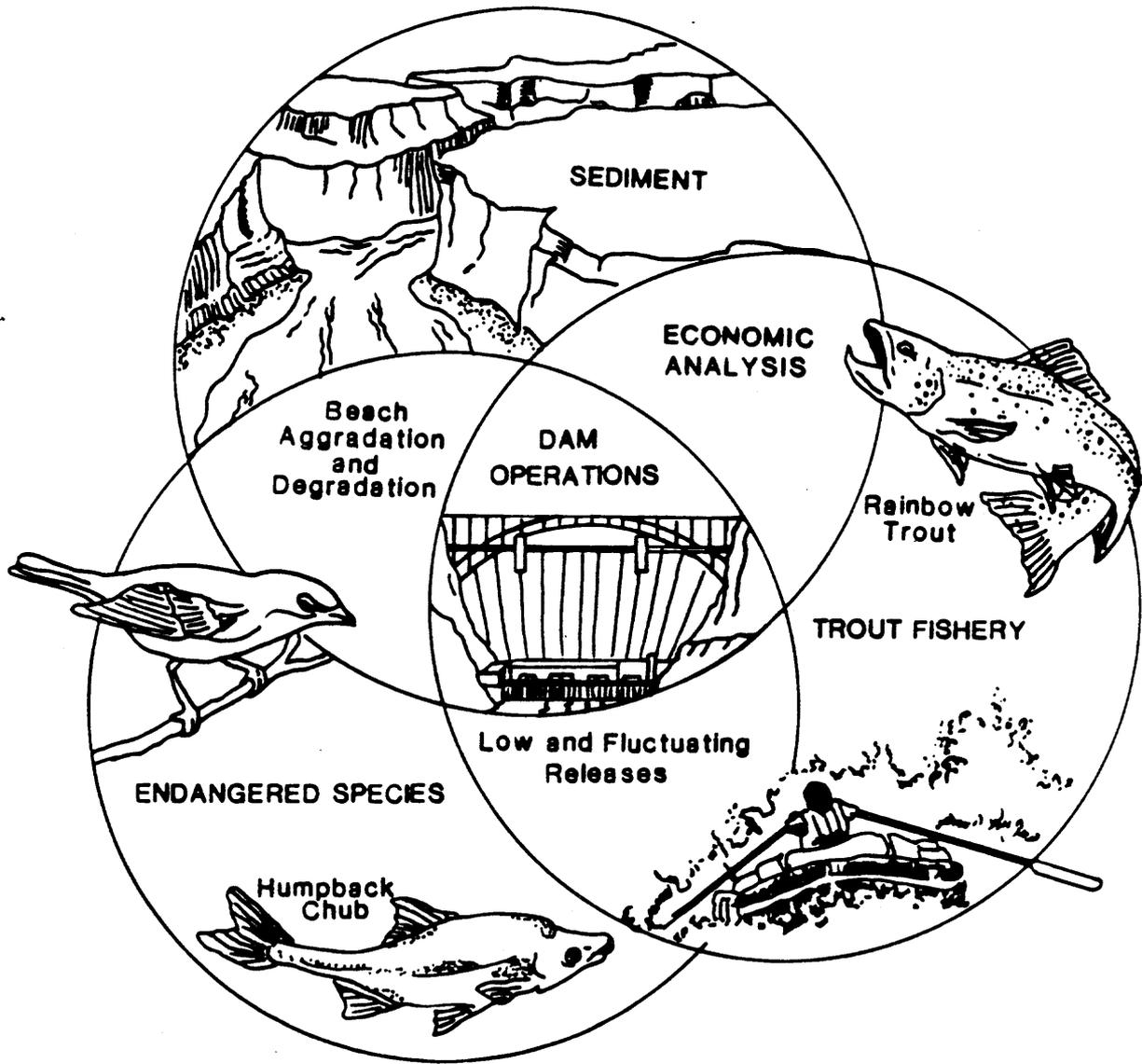


GLEN CANYON DAM

MONITORING OF INTERIM OPERATING CRITERIA



JUNE 1993 - NOVEMBER 1993

BUREAU OF RECLAMATION

570.00
PRT-13.00

5558

(2186)

PL 5
C.1

31 MGT/SDI-nob

GLEN CANYON DAM
MONITORING
OF
INTERIM OPERATING CRITERIA

June 1993 through November 1993

Bureau of Reclamation

This document summarizes the monitoring of Interim Operating Criteria for Glen Canyon Dam from June 1993 through November 1993. This is the sixth report of monitoring of operating criteria, with the first report covering August through December 1991, the second report covering January through April 1992, the third report covering May through September 1992, the fourth report covering October 1992 through February 1993, and the fifth report covering March through May 1993. Summaries will be published periodically throughout the interim operation period.

BACKGROUND

The Glen Canyon Dam Interim Operating Criteria were implemented on November 1, 1991, following a 3-month testing of the proposed interim flow criteria. An Environmental Assessment was completed in October 1991 with a Finding of No Significant Impact. The Interim Operating Criteria will remain in effect until completion of the Glen Canyon Dam Environmental Impact Statement, scheduled for completion in October 1994, and Record of Decision scheduled shortly thereafter.

Exception Criteria. The Western Area Power Administration and the Bureau of Reclamation signed an interagency agreement on October 21, 1991, implementing exception and associated interim operating criteria, including financial exception criteria.

The exception criteria allow deviation from the interim flow criteria for response to power system disturbances or other emergency situations and for power system regulation. The agreement incorporates emergency and system regulation provisions which were in place during research flows and, in addition, includes "financial criteria" as a means of avoiding the expense of purchasing replacement firm capacity and energy during the interim period. The financial criteria element is conditional. The primary conditions include:

- limiting the use of financial criteria to not more than 3 percent of the time (22 hours) in any consecutive 30-day period
- periodic review and renewal, and
- reporting the use and costs associated with the financial criteria

MONITORING OF INTERIM FLOW CRITERIA

The operating criteria parameters--maximum daily flows, minimum daily flows, daily fluctuation, and ramp rates--are monitored at the Glen Canyon Dam using Reclamation's Supervisory Control and Data Acquisition (SCADA) system. The discharge and river stage changes are monitored at downstream gaging stations near Lees Ferry and Grand Canyon Village. The SCADA data at Glen Canyon Dam is recorded in megawatts of energy and require conversion to flow--cubic feet per second (cfs).

From June 1, 1993, through November 30, 1993, the maximum flow of 20,000 cfs was adhered to as shown on the charts in Attachment A. The minimum flow of 5,000 cfs at night and 8,000 cfs between 7 a.m. and 7 p.m. was also met throughout the period. The release volumes of the individual months were as follows:

June 1993	617,986 acre-feet
July 1993	910,000 acre-feet
August 1993	910,000 acre-feet
September 1993	666,000 acre-feet
October 1993	550,000 acre-feet
November 1993	600,000 acre-feet

Ramp Rates - Ramp rates may be exceeded under the criteria for system disturbances, regulation, and other emergency situations to allow for power system operation adjustments. The ramp rates were exceeded periodically as a result of system disturbances and regulation responses to power demands. The deviations that occurred were resolved within the hour that they occurred in. All deviations were reported to the Glen Canyon Environmental Studies (GCES) office and appropriate monitoring actions were initiated. The number of times ramp rates were exceeded has been consistently reduced as operators have become more experienced with projecting power system adjustments.

Attachment B shows the traces of discharge and river stages at Lees Ferry and Grand Canyon Village for June 1993 through November 1993.

MONITORING OF EXCEPTION CRITERIA

The exception criteria are monitored at Glen Canyon Dam using Reclamation's SCADA system. Several deviations from the interim flow criteria occurred, primarily due to electrical system emergencies caused by electrical transmission system and generation capability. None of the system deviations lasted longer than 1 hour (see Attachment B).

Deviations from the ramp rate criteria have occurred periodically, particularly when the dam is following the power load under system regulation and generally occurs during the upramp. Such deviations are allowed under the generator regulation exception criteria.

The estimated net expenses of interim operations are included in Appendix C. Summary of estimated costs by month is shown in the following tabulation:

<u>Month</u>	<u>Net Expense</u>
June 1993	\$618,118
July 1993	\$680,830
August 1993	\$552,370
September 1993	\$446,771
October 1993	\$387,899
November 1993	\$464,447

To date, financial exception criteria have not been used.

INTERIM FLOW MONITORING PROGRAM - RESOURCES AND RESPONSES

The program focuses on the evaluation of critical resources and ecosystem processes relative to the interim flow regime to determine natural changes in the ecosystem, changes as a result of interim flows, and effects on power generation.

Resource Response - Environmental and cultural resources in the Glen and Grand Canyon areas have been continuously monitored during the last three months. The intent of the interim flow monitoring is threefold; (1) to satisfy the interim flow objectives; (2) to provide additional information for completion of the GCES Phase II research programs; and (3) to define the baseline for the long-term monitoring program. The following resource categories were monitored.

Sediment - The importance and longevity of the sediment deposits laid down in the January and February 1993 floods from the Little Colorado River continue to be a focus of much of the sediment resource monitoring effort. The majority of the sediment deposits have been eroded back to the pre-January 1993 levels with the sediment moving into the adjacent backwaters, return channels and eddies. This movement of sediment into adjacent areas is providing the "bank account" of sediment that is the focus of the proposed 1995 flood release experiment.

There has been no high runoffs or severe winter storms this year in the Little Colorado or Paria River drainages. With the low snowpack in the Little Colorado River basin a large runoff is not anticipated. Glen Canyon Dam releases are set for a low 8.23 maf year release so we do not anticipate that the bank account of sediment in the main channel will be moving prior to the experimental flood next spring.

GCES is planning our annual Memorial Day low flow aerial photography run in the Grand Canyon again this year. The photographs, collected at a steady flow of 8,000 cfs have provided valuable pictures of what the system looks like. We are hoping that we have clear weather and a base flow situation in the Little

Colorado River again this year. Additional research this year will be focusing on the formation and location of backwaters in the critical Geographic Information System reaches. The dam releases will return to normal summer interim flow operations after the photography is completed.

Riparian Ecosystem - With the movement of the sediment back towards the channel, many of the backwaters, eddies and return channels that had been the locations of small marshes and localized habitats are changing. With the increase in sediment and the continual movement of the riparian vegetation from the 30,000 cfs zone to the 20,000 cfs interim flow cap level, many of the marshes are losing their aquatic flavor and becoming more terrestrial in nature. We are very interested in the recolonization rate and use of the marshes-turned-riparian areas by neotropical birds and reptiles.

Studies this winter have again focused on the use of the Nankoweap Canyon area by the wintering Bald Eagles, Halieaeetus leucocephalus. This winter Nankoweap Creek turned cold early in the winter and the number of spawning Rainbow Trout, Onchorynchus mykiss, never reached the capacity level necessary to support large numbers of birds. Early returns from the eagle survey indicate that the wintering birds spread themselves out through the Canyon and were more isolated in their locations. It appears that the numbers of spawning trout are a large determinant on the number of birds that the area supports.

Several trips this spring will continue to document the migration of the riparian vegetation down to the 20,000 cfs Interim Flow maximum flow level. Additional work begins this spring on the food and habitat studies on the neotropical migrants that utilize the nearshore riparian zone.

Aquatic Resources -

Native Fish: The native fish studies in the Grand Canyon have been relatively dormant the past three months as the researchers have been spending time focusing on the interpretation of their 1993 results and beginning work on their final reports. Much of the effort has focused on following the progress and recruitment of the 1993 humpback chub, Gila cypha, year class. As of this writing the adult chubs are beginning to mass in the vicinity of the Little Colorado River awaiting the cues to initiate spawning.

Some initial findings that will continue to be evaluated and verified during the 1994 interim flow work include:

1. The use of the spring area in the River Mile 30 area. Evidence was found last year that some spawning may be occurring in the areas around the warm water springs.
2. Utilization of near shore habitats by juvenile and young-of-year fish.
3. Fidelity of specific locations and habitat types by adult chubs
4. Population demographics of other native fish species

Non-Native Fish: Studies continue on the trout and other non

-native fish populations in the Grand Canyon. The rainbow trout fishery in the Lee's Ferry area continues to improve with an increasing percentage coming each year from natural reproduction. Predation studies in the Canyon have identified that Brown Trout, Salmo trutta, has a large impact on the native fish. Additional non-native work in the lower Grand Canyon has shown that the fish utilize the tributary mouths as a staging area from which they leap-frog upstream. Under lower flow, warmer water conditions, the non-native fish may find it easier to migrate upstream and establish population centers at upstream tributary mouths.

Endangered Species Studies - In addition to the humpback chub and Bald Eagle studies, additional endangered species work has centered on the Kanab Ambersnail, Oxyloma haydeni Kanabensis, and the Southwest Willow Flycatcher, Empidonax trailli. We anticipate doing habitat and baseline population surveys, in conjunction with the National Park Service and the Fish & Wildlife Service this spring on the Kanab Ambersnail. The main area of interest is in the Vasey's Paradise area (River Mile 32).

The Southwest Willow Flycatcher work will focus this year on the determination of nesting pairs along the river corridor and evaluation of their specific habitat requirements. Both species will have their habitats integrated into the GCES Geographic Information System for the long-term monitoring sites.

Additional work this spring will focus on the scientific determination of the research that would need to be acquired to address the concerns of the FWS Biological Opinion. While no new research will begin this year we feel that it is important to begin to evaluate the needs so that critical information is not lost.

Cultural Resources - The National Park Service continues to take the lead in the monitoring of the cultural resource sites in the Grand Canyon. The Park Service has also been working with the tribes to begin developing the long-term monitoring elements required through the Programmatic Agreement. The specific technical geomorphological and geological information is being collected and analyzed by the U.S. Geological Survey.

Native American Studies - All tribes have been actively involved with GCES in setting up specific monitoring studies in the Grand Canyon. The Havasupai Tribe is currently awaiting the award of their contract so that water quantity and quality studies can begin on Havasu Creek. The Kaibab Paiutes have signed their agreement and have begun their specific technical studies on the cultural resources.

Economic Resources - The power studies are entering their final stages with sensitivity studies beginning on the Power Resource model. Meetings have been held with EDF and environmental consultants to address their concerns with the large and small scale system approaches. The Recreation studies have been completed. The non-use studies have gained OMB approval for the pilot study. We are currently reviewing the initial results of the pilot test. Based on the results Phase III, the field CVM test, will be initiated.

Upcoming Events - Over the next several months specific areas of interest will include:

1. Development of the experimental flow study outline/plan
2. Continue evolvement of the long-term monitoring program
3. Steady flow aerial photography
4. Backwater studies at constant flow releases
5. Continued involvement of the GCES final reports.

Attachments

Attachment A - Glen Canyon Dam Releases

- Integrated Hourly Values - June 1993
- Hourly Ramping Rates (cfs/hour) - June 1993

- Integrated Hourly Values - July 1993
- Hourly Ramping Rates (cfs/hour) - July 1993

- Integrated Hourly Values - August 1993
- Hourly Ramping Rates (cfs/hour) - August 1993

- Integrated Hourly Values - September 1993
- Hourly Ramping Rates (cfs/hour) - September 1993

- Integrated Hourly Values - October 1993
- Hourly Ramping Rates (cfs/hour) - October 1993

- Integrated Hourly Values - November 1993
- Hourly Ramping Rates (cfs/hour) - November 1993

Attachment B - Gaging Stations

- Lees Ferry - Flow Rate - June 1993
- Lees Ferry - Gage Height - June 1993

- Grand Canyon Village - Flow Rate - June 1993
- Grand Canyon Village - Gage Height - June 1993

- Lees Ferry - Flow Rate - July 1993
- Lees Ferry - Gage Height - July 1993

- Grand Canyon Village - Flow Rate - July 1993
- Grand Canyon Village - Gage Height - July 1993

- Lees Ferry - Flow Rate - August 1993
- Lees Ferry - Gage Height - August 1993

- Grand Canyon Village - Flow Rate - August 1993
- Grand Canyon Village - Gage Height - August 1993

- Lees Ferry - Flow Rate - September 1993
- Lees Ferry - Gage Height - September 1993

- Grand Canyon Village - Flow Rate - September 1993
- Grand Canyon Village - Gage Height - September 1993

- Lees Ferry - Flow Rate - October 1993
- Lees Ferry - Gage Height - October 1993

- Grand Canyon Village - Flow Rate - October 1993
- Grand Canyon Village - Gage Height - October 1993

- Lees Ferry - Flow Rate - November 1993
- Lees Ferry - Gage Height - November 1993

- Grand Canyon Village - Flow Rate - November 1993
- Grand Canyon Village - Gage Height - November 1993

**Attachment C - Glen Canyon Dam Interim Operations - Western Area Power
Administration**

- June through November 1993

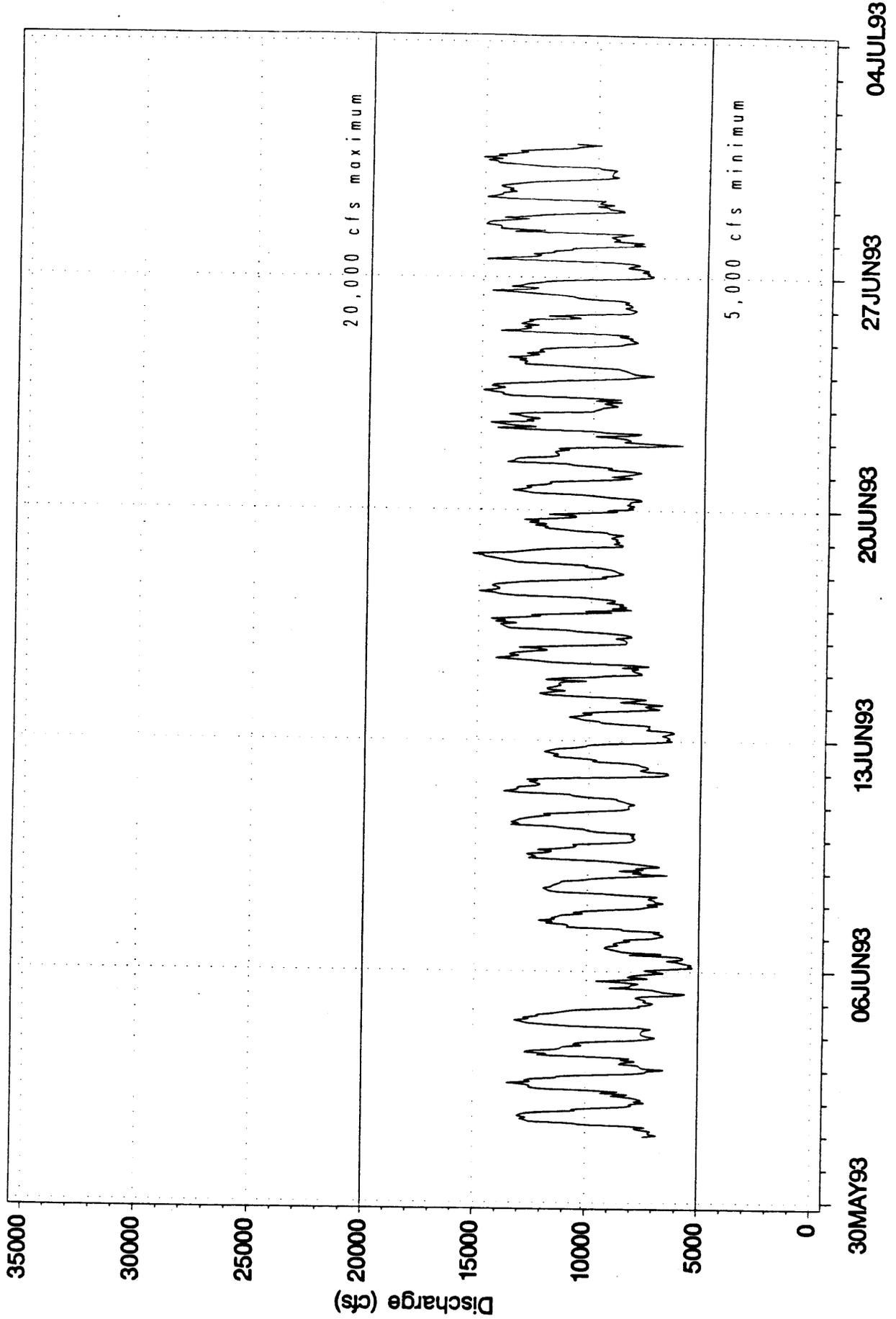
Attachment A

Glen Canyon Dam Releases

Glen Canyon Dam Powerplant Releases

June 1993

Integrated Hourly Values

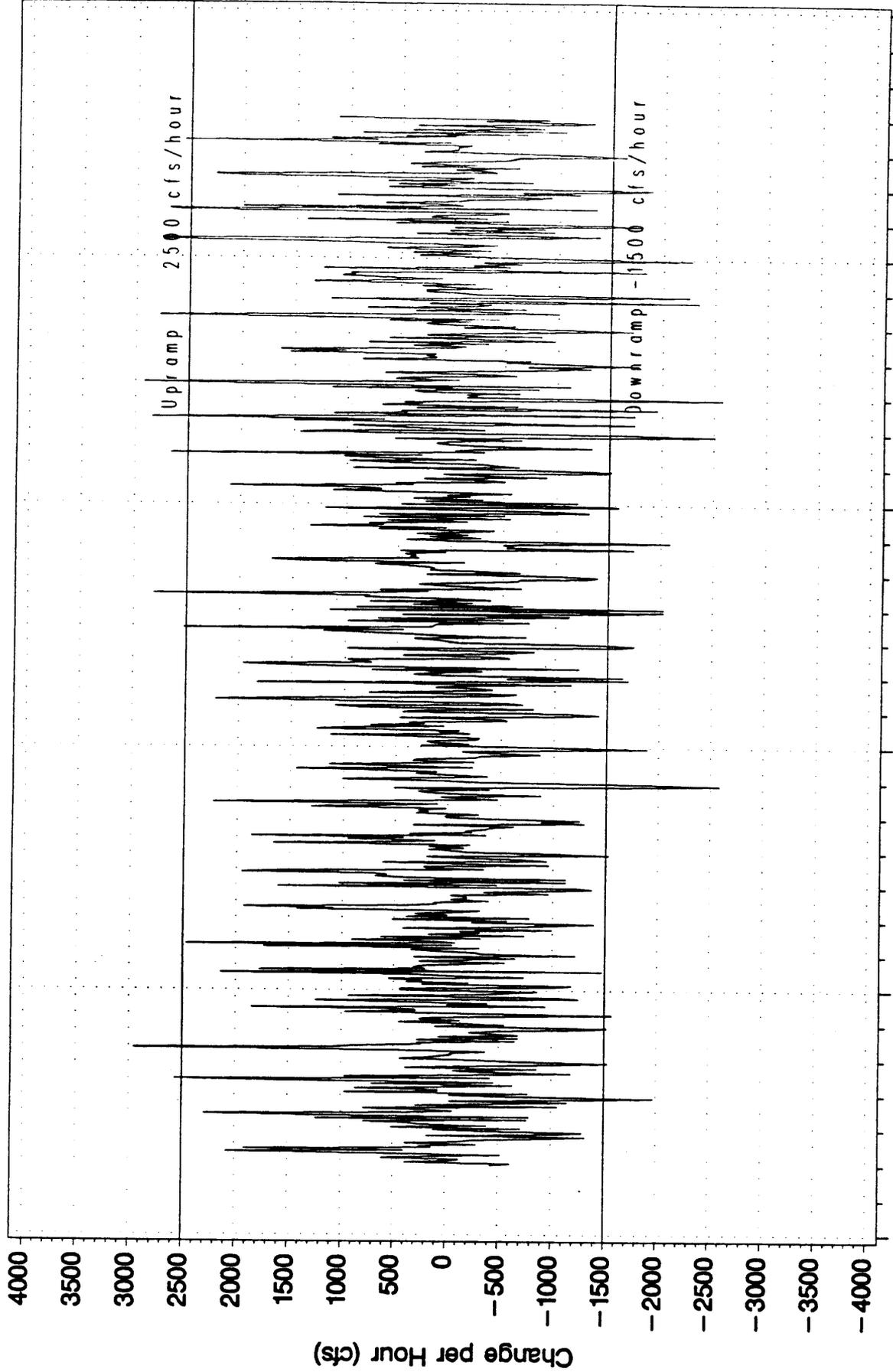


Date

Glen Canyon Dam Powerplant Releases

June 1993

Hourly Ramping Rates, (cfs/hour)



30MAY93

06JUN93

13JUN93

20JUN93

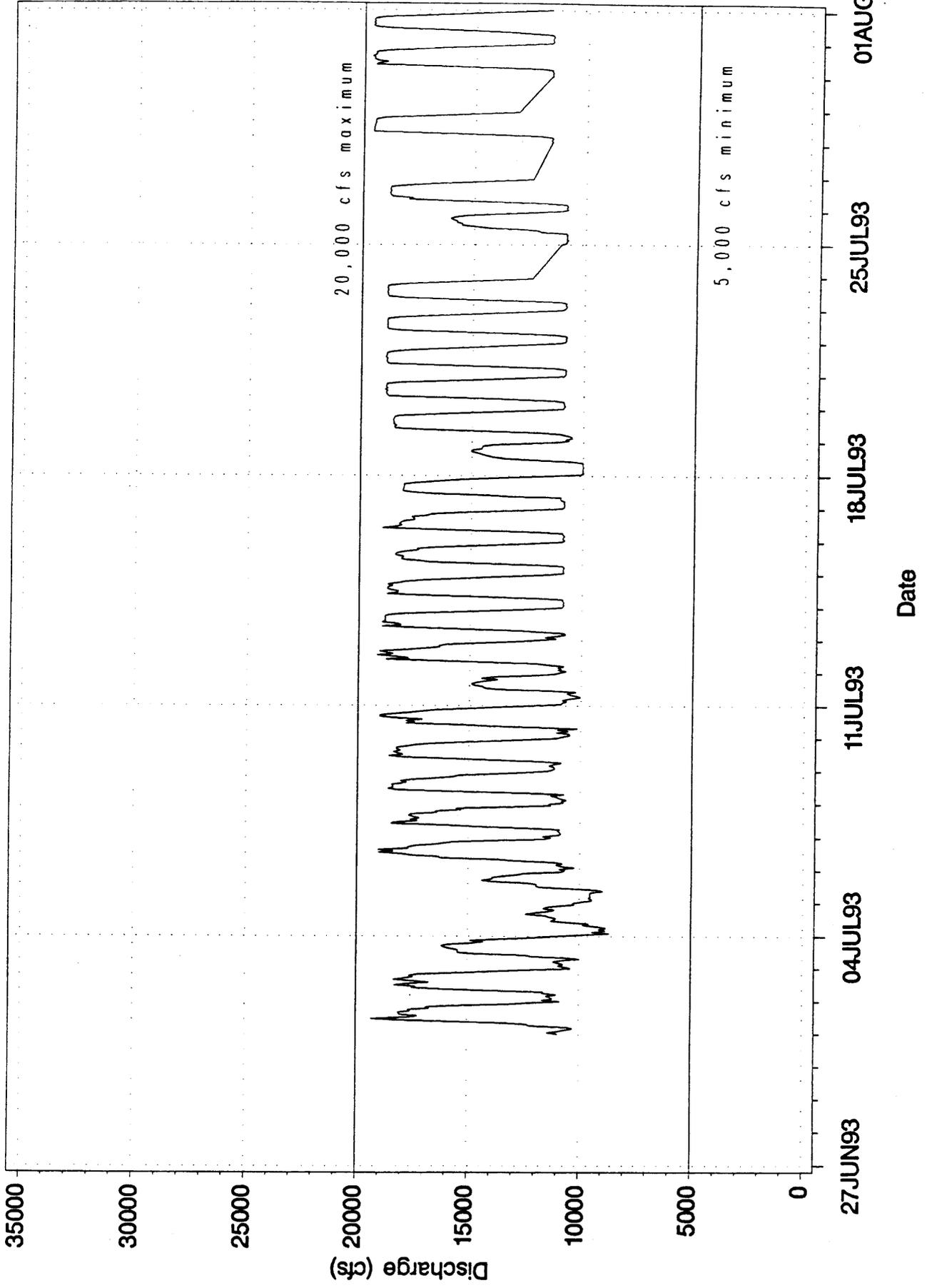
27JUN93

04JUL93

Date

Glen Canyon Dam Powerplant Releases

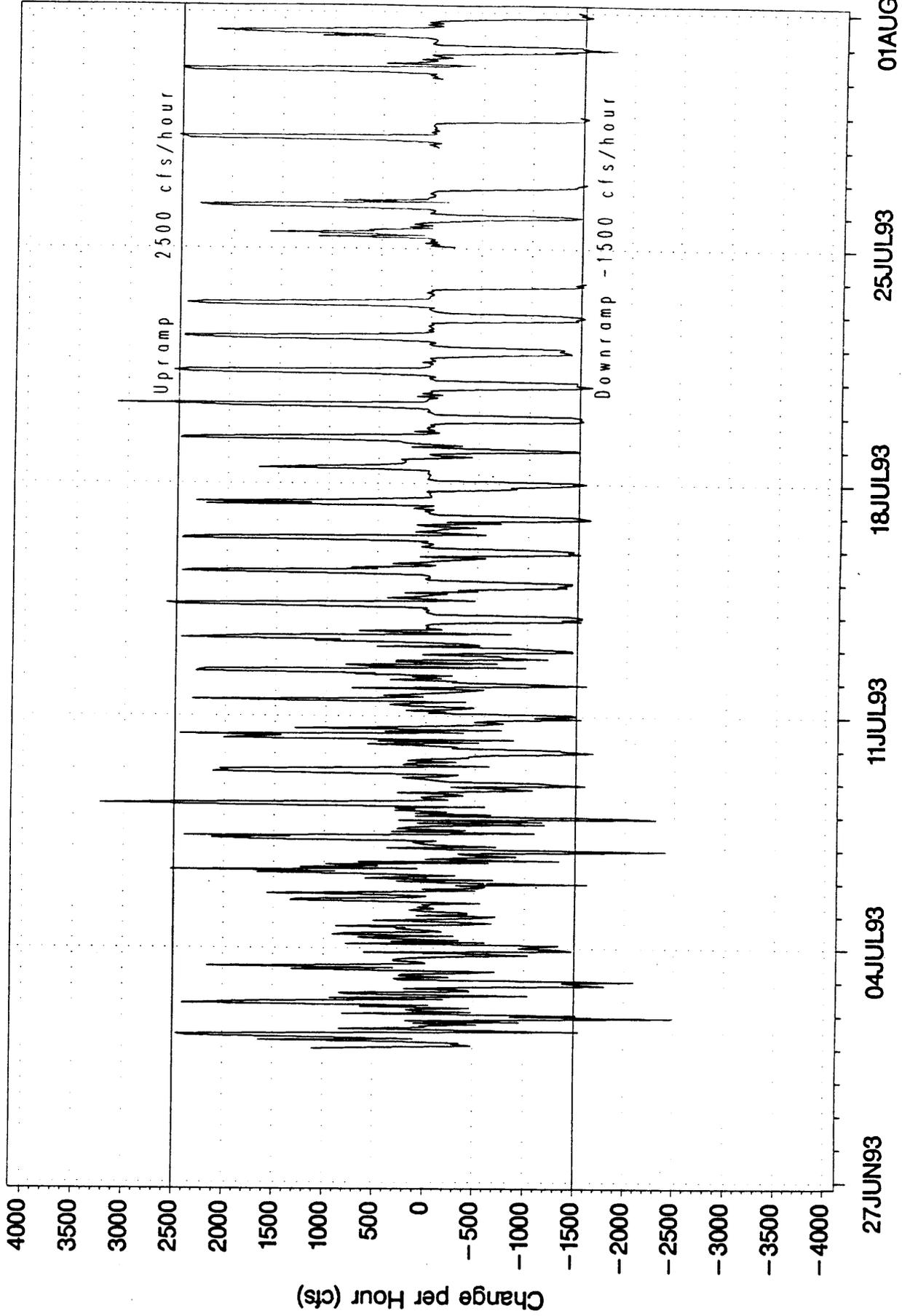
July 1993
Integrated Hourly Values



Glen Canyon Dam Powerplant Releases

July 1993

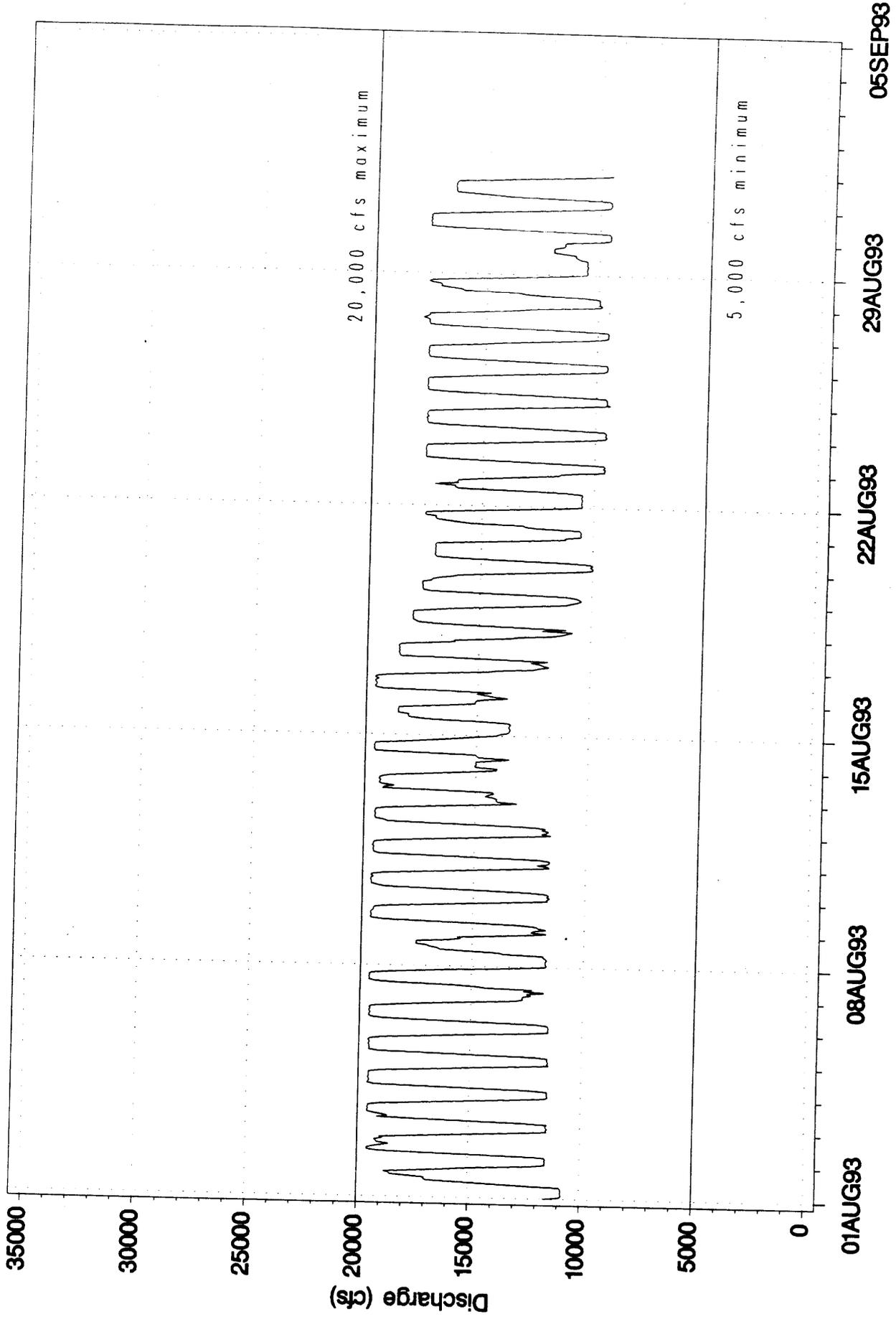
Hourly Ramping Rates (cfs/hour)



Date

Glen Canyon Dam Powerplant Releases

August 1993
Integrated Hourly Values

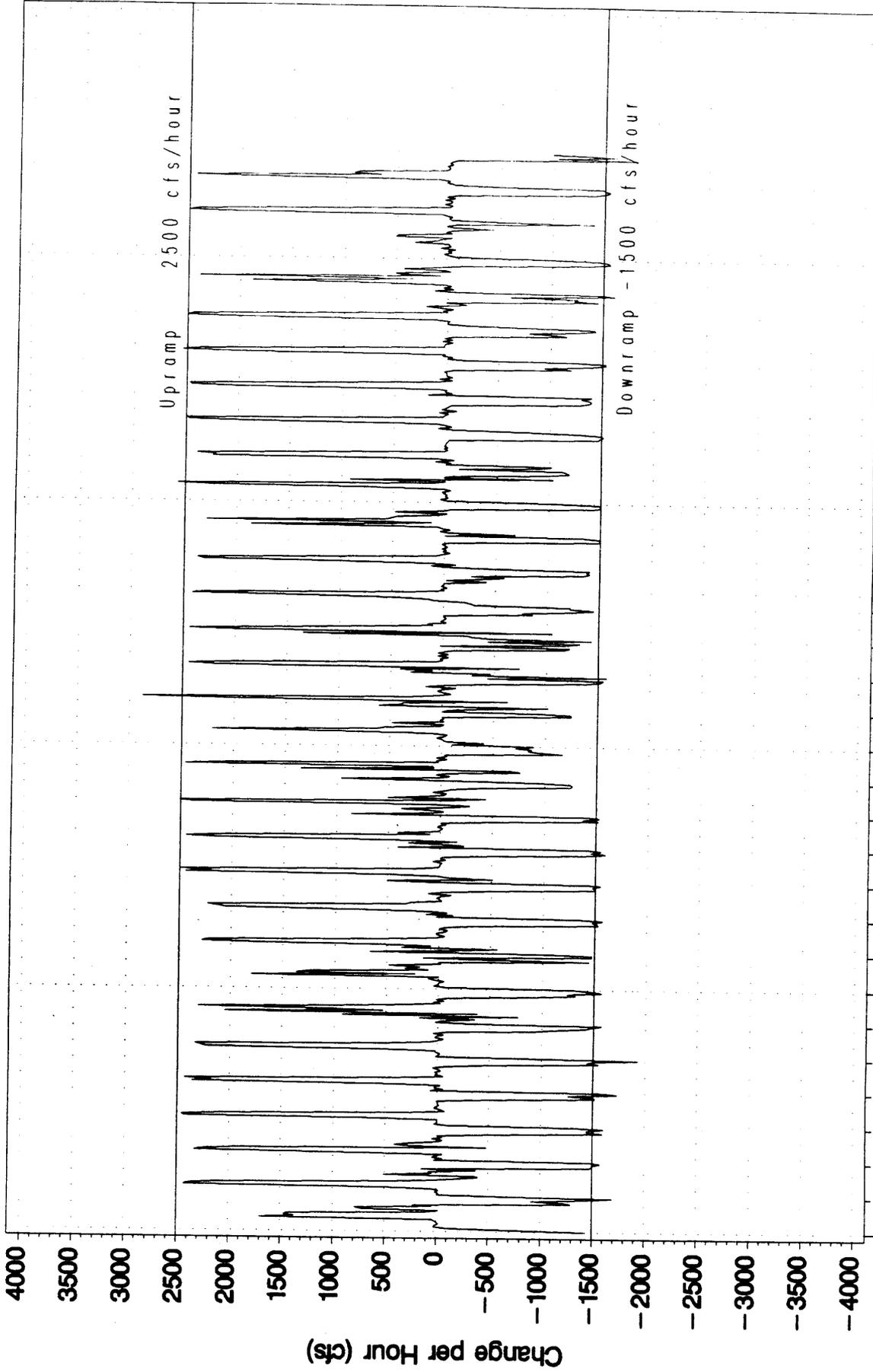


Date

Glen Canyon Dam Powerplant Releases

August 1993

Hourly Ramping Rates (cfs/hour)



01AUG93

08AUG93

15AUG93

22AUG93

29AUG93

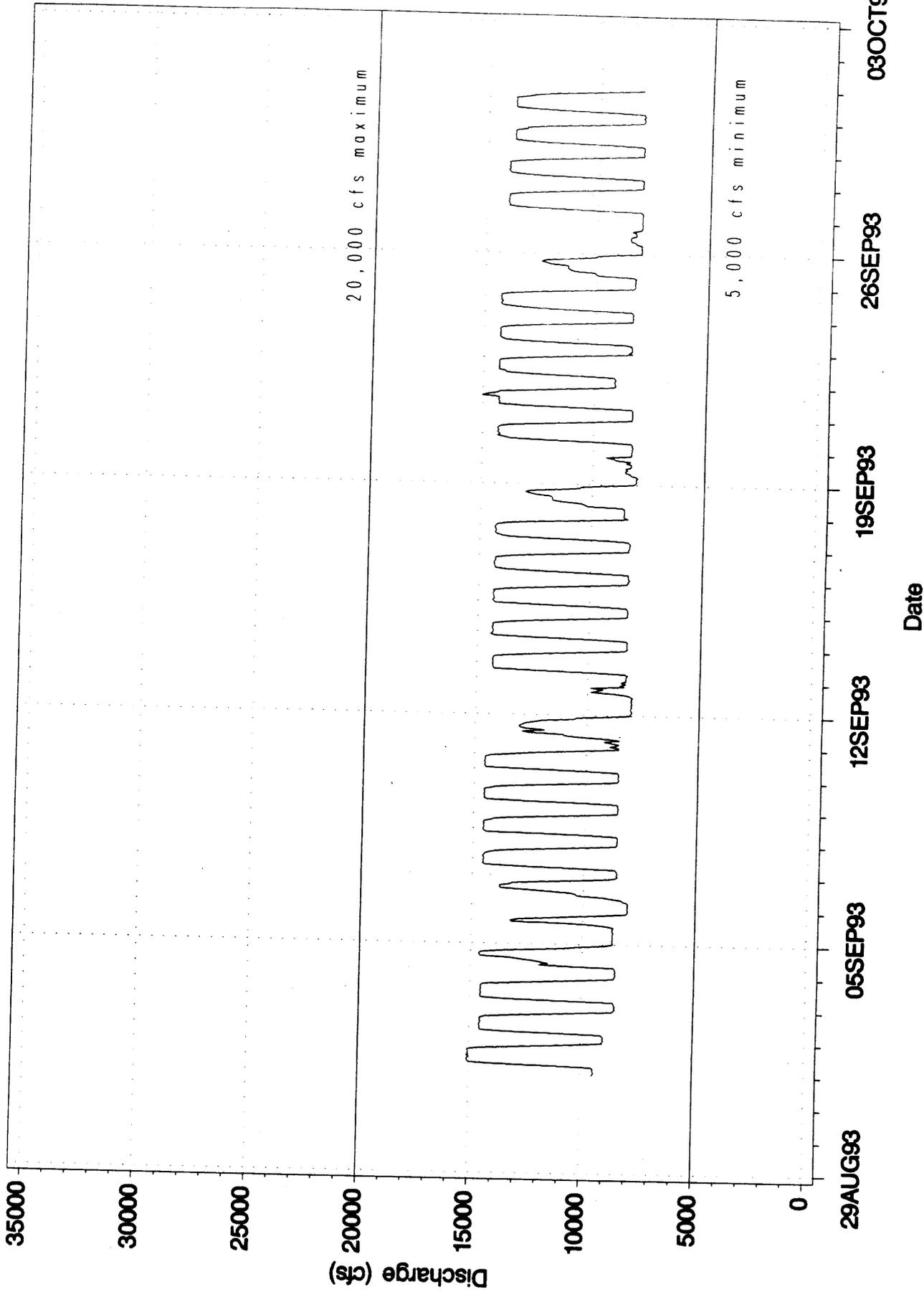
05SEP93

Date

Glen Canyon Dam Powerplant Releases

September 1993

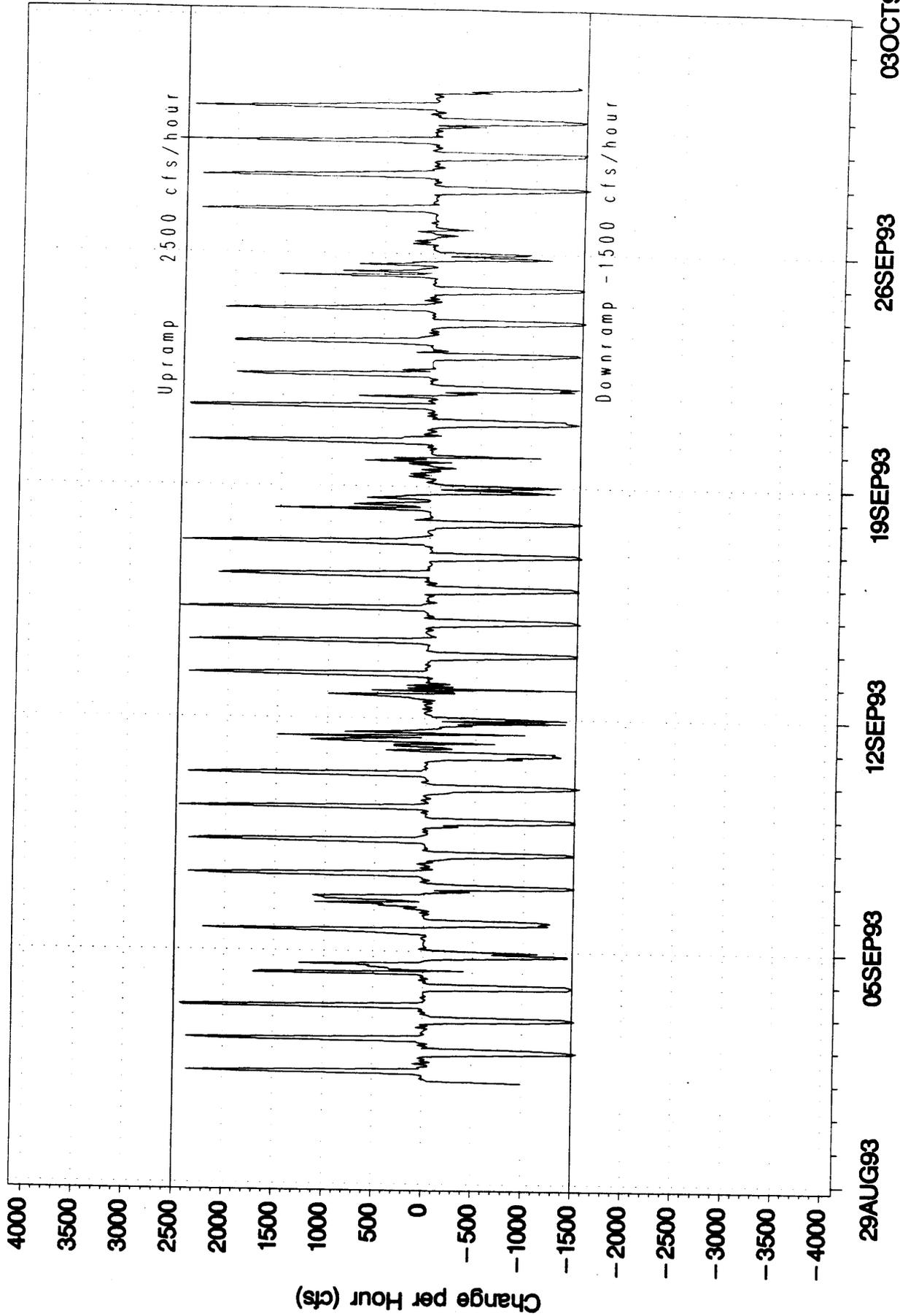
Integrated Hourly Values



Glen Canyon Dam Powerplant Releases

September 1993

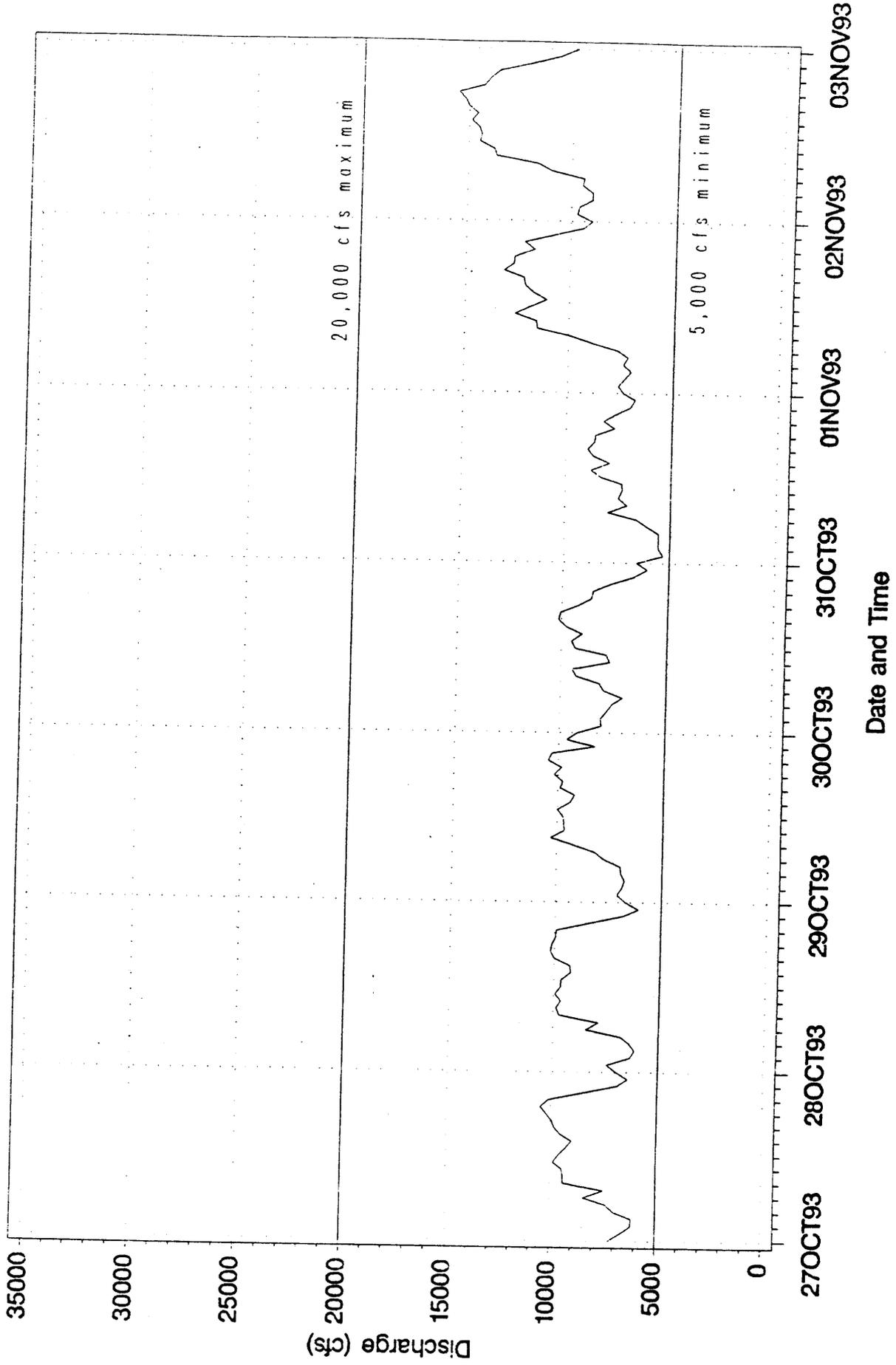
Hourly Ramping Rates (cfs/hour)



Date

Glen Canyon Dam Hourly Releases

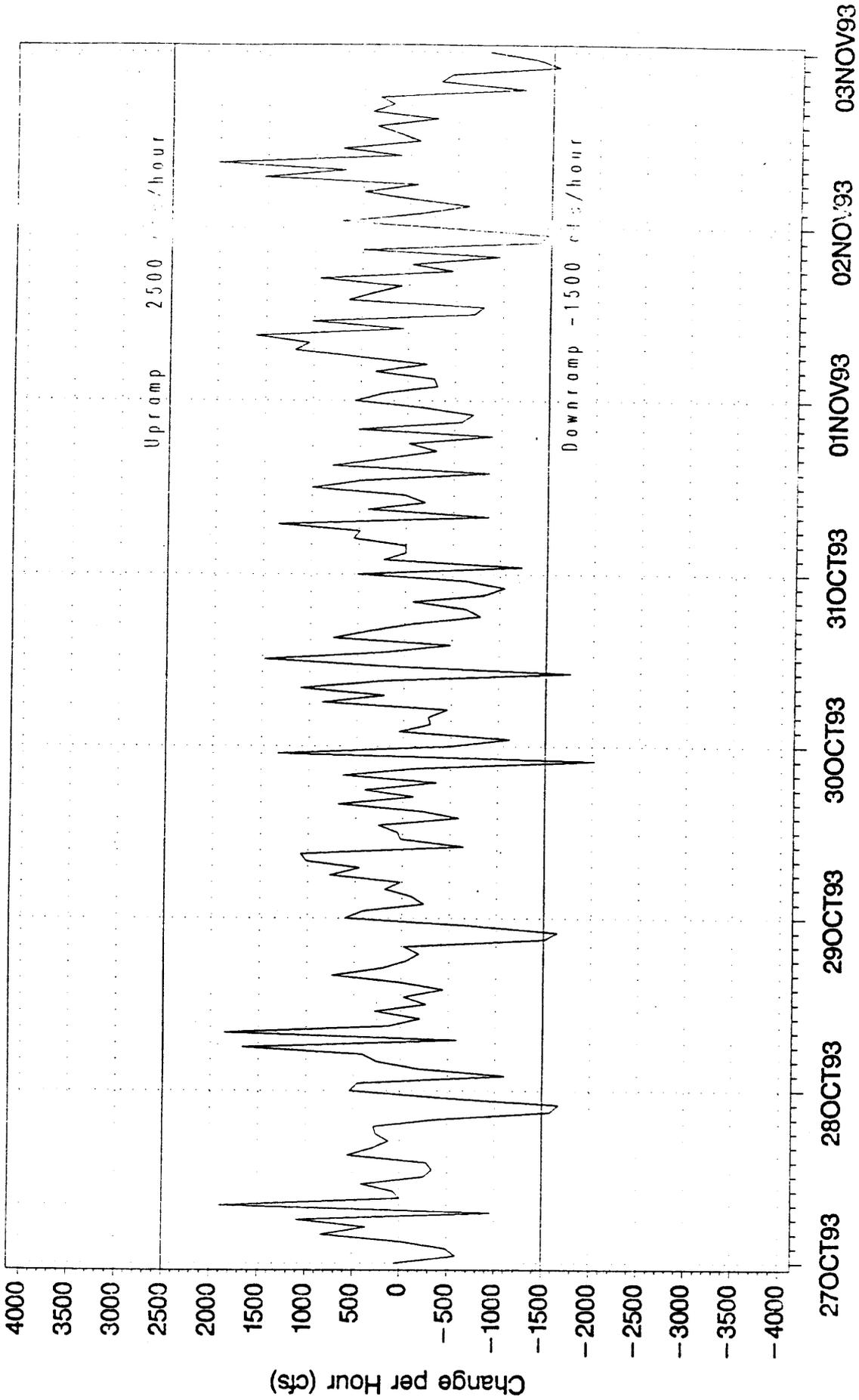
Integrated Hourly Values



Dotted vertical lines indicate midnight hour
All time values expressed as Mountain Standard Time

Glen Canyon Dam Hourly Releases

Hourly Ramping Rates (cfs/hour)

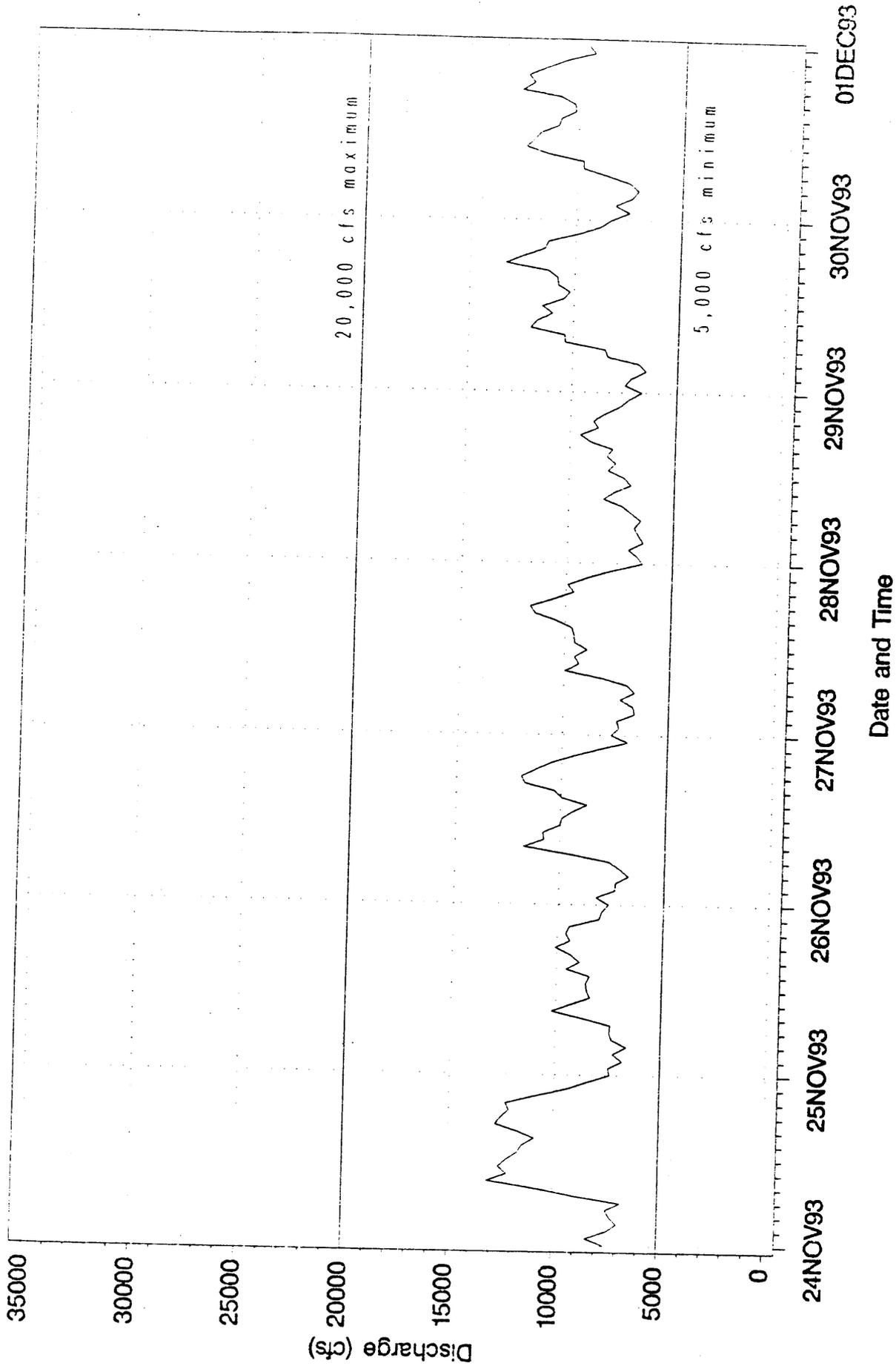


Dotted vertical lines indicate midnight hour

All time values expressed as Mountain Standard Time

Glen Canyon Dam Hourly Releases

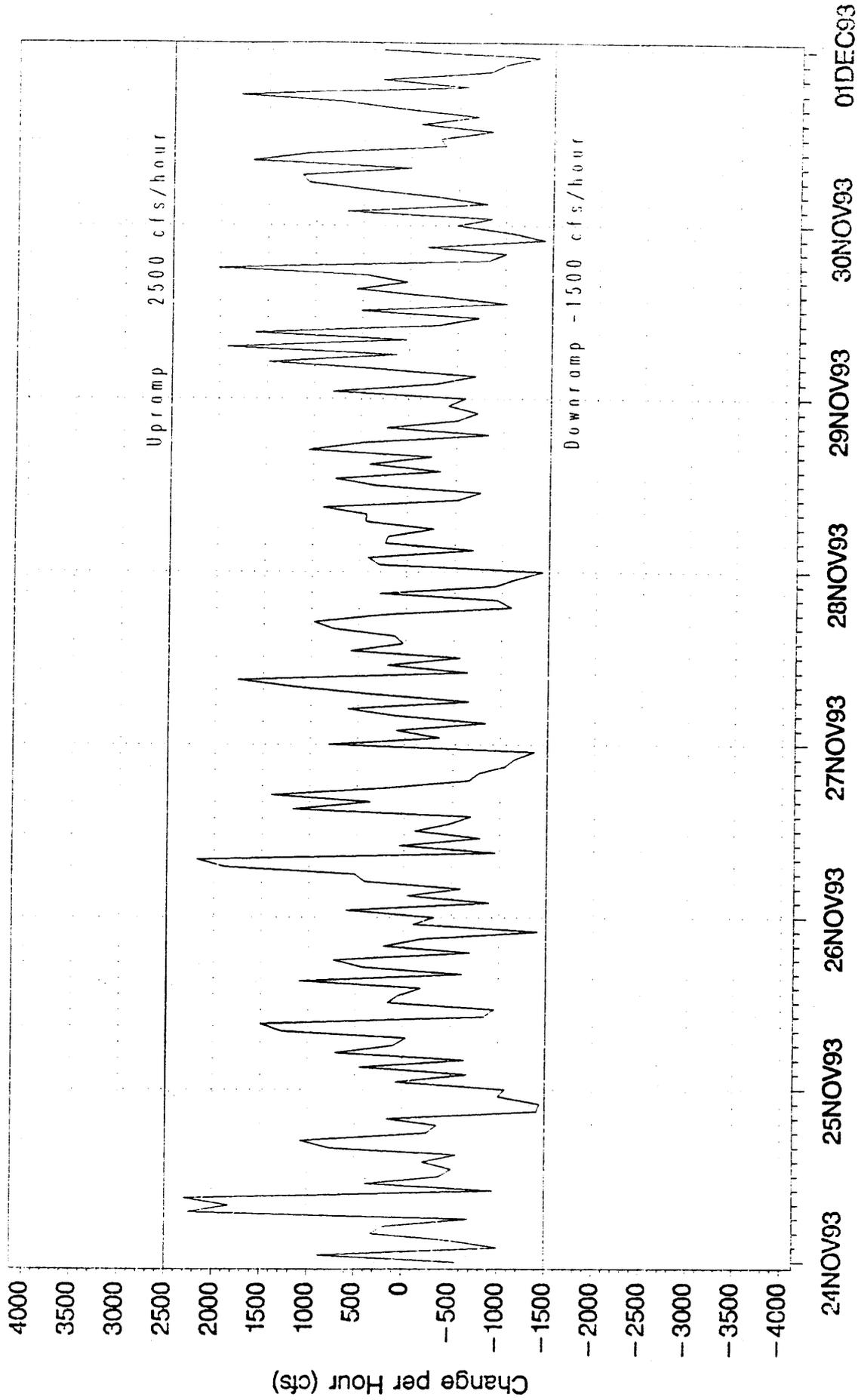
Integrated Hourly Values



Dotted vertical lines indicate midnight hour
All time values expressed as Mountain Standard Time

Glen Canyon Dam Hourly Releases

Hourly Ramping Rates (cfs/hour)



Date and Time

Dotted vertical lines indicate midnight hour

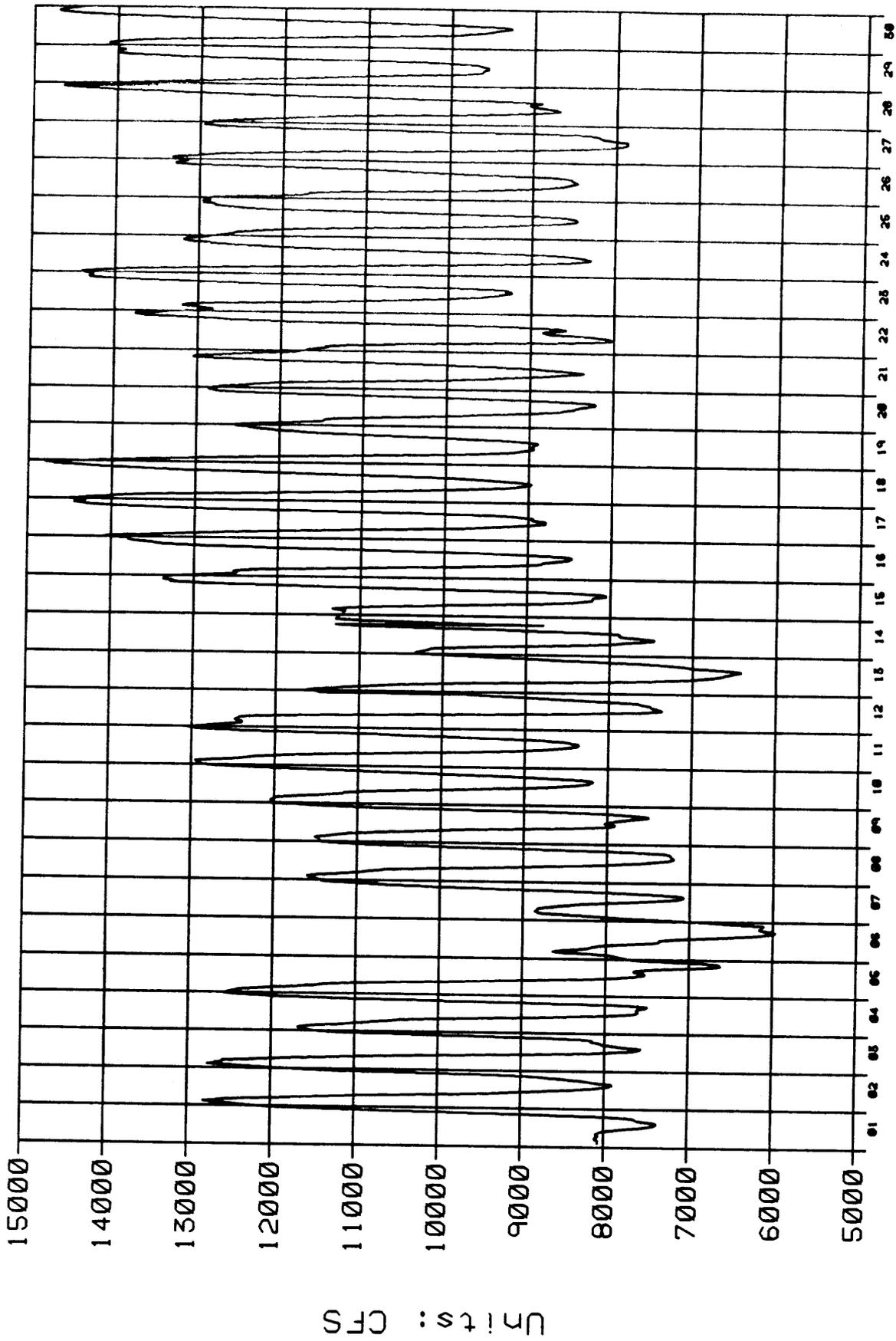
All time values expressed as Mountain Standard Time

Attachment B

Gaging Stations

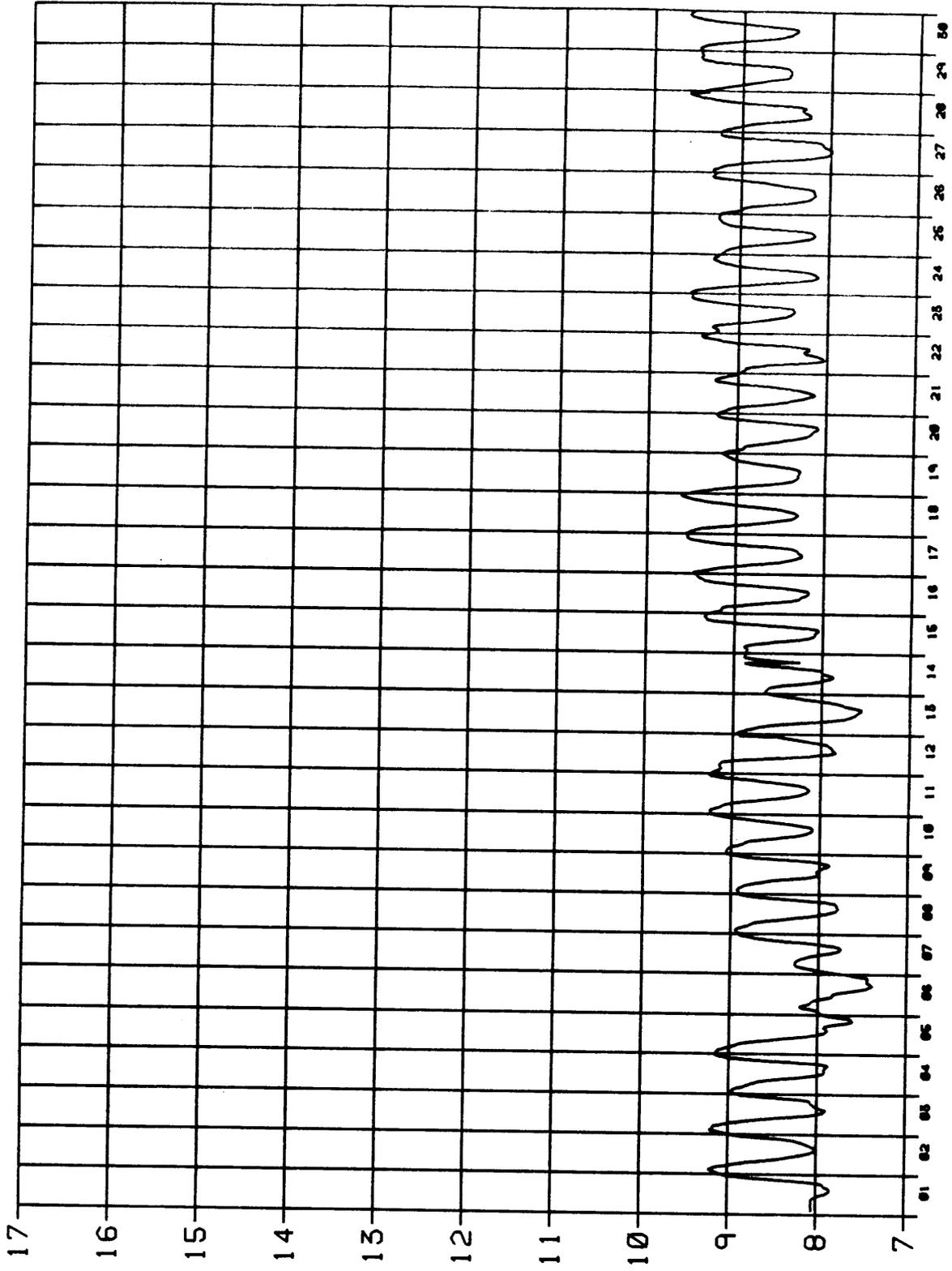


Data From 01-JUN-1993 Through 30-JUN-1993
Plotted 1-JUN-94 07:42:27



CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
Flow Rate (cfs)

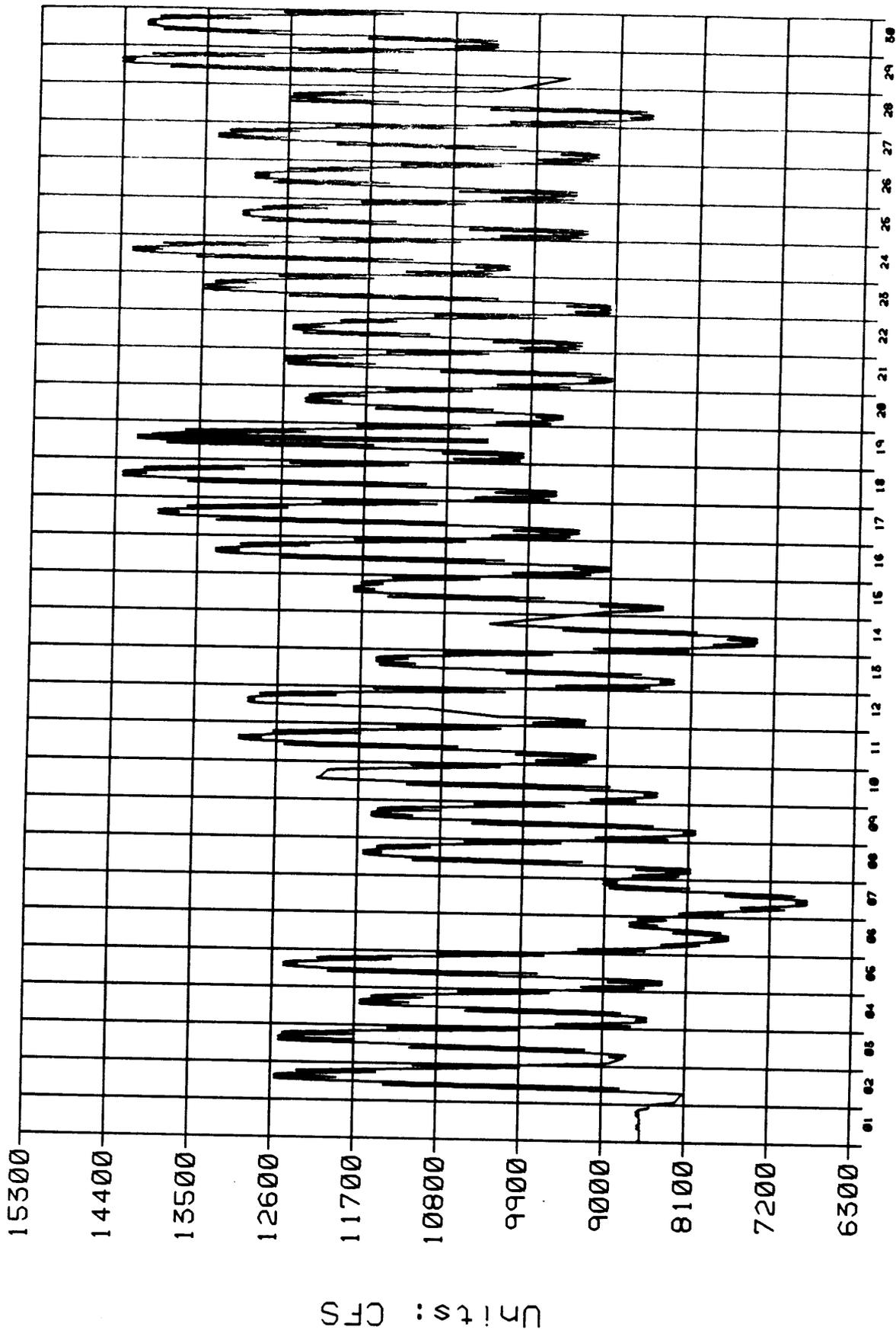
Data From 01-JUN-1993 Through 30-JUN-1993
Plotted 1-JUN-94 07:41:46



Units: FEET

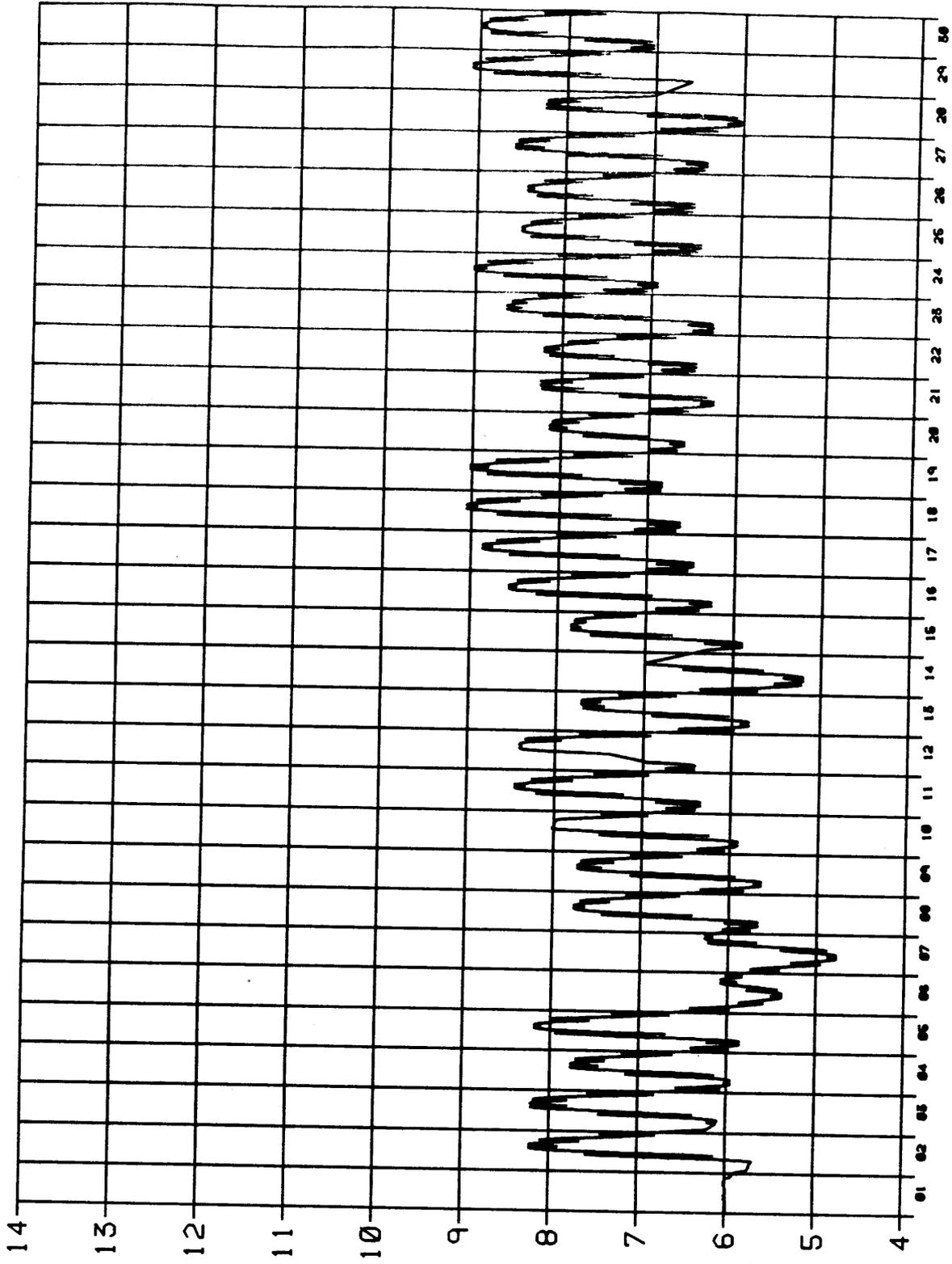
CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
— GH Gage Height (feet)

Data From 01-JUN-1993 Through 30-JUN-1993
Plotted 2-JUN-94 08:20:39



CGCA _____ 0 COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Flow Rate (cfs)

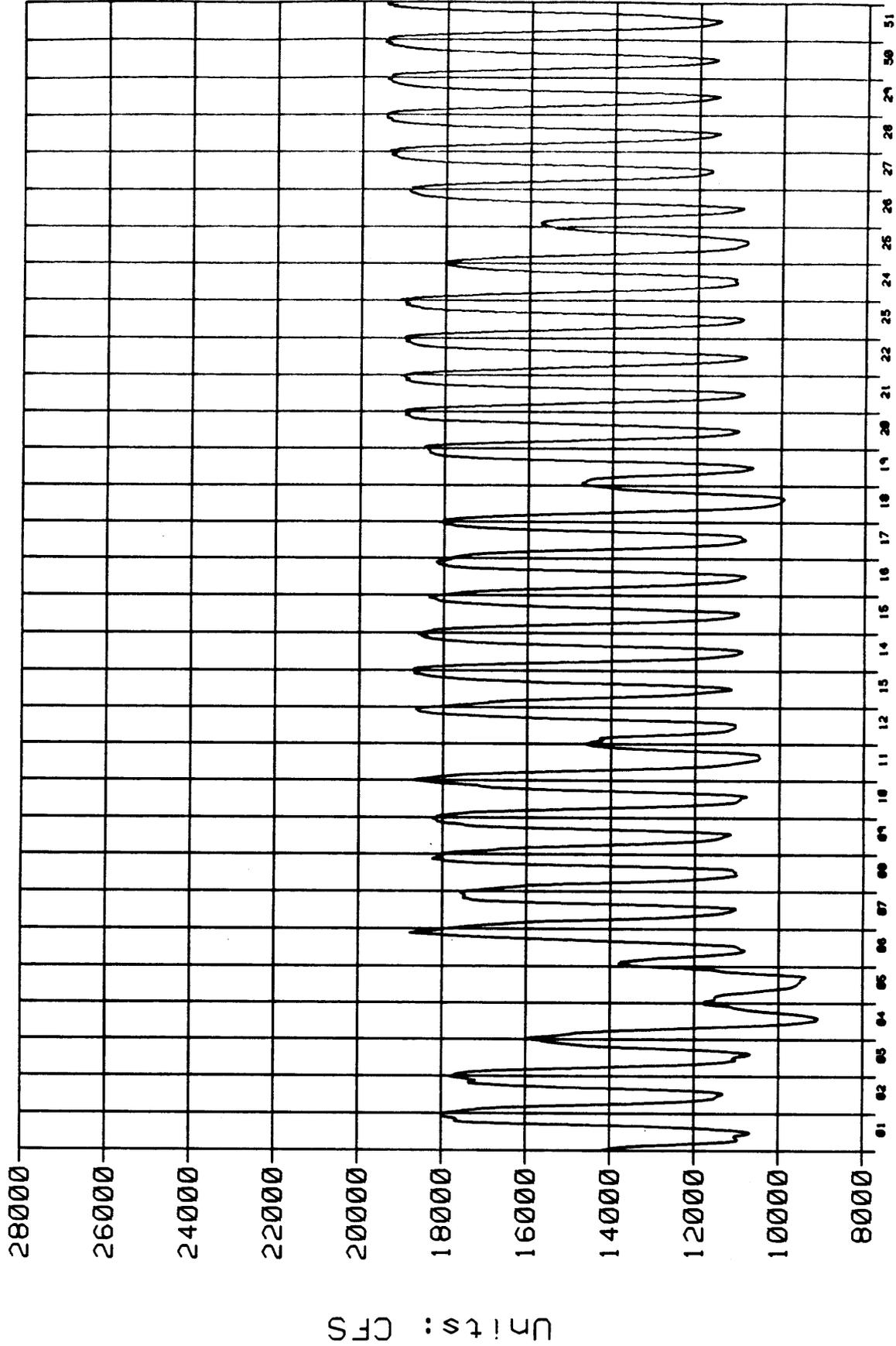
Data From 01-JUN-1993 Through 30-JUN-1993
Plotted 1-JUN-94 12:35:39



Units: FEET

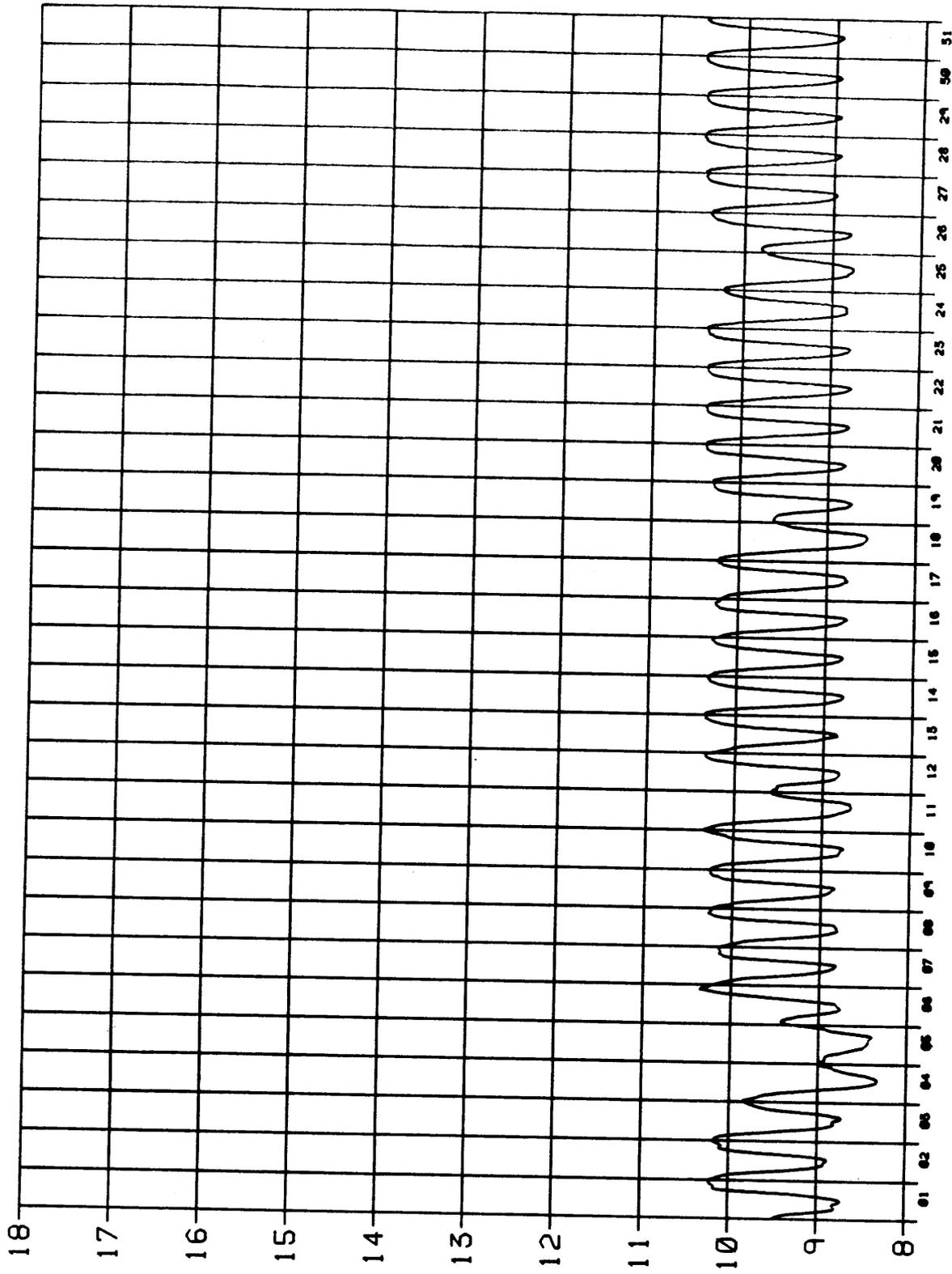
CGCA _____ GH
COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Gage Height (feet)

Data From 01-JUL-1993 Through 31-JUL-1993
Plotted 1-JUN-94 07:40:58



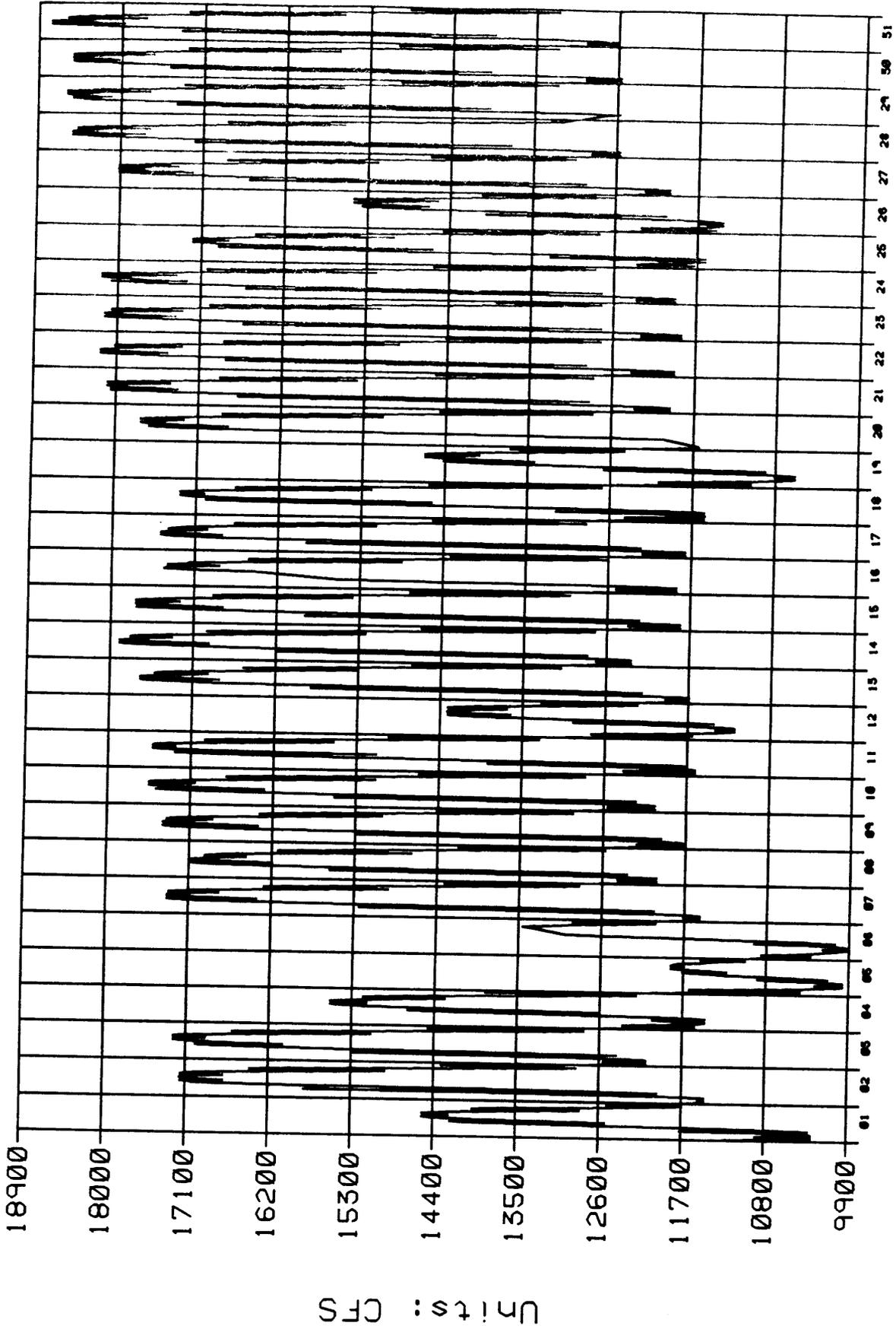
CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
Flow Rate (cfs)

Date From 01-JUL-1993 Through 31-JUL-1993
Plotted 1-JUN-94 07:40:11



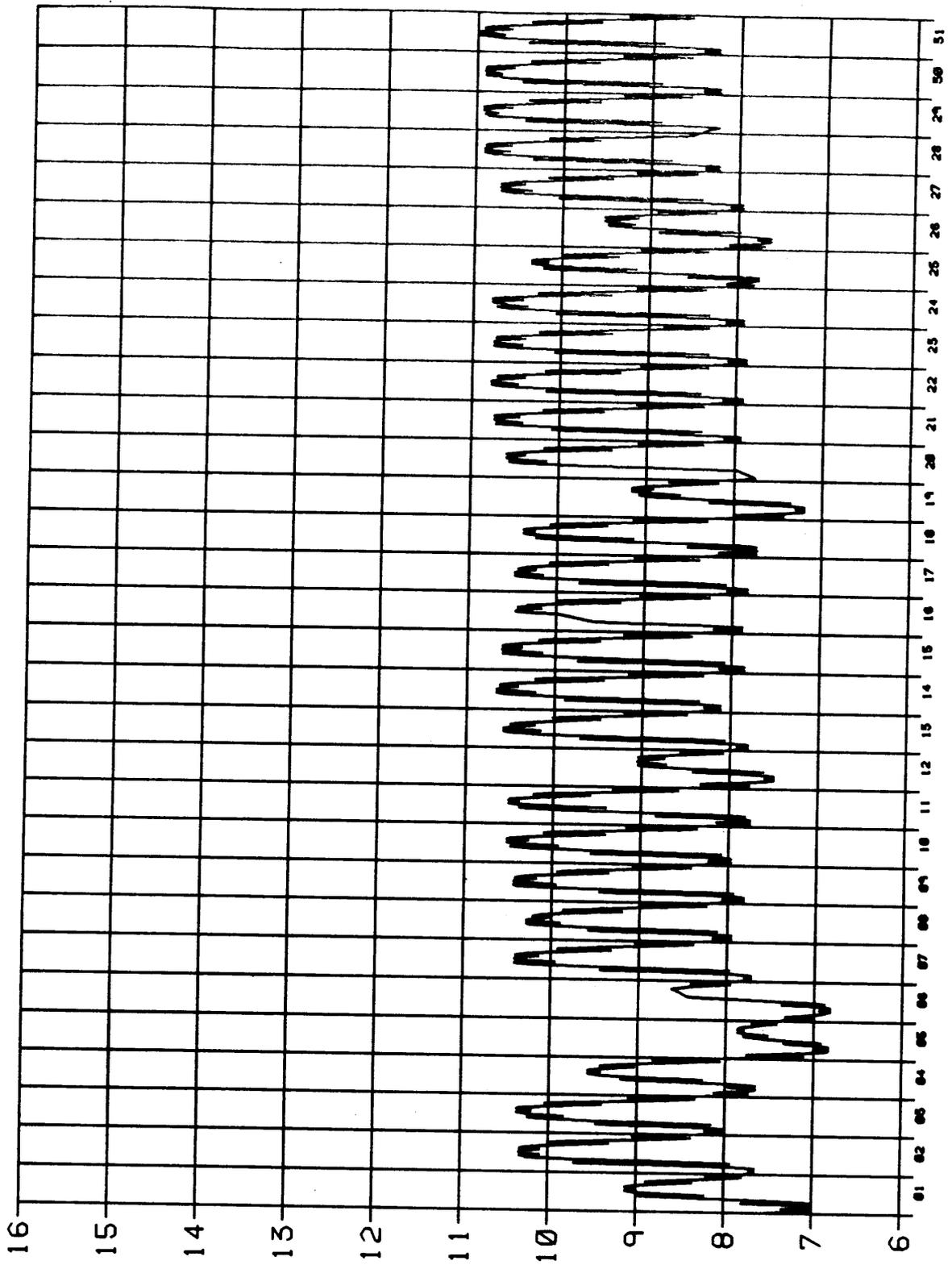
CLFA _____ GH
COLORADO RIVER NEAR LEES FERRY, ARIZONA
Gage Height (feet)

Data From 01-JUL-1993 Through 31-JUL-1993
Plotted 1-JUN-94 08:01:58



CGCA 0 COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Flow Rate (cfs)

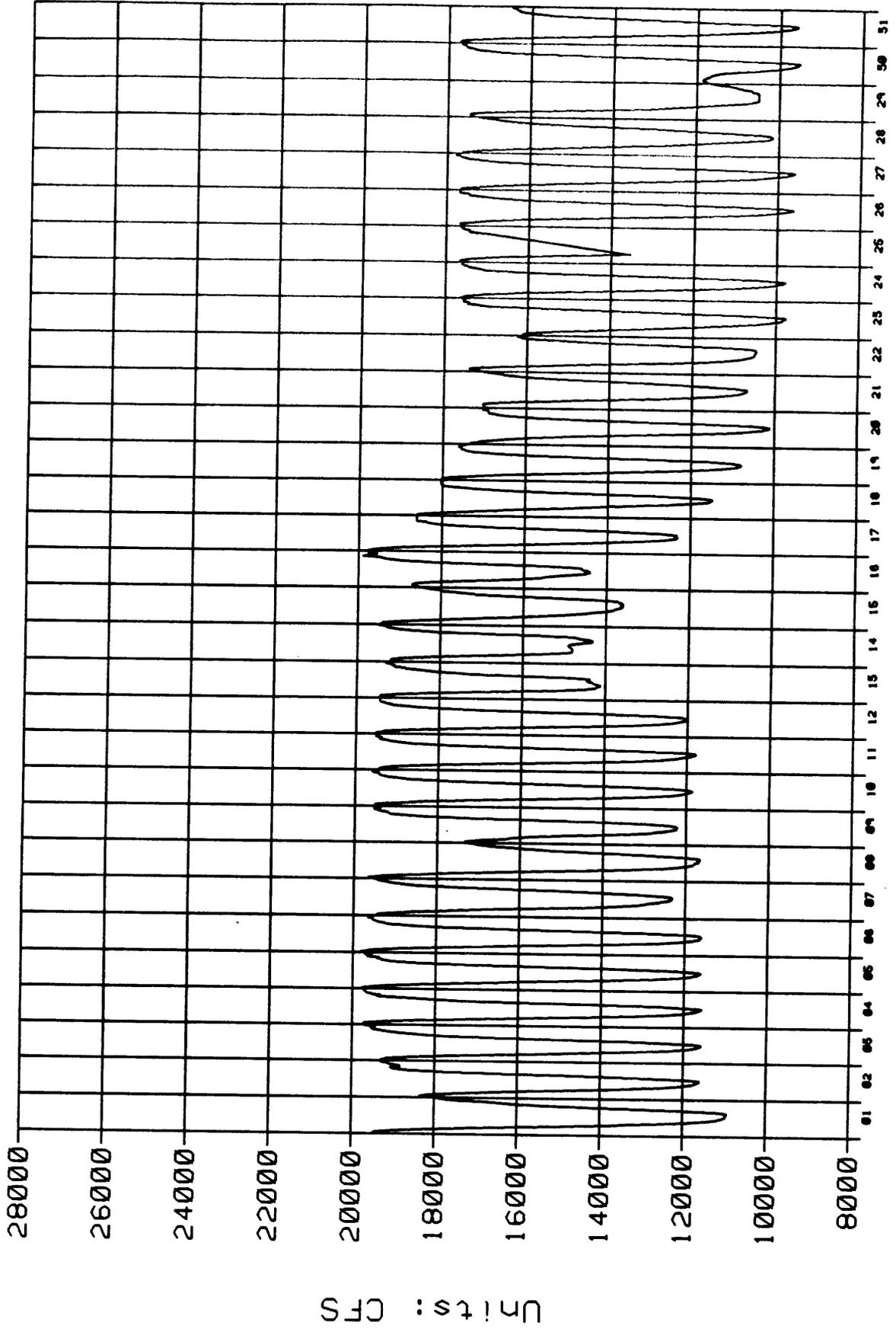
Data From 01-JUL-1993 Through 31-JUL-1993
Plotted 1-JUN-94 08:01:17



Units: FEET

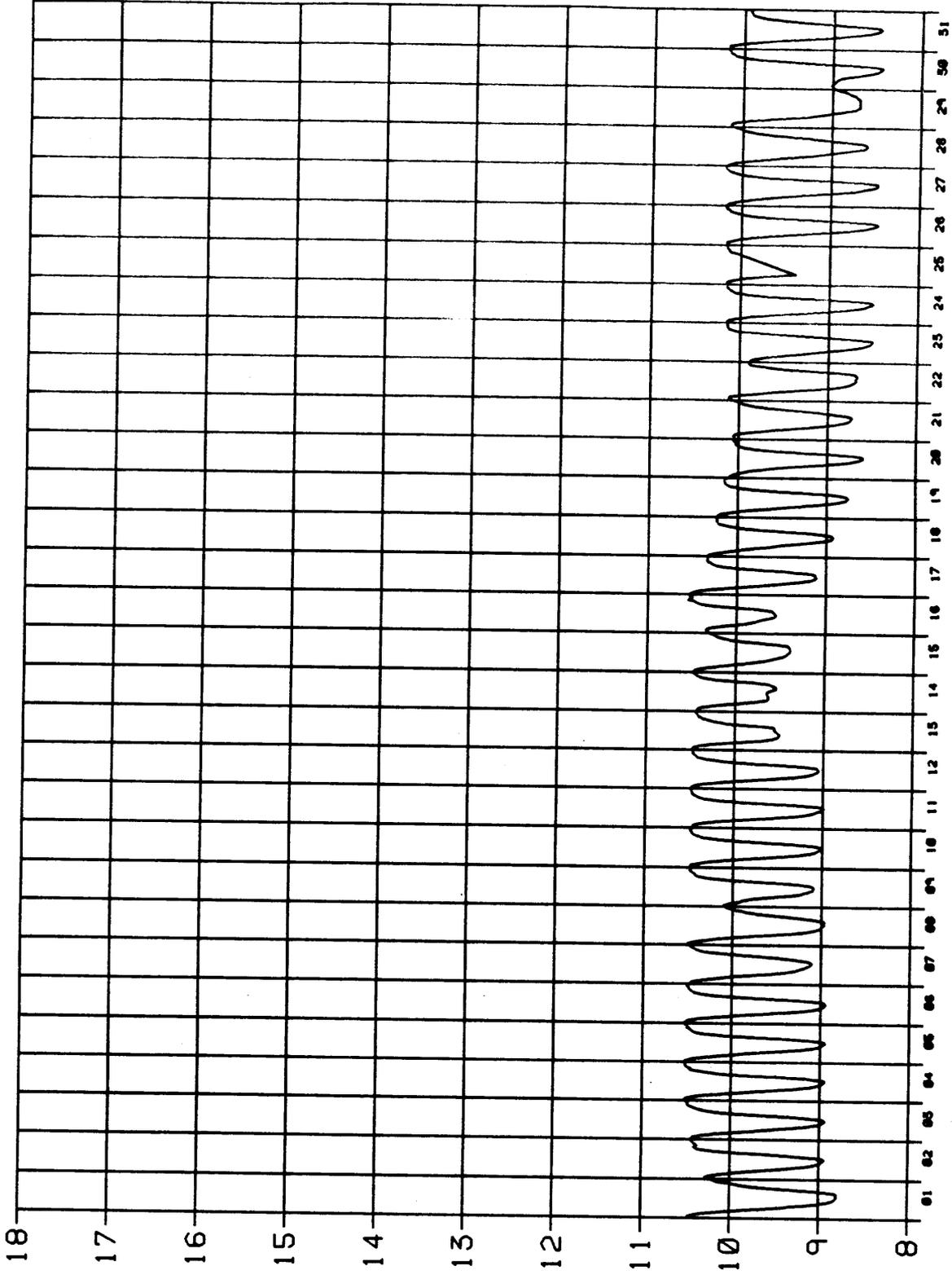
CGCA COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
—— GH Gage Height (feet)

Data From 01-AUG-1993 Through 31-AUG-1993
Plotted 1-JUN-94 07:39:29



CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
Flow Rate (Cfs)

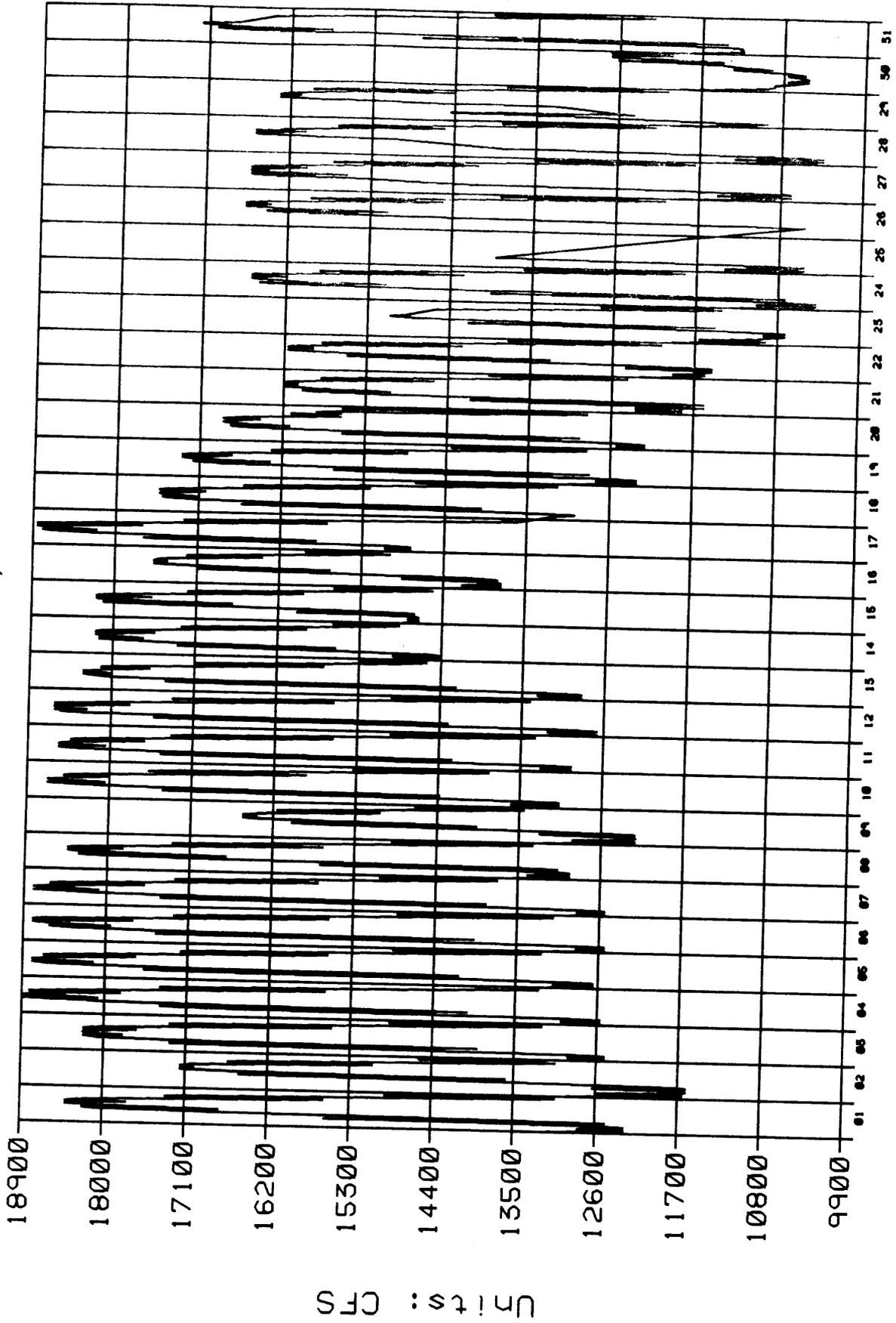
Data From 01-AUG-1993 Through 31-AUG-1993
Plotted 1-JUN-94 07:38:52



Units: FEET

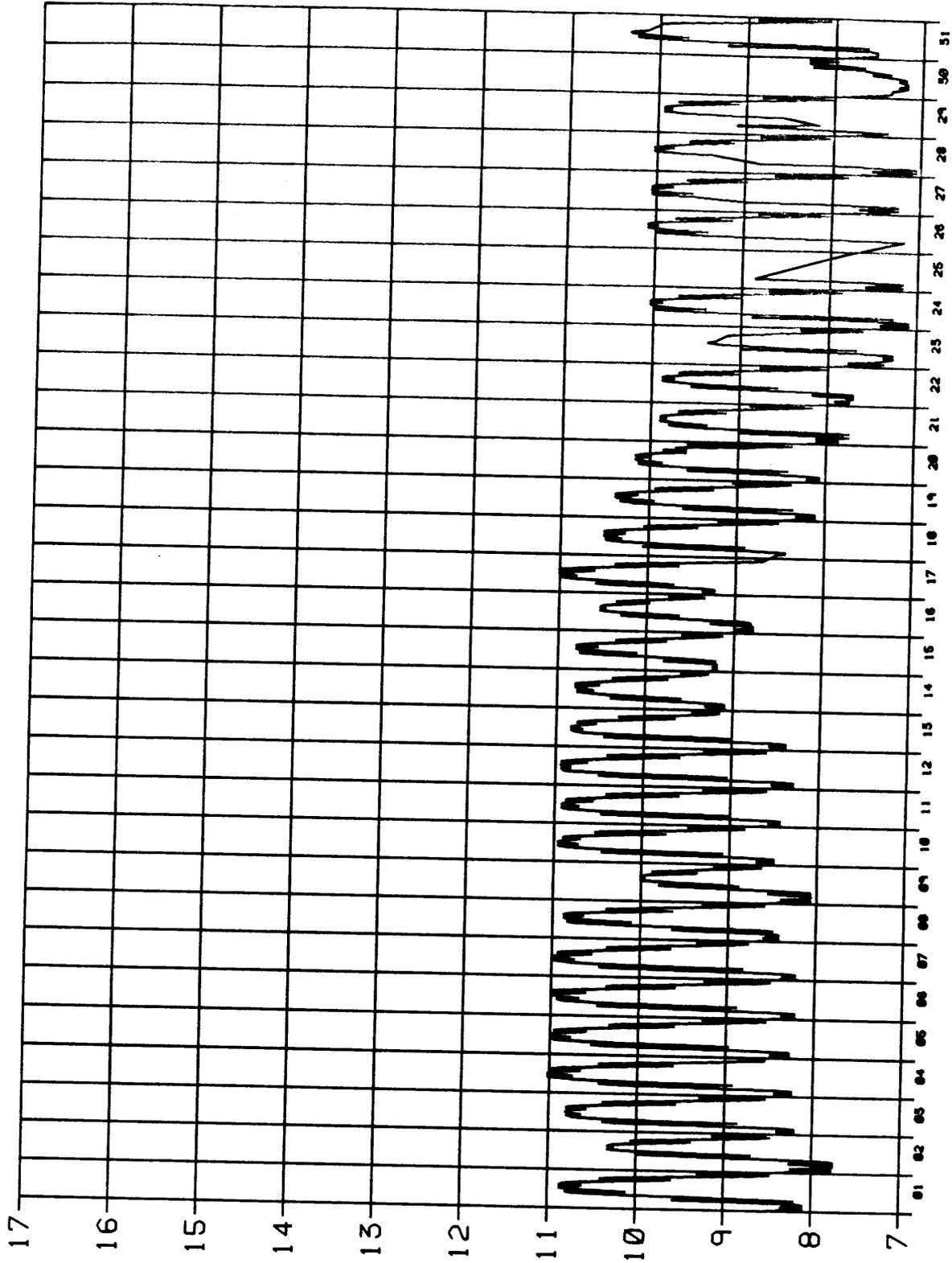
CLFA _____ GH
COLORADO RIVER NEAR LEES FERRY, ARIZONA
Gage Height (feet)

Data From 01-AUG-1993 Through 31-AUG-1993
Plotted 2-JUN-94 08:15:40



CGCA _____ 0 COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Flow Rate (cfs)

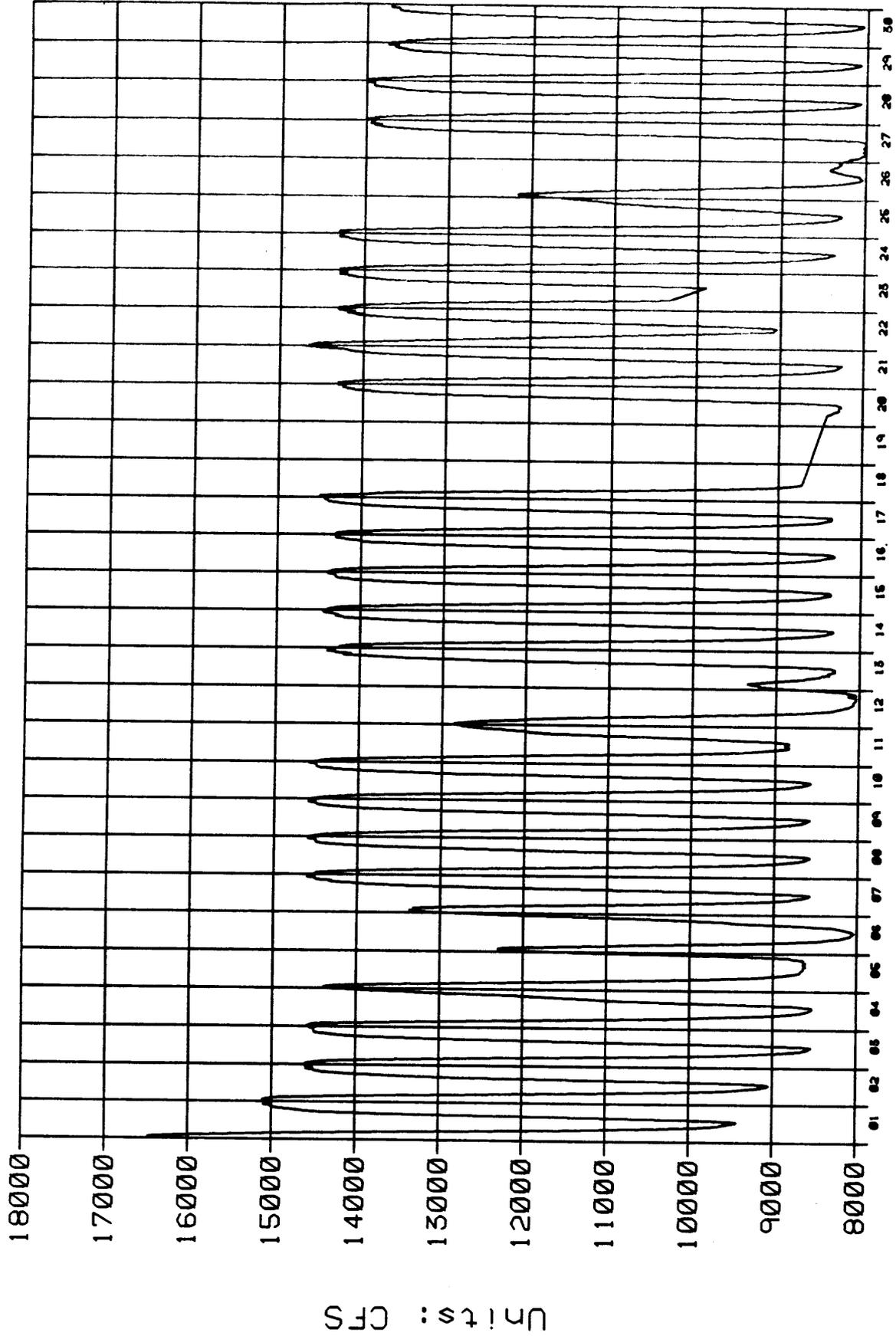
Data From 01-AUG-1993 Through 31-AUG-1993
Plotted 1-JUN-94 12:34:42



Units: FEET

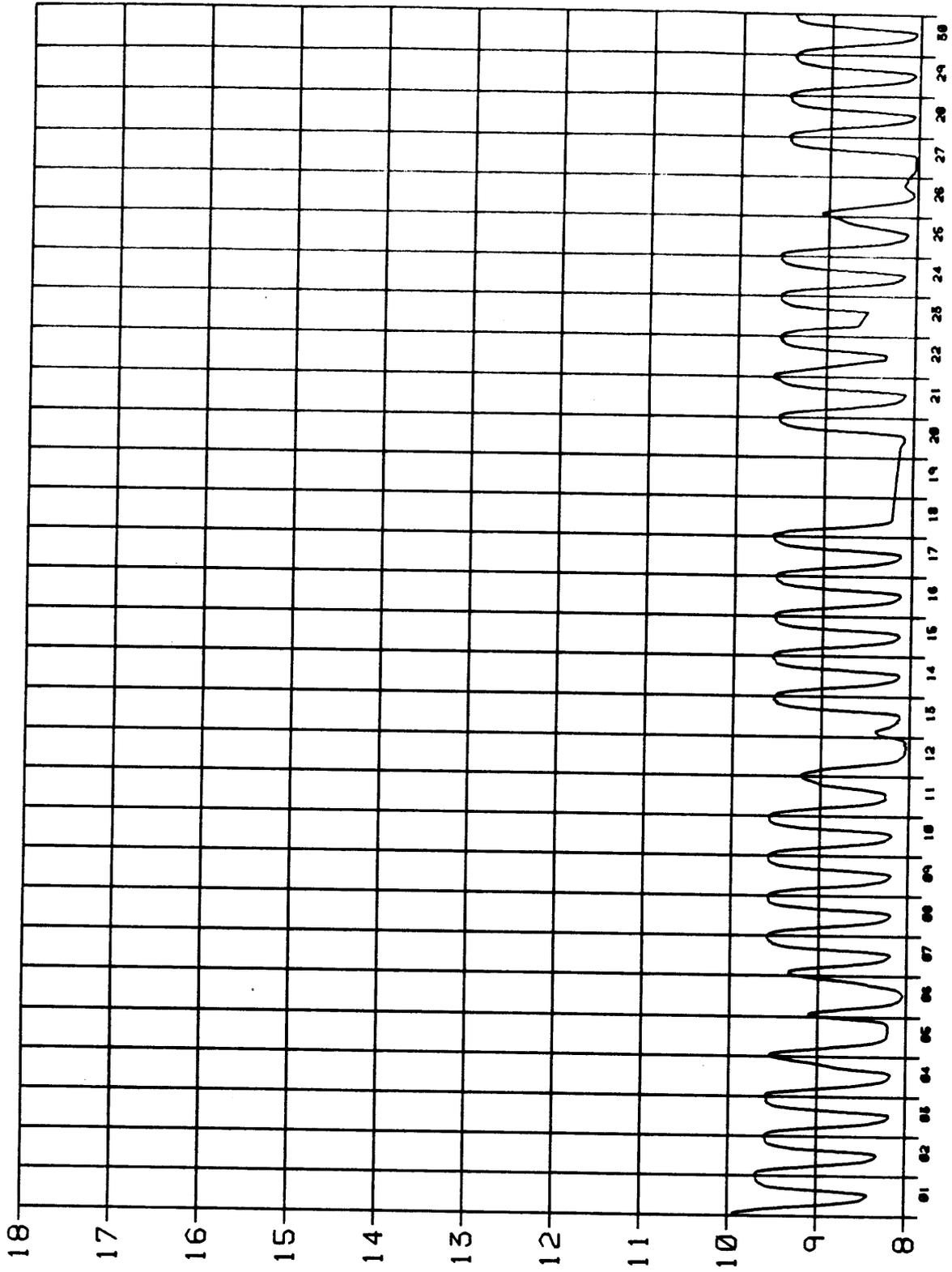
CGCA _____ GH
COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Gage Height (feet)

Data From 01-SEP-1993 Through 30-SEP-1993
Plotted 1-JUN-94 07:38:05



CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
Flow Rate (cfs)

Date From 01-SEP-1993 Through 30-SEP-1993
Plotted 1-JUN-94 07:37:19

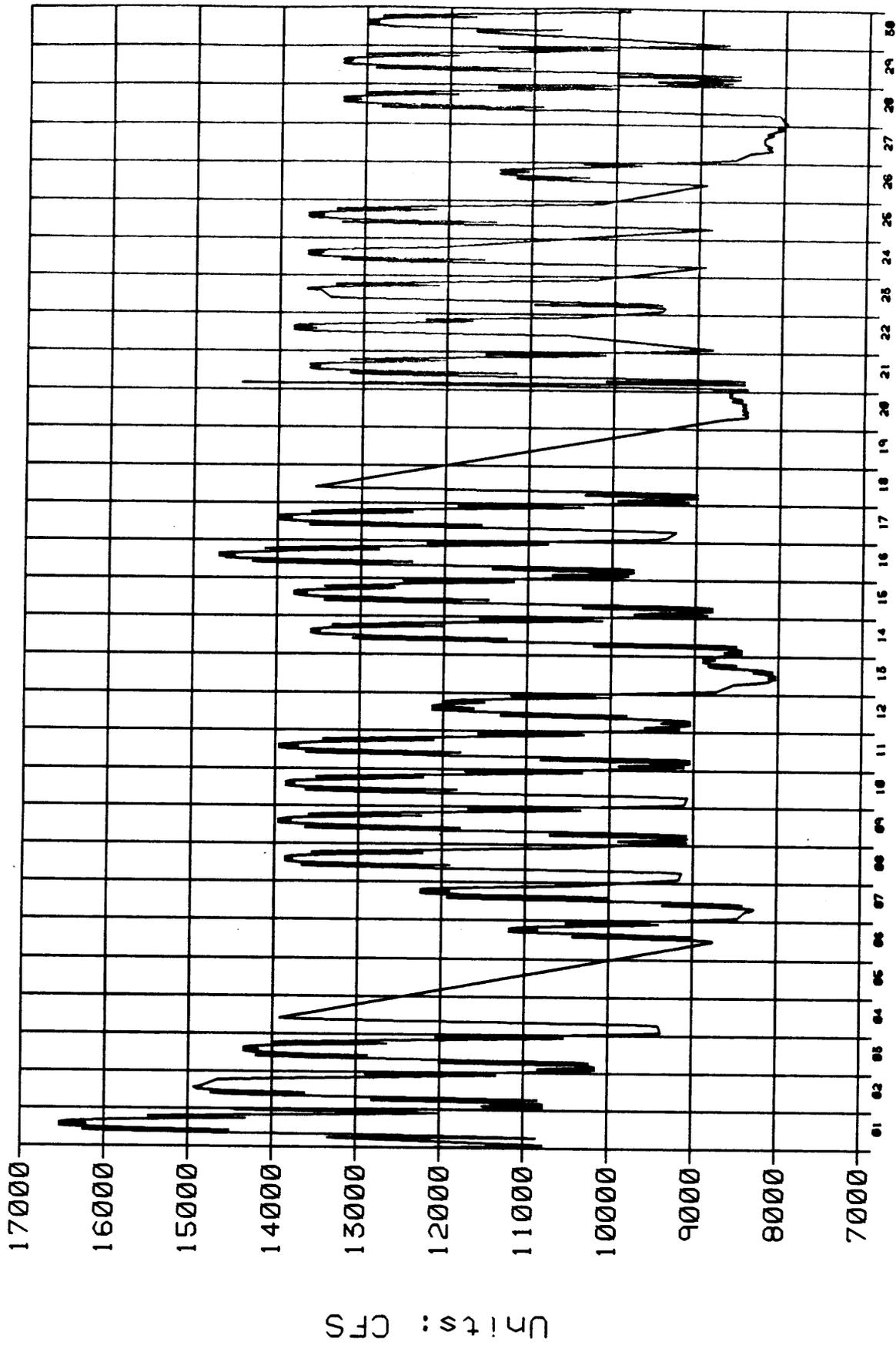


Units: FEET

CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
Gage Height (feet)

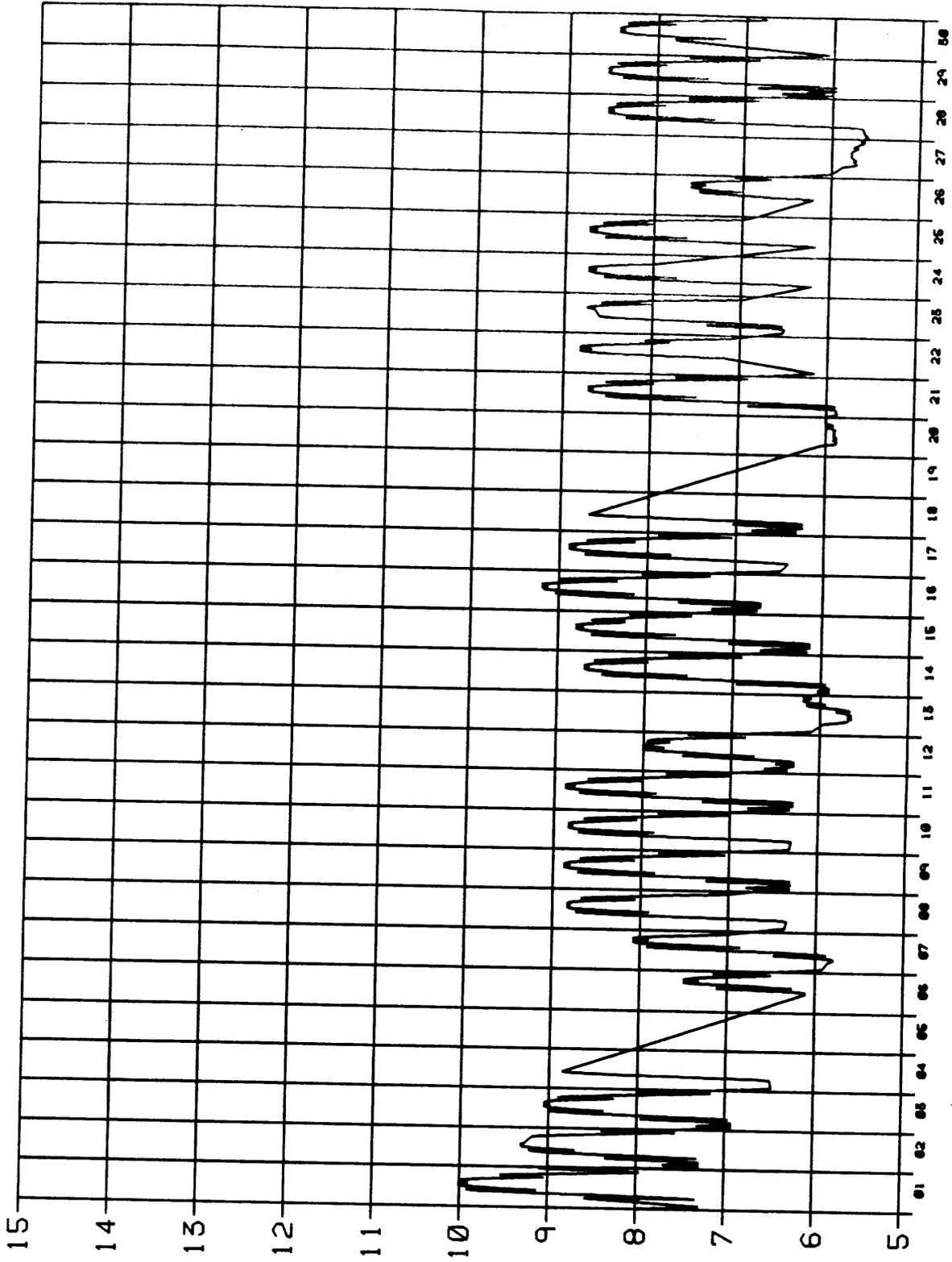
GH

Data From 01-SEP-1993 Through 30-SEP-1993
Plotted 2-JUN-94 08:11:05



CGCA _____ 0 COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Flow Rate (cfs)

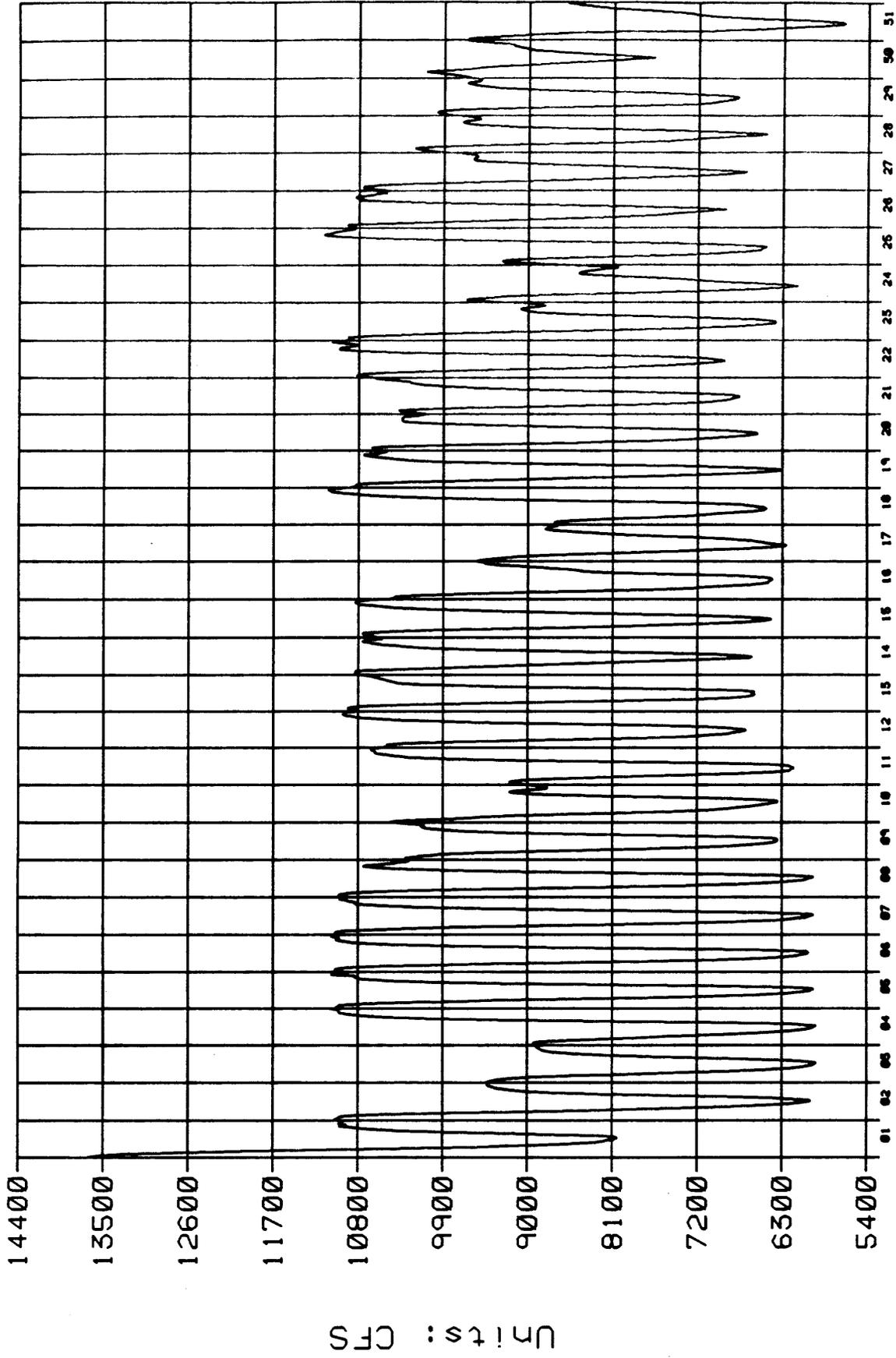
Data From 01-SEP-1993 Through 30-SEP-1993
Plotted 1-JUN-94 12:33:56



Units: FEET

CGCA COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
— GH Gage Height (feet)

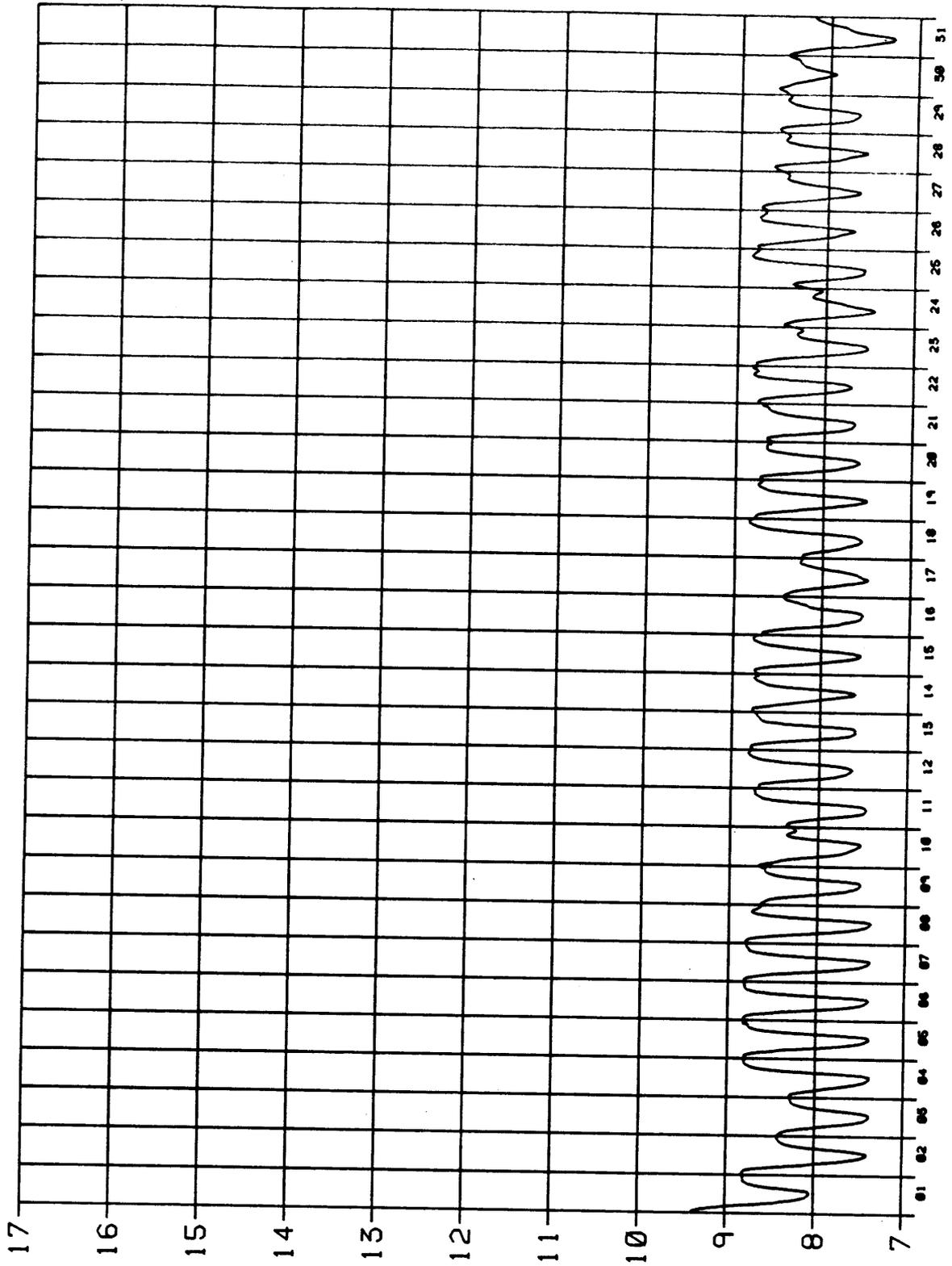
Data From 01-OCT-1993 Through 31-OCT-1993
Plotted 1-JUN-94 07:34:27



CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
Flow Rate (cfs)

Q

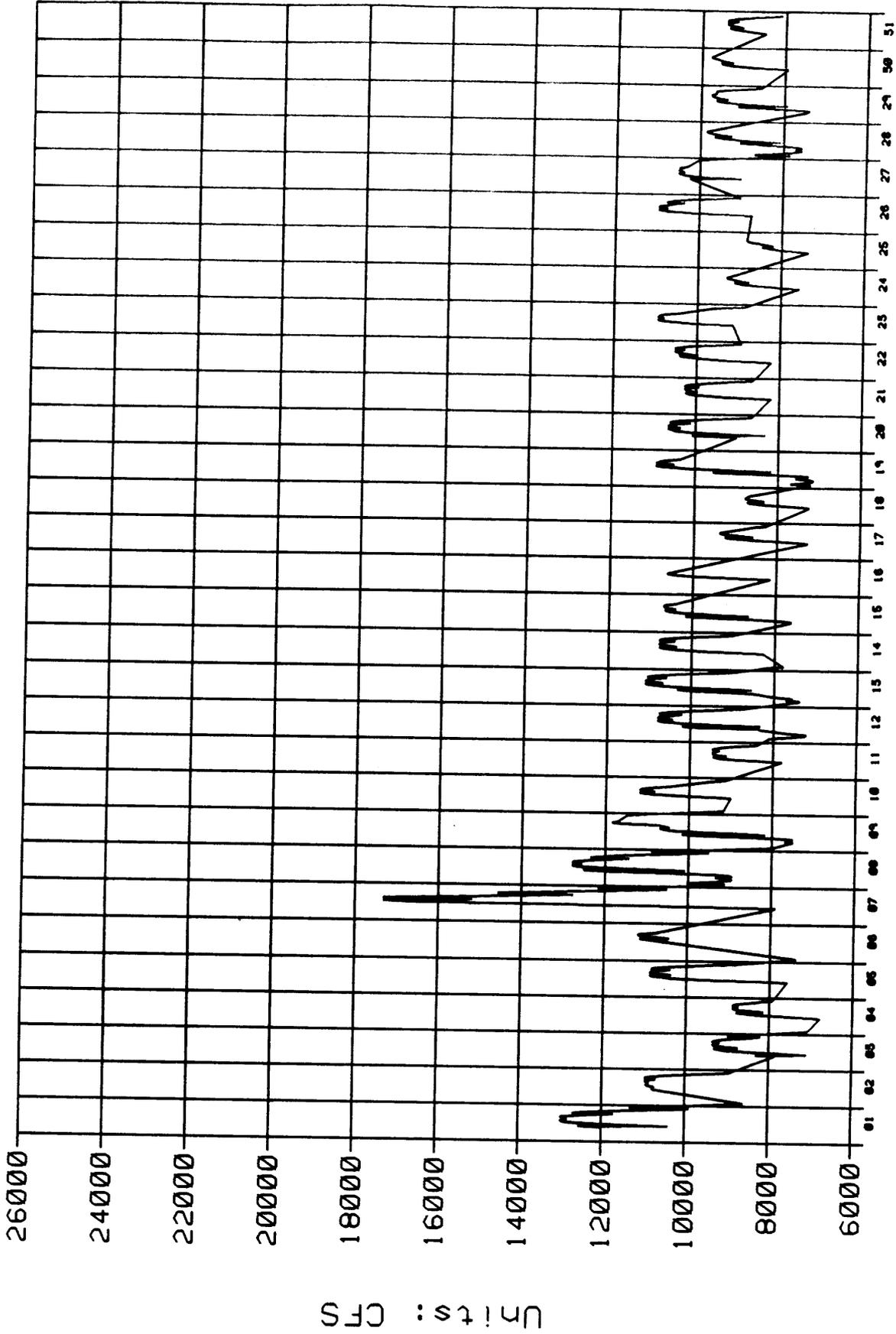
Data From 01-OCT-1993 Through 31-OCT-1993
Plotted 1-JUN-94 07:33:41



Units: FEET

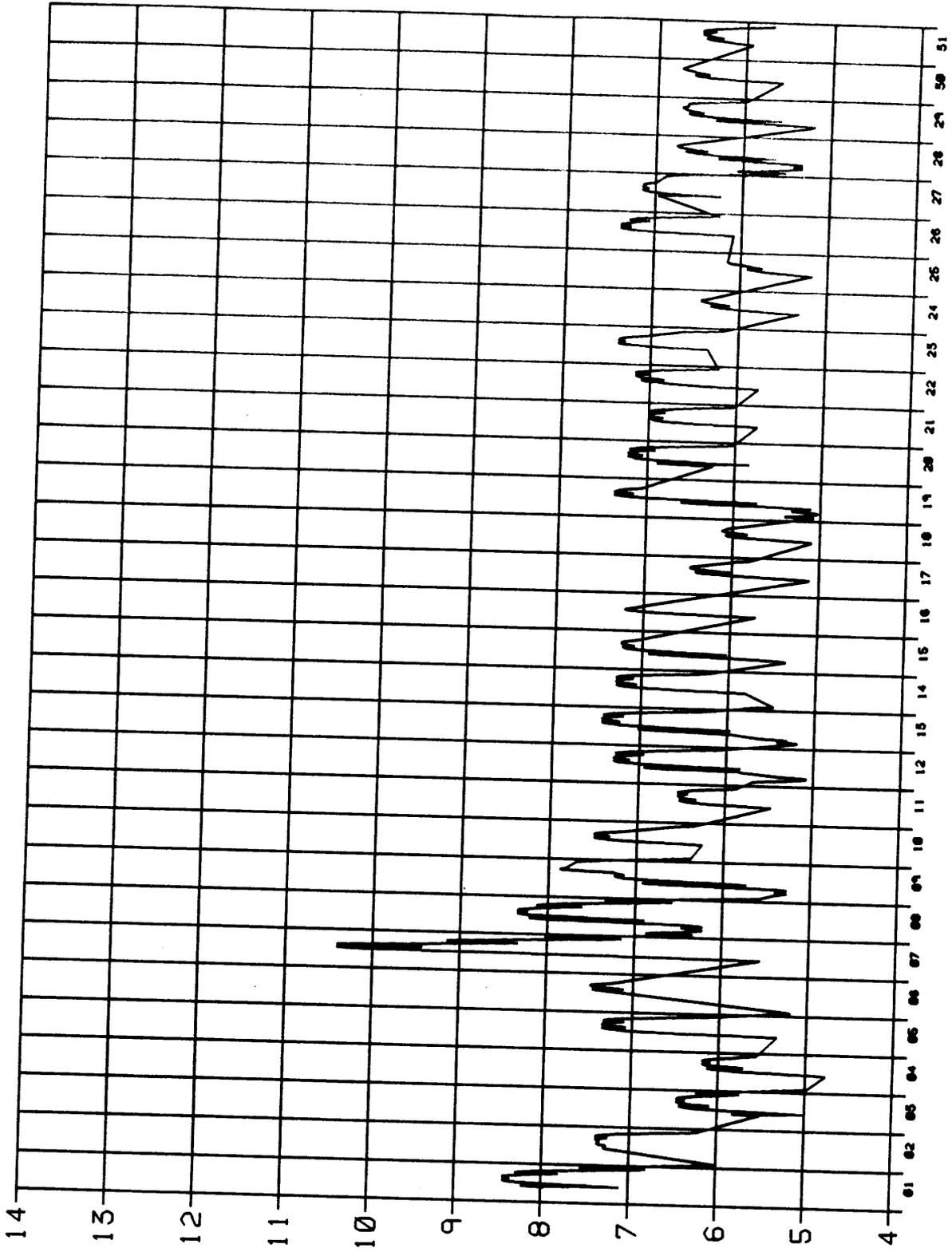
CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
— GH Gage Height (feet)

Data From 01-OCT-1993 Through 31-OCT-1993
Plotted 2-JUN-94 08:03:17



CGCA COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Flow Rate (cfs)

Date From 01-OCT-1993 Through 31-OCT-1993
Plotted 1-JUN-94 12:33:15

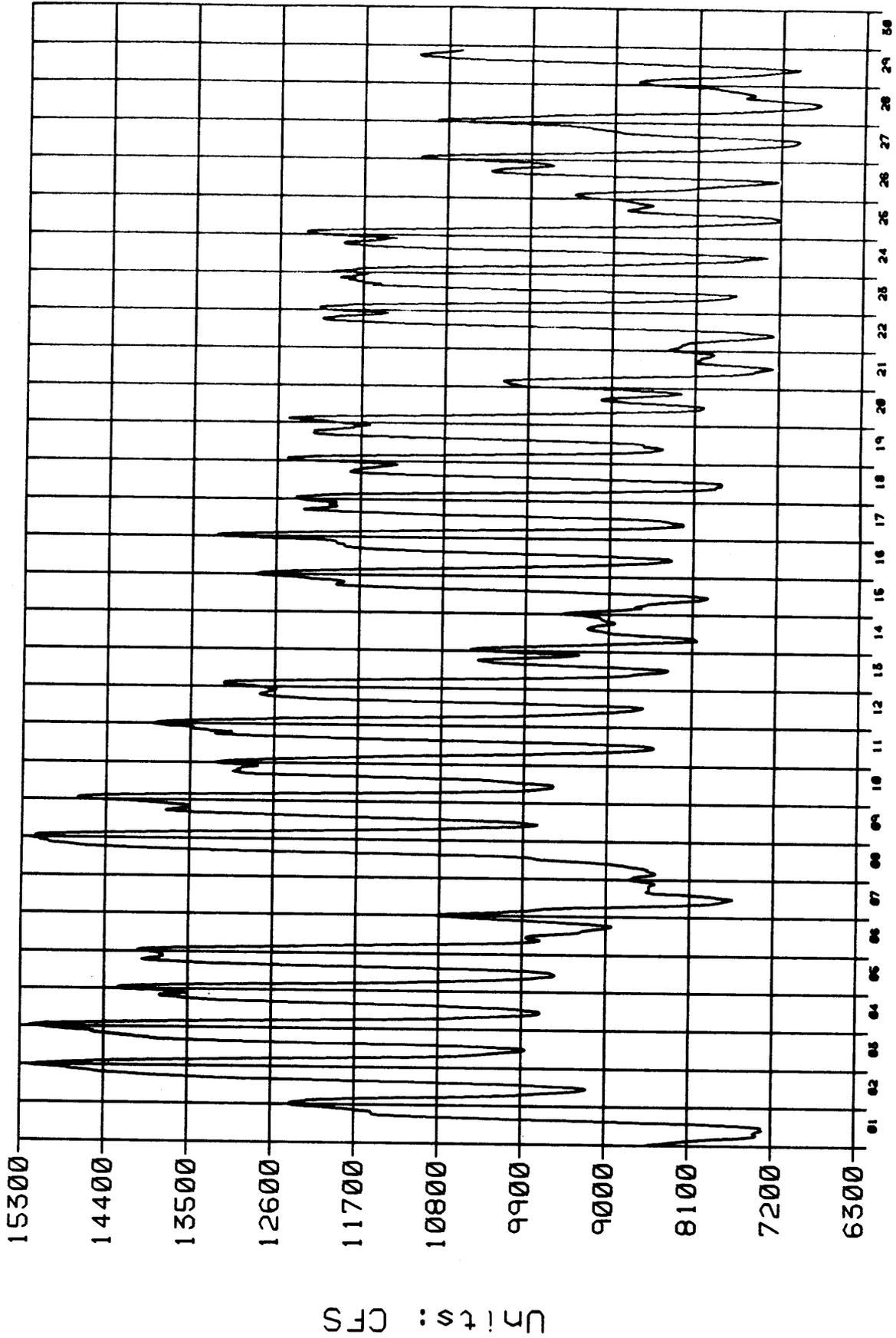


Units: FEET

CGCA COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Gage Height (feet)

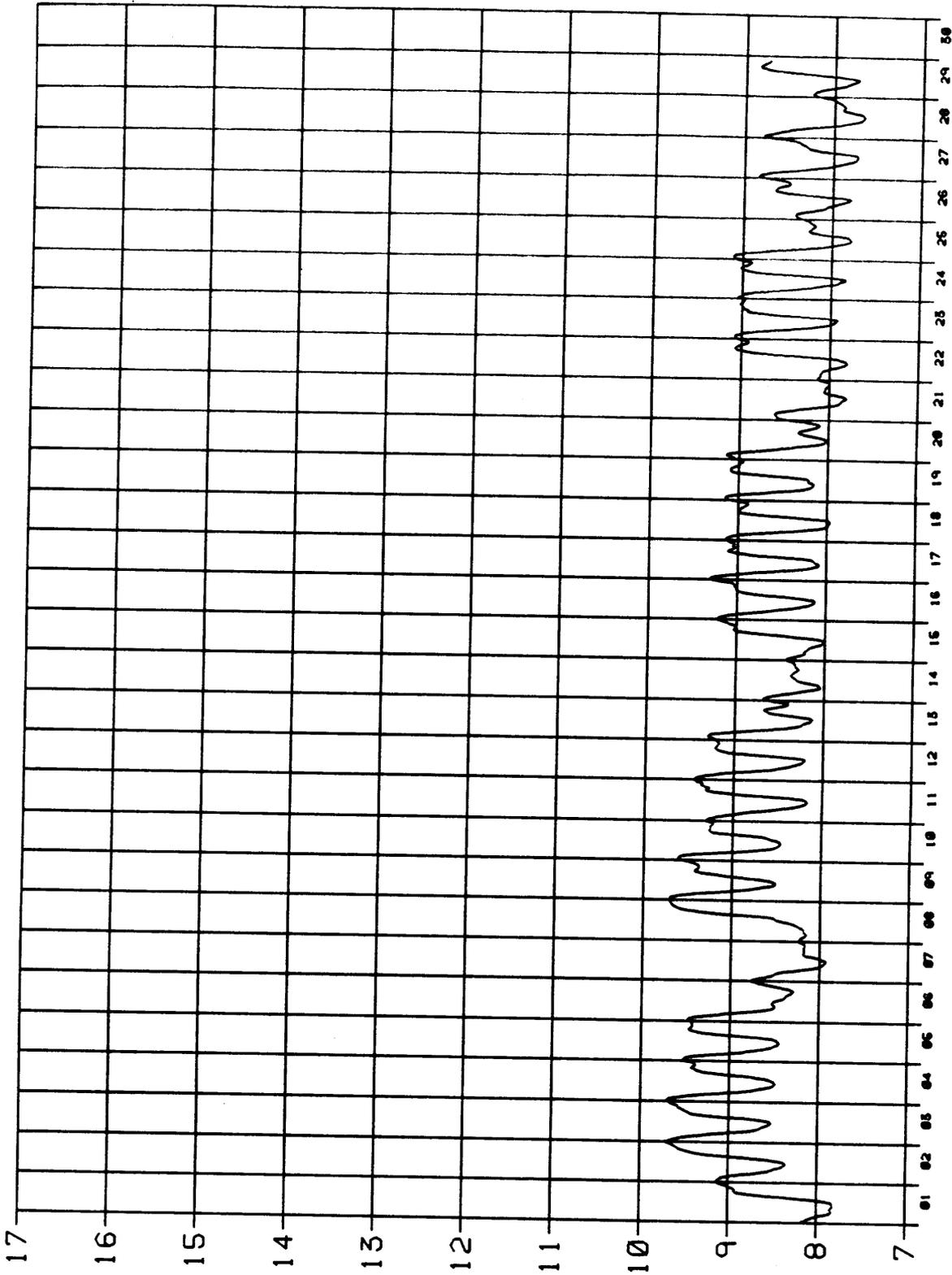
— GH

Date From 01-NOV-1993 Through 30-NOV-1993
Plotted 1-JUN-94 07:31:37



CLFA 0 COLORADO RIVER NEAR LEES FERRY, ARIZONA
Flow Rate (cfs)

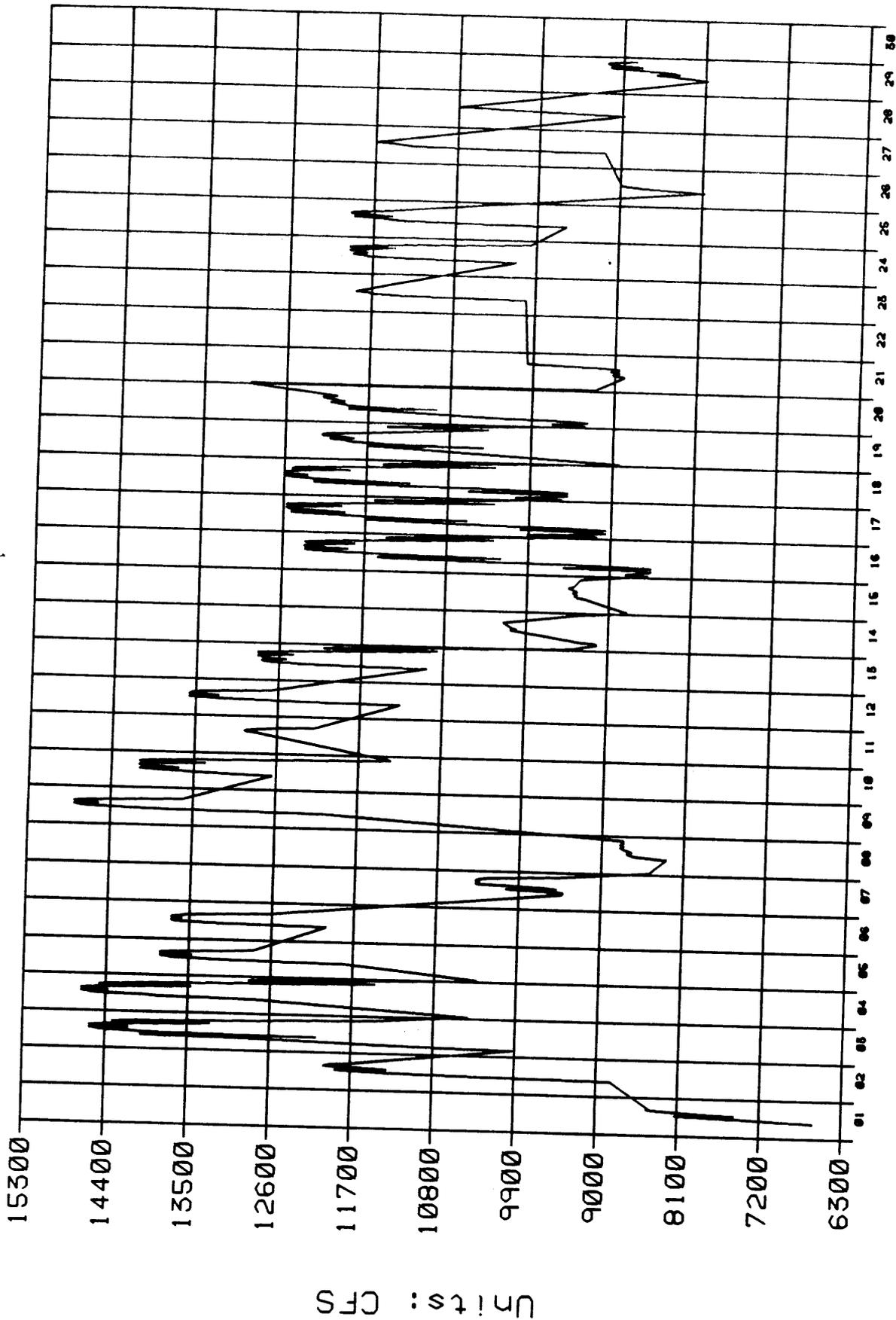
Data From 01-NOV-1993 Through 30-NOV-1993
Plotted 1-JUN-94 07:30:35



Units: FEET

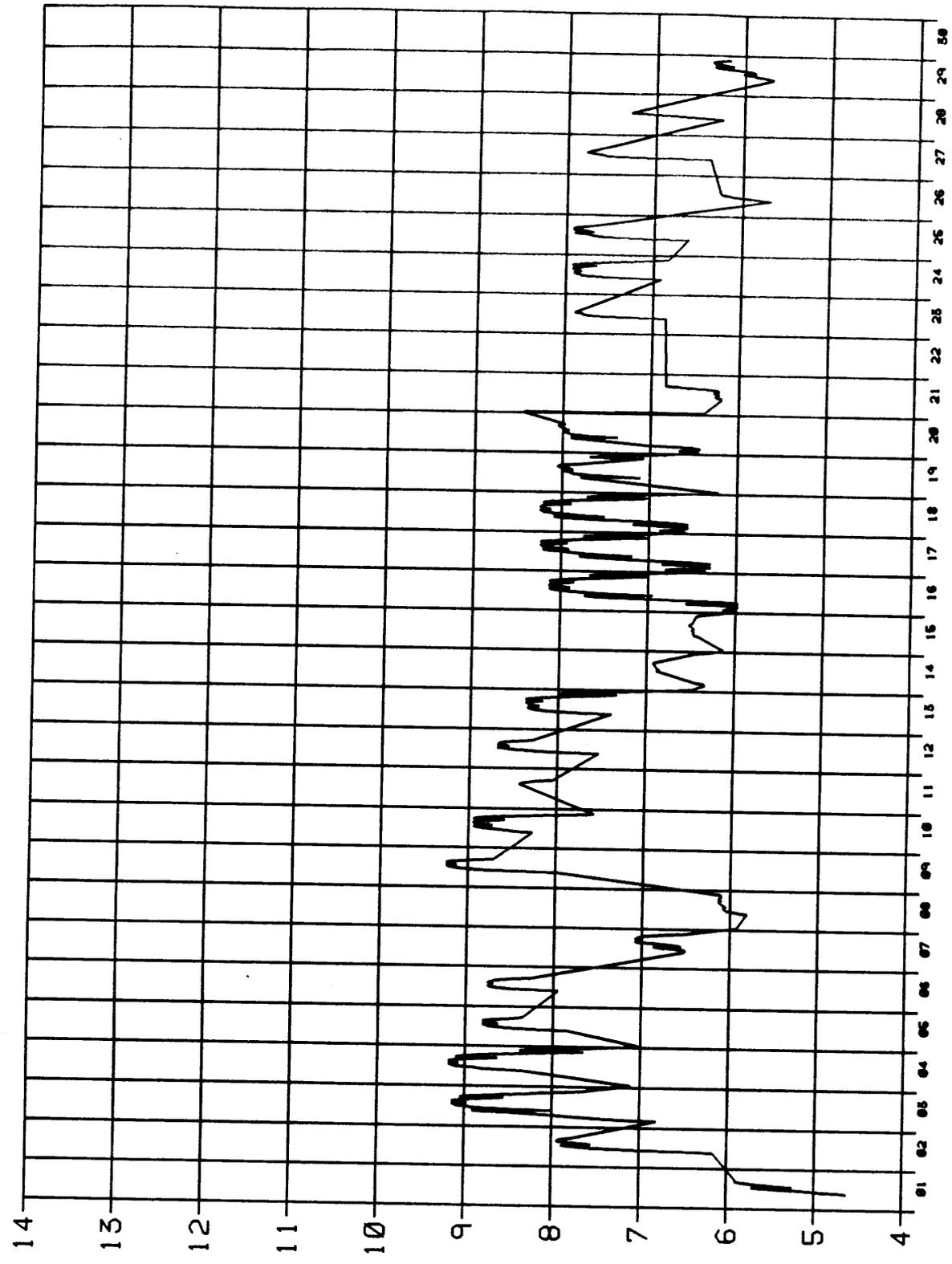
CLFA COLORADO RIVER NEAR LEES FERRY, ARIZONA
— GH Gage Height (feet)

Data From 01-NOV-1993 Through 30-NOV-1993
Plotted 2-JUN-94 07:50:22



CGCA 0 COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Flow Rate (cfs)

Data From 01-NOV-1993 Through 30-NOV-1993
Plotted 1-JUN-94 12:32:33



Units: FEET

CGCA _____ GH
COLORADO RIVER NEAR GRAND CANYON VILLAGE, ARIZONA
Gage Height (feet)

Attachment C

**Glen Canyon Dam Interim Operations
Western Area Power Administration**

GLEN CANYON DAM INTERIM OPERATIONS

Estimated Net Expense
June 1993 Through November 1993

January 1994

GLEN CANYON DAM INTERIM OPERATIONS

Estimated Net Expense

June 1993 Through November 1993

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY	1
II. INTRODUCTION	1
III. SCHEDULING	2
IV. ANALYSIS OF RAMPING EVENTS	5
V. Expenses	6
A. Net Expense	6
B. Purchases	7
C. Economy Energy Sales	7
D. Average Purchase Prices—Base Case and Actual	8
E. Economy Energy Sales Prices—Base Case and Actual	8

GLEN CANYON DAM INTERIM OPERATIONS

Estimated Net Expense

June 1993 Through November 1993

I. EXECUTIVE SUMMARY

Power Scheduling and Real-Time Operations

- In June, high generation levels at the Glen Canyon and the Aspinall units reduced onpeak purchase requirements, forcing Western to sell energy for a low of 3 mills/kWh.
- In early November, the economy energy market tightened due to operational problems with the Laramie River station and with the Palo Verde units, forcing Western to purchase energy at 33 mills/kWh.

Analysis of Ramping Events

- There were 102 deviations: "Control Area Regulation" accounted for most of the anomalies.

Expenses

- Net expense of interim releases:

June 1993	.....	\$618,118
July 1993	.....	\$680,830
August 1993	.....	\$552,370
September 1993	.....	\$446,771
October 1993	.....	\$387,899
November 1993	.....	\$464,447

Power Scheduling Concerns (Future)

- If the low snowpack trend continues across the Upper Colorado River basin, release from the Glen Canyon will be reduced to the 8.230 million acre feet (AF) minimum release requirement. If the entire 475,000 AF equilization releases are eliminated due to low runoff conditions, Western's purchase power requirements will increase approximately 250 GWH during the late Winter and Spring months.

II. INTRODUCTION

On August 1, 1991, former Interior Secretary Manual Lujan implemented interim flows at Glen Canyon Dam. These interim flows were a considerable departure from previous operation of the dam and have had a significant impact on the daily operation of Western Area Power Administration's (Western) Upper Colorado Control Area.

The impacts of this change in dam operations have required Western to implement new scheduling procedures for its customers, develop interim release guidelines for real-time operations, purchase higher-priced energy during onpeak periods, and increase the firm-power rates to its customers to cover the additional costs.

The following sections are a review of Power Operations for the reporting period.

III. SCHEDULING

A. Interim release restrictions have limited Western's ability to accommodate hourly changes in the preschedules. These restrictions have required Western to request customer prescheduling 3 days in advance in order to match firm loads to available project resources and substitute purchases for any hourly deficits. Hourly changes to preschedules have been restricted by the lack of system flexibility. The burden to adjust to changes in real-time load has shifted from the contractors' use of their SLCA/IP resources to the contractors' alternate resources. A majority of these other resources are thermal and have higher costs associated with their use.

B. Power Scheduling and Real-Time Operations

1. Power Scheduling and Purchases for June 1993

Scheduled water releases for Glen Canyon was 675,000 acre foot (AF) for the month. Due to low loads and the lack of an economy sale market the actual release for June was 617,986 AF. The water not released in June will be moved into future months. The daily maximum fluctuation rate was 6,000 cfs. Offpeak generation was scheduled at approximately 7,000 cfs (578 MW) ramping to approximately 13,000 cfs (1074 MW) during onpeak hours. High generation levels at Glen Canyon and the Aspinall units greatly reduced onpeak purchased power requirements. However, the same high generation levels forced dump energy sales during the offpeak hours. Prices for offpeak dump energy sales got as low as 3 mills.

Runoff for the entire month was moderately heavy. Water was bypassed and spilled over the top at Crystal during June. Flaming Gorge releases were high the first 3 weeks of June to accommodate the Endangered Fish Studies spring release request. Flows at Flaming Gorge were gradually reduced to a constant 800 cfs (26 MW) by the end of June. Glen Canyon elevation for the end of June was 3,666' or approximately 34' from full.

2. Power Scheduling and Purchases for July 1993

Scheduled water releases for Glen Canyon was 910,000 AF for the month. The daily maximum fluctuation rate was 8,000 cfs. Offpeak generation was scheduled at approximately 10,800 (427 MW) ramping to approximately 19,500 cfs (770 MW) during onpeak hours. Most firming purchase requirements were met through long term and seasonal purchase agreements with Rocky Mountain Generation

Cooperative, Inc. (RMGC), and Plains Electric Generation & Transmission Cooperative, Inc. (PG&T).

Runoff declined throughout the month. Releases from Crystal were reduced and the by-pass was closed. Inflows and outflows from Blue Mesa were equalized. A special release at Flaming Gorge powerplant, to assist the State of Utah Department of Fish & Wildlife fish survey, was completed. Glen Canyon elevation for the end of July was 3,668 feet or approximately 32 feet from full.

3. Power Scheduling and Purchases for August 1993

Scheduled water releases for Glen Canyon was 910,100 AF for the month. The daily maximum fluctuation rate was 8,000 cfs. Offpeak generation was scheduled at approximately 9,500 cfs (373 MW) ramping to approximately 17,500 cfs (688 MW) during onpeak hours. Most firming purchase requirements were met through long term and seasonal purchase agreements with RMGC and PGT.

Runoff continued to decline throughout the month. A gradual draw down to meet calendar year end carryover requirements was begun at Blue Mesa. A special release at Flaming Gorge powerplant, to assist aerial photography, was completed. Glen Canyon elevation for the end of August was 3,664 feet or approximately 36 feet from full.

4. Power Scheduling and Purchases for September 1993

Scheduled water releases for Glen Canyon was 666,000 AF for the month of September. The daily maximum fluctuation rate was 6,000 cfs. Offpeak generation was scheduled at approximately 8,250 cfs (323 MW) ramping to approximately 14,250 cfs (558 MW) during onpeak hours.

Several special releases at Flaming Gorge were completed during the month. Glen Canyon elevation for the end of September was 3,663 feet or approximately 37 feet from full. Most firming purchase requirements were met through long term and seasonal purchase agreements with RMGC and PGT.

5. Power Scheduling and Purchases for October 1993

Scheduled water releases for Glen Canyon was 550,000 AF for the month of October. The daily maximum fluctuation rate was 5,000 cfs. Offpeak generation was scheduled at approximately 6,000 cfs (235 MW) ramping to approximately 11,000 cfs (430 MW) during onpeak hours.

Irrigation requirements through Gunnison tunnel were slowly reduced through the month. Glen Canyon elevation for the end of October was 3,662 feet or approximately 38 feet from full. Most firming purchase requirements were met through the long term purchase agreement with RMGC.

6. Power Scheduling and Purchases for November 1993

Scheduled water releases for Glen Canyon was initially scheduled at 550,000 AF for the month of November. This was revised upward to 600,000 AF due to the unavailability of spot market purchase power, requiring the use of water that had been held back for anticipated spring 1994 spike releases at Glen Canyon. The maximum daily fluctuation was 6,000 cfs. Offpeak generation was scheduled at approximately 8,250 cfs (323 MW). Ramping to approximately 14,250 (558 MW) during onpeak hours.

In early November 1993, the economy energy market tightened due to operational problems with the Laramie River Station and the Palo Verde units. RMGC had no energy to preschedule for 2 days, indicative of the energy market in which no utility (apparently) had any energy at any price. This "energy shortage" was alleviated when the Power Control Staff was given permission from Reclamation to move additional water into November, thereby, increasing Glen Canyon Dam releases (From: Secretary's Report, November 5, 1993).

Irrigation through the Gunnison tunnel was reduced to zero in November. A special release at Crystal was requested to allow work on the tunnel shut-off valve. The valve would not close completely. Glen Canyon elevation for the end of November was 3,662 feet or approximately 38 feet from full. Most firming purchase requirements were met through the long term purchase agreement with RMGC.

7. Power Scheduling and Purchases for December 1993

Scheduled water releases for Glen Canyon was 801,000 AF for the month of December. The maximum daily fluctuation was 8,000 cfs. Offpeak generation was scheduled at approximately 9,000 cfs (351 MW). Ramping to approximately 17,000 cfs (662 MW) during onpeak hours. Glen Canyon elevation for the end of December was 3,654 feet or approximately 41 feet from full. Most firming purchase requirements were met the long term purchase agreement with RMGC.

C. Future Scheduling Concerns for Winter/Spring Operations

The December, 1993, USBR Annual Operating Plan for water year 1994, lists annual releases from Glen Canyon powerplant to be 8.705 million AF. This equates to 475,000 AF of equalization releases into Lake Mead. At the present time, snowpack across the Upper Colorado River basin is below normal. If the low snowpack trends continue, releases from Glen Canyon will be reduced to the 8.230 million AF minimum release requirement. If the entire 475,000 AF equalization releases are eliminated due to low runoff conditions, the Salt Lake City Area (SLCA) purchase power requirements will increase approximately 250 GWH. With increased purchase requirements, the SLCA will loose powerplant capacity in months where water reductions decrease monthly fluctuation amounts below 8,000 cfs and below 6,000 cfs.

Low snowpack conditions exist in the upper Green River Basin. As of January 10, releases from Flaming Gorge have been cut back the equivalent of 300 MWh per day, necessitating the lost energy to be recovered through Western purchases. This reduction equates to a loss of 25 MW of generating capacity across peak periods due to existing ramping procedures in place for the on going winter endangered fish studies. If below normal snow conditions continue, Flaming Gorge releases will be maintained at lower than anticipated levels through spring. This leaves a big concern over the magnitude of the spring release for endangered fish studies. High spring releases equate to lower fall and winter releases impacting Western's purchase needs.

Snowpack conditions in the Gunnison Basin are about 75 percent of normal. Releases from Crystal powerplant will be cut from 1,400 cfs to approximately 800 cfs the week of January 10. This is a loss of approximately 800 MWh of generation on a daily basis and reduces the number of hours the Aspinal units can be made available for peaking purposes. Due to the limited number of hours the Aspinal units will be available for generation, Glen Canyon will be maintained on regulation control for the remainder of the winter season.

The winter season energy market appears to be healthy; energy availability should remain stable. Before the reduction in water releases, Western's system generation has been high enough to meet most of Western's firming requirements in conjunction with seasonal energy purchase contracts.

Because generating capability will be reduced, Western will be purchasing more energy from a volatile economy energy market exposing Power Control Operations to potential emergency conditions.

Water releases for the upcoming summer season are unknown and difficult to plan for. Western has three long-term purchase agreements that will provide for most energy requirements should any emergencies develop.

IV. ANALYSIS OF RAMPING EVENTS

A study was made to analyze hourly release rates which appeared to deviate from interim flow criteria. Operational records and logs kept during the study period, June 1, 1993, through November 30, 1993 were reviewed.

The operational records and logs are contained within the packet Glen Canyon Dam Interim Flows—Glen Canyon Power Plant Operations, for June 1993 through November 1993 and provide specific explanations for each ramping event.

Each page within the packet contains (1) a strip chart of real-time Glen Canyon Dam operations during the ramping event, (2) a graph of the USGS Lees Ferry Gauge showing river elevation during the ramping event, (3) a graph of hourly integrated Glen Canyon Dam generation during the ramping event, and (4) a brief written explanation of the ramping event.

For the study period, 102 instances of deviations were found. Most of the conditions were caused by more than one factor: for example, control area regulation and imports/exports different than preschedule; therefore, multiple variations can be explained by one anomaly.

The following table summarizes the causes and frequency of the 102 deviations:

<u>Primary Cause(s) of Deviation</u>	<u>Number Of Instances</u>	<u>Percent Of Events</u>
Control Area Regulation	39/102	38
CRSP Resource Availability	14/102	14
Aspinall Operations	1/102	1
Morrow Point Operations	4/102	4
Blue Mesa Operations	2/102	2
Imports/Exports Different than Preschedule	18/102	18
Glen Canyon Operations	5/102	5
Other	19/102	19

V. **Expenses**

A. **Net Expense**

The estimated net expense of interim releases for June through November 1993 are summarized below:

	<u>Net Expense</u>
June 1993	\$618,118
July 1993	\$680,830
August 1993	\$552,370
September 1993	\$446,771
October 1993	\$387,899
November 1993	\$464,447

Attached are Tables 1 through 6 detailing the net expense analysis by component for June 1993, July 1993, August 1993, September 1993, October 1993, and November 1993.

B. Purchases

A comparison of Base Case purchases to Actual purchases are summarized below:

Energy Purchase Comparison			
Months	Simulated Base Case Purchases	Actual Purchases	Differences
June 1993	9,661 MWh	34,704 MWh	(25,043) MWh
July 1993	51,107 MWh	55,475 MWh	(4,368) MWh
August 1993	64,660 MWh	66,309 MWh	(1,649) MWh
September 1993	83,788 MWh	68,124 MWh	15,664 MWh
October 1993	117,645 MWh	115,149 MWh	2,496 MWh
November 1993	90,452 MWh	58,594 MWh	31,858 MWh

For June, July, and August, actual purchases were greater than projected for Base Case conditions. However, for September, October, and November, actual purchases were less than projected for Base Case conditions. This is due to a shift in deficits from onpeak to offpeak hours in the Base Case, resulting in higher purchases during offpeak hours.

C. Economy Energy Sales (Surplus)

For the exception of July and August, actual nonfirm energy sales were less than projected for Base Case conditions. Revenues foregone are estimated below:

ENERGY SALES AND REVENUES FOREGONE			
Months	Base Case	Actual	Revenues Foregone
June 1993	\$796,224	\$772,299	\$23,925
July 1993	579,793	598,368	(18,575)
August 1993	589,793	624,095	(34,302)
September 1993	418,279	55,452	362,827
October 1993	83,402	27,442	55,960
November 1993	739,834	33,883	705,951

D. Average Purchase Prices—Base Case and Actual

The average monthly purchase price estimates are derived from the actual nonfirm energy purchase prices. With the help of the Power Control staff (Montrose), some of the higher purchase prices for June, September, October, and November that are associated directly with interim release constraints, were excluded. There were no changes in the purchase prices for July and August because it reflected market purchase prices if restrictions were not in place at the Glen Canyon Dam, according to Montrose. An adjusted weighted average of remaining purchase amounts and prices are rendered to calculate the base case offpeak and onpeak purchase prices.

Average Base Case monthly purchase prices are estimated as follows:

ENERGY PURCHASE PRICES				
Months	Base Case		Actual	
	Offpeak	Onpeak	Offpeak	Onpeak
June 1993	\$13.06/MWh	\$20.98/MWh	\$13.65/MWh	\$20.98/MWh
July 1993	10.03/MWh	22.11/MWh	10.03/MWh	22.11/MWh
August 1993	13.25/MWh	22.09/MWh	13.25/MWh	22.09/MWh
September 1993	15.79/MWh	22.78/MWh	15.82/MWh	23.03/MWh
October 1993	14.87/MWh	24.27/MWh	15.18/MWh	23.29/MWh
November 1993	16.00/MWh	24.56/MWh	16.02/MWh	25.58/MWh

E. Economy Energy Sales Prices—Base Case and Actual

The sales price for the Base Case is determined with the help of the Montrose Power Control Staff (Montrose). The estimate of economy energy sales prices involve three steps:

1. Identification of the range of market prices through review of Montrose District Office Power Control staff's summaries of then-current weekly market prices, as reflected in Western's Weekly Reports to the Secretary.
2. Review of the actual monthly economy energy sales summary and, with the help of the Power Control staff, identification of those forced sales directly associated with interim release constraints.
3. Assumption of expected sales price based on then-current market conditions for that portion of sales identified in step 2.

In most instances, Western would have had the flexibility of making all or most of the nonfirm energy sales during periods

when the value is greatest. For October and November, the economy energy sales prices under the Base Case is the same as the actual sales price, reflecting no forced sales within this period. However, during the Summer months, (June, July, August) and September there were significant price difference between Base Case and actual sales prices. This is due to high releases that occurred during the Summer months and in September.

A comparison of average monthly economy energy sales, for Base Case prices to Actual prices, and depicting the range of forced sales that occurred during the summer and winter months are presented below:

ECONOMY ENERGY SALES PRICES BASE CASE & ACTUAL			
Months	Base Case Prices	Actual Prices	Differences Between Base Case Prices and Actual Prices
June 1993	\$17.16/MWh	\$10.81/MWh	\$6.35/MWh
July 1993	18.29/MWh	16.59/MWh	1.70/MWh
August 1993	21.16/MWh	21.14/MWh	0.02/MWh
September 1993	23.08/MWh	22.56/MWh	0.52/MWh
October 1993	22.42/MWh	22.42/MWh	0.00/MWh
November 1993	22.16/MWh	22.16/MWh	0.00/MWh

Table 1
Glen Canyon Dam Interim Release
for June 1993
Net Expense Analysis

<u>Base Case (Without Interim Release)</u>		<u>Actual (With Interim Release)</u>	
Firm Load & Losses:	511,835 MWh	Firm Load & Losses:	511,835 MWh
GC Generation:	288,767 MWh	GC Generation:	288,767 MWh
Other CRSP/IP Generation:	259,807 MWh	Other CRSP/IP Generation:	259,807 MWh
Total Generation:	548,574 MWh	Total Generation:	548,574 MWh
Purchases:	9,661 MWh	Purchases:	34,704 MWh
Off Peak:	8,856 MWh	Off Peak:	184 MWh
On Peak:	805 MWh	On Peak:	34,520 MWh
Surplus:	46,400 MWh	Surplus:	71,443 MWh
Off Peak:	12,414 MWh	Off Peak:	51,392 MWh
On Peak:	33,986 MWh	On Peak:	20,051 MWh
<hr/>			
Purchase Prices:		Purchase Prices:	
Off Peak:	\$13.06/MWh	Off Peak:	\$13.65/MWh
On Peak:	\$20.98/MWh	On Peak:	\$20.98/MWh
Sales Price:	\$17.16/MWh	Sales Price:	\$10.81/MWh
<hr/>			
Purchase Expense:	\$132,548	Purchase Expense:	\$726,741
Off Peak:	\$115,659	Off Peak:	\$2,512
On Peak:	\$ 16,889	On Peak:	\$724,230
Surplus Sales:	\$796,224	Surplus Sales:	\$772,299
<hr/>			
Base Case Expense:	(\$663,676)	Change Case Expense:	(\$45,558)
Total Net Expense for June 1993			\$618,118

Table 2
 Glen Canyon Dam Interim Release
 for July 1993
 Net Expense Analysis

<u>Base Case (Without Interim Release)</u>		<u>Actual (With Interim Release)</u>	
Firm Load & Losses:	627,864 MWh	Firm Load & Losses:	627,864 MWh
GC Generation:	430,622 MWh	GC Generation:	430,622 MWh
Other CRSP/IP Generation:	177,835 MWh	Other CRSP/IP Generation:	177,835 MWh
Total Generation:	608,457 MWh	Total Generation:	608,457 MWh
Purchases:	51,107 MWh	Purchases:	55,475 MWh
Off Peak:	49,974 MWh	Off Peak:	71 MWh
On Peak:	1,133 MWh	On Peak:	55,404 MWh
Surplus:	31,700 MWh	Surplus:	36,068 MWh
Off Peak:	4,284 MWh	Off Peak:	30,512 MWh
On Peak:	27,416 MWh	On Peak:	5,556 MWh
<hr/>			
Purchase Prices:		Purchase Prices:	
Off Peak:	\$10.03/MWh	Off Peak:	\$10.03/MWh
On Peak:	\$22.11/MWh	On Peak:	\$22.11/MWh
Sales Price:	\$18.29/MWh	Sales Price:	\$16.59/MWh
<hr/>			
Purchase Expense:	\$526,290	Purchase Expense:	\$1,225,695
Off Peak:	\$501,239	Off Peak:	\$712
On Peak:	\$25,051	On Peak:	\$1,224,982
Surplus Sales:	\$579,793	Surplus Sales:	\$598,368
<hr/>			
Base Case Expense:	(\$53,503)	Change Case Expense:	\$627,326
Total Net Expense for July 1993			\$680,830

Table 3
 Glen Canyon Dam Interim Release
 for August 1993
 Net Expense Analysis

<u>Base Case (Without Interim Releases)</u>		<u>Actual (With Interim Release)</u>	
Firm Load & Losses:	632,575 MWh	Firm Load & Losses:	632,575 MWh
GC Generation:	441,676 MWh	GC Generation:	441,676 MWh
Other CRSP/IP Generation:	154,112 MWh	Other CRSP/IP Generation:	154,112 MWh
Total Generation:	595,788 MWh	Total Generation:	595,788 MWh
Purchases:	64,660 MWh	Purchases:	66,309 MWh
Off Peak:	62,871 MWh	Off Peak:	626 MWh
On Peak:	1,789 MWh	On Peak:	65,683 MWh
Surplus:	27,873 MWh	Surplus:	29,522 MWh
Off Peak:	5,102 MWh	Off Peak:	25,898 MWh
On Peak:	22,771 MWh	On Peak:	3,624 MWh
<hr/>			
Purchase Prices:		Purchase Prices:	
Off Peak:	\$13.25/MWh	Off Peak:	\$13.25/MWh
On Peak:	\$22.09/MWh	On Peak:	\$22.09/MWh
Sales Price:	\$21.16/MWh	Sales Price:	\$21.14/MWh
<hr/>			
Purchase Expense:	\$872,560	Purchase Expense:	\$1,459,232
Off Peak:	\$833,041	Off Peak:	\$8,295
On Peak:	\$39,519	On Peak:	\$1,450,937
Surplus Sales:	\$589,793	Surplus Sales:	\$624,095
<hr/>			
Base Case Expense:	\$282,767	Change Case Expense:	\$835,137
Total Net Expense for August 1993			\$552,370

Table 4
 Glen Canyon Dam Interim Release
 for September 1993
 Net Expense Analysis

<u>Base Case (Without Interim Releases)</u>		<u>Actual (With Interim Release)</u>	
Firm Load & Losses:	519,336 MWh	Firm Load & Losses:	519,336 MWh
GC Generation:	314,013 MWh	GC Generation:	314,013 MWh
Other CRSP/IP Generation:	139,657 MWh	Other CRSP/IP Generation:	139,657 MWh
Total Generation:	453,670 MWh	Total Generation:	453,670 MWh
Purchases:	83,788 MWh	Purchases:	68,124 MWh
Off Peak:	75,997 MWh	Off Peak:	14,907 MWh
On Peak:	7,791 MWh	On Peak:	53,217 MWh
Surplus:	18,123 MWh	Surplus:	2,458 MWh
Off Peak:	2,977 MWh	Off Peak:	941 MWh
On Peak:	15,146 MWh	On Peak:	1,517 MWh
<hr/>			
Purchase Prices:		Purchase Prices:	
Off Peak:	\$15.79/MWh	Off Peak:	\$15.82/MWh
On Peak:	\$22.78/MWh	On Peak:	\$23.03/MWh
Sales Price:	\$23.08/MWh	Sales Price:	\$22.56/MWh
<hr/>			
Purchase Expense:	\$1,377,472	Purchase Expense:	\$1,461,416
Off Peak:	\$1,199,993	Off Peak:	\$235,829
On Peak:	\$177,479	On Peak:	\$1,225,588
Surplus Sales:	\$418,279	Surplus Sales:	\$55,452
<hr/>			
Base Case Expense:	\$959,193	Change Case Expense:	\$1,405,964
Total Net Expense for September 1993			\$446,771

Table 5
 Glen Canyon Dam Interim Release
 for October 1993
 Net Expense Analysis

<u>Base Case (Without Interim Releases)</u>		<u>Actual (With Interim Release)</u>	
Firm Load & Losses:	462,372 MWh	Firm Load & Losses:	462,372 MWh
GC Generation:	253,459 MWh	GC Generation:	253,459 MWh
Other CRSP/IP Generation:	94,988 MWh	Other CRSP/IP Generation:	94,988 MWh
Total Generation:	348,447 MWh	Total Generation:	348,447 MWh
Purchases:	117,645 MWh	Purchases:	115,149 MWh
Off Peak:	93,174 MWh	Off Peak:	45,681 MWh
On Peak:	24,471 MWh	On Peak:	69,468 MWh
Surplus:	3,720 MWh	Surplus:	1,224 MWh
Off Peak:	804 MWh	Off Peak:	637 MWh
On Peak:	2,916 MWh	On Peak:	587 MWh
<hr/>			
Purchase Prices:		Purchase Prices:	
Off Peak:	\$14.87/MWh	Off Peak:	\$15.18/MWh
On Peak:	\$24.27/MWh	On Peak:	\$23.29/MWh
Sales Price:	\$22.42/MWh	Sales Price:	\$22.42/MWh
<hr/>			
Purchase Expense:	\$1,979,409	Purchase Expense:	\$2,311,347
Off Peak:	\$1,385,497	Off Peak:	\$693,438
On Peak:	\$593,911	On Peak:	\$1,617,910
Surplus Sales:	\$83,402	Surplus Sales:	\$27,442
<hr/>			
Base Case Expense:	\$1,896,006	Change Case Expense:	\$2,283,905
Total Net Expense for October 1993			\$387,899

Table 6
 Glen Canyon Dam Interim Release
 for November 1993
 Net Expense Analysis

<u>Base Case (Without Interim Releases)</u>		<u>Actual (With Interim Release)</u>	
Firm Load & Losses:	468,852 MWh	Firm Load & Losses:	468,852 MWh
GC Generation:	292,691 MWh	GC Generation:	292,692 MWh
Other CRSP/IP Generation:	119,095 MWh	Other CRSP/IP Generation:	119,095 MWh
Total Generation:	411,786 MWh	Total Generation:	411,787 MWh
Purchases:	90,452 MWh	Purchases:	58,594 MWh
Off Peak:	88,642 MWh	Off Peak:	29,039 MWh
On Peak:	1,810 MWh	On Peak:	29,555 MWh
Surplus:	33,386 MWh	Surplus:	1,529 MWh
Off Peak:	3,343 MWh	Off Peak:	165 MWh
On Peak:	30,043 MWh	On Peak:	1,364 MWh
<hr/>			
Purchase Prices:		Purchase Prices:	
Off Peak:	\$16.00/MWh	Off Peak:	\$16.02/MWh
On Peak:	\$24.56/MWh	On Peak:	\$25.58/MWh
Sales Price:	\$22.16/MWh	Sales Price:	\$22.16/MWh
<hr/>			
Purchase Expense:	\$1,462,726	Purchase Expense:	\$1,221,222
Off Peak:	\$1,418,272	Off Peak:	\$465,205
On Peak:	\$44,454	On Peak:	\$756,017
Surplus Sales:	\$739,834	Surplus Sales:	\$33,883
<hr/>			
Base Case Expense:	\$722,892	Change Case Expense:	\$1,187,339
Total Net Expense for November 1993			\$464,447

**TABLE 7
GLEN CANYON DAM INTERIM RELEASE
Summary of Estimated Actual Net Expense
Associated With Interim Release**

WY 1992 Cumulative Net Expense \$5,311,632		
Month/Yr	Estimated Actual Net Expense	Cumulative Estimated Actual Net Expense
October 1992	\$336,662	\$5,648,294
November 1992	375,274	6,023,568
December 1992	471,698	6,495,266
January 1993	466,684	6,961,950
February 1993	380,314	7,342,264
March 1993	344,101	7,686,365
April 1993	227,469	7,913,834
May 1993	311,296	8,225,130
June 1993	618,118	8,843,248
July 1993	680,830	9,524,078
August 1993	552,370	10,076,448
September 1993	446,771	10,523,219
WY 1993 Net Expense \$5,211,587		
WY 1993 Cumulative Net Expense \$10,523,219		
October 1993	387,899	10,911,118
November 1993	464,447	11,375,564
WY 1994 Net Expense \$852,346		

JUNE 22, 1994

**GLEN CANYON DAM
PRELIMINARY MONITORING OF RELEASES
JANUARY THROUGH MAY 1994**

Monthly Plots:

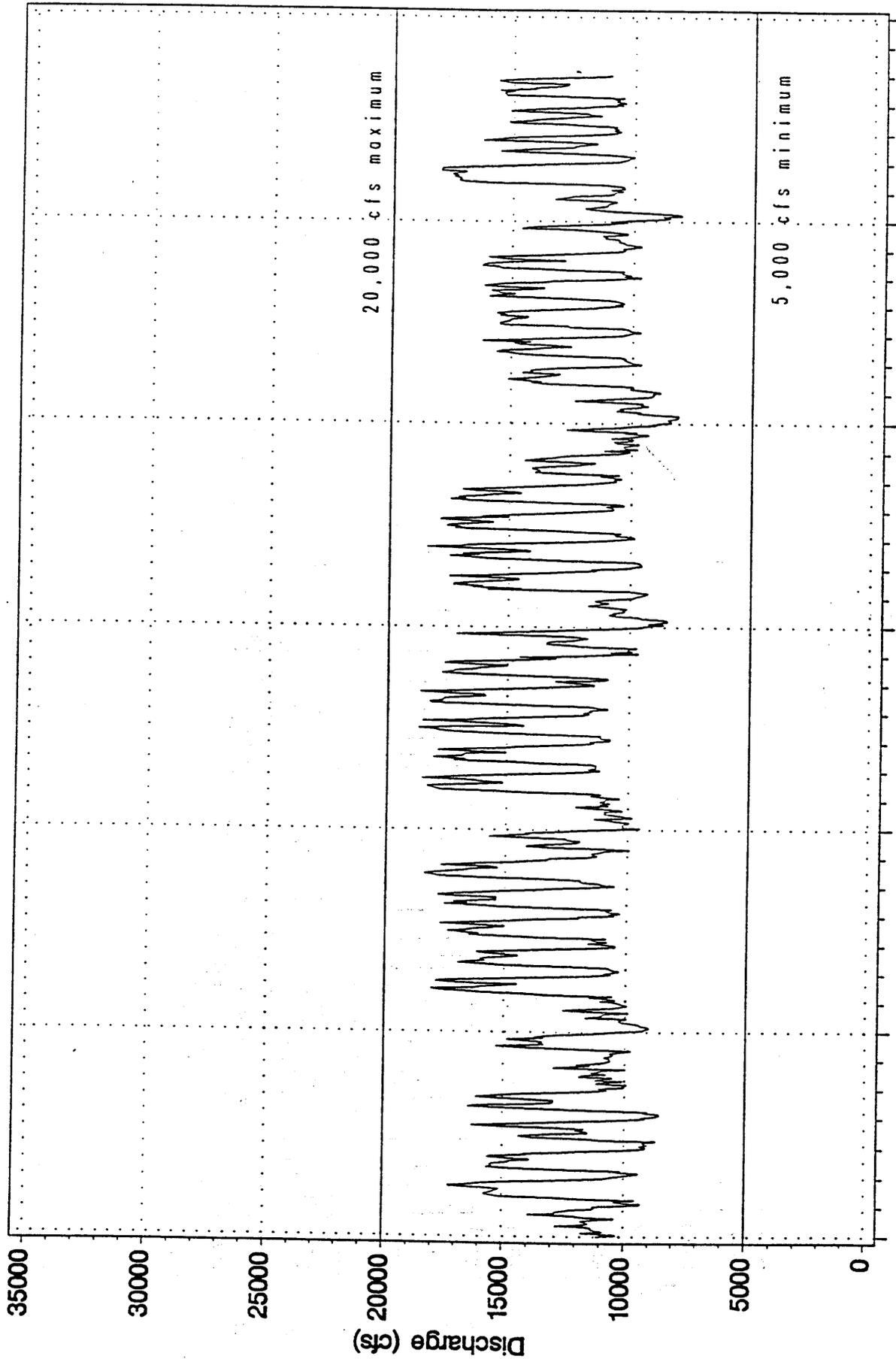
Glen Canyon Dam Integrated Hourly Releases

Glen Canyon Dam Integrated Hourly Ramping Rates

Glen Canyon Dam Powerplant Releases

January 1994

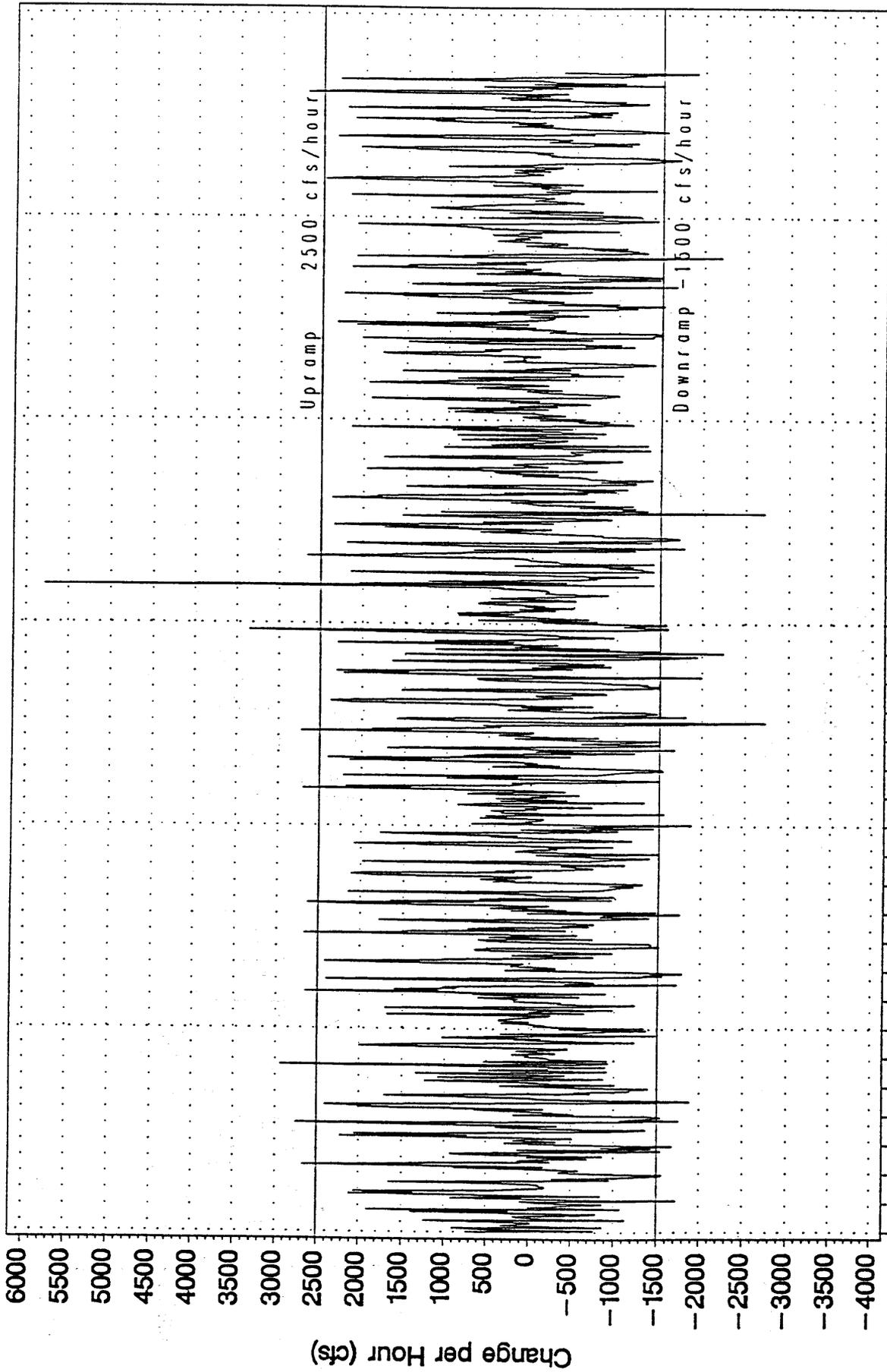
Integrated Hourly Values



Glen Canyon Dam Powerplant Releases

January 1994

Hourly Ramping Rates (cfs/hour)



26DEC93

02JAN94

09JAN94

16JAN94

23JAN94

30JAN94

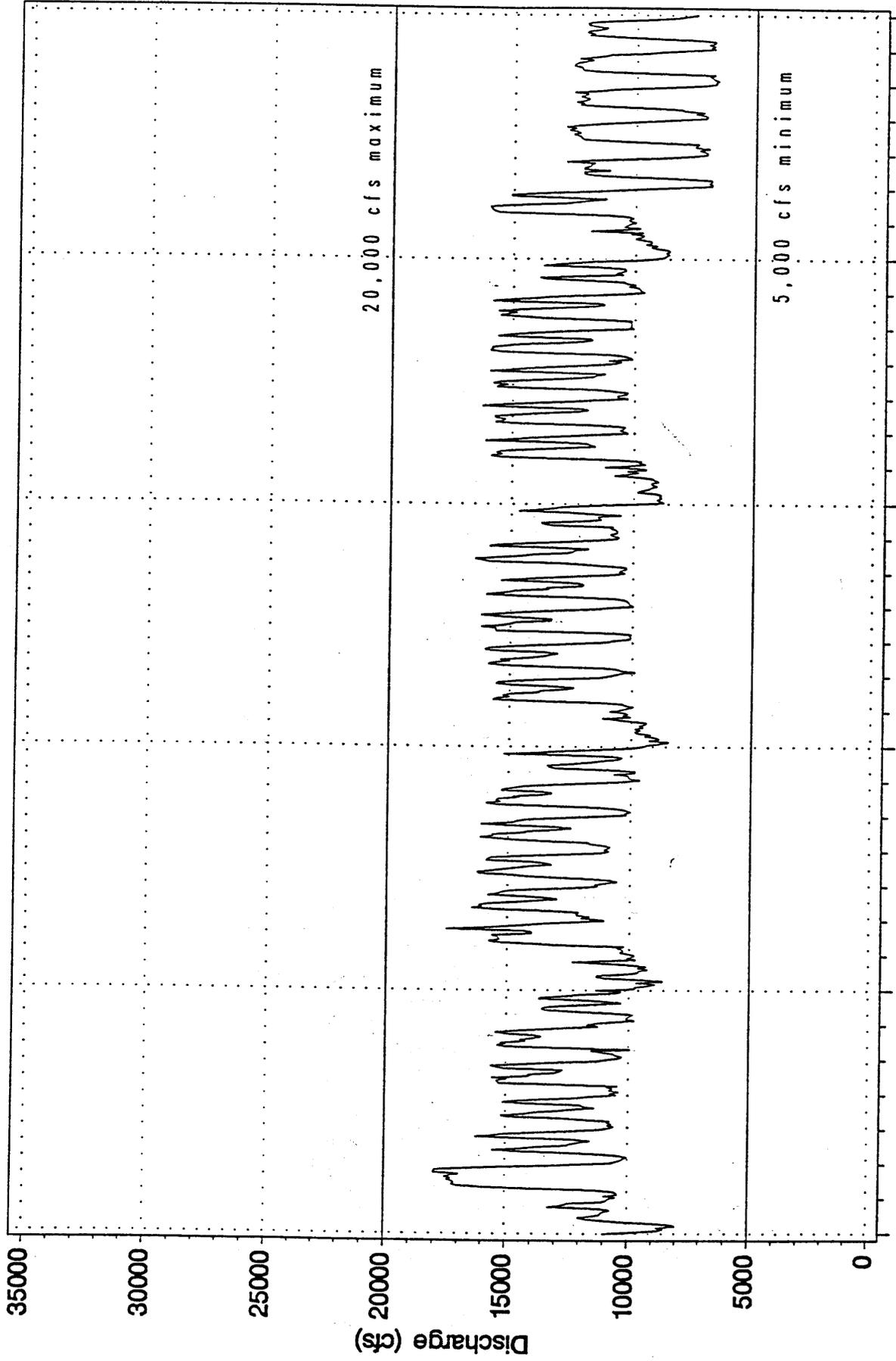
06FEB94

Date

Glen Canyon Dam Powerplant Releases

February 1994

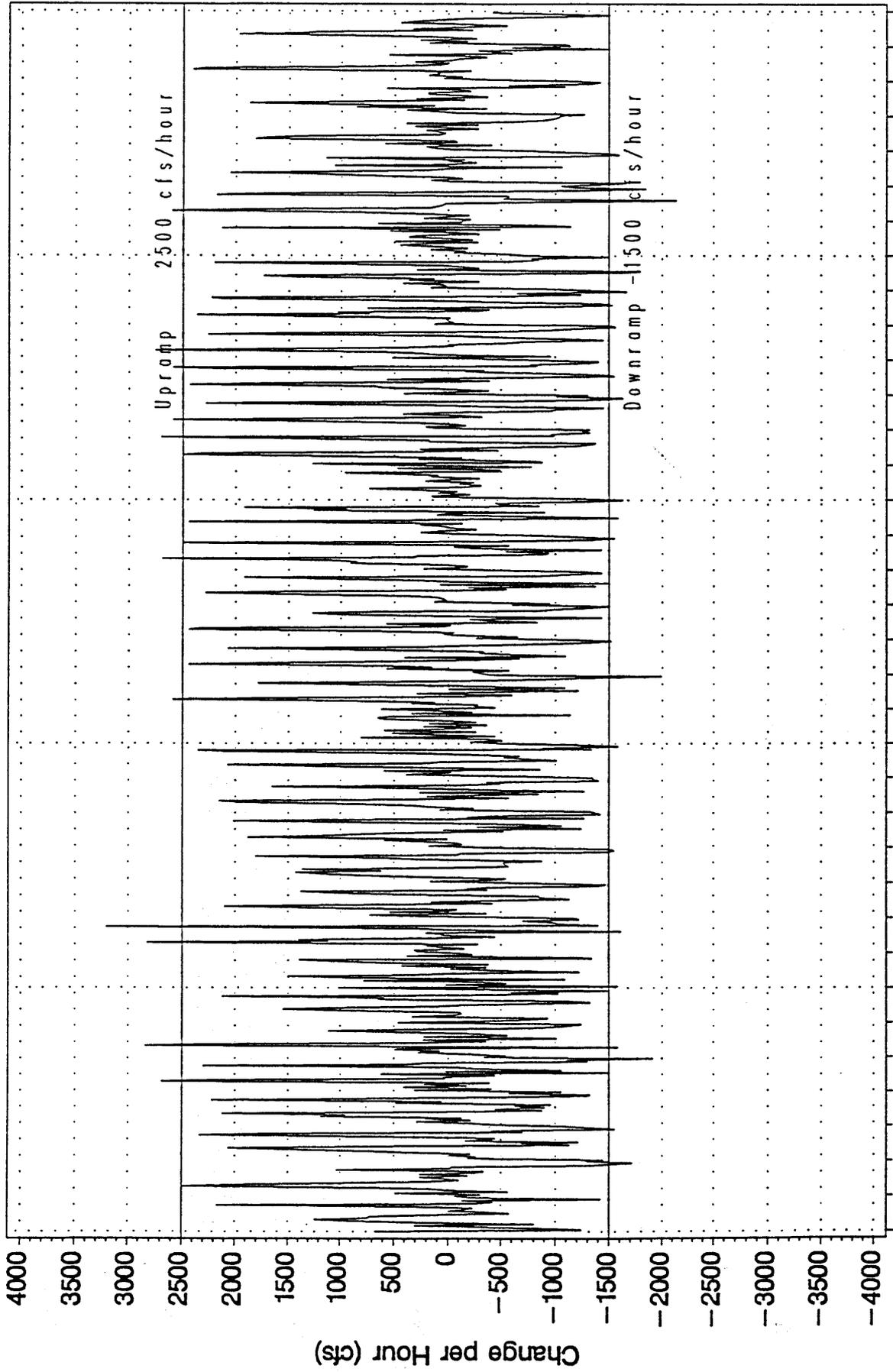
Integrated Hourly Values



Glen Canyon Dam Powerplant Releases

February 1994

Hourly Ramping Rates (cfs/hour)



30 JAN 94

06 FEB 94

13 FEB 94

20 FEB 94

27 FEB 94

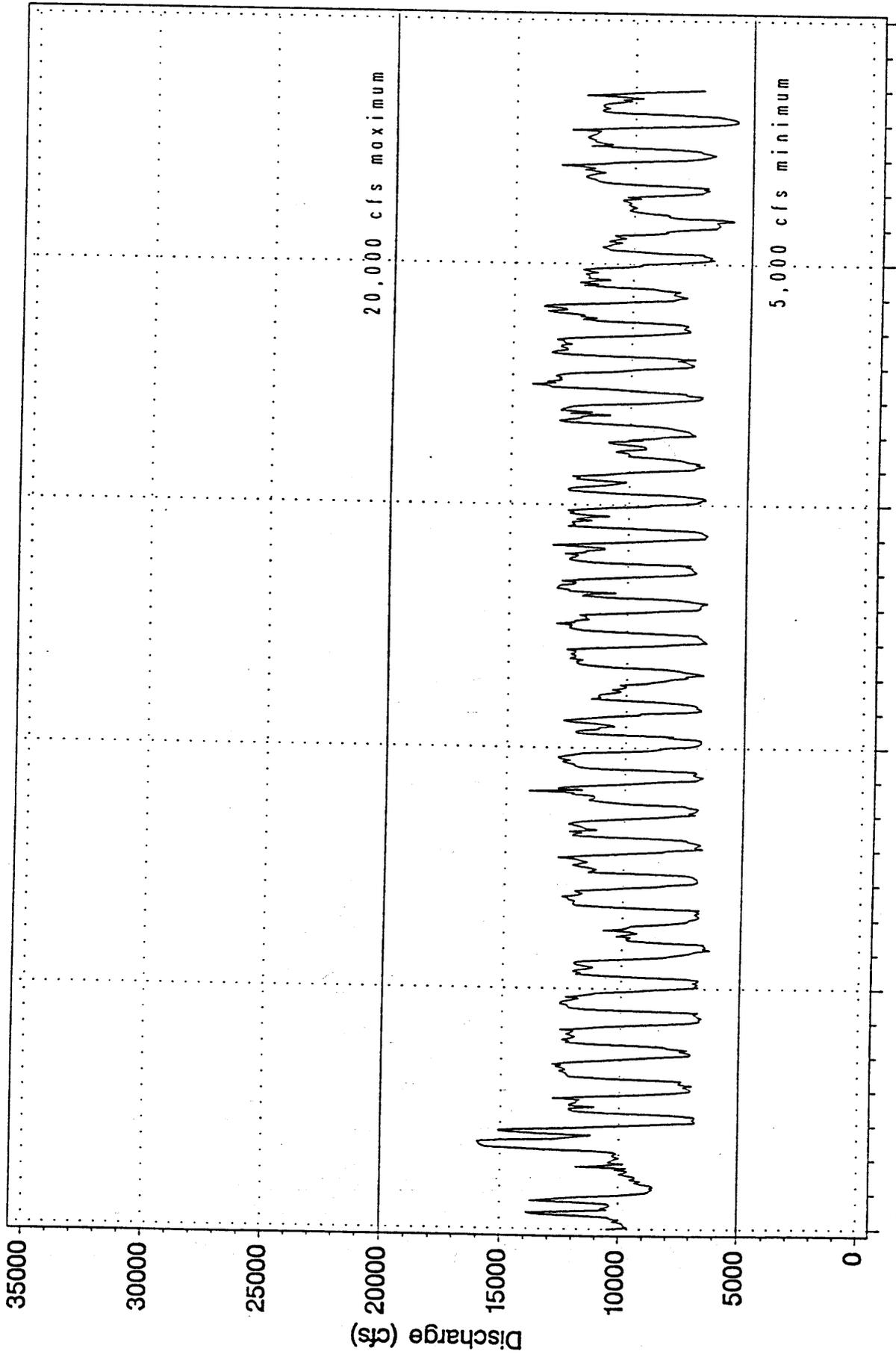
06 MAR 94

Date

Glen Canyon Dam Powerplant Releases

March 1994

Integrated Hourly Values



26FEB94

05MAR94

12MAR94

19MAR94

26MAR94

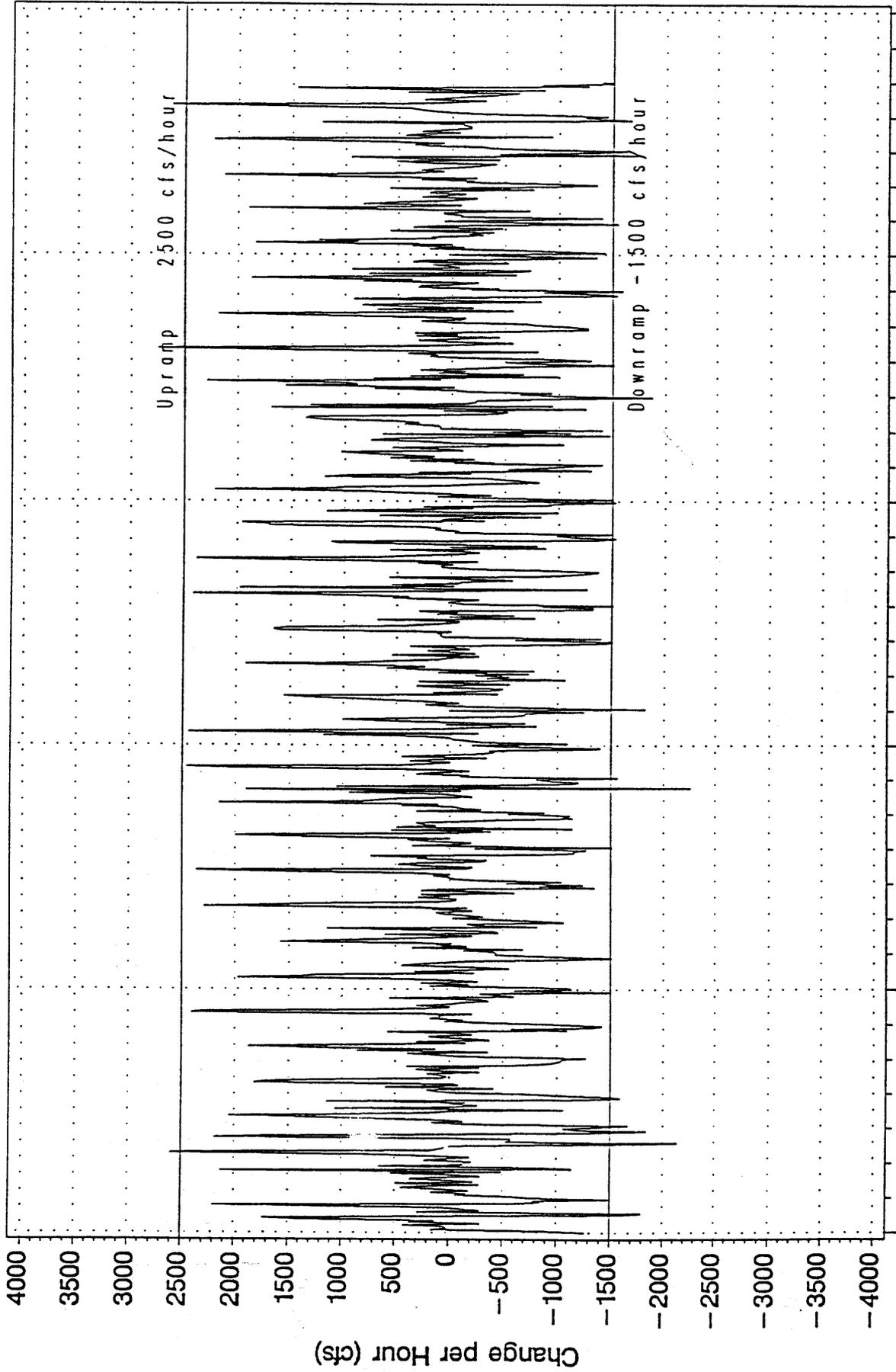
02APR94

Date

Glen Canyon Dam Powerplant Releases

March 1994

Hourly Ramping Rates (cfs/hour)



26FEB94

05MAR94

12MAR94

19MAR94

26MAR94

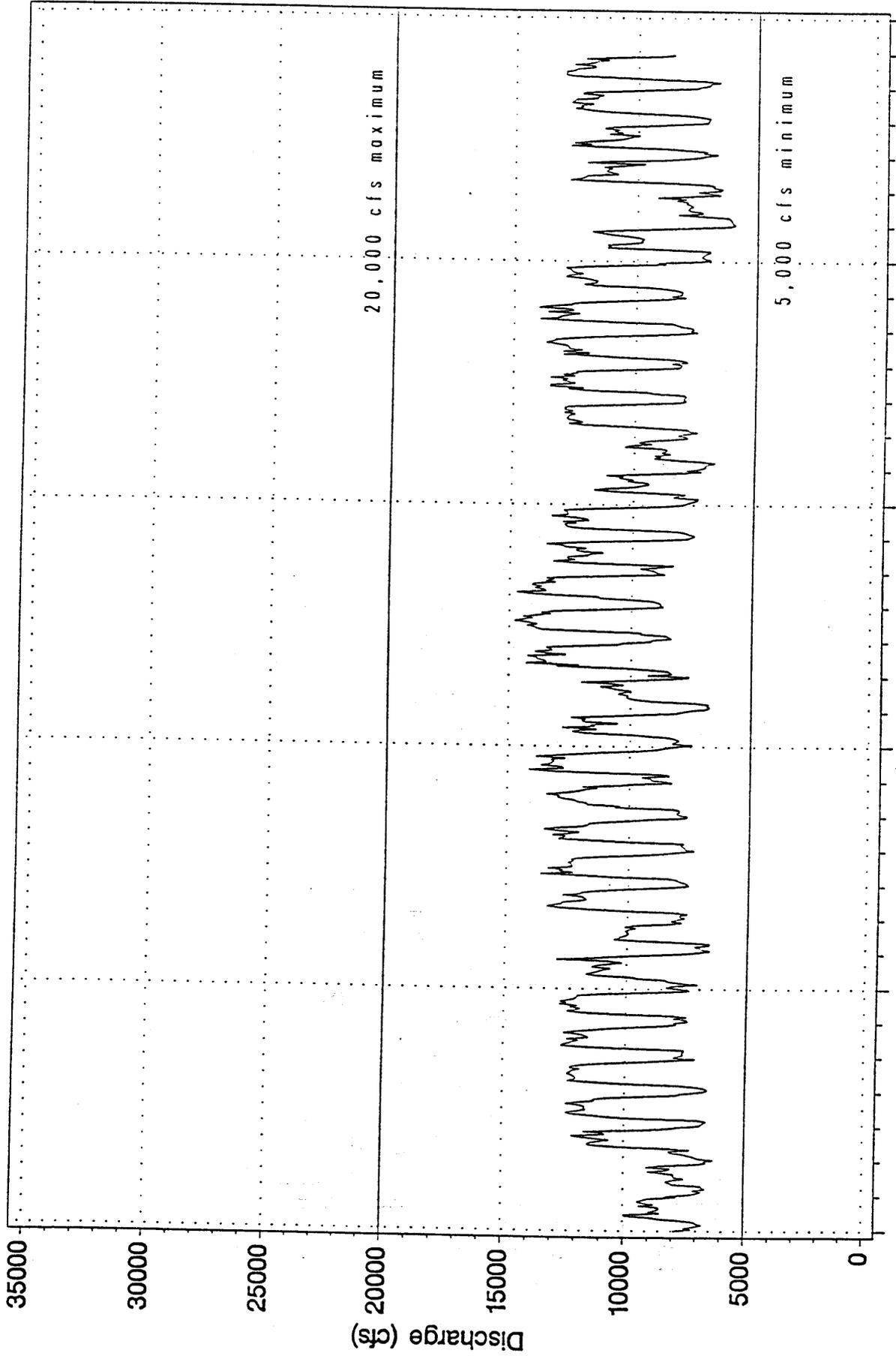
02APR94

Date

Glen Canyon Dam Powerplant Releases

April 1994

Integrated Hourly Values



02APR94

09APR94

16APR94

23APR94

30APR94

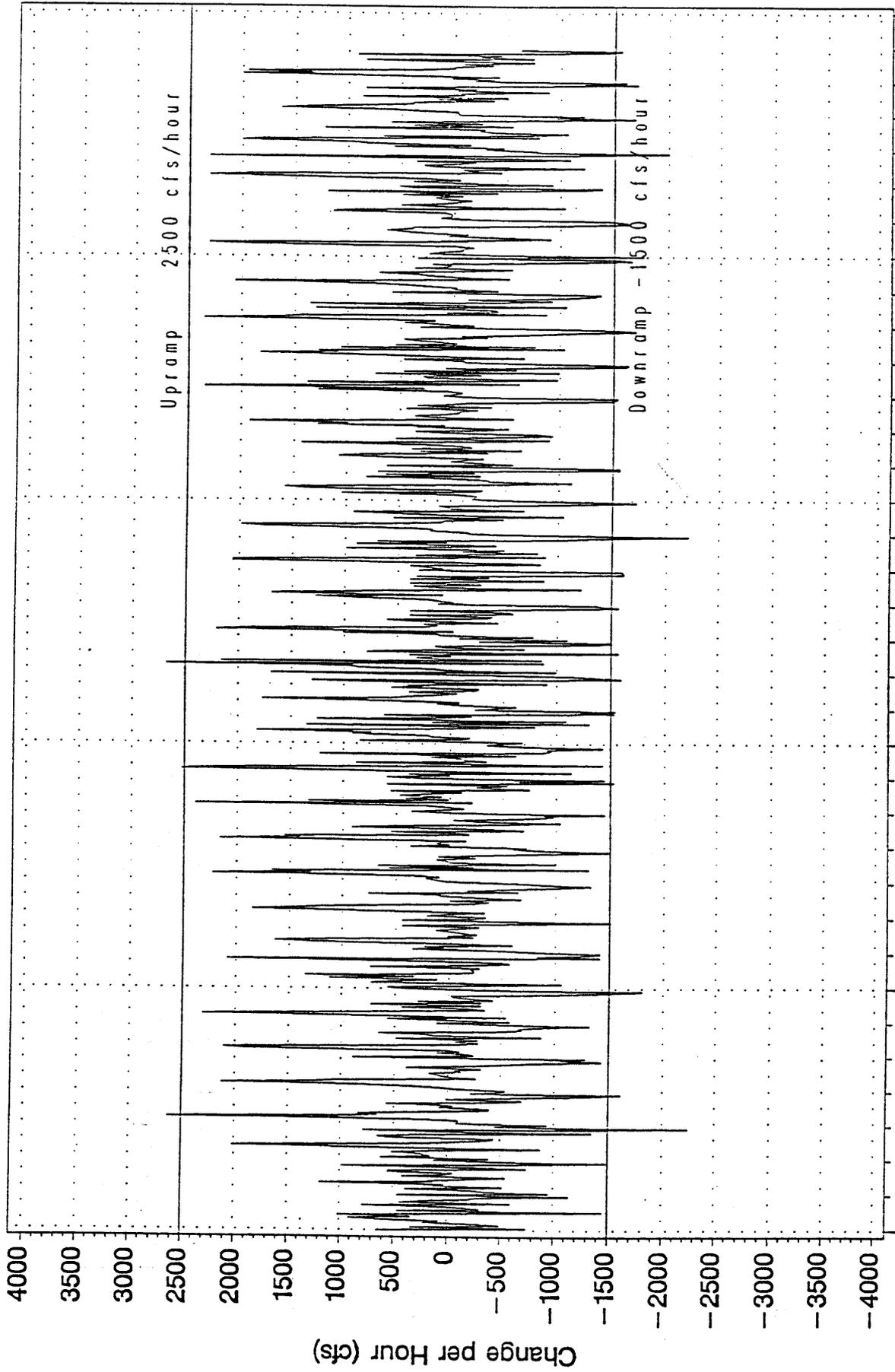
07MAY94

Date

Glen Canyon Dam Powerplant Releases

April 1994

Hourly Ramping Rates (cfs/hour)



02APR94

09APR94

16APR94

23APR94

30APR94

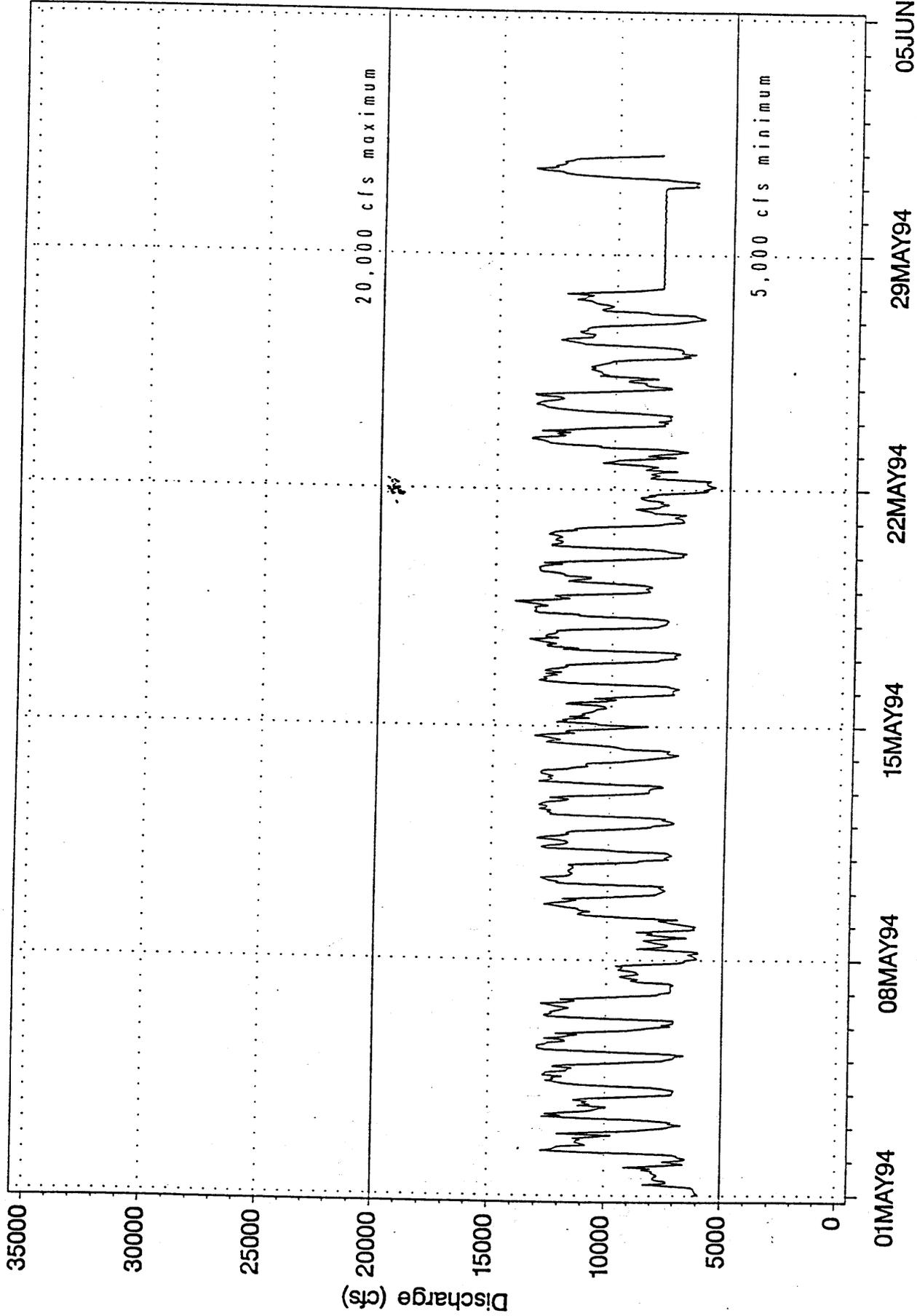
07MAY94

Date

Glen Canyon Dam Powerplant Releases

May 1994

Integrated Hourly Values



Glen Canyon Dam Powerplant Releases

May 1994

Hourly Ramping Rates (cfs/hour)

