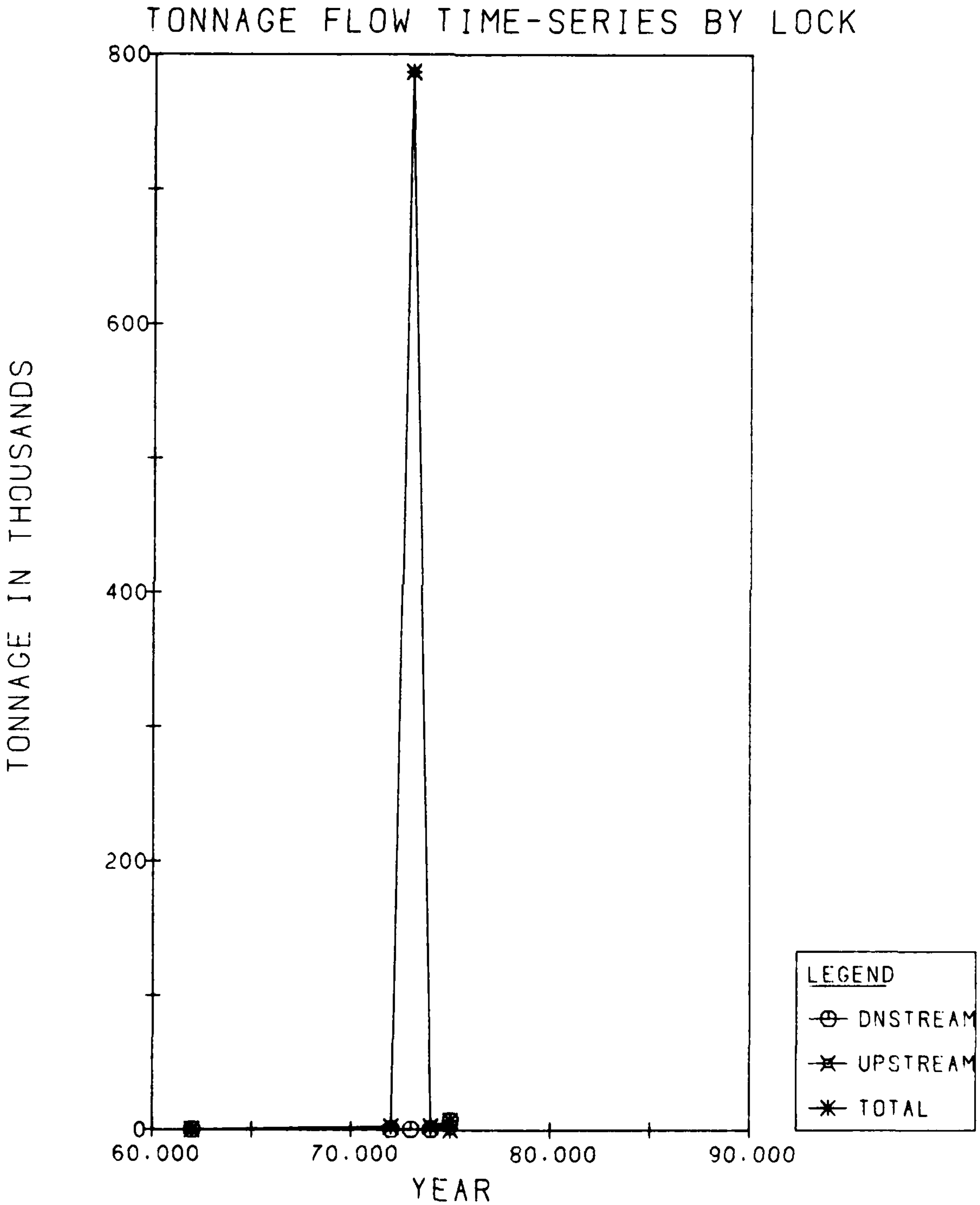
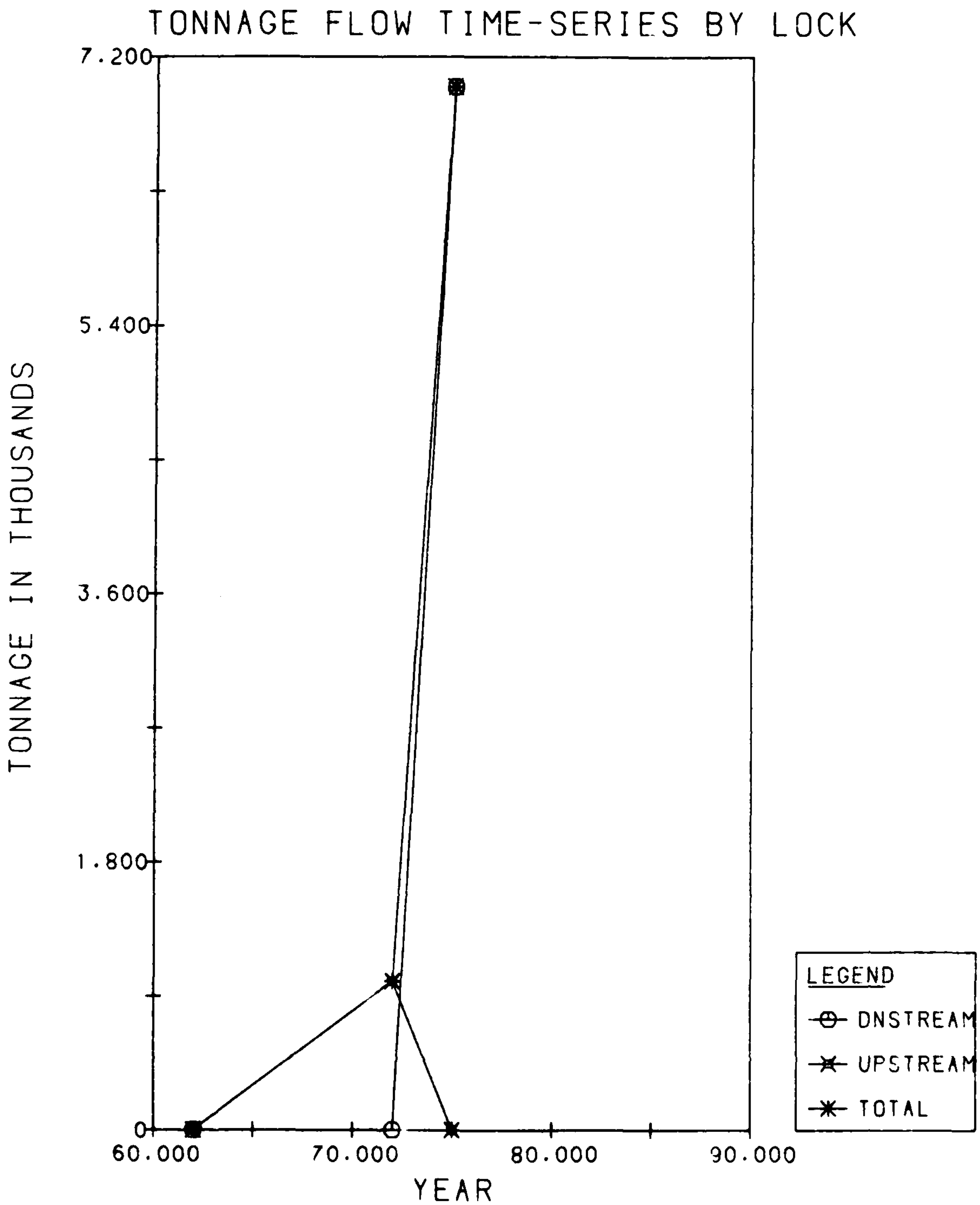


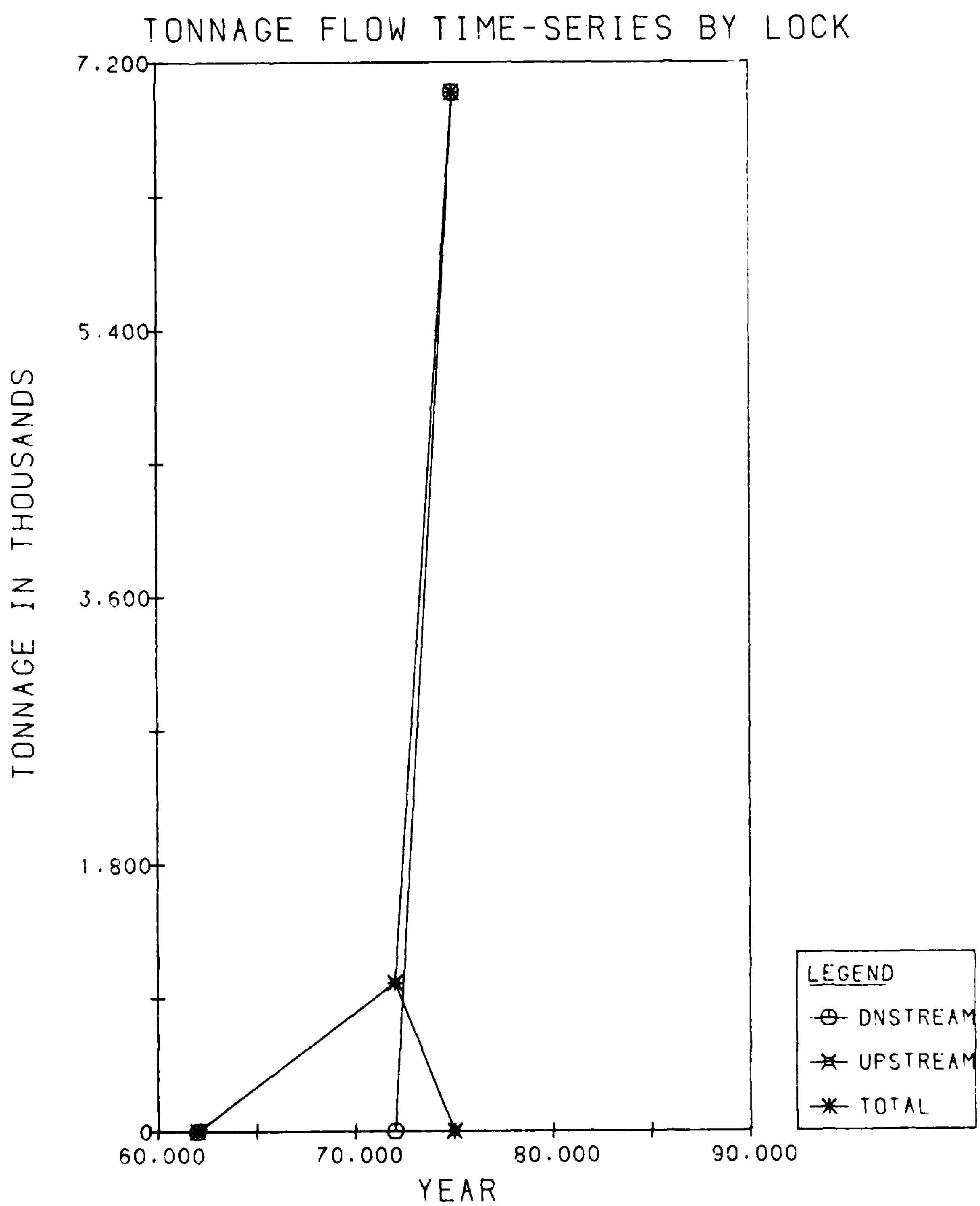

KENTUCKY LOCK & DAM #6




KENTUCKY LOCK & DAM #7




KENTUCKY LOCK & DAM #8

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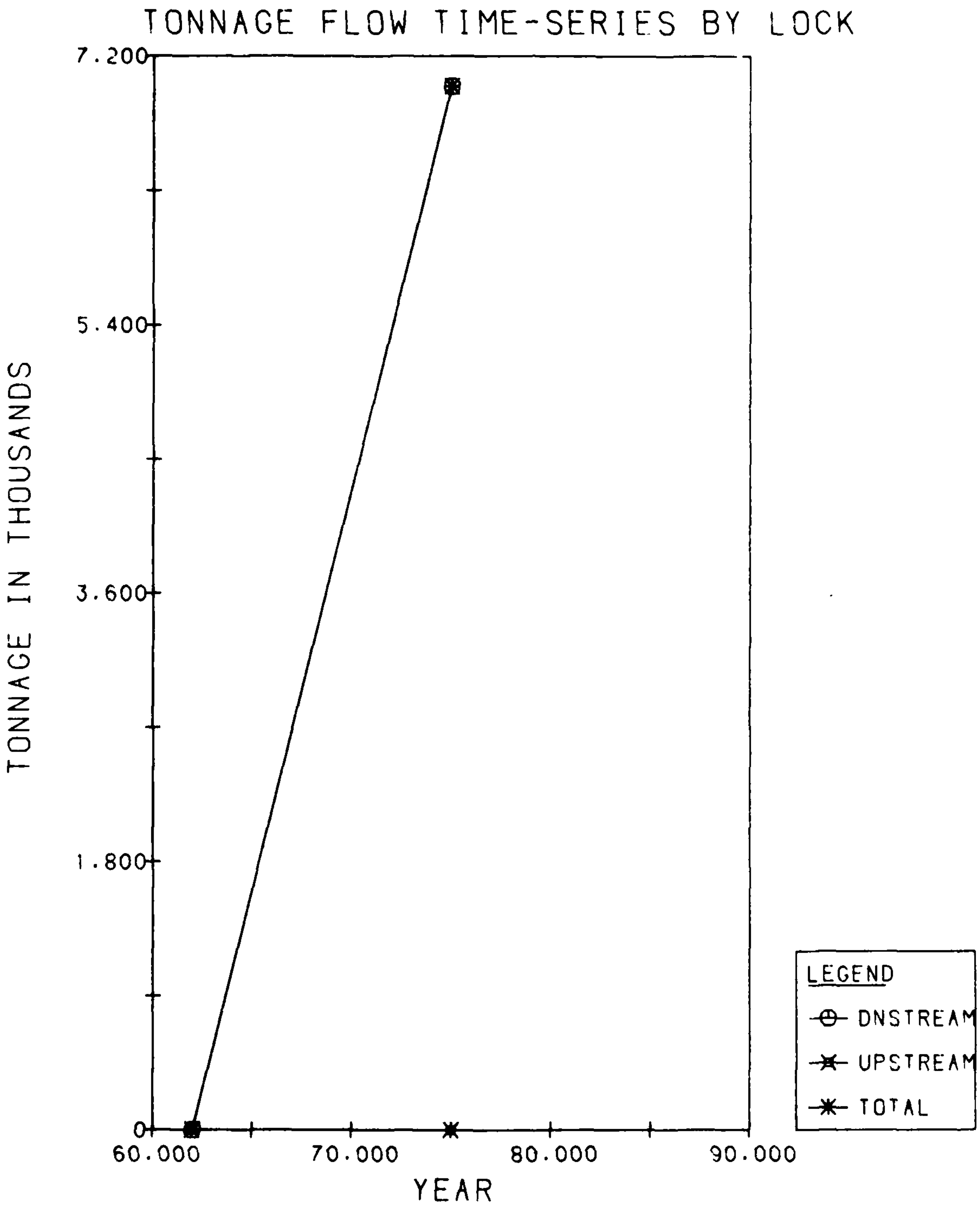


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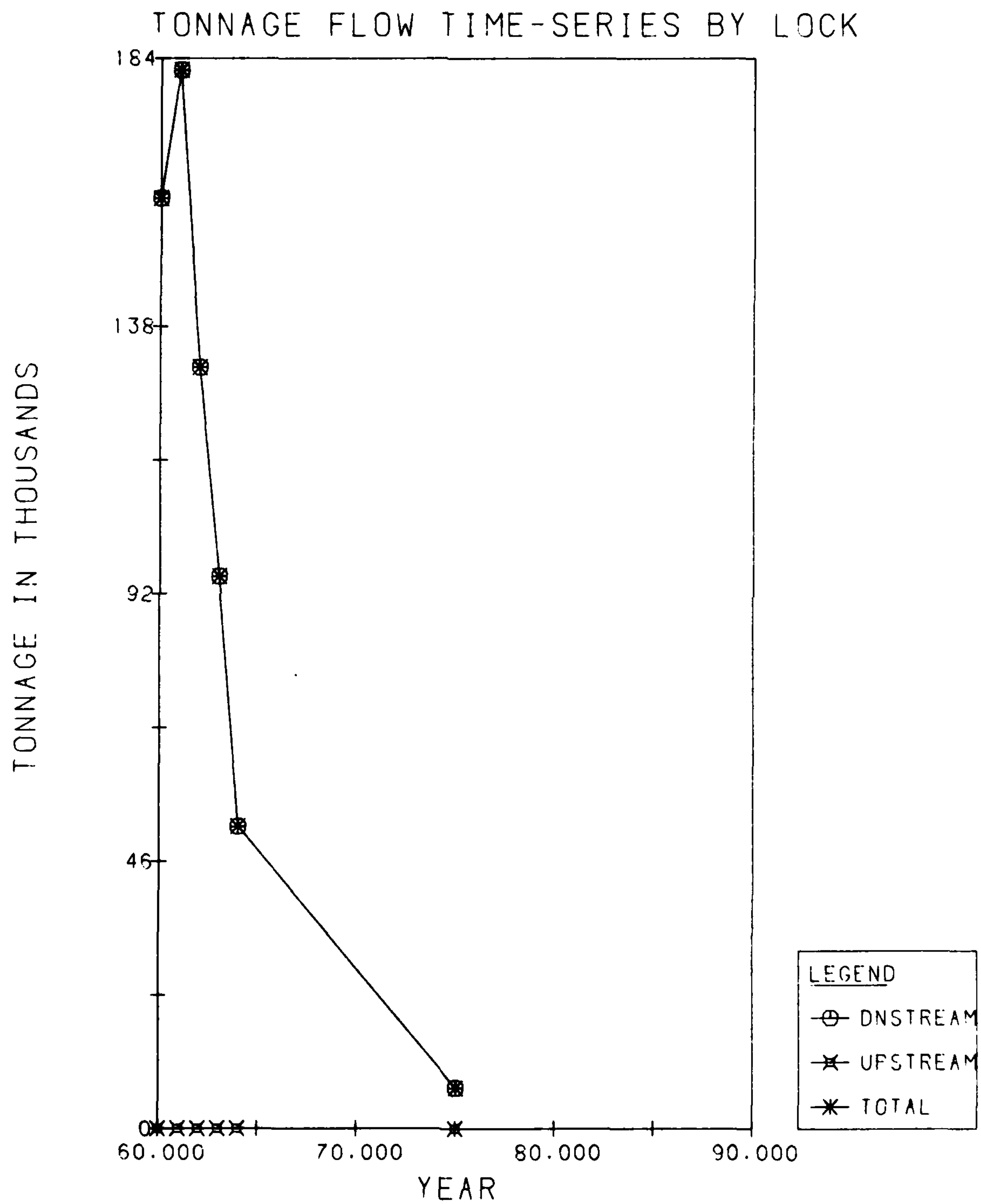


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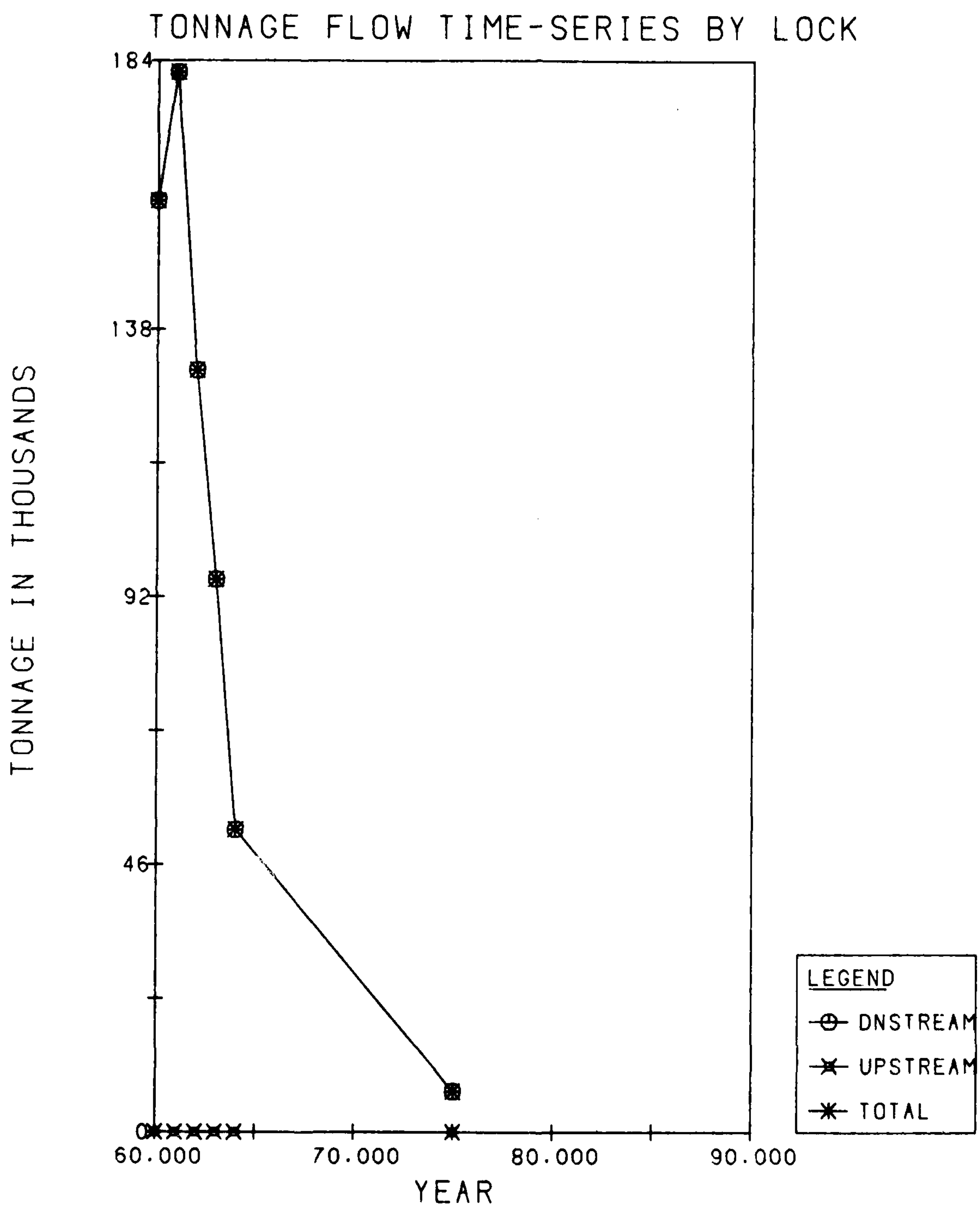


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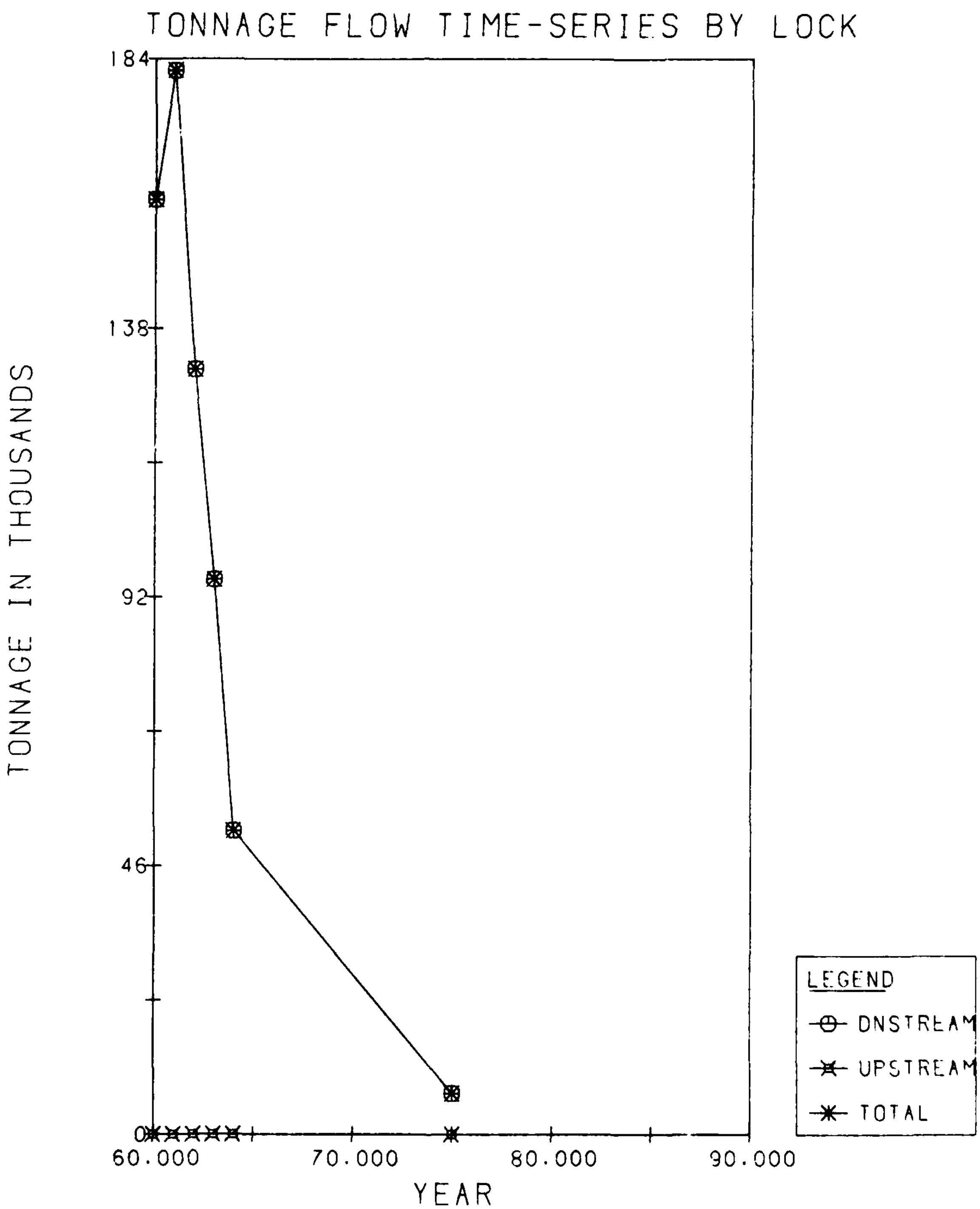
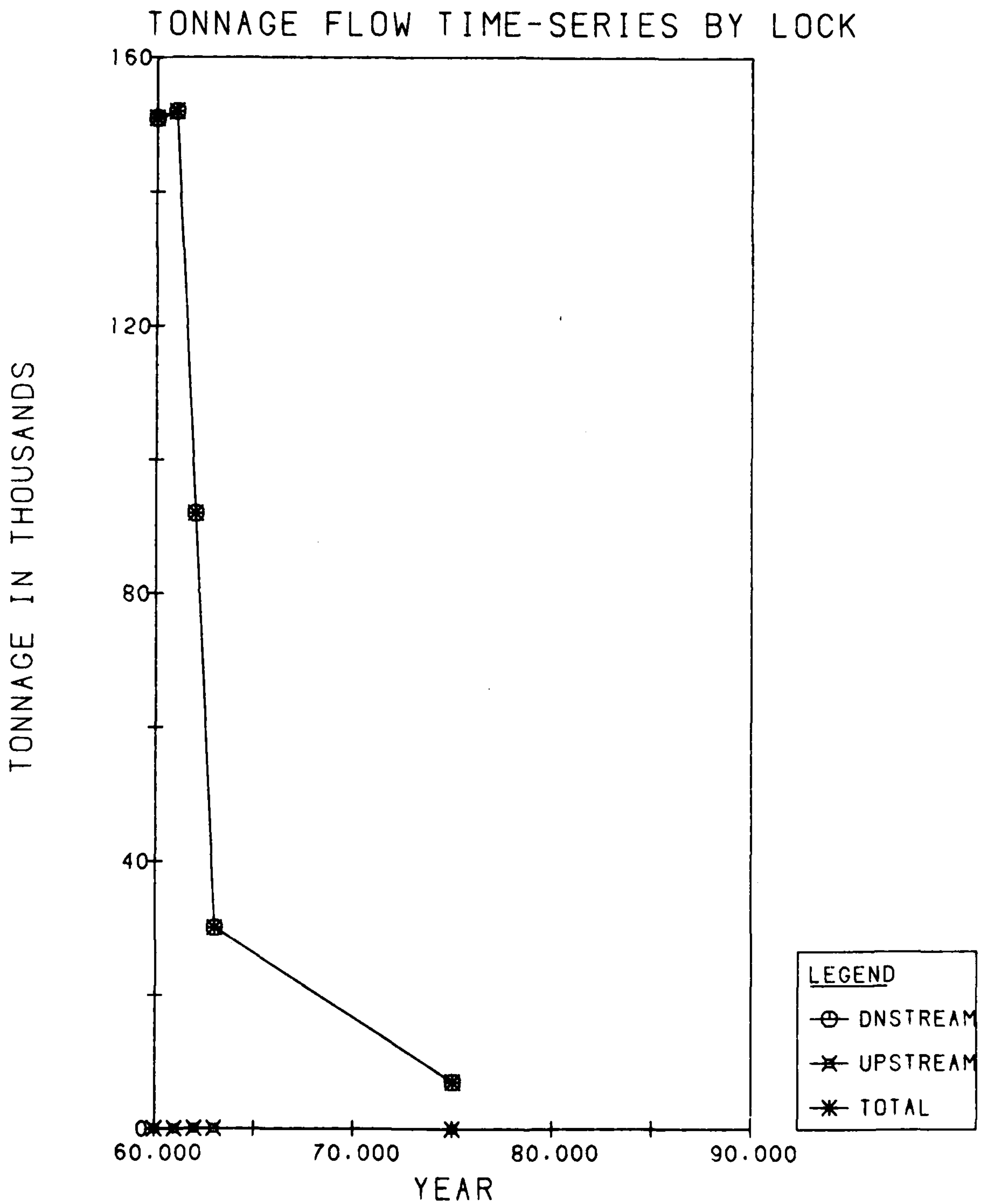



KENTUCKY LOCK & DAM #13

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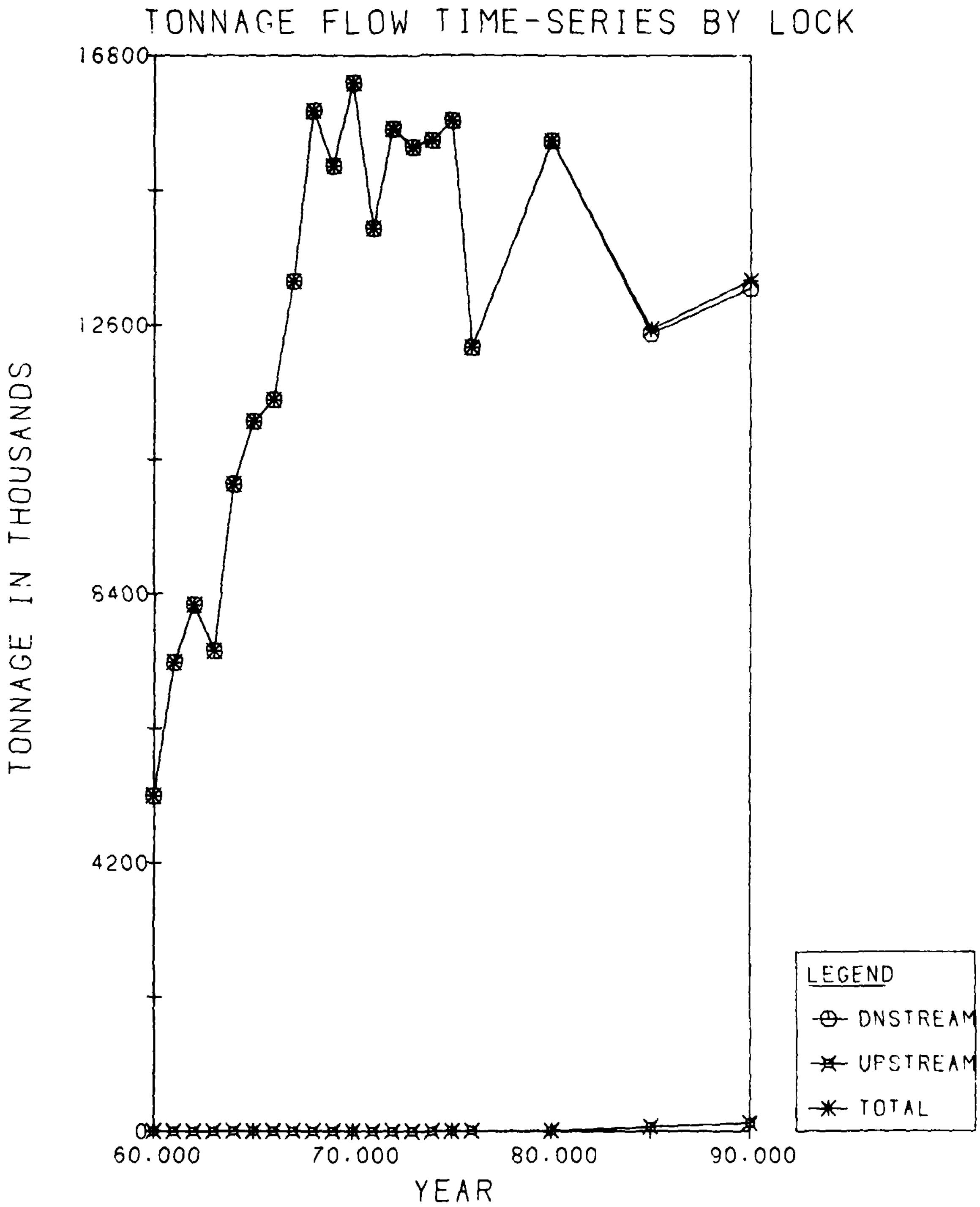
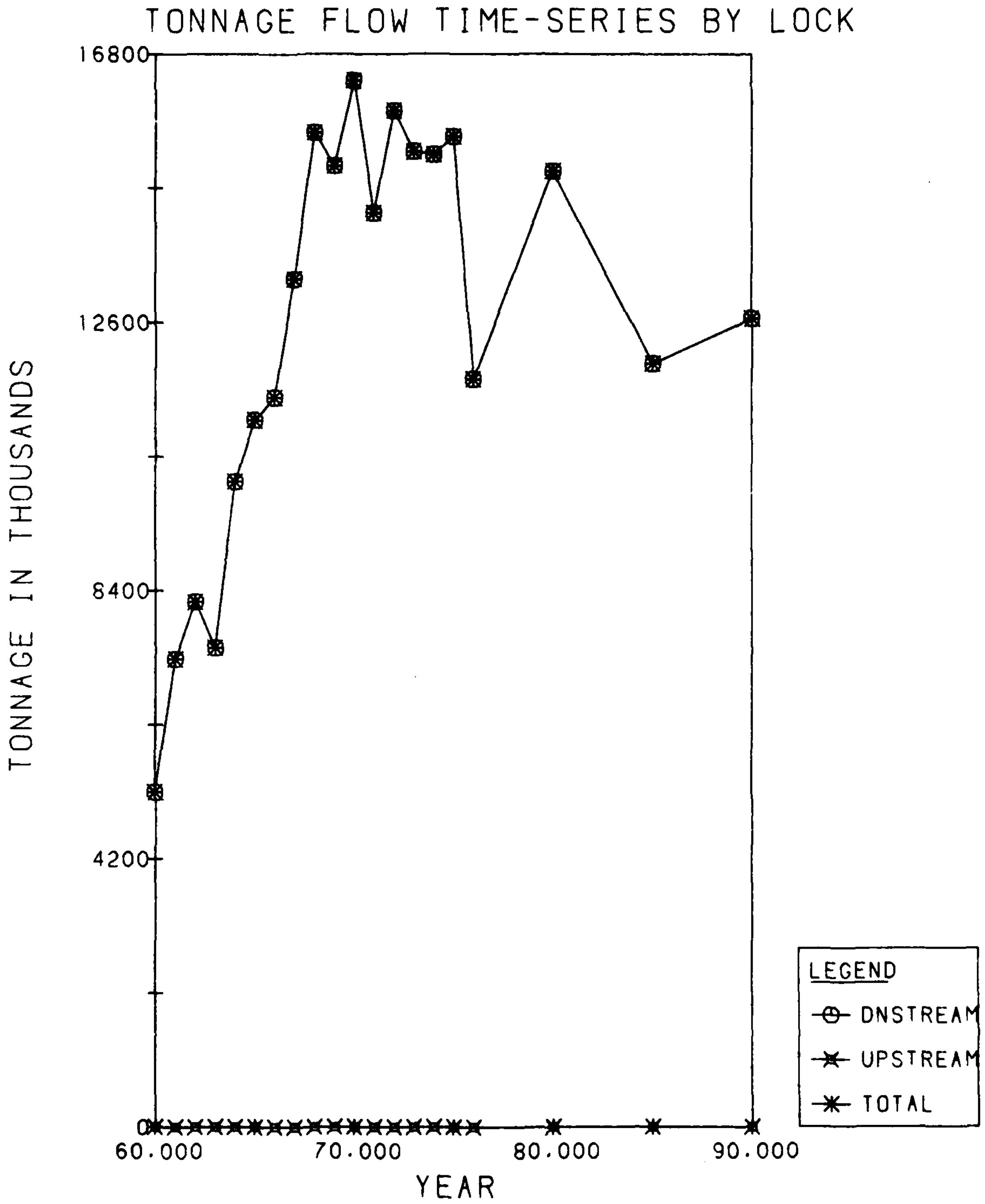
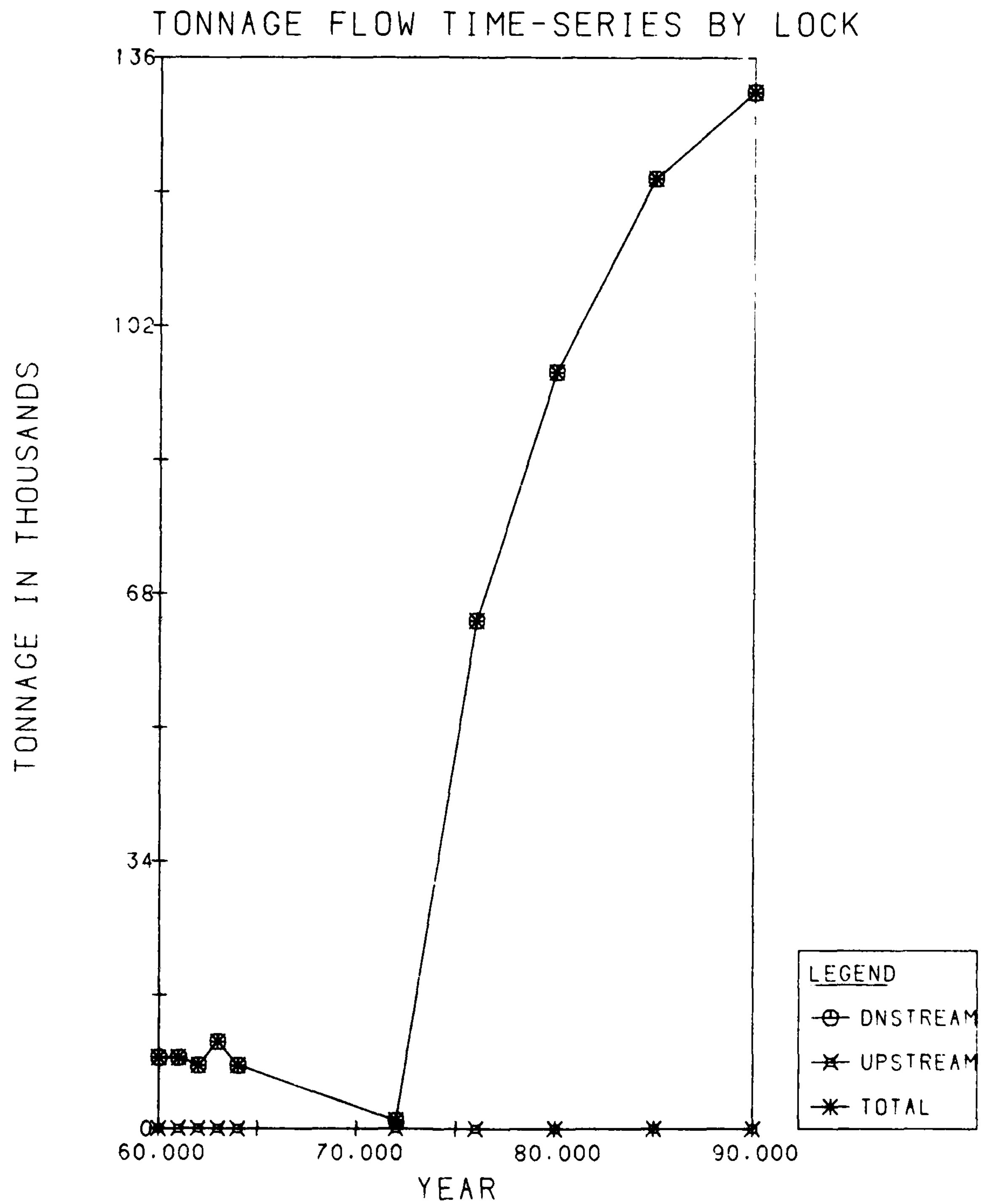



GREEN LOCK & DAM #1

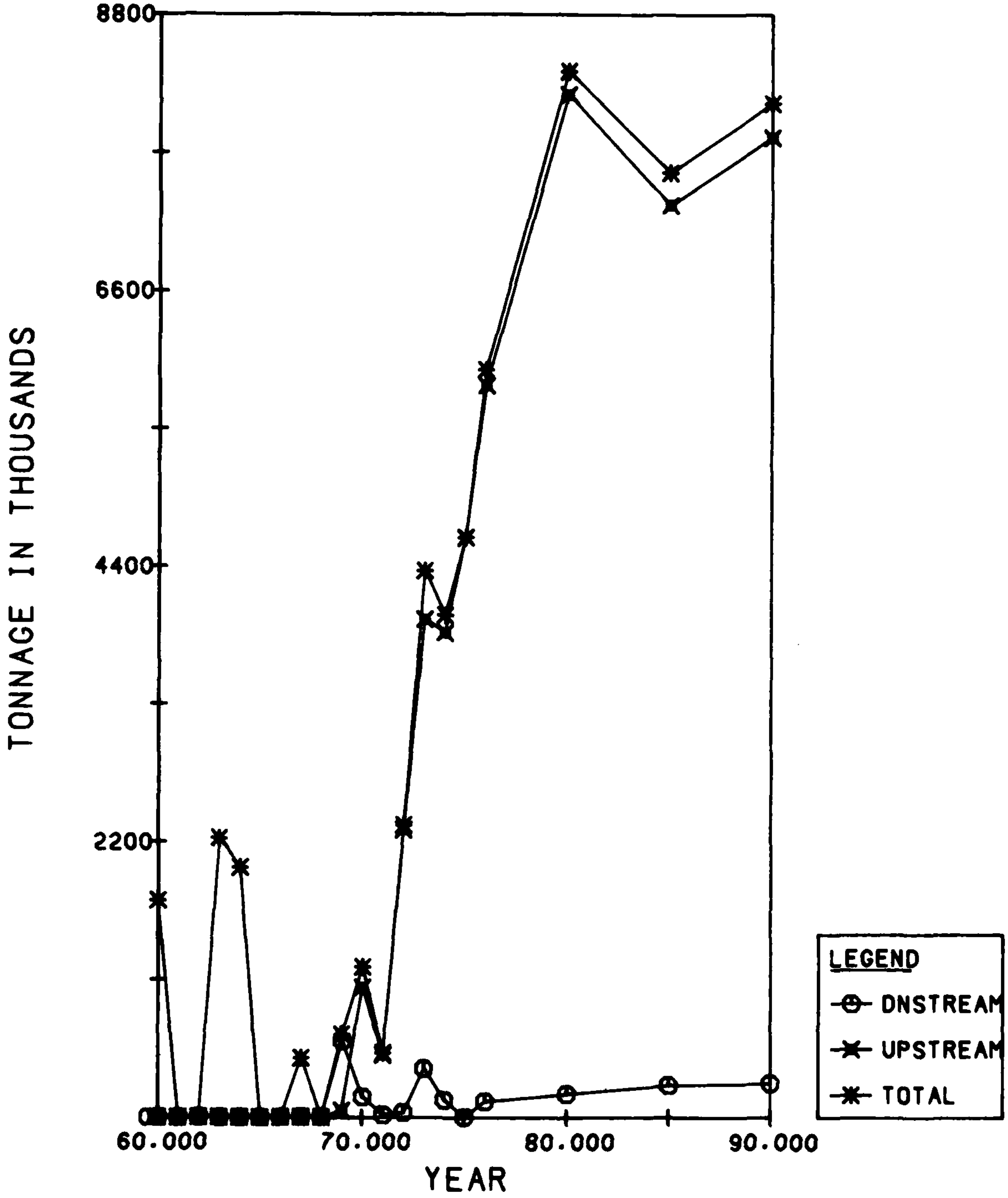



GREEN LOCK & DAM #2

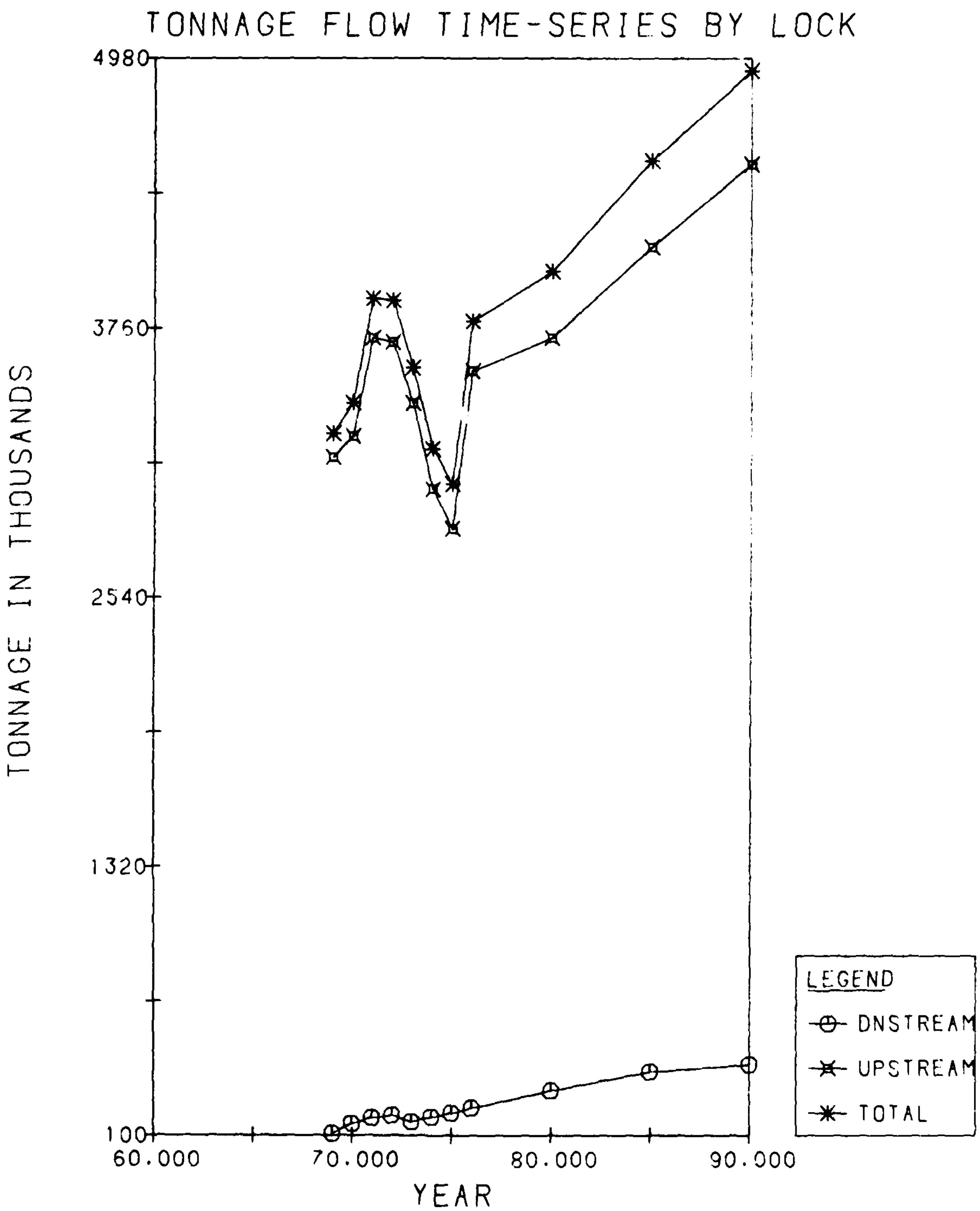



GREEN LOCK & DAM #3

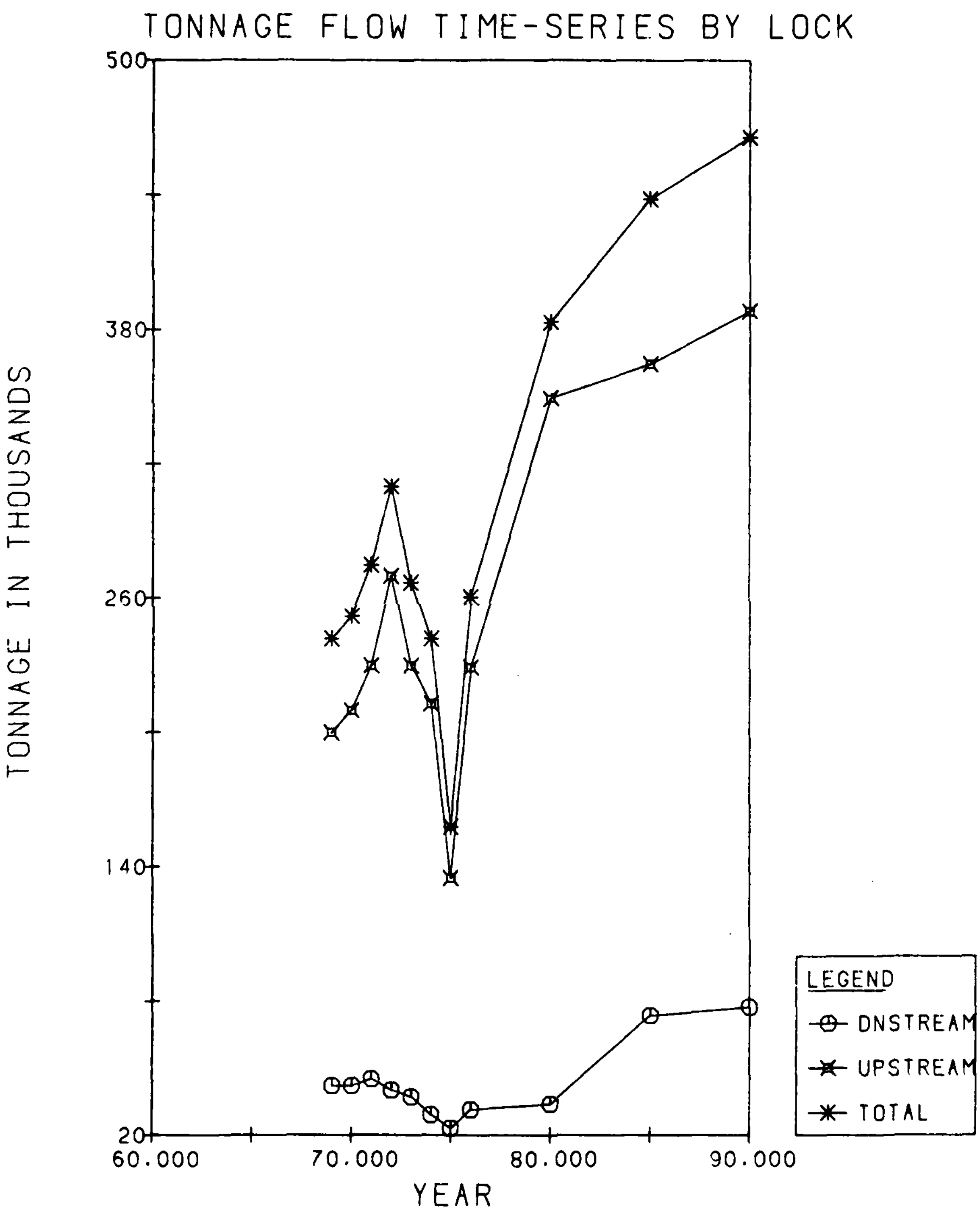
TONNAGE FLOW TIME-SERIES BY LOCK



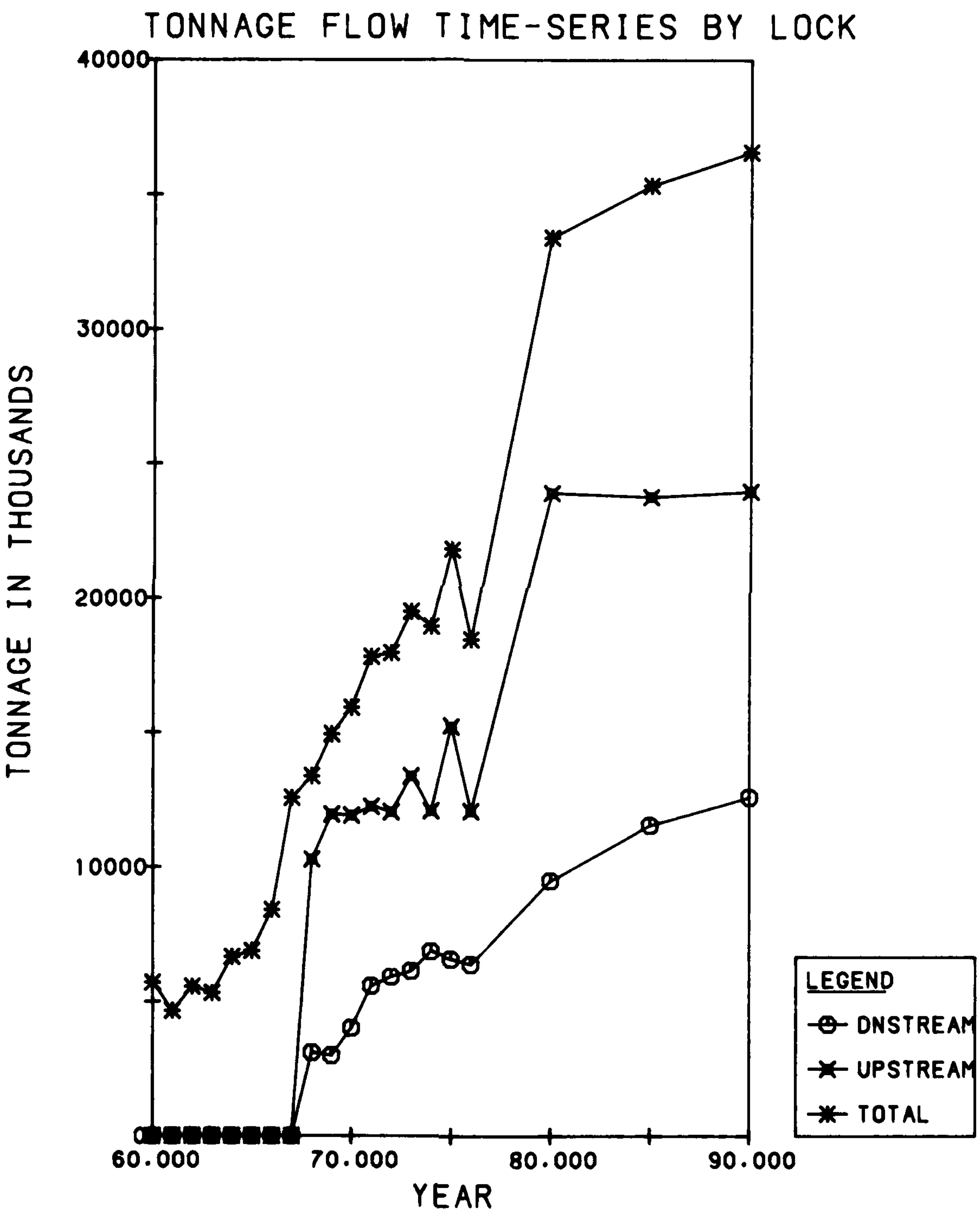

BARKLEY LOCK & DAM



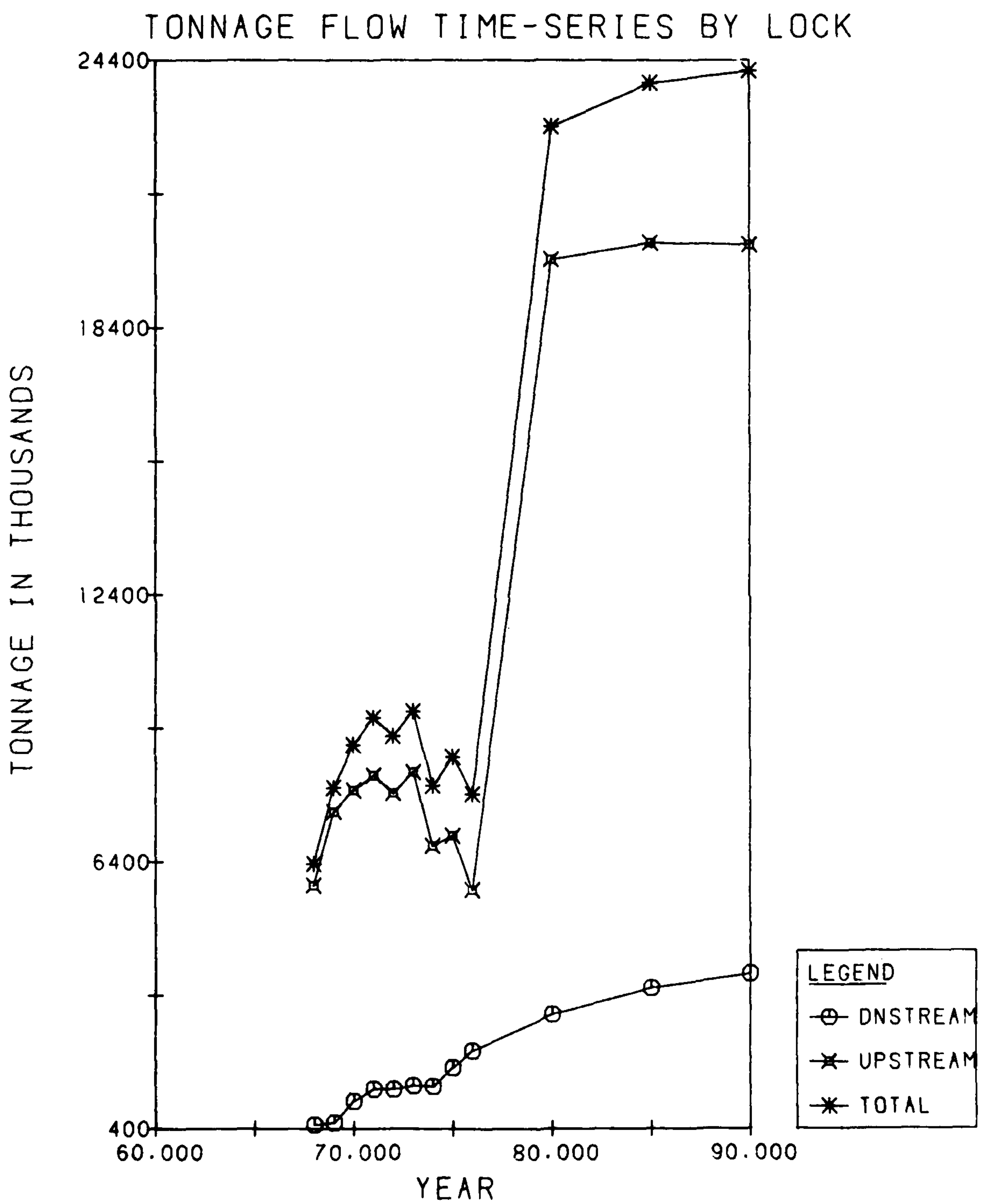

CHEATHAM LOCK & DAM



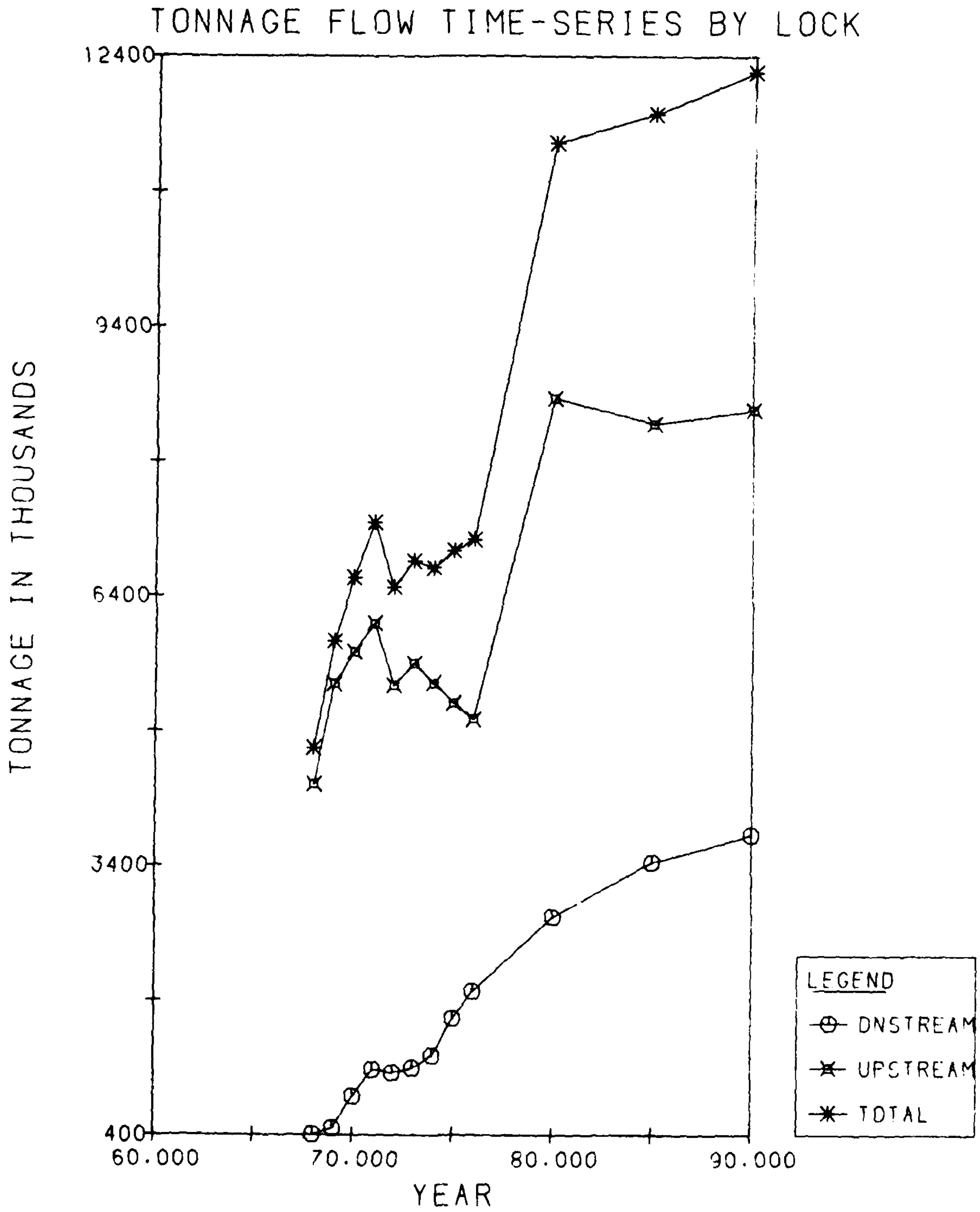

OLD HICKORY LOCK & DAM



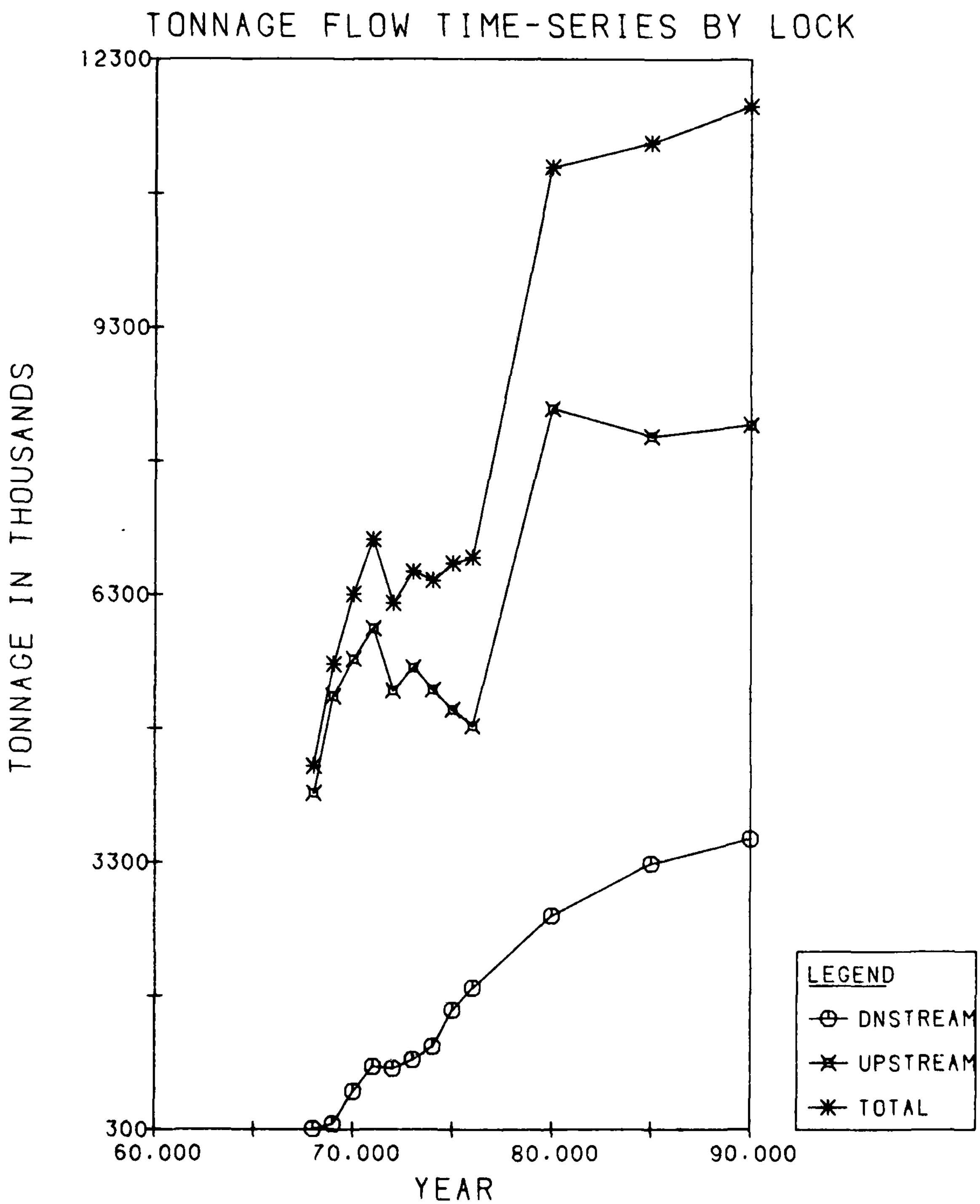

KENTUCKY DAM



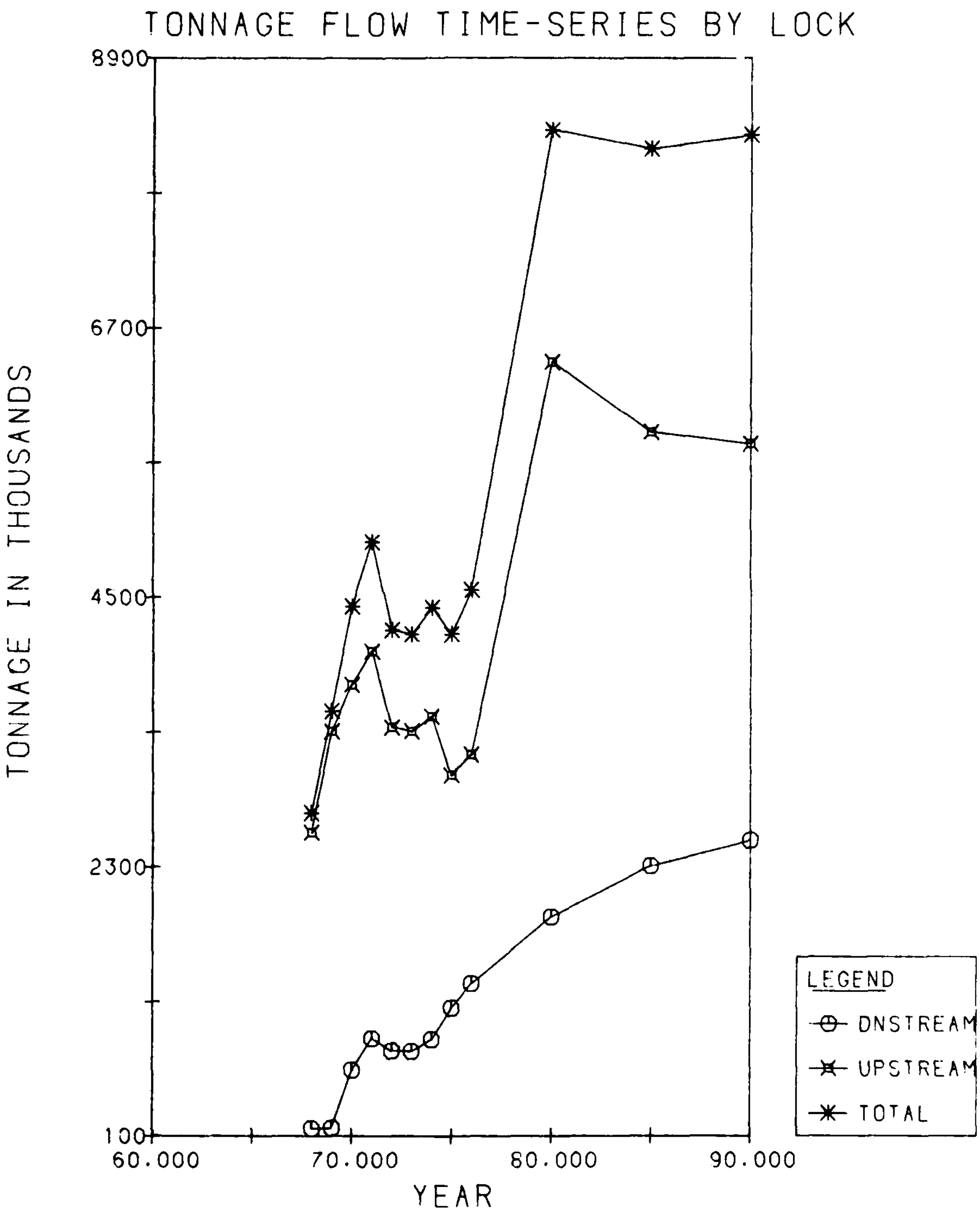

PICKWICK LOCK & DAM



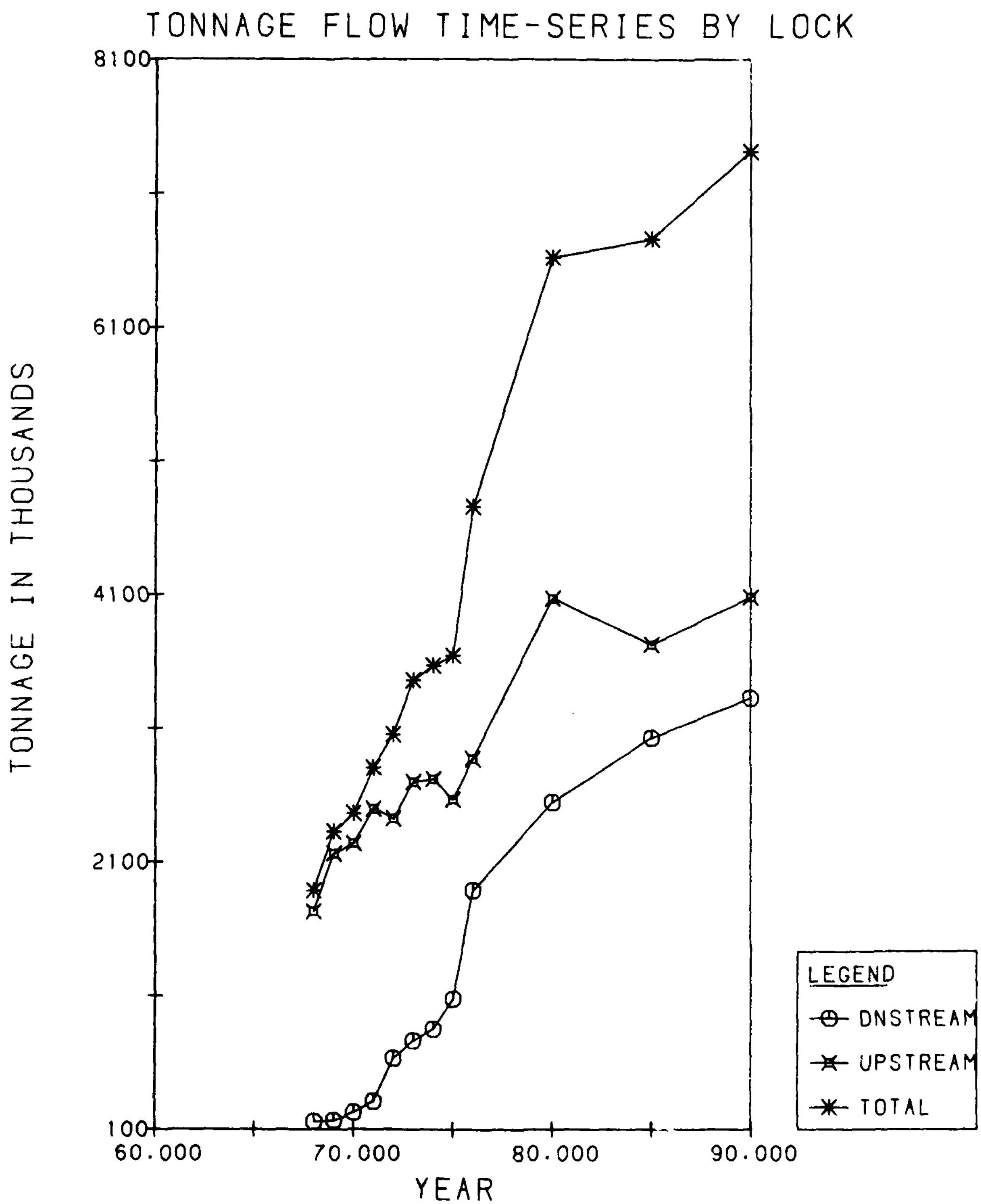

WILSON LOCK & DAM



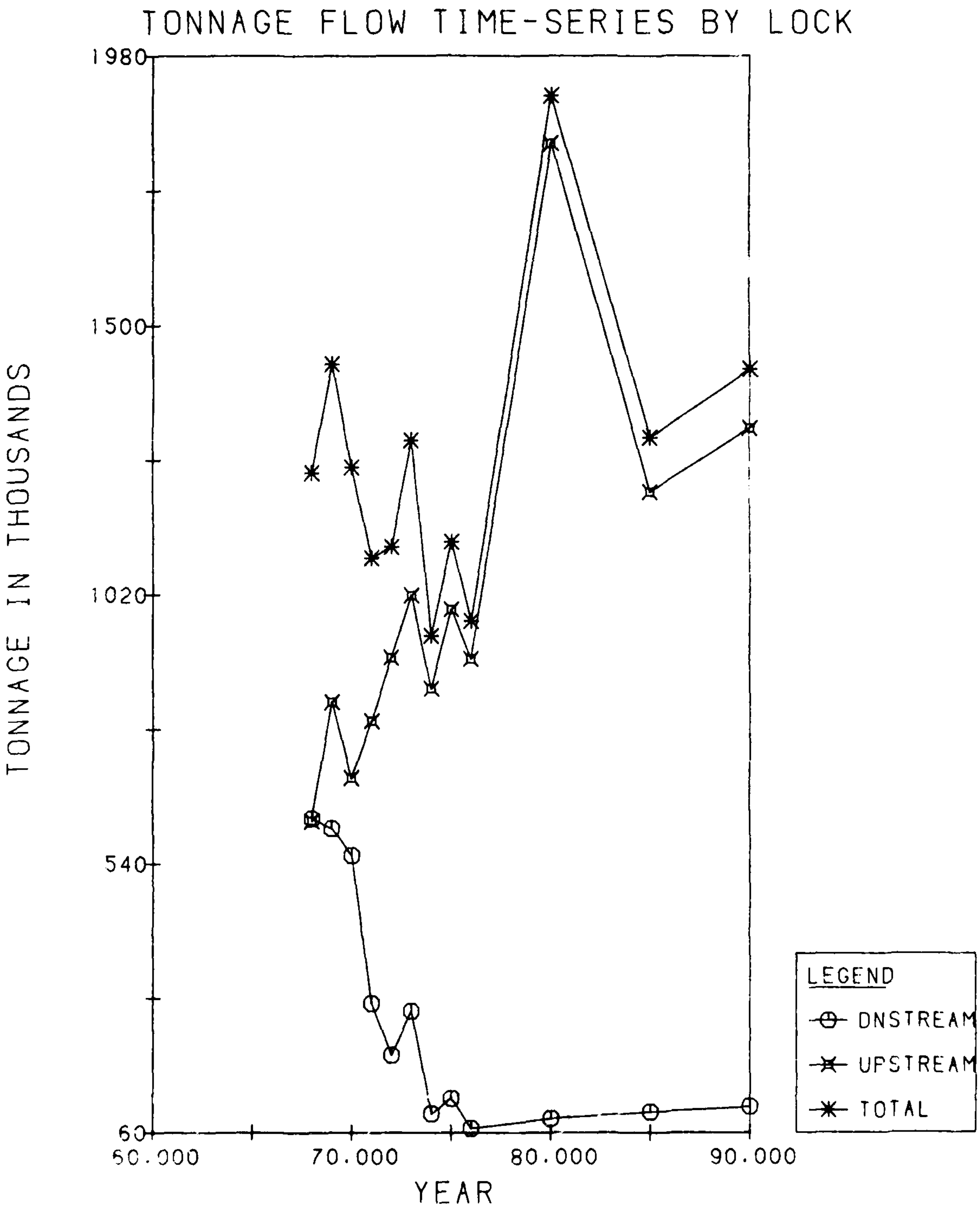

WHEELER LOCK & DAM



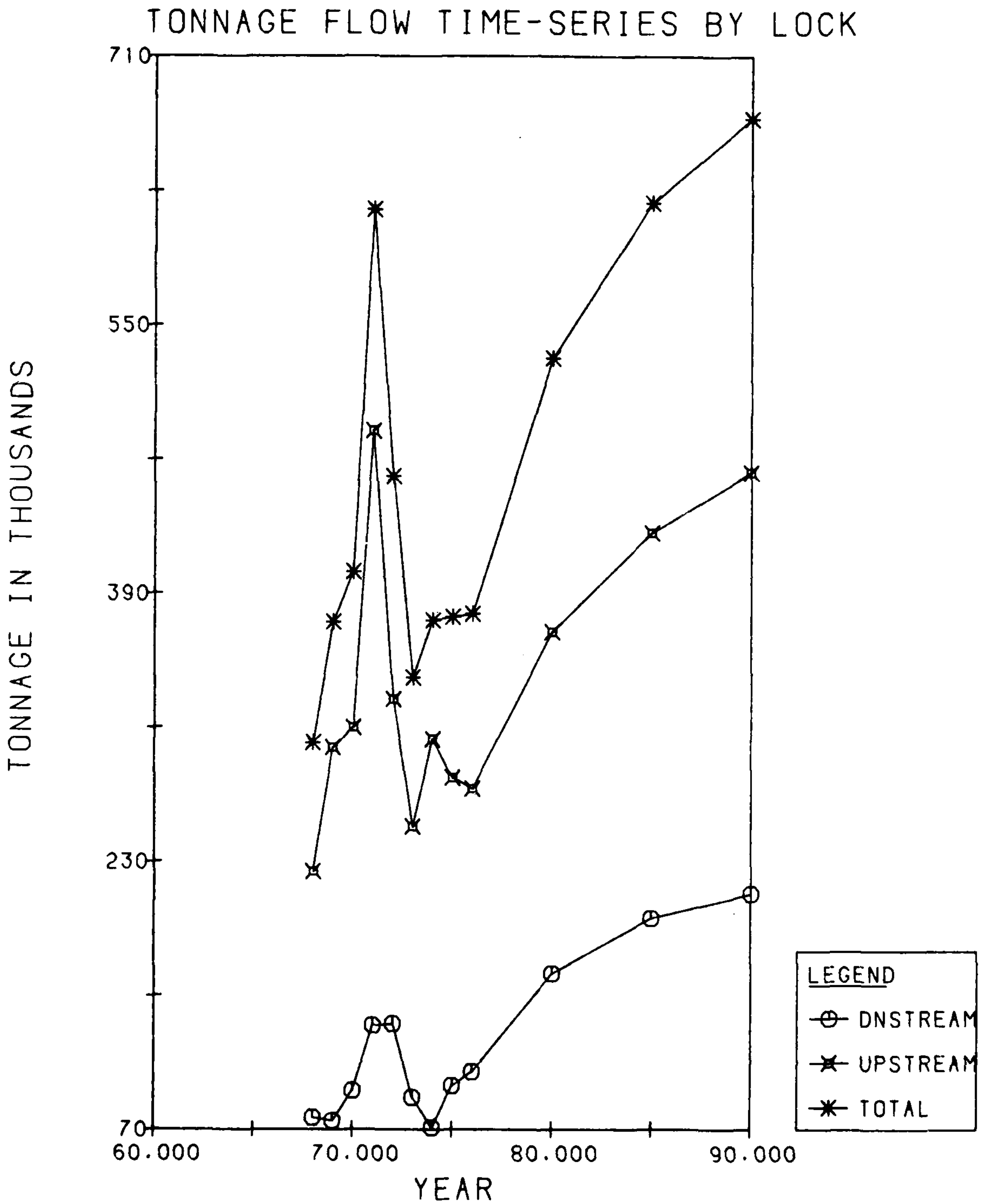

GUNTERSVILLE LOCK & DAM



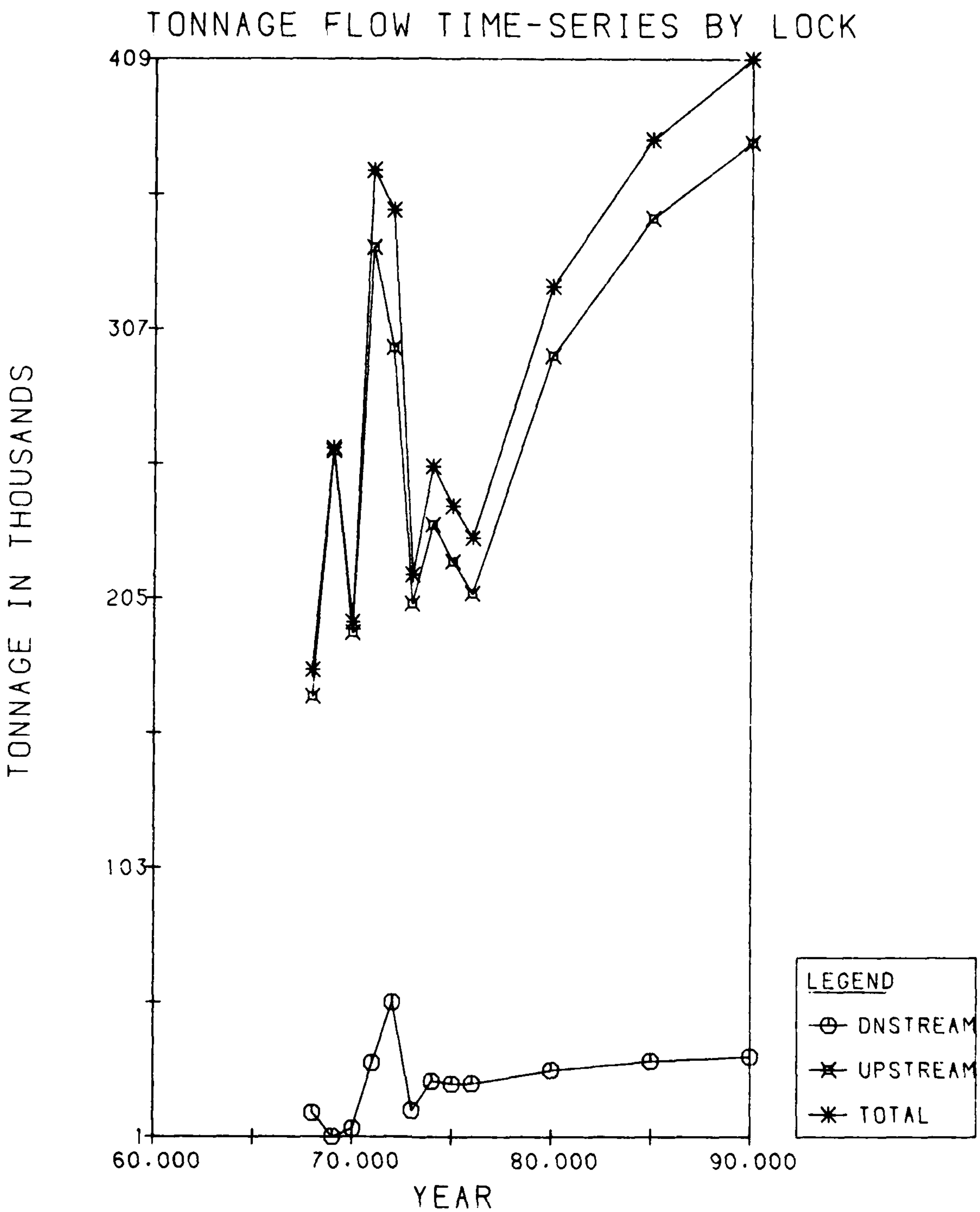

NICKAJACK LOCK & DAM



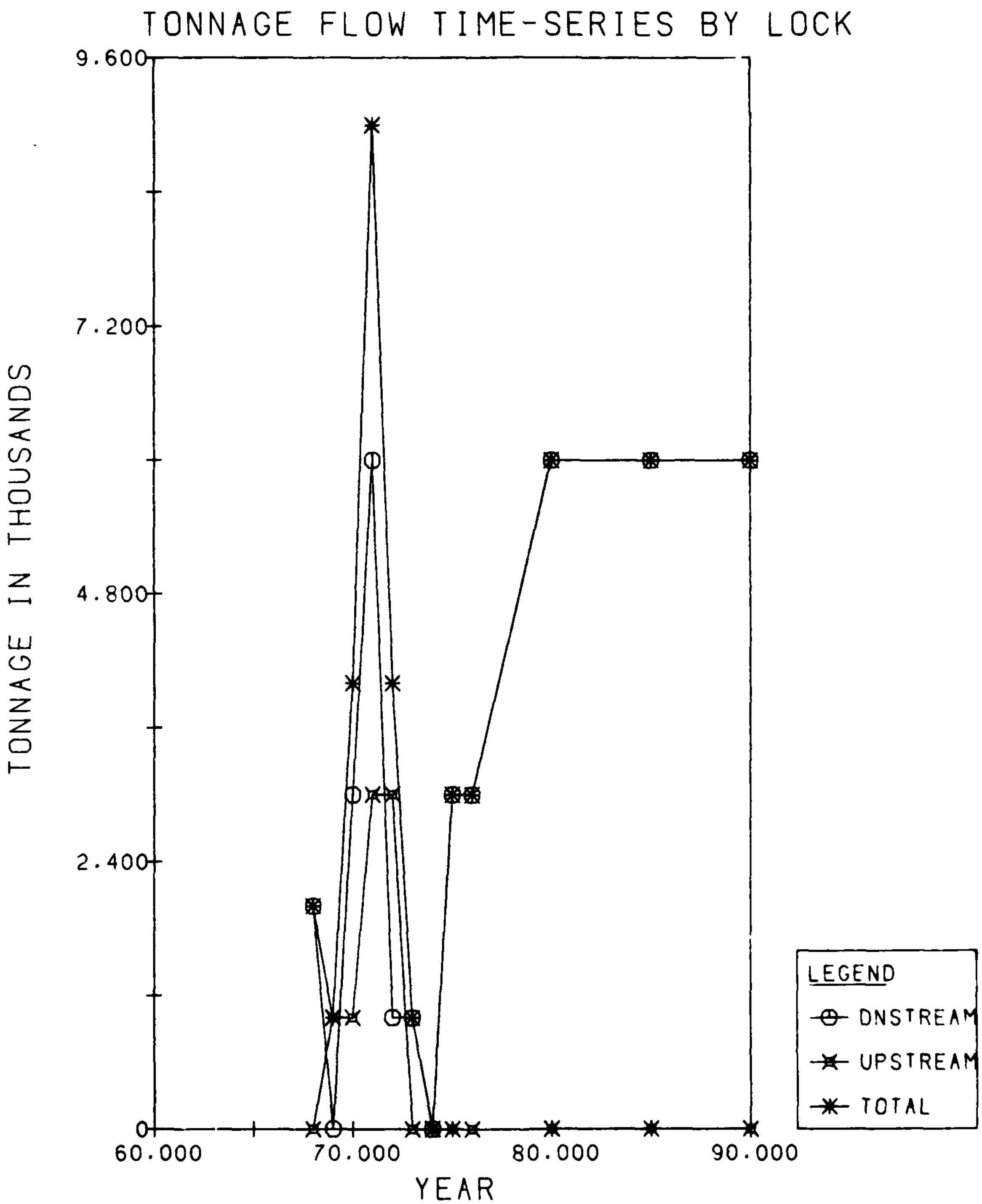

CHICKAMAUGA LOCK & DAM




WATT'S BAR LOCK & DAM




FT. LOUDON LOCK & DAM




MELTON HILL LOCK & DAM

APPENDIX C

EXISTING AND PROJECTED TONNAGE

BY LOCK AND DIRECTION OF MOVEMENT

1976-1990

1976 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
LOCK OHIC RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT



| LOCK | VECTOR COUNT / ROW PCT | DOWNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| EMSWORTH | 1. | 11669 | 12285 | 23954 |
| | | 48.7 | 51.3 | 2.5 |
| DASHIELDS | 2. | 11120 | 12611 | 23731 |
| | | 46.9 | 53.1 | 2.5 |
| MONTGOMERY | 3. | 6836 | 14257 | 21093 |
| | | 32.4 | 67.6 | 2.2 |
| NEW CUMBERLAND | 4. | 5792 | 18904 | 24696 |
| | | 23.5 | 76.5 | 2.6 |
| PIKE ISLAND | 5. | 5618 | 20839 | 26457 |
| | | 21.2 | 78.8 | 2.8 |
| HANNIBAL | 6. | 10109 | 20690 | 30799 |
| | | 32.8 | 67.2 | 3.3 |
| WILLOW ISLAND | 7. | 11703 | 20530 | 32233 |
| | | 36.3 | 63.7 | 3.4 |
| BELLEVILLE | 8. | 11342 | 23281 | 34623 |
| | | 32.8 | 67.2 | 3.7 |
| RACINE | 9. | 12897 | 23826 | 36723 |
| | | 35.1 | 64.9 | 3.9 |
| GALLIPOLIS | 10. | 9979 | 32690 | 42669 |
| | | 23.4 | 76.6 | 4.5 |
| GREENUP | 11. | 15833 | 18238 | 34071 |
| | | 46.5 | 53.5 | 3.6 |
| MELDAHL | 12. | 11543 | 18925 | 30468 |
| | | 37.9 | 62.1 | 3.2 |
| MARKLAND | 13. | 9059 | 25807 | 34866 |
| | | 26.0 | 74.0 | 3.7 |
| MCALPINE | 14. | 9138 | 31332 | 40470 |
| | | 22.6 | 77.4 | 4.3 |
| | COLUMN TOTAL | 394635 | 549188 | 943823 |
| | | 41.8 | 58.2 | 100.0 |

(CONTINUED)

1976 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT



| LOCK | VECTOR<br>COUNT<br>ROW PCT | DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| CANNELTON | 15. | 8411 | 34179 | 42590 |
| | | 19.7 | 80.3 | 4.5 |
| NEWBURGH | 16. | 9298 | 30233 | 39531 |
| | | 23.5 | 76.5 | 4.2 |
| UNIONTOWN | 17. | 22527 | 23576 | 46103 |
| | | 48.9 | 51.1 | 4.9 |
| SMITHLAND | 18. | 28220 | 23670 | 51890 |
| | | 54.4 | 45.6 | 5.5 |
| OHIO LOCK^DAM 52 | 19. | 28733 | 32107 | 60840 |
| | | 47.2 | 52.8 | 6.4 |
| OHIO LOCK^DAM 53 | 20. | 26804 | 29377 | 56181 |
| | | 47.7 | 52.3 | 6.0 |
| LONDON | 201. | 1285 | 327 | 1612 |
| | | 79.7 | 20.3 | .2 |
| MARMET | 202. | 4239 | 1604 | 5843 |
| | | 72.5 | 27.5 | .6 |
| WINFIELD | 203. | 4064 | 7354 | 11418 |
| | | 35.6 | 64.4 | 1.2 |
| KENTUCKY L^D 4 | 411. | 3 | 538 | 541 |
| | | .6 | 99.4 | .1 |
| KENTUCKY L^D 3 | 412. | 3 | 538 | 541 |
| | | .6 | 99.4 | .1 |
| KENTUCKY L^D 2 | 413. | 3 | 538 | 541 |
| | | .6 | 99.4 | .1 |
| KENTUCKY L^D 1 | 414. | 3 | 538 | 541 |
| | | .6 | 99.4 | .1 |
| GREEN L^D 3 | 501. | 65 | 0 | 65 |
| | | 100.0 | 0 | .0 |
| | COLUMN TOTAL | 394635 | 549188 | 943823 |
| | | 41.8 | 58.2 | 100.0 |

(CONTINUED)

1976 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT


| LOCK | | VECTOR: DOWNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| COUNT / ROW PCT | | | | |
| GREEN LAD 2 | 502. | 11729 | 0 | 11729 |
| | | 100.0 | 0 | 1.2 |
| GREEN LAD 1 | 503. | 12246 | 6 | 12252 |
| | | 100.0 | .0 | 1.3 |
| ALLEGHENY LAD 6 | 604. | 3 | 126 | 129 |
| | | 2.3 | 97.7 | .0 |
| ALLEGHENY LAD 5 | 605. | 1332 | 252 | 1584 |
| | | 84.1 | 15.9 | .2 |
| ALLEGHENY LAD 4 | 606. | 1557 | 377 | 1934 |
| | | 80.5 | 19.5 | .2 |
| ALLEGHENY LAD 3 | 607. | 1446 | 2160 | 3606 |
| | | 40.1 | 59.9 | .4 |
| ALLEGHENY LAD 2 | 608. | 1896 | 2161 | 4057 |
| | | 46.7 | 53.3 | .4 |
| OPEKISKA | 701. | 92 | 96 | 188 |
| | | 48.9 | 51.1 | .0 |
| HILDEBRAND | 702. | 148 | 96 | 244 |
| | | 60.7 | 39.3 | .0 |
| MORGANTOWN | 703. | 945 | 96 | 1041 |
| | | 90.8 | 9.2 | .1 |
| MONONGAHELA LAD8 | 704. | 3411 | 1952 | 5363 |
| | | 63.6 | 36.4 | .6 |
| MONONGAHELA LAD7 | 705. | 6095 | 1147 | 7242 |
| | | 84.2 | 15.8 | .8 |
| MAXWELL | 706. | 14731 | 2270 | 17001 |
| | | 86.6 | 13.4 | 1.8 |
| MONONGAHELA LAD4 | 707. | 15638 | 2381 | 18019 |
| | | 86.8 | 13.2 | 1.9 |
| COLUMN TOTAL | | 394635 | 549188 | 943823 |
| | | 41.8 | 58.2 | 100.0 |

(CONTINUED)

C R O S S T A B U L A T I O N O F
LOCK OHIO RIVEF BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT



| LOCK | COUNT / RCW PCT | VECTOR: DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| MONONGAHELA L&D3 | 708. | 18230 | 4134 | 22364 |
| | | 81.5 | 18.5 | 2.4 |
| MONONGAHELA L&D2 | 709. | 12588 | 8311 | 20899 |
| | | 60.2 | 39.8 | 2.2 |
| OLD HICKORY | 801. | 31 | 229 | 260 |
| | | 11.9 | 88.1 | .0 |
| CHEATHAM | 802. | 224 | 3568 | 3792 |
| | | 5.9 | 94.1 | .4 |
| BARKLEY | 803. | 128 | 5846 | 5974 |
| | | 2.1 | 97.9 | .6 |
| FORT LOUDON | 902. | 21 | 207 | 228 |
| | | 9.2 | 90.8 | .0 |
| WATTS BAR | 903. | 104 | 274 | 378 |
| | | 27.5 | 72.5 | .0 |
| CHICKAMAUGA | 904. | 68 | 906 | 974 |
| | | 7.0 | 93.0 | .1 |
| NICKAJACK | 905. | 1889 | 2874 | 4763 |
| | | 39.7 | 60.3 | .5 |
| GUNTERSVILLE | 906. | 1347 | 3214 | 4561 |
| | | 29.5 | 70.5 | .5 |
| WHEELER | 907. | 1893 | 4829 | 6722 |
| | | 28.2 | 71.8 | .7 |
| WILSON | 908. | 2003 | 5028 | 7031 |
| | | 28.5 | 71.5 | .7 |
| PICKWICK | 909. | 2156 | 5767 | 7923 |
| | | 27.2 | 72.8 | .8 |
| KENTUCKY | 910. | 6388 | 12087 | 18475 |
| | | 34.6 | 65.4 | 2.0 |
| | COLUMN TOTAL | 394635 | 549188 | 943823 |
| | | 41.8 | 58.2 | 100.0 |

1980 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT



| LOCK | COUNT / ROW PCT | DOWNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| EMSWORTH | 1. | 16530 | 13912 | 30442 |
| | | 54.3 | 45.7 | 2.3 |
| DASHIELDS | 2. | 16088 | 14317 | 30405 |
| | | 52.9 | 47.1 | 2.3 |
| MONTGOMERY | 3. | 9505 | 16345 | 25850 |
| | | 36.8 | 63.2 | 2.0 |
| NEW CUMBERLAND | 4. | 7848 | 24548 | 32396 |
| | | 24.2 | 75.8 | 2.5 |
| PIKE ISLAND | 5. | 8300 | 26619 | 34919 |
| | | 23.8 | 76.2 | 2.7 |
| HANNIBAL | 6. | 16096 | 25310 | 41406 |
| | | 38.9 | 61.1 | 3.2 |
| WILLOW ISLAND | 7. | 17045 | 25201 | 42246 |
| | | 40.3 | 59.7 | 3.2 |
| BELLEVILLE | 8. | 16472 | 27978 | 44450 |
| | | 37.1 | 62.9 | 3.4 |
| RACINE | 9. | 18417 | 28532 | 46949 |
| | | 39.2 | 60.8 | 3.6 |
| GALLIPOLIS | 10. | 15069 | 45020 | 60089 |
| | | 25.1 | 74.9 | 4.6 |
| GREENUP | 11. | 28039 | 22802 | 50841 |
| | | 55.2 | 44.8 | 3.9 |
| MELDAHL | 12. | 22264 | 24740 | 47004 |
| | | 47.4 | 52.6 | 3.6 |
| MARKLAND | 13. | 17390 | 32166 | 49556 |
| | | 35.1 | 64.9 | 3.8 |
| MCALPINE | 14. | 19671 | 36904 | 56575 |
| | | 34.8 | 65.2 | 4.3 |
| | COLUMN TOTAL | 603792 | 707783 | 1311575 |
| | | 46.0 | 54.0 | 100.0 |

(CONTINUED)

1980 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * * *

LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT



| LOCK | COUNT / ROW PCT | VECTOR: DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| CANNELTON | 15. | 18528 | 39852 | 58380 |
| | | 31.7 | 68.3 | 4.5 |
| NEWBURGH | 16. | 20624 | 36232 | 56856 |
| | | 36.3 | 63.7 | 4.3 |
| UNIONTOWN | 17. | 38545 | 29183 | 67728 |
| | | 56.9 | 43.1 | 5.2 |
| SMITHLAND | 18. | 46138 | 29396 | 75534 |
| | | 61.1 | 38.9 | 5.8 |
| OHIO LOCK&DAM 52 | 19. | 41562 | 42158 | 83720 |
| | | 49.6 | 50.4 | 6.4 |
| OHIO LOCK&DAM 53 | 20. | 35820 | 35428 | 71248 |
| | | 50.3 | 49.7 | 5.4 |
| LONDON | 201. | 1597 | 327 | 1924 |
| | | 83.0 | 17.0 | .1 |
| MARMET | 202. | 4253 | 1836 | 6089 |
| | | 69.8 | 30.2 | .5 |
| WINFIELD | 203. | 5443 | 10063 | 15506 |
| | | 35.1 | 64.9 | 1.2 |
| KENTUCKY L&D 4 | 411. | 3 | 625 | 628 |
| | | .5 | 99.5 | .0 |
| KENTUCKY L&D 3 | 412. | 3 | 625 | 628 |
| | | .5 | 99.5 | .0 |
| KENTUCKY L&D 2 | 413. | 3 | 625 | 628 |
| | | .5 | 99.5 | .0 |
| KENTUCKY L&D 1 | 414. | 3 | 625 | 628 |
| | | .5 | 99.5 | .0 |
| GREEN L&D 3 | 501. | 96 | 0 | 96 |
| | | 100.0 | 0 | .0 |
| COLUMN TOTAL | | 603792 | 707783 | 1311575 |
| | | 46.0 | 54.0 | 100.0 |

(CONTINUED)

1980 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * PAGE 3 OF 4

| LOCK | COUNT / ROW PC | VECTOR: DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| GREEN L&D 2 | 502. | 14977 | 0 | 14977 |
| | | 100.0 | 0 | 1.1 |
| GREEN L&D 1 | 503. | 15469 | 7 | 15476 |
| | | 100.0 | .0 | 1.2 |
| ALLEGHENY L&D 6 | 604. | 5 | 142 | 147 |
| | | 3.4 | 96.6 | .0 |
| ALLEGHENY L&D 5 | 605. | 1558 | 284 | 1842 |
| | | 84.6 | 15.4 | .1 |
| ALLEGHENY L&D 4 | 606. | 1893 | 436 | 2329 |
| | | 81.3 | 18.7 | .2 |
| ALLEGHENY L&D 3 | 607. | 1954 | 2214 | 4168 |
| | | 46.9 | 53.1 | .3 |
| ALLEGHENY L&D 2 | 608. | 2429 | 2215 | 4644 |
| | | 52.3 | 47.7 | .4 |
| OPEKISKA | 701. | 138 | 128 | 266 |
| | | 51.9 | 48.1 | .0 |
| HILDEBRAND | 702. | 186 | 128 | 314 |
| | | 59.2 | 40.8 | .0 |
| MORGANTOWN | 703. | 1385 | 128 | 1513 |
| | | 91.5 | 8.5 | .1 |
| MONONGAHELA L&D8 | 704. | 5159 | 2527 | 7686 |
| | | 67.1 | 32.9 | .6 |
| MONONGAHELA L&D7 | 705. | 9252 | 1544 | 10796 |
| | | 85.7 | 14.3 | .8 |
| MAXWELL | 706. | 20314 | 2794 | 23108 |
| | | 87.9 | 12.1 | 1.8 |
| MONONGAHELA L&D4 | 707. | 21432 | 2900 | 24332 |
| | | 88.1 | 11.9 | 1.9 |
| | COLUMN TOTAL | 603792 | 707783 | 1311575 |
| | | 46.0 | 54.0 | 100.0 |

(CONTINUED)

1980 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 

| LOCK | COUNT / ROW PCT | VECTOR: DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| | 708. | 24608 | 4715 | 29323 |
| MONONGAHELA L^03 | | 83.9 | 16.1 | 2.2 |
| | 709. | 18434 | 10177 | 28611 |
| MONONGAHELA L^02 | | 64.4 | 35.6 | 2.2 |
| | 801. | 34 | 349 | 383 |
| OLD HICKORY | | 8.9 | 91.1 | .0 |
| | 802. | 302 | 3718 | 4020 |
| CHEATHAM | | 7.5 | 92.5 | .3 |
| | 803. | 186 | 8163 | 8349 |
| BARKLEY | | 2.2 | 97.8 | .6 |
| | 902. | 26 | 297 | 323 |
| FORT LOUDON | | 8.0 | 92.0 | .0 |
| | 903. | 163 | 367 | 530 |
| WATTS BAR | | 30.8 | 69.2 | .0 |
| | 904. | 85 | 1825 | 1910 |
| CHICKAMAUGA | | 4.5 | 95.5 | .1 |
| | 905. | 2551 | 4074 | 6625 |
| NICKAJACK | | 38.5 | 61.5 | .5 |
| | 906. | 1892 | 6424 | 8316 |
| GUNTERSVILLE | | 22.8 | 77.2 | .6 |
| | 907. | 2702 | 8390 | 11092 |
| WHEELER | | 24.4 | 75.6 | .8 |
| | 908. | 2831 | 8607 | 11438 |
| WILSON | | 24.8 | 75.2 | .9 |
| | 909. | 2975 | 19941 | 22916 |
| PICKWICK | | 13.0 | 87.0 | 1.7 |
| | 910. | 9500 | 23920 | 33420 |
| KENTUCKY | | 28.4 | 71.6 | 2.5 |
| | COLUMN | 603792 | 707783 | 1311575 |
| | TOTAL | 46.0 | 54.0 | 100.0 |

1985 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 

| LOCK | | VECTOR: DOWNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| EMSWORTH | 1. COUNT | 20064 | 15590 | 35654 |
| | ROW PCT | 56.3 | 43.7 | 2.4 |
| DASHIELDS | 2. COUNT | 19982 | 16101 | 36083 |
| | ROW PCT | 55.4 | 44.6 | 2.4 |
| MONTGOMERY | 3. COUNT | 11583 | 18291 | 29874 |
| | ROW PCT | 38.8 | 61.2 | 2.0 |
| NEW CUMBERLAND | 4. COUNT | 9387 | 27733 | 37120 |
| | ROW PCT | 25.3 | 74.7 | 2.5 |
| PIKE ISLAND | 5. COUNT | 9554 | 29784 | 39338 |
| | ROW PCT | 24.3 | 75.7 | 2.7 |
| HANNIBAL | 6. COUNT | 18077 | 28848 | 46925 |
| | ROW PCT | 38.5 | 61.5 | 3.2 |
| WILLOW ISLAND | 7. COUNT | 18305 | 28804 | 47109 |
| | ROW PCT | 38.9 | 61.1 | 3.2 |
| BELLEVILLE | 8. COUNT | 18342 | 31897 | 50239 |
| | ROW PCT | 36.5 | 63.5 | 3.4 |
| RACINE | 9. COUNT | 20487 | 32471 | 52958 |
| | ROW PCT | 38.7 | 61.3 | 3.6 |
| GALLIPOLIS | 10. COUNT | 16193 | 50257 | 66450 |
| | ROW PCT | 24.4 | 75.6 | 4.5 |
| GREENUP | 11. COUNT | 40168 | 23871 | 64039 |
| | ROW PCT | 62.7 | 37.3 | 4.3 |
| MELDAHL | 12. COUNT | 24314 | 28554 | 52868 |
| | ROW PCT | 46.0 | 54.0 | 3.6 |
| MARKLAND | 13. COUNT | 19202 | 33640 | 52842 |
| | ROW PCT | 36.3 | 63.7 | 3.6 |
| MCALPINE | 14. COUNT | 21360 | 38818 | 60178 |
| | ROW PCT | 35.5 | 64.5 | 4.1 |
| | COLUMN TOTAL | 681744 | 793997 | 1475741 |
| | | 46.2 | 53.8 | 100.0 |

(CONTINUED)

1985 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT



| LOCK | COUNT / ROW PCT | DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| CANNELTON | 15. | 20117 | 41879 | 61996 |
| | | 32.4 | 67.6 | 4.2 |
| NEWBURGH | 16. | 21594 | 46472 | 68066 |
| | | 31.7 | 68.3 | 4.6 |
| UNIONTOWN | 17. | 39044 | 38574 | 77618 |
| | | 50.3 | 49.7 | 5.3 |
| SMITHLAND | 18. | 46275 | 38849 | 85124 |
| | | 54.4 | 45.6 | 5.8 |
| OHIO LOCK+DAM 52 | 19. | 46390 | 52176 | 98566 |
| | | 47.1 | 52.9 | 6.7 |
| OHIC LOCK+DAM 53 | 20. | 41433 | 38901 | 80334 |
| | | 51.6 | 48.4 | 5.4 |
| LONDON | 201. | 2139 | 337 | 2476 |
| | | 86.4 | 13.6 | .2 |
| MARMET | 202. | 6240 | 2002 | 8242 |
| | | 75.7 | 24.3 | .6 |
| WINFIELD | 203. | 8480 | 10872 | 19352 |
| | | 43.8 | 56.2 | 1.3 |
| KENTUCKY L+D 4 | 411. | 3 | 755 | 758 |
| | | .4 | 99.6 | .1 |
| KENTUCKY L+D 3 | 412. | 3 | 755 | 758 |
| | | .4 | 99.6 | .1 |
| KENTUCKY L+D 2 | 413. | 3 | 755 | 758 |
| | | .4 | 99.6 | .1 |
| KENTUCKY L+D 1 | 414. | 3 | 755 | 758 |
| | | .4 | 99.6 | .1 |
| GREEN L+D 3 | 501. | 121 | 0 | 121 |
| | | 100.0 | 0 | .0 |
| | COLUMN TOTAL | 681744 | 793997 | 1475741 |
| | | 46.2 | 53.8 | 100.0 |

(CONTINUED)

1985 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * *
LOC OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * PAGE 3 OF 4

| LOCK | COUNT / ROW PCT | VECTOR: DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| GREEN L&D 2 | 502. | 11970 | 0 | 11970 |
| | | 100.0 | 0 | .8 |
| GREEN L&D 1 | 503. | 12468 | 67 | 12535 |
| | | 99.5 | .5 | .8 |
| ALLEGHENY L&D 6 | 604. | 6 | 148 | 154 |
| | | 3.9 | 96.1 | .0 |
| ALLEGHENY L&D 5 | 605. | 1690 | 296 | 1986 |
| | | 85.1 | 14.9 | .1 |
| ALLEGHENY L&D 4 | 606. | 2108 | 461 | 2569 |
| | | 82.1 | 17.9 | .2 |
| ALLEGHENY L&D 3 | 607. | 1687 | 2399 | 4086 |
| | | 41.3 | 58.7 | .3 |
| ALLEGHENY L&D 2 | 608. | 2552 | 2401 | 4953 |
| | | 51.5 | 48.5 | .3 |
| OPEKISKA | 701. | 173 | 150 | 323 |
| | | 53.6 | 46.4 | .0 |
| HILDEBRAND | 702. | 229 | 150 | 379 |
| | | 60.4 | 39.6 | .0 |
| MORGANTOWN | 703. | 1622 | 150 | 1772 |
| | | 91.5 | 8.5 | .1 |
| MONONGAHELA L&D8 | 704. | 7060 | 2543 | 9603 |
| | | 73.5 | 26.5 | .6 |
| MONONGAHELA L&D7 | 705. | 11172 | 1632 | 12804 |
| | | 87.3 | 12.7 | .9 |
| MAXWELL | 706. | 24752 | 2980 | 27732 |
| | | 89.3 | 10.7 | 1.9 |
| MONONGAHELA L&D4 | 707. | 26066 | 3069 | 29135 |
| | | 89.5 | 10.5 | 2.0 |
| | COLUMN TOTAL | 681744 | 793997 | 1475741 |
| | | 46.2 | 53.8 | 100.0 |

(CONTINUED)

1985 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

C R O S S T A B U L A T I O N O F
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT



| LOCK | COUNT / ROW PCT | VECTOR: DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| MONONGAHELA L^D3 | 708. | 29510 | 5202 | 34712 |
| | | 85.0 | 15.0 | 2.4 |
| MONONGAHELA L^D2 | 709. | 22560 | 10766 | 33326 |
| | | 67.7 | 32.3 | 2.3 |
| OLD HICKORY | 801. | 74 | 365 | 439 |
| | | 16.9 | 83.1 | .0 |
| CHEATHAM | 802. | 388 | 4130 | 4518 |
| | | 8.6 | 91.4 | .3 |
| BARKLEY | 803. | 256 | 7287 | 7543 |
| | | 3.4 | 96.6 | .5 |
| FORT LOUDON | 902. | 30 | 349 | 379 |
| | | 7.9 | 92.1 | .0 |
| WATTS BAR | 903. | 196 | 427 | 623 |
| | | 31.5 | 68.5 | .0 |
| CHICKAMAUGA | 904. | 97 | 1204 | 1301 |
| | | 7.5 | 92.5 | .1 |
| NICKAJACK | 905. | 3035 | 3732 | 6767 |
| | | 44.9 | 55.1 | .5 |
| GUNTERSVILLE | 906. | 2310 | 5854 | 8164 |
| | | 28.3 | 71.7 | .6 |
| WHEELER | 907. | 3288 | 8078 | 11366 |
| | | 28.9 | 71.1 | .8 |
| WILSON | 908. | 3441 | 8323 | 11764 |
| | | 29.3 | 70.7 | .8 |
| PICKWICK | 909. | 3573 | 20318 | 23891 |
| | | 15.0 | 85.0 | 1.6 |
| KENTUCKY | 910. | 11568 | 23775 | 35343 |
| | | 32.7 | 67.3 | 2.4 |
| COLUMN TOTAL | | 681744 | 793997 | 1475741 |
| | | 46.2 | 53.8 | 100.0 |

1990 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT



| LOCK | COUNT / ROW PCT | VECTOR: DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| EMSWORTH | 1. | 21525 | 16803 | 38328 |
| | | 56.2 | 43.8 | 2.4 |
| DASHIELDS | 2. | 21446 | 17353 | 38799 |
| | | 55.3 | 44.7 | 2.4 |
| MONTGOMERY | 3. | 12283 | 19689 | 31972 |
| | | 38.4 | 61.6 | 2.0 |
| NEW CUMBERLAND | 4. | 9885 | 29749 | 39634 |
| | | 24.9 | 75.1 | 2.5 |
| PIKE ISLAND | 5. | 10031 | 31822 | 41853 |
| | | 24.0 | 76.0 | 2.6 |
| HANNIBAL | 6. | 18909 | 31525 | 50434 |
| | | 37.5 | 62.5 | 3.2 |
| WILLOW ISLAND | 7. | 19041 | 31450 | 50491 |
| | | 37.7 | 62.3 | 3.2 |
| BELLEVILLE | 8. | 18918 | 35197 | 54115 |
| | | 35.0 | 65.0 | 3.4 |
| RACINE | 9. | 21270 | 35768 | 57038 |
| | | 37.3 | 62.7 | 3.6 |
| GALLIPOLIS | 10. | 16910 | 53305 | 70215 |
| | | 24.1 | 75.9 | 4.4 |
| GREENUP | 11. | 43129 | 24478 | 67607 |
| | | 63.8 | 36.2 | 4.3 |
| MELDAHL | 12. | 25910 | 29275 | 55185 |
| | | 47.0 | 53.0 | 3.5 |
| MARKLAND | 13. | 20056 | 40434 | 60490 |
| | | 33.2 | 66.8 | 3.8 |
| MCALPINE | 14. | 22712 | 44144 | 66856 |
| | | 34.0 | 66.0 | 4.2 |
| | COLUMN TOTAL | 724273 | 860117 | 1584390 |
| | | 45.7 | 54.3 | 100.0 |

(CONTINUED)

1990 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT


| LOCK | COUNT / ROW PCT | VECTOR: DONSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| CANNELTON | 15. | 21359 | 47364 | 68723 |
| | | 31.1 | 68.9 | 4.3 |
| NEWBURGH | 16. | 23008 | 50663 | 73671 |
| | | 31.2 | 68.8 | 4.6 |
| UNIONTOWN | 17. | 41031 | 42183 | 83214 |
| | | 49.3 | 50.7 | 5.3 |
| SMITHLAND | 18. | 48429 | 42484 | 90913 |
| | | 53.3 | 46.7 | 5.7 |
| OHIO LOCK&DAM 52 | 19. | 50208 | 56479 | 106687 |
| | | 47.1 | 52.9 | 6.7 |
| OHIO LOCK&DAM 53 | 20. | 44960 | 42700 | 87660 |
| | | 51.3 | 48.7 | 5.5 |
| LONDON | 201. | 2188 | 343 | 2531 |
| | | 86.4 | 13.6 | .2 |
| MARMET | 202. | 6431 | 2142 | 8573 |
| | | 75.0 | 25.0 | .5 |
| WINFIELD | 203. | 8797 | 11466 | 20263 |
| | | 43.4 | 56.6 | 1.3 |
| KENTUCKY L&D 4 | 411. | 3 | 911 | 914 |
| | | .3 | 99.7 | .1 |
| KENTUCKY L&D 3 | 412. | 3 | 911 | 914 |
| | | .3 | 99.7 | .1 |
| KENTUCKY L&D 2 | 413. | 3 | 911 | 914 |
| | | .3 | 99.7 | .1 |
| KENTUCKY L&D 1 | 414. | 3 | 911 | 914 |
| | | .3 | 99.7 | .1 |
| GREEN L&D 3 | 501. | 132 | 0 | 132 |
| | | 100.0 | 0 | .0 |
| COLUMN TOTAL | | 724273 | 860117 | 1584390 |
| | | 45.7 | 54.3 | 100.0 |

(CONTINUED)

1990 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )

* * * * * * * * * * * * * * * * * * C R O S S T A B U L A T I O N O F * * * * * * * * * * * * * * * *
LOCK OHIO RIVER BASIN LOCK AND DAM NAME BY VECTOR DIRECTION OF MOVEMENT



| LOCK | COUNT / ROW PCT | VECTOR: DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| | 502. | 12674 | 0 | 12674 |
| GREEN LAD 2 | | 100.0 | 0 | .8 |
| | 503. | 13175 | 128 | 13303 |
| GREEN LAD 1 | | 99.0 | 1.0 | .8 |
| | 604. | 7 | 148 | 155 |
| ALLEGHENY LAD 6 | | 4.5 | 95.5 | .0 |
| | 605. | 1830 | 296 | 2126 |
| ALLEGHENY LAD 5 | | 86.1 | 13.9 | .1 |
| | 606. | 2286 | 463 | 2749 |
| ALLEGHENY LAD 4 | | 83.2 | 16.8 | .2 |
| | 607. | 1755 | 2471 | 4226 |
| ALLEGHENY LAD 3 | | 41.5 | 58.5 | .3 |
| | 608. | 2620 | 2473 | 5093 |
| ALLEGHENY LAD 2 | | 51.4 | 48.6 | .3 |
| | 701. | 188 | 163 | 351 |
| OPEKISKA | | 53.6 | 46.4 | .0 |
| | 702. | 244 | 163 | 407 |
| HILDEBRAND | | 60.0 | 40.0 | .0 |
| | 703. | 1656 | 163 | 1819 |
| MORGANTOWN | | 91.0 | 9.0 | .1 |
| | 704. | 6137 | 2547 | 8684 |
| MONONGAHELA LAD8 | | 70.7 | 29.3 | .5 |
| | 705. | 11479 | 1645 | 13124 |
| MONONGAHELA LAD7 | | 87.5 | 12.5 | .8 |
| | 706. | 26448 | 3036 | 29484 |
| MAXWELL | | 89.7 | 10.3 | 1.9 |
| | 707. | 27847 | 3150 | 30997 |
| MONONGAHELA LAD4 | | 89.8 | 10.2 | 2.0 |
| | COLUMN TOTAL | 724273 | 860117 | 1584390 |
| | | 45.7 | 54.3 | 100.0 |

(CONTINUED)

1990 OHIO RIVER BASIN LOCK FLOWS (IN THOUSANDS OF TONS)
FILE APPENDIX (CREATION DATE = 07/30/79 )



| LOCK | COUNT / ROW PCT | VECTOR: DNSTREAM MOVEMENT 1. | UPSTREAM MOVEMENT 2. | ROW TOTAL |
|---|---|---|---|---|
| MONONGAHELA L&D3 | 788. | 32178 | 5456 | 37634 |
| | | 85.5 | 14.5 | 2.4 |
| MONONGAHELA L&D2 | 789. | 24394 | 11712 | 36106 |
| | | 67.6 | 32.4 | 2.3 |
| OLD HICKORY | 801. | 77 | 388 | 465 |
| | | 16.6 | 83.4 | .0 |
| CHEATHAM | 802. | 421 | 4502 | 4923 |
| | | 8.6 | 91.4 | .3 |
| BARKLEY | 803. | 272 | 7823 | 8095 |
| | | 3.4 | 96.6 | .5 |
| FORT LOUDON | 902. | 31 | 378 | 409 |
| | | 7.6 | 92.4 | .0 |
| WATTS BAR | 903. | 211 | 462 | 673 |
| | | 31.4 | 68.6 | .0 |
| CHICKAMAUGA | 904. | 106 | 1317 | 1423 |
| | | 7.4 | 92.6 | .1 |
| NICKAJACK | 905. | 3331 | 4083 | 7414 |
| | | 44.9 | 55.1 | .5 |
| GUNTERSVILLE | 906. | 2519 | 5758 | 8277 |
| | | 30.4 | 69.6 | .5 |
| WHEELER | 907. | 3568 | 8211 | 11779 |
| | | 30.3 | 69.7 | .7 |
| WILSON | 908. | 3743 | 8477 | 12220 |
| | | 30.6 | 69.4 | .8 |
| PICKWICK | 909. | 3891 | 20268 | 24159 |
| | | 16.1 | 83.9 | 1.5 |
| KENTUCKY | 910. | 12605 | 23976 | 36581 |
| | | 34.5 | 65.5 | 2.3 |
| COLUMN TOTAL | | 724273 | 860117 | 1584390 |
| | | 45.7 | 54.3 | 100.0 |

APPENDIX D

TOTAL OHIO RIVER BASIN TONNAGE

BY ORIGIN AND DESTINATION BEA

1969-1976

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Tallahassee BEA Origin** | | | | |
| To Chattanooga BEA | 1 | 2 | 2 | 2 |
| Nashville BEA | 10 | 10 | 11 | 11 |
| Knoxville BEA | 6 | 9 | 11 | 12 |
| Huntington BEA | 8 | 9 | 10 | 11 |
| Louisville BEA | 1 | 1 | 1 | 1 |
| Evansville BEA | 41 | 0 | 0 | 0 |
| Pittsburgh BEA | 3 | 4 | 4 | 4 |
| **Pensacola BEA Origin** | | | | |
| To Pittsburgh BEA | 1 | 1 | 1 | 2 |
| **Birmingham BEA Origin** | | | | |
| To Chattanooga BEA | 2 | 4 | 5 | 5 |
| Huntington BEA | 15 | 14 | 16 | 16 |
| Cleveland BEA | 1 | 2 | 2 | 2 |
| **Memphis BEA Origin** | | | | |
| To Nashville BEA | 352 | 373 | 392 | 411 |
| Huntington BEA | 21 | 22 | 23 | 24 |
| Louisville BEA | 109 | 114 | 117 | 124 |
| Evansville BEA | 102 | 106 | 110 | 116 |
| Cincinnati BEA | 49 | 53 | 59 | 68 |
| Columbus BEA | 3 | 3 | 4 | 4 |
| Pittsburgh BEA | 109 | 95 | 101 | 105 |
| Cleveland BEA | 22 | 22 | 23 | 24 |
| Paducah BEA | 7 | 9 | 9 | 10 |
| **Huntsville BEA Origin** | | | | |
| To Memphis BEA | 24 | 35 | 42 | 46 |
| Huntsville BEA | 3030 | 1802 | 626 | 683 |
| Chattanooga BEA | 230 | 379 | 461 | 497 |
| Nashville BEA | 1 | 1 | 1 | 2 |
| Huntington BEA | 73 | 77 | 82 | 85 |
| Louisville BEA | 2 | 4 | 5 | 5 |
| Evansville BEA | 12 | 13 | 14 | 15 |
| Cincinnati BEA | 23 | 27 | 33 | 42 |
| Columbus BEA | 2 | 2 | 2 | 2 |
| Pittsburgh BEA | 43 | 52 | 61 | 65 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Huntsville BEA Origin (Cont'd) | | | | |
| To Cleveland BEA | 5 | 5 | 5 | 5 |
| Chicago BEA | 217 | 303 | 371 | 406 |
| Peoria BEA | 4 | 5 | 5 | 6 |
| Davenport BEA | 4 | 6 | 6 | 7 |
| La Crosse BEA | 14 | 16 | 18 | 20 |
| Minneapolis BEA | 18 | 20 | 22 | 23 |
| Wichita BEA | 9 | 10 | 11 | 13 |
| Kansas City BEA | 1 | 1 | 2 | 2 |
| Quincy BEA | 8 | 9 | 10 | 11 |
| St. Louis BEA | 8 | 9 | 10 | 10 |
| Paducah BEA | 49 | 26 | 3 | 3 |
| Little Rock BEA | 4 | 5 | 5 | 6 |
| Mobile BEA | 31 | 44 | 55 | 60 |
| New Orleans BEA | 366 | 583 | 706 | 764 |
| Houston BEA | 83 | 88 | 93 | 95 |
| McAllen BEA | 1 | 1 | 1 | 1 |
| Chattanooga BEA Origin | | | | |
| To Huntsville BEA | 68 | 84 | 94 | 104 |
| Chattanooga BEA | 1963 | 2185 | 2388 | 2589 |
| Nashville BEA | 4 | 5 | 5 | 6 |
| Knoxville BEA | 14 | 17 | 19 | 21 |
| Pittsburgh BEA | 10 | 10 | 11 | 11 |
| Cleveland BEA | 2 | 2 | 2 | 2 |
| Chicago BEA | 27 | 38 | 47 | 51 |
| Peoria BEA | 13 | 15 | 16 | 19 |
| Davenport BEA | 10 | 11 | 12 | 14 |
| Dubuque BEA | 6 | 6 | 7 | 8 |
| La Crosse BEA | 19 | 28 | 35 | 39 |
| Wichita BEA | 1 | 2 | 2 | 2 |
| St. Louis BEA | 2 | 3 | 4 | 4 |
| New Orleans BEA | 1022 | 1467 | 1818 | 1984 |
| McAllen BEA | 12 | 17 | 21 | 22 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Nashville BEA Origin** | | | | |
| To Huntsville BEA | 88 | 109 | 121 | 135 |
| Nashville BEA | 1289 | 1591 | 1842 | 2102 |
| Huntington BEA | 26 | 29 | 32 | 35 |
| Evansville BEA | 5 | 5 | 42 | 42 |
| Pittsburgh BEA | 20 | 22 | 23 | 24 |
| Chicago BEA | 3 | 3 | 3 | 3 |
| Peoria BEA | 10 | 10 | 11 | 11 |
| Minneapolis BEA | 28 | 39 | 47 | 55 |
| St. Louis BEA | 22 | 23 | 23 | 24 |
| Paducah BEA | 81 | 136 | 167 | 180 |
| New Orleans BEA | 172 | 236 | 313 | 395 |
| Beaumont BEA | 11 | 19 | 23 | 25 |
| Houston BEA | 4 | 7 | 9 | 10 |
| McAllen BEA | 22 | 25 | 29 | 35 |
| **Knoxville BEA Origin** | | | | |
| To Columbia BEA | 1 | 2 | 2 | 2 |
| Birmingham BEA | 2 | 4 | 5 | 5 |
| Huntsville BEA | 4 | 7 | 9 | 10 |
| Chattanooga BEA | 43 | 73 | 89 | 96 |
| Knoxville BEA | 115 | 142 | 158 | 175 |
| Clarksburg BEA | 1 | 2 | 2 | 2 |
| Chicago BEA | 17 | 19 | 21 | 22 |
| Paducah BEA | 2 | 2 | 2 | 2 |
| **Huntington BEA Origin** | | | | |
| To Pensacola BEA | 2 | 2 | 2 | 4 |
| Memphis BEA | 33 | 36 | 40 | 45 |
| Huntsville BEA | 53 | 241 | 347 | 452 |
| Nashville BEA | 148 | 567 | 1072 | 1075 |
| Huntington BEA | 13012 | 19157 | 24821 | 26271 |
| Louisville BEA | 639 | 976 | 989 | 886 |
| Evansville BEA | 302 | 341 | 268 | 258 |
| Cincinnati BEA | 6059 | 11013 | 21615 | 23899 |
| Columbus BEA | 787 | 799 | 860 | 865 |
| Clarksburg BEA | 756 | 1048 | 1048 | 1048 |
| Pittsburgh BEA | 10993 | 12671 | 14057 | 15366 |
| Cleveland BEA | 1261 | 2517 | 3082 | 3568 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Huntington BEA Origin (Cont'd) | | | | |
| To Chicago BEA | 169 | 185 | 199 | 201 |
| Peoria BEA | 11 | 12 | 13 | 14 |
| Davenport BEA | 1 | 1 | 1 | 1 |
| Dubuque BEA | 10 | 13 | 16 | 18 |
| La Crosse BEA | 1 | 1 | 2 | 2 |
| Minneapolis BEA | 17 | 21 | 21 | 21 |
| Sioux City BEA | 1 | 1 | 1 | 1 |
| Wichita BEA | 1 | 1 | 1 | 1 |
| Kansas City BEA | 5 | 6 | 6 | 6 |
| St. Louis BEA | 522 | 745 | 882 | 1014 |
| Paducah BEA | 187 | 1798 | 1522 | 1523 |
| Little Rock BEA | 1 | 1 | 1 | 1 |
| Fort Smith BEA | 5 | 6 | 6 | 6 |
| Monroe BEA | 1 | 2 | 2 | 2 |
| Jackson BEA | 291 | 13 | 13 | 13 |
| Mobile BEA | 387 | 483 | 559 | 593 |
| New Orleans BEA | 108 | 247 | 257 | 262 |
| Lake Charles BEA | 3 | 3 | 3 | 3 |
| Beaumont BEA | 9 | 10 | 11 | 12 |
| Houston BEA | 422 | 558 | 669 | 720 |
| Corpus Christi BEA | 3 | 3 | 4 | 4 |
| Louisville BEA Origin | | | | |
| To Tallahassee BEA | 1 | 2 | 2 | 2 |
| Memphis BEA | 5 | 5 | 5 | 5 |
| Huntsville BEA | 13 | 13 | 14 | 16 |
| Nashville BEA | 10 | 10 | 10 | 10 |
| Huntington BEA | 831 | 989 | 1245 | 1547 |
| Louisville BEA | 2575 | 2966 | 3283 | 3636 |
| Evansville BEA | 462 | 470 | 480 | 493 |
| Cincinnati BEA | 445 | 550 | 679 | 849 |
| Columbus BEA | 54 | 64 | 79 | 99 |
| Pittsburgh BEA | 231 | 489 | 568 | 684 |
| Cleveland BEA | 61 | 61 | 61 | 61 |
| Chicago BEA | 8 | 21 | 24 | 30 |
| Peoria BEA | 8 | 9 | 10 | 11 |
| St. Louis BEA | 39 | 112 | 132 | 164 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Louisville BEA Origin (Cont'd) | | | | |
| To Paducah BEA | 249 | 261 | 267 | 270 |
| Monroe BEA | 12 | 21 | 25 | 27 |
| Jackson BEA | 12 | 18 | 21 | 23 |
| Mobile BEA | 3 | 376 | 469 | 625 |
| New Orleans BEA | 198 | 696 | 833 | 1054 |
| Houston BEA | 4 | 4 | 5 | 5 |
| Evansville BEA Origin | | | | |
| To Tallahassee BEA | 1495 | 1496 | 1496 | 1497 |
| Pensacola BEA | 53 | 53 | 53 | 53 |
| Memphis BEA | 1368 | 1760 | 2063 | 2199 |
| Huntsville BEA | 528 | 157 | 86 | 93 |
| Chattanooga BEA | 222 | 2392 | 1684 | 1317 |
| Nashville BEA | 6549 | 9600 | 7449 | 7735 |
| Huntington BEA | 979 | 982 | 999 | 1003 |
| Louisville BEA | 7271 | 7102 | 7143 | 7166 |
| Evansville BEA | 2835 | 3302 | 3653 | 3996 |
| Springfield BEA | 24 | 26 | 27 | 28 |
| Cincinnati BEA | 4540 | 4602 | 5471 | 9634 |
| Columbus BEA | 835 | 835 | 835 | 835 |
| Pittsburgh BEA | 174 | 179 | 183 | 185 |
| Cleveland BEA | 54 | 56 | 58 | 60 |
| Chicago BEA | 798 | 1097 | 1327 | 1435 |
| Peoria BEA | 120 | 120 | 120 | 120 |
| Davenport BEA | 125 | 134 | 139 | 142 |
| Dubuque BEA | 256 | 381 | 479 | 522 |
| La Crosse BEA | 169 | 209 | 240 | 255 |
| Minneapolis BEA | 147 | 183 | 210 | 223 |
| St. Louis BEA | 795 | 966 | 1099 | 1160 |
| Paducah BEA | 1992 | 3165 | 3858 | 4053 |
| Tulsa BEA | 1 | 1 | 1 | 1 |
| Monroe BEA | 2 | 4 | 5 | 5 |
| Greenville BEA | 2 | 2 | 2 | 2 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Evansville BEA Origin (Cont'd)** | | | | |
| To Mobile BEA | 670 | 722 | 763 | 787 |
| New Orleans BEA | 5361 | 5087 | 6006 | 6462 |
| Beaumont BEA | 11 | 12 | 16 | 19 |
| Houston BEA | 10 | 12 | 14 | 15 |
| Corpus Christi BEA | 5 | 5 | 5 | 6 |
| McAllen BEA | 9 | 9 | 6 | 6 |
| **Springfield BEA Origin** | | | | |
| To Huntsville BEA | 9 | 11 | 13 | 15 |
| Chattanooga BEA | 3 | 3 | 3 | 3 |
| **Cincinnati BEA Origin** | | | | |
| To Tallahassee BEA | 1 | 1 | 2 | 2 |
| Memphis BEA | 12 | 15 | 17 | 19 |
| Huntsville BEA | 10 | 1012 | 1513 | 1515 |
| Chattanooga BEA | 15 | 368 | 330 | 252 |
| Nashville BEA | 1 | 301 | 65 | 77 |
| Huntington BEA | 1203 | 1265 | 1441 | 1579 |
| Louisville BEA | 948 | 1112 | 1242 | 1383 |
| Evansville BEA | 64 | 87 | 152 | 217 |
| Cincinnati BEA | 3818 | 6066 | 8694 | 9936 |
| Columbus BEA | 232 | 354 | 517 | 519 |
| Pittsburgh BEA | 588 | 662 | 730 | 775 |
| Cleveland BEA | 9 | 252 | 473 | 474 |
| Chicago BEA | 2 | 2 | 3 | 3 |
| Peoria BEA | 2 | 2 | 3 | 3 |
| Minneapolis BEA | 4 | 5 | 6 | 7 |
| St. Louis BEA | 34 | 50 | 62 | 68 |
| Paducah BEA | 453 | 2113 | 1777 | 1921 |
| Monroe BEA | 1 | 1 | 2 | 2 |
| Mobile BEA | 23 | 29 | 33 | 38 |
| New Orleans BEA | 1484 | 2002 | 2307 | 2678 |
| Beaumont BEA | 2 | 0 | 0 | 0 |
| Houston BEA | 3 | 27 | 36 | 49 |

# TOTAL OHIO RIVER BASIN TONNAGE BY BEA OF ORIGIN AND DESTINATION 1976 - 1990 (IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Columbus BEA Origin** | | | | |
| To Huntsville BEA | 11 | 10 | 11 | 11 |
| Huntington BEA | 2156 | 2398 | 3252 | 3252 |
| Louisville BEA | 15 | 15 | 15 | 15 |
| Evansville BEA | 2 | 0 | 0 | 0 |
| Cincinnati BEA | 16 | 16 | 16 | 16 |
| Columbus BEA | 178 | 221 | 246 | 272 |
| Pittsburgh BEA | 46 | 58 | 66 | 73 |
| Cleveland BEA | 10 | 10 | 11 | 11 |
| Chicago BEA | 26 | 29 | 33 | 34 |
| Minneapolis BEA | 1 | 1 | 1 | 1 |
| St. Louis BEA | 8 | 9 | 9 | 10 |
| Paducah BEA | 9 | 4 | 0 | 0 |
| New Orleans BEA | 3 | 4 | 4 | 5 |
| **Clarksburg BEA Origin** | | | | |
| To Huntsville BEA | 0 | 244 | 0 | 0 |
| Nashville BEA | 0 | 105 | 500 | 500 |
| Columbus BEA | 0 | 454 | 787 | 786 |
| Clarksburg BEA | 788 | 983 | 911 | 902 |
| Pittsburgh BEA | 3192 | 4036 | 4378 | 4421 |
| Cleveland BEA | 219 | 318 | 396 | 430 |
| **Pittsburgh BEA Origin** | | | | |
| To Tallahassee BEA | 30 | 35 | 40 | 44 |
| Pensacola BEA | 1 | 1 | 1 | 1 |
| Birmingham BEA | 10 | 13 | 15 | 16 |
| Memphis BEA | 113 | 121 | 126 | 131 |
| Huntsville BEA | 63 | 2626 | 2591 | 2362 |
| Chattanooga BEA | 66 | 70 | 74 | 78 |
| Nashville BEA | 631 | 97 | 144 | 146 |
| Huntington BEA | 2694 | 3272 | 3398 | 3525 |
| Louisville BEA | 421 | 453 | 498 | 514 |
| Evansville BEA | 77 | 86 | 93 | 101 |
| Cincinnati BEA | 3406 | 5067 | 5517 | 6019 |
| Columbus BEA | 1286 | 2040 | 2664 | 2901 |
| Clarksburg BEA | 994 | 1246 | 1257 | 1255 |
| Pittsburgh BEA | 31835 | 39599 | 45038 | 48562 |
| Cleveland BEA | 4038 | 6486 | 7376 | 7634 |

# TOTAL OHIO RIVER BASIN TONNAGE
# BY BEA OF ORIGIN AND DESTINATION
# 1976 - 1990
# (IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Pittsburgh BEA Origin (Cont'd)** | | | | |
| To Chicago BEA | 77 | 81 | 87 | 91 |
| Peoria BEA | 27 | 24 | 26 | 27 |
| Minneapolis BEA | 28 | 28 | 28 | 28 |
| Wichita BEA | 1 | 1 | 1 | 1 |
| Kansas City BEA | 4 | 5 | 5 | 5 |
| St. Louis BEA | 173 | 179 | 183 | 191 |
| Paducah BEA | 57 | 88 | 119 | 122 |
| Little Rock BEA | 2 | 2 | 3 | 3 |
| Fort Smith BEA | 45 | 49 | 53 | 57 |
| Tulsa BEA | 34 | 38 | 42 | 44 |
| Monroe BEA | 1 | 1 | 1 | 1 |
| Greenville BEA | 3 | 3 | 4 | 4 |
| Jackson BEA | 9 | 9 | 9 | 9 |
| Mobile BEA | 25 | 27 | 31 | 34 |
| New Orleans BEA | 558 | 666 | 757 | 823 |
| Beaumont BEA | 19 | 20 | 20 | 21 |
| Houston BEA | 378 | 421 | 466 | 501 |
| Corpus Christi BEA | 34 | 38 | 42 | 48 |
| McAllen BEA | 11 | 12 | 14 | 15 |
| **Cleveland BEA Origin** | | | | |
| To Memphis BEA | 2 | 2 | 3 | 3 |
| Huntsville BEA | 3 | 3 | 4 | 4 |
| Huntington BEA | 49 | 49 | 50 | 50 |
| Louisville BEA | 1 | 1 | 1 | 1 |
| Cincinnati BEA | 2 | 2 | 2 | 2 |
| Columbus BEA | 21 | 18 | 20 | 20 |
| Clarksburg BEA | 135 | 178 | 178 | 178 |
| Pittsburgh BEA | 73[illegible] | 737 | 840 | 894 |
| Cleveland BEA | 25 | 28 | 30 | 30 |
| Chicago BEA | 7 | 10 | 12 | 13 |
| Peoria BEA | 3 | 4 | 5 | 5 |
| Wichita BEA | 1 | 1 | 1 | 1 |
| St. Louis BEA | 2 | 3 | 4 | 5 |
| Paducah BEA | 9 | 9 | 9 | 9 |
| Jackson BEA | 1 | 1 | 1 | 2 |
| Houston BEA | 11 | 14 | 16 | 16 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Chicago BEA Origin | | | | |
| To Huntsville BEA | 298 | 350 | 396 | 428 |
| Chattanooga BEA | 139 | 151 | 163 | 172 |
| Nashville BEA | 95 | 104 | 114 | 119 |
| Knoxville BEA | 1 | 2 | 2 | 2 |
| Huntington BEA | 93 | 94 | 98 | 100 |
| Louisville BEA | 42 | 45 | 48 | 50 |
| Evansville BEA | 57 | 77 | 92 | 100 |
| Cincinnati BEA | 7 | 7 | 8 | 9 |
| Columbus BEA | 102 | 19 | 21 | 22 |
| Pittsburgh BEA | 19 | 20 | 20 | 21 |
| Cleveland BEA | 2 | 4 | 5 | 5 |
| Paducah BEA | 39 | 39 | 39 | 39 |
| Peoria BEA Origin | | | | |
| To Huntsville BEA | 112 | 137 | 155 | 175 |
| Chattanooga BEA | 11 | 12 | 13 | 13 |
| Nashville BEA | 2 | 2 | 3 | 3 |
| Cincinnati BEA | 2 | 3 | 3 | 3 |
| Pittsburgh BEA | 66 | 70 | 73 | 75 |
| Davenport BEA Origin | | | | |
| To Huntsville BEA | 17 | 21 | 23 | 25 |
| Chattanooga BEA | 9 | 9 | 9 | 9 |
| Huntington BEA | 1 | 1 | 1 | 2 |
| Evansville BEA | 4 | 4 | 4 | 5 |
| Cincinnati BEA | 4 | 5 | 6 | 9 |
| Pittsburgh BEA | 10 | 11 | 12 | 13 |
| Dubuque BEA Origin | | | | |
| To Huntsville BEA | 1 | 1 | 2 | 2 |
| Pittsburgh BEA | 1 | 1 | 1 | 1 |
| La Crosse BEA Origin | | | | |
| To Huntsville BEA | 3 | 4 | 5 | 5 |
| Chattanooga BEA | 3 | 3 | 4 | 4 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Minneapolis BEA Origin** | | | | |
| To Huntsville BEA | 134 | 169 | 194 | 219 |
| Chattanooga BEA | 295 | 356 | 408 | 460 |
| Nashville BEA | 57 | 87 | 106 | 118 |
| Knoxville BEA | 9 | 11 | 13 | 14 |
| Evansville BEA | 56 | 69 | 78 | 88 |
| Cincinnati BEA | 12 | 12 | 16 | 21 |
| Pittsburgh BEA | 13 | 13 | 14 | 15 |
| **Sioux City BEA Origin** | | | | |
| To Huntsville BEA | 43 | 73 | 89 | 96 |
| Chattanooga BEA | 2 | 3 | 3 | 4 |
| Evansville BEA | 1 | 1 | 2 | 2 |
| **Wichita BEA Origin** | | | | |
| To Huntsville BEA | 21 | 32 | 38 | 41 |
| Chattanooga BEA | 38 | 47 | 53 | 60 |
| Louisville BEA | 9 | 10 | 11 | 12 |
| Evansville BEA | 89 | 111 | 127 | 143 |
| Cincinnati BEA | 13 | 19 | 22 | 24 |
| Pittsburgh BEA | 4 | 7 | 9 | 10 |
| **Kansas City BEA Origin** | | | | |
| To Huntsville BEA | 69 | 85 | 98 | 111 |
| Chattanooga BEA | 195 | 241 | 277 | 314 |
| Knoxville BEA | 1 | 1 | 2 | 2 |
| Evansville BEA | 1 | 1 | 2 | 2 |
| **Columbia BEA Origin** | | | | |
| To Huntsville BEA | 1 | 1 | 2 | 2 |
| **Quincy BEA Origin** | | | | |
| To Huntsville BEA | 24 | 29 | 32 | 37 |
| Chattanooga BEA | 7 | 7 | 8 | 9 |
| Huntington BEA | 1 | 1 | 1 | 1 |
| Evansville BEA | 9 | 10 | 11 | 12 |
| Cincinnati BEA | 27 | 32 | 45 | 60 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **St. Louis BEA Origin** | | | | |
| To Huntsville BEA | 270 | 299 | 319 | 341 |
| Chattanooga BEA | 282 | 348 | 388 | 410 |
| Nashville BEA | 808 | 706 | 809 | 854 |
| Knoxville BEA | 106 | 178 | 217 | 234 |
| Huntington BEA | 1032 | 1037 | 1040 | 1041 |
| Louisville BEA | 760 | 787 | 816 | 974 |
| Evansville BEA | 635 | 675 | 713 | 657 |
| Cincinnati BEA | 517 | 657 | 835 | 904 |
| Columbus BEA | 42 | 33 | 48 | 87 |
| Pittsburgh BEA | 469 | 553 | 854 | 1044 |
| Cleveland BEA | 14 | 15 | 15 | 16 |
| Paducah BEA | 93 | 132 | 145 | 153 |
| **Paducah BEA Origin** | | | | |
| To Tallahassee BEA | 7 | 11 | 13 | 14 |
| Pensacola BEA | 390 | 580 | 728 | 795 |
| Memphis BEA | 1826 | 2673 | 3193 | 3458 |
| Huntsville BEA | 50 | 7170 | 7715 | 7715 |
| Chattanooga BEA | 153 | 319 | 70 | 71 |
| Nashville BEA | 1545 | 1900 | 2124 | 2372 |
| Knoxville BEA | 1 | 1 | 2 | 2 |
| Huntington BEA | 2095 | 4644 | 3137 | 1644 |
| Louisville BEA | 70 | 85 | 86 | 86 |
| Evansville BEA | 126 | 186 | 8189 | 10188 |
| Cincinnati BEA | 1422 | 2702 | 2721 | 2748 |
| Columbus BEA | 28 | 29 | 31 | 32 |
| Pittsburgh BEA | 103 | 140 | 160 | 169 |
| Cleveland BEA | 248 | 364 | 428 | 461 |
| Chicago BEA | 159 | 168 | 173 | 174 |
| Peoria BEA | 10 | 187 | 258 | 258 |
| Davenport BEA | 21 | 32 | 40 | 43 |
| La Crosse BEA | 14 | 22 | 27 | 30 |
| Minneapolis BEA | 1 | 2 | 2 | 2 |
| Kansas City BEA | 5 | 5 | 5 | 5 |
| Quincy BEA | 17 | 25 | 31 | 34 |
| St. Louis BEA | 195 | 280 | 345 | 375 |
| Paducah BEA | 2843 | 3751 | 4283 | 4620 |
| Little Rock BEA | 1 | 2 | 2 | 2 |
| Tulsa BEA | 2 | 2 | 2 | 2 |
| Shreveport BEA | 444 | 746 | 910 | 981 |
| Monroe BEA | 442 | 737 | 898 | 969 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| **Paducah BEA Origin (Cont'd)** | | | | |
| To Greenville BEA | 570 | 852 | 1009 | 1097 |
| Jackson BEA | 141 | 221 | 265 | 287 |
| Mobile BEA | 88 | 124 | 152 | 165 |
| New Orleans BEA | 2271 | 3719 | 4436 | 4774 |
| Lake Charles BEA | 6 | 7 | 8 | 9 |
| Beaumont BEA | 54 | 65 | 70 | 75 |
| Houston BEA | 10 | 11 | 12 | 13 |
| **Little Rock BEA Origin** | | | | |
| To Huntsville BEA | 3 | 6 | 7 | 7 |
| Knoxville BEA | 1 | 1 | 2 | 2 |
| Evansville BEA | 1 | 1 | 2 | 2 |
| Pittsburgh BEA | 3 | 4 | 5 | 5 |
| **Fort Smith BEA Origin** | | | | |
| To Pittsburgh BEA | 56 | 58 | 60 | 61 |
| **Tulsa BEA Origin** | | | | |
| To Huntsville BEA | 1 | 1 | 2 | 2 |
| Chattanooga BEA | 85 | 102 | 118 | 134 |
| Evansville BEA | 0 | 21 | 42 | 63 |
| Cincinnati BEA | 11 | 11 | 12 | 12 |
| Columbus BEA | 1 | 2 | 2 | 2 |
| Pittsburgh BEA | 1 | 1 | 1 | 1 |
| Cleveland BEA | 13 | 14 | 14 | 15 |
| Paducah BEA | 3 | 6 | 7 | 7 |
| **Monroe BEA Origin** | | | | |
| To Chattanooga BEA | 1 | 2 | 2 | 2 |
| Nashville BEA | 3 | 6 | 7 | 7 |
| Evansville BEA | 4 | 7 | 9 | 10 |
| **Greenville BEA Origin** | | | | |
| To Chattanooga BEA | 2 | 3 | 3 | 4 |
| Nashville BEA | 49 | 50 | 52 | 52 |
| Louisville BEA | 74 | 76 | 38 | 20 |
| Evansville BEA | 4 | 4 | 4 | 4 |
| Cincinnati BEA | 17 | 23 | 32 | 47 |
| Columbus BEA | 1 | 1 | 1 | 1 |
| Pittsburgh BEA | 86 | 91 | 93 | 94 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Jackson BEA Origin | | | | |
| To Huntsville BEA | 8 | 9 | 10 | 11 |
| Huntington BEA | 9 | 10 | 11 | 12 |
| Pittsburgh BEA | 12 | 17 | 20 | 21 |
| Mobile BEA Origin | | | | |
| To Huntsville BEA | 88 | 96 | 104 | 117 |
| Chattanooga BEA | 57 | 60 | 62 | 65 |
| Nashville BEA | 132 | 142 | 157 | 175 |
| Louisville BEA | 201 | 211 | 222 | 231 |
| Evansville BEA | 269 | 304 | 330 | 359 |
| Cincinnati BEA | 140 | 146 | 151 | 155 |
| Pittsburgh BEA | 4 | 5 | 5 | 6 |
| Cleveland BEA | 5 | 5 | 5 | 5 |
| Paducah BEA | 55 | 84 | 89 | 89 |
| New Orleans BEA Origin | | | | |
| To Huntsville BEA | 446 | 500 | 552 | 593 |
| Chattanooga BEA | 443 | 489 | 539 | 598 |
| Nashville BEA | 1400 | 1059 | 1152 | 1243 |
| Knoxville BEA | 14 | 19 | 23 | 25 |
| Huntington BEA | 1249 | 1514 | 1591 | 1651 |
| Louisville BEA | 1075 | 1201 | 1348 | 1520 |
| Evansville BEA | 1397 | 1025 | 1147 | 1221 |
| Cincinnati BEA | 1840 | 2135 | 2594 | 3217 |
| Columbus BEA | 666 | 765 | 912 | 1499 |
| Clarksburg BEA | 50 | 53 | 58 | 64 |
| Pittsburgh BEA | 2899 | 3086 | 3575 | 3853 |
| Cleveland BEA | 462 | 491 | 521 | 548 |
| Paducah BEA | 907 | 1039 | 1160 | 1174 |
| Lake Charles BEA Origin | | | | |
| To Cincinnati BEA | 53 | 60 | 84 | 118 |
| Columbus BEA | 2 | 2 | 2 | 2 |
| Beaumont BEA Origin | | | | |
| To Huntsville BEA | 45 | 48 | 51 | 54 |
| Chattanooga BEA | 155 | 188 | 209 | 222 |
| Nashville BEA | 71 | 119 | 145 | 156 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| Beaumont BEA Origin (Cont'd) | | | | |
| To Knoxville BEA | 38 | 39 | 40 | 42 |
| Huntington BEA | 316 | 354 | 392 | 435 |
| Louisville BEA | 18 | 25 | 30 | 37 |
| Evansville BEA | 5 | 5 | 5 | 5 |
| Cincinnati BEA | 205 | 283 | 330 | 360 |
| Pittsburgh BEA | 354 | 464 | 533 | 576 |
| Cleveland BEA | 19 | 25 | 30 | 32 |
| Paducah BEA | 3 | 3 | 3 | 3 |
| Houston BEA Origin | | | | |
| To Huntsville BEA | 852 | 880 | 909 | 952 |
| Chattanooga BEA | 86 | 104 | 115 | 122 |
| Nashville BEA | 26 | 28 | 30 | 33 |
| Knoxville BEA | 16 | 17 | 19 | 22 |
| Huntington BEA | 646 | 650 | 703 | 729 |
| Louisville BEA | 232 | 264 | 258 | 268 |
| Evansville BEA | 23 | 26 | 28 | 30 |
| Cincinnati BEA | 329 | 395 | 456 | 535 |
| Columbus BEA | 63 | 52 | 63 | 69 |
| Pittsburgh BEA | 791 | 904 | 1004 | 1033 |
| Cleveland BEA | 156 | 177 | 206 | 236 |
| Paducah BEA | 101 | 102 | 5 | 6 |
| Corpus Christi BEA Origin | | | | |
| To Huntsville BEA | 24 | 23 | 24 | 24 |
| Chattanooga BEA | 1 | 1 | 1 | 2 |
| Nashville BEA | 2 | 2 | 3 | 3 |
| Huntington BEA | 118 | 133 | 159 | 173 |
| Louisville BEA | 6 | 0 | 0 | 0 |
| Evansville BEA | 330 | 363 | 364 | 364 |
| Cincinnati BEA | 47 | 62 | 87 | 122 |
| Columbus BEA | 2 | 2 | 3 | 3 |
| Pittsburgh BEA | 25 | 21 | 22 | 22 |
| Paducah BEA | 3 | 3 | 3 | 3 |

TOTAL OHIO RIVER BASIN TONNAGE
BY BEA OF ORIGIN AND DESTINATION
1976 - 1990
(IN THOUSAND TONS)

| | 1976 | 1980 | 1985 | 1990 |
|---|---|---|---|---|
| McAllen BEA Origin | | | | |
| To Huntsville BEA | 13 | 16 | 19 | 20 |
| Nashville BEA | 2 | 2 | 3 | 3 |
| Huntington BEA | 34 | 32 | 36 | 37 |
| Louisville BEA | 1 | 1 | 1 | 2 |
| Cincinnati BEA | 23 | 28 | 36 | 45 |
| Pittsburgh BEA | 164 | 183 | 207 | 211 |
| Cleveland BEA | 67 | 67 | 69 | 71 |

Source: Based on Battelle Survey

Note: All movements which originate and terminate in the Lexington, Ky. BEA have been deleted to avoid disclosure of individual shipper/receiver operations.