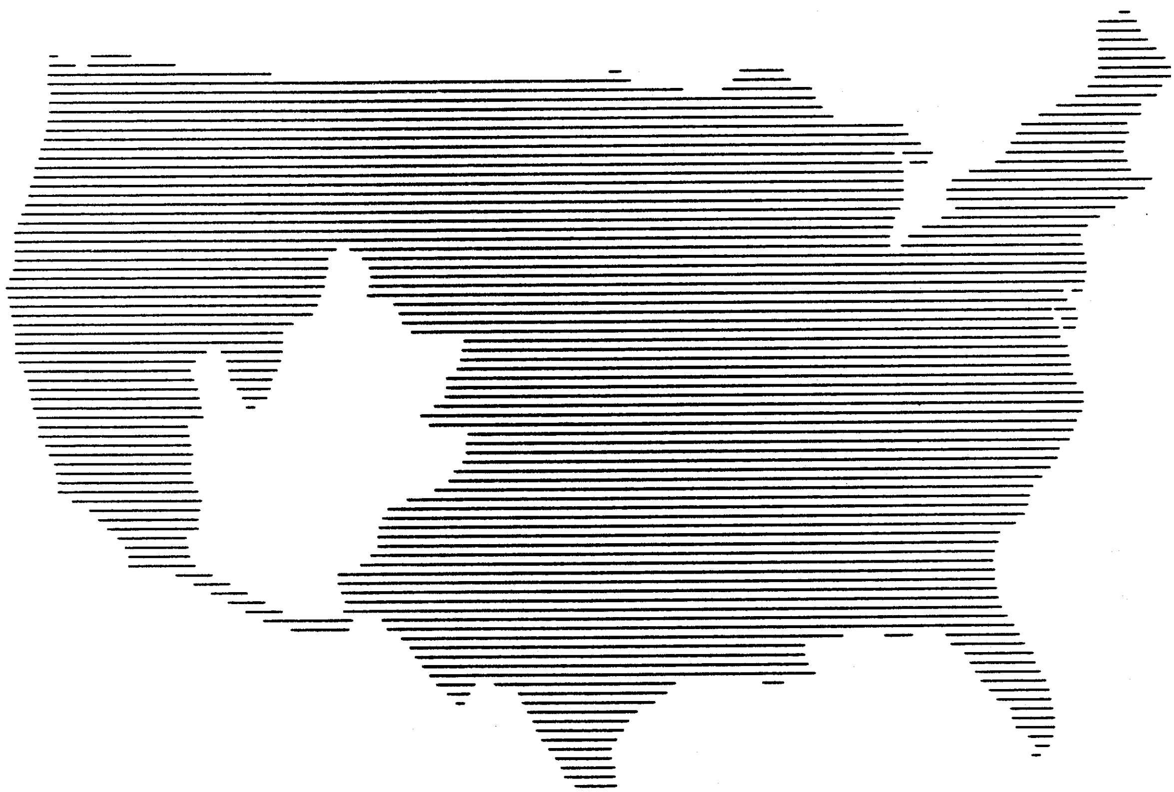
CRSS Colorado River Simulation System



SYSTEM OVERVIEW

U.S. Department of the Interior
Bureau of Reclamation

18

COLORADO RIVER SIMULATION SYSTEM DOCUMENTATION

SYSTEM OVERVIEW

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Hydraulic Engineer

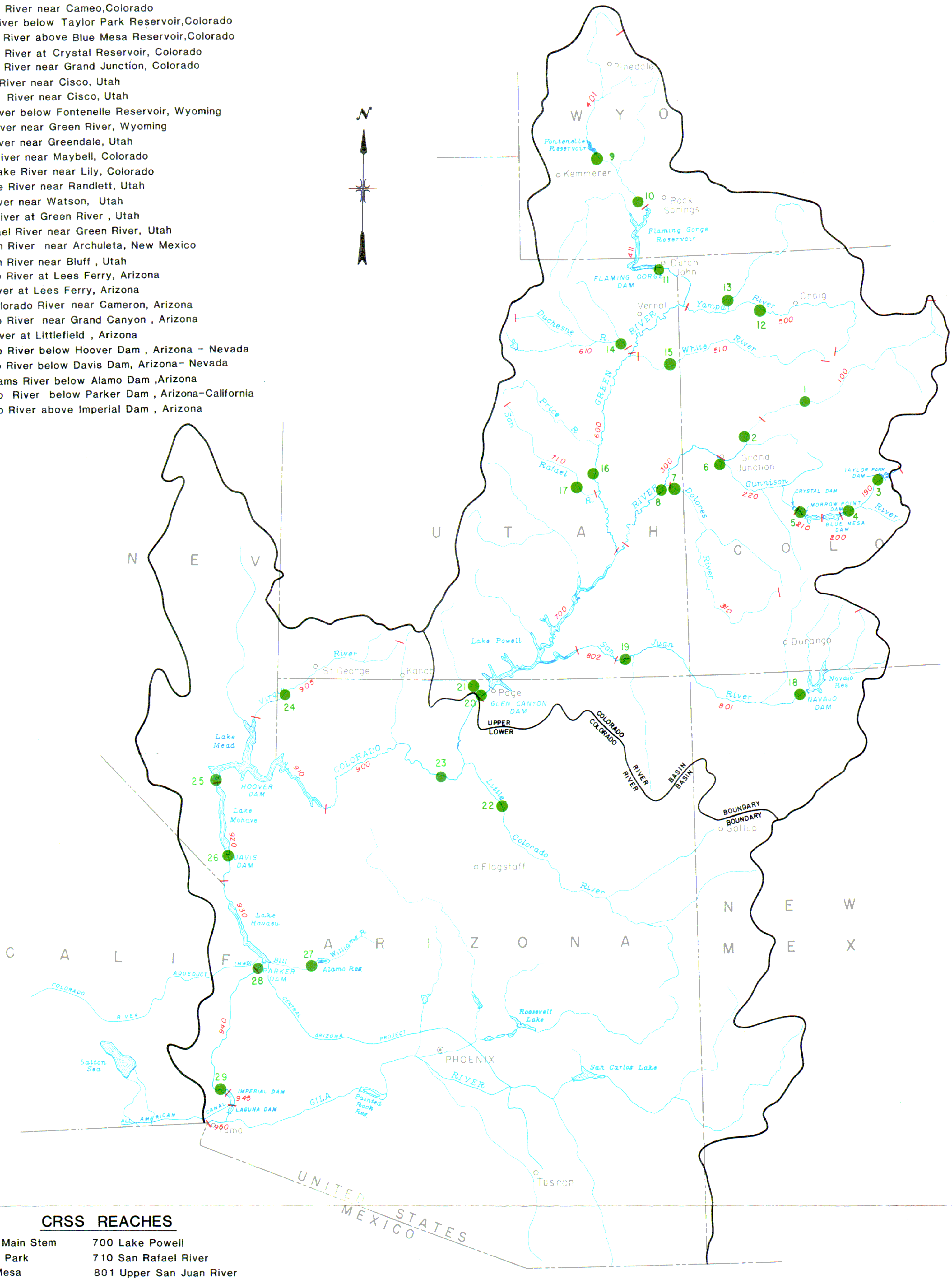
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Denver, Colorado

May 1985
Revised May 1987

STREAMFLOW GAUGING STATIONS

1. Colorado River at Glenwood Springs,Colorado
2. Colorado River near Cameo,Colorado
3. Taylor River below Taylor Park Reservoir,Colorado
4. Gunnison River above Blue Mesa Reservoir,Colorado
5. Gunnison River at Crystal Reservoir, Colorado
6. Gunnison River near Grand Junction, Colorado
7. Dolores River near Cisco, Utah
8. Colorado River near Cisco, Utah
9. Green River below Fontenelle Reservoir, Wyoming
10. Green River near Green River, Wyoming
11. Green River near Greendale, Utah
12. Yampa River near Maybell, Colorado
13. Little Snake River near Lily, Colorado
14. Duchesne River near Randlett, Utah
15. White River near Watson, Utah
16. Green River at Green River , Utah
17. San Rafael River near Green River, Utah
18. San Juan River near Archuleta, New Mexico
19. San Juan River near Bluff , Utah
20. Colorado River at Lees Ferry, Arizona
21. Paria River at Lees Ferry, Arizona
22. Little Colorado River near Cameron, Arizona
23. Colorado River near Grand Canyon , Arizona
24. Virgin River at Littlefield , Arizona
25. Colorado River below Hoover Dam , Arizona – Nevada
26. Colorado River below Davis Dam, Arizona– Nevada
27. Bill Williams River below Alamo Dam ,Arizona
28. Colorado River below Parker Dam , Arizona-California
29. Colorado River above Imperial Dam , Arizona



CRSS REACHES

100 Upper Main Stem	700 Lake Powell
190 Taylor Park	710 San Rafael River
200 Blue Mesa	801 Upper San Juan River
210 Morrow Point	802 Lower San Juan River
220 Lower Gunnison	900 Glen Canyon To Lake Mead
300 Grand Valley	905 Virgin River
310 Dolores River	910 Lake Mead
401 Fontenelle	920 Lake Mohave
411 Flaming Gorge	930 Lake Havasu
500 Yampa River	940 Parker Dam To Imperial Dam
510 White River	945 Imperial Dam Diversions
600 Green River	950 Users Below Imperial Dam
610 Duchesne River	

LEGEND

| 950 | CRSS Reach

29 ● Streamflow Gauging Station

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

COLORADO RIVER SIMULATION SYSTEM

BASIN MAP

25 0 25 50 75 100 125 150

SCALE OF MILES

X – D – 4363

AUGUST, 1985

GPO 845-977

DISCLAIMER

This program is furnished by the Government and is accepted and used by the recipient upon the express understanding that the United States Government makes no warranties, express or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the information and data contained in this program or furnished in connection therewith, and the United States shall be under no liability whatsoever to any person by reason of any use made thereof.

The program herein belongs to the Government. Therefore, the recipient further agrees not to assert any proprietary rights therein or to represent this program to anyone as other than a Government program.

Nothing in this document is intended to interpret the provisions of the Colorado River Compact (42 Stat. 171), Upper Colorado River Basin Compact (63 Stat. 31), Water Treaty of 1944 with the United Mexican States (Treaty Series 944, 59 Stat. 1219), the decree entered by the Supreme Court of the United States in Arizona versus California, et al. (376 U.S. 340), Boulder Canyon Project Act (45 Stat. 1057), Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S.C. 618a), Colorado River Storage Project Act (70 Stat. 105; 43 U.S.C. 620), or the Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C. 1501).

FOREWORD

The Colorado River and its major tributaries originate as snowmelt-fed streams high in the Rocky Mountains. The river drains approximately 242,700 square miles from seven states as it winds its way southward to Mexico and the Gulf of California. The annual natural flow of the Colorado River at Lees Ferry, Arizona has ranged from 5.0 to 24.5 million acre-feet of water over the last 80 years, with a mean of approximately 15 million acre-feet. Ten major storage dams provide a storage capacity of approximately 60 million acre-feet. The storage projects serve a number of purposes including flood control, irrigation water supply, municipal and industrial water supply, power generation, water quality improvement, fish and wildlife propagation, and recreation.

The Colorado River is probably the most legislated and regulated major river in the world as it is governed by more than 20 major legal actions, congressional acts, United States Supreme Court decisions, intrabasin compacts, and international treaties. The amount of water that is legally apportioned is greater than the estimated average annual water supply of the river. Due to the many different uses of Colorado River water and the overapportioned future water supply, management and development of the Colorado River is a highly complicated and technical task. The CRSS (Colorado River Simulation System) is a comprehensive tool designed to assist water resource managers in successfully performing this task.

The purpose of this System Overview is to provide a discussion of the applications, capabilities, limitations, and underlying assumptions of the CRSS. The System Overview discusses technical and managerial aspects of the CRSS.

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Part I - General Overview

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Part II - Major Components

Part III - Specific Modeling Procedures

CONTENTS - Continued

LIST OF FIGURES

ABBREVIATIONS AND TERMINOLOGY

Abbreviations

CAP - Central Arizona Project
CRSM - Colorado River Simulation Model
CRSP - Colorado River Storage Project
CRSS - Colorado River Simulation System
EOWY - End of water year (September 30)
ft^3/s - cubic feet per second
MAF - million acre-feet
mg/L - milligram per liter
MWD - Metropolitan Water District
M&I - Municipal and Industrial
SNWP - Robert B. Griffith Water Project (Southern Nevada Water Project)
USGS - United States Geological Survey

Terminology

Current month - The month being modeled.
Demand - A scheduled diversion of water from the river.
Depletion schedule - A schedule of demands and consumptive uses.
Inflow - A flow of water into the river.
Lee Ferry - A point in the Colorado River mainstem, 1 mile downstream of the mouth of the Paria River. It is defined in the Colorado River Compact (1922) and is also known as the Compact Point.
Lees Ferry - A streamflow gauging station on the mainstream of the Colorado River just upstream of the mouth of the Paria River.
(the) Model - Colorado River Simulation Model.
Reach - A length of river used in the model.
Return flow - An inflow created by the unused portion of a diversion.
Sequence point - One of the 20 possible points that make up a reach. Each sequence point represents either an inflow, diversion, or reservoir.
Water year - A year beginning October 1.
Withdrawal - A diversion of water from the river.

PART I

GENERAL OVERVIEW

1. Introduction

1.1 Purpose of CRSS

The CRSS is a package of computer programs and data bases designed to be used by water resource managers as a tool to assist them in performing comprehensive long-range planning and operational studies. The CRSS is used to address the many "what will happen if . . . " type questions that arise from proposed changes in the methods of operating the river or from proposed basin development or changes in present water use throughout the basin.

1.2 Applications

The CRSS is used to study a variety of future events to determine:

- Effects of proposed changes in imports to and exports from the basin
- Effects of proposed changes in the methods of operating the river
- Effects of water quality improvement projects
- Effects of weather modification
- Future water supply

The CRSS can provide more than 60 output parameters for studying the effects previously listed. The most frequently obtained parameters are:

- Quantity of water in the river
- Quality of water in the river
- Reservoir operation parameters (water surface elevation, surface area, surface storage, bank storage, evaporation, sediment accumulation, and water quality)
- Water shortages
- Hydroelectric power production (energy and capacity)

1.3 Past Studies

The CRSS has been used in a number of specific studies by both the public and private sectors. Some of the larger studies are:

- Westwide water studies
- Upper Colorado Emerging Energy Technology Study
- Lower Colorado Emerging Energy Technology Study
- CREST (Colorado River Enhanced Snowpack Test)
- Quality of Water Progress Report
- Evaluation of Salinity Control Programs in the Colorado River Basin
- Hydrologic yield studies
- Colorado River Alternative Operating Strategies for Distributing Surplus Water and Avoiding Spills
- Western Area Power Administration operation studies for power marketing and power rate determination
- Bureau of Land Management oil shale development studies
- Study to evaluate impacts of the maximum error term in the Lake Mead inflow forecast
- Central Arizona Project Water Supply Study

1.4 Brief History of Development

Planning and operation studies on the Colorado River have been performed for decades. Up until the early 1960's, these studies were performed manually. In 1965, the first computer model of the Colorado River, the CRSP (Colorado River Storage Project) model, was completed.

The CRSP model was used primarily to develop annual operating plans for the Upper Basin reservoirs during the filling of Lake Powell. Over the years, the model was expanded to include the Lower Basin reservoirs, powerplants, salinity, and some formal operating criteria. Drawbacks to the CRSP model were that it could not model individual project effects on tributaries, and it accounted for salinity using a crude procedure. Many of the modeling parameters were fixed and were not easily modified, and the model did not allow convenient or practical addition of new features or parameters.

A second model, the River Network Model, was written in 1973 to evaluate the salinity impacts resulting from water resource developments and salinity control projects and to aid in establishing salinity standards for the Colorado River. The River Network Model was a simple flow and salt routing model and did not include powerplant simulation, operating strategies, or legislative requirements.

The CRSS was borne out of the need to have a flexible, comprehensive river basin model of the Colorado River that would incorporate all areas of interest including legislative requirements. Work on the CRSS began in 1970. After 10 years of development, testing, and initial use, the model began to gain widespread use and support in the early 1980's. Documentation was written in the early to mid-1980's. Today, the CRSS is the most comprehensive and detailed simulation system of the Colorado River, and serves as Reclamation's primary tool in studying the operation of the river and projected developments in the Colorado River Basin.

2. Management of CRSS

2.1 Organizational Chart

The CRSS is technically supported by a technical management team and administratively guided by a steering committee. The two groups are made up of personnel from the Upper Colorado Regional Office, Lower Colorado Regional Office, and E&R Center (Engineering and Research Center).

The technical management team has the responsibilities of (1) maintaining technical adequacy of the model, data bases, and documentation; (2) carrying out development work on the model; and (3) performing studies using the model. The team consists of personnel from the areas of planning and operations, specifically the fields of hydrology and water scheduling. The two regional offices and the E&R Center each provide a CRSS coordinator to coordinate activities in their respective offices. In addition, the E&R Center provides an executive secretary to the steering committee who is the liaison between the technical management team and steering committee. The executive secretary coordinates activities between the CRSS coordinators and plans steering committee meetings. The technical management team meets several times a year as needed.

The steering committee has the responsibility of reviewing the accomplishments of the technical management team, approving work schedules for the team, approving changes to the model which affect policy, and setting policy and guidelines. The steering committee consists of an Assistant Regional Director from the Upper Colorado and Lower Colorado Regional Offices, and 3 members from the E&R Center: the Chief, Colorado River Water Quality Office; Chief, Division of Water and Land Technical Services; and Chief, Division of Planning Technical Services. The steering committee meets once every 6 months.

An organizational chart is shown on figure 2.1.

STEERING COMMITTEE

Upper Colorado Assistant Regional Director, UC-105
Lower Colorado Assistant Regional Director, LC-105
Chief, Division of Water and Land Technical Services, D-400
Chief, Division of Planning Technical Services, D-700
Chief, Colorado River Water Quality Office, D-1000

EXECUTIVE SECRETARY, D-755
- Coordination
- Liaison

TECHNICAL MANAGEMENT TEAM

Upper Colorado Region CRSS Coordinator UC-415 (1) • Coordination • Data Bases • Studies	**Lower Colorado Region CRSS Coordinator** LC-755 (1/4) • Coordination • Data Bases • Studies	**E & R Center CRSS Coordinator** D-755 (1) • Coordination • Development • Studies
Water Resources Branch UC-750 (0) • Data Bases	**Water Scheduling Branch** LC-460 (1/4) • Development • Studies **Hydrology Branch** LC-750 (1/2) • Data Bases • Studies	**Hydrology Branch** D-755 (1) • CRSS Maintenance • Development • Documentation

USERS

Water Operations Branch UC-430	**Water Scheduling Branch** LC-460 **Hydrology Branch** D-750	**Hydrology Branch** D-755 **Colorado River Water Quality Office** D-1000

( ) Designates the approximate number of staff from each office working full time on the CRSS Technical Management Team. 5/87

Figure 2.1 CRSS Organizational Chart.

2.2 Persons to Contact

For additional information or assistance involving CRSS, contact one of the following offices:

Regional Director
Bureau of Reclamation
Upper Colorado Region
Attention: UC-415
P.O. Box 11568
Salt Lake City, Utah 84147

Telephone (CRSS Coordinator)
801-524-5872 or FTS-588-5872

-- * --

Regional Director
Bureau of Reclamation
Lower Colorado Region
Attention: LC-755
P.O. Box 427
Boulder City, Nevada 89005

Telephone (CRSS Coordinator)
702-293-8648 or FTS-598-7648

-- * --

Chief, Division of Planning Technical Services
Bureau of Reclamation
Engineering and Research Center
Attention: D-755
P.O. Box 25007
Denver, Colorado 80225

Telephone (CRSS Coordinator)
303-236-3807 or FTS-776-3807

2.3 Publications and Manuals

A number of publications and manuals documenting the CRSS are available. The Executive Summary is a 10-page document that gives a brief, non-technical description of the applications, characteristics, and limitations of the CRSS. This document is available from the office listed in section 2.4.

Hydrology Data Base, Upper Colorado Region is a 150-page document describing the derivation of the Upper Basin portion of the hydrology data base. Hydrology Data Base, Lower Colorado Region (Lees Ferry to Imperial Dam) is a 100-page document describing the derivation of the Lower Basin portion of the hydrology data base. Each of these documents is available from the respective Regional Office listed in section 2.2.

User manuals are available for personnel using the CRSS simulation model. These manuals are not available for general distribution.

2.4 Policies and Procedures

2.4.1 Dissemination of Information

Dissemination of CRSS information including data, computer code, and documentation is handled by the Technical Services Staff at the Engineering and Research Center. Their address and telephone numbers are given below. A nominal cost may be charged.

Technical Services Staff
Bureau of Reclamation
Engineering and Research Center
Attention: D-3215
P.O. Box 25007
Denver, Colorado 80225

Information released consists of the versions which are "official" at the time of the request. Updates to the data, code, and documentation are sent only to the CRSS Technical Management Team. No notification of changes and no technical support are provided to any person outside the Bureau of Reclamation who has acquired the CRSS or portions thereof.

2.4.2 Updating CRSS

Changes are continuously made to the CRSS as data bases are extended and refined, new methods are developed, and computer systems are updated. These changes are incorporated into the CRSS each October 1, which creates an "official" version of the CRSS for the coming year. During the year as changes are made and successfully tested, they are temporarily incorporated into a "current" version of CRSS. The following procedure is used to make a change in the CRSM:

(1) The person making the change sends a form titled "CRSM Change File Documentation" to the CRSS computer specialist at the E&R Center in Denver, Colorado. Included is a description of the change, reason for the change, a copy of the new code, modifications to data file and support programs, and modifications to any documentation. The person making the change is required to thoroughly test the model with the new change before submitting it to the E&R Center.

(2) The change is reviewed at the E&R Center and further testing is made, if necessary. The code is modified, if necessary, to conform to the guidelines developed for keeping the code consistent and easily readable.

(3) The change is incorporated into the "current" version of CRSS. A copy of the CRSM Change File Documentation is sent to the CRSS Regional Coordinators who distribute copies to members of the Technical Management Team in their region. The documentation includes the date on which the change becomes active in the current version.

(4) Before October 1, the steering committee approves all changes made during the year. The model is tested and results are compared to model results from 1 year ago.

(5) On October 1, the changes are permanently placed in the model creating a new official version of CRSS. The current version is purged. A new current version is created as new changes are submitted during the year.

2.4.3 Studies for Outside Users

Studies using the CRSS can be performed by members of the Technical Management Team for other Bureau of Reclamation offices, Federal and State agencies, and other interested parties, as time permits. Charges for these studies will include staff costs, computer costs, and output costs. For more information contact one of the CRSS coordinators listed in section 2.2.

2.5 Computer Requirements and Costs

The CRSM and supporting programs are set up to run on a CDC (Control Data Corporation) Cyber 170/875 computer. On this 60-bit word machine, the CRSM requires approximately 310,000 octal words of field length to execute. A single-trace 60-year run takes approximately 50 central processor seconds to execute.

The CRSS contains approximately 22,000 lines of computer code and 11,000 lines of data. The computer code is written in Fortran IV and uses software routines that are unique to Control Data Corporation Cyber computer systems.

The cost of a study varies depending on the number of scenarios that are studied and the number of hydrologic traces and depletion schedules that are imposed on each scenario. The number of years in the study period and the type of output also affect the total cost. A small study consisting of 1 scenario, 1 depletion schedule, 15 hydrologic traces, plotted output, and taking about 2 weeks to complete would cost approximately $3,000, which includes both labor and computer costs. A larger study consisting of 10 scenarios and taking up to 2 months to complete would cost approximately $15,000. These costs do not include any written report. The large 1984 special study Colorado River Alternative Operating Strategies for Distributing Surplus Water and Avoiding Spills cost approximately $150,000. This study required development of new operating strategies, a formal report, and took 24 staff-months to complete.

3. Description of CRSS

3.1 General Description

The CRSS is comprised of computer programs, data files, and data bases. The main component of the CRSS is the CRSM (Colorado River Simulation Model), referred to as the "model." This computer model, generally speaking, is a water and salt accounting program. Water is brought into the basin at several points, routed through the system, and deliveries made. Salt is introduced to the basin through inflows and return flows, and is routed through the system along with the water. However, there are a number of features that make the CRSM much more than an accounting tool. The model additionally applies runoff forecasting, reservoir operations (rule curves, evaporation, bank storage, and sediment accumulation), flood control regulations, operating strategies of the system (shortage and surplus strategies), hydroelectric power generation, and legislative requirements.

Two additional components of the CRSS are the hydrology data base and the demand data base. The hydrology data base contains the flow and salt data for the Colorado River Basin. The demand data base contains the diversion data. Other components of the CRSS consist of computer input data files, computer programs that process the information in the hydrology and demand data bases, and computer programs that process the output data that is generated by the model.

3.2 Basic Characteristics

The basic characteristics of the model and data bases are:

- The major **rivers** modeled are the Colorado, Gunnison, Dolores, Green, Yampa, Duchesne, White, San Rafael, San Juan, and Virgin Rivers. These are modeled with inflows, diversions, and reservoirs. Other rivers like the Paria, Little Colorado, and the Bill Williams are modeled as inflows to the Colorado River.

- **Reservoirs** modeled are Taylor Park, Blue Mesa, Morrow Point, Crystal, Fontenelle, Flaming Gorge, Starvation (a composite of eight small reservoirs), Navajo, Powell, Mead, Mohave, and Havasu.

- The model uses a **monthly time frame** to simulate riverflows, water deliveries, reservoir operations, water quality, and hydroelectric power production.

• The **basin** is divided into 25 reaches. Each reach contains inflow points, diversion points, and possibly a reservoir. Inflow points are used to model headwaters, return flows, or gains and losses to the system. Diversion points are used to model demands on the system.

• The **hydrology** data base consists of natural flow and salt data for 29 inflow points. Natural data are defined as historical or gauged data adjusted to remove the effects of human development, i.e. consumptive use, reservoir regulation, imports and exports. The data is complete for the years 1906-85 and is updated every 5 years.

• The **demand** data base contains the diversion point data. The data consists of annual schedules of withdrawals and depletions, monthly distributions, salt pickup data, and type of water use information.

• The CRSS satisfies the provisions of the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs. These **Operating Criteria** have been adopted by the Secretary of the Interior as specified in the Colorado River Basin Project Act (Public Law 90-537) to comply with and carry out the provisions of the Colorado River Compact, the Upper Colorado River Basin Compact, and the Mexican Water Treaty.

• Most of the items listed above are **variable**. For example, the number of reaches, inflow points, diversion points, or reservoirs can be changed; a stochastic hydrology data base can be used in lieu of the natural data base; and values used to model the Operating Criteria can be varied.

3.3 Limitations

Limitations of the model and data bases are:

• A maximum of 150 **years** can be modeled in one simulation model run.

• Each **reach** can model up to 10 inflow points, 10 diversion points, and 1 reservoir. Each diversion point can model up to 10 users or demands on the system.

• **Salinity** is the only water quality parameter modeled, and is modeled as total dissolved solids; precipitation and ion exchange are not modeled.

• Small reservoirs on tributaries are not modeled; therefore, some **shortages** may occur on these tributaries in the model, which would not occur under actual conditions.

• State **water rights** or priorities of water use are not modeled. Deliveries are made as the simulation proceeds downstream through each reach. If a shortage occurs, the shortage is met from an upstream reservoir, if possible, but is not met by shorting a user with a junior water right.

• **Accuracy** of the CRSS is affected by two items: (1) the accuracy of the data and (2) the ability of the model to simulate actual conditions. The former is largely dependent on the accuracy of the United States Geological Survey flow and salt measurements, which are reported in this agency's Water Resources Data reports to be accurate to within 5 to 15 percent, 95 percent of the time. The latter has been determined by comparing simulated flow and salt values from a CRSS run with historically gauged values. The differences between the simulated and historical values were 5 percent or less, based on the average of 192 monthly values.

3.4 Incorporating Legislative Requirements

The CRSS satisfies the provisions of the Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs (Operating Criteria). These Operating Criteria have been adopted by the Secretary of the Interior as specified in the Colorado River Basin Project Act (Public Law 90-537) in order to comply with and carry out the provisions of the Colorado River Compact, the Upper Colorado River Basin Compact, and the Mexican Water Treaty.

The particular items incorporated in the CRSM to satisfy the Operating Criteria and other laws and regulations of the Colorado River are listed below. These items are included in the model for technical evaluation and do not comprise a formal interpretation of the laws and regulations. Many of the items and values are optional or variable. For a more detailed description of an item, refer to the section number specified in brackets.

(1) An objective minimum annual release from Lake Powell of 8.23 million acre-feet. [8.2.1]

(2) Additional water is released from Lake Powell to equalize the active contents of Lakes Powell and Mead by the EOWY (end of the water year) if the total Upper Basin projected EOWY active contents is greater than the storage required by section 602(a) of Public Law 90-537, and if the projected EOWY active contents of Lake Powell are greater than the projected EOWY active contents of Lake Mead. [8.2.2]

3) The additional water released in item (2) is constrained to the extent that it can be passed through the Glen Canyon Powerplant. Any water thus retained in Lake Powell to avoid bypass of water at the Glen Canyon Powerplant will be released in subsequent months if possible. [8.2.2]

(4) The value for the 602(a) storage quantity used to control the equalization of Lakes Powell and Mead is determined by considering several factors including: historic streamflows, the most critical period of record, estimated future depletions in the Upper Basin, an objective minimum annual release from Lake Powell of 8.23 million acre-feet, an allowable shortage in the Upper Basin, sediment accumulation in Lake Powell, and the objective of maintaining minimum power pool in the Upper Basin reservoirs. [8.2.4]

(5) Normal deliveries to Mexico of 1.515 million acre-feet of water are scheduled annually. This value includes 15,000 acre-feet of water for unavoidable overdeliveries.

(6) Flood control is implemented following the Recommended Field Working Agreement between Department of the Interior, Bureau of Reclamation, and Department of the Army, Corps of Engineers. In August through December the target contents for Lake Mead are set to obtain the monthly flood control space specified in the working agreement. Space building releases are held to a maximum of 28,000 ft^3/s. In January through July a minimum flood control release is computed based on the forecasting procedures described in the working agreement. A minimum flood control space in Lake Mead of 1.5 million acre-feet is maintained at all times. [8.3.1]

(7) Shortages are imposed on Arizona, Nevada, and Mexico as Lake Mead drops below specified elevations. [8.5]

(8) The model has the optional capability to schedule releases from Lake Powell in excess of the minimum annual release and from Lake Mead in excess of downstream demands in order to avoid anticipated spills from Lakes Powell and Mead. This is known as the surplus strategy. [8.4]

(9) Water delivered from Lake Mead in excess of normal downstream demands is distributed equally to Arizona via CAP and California via MWD. If either CAP or MWD reaches its capacity, the other user can take remaining excess up to its capacity. After both CAP and MWD reach their capacities, remaining excess water flows to Mexico.

The previous items are normally applied in studies using the CRSS. However, most of the values and procedures described can be easily modified or bypassed by simply changing the input data. Therefore, studies can be made using variations of these items; or the items themselves can be studied using the CRSS.

3.5 Components of CRSS

The CRSS is composed of a number of computer programs, data bases, and input data files. The relationship between these programs and files is shown on figure 3.1. Boldface words on the figure are computer file names.

The components of the CRSS can be divided into three general groups: the demand files, the hydrology files, and the CRSM and TAPEDIT files. The demand files are shown on the upper left part of figure 3.1 and are described in section 4: Demand Data. The hydrology files are shown on the upper right part of figure 3.1 and are described in section 5: Hydrology Data. The CRSM and TAPEDIT files are shown on the lower half of figure 3.1 and are described in section 6: Colorado River Simulation Model.

3.6 Basin Configuration

The Colorado River Basin is divided into 25 reaches in the CRSS. These 25 reaches are shown in red on the basin map found in front of this System Overview. Figure 3.2 shows a schematic of the 25 reaches. Each block on the figure represents one reach; for example, Reach 510, White River, flows into Reach 600, Lower Green River.

Each reach consists of inflow points, diversion points, and possibly a reservoir. Figure 3.3 shows a schematic of one of the CRSS reaches: Reach 411 - Flaming Gorge Reservoir - Green River. This reach contains an inflow point (I1), a diversion with a return flow (D1 and I3), a reservoir (I6), and a salinity checkpoint (I7). Each reach can contain a maximum of 10 inflow points, 10 diversion points, and 1 reservoir. (If a reservoir is used, only 9 inflow points are allowed.)

The number and arrangement of CRSS reaches can be changed, if necessary, by modifying the input data to the model. This is a time-consuming task, but can be accomplished without revision to the CRSM computer code. The number and arrangement of points within a reach can also be modified.

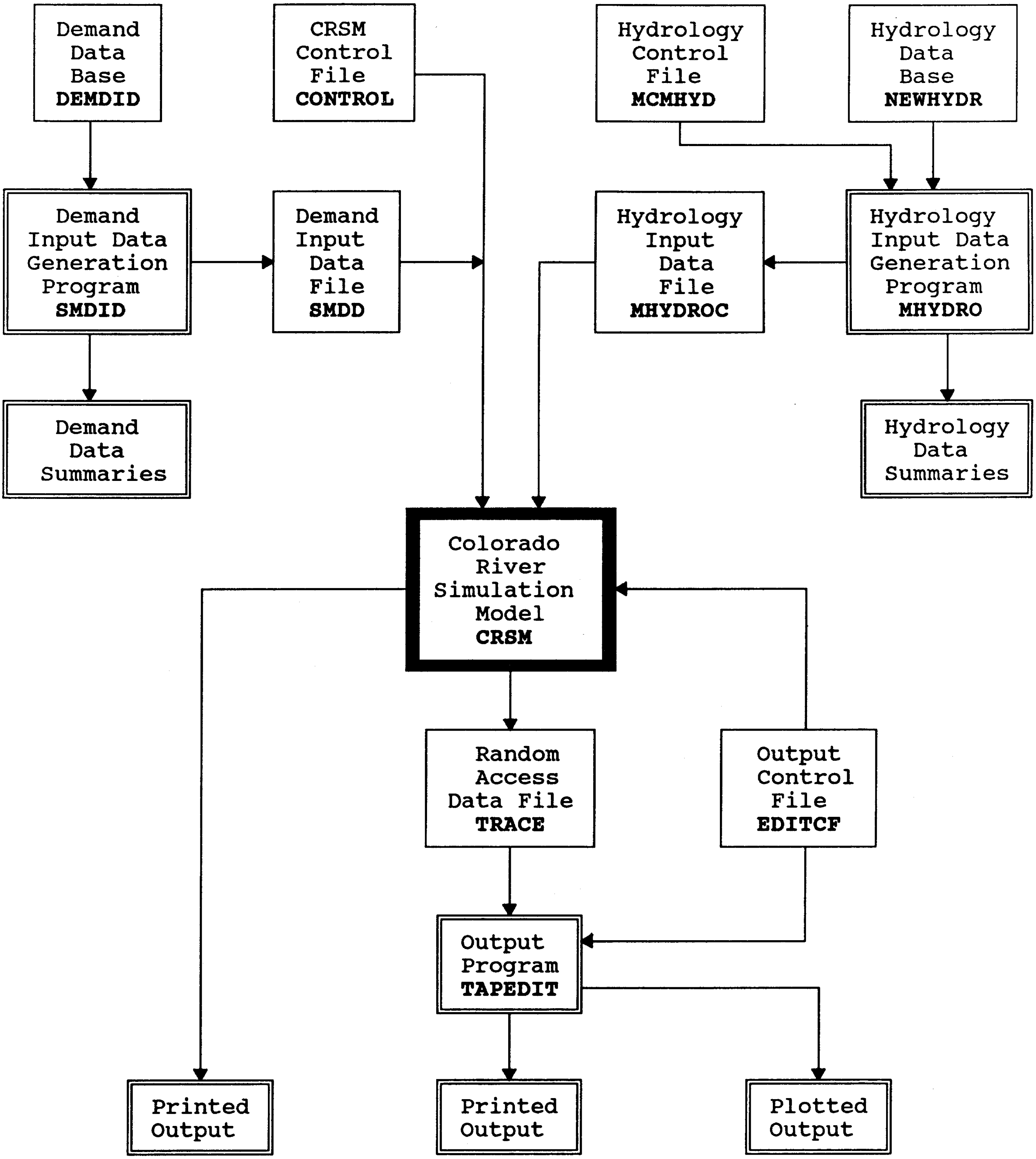


Figure 3.1 Components of CRSS.

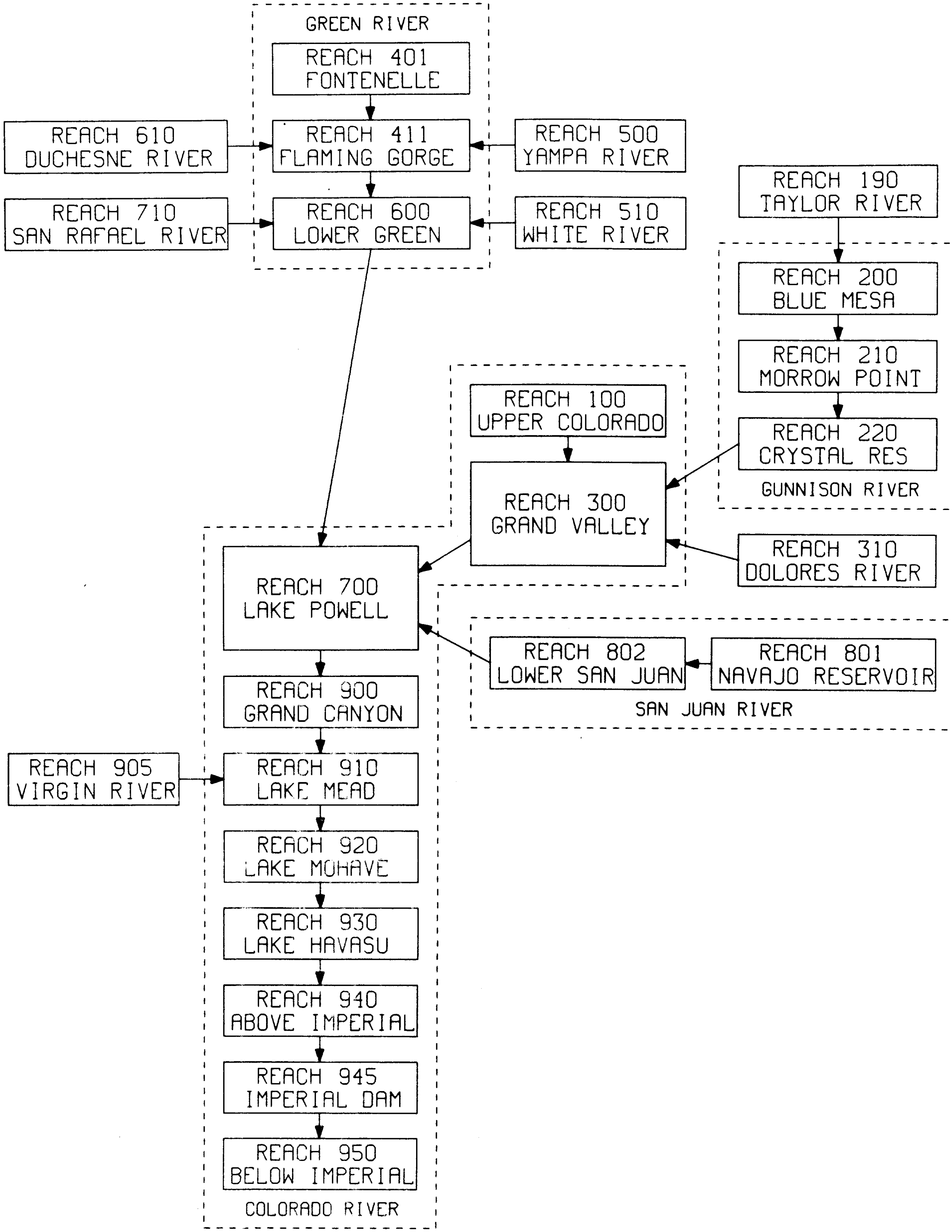


Figure 3.2 Schematic of the Colorado River Basin divided into 25 CRSS reaches.

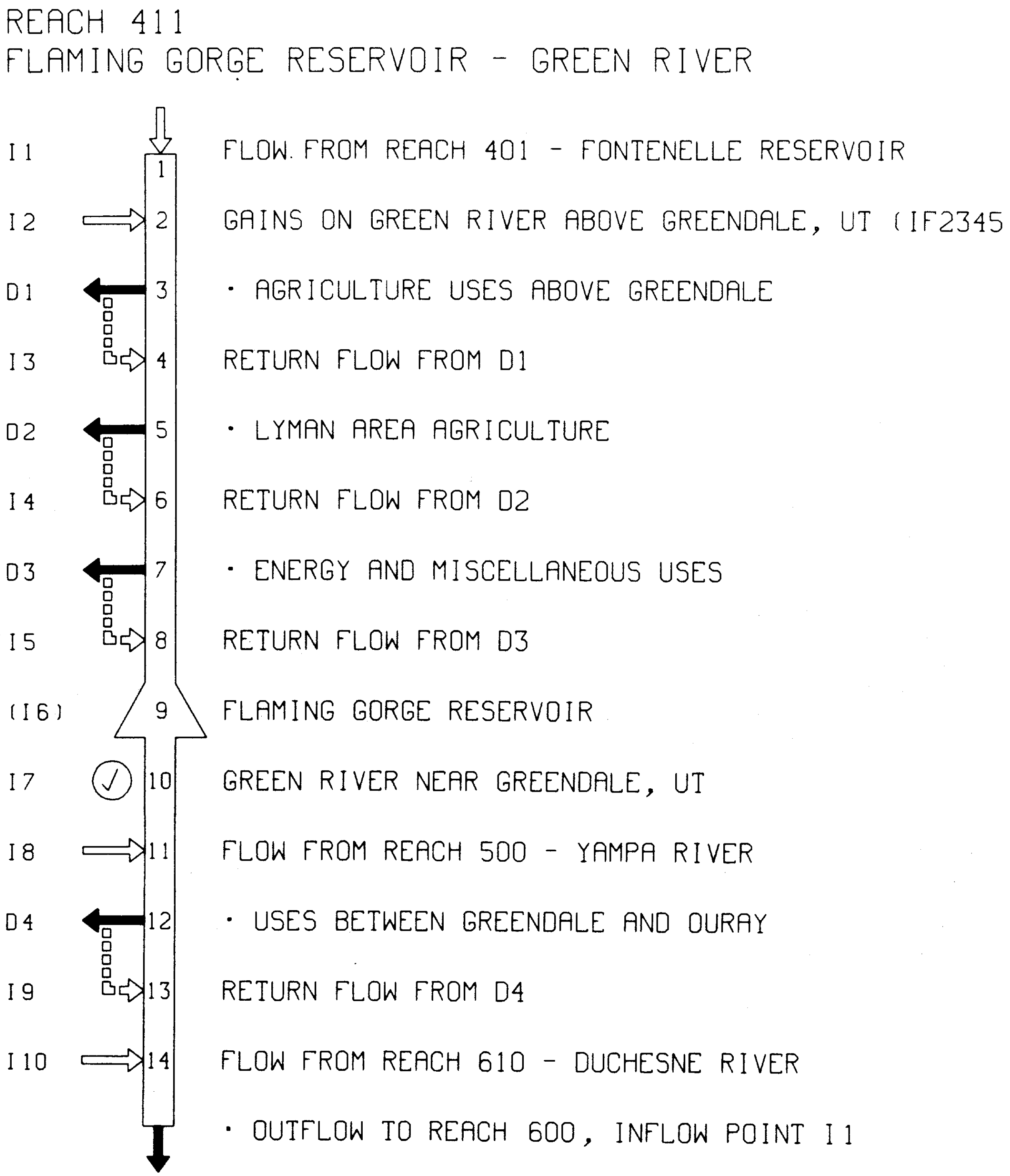


Figure 3.3 Schematic of a CRSS reach.

3.7 Performing a Study Using CRSS

A CRSM computer run uses one set of control data, one demand schedule, and one set of hydrology data. A CRSS study consists of making several runs with the CRSM, and varying the control data, demand input data, hydrology input data, or a combination of these.

The control data can be modified to study the effects of maximum and minimum reservoir releases, generator efficiencies, flood control space-building volumes, initial reservoir conditions, bank storage coefficients, shortage and surplus distributions, surplus strategy assurance levels, and many other parameters.

Varying the demand input data allows the user to study the effects of different demands or levels of developments on the river. Also, scenarios with no water quality improvement projects can be compared with scenarios containing water quality improvement projects.

The effects of different hydrologic sequences can be studied by varying the hydrology input data. This can be done in a number of ways: using the CRSS natural flow record and varying the starting year of the hydrologic sequence, using the CRSS natural flow record and averaging the results from several different hydrologic sequences, or using a synthetic or stochastic natural flow records instead of the CRSS natural flow record.

Most studies involve a combination of the fore-mentioned variations. Studies involving control data variations are often run with more than one demand schedule to see what further effect the level of development might have. Studies involving control data or demand data variations are normally run using a variety of hydrologic sequences to determine probable or "average" results or to see the effect of different flow patterns and volumes.

PART II

MAJOR COMPONENTS

4. Demand Data

4.1 General

The CRSS demand data consists of the depletion information used by the simulation model. Since the CRSS uses a natural streamflow hydrology data base (see section 5), it is necessary to have demand data to deplete the natural flows for studying various levels of basin development and the resulting effects on water quality, flow, power generation, reservoir levels, etc.

The CRSM is structured to allow up to 10 diversion points in each reach. The demand data base is structured such that each of these 10 diversion points can further be divided into as many as 10 separate "users." These 10 users are constrained to having the same monthly distribution and the same return flow loop.

The maximum number of diversion point users in the CRSS is 2500 (25 reaches x 10 diversion points per reach x 10 users per diversion point), however, the practical limit is less because some tributary reaches have few diversions. Since the model is also limited to a total of 10 inflow points per reach and many diversions require an inflow point for their return flow, this also indirectly limits the number of diversions possible in a reach. The present demand data base contains approximately 120 diversions consisting of a total of 245 users.

Two Lower Basin demands, the Central Arizona Project and Metropolitan Water District, are handled uniquely. Both of these demands use two diversion points. The first point gives the normal diversion schedule, which represents the demand's projected share of Colorado River water. The second point is used by the model to store the actual delivery that is made, which is the scheduled delivery minus any declared shortage or plus any delivered surplus.

4.2 Demand Data Base

The demand data is contained in the demand data base. The Bureau of Reclamation maintains an official CRSS demand data base that is updated as current or projected demands on the river change. Other demand bases are created from this official demand data base for CRSS studies as the need arises.

The demand data base is not input directly to the model; it is input to the SMDID (Simulation Model Demand Input Data) generation program. With the demand data base as input, SMDID generates a demand data input file for CRSM.

A considerable amount of information is contained in the demand data base. This information includes locations of diversions and return flows, annual amounts of withdrawals and depletions for each user, monthly distributions of withdrawals and depletions, types of water use, and information on salt pickup.

An annual withdrawal is specified in the demand data base for each user at each diversion point. A depletion is specified for each withdrawal. Both the withdrawal and depletion values are specified in thousands of acre-feet. These values are specified for an initial year and for each year there is a change in the withdrawal or depletion. Withdrawals and depletions can be "fixed" amounts, held constant for a number of years, or they can be "trended" amounts, varying linearly over a number of years (see section 11.1). A monthly distribution is specified for each diversion point for converting annual values of withdrawal and depletion into monthly values. The model is designed to allow return flows to be lagged up to 10 months, however, this feature has never been used or tested.

A "salt pickup" of a return flow is specified in mg/L (milligrams/liter). This value can be either positive, negative, or zero and is used to simulate salt leached from irrigated land and picked up by return flows (+), a reduction in salt load from a water quality improvement project (-), or any similar increase or decrease (+ or -) in salt load. This salt pickup is in addition to the change in concentration of the river caused by the change in volume of water in the river due to the depletion.

Flags are set in the demand data base to indicate one of three special cases. The first case is a special export. A special export is a diversion with no return flow that diverts water at a specific salt concentration. The salt concentration is specified in the demand data base. This allows an export to divert water at a concentration different from the concentration in the river at the modeled point of diversion, if the actual river diversion is farther upstream than the CRSM models.

The second special case is a water quality improvement project. This type of project removes salt from the river and therefore has a negative "salt pickup." The third special case is a diversion made directly from a reservoir. An example of such a diversion is the Navajo Indian Irrigation Project, which is diverted from Navajo Reservoir. Reservoir diversions require special handling because the ability to meet such a demand is dependent upon a reservoir elevation and not on the inflow or release downstream of the reservoir.

Additional data contained in the demand data base are the State in which the diversion occurs, and the demand use. The nine demand uses are (1) thermal power, (2) agriculture, (3) fish, wildlife, and recreation, (4) mineral, (5) water quality improvement, (6) municipal and industrial, (7) export, (8) coal gasification, and (9) oil shale.

Information used to control the output is also included in the demand data base file. These include such things as type of output reports desired (see section 4.4) and years of output data desired.

4.3 Sources and Derivation of Demand Data

4.3.1 Upper Basin

The Upper Basin projected depletions used in the Bureau of Reclamation's official demand data base are essentially those depletions presented in the current version of the Upper Colorado Region's report titled Projected Water Supply and Depletions - Upper Colorado River Basin. This depletion schedule represents the Bureau of Reclamation's best estimate of existing and projected depletions of water due to man's activities in the Upper Colorado River Basin. Each State's portion of the schedule was prepared in consultation with the water resource agency of the respective Upper Basin State and has been reviewed by the States, however, the values in the schedule do not necessarily have the concurrence of the States. Since projected depletions change from time to time, the depletion schedule is typically reviewed on an annual basis and updated if necessary.

Estimates of present use were developed by updating depletions reported in the Upper Colorado Region Comprehensive Framework Study published in June 1971. This study was a large State-Federal interagency effort to formulate framework plans for short- and long-term water resource needs. Included in the study was a report of water uses by State and type of use for a normalized 1965 level of development. Values from the study have been updated to the 1983 level of development. Projections of water use beyond 1983 for the near future are developed from projections supplied by State water resource agencies and from construction schedules of projects authorized for construction or already under construction.

Other input data including monthly distribution of diversions, return flow values, and salt pickup values are taken from project data. If project data do not exist, the data values are estimated. As more and better data become available, these values are revised.

The demand data base does not include evaporation from Upper Basin reservoirs because these quantities are computed in the modeling process.

4.3.2 Lower Basin

The Lower Basin depletions used in the Bureau of Reclamation's official demand data base are essentially those depletions presented in tables 2 through 8 of the Lower Colorado Region's report titled Consumptive Use of Diversions from the Main Stem, revised September 1982. These water use projections are derived from basic apportionments, existing contracts, and information supplied by the Lower Basin States.

The diversions needed to supply the consumptive use of demands with return flows are calculated from either historical diversion to consumptive use ratios, maximum diversion capacity to maximum allowable consumptive use ratios, or an assumed diversion to consumptive use ratio of approximately 167 percent when no other data are available. For exports, or demands where no return flows are assumed, the diversion is set equal to the consumptive use. Other water uses not projected in the above consumptive use report, such as phreatophyte consumptive use and diversions to water quality improvement projects, are estimated. Evaporation from Lower Basin reservoirs are not included in the demand data base since evaporation is computed in the modeling process.

Monthly distributions of diversions are calculated from historical data or from average monthly distributions of similar diversions if no other data are available. The monthly distributions for State of Nevada diversions were supplied directly for use in the CRSS by the Colorado River Commission of Nevada.

Salt pickup data for individual irrigation project return flows are scarce in the Lower Basin. A value of salt pickup is provided for two projects: the Palo Verde Irrigation District and the Colorado River Indian Reservation. These values were determined from Reclamation project data. Salt pickup from other irrigation projects is accounted for in the salt gains and losses values in the hydrology data base.

The delivery of water to Mexico is included in the data base as a Lower Basin diversion. The diversion is the amount specified by the Mexican Water Treaty of 1.5 million acre-feet per year plus an estimated 1 percent additional water for unavoidable overdeliveries of 15,000 acre-feet per year.

4.4 Demand Data Output

The SMDID program can generate several reports when it creates the demand data input file from the demand data base. The reports summarize the data contained in the demand data base.

Report 1 summarizes the demand data by user. The withdrawals, depletions, return flows, and salt pickup are displayed for each user for the years specified in the data base for Reports 1-3. Totals are accumulated for each diversion point and reach. Salt pickup accumulation for a diversion point is weighted proportionally to the individual user return flow in mg/L.

Report 2 summarizes the demand data by reach. The withdrawals, depletions, return flows, and salt pickup are displayed for each reach and are broken down by use (thermal power; agriculture; fish, wildlife, and recreation; mineral; livestock and stockpond evaporation; municipal and industrial; export; coal gasification; and oil shale). Output is received for the years specified in the data base for Reports 1-3.

Report 3 summarizes the demand data by State. Withdrawals and depletions are summarized for each State, and totals are given for the upper and lower subbasins and the entire basin. Output is received for the years specified in the data base for Reports 1-3. The Upper Basin portion of this report is similar to the summary table that appears in the Projected Water Supply and Depletions report.

Report 4 summarizes incremental depletions by State. Base year depletions and increases in depletions are broken down by reach and by use. Output is received for the years specified in the data base for Reports 4 and 5.

Report 5 summarizes total depletions by State. Depletions are broken down by use and include totals for the two subbasins and for the entire basin. Output is received for the years specified in the data base for Reports 4 and 5.

Report 6 is a listing of the initialization data file created as input to the simulation model. This file contains the demand data for the initial or base level of development. The initialization data file is the first half of the demand input data file that is input to the simulation model.

Report 7 is a listing of the transaction data file created as input to the simulation model. This file contains the demand data for increases or decreases in demands from the base level of development. The transaction data file is the second half of the demand input data file that is input to the simulation model.

The SMDID program also produces diagnostic input error messages that are helpful in assuring that data are input in the correct order and format.

5. Hydrology Data

5.1 General

The CRSS hydrology data consists of the natural flow and salt data used by the simulation model. Natural data are defined as historical data adjusted to remove the effects of human development. Consumptive use, reservoir regulation, exports, and imports have been factored into historically recorded data to obtain "natural" conditions. With the exception of Lower Basin actual flow stations, all data in the hydrology data base are natural data.

The hydrology data is input to the model at CRSS inflow points known as hydrology input stations. There are 29 hydrology input stations, corresponding to the 29 USGS streamflow gauging stations from which they were derived, shown on the CRSS Basin Map (inside front cover). The 29 hydrology input stations are located on key reaches of the Colorado River mainstem, most of the major tributaries, and below major structures. Fourteen of the stations are actual flow stations. In the Upper Basin, actual flow stations are the most upstream points modeled in each tributary. In the Lower Basin, actual flow stations represent the entire tributary. The remaining 15 stations are intervening flow stations. Intervening flow stations contain gains or losses in flow and salt between a station and the last upstream station.

5.2 Hydrology Data Base

The hydrology data base contains monthly values of flow and salt for each hydrology input station from water year 1906 through water year 1985. The hydrology data base is updated every 5 years. Values of flow are represented in units of 1,000 acre-feet. Values of salt are represented as salt load in units of 1,000 tons.

The hydrology data base is not input directly to the model, but is input to the Hydrology Input Data Generation Program (MHYDRO). MHYDRO uses the hydrology data base to generate a hydrology data input file for the model.

Hydrology data bases created with stochastic flow and salt data can also be used by the CRSM. These are described in section 5.5.

5.3 Sources and Derivation of Hydrology Data

The major source of data for the hydrology data base was USGS streamflow records. Data from 29 stream gauges were selected for use in the CRSS. To produce a homogeneous data set for modeling purposes, it was necessary to adjust the data at each stream gauge to reflect the same conditions, i.e., a common level of development and a common period of record.

The common level of development chosen is "natural," sometimes called virgin or undepleted / unregulated. All of the data in the hydrology data base have been adjusted to this "natural" level except the Lower Basin actual flow stations which are described in section 5.3.2. The common period of record begins with water year 1906. After flow records were adjusted to natural conditions, any missing data in the records were filled in using multiple regression techniques, where possible.

5.3.1 Upper Basin

Monthly values of natural flow and natural salt are computed for 21 USGS stream gauges in the Upper Basin. These natural flow and natural salt values are then used to create the monthly flow and salt data for the CRSS actual flow and intervening flow hydrology input stations.

Upper Basin Natural Flow

The basic equations used to determine natural flows for one month at a stream gauge are:

Natural flow = historical flow + upstream uses

Upstream uses = crop consumptive use + reservoir regulation + exports + M&I depletions + incidental depletions - imports

Not every term of the equation, of course, was applicable at every stream gauge. The historical flow was gauged flow as recorded by the USGS. The other terms are described in the following paragraphs.

Monthly crop consumptive use was calculated by the modified Blaney-Criddle method. The area upstream of the stream gauge was broken into subareas and the irrigation consumptive use for each subarea was calculated based on recorded crop distribution patterns, growing seasons, and climate. Irrigation consumptive use values for all subareas above a stream gauge were added together to determine a monthly total irrigation consumptive use value for the particular stream gauge. Care was taken to be consistent with earlier studies such as the 1948 Final Report of the Engineering Advisory Committee and the 1971 Upper Colorado Region Comprehensive Framework Study.

Reservoir regulation was analyzed in three parts: monthly change in surface storage, monthly change in bank storage, and monthly evaporation. The changes in these factors were added algebraically for each reservoir on a monthly basis. Monthly reservoir regulation values for all reservoirs upstream of the stream gauge were then totaled to compute the reservoir regulation for that stream gauge.

Monthly flows for out-of-basin exports were obtained from the USGS and irrigation districts. The export term is the monthly sum of all export flows out of the basin, upstream of the stream gauge.

Municipal and industrial use is primarily municipal use and thermal powerplant use upstream of the stream gauge. It was determined from diversion records and records of powerplant uses. The monthly values were calculated by dividing the annual values by twelve. Refinements are being investigated that would more realistically relate the monthly values to actual use patterns.

Monthly flows for imports were obtained from the USGS and irrigation districts. The import term is the monthly sum of all import flows into the basin, upstream of the stream gauge.

Incidental depletions or miscellaneous adjustments account for such uses as stock pond evaporation, fish and wildlife uses, etc. Generally, only annual totals were estimated with monthly values being determined by a fixed percentage distribution.

Computer programs have been developed to handle the great amount of data necessary to make the adjustments from historical flow to natural flow.

After all of the historical flow data had been converted to natural flows, it was necessary to extend the data back to 1906 at those stream gauges which had no record in the early years, as well as fill-in any gaps which may have existed. Generally, this was done by step-wise multiple regression techniques using data from one to four nearby stream gauges. In some cases, the Upper Colorado River Commission's Engineering Advisory Committee had made previous estimates of virgin flows for the early years. To check for accuracy, the CRSS natural flow data was checked against this earlier work. The coefficient of determination (r^2) for most of the extensions were above 0.90 with many in the 0.95 to 0.98 range. This would indicate that reasonably accurate extensions of data were obtained.

Upper Basin Natural Salinity

Natural salinity was initially derived using the following procedure. First, the historical salt load vs. the historical flow was plotted on log-log paper at each stream gauge for each month. It was found that best-fit curves with this data were straight lines on log-log paper, i.e., the relationship had the form $TDS=AQ^B$, where TDS was tons of salt, Q was monthly discharge in 1,000 acre-feet, B was the slope of the line, and A was a constant.

It was reasoned that irrigated acreage can be used as an index of man-caused salinity and that most of the deviation of the points from the best-fit line can be accounted for by changes in irrigated acreage from year to year. The deviation of each point from the best-fit line was then plotted on arithmetic paper against the estimate of irrigated acreage for that particular year. The best-fit straight-line curve was computed and the intercept value or the "zero-acreage factor" was determined.

The zero- acreage factors were then plotted against the month of the year and generally were found to fall into a rough sinusoidal pattern. By trial, the best-fit sine curve was plotted and new "smoothed" values for zero acreage factors were determined. Zero-acreage or curves of natural salt load vs. flow were then computed for each month from the equation $TDS=A'Q^B$, where A' was the adjusted zero acreage factor. It was assumed that the slope, B, would remain the same as before.

Theoretically, it would now have been possible to compute the average annual natural salt loading if the average monthly natural flows were known. It was felt, however, that the relationships were not strong enough to provide this value with any reliability. Therefore, the results from the procedure previously described were used to provide a means for distributing on a monthly basis independent estimates of annual natural and man-caused salinity values.

The independent estimates used were those of Von Iorns as presented in USGS Professional Paper 441. Using the data in P.P. 441, an iterative process was used to adjust the salinity equation such that the determined monthly values would be summed to the annual values. Equations were developed for each stream gauge for each month and the natural salt load for the entire period of record was determined. These natural salt load values were used in the CRSS until October 1986.

The USGS, in 1986, derived natural salinity values for most of the Upper Basin hydrology stations using a regression procedure. The results showed slight variations from the previous work, but for the most part verified the accuracy of the existing CRSS natural salinity data. The natural salinity values computed by the USGS were incorporated into the CRSS hydrology data base in October 1986.

The USGS developed a statistical method to estimate monthly natural salt load at selected hydrology stations in the Upper Colorado River Basin. The method used weighted least-squares regression to develop a model of historical salt load as a function of historical streamflow and several variables representing development. Development variables included upstream adjustments to streamflow, consumptive use, diversions, and irrigated acreage.

The regression equation took the form $C = aQ^b$, where C is concentration in mg/L, Q is streamflow in ft^3/s, and a and b are empirical constants. After the model was calibrated for an individual station, the development variables were removed resulting in a relationship between salt load and streamflow for conditions of no upstream development. Natural salt load was calculated using this relationship and estimates of natural streamflow provided by the U.S. Bureau of Reclamation.

A limitation of this analysis was a lack of data to adequately represent all the effects of development and to verify the monthly natural salt load estimates. However, results from the CRSS showed a good comparison between a simulation run using the USGS natural salinity values and historical data. In addition, mean annual natural salt load values were approximately equal to mass-balance estimates.

Upper Basin Actual and Intervening Flow Stations

Actual flow stations in the Upper Basin are the upstream-most points modeled in each tributary. The monthly values of flow and salt for an actual flow station are the natural flow and natural salt values previously described. The first diversion point on each tributary introduces all depletions, reservoir regulation, exports, and imports that occur upstream of the actual flow station.

Intervening flow stations contain gains and losses in flow and salt that occur along the river between two stream gauges. In the Upper Basin, monthly flow and salt values for an intervening flow station are computed by taking the natural flow and salt values computed for the downstream gauge and subtracting the natural flow and salt values computed for the upstream gauge. Since natural flow and salt values are used in the computation, the intervening flow and salt values are also natural.

5.3.2 Lower Basin

Hydrology in the Lower Basin consists primarily of gains and losses in flow and salt along the Colorado River mainstem. The monthly flow and salt values for both the actual flow and intervening flow stations are based on historical flow and salt data from the 8 Lower Basin streamflow gauges. Intervening flow data are then adjusted to natural conditions by taking into account the effects of depletions, reservoir regulation, evaporation, inflows, etc., between the stream gauges.

Note that the difference in computing intervening natural flow and salt values in the Upper and Lower Basins is that the Upper Basin adjusts every stream gauge to a natural condition and then computes the differences between naturalized stream gauges to obtain intervening values; the Lower Basin computes the differences in historical values between stream gauges to obtain intervening values and adjusts the differences to a natural condition.

Lower Basin Actual and Intervening Flow Stations

Actual flow stations in the Lower Basin represent entire tributaries. These tributaries are not modeled individually because of their very small size relative to the flow and salt in the Colorado River mainstem. These tributaries include the Paria (physically located in the Upper Basin), Little Colorado, Virgin, and Bill Williams Rivers. Since the tributaries themselves are not modeled (i.e., depletions, inflows, and reservoir regulation are not modeled on the tributary except for some future depletions on the Virgin), the flow and salt data for Lower Basin actual flow stations are left in a historical condition rather than being adjusted to a natural condition. In the hydrology data base, monthly flow and salt values for these four actual flow stations are historically recorded data.

Intervening flow and salt values (gains and losses) in the Lower Basin are determined by taking the difference between historical flow and salt values of two stream gauges, and adjusting the difference to a natural condition. The actual procedure involves two steps. First, flow values are computed at the location of the downstream gauge by taking the historical flow values at the upstream gauge and subtracting all diversions, adding all inflows, and adding or subtracting any change in reservoir storage that occur between the two stream gauges. (Diversions include agricultural and M&I consumptive uses, reservoir evaporation, and any exports that occur within the reach.) Adjusted salt values are computed similarly.

The second step is to subtract the flow and salt values computed at the location of the downstream gauge from the recorded historical flow and salt values of the downstream stream gauge. This subtraction gives the gains and losses that have occurred between the two gauges. The gains and losses are natural because of the adjustment in step one.

Lower Basin Special Considerations and Assumptions

Several of the intervening flow stations in the Lower Basin use average values for portions of their record sets. For the intervening flow stations at the Grand Canyon and at Hoover Dam, only the 1963 to present (the closure of Glen Canyon Dam to present) data contain the historically recorded data adjusted to natural conditions. The 1906 to 1962 period of the data base contains average monthly values calculated from the 1963 to present data. For example, the average of the January flow values of years 1963 to present is used as the January flow value for each year 1906 through 1962. For the intervening flow stations downstream of Hoover Dam, the 1906 to 1934 period of the data base uses average monthly values calculated from the 1935 to present data.

This use of average values is based on the assumption that the reach gains and losses that historically occurred before the closure of Glen Canyon Dam and Hoover Dam do not describe the present and projected river conditions below these dams. The nature of the meandering river flowing through the Lower Basin that existed before the closure of these dams has undergone significant changes. The results of these changes and the expected behavior of the river system below these dams can only be described by data recorded subsequent to their closure.

Three of the four actual flow stations in the Lower Basin also use average values for portions of their record sets. For these stations, average values of the existing portions of the record sets were used to fill in gaps in the early years of the records. Average values were used because of a lack of historical data and poor relationships between available data at stream gauges. This prevented extension of the data using multiple regression or other techniques. Average values were used at the Little Colorado River station from 1906-1925, at the Virgin River station from 1906-1909, and the Bill Williams River station from 1906-1913.

The hydrology data base presently extends only to Imperial Dam. This in effect assumes that the sum of gains and losses between Imperial Dam and the Southern International Boundary is zero. Work is presently underway to extend the hydrology data base from Imperial Dam to Mexico. This work is expected to be completed and documented by the end of 1987.

5.4 Hydrology Data Output

The MHYDRO program can generate statistical and graphical output data in addition to creating the hydrology data input file. The output data summarizes the data contained in the hydrology data base. The output data that are available are listed below along with the MHYDRO command associated with it.

CHECKSUM - Sums monthly flow and salt values to obtain total values of flow and salt for the entire period of record at one or more stations.

CORRELATE - Computes correlation coefficients between specified stations.

INDEX - Prints an index of stations in the data base.

PLOT - Creates plots (with the help of another program) of annual values of flow and salt versus time, a double mass plot of accumulated flow or salt, accumulated values of flow and salt versus time, or flow versus salt.

PRINT - Prints tables of flow and salt data.

STATISTICS - Computes statistics of annual values.

5.5 Use of Stochastic Data

Stochastic hydrology offers the capability to assess the impacts of operational and water use changes under a much wider variety of hydrologic sequences than the historical record provides. Stochastic hydrology allows for the generation of a equally likely hydrologic sequences, which still preserve key statistical properties of the historical record.

The CRSS has the capability to use stochastic hydrology inflow data in place of the historical-based data normally used. Although only limited use has been made of stochastically generated hydrology data in CRSS studies, the potential for wider use exists and the added effort required to generate a series of stochastic traces is often worthwhile. The results of a study using several stochastically-generated hydrologic sequences generally provides a broader range of operating characteristics than results of a modeling study which relies exclusively on the historical record.

An example of a study which used stochastic hydrology data is Alternative Operating Strategies for Distributing Surplus Water and Avoiding Spills. This study utilized the CRSS package with a combination of historical and stochastic hydrologic traces to evaluate the effects of alternative operating strategies on reservoir content and releases, power generation, water quality, deliveries to various water users, and other parameters of interest. Monthly stochastic flow and salt values were generated using several computer programs written specifically for that study, but which could easily be modified for use in other studies.

The LAST (Lane's Applied Stochastic Techniques) computer package supported by the Bureau of Reclamation can also be used to generate stochastic traces from historical record sets. The LAST package creates annual and seasonal stochastic values while preserving statistical properties and correlations of the historical data set. The stochastic values can then be transformed into the format needed for input to the CRSM. More information is available on the LAST package in the Bureau of Reclamation's Applied Stochastic Techniques User's Manual.

6. Colorado River Simulation Model - CRSM

6.1 General

The main part of the CRSS is the Colorado River Simulation Model. All of the water and salt accounting, reservoir operations, decision-making, and other river simulation takes place in the CRSM.

A general flowchart of the model is presented in section 6.4 and a detailed flowchart of the model is presented in section 6.5. Discussions on specific parts of the model and underlying assumptions are presented throughout sections 7, 8, 9, 10, and 11. The input files, output files, and output program used in conjunction with the model are discussed below.

6.2 CRSM Input Data

There are four computer files that are input to the CRSM (see figure 3.1):

- CRSM control file
- Demand data input file
- Hydrology data input file
- TAPEDIT (output program) control file

The CRSM control file contains the data that describe the system characteristics, constraints, and initial conditions. These data include reach configuration; identification of inflow points and delivery points; reservoir information like area-capacity curves, maximum and minimum contents, evaporation rates, bank storage rates, maximum and minimum releases, target storage levels, and initial contents; powerplant information like generator ratings, efficiency, maximum and minimum power head, tailwater curves, discharge curves, and power factor; monthly distribution of annual salt pickup; and data for making decisions involving runoff forecasts, shortage conditions, and surplus conditions. This file also includes run control information like length of run, starting year of hydrology, operating strategies to be used, if any, and titles.

The demand data input file, which is merged with the CRSM control file before input to the model, contains the data for each diversion point in the system. This file is created from the demand data base using the SMDID program and contains demand schedules, consumptive use, and return flow information. These data are discussed in detail in section 4: Demand Data.

The hydrology data input file contains the data for each hydrology input station in the system. This file is created from the hydrology data base using the MHYDRO program and contains monthly flow and salt values for each inflow point and monthly total inflows for reaches where spring runoff is to be predicted. This data is discussed in detail in section 5: Hydrology Data.

The TAPEDIT control file specifies what data is to be generated by the CRSM and what is to be done with the data. The first part of the TAPEDIT control file specifies what data should be generated by the CRSM and transferred to the TAPEDIT output program. This information includes the types of output desired, the locations in the basin where the output is desired, and the length of periods desired. The second part of the TAPEDIT control file specifies what the TAPEDIT output program is to do with the data. This part of the file controls the printing, plotting, and manipulation of data and supplies labels for tables and plots.

6.3 CRSM Output Data

There are two sets of output from the CRSM. The first set of output comes directly from the model while the second set of output comes from the TAPEDIT output program (see figure 3.1).

The first set of output, called the CRSM output, contains run information, error messages, debugging information, shortage messages, comment messages, and an annual flow and salt summary table. This information is received each time the model is run and is controlled by the CRSM control file.

The second set of output contains all the detailed output data from the model. The TAPEDIT output program has the ability to print tables, create plots, and manipulate data like adding and subtracting output data or performing statistical analyses on the data. Data that can be obtained through the TAPEDIT output program includes flow of the river, quality of the river, quantity or quality of inflow, planned or actual diversions, reservoir operation data, powerplant data, planned or actual amounts of consumptive use, and flow-weighted salinity of riverflow. Several of these items are broken down into specific information like monthly reservoir contents, uncontrolled spills, controlled releases, and release salinity concentrations.

6.4 General Flowchart of CRSM

The general flowchart on figure 6.1 illustrates the basic flow of the model. The flowchart includes the three major subroutines that are used in the model during each month of simulation: SURPLUS, HYDRBAL, AND RSALT. Each of these subroutines in turn calls other subroutines, not shown on the figure, to perform its basic function.

Subroutine SURPLUS is the part of the model that determines monthly releases from Lakes Powell and Mead, incorporating operational strategies and legislative requirements. In determining monthly releases from Lakes Powell and Mead, subroutine SURPLUS uses forecast procedures, strategies to distribute surplus water or shortages, minimum delivery requirements, minimum storage requirements, reservoir balancing, and flood control regulations. Each of these items is discussed individually in sections 7 and 8.

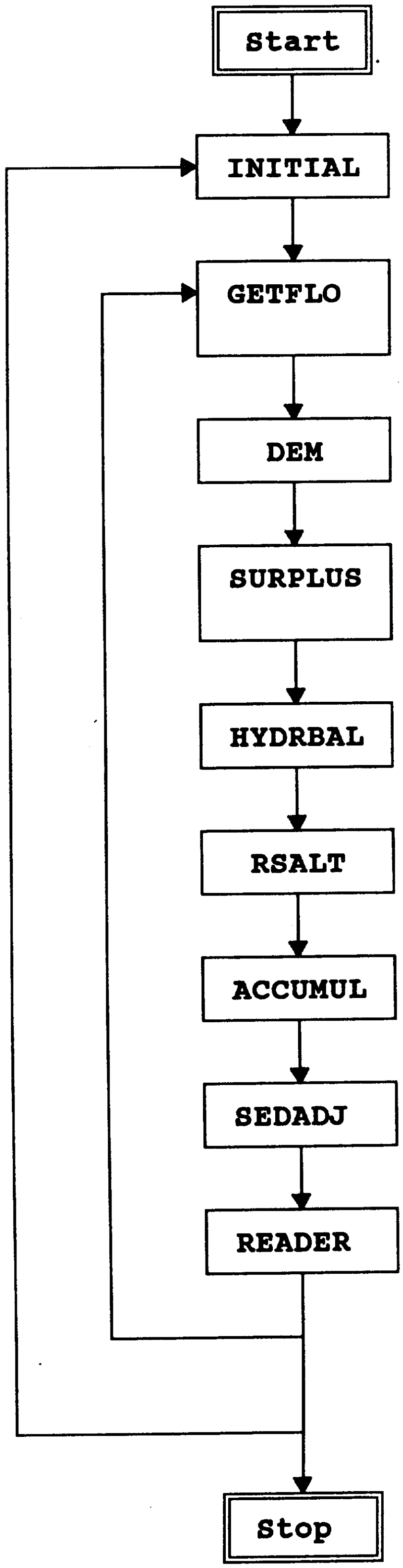
Subroutine HYDRBAL routes the water through the system. This subroutine handles inflows, return inflows, deliveries, reservoir operations, and power generation. Each of these items is discussed individually in sections 7, 9, and 11.

Subroutine RSALT routes the salt through the system. The salt routing procedures are discussed in section 10.

This flowchart is intended to give only a very general picture of flow through the model. A detailed flowchart of what happens in the model is presented in the next section.

6.5 Detailed Flowchart of CRSM

A detailed flowchart of the CRSM is presented on figure 6.2. This flowchart lays out the major steps, decisions, and equations in the CRSM and its main subroutines. The flowchart should be used to understand the steps and procedures the model follows to simulate operation of the Colorado River System. Additional discussions on procedures and underlying assumptions are given throughout the remainder of this System Overview.



Begin the computer run.

Begin new simulation. Read input data.

Begin new month of simulation.
Read monthly flow and salt data.

Compute scheduled diversions and consumptive use.

Compute releases from Lakes Powell and Mead.
Apply surplus or shortage strategies.

Process inflows, diversions, and reservoirs.

Route the salt through the system.

Save results for this month's simulation.

Adjust reservoirs for sediment accumulation.

Read input data that changes between months.

If there is another month of simulation, return to beginning of loop to simulate the next month.

If there is another simulation, increment the hydrology record and return to beginning of loop.

Output the results and end the computer run.

Figure 6.1 General Flowchart of CRSM

```
  ***********
  *  CRSM   *                                         READ AND PROCESS THE RUN DATA.
B *         *
  *         *  ***********
  *         *>>* INITIAL *                            INITIALIZE THE RUN:
  *         *  *         *                            GET DATE AND TIME.  SET VALUES = 0.
  *         *  *         *  ***********
  *         *  *         *<>* RESBAL  *               SET VALUES = 0.
  *         *  *         *  ***********
  *         *  *         *  ***********
  *         *  *         *<>* RANFSET *               SET RANDOM NUMBER GENERATOR SEED. (RANFSET IS AN ENTRY POINT IN RANF38.)
  *         *  *         *  ***********
  *         *  *         *                            READ AND PROCESS INPUT DATA.
  *         *  *         *  ***********
  *         *  *         *<>* READER  *               READ AND PROCESS INPUT DATA.
  *         *  *         *  ***********
  *         *  *         *                            SET UP TABLES, FLAGS, AND TITLES.
  *         *  *         *  ***********
  *         *  *         *<>* CREATIS *               CREATE THE INDEX-SEQUENTIAL RANDOM-ACCESS OUTPUT FILE.
  *         *  *         *  ***********
  *         *  *         *                            WRITE HEADING INFORMATION TO THE INDEX-SEQUENTIAL FILE.
  *         *  *         *                            READ GENERAL INFORMATION FROM THE HYDROLOGY FILE.
  *         *  *         *  ***********
  *         *  *         *>>* GETFLO  *               SET VALUES = 0.
  *         *  *         *<<*         *               IF BEGINNING MONTH IS .NE. 1 AND .LE. 9, READ SPRING RUNOFF DATA FOR THE YEAR.
  *         *  *         *  ***********
  *         *  *         *  ***********
  *         *  *         *<>*  ACOMP  *               SET INITIAL RESERVOIR ELEVATION AND AREA, IF THEY WEREN'T READ IN.
  *         *  *         *  ***********
  *         *  *         *  ***********
  *         *  *         *>>*   DEM   *               COMPUTE DIVERSION AND CONSUMPTIVE USE FOR EACH MONTH OF YEAR 1, FOR EACH
  *         *  *         *<<*         *                 DEMAND.
  *         *  *         *  ***********
  *         *  *         *  ***********
  *         *  *         *<>* FLOWHT  *               SET VALUES = 0.  SET UP REACH INDICES.
  *         *  *         *  ***********
  *         *<<*         *
  *         *  ***********
  *         *
A *         *                                         BEGIN TO MODEL THE SYSTEM FOR A TIME PERIOD OF ONE MONTH.
  *         *
  *         *  ***********
  *         *>>* GETFLO  *                            IF MONTH = 1, READ SPRING RUNOFF DATA FOR THE YEAR.
  *         *<<*         *                            READ HYDROLOGY DATA FOR THE MONTH.
  *         *  ***********
  *         *
  *         *  ***********
  *         *<>* SNAPER  *                            IF THERE IS SNAPSHOT DATA, PROCESS THE DATA.
  *         *  ***********
  *         *                                         IF MONTH = 1 AND YEAR IS .NE. 1, CALL DEM:
  *         *  ***********
  *         *>>*   DEM   *                            COMPUTE DIVERSION AND CONSUMPTIVE USE FOR EACH MONTH OF THE YEAR, FOR EACH
  *         *<<*         *                              DEMAND.
  *         *  ***********
  *         *
  *         *  ***********
  *         *>>* SURPLUS *                            DETERMINE THE MONTHLY RELEASES FROM LAKES POWELL AND MEAD:
  *         *  *         *
  *         *  *         *                            IF MONTH = 1, CALL SIXO2A:
```

Figure 6.2 Detailed Flowchart of CRSM

```
*  CRSM   *  * SURPLUS *  ***********
*         *  *         *>>>* SIX02A *
*         *  *         *  *         *
*         *  *         *<<<         *
*         *  *         *  ***********
*         *  *         *
*         *  *         *  ***********
*         *  *         *>>>*  APPOR *
*         *  *         *  *         *
```

```
COMPUTE REQUIRED 602(A) STORAGE IN THE UB RESERVOIRS:
AVERAGE ANNUAL UB DEPLETION = AVERAGE OF ANNUAL DEPLETIONS FOR THE NEXT "L"
  YEARS + AVERAGE ANNUAL UB EVAPORATION.  ("L" IS EQUAL TO THE LENGTH OF
  CRITICAL PERIOD.)
MINIMUM POWER POOL TO PRESERVE = MINIMUM POWER POOL TO PRESERVE IN THE UB
  RESERVOIRS SPECIFIED IN THE CRSM CONTROL FILE - SEDIMENT ACCUMULATED
  IN LIVE CAPACITY SINCE BEGINNING OF SIMULATION.
REQUIRED STORAGE = AVERAGE ANNUAL UB DEPLETION REDUCED BY AN ALLOWABLE
  SHORTAGE, IF SPECIFIED + THE LAKE POWELL ANNUAL OBJECTIVE MINIMUM
  RELEASE - THE AVERAGE ANNUAL NATURAL FLOW AT LEES FERRY FOR THE
  CRITICAL PERIOD, ALL TIMES THE CRITICAL PERIOD, + MINIMUM POWER POOL
  TO PRESERVE.

IF THE OPERATION STRATEGY = 0, SET THE MONTHLY DELIVERY TO CAP & MWD TO THEIR
  NORMAL DELIVERY SCHEDULES (I.E. NO SURPLUSES ARE SCHEDULED).
IF IOS(6) = 3, BYPASS SURPLUS & SHORTAGE COMPUTATIONS -- OTHERWISE CALL APPOR:

COMPUTE SURPLUSES OR SHORTAGES:
IF THIS IS THE FIRST MONTH OF THE RUN, COMPUTE INITIAL VALUES AND
  SET SHORTAGE AND SURPLUS FLAGS = 0.
SET MONTHLY SHORTAGE VALUES = 0.
IF MONTH IS .NE. 10, SKIP DOWN TO "BEGIN MONTHLY SURPLUS DISTRIBUTIONS."

BEGIN SURPLUS COMPUTATIONS:

SET SURPLUS FLAG = 0.
SET POWELL MONTHLY RELEASES = MONTHLY RELEASES SCHEDULED TO MEET THE
  OBJECTIVE MINIMUM RELEASE.
POWELL MINIMUM ANNUAL RELEASE = SUM OF POWELL MONTHLY RELEASES.

[COMPUTE ANNUAL SURPLUS RELEASE FROM LAKE MEAD:]
COMPUTE ESTIMATED UB AND LB USES INCLUDING EVAPORATION.
COMPUTE POWELL AND MEAD COMBINED CONTENTS.
IF OPERATION STRATEGY = 0, BYPASS SURPLUS COMPUTATIONS -- SKIP DOWN TO "BEGIN
  SHORTAGE COMPUTATIONS."
EOWY (END OF WATER YEAR) COMBINED TARGET STORAGE = CAPACITY OF POWELL AND
  MEAD - 70% OF FLOOD CONTROL SPACE REQUIRED ON OCT. 1.   (30% IS ASSUMED TO
  BE AVAILABLE SPACE IN UB RESERVOIRS.)
SURPLUS RELEASE FROM MEAD = COMBINED CONTENTS - EOWY COMBINED TARGET STORAGE +
  INFLOW CORRESPONDING TO THE OPERATION STRATEGY ASSURANCE LEVEL - UB & LB
  USES.
IF SURPLUS RELEASE IS .LT. 200,000 AF, SET SURPLUS RELEASE = 0.
IF SURPLUS RELEASE IS BETWEEN 200,000 AND 300,000 AF,
  SET SURPLUS RELEASE = 300,000 AF.
IF SURPLUS RELEASE = 0 OR LESS, SKIP DOWN TO "BEGIN SHORTAGE COMPUTATIONS."
SET SURPLUS FLAG = 1 (ON).

[COMPUTE ANNUAL SURPLUS DELIVERIES:]
MAXIMUM SURPLUS TO CAP & MWD = 2 X THE AVAILABLE EXCESS DIVERSION CAPACITY
  IN THE AQUEDUCT WHICH HAS THE LEAST AVAILABLE EXCESS DIVERSION CAPACITY.
  IF CAP CAN NOT YET TAKE A SURPLUS, MWD CAN TAKE UP TO ITS CAPACITY.
SURPLUS DELIVERY TO CAP & MWD = LESSER OF THE MAXIMUM SURPLUS TO CAP & MWD
  AND THE SURPLUS RELEASE FROM MEAD.
DISTRIBUTE ON A MONTHLY BASIS THE SURPLUS DELIVERY TO CAP & MWD, PROPORTIONED
  TO EACH AQUEDUCT BY THE RELATION OF THE EXCESS DIVERSION CAPACITY AVAILABLE
  IN THE AQUEDUCT FOR THE MONTH TO THE EXCESS DIVERSION CAPACITY AVAILABLE
  IN THE AQUEDUCT FOR THE YEAR.
IF THERE IS AT LEAST 200,000 AF OF SURPLUS RELEASE REMAINING, SET
```

```
*  CRSM  * * SURPLUS * *  APPOR  *   SURPLUS DELIVERY TO MEXICO = 200,000 AF, AND SET
*        * *         * *         *   SURPLUS DELIVERY TO MEXICO FOR POWER OPERATIONS = REMAINING SURPLUS RELEASE.
*        * *         * *         *
*        * *         * *         * [COMPUTE ANNUAL SURPLUS RELEASE FROM LAKE POWELL:]
*        * *         * *         * EOWY POWELL TARGET STORAGE = A SPECIFIED PERCENTAGE (USUALLY 50%) OF:
*        * *         * *         *   POWELL AND MEAD COMBINED CONTENTS + AVERAGE NATURAL FLOW AT LEES FERRY -
*        * *         * *         *   UB AND LB USES - SURPLUS RELEASE FROM MEAD.
*        * *         * *         * EOWY PREDICTED TOTAL UB STORAGE = EOWY POWELL TARGET STORAGE + CONTENTS OF
*        * *         * *         *   FLAMING GORGE, BLUE MESA, AND NAVAJO.
*        * *         * *         * IF EOWY PREDICTED TOTAL UB STORAGE IS .LT. THE REQUIRED 602(A) STORAGE +
*        * *         * *         *   AVERAGE NATURAL FLOW AT LEES FERRY - NATURAL FLOW AT LEES FERRY AT A
*        * *         * *         *   SPECIFIED PERCENTILE (USUALLY LOWER DECILE), THEN SET EOWY POWELL TARGET
*        * *         * *         *   STORAGE = THE REQUIRED 602(A) STORAGE + AVERAGE FLOW - SPECIFIED PERCENTILE
*        * *         * *         *   FLOW - CONTENTS OF FLAMING GORGE, BLUE MESA, AND NAVAJO.
*        * *         * *         * SURPLUS RELEASE FROM POWELL = POWELL CONTENTS - EOWY POWELL TARGET STORAGE +
*        * *         * *         *   AVERAGE NATURAL FLOW AT LEES FERRY - UB USES - POWELL MINIMUM ANNUAL RELEASE.
*        * *         * *         * IF THE TOTAL RELEASE FROM POWELL IS .GT. THE TOTAL RELEASE FROM MEAD, AND
*        * *         * *         *   POWELL CONTENTS IS .LT. MEAD CONTENTS, SET SURPLUS RELEASE FROM POWELL =
*        * *         * *         *   TOTAL RELEASE FROM MEAD - POWELL MINIMIUM ANNUAL RELEASE.
*        * *         * *         * IF SURPLUS RELEASE FROM POWELL = 0 OR LESS, SKIP DOWN TO "BEGIN MONTHLY
*        * *         * *         *   SURPLUS DISTRIBUTIONS."  (MONTHLY POWELL RELEASES WILL REMAIN EQUAL TO
*        * *         * *         *   THE MONTHLY RELEASES SCHEDULED TO MEET THE OBJECTIVE MINIMUM RELEASE.)
*        * *         * *         *
*        * *         * *         * [COMPUTE MONTHLY POWELL RELEASES:]
*        * *         * *         * TOTAL ANNUAL RELEASE FROM POWELL = MINIMUM ANNUAL RELEASE + SURPLUS RELEASE
*        * *         * *         *   FROM POWELL.
*        * *         * *         * COMPUTE THE MAXIMUM DESIRED MONTHLY RELEASE FROM POWELL BASED ON 6 OF 8
*        * *         * *         *   GENERATOR UNITS OPERATING AT MAXIMUM CAPACITY.
*        * *         * *         * DISTRIBUTE HALF OF THE TOTAL ANNUAL RELEASE FROM POWELL TO OCTOBER THROUGH
*        * *         * *         *   MARCH IN PROPORTION TO THE MINIMUM RELEASE SCHEDULE.  IF ANY MONTHLY RELEASE
*        * *         * *         *   EXCEEDS THE MAXIMUM DESIRED MONTHLY RELEASE, DELAY THE EXCESS TO THE NEXT
*        * *         * *         *   MONTH.
*        * *         * *         * (MONTHLY MEAD RELEASES ARE COMPUTED IN SUBROUTINE SURPLUS BASED ON NORMAL
*        * *         * *         *   DELIVERIES TO LB USERS AND SURPLUS DELIVERIES TO CAP, MWD, AND MEXICO.)
*        * *         * *         *
*        * *         * *         * BEGIN MONTHLY SURPLUS DISTRIBUTIONS:
*        * *         * *         *
*        * *         * *         * (MONTHLY SURPLUS DISTRIBUTIONS FOR CAP AND MWD WERE COMPUTED IN
*        * *         * *         *   OCTOBER AS PART OF THE ANNUAL SURPLUS COMPUTATIONS.  THIS SECTION
*        * *         * *         *   DISTRIBUTES THE ANNUAL SURPLUS DELIVERIES TO MEXICO.)
*        * *         * *         * IF MONTH IS APRIL THROUGH SEPTEMBER, SET THE ANNUAL SURPLUS DELIVERY TO MEXICO
*        * *         * *         *   FOR POWER OPERATIONS = 0.
*        * *         * *         * IF THE SURPLUS FLAG = 0 (OFF), SKIP DOWN TO "BEGIN SHORTAGE COMPUTATIONS."
*        * *         * *         * COMPUTE THE SURPLUS DELIVERY TO MEXICO FOR THE CURRENT MONTH BY PROPORTIONING
*        * *         * *         *   THE 200,000 AF SURPLUS DELIVERY TO MEXICO ACCORDING TO THE NORMAL MEXICAN
*        * *         * *         *   DEMAND SCHEDULE AND BY PROPORTIONING THE SURPLUS DELIVERY TO MEXICO FOR
*        * *         * *         *   POWER OPERATIONS ACCORDING TO A GENERALLY-OBSERVED HISTORICAL MEAD RELEASE
*        * *         * *         *   PATTERN.
*        * *         * *         * IF THE NORMAL CONSUMPTIVE USE BELOW PARKER DAM + THE MONTHLY SURPLUS DELIVERY
*        * *         * *         *   TO MEXICO IS .GT. THE MAXIMUM AVERAGE MONTHLY PARKER POWERPLANT RELEASE, SET
*        * *         * *         *   THE MONTHLY SURPLUS DELIVERY TO MEXICO = THE MAXIMUM AVERAGE MONTHLY PARKER
*        * *         * *         *   POWERPLANT RELEASE - THE NORMAL CONSUMPTIVE USE BELOW PARKER DAM.
*        * *         *<<*        * EXIT FROM SUBROUTINE APPOR.
*        * *         * *         *
*        * *         * *         * BEGIN SHORTAGE COMPUTATIONS:
*        * *         * *         *
*        * *         *<<*        * IF CAP IS NOT ON LINE, BYPASS SHORTAGE STRATEGY.  EXIT FROM SUBROUTINE APPOR.
*        * *         *<<*        * IF IOS(6) = 2, BYPASS SHORTAGE STRATEGY.  EXIT FROM SUBROUTINE APPOR.
*        * *         *<<*        * IF MONTH IS .NE. 1 AND SHORTAGE FLAG = 0 (OFF), EXIT FROM SUBROUTINE APPOR.
```

* CRSM * * SURPLUS * * APPOR *

IF MONTH IS .NE. 1 AND SHORTAGE FLAG = 1 (ON), SKIP DOWN TO "BEGIN MONTHLY SHORTAGE DISTRIBUTION."

[BEGIN ANNUAL SHORTAGE COMPUTATIONS:]
SET SHORTAGE FLAG = 0 (OFF).
IF THE ELEVATION OF MEAD IS .GT. THE SHORTAGE FLAG ELEVATION (THE ELEVATION OF MEAD THAT TRIGGERS THE SHORTAGE CRITERIA), EXIT FROM SUBROUTINE APPOR.
SET SHORTAGE FLAG = 1 (ON).

[COMPUTE FIRST LEVEL OF SHORTAGES:]
ANNUAL SHORTAGES TO CAP = NORMAL ANNUAL DELIVERY TO CAP - MINIMUM ANNUAL DELIVERY TO CAP.
ANNUAL SHORTAGE TO SNWP (SOUTHERN NEVADA WATER PROJECT) = 4% OF THE ANNUAL SHORTAGE TO CAP.
IF ANNUAL CONSUMPTIVE USE OF SNWP IS .LE. 256,000 AF, SET THE ANNUAL SHORTAGE TO SNWP = 0.
COMPUTE A PROJECTED MEAD ELEVATION = THE ELEVATION MEAD WOULD BE AT IF CAP AND SNWP WERE SHORTED BY THE ANNUAL AMOUNTS COMPUTED ABOVE.
IF THE PROJECTED MEAD ELEVATION IS .GT. THE MINIMUM MEAD ELEVATION (THE ELEVATION OF MEAD THAT TRIGGERS THE ADDITIONAL LEVELS OF SHORTAGES), THEN KEEP THE CURRENT LEVEL OF SHORTAGES AND SKIP DOWN TO "BEGIN MONTHLY SHORTAGE DISTRIBUTION."

[COMPUTE SECOND LEVEL OF SHORTAGES:]
DEFICIENCY = VOLUME OF MEAD AT MINIMUM MEAD ELEVATION - VOLUME OF MEAD AT THE PROJECTED MEAD ELEVATION.
ANNUAL SHORTAGE TO SNWP = ANNUAL SHORTAGE TO SNWP + 4% OF DEFICIENCY.
IF THE ANNUAL SHORTAGE TO SNWP IS .GT. THE ANNUAL CONSUMPTIVE USE OF SNWP, SET THE ANNUAL SHORTAGE TO SNWP = THE ANNUAL CONSUMPTIVE USE OF SNWP.
DEFICIENCY = DEFICIENCY - ANNUAL SHORTAGE TO SNWP.
ANNUAL SHORTAGE TO CAP = ANNUAL SHORTAGE TO CAP + DEFICIENCY.
IF DEFICIENCY IS .LE. THE MINIMUM DELIVERY TO CAP (I.E. CAP CAN TAKE ALL THE DEFICIENCY), THEN KEEP THE CURRENT ANNUAL SHORTAGES AND SKIP DOWN TO "BEGIN MONTHLY SHORTAGE DISTRIBUTION."

[COMPUTE THIRD LEVEL OF SHORTAGES:]
ANNUAL SHORTAGE TO CAP = NORMAL ANNUAL DELIVERY TO CAP.
DEFICIENCY = DEFICIENCY - MINIMUM ANNUAL DELIVERY TO CAP. (THIS SETS THE DEFICIENCY TO THE DEFICIENCY REMAINING AFTER CAP IS SHORTED TO ZERO.)
SHORT MEXICO IN PROPORTION TO UNITED STATES SHORTAGES: ANNUAL SHORTAGE TO MEXICO = LAST YEAR'S UB SHORTAGES + ANNUAL SHORTAGES TO CAP AND SNWP, PROPORTIONED BY THE RELATION OF MEXICO'S NORMAL DELIVERY TO THE TOTAL UB AND LB USES.

BEGIN MONTHLY SHORTAGE DISTRIBUTION:

MONTHLY SHORTAGE TO SNWP = THE ANNUAL SHORTAGE TO SNWP PROPORTIONED BY THE RELATION OF THE NORMAL MONTHLY CONSUMPTIVE USE OF SNWP TO THE NORMAL ANNUAL CONSUMPTIVE USE OF SNWP.
MONTHLY SHORTAGE TO MEXICO = THE ANNUAL SHORTAGE TO MEXICO PROPORTIONED BY THE RELATION OF THE NORMAL MONTHLY DELIVERY TO MEXICO TO THE NORMAL ANNUAL DELIVERY TO MEXICO.
MONTHLY SHORTAGE TO CAP = THE NORMAL MONTHLY DELIVERY TO CAP - THE MINIMUM MONTHLY DELIVERY TO CAP (THIS IS THE FIRST LEVEL OF SHORTAGE), + ADDITIONAL LEVELS OF ANNUAL SHORTAGE PROPORTIONED BY THE RELATION OF THE MINIMUM MONTHLY DELIVERY TO CAP TO THE MINIMUM ANNUAL DELIVERY TO CAP.
IF ANY OF THE MONTHLY SHORTAGE AMOUNTS ARE LESS THAN ZERO, SET THEM = ZERO.

```
*  CRSM  *  * SURPLUS *
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MINIMUM ANNUAL RELEASE FROM LAKE POWELL = SUM OF THE MONTHLY POWELL RELEASES COMPUTED IN SUBROUTINE APPOR. (IF APPOR WAS BYPASSED, THE MINIMUM ANNUAL RELEASE = THE ANNUAL OBJECTIVE MINIMUM RELEASE.)
COMPUTE POWELL MINIMUM AND MAXIMUM MONTHLY RELEASES.
SET MEAD RELEASE = D/S DEMANDS (INCLUDING SHORTAGES OR SURPLUSES).
ADJUST MEAD RELEASE TO MEET MOHAVE AND HAVASU TARGET STORAGE LEVELS AND TO ACCOUNT FOR INFLOWS D/S OF MEAD AND EVAPORATION FROM MOHAVE AND HAVASU.
SET POWELL RELEASE = POWELL RELEASE SCHEDULED IN SUBROUTINE APPOR. (IF APPOR WAS BYPASSED, RELEASE = RELEASE REQUIRED TO MEET THE OBJECTIVE MINIMUM RELEASE.)
COMPUTE RUNOFF FORECAST ERROR TERM.

```
*>>*  RULES  *
```

COMPUTE UB RESERVOIR TARGET STORAGE CONTENTS FOR THE MONTH:
IF MONTH IS .GE. 8, THE TARGET SPACES OF FLAMING GORGE, BLUE MESA, AND NAVAJO ARE EQUAL TO THE TARGET SPACES FOR THE MONTH SPECIFIED IN THE DATA STATEMENT. (THE TARGET SPACES OF OTHER UB RESERVOIRS ARE ALWAYS = 0.)
IF MONTH IS .LT. 8, CALL FORCST:

```
*>>*  FORCST  *
*<<*          *
```

COMPUTE A TARGET SPACE FOR FLAMING GORGE, BLUE MESA, AND NAVAJO BASED ON FORECASTED INFLOWS TO THESE RESERVOIRS.

COMPUTE CONTENTS RATIO = UB CONTENTS / UB CAPACITY
IF POWELL IS ABOVE TURBINE OVERLOAD ELEVATION, SET UB RESERVOIR TARGET CONTENTS = LIVE CAPACITY - TARGET SPACE.
IF POWELL IS BETWEEN RATED HEAD AND TURBINE OVERLOAD ELEVATIONS, SET FLAMING GORGE TARGET CONTENTS = THE LARGER OF ITS RATED HEAD CONTENTS OR ITS MAXIMUM CAPACITY X RATIO, AND SET THE OTHER UB RESERVOIR TARGET CONTENTS = LIVE CAPACITY - TARGET SPACE.
IF POWELL IS BETWEEN MINIMUM POWER POOL AND RATED HEAD ELEVATIONS, SET FLAMING GORGE, BLUE MESA, AND NAVAJO TARGET CONTENTS = THE LARGER OF THEIR RATED HEAD CONTENTS OR THEIR MAXIMUM CAPACITIES X RATIO, AND SET MORROW POINT AND CRYSTAL TARGET CONTENTS = LIVE CAPACITY.
IF POWELL IS NEAR MINIMUM POWER POOL, SET UB RESERVOIR TARGET CONTENTS = THEIR MINIMUM POWER POOLS OR MINIMUM OPERATING LEVELS (NAVAJO).

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*<<*
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*<<*
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IF MONTH IS .GT. 9, EXIT FROM SURPLUS.
COMPUTE THE FORECASTED INFLOW TO POWELL FROM THE ACTUAL INFLOW TO POWELL, THE FORECAST ERROR TERM, AND UB DEPLETIONS.
REMAINING POWELL RELEASE (THROUGH EOWY) = THE ANNUAL POWELL RELEASE SCHEDULED IN SUBROUTINE APPOR - THE RELEASES MADE SINCE BEGINNING OF WATER YEAR.
IF REMAINING POWELL RELEASE IS .LT. POWELL MINIMUM RELEASE OVER THE REMAINING MONTHS, SET THE REMAINING POWELL RELEASE = THE POWELL MINIMUM RELEASE X THE NUMBER OF MONTHS REMAINING.
EFFECTIVE SPACE IN UB RESERVOIRS = THE SMALLER OF EITHER THE CURRENT SPACE OR THE ESTIMATED END OF JULY SPACE IN FLAMING GORGE, BLUE MESA, AND NAVAJO.
FORECASTED INFLOW TO POWELL = FORECASTED INFLOW TO POWELL - EFFECTIVE SPACE IN THE UB RESERVOIRS.
POWELL EOWY PREDICTED CONTENTS = CONTENTS + FORECASTED INFLOW - REMAINING RELEASE - BANK STORAGE - EVAPORATION (THROUGH EOWY).
TOTAL UB PREDICTED CONTENTS = UB CONTENTS + POWELL EOWY PREDICTED CONTENTS.
REMAINING MEAD RELEASE (THROUGH EOWY) = SUM OF SCHEDULED MEAD RELEASES THROUGH EOWY.
MEAD EOWY PREDICTED CONTENTS = CONTENTS + REMAINING POWELL RELEASE - REMAINING MEAD RELEASE - BANK STORAGE - EVAPORATION (THROUGH EOWY).
IF IOS(5) = 1, BYPASS THE 602(A) CONSTRAINT ON EQUALIZING AND EQUALIZE POWELL AND MEAD IF POWELL CONTENTS ARE .GE. MEAD CONTENTS.
IF IOS(5) = 2, BYPASS THE EQUALIZING OF POWELL AND MEAD.
IF TOTAL UB PREDICTED CONTENTS IS .LT. 602(A) REQUIRED STORAGE, BYPASS THE EQUALIZING OF POWELL AND MEAD.

```
*  CRSM   *  * SURPLUS *                           IF MEAD EOWY PREDICTED CONTENTS ARE .GE. POWELL EOWY PREDICTED CONTENTS,
*         *  *         *                             BYPASS THE EQUALIZING OF POWELL AND MEAD.
*         *  *         *                           ADDITIONAL RELEASE FOR EQUALIZING = HALF THE DIFFERENCE BETWEEN THE EOWY
*         *  *         *                             PREDICTED CONTENTS OF POWELL AND MEAD, DIVIDED BY THE NUMBER OF MONTHS
*         *  *         *                             REMAINING UNTIL THE EOWY.
*         *  *         *                           POWELL RELEASE = THE REMAINING POWELL RELEASE PROPORTIONED BY THE RELATION OF
*         *  *         *                             THE POWELL RELEASE SCHEDULED FOR THE CURRENT MONTH TO THE POWELL RELEASE
*         *  *         *                             SCHEDULED FOR THE CURRENT MONTH THROUGH SEPTEMBER, PLUS ANY ADDITIONAL
*         *  *         *                             RELEASE FOR EQUALIZATION.
*         *  *         *                           LIMIT THE POWELL RELEASE TO THE MINIMUM OR MAXIMUM RELEASE IF NEEDED.
*         *<<*         *                           IF MONTH IS 1 THROUGH 7, EXIT FROM SURPLUS.
*         *  *         *                           COMPUTE ESTIMATED MEAD INFLOW.
*         *  *         *                           COMPUTE AVAILABLE SPACE IN POWELL AND MEAD.
*         *<<*         *                           IF IOS(1) IS .GT. O, BYPASS MIN12.  EXIT FROM SURPLUS.
*         *  *         *  ***********
*         *  *         *>>*  MIN12  *              COMPUTE THE MINIMUM REQUIRED FLOOD CONTROL RELEASE FROM MEAD FOR THE MONTH,
*         *  *         *<<*         *                BASED ON ESTIMATED MEAD INFLOW AND AVAILABLE SPACE IN POWELL AND MEAD.
*         *  *         *  ***********
*         *  *         *                           IF A FLOOD CONTROL RELEASE IS REQUIRED, TURN THE SHORTAGE FLAG OFF.
*         *  *         *                           IF THE FLOOD CONTROL RELEASE IS .GT. SCHEDULED DOWNSTREAM DEMANDS, CALL
*         *  *         *                             SUBROUTINE FLOOD TO DISTRIBUTE THE EXCESS RELEASE TO CAP, MWD, AND MEXICO:
*         *  *         *  ***********
*         *  *         *>>*  FLOOD  *              DISTRIBUTE THE EXCESS RELEASE EVENLY TO CAP & MWD. IF CAP IS NOT YET TAKING A
*         *  *         *  *         *                SURPLUS, MWD CAN TAKE UP TO ITS CAPACITY.
*         *  *         *  *         *              IF EITHER CAP OR MWD REACHES THEIR CAPACITY BEFORE THE EXCESS IS FULLY
*         *  *         *  *         *                DISTRIBUTED, THE OTHER AQUEDUCT CAN TAKE UP TO ITS CAPACITY.
*         *  *         *<<*         *              IF CAP & MWD ARE BOTH AT THEIR CAPACITIES, REMAINING EXCESS GOES TO MEXICO.
*         *  *         *  ***********
*         *  *         *                           IF MEAD RELEASE (BASED ON DEMANDS) IS .LT. THE MINIMUM REQUIRED FLOOD CONTROL
*         *  *         *                             RELEASE, SET THE MEAD RELEASE = THE MINIMUM REQUIRED FLOOD CONTROL RELEASE.
*         *<<*         *
*         *  ***********
*         *
*         *  ***********
*         *>>* HYDRBAL *                           HYDROLOGICALLY BALANCE THE SYSTEM FOR THE MONTH:
*         *  *         *                           [FLOW IN THE RIVER IS A SINGLE VALUE THAT IS CARRIED FROM SEQUENCE POINT TO
*         *  *         *                             SEQUENCE POINT AND ADJUSTED FOR DIVERSIONS, RELEASES, AND INFLOWS.]
*         *  *         *                           IF THIS IS THE FIRST SEQUENCE POINT IN A REACH, SET FLOW IN THE RIVER =
*         *  *         *                             THE INFLOW AT THE FIRST SEQUENCE POINT.
*         *  *         *
*         *  *         *                           PROCESS THE NEXT SEQUENCE POINT IN THE SYSTEM:
*         *  *         *                           DEPENDING ON WHETHER THE SEQUENCE POINT IS A DEMAND, RESERVOIR, OR INFLOW,
*         *  *         *                             SKIP DOWN TO ONE OF THE 3 LINES MARKED WITH ****.
*         *  *         *
*         *  *         *                           **** IF THE SEQUENCE POINT IS A DEMAND DO THE FOLLOWING:
*         *  *         *
*         *  *         *                           IF THE DEMAND IS CAP, MWD, SNWP, OR MEXICO, SHORT OR SURPLUS THE DEMAND BY
*         *  *         *                             THE AMOUNT DETERMINED IN SUBROUTINE APPOR.
*         *  *         *                           IF THE DEMAND IS A PUMPED DIVERSION FROM A RESERVOIR, COMPUTE THE AMOUNT OF
*         *  *         *                             DIVERSION. THE WATER WILL BE REMOVED FROM THE RIVER WHEN THE RESERVOIR IS
*         *  *         *                             PROCESSED.  OTHERWISE:
*         *  *         *                           FLOW IN THE RIVER = FLOW IN THE RIVER - THE DEMAND.
*         *  *         *                           IF THE FLOW IN THE RIVER IS POSITIVE, SKIP DOWN TO SUBROUTINE RETURN.
*         *  *         *                           IF THE FLOW IN THE RIVER IS NEGATIVE, CALL ON UPSTREAM RESERVOIRS FOR
*         *  *         *                             A POSSIBLE SUPPLY AS FOLLOWS:
*         *  *         *  ***********
*         *  *         *>>* DQDHMX   *             RANK THE U/S RESERVOIRS THAT ARE DESIGNATED TO SUPPLY ADDITIONAL WATER IN
*         *  *         *<<*         *               DESCENDING ORDER BY THE SIZE OF THEIR CURRENT SURFACE AREA.
*         *  *         *  ***********
```

```
*  CRSM   *  * HYDRBAL *                          IF THERE IS NO ADDITIONAL WATER AVAILABLE, SET THE FLOW IN THE RIVER = 10 AF
*         *  *         *                            AND SKIP DOWN TO SUBROUTINE RETURN.
*         *  *         *  ***********
*         *  *         *>>>* RESBAL  *            CALL ON THE HIGHEST RANKED RESERVOIR TO REDUCE THE DEFICIT:
*         *  *         *<<<*         *            IF RESERVOIR CONTENTS ARE .LE. INACTIVE CAPACITY, RETURN TO HYDRBAL.
*         *  *         *   *         *            SET DESIRED ADDITIONAL RELEASE = DEFICIT.
*         *  *         *   *         *            ADJUST DESIRED ADDITIONAL RELEASE TO KEEP THE TOTAL RELEASE AND CONTENTS
*         *  *         *   *         *              WITHIN MAXIMUM AND MINIMUM CONSTRAINTS. (MAINTAINING TARGET CONTENTS ARE
*         *  *         *   *         *              NOT A PRIORITY WHEN MEETING A D/S DEMAND.)
*         *  *         *   *         *            NEW RELEASE = PREVIOUS RELEASE + DESIRED ADDITIONAL RELEASE.
*         *  *         *   *         *            COMPUTE NEW EVAPORATION, BANK STORAGE, ELEVATION, AND AREA.
*         *  *         *   *         *  ***********
*         *  *         *   *         *>>>* PWRSIM  * RE-SIMULATE POWERPLANT OPERATION FOR THE MONTH FOR THIS RESERVOIR.
*         *  *         *   *         *   *         *   RE-COMPUTE TAILWATER ELEVATION, GROSS HEAD, DISCHARGE, HORSEPOWER,
*         *  *         *   *         *   *         *   POWER GENERATION, AND HOURS OF OPERATION.
*         *  *         *   *         *   *         * IF POWER IS THE FIRST PRIORITY, FLAG WHETHER THE RELEASE NEEDS TO BE
*         *  *         *   *         *<<<*         *   INCREASED OR DECREASED TO MEET FIRM POWER.
*         *  *         *   *         *  ***********
*         *  *         *   *         *            IF THE RELEASE WAS FLAGGED ABOVE IN PWRSIM, ADJUST THE RELEASE AND RECHECK THE
*         *  *         *   *         *              CONSTRAINTS.
*         *  *         *   *         *            CHECK MASS BALANCE OF THE RESERVOIR. ON FIRST CALL TO RESBAL THIS MONTH
*         *  *         *   *         *              FOR THIS RESERVOIR, THE CHECK IS SPATIAL. ON LATER CALLS THIS MONTH
*         *  *         *<<<*         *              FOR THIS RESERVOIR, THE CHECK IS TEMPORAL.
*         *  *         *  ***********
*         *  *         *  ***********
*         *  *         *>>>*  ROUTE  *            IF AN ADDITIONAL RELEASE WAS OBTAINED FROM THE RESERVOIR, ROUTE THE WATER
*         *  *         *   *         *              THROUGH EACH REACH FROM THE RESERVOIR TO THE DEMAND THAT IS IN SHORT SUPPLY:
*         *  *         *   *         *  ***********
*         *  *         *   *         *>>>* RESBAL  * IF THE REACH CONTAINS A RESERVOIR, TEMPORARILY STORE THE WATER IN THE
*         *  *         *   *         *   *         *   RESERVOIR. IF ALL THE WATER CAN NOT BE TEMPORARILY STORED, INCREASE THE
*         *  *         *   *         *   *         *   RELEASE FROM THE RESERVOIR. (ALL COMPUTATIONS AND CHECKS DESCRIBED IN THE
*         *  *         *   *         *<<<*         *   PREVIOUS CALL TO RESBAL ARE PERFORMED, INCLUDING THE CALL TO PWRSIM.)
*         *  *         *   *         *  ***********
*         *  *         *   *         *  ***********
*         *  *         *   *         *>>>* RESBAL  * IF THE REACH CONTAINS A RESERVOIR, RELEASE THE AMOUNT TEMPORARILY STORED
*         *  *         *   *         *   *         *   IN THE RESERVOIR. (ALL COMPUTATIONS AND CHECKS DESCRIBED IN THE PREVIOUS
*         *  *         *   *         *<<<*         *   CALL TO RESBAL ARE PERFORMED, INCLUDING THE CALL TO PWRSIM.)
*         *  *         *   *         *  ***********
*         *  *         *   *         *            IF THERE IS ANOTHER REACH IN THE PATH, RETURN TO THE BEGINNING OF SUBROUTINE
*         *  *         *   *         *              ROUTE AND PROCESS THE NEXT D/S REACH.
*         *  *         *   *         *  ***********
*         *  *         *   *         *>>>* UPDATE  * UPDATE THE TQTOT ARRAY AT EACH SEQUENCE POINT FROM THE SUPPLYING RESERVOIR
*         *  *         *   *         *<<<*         *   TO THE DEMAND IN SHORT SUPPLY.
*         *  *         *   *         *  ***********
*         *  *         *<<<*         *
*         *  *         *  ***********
*         *  *         *                          REDUCE THE NEGATIVE FLOW IN THE RIVER BY THE AMOUNT SUPPLIED BY THE RESERVOIR.
*         *  *         *                          DETERMINE IF THE NEGATIVE FLOW IN THE RIVER HAS BEEN ENTIRELY TAKEN CARE OF.
*         *  *         *                          IF A DEFICIT STILL REMAINS, GO BACK TO THE CALL TO RESBAL (FROM HYDRBAL)
*         *  *         *                            AND GO THROUGH THE PROCESS AGAIN WITH THE NEXT HIGHEST RANKED RESERVOIR
*         *  *         *                            TO FURTHER REDUCE THE DEFICIT.
*         *  *         *
*         *  *         *                          IF AFTER ALL POSSIBLE SUPPLIES THERE IS STILL NEGATIVE FLOW IN THE RIVER,
*         *  *         *                            SET THE FLOW IN THE RIVER = 10 AF.
*         *  *         *  ***********
*         *  *         *>>>* RETURN  *            IF THE DEMAND WAS NOT ENTIRELY MET, COMPUTE THE PERCENT SHORTAGE.
*         *  *         *   *         *            COMPUTE THE QUANTITY AND QUALITY OF THE RETURN FLOW, INCLUDING SALT PICKUP.
*         *  *         *   *         *            STORE THE QUANTITY AND QUALITY IN THE INFLOW VARIABLE AT THE SEQ. PT.
*         *  *         *   *         *              WHERE THE RETURN FLOW RETURNS TO THE RIVER, OR AT THE POINT
```

```
*  CRSM    *  * HYDRBAL *<<* RETURN  *               IMMEDIATELY D/S OF THE DEMAND (FOR LAGGED FLOWS).
*          *  *         *  **********
*          *  *         *                           PROCESSING OF THIS DEMAND IS COMPLETE. STORE THE FLOW IN THE RIVER
*          *  *         *                             IN THE TQTOT ARRAY FOR THIS SEQ. PT.   RETURN TO THE BEGINNING OF
*          *  *         *                             HYDRBAL AND PROCESS THE NEXT SEQ. PT.
*          *  *         *
*          *  *         *                           **** IF THE SEQUENCE POINT IS A RESERVOIR DO THE FOLLOWING:
*          *  *         *
*          *  *         *  **********
*          *  *         *>>* RESBAL  *              STORE THE INFLOW IN THE RESERVOIR. (THE INFLOW = THE FLOW IN THE RIVER
*          *  *         *  *         *                AT THE SEQ. PT. IMMEDIATELY U/S OF THE RESERVOIR).
*          *  *         *  *         *              SET THE CONTENTS = THE TARGET STORAGE CONTENTS FOR THE MONTH.
*          *  *         *  *         *              ADJUST THE RESERVOIR RELEASE TO OBTAIN THE TARGET CONTENTS.
*          *  *         *  *         *              ADJUST THE CONTENTS AND THE RELEASE TO MEET CONTENTS AND RELEASE CONSTRAINTS.
*          *  *         *  *         *              COMPUTE EVAPORATION, BANK STORAGE, ELEVATION, AND AREA.
*          *  *         *  *         *  **********
*          *  *         *  *         *>>* PWRSIM  * SIMULATE POWERPLANT OPERATION FOR THE MONTH FOR THIS RESERVOIR.
*          *  *         *  *         *  *         *   COMPUTE TAILWATER ELEVATION, GROSS HEAD, DISCHARGE, HORSEPOWER,
*          *  *         *  *         *  *         *   POWER GENERATION, AND HOURS OF OPERATION.
*          *  *         *  *         *  *         * IF POWER IS THE FIRST PRIORITY, FLAG WHETHER THE RELEASE NEEDS TO BE
*          *  *         *  *         *<<*         *   INCREASED OR DECREASED TO MEET FIRM POWER.
*          *  *         *  *         *  **********
*          *  *         *  *         *              IF THE RELEASE WAS FLAGGED ABOVE IN PWRSIM, ADJUST THE RELEASE AND RECHECK THE
*          *  *         *  *         *                CONSTRAINTS.
*          *  *         *<<*         *              CHECK MASS BALANCE OF THE RESERVOIR.
*          *  *         *  **********
*          *  *         *                           PROCESSING OF THIS RESERVOIR IS COMPLETE. STORE THE FLOW IN THE RIVER
*          *  *         *                             (I.E. THE RELEASE) IN THE TQTOT ARRAY FOR THIS SEQ. PT.   RETURN TO THE
*          *  *         *                             BEGINNING OF HYDRBAL AND PROCESS THE NEXT SEQ. PT.
*          *  *         *
*          *  *         *                           **** IF THE SEQUENCE POINT IS AN INFLOW DO THE FOLLOWING:
*          *  *         *
*          *  *         *                           IF THE INFLOW POINT IS A TEMPORARY STORAGE POINT FOR A LAGGED RETURN FLOW,
*          *  *         *                             CALL CHMTT:
*          *  *         *  **********
*          *  *         *>>*  CHMTT  *              OBTAIN THE QUANTITY AND THE QUALITY OF THE FLOW THAT HAS BEEN LAGGED TO RETURN
*          *  *         *  *         *                THIS MONTH AND PLACE THEM IN THE INFLOW VARIABLE AT THE D/S SEQ. PT. WHERE
*          *  *         *  *         *                THE RETURN FLOW RETURNS TO THE RIVER. THEY WILL THEN BE PROCESSED WHEN THAT
*          *  *         *  *         *                D/S SEQ. PT. IS REACHED.
*          *  *         *<<*         *              RETURN TO THE BEGINNING OF HYDRBAL AND PROCESS THE NEXT SEQ. PT.
*          *  *         *  **********
*          *  *         *                           ADD THE INFLOW TO THE FLOW IN THE RIVER.
*          *  *         *                           IF THE FLOW IN THE RIVER IS POSITIVE, STORE THE FLOW IN THE RIVER
*          *  *         *                             IN THE TQTOT ARRAY FOR THIS SEQ. PT.   RETURN TO THE BEGINNING OF
*          *  *         *                             HYDRBAL AND PROCESS THE NEXT SEQ. PT.
*          *  *         *                           IF THE FLOW IN THE RIVER IS NEGATIVE, CALL ON U/S RESERVOIRS
*          *  *         *                             FOR A POSSIBLE SUPPLY AS FOLLOWS:
*          *  *         *  **********
*          *  *         *>>* DQDHMX  *              RANK THE U/S RESERVOIRS THAT ARE DESIGNATED TO SUPPLY ADDITIONAL WATER IN
*          *  *         *<<*         *                DESCENDING ORDER BY THE SIZE OF THEIR CURRENT SURFACE AREA.
*          *  *         *  **********
*          *  *         *                           IF THERE IS NO U/S WATER SUPPLY AVAILABLE, PRINT A NEGATIVE INFLOW
*          *  *         *                             SHORTAGE MESSAGE AND SET THE FLOW IN THE RIVER = 10 AF.
*          *  *         *                             STORE THE FLOW IN THE RIVER IN THE TQTOT ARRAY FOR THIS SEQ. PT.
*          *  *         *                             RETURN TO THE BEGINNING OF HYDRBAL AND PROCESS THE NEXT SEQ. PT.
*          *  *         *                           CALL SUBROUTINES RESBAL AND ROUTE, AS DESCRIBED ABOVE FOR A DEMAND,
*          *  *         *                             TO REDUCE THE DEFICIT CAUSED BY THE NEGATIVE INFLOW.
*          *  *         *                           IF AFTER ALL POSSIBLE SUPPLIES THERE IS STILL NEGATIVE FLOW IN THE RIVER,
*          *  *         *                             PRINT A NEGATIVE INFLOW SHORTAGE MESSAGE AND SET THE FLOW IN THE RIVER
```

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*  CRSM    *  * HYDRBAL *          = 10 AF.
*          *  *         *        PROCESSING OF THIS INFLOW IS COMPLETE. STORE THE FLOW IN THE RIVER IN THE
*          *  *         *          TQTOT ARRAY FOR THIS SEQ. PT.   RETURN TO THE BEGINNING OF HYDRBAL AND
*          *  *         *          PROCESS THE NEXT SEQ. PT.
*          *<<*         *
*          *  ***********
*          *                     SUM CONTENTS OF UB AND LB RESERVOIRS, COMPUTE POWERPLANT BYPASSES, AND SUM
*          *                       UB AND LB POWER GENERATION AND POWERPLANT BYPASSES, FOR OUTPUT VIA TAPEDIT.
*          *  ***********
*          *<>* SCRIB1  *        IF MONTH = 1 AND YEAR = 1 AND PRINT OPTION IS ON, PRINT THE REACH DESCRIPTIONS.
*          *  ***********
*          *
*          *  ***********
*          *>>*  RSALT  *        ROUTE THE SALT DOWN THROUGH THE SYSTEM:
*          *  *         *        IF THIS IS THE FIRST SEQUENCE POINT IN A REACH, SET THE FLOW IN THE RIVER =
*          *  *         *          THE INFLOW AT SEQ. PT. 1, AND SET THE CIR (CONCENTRATION IN THE RIVER) =
*          *  *         *          THE CONCENTRATION OF THE INFLOW AT SEQ. PT. 1.
*          *  *         *          (BOTH VALUES ARE ADJUSTED AS THEY ARE CARRIED FROM SEQ. PT. TO SEQ. PT.)
*          *  *         *
*          *  *         *        PROCESS THE NEXT SEQUENCE POINT IN THE SYSTEM:
*          *  *         *        DEPENDING ON WHETHER THE SEQUENCE POINT IS A DEMAND, RESERVOIR, OR INFLOW,
*          *  *         *          SKIP DOWN TO ONE OF THE THREE LINES MARKED ***.
*          *  *         *
*          *  *         *        *** IF THE SEQUENCE POINT IS A DEMAND DO THE FOLLOWING:
*          *  *         *
*          *  *         *        FLOW IN THE RIVER = FLOW IN THE RIVER - THE ACTUAL DIVERSION COMPUTED IN
*          *  *         *          SUBROUTINE HYDRBAL FOR THIS DEMAND, THIS MONTH.
*          *  *         *        IF THE DEMAND IS AN EXPORT, RECOMPUTE CIR BASED ON THE QUALITY OF THE EXPORT
*          *  *         *          SPECIFIED, OTHERWISE CIR DOESN'T CHANGE BECAUSE THE DIVERSION IS MADE AT
*          *  *         *  ***********   THE SAME CONCENTRATION AS CIR.
*          *  *         *<>* RETURN  *
*          *  *         *  ***********   REPEAT THE COMPUTATIONS PERFORMED DURING THE CALL TO RETURN FROM HYDRBAL.
*          *  *         *
*          *  *         *                IF FLOW IN THE RIVER OR CIR IS NEGATIVE, PRINT MESSAGE.
*          *  *         *                STORE FLOW IN THE RIVER IN THE QTOT ARRAY AND CIR IN THE WQAL ARRAY.
*          *  *         *                PROCESSING OF THE DEMAND IS COMPLETE, RETURN TO THE BEGINNING OF
*          *  *         *                  RSALT AND PROCESS THE NEXT SEQ. PT.
*          *  *         *
*          *  *         *                *** IF THE SEQUENCE POINT IS A RESERVOIR DO THE FOLLOWING:
*          *  *         *  ***********
*          *  *         *>>* RESQAL  *   COMPUTE THE CONCENTRATION OF SALT IN THE RESERVOIR.
*          *  *         *<<*         *   COMPUTE THE CONCENTRATION OF SALT IN THE RELEASE.
*          *  *         *  ***********
*          *  *         *                IF FLOW IN THE RIVER OR CIR IS NEGATIVE, PRINT MESSAGE.
*          *  *         *                STORE FLOW IN THE RIVER (THE RELEASE) IN THE QTOT ARRAY AND
*          *  *         *                  CIR (IN THE RELEASE) IN THE WQAL ARRAY.
*          *  *         *                PROCESSING OF THIS DEMAND IS COMPLETE, RETURN TO THE BEGINNING OF
*          *  *         *                  RSALT AND PROCESS THE NEXT SEQ. PT.
*          *  *         *
*          *  *         *                *** IF THE SEQUENCE POINT IS AN INFLOW DO THE FOLLOWING:
*          *  *         *
*          *  *         *                IF THE INFLOW IS A CHECK STATION, COMPARE CIR AGAINST THE
*          *  *         *  ***********     MAXIMUM AND MINIMUM LIMITS FOR THE STATION.
*          *  *         *>>*  CHMTT  *
*          *  *         *  *         *   REPEAT THE COMPUTATIONS THAT WERE PERFORMED DURING THE CALL TO
*          *  *         *  *         *     CHMTT FROM HYDRBAL.
*          *  *         *  *         *   UPDATE THE TTANK LAG ARRAY TO SHIFT THE STORED FLOWS AND CONCENTRATIONS
                                           NOT YET RETURNED ONE PLACE IN THE ARRAY, SIMULATING ONE MORE
```

```
*  CRSM   *  *  RSALT  *<<*  CHMTT  *        MONTH OF LAG.
*         *  *         *  ***********
*         *  *         *                    COMPUTE A NEW CIR BASED ON THE CURRENT FLOW IN THE RIVER, CURRENT CIR, AND
*         *  *         *                      THE QUANTITY AND QUALITY OF THE INFLOW AT THIS SEQ. PT.
*         *  *         *                    COMPUTE A NEW CIR BASED ON TONS PICKUP OF THE RETURN FLOW (IF APPLICABLE).
*         *  *         *                    IF FLOW IN THE RIVER OR CIR IS NEGATIVE, PRINT MESSAGE.
*         *  *         *                    STORE FLOW IN THE RIVER IN THE QTOT ARRAY AND CIR IN THE WQAL ARRAY.
*         *  *         *                    PROCESSING OF THIS INFLOW IS COMPLETE, RETURN TO THE BEGINNING OF
*         *  *         *                      RSALT AND PROCESS THE NEXT SEQ. PT.
*         *  *         *
*         *  *         *                    AFTER ALL SEQUENCE POINTS HAVE BEEN PROCESSED, COMPARE THE FLOW IN THE
*         *  *         *                      RIVER AT EACH SEQ. PT. STORED IN THE TQTOT ARRAY (IN HYDRBAL) AND
*         *  *         *                      THE QTOT ARRAY (IN RSALT). IF DIFFERENCE IS GREATER THAN 100 AF,
*         *<<*         *                      PRINT AN ERROR MESSAGE.
*         *  ***********
*         *
*         *  ***********
*         *>>* MASSBAL *                    CHECK MASS BALANCE OF WATER IN THE SYSTEM FOR THE MONTH:
*         *  *         *                    COMPUTE THE SUM OF ALL INFLOWS FOR THE MONTH.
*         *  *         *                    COMPUTE THE SUM OF ALL DIVERSIONS, EVAPORATION, STORAGE, AND
*         *  *         *                      FLOW OUT THE LAST REACH, FOR THE MONTH.
*         *<<*         *                    IF THE DIFFERENCE IN THE ABOVE SUMS IS .GT. 1000 AF, PRINT AN ERROR MESSAGE.
*         *  ***********
*         *
*         *  ***********
*         *>>* FLOWHT  *                    ADD THE MONTHLY SALT MASS AND FLOW AT SELECTED POINTS TO THE YEARLY
*         *  *         *                      SALT MASS AND FLOW ACCUMULATORS.
*         *  *         *                    IF THE MONTH = THE ENDING MONTH FOR THE ANNUAL SUMMARY TABLE,
*         *  *         *                      ADD THE YEARLY SALT MASS AND FLOW TO THE OVERALL ACCUMULATORS, AND
*         *<<*         *                      COMPUTE THE YEARLY FLOW-WEIGHTED AVERAGE QUALITY AND SAVE IT.
*         *  ***********
*         *
*         *  ***********
*         *>>* ACCUMUL *                    ACCUMULATE DATA SELECTED FOR OUTPUT TO TAPEDIT.
*         *  *         *                    IF 60 MONTHS OF DATA HAVE BEEN ACCUMULATED, CALL SUBROUTINE SUMATE
*         *  *         *                      TO COMPUTE ANNUAL DATA FROM THE MONTHLY DATA, AND THEN WRITE THE 60 MONTHS
*         *<<*         *                      OF DATA TO THE INDEX-SEQUENTIAL RANDOM-ACCESS FILE.
*         *  ***********
*         *
*         *  ***********
*         *<>* SCRIB2  *                    IF THE PRINT OPTION IS ON, PRINT THE MONTHLY SUMMARY FOR EACH RESERVOIR.
*         *  ***********
*         *
*         *  ***********
*         *>>* SEDADJ  *                    UPDATE THE AREA-CAPACITY COEFFICIENTS, RULE CURVES, AND RESERVOIR CAPACITIES
*         *  *         *                      AND CONTENTS TO REFLECT SEDIMENT ACCUMULATION IN FLAMING GORGE, NAVAJO,
*         *<<*         *                      POWELL, AND MEAD.
*         *  ***********
*         *
*         *                                 IF THIS WAS THE FINAL MONTH AND YEAR OF THE RUN, SKIP DOWN TO
*         *                                   "BEGIN RUN COMPLETION."
*         *                                 INCREMENT THE MONTH.
*         *                                 IF THE MONTH IS .GT. 12, INCREMENT THE YEAR AND SET MONTH = 1.
*         *  ***********
*         *>>* READER  *                    IF IT IS TIME TO READ NEW CARD DATA (TRANSACTION DATA),
*         *<<*         *                      CALL READER AND READ IT.
*         *  ***********
*         *                                 GO BACK TO POINT "A" (JUST ABOVE THE CALL TO GETFLO FROM CRSM).
*         *
```

```
*  CRSM   *
*         *
*         *
*         *  ***********
*         *<>* SHORTMS *
*         *  ***********
*         *  ***********
*         *<>* COMENTS *
*         *  ***********
*         *  ***********
*         *<>* PRNFLW  *
*         *  ***********
*         *
*         *
*         *
*         *
*         *
***********
```

BEGIN RUN COMPLETION:

PRINT RUN INFORMATION.

PRINT THE SHORTAGE MESSAGES GENERATED DURING THE RUN.

PRINT THE COMMENT MESSAGES GENERATED DURING THE RUN.

PRINT THE ANNUAL SUMMARY SHEET.

IF THERE IS ANOTHER RUN TO BE MADE, INCREMENT THE RUN NUMBER AND EITHER THE STARTING YEAR OF HYDROLOGY OR THE OPERATION STRATEGY AND GO BACK TO POINT "B" (JUST ABOVE THE CALL TO INITIAL FROM CRSM).

THIS IS THE END OF THE RUN.

PART III

SPECIFIC MODELING PROCEDURES

7. Hydrologic Analysis

7.1 Runoff Forecast Procedure

The CRSM develops a runoff forecast to simulate operations of Lake Powell and Lake Mead. At Lake Powell, the runoff forecast is used to avoid excessive releases at Glen Canyon Dam, and is also used to predict the EOWY contents of Lakes Powell and Mead to determine if equalization releases are necessary (see section 8.2). At Lake Mead, the runoff forecast is used to determine flood control releases at Hoover Dam during the January to July period (see section 8.6).

7.1.1 Lake Powell Forecast

The CRSM develops a runoff forecast for Lake Powell each month from January through September. Each month, the runoff volume for the current month being modeled through September is forecasted. Because CRSM "reads" the natural inflow that will occur during the forecast period, it already has a perfect forecast. To use the perfect forecast in determining the reservoir operation would unrealistically bias the results obtained from CRSM. So, a forecast error is computed and added to or subtracted from the perfect forecast in order to more realistically simulate the reservoir operation.

The monthly Lake Powell runoff forecast is equal to:

(1) The natural flow into Lake Powell for the current month being modeled through July,

plus

(2) the long-term average natural flow into Lake Powell for the months of August and September,

minus

(3) The estimated depletion in the Upper Basin during the forecast period,

plus

(4) A forecast error, which can be either positive or negative.

Items (1), (2), and (3) are all read from input data files by the CRSM. Item (1) is read from the hydrology data input file. Item (2) is read from the CRSM control file. Item (3) is read from the demand data input file. Item

(4) is computed each month, except August and September in which no forecast error is assumed.

Forecast Error

The runoff forecast error is computed using equations derived from an analysis of past Colorado River forecasts and runoff data for the period 1947 to 1983. Analysis of these data reveals two strongly established patterns: (1) high runoff years are underforecast, and low runoff years are overforecast; (2) the error in this month's seasonal forecast is strongly correlated with the error in the preceding month's forecast. Since these established patterns are inherent in the equations used by the CRSM, the forecast errors computed by the CRSM will also tend to produce these same patterns.

A regression model has been developed to aid in determining the error to be incorporated into the seasonal forecast for each month from January to June. The error is the sum of a deterministic and a random component. The deterministic component is computed from the regression equation. The random component is computed by multiplying the standard error of the regression equation by a random mean deviation selected from the standard normal distribution (mean = 0, variance = 1).

The forecast error equation has the following form (all runoff units are million acre-feet):

$$E_i = a_i X_i + b_i E_{(i-1)} + C_i + Z_r d_i$$

Where:

- I = month
- E_i = error in the forecast for month "i."
- X_i = natural runoff into Lake Powell from month "i" through July.
- a_i = linear regression coefficient for X_i.
- $E_{(i-1)}$ = previous month's forecast error
- b_i = linear regression coefficient for $E_{(i-1)}$.
- C_i = constant term in regression equation for month "i."
- Z_r = randomly determined mean deviation taken from the standard normal distribution
- d_i = standard error of estimate for regression equation for month "i."

The following table summarizes the regression equation coefficients for each month.

Month	(i)	Runoff coefficient (a_i)	Error coefficient (b_i)	Constant (C_i)	Standard error of estimate (d_i)
Jan.	1	0.70	0.00	-8.195	1.270
Feb.	2	0.00	0.80	-0.278	0.977
March	3	0.00	0.90	0.237	0.794
April	4	0.00	0.76	0.027	0.631
May	5	0.00	0.85	0.132	0.377
June	6	0.24	0.79	0.150	0.460

There are three additions to the procedure described above. (1) The magnitude of the June forecast error may not exceed 50 percent of the May forecast error. (2) The July forecast error is equal to 25 percent of the June forecast error. (3) There is no forecast error for the months of August and September.

7.1.2 Lake Mead Forecast

The operation of Lake Mead and Hoover Dam requires a runoff forecast in each month from January through July. Each month, the runoff volume for the current month being modeled through July is forecasted. Flood control operation of Lake Mead requires use of the maximum forecast. The maximum forecast is defined by the flood control criteria for Lake Mead as the estimated inflow volume that, on the average, will not be exceeded 19 times out of 20.

The CRSM first develops a mean monthly forecast for Lake Mead by taking the Lake Powell current month through September forecast, subtracting the portion which is forecast for August and September, and adding the long-term average natural tributary inflows between Lake Powell and Lake Mead for the current month through July period. No additional error is incorporated into the Lake Mead forecast.

The maximum forecast for Lake Mead is determined by adding a monthly constant to the mean forecast. Seven constants are supplied by the CRSM control file that correspond to the seven forecasts from January through July. The constants currently used are:

Forecast period	Quantity added to the Lake Mead mean forecast to determine the maximum forecast (million acre-feet)
January - July	4.980
February - July	4.260
March - July	3.600
April - July	2.970
May - July	2.525
June - July	2.130
July	0.750

7.2 Routing the Water Through the System

The CRSM simulates riverflows on a monthly time frame, starting at the upstream end of the basin and proceeding downstream. Computations are done reach by reach in the order specified as input to the model. Within a reach, computations are done point by point from the upstream to the downstream end.

At the beginning of each monthly time increment, the flow at every sequence point is considered to be zero. In other words, the model assumes all storage of water is in the reservoirs, that no water is stored in the river. Water occurs in the river only as it is routed through the system each month.

A sample river basin is shown on figure 7.1. Each sequence point is either an inflow, a diversion, or a reservoir. A typical order of processing sequence points is given by the numbers on the figure. As the model moves from sequence point to sequence point, the procedure is basically to add inflows to the flow in the river, subtract diversions from the flow in the river, and operate reservoirs to store and release water.

The first sequence point in a reach is always an inflow point. When the first sequence point of a reach is processed each month, a value called "flow in river" is set to zero. On figure 7.1, point 1 is the first sequence point of Reach 1-7. As Reach 1-7 is processed each month, the model first sets flow in river to zero. The model then adds the inflow at point 1 to flow in river. Next, the model adds the inflow at point 2 to flow in river. The model then subtracts the diversion at point 3 from flow in river, and so on. When the entire Reach 1-7 is processed, the value of flow in river computed at point 7 is saved as an inflow to point 25. When Reach 22-30 is processed, point 25 will be processed as an inflow using the value of flow in river computed at point 7 as the inflow amount.

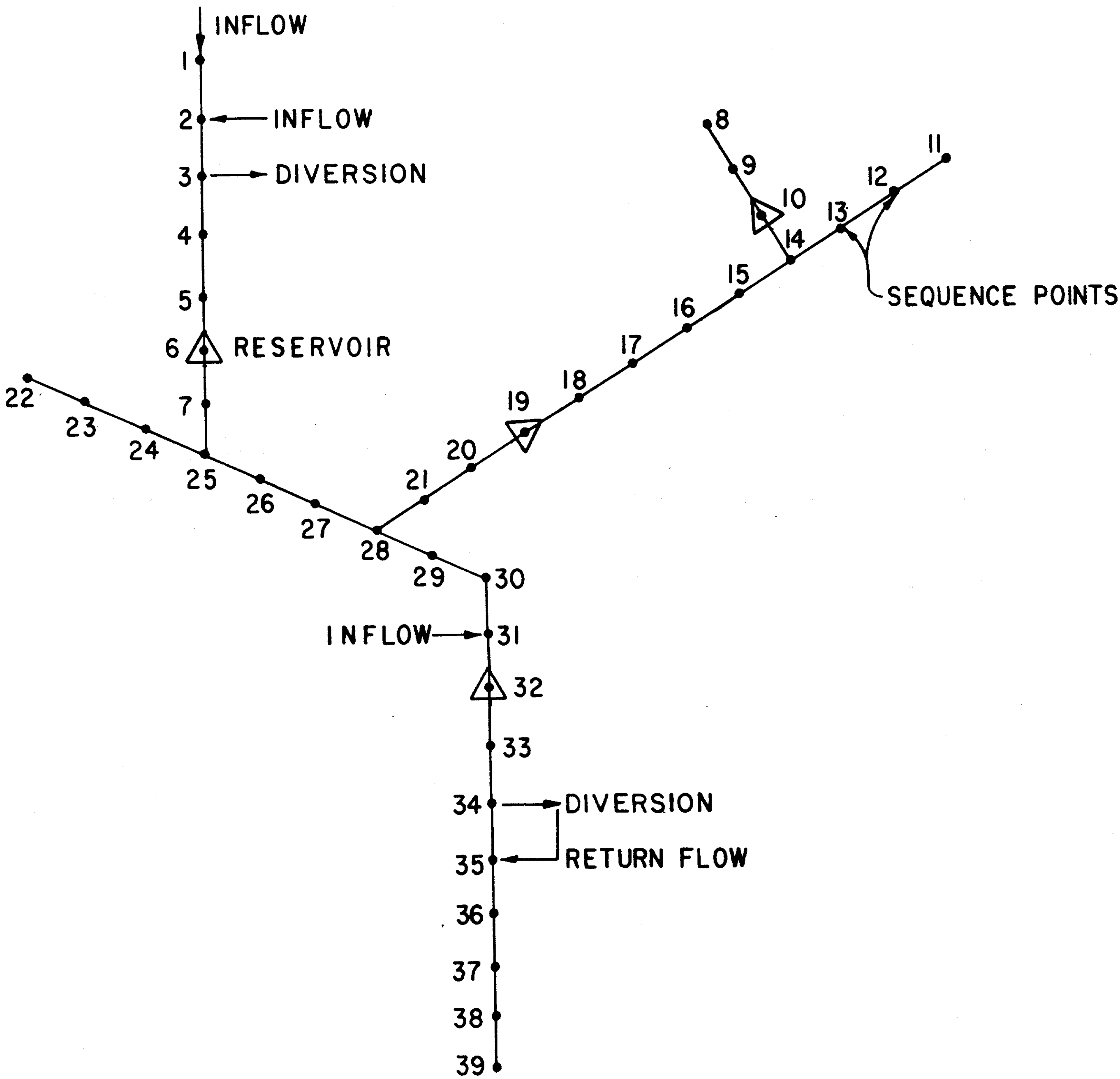


Figure 7.1- Sample River Basin

Inflow points are either hydrology input stations, return flows, flows from upstream reaches, or salinity check points. Hydrology input stations are points where monthly values of flow and salt are introduced into the basin. These monthly values come from the hydrology data input file, which is described in section 5. Return flows are the portions of demands that are diverted but are not consumptively used. These flows are returned to the river at an inflow point downstream of the diversion, but not necessarily to the same reach as the diversion. Salinity check points are points used to check the salinity of the river against maximum and minimum limits specified for the point.

Diversion points are points where water is diverted from the river. Each diversion point has a diversion schedule which is supplied to the model from the demand data input file (see section 4). If there is enough flow in the river at a diversion point to meet the scheduled diversion, then the entire amount is diverted from the river. The diverted water is consumptively used, returned to the river downstream, or a combination of these.

If there is not enough flow in the river to meet a scheduled diversion, designated upstream reservoirs are called upon to supply additional water. Reservoirs that can be used to supply additional water include the reservoir that is in the same reach as the demand, if it is upstream of the diversion, plus any upstream reservoirs specified in the CRSM control file as being able to supply additional water to the demands in this reach. If a diversion is in need of additional water, these reservoirs are ranked in descending order by the size of their current surface areas. The reservoir with the largest surface area then supplies additional water until either the demand is satisfied or the reservoir reaches minimum active capacity or maximum allowable release. If additional water is still needed, the next ranked reservoir is called upon, and so on until the demand is met. If the demand cannot be fully met, the demand is shorted and a shortage message is printed.

The third type of sequence point is the reservoir. Each reservoir has a set of "rule curves" that specify monthly target storage values for each reservoir. These rule curves are read in from the CRSM control file. In addition, the rule curves for Flaming Gorge, Blue Mesa, Navajo, Powell, and Mead are adjusted monthly based on conditions in the system. These rule curves and adjustments are further described in section 11.2. Each time water is routed through a reservoir, the attempt is made to bring the reservoir contents to the specified target storage.

The first step in routing water through a reservoir is to add the flow in the river from the upstream sequence point to the current contents of the reservoir. Next, the reservoir release is increased or decreased to force the contents, with the inflow added in, to meet the target storage. Finally, the release and contents are checked against minimum and maximum values and adjusted if necessary.

The reservoir release becomes the new flow in the river. After the release and contents are determined, a new water surface elevation and area, evaporation, bank storage, and power generation are computed. Two of the reservoirs, Lakes Powell and Mead, have special procedures for determining releases; these are discussed separately in section 8.

A numerical example of how water is routed through a reach is given on figure 7.2.

Salt in the river is routed through the system similarly to the procedure of routing water. Salt is added to the river at inflow points, diverted from the river at diversion points, and mixed into reservoir contents. The procedure is described in detail in section 10.

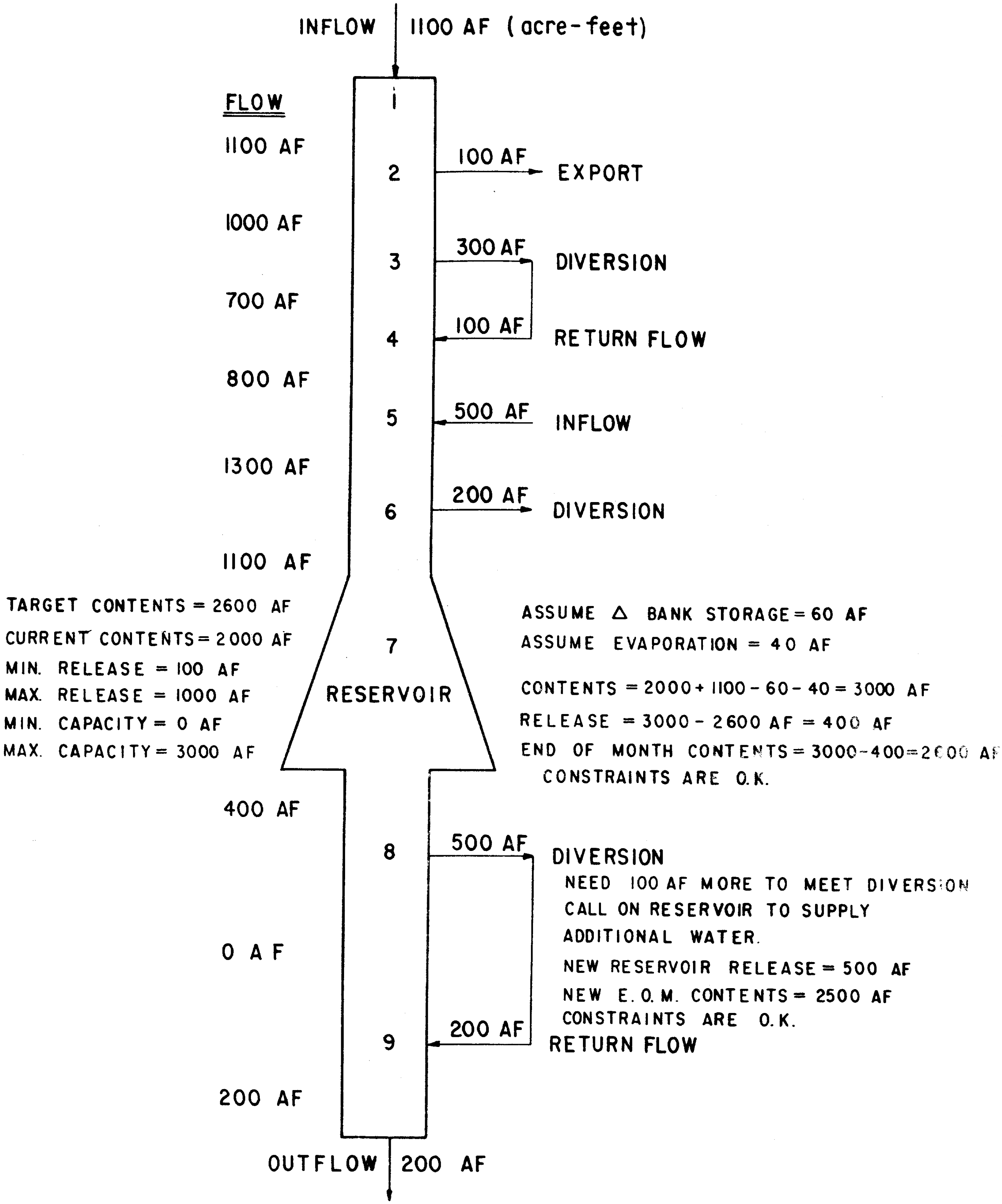


Figure 7.2 - Example of Water Routing

8. Releases From Lakes Powell and Mead

8.1 General

Lakes Powell and Mead are operated differently than the other Colorado River reservoirs. Lakes Powell and Mead are operated not only to meet target storage levels each month, but also to meet specific requirements of each reservoir.

Releases from Lake Powell are made to satisfy an objective minimum release schedule. Additional releases are made (1) if Lake Powell exceeds its maximum capacity or target storage levels, (2) if dictated by the surplus strategy, or (3) if needed to equalize the contents of Lakes Powell and Mead.

Releases from Lake Mead are made to satisfy downstream demands. Additional releases are made (1) if Lake Mead exceeds its maximum capacity or target storage levels, (2) if needed to meet the target storage levels of Lakes Mohave and Havasu, (3) if dictated by the surplus strategy, or (4) if needed for flood control regulation.

8.2 Releases from Lake Powell

Releases from Lake Powell are initially scheduled to follow an objective minimum release schedule, and then modified if necessary. Releases in excess of the minimum release schedule can be caused by either (1) Lake Powell exceeding maximum capacity or target storage levels, (2) releases dictated by the surplus strategy, if used, whereby excess releases are scheduled to avoid spills, or (3) releases needed to equalize the active contents of Lakes Powell and Mead by the end of the water year. The objective minimum release is discussed in section 8.2.1, the surplus strategy is discussed in section 8.4, and releases which are scheduled for equalization are discussed in section 8.2.2.

8.2.1 Objective Minimum Release

Article II(2) of <u>Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs</u> specifies "the objective shall be to maintain a minimum release of water from Lake Powell of 8.23 million acre-feet." The CRSM schedules Lake Powell releases to meet this annual objective minimum release. This annual release is divided into 12 monthly releases which are specified in the CRSM control file. Lake Powell monthly releases are equal to these monthly objective minimum releases unless they are increased due to one of the three conditions previously described in section 8.2.

If it is desired to model the operation of the Colorado River using a different objective minimum release from Lake Powell, it can be easily accomplished by changing one line of data in the CRSM control file. This is the only change required to model the river with a different objective minimum release from Lake Powell.

8.2.2 Reservoir Equalizing

Articles II(3) and II(4) of Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs specify that "If, in the plan of operation, the Upper Basin Storage Reservoirs active storage forecast for September 30 of the current water year is greater than the quantity of 602(a) storage determination for that date, water shall be released annually from Lake Powell at a rate greater than 8.23 million acre-feet per year to the extent necessary . . . to maintain, as nearly as practicable, active storage in Lake Mead equal to the active storage in Lake Powell." Furthermore, the annual release made for equalization purposes " . . . will be made to the extent that it can be passed through Glen Canyon Powerplant when operated at the available capability of the powerplant. Any water thus retained in Lake Powell to avoid bypass of water at the Glen Canyon Powerplant will be released through Glen Canyon Powerplant as soon as practicable to equalize the active storage in Lake Powell and Lake Mead."

The CRSM simulates the reservoir equalizing criteria with the following steps. First, the model computes the quantity of 602(a) storage required by the criteria. Details of this computation are described in section 8.2.4. Next, the model predicts the EOWY contents of Lake Powell, Lake Mead, and the sum of Upper Basin reservoirs. Details of how the EOWY contents are predicted are described in section 8.2.3. Next, the model makes two checks to see if the reservoirs should be equalized. If the sum of Upper Basin reservoir contents are greater than the 602(a) storage quantity, and if the predicted EOWY contents of Lake Powell are greater than the predicted EOWY contents of Lake Mead, then the active contents of Lake Powell and Lake Mead are equalized.

The volume of water required to be released from Lake Powell for equalization is computed each month from January through September by taking half of the difference between the predicted EOWY contents of Lake Powell and Lake Mead and dividing by the number of months remaining through September. This procedure spreads the additional releases for equalization out over the water year and closely equalizes the two reservoirs by September 30.

Since the predicted EOWY contents in any given month are only projections, the equalization releases will not exactly balance the reservoirs.

Several constraints in the model can alter the amount of additional release computed as described above. If the additional release would cause the total Upper Basin storage to drop below the 602(a) storage quantity, then the amount of additional release is reduced to prevent this from happening. Likewise, the additional release is reduced if it would cause Lake Mead contents to exceed Lake Mead live capacity below exclusive flood control space.

The total release from Lake Powell is constrained by the maximum release specified in the CRSM control file. For Lake Powell, the maximum release is normally set to powerplant capacity. This will constrain the additional release for equalization to the amount that can go through the Glen Canyon Powerplant. If the additional release is reduced because of the maximum powerplant capacity limitation, a greater amount will be released for equalization in subsequent months since the reservoirs will be further out of balance, unless of course the maximum release is also reached each subsequent month in the water year.

A different than normal pattern will develop if additional releases are being made for equalization and then the spring runoff is significantly less than the runoff used to predict the EOWY contents. In this case, in the month when the predicted EOWY contents of Lake Powell drops below the predicted EOWY contents of Lake Mead, the model will reduce the monthly releases from Lake Powell to less than the monthly objective minimum releases in order to not exceed the annual objective minimum release. What this means is that in order to meet the annual objective minimum release, if the spring runoff was lower than expected and the releases early in the year were therefore greater than needed, then the releases later in the year will be less than that which would normally be needed to meet the objective minimum.

8.2.3 Predicting EOWY Contents

Section 8.2.2 discusses the provision of equalization of the active contents of Lakes Powell and Mead by the end of the water year. In order to satisfy this provision, it is necessary to predict the EOWY contents of Lakes Powell and Mead, and the EOWY contents of the Upper Basin reservoirs. These predictions begin in January and are made each month through the end of the water year. Note that since the model is a monthly model, EOWY contents are the same as September contents.

Lake Powell EOWY contents are computed each month by taking the current contents, adding estimated inflow, and subtracting the assumed release, estimate of evaporation, and change in bank storage. Lake Powell inflow is estimated by taking the remaining monthly inflows from the hydrology record and applying a forecast error term composed of both random and deterministic components. The model assumes that the Lake Powell releases for the remainder of the water year will follow the objective minimum release schedule.

Lake Mead EOWY contents are computed each month by taking the current contents, adding the Powell release (Mead inflow), and subtracting the Mead release, estimate of evaporation, and change in bank storage. The model computes Lake Mead releases for the remainder of the water year based upon downstream demands including any scheduled surplus releases.

Total Upper Basin predicted contents are computed by adding the current contents of Flaming Gorge, Blue Mesa, and Navajo Reservoirs to the predicted EOWY contents of Lake Powell.

8.2.4 602(a) Storage

Section 602(a) of Public Law 90-537 contains provisions for the storage of water in reservoirs of the Colorado River Storage Project and for release of water from Lake Powell. Generally, section 602(a) provides that water not required to be released from Lake Powell as part of the annual objective minimum release shall be stored to assure future deliveries to the Lower Basin without impairing annual consumptive uses in the Upper Basin. It further provides that water not required to be stored for this purpose shall be released from Lake Powell to either maintain, as nearly as practicable, active storage in Lake Mead equal to the active storage in Lake Powell, or to avoid anticipated spills from Lake Powell. The term "602(a) storage" refers to the quantity of water required to be in storage in the Upper Basin so as to assure future deliveries to the Lower Basin without impairing annual consumptive uses in the Upper Basin.

The CRSM, in determining 602(a) storage, considers all relevant factors including, but not limited to, (1) historic streamflows, (2) the most critical period of record, and (3) probabilities of water supply. The computation of 602(a) storage is dependent on four variables specified in the CRSM control file. There are no values "hardwired" into the model. These four variables are:

1. Length of critical period,

2. Average annual natural flow at Lees Ferry for the critical period,

3. Percent shortage to be applied to Upper Basin scheduled depletions for the purpose of computing 602(a) storage, if any,

4. Amount of power pool to be preserved in Upper Basin reservoirs, if any.

The CRSM computes a value of 602(a) storage at the beginning of each calendar year. 602(a) storage is computed by taking the scheduled Upper Basin depletions for the next "n" years (where "n" is equal to the length of critical period), reducing the depletions by the percent shortage, adding the objective minimum release for the next "n" years, subtracting the natural flow at Lees Ferry for the critical period, and adding the amount of minimum power pool to be preserved in the Upper Basin reservoirs.

Note that the method of determining 602(a) storage described here is used for simulation only and is not intended to be a formal determination of 602(a) storage as required by the Criteria for Long-Range Operation of Colorado River Reservoirs.

8.3 Releases from Lake Mead

Releases from Lake Mead are initially scheduled by taking the scheduled consumptive use downstream of Hoover Dam, adding any additional volume of water required to meet reservoir target storage levels for Lake Mohave and Lake Havasu, and subtracting the net volume of gains and losses for the month for all reaches of the system downstream of Hoover Dam.

Releases in excess of the initial release schedule can be caused by either (1) Lake Mead exceeding maximum capacity or target storage levels, (2) releases dictated by the surplus strategy, if used, whereby excess releases are scheduled to avoid spills, or (3) releases dictated by flood control requirements. The initial release schedule can be reduced due to shortage conditions, which are described in section 8.5. The surplus strategy is discussed in section 8.4 and flood control requirements are discussed in section 8.3.1.

8.3.1 Flood Control

The CRSM simulates the flood control operation of Lake Mead in accordance with the regulations published in Exhibit A of the Water Control Manual for Flood Control (December 1982). These regulations are also described in Appendix F of the report Review of Flood Control Regulation - Colorado River Basin - Hoover Dam (July 1982). Both reports are written by the United States Army Corps of Engineers, Los Angeles District. The data values described throughout this section are taken from these reports and are normally used in CRSS simulations. However, the values are part of the CRSM input data and can be readily changed to investigate or evaluate alternative flood control plans.

There are three different flood control procedures in effect during different times of the year. The first procedure is used during the runoff forecast season, January through July. This is the period from the earliest reliable runoff forecast to the conclusion of the snowmelt runoff. The objective during this period is to route the forecasted maximum inflow through the reservoir system using specific rates of Hoover Dam discharge, so that the reservoir system is full by the end of July.

The second flood control procedure is used during the space-building or drawdown season, August through December. The objective during this period is to gradually draw down the reservoir system to create space for the next spring's snowmelt runoff.

The third flood control procedure is in effect all year. The objective of this procedure is to maintain a minimum space of 1.5 million acre-feet in Lake Mead for rain floods.

Forecast Season

The first flood control procedure is used each month during the forecast season, January through July. For each month of the forecast season, the flood control regulations contain a table that gives the minimum average release in cubic feet per second based on the maximum forecast, the available space in Lake Mead (below elevation 1229), and the available space in Lake Powell (below elevation 3700). To determine the minimum average flood control release from Lake Mead each month, the CRSM uses the same iterative procedure that was used to develop the minimum average release tables in the flood control regulations.

The first step in the iterative procedure is to compute a value of minimum average release using a mass balance equation that considers the forecasted inflow, available space, losses, and an assumed Mead release for the remainder of the forecast season. The computation consists of taking the available space in Lakes Powell and Mead, subtracting the exclusive flood control space (1.5 million acre-feet), adding losses from Lakes Powell and Mead, subtracting the maximum forecasted inflow, and adding the discharge from Lake Mead for the remainder of the forecast season at an assumed level 1 discharge rate (see below). Losses consist of evaporation and changes in bank storage at Lakes Powell and Mead, and depletions from Lake Mead. The maximum forecast value used in the computation is described in section 7.1.

The levels of discharge specified in the flood control regulations and used by CRSM are the following:

Level 1 = 19,000 ft^3/s	Parker Powerplant capacity
Level 2 = 28,000 ft^3/s	Nondamaging release limit
Level 3 = 35,000 ft^3/s	Approx. Hoover Powerplant capacity
Level 4 = 40,000 ft^3/s	Historic floodway
Level 5 = 73,000 ft^3/s	Hoover controlled discharge capacity

The minimum average release computed in step 1 is next compared to the assumed discharge level. If the computed release is greater than the assumed discharge level used in the computation, then the procedure is repeated by recomputing the minimum average release using the next higher discharge level in the computation. When the iteration procedure is complete, i.e., the computed release is less than or equal to the discharge level used in the computation, then one final check is made. If the computed release is less than the discharge at the next smaller level than the that used in the final computation, then the minimum average release is set equal to the discharge at the next smaller level.

The release computed by this flood control procedure is the minimum average release for the month. If any other criteria call for a larger release during a given month, like downstream demands, then the larger amount will be released. The CRSM, however, will never decrease the releases from Mead less than the minimum average release computed by this procedure. This procedure is in effect in January through July, the forecast season.

Drawdown Season

The second flood control procedure is used in the drawdown season, August through December. The flood control regulations specify monthly minimum vacant space requirements for Lake Mead that are intended to provide a gradual drawdown of the reservoir system. These values, which are used by the CRSM, are as follows:

August 1	-	1.50 million acre-feet
September 1	-	2.27 million acre-feet
October 1	-	3.04 million acre-feet
November 1	-	3.81 million acre-feet
December 1	-	4.58 million acre-feet
January 1	-	5.35 million acre-feet

The regulations specify maximum amounts of space in Lake Powell, Flaming Gorge, Blue Mesa, and Navajo Reservoirs that can be credited towards the Lake Mead space requirement. These values are respectively 3,850,000; 1,507,200; 748,500; and 1,036,100 acre-feet. In the CRSM, the operation of the Upper Basin reservoirs is determined before the operation of Lake Mead. Therefore, the model knows what the vacant space in these reservoirs will be at the end of the month and can use these values to determine Lake Mead flood control operations.

The required space in Lake Mead is obtained in the model each month by setting the target storage contents for the month to the level that will provide the required space. The release for flood control space-building is then determined so that the reservoir will reach the target storage level. The model, however, constrains the release during the space-building season to 28,000 ft^3/s as specified in the flood control regulations. As in the January to July period, the release may be increased over that which is required for spacebuilding by other criteria such as downstream demands.

Exclusive Space Requirements

The third flood control procedure is used all year. The flood control regulations specify a minimum space of 1.5 million acre-feet in Lake Mead at any time for control of rain floods. Since the CRSM is a monthly model, the model can only deal with this requirement on a monthly basis. Target content levels are set to maintain the required minimum space. The model will force releases to maintain this minimum space on a monthly basis.

Distribution of Excess Releases

Releases from Lake Mead due to flood control that are in excess of normal downstream demands or scheduled surplus deliveries are distributed by the CRSM each month as follows. Excess releases are divided equally between CAP and

MWD. If either aqueduct reaches its maximum capacity and there is excess release remaining, the other aqueduct can take the remaining excess, up to its maximum capacity. After both aqueducts reach their maximum capacities, any remaining excess flows to Mexico. In the years before CAP can take a surplus (specified in the input file), MWD can take all excess releases up to its maximum capacity.

8.4 Surplus Strategy

The surplus strategy is the decisionmaking process used to (1) anticipate spring runoff in excess or surplus of normal demands and storage space, and to (2) distribute this surplus water to users throughout the water year to prevent spills.

The CRSM has a surplus strategy that varies in the degree of assurance of being able to anticipate and distribute surplus water without having to make flood control releases. The amount of assurance, referred to as the assurance level, is input to the model as a probability and serves as the identification of the strategy chosen. For example, an assurance level of 0.95 schedules appropriate surplus releases from Lakes Powell and Mead and distributes them throughout the water year to assure that unscheduled releases for flood control will only be expected in approximately 5 percent of the years of operation.

The surplus strategy in the CRSM is optional. The strategy can be turned off by simply setting the assurance level to zero. If this is done, the CRSM does not schedule any surplus releases from Lakes Powell and Mead in advance. Any surplus releases that occur are due to monthly reservoir operations like flood control, or the contents of Lakes Powell or Mead exceeding their maximum capacities.

Annual surplus releases from Lakes Powell and Mead, and most of the distribution of these releases, are computed at the beginning of each water year (October). The annual surplus release is divided into three categories. Category I is surplus water for CAP and MWD and consists of as much surplus as is available up to their maximum capacities. Category II is surplus water for Mexico and consists of any remaining surplus up to 200,000 acre-feet. Category III is surplus used for power generation operational flexibility and consists of any remaining surplus. Category III surplus water flows to Mexico.

Category I annual surplus is distributed to CAP and MWD on a monthly basis, proportioned to each aqueduct by the ratio of the monthly capacity available in the aqueduct to the annual capacity available in the aqueduct under a normal demand schedule. Category II annual surplus to Mexico is distributed on a monthly basis using the same monthly distribution as the normal Mexican demand schedule. Category III annual surplus to Mexico (for power generation operational flexibility) in October through March is distributed according to a generally observed historical Mead release pattern. In April through September, no Category III surplus releases are scheduled.

Categories I and II surplus releases are committed to be delivered throughout the water year regardless of the actual runoff. Half of Category III and Lake Powell surplus releases are committed to be delivered throughout the first 6 months of the water year. The remaining half of Category III and Lake Powell surplus releases are not committed in order to provide some operational flexibility in case the actual runoff is not as great as the inflow used in the surplus release computations. All surplus releases and deliveries that have been committed by the surplus strategy are added into the normal release and delivery schedules are processed by the model as the normal releases and deliveries are processed.

The annual surplus release from Lake Mead is based on current storage levels of Lakes Powell and Mead, target storage levels of Lakes Powell and Mead, Upper and Lower Basin scheduled depletions, and an assumed inflow to Lake Mead. This assumed inflow is equal to the inflow from the normally distributed natural flow record for Lees Ferry that would occur at a probability level equal to the assurance level specified for the surplus strategy. The annual surplus release may be constrained by Lower Basin powerplant capacity and other limitations.

An EOWY target storage level is computed for Lake Powell based on Lake Mead surplus releases, current storage levels of Lakes Powell and Mead, Upper and Lower Basin scheduled depletions, and the mean annual natural flow at Lees Ferry. In order to assure that 602(a) requirements are met during surplus operations, this EOWY target Powell storage plus the current storage of the other Upper Basin reservoirs is checked against a value equal to 602(a) storage plus a buffer amount. The buffer amount is usually equal to the difference between the mean and lower decile annual natural flow at Lees Ferry although a different percentile could be specified in the input data.

The annual surplus release from Lake Powell is based on the EOWY target storage level for Lake Powell, the current storage level of Lake Powell, Upper Basin depletions, the mean annual natural flow at Lees Ferry, and the assumed minimum annual objective release.

A detailed description of the surplus strategy is given in the Bureau of Reclamation report "Colorado River Alternative Operating Strategies for Distributing Surplus Water and Avoiding Spills."

8.5 Shortage Strategy

The shortage strategy is the decisionmaking process within the CRSM by which water delivery to certain demands in the Lower Basin is curtailed in order to conserve water in Lake Mead to assure future supplies for higher priority users, or to maintain sufficient head for power generation. The shortage strategy has its legal foundation in the Supreme Court Decree in Arizona vs. California, the Colorado River Basin Project Act (Public Law 90-537), and the Mexican Water Treaty.

A sequence of dry years will cause Lake Mead to be drawn down to satisfy water demands in the Lower Basin States and Mexico. If the Lake Powell annual release equals the objective minimum release of 8.23 million acre-feet per year, Lake Mead will be drawn down approximately 1 million acre-feet per year. Should a series of dry years be long enough, eventually Lake Mead would fall below critical operating levels, or even go dry. Such extreme drawdown could be considered contrary to the Supreme Court Decree and Public Law 90-537 which require that consideration be given to holders of higher priority water rights in the Lower Basin States, at the expense of those with lesser priority (primarily CAP and SNWP).

There are three levels of shortages imposed by the CRSM. The elevation of Lake Mead is checked, and levels of shortages are imposed, if necessary, in January of each year. Any shortages that are imposed remain in effect for 1 year. Level 1 shortages are triggered by an elevation specified in the CRSM control file and referred to as the shortage flag elevation. Level 2 shortages are triggered by an elevation specified in the CRSM control file and referred to as the minimum Mead elevation. Level 3 shortages are imposed if the previous two levels of shortages are not sufficient to keep Lake Mead above the minimum Mead elevation.

Level 1 shortages consist of shortages to Arizona and Nevada and are borne by CAP and SNWP, respectively. Arizona's shortage is equal to the difference between CAP's normal diversion and the shortage diversion for CAP specified in the input data. Currently, a shortage diversion to CAP of 450,000 acre-feet per year is often used, however this value is variable. Nevada's shortage is equal to 4 percent of the shortage imposed on Arizona. Four percent is the ratio of Nevada's normal delivery to the total 7.5 MAF allocated to the Lower Basin States.

Level 2 shortages are based on a volume of deficiency which is equal to the volume of Lake Mead at the minimum Mead elevation minus the volume Lake Mead will be at after level 1 shortages are imposed for a year. Level 2 shortages consist of further shortages to CAP and SNWP. SNWP's shortage is equal to 4 percent of the deficiency. CAP's shortage is equal to the remaining deficiency, or the amount that sets CAP's diversion to zero, whichever is less.

Level 3 shortages are imposed if any deficiency remains after level 2 shortages are imposed. Level 3 shortages consist of shorting Mexico proportionately to the shortages imposed on United States users. To compute the shortage to Mexico, Mexico's normal delivery is multiplied by the ratio of U.S. reductions divided by U.S. normal deliveries.

The monthly distributions of the annual shortages are determined as follows. The monthly shortage to SNWP is equal to the annual shortage to SNWP proportioned by the ratio of the normal monthly consumptive use of SNWP to the normal annual consumptive use of SNWP. The monthly shortage to CAP is equal to the normal delivery for the month minus the level 1 shortage delivery for the month specified in the input data, plus level 2 annual shortages proportioned by the ratio of the level 1 shortage delivery for the month to the level 1 shortage delivery for the year. Monthly shortage to Mexico is equal to the annual shortage to Mexico proportioned by the ratio of the normal monthly delivery to Mexico to the annual delivery to Mexico.

The input data that affect the shortage strategy, namely the shortage flag elevation, minimum Mead elevation, and CAP annual and monthly level 1 shortage diversions, can be readily changed in the CRSM control file. Also, the entire shortage strategy can be bypassed during a CRSM run if desired.

9. Power Generation

9.1 General

The CRSM computes monthly electrical power generation and energy generation for Fontenelle, Flaming Gorge, Blue Mesa, Morrow Point, Crystal, Glen Canyon, Hoover, Davis, and Parker powerplants. Power generation is computed in units of kilowatts and energy generation is computed in units of kilowatt hours.

An iteration procedure is necessary to determine the discharge through a powerplant. The iteration procedure begins with the quantity of discharge that would occur operating at maximum horsepower. The discharge is used to compute tailwater elevation, which is subtracted from the reservoir elevation to obtain gross head, which in turn is used to compute a value of actual discharge. The new discharge is compared with the old discharge and, if they differ more than 5 ft^3/s, the computations are repeated starting with the new discharge. When the iteration process is complete, the horsepower produced by the powerplant is computed as a function of the gross head. The total kilowatts produced is then determined from this horsepower. The iteration procedure is further described in section 9.2.

The method used to determine the number of hours of power production and subsequently the amount of energy produced in kilowatt hours is different for the Upper and Lower Basins. The Upper Basin computations assume the powerplant is operating at maximum horsepower at all times. Lower Basin computations assume two levels of power generation, the first level at maximum horsepower, called peak power generation, and the second level at an off-peak or base level of power generation. The powerplant discharges corresponding to the base level of power generation are specified in the CRSM control file.

9.2 Modeling Procedure

The first step in the power generation modeling procedure is to determine whether the gross head is greater than the minimum rated head. For this initial check, the gross head is computed from the average reservoir release for the month. If the gross head is less than the minimum rated head specified in the CRSM control file, no power is produced for the month. If the gross head is greater than the minimum rated head, then power generation is computed using the steps below.

In the power computations, discharge is computed as a function of gross head using a third-degree polynomial equation. Horsepower is similarly computed from gross head. Tailwater elevation is computed from discharge using a third-degree polynomial equation for all dams except Hoover. Tailwater elevation at Hoover Dam is computed as a function of Lake Mohave's water surface elevation and Hoover Dam's discharge.

The first set of computations determines the discharge when operating at maximum horsepower. The generator capacity in kilowatts is computed from the product of the generator rating, power factor, and percent overload. This capacity is divided by the generator efficiency at maximum horsepower to determine the maximum horsepower that can be produced by one generator. The gross head required for maximum horsepower is computed as a function of the maximum horsepower. Next, the turbine discharge at maximum horsepower is determined as a function of this gross head. The iteration procedure begins here.

The first step in the iteration procedure is to compute tailwater elevation from the powerplant discharge at maximum horsepower. Gross head is then computed by taking the average of the beginning and end of month reservoir elevations and subtracting the tailwater elevation. A new value of turbine discharge is then computed as a function of the gross head. If the gross head is greater than the maximum rated head specified in the CRSM control file, then the maximum rated head is used to compute the new turbine discharge.

The new turbine discharge is compared to the initial turbine discharge. If the discharges are within 5 ft^3/s of each other, the iteration is complete and the final computations are performed. If the difference in discharges is greater than 5 ft^3/s, then the iteration procedure is repeated using the new discharge as the initial discharge.

When the iteration process is complete, the final gross head that was computed is used to compute the horsepower produced by one generator. This horsepower is then converted to power in kilowatts, also known as generator capacity. The generator capacity is then multiplied by the number of generating units to determine the powerplant capacity for the month. The turbine discharge is also multiplied by the number of generating units to determine the powerplant discharge, in cubic feet per second.

The method of computing the number of hours of generation and subsequently kilowatt hours of energy depends on the powerplant. The model assumes that Upper Basin powerplants operate at one level of generation and discharge. Hours of generation at Upper Basin powerplants are computed by dividing the total reservoir release through the powerplant for the month in acre-feet by the powerplant discharge in cubic feet per second, and applying the proper conversion factors to convert to hours. The number of hours is then multiplied by the powerplant capacity (kilo-watts produced) to obtain the energy produced for the month in kilowatt hours.

The model assumes that Lower Basin powerplants are operated at two levels of generation and discharge. This is an effort to simulate actual operations at Lower Basin powerplants where frequently a unit is only partially loaded and therefore operating at less than maximum efficiency. The lower level of discharge, called base flow, produces 60, 16, or 8 megawatts of power at Hoover, Davis, and Parker powerplants, respectively. The upper level of discharge, called peak flow, corresponds to the discharge computed earlier by the discharge iteration procedure.

The monthly release in acre-feet at base flow is computed by applying the specified base flow over the entire month. The monthly release in acre-feet at peak flow is computed by subtracting the monthly release at base flow from the reservoir release through the powerplant for the month. The number of hours of generation at peak flows is then computed by dividing the monthly release in acre-feet at peak flow by the difference between peak flow discharge and base flow discharge, and applying the proper conversion factors to convert to hours.

The number of hours of generation at base flow is computed as the difference between the number of hours in the month and the number of hours of generation at peak flow. If the monthly release from the reservoir in cubic feet per second is greater than the peak discharge, then the number of hours of generation at base flow is set to zero. The number of hours of generation at each flow level is multiplied by the powerplant capacity at each level and added together to obtain the total energy produced for the month in kilowatt hours.

10. Salinity

10.1 General

Salinity is the only water quality parameter modeled by the CRSS. Salinity is modeled as total dissolved solids; precipitation and ion exchange are not modeled. Salinity is computed by the CRSM at each point in the system as concentration in the river, in units of mg/L. (The CRSS assumes mg/L and parts per million are equivalent.) The concentration in the river can increase, decrease, or remain constant at each point depending on whether salt is being added or removed, whether water is being added or removed, and on the concentration of the inflow or diversion.

The salt loads from natural point or natural diffuse sources of salinity are included in the natural salt values in the hydrology input data. These salt loads, therefore, enter the system at CRSS inflow points.

10.2 Concentration in the River

The concentration in the river at an inflow point increases if the concentration of the inflow is greater than the concentration in the river. The concentration in the river decreases if the concentration of the inflow is less than the concentration in the river. The concentration of the inflow is computed from the natural salt load in the hydrology input data file.

The concentration in the river at a diversion point normally does not change. With the exception of special exports, diversions are made at the same concentration as the concentration in the river, which, therefore, does not change the concentration in the river. A special export diverts water at the concentration specified in the demand data input file. This allows special exports to divert water at a concentration that is different than the concentration in the river, if the export is actually diverted farther upstream than the CRSM models. The concentration in the river increases if the concentration of the special export is less than the concentration in the river.

The concentration in the river at a return flow point increases if the concentration of the return flow is greater than the concentration in the river. The concentration in the river decreases if the concentration of the return flow is less than the concentration in the river. The concentration of the return flow is firstly dependent on the amount of diversion that is depleted. All salt that is diverted from the river is returned in the return flow, therefore, the greater the depletion, the greater the concentration of the return flow. The concentration of the return flow is also dependent on any salt pickup specified in the demand data input file. An irrigation project which is leaching salts, for example, will have a positive salt pickup and a water quality improvement project will have a negative salt pickup. A positive salt pickup will increase the concentration of the return flow and a negative salt pickup will decrease the concentration of the return flow.

The concentration in the river at a reservoir is the concentration of the release. The concentration in the river increases if the concentration of the reservoir inflow is greater than the concentration of the reservoir. The concentration in the river decreases if the concentration of the reservoir inflow is less than the concentration of the reservoir. The concentration in the river is further altered by the movement of water in and out of bank storage and by evaporation. The evaporation of water is a loss of water with no loss of salt.

Figure 10.1 shows an example of the salt routing process. At a diversion point, concentration in the river is computed by taking the current flow in the river multiplied by the current concentration in the river, subtracting the flow in the diversion multiplied by the concentration of the diversion, and dividing by the new flow in the river. The concentration in the river at an inflow point is computed similarly except the terms are added instead of subtracted. The concentration of a return flow is equal to the concentration of the diversion multiplied by the ratio of the diversion flow to the return flow.

10.3 Reservoir Mixing

The CRSM assumes that the reservoirs are of uniform salinity, and completely mixed at all times. While this is not completely accurate, the difference between this assumption and correlating inflow to outflow through a lag function is small. This was verified as applicable to Lake Mead on a monthly basis by Dr. John Hendrick in his Ph.D. dissertation (1973), Colorado State University.

The concentration in a reservoir is based on the volume of the inflow, the volume of the release, the concentration of the inflow, and the concentration in the reservoir at the beginning of each month. The model has an algorithm which determines the concentration of the reservoir release by weighting the current month's and previous month's reservoir concentrations. This release quality is equivalent to that which would occur from a constantly mixed reservoir with a uniform inflow rate.

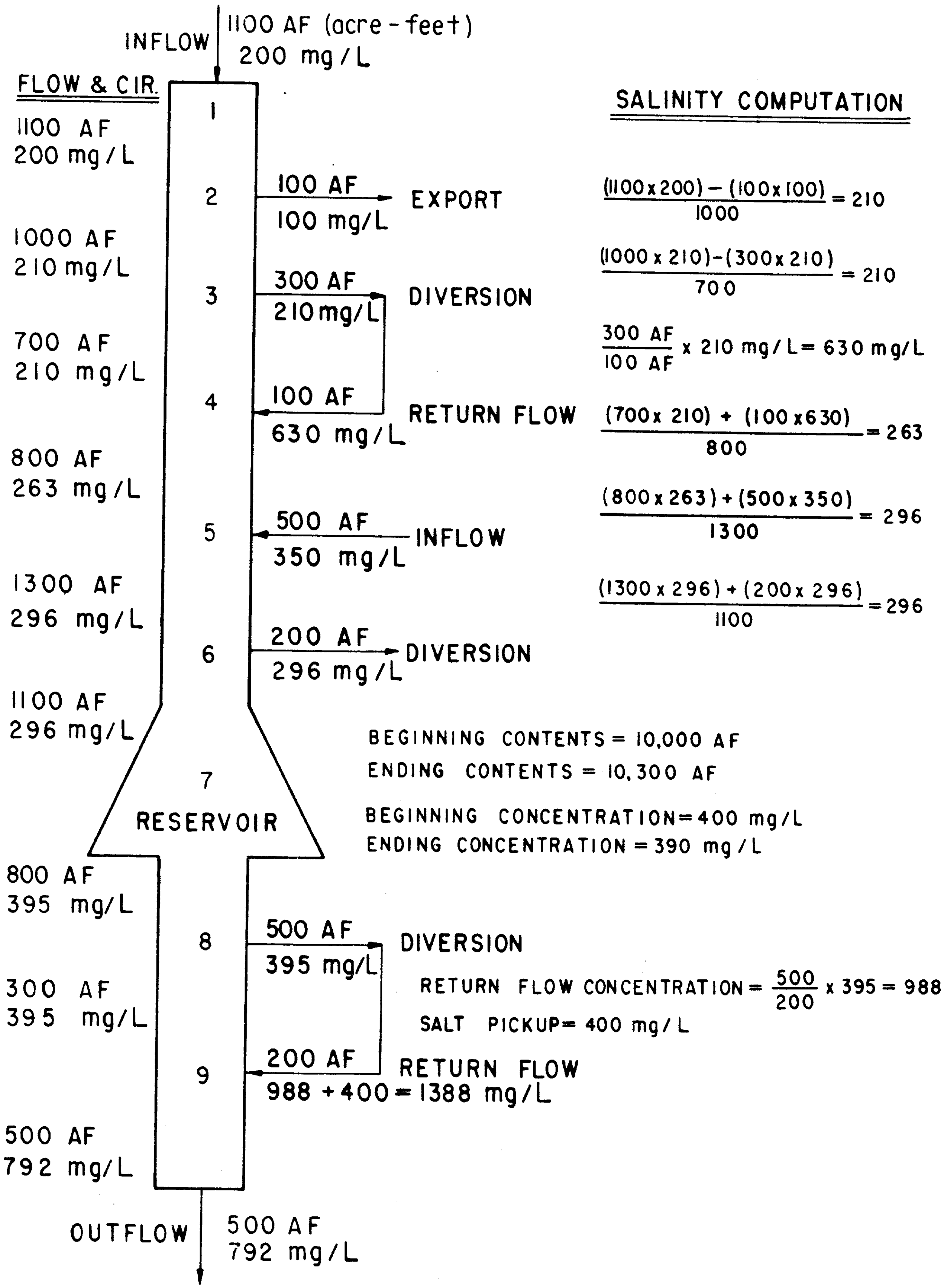


Figure 10.1 Example of Salt Routing

Any flows to bank storage occur at the monthly reservoir concentration. These flows are mixed into a bank storage "tank." When reservoir levels decrease, flows come out of bank storage at the average concentration of the bank storage "tank."

A diversion from a reservoir is made at the same concentration as the concentration in the reservoir.

10.4 Flow-Weighted Averages

Salinities at specific locations are often output from the CRSS as flow-weighted averages. A flow-weighted average is an annual average equal to the sum of tons of salt for each month divided by the sum of the monthly flows. This is in contrast to a time-weighted average, which is the average of each month's concentration. The existing standards in the Colorado River Basin are flow-weighted, and flow-weighting gives a better representation of the overall salt load at a station, especially one which has undergone upstream regulation.

11. Miscellaneous Discussions

11.1 Trended Demands

Demands in the CRSS, i.e. withdrawals and depletions, may be "untrended" or they may be "trended." Untrended demands are held constant from year to year; trended demands vary over time. Trended demands are either linearly trended or stepped.

Linearly trended demands are those in which the annual demand increases or decreases by a uniform amount each year, until a specified quantity is reached in a specified year. An example of such a demand would be a large irrigation project in which the rate of development is fairly uniform over a number of years until full development is reached.

Stepped demands are those in which the demand remains constant for a number of years until it is "stepped" up or down by a specified amount in a specified year. An example of such a demand would be a large thermal powerplant in which each unit would consume a relatively large block of water, and several years would be required to bring additional units on-line.

Demands can be a combination of linearly trended, stepped, and untrended. For example, a demand could follow a pattern such as this:

Year	Withdrawal amount	Demand type	Change each year
1985	20,000		
		> Linearly trended	+1,000
1990	25,000		
		> Linearly trended	+2,000
1995	35,000		
		> Linearly trended	+1,000
2000	40,000		
		> Stepped (in year 2010)	0
2010	50,000		
		> Stepped (in year 2020)	0
2020	60,000		
		> Untrended	0
2040	60,000		

Demands are specified in the demand data base as being either linearly trended or stepped. When the demand data generation program (SMDID) creates the demand data input file to the CRSM, it converts all demands to linearly trended demands. Stepped and untrended demands become linearly trended demands with zero slopes, which means they have a uniform change from year to year of zero.

11.2 Rule Curves

Each reservoir has a set of 12 monthly target storage levels that make up what is known as a rule curve. Each month, releases from a reservoir are initially computed to bring the reservoir's contents to the target storage level specified by its rule curve. If the reservoir's contents are below its rule curve, then the release is initially set to the reservoir's minimum monthly release. If the reservoir's contents are above its rule curve, then the release is initially set to the amount needed to reduce the contents to the target storage level. The release is then adjusted, if necessary, to meet downstream demands, release constraints, storage constraints, or other operating requirements.

Target storage values are obtained or computed in different manners, depending on the reservoir. Initially, target storage values for all reservoirs are read from the CRSM control file, however, the target storage values of several of the reservoirs are modified as the modeling run progresses. The target storage values for Blue Mesa, Morrow Point, Crystal, Flaming Gorge, and Navajo are modified each month depending upon the elevation of Lake Powell. The target storage values for Lake Mead are modified in August through December for flood control.

The target storage values for Blue Mesa, Flaming Gorge, and Navajo are determined from specified target spaces if Lake Powell is above its rated power generation head (elevation 3570). The target spaces for months August through December are specified in the model. The target spaces for months January through July are computed using a simulated forecast procedure which varies the target space as a function of upcoming runoff. This produces a greater drawdown in wet years and a lesser drawdown in dry years, which simulates what is done in actual practice.

The rule curves of the Upper Basin Reservoirs are adjusted as follows. If Lake Powell is above turbine overload elevation (3690), then the target storage values for Flaming Gorge, Blue Mesa, and Navajo are set to live capacity minus target space. The target storage values for Morrow Point and Crystal are set to live capacity.

If Lake Powell is between turbine overload elevation and rated power generation head, then the target storage value for Flaming Gorge is set to the greater of its own rated power generation head contents or a computed percentage of its maximum content. This percentage is computed by dividing the current total Upper Basin contents by the total Upper Basin storage capacity. The target storage values for Blue Mesa and Navajo are set to live capacity minus target space and the target storage values for Morrow Point and Crystal are set to live capacity.

If Lake Powell is between rated power generation head and minimum power pool (elevation 3490), then the target storage values for Blue Mesa, Flaming Gorge, and Navajo are set to the greater of their own rated power generation head contents or the computed percentage of their maximum content. This procedure tends to keep these reservoirs near the same percentage of full content when Lake Powell is below its rated power generation head. The target storage values for Morrow Point and Crystal are set to live capacity.

As Lake Powell approaches its minimum power pool, the target storage values for the Upper Basin reservoirs are set to their minimum power pool contents or minimum operating levels (Navajo). This causes the reservoirs to evacuate storage at their maximum powerplant capacity, tends to keep Glen Canyon powerplant on-line longer, and allows all of the Upper Basin reservoirs to reach their minimum operating levels together.

The target storage values for Lake Mead in January through July are the values that were read from the CRSM control file. The target storage values for Lake Mead in August through December are the target contents needed to obtain required flood control space in Lake Mead. The target values are computed by taking the maximum capacity of Lake Mead, subtracting the required flood control space, and adding creditable flood control space in the Upper Basin reservoirs.

11.3 Shortages

The CRSM computes the amount of shortage that occurs at each diversion point, if there is not sufficient water in the river to satisfy the demand. The model "allows" a certain amount of shortage to occur before a shortage message is printed. This allowable shortage is only valid with respect to the printing of shortage messages and has no affect on the amount of water a demand receives during a shortage condition. The allowable shortage for message printing is specified in the demand data base for each demand.

There are two parts of the model that can impart some type of shortage. In the determination of the 602(a) storage quantity, a shortage factor can be applied to Upper Basin depletions if a shortage value is specified in the CRSM control file (see section 8.2.4). Second, the shortage strategy in the model imposes specific shortages on certain Lower Basin users during shortage conditions (see section 8.5).

Shortages can occur at some diversion points in the model that might not occur in actuality. This can happen at diversion points high in the basin that receive their water from small tributary or offstream reservoirs that are not modeled by the CRSM. (Although the operation of these small reservoirs is not directly modeled, they are used in the derivation of CRSS natural flows.) In the CRSM, these demands get their water directly from the river. If the river runs dry in months of low flow, these demands will incur shortages that might not occur in actuality if there was water available in the small supply reservoirs.

11.4 Bank Storage

The CRSM models reservoir bank storage as a function of reservoir surface storage. Change in bank storage is simply computed as a percentage of the change in reservoir contents for the month. The percentage used for each reservoir is entered into the model from the CRSM control file. The percentages currently being used have been determined in various studies of historical data and are given in appendix B.

11.5 Evaporation

The CRSM models reservoir evaporation as a function of monthly evaporation rates and reservoir surface area. The monthly evaporation rates are entered into the model from the CRSM control file in units of feet. Reservoir evaporation is computed each month by multiplying the reservoir's current surface area by the evaporation rate for that month. Annual evaporation rates are given in appendix B.

11.6 Capacity and Storage

Total capacity of a reservoir is defined as the maximum capacity of the reservoir including any flood control or surcharge capacity. Live capacity is that part of the total capacity from which water can be withdrawn by gravity. Dead storage is equal to total capacity minus live capacity. Active capacity is the portion of live capacity that is normally usable for storage and regulation of reservoir inflows to meet established reservoir operating requirements. Inactive capacity is equal to the difference between live capacity and active capacity. Inactive capacity, for example, might be equal to the volume of water at minimum power pool. In this case, inactive capacity would be equal to volume of water between minimum power pool and top of dead storage.

The parameters in the CRSM that deal with monthly reservoir storage, specifically current reservoir contents and area-capacity coefficients, deal with live capacity only. These parameters do not include dead storage.

Area-capacity coefficients, live capacity, active capacity, and dead storage are updated monthly by the CRSM to account for sediment accumulation in the reservoirs, which is discussed in section 11.6.2.

11.6.1 Area-Capacity Equations

The CRSM computes water surface elevations and surface areas from reservoir contents using a set of area-capacity equations for each reservoir. The CRSM computes reservoir elevation from reservoir contents by determining the root of a second-degree polynomial equation, and computes surface area from elevation by solving a first-degree polynomial equation. The polynomial equation coefficients are based on reservoir area-elevation data and are entered into the model from the CRSM control file. The area-capacity equations deal with live capacity of the reservoir.

The area-capacity coefficients are updated monthly, during a CRSM simulation, to account for increases in sediment. Since a significant amount of sediment has deposited in these reservoirs since their closure, the initial area-capacity coefficients in the CRSM control file have been updated to a 1984 condition.

11.6.2 Sedimentation

The CRSM models sediment accumulation in four of the Colorado River system reservoirs: Flaming Gorge, Navajo, Lake Powell, and Lake Mead. The model simulates the deposition of sediment in these reservoirs by accumulating on a monthly basis the amounts shown below. The monthly volumes shown are for the total reservoir (live capacity + dead storage).

Monthly Sediment Accumulation (acre-feet)

	Flaming Gorge	Navajo	Lake Powell	Lake Mead
January	0	0	3,125	3,208
February	0	0	3,125	3,208
March	0	0	3,125	3,208
April	500	830	9,000	3,208
May	500	830	9,000	3,208
June	500	830	9,000	3,208
July	500	830	9,000	3,208
August	0	0	3,125	3,208
September	0	0	3,125	3,208
October	0	0	3,125	3,208
November	0	0	3,125	3,208
December	0	0	3,125	3,208
Total	2,000	3,320	61,000	38,500

These sediment volumes were estimated by averaging the results of the Lane and Koelzer unit weight method and the Trask unit weight method over the 1944 through 1960 time frame (reference: May 1962, Sedimentation Study, Glen Canyon Dam, CRSP). In order to simplify the sediment procedure, the annual sediment volume is constant from year to year, rather than being a function of annual inflow.

Area-capacity coefficients, live capacity, active capacity, and dead storage are updated monthly by the CRSM to account for sediment accumulation in the reservoirs. The volume of sediment that accumulates in live capacity is determined according to a Type II (Flood plain-Foothill) sediment distribution as defined in Distribution of Sediment in Large Reservoirs by Borland and Miller. Only the portion of sediment that accumulates in live capacity is used in updating the area-capacity coefficients.

PART IV

VALIDATION

12. Comparison with Historical Data

A study was performed to compare historical flow and salt data with flow and salt data generated by a CRSS simulation. The purpose of the study was to verify accuracy of the data and assumptions used in the CRSS, and to provide insight into the areas of the data bases and simulation model that might need improvement or adjustment.

12.1 Data and Procedures

The period chosen to compare historically recorded flow and salt values with CRSS simulated flow and salt values is 1968 to 1983. The advantages for choosing this period are (1) all reservoirs modeled by the CRSS are operational, (2) the available historic data is continuous, and (3) the period is sufficiently long enough to span a wide range of naturally occurring hydrologic events. The main disadvantage is that this period includes the filling of Lake Powell.

Historically recorded flow and salt data were taken from the Colorado River Quality of Water Progress Report. Simulated flow and salt data were generated by the CRSM. The hydrology input data used in the simulation were the natural flow and salt hydrology data base for the period 1968-1983. The 1981-1983 data were provisional at the time of this study.

Depletions for the simulation were taken from the Colorado River System Consumptive Uses and Losses reports. The 1971 through 1980 annual values given in the reports were averaged for the Upper and Lower Basins, and the average values were entered into the CRSM as constant values over the 1968-1983 period. Upper Basin depletions were held constant at 3,047,000 acre-feet and Lower Basin depletions were held constant at 6,133,000 acre-feet. In addition to the above depletions, 514,000 acre-feet of depletions were scheduled for native vegetation and losses from the Senator Wash Dam, Reservoir, and Pumping-generating facility; and 1,515,000 acre-feet of depletions were scheduled for delivery to Mexico. Evaporation is not included in the depletion schedule since it is accounted for by the CRSM.

Bank storage computations at Lake Powell were modified to more accurately reflect what occurred during the filling period. Change in bank storage was modeled at a rate of 15 percent of the change in reservoir contents for 1968-1979, and at a rate of 8 percent for 1980-1983. The bank storage rate modeled at Lake Mead was 6.5 percent.

Initial reservoir contents were set equal to the contents historically recorded on December 31, 1967. Initial reservoir salt concentrations were set equal to the salt concentrations historically recorded during December 1967, in the river below each reservoir. No surplus strategy was used during the CRSM simulation. In order to more accurately simulate the historical release patterns caused by day to day operations of the river system, the monthly reservoir contents in the CRSS simulation were forced to match the historically recorded end-of-month contents.

12.2 Results

Comparisons of flow and salt values are provided at five locations. Results are presented in tabular and graphical forms for each of the five locations. The tables provide monthly values of historic flow, simulated flow, and the difference between historic and simulated flow expressed as a percentage of historic flow. Similar tables are provided for historic and simulated salt values.

Four types of graphs are provided: (1) a time series plot of historic flow and simulated flow, (2) a time series plot of the arithmetic difference between historic and simulated flows, (3) a time series plot of the cumulative arithmetic difference between historic and simulated flows, and (4) a correlation diagram of historic flow plotted against simulated flow. On the fourth graph, the symbol used to identify 1968-1982 values is a square; the symbol used to identify 1983 values is a triangle.

Results show that simulated values are very close to the historic values with flow generally simulated better than salt. Results are summarized in the following table.

Percent difference of 16-year averages (simulated - historic)

Station	Flow	Salt
Colorado River near Cisco, UT	0.15	4.45
Green River at Green River, UT	-1.61	-1.78
Colorado River at Lees Ferry, AZ	-0.67	3.08
Colorado River below Hoover Dam	-1.62	-3.15
Colorado River at Imperial Dam	-4.42	-5.28

As seen in the table, the CRSM generally yields values of flow and salt that are lower than historical data, especially at the lower end of the basin, but that are well within acceptable limits.

It was determined during the study that results were very sensitive to the magnitude of depletions and bank storage rates, especially the cumulative difference graphs. In addition to this, the four graphs reveal some recurring monthly patterns and general trends that might be a result of estimated parameters like monthly demand distributions.

Results are presented on the following pages.

COLORADO RIVER NEAR CISCO, UTAH 9180500 RUN DATE 85/05/13.

HISTORIC FLOW FOR STATION 9180500 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	205.29	193.11	171.04	230.21	667.21	1170.66	305.54	364.92	158.68	213.39	256.43	248.37	4184.85
1969	259.42	188.59	249.80	714.20	987.39	731.10	471.82	198.97	239.94	324.14	288.92	252.12	4906.41
1970	235.72	219.75	276.66	327.36	1384.50	1339.85	537.71	245.06	406.78	359.83	338.27	316.96	5988.44
1971	332.00	320.61	412.69	579.48	767.97	1141.11	535.45	245.93	282.41	279.65	276.10	284.14	5457.54
1972	267.24	226.67	278.98	201.64	452.95	758.83	191.53	119.45	200.69	302.29	281.30	267.16	3548.72
1973	282.57	210.65	240.32	387.97	1556.65	1557.25	798.66	330.61	220.49	250.85	247.50	290.03	6373.54
1974	311.55	294.09	363.36	361.31	1016.35	746.93	313.43	160.70	157.89	205.85	258.91	225.88	4416.24
1975	235.82	207.22	240.44	377.06	1007.16	1243.26	806.51	226.38	185.16	233.06	278.60	262.30	5302.97
1976	229.51	206.19	220.19	276.64	639.20	591.86	231.18	150.43	176.31	218.84	219.65	219.36	3379.35
1977	206.52	146.12	123.53	97.49	142.75	167.82	126.92	108.66	127.04	141.19	142.34	129.70	1660.09
1978	136.56	138.43	191.43	476.64	956.74	1343.23	535.41	159.43	181.69	200.21	249.27	244.03	4813.06
1979	238.81	251.11	371.43	715.96	1513.41	1555.46	755.10	278.29	218.05	225.03	225.80	258.07	6606.52
1980	261.88	257.40	272.81	565.71	1655.23	1578.27	509.32	203.09	206.40	220.27	264.02	255.04	6249.45
1981	228.80	162.23	155.29	175.08	296.41	406.76	195.75	127.02	183.06	242.50	199.92	178.99	2551.81
1982	170.09	205.95	263.21	409.16	893.21	1064.94	589.56	352.92	380.02	371.63	321.27	286.79	5308.74
1983	252.12	229.91	298.85	448.21	1563.00	2740.40	1699.66	672.59	307.94	350.92	327.50	344.81	9235.91
TOT	3853.90	3458.03	4130.02	6344.13	15500.14	18137.72	8603.53	3944.45	3632.54	4139.65	4175.78	4063.75	79983.65
AVG	240.87	216.13	258.13	396.51	968.76	1133.61	537.72	246.53	227.03	258.73	260.99	253.98	4998.98

MINIMUM HISTORIC FLOW = 97.49 MAXIMUM HISTORIC FLOW = 2740.40

SIMULATED FLOW FOR STATION 9180500 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	200.25	191.10	170.11	189.40	535.68	1289.76	378.51	427.38	186.46	208.08	252.50	240.04	4269.27
1969	254.19	184.20	238.42	749.36	1111.91	559.04	548.31	278.23	270.25	319.01	287.32	234.20	5034.42
1970	225.41	203.55	250.22	272.90	1422.07	1268.87	650.36	338.27	426.84	369.94	332.81	295.08	6056.30
1971	305.94	292.62	385.21	566.59	630.90	1210.67	635.05	324.14	285.58	274.87	274.69	277.47	5463.72
1972	251.35	211.11	284.26	196.86	413.70	796.06	221.59	158.48	227.16	325.43	267.53	254.88	3608.41
1973	260.70	198.44	230.51	360.52	1493.34	1533.70	904.17	425.15	234.78	240.55	232.58	270.08	6384.51
1974	280.47	270.75	342.53	347.20	1121.28	705.31	359.83	202.72	161.05	193.93	252.59	213.79	4451.45
1975	224.15	199.30	234.00	331.66	888.56	1254.87	1004.19	268.54	182.13	212.38	267.38	248.00	5315.16
1976	215.39	197.27	209.54	303.15	593.57	472.05	243.67	152.46	185.83	221.27	212.65	203.73	3210.57
1977	191.60	137.95	143.40	128.58	49.43	34.42	27.23	72.28	126.63	154.13	161.65	144.32	1371.60
1978	143 42	138.91	208.67	478.66	885.25	1580.70	690.87	169.53	170.92	191.56	236.23	239.35	5134.05
1979	231.14	234.38	363.22	706.70	1469.95	1615.70	840.20	320.35	239.19	206.58	220.46	243.57	6691.43
1980	254.17	305.21	211.14	533.20	1523.04	1663.26	577.05	202.81	216.12	214.99	264.57	247.95	6213.51
1981	222.19	165.38	157.64	198.77	153.08	296.66	191.36	101.55	213.21	261.74	210.58	187.32	2359.47
1982	172.40	199.48	257.77	406.05	799.56	1152.76	775.07	414.60	448.94	449.97	322.45	284.28	5683.35
1983	257.43	225.02	288.04	420.82	1367.20	2793.53	1839.05	724.68	259.95	259.24	236.22	186.97	8858.17
TOT	3690.19	3354.68	3974.66	6190.42	14458.51	18227.36	9886.51	4581.16	3835.03	4103.67	4032.19	3771.02	80105.40
AVG	230.64	209.67	248.42	386.90	903.66	1139.21	617.91	286.32	239.69	256.48	252.01	235.69	5006.59

MINIMUM SIMULATED FLOW = 27.23 MAXIMUM SIMULATED FLOW = 2793.53

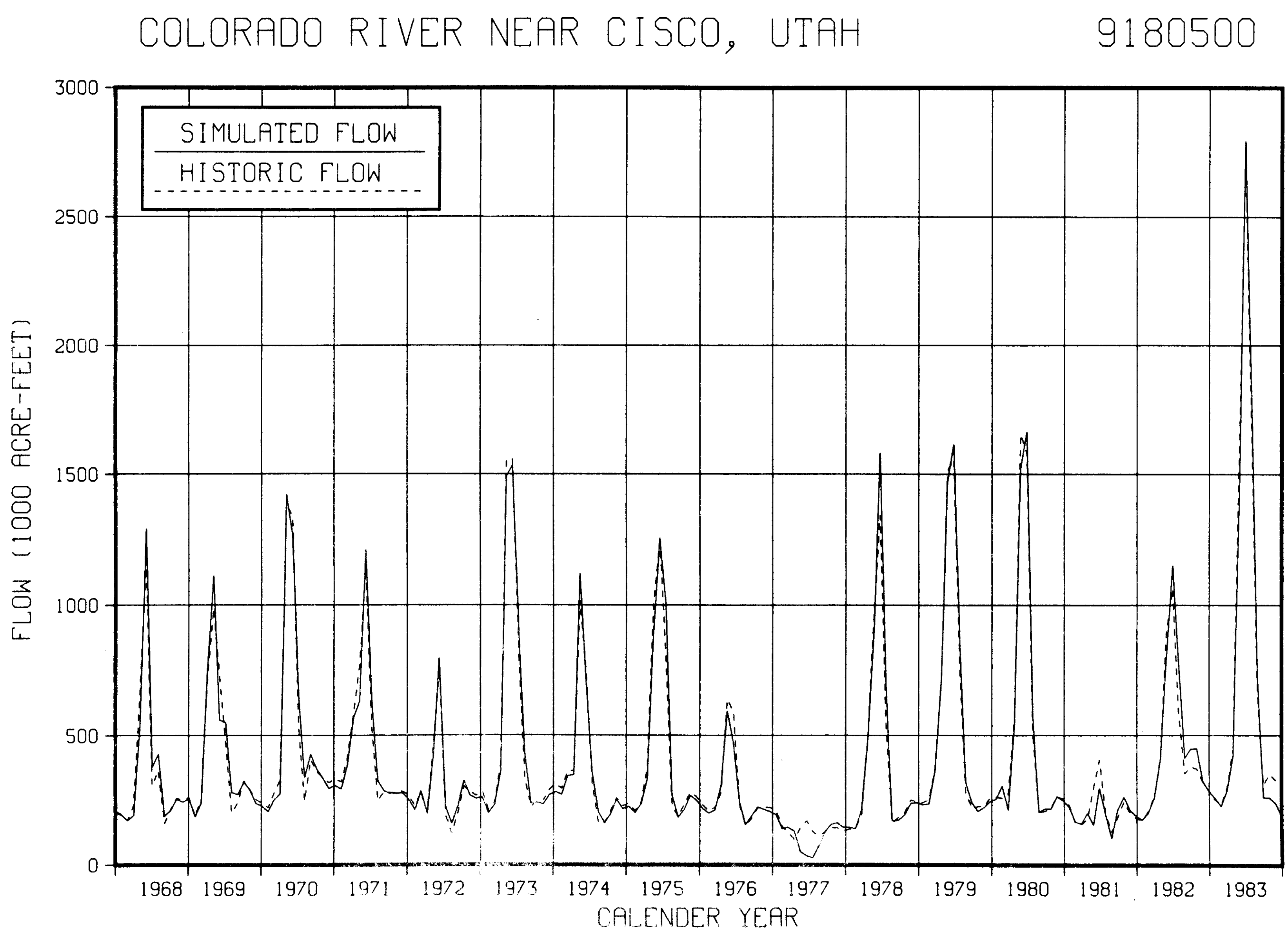
COLORADO RIVER NEAR CISCO, UTAH 9180500 RUN DATE 85/05/13.

PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC FLOWS AT STATION 9180500

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	-2.45	-1.04	-.54	-17.73	-19.71	10.17	23.88	17.12	17.51	-2.49	-1.53	-3.36	2.02
1969	-2.02	-2.33	-4.56	4.92	12.61	-23.53	16.21	39.84	12.63	-1.58	-.55	-7.11	2.61
1970	-4.37	-7.37	-9.56	-16.63	2.71	-5.30	20.95	38.04	4.93	2.81	-1.61	-6.90	1.13
1971	-7.85	-8.73	-6.66	-2.22	-17.85	6.10	18.60	31.80	1.12	-1.71	-.51	-2.35	.11
1972	-5.95	-6.87	1.89	-2.37	-8.67	4.91	15.70	32.68	13.19	7.66	-4.90	-4.59	1.68
1973	-7.74	-5.80	-4.08	-7.08	-4.07	-1.51	13.21	28.60	6.48	-4.11	-6.03	-6.88	.17
1974	-9.98	-7.94	-5.73	-3.91	10.32	-5.57	14.80	26.14	2.01	-5.79	-2.44	-5.35	.80
1975	-4.95	-3.82	-2.68	-12.04	-11.78	.93	24.51	18.62	-1.63	-8.87	-4.03	-5.45	.23
1976	-6.15	-4.32	-4.84	9.58	-7.14	-20.24	5.40	1.35	5.40	1.11	-3.19	-7.12	-4.99
1977	-7.23	-5.59	16.08	31.89	-65.38	-79.49	-78.55	-33.48	-.33	9.17	13.57	11.27	-17.38
1978	5.02	.35	9.01	.42	-7.47	17.68	29.04	6.33	-5.93	-4.32	-5.23	-1.92	6.67
1979	-3.21	-6.66	-2.21	-1.29	-2.87	3.87	11.27	15.12	9.70	-8.20	-2.36	-5.62	1.29
1980	-2.95	18.58	-22.61	-5.75	-7.99	5.38	13.30	-.14	4.71	-2.40	.21	-2.78	-.58
1981	-2.89	1.94	1.51	13.53	-48.36	-27.07	-2.24	-20.05	16.47	7.93	5.33	4.66	-7.54
1982	1.36	-3.14	-2.07	-.76	-10.48	8.25	31.47	17.48	18.14	21.08	.37	-.88	7.06
1983	2.11	-2.12	-3.62	-6.11	-12.53	1.94	8.20	7.75	-15.58	-26.13	-27.87	-45.78	-4.09

PERCENT DIFFERENCE OF 16 YEAR AVERAGES = .15

PLOT 1 11.43.56 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



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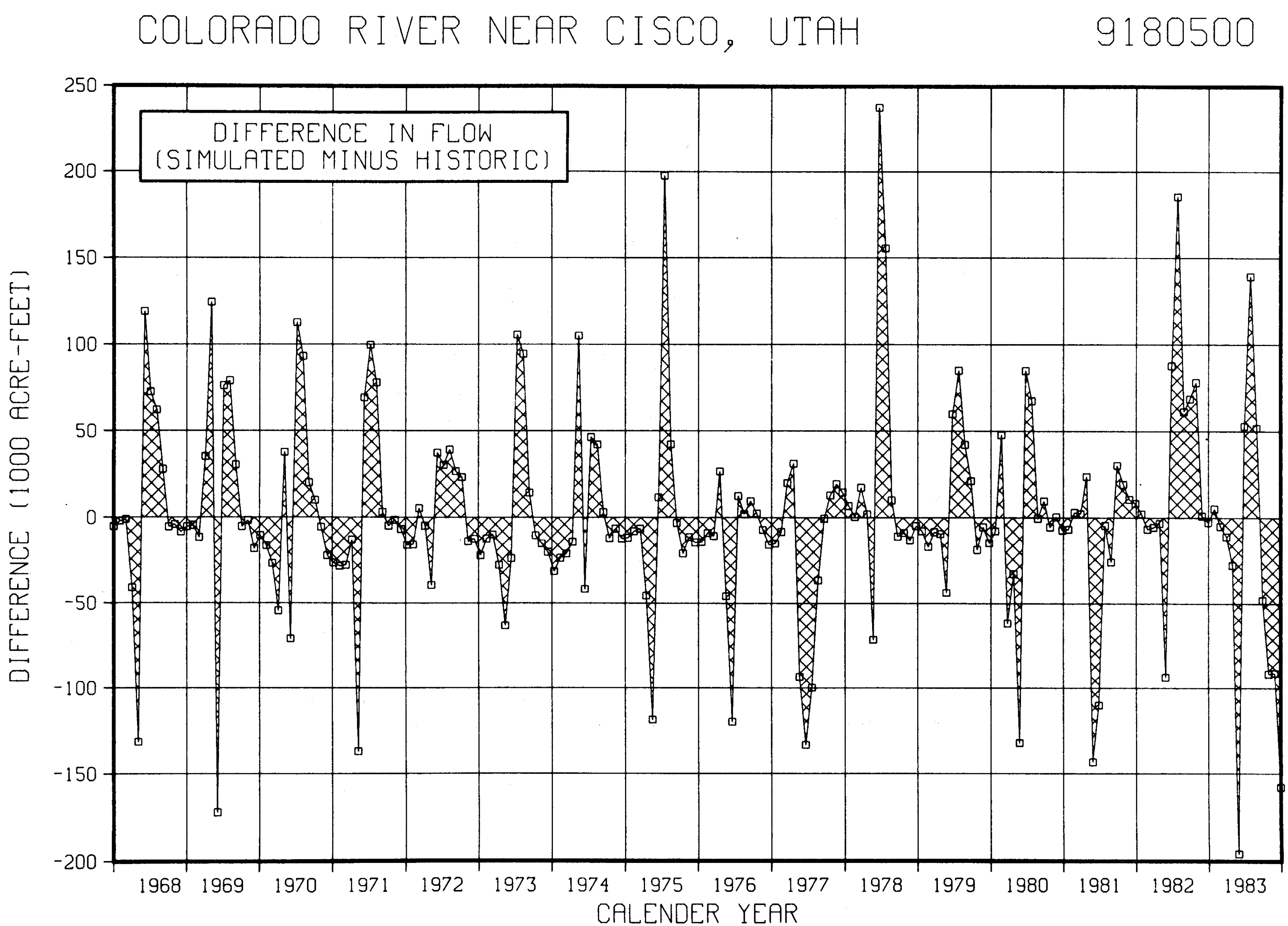
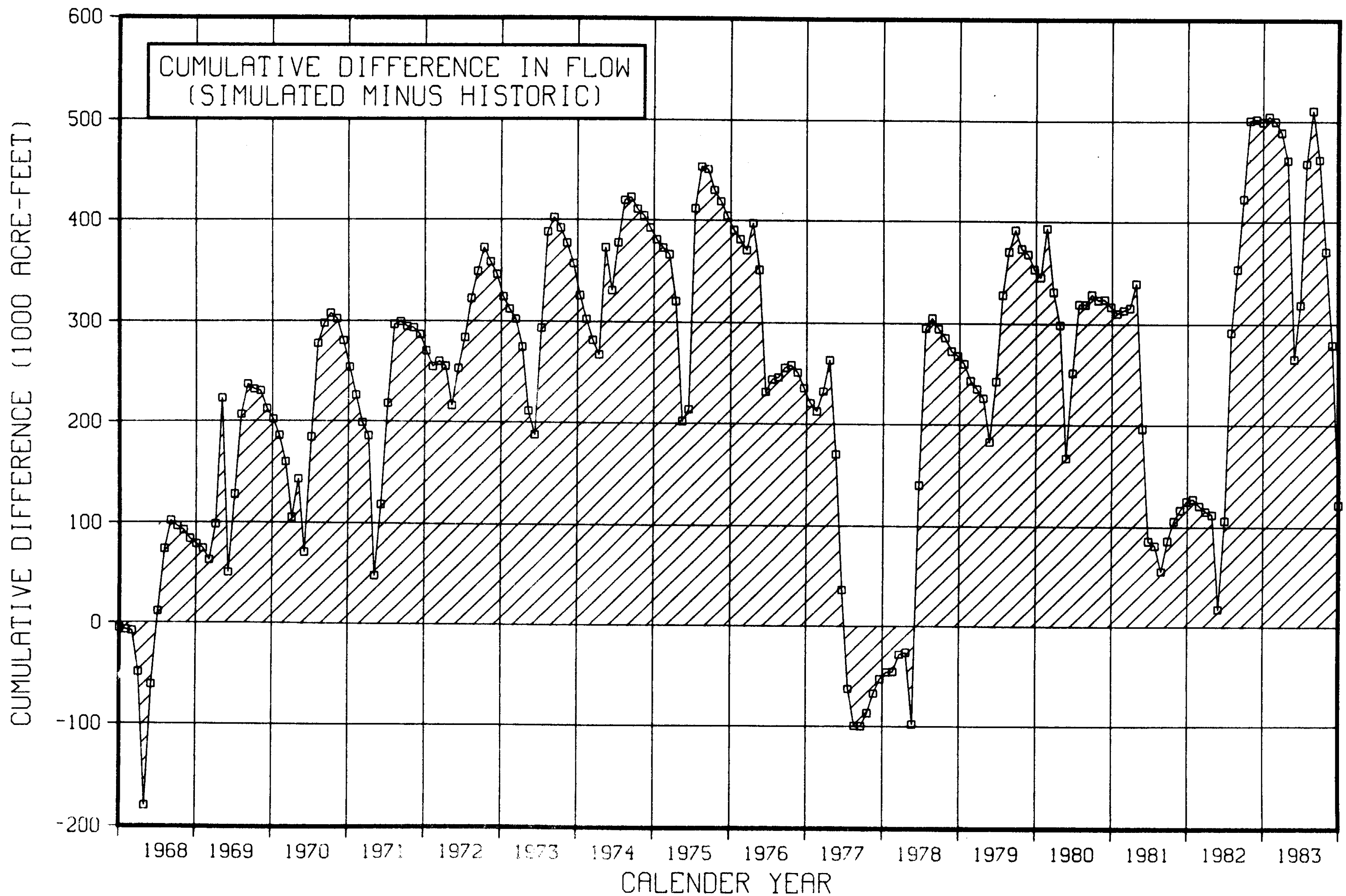


PLOT 2 11.44.08 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2

COLORADO RIVER NEAR CISCO, UTAH 9180500



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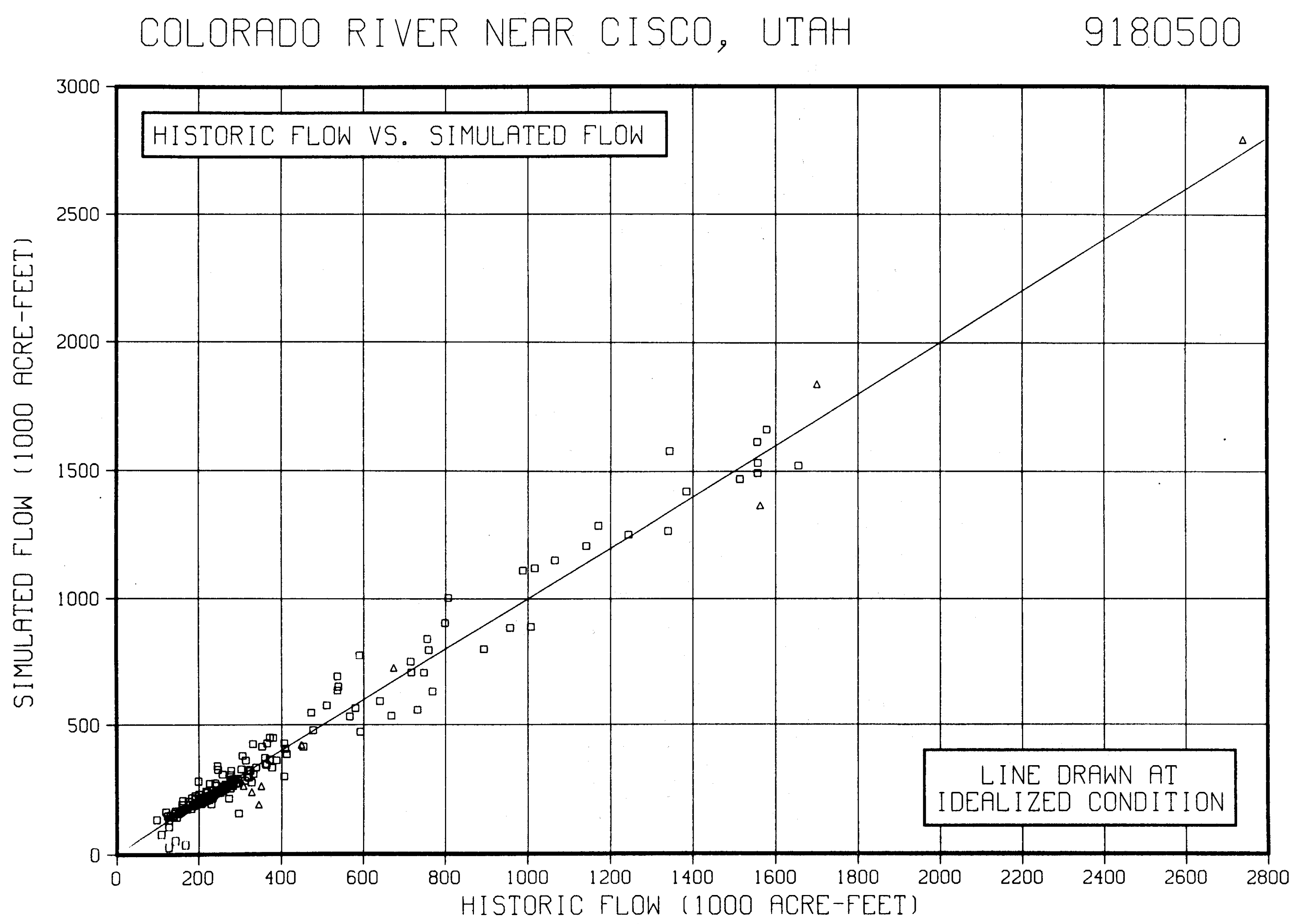


COLORADO RIVER NEAR CISCO, UTAH 9180500 RUN DATE 85/05/13.

HISTORIC SALT FOR STATION 9180500 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	225.82	227.87	236.03	227.90	373.64	479.97	317.76	419.66	258.65	317.94	312.84	280.66	3678.76
1969	269.80	226.31	247.30	378.53	444.32	445.97	358.58	256.66	314.33	340.35	291.81	264.73	3838.69
1970	249.86	208.76	240.69	265.16	498.42	495.75	349.51	279.37	406.78	331.04	287.53	272.59	3885.46
1971	255.64	224.43	264.12	289.74	391.67	445.03	337.33	270.53	299.36	324.40	287.15	289.82	3679.20
1972	267.24	231.21	256.66	207.69	312.54	364.24	226.00	195.89	280.97	365.76	298.18	269.83	3276.20
1973	288.22	244.35	281.18	353.06	622.66	591.75	447.25	327.30	286.63	321.09	292.05	266.82	4322.37
1974	264.82	232.33	294.32	285.44	386.21	358.52	304.03	233.02	252.62	310.83	313.28	264.28	3499.70
1975	259.40	223.79	259.68	305.42	443.15	484.87	403.26	264.86	268.48	316.96	312.03	275.41	3817.32
1976	243.28	239.17	240.00	307.07	377.13	361.03	268.17	231.66	248.60	271.36	259.19	236.90	3283.58
1977	241.63	198.73	189.00	150.13	185.58	206.42	224.66	197.75	205.81	216.01	217.77	188.07	2421.57
1978	187.09	181.34	229.71	357.48	497.51	537.29	353.37	213.64	241.65	266.28	284.16	261.11	3610.63
1979	269.86	236.04	334.29	436.74	620.50	606.63	415.30	303.33	270.38	281.29	273.22	268.40	4315.97
1980	256.64	247.10	264.63	362.06	678.64	552.39	351.43	257.93	262.13	281.94	277.23	265.24	4057.37
1981	240.24	196.30	201.87	203.10	269.74	276.59	256.44	200.70	248.96	261.90	235.90	230.90	2822.63
1982	226.21	228.60	231.62	294.59	428.74	457.92	359.63	328.22	357.22	327.03	301.99	266.72	3808.51
1983	239.52	213.81	260.00	322.71	672.09	822.12	611.88	437.18	298.70	308.81	291.47	303.43	4781.73
TOT	3985.27	3560.17	4031.12	4746.81	7202.53	7486.52	5584.58	4417.71	4501.25	4843.02	4535.80	4204.92	59099.68
AVG	249.08	222.51	251.94	296.68	450.16	467.91	349.04	276.11	281.33	302.69	283.49	262.81	3693.73

MINIMUM HISTORIC SALT = 150.13 MAXIMUM HISTORIC SALT = 822.12

SIMULATED SALT FOR STATION 9180500 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	262.67	247.17	255.90	273.40	431.09	503.62	361.07	368.10	300.08	310.40	248.11	264.24	3825.86
1969	261.07	230.42	265.41	405.38	516.35	449.77	372.48	332.25	322.07	339.40	252.45	260.35	4007.41
1970	249.01	229.72	269.45	283.39	563.91	520.40	383.85	340.51	368.04	349.41	259.46	272.08	4089.23
1971	265.84	249.41	318.58	359.76	436.13	498.42	380.35	337.33	324.07	325.72	248.58	269.07	4013.26
1972	255.57	232.16	302.36	262.06	399.62	468.97	328.87	301.36	309.89	345.44	248.49	264.17	3718.95
1973	258.63	234.88	277.74	308.31	559.12	520.45	403.29	358.07	306.68	312.28	240.07	264.92	4044.43
1974	254.00	241.70	311.03	306.25	509.97	457.80	346.92	312.12	280.87	300.75	243.28	252.40	3817.09
1975	246.13	227.26	268.93	296.24	486.47	505.52	405.40	327.14	289.18	301.02	243.49	256.69	3853.47
1976	237.84	229.66	259.50	292.01	429.10	440.35	332.34	300.55	293.52	311.02	233.71	249.01	3608.60
1977	232.76	204.48	230.83	231.89	304.14	374.54	279.70	277.98	276.44	289.89	224.83	236.97	3164.44
1978	225.09	210.83	272.67	342.80	478.67	527.38	387.67	304.78	281.80	296.00	240.69	258.27	3826.64
1979	245.49	229.86	310.99	389.93	563.00	527.26	397.71	334.49	299.80	298.33	235.87	255.53	4088.26
1980	252.69	264.77	236.95	347.93	570.47	541.50	371.17	305.40	297.02	302.94	241.46	255.29	3987.60
1981	237.69	209.47	225.09	254.84	334.44	418.78	324.50	283.58	305.08	324.43	236.14	248.37	3402.39
1982	232.25	225.28	277.96	322.03	464.99	497.52	394.24	358.20	373.85	373.86	259.00	269.24	4048.41
1983	254.09	233.83	294.43	321.66	541.33	606.41	480.66	403.51	310.34	314.40	237.65	235.81	4234.12
TOT	3970.80	3700.90	4377.82	4997.89	7588.77	7858.68	5950.22	5245.37	4938.72	5095.29	3893.29	4112.42	61730.17
AVG	248.18	231.31	273.61	312.37	474.30	491.17	371.89	327.84	308.67	318.46	243.33	257.03	3858.14

MINIMUM SIMULATED SALT = 204.48 MAXIMUM SIMULATED SALT = 606.41

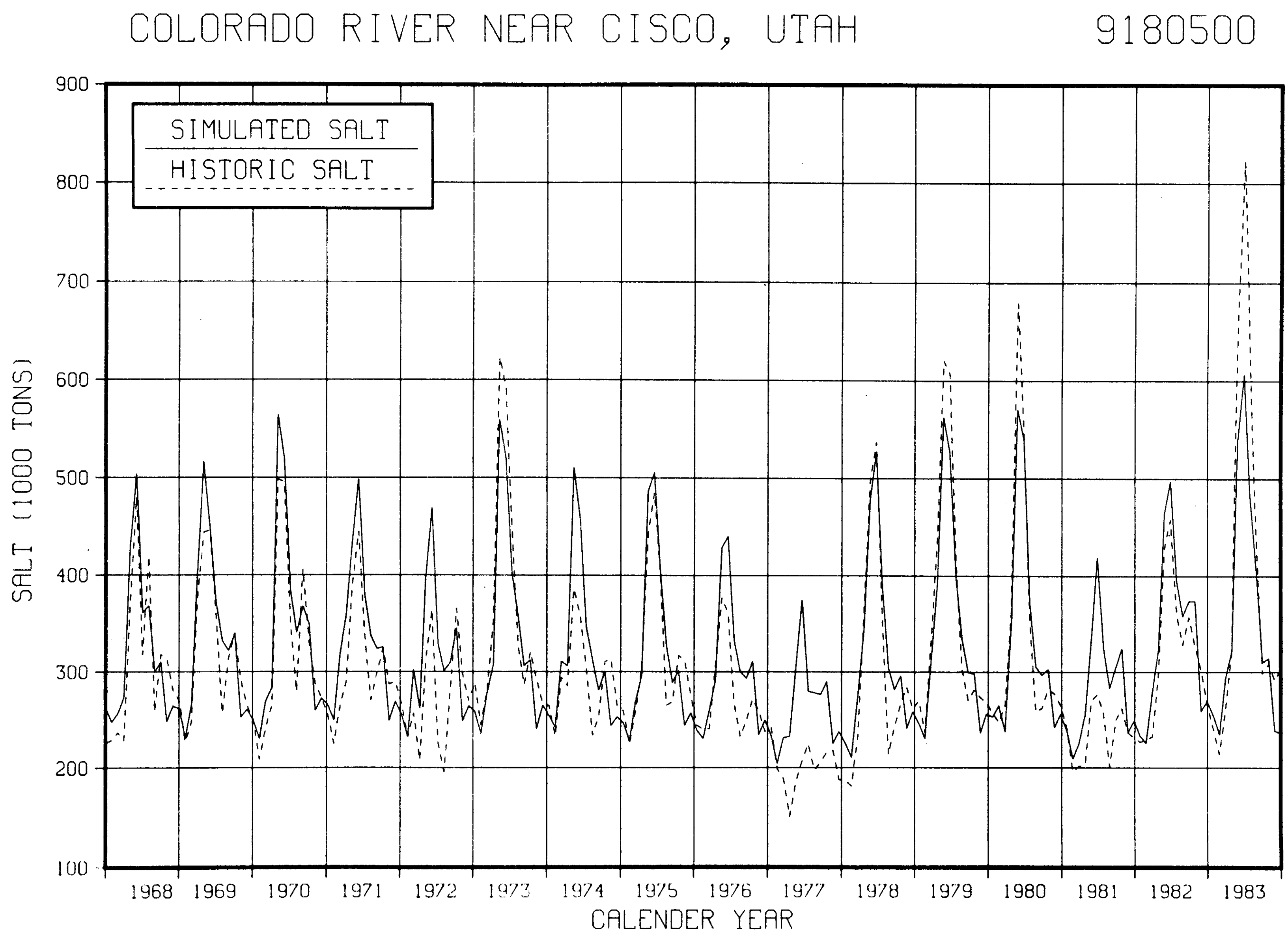
COLORADO RIVER NEAR CISCO, UTAH 9180500 RUN DATE 85/05/13.

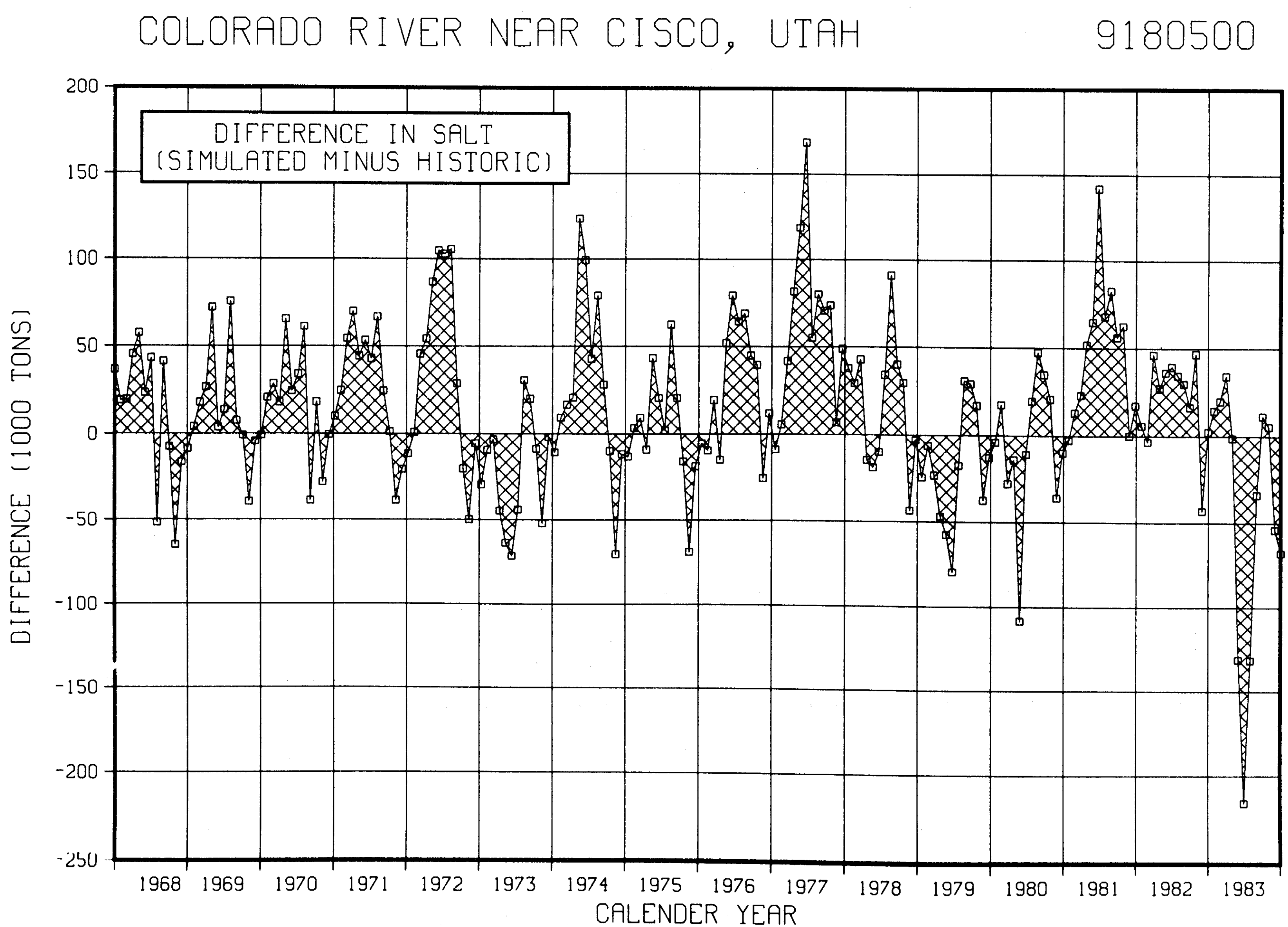
PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC SALT AT STATION 9180500

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	16.32	8.47	8.42	19.96	15.38	4.93	13.63	-12.29	16.02	-2.37	-20.69	-5.85	4.00
1969	-3.24	1.82	7.32	7.10	16.21	.85	3.88	29.45	2.46	-.28	-13.49	-1.65	4.40
1970	-.34	10.04	11.95	6.88	13.14	4.97	9.82	21.88	-9.52	5.55	-9.76	-.19	5.24
1971	3.99	11.13	20.62	24.17	11.35	12.00	12.75	24.69	8.26	.41	-13.43	-7.16	9.08
1972	-4.37	.41	17.81	26.18	27.86	28.75	45.52	53.84	10.29	-5.56	-16.66	-2.10	13.51
1973	-10.27	-3.87	-1.22	-12.67	-10.21	-12.05	-9.83	9.40	6.99	-2.74	-17.80	-.71	-6.43
1974	-4.08	4.03	5.68	7.29	32.04	27.69	14.11	33.95	11.18	-3.24	-22.34	-4.49	9.07
1975	-5.12	1.55	3.56	-3.01	9.77	4.26	.53	23.52	7.71	-5.03	-21.97	-6.80	.95
1976	-2.24	-3.98	8.12	-4.90	13.78	21.97	23.93	29.74	18.07	14.61	-9.83	5.11	9.90
1977	-3.67	2.89	22.13	54.46	63.89	81.44	24.50	40.57	34.32	34.20	3.24	26.00	30.68
1978	20.31	16.26	18.70	-4.11	-3.79	-1.85	9.71	42.66	16.62	11.16	-15.30	-1.09	5.98
1979	-9.03	-2.62	-6.97	-10.72	-9.27	-13.08	-4.24	10.27	10.88	6.06	-13.67	-4.79	-5.28
1980	-1.54	7.15	-10.46	-3.90	-15.94	-1.97	5.62	18.41	13.31	7.45	-12.90	-3.75	-1.72
1981	-1.06	6.71	11.50	25.48	23.99	51.41	26.54	41.30	22.54	23.88	.10	7.57	20.54
1982	2.67	-1.45	20.00	9.31	8.45	8.65	9.62	9.14	4.66	14.32	-14.23	.94	6.30
1983	6.08	9.36	13.24	-.33	-19.46	-26.24	-21.44	-7.70	3.90	1.81	-18.46	-22.28	-11.45

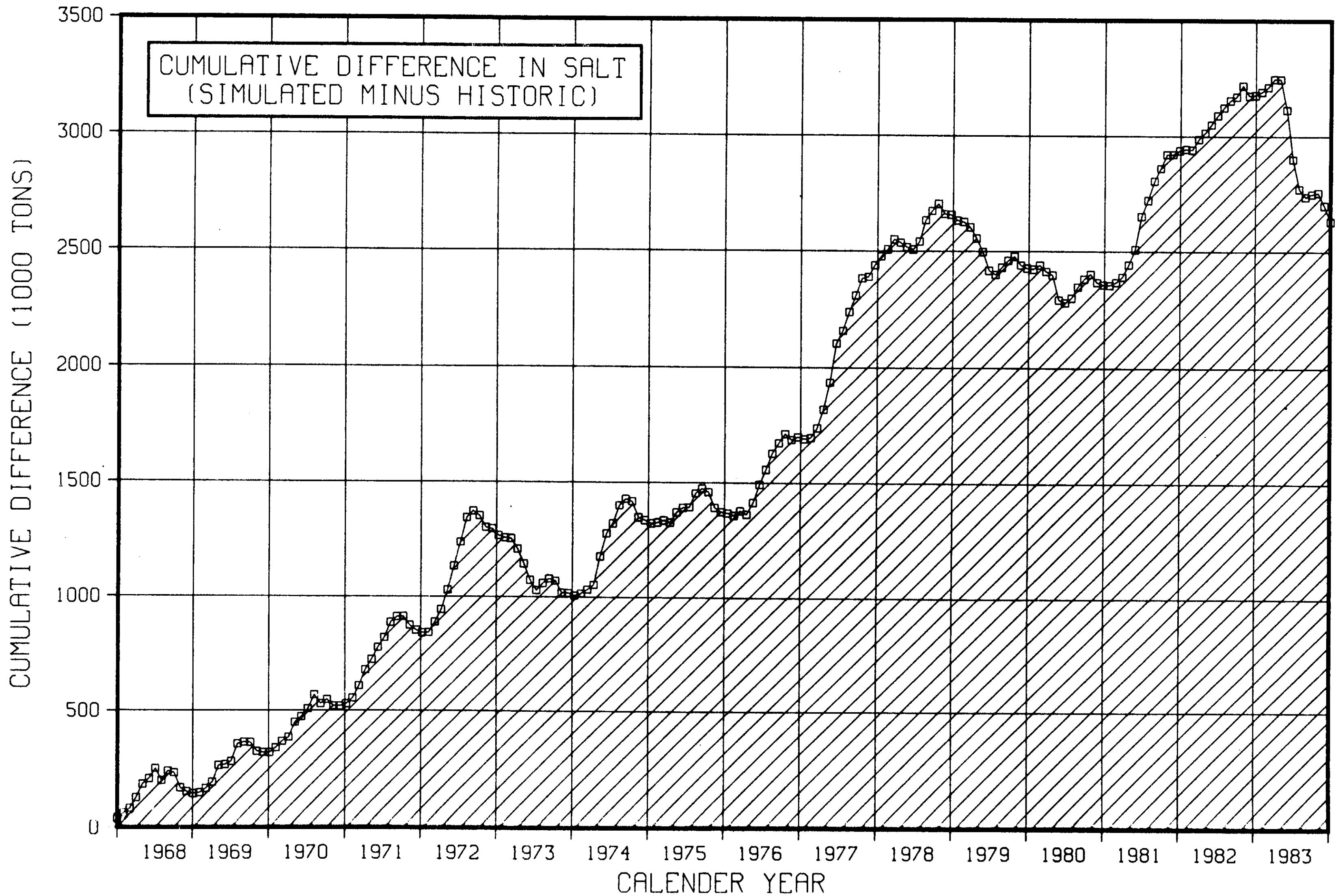
PERCENT DIFFERENCE OF 16 YEAR AVERAGES = 4.45

PLOT 1 11.44.18 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



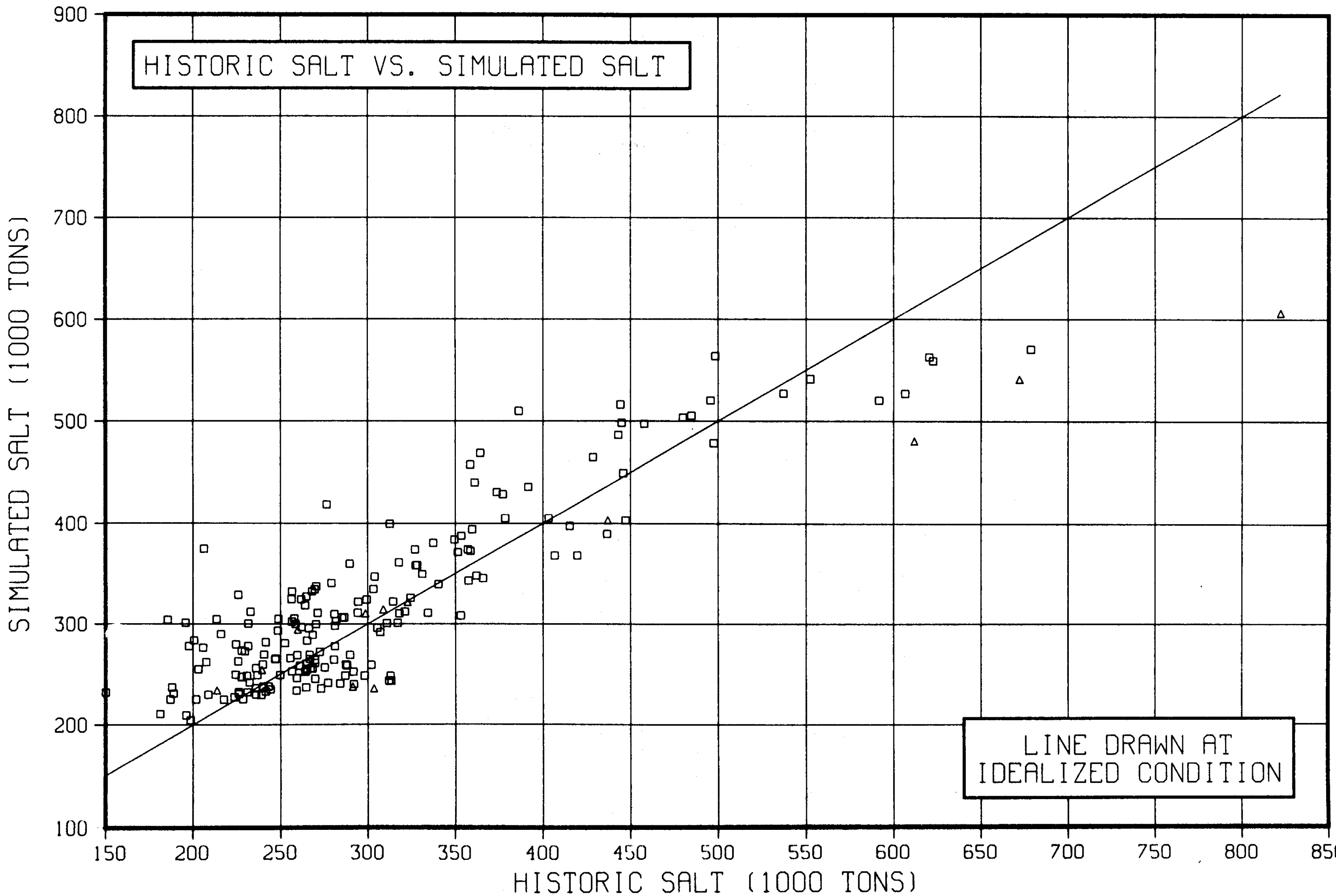

COLORADO RIVER NEAR CISCO, UTAH
9180500
DIFFERENCE IN SALT
(SIMULATED MINUS HISTORIC)
DIFFERENCE (1000 TONS)
200
150
100
50
0
-50
-100
-150
-200
-250
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
CALENDER YEAR

COLORADO RIVER NEAR CISCO, UTAH 9180500



PLOT 3 11.44.33 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2

COLORADO RIVER NEAR CISCO, UTAH 9180500



GREEN RIVER AT GREEN RIVER, UTAH 9315000 RUN DATE 85/05/13.

HISTORIC FLOW FOR STATION 9315000 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	248.73	195.95	241.49	274.79	708.55	1247.62	425.64	345.45	240.60	230.58	221.06	208.84	4589.30
1969	282.17	312.82	354.39	657.43	1095.29	684.13	357.39	270.31	245.95	255.28	236.35	270.83	5022.34
1970	190.99	175.22	193.59	248.51	866.61	1018.92	420.28	212.00	179.37	174.41	159.18	144.76	3983.84
1971	154.44	164.89	201.66	479.17	714.36	1060.38	396.98	196.98	209.52	211.08	262.58	267.08	4319.11
1972	272.14	302.82	322.56	323.67	635.36	833.69	246.49	201.52	123.53	302.48	340.47	277.19	4181.91
1973	264.20	265.39	342.02	303.02	1167.67	1069.31	520.75	303.30	232.55	230.90	255.38	238.64	5193.10
1974	231.00	150.31	300.12	356.51	1178.99	892.10	268.71	192.38	173.10	228.74	233.02	204.82	4409.80
1975	255.79	258.47	249.41	224.22	652.14	1252.98	898.57	318.09	170.90	160.41	204.58	291.95	4937.49
1976	258.61	249.15	293.56	309.74	765.14	657.59	281.30	206.38	185.04	214.32	219.24	225.74	3865.80
1977	236.71	199.50	286.87	266.25	347.43	262.40	183.12	169.69	140.33	116.71	116.13	118.36	2443.49
1978	126.01	124.78	248.12	374.13	686.05	1074.26	483.00	173.12	138.77	140.79	183.81	177.19	3930.03
1979	182.68	166.81	345.55	517.73	949.88	941.77	403.03	213.66	149.89	150.85	180.64	166.83	4369.31
1980	206.36	304.90	267.97	350.17	1040.35	1011.88	311.77	142.61	182.96	186.67	193.37	174.37	4373.38
1981	137.38	157.09	170.09	213.78	355.86	458.03	159.16	121.47	174.11	228.04	162.61	162.85	2500.46
1982	140.49	213.56	271.68	357.45	842.04	897.73	482.33	230.34	266.86	473.50	380.36	333.03	4889.37
1983	223.74	257.00	442.28	419.69	960.61	2258.22	1359.69	577.44	357.29	448.03	371.53	339.36	8014.87
TOT	3411.44	3498.67	4531.35	5676.26	12966.30	15621.00	7198.18	3874.75	3170.77	3752.78	3720.29	3601.82	71023.60
AVG	213.22	218.67	283.21	354.77	810.39	976.31	449.89	242.17	198.17	234.55	232.52	225.11	4438.98

MINIMUM HISTORIC FLOW = 116.13 MAXIMUM HISTORIC FLOW = 2258.22

SIMULATED FLOW FOR STATION 9315000 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	222.02	184.71	228.05	251.61	681.10	1221.01	607.28	380.95	219.57	211.86	194.94	186.85	4589.94
1969	253.16	283.11	312.14	613.06	1008.10	722.10	461.55	345.70	235.62	199.01	222.67	266.90	4923.12
1970	205.69	180.32	215.42	310.57	1042.82	1043.25	514.37	262.22	171.64	219.45	156.75	158.57	4481.07
1971	146.66	153.97	193.20	466.14	721.33	1080.23	482.13	269.49	192.53	187.50	238.73	242.08	4373.99
1972	262.93	284.68	304.45	315.55	649.83	915.19	364.09	246.09	108.29	279.87	315.81	246.96	4293.74
1973	235.60	242.66	300.55	277.78	1102.01	1068.94	570.12	339.02	196.82	230.60	245.74	233.47	5043.31
1974	216.76	140.94	304.15	388.22	1282.93	971.28	391.78	260.74	173.58	214.47	239.66	205.80	4790.30
1975	245.86	259.18	253.35	212.03	662.42	1131.44	818.86	299.94	119.01	132.19	198.62	268.32	4601.22
1976	238.60	226.56	261.87	299.58	743.69	764.27	520.23	229.08	161.15	195.61	210.50	218.71	4069.87
1977	226.40	192.30	279.08	234.23	347.37	306.26	160.91	146.11	136.47	103.59	112.66	114.81	2360.19
1978	117.52	112.57	231.74	370.10	670.36	1077.27	528.48	169.90	116.69	132.02	169.08	161.48	3857.22
1979	167.84	145.34	306.50	484.65	926.50	1037.20	436.12	149.19	118.38	131.70	179.99	154.84	4238.25
1980	199.54	294.13	281.60	388.01	1115.99	909.56	322.20	98.19	159.33	167.32	177.85	146.28	4260.00
1981	128.13	157.25	176.05	245.71	382.12	642.76	188.69	91.09	162.04	226.42	162.24	159.64	2722.13
1982	128.51	183.33	247.48	324.22	872.88	773.09	511.15	207.54	239.32	410.41	321.93	282.00	4501.85
1983	170.56	210.92	363.96	416.66	942.77	1965.48	1308.02	520.56	333.35	191.20	182.30	167.52	6773.28
TOT	3165.78	3251.97	4259.60	5598.12	13152.22	15629.31	8185.95	4015.82	2843.77	3233.23	3329.46	3214.24	69879.49
AVG	197.86	203.25	266.23	349.88	822.01	976.83	511.62	250.99	177.74	202.08	208.09	200.89	4367.47

MINIMUM SIMULATED FLOW = 91.09 MAXIMUM SIMULATED FLOW = 1965.48

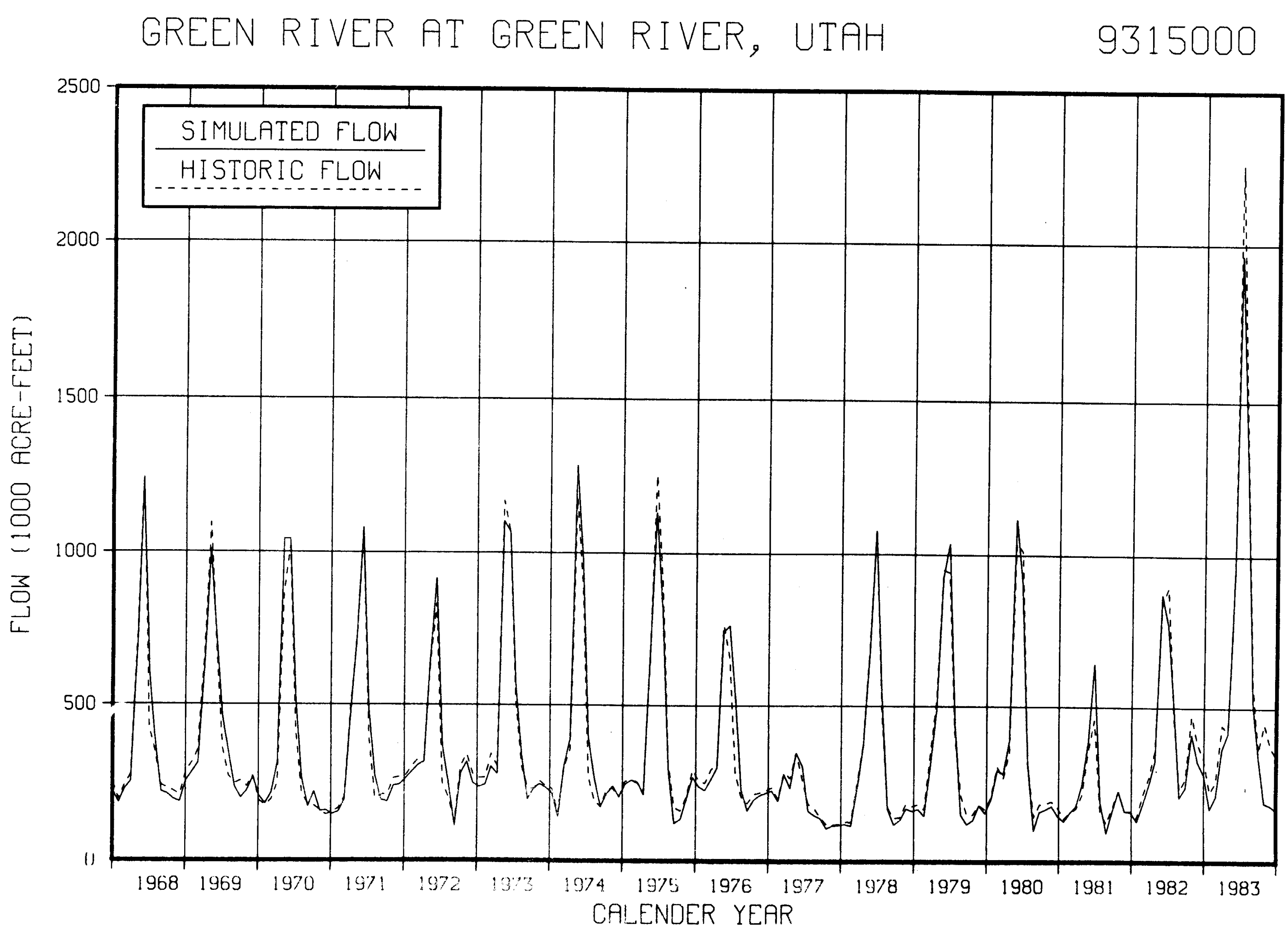
GREEN RIVER AT GREEN RIVER, UTAH 9315000 RUN DATE 85/05/13.

PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC FLOWS AT STATION 9315000

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	-10.74	-5.74	-5.57	-8.44	-3.87	-2.13	42.67	10.28	-8.74	-8.12	-11.82	-10.53	.01
1969	-10.28	-9.50	-11.92	-6.75	-7.96	5.55	29.15	27.89	-4.20	-22.04	-5.79	-1.45	-1.98
1970	7.70	2.91	11.28	24.97	20.33	2.39	22.39	23.69	-4.31	25.83	-1.52	9.54	12.48
1971	-5.04	-6.62	-4.20	-2.72	.98	1.87	21.45	36.81	-8.11	-11.17	-9.08	-9.36	1.27
1972	-3.38	-5.99	-5.61	-2.51	2.28	9.78	47.71	22.12	-12.34	-7.48	-7.24	-10.91	2.67
1973	-10.82	-8.57	-12.12	-8.33	-5.62	-.03	9.48	11.78	-15.36	-.13	-3.77	-2.16	-2.88
1974	-6.16	-6.23	1.34	8.89	8.82	8.88	45.80	35.54	.27	-6.24	2.85	.48	8.63
1975	-3.88	.27	1.58	-5.44	1.58	-9.70	-8.87	-5.71	-30.36	-17.59	-2.91	-8.09	-6.81
1976	-7.74	-9.06	-10.79	-3.28	-2.80	16.22	84.94	11.00	-12.91	-8.73	-3.98	-3.11	5.28
1977	-4.35	-3.61	-2.72	-12.02	-.02	16.71	-12.13	-13.89	-2.75	-11.24	-2.99	-3.00	-3.41
1978	-6.74	-9.78	-6.60	-1.08	-2.29	.28	9.41	-1.86	-15.91	-6.23	-8.01	-8.87	-1.85
1979	-8.13	-12.87	-11.30	-6.39	-2.46	10.13	8.21	-30.18	-21.02	-12.69	-.36	-7.19	-3.00
1980	-3.30	-3.53	5.09	10.81	7.27	-10.11	3.35	-31.15	-12.92	-10.36	-8.03	-16.11	-2.59
1981	-6.73	.10	3.51	14.94	7.38	40.33	18.55	-25.01	-6.93	-.71	-.22	-1.97	8.87
1982	-8.53	-14.16	-8.91	-9.30	3.66	-13.88	5.97	-9.90	-10.32	-13.32	-15.36	-15.32	-7.93
1983	-23.77	-17.93	-17.71	-.72	-1.86	-12.96	-3.80	-9.85	-6.70	-57.32	-50.93	-50.64	-15.49

PERCENT DIFFERENCE OF 16 YEAR AVERAGES = -1.61

PLOT 1 11.44.41 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



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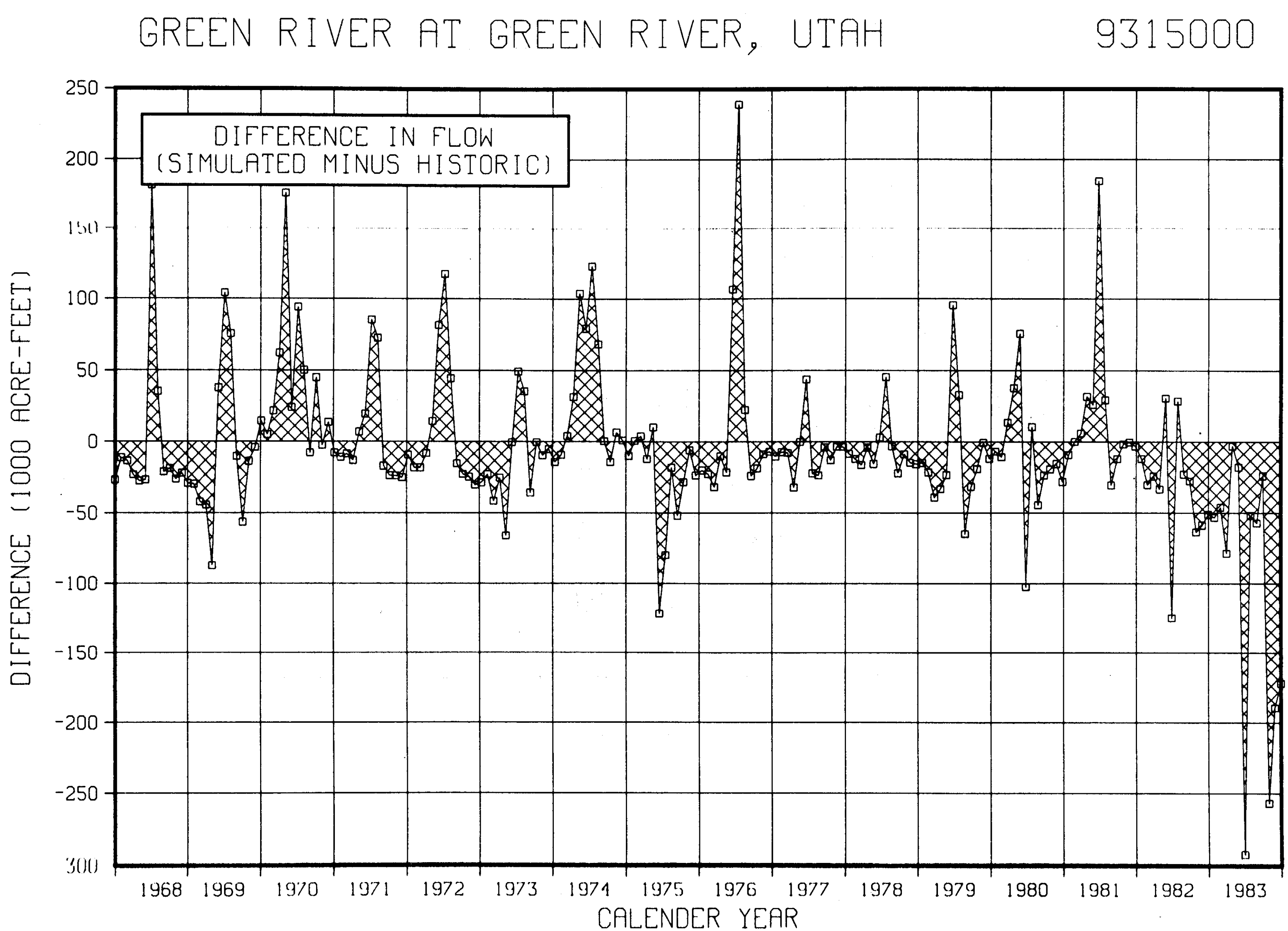

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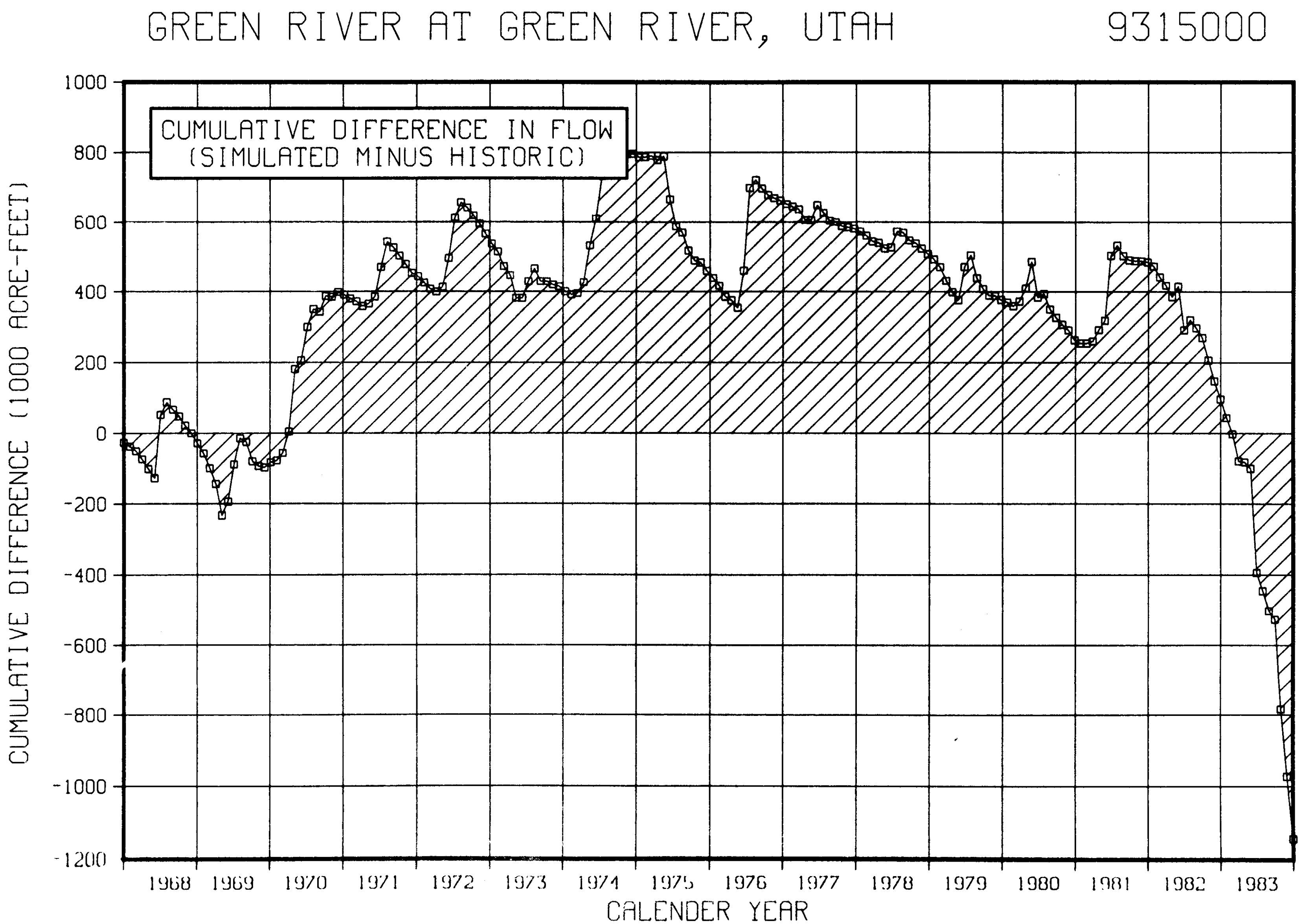

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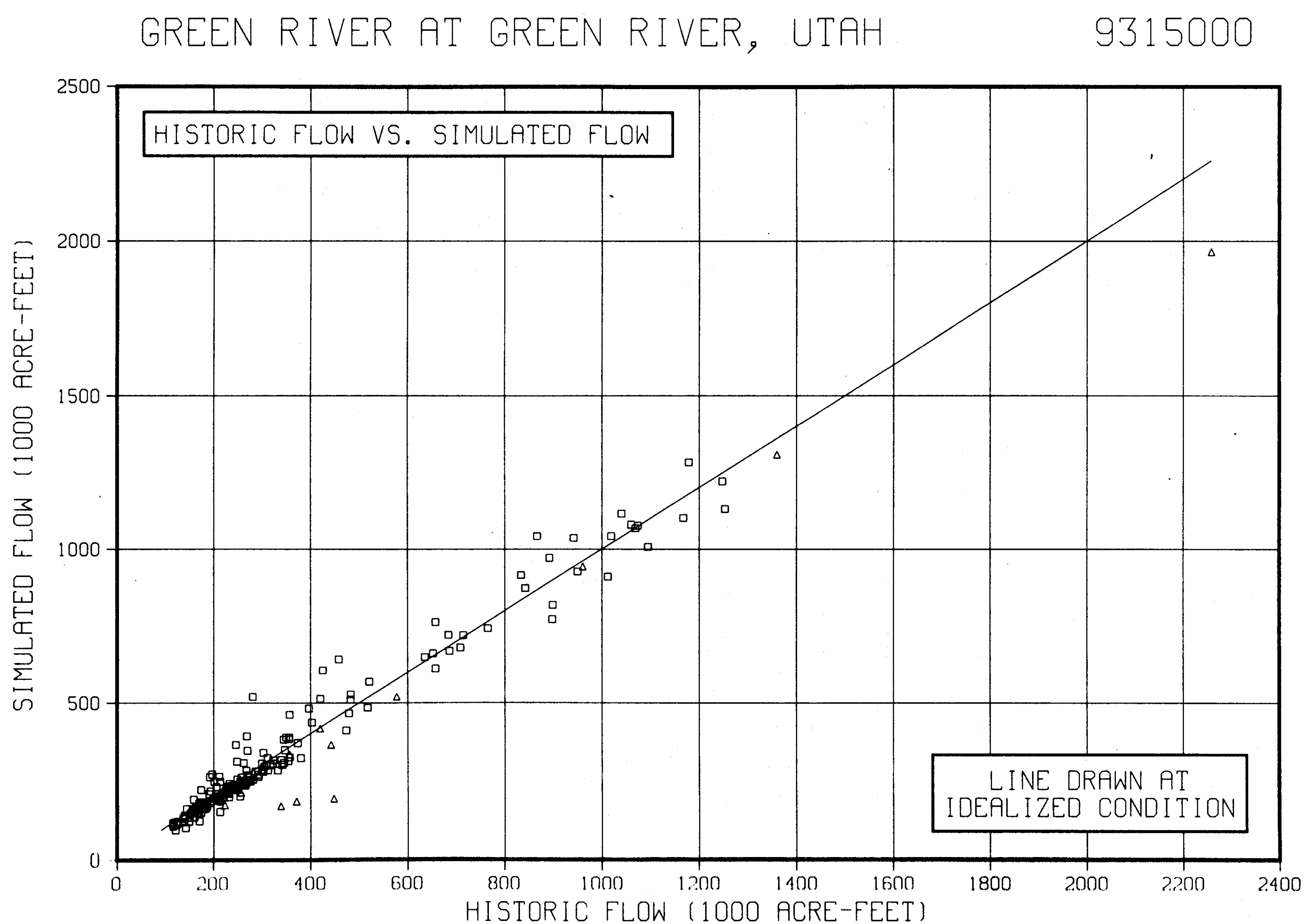


GREEN RIVER AT GREEN RIVER, UTAH 9315000 RUN DATE 85/05/13.

HISTORIC SALT FOR STATION 9315000 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	218.88	184.19	248.74	247.31	361.36	424.19	268.15	293.63	214.13	219.05	205.59	179.60	3064.84
1969	228.56	250.25	322.50	440.48	470.97	362.59	243.02	240.58	226.28	227.20	196.17	211.25	3419.84
1970	158.52	147.19	162.62	201.30	355.31	397.38	231.16	169.60	163.22	153.48	155.99	130.28	2426.04
1971	129.73	128.61	159.31	273.13	314.32	371.13	202.46	163.49	186.47	189.98	231.07	205.65	2555.35
1972	209.54	211.97	229.02	200.67	273.20	300.13	152.82	151.14	112.41	251.06	268.97	207.90	2568.85
1973	195.51	193.74	307.81	266.66	478.74	417.03	317.66	230.51	202.32	207.81	214.52	200.45	3232.74
1974	191.73	135.28	240.10	267.39	412.65	303.31	185.41	163.52	154.06	203.58	212.05	188.43	2657.50
1975	209.75	201.61	214.49	186.10	299.98	438.54	377.40	235.39	162.35	152.39	180.03	230.64	2888.66
1976	204.30	181.88	240.72	272.57	367.26	302.49	180.03	169.23	148.03	167.17	173.20	171.56	2578.45
1977	177.53	163.59	218.02	186.37	208.46	149.57	157.48	149.33	119.28	106.21	103.36	107.70	1846.90
1978	108.37	107.31	218.34	250.67	301.86	354.51	212.52	122.92	117.95	122.49	169.11	168.33	2254.37
1979	149.80	131.78	317.90	429.72	417.95	329.62	193.45	168.79	125.91	134.25	155.35	141.81	2696.33
1980	169.22	240.87	243.85	259.12	457.75	364.28	180.82	119.80	175.64	171.73	168.23	148.21	2699.54
1981	127.76	135.10	159.88	173.16	195.72	187.79	127.32	106.89	154.96	166.47	130.09	130.28	1795.43
1982	118.01	153.77	214.63	250.21	353.65	314.21	217.05	170.45	210.82	317.25	270.05	219.80	2809.90
1983	161.09	187.61	327.29	302.18	499.52	880.70	611.86	369.56	257.25	277.78	237.78	227.37	4339.98
TOT	2758.31	2754.76	3825.21	4207.04	5768.72	5897.47	3858.62	3024.83	2731.09	3067.88	3071.54	2869.26	43834.72
AVG	172.39	172.17	239.08	262.94	360.54	368.59	241.16	189.05	170.69	191.74	191.97	179.33	2739.67

MINIMUM HISTORIC SALT = 103.36 MAXIMUM HISTORIC SALT = 880.70

SIMULATED SALT FOR STATION 9315000 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	253.24	190.46	206.36	243.18	348.42	469.35	380.08	283.77	204.92	198.69	198.00	208.93	3185.41
1969	259.22	249.91	265.43	390.01	509.56	328.22	290.87	246.16	184.25	154.93	182.64	233.35	3294.57
1970	186.11	144.76	166.18	205.55	344.07	411.47	275.18	188.68	140.12	162.00	142.36	156.75	2523.23
1971	166.79	127.25	165.77	280.15	338.81	455.71	275.07	193.66	133.15	148.16	181.88	200.51	2666.92
1972	208.94	182.01	226.27	228.28	370.25	424.06	250.95	169.63	78.93	186.34	204.00	195.61	2725.26
1973	173.25	151.23	211.55	217.93	448.17	422.96	284.24	225.73	127.89	155.49	176.91	189.74	2785.07
1974	181.75	107.51	205.48	231.22	456.61	402.28	224.55	173.79	132.21	153.59	173.27	168.11	2610.36
1975	200.69	174.26	177.23	166.85	292.05	461.77	416.92	207.37	103.49	115.65	151.59	210.14	2678.00
1976	189.32	159.78	192.64	224.08	391.20	354.66	244.20	160.52	129.18	150.86	159.34	171.57	2527.35
1977	173.41	132.37	190.85	196.94	243.14	291.46	187.39	149.06	128.82	111.27	121.37	139.94	2066.02
1978	133.08	100.95	195.21	254.78	317.28	459.52	304.19	148.11	104.19	120.57	151.48	156.79	2446.15
1979	152.51	114.02	226.46	291.52	379.78	381.97	241.30	134.54	101.64	127.23	155.12	161.45	2467.54
1980	187.80	221.49	204.14	259.26	441.56	402.95	237.25	121.27	126.31	142.61	151.39	159.99	2656.02
1981	139.53	121.58	152.00	182.59	220.08	315.60	174.54	120.77	146.41	167.77	144.61	161.85	2047.35
1982	138.30	148.57	193.17	260.50	420.92	364.07	298.25	162.83	161.97	275.88	239.46	241.38	2905.30
1983	158.01	162.40	267.96	275.60	424.50	737.15	551.78	291.32	169.64	139.76	143.43	148.61	3470.16
TOT	2901.94	2488.56	3246.70	3908.43	5946.40	6683.21	4636.75	2977.21	2173.12	2510.83	2676.86	2904.71	43054.72
AVG	181.37	155.54	202.92	244.28	371.65	417.70	289.80	186.08	135.82	156.93	167.30	181.54	2690.92

MINIMUM SIMULATED SALT = 78.93 MAXIMUM SIMULATED SALT = 737.15

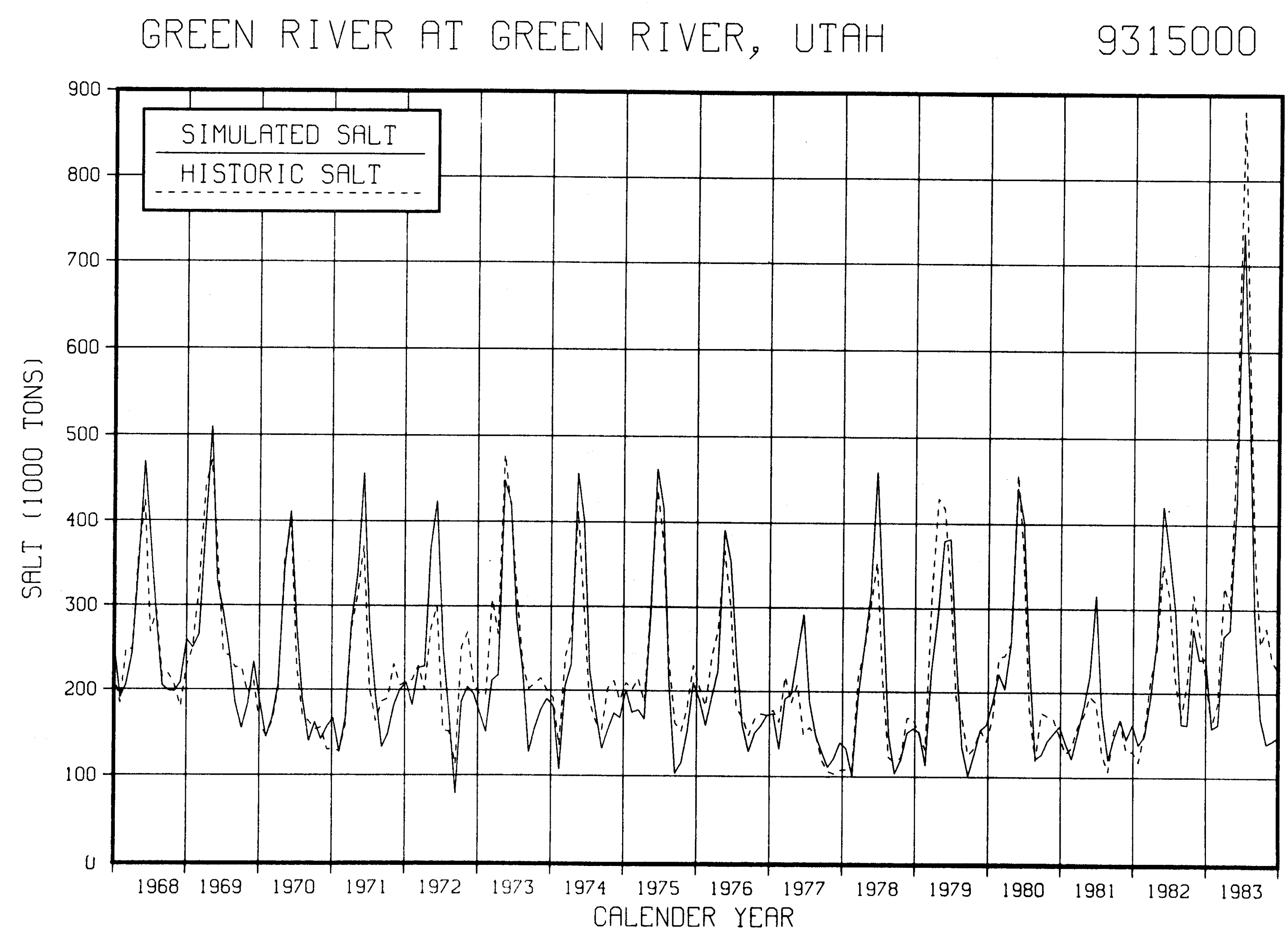
GREEN RIVER AT GREEN RIVER, UTAH 9315000 RUN DATE 85/05/13.

PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC SALT AT STATION 9315000

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	15.70	3.41	-17.04	-1.67	-3.58	10.65	41.74	-3.36	-4.30	-9.29	-3.69	16.33	3.93
1969	13.41	-.14	-17.70	-11.46	8.19	-9.48	19.69	2.32	-18.57	-31.81	-6.90	10.47	-3.66
1970	17.40	-1.65	2.19	2.11	-3.16	3.55	19.04	11.25	-14.15	5.55	-8.74	20.32	4.01
1971	28.57	-1.06	4.05	2.57	7.79	22.79	35.86	18.45	-28.59	-22.01	-21.29	-2.50	4.37
1972	-.29	-14.14	-1.20	13.76	35.52	41.29	64.21	12.23	-29.78	-25.78	-24.15	-5.91	6.09
1973	-11.39	-21.94	-31.27	-18.27	-6.39	1.42	-10.52	-2.07	-36.79	-25.18	-17.53	-5.35	-13.85
1974	-5.20	-20.53	-14.42	-13.52	10.65	32.63	21.11	6.28	-14.19	-24.55	-18.29	-10.79	-1.77
1975	-4.32	-13.56	-17.37	-10.34	-2.65	5.30	10.47	-11.90	-36.26	-24.11	-15.80	-8.89	-7.29
1976	-7.33	-12.15	-19.97	-17.79	6.52	17.25	35.64	-5.15	-12.74	-9.75	-8.00	.00	-1.98
1977	-2.32	-19.08	-12.46	5.67	16.64	94.87	18.99	-.18	8.00	4.77	17.43	29.93	11.86
1978	22.81	-5.93	-10.60	1.64	5.11	29.62	43.13	20.49	-11.66	-1.56	-10.42	-6.86	8.51
1979	1.81	-13.48	-28.77	-32.16	-9.13	15.88	24.73	-20.29	-19.28	-5.23	-.15	13.85	-8.49
1980	10.98	-8.05	-16.28	.05	-3.54	10.62	31.21	1.23	-28.09	-16.96	-10.01	7.94	-1.61
1981	9.21	-10.01	-4.93	5.44	12.45	68.06	37.09	12.98	-5.52	.78	11.17	24.24	14.03
1982	17.19	-3.38	-10.00	4.11	19.02	15.87	37.41	-4.48	-23.17	-13.04	-11.33	9.82	3.40
1983	-1.91	-13.44	-18.13	-8.80	-15.02	-16.30	-9.82	-21.17	-34.05	-49.69	-39.68	-34.64	-20.04

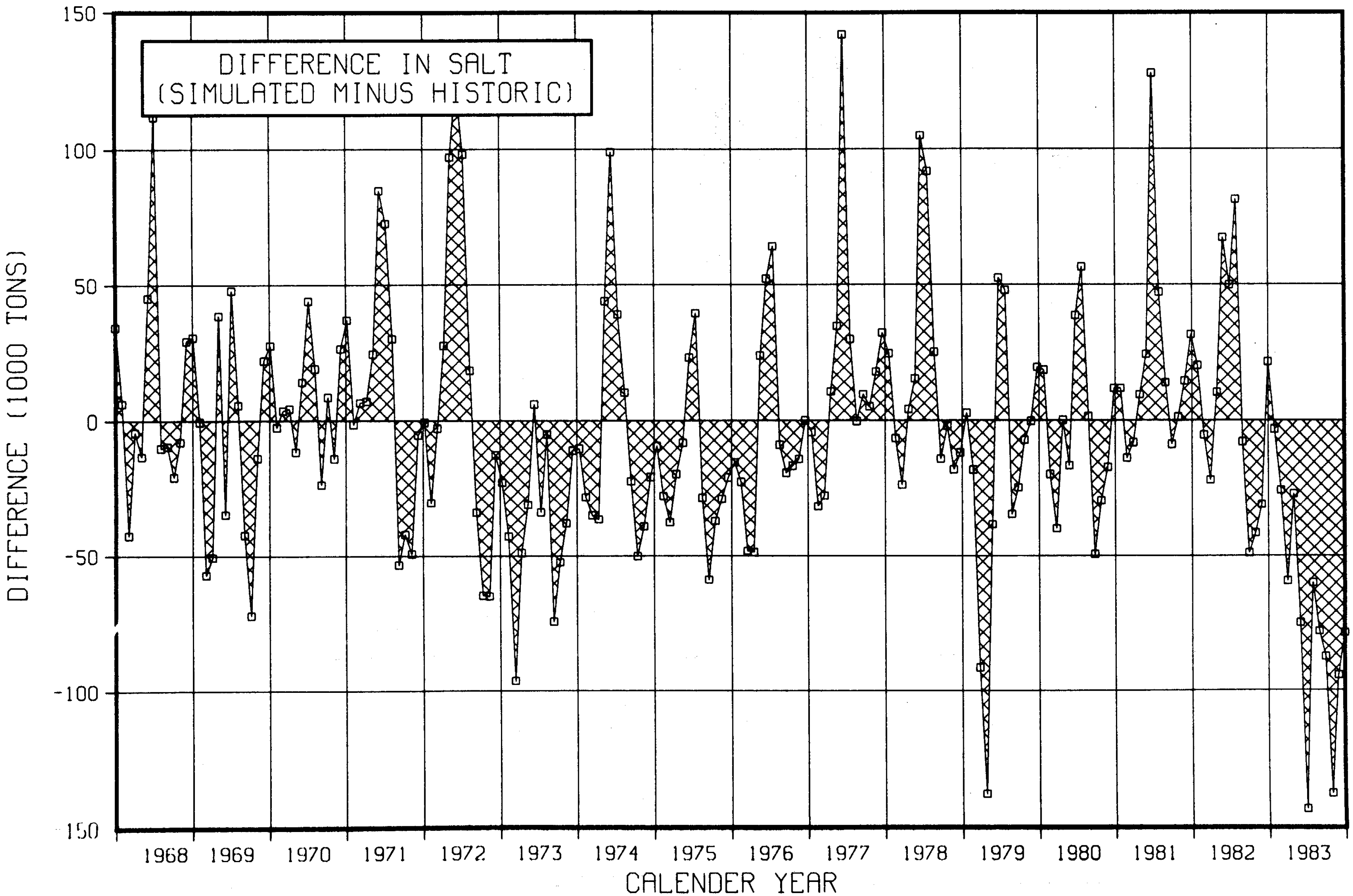
PERCENT DIFFERENCE OF 16 YEAR AVERAGES = -1.78

PLOT 1 11.45.01 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



PLOT 2 11.45.08 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2

GREEN RIVER AT GREEN RIVER, UTAH 9315000



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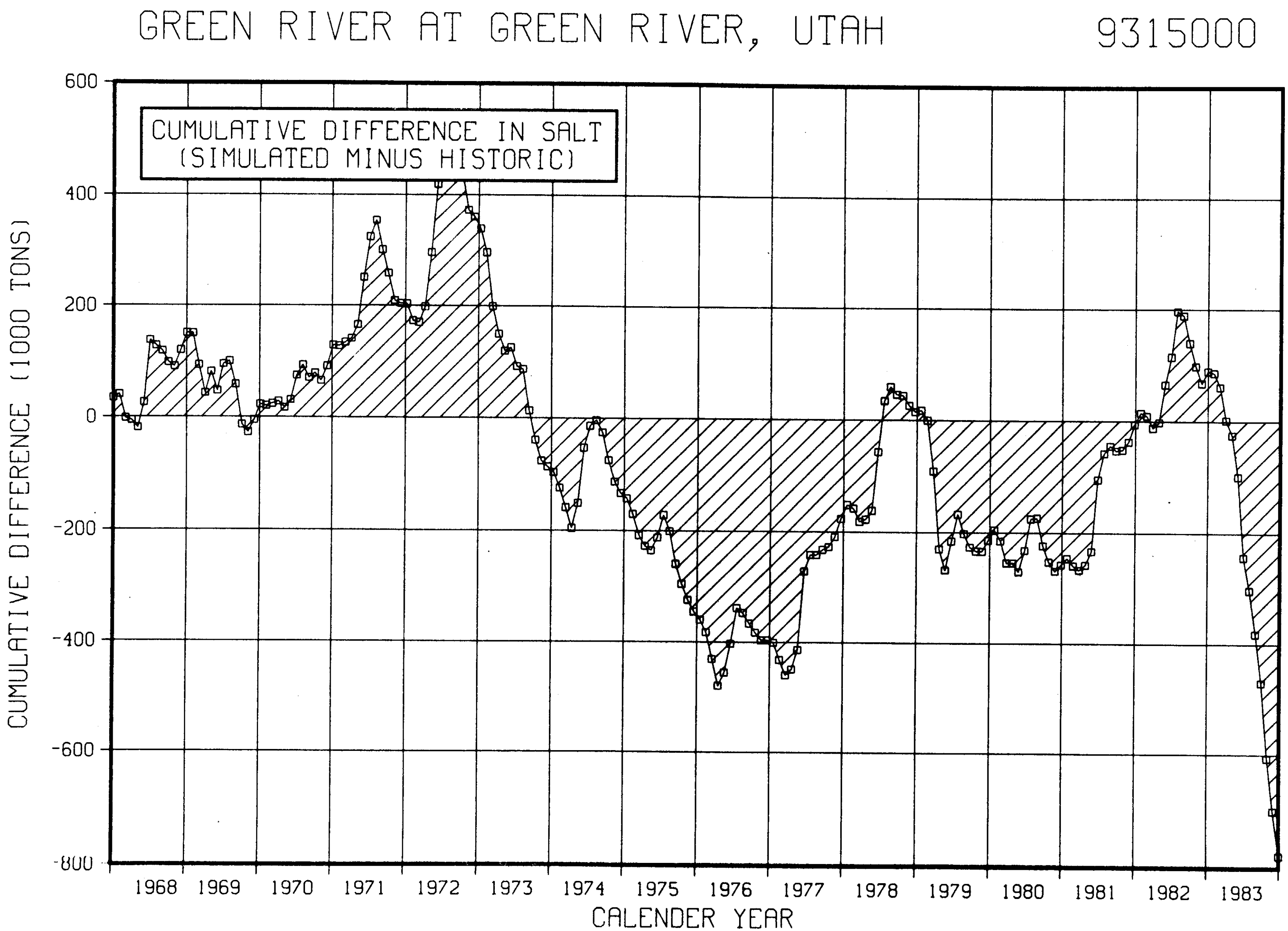

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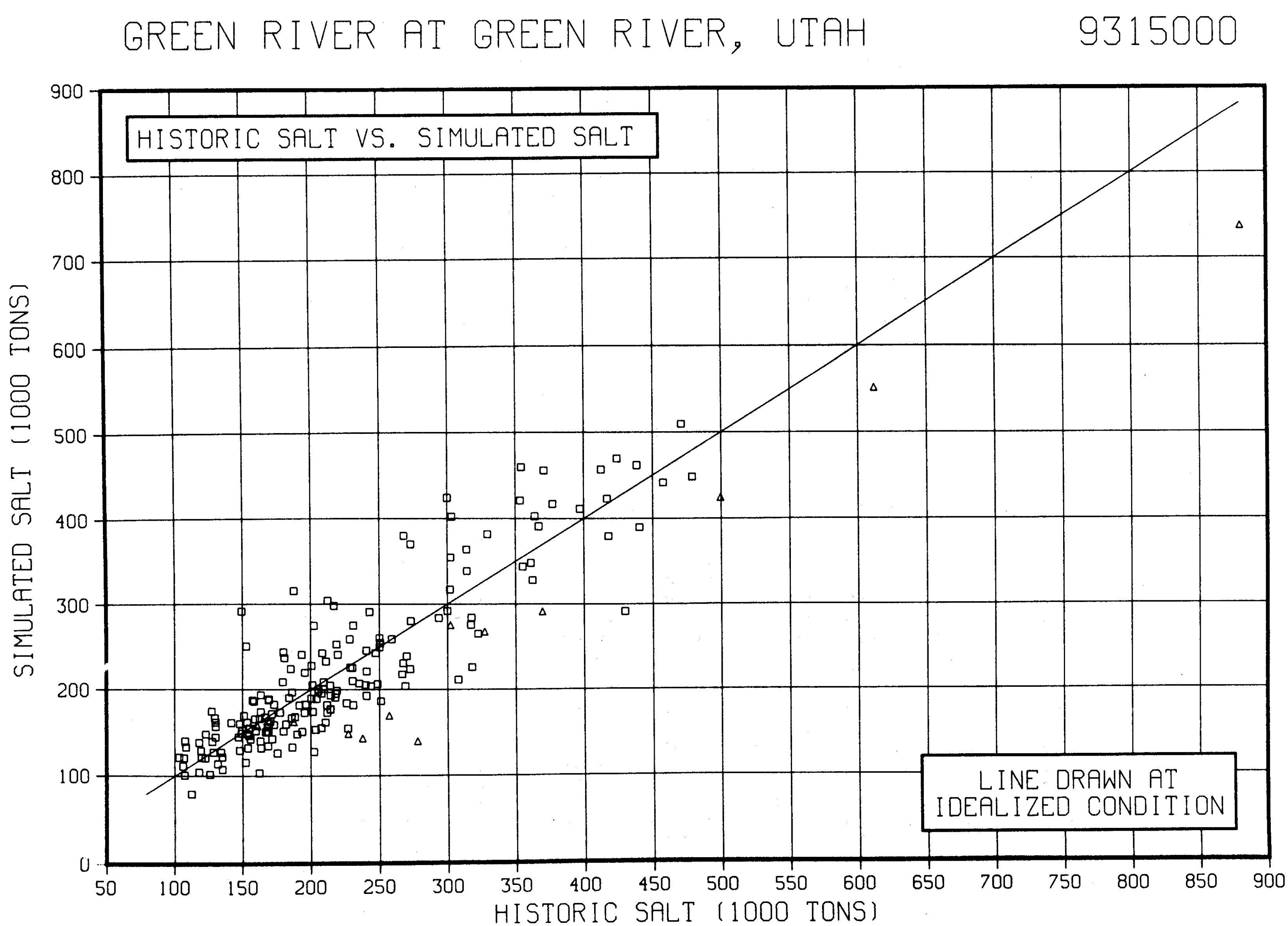


COLORADO RIVER AT LEES FERRY, ARIZONA 9380000 RUN DATE 85/05/13.

HISTORIC FLOW FOR STATION 9380000 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	633.21	463.96	857.63	967.95	942.76	894.56	827.22	685.16	634.90	625.12	633.87	637.46	8803.78
1969	569.64	460.77	708.41	870.54	763.15	875.32	955.65	929.67	793.90	629.84	706.38	814.50	9077.76
1970	706.32	445.00	486.16	942.16	899.52	800.05	768.57	772.87	701.01	498.14	448.91	670.50	8139.19
1971	491.49	416.10	640.35	1010.69	925.70	894.32	942.56	876.23	775.87	584.34	763.95	936.91	9258.50
1972	805.78	444.48	377.50	782.35	901.90	862.70	914.67	1005.48	930.86	631.23	671.24	1016.84	9345.02
1973	1206.72	763.89	1095.13	1677.64	647.85	750.66	656.16	566.61	424.25	509.86	412.45	333.07	9044.29
1974	845.98	299.21	388.49	494.55	803.46	913.72	1226.40	1212.71	826.31	602.45	710.21	564.13	8887.61
1975	768.25	555.72	507.62	458.86	892.08	987.29	1220.84	1021.50	966.32	636.88	425.01	520.15	8960.52
1976	691.90	742.07	676.00	660.19	1046.10	756.25	765.87	720.03	841.72	791.81	897.51	810.34	9399.79
1977	994.09	471.00	458.43	163.70	205.56	465.81	847.43	1177.80	977.03	379.13	390.00	823.43	7353.41
1978	947.64	601.40	579.24	492.27	647.45	758.05	701.70	1064.94	968.54	684.47	671.24	889.04	9005.98
1979	1018.43	746.27	204.38	341.44	517.38	614.25	859.57	1063.79	686.37	617.84	801.93	637.34	8108.98
1980	604.12	615.26	605.70	863.10	845.43	1472.11	1585.02	1278.56	981.24	777.02	935.93	765.33	11328.82
1981	745.46	640.33	462.61	472.65	552.90	527.00	845.63	903.29	667.13	608.70	584.74	837.85	7848.27
1982	892.22	677.15	508.69	613.66	616.21	634.17	796.81	916.99	617.35	792.31	974.89	976.30	9016.73
1983	913.64	860.52	660.51	951.27	1258.73	3314.23	3369.97	1833.15	1584.82	1564.78	1422.57	1473.15	19207.32
TOT	12834.89	9203.12	9216.83	11763.01	12466.17	15520.48	17284.06	16028.78	13377.60	10933.90	11450.81	12706.34	152785.98
AVG	802.18	575.20	576.05	735.19	779.14	970.03	1080.25	1001.80	836.10	683.37	715.68	794.15	9549.12

MINIMUM HISTORIC FLOW = 163.70 MAXIMUM HISTORIC FLOW = 3369.97

SIMULATED FLOW FOR STATION 9380000 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	623.81	353.61	859.56	922.04	631.52	1011.07	1176.49	772.45	701.42	620.97	616.94	662.76	8952.63
1969	503.18	380.83	632.79	767.07	696.01	746.72	1228.82	1150.98	881.56	533.47	689.21	818.58	9029.20
1970	768.82	431.81	468.15	1007.17	945.62	771.14	1180.52	954.41	748.45	572.17	484.36	713.21	9045.81
1971	473.18	381.73	601.91	1012.87	702.52	953.71	1282.64	1063.30	872.18	527.59	767.37	937.46	9576.45
1972	832.74	401.71	331.07	800.09	844.06	952.66	1113.34	1143.53	1016.85	297.67	653.99	992.24	9379.94
1973	1279.83	634.86	1045.76	1639.81	174.83	646.18	951.53	762.09	475.91	594.83	436.86	332.20	8974.69
1974	876.59	294.26	348.20	503.90	927.95	1021.80	1537.55	1474.23	914.53	562.82	728.11	627.77	9817.70
1975	868.96	556.36	493.45	363.44	595.87	820.92	1347.24	1126.27	972.00	581.47	439.38	510.71	8676.07
1976	717.58	723.07	615.43	647.62	858.69	696.00	1015.56	802.89	833.99	824.28	944.58	863.50	9543.18
1977	1012.23	414.14	454.49	137.29	61.00	413.97	690.06	1200.25	1035.47	380.59	429.34	904.18	7133.01
1978	963.11	593.42	521.81	333.38	320.91	1127.62	1008.21	1218.38	1063.25	684.79	857.66	1064.55	9757.07
1979	1082.08	374.49	.01	154.08	323.03	458.36	1172.54	1087.70	747.23	585.42	937.64	641.13	7563.71
1980	468.61	566.75	571.70	705.89	662.04	1644.90	1712.90	1215.00	927.24	714.12	929.09	703.23	10821.45
1981	709.38	601.45	403.30	465.38	327.20	592.57	848.54	799.88	598.05	559.35	837.68	849.86	7592.64
1982	893.88	604.18	397.51	506.61	371.21	562.18	921.01	888.00	587.11	834.71	932.40	917.37	8416.16
1983	822.07	758.38	637.21	708.38	896.30	3157.67	3449.11	1818.49	1603.57	1273.52	1209.99	1143.12	17477.80
TOT	12896.02	8071.02	8382.35	10675.00	9338.74	15577.45	20636.05	17477.83	13978.81	10147.76	11894.60	12681.88	151757.51
AVG	806.00	504.44	523.90	667.19	583.67	973.59	1289.75	1092.36	873.68	634.24	743.41	792.62	9484.84

MINIMUM SIMULATED FLOW = .01 MAXIMUM SIMULATED FLOW = 3449.11

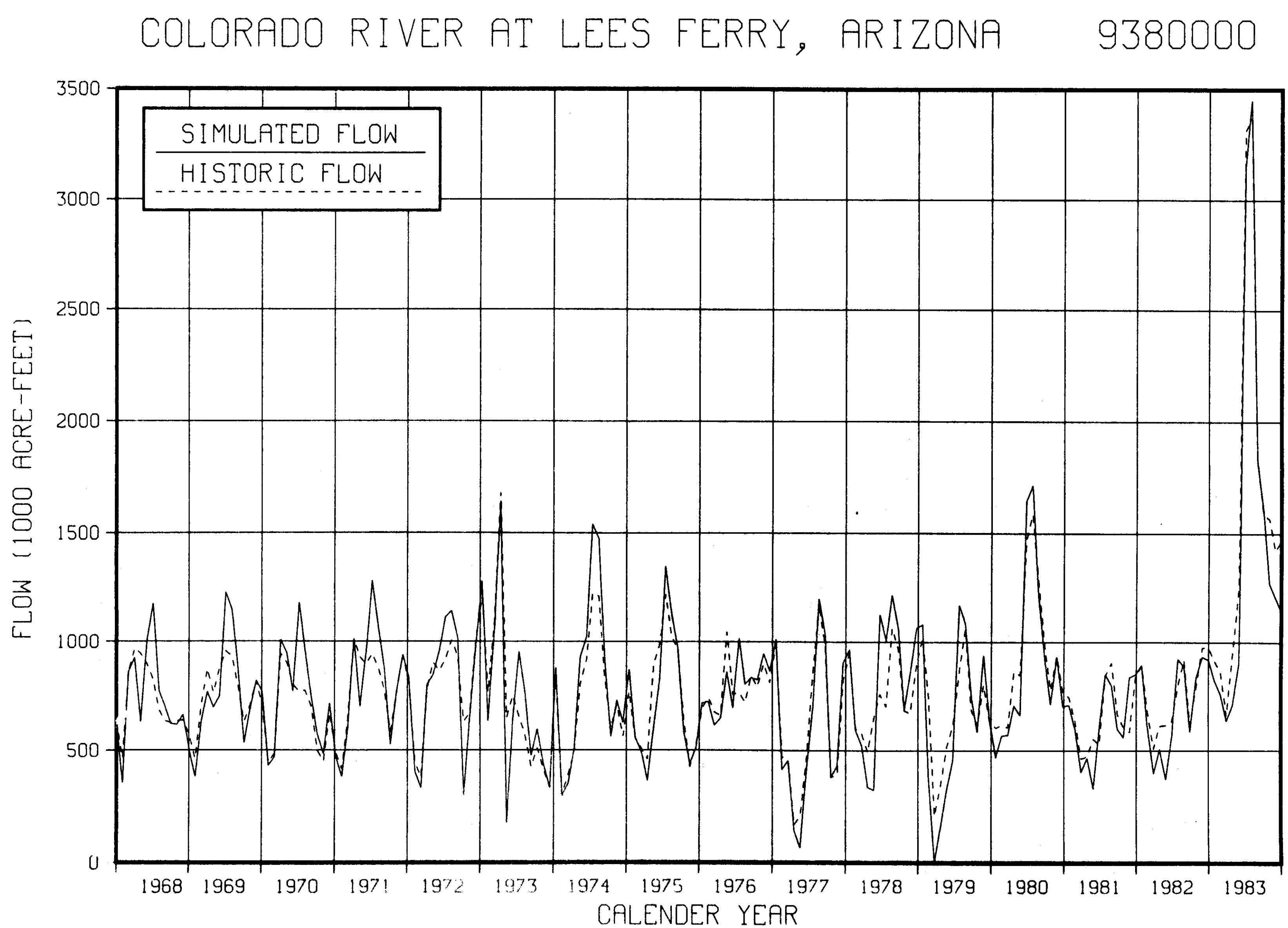
COLORADO RIVER AT LEES FERRY, ARIZONA 9380000 RUN DATE 85/05/13.

PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC FLOWS AT STATION 9380000

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	-1.49	-23.78	.23	-4.74	-33.01	13.02	42.22	12.74	10.48	-.66	-2.67	3.97	1.69
1969	-11.67	-17.35	-10.67	-11.89	-8.80	-14.69	28.58	23.81	11.04	-15.30	-2.43	.50	-.53
1970	8.85	-2.96	-3.70	6.90	5.13	-3.61	53.60	23.49	6.77	14.86	7.90	6.37	11.14
1971	-3.73	-8.26	-6.00	.22	-24.11	6.64	36.08	21.35	12.41	-9.71	.45	.06	3.43
1972	3.35	-9.62	-12.30	2.27	-6.41	10.43	21.72	13.73	9.24	-52.84	-2.57	-2.42	.37
1973	6.06	-16.89	-4.51	-2.26	-73.01	-13.92	45.02	34.50	12.18	16.66	5.92	-.26	-.77
1974	3.62	-1.66	-10.37	1.89	15.50	11.83	25.37	21.56	10.68	-6.58	2.52	11.28	10.47
1975	13.11	.12	-2.79	-20.80	-33.20	-16.85	10.35	10.26	.59	-8.70	3.38	-1.81	-3.17
1976	3.71	-2.56	-8.96	-1.90	-17.91	-7.97	32.60	11.51	-.92	4.10	5.24	6.56	1.53
1977	1.82	-12.07	-.86	-16.13	-70.32	-11.13	-18.57	1.91	5.98	.39	10.09	9.81	-3.00
1978	1.63	-1.33	-9.92	-32.28	-50.44	48.75	43.68	14.41	9.78	.05	27.77	19.74	8.34
1979	6.25	-49.82	-100.00	-54.87	-37.56	-25.38	36.41	2.25	8.87	-5.25	16.92	.60	-6.72
1980	-22.43	-7.89	-5.61	-18.21	-21.69	11.74	8.07	-4.97	-5.50	-8.09	-.73	-8.11	-4.48
1981	-4.84	-6.07	-12.82	-1.54	-40.82	12.44	.34	-11.45	-10.35	-8.11	43.26	1.43	-3.26
1982	.19	-10.78	-21.86	-17.44	-39.76	-11.35	15.59	-3.16	-4.90	5.35	-4.36	-6.04	-6.66
1983	-10.02	-11.87	-3.53	-25.53	-28.79	-4.72	2.35	-.80	1.18	-18.61	-14.94	-22.40	-9.00

PERCENT DIFFERENCE OF 16 YEAR AVERAGES = -.67

PLOT 1 11.48.16 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



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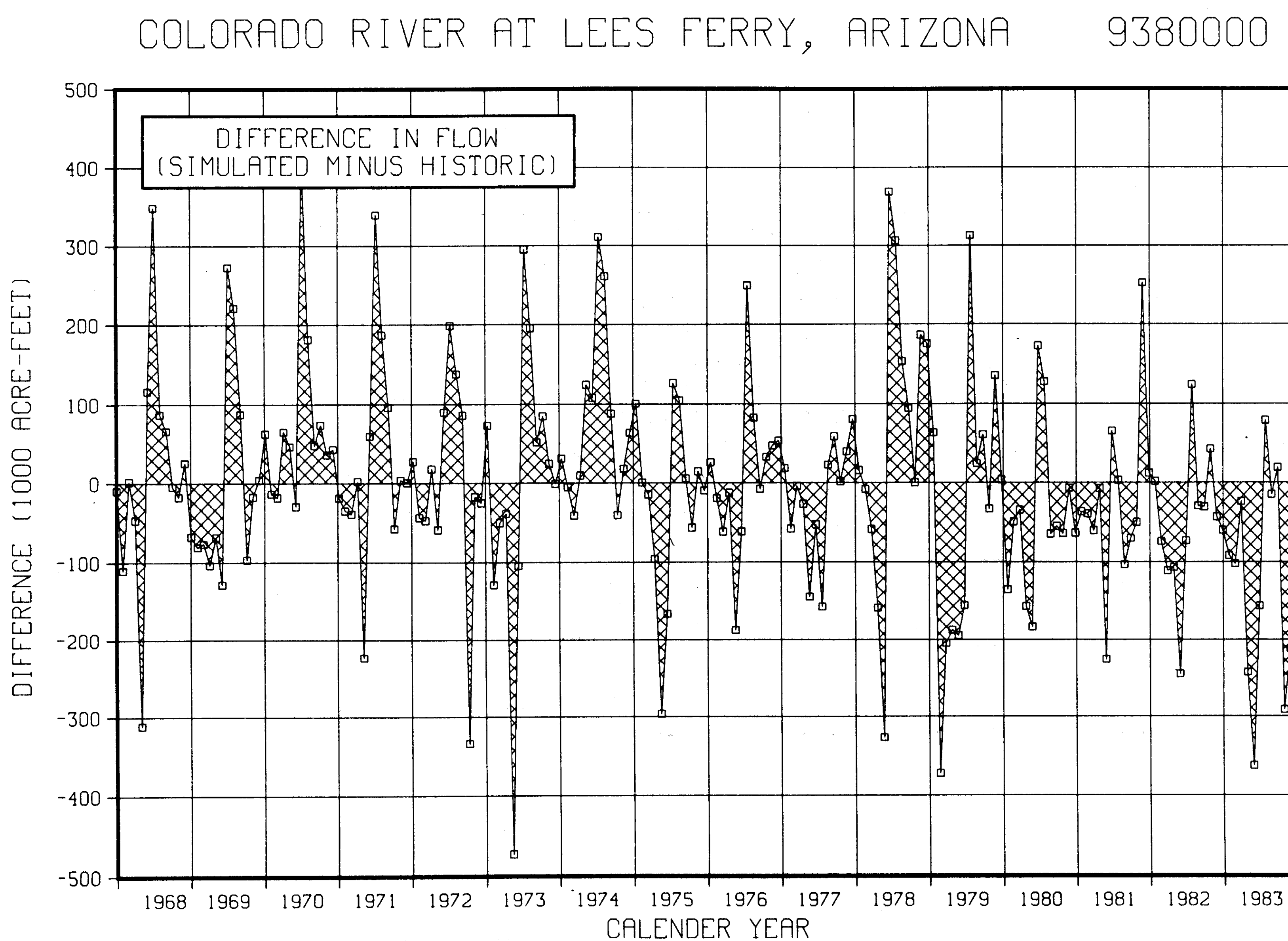

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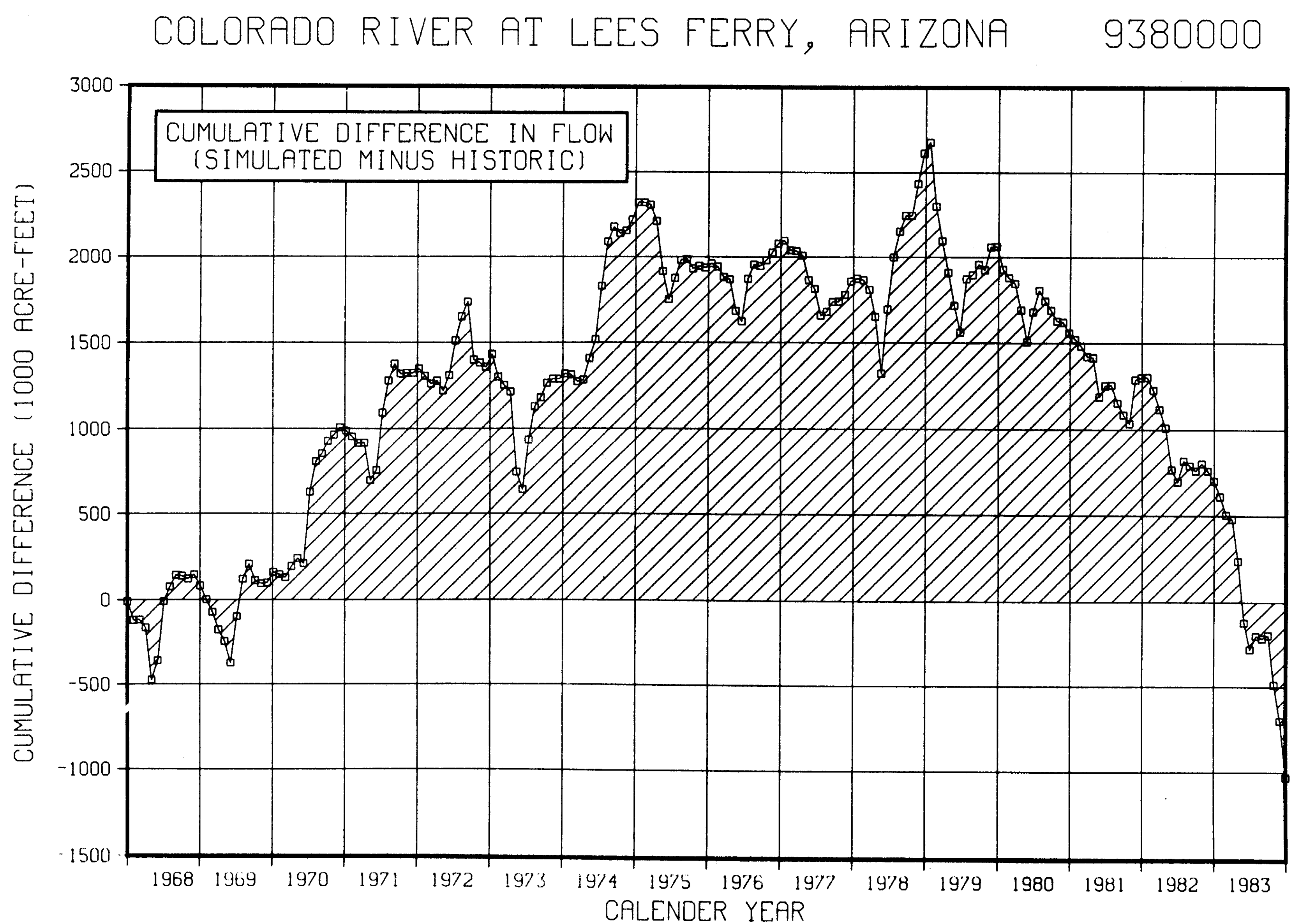

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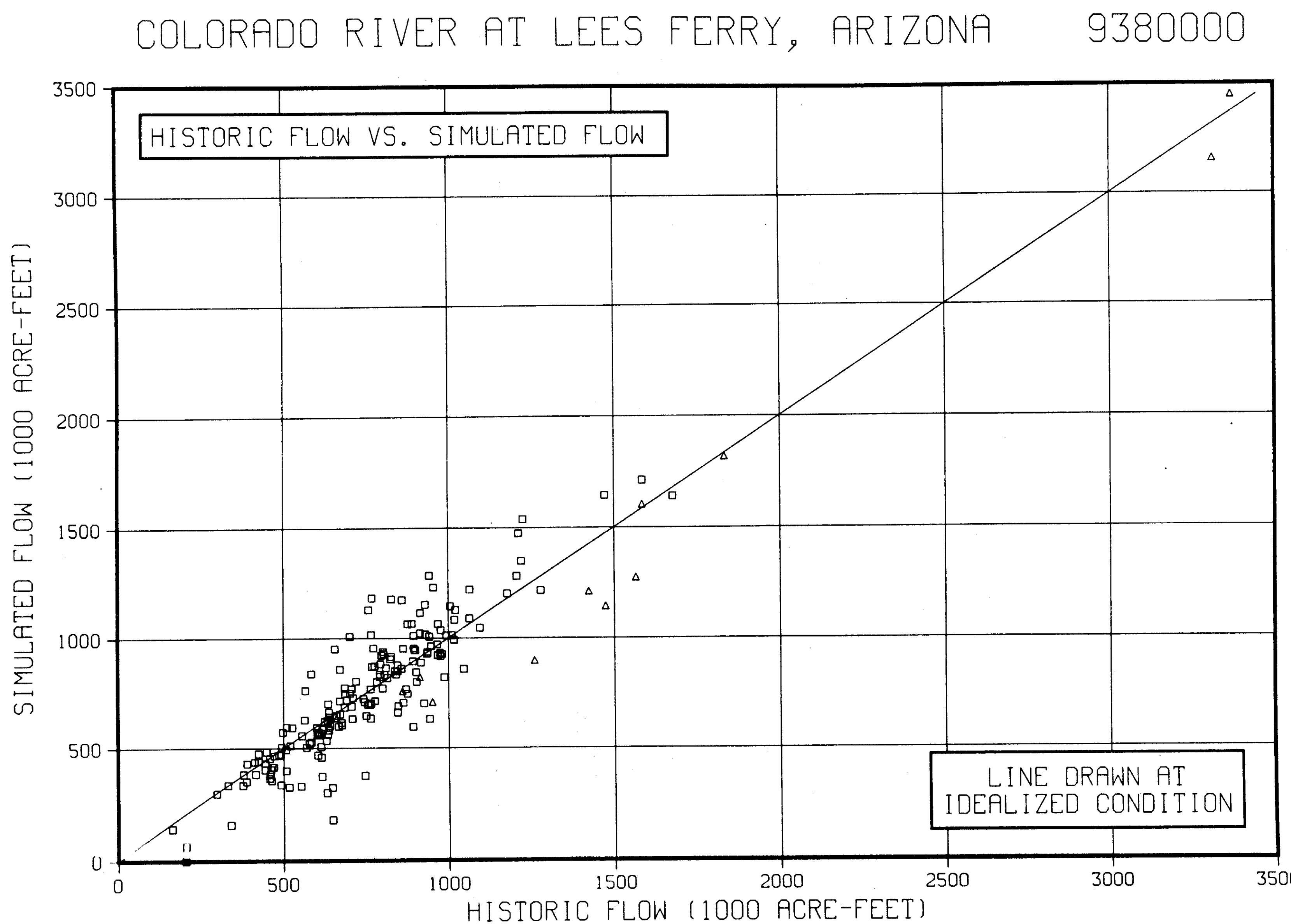


COLORADO RIVER AT LEES FERRY, ARIZONA 9380000 RUN DATE 85/05/13.

HISTORIC SALT FOR STATION 9380000 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	595.22	454.68	866.20	1016.35	961.61	903.50	678.32	472.76	444.43	425.08	431.03	490.84	7740.03
1969	512.68	428.51	680.07	853.13	724.99	787.79	793.19	669.36	539.85	453.49	515.66	594.59	7553.30
1970	572.12	378.25	447.26	857.37	800.57	656.04	614.85	602.84	525.76	368.62	345.66	522.99	6692.33
1971	358.79	341.20	557.11	869.20	768.33	679.68	716.34	639.65	512.07	403.19	527.12	646.47	7019.15
1972	580.16	320.03	305.78	657.18	712.50	655.65	667.71	734.00	651.60	441.86	476.58	772.80	6975.84
1973	856.77	550.00	876.10	1375.67	531.24	593.02	524.93	430.62	322.43	372.20	301.09	223.16	6957.22
1974	566.81	197.48	299.14	395.64	618.66	676.15	883.01	861.03	578.41	415.69	482.94	372.32	6347.28
1975	530.09	394.56	380.71	348.74	695.82	730.59	891.22	725.27	686.09	439.45	301.75	364.11	6488.39
1976	477.41	556.55	534.04	521.55	805.50	559.62	551.43	511.22	597.62	546.35	628.26	567.24	6856.78
1977	705.80	357.96	366.74	129.32	164.45	363.33	644.05	930.46	742.54	284.34	292.50	625.81	5607.32
1978	739.16	469.09	463.39	408.58	550.34	636.77	582.41	883.90	803.89	554.42	523.56	666.78	7282.29
1979	743.45	559.70	163.50	300.47	439.77	503.69	687.66	819.12	535.37	475.74	609.47	458.88	6296.81
1980	434.96	455.29	490.62	699.11	667.89	1045.20	1077.81	869.42	677.05	528.37	627.08	497.47	8070.27
1981	499.46	448.23	346.96	354.49	420.20	400.52	625.76	650.37	466.99	413.91	415.16	603.25	5645.31
1982	660.24	514.63	376.43	484.79	468.32	500.99	605.58	687.74	432.14	578.39	701.92	663.88	6675.05
1983	612.14	610.97	488.77	675.40	868.52	2220.53	2224.18	1264.87	1109.37	1079.70	981.57	1016.47	13152.50
TOT	9445.27	7037.14	7642.83	9946.96	10198.71	11913.08	12768.44	11752.63	9625.62	7780.80	8161.35	9087.06	115359.88
AVG	590.33	439.82	477.68	621.68	637.42	744.57	798.03	734.54	601.60	486.30	510.08	567.94	7209.99

MINIMUM HISTORIC SALT = 129.32 MAXIMUM HISTORIC SALT = 2224.18

SIMULATED SALT FOR STATION 9380000 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	518.61	301.58	751.90	830.11	572.32	833.16	896.74	595.78	553.90	506.32	516.29	565.34	7442.04
1969	435.09	332.25	556.79	663.30	566.12	577.93	935.36	880.62	686.41	421.16	550.51	660.49	7266.01
1970	625.95	354.00	386.42	839.58	757.22	568.15	832.12	676.55	539.13	417.22	357.77	532.02	6886.13
1971	355.19	287.61	456.87	770.73	532.24	701.75	915.45	763.47	636.91	392.01	579.49	715.89	7107.62
1972	640.18	310.09	257.72	631.56	675.69	754.42	875.85	917.75	830.52	245.08	539.92	822.60	7501.38
1973	1062.67	527.36	873.53	1377.85	139.59	469.07	650.45	514.66	324.59	410.80	305.49	234.36	6890.42
1974	621.85	209.82	250.34	365.85	663.49	711.68	1070.01	1042.28	658.69	412.31	540.47	470.67	7017.46
1975	657.08	423.68	379.02	282.03	460.12	610.34	956.99	791.60	692.86	420.59	321.44	376.09	6371.83
1976	531.19	538.43	462.41	492.21	655.61	529.84	775.02	620.49	654.67	656.09	759.94	699.44	7375.33
1977	823.61	338.67	374.38	114.36	51.76	360.59	618.80	1101.28	965.17	359.78	410.75	872.65	6391.79
1978	935 39	580.07	513.24	327.75	310.13	1025.96	867.62	1046.69	925.51	603.60	761.44	945.83	8843.85
1979	962.44	333.90	.01	134.90	268.70	355.95	868.94	801.37	557.68	443.10	718.37	494.92	5940.28
1980	363.63	441.02	445.89	551.09	503.29	1187.05	1207.53	866.67	670.93	523.04	688.04	524.88	7973.08
1981	532.96	454.61	307.49	359.01	256.77	471.21	682.31	654.89	498.20	470.47	707.10	721.64	6116.65
1982	764.85	519.90	343.89	440.51	320.17	471.43	754.41	725.00	481.25	686.47	769.30	759.32	7036.49
1983	681.82	630.03	529.96	589.21	731.54	2385.85	2388.93	1224.58	1085.24	871.38	837.99	799.73	12756.25
TOT	10513.10	6583.00	6889.86	8770.06	7464.75	12014.38	15296.54	13223.67	10761.67	7839.39	9364.32	10195.87	118916.62
AVG	657.07	411.44	430.62	548.13	466.55	750.90	956.03	826.48	672.60	489.96	585.27	637.24	7432.29

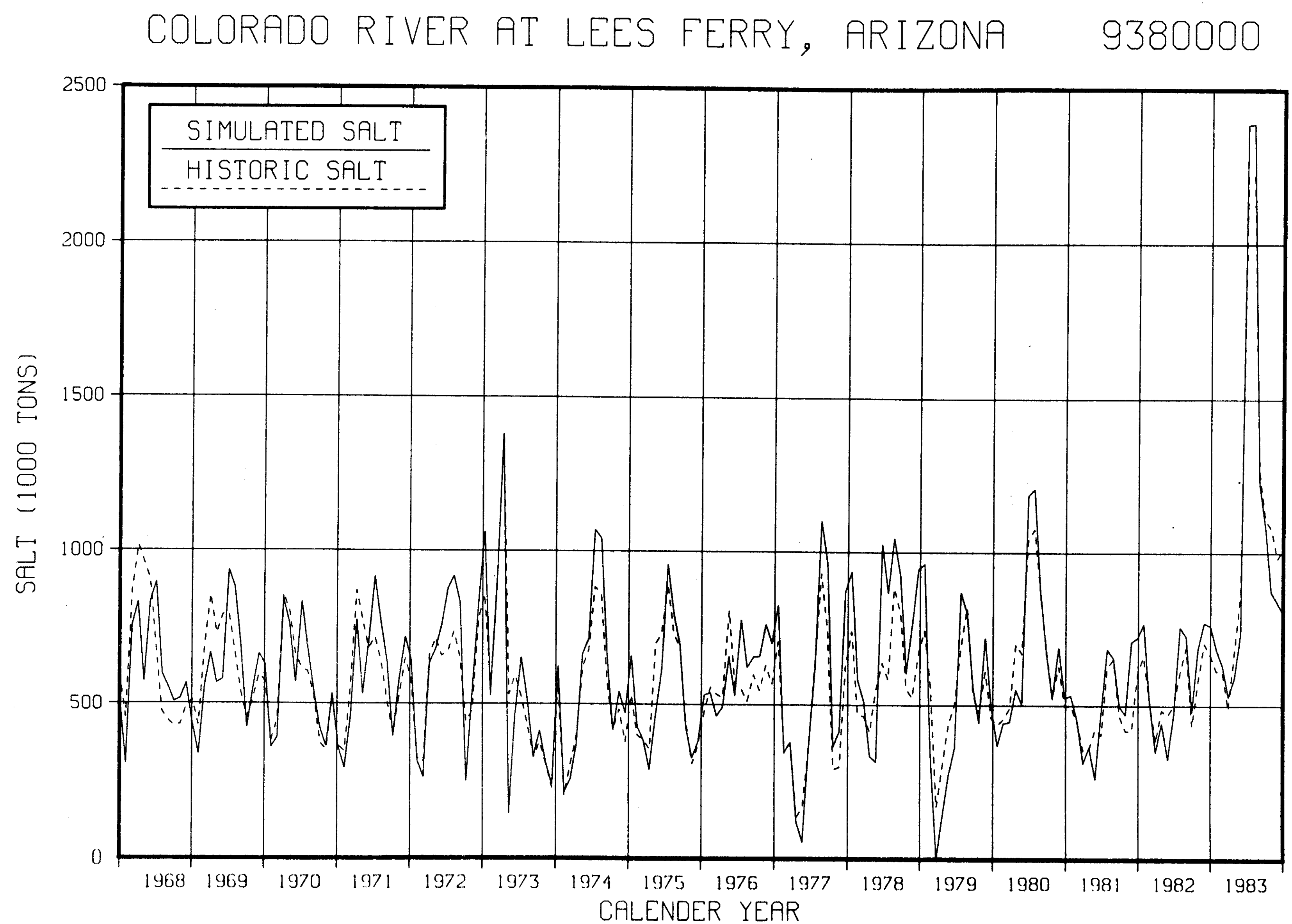
MINIMUM SIMULATED SALT = .01 MAXIMUM SIMULATED SALT = 2388.93

COLORADO RIVER AT LEES FERRY, ARIZONA 9380000 RUN DATE 85/05/13.

PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC SALT AT STATION 9380000

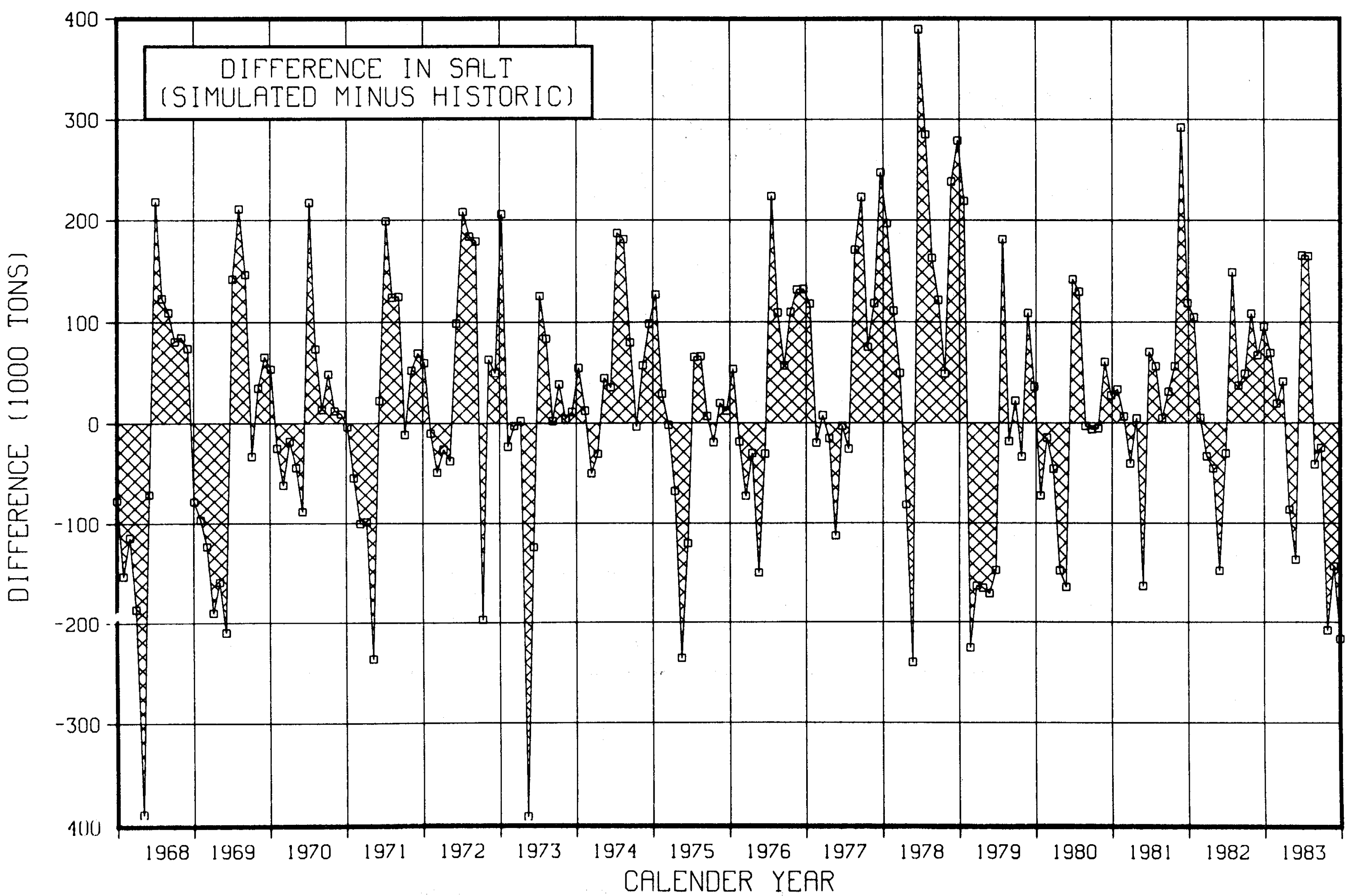
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	-12.87	-33.67	-13.20	-18.32	-40.48	-7.79	32.20	26.02	24.63	19.11	19.78	15.18	-3.85
1969	-15.13	-22.47	-18.13	-22.25	-21.91	-26.64	17.92	31.56	27.15	-7.13	6.76	11.08	-3.80
1970	9.41	-6.41	-13.60	-2.07	-5.41	-13.40	35.34	12.23	2.54	13.18	3.50	1.73	2.90
1971	-1.00	-15.71	-17.99	-11.33	-30.73	3.25	27.79	19.36	24.38	-2.77	9.94	10.74	1.26
1972	10.35	-3.11	-15.71	-3.90	-5.17	15.06	31.17	25.03	27.46	-44.54	13.29	6.44	7.53
1973	24.03	-4.12	-.29	.16	-73.72	-20.90	23.91	19.52	.67	10.37	1.46	5.02	-.96
1974	9.71	6.25	-16.31	-7.53	7.25	5.25	21.18	21.05	13.88	-.81	11.91	26.42	10.56
1975	23.96	7.38	-.45	-19.13	-33.87	-16.46	7.38	9.15	.99	-4.29	6.52	3.29	-1.80
1976	11.26	-3.26	-13.41	-5.63	-18.61	-5.32	40.55	21.37	9.55	20.09	20.96	23.31	7.56
1977	16.69	-5.39	2.08	-11.57	-68.53	-.75	-3.92	18.36	29.98	26.53	40.43	39.44	13.99
1978	26.63	23.66	10.76	-19.78	-43.65	61.12	48.97	18.42	15.13	8.87	45.43	41.85	21.44
1979	29.46	-40.34	-99.99	-55.10	-38.90	-29.33	26.36	-2.17	4.17	-6.86	17.87	7.85	-5.66
1980	-16.40	-3.13	-9.12	-21.17	-24.64	13.57	12.04	-.32	-.90	-1.01	9.72	5.51	-1.20
1981	6.71	1.42	-11.38	1.28	-38.89	17.65	9.04	.70	6.68	13.66	70.32	19.62	8.35
1982	15.84	1.02	-8.64	-9.13	-31.63	-5.90	24.58	5.42	11.36	18.69	9.60	14.38	5.41
1983	11.38	3.12	8.43	-12.76	-15.77	7.44	7.41	-3.19	-2.18	-19.29	-14.63	-21.32	-3.01

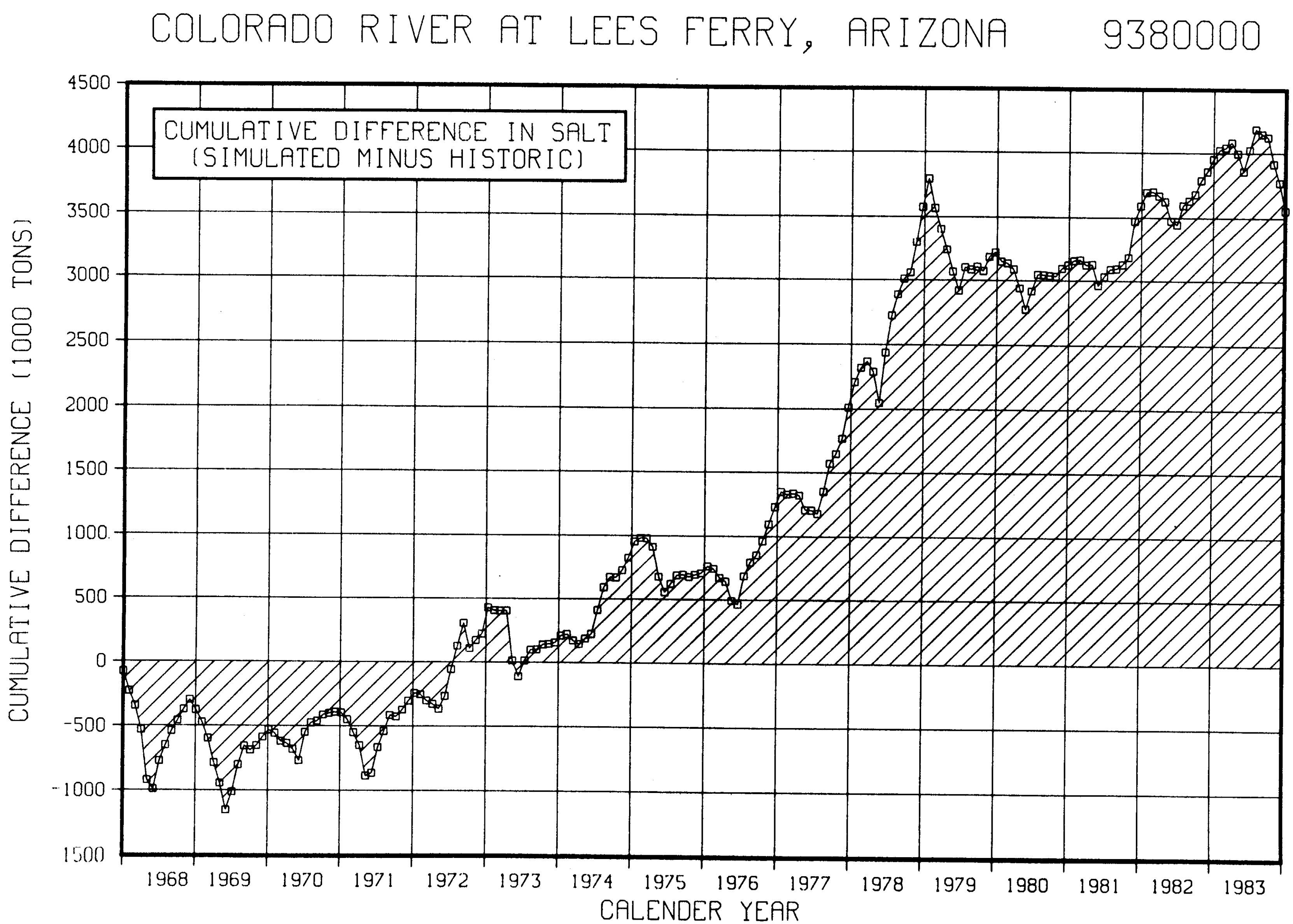
PERCENT DIFFERENCE OF 16 YEAR AVERAGES = 3.08


COLORADO RIVER AT LEES FERRY, ARIZONA 9380000
SIMULATED SALT
HISTORIC SALT
SALT (1000 TONS)
2500
2000
1500
1000
500
0
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
CALENDER YEAR

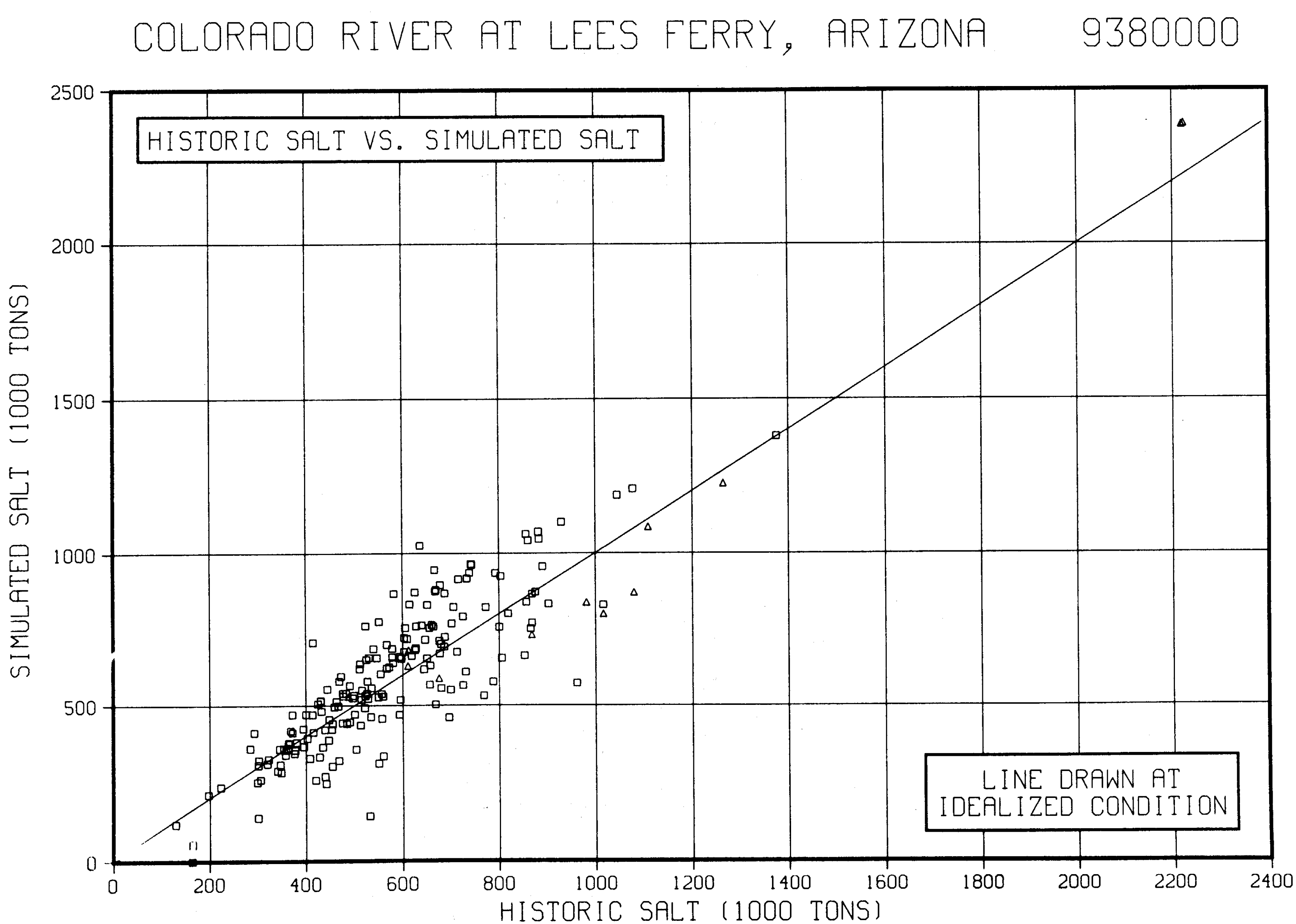
PLOT 2 11.49.09 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2

COLORADO RIVER AT LEES FERRY, ARIZONA 9380000




COLORADO RIVER AT LEES FERRY, ARIZONA 9380000
CUMULATIVE DIFFERENCE IN SALT
(SIMULATED MINUS HISTORIC)
CUMULATIVE DIFFERENCE (1000 TONS)
4500
4000
3500
3000
2500
2000
1500
1000.
500
0
-500
-1000
1500
1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983
CALENDER YEAR

PLOT 3 11.49.20 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



COLORADO RIVER BELOW HOOVER DAM, AZ-NV 9421500 RUN DATE 85/05/13.

HISTORIC FLOW FOR STATION 9421500 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	395.83	495.56	850.03	883.29	852.73	752.12	757.06	692.72	663.34	486.26	456.74	552.62	7838.30
1969	548.91	551.69	824.82	894.24	834.32	753.29	772.04	692.68	618.08	522.89	425.70	453.43	7892.09
1970	602.51	535.59	753.06	918.82	926.65	780.17	792.33	676.49	506.96	583.35	449.56	497.07	8022.54
1971	560.76	663.10	859.53	913.20	860.88	741.00	739.73	741.65	622.88	502.68	452.36	506.37	8164.12
1972	567.64	636.17	904.75	876.91	865.78	795.44	768.77	756.31	634.18	517.32	397.10	379.13	8099.48
1973	581.05	553.62	610.68	864.81	1010.83	683.24	823.21	856.81	659.36	559.80	526.48	571.25	8301.12
1974	436.43	588.52	864.19	951.25	959.91	880.26	847.47	947.54	713.51	613.68	503.87	425.22	8731.84
1975	515.33	617.29	749.17	871.41	968.46	807.07	830.23	804.85	667.73	548.99	485.84	500.89	8367.25
1976	508.83	495.56	909.71	873.54	928.93	716.34	842.63	893.79	608.68	351.22	304.39	486.97	7926.58
1977	250.42	608.34	854.10	988.04	760.57	720.09	892.54	875.93	469.26	428.44	462.55	562.76	7873.03
1978	234.91	429.21	740.36	901.68	859.87	654.04	830.67	892.20	688.33	502.04	375.32	367.86	7476.49
1979	217.69	291.36	618.03	703.30	1010.55	865.28	857.67	875.87	702.93	530.35	542.90	505.30	7721.23
1980	471.52	267.77	929.59	1129.45	1260.30	1056.81	1190.02	1194.27	879.01	986.85	836.78	885.24	11087.59
1981	618.75	536.02	814.50	1016.06	857.27	834.95	864.15	915.09	662.57	379.40	387.97	397.22	8283.96
1982	462.82	548.48	792.11	1042.43	843.29	635.01	735.38	764.42	393.86	392.55	379.42	463.76	7453.53
1983	1176.22	364.67	633.36	1059.94	1215.89	1886.31	2574.39	2421.85	2186.61	2105.68	1749.84	1692.32	19067.07
TOT	8149.59	8182.93	12707.98	14894.36	15016.23	13561.42	15118.28	15002.46	11677.28	10011.50	8736.82	9247.39	142306.24
AVG	509.35	511.43	794.25	930.90	938.51	847.59	944.89	937.65	729.83	625.72	546.05	577.96	8894.14

MINIMUM HISTORIC FLOW = 217.69 MAXIMUM HISTORIC FLOW = 2574.39

SIMULATED FLOW FOR STATION 9421500 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	385.92	381.32	845.97	831.40	537.16	864.63	1102.87	778.63	727.73	477.82	437.15	574.74	7945.36
1969	476.10	466.74	742.72	785.24	762.04	620.09	1042.22	912.04	702.76	423.79	406.64	455.17	7795.55
1970	660.35	518.93	729.88	980.27	968.28	747.19	1201.06	852.19	550.41	653.27	479.44	534.86	8876.12
1971	536.28	623.72	1064.18	870.31	632.33	796.21	1078.51	926.86	716.44	443.13	453.42	504.75	8646.14
1972	589.56	588.76	854.18	892.07	805.56	884.33	967.26	894.04	718.46	180.63	376.55	351.04	8102.42
1973	649.80	421.10	556.13	824.66	534.59	577.00	1118.48	1052.17	709.71	644.52	549.82	568.25	8206.23
1974	462.33	581.41	820.45	957.83	1082.66	988.72	1157.50	1207.25	800.17	569.65	518.00	483.69	9629.66
1975	612.30	613.45	730.51	771.52	670.02	640.70	953.52	910.50	671.52	491.69	499.15	489.19	8054.05
1976	530.50	470.01	844.54	863.24	740.23	656.15	1091.12	977.10	597.80	379.34	350.04	538.09	8038.15
1977	263.85	548.17	844.29	958.40	611.87	666.32	735.48	897.76	526.02	428.53	499.70	638.95	7619.33
1978	244.96	416.46	675.99	738.94	531.74	1023.08	1137.04	1046.94	782.36	504.26	555.61	540.66	8198.03
1979	276.80	.01	.01	809.96	814.48	710.23	1175.88	899.53	770.71	497.89	669.78	497.13	7122.40
1980	293.86	87.77	843.72	913.00	986.72	1206.73	1315.36	1133.26	799.49	935.54	822.95	825.01	10163.39
1981	614.68	533.80	780.63	1055.09	687.04	922.62	911.52	770.49	581.05	320.15	620.68	411.14	8208.89
1982	468.06	459.50	649.80	942.15	602.05	584.86	853.65	703.27	310.21	453.99	379.43	270.85	6677.82
1983	1156.05	273.22	462.88	721.34	698.88	1817.81	2527.70	2291.32	2197.38	1763.00	1502.83	1303.46	16715.85
TOT	8221.39	6984.38	11445.86	13915.41	11665.64	13706.67	18369.16	16253.35	12162.20	9167.21	9121.17	8986.97	139999.40
AVG	513.84	436.52	715.37	869.71	729.10	856.67	1148.07	1015.83	760.14	572.95	570.07	561.69	8749.96

MINIMUM SIMULATED FLOW = .01 MAXIMUM SIMULATED FLOW = 2527.70

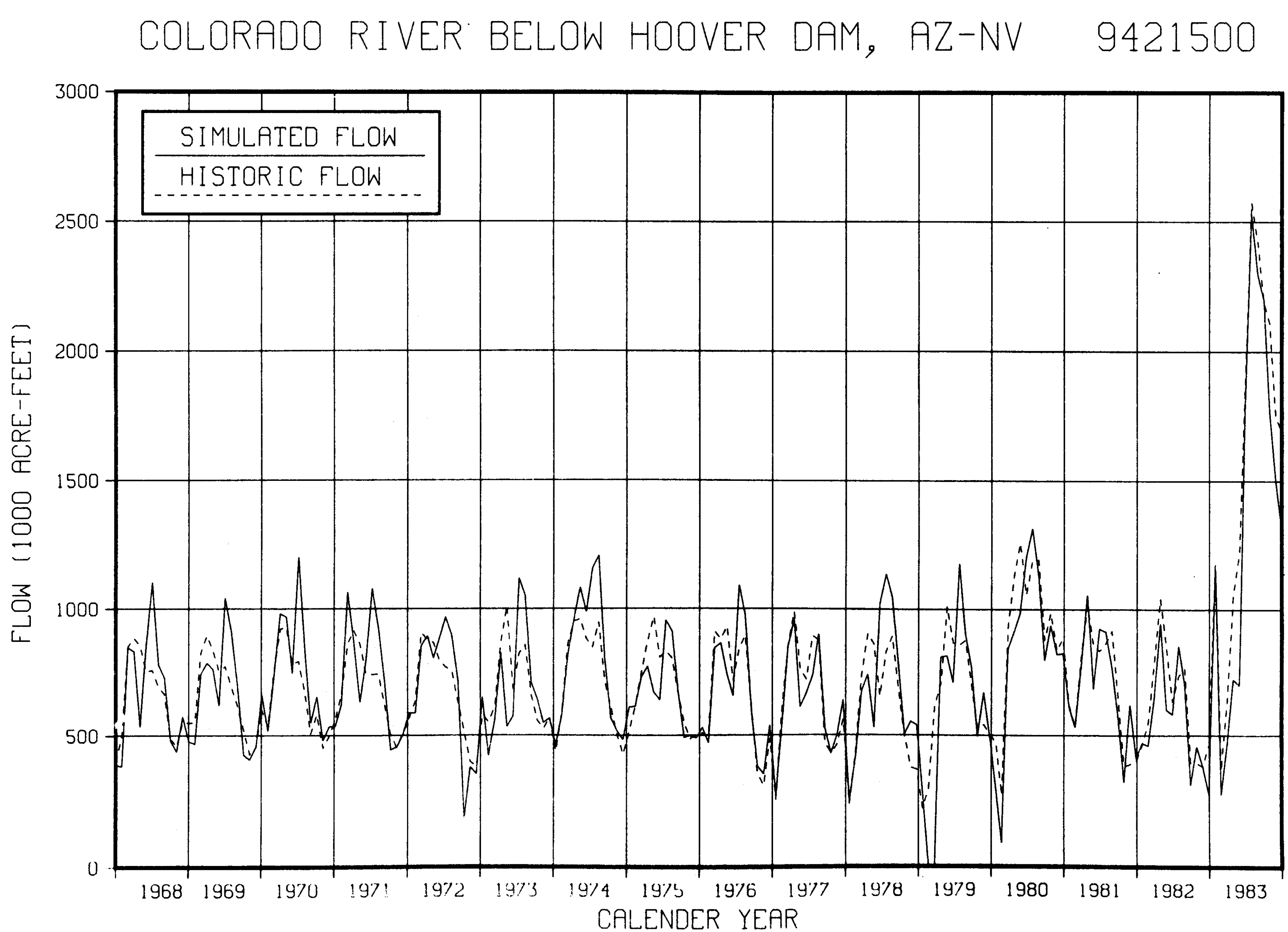
COLORADO RIVER BELOW HOOVER DAM, AZ-NV 9421500 RUN DATE 85/05/13.

PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC FLOWS AT STATION 9421500

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	-2.50	-23.05	-.48	-5.87	-37.01	14.96	45.68	12.40	9.71	-1.73	-4.29	4.00	1.37
1969	-13.27	-15.40	-9.95	-12.19	-8.66	-17.68	35.00	31.67	13.70	-18.95	-4.48	.38	-1.22
1970	9.60	-3.11	-3.08	6.69	4.49	-4.23	51.59	25.97	8.57	11.99	6.65	7.60	10.64
1971	-4.37	-5.94	23.81	-4.70	-26.55	7.45	45.80	24.97	15.02	-11.85	.24	-.32	5.90
1972	3.86	-7.45	-5.59	1.73	-6.96	11.17	25.82	18.21	13.29	-65.08	-5.17	-7.41	.04
1973	11.83	-23.94	-8.93	-4.64	-47.11	-15.55	35.87	22.80	7.64	15.13	4.43	-.53	-1.14
1974	5.93	-1.21	-5.06	.69	12.79	12.32	36.58	27.41	12.15	-7.17	2.80	13.75	10.28
1975	18.82	-.62	-2.49	-11.46	-30.82	-20.61	14.85	13.13	.57	-10.44	2.74	-2.34	-3.74
1976	4.26	-5.16	-7.16	-1.85	-20.31	-8.40	29.49	9.32	-1.79	8.01	15.00	10.50	1.41
1977	5.37	-9.89	-1.15	-3.00	-19.55	-7.47	-17.60	2.49	12.10	.02	8.03	13.54	-3.22
1978	4.28	-2.97	-8.70	-18.05	-38.16	56.42	36.88	17.34	13.66	.44	48.04	46.98	9.65
1979	27.16	-100.00	-100.00	15.16	-19.40	-17.92	37.10	2.70	9.64	-6.12	23.37	-1.62	-7.76
1980	-37.68	-67.22	-9.24	-19.16	-21.71	14.19	10.53	-5.11	-9.05	-5.20	-1.65	-6.80	-8.34
1981	-.66	-.42	-4.16	3.84	-19.86	10.50	5.48	-15.80	-12.30	-15.62	59.98	3.50	-.91
1982	1.13	-16.22	-17.97	-9.62	-28.61	-7.90	16.08	-8.00	-21.24	15.65	.00	-41.60	-10.41
1983	-1.71	-25.08	-26.92	-31.95	-42.52	-3.63	-1.81	-5.39	.49	-16.27	-14.12	-22.98	-12.33

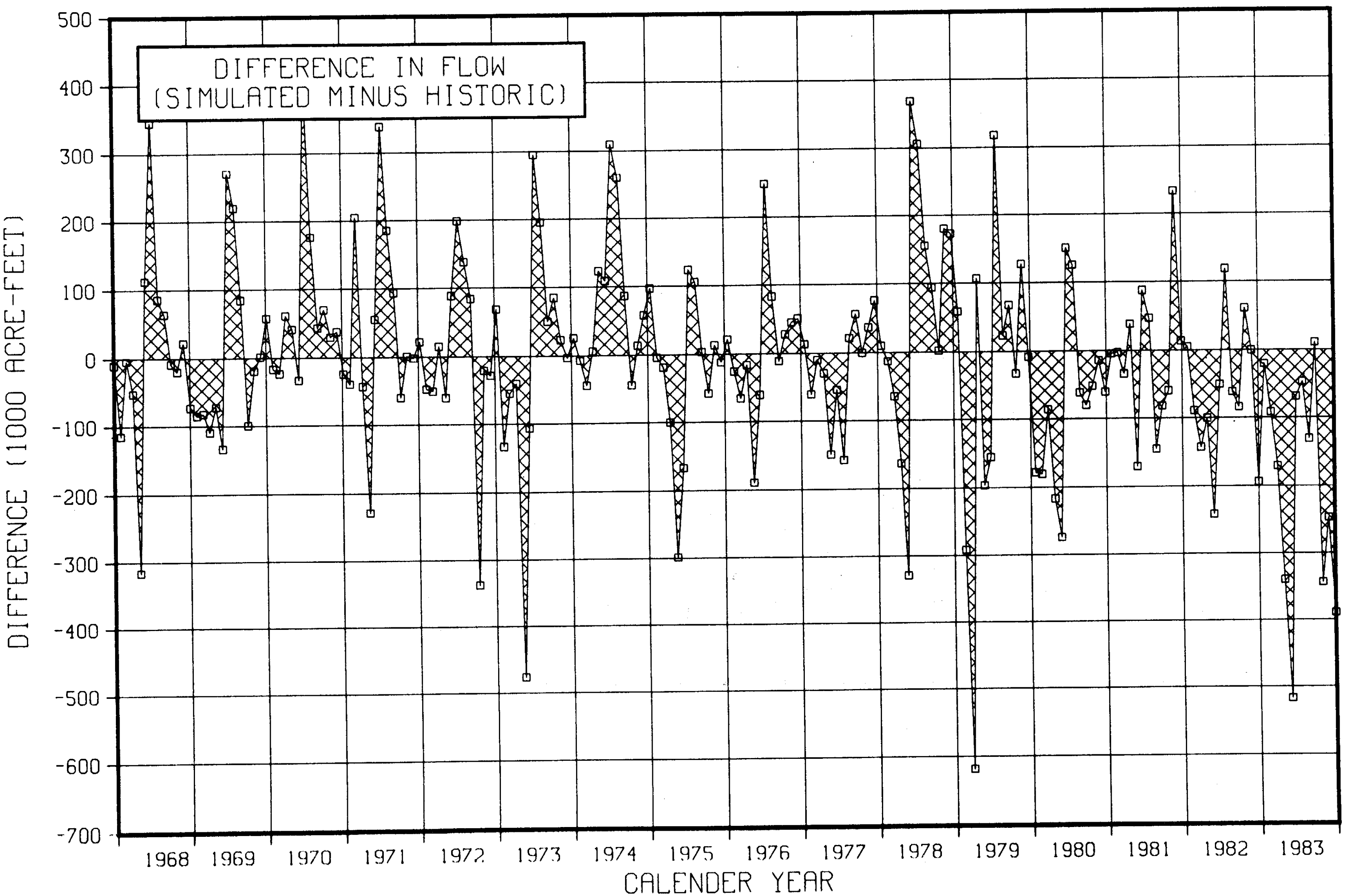
PERCENT DIFFERENCE OF 16 YEAR AVERAGES = -1.62

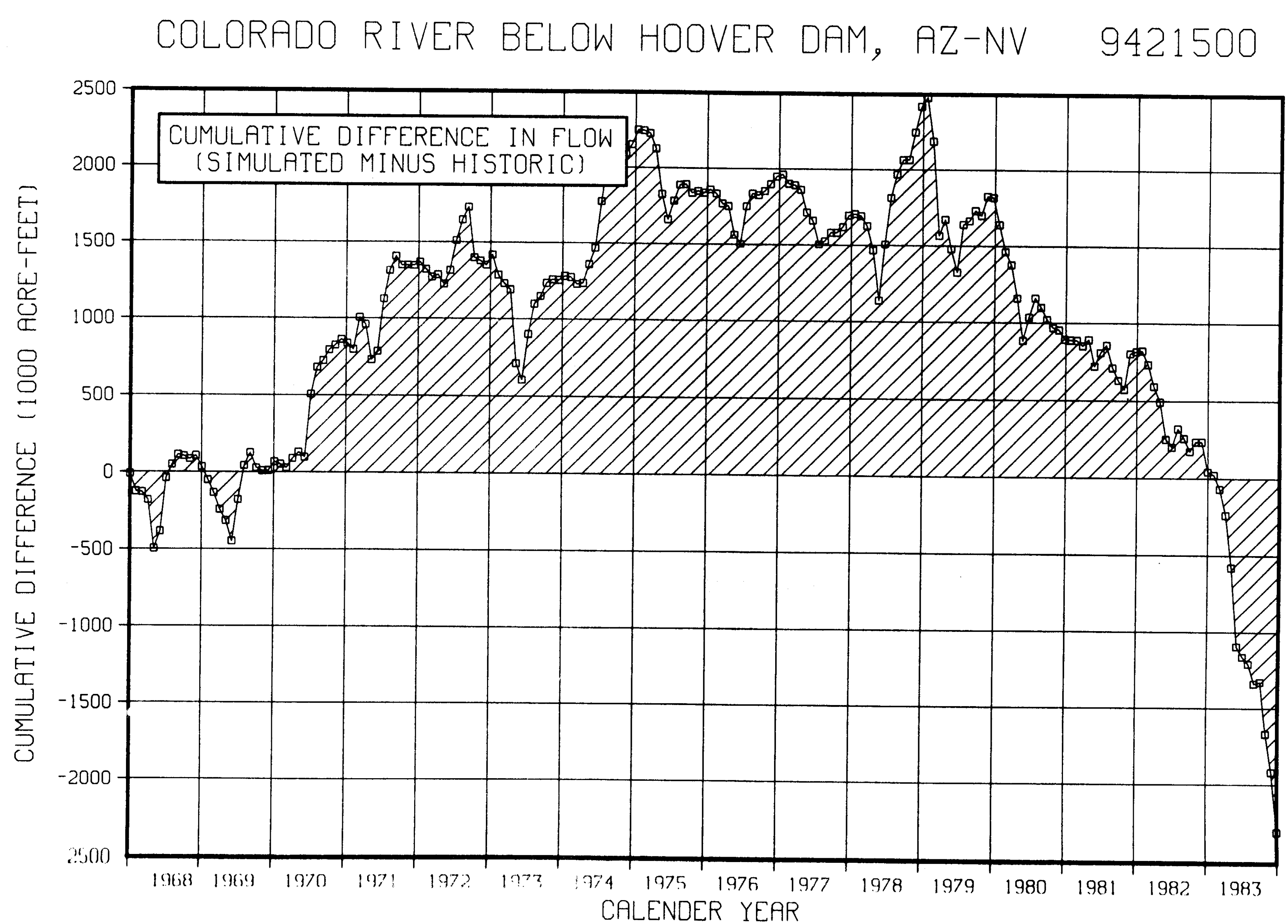
PLOT 1 11.50.23 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



PLOT 2   11.50.36   MON 13 MAY, 1985   JOB-ADUL   , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2

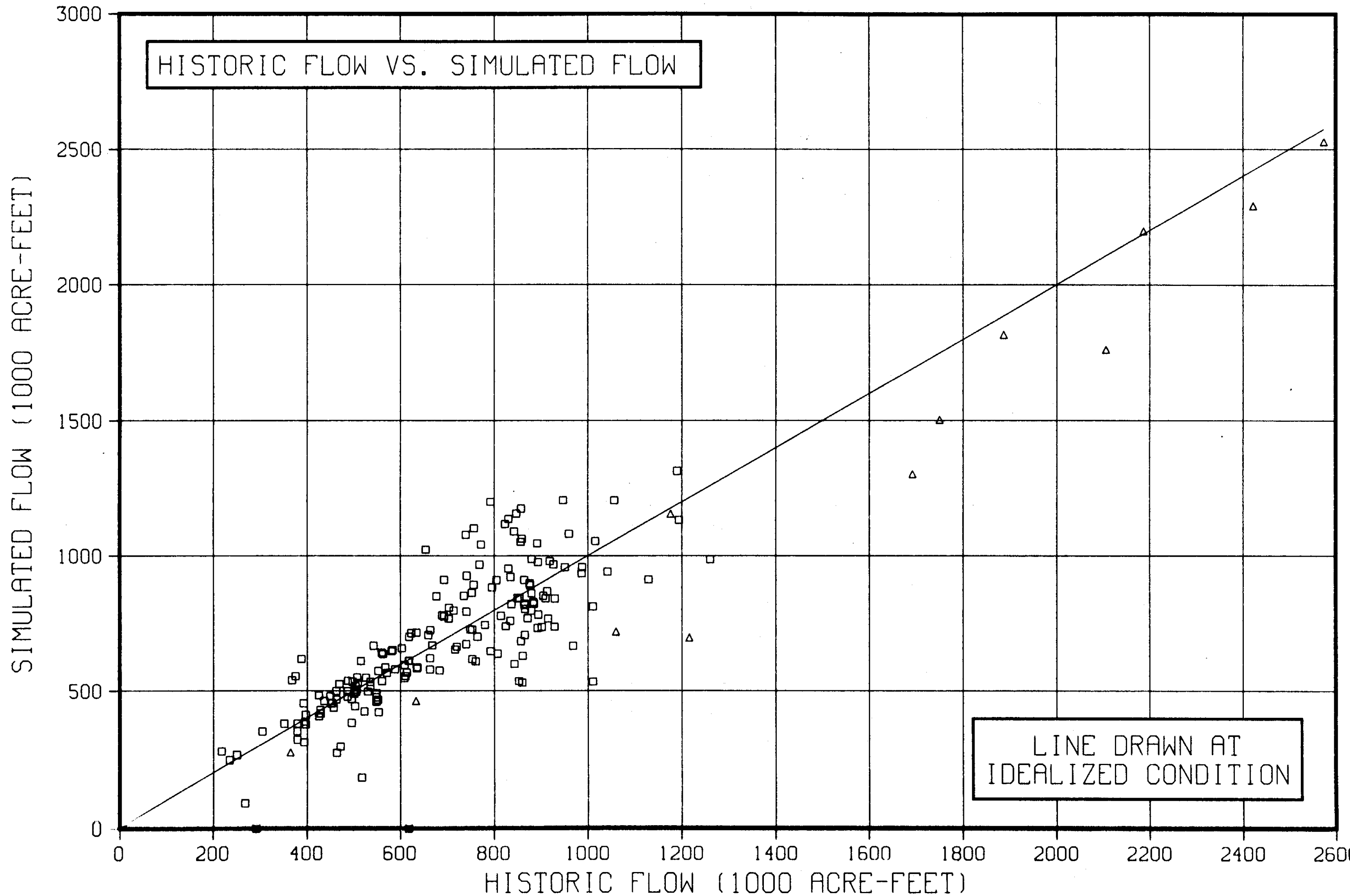
COLORADO RIVER BELOW HOOVER DAM, AZ-NV   9421500




COLORADO RIVER BELOW HOOVER DAM, AZ-NV 9421500
CUMULATIVE DIFFERENCE IN FLOW
(SIMULATED MINUS HISTORIC)
CUMULATIVE DIFFERENCE (1000 ACRE-FEET)
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
2500
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
CALENDER YEAR

PLOT 3 11.50.49 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2

COLORADO RIVER BELOW HOOVER DAM, AZ-NV 9421500



COLORADO RIVER BELOW HOOVER DAM, AZ-NV 9421500 RUN DATE 85/05/13.

HISTORIC SALT FOR STATION 9421500 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	372.08	470.78	807.53	839.13	810.09	722.04	726.78	665.01	636.81	471.67	447.61	547.10	7516.61
1969	548.91	551.69	833.07	885.30	834.32	753.29	779.76	699.60	618.08	517.66	425.70	467.03	7914.42
1970	620.58	546.30	760.59	928.01	926.65	787.97	800.25	669.73	496.82	589.18	476.53	511.98	8114.59
1971	571.97	676.37	876.72	931.47	878.10	755.82	747.12	734.23	635.34	517.76	465.93	521.56	8312.37
1972	607.37	655.25	886.66	859.37	831.15	787.49	768.77	748.75	627.84	486.28	373.27	356.38	7988.57
1973	551.99	514.86	555.72	778.33	909.75	635.41	757.36	779.70	606.61	503.82	479.10	542.69	7615.32
1974	418.97	553.21	777.77	884.66	902.32	818.64	788.15	871.73	663.56	558.44	463.56	391.21	8092.23
1975	474.11	567.90	696.73	801.70	900.67	742.50	763.82	748.51	627.66	516.05	446.97	460.82	7747.43
1976	473.21	455.91	836.94	809.18	845.33	659.03	775.22	813.34	553.90	323.12	280.04	443.14	7268.36
1977	230.38	553.59	768.69	889.24	692.12	655.28	812.21	797.10	417.64	381.31	416.30	506.48	7120.33
1978	213.76	394.87	681.13	829.54	791.08	608.26	764.22	829.74	640.15	456.86	345.29	342.11	6897.02
1979	202.45	273.87	580.94	661.10	949.92	813.37	797.63	823.32	653.73	487.92	510.33	469.93	7224.51
1980	438.51	251.71	873.82	1061.68	1197.28	1003.97	1118.62	1122.61	826.27	927.64	786.57	832.12	10440.79
1981	575.44	498.50	757.49	944.93	797.26	776.51	803.66	851.03	609.56	349.05	356.94	365.44	7685.81
1982	425.79	510.08	728.74	959.03	775.82	590.56	676.55	703.27	362.35	361.15	349.07	426.66	6869.09
1983	1093.88	339.14	589.02	985.75	1130.77	1754.27	2368.43	2203.89	1946.08	1853.00	1539.86	1472.32	17276.42
TOT	7819.42	7814.04	12011.54	14048.41	14172.63	12864.40	14248.53	14061.56	10922.40	9300.92	8163.06	8656.96	134083.87
AVG	488.71	488.38	750.72	878.03	885.79	804.02	890.53	878.85	682.65	581.31	510.19	541.06	8380.24

MINIMUM HISTORIC SALT = 202.45 MAXIMUM HISTORIC SALT = 2368.43

SIMULATED SALT FOR STATION 9421500 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	353.27	346.99	766.11	748.24	480.48	767.73	973.98	688.99	647.93	428.41	395.51	523.94	7121.57
1969	435.44	427.48	680.49	717.78	694.09	563.63	944.97	827.19	640.60	388.10	373.58	419.86	7113.22
1970	611.48	481.18	676.30	906.67	892.71	686.55	1096.94	773.76	498.97	592.06	434.77	485.95	8137.35
1971	489.02	569.72	971.16	793.21	576.52	726.99	983.25	843.51	653.46	405.94	417.46	467.79	7898.04
1972	550.35	552.11	801.46	835.25	753.29	827.93	907.27	840.28	677.42	171.08	358.00	334.81	7609.26
1973	622.90	406.01	537.84	796.93	516.17	556.42	1072.07	1001.25	672.42	608.72	517.83	534.31	7842.87
1974	434.44	546.29	770.46	897.54	1010.25	918.01	1068.49	1108.05	732.05	520.66	473.49	442.23	8921.95
1975	560.23	561.58	668.52	705.90	612.83	585.48	869.34	828.05	610.80	448.01	455.13	445.89	7351.76
1976	483.74	428.17	766.95	781.35	668.82	592.64	984.78	881.98	540.56	343.96	318.27	490.57	7281.80
1977	241.52	503.12	774.66	878.69	560.81	611.00	676.09	829.04	488.21	399.09	466.41	599.23	7027.90
1978	231.16	394.69	642.36	703.31	506.47	974.53	1081.36	992.93	740.45	477.04	526.00	513.12	7783.43
1979	264.00	.01	.01	774.49	775.13	673.61	1110.89	846.41	723.81	466.86	626.73	464.59	6726.54
1980	274.90	81.99	783.13	843.51	910.35	1112.19	1211.53	1044.64	737.46	863.54	761.39	766.00	9390.63
1981	572.08	496.55	725.06	978.75	637.64	858.18	850.08	721.50	547.07	302.88	589.12	391.24	7670.14
1982	446.51	438.91	620.73	899.98	575.85	560.91	820.67	677.97	300.25	440.65	368.58	263.27	6414.29
1983	1124.65	265.70	449.28	698.75	675.85	1739.69	2366.57	2110.27	2007.98	1600.87	1357.54	1172.47	15569.62
TOT	7695.71	6500.50	10634.53	12960.35	10847.27	12755.50	17018.27	15015.81	11219.44	8457.89	8439.80	8315.28	129860.37
AVG	480.98	406.28	664.66	810.02	677.95	797.22	1063.64	938.49	701.21	528.62	527.49	519.70	8116.27

MINIMUM SIMULATED SALT = .01 MAXIMUM SIMULATED SALT = 2366.57

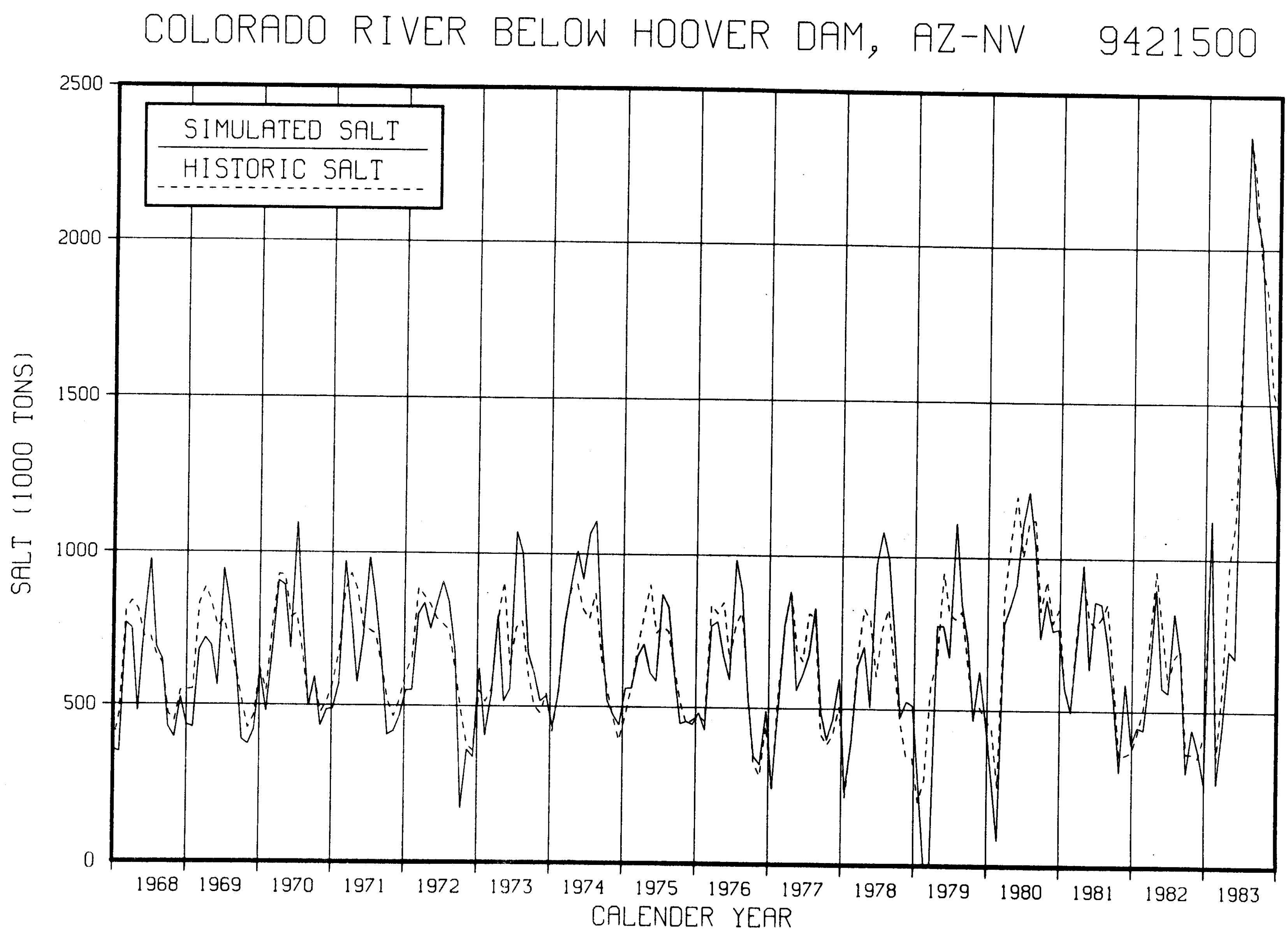
COLORADO RIVER BELOW HOOVER DAM, AZ-NV 9421500 RUN DATE 85/05/13.

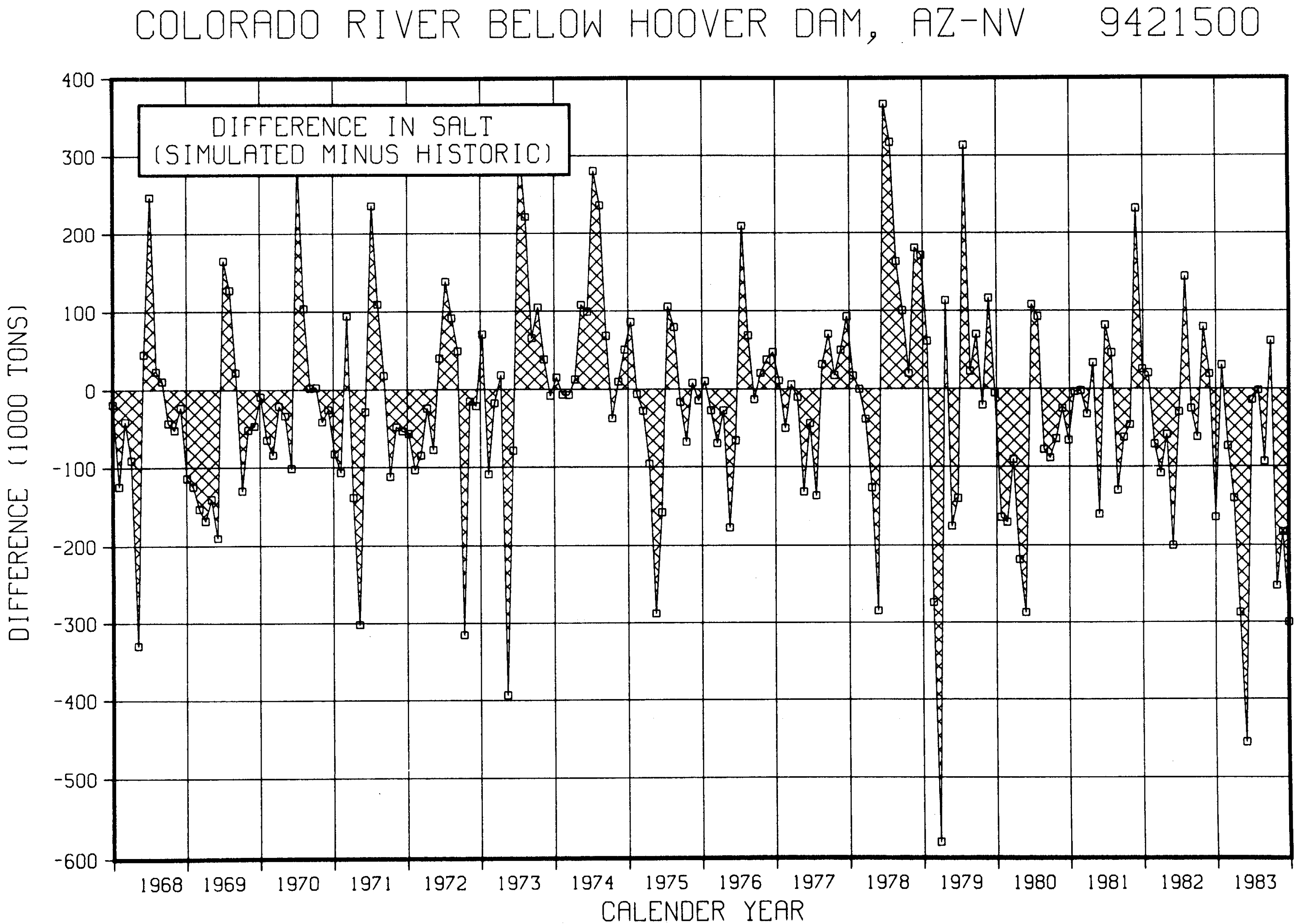
PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC SALT AT STATION 9421500

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	-5.06	-26.30	-5.13	-10.83	-40.69	6.33	34.01	3.61	1.75	-9.17	-11.64	-4.23	-5.26
1969	-20.67	-22.51	-18.31	-18.92	-16.81	-25.18	21.19	18.24	3.64	-25.03	-12.24	-10.10	-10.12
1970	-1.47	-11.92	-11.08	-2.30	-3.66	-12.87	37.07	15.53	.43	.49	-8.76	-5.08	.28
1971	-14.50	-15.77	10.77	-14.84	-34.34	-3.81	31.60	14.88	2.85	-21.60	-10.40	-10.31	-4.98
1972	-9.39	-15.74	-9.61	-2.81	-9.37	5.14	18.02	12.22	7.90	-64.82	-4.09	-6.05	-4.75
1973	12.85	-21.14	-3.22	2.39	-43.26	-12.43	41.55	28.41	10.85	20.82	8.08	-1.54	2.99
1974	3.69	-1.25	-.94	1.46	11.96	12.14	35.57	27.11	10.32	-6.77	2.14	13.04	10.25
1975	18.17	-1.11	-4.05	-11.95	-31.96	-21.15	13.82	10.63	-2.69	-13.19	1.83	-3.24	-5.11
1976	2.23	-6.09	-8.36	-3.44	-20.88	-10.07	27.03	8.44	-2.41	6.45	13.65	10.70	.18
1977	4.83	-9.12	.78	-1.19	-18.97	-6.76	-16.76	4.01	16.90	4.66	12.04	18.31	-1.30
1978	8.14	-.05	-5.69	-15.22	-35.98	60.22	41.50	19.67	15.67	4.42	52.33	49.99	12.85
1979	30.40	-100.00	-100.00	17.15	-18.40	-17.18	39.27	2.80	10.72	-4.32	22.81	-1.14	-6.89
1980	-37.31	-67.43	-10.38	-20.55	-23.96	10.78	8.31	-6.95	-10.75	-6.91	-3.20	-7.95	-10.06
1981	-.58	-.39	-4.28	3.58	-20.02	10.52	5.78	-15.22	-10.25	-13.23	65.05	7.06	-.20
1982	4.87	-13.95	-14.82	-6.16	-25.78	-5.02	21.30	-3.60	-17.14	22.01	5.59	-38.30	-6.62
1983	2.81	-21.66	-23.72	-29.11	-40.23	-.83	-.08	-4.25	3.18	-13.61	-11.84	-20.37	-9.88

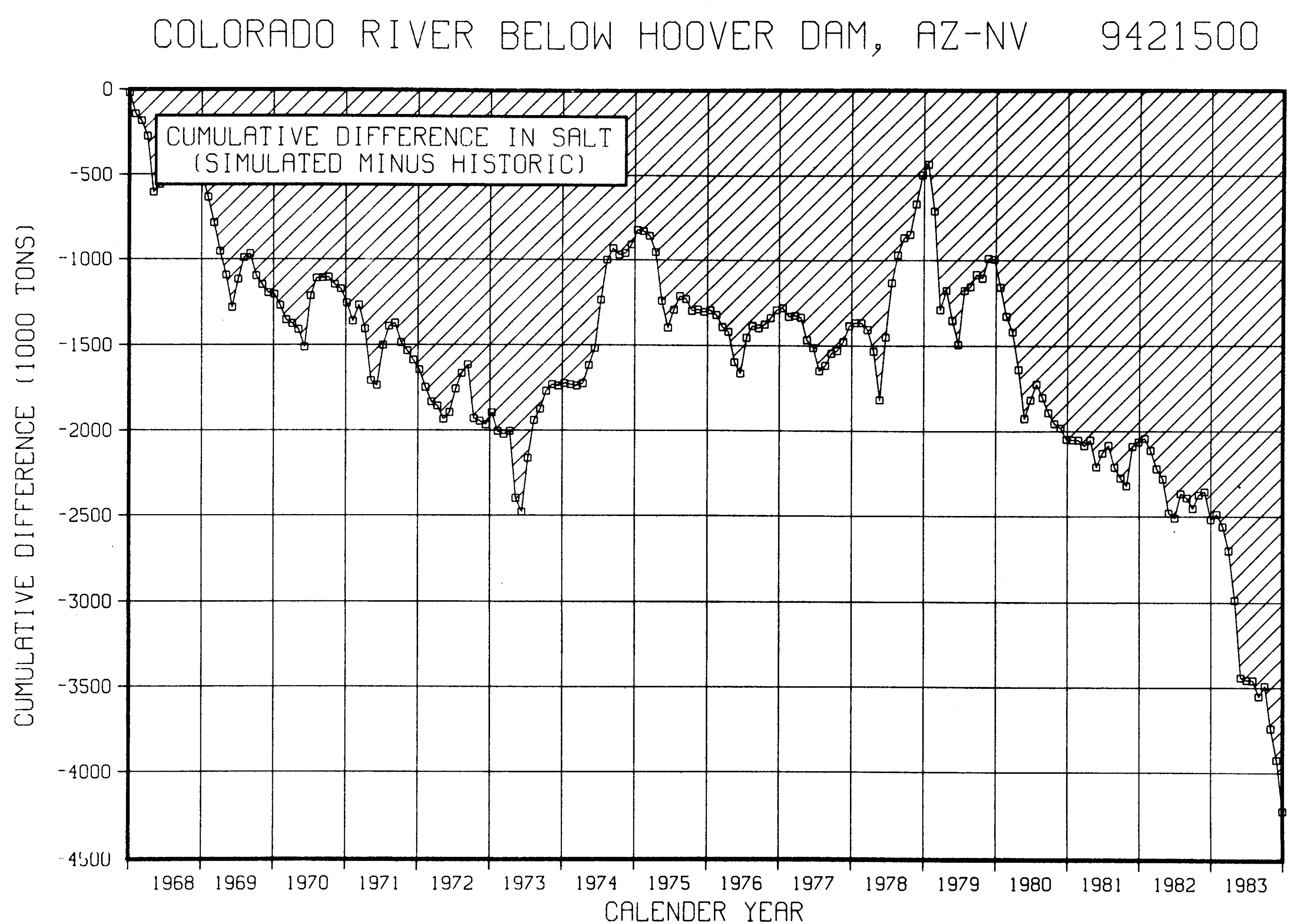
PERCENT DIFFERENCE OF 16 YEAR AVERAGES = -3.15

PLOT 1 11.50.59 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2




COLORADO RIVER BELOW HOOVER DAM, AZ-NV 9421500
DIFFERENCE IN SALT
(SIMULATED MINUS HISTORIC)
DIFFERENCE (1000 TONS)
400
300
200
100
0
-100
-200
-300
-400
-500
-600
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
CALENDER YEAR

PLOT 2 11.51.20 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



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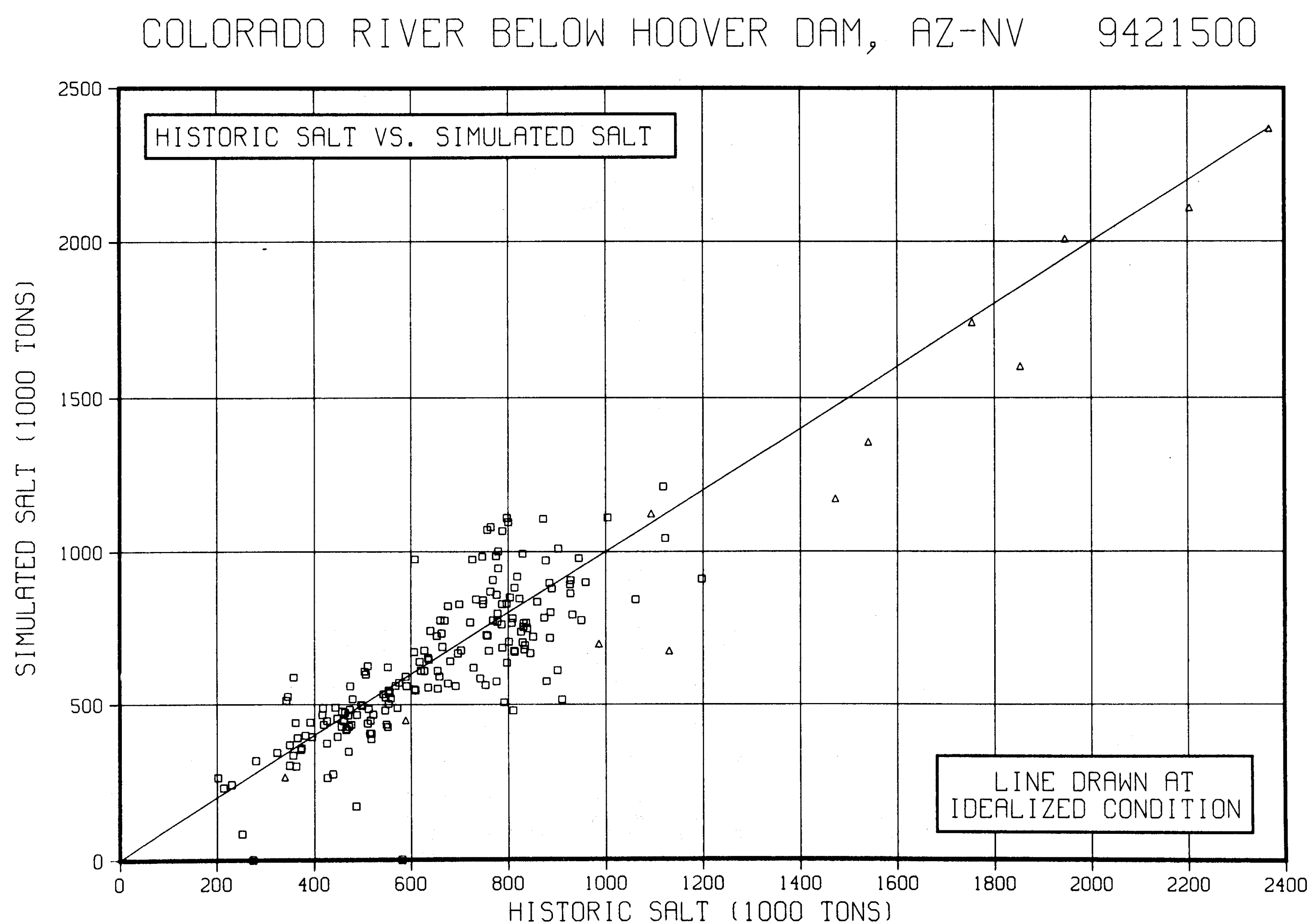


COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490 RUN DATE 85/05/13.

HISTORIC FLOW FOR STATION 9429490 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	342.18	366.28	565.93	621.63	532.44	580.27	625.26	608.99	494.23	398.70	297.92	304.07	5737.88
1969	270.46	376.00	602.47	638.05	550.04	552.86	621.91	627.51	442.39	417.20	224.74	292.12	5615.74
1970	352.46	352.13	557.97	676.89	540.19	548.50	621.77	577.08	439.52	423.22	298.76	314.91	5703.40
1971	324.18	390.58	611.25	627.08	523.59	578.17	675.08	599.34	471.70	389.11	299.74	333.29	5823.10
1972	340.45	388.86	617.59	643.86	560.11	558.88	666.66	632.31	483.55	294.46	266.88	339.77	5793.38
1973	358.43	308.60	535.13	663.14	574.70	524.20	644.97	615.85	545.22	453.15	310.92	329.35	5863.68
1974	252.78	407.38	572.46	710.24	625.08	621.20	725.72	734.16	558.23	407.77	290.34	301.02	6206.37
1975	350.84	381.69	558.06	661.35	641.74	554.68	653.52	661.12	560.28	449.33	333.25	348.17	6154.01
1976	340.73	327.08	657.51	678.21	591.07	555.99	646.75	669.25	448.99	369.43	256.80	355.32	5897.13
1977	264.42	389.50	568.71	680.84	534.00	586.05	734.49	603.20	432.90	325.43	277.19	309.66	5706.39
1978	170.88	340.07	550.48	697.80	563.55	589.79	708.31	663.66	501.15	356.77	273.92	285.15	5701.53
1979	183.75	265.21	446.94	613.16	644.38	661.64	762.26	722.63	624.05	499.80	368.48	339.52	6131.81
1980	316.79	343.17	857.51	979.06	861.04	921.93	1065.93	986.40	863.81	818.00	727.35	697.80	9438.76
1981	504.40	368.10	602.23	735.68	578.90	624.47	745.00	726.10	505.59	344.97	256.88	276.60	6268.93
1982	331.01	378.10	539.06	707.61	534.99	496.79	590.03	561.89	415.13	366.95	246.71	237.88	5406.13
1983	862.74	447.95	505.02	840.13	960.41	1339.26	2226.88	2320.70	2142.18	2218.94	1609.41	1456.09	16929.71
TOT	5566.50	5830.69	9348.31	11174.71	9816.23	10294.67	12714.54	12310.16	9928.90	8533.22	6339.28	6520.72	108377.95
AVG	347.91	364.42	584.27	698.42	613.51	643.42	794.66	769.39	620.56	533.33	396.21	407.54	6773.62

MINIMUM HISTORIC FLOW = 170.88 MAXIMUM HISTORIC FLOW = 2320.70

SIMULATED FLOW FOR STATION 9429490 (UNITS = 1000 ACRE-FEET)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	312.96	250.92	547.66	560.91	226.59	682.10	948.55	684.43	552.28	385.97	279.13	342.96	5774.46
1969	194.18	278.68	490.16	481.93	454.90	382.14	874.98	850.40	506.11	339.55	187.62	299.52	5340.17
1970	397.29	329.89	490.19	729.06	586.62	494.78	1026.27	723.74	467.43	507.60	336.06	349.53	6438.45
1971	302.33	350.53	816.59	596.25	309.78	668.88	1015.88	766.29	571.30	341.00	315.16	333.79	6387.76
1972	375.27	380.45	576.97	660.37	521.47	629.19	870.93	761.65	557.47	61.79	233.12	290.31	5918.98
1973	434.39	139.84	404.54	636.22	128.78	410.31	945.89	805.23	592.56	559.66	338.97	333.86	5730.26
1974	279.58	360.77	530.73	731.31	757.32	839.04	1024.69	990.06	647.07	374.90	254.25	348.31	7138.03
1975	430.74	338.44	517.98	538.47	346.07	342.20	743.62	732.79	526.99	376.20	290.04	286.27	5469.79
1976	327.01	245.54	592.31	624.92	396.35	475.67	875.74	738.69	373.06	331.23	241.66	368.49	5590.67
1977	228.06	349.73	577.98	672.72	403.45	555.43	611.59	634.22	481.13	341.89	368.96	388.21	5613.36
1978	163.25	241.95	445.45	530.61	179.43	934.42	981.54	780.49	539.46	329.18	397.52	403.18	5926.47
1979	163.30	.01	.01	733.29	462.06	508.10	1082.47	728.08	673.53	418.08	440.83	304.84	5514.59
1980	70.25	105.15	811.96	789.64	580.27	1144.37	1205.82	969.53	781.58	724.13	680.24	584.08	8446.99
1981	387.16	379.90	544.27	782.36	388.15	765.63	824.34	570.23	353.64	193.21	391.67	249.96	5830.54
1982	260.31	315.50	397.94	610.77	278.65	423.97	730.84	423.68	270.25	332.15	126.75	13.14	4183.96
1983	963.23	160.49	163.59	579.44	421.37	1450.94	2230.98	2083.77	2146.03	1756.13	1298.34	1033.99	14288.30
TOT	5289.30	4227.79	7908.30	10258.25	6441.26	10707.17	15994.12	13243.27	10039.89	7372.67	6180.33	5930.44	103592.77
AVG	330.58	264.24	494.27	641.14	402.58	669.20	999.63	827.70	627.49	460.79	386.27	370.65	6474.55

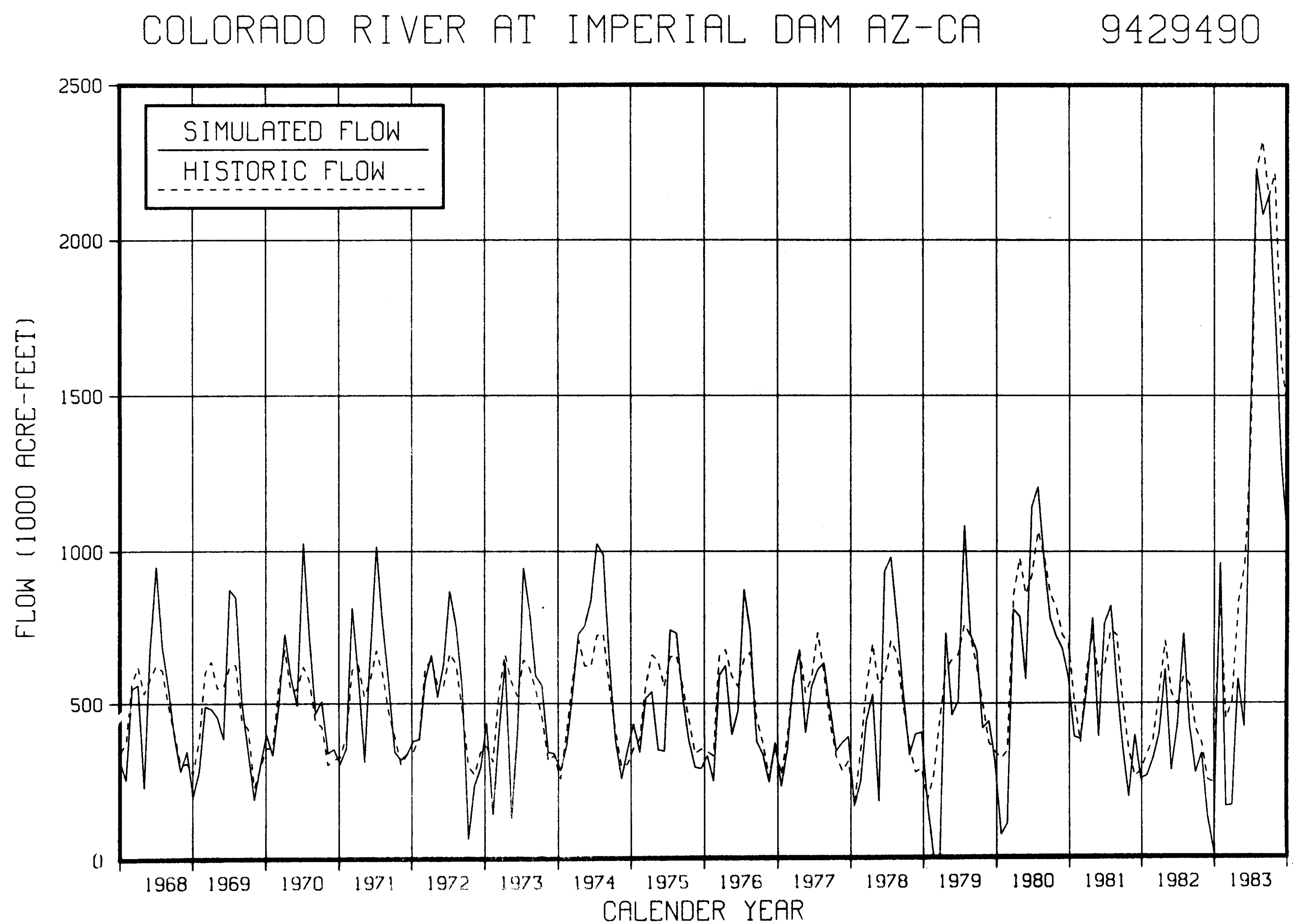
MINIMUM SIMULATED FLOW = .01 MAXIMUM SIMULATED FLOW = 2230.98

COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490 RUN DATE 85/05/13.

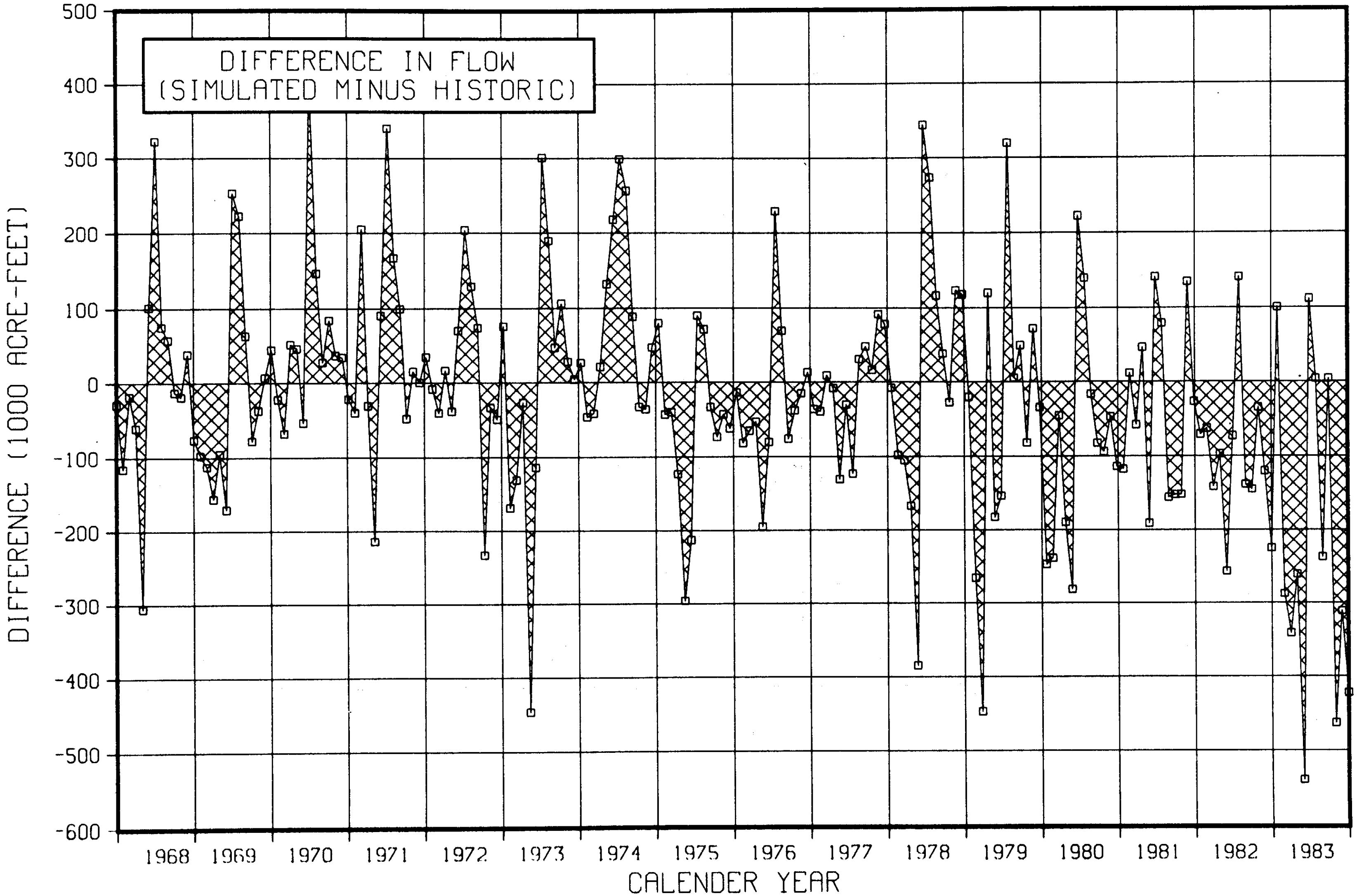
PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC FLOWS AT STATION 9429490

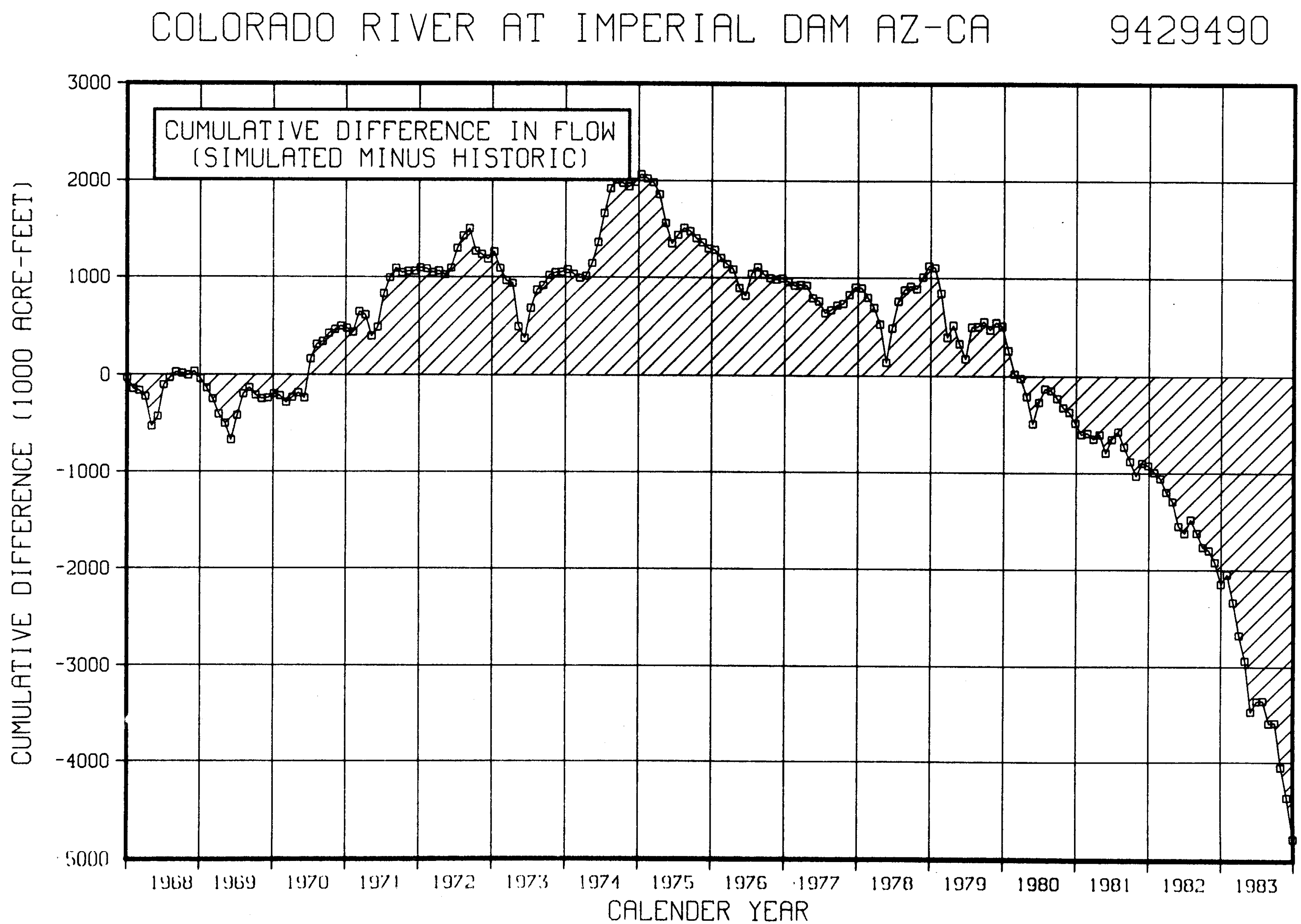
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	-8.54	-31.49	-3.23	-9.77	-57.44	17.55	51.70	12.39	11.75	-3.19	-6.30	12.79	.64
1969	-28.20	-25.88	-18.64	-24.47	-17.30	-30.88	40.69	35.52	14.40	-18.61	-16.52	2.53	-4.91
1970	12.72	-6.31	-12.15	7.71	8.59	-9.79	65.06	25.41	6.35	19.94	12.49	10.99	12.89
1971	-6.74	-10.26	33.59	-4.92	-40.83	15.69	50.48	27.86	21.11	-12.36	5.15	.15	9.70
1972	10.23	-2.16	-6.58	2.56	-6.90	12.58	30.64	20.45	15.29	-79.02	-12.65	-14.56	2.17
1973	21.19	-54.68	-24.40	-4.06	-77.59	-21.73	46.66	30.75	8.68	23.51	9.02	1.37	-2.28
1974	10.60	-11.44	-7.29	2.97	21.16	35.07	41.20	34.86	15.92	-8.06	-12.43	15.71	15.01
1975	22.77	-11.33	-7.18	-18.58	-46.07	-38.31	13.79	10.84	-5.94	-16.28	-12.97	-17.78	-11.12
1976	-4.03	-24.93	-9.92	-7.86	-32.94	-14.45	35.41	10.38	-16.91	-10.34	-5.90	3.71	-5.20
1977	-13.75	-10.21	1.63	-1.19	-24.45	-5.22	-16.73	5.14	11.14	5.06	33.11	25.37	-1.63
1978	-4.47	-28.85	-19.08	-23.96	-68.16	58.43	38.57	17.60	7.64	-7.73	45.12	41.39	3.95
1979	-11.13	-100.00	-100.00	19.59	-28.29	-23.21	42.01	.75	7.93	-16.35	19.64	-10.21	-10.07
1980	-77.83	-69.36	-5.31	-19.35	-32.61	24.13	13.12	-1.71	-9.52	-11.48	-6.48	-16.30	-10.51
1981	-23.24	3.21	-9.62	6.34	-32.95	22.61	10.65	-21.47	-30.05	-43.99	52.47	-9.63	-6.99
1982	-21.36	-16.56	-26.18	-13.69	-47.91	-14.66	23.86	-24.60	-34.90	-9.48	-48.62	-94.48	-22.61
1983	11.65	-64.17	-67.61	-31.03	-56.13	8.34	.18	-10.21	.18	-20.86	-19.33	-28.99	-15.60

PERCENT DIFFERENCE OF 16 YEAR AVERAGES = -4.42

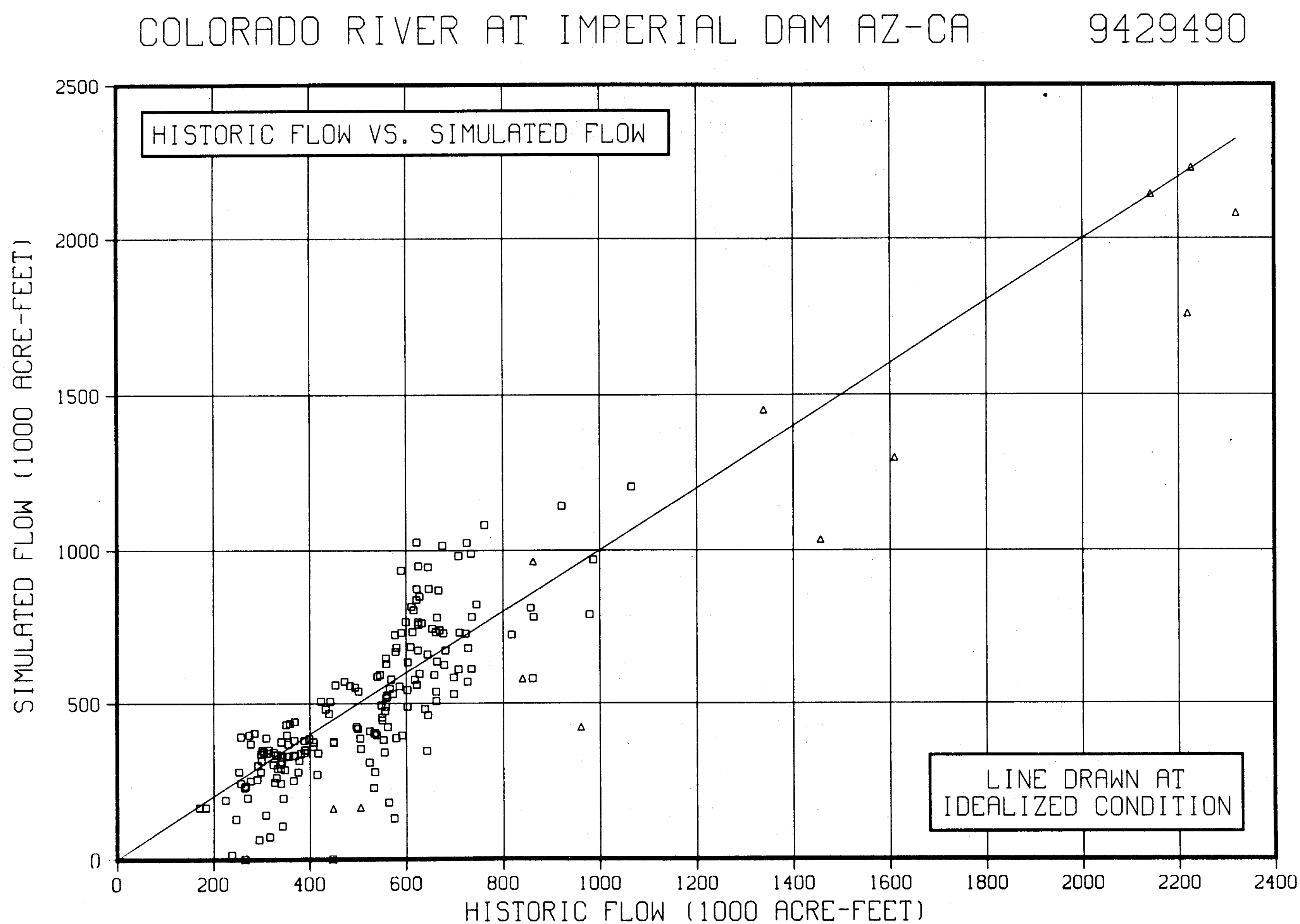

COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490
SIMULATED FLOW
HISTORIC FLOW
FLOW (1000 ACRE-FEET)
2500
2000
1500
1000
500
0
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
CALENDER YEAR

COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490




COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490
CUMULATIVE DIFFERENCE IN FLOW
(SIMULATED MINUS HISTORIC)
CUMULATIVE DIFFERENCE (1000 ACRE-FEET)
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983
CALENDER YEAR

PLOT 3 11.52.59 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490 RUN DATE 85/05/13.

HISTORIC SALT FOR STATION 9429490 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	396.93	406.57	622.52	683.79	606.99	649.90	700.29	688.16	573.30	478.44	369.41	370.96	6547.26
1969	338.07	436.16	680.80	740.14	654.55	652.37	727.64	740.46	544.13	508.99	296.65	379.75	6699.71
1970	437.06	433.12	663.98	798.73	653.63	669.17	746.13	686.72	545.00	524.80	382.41	406.24	6946.98
1971	414.95	472.60	727.38	758.77	644.02	693.81	796.60	713.21	566.04	478.60	380.67	416.61	7063.25
1972	422.15	458.86	710.23	746.88	655.32	642.71	753.33	714.51	556.08	373.96	333.60	414.52	6782.16
1973	433.71	370.32	583.29	722.83	660.91	602.83	715.92	689.75	621.56	525.65	382.44	405.11	6714.30
1974	323.56	464.41	641.16	788.36	712.59	695.74	798.29	800.23	619.63	473.02	357.12	367.25	7041.36
1975	410.48	438.95	619.44	727.48	725.17	621.24	712.34	727.23	621.91	521.22	399.90	414.33	6939.67
1976	402.07	389.23	703.54	739.24	656.09	617.15	698.49	722.79	493.89	428.54	323.57	415.73	6590.31
1977	325.24	436.24	625.58	742.11	598.08	638.79	778.56	657.49	484.85	380.76	327.09	356.11	6350.89
1978	228.98	374.08	578.01	732.68	619.91	642.88	764.97	723.39	556.28	410.29	328.71	342.18	6302.34
1979	238.88	307.65	482.70	656.08	702.37	714.57	807.99	765.99	661.49	539.79	412.69	387.05	6677.24
1980	367.47	387.78	806.06	988.85	895.48	968.03	1097.91	1015.99	863.81	850.71	778.26	739.66	9760.01
1981	564.93	419.63	662.45	794.53	648.37	686.91	812.05	784.19	556.15	413.96	315.97	334.68	6993.85
1982	390.59	419.69	582.18	750.07	588.49	556.40	643.13	618.07	481.55	436.67	310.85	297.35	6075.04
1983	888.63	492.75	545.42	848.53	989.22	1325.87	2137.80	2158.25	2013.65	1997.05	1512.85	1441.53	16351.53
TOT	6583.68	6708.01	10234.74	12219.08	11011.18	11378.36	13691.44	13206.43	10759.32	9342.43	7212.18	7489.05	119835.89
AVG	411.48	419.25	639.67	763.69	688.20	711.15	855.71	825.40	672.46	583.90	450.76	468.07	7489.74

MINIMUM HISTORIC SALT = 228.98 MAXIMUM HISTORIC SALT = 2158.25

SIMULATED SALT FOR STATION 9429490 (UNITS = 1000 TONS)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	318.73	304.44	619.19	661.76	340.65	761.28	1061.03	781.59	590.06	407.86	290.59	341.51	6478.69
1969	215.46	290.41	523.88	571.67	503.76	460.78	966.07	918.89	575.40	380.41	213.61	310.34	5930.68
1970	398.23	326.54	545.43	778.62	667.22	586.11	1120.47	809.32	533.89	532.53	344.14	417.27	7059.76
1971	299.76	370.77	830.29	645.30	382.09	755.18	1090.84	820.81	600.87	363.73	341.19	341.20	6842.01
1972	372.77	399.30	620.72	746.80	608.82	737.11	989.90	862.67	628.63	99.62	270.91	316.40	6653.65
1973	431.74	186.14	490.20	704.81	204.92	520.08	1067.66	931.87	671.77	590.78	374.53	381.31	6555.82
1974	306.93	404.94	605.11	840.72	854.88	940.32	1138.61	1079.81	726.30	415.47	293.51	362.75	7969.34
1975	413.72	378.42	569.87	629.81	436.52	456.32	846.00	834.61	575.74	388.38	296.69	287.04	6113.11
1976	330.21	294.10	628.38	695.72	472.39	547.00	959.54	807.19	403.78	356.63	265.32	357.79	6118.06
1977	240.48	371.62	630.15	753.82	494.86	659.74	716.70	725.34	502.27	345.79	378.28	363.52	6182.57
1978	181.51	297.01	518.53	613.75	268.57	1016.96	1079.65	883.57	601.18	295.71	452.42	456.40	6665.26
1979	240.55	.01	.01	724.73	482.62	521.86	1165.88	730.30	657.16	462.85	478.12	310.84	5774.94
1980	89.90	159.10	810.12	792.09	609.78	1154.94	1254.39	1020.89	827.17	745.04	692.69	570.87	8727.00
1981	391.61	413.45	596.47	847.36	475.11	861.16	950.08	677.53	430.07	241.23	434.28	265.02	6583.37
1982	280.91	365.41	473.57	704.74	378.00	545.80	886.18	548.69	358.06	390.96	176.87	28.68	5137.87
1983	996.68	219.91	251.95	687.59	530.33	1574.22	2333.73	2116.11	2098.72	1688.21	1244.61	968.83	14710.90
TOT	5509.19	4781.58	8713.87	11399.29	7710.52	12098.86	17626.73	14549.17	10781.08	7705.20	6547.76	6079.79	113503.03
AVG	344.32	298.85	544.62	712.46	481.91	756.18	1101.67	909.32	673.82	481.58	409.23	379.99	7093.94

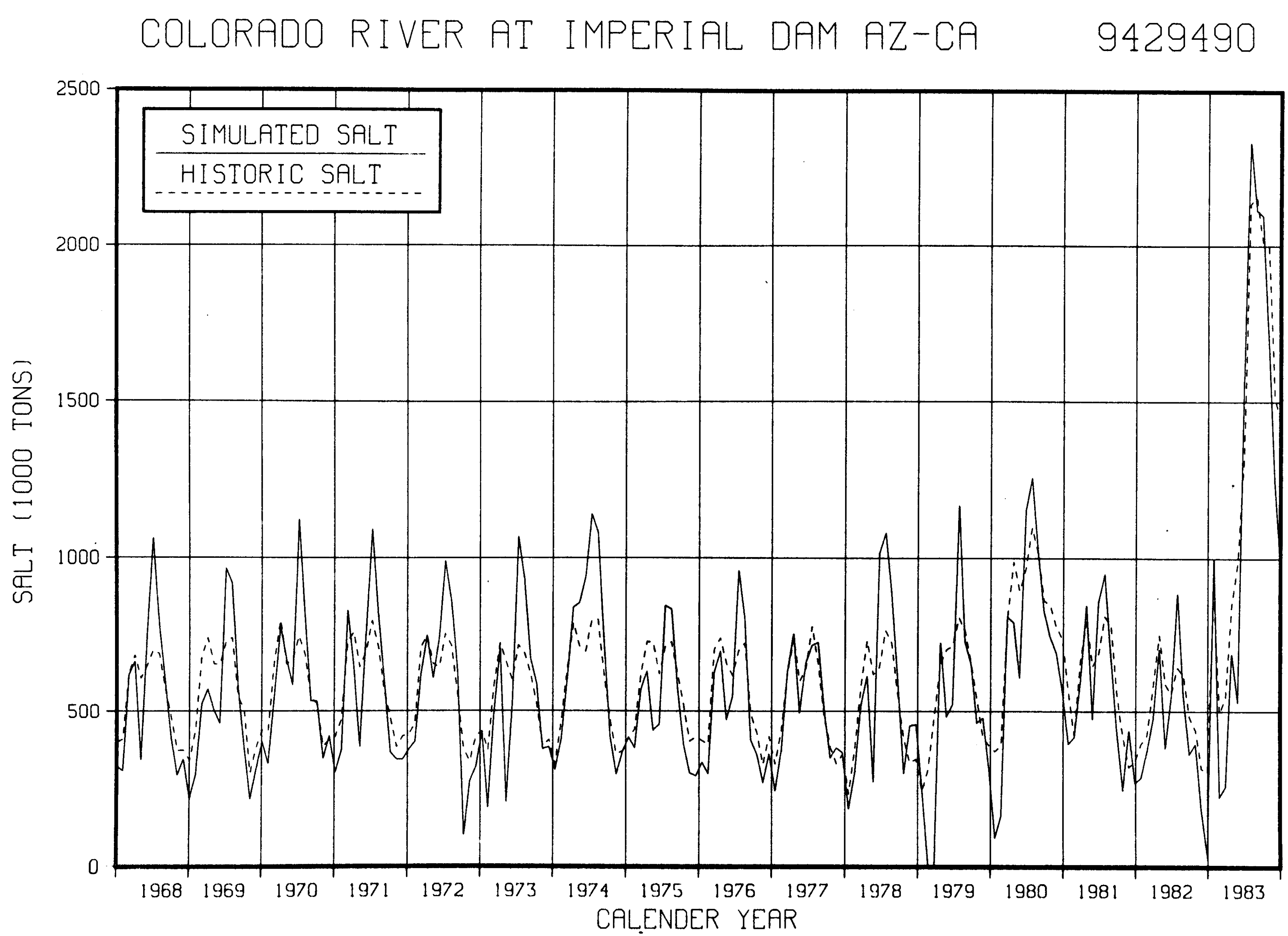
MINIMUM SIMULATED SALT = .01 MAXIMUM SIMULATED SALT = 2333.73

COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490 RUN DATE 85/05/13.

PERCENT DIFFERENCE BETWEEN SIMULATED AND HISTORIC SALT AT STATION 9429490

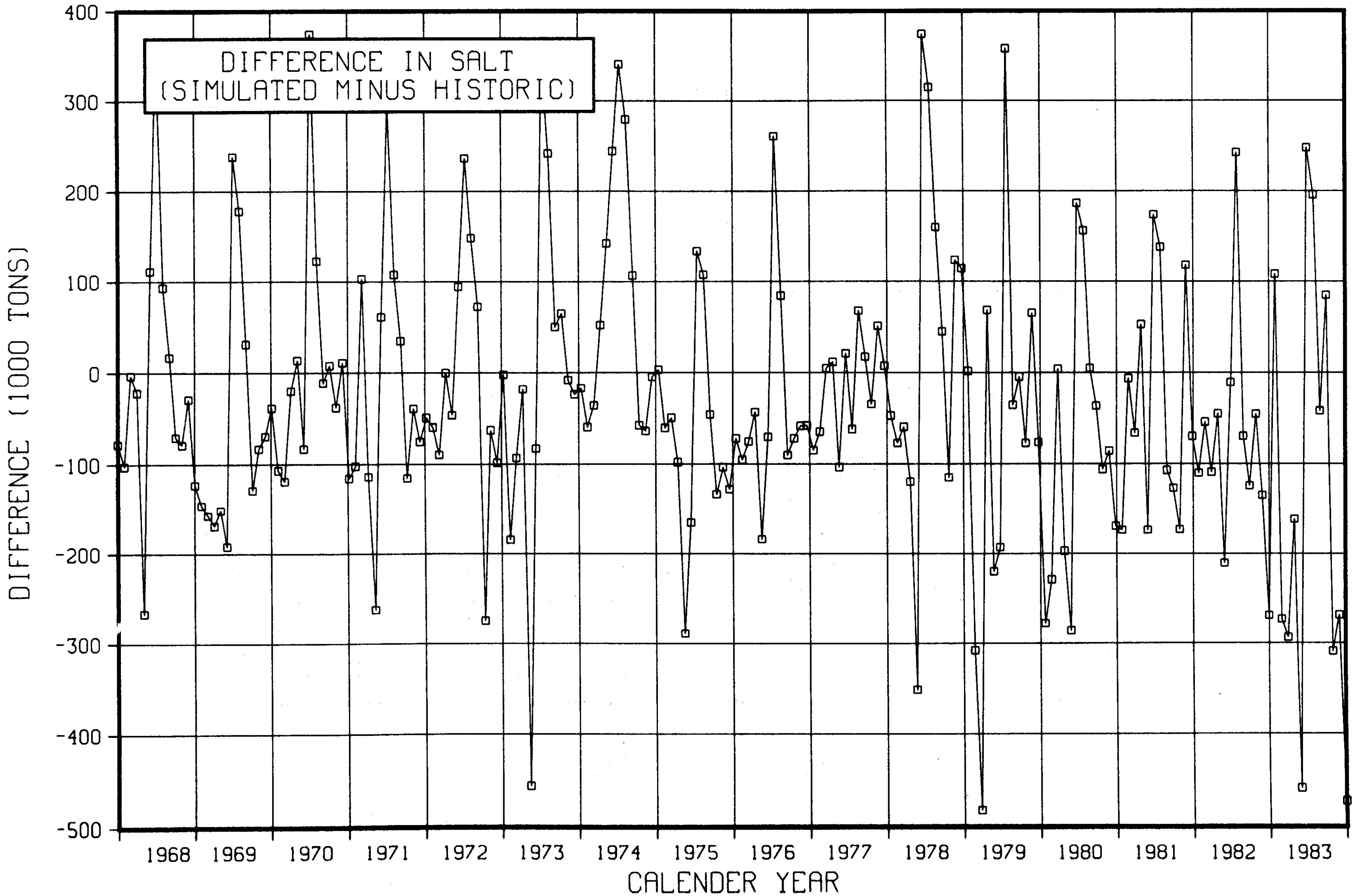
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1968	-19.70	-25.12	-.54	-3.22	-43.88	17.14	51.51	13.58	2.92	-14.75	-21.34	-7.94	-1.05
1969	-36.27	-33.42	-23.05	-22.76	-23.04	-29.37	32.77	24.10	5.75	-25.26	-27.99	-18.28	-11.48
1970	-8.88	-24.61	-17.85	-2.52	2.08	-12.41	50.17	17.85	-2.04	1.47	-10.01	2.72	1.62
1971	-27.76	-21.55	14.15	-14.95	-40.67	8.85	36.94	15.09	6.15	-24.00	-10.37	-18.10	-3.13
1972	-11.70	-12.98	-12.60	-.01	-7.10	14.69	31.40	20.73	13.05	-73.36	-18.79	-23.67	-1.89
1973	-.45	-49.74	-15.96	-2.49	-68.99	-13.73	49.13	35.10	8.08	12.39	-2.07	-5.87	-2.36
1974	-5.14	-12.81	-5.62	6.64	19.97	35.15	42.63	34.94	17.21	-12.17	-17.81	-1.22	13.18
1975	.79	-13.79	-8.00	-13.43	-39.80	-26.55	18.76	14.77	-7.42	-25.49	-25.81	-30.72	-11.91
1976	-17.87	-24.44	-10.68	-5.89	-28.00	-11.37	37.37	11.68	-18.24	-16.78	-18.00	-13.94	-7.17
1977	-26.06	-14.81	.73	1.58	-17.26	3.28	-7.95	10.32	3.59	-9.18	15.65	2.08	-2.65
1978	-20.73	-20.60	-10.29	-16.23	-56.68	58.19	41.14	22.14	8.07	-27.92	37.64	33.38	5.76
1979	.70	-100.00	-100.00	10.46	-31.29	-26.97	44.29	-4.66	-.66	-14.25	15.85	-19.69	-13.51
1980	-75.53	-58.97	.50	-19.90	-31.90	19.31	14.25	.48	-4.24	-12.42	-11.00	-22.82	-10.58
1981	-30.68	-1.47	-9.96	6.65	-26.72	25.37	17.00	-13.60	-22.67	-41.73	37.44	-20.82	-5.87
1982	-28.08	-12.93	-18.66	-6.04	-35.77	-1.91	37.79	-11.23	-25.64	-10.47	-43.10	-90.35	-15.43
1983	12.16	-55.37	-53.81	-18.97	-46.39	18.73	9.17	-1.95	4.22	-15.46	-17.73	-32.79	-10.03

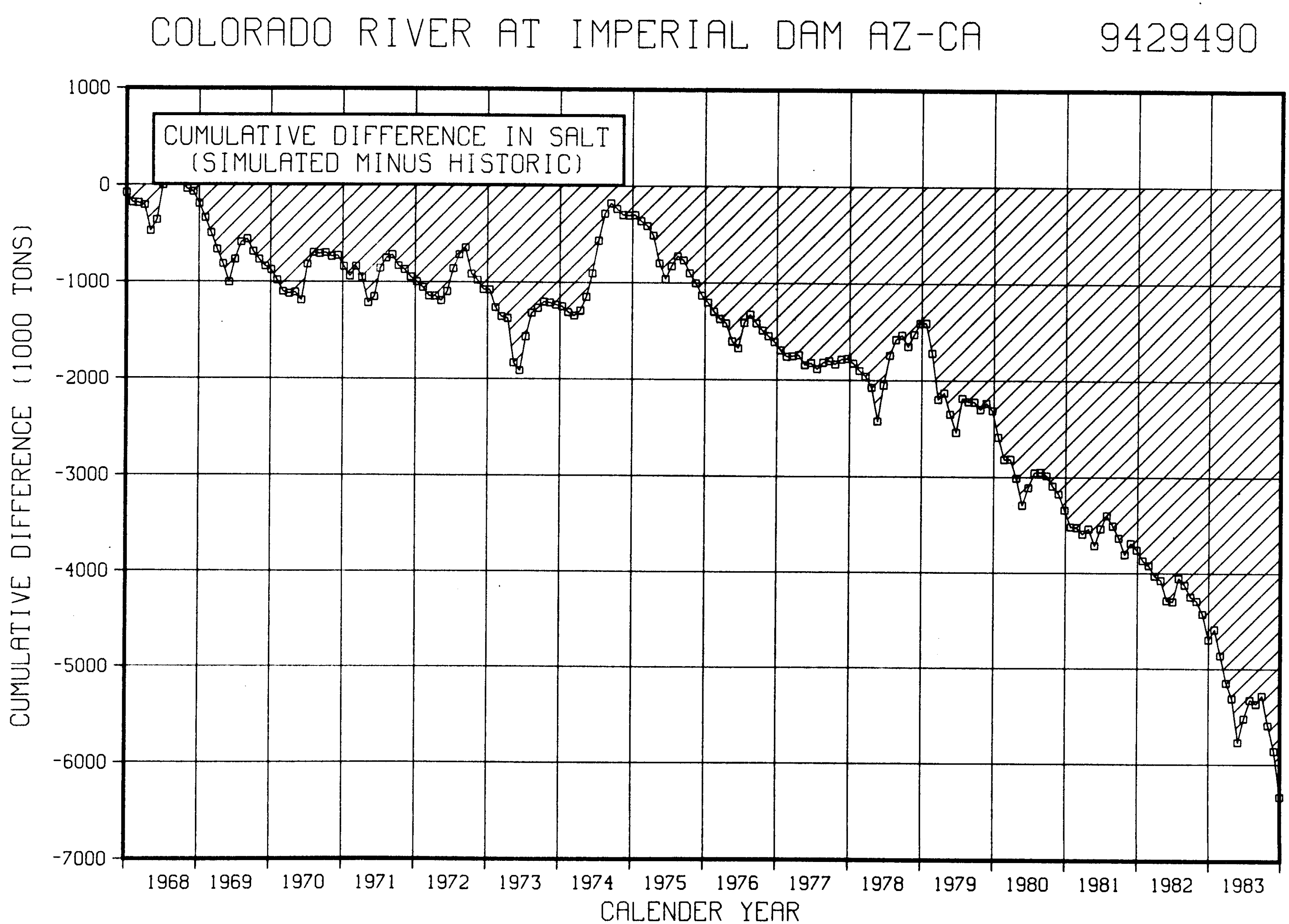
PERCENT DIFFERENCE OF 16 YEAR AVERAGES = -5.28


COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490
SIMULATED SALT
HISTORIC SALT
SALT (1000 TONS)
2500
2000
1500
1000
500
0
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
CALENDER YEAR

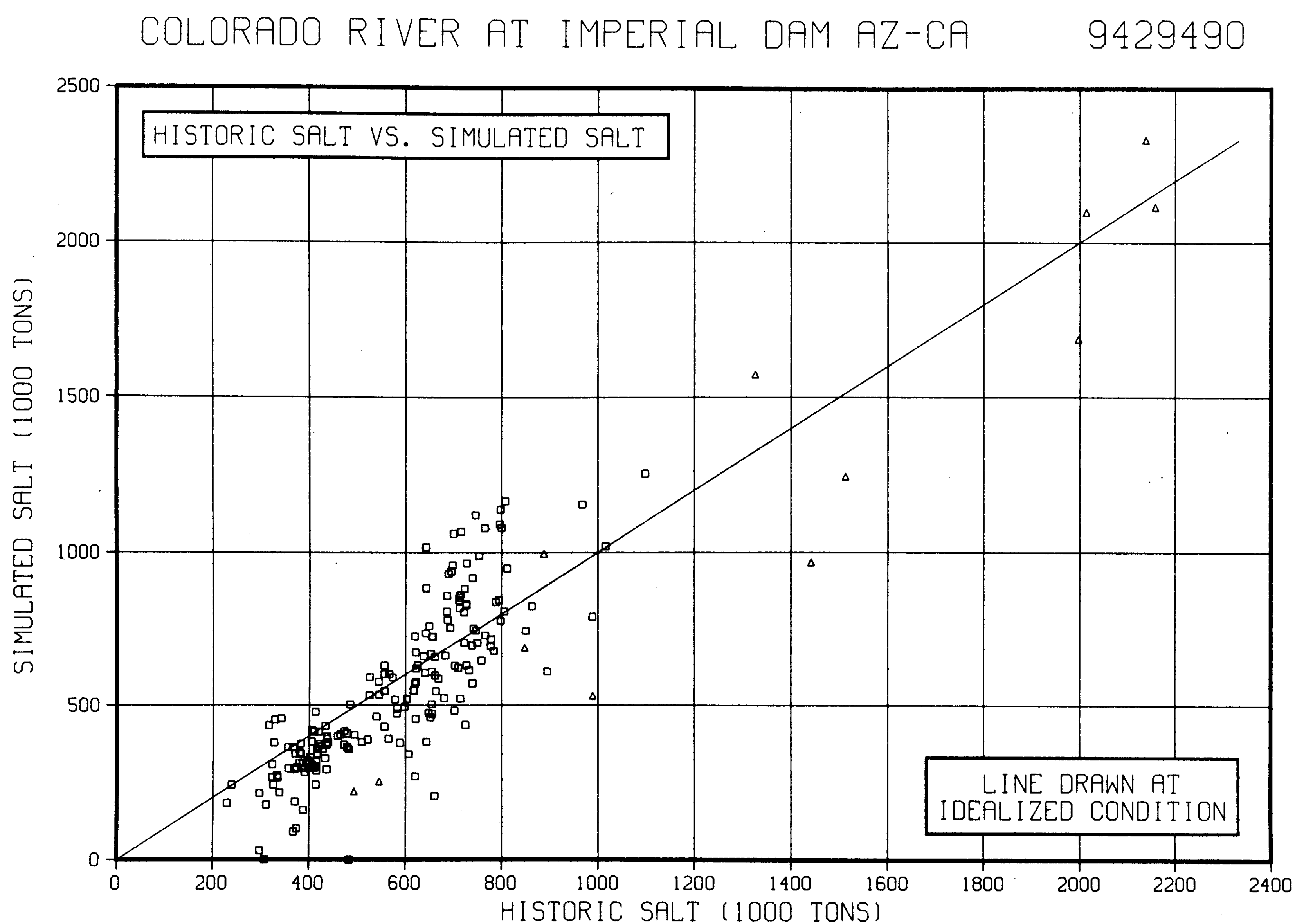
PLOT 2 11.53.10 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2

COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490




COLORADO RIVER AT IMPERIAL DAM AZ-CA 9429490
CUMULATIVE DIFFERENCE IN SALT
(SIMULATED MINUS HISTORIC)
CUMULATIVE DIFFERENCE (1000 TONS)
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983
CALENDER YEAR

PLOT 3 11.53.19 MON 13 MAY, 1985 JOB-ADUL , BUREAU OF RECLAMATION. 26JUL83 DISSPLA VER 8.2



APPENDIX A

SAMPLE OUTPUT

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 ********    *********    ********    ********     ***************************************************************************
**********  **********  **********  **********     *                                                                         *
**      *   **      **  **       *  **       *     *  TITLE OF RUN:   SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW                   *
**          **      **  **          **             *                                                                         *
**          **********  *********   *********      *  DATE OF RUN:   06/11/87      TIME:   17.00.22.                         *
**          *********    *********   *********     *                                                                         *
**          **    **            **         **      *  COLORADO RIVER SIMULATION SYSTEM                                       *
**      *   **     **   *       **  *      **      *  U.S. DEPARTMENT OF THE INTERIOR - BUREAU OF RECLAMATION                *
**********  **      **  **********  **********     *                                                                         *
 ********   **      **   ********    ********      ***************************************************************************
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CRSM VERSION

THE CRSM VERSION USED IN THIS RUN WAS THE 1987 VERSION
ESTABLISHED ON 10/01/86, WITH THE FOLLOWING MODIFICATIONS:

FLD0417 INITIALIZE SRPCAP AND SRPMWD IN S.R. APPOR
RJS0313 DON'T LET POWMAXR EXCEED RELMAX
FLD0303 NEW FORMAT FOR THE RUN CARD
FLD0225 ALLOW MODEL TO RUN FOR 150 YEARS
FLD1223 HANDLE DEMANDS FOR BOTH WY AND CY RUNS
FLD1104 READ TRNXXX CARDS EXCEPT TRNCUS FROM CONTROL
FLD1014 CHANGE THE VERSION DATES

LENGTH OF RUN

BEGINNING MONTH OF RUN 10
BEGINNING YEAR OF RUN 1987
ENDING MONTH OF RUN 9
ENDING YEAR OF RUN 1998

HYDROLOGY DATA BASE

DATA BASE TITLE: C.R.S.S. NATURAL FLOW HYDROLOGIC DATA BASE
THE DATA BASE WAS LAST MODIFIED ON: 86/09/19.   THE INPUT FILE WAS CREATED FROM THE DATA BASE ON: 86/11/25. 15.42.29.
THE HYDROLOGY DATA IS COMPLETE FOR YEARS 1906 THROUGH 1983

DEMAND DATA

THE DEMAND DATA IS COMPLETE FOR YEARS 1982 THROUGH 2040

SURPLUS STRATEGY

THE SURPLUS STRATEGY WAS SET TO .70 FOR ALL TRACES

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*****************************************************

       THE OUTPUT FOR TRACE NUMBER   1 BEGINS HERE

    THE HYDROLOGY FOR THIS TRACE STARTED WITH YEAR 1906

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RUN INFORMATION

TITLE: SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW

NORMAL TERMINATION FOR TRACE 1, STARTED AT 17.00.22. 06/11/87

    49 SHORTAGE MESSAGES WERE GENERATED DURING THIS RUN

THE PRINTING OF SHORTAGE MESSAGES HAS BEEN SUPPRESSED FOR THIS RUN.

    10 COMMENT MESSAGES WERE GENERATED DURING THIS RUN

THE PRINTING OF COMMENT MESSAGES HAS BEEN SUPPRESSED FOR THIS RUN.

SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW *-1906 TRACE 1 INIT. HYDR. YEAR=1906 RUN AT 17.00.22. 06/11/87

FLOW WEIGHTED QUALITY (MG/L) AND REGULATED FLOWS (THOUS. ACRE FEET) ON A YEARLY BASIS (STARTING MONTH=10), AT SELECTED POINTS

YEAR	GREEN NR GREENDAL	GREEN AT GR UTAH	SAN RAFAEL	COLO AT GLENWOOD	GUNNISON N GR JCT	DOLORES NR CISCO	COLORADO NR CISCO	SAN JUAN NR BLUFF	AT LEES FERRY	AT GRAND CANYON	BELOW HOOVER	IMPERIAL DAM
QUAL 1988	442.	444.	812.	270.	401.	451.	494.	540.	458.	497.	526.	631.
FLOW 1988	1656.	4973.	143.	2125.	2505.	818.	6146.	1782.	10926.	11296.	10919.	7192.
QUAL 1989	391.	370.	599.	238.	432.	431.	454.	563.	462.	486.	531.	594.
FLOW 1989	3024.	8011.	244.	2525.	2374.	880.	6863.	1582.	17090.	17449.	16803.	12805.
QUAL 1990	368.	503.	1385.	474.	733.	845.	846.	670.	467.	506.	529.	618.
FLOW 1990	1467.	3755.	77.	1034.	1301.	394.	3361.	1393.	10359.	10719.	12455.	8406.
QUAL 1991	384.	376.	615.	225.	426.	425.	442.	470.	519.	547.	561.	664.
FLOW 1991	2667.	7281.	239.	2479.	2501.	883.	7110.	2524.	14502.	14868.	11553.	7567.
QUAL 1992	356.	467.	746.	414.	547.	639.	633.	613.	493.	527.	564.	653.
FLOW 1992	1741.	4459.	225.	1229.	1820.	571.	4742.	1544.	11944.	12312.	13379.	8734.
QUAL 1993	396.	534.	1081.	338.	523.	554.	568.	466.	543.	579.	588.	716.
FLOW 1993	1259.	3462.	127.	1522.	1986.	659.	5387.	2510.	10582.	10949.	10704.	6110.
QUAL 1994	427.	447.	743.	241.	393.	418.	424.	469.	549.	578.	611.	719.
FLOW 1994	1896.	5164.	164.	2316.	2687.	927.	7498.	2403.	13376.	13732.	12181.	7532.
QUAL 1995	411.	481.	904.	429.	594.	646.	695.	689.	539.	574.	616.	730.
FLOW 1995	1780.	4639.	158.	1157.	1654.	570.	4234.	1267.	10988.	11352.	11829.	7221.
QUAL 1996	398.	418.	590.	235.	415.	538.	451.	501.	547.	574.	629.	748.
FLOW 1996	2418.	6197.	235.	2413.	2584.	694.	7033.	2284.	14315.	14674.	11992.	7395.
QUAL 1997	396.	553.	1380.	430.	609.	597.	698.	473.	523.	557.	616.	715.
FLOW 1997	1093.	3256.	81.	1143.	1596.	602.	4161.	2474.	11543.	11902.	13204.	8530.
QUAL 1998	440.	486.	859.	326.	453.	392.	489.	435.	551.	582.	631.	765.
FLOW 1998	1625.	4649.	162.	1626.	2357.	1068.	6478.	2811.	12365.	12725.	10172.	6004.

11 YEAR AVERAGE ANNUAL VALUES

FLOW WEIGHTED QUALITY IN MG/L

400.	446.	795.	301.	481.	507.	533.	515.	513.	545.	580.	678.

AVERAGE SALT MASS IN 1000 TONS/YEAR

1020.	3082.	182.	728.	1389.	506.	4152.	1438.	8764.	9571.	9697.	7340.

AVERAGE FLOW/YEAR (THOUS. ACRE FEET)

1875.	5077.	169.	1779.	2124.	733.	5729.	2052.	12545.	12907.	12290.	7954.

JOB RUN 02/26/85 10.36.17. * SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *-1906

OCTOBER 1984

REACH AND RESERVOIR NAME		RESERVOIR INFLOW	EVAP	BANK STORAGE CHANGE	RELEASE POWER	RELEASE OTHER	END OF MONTH CONTENT	END OF MONTH ELEVATION	POWER		INFLOW TDS	RELEASE TDS
		THOUSANDS OF ACRE - FEET						(FT)	(MW)	(GWH)	(PPM)	(PPM)
190	TAYLOR PA	5.0	0.0	0.0	0.0	10.3	75.0	9313.1	0.0	0.0	294.2	130.5
200	BLUE MESA	37.9	.6	0.0	53.9	.0	729.5	7508.1	78.6	17.4	211.9	127.0
210	MORROW PO	53.9	.1	0.0	53.8	.0	117.0	7159.7	156.6	20.2	127.0	125.4
220	CRYSTAL R	57.7	.0	0.0	57.1	.0	17.6	6754.9	31.8	11.4	135.2	131.4
401	FONTENELL	28.0	.9	0.0	18.4	.0	186.6	6483.6	10.9	1.5	418.1	295.5
610	STARVATIO	17.1	0.0	0.0	0.0	17.1	255.3	5735.0	0.0	0.0	224.0	128.3
411	FLAMING G	45.2	5.1	-.3	49.2	.0	3365.9	6031.2	141.5	18.9	598.6	494.1
801	NAVAJO RE	45.4	1.6	0.0	0.0	18.4	1482.6	6074.4	0.0	0.0	248.2	131.9
700	LAKE POWE	406.3	57.6	-16.5	568.0	.0	22660.3	3688.6	1179.5	276.5	1022.5	405.7
910	LAKE MEAD	620.4	75.8	9.8	364.9	.0	23521.6	1206.5	1638.0	137.1	521.3	624.7
920	LAKE MOHA	369.8	14.4	0.0	567.3	.0	1371.1	630.5	246.2	60.0	608.2	674.6
930	LAKE HAVA	469.5	11.9	0.0	454.3	.0	548.2	446.3	112.1	23.1	686.0	687.7

NOVEMBER 1984

190	TAYLOR PA	4.6	0.0	0.0	0.0	9.6	70.0	9310.1	0.0	0.0	1641.8	183.0
200	BLUE MESA	30.0	.3	0.0	79.7	.0	679.5	7502.2	78.6	25.5	215.6	130.5
210	MORROW PO	79.7	.0	0.0	79.7	.0	117.0	7159.7	156.6	29.9	130.5	127.1
220	CRYSTAL R	83.9	.0	0.0	83.9	.0	17.6	6754.9	32.0	16.8	127.2	129.2
401	FONTENELL	24.0	.6	0.0	17.9	.0	192.2	6484.5	11.1	1.4	455.1	314.9
610	STARVATIO	19.7	0.0	0.0	0.0	19.7	255.3	5735.0	0.0	0.0	243.4	135.7
411	FLAMING G	38.0	2.4	-.4	47.6	.0	3354.4	6030.9	141.5	18.2	752.3	496.7
801	NAVAJO RE	30.6	.7	0.0	0.0	17.9	1494.5	6075.2	0.0	0.0	241.6	134.8
700	LAKE POWE	409.6	47.7	-16.5	584.8	.0	22454.0	3687.2	1179.5	284.0	857.5	415.5
910	LAKE MEAD	643.4	76.0	1.3	527.8	.0	23547.7	1206.7	1642.2	224.6	522.0	624.0
920	LAKE MOHA	527.7	10.2	0.0	410.6	.0	1478.0	634.7	246.2	42.5	630.6	665.6
930	LAKE HAVA	313.6	8.4	0.0	310.7	.0	542.7	446.0	111.9	12.8	653.8	688.0

SAMPLE OUTPUT -- RESERVOIR OPERATION MONTHLY SUMMARY

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----------------------------------------  SURPLUS FORCASTING DETAILS FOR 12/1984  ----------------------------------------

   POWELL RULE =  22451879. FLAMING GORGE=   3401300. BLUE MESA =    629520. NAVAJO =   1481600.

    NORMAL POWELL RELEASE IS    856000.
   CURRENT PLANNED RELEASE---   856000.
    MEAD RELEASE FOR DOWNSTREAM DEMANDS AND RULE CURVES AT MOHAVE AND HAVASU IS---    492550.
   MEAD RELEASE (AS ABOVE) PLUS GAINS AND LOSSES BELOW MEAD IS---    498569.

    CAP DEMAND IS     12000. AF
    MWD DEMAND IS    63960. AF
MO  YR       MAX MEAD       SPACE REQ'D    CRED SPACE     CRED SPACE      MEAD RULE      CONTENT
             CONTENT        IN SYSTEM        IN UB          IN MEAD         CURVE         OF MEAD
12/1984      27016625.       5350000.       3289989.       1500000.       24956614.     23539589.

----------------------------------------  SURPLUS FORCASTING DETAILS FOR  1/1985  ----------------------------------------

   POWELL RULE =  24449769. FLAMING GORGE=   3325282. BLUE MESA =    542673. NAVAJO =   1374837.
   ACTUAL RUNOFF READ FROM TAPE IS    14152580.

    FORECAST INFLOW TO POWELL IS     11208124.430 ACRE-FT FROM MO.  1 THROUGH SEPTEMBER----ERROR OF ESTIMATE =  2358831. AC. FT.
   TOTAL UB DEPLETION =          3496.000     DIST FOR AUG =   .13     DIST FOR SEPT =   .04    IYR =    85   IYRBEG =    84
    FORECAST INFLOW TO POWELL IS    10106444.430 ACRE-FEET FROM MO.  1 THROUGH JULY---QSUM(IPOW,MO)= 14152580.
   QTODEL =     6221200.
             ACTUAL          ESTIMATED    RULE CURVE
 NAVAJO        160110.           0.      1641000.
 FLMNG GRGE    544500.           0.      1041000.
 BLUE MESA     200000.           0.       249395.
 EFFECTIVE STORAGE SPACE =      904610.

   CENDG =     25230580.
   QTOGLN =     10303515.
   QTODEL =      6221200.
   EFSTG =       904610.
   CENDM =     28566369.
   QTODEL =      6221200.
   REL =       391513.

    SIXO2A REQD IS   6521000.     WATER AVAIL. IS 30674658.

    EXPECTED SEPTEMBER EOM CONTENTS.
        MEAD  28566369.
        GLEN  25230580.

CORPS FLOOD CRITERIA
   ADJUSTED MEAD INFLOW   12224990.
   SPACE IN MEAD      3160618.
   SPACE IN POWELL      2543782.
   REQUIRED RELEASE IN 1000 CFS =           0.     IN AF =           0.

    NORMAL POWELL RELEASE IS    889000.
   CURRENT PLANNED RELEASE---   885470.
    MEAD RELEASE FOR DOWNSTREAM DEMANDS AND RULE CURVES AT MOHAVE AND HAVASU IS---    374400.
   MEAD RELEASE (AS ABOVE) PLUS GAINS AND LOSSES BELOW MEAD IS---    391513.

    CAP DEMAND IS     12000. AF
    MWD DEMAND IS    55965. AF
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SAMPLE OUTPUT -- SURPLUS FORECASTING DETAILS

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MONTH  4 / YEAR 1985
REQ'D FLOOD CONTROL RELEASE =   978619.230
DOWNSTREAM DEMANDS (INCL. SCHEDULED SURPLUS) =   814064.002
EXCESS RELEASE (FLOOD CONTROL - D/S DEMANDS) =   164555.228
ROOM FOR EXCESS IN CAP AND MWD =                        0.000        32290.000
DISTRIBUTION OF EXCESS TO CAP, MWD, AND MEXICO =        0.000        32290.000        132265.228

MONTH  6 / YEAR 1985
REQ'D FLOOD CONTROL RELEASE =  1130535.495
DOWNSTREAM DEMANDS (INCL. SCHEDULED SURPLUS) =   814545.684
EXCESS RELEASE (FLOOD CONTROL - D/S DEMANDS) =   315989.811
ROOM FOR EXCESS IN CAP AND MWD =                        0.000            0.000
DISTRIBUTION OF EXCESS TO CAP, MWD, AND MEXICO =        0.000            0.000        315989.811

MONTH  7 / YEAR 1985
REQ'D FLOOD CONTROL RELEASE =   786622.381
DOWNSTREAM DEMANDS (INCL. SCHEDULED SURPLUS) =   747511.247
EXCESS RELEASE (FLOOD CONTROL - D/S DEMANDS) =    39111.133
ROOM FOR EXCESS IN CAP AND MWD =                        0.000            0.000
DISTRIBUTION OF EXCESS TO CAP, MWD, AND MEXICO =        0.000            0.000         39111.133

MONTH  8 / YEAR 1985
REQ'D FLOOD CONTROL RELEASE =  1585815.132
DOWNSTREAM DEMANDS (INCL. SCHEDULED SURPLUS) =   697307.283
EXCESS RELEASE (FLOOD CONTROL - D/S DEMANDS) =   888507.849
ROOM FOR EXCESS IN CAP AND MWD =                        0.000            0.000
DISTRIBUTION OF EXCESS TO CAP, MWD, AND MEXICO =        0.000            0.000        888507.849

MONTH  9 / YEAR 1985
REQ'D FLOOD CONTROL RELEASE =  2087422.791
DOWNSTREAM DEMANDS (INCL. SCHEDULED SURPLUS) =   645450.511
EXCESS RELEASE (FLOOD CONTROL - D/S DEMANDS) =  1441972.280
ROOM FOR EXCESS IN CAP AND MWD =                        0.000            0.000
DISTRIBUTION OF EXCESS TO CAP, MWD, AND MEXICO =        0.000            0.000       1441972.280

MONTH 10 / YEAR 1985
REQ'D FLOOD CONTROL RELEASE =  1864127.322
DOWNSTREAM DEMANDS (INCL. SCHEDULED SURPLUS) =   665841.994
EXCESS RELEASE (FLOOD CONTROL - D/S DEMANDS) =  1198285.328
ROOM FOR EXCESS IN CAP AND MWD =                        0.000            0.000
DISTRIBUTION OF EXCESS TO CAP, MWD, AND MEXICO =        0.000            0.000       1198285.328

MONTH 11 / YEAR 1985
REQ'D FLOOD CONTROL RELEASE =  1384987.815
DOWNSTREAM DEMANDS (INCL. SCHEDULED SURPLUS) =   638054.405
EXCESS RELEASE (FLOOD CONTROL - D/S DEMANDS) =   746933.410
ROOM FOR EXCESS IN CAP AND MWD =                        0.000            0.000
DISTRIBUTION OF EXCESS TO CAP, MWD, AND MEXICO =        0.000            0.000        746933.410

MONTH 12 / YEAR 1985
REQ'D FLOOD CONTROL RELEASE =  1166281.795
DOWNSTREAM DEMANDS (INCL. SCHEDULED SURPLUS) =   608467.281
EXCESS RELEASE (FLOOD CONTROL - D/S DEMANDS) =   557814.514
ROOM FOR EXCESS IN CAP AND MWD =                        0.000            0.000
DISTRIBUTION OF EXCESS TO CAP, MWD, AND MEXICO =        0.000            0.000        557814.514
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SAMPLE OUTPUT -- FLOOD CONTROL RELEASE DISTRIBUTION DETAILS

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1985  TOT UB SCHED=    3496250.  TOT UB DEP=    3494436.  TOT UB SHRT=       1814.
      TOT LB SCHED=    6615005.  TOT LB DEP=    6744475.  TOT LB SHRT=          0.
         TOT SCHED=   10111255.     TOT DEP=   10238912.     TOT SHRT=       1814.

1986  TOT UB SCHED=    3510000.  TOT UB DEP=    3510000.  TOT UB SHRT=          0.
      TOT LB SCHED=    7056100.  TOT LB DEP=    7625100.  TOT LB SHRT=          0.
         TOT SCHED=   10566100.     TOT DEP=   11135100.     TOT SHRT=          0.

1987  TOT UB SCHED=    3523750.  TOT UB DEP=    3512740.  TOT UB SHRT=      11010.
      TOT LB SCHED=    7436700.  TOT LB DEP=    8022700.  TOT LB SHRT=          0.
         TOT SCHED=   10960450.     TOT DEP=   11535440.     TOT SHRT=      11010.

1988  TOT UB SCHED=    3537500.  TOT UB DEP=    3535225.  TOT UB SHRT=       2275.
      TOT LB SCHED=    7832300.  TOT LB DEP=    8431648.  TOT LB SHRT=          0.
         TOT SCHED=   11369800.     TOT DEP=   11966873.     TOT SHRT=       2275.

1989  TOT UB SCHED=    3551250.  TOT UB DEP=    3536804.  TOT UB SHRT=      14445.
      TOT LB SCHED=    7842900.  TOT LB DEP=    8462900.  TOT LB SHRT=          0.
         TOT SCHED=   11394150.     TOT DEP=   11999704.     TOT SHRT=      14445.

1990  TOT UB SCHED=    4035000.  TOT UB DEP=    3985580.  TOT UB SHRT=      49420.
      TOT LB SCHED=    7867500.  TOT LB DEP=    8504500.  TOT LB SHRT=          0.
         TOT SCHED=   11902500.     TOT DEP=   12490080.     TOT SHRT=      49420.

1991  TOT UB SCHED=    4043500.  TOT UB DEP=    4013216.  TOT UB SHRT=      30284.
      TOT LB SCHED=    7872400.  TOT LB DEP=    8509400.  TOT LB SHRT=          0.
         TOT SCHED=   11915900.     TOT DEP=   12522616.     TOT SHRT=      30284.

1992  TOT UB SCHED=    4052000.  TOT UB DEP=    4051864.  TOT UB SHRT=        136.
      TOT LB SCHED=    7876800.  TOT LB DEP=    8653070.  TOT LB SHRT=          0.
         TOT SCHED=   11928800.     TOT DEP=   12704934.     TOT SHRT=        136.

1993  TOT UB SCHED=    4060500.  TOT UB DEP=    4059330.  TOT UB SHRT=       1170.
      TOT LB SCHED=    7881200.  TOT LB DEP=    9016550.  TOT LB SHRT=          0.
         TOT SCHED=   11941700.     TOT DEP=   13075880.     TOT SHRT=       1170.

1994  TOT UB SCHED=    4069000.  TOT UB DEP=    4063206.  TOT UB SHRT=       5794.
      TOT LB SCHED=    7885600.  TOT LB DEP=    8661652.  TOT LB SHRT=          0.
         TOT SCHED=   11954600.     TOT DEP=   12724858.     TOT SHRT=       5794.

                AVERAGE OF  10 YEARS
      TOT UB SCHED=    3787875.  TOT UB DEP=    3776240.  TOT UB SHRT=      11635.
      TOT LB SCHED=    7616651.  TOT LB DEP=    8263200.  TOT LB SHRT=          0.
         TOT SCHED=   11404526.     TOT DEP=   12039440.     TOT SHRT=      11635.
```

SAMPLE OUTPUT -- ANNUAL DEPLETION AND SHORTAGE SUMMARY

TOTAL SPRING RUNOFF VALUES (SUMMED FROM MONTH SHOWN TO MONTH 7) FOR RESERVOIRS IN CERTAIN REACHES FOR YEAR 1985

MONTH	REACH 700	REACH 411	REACH 200	REACH 801	REACH 910
1	14152580.	2062795.	1196020.	1273871.	533155.
2	13926054.	2026511.	1170020.	1249633.	461340.
3	13681245.	1988303.	1148020.	1226448.	366619.
4	13063738.	1835442.	1109020.	1193513.	271336.
5	11801168.	1611542.	1002020.	1026886.	189291.
6	7841091.	1024771.	668010.	562478.	97053.
7	2758191.	366047.	213582.	131339.	59745.

TOTAL SPRING RUNOFF VALUES (SUMMED FROM MONTH SHOWN TO MONTH 7) FOR RESERVOIRS IN CERTAIN REACHES FOR YEAR 1986

MONTH	REACH 700	REACH 411	REACH 200	REACH 801	REACH 910
1	17105800.	2841372.	1364120.	923152.	526130.
2	16816319.	2780705.	1338120.	915051.	453454.
3	16429345.	2695163.	1317120.	903221.	359122.
4	15641756.	2528850.	1266120.	872776.	269189.
5	14020465.	2208685.	1147120.	799023.	187739.
6	10865665.	1633092.	925110.	637033.	95378.
7	4746796.	760825.	391282.	277620.	57654.

TOTAL SPRING RUNOFF VALUES (SUMMED FROM MONTH SHOWN TO MONTH 7) FOR RESERVOIRS IN CERTAIN REACHES FOR YEAR 1987

MONTH	REACH 700	REACH 411	REACH 200	REACH 801	REACH 910
1	9224798.	1299430.	700520.	937003.	524261.
2	8906169.	1266590.	675520.	911703.	452569.
3	8548727.	1229811.	653520.	867603.	358181.
4	7880120.	1140112.	617520.	748603.	268678.
5	6733500.	987224.	525520.	569603.	188180.
6	4983202.	712577.	390510.	384603.	95942.
7	1850885.	300478.	142882.	134974.	58515.

TOTAL SPRING RUNOFF VALUES (SUMMED FROM MONTH SHOWN TO MONTH 7) FOR RESERVOIRS IN CERTAIN REACHES FOR YEAR 1988

MONTH	REACH 700	REACH 411	REACH 200	REACH 801	REACH 910
1	17530309.	2739126.	1423220.	1393392.	556053.
2	17155209.	2689923.	1398220.	1358292.	484423.
3	16846271.	2650493.	1377220.	1337592.	390035.
4	16126564.	2448052.	1338220.	1228592.	300471.
5	14934392.	2229421.	1245220.	967592.	245141.
6	11218237.	1699718.	884210.	602292.	111909.
7	3842885.	656050.	327382.	152337.	60108.

SAMPLE OUTPUT -- SPRING RUNOFF VALUES

SHORTAGE MESSAGES

DATE	AVAILABLE	NEEDED	SHORT	RCH	SEQ	DEMAND ID
12/1984	1161.	1920.	39.54	710	1	SAN RAFAEL ENERGY USES
12/1984	145.	160.	9.31	710	3	MISC USES
1/1985	1336.	1920.	30.42	710	1	SAN RAFAEL ENERGY USES
2/1985	1464.	1920.	23.75	710	1	SAN RAFAEL ENERGY USES
12/1986	1481.	1920.	22.87	710	1	SAN RAFAEL ENERGY USES
1/1987	1123.	1920.	41.53	710	1	SAN RAFAEL ENERGY USES
1/1987	140.	160.	12.30	710	3	MISC USES
2/1987	1410.	1920.	26.57	710	1	SAN RAFAEL ENERGY USES
4/1987	5756.	8450.	31.89	710	2	SAN RAFAEL AGRICULTURE
5/1987	12301.	18850.	34.75	710	2	SAN RAFAEL AGRICULTURE
12/1987	60.	1920.	96.85	710	1	SAN RAFAEL ENERGY USES
12/1987	8.	160.	95.28	710	3	MISC USES
2/1988	1657.	1920.	13.70	710	1	SAN RAFAEL ENERGY USES
4/1988	0.	830.	100.00	905	1	WARNER VALLEY PROJ.(VIRGIN R.)
8/1988	0.	996.	100.00	905	1	WARNER VALLEY PROJ.(VIRGIN R.)
9/1988	0.	1826.	100.00	905	1	WARNER VALLEY PROJ.(VIRGIN R.)
6/1989	15610.	19500.	19.95	710	2	SAN RAFAEL AGRICULTURE
7/1989	44395.	54950.	19.21	401	1	AGRICULTURAL USE AB FONTENELLE
4/1990	3649.	7670.	52.43	710	2	SAN RAFAEL AGRICULTURE
6/1990	89070.	102550.	13.14	610	2	AGRICULTURE ABOVE RANDLETT
7/1990	27092.	29300.	7.54	610	2	AGRICULTURE ABOVE RANDLETT
7/1990	10092.	11800.	14.48	710	2	SAN RAFAEL AGRICULTURE
8/1990	2362.	11720.	79.85	610	2	AGRICULTURE ABOVE RANDLETT
8/1990	1181.	6650.	82.24	610	3	UPALCO,UINTA,BONN,DEF INDIAN
8/1990	12.	70.	83.13	610	4	UINTA BASIN WQIP
8/1990	550.	720.	23.58	610	5	MISC USES ABOVE RANDLETT
9/1990	629.	8790.	92.85	610	2	AGRICULTURE ABOVE RANDLETT
9/1990	314.	4550.	93.09	610	3	UPALCO,UINTA,BONN,DEF INDIAN
9/1990	3.	60.	94.76	610	4	UINTA BASIN WQIP
9/1990	146.	640.	77.12	610	5	MISC USES ABOVE RANDLETT
4/1991	1649.	7670.	78.50	710	2	SAN RAFAEL AGRICULTURE
5/1991	50793.	73250.	30.66	610	2	AGRICULTURE ABOVE RANDLETT
5/1991	15304.	17110.	10.56	710	2	SAN RAFAEL AGRICULTURE
1/1992	2264.	2400.	5.68	710	1	SAN RAFAEL ENERGY USES
4/1993	6500.	7670.	15.25	710	2	SAN RAFAEL AGRICULTURE
10/1993	7706.	7924.	2.75	905	1	WARNER VALLEY PROJ.(VIRGIN R.)
11/1993	2268.	2400.	5.49	710	1	SAN RAFAEL ENERGY USES
2/1994	2355.	2400.	1.89	710	1	SAN RAFAEL ENERGY USES
4/1994	6299.	7670.	17.87	710	2	SAN RAFAEL AGRICULTURE
5/1994	15394.	17110.	10.03	710	2	SAN RAFAEL AGRICULTURE
7/1994	9977.	11800.	15.44	710	2	SAN RAFAEL AGRICULTURE
8/1994	2833.	3540.	19.97	710	2	SAN RAFAEL AGRICULTURE

SAMPLE OUTPUT -- SHORTAGE MESSAGES

SAMPLE OUTPUT FROM TAPEDIT PROGRAM

SINGLE-TRACE RUN

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE POWELL
END OF MONTH CONTENTS - LAKE POWELL (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1985	22660313.	22454000.	21912980.	21449654.	21403853.	21677434.	22185293.	23841557.	24431287.	24425093.	24418868.	24416706.
1986	23413543.	22412397.	22021878.	21443807.	21117707.	21085078.	21363707.	22058026.	24321947.	24383559.	24377316.	24375146.
1987	23371976.	22370823.	21902803.	21621258.	21556263.	21632959.	21871055.	22075547.	22897999.	23170450.	23205359.	23074075.
1988	23074843.	22329124.	21895613.	21216105.	20925002.	20850668.	20792126.	21861598.	24306294.	24300131.	24293840.	24291656.
1989	23288471.	22287302.	21915680.	21596808.	21556750.	22199114.	22999528.	24229991.	24264148.	24257841.	23928359.	23953460.
1990	23246154.	22244978.	21848190.	21584085.	21731463.	22119757.	22226508.	23284494.	24221776.	24215491.	24059526.	23902265.
1991	23203763.	22202579.	21791588.	21335310.	21067403.	20872903.	20600619.	21719175.	24179492.	24173263.	24166906.	24164698.
1992	23161490.	22160299.	21699110.	21414211.	21327662.	21376299.	22082875.	23209332.	23799834.	23961354.	23705112.	23495025.
1993	23118872.	22117672.	21669271.	21220533.	21025470.	21052014.	21318315.	23006136.	24094335.	24087990.	24081588.	24079365.
1994	23104371.	22074934.	21655304.	21384979.	21397804.	21371882.	21850739.	22471451.	23484881.	23858787.	23520606.	23160740.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE POWELL
WATER SURFACE ELEVATION - LAKE POWELL (FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1985	3689.	3687.	3684.	3681.	3680.	3682.	3686.	3696.	3700.	3700.	3700.	3700.
1986	3694.	3687.	3685.	3681.	3679.	3678.	3680.	3685.	3700.	3700.	3700.	3700.
1987	3694.	3687.	3684.	3682.	3682.	3682.	3684.	3685.	3691.	3693.	3693.	3692.
1988	3692.	3687.	3684.	3680.	3678.	3677.	3677.	3684.	3700.	3700.	3700.	3700.
1989	3694.	3687.	3685.	3683.	3682.	3687.	3692.	3700.	3700.	3700.	3698.	3698.
1990	3694.	3687.	3685.	3683.	3684.	3686.	3687.	3694.	3700.	3700.	3699.	3698.
1991	3694.	3687.	3684.	3681.	3680.	3678.	3676.	3684.	3700.	3700.	3700.	3700.
1992	3694.	3687.	3684.	3682.	3682.	3682.	3687.	3694.	3698.	3699.	3697.	3696.
1993	3694.	3687.	3684.	3681.	3680.	3680.	3682.	3693.	3700.	3700.	3700.	3700.
1994	3694.	3687.	3684.	3683.	3683.	3682.	3686.	3690.	3696.	3699.	3697.	3694.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE POWELL
MONTHLY RELEASES FROM LAKE POWELL (ACRE-FEET)

MONTH / YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	568000.	584800.	856000.	885470.	524908.	507975.	515943.	548812.	1969615.	1988155.	1080813.	1346522.	11377014.
1986	1867203.	1667280.	856000.	1145131.	1033035.	1025060.	1132156.	1168409.	1314697.	2035269.	1463703.	915021.	15622965.
1987	1815454.	1554546.	856000.	823469.	608072.	616060.	602101.	599225.	558335.	527703.	481169.	516841.	9558975.
1988	568000.	1275829.	856000.	1335032.	950259.	931771.	1072020.	1127604.	1969615.	2035269.	1373258.	1277709.	14772367.
1989	2030966.	1688624.	856000.	885835.	681742.	616032.	675833.	701445.	1395394.	640971.	615122.	438531.	11226494.
1990	1393448.	1595829.	856000.	868284.	522970.	536167.	577140.	630244.	945553.	1158567.	640174.	580760.	10305134.
1991	1851284.	1608098.	856000.	1041277.	880570.	889444.	1019033.	1037137.	1097455.	2035269.	1007581.	523161.	13846308.
1992	1696844.	1690415.	856000.	852942.	597378.	572007.	618892.	645171.	679981.	738463.	757049.	709769.	10414911.
1993	1029761.	1651762.	856000.	1066426.	844141.	926802.	989720.	1047145.	1969615.	2035269.	1023625.	667886.	14108152.
1994	2035269.	1732441.	856000.	797466.	593820.	631490.	603243.	610904.	660752.	699779.	723584.	669734.	10614480.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE POWELL
ANNUAL RELEASES FROM LAKE POWELL (ACRE-FEET)

YEAR
1985 11377014. 15622965. 9558975. 14772367. 11226494. 10305134. 13846308. 10414911. 14108152. 10614480.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE MEAD
END OF MONTH CONTENTS - LAKE MEAD (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1985	23521582.	23547730.	23862773.	24327234.	24307783.	24131542.	23695167.	23363704.	24285513.	25339131.	24896823.	24541956.
1986	24631989.	24955369.	24694585.	24679904.	24688238.	24570956.	24335366.	23957580.	23553160.	25325502.	25016363.	24253770.
1987	24544994.	24926595.	24743635.	24999562.	24912406.	24681376.	24396115.	24037287.	23683706.	23349189.	23034008.	22814052.
1988	22591049.	23068993.	23199364.	23357045.	23251459.	23046910.	22965135.	22959191.	23732537.	25314391.	24904883.	24479920.
1989	24724891.	24869092.	24590381.	24867057.	24806402.	24569784.	24353040.	24068991.	24480953.	24233614.	24024902.	23727257.
1990	24272927.	24840110.	24586902.	24882925.	24677270.	24359392.	24071289.	23749098.	23744838.	24001785.	23803673.	23643359.
1991	24429511.	24811098.	24572425.	24449790.	24307348.	24051905.	23928896.	23801489.	23691789.	24812855.	24769412.	24075668.
1992	24403512.	24781996.	24593853.	24878215.	24788149.	24509210.	24167482.	23772160.	23466507.	23259458.	23131836.	23019470.
1993	23262112.	24141744.	24311919.	24218722.	24052644.	23842936.	23737630.	23633984.	24718174.	25226264.	24672260.	23973533.
1994	24313867.	24723659.	24494633.	24738338.	24656324.	24409805.	24055235.	23682766.	23372879.	23127075.	22955269.	22800751.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE MEAD
WATER SURFACE ELEVATION - LAKE MEAD (FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1985	1207.	1207.	1209.	1212.	1212.	1211.	1208.	1206.	1212.	1219.	1216.	1213.
1986	1214.	1216.	1215.	1214.	1214.	1214.	1212.	1210.	1207.	1219.	1217.	1212.
1987	1214.	1216.	1215.	1217.	1216.	1215.	1213.	1210.	1208.	1206.	1204.	1202.
1988	1201.	1204.	1205.	1206.	1205.	1204.	1203.	1203.	1209.	1219.	1216.	1214.
1989	1215.	1216.	1214.	1216.	1216.	1214.	1213.	1211.	1214.	1212.	1211.	1209.
1990	1212.	1216.	1215.	1216.	1215.	1213.	1211.	1209.	1209.	1211.	1210.	1208.
1991	1214.	1216.	1215.	1214.	1213.	1211.	1210.	1210.	1209.	1216.	1216.	1212.
1992	1214.	1216.	1215.	1217.	1216.	1214.	1212.	1210.	1208.	1206.	1205.	1205.
1993	1206.	1212.	1213.	1213.	1212.	1210.	1210.	1209.	1216.	1219.	1216.	1211.
1994	1213.	1216.	1215.	1216.	1216.	1214.	1212.	1209.	1207.	1206.	1205.	1204.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE MEAD
MONTHLY RELEASES FROM LAKE MEAD (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	364924.	527828.	498569.	391513.	575340.	720451.	978619.	898112.	1130535.	786622.	1482261.	1666140.	10020916.
1986	1721678.	1284862.	1115075.	1168220.	1055166.	1168220.	1378136.	1564267.	1666080.	1601529.	1721678.	1666140.	17111052.
1987	1461146.	1112536.	1030857.	555744.	729057.	877379.	899722.	973754.	854962.	797924.	748641.	697502.	10739224.
1988	759558.	731246.	701883.	1168220.	1092851.	1168220.	1130535.	1168220.	1277334.	1276009.	1721678.	1666140.	13861896.
1989	1721678.	1498223.	1136485.	604370.	774699.	927737.	923120.	995972.	872798.	819326.	770415.	719474.	11764298.
1990	760264.	950031.	1099275.	602438.	774115.	928211.	923514.	995146.	873406.	820202.	772547.	722260.	10221411.
1991	960372.	1159823.	1082701.	1168220.	1055166.	1168220.	1130535.	1168220.	1130535.	819500.	974468.	1191207.	13008968.
1992	1329461.	1246619.	1028683.	546869.	714780.	877708.	978142.	1043971.	921798.	868333.	820862.	771060.	11148286.
1993	714132.	671228.	652455.	1168220.	1055166.	1168220.	1130535.	1168220.	1666080.	1614749.	1523598.	1337478.	13870083.
1994	1618628.	1248952.	1068064.	533085.	704030.	902200.	984630.	1037711.	916380.	866139.	823962.	786170.	11489952.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE MEAD
ANNUAL RELEASES FROM LAKE MEAD (ACRE-FEET)

YEAR
1985 10020916.17111052.10739224.13861896.11764298.10221411.13008968.11148286.13870083.11489952.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

TOTAL UPPER BASIN STORAGE (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	28372927.	28117011.	27491501.	26814778.	26491091.	26531893.	27024971.	29388820.	30753110.	30707651.	30574486.	30491579.	342759817.
1986	29348417.	28192271.	27678527.	26836297.	26199847.	25923409.	26179383.	27187826.	30328636.	30669130.	30623091.	30445677.	339612510.
1987	29302109.	28145956.	27554376.	27043613.	26778103.	26776263.	27092480.	27442077.	28545802.	28999875.	29210635.	29116779.	336008068.
1988	29000223.	28099504.	27542095.	26597065.	25957002.	25693469.	25600389.	27191050.	30596929.	30576837.	30510782.	30512890.	337878235.
1989	29215623.	28052919.	27557060.	27023059.	26751884.	27422931.	28335212.	30186693.	30490177.	30380006.	30024374.	29998846.	345438784.
1990	29161991.	28005815.	27484446.	26947142.	26792181.	27057362.	27230684.	28647466.	30126045.	30317494.	30094970.	29897620.	341763216.
1991	29114821.	27958638.	27422717.	26709347.	26139536.	25737462.	25411273.	27015942.	30233893.	30404936.	30248054.	30167154.	336563773.
1992	29064675.	27911573.	27325109.	26798951.	26478556.	26349815.	27227225.	28759852.	29677706.	29981883.	29612305.	29414316.	338601966.
1993	28956190.	27844792.	27287763.	26563549.	26090593.	25959721.	26232331.	28640619.	30341700.	30326145.	30191979.	30116034.	338551416.
1994	29001041.	27816603.	27270995.	26748330.	26511775.	26337526.	26933744.	27794359.	29174772.	29645501.	29301441.	28990958.	335527045.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

TOTAL LOWER BASIN STORAGE (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	25440882.	25568430.	25986873.	26510334.	26545583.	26387642.	25987467.	25729004.	26562913.	27462131.	26874923.	26470456.	315526639.
1986	26551289.	26976069.	26818685.	26863004.	26926038.	26827056.	26627666.	26322880.	25830560.	27448502.	26994463.	26182270.	320368483.
1987	26464294.	26947295.	26867735.	27182662.	27150206.	26937476.	26688415.	26402587.	25961106.	25472189.	25012108.	24742552.	315828625.
1988	24510349.	25089693.	25323464.	25540145.	25489259.	25303010.	25257435.	25324491.	26009937.	27437391.	26882983.	26408420.	308576576.
1989	26644191.	26889792.	26714481.	27050157.	27044202.	26825884.	26645340.	26434291.	26758353.	26356614.	26003002.	25655757.	319022064.
1990	26192227.	26860810.	26711002.	27066025.	26915070.	26615492.	26363589.	26114398.	26022238.	26124785.	25781773.	25571859.	316339269.
1991	26348811.	26831798.	26696525.	26632890.	26545148.	26308005.	26221196.	26166789.	25969189.	26935855.	26747512.	26004168.	317407886.
1992	26322812.	26802696.	26717953.	27061315.	27025949.	26765310.	26459782.	26137460.	25743907.	25382458.	25109936.	24947970.	314477549.
1993	25181412.	26162444.	26436019.	26401822.	26290444.	26099036.	26029930.	25999284.	26995574.	27349264.	26650360.	25902033.	315497622.
1994	26233167.	26744359.	26618733.	26921438.	26894124.	26665905.	26347535.	26048066.	25650279.	25250075.	24933369.	24729251.	313036302.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

TOTAL SYSTEM STORAGE (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	53813810.	53685441.	53478374.	53325112.	53036674.	52919535.	53012439.	55117824.	57316022.	58169781.	57449409.	56962035.	658286455.
1986	55899706.	55168340.	54497212.	53699301.	53125885.	52750465.	52807050.	53510705.	56159195.	58117632.	57617555.	56627948.	659980993.
1987	55766403.	55093251.	54422111.	54226275.	53928308.	53713740.	53780896.	53844664.	54506908.	54472064.	54222744.	53859331.	651836693.
1988	53510571.	53189197.	52865560.	52137210.	51446261.	50996478.	50857823.	52515542.	56606866.	58014228.	57393765.	56921310.	646454811.
1989	55859814.	54942711.	54271541.	54073217.	53796086.	54248816.	54980552.	56620983.	57248530.	56736620.	56027375.	55654603.	664460848.
1990	55354219.	54866625.	54195448.	54013168.	53707251.	53672854.	53594273.	54761864.	56148282.	56442279.	55876743.	55469479.	658102484.
1991	55463633.	54790436.	54119242.	53342237.	52684684.	52045467.	51632468.	53182731.	56203082.	57340791.	56995566.	56171322.	653971659.
1992	55387487.	54714269.	54043062.	53860265.	53504505.	53115126.	53687007.	54897312.	55421614.	55364341.	54722241.	54362286.	653079514.
1993	54137602.	54007236.	53723782.	52965371.	52381037.	52058757.	52262261.	54639903.	57337274.	57675409.	56842338.	56018067.	654049038.
1994	55234207.	54560962.	53889729.	53669768.	53405899.	53003432.	53281279.	53842425.	54825051.	54895576.	54234810.	53720209.	648563346.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE HAVASU
CENTRAL ARIZONA PROJECT
SCHEDULED DIVERSIONS TO CAP (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	12000.	12000.	12000.	12000.	11000.	12000.	5000.	5000.	4000.	5000.	5000.	5000.	100000.
1986	90000.	90000.	90000.	90000.	82500.	90000.	37500.	37500.	30000.	37500.	37500.	37500.	750000.
1987	135000.	135000.	135000.	135000.	123750.	135000.	56250.	56250.	45000.	56250.	56250.	56250.	1125000.
1988	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1989	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1990	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1991	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1992	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1993	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1994	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE HAVASU
CENTRAL ARIZONA PROJECT
ACTUAL DIVERSIONS TO CAP (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	12000.	12000.	12000.	12000.	11000.	12000.	5000.	5000.	4000.	5000.	5000.	5000.	100000.
1986	90000.	90000.	90000.	90000.	82500.	90000.	37500.	37500.	30000.	37500.	37500.	37500.	750000.
1987	135000.	135000.	135000.	135000.	123750.	135000.	56250.	56250.	45000.	56250.	56250.	56250.	1125000.
1988	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1989	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1990	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1991	181800.	181800.	181800.	181800.	166650.	181800.	75750.	75750.	60600.	75750.	75750.	75750.	1515000.
1992	184000.	179000.	184000.	184000.	167000.	184000.	130560.	125380.	110230.	125380.	125380.	125380.	1824310.
1993	184000.	179000.	184000.	184000.	167000.	184000.	179000.	184000.	179000.	184000.	184000.	179000.	2171000.
1994	184000.	179000.	184000.	184000.	167000.	184000.	130560.	125380.	110230.	125380.	125380.	125380.	1824310.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

CENTRAL ARIZONA PROJECT
SURPLUS DIVERSIONS TO CAP (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1991	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1992	2200.	-2800.	2200.	2200.	350.	2200.	54810.	49630.	49630.	49630.	49630.	49630.	309310.
1993	2200.	-2800.	2200.	2200.	350.	2200.	103250.	108250.	118400.	108250.	108250.	103250.	656000.
1994	2200.	-2800.	2200.	2200.	350.	2200.	54810.	49630.	49630.	49630.	49630.	49630.	309310.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE HAVASU
METROPOLITAN WATER DISTRICT OF CALIFORNIA
SCHEDULED DIVERSIONS TO MWD (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	71955.	63960.	63960.	55965.	55965.	63960.	63960.	71955.	71955.	71955.	71955.	71955.	799500.
1986	52740.	46880.	46880.	41020.	41020.	46880.	46880.	52740.	52740.	52740.	52740.	52740.	586000.
1987	51210.	45520.	45520.	39830.	39830.	45520.	45520.	51210.	51210.	51210.	51210.	51210.	569000.
1988	49680.	44160.	44160.	38640.	38640.	44160.	44160.	49680.	49680.	49680.	49680.	49680.	552000.
1989	48150.	42800.	42800.	37450.	37450.	42800.	42800.	48150.	48150.	48150.	48150.	48150.	535000.
1990	46620.	41440.	41440.	36260.	36260.	41440.	41440.	46620.	46620.	46620.	46620.	46620.	518000.
1991	46620.	41440.	41440.	36260.	36260.	41440.	41440.	46620.	46620.	46620.	46620.	46620.	518000.
1992	46620.	41440.	41440.	36260.	36260.	41440.	41440.	46620.	46620.	46620.	46620.	46620.	518000.
1993	46620.	41440.	41440.	36260.	36260.	41440.	41440.	46620.	46620.	46620.	46620.	46620.	518000.
1994	46620.	41440.	41440.	36260.	36260.	41440.	41440.	46620.	46620.	46620.	46620.	46620.	518000.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

LAKE HAVASU
METROPOLITAN WATER DISTRICT OF CALIFORNIA
ACTUAL DIVERSIONS TO MWD (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	71955.	63960.	63960.	55965.	55965.	63960.	96250.	71955.	96250.	96250.	96250.	96250.	928970.
1986	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	1155000.
1987	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	1155000.
1988	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	1155000.
1989	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	1155000.
1990	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	1155000.
1991	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	1155000.
1992	96250.	96250.	96250.	38460.	36610.	43640.	96250.	96250.	96250.	96250.	96250.	96250.	984960.
1993	48820.	38640.	43640.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	96250.	997350.
1994	96250.	96250.	96250.	38460.	36610.	43640.	96250.	96250.	96250.	96250.	96250.	96250.	984960.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

METROPOLITAN WATER DISTRICT OF CALIFORNIA
SURPLUS DIVERSIONS TO MWD (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	0.	0.	0.	0.	0.	0.	32290.	0.	24295.	24295.	24295.	24295.	129470.
1986	43510.	49370.	49370.	55230.	55230.	49370.	49370.	43510.	43510.	43510.	43510.	43510.	569000.
1987	45040.	50730.	50730.	56420.	56420.	50730.	50730.	45040.	45040.	45040.	45040.	45040.	586000.
1988	46570.	52090.	52090.	57610.	57610.	52090.	52090.	46570.	46570.	46570.	46570.	46570.	603000.
1989	48100.	53450.	53450.	58800.	58800.	53450.	53450.	48100.	48100.	48100.	48100.	48100.	620000.
1990	49630.	54810.	54810.	59990.	59990.	54810.	54810.	49630.	49630.	49630.	49630.	49630.	637000.
1991	49630.	54810.	54810.	59990.	59990.	54810.	54810.	49630.	49630.	49630.	49630.	49630.	637000.
1992	49630.	54810.	54810.	2200.	350.	2200.	54810.	49630.	49630.	49630.	49630.	49630.	466960.
1993	2200.	-2800.	2200.	59990.	59990.	54810.	54810.	49630.	49630.	49630.	49630.	49630.	479350.
1994	49630.	54810.	54810.	2200.	350.	2200.	54810.	49630.	49630.	49630.	49630.	49630.	466960.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

USERS BELOW IMPERIAL DAM
MEXICAN TREATY DELIVERY
SCHEDULED DELIVERIES TO MEXICO (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.
1986	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.
1987	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.
1988	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.
1989	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.
1990	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.
1991	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.
1992	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.
1993	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.
1994	106050.	90900.	90900.	30300.	106050.	106050.	166650.	166650.	181800.	181800.	166650.	121200.	1515000.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

USERS BELOW IMPERIAL DAM
FLOW AVAILABLE TO MEXICO
ACTUAL DELIVERIES TO MEXICO (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	106055.	90901.	90901.	30300.	106051.	106050.	298917.	166649.	497790.	220900.	951608.	1141889.	3808011.
1986	1161886.	737708.	597508.	688664.	474756.	443545.	665390.	777046.	1008737.	1004781.	1159203.	1109523.	9828748.
1987	855396.	519686.	467482.	30300.	106051.	106050.	166652.	166649.	181800.	181800.	166654.	121200.	3069720.
1988	106050.	90901.	90901.	595088.	425599.	348437.	376391.	340481.	587755.	639759.	1119429.	1069401.	5790192.
1989	1066912.	856831.	524494.	30300.	106051.	106050.	166652.	166649.	181800.	181800.	166654.	121200.	3675394.
1990	106050.	308923.	487177.	30300.	106051.	106050.	166652.	166649.	181800.	181800.	166654.	121200.	2129307.
1991	306432.	518825.	470641.	596069.	387122.	346098.	373749.	340098.	439509.	181800.	369189.	590531.	4920064.
1992	673635.	608551.	414470.	30300.	106051.	106050.	166652.	166649.	181800.	181800.	166654.	121200.	2923812.
1993	106050.	90901.	90901.	596553.	388422.	316606.	263611.	232008.	857872.	870293.	806670.	617842.	5237729.
1994	963930.	611444.	450947.	30300.	106051.	106050.	166652.	166649.	181800.	181800.	166654.	121200.	3253478.

10/1984 TO 9/1994

02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

SURPLUS DELIVERIES TO MEXICO (ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	5.	1.	1.	-0.	1.	0.	132267.	-1.	315990.	39100.	784958.	1020689.	2293011.
1986	1055836.	646808.	506608.	658364.	368706.	337495.	498740.	610396.	826937.	822981.	992553.	988323.	8313748.
1987	749346.	428786.	376582.	-0.	1.	0.	2.	-1.	0.	-0.	4.	-0.	1554720.
1988	0.	1.	1.	564788.	319549.	242387.	209741.	173831.	405955.	457959.	952779.	948201..	4275192.
1989	960862.	765931.	433594.	-0.	1.	0.	2.	-1.	0.	-0.	4.	-0.	2160394.
1990	0.	218023.	396277.	-0.	1.	0.	2.	-1.	0.	-0.	4.	-0.	614307.
1991	200382.	427925.	379741.	565769.	281072.	240048.	207099.	173448.	257709.	-0.	202539.	469331.	3405064.
1992	567585.	517651.	323570.	-0.	1.	0.	2.	-1.	0.	-0.	4.	-0.	1408812.
1993	0.	1.	1.	566253.	282372.	210556.	96961.	65358.	676072.	688493.	640020.	496642.	3722729.
1994	857880.	520544.	360047.	-0.	1.	0.	2.	-1.	0.	-0.	4.	-0.	1738478.

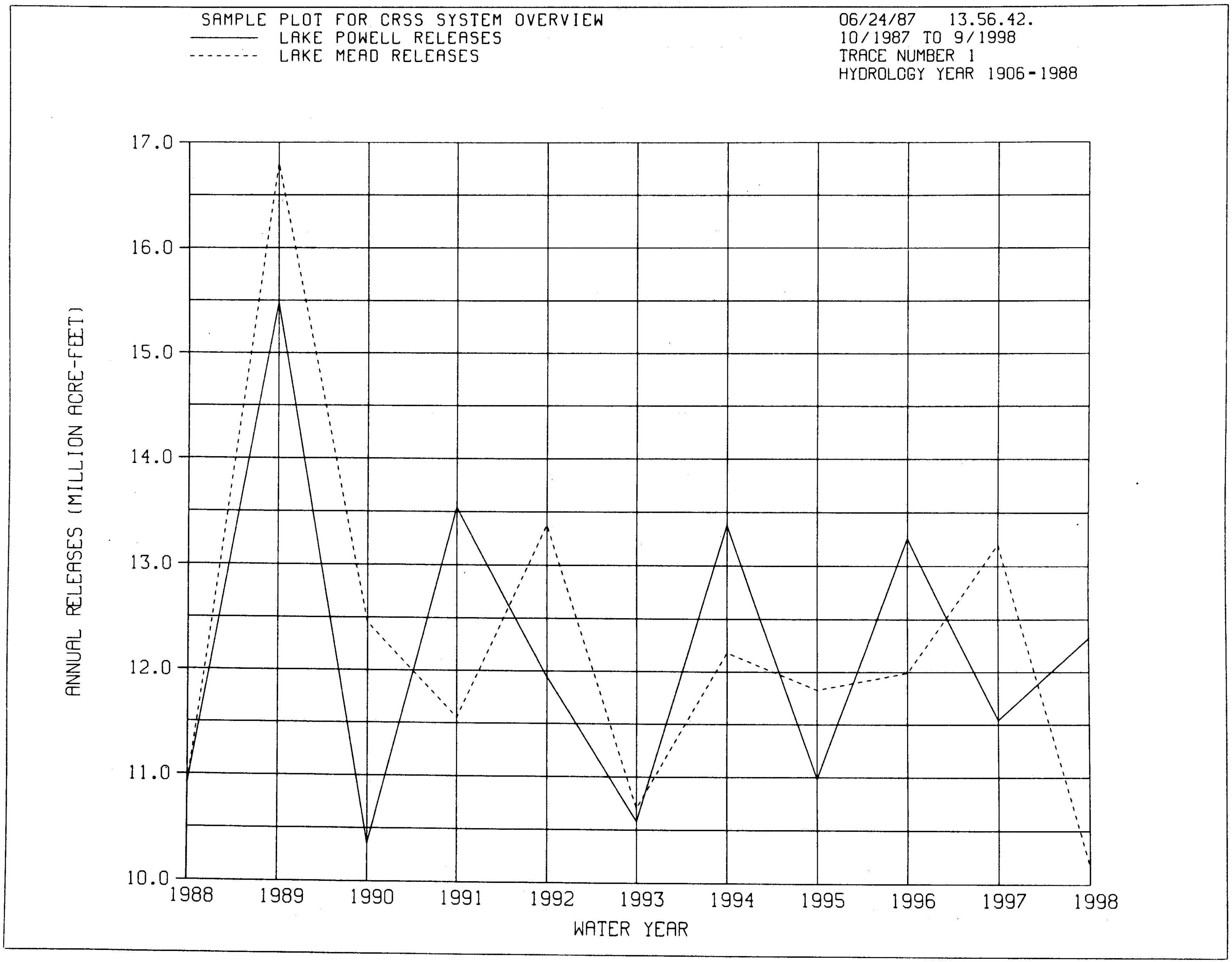
10/1984 TO 9/1994

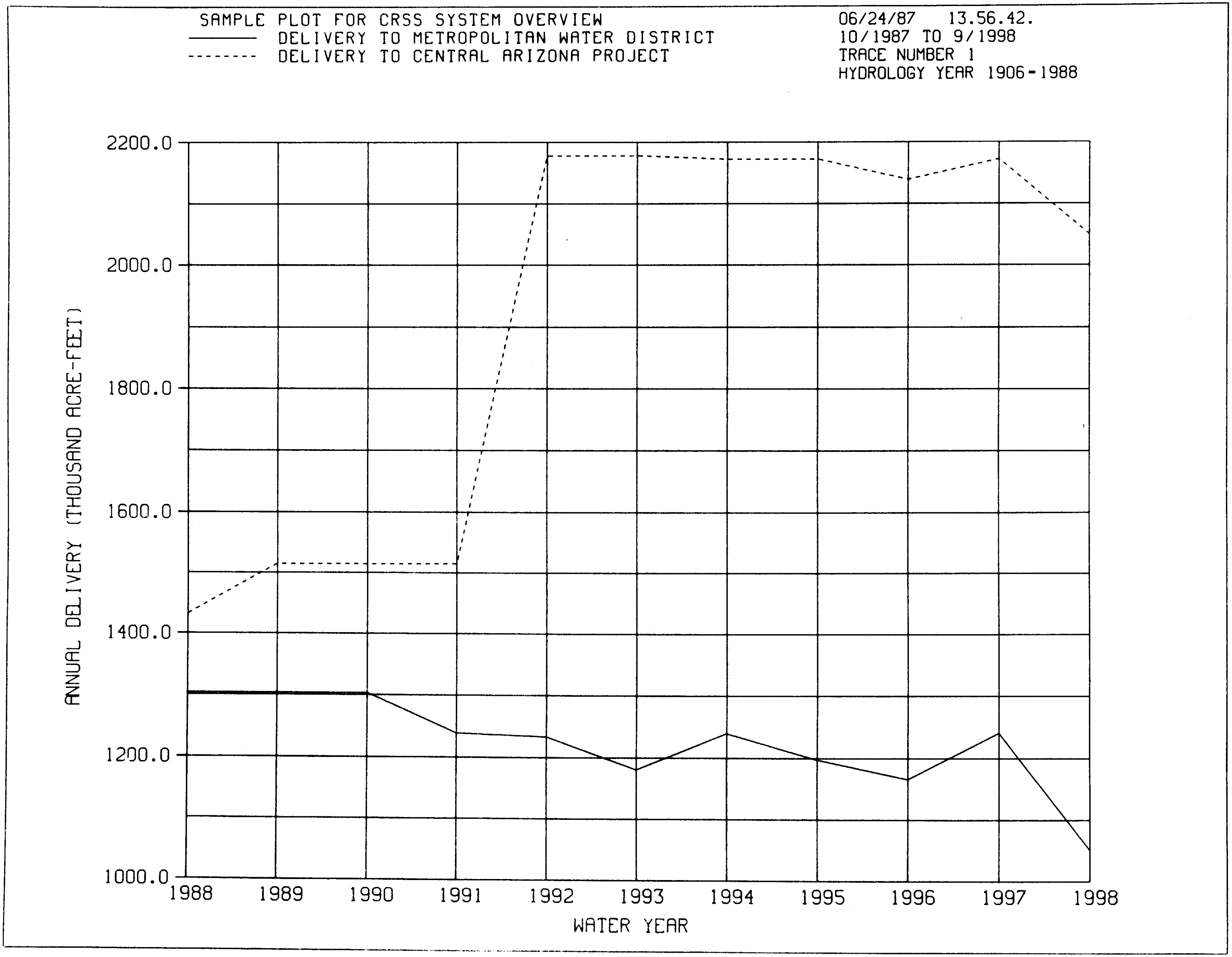
02/26/85 14.30.35.
TRACE NUMBER 1
HYDROLOGY YEAR 1906=1985

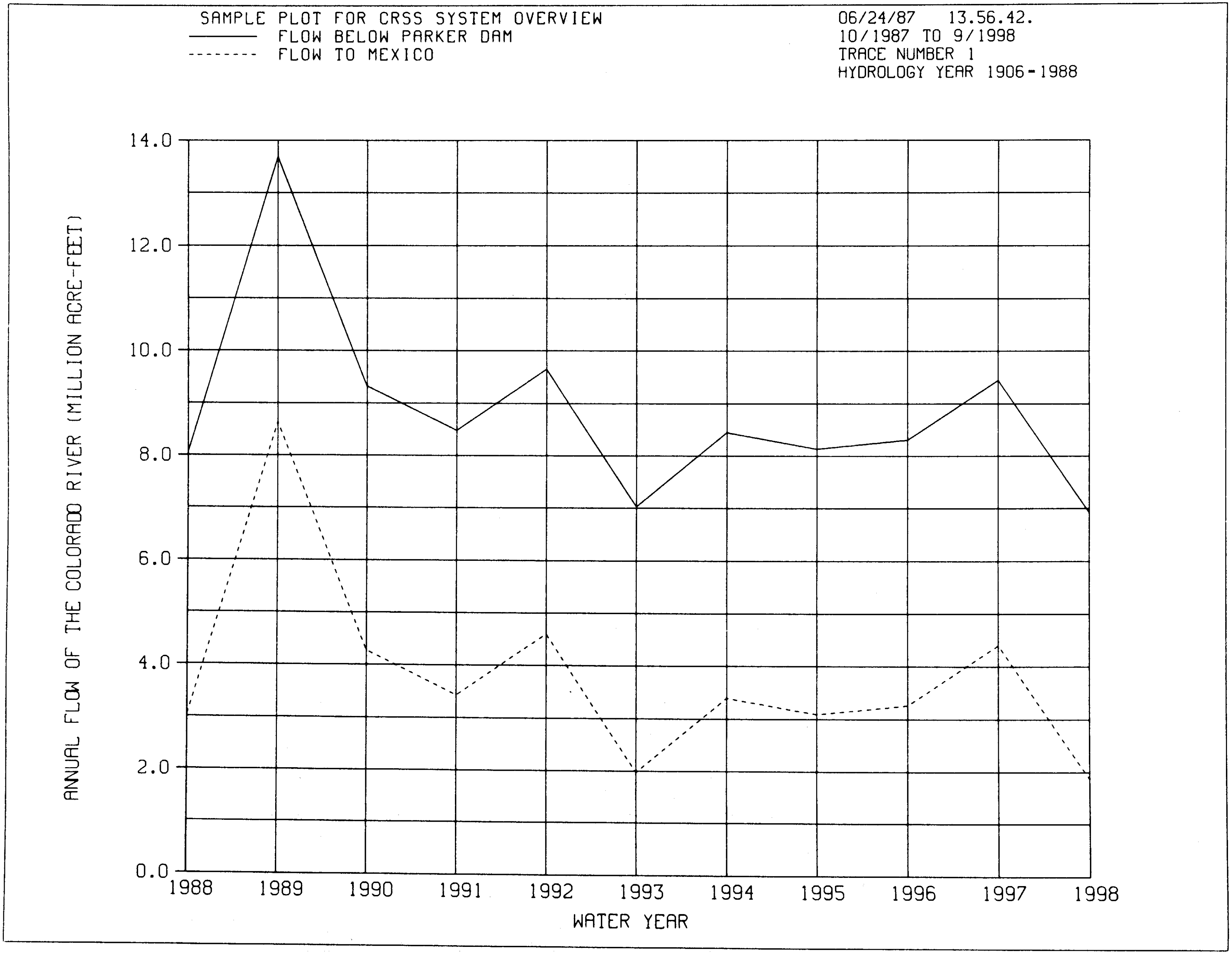
* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW *

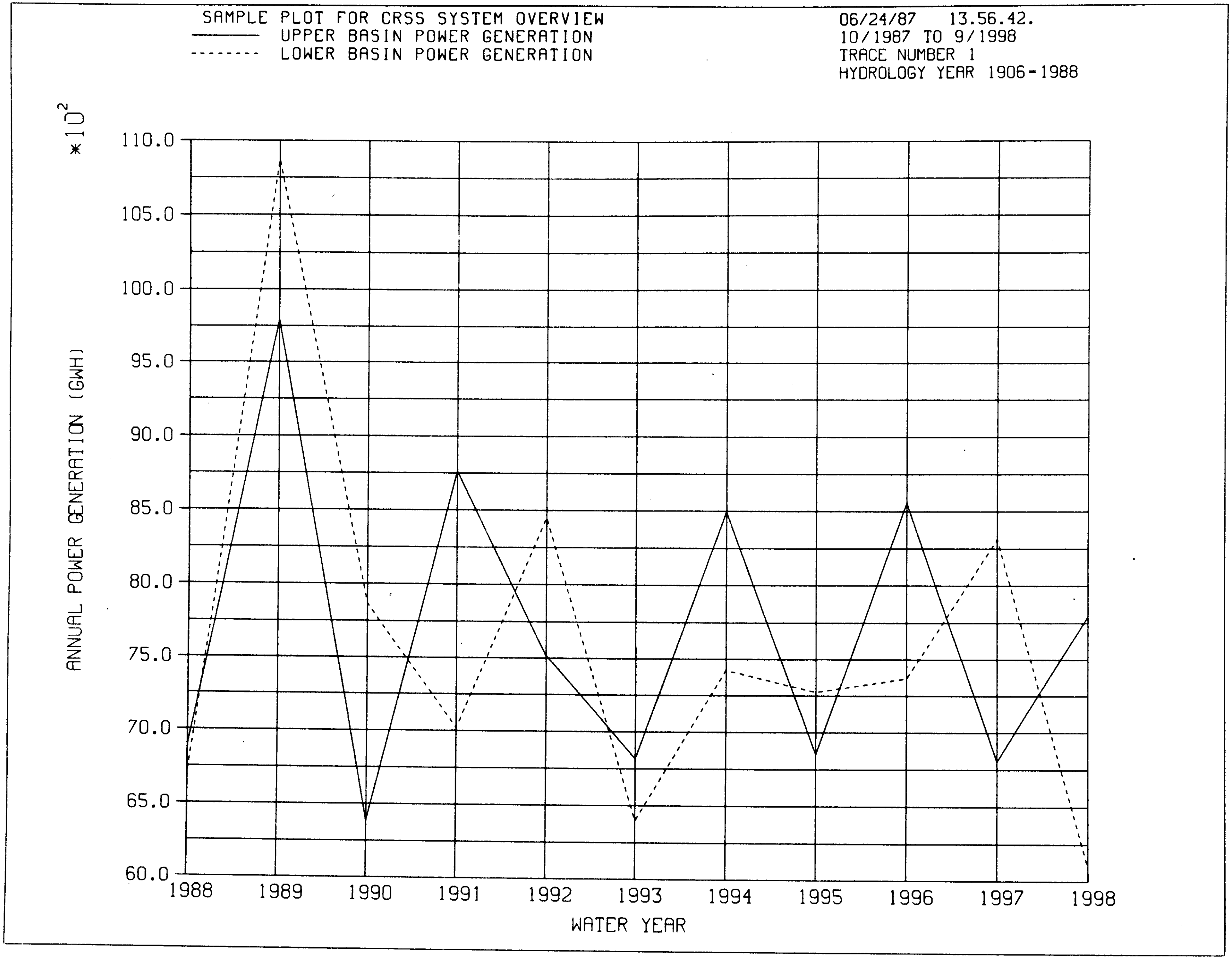
IMPERIAL DAM
SALINITY AT IMPERIAL (MGL)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1985	783.	813.	739.	764.	756.	763.	751.	772.	738.	808.	699.	658.
1986	636.	640.	617.	615.	628.	650.	656.	651.	649.	664.	640.	617.
1987	608.	619.	589.	642.	648.	664.	688.	691.	713.	752.	737.	715.
1988	687.	716.	646.	612.	627.	656.	682.	691.	684.	702.	655.	632.
1989	616.	614.	600.	655.	663.	681.	705.	708.	729.	768.	751.	728.
1990	701.	673.	619.	674.	683.	703.	727.	731.	755.	795.	778.	753.
1991	690.	669.	639.	637.	661.	689.	717.	726.	736.	820.	761.	705.
1992	675.	674.	652.	708.	718.	739.	763.	767.	792.	832.	813.	787.
1993	755.	783.	713.	675.	695.	732.	772.	778.	730.	744.	730.	717.
1994	679.	686.	664.	719.	726.	753.	779.	779.	803.	842.	823.	799.


SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW
LAKE POWELL RELEASES
LAKE MEAD RELEASES
06/24/87 13.56.42.
10/1987 TO 9/1998
TRACE NUMBER 1
HYDROLOGY YEAR 1906-1988
ANNUAL RELEASES (MILLION ACRE-FEET)
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
WATER YEAR


SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW
DELIVERY TO METROPOLITAN WATER DISTRICT
DELIVERY TO CENTRAL ARIZONA PROJECT
06/24/87 13.56.42.
10/1987 TO 9/1998
TRACE NUMBER 1
HYDROLOGY YEAR 1906-1988
2200.0
2000.0
1800.0
1600.0
1400.0
1200.0
1000.0
ANNUAL DELIVERY (THOUSAND ACRE-FEET)
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
WATER YEAR


SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW
FLOW BELOW PARKER DAM
FLOW TO MEXICO
06/24/87 13.56.42.
10/1987 TO 9/1998
TRACE NUMBER 1
HYDROLOGY YEAR 1906-1988
ANNUAL FLOW OF THE COLORADO RIVER (MILLION ACRE-FEET)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
WATER YEAR


SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW
UPPER BASIN POWER GENERATION
LOWER BASIN POWER GENERATION
06/24/87 13.56.42.
10/1987 TO 9/1998
TRACE NUMBER 1
HYDROLOGY YEAR 1906-1988
*10²
ANNUAL POWER GENERATION (GWH)
110.0
105.0
100.0
95.0
90.0
85.0
80.0
75.0
70.0
65.0
60.0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
WATER YEAR

SAMPLE OUTPUT FROM TAPEDIT PROGRAM

15-TRACE RUN

10/1984 TO 9/1994

05/09/85 08.26.22.
15 TRACE(S)
INCREMENT TRACES BY 5 YEARS

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW

LAKE POWELL
MONTHLY RELEASES FROM LAKE POWELL (THOUSANDS OF ACRE-FEET)

SEQUENCE

1985	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AVER
OCT	568.	568.	568.	568.	568.	568.	568.	568.	568.	568.	568.	568.	568.	568.	568.	568.
NOV	585.	790.	696.	867.	1268.	745.	560.	907.	747.	560.	560.	560.	1036.	900.	560.	756.
DEC	856.	856.	856.	856.	856.	856.	856.	856.	856.	856.	856.	856.	856.	856.	856.	856.
JAN	885.	856.	870.	845.	788.	863.	889.	840.	862.	889.	889.	889.	821.	841.	889.	861.
FEB	525.	508.	516.	979.	467.	511.	527.	498.	511.	527.	527.	527.	487.	498.	527.	542.
MAR	508.	491.	499.	1064.	452.	495.	510.	482.	495.	510.	510.	510.	471.	482.	510.	533.
APR	516.	499.	881.	1163.	459.	503.	518.	868.	502.	518.	518.	518.	479.	490.	518.	597.
MAY	549.	531.	1029.	1241.	666.	535.	551.	1349.	534.	551.	551.	551.	509.	521.	551.	681.
JUN	1970.	1319.	1970.	1970.	1970.	568.	707.	1970.	567.	585.	585.	585.	540.	1522.	585.	1161.
JUL	1988.	1257.	1802.	2035.	1149.	1014.	997.	1452.	1014.	1045.	1045.	1045.	965.	1373.	1045.	1282.
AUG	1081.	526.	1589.	1641.	557.	982.	997.	766.	982.	1012.	1012.	1012.	935.	610.	1012.	981.
SEP	1347.	446.	756.	894.	314.	591.	1025.	625.	591.	609.	609.	609.	563.	473.	609.	671.
TOT	11377.	8647.	12031.	14124.	9514.	8230.	8705.	11180.	8230.	8230.	8230.	8230.	8230.	9134.	8230.	9488.

SEQUENCE

1986	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AVER
OCT	1867.	2035.	2035.	1625.	1556.	568.	855.	2035.	568.	568.	568.	568.	568.	1654.	568.	1176.
NOV	1667.	1833.	1970.	1608.	1526.	560.	1631.	1970.	560.	921.	560.	560.	560.	1629.	560.	1208.
DEC	856.	856.	856.	856.	856.	856.	856.	1722.	856.	856.	856.	856.	856.	856.	856.	914.
JAN	1144.	998.	1291.	1055.	943.	889.	846.	981.	935.	1207.	1042.	930.	889.	739.	889.	985.
FEB	1071.	926.	1268.	947.	810.	530.	601.	966.	618.	1013.	785.	626.	527.	538.	527.	783.
MAR	1061.	903.	1284.	922.	771.	510.	573.	951.	573.	987.	742.	592.	510.	507.	510.	760.
APR	1159.	974.	1382.	995.	819.	518.	576.	990.	588.	1081.	805.	612.	518.	514.	518.	803.
MAY	1186.	996.	1414.	1047.	854.	551.	587.	991.	612.	1155.	860.	638.	551.	531.	551.	835.
JUN	1309.	1442.	1967.	1970.	996.	585.	922.	1970.	645.	1970.	1029.	728.	585.	568.	585.	1151.
JUL	2035.	2035.	2035.	1409.	2035.	1044.	977.	1157.	1036.	1564.	2035.	1259.	1045.	673.	1045.	1426.
AUG	1464.	1038.	1308.	817.	996.	1011.	530.	632.	966.	900.	1528.	936.	1012.	614.	1012.	984.
SEP	915.	552.	762.	569.	1970.	609.	467.	337.	869.	623.	972.	656.	609.	598.	609.	741.
TOT	15735.	14588.	17573.	13822.	14131.	8230.	9419.	14703.	8824.	12844.	11781.	8962.	8230.	9422.	8230.	11766.

10/1984 TO 9/1994

05/09/85 08.26.22.
15 TRACE AVERAGE
TRACE 1-HYDROLOGY YEAR 1906=1985
INCREMENT TRACES BY 5 YEARS

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW

LAKE POWELL
MONTHLY RELEASES FROM LAKE POWELL (THOUSANDS OF ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	568.	756.	856.	861.	542.	533.	597.	681.	1161.	1282.	981.	671.	9488.
1986	1176.	1208.	914.	985.	783.	760.	803.	835.	1151.	1426.	984.	741.	11766.
1987	1358.	1513.	856.	954.	757.	783.	783.	783.	872.	958.	695.	575.	10888.
1988	1062.	1360.	856.	966.	648.	624.	667.	687.	995.	1194.	908.	674.	10642.
1989	1036.	1229.	856.	940.	665.	596.	648.	681.	894.	1056.	825.	608.	10034.
1990	1123.	1323.	856.	857.	517.	523.	556.	609.	884.	1092.	890.	608.	9838.
1991	1039.	1054.	856.	1030.	784.	774.	845.	856.	1032.	1212.	893.	812.	11188.
1992	1010.	1184.	856.	976.	676.	657.	706.	740.	1011.	1169.	854.	694.	10534.
1993	1012.	1143.	856.	892.	612.	627.	633.	658.	992.	1226.	947.	736.	10334.
1994	956.	1111.	856.	927.	646.	673.	658.	679.	784.	1123.	931.	717.	10062.

10/1984 TO 9/1994

05/09/85 08.26.22.
15 TRACE AVERAGE
TRACE 1-HYDROLOGY YEAR 1906=1985
INCREMENT TRACES BY 5 YEARS

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW
LAKE POWELL
MONTHLY RELEASES FROM LAKE POWELL (THOUSANDS OF ACRE-FEET)

YEAR	MINIMUM	MAXIMUM	MEAN	ST. DEVIATION	COEF. OF SKEW	KURTOSIS
1985	532.63	1281.87	790.68	235.71	.7812	2.4509
1986	741.08	1425.75	980.52	208.00	.6603	2.3548
1987	574.62	1513.20	907.33	258.79	1.2437	3.5606
1988	623.86	1359.61	886.80	228.65	.5722	2.2564
1989	595.65	1229.01	836.16	194.91	.4427	2.1145
1990	517.28	1322.84	819.82	253.28	.4357	2.0870
1991	773.88	1212.44	932.34	131.24	.6015	2.2897
1992	657.04	1183.92	877.85	181.70	.3643	1.7673
1993	611.64	1225.85	861.21	201.36	.2730	1.8444
1994	646.31	1123.37	838.53	164.87	.4280	1.8609

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW
LAKE POWELL
MONTHLY RELEASES FROM LAKE POWELL (THOUSANDS OF ACRE-FEET)

MONTH	MINIMUM	MAXIMUM	MEAN	ST. DEVIATION	COEF. OF SKEW	KURTOSIS
10	568.00	1358.35	1034.05	189.31	-.9439	4.5739
11	756.00	1513.20	1188.10	191.80	-.5909	3.5167
12	856.00	913.75	861.78	17.33	2.6667	8.1111
1	856.60	1030.36	938.75	52.95	-.1235	2.0912
2	517.28	783.84	663.13	87.80	-.0994	1.9737
3	522.95	782.63	654.86	89.10	.0778	1.7894
4	555.51	845.02	689.70	88.96	.3584	1.9780
5	609.30	856.34	721.15	76.16	.5220	2.0756
6	783.71	1160.73	977.65	115.17	.1128	2.1065
7	957.99	1425.75	1173.96	122.23	.2760	2.9493
8	695.25	984.29	890.88	81.18	-1.1267	3.7767
9	574.62	811.81	683.52	68.76	.1002	2.2217

STATISTICS OF ALL 120 MONTHS

	MINIMUM	MAXIMUM	MEAN	ST. DEVIATION	COEF. OF SKEW	KURTOSIS
	517.28	1513.20	873.13	216.09	.5679	2.8095

10/1984 TO 9/1994

05/09/85 08.26.22.
15 TRACE(S)
TRACE 1-HYDROLOGY YEAR 1906=1985
INCREMENT TRACES BY 5 YEARS

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW

LAKE POWELL
ANNUAL RELEASES FROM LAKE POWELL (THOUSANDS OF ACRE-FEET)

SEQUENCE

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AVER
1985	11377.	8647.	12031.	14124.	9514.	8230.	8705.	11180.	8230.	8230.	8230.	8230.	8230.	9134.	8230.	9488.
1986	15735.	14588.	17573.	13822.	14131.	8230.	9419.	14703.	8824.	12844.	11781.	8962.	8230.	9422.	8230.	11766.
1987	9345.	10810.	11802.	14046.	13428.	8674.	13498.	10174.	11656.	8921.	12935.	8230.	8230.	13342.	8230.	10888.
1988	15125.	15075.	9579.	11078.	16432.	8230.	9431.	10721.	11636.	8230.	8230.	8230.	9109.	10289.	8230.	10642.
1989	11003.	10599.	14761.	9056.	11200.	8230.	8230.	9750.	9968.	8230.	8312.	10451.	10437.	10650.	9632.	10034.
1990	10290.	13224.	15932.	11280.	8230.	8481.	10139.	8509.	8802.	8230.	8230.	8601.	10868.	8522.	8230.	9838.
1991	14125.	17213.	13861.	13483.	9686.	9347.	13378.	9879.	13015.	9903.	9857.	8230.	9361.	8230.	8255.	11188.
1992	10111.	11243.	13459.	12972.	8794.	11020.	9754.	10467.	8756.	10798.	8230.	8709.	12048.	8230.	13423.	10534.
1993	14548.	9374.	10798.	15662.	8230.	8773.	10331.	11130.	8230.	8230.	8230.	9280.	10048.	8955.	13198.	10334.
1994	10304.	14136.	8634.	10891.	8230.	8230.	9399.	9710.	8230.	8230.	9861.	10090.	10251.	9692.	15046.	10062.
TOT	121963.	124908.	128430.	126413.	107875.	87445.	102284.	106222.	97348.	91846.	93896.	89014.	96813.	96466.	100704.	104775.
MAX	15735.	17213.	17573.	15662.	16432.	11020.	13498.	14703.	13015.	12844.	12935.	10451.	12048.	13342.	15046.	14101.
MIN	9345.	8647.	8634.	9056.	8230.	8230.	8230.	8509.	8230.	8230.	8230.	8230.	8230.	8230.	8230.	8433.
MEAN	12196.	12491.	12843.	12641.	10787.	8744.	10228.	10622.	9735.	9185.	9390.	8901.	9681.	9647.	10070.	10478.
MED	11190.	12233.	12745.	13227.	9600.	8356.	9593.	10321.	8813.	8230.	8271.	8655.	9704.	9278.	8242.	9897.
SDEV	2407.	2770.	2815.	1992.	2918.	878.	1799.	1635.	1750.	1565.	1719.	809.	1282.	1533.	2712.	
CV	20.	22.	22.	16.	27.	10.	18.	15.	18.	17.	18.	9.	13.	16.	27.	
CS	3.	2.	1.	-3.	8.	20.	11.	15.	8.	15.	11.	9.	3.	14.	9.	
KURT	1.	2.	2.	2.	2.	5.	2.	4.	2.	3.	2.	2.	2.	4.	2.	
MAX3	15136.	15625.	16089.	14611.	14664.	9713.	12402.	12338.	12102.	11182.	11526.	9941.	11118.	11427.	13889.	12784.
MIN3	9915.	9540.	9670.	10342.	8230.	8230.	8778.	9323.	8230.	8230.	8230.	8230.	8230.	8327.	8230.	8782.

10/1984 TO 9/1994

05/09/85 08.26.22.
15 TRACE(S)
TRACE 1-HYDROLOGY YEAR 1906=1985
INCREMENT TRACES BY 5 YEARS

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW

LAKE MEAD
MONTHLY RELEASES FROM LAKE MEAD (THOUSANDS OF ACRE-FEET)

SEQUENCE

1985	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AVER
OCT	365.	365.	365.	365.	365.	365.	442.	454.	505.	362.	327.	345.	319.	331.	323.	373.
NOV	528.	528.	528.	528.	528.	528.	564.	566.	555.	552.	476.	553.	461.	467.	511.	525.
DEC	499.	499.	502.	500.	498.	502.	506.	486.	477.	531.	458.	425.	398.	495.	517.	486.
JAN	392.	392.	964.	1168.	394.	400.	416.	1168.	454.	413.	405.	439.	367.	389.	385.	543.
FEB	575.	575.	679.	1055.	573.	602.	639.	932.	628.	646.	611.	652.	660.	642.	612.	672.
MAR	943.	720.	1168.	1168.	772.	750.	796.	1168.	676.	819.	781.	802.	747.	775.	772.	857.
APR	948.	814.	1131.	1594.	854.	821.	879.	1131.	850.	735.	763.	814.	820.	799.	803.	917.
MAY	898.	898.	897.	1432.	898.	899.	912.	1171.	924.	884.	870.	957.	913.	876.	862.	953.
JUN	1131.	790.	1131.	1765.	1026.	791.	844.	1073.	778.	765.	780.	818.	799.	727.	800.	934.
JUL	723.	723.	874.	1796.	723.	724.	789.	646.	740.	749.	687.	715.	733.	725.	725.	805.
AUG	1355.	673.	1722.	1722.	828.	615.	733.	1244.	678.	586.	669.	604.	656.	595.	722.	893.
SEP	1666.	673.	1666.	1666.	1099.	627.	714.	1297.	705.	623.	601.	651.	585.	654.	477.	914.
TOT	10022.	7650.	11625.	14761.	8557.	7625.	8233.	11337.	7970.	7665.	7427.	7775.	7460.	7476.	7509.	8873.

SEQUENCE

1986	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AVER
OCT	1722.	1722.	1722.	1469.	1153.	622.	678.	1722.	675.	626.	647.	576.	579.	1305.	581.	1053.
NOV	1285.	1282.	1666.	1173.	1088.	589.	615.	1666.	577.	574.	551.	566.	555.	1232.	558.	932.
DEC	1115.	1104.	1136.	1244.	1133.	550.	643.	1722.	569.	579.	545.	547.	479.	1137.	538.	869.
JAN	1168.	1168.	1263.	1168.	1168.	459.	470.	1168.	476.	1168.	450.	454.	440.	438.	420.	792.
FEB	1055.	1055.	1555.	1055.	1055.	411.	751.	1055.	670.	1055.	1055.	732.	698.	667.	695.	904.
MAR	1168.	1168.	1722.	1168.	1079.	790.	793.	1168.	707.	1168.	846.	865.	827.	811.	785.	1004.
APR	1606.	1131.	1666.	1131.	934.	837.	878.	1131.	905.	1131.	1087.	834.	823.	814.	824.	1049.
MAY	1532.	1168.	1722.	1168.	905.	911.	923.	1168.	888.	1411.	969.	925.	923.	891.	862.	1091.
JUN	1666.	1131.	2058.	1548.	1131.	796.	834.	1257.	773.	1666.	1131.	811.	787.	805.	785.	1145.
JUL	1440.	946.	1700.	1019.	731.	736.	772.	990.	777.	1515.	874.	750.	748.	743.	736.	965.
AUG	1722.	1326.	1721.	1184.	1014.	691.	757.	908.	652.	1308.	1722.	650.	656.	643.	626.	1039.
SEP	1666.	1228.	1406.	1268.	1666.	651.	696.	993.	708.	1290.	1666.	613.	614.	665.	560.	1046.
TOT	17144.	14428.	19337.	14595.	13058.	8044.	8809.	14948.	8376.	13492.	11543.	8326.	8129.	10150.	7970.	11890.

10/1984 TO 9/1994

05/09/85 08.26.22.
15 TRACE AVERAGE
TRACE 1-HYDROLOGY YEAR 1906=1985
INCREMENT TRACES BY 5 YEARS

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW

LAKE MEAD
MONTHLY RELEASES FROM LAKE MEAD (THOUSANDS OF ACRE-FEET)

MONTH YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOT
1985	373.	525.	486.	543.	672.	857.	917.	953.	934.	805.	893.	914.	8873.
1986	1053.	932.	869.	792.	904.	1004.	1049.	1091.	1145.	965.	1039.	1046.	11890.
1987	1023.	1023.	1025.	820.	936.	1062.	993.	1023.	898.	763.	751.	813.	11130.
1988	848.	876.	875.	746.	843.	939.	969.	1003.	998.	918.	923.	848.	10787.
1989	952.	883.	848.	588.	799.	902.	916.	989.	887.	825.	777.	725.	10091.
1990	820.	871.	855.	631.	770.	907.	886.	1031.	922.	880.	854.	813.	10239.
1991	901.	861.	819.	819.	892.	1039.	1017.	1070.	984.	806.	834.	906.	10948.
1992	902.	901.	867.	656.	796.	884.	930.	964.	890.	796.	821.	839.	10247.
1993	877.	873.	819.	638.	793.	961.	905.	970.	937.	881.	911.	846.	10410.
1994	943.	853.	807.	627.	789.	921.	897.	992.	941.	879.	839.	782.	10268.

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW
LAKE MEAD
MONTHLY RELEASES FROM LAKE MEAD (THOUSANDS OF ACRE-FEET)

YEAR	MINIMUM	MAXIMUM	MEAN	ST. DEVIATION	COEF. OF SKEW	KURTOSIS
1985	373.32	952.70	739.40	198.85	-.5241	1.7001
1986	791.98	1145.27	990.82	96.85	-.4691	2.4249
1987	751.12	1061.58	927.48	109.12	-.4156	1.5786
1988	746.15	1003.06	898.94	71.29	-.3403	2.6201
1989	587.90	989.09	840.88	104.50	-.9224	3.4806
1990	630.59	1031.19	853.28	91.57	-.6037	4.2021
1991	806.16	1069.98	912.31	89.02	.4740	1.7891
1992	655.91	964.09	853.94	77.50	-1.0943	4.0545
1993	637.54	970.48	867.49	86.14	-1.3467	4.6153
1994	626.74	991.70	855.70	93.48	-.8841	3.5768

* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW
LAKE MEAD
MONTHLY RELEASES FROM LAKE MEAD (THOUSANDS OF ACRE-FEET)

MONTH	MINIMUM	MAXIMUM	MEAN	ST. DEVIATION	COEF. OF SKEW	KURTOSIS
10	373.32	1053.30	869.30	179.11	-1.9361	6.0541
11	524.92	1023.49	859.82	121.23	-1.8361	6.1703
12	486.15	1024.59	826.90	127.54	-1.5215	5.6770
1	543.05	820.01	685.89	95.07	.2110	1.6079
2	672.14	936.49	819.51	73.15	-.2014	2.6079
3	857.16	1061.58	947.46	64.54	.4720	1.9719
4	886.38	1048.62	947.99	52.79	.6342	2.0074
5	952.70	1091.12	1008.59	43.05	.5979	2.2380
6	886.67	1145.27	953.62	72.82	1.6533	4.9802
7	763.09	965.05	851.80	59.68	.3385	2.1043
8	751.12	1038.54	864.30	78.00	.7132	3.1507
9	725.24	1045.98	853.08	82.87	.8717	3.6147

STATISTICS OF ALL 120 MONTHS

	MINIMUM	MAXIMUM	MEAN	ST. DEVIATION	COEF. OF SKEW	KURTOSIS
	373.32	1145.27	874.02	124.23	-1.1082	5.4216

10/1984 TO 9/1994

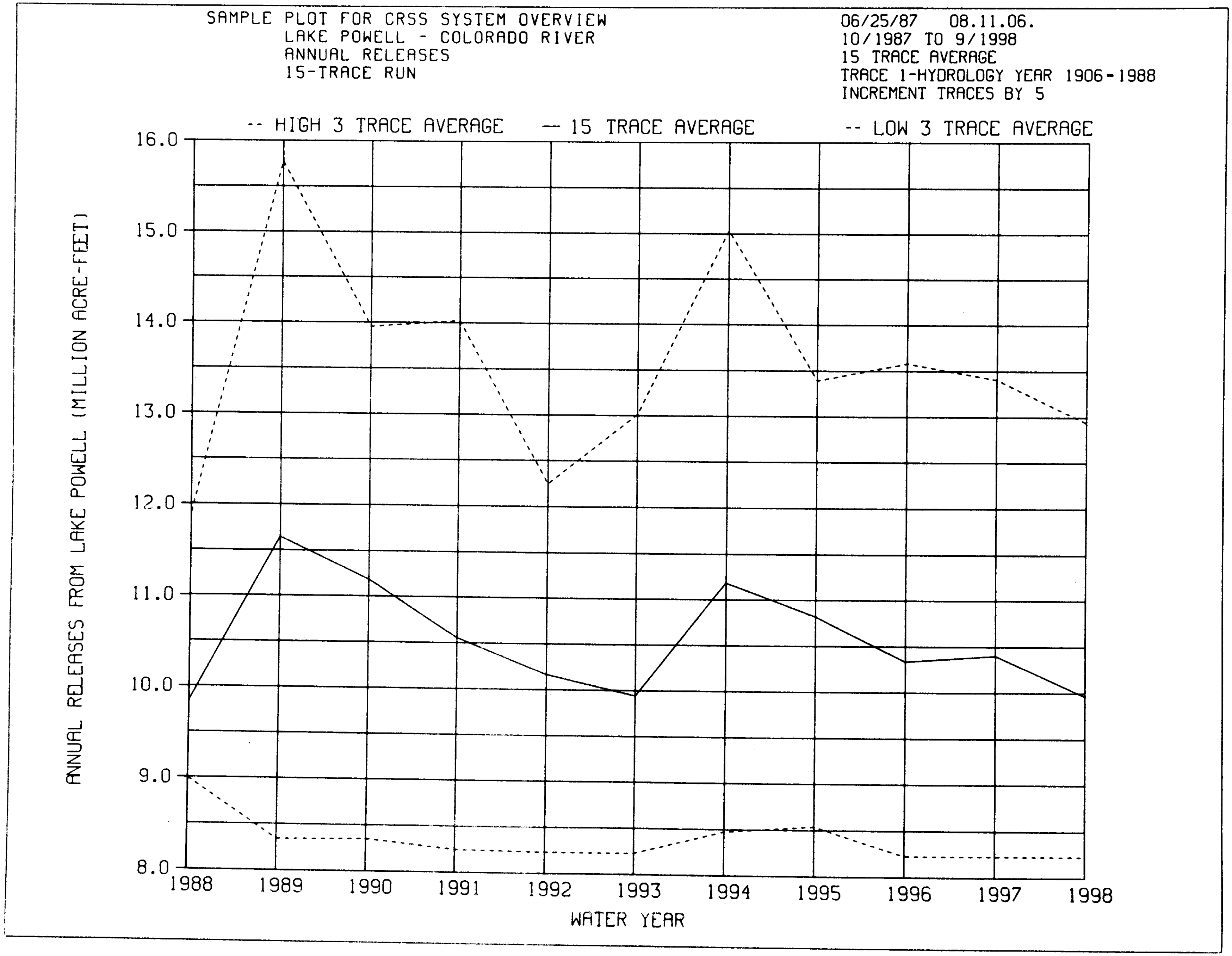
05/09/85 08.26.22.
15 TRACE(S)
TRACE 1-HYDROLOGY YEAR 1906=1985
INCREMENT TRACES BY 5 YEARS

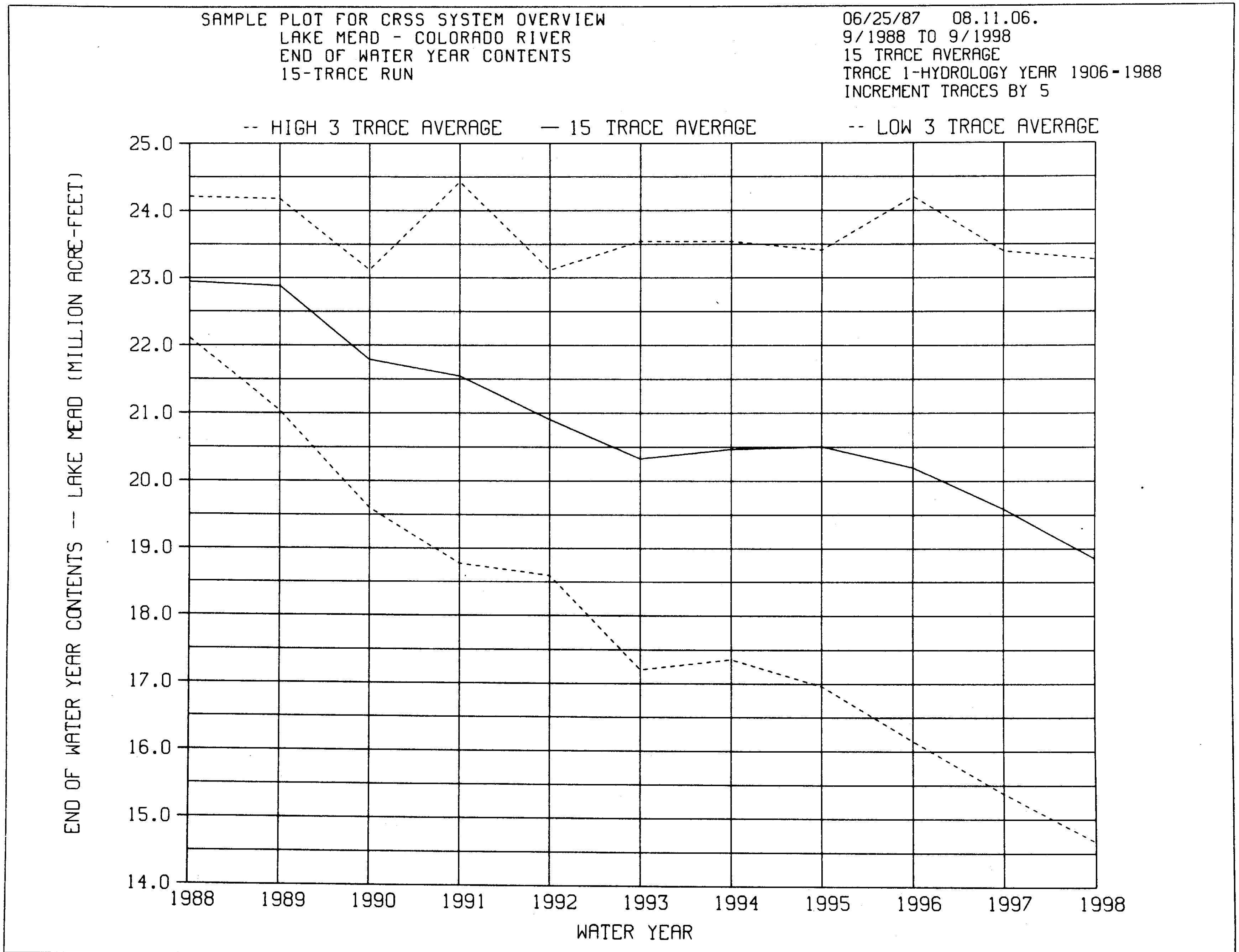
* SAMPLE RUN FOR THE CRSS SYSTEM OVERVIEW

LAKE MEAD
ANNUAL RELEASES FROM LAKE MEAD (THOUSANDS OF ACRE-FEET)

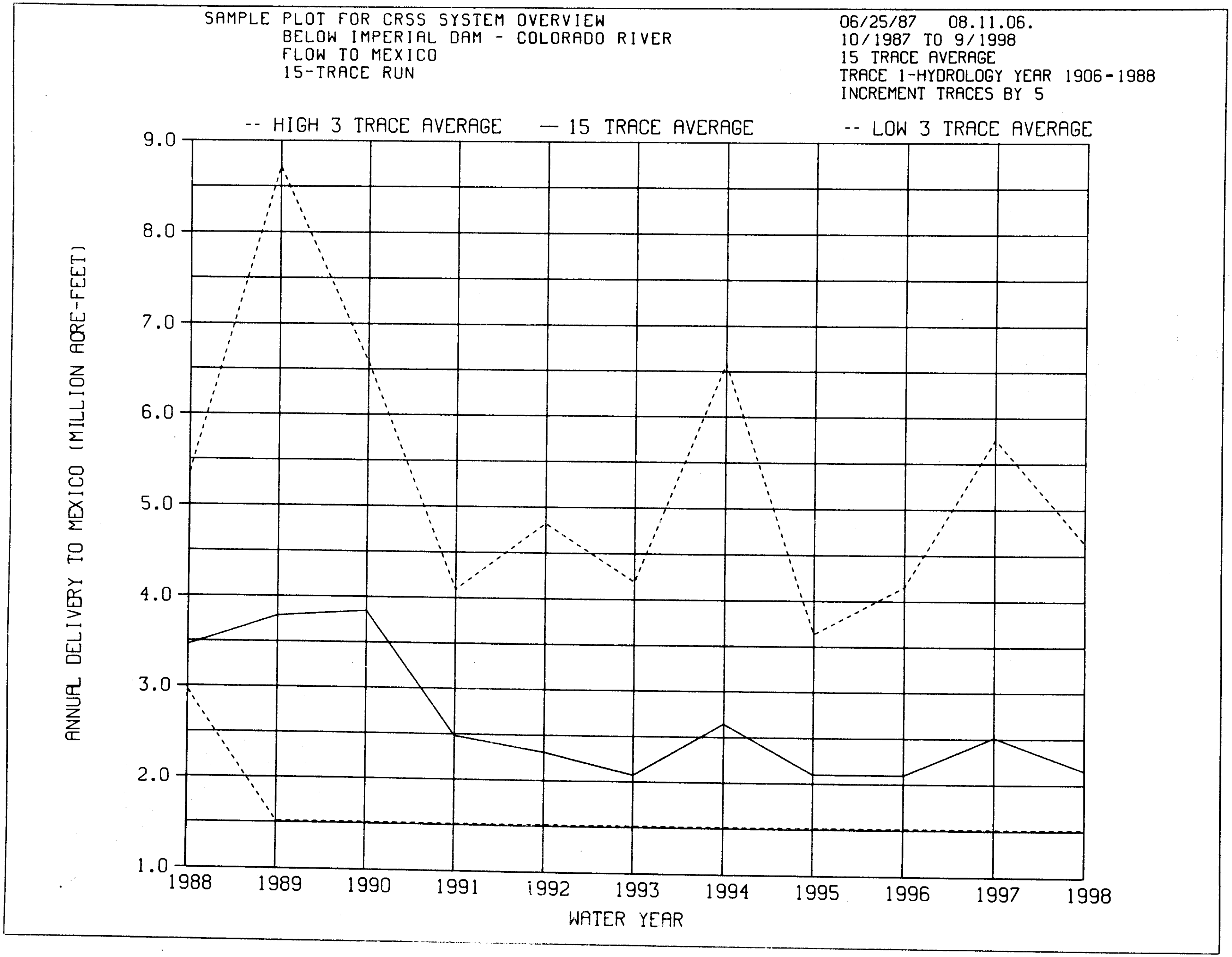
SEQUENCE

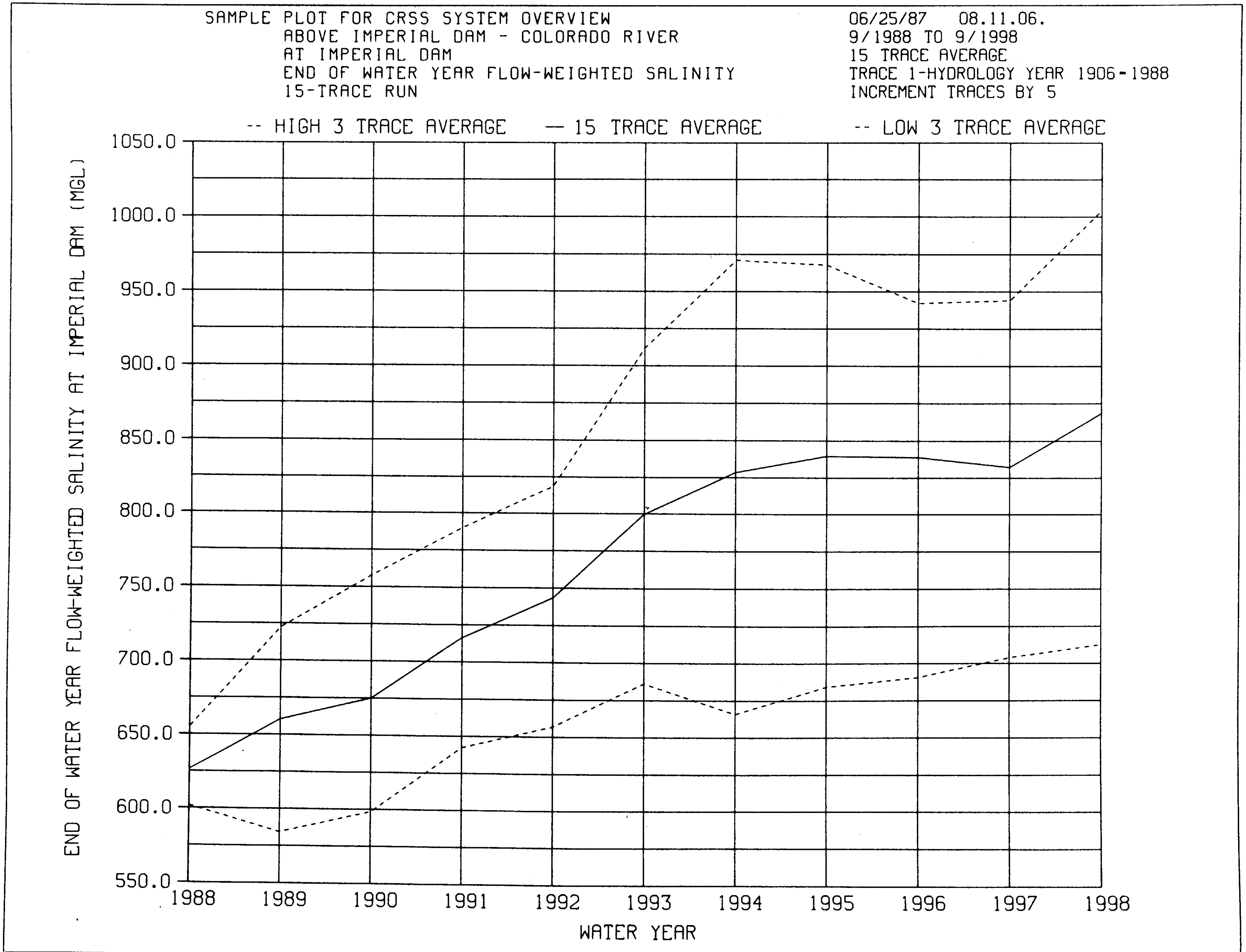
YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	AVER
1985	10022.	7650.	11625.	14761.	8557.	7625.	8233.	11337.	7970.	7665.	7427.	7775.	7460.	7476.	7509.	8873.
1986	17144.	14428.	19337.	14595.	13058.	8044.	8809.	14948.	8376.	13492.	11543.	8326.	8129.	10150.	7970.	11890.
1987	10275.	11310.	11947.	13917.	14108.	9083.	13038.	10738.	10844.	9864.	13242.	8964.	8618.	12534.	8465.	11130.
1988	14308.	15056.	9839.	11044.	15595.	9107.	10599.	9777.	10917.	9049.	9442.	9033.	9015.	10454.	8575.	10787.
1989	11282.	10978.	15097.	9354.	12561.	9277.	9348.	9570.	10406.	8754.	8997.	8938.	9089.	9498.	8210.	10091.
1990	10200.	12758.	17315.	9759.	9989.	9605.	9094.	9525.	9037.	8799.	9147.	8799.	10177.	9993.	9393.	10239.
1991	13485.	18683.	13943.	12752.	8783.	9300.	11447.	9115.	12038.	9036.	9064.	8867.	9995.	8709.	8998.	10948.
1992	10533.	10685.	13311.	12974.	9085.	9386.	10457.	9007.	10027.	8867.	9134.	8983.	10959.	8830.	11470.	10247.
1993	14474.	10439.	10949.	15189.	9083.	9058.	9436.	10194.	9024.	8884.	9009.	8992.	10368.	8551.	12497.	10410.
1994	10875.	14024.	8976.	12492.	9249.	9320.	9343.	10315.	8725.	8971.	8910.	9060.	9207.	8182.	16375.	10268.
TOT	122597.	126011.	132339.	126837.	110067.	89805.	99805.	104525.	97366.	93380.	95914.	87737.	93017.	94377.	99462.	104883.
MAX	17144.	18683.	19337.	15189.	15595.	9605.	13038.	14948.	12038.	13492.	13242.	9060.	10959.	12534.	16375.	14083.
MIN	10022.	7650.	8976.	9354.	8557.	7625.	8233.	9007.	7970.	7665.	7427.	7775.	7460.	7476.	7509.	8180.
MEAN	12260.	12601.	13234.	12684.	11007.	8981.	9980.	10453.	9737.	9338.	9591.	8774.	9302.	9438.	9946.	10488.
MED	11078.	12034.	12629.	12863.	9619.	9192.	9392.	9985.	9532.	8927.	9099.	8951.	9148.	9164.	8787.	10027.
SDEV	2438.	3083.	3283.	2061.	2577.	633.	1431.	1736.	1310.	1553.	1622.	410.	1080.	1436.	2755.	
CV	20.	24.	25.	16.	23.	7.	14.	17.	13.	17.	17.	5.	12.	15.	28.	
CS	8.	4.	6.	-4.	6.	-13.	10.	19.	3.	21.	12.	-17.	-1.	8.	14.	
KURT	2.	2.	2.	2.	1.	3.	2.	5.	2.	5.	3.	4.	2.	3.	3.	
MAX3	15309.	16056.	17250.	14848.	14254.	9437.	11695.	12341.	11266.	10802.	11409.	9029.	10502.	11046.	13447.	12579.
MIN3	10166.	9591.	9921.	10052.	8808.	8242.	8712.	9216.	8357.	8406.	8444.	8300.	8069.	8070.	7896.	8817.


SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW
LAKE POWELL - COLORADO RIVER
ANNUAL RELEASES
15-TRACE RUN
06/25/87 08.11.06.
10/1987 TO 9/1998
15 TRACE AVERAGE
TRACE 1-HYDROLOGY YEAR 1906-1988
INCREMENT TRACES BY 5
-- HIGH 3 TRACE AVERAGE
— 15 TRACE AVERAGE
-- LOW 3 TRACE AVERAGE
ANNUAL RELEASES FROM LAKE POWELL (MILLION ACRE-FEET)
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
WATER YEAR



SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW
LAKE MEAD - COLORADO RIVER
END OF WATER YEAR CONTENTS
15-TRACE RUN
06/25/87 08.11.06.
9/1988 TO 9/1998
15 TRACE AVERAGE
TRACE 1-HYDROLOGY YEAR 1906-1988
INCREMENT TRACES BY 5
-- HIGH 3 TRACE AVERAGE
— 15 TRACE AVERAGE
-- LOW 3 TRACE AVERAGE
END OF WATER YEAR CONTENTS -- LAKE MEAD (MILLION ACRE-FEET)
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
17.0
16.0
15.0
14.0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
WATER YEAR


SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW
BELOW IMPERIAL DAM - COLORADO RIVER
FLOW TO MEXICO
15-TRACE RUN
06/25/87 08.11.06.
10/1987 TO 9/1998
15 TRACE AVERAGE
TRACE 1-HYDROLOGY YEAR 1906-1988
INCREMENT TRACES BY 5
-- HIGH 3 TRACE AVERAGE
— 15 TRACE AVERAGE
-- LOW 3 TRACE AVERAGE
ANNUAL DELIVERY TO MEXICO (MILLION ACRE-FEET)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
WATER YEAR


SAMPLE PLOT FOR CRSS SYSTEM OVERVIEW
ABOVE IMPERIAL DAM - COLORADO RIVER
AT IMPERIAL DAM
END OF WATER YEAR FLOW-WEIGHTED SALINITY
15-TRACE RUN
06/25/87 08.11.06.
9/1988 TO 9/1998
15 TRACE AVERAGE
TRACE 1-HYDROLOGY YEAR 1906-1988
INCREMENT TRACES BY 5
-- HIGH 3 TRACE AVERAGE
— 15 TRACE AVERAGE
-- LOW 3 TRACE AVERAGE
END OF WATER YEAR FLOW-WEIGHTED SALINITY AT IMPERIAL DAM (MGL)
1050.0
1000.0
950.0
900.0
850.0
800.0
750.0
700.0
650.0
600.0
550.0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
WATER YEAR

APPENDIX B

TYPICAL INPUT VALUES

* * * * * GENERAL INPUT DATA * * * * *

602(A) DATA

LENGTH OF CRITICAL PERIOD = 12.0 YEARS
AVERAGE RUNOFF AT LEES FERRY FOR CRITICAL PERIOD = 12.18 MILLION ACRE-FEET
UPPER BASIN DEPLETION SHORTAGE = 0.00 PERCENT
MINIMUM POWER POOL TO PRESERVE = 5.18 MILLION ACRE-FEET

SHORTAGE/SURPLUS DATA

WATER SURFACE ELEVATION OF LAKE MEAD AT WHICH THE FIRST LEVEL OF SHORTAGES TO ARIZONA AND NEVADA ARE IMPOSED = 1095.0 FEET
WATER SURFACE ELEVATION OF LAKE MEAD AT WHICH ADDITIONAL LEVELS OF SHORTAGES ARE IMPOSED = 895.0 FEET
FIRST YEAR THAT THE CENTRAL ARIZONA PROJECT CAN TAKE SURPLUS WATER = 1992
MAXIMUM MONTHLY DIVERSION TO THE METROPOLITAN WATER DISTRICT = 1800.0 CFS
MAXIMUM AND MINIMUM MONTHLY DIVERSIONS TO THE CENTRAL ARIZONA PROJECT: SEE TABLE BELOW

FLOOD CONTROL DATA

FLOOD CONTROL RELEASE LEVELS FROM LAKE MEAD (CFS): 0.0 19000.0 28000.0 35000.0 40000.0 73000.0
MAXIMUM RELEASE FROM LAKE MEAD DURING THE AUGUST TO DECEMBER SPACE-BUILDING PERIOD = 28000.0 CFS
MINIMUM FLOOD CONTROL SPACE IN LAKE MEAD = 1.50 MILLION ACRE-FEET
REQUIRED FLOOD CONTROL SPACE IN THE SYSTEM DURING THE AUGUST TO DECEMBER SPACE-BUILDING PERIOD: SEE TABLE BELOW
CREDITABLE FLOOD CONTROL SPACE DURING THE AUGUST TO DECEMBER SPACE-BUILDING PERIOD (MILLION ACRE-FEET):
FLAMING GORGE = 1.507 BLUE MESA = .749 NAVAJO = 1.036 LAKE POWELL = 3.850

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
QAVG (1)	334.	373.	627.	1210.	3097.	4160.	2189.	1061.	635.	560.	452.	358.	15056.
DIST (2)	889.	527.	510.	518.	551.	585.	1045.	1012.	609.	568.	560.	856.	8230.
FORCMAX (3)	4980.	4260.	3600.	2970.	2525.	2130.	750.	-	-	-	-	-	-
SPACE (4)	-	-	-	-	-	-	-	2270.	3040.	3810.	4580.	5350.	-
CAPMIN (5)	16.8	16.8	33.8	39.4	39.4	50.6	56.3	61.8	56.3	33.8	22.5	22.5	450.0
CAPMAX (6)	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	3000.	-

(1) LONG-TERM AVERAGE NATURAL INFLOW TO LAKE POWELL (1000 ACRE-FEET)
(2) MONTHLY DISTRIBUTION OF THE OBJECTIVE MINIMUM RELEASE FROM LAKE POWELL (1000 ACRE-FEET)
(3) THE AMOUNT ADDED TO THE LAKE MEAD MEAN APRIL TO JULY RUNOFF FORECAST TO DEVELOP THE MAXIMUM FORECAST (1000 ACRE-FEET)
(4) REQUIRED FLOOD CONTROL SPACE IN THE SYSTEM DURING THE AUGUST TO DECEMBER SPACE-BUILDING PERIOD (1000 ACRE-FEET)
(5) CENTRAL ARIZONA PROJECT MINIMUM DIVERSION (USED IN THE SHORTAGE COMPUTATION) (1000 ACRE-FEET)
(6) CENTRAL ARIZONA PROJECT MAXIMUM DIVERSION (CFS)

* * * * * RESERVOIR INPUT DATA * * * * *

	INITIAL CONTENTS (ACRE-FEET)	INITIAL SALINITY (PPM)	LIVE CAPACITY (ACRE-FEET)	MAXIMUM INACTIVE CAPACITY (ACRE-FEET)	DEAD CAPACITY (ACRE-FEET)	CONTROLLED RELEASE (CFS)	MINIMUM RELEASE (CFS)	ANNUAL EVAPORATION (FEET)	BANK STORAGE COEFFICIENT (PERCENT)
TAYLOR PARK RES	77000.	105.0	106230.	0.	0.	5000.	50.	0.00	0.00
BLUE MESA RESER	577000.	105.0	829520.	82000.	111200.	3000.	0.	1.05	0.00
MORROW POINT RE	115000.	105.0	117020.	74900.	165.	5000.	0.	1.05	0.00
CRYSTAL RESERVO	17000.	105.0	17570.	12000.	7700.	3800.	200.	1.05	0.00
FONTENELLE RESE	220000.	260.0	344830.	0.	563.	18700.	300.	2.27	0.00
DUCHESNE RIVER	255000.	105.0	255330.	0.	0.	5000.	100.	0.00	0.00
FLAMING GORGE R	3257000.	456.0	3723900.	219200.	28700.	4250.	800.	2.10	3.30
NAVAJO RESERVOI	1430000.	150.0	1641600.	659900.	7600.	5900.	300.	1.80	0.00
LAKE POWELL - C	22564000.	431.0	24454000.	4126000.	1448000.	33100.	1000.	3.96	8.00
LAKE MEAD - COL	24456000.	519.0	27019000.	0.	2035000.	80000.	3000.	6.50	6.50
LAKE MOHAVE - C	1524000.	539.0	1809800.	0.	8530.	73600.	2000.	7.31	0.00
LAKE HAVASU - C	593000.	559.0	619400.	0.	28600.	44600.	3600.	7.39	0.00

MONTHLY TARGET STORAGE (1000 ACRE-FEET)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
TAYLOR PARK RES	60.	55.	50.	50.	70.	106.	106.	90.	80.	75.	70.	65.
BLUE MESA RESER	249.	249.	249.	249.	249.	249.	249.	249.	249.	249.	249.	249.
MORROW POINT RE	80.	80.	80.	80.	80.	80.	80.	80.	80.	80.	80.	80.
CRYSTAL RESERVO	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.	14.
FONTENELLE RESE	220.	190.	165.	165.	200.	345.	345.	345.	300.	280.	260.	240.
DUCHESNE RIVER	255.	255.	255.	255.	255.	255.	255.	255.	255.	255.	255.	255.
FLAMING GORGE R	1041.	1041.	1041.	1041.	1041.	1041.	1041.	1041.	1041.	1041.	1041.	1041.
NAVAJO RESERVOI	1145.	1045.	947.	1145.	1445.	1641.	1641.	1641.	1545.	1445.	1345.	1245.
LAKE POWELL - C	24454.	24454.	24454.	24454.	24454.	24454.	24454.	24454.	24454.	23453.	22454.	22454.
LAKE MEAD - COL	25517.	25517.	25517.	25517.	25517.	25517.	25517.	25517.	25517.	25517.	25517.	25517.
LAKE MOHAVE - C	1644.	1699.	1699.	1699.	1754.	1666.	1543.	1417.	1371.	1371.	1478.	1585.
LAKE HAVASU - C	539.	539.	557.	594.	611.	611.	580.	561.	557.	548.	543.	539.

NOTE: THE VALUES GIVEN ON THIS PAGE ARE INITIAL VALUES. SOME OF THE VALUES CAN CHANGE THROUGHOUT THE RUN DUE TO THINGS LIKE SEDIMENTATION OR THE USE OF TRANSACTION CARDS.