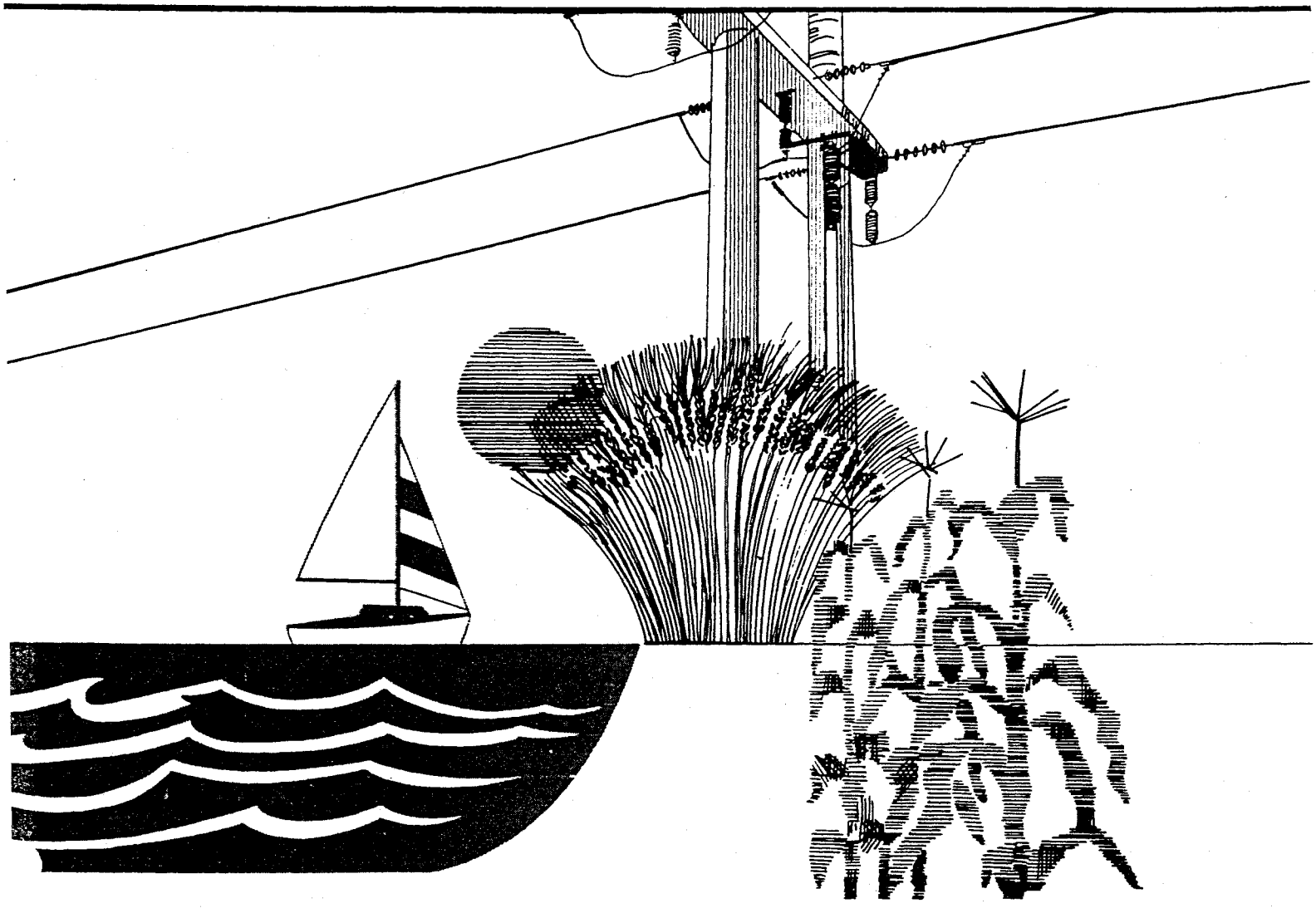
15th Annual Report

# Operation of the Colorado River Basin 1985 Projected Operations 1986



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annel Catfish Catch




United States
Department of the Interior
Bureau of Reclamation

January 1986

Prepared pursuant to the Colorado River
Basin Project Act of 1968
Public Law 90-537

## Colorado River Basin

## Introduction

The operation of the Colorado River Basin during the past year and the projected operation for the current year reflect flood control, domestic use, irrigation, hydroelectric power generation, water quality control, fish and wildlife propagation, recreation, and Colorado River Compact requirements.

Storage and release of water from the Upper Basin reservoirs are governed by all applicable laws and agreements concerning the Colorado River, including the impoundment and release of water in the Upper Basin required by Section 602(a) of the Colorado River Basin Project Act of September 30, 1968 (Public Law 90-537). The operation of the Lower Basin reservoirs reflects Mexican Treaty obligations and Lower Basin contractual commitments.

Nothing in this report is intended to interpret the provisions of the Colorado River Compact (45 Stat. 1057), the Upper Colorado River Basin Compact (63 Stat. 31), the Water Treaty of 1944 with the United Mexican States (Treaty Series 994, 59 Stat. 1219), the Decree entered by the Supreme Court of the United States in Arizona v. California et al. (376 U.S. 340), the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S.C. 618a), the Colorado River Storage Project Act (70 Stat. 105; 43 U.S.C. 620), the Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C. 1501), or the Hoover Power Plant Act of 1984 (98 Stat. 1333).

## Authority for Report

Pursuant to the Colorado River Basin Project Act (Public Law 90-537) of 1968, I am pleased to present to the Congress, and to the Governors of the Colorado River Basin States, the fifteenth annual report on the Operation of the Colorado River Basin.

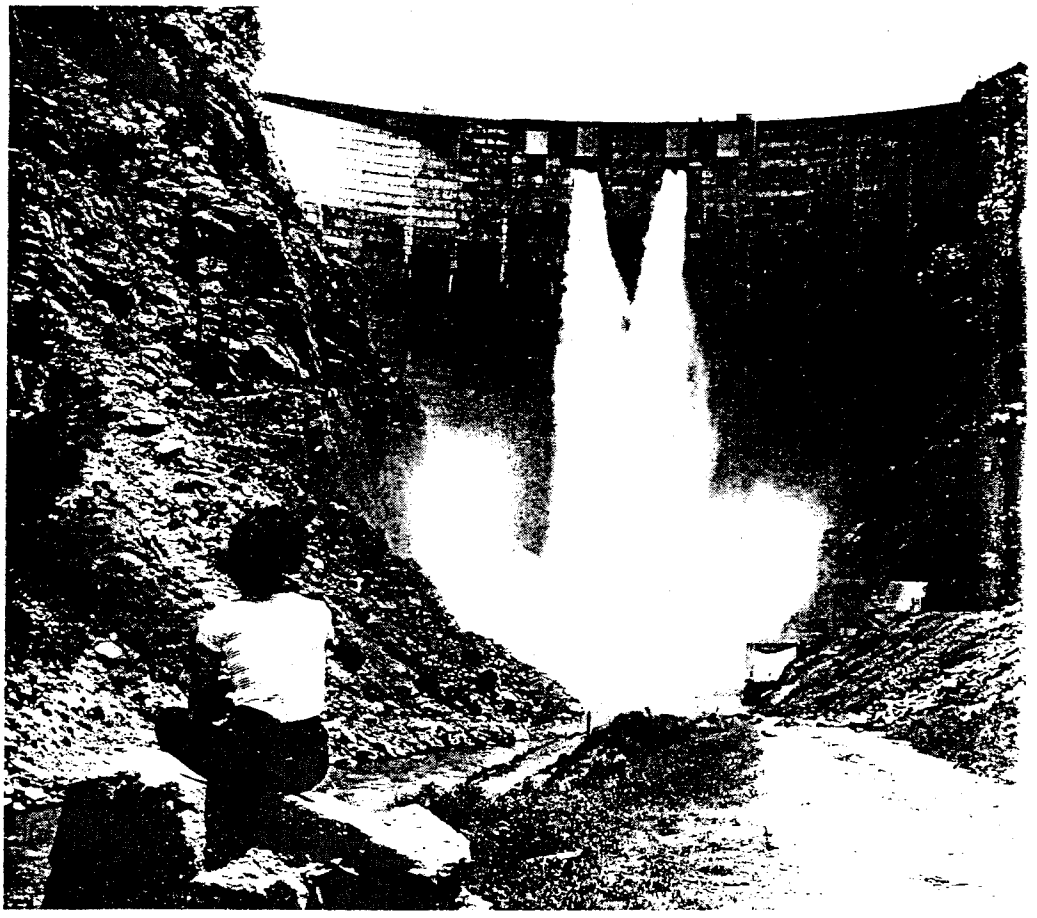
This report describes the actual operation of the reservoirs in the Colorado River drainage area constructed under the authority of the Colorado River Storage Project Act, the Boulder Canyon Project Act, and the Boulder Canyon Project Adjustment Act during water year 1985 and the projected operation of these reservoirs during water year 1986 under the "Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs," published in the Federal Register June 10, 1970.

Donald Paul Hodel, Secretary
United States Department of the Interior

## Actual Operations Under Criteria — Water Year 1985

The initial plan of operation for the water year ending September 30, 1985, based on forecasted inflow conditions for October through January and average inflow conditions through the rest of water year 1985 called for scheduled releases from Lake Powell of 13.7 million acre-feet (maf). This plan of operation would have created 6.2 maf of space by the end of September 1985, of which 1.7 maf would have been in Lake Powell. With this plan of operation the contents of Lakes Mead and Powell would have been within 0.15 maf of each other at the end of September 1985.

The April through July forecast of unregulated runoff at Lake Powell made on January 6, 1985, was 11.5 maf or 154 percent of the long term average. As a result, the releases from Glen Canyon were kept at maximum powerplant capacity. The weather pattern during January was such that the upper Green



Morrow Point Dam

River drainage received less than normal precipitation while the mainstem drainage of the Colorado River and southwestern Colorado received at or above normal precipitation. The April-July forecast dropped slightly in February to 11.0 maf, but Glen Canyon's powerplant was still operated at capacity. The February-March period had near normal temperatures and below normal precipitation over most of the Upper Colorado River Basin. Snowpack water content on March 1 was about 105 percent of normal but monthly precipitation had fallen to 50 percent over most of the Upper Colorado Basin. The prevailing dry period resulted in the April-July forecast in March and April dropping to 10 maf and 10.3 maf respectively. In response to a declining forecast and to insure filling Lake Powell, the powerplant discharge at Glen Canyon was reduced to 80 percent of capacity for March and April.

During late April and early May the weather pattern changed and precipitation over western and southwestern Colorado increased. The April-July forecast on May 1 was 10.8 maf. On May 10 a storm system moved into the basin leaving 50 to 100 percent of the average May precipitation. River flows had remained above average except in Wyoming for the January-May period, and in conjunction with a wet weather pattern the April-July forecast was increased on May 14 to 11.45 maf. With this increase in forecast and the possibility of going into surcharge, the powerplant at Glen Canyon was again operated at full capacity and the bypass tubes were operated to bypass 0.4 maf in May. The weather pattern caused an early melt of lower elevation snow with the peak inflow occurring in early May at 93,600 cubic feet per second (cfs), unregulated. Unregulated runoff is the inflow to Lake Powell plus or minus the change in storage of the upstream reservoirs discussed in this report.

Hoover Dam

The first part of June was hot and dry and brought a secondary snow melt peak the latter part of June of 31,600 cfs. unregulated flow. To keep Lake Powell from going into surcharge the Glen Canyon powerplant was operated at capacity, and an additional 0.6 maf was discharged through the bypass tubes. The forecast at mid-June for the April-July period was adjusted to 11.7 maf. The bypass was terminated at the end of June with the powerplant continuing to operate at full capacity throughout July. The actual unregulated April-July runoff into Lake Powell was 11.97 maf in 1985, 160 percent of normal, and Lake Powell reached its maximum elevation of 3700.12 feet on July 1.

The total unregulated runoff for water year 1985 at Lake Powell was 17.5 maf or 147 percent of the long-term average. Water supply for the San Juan River above Navajo Dam and the mainstem Colorado River above Grand Junction, Colorado, for the water year were at 184 percent, while the Gunnison River above Blue Mesa Dam was at 129 and the Green River above Flaming Gorge Dam was at 91 percent of average. Total releases from Glen Canyon were 19.26 maf while the regulated inflow for the year was 18.1 maf. Aggregate Colorado River storage at the end of the year was 55.59 maf representing a decrease of 1.75 maf from the previous year.

# Projected Plan of Operation Under Criteria — Water Year 1986

**Determination of "602(a) Storage"**

Section 602(a)(3) of the Colorado River Basin Project Act of September 30, 1968 (Public Law 90-537), provides for the storage of Colorado River water, not required to be released under article III(c) and III(d) of the Colorado River Compact in Upper Basin reservoirs, to the extent the Secretary of the Interior (Secretary) finds it necessary to assure compact deliveries without impairment of annual consumptive uses in the Upper Basin.

Article II of the "Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs" (Operating Criteria) provides that the annual plan of operation shall include a determination by the Secretary of the quantity of water considered necessary to be in Upper Basin storage as of September 30 of the current year.

This determination shall consider all applicable laws and relevant factors including, but not limited to the following: (a) historic streamflows; (b) the most critical period of record; (c) probabilities of water supply; (d) estimated future depletions in the Upper Basin, including effects of recurrence of critical periods of water supply; (e) the "Report of the Committee on Probabilities and Test Studies to the Task Force on Operating Criteria for the Colorado River," dated October 30, 1969, and such additional studies as the Secretary deems necessary; and (f) the necessity to assure that Upper Basin consumptive uses are not impaired because of failure to store sufficient water to assure deliveries under Section 602(a)(1) and (2) of Public Law 90-537.

Taking into consideration these relevant factors, the Secretary has determined that the active storage in Upper Basin reservoirs forecast for September 30, 1986, exceeds the "602(a) Storage" requirement under any reasonable range of assumptions which might be applied to those items previously listed. Therefore, the accumulation of "602(a) Storage" is not the criterion governing the release of water during the current year.

**Mexican Treaty Obligations**

Annual calendar year schedules of monthly deliveries of water in the limitrophe section of the Colorado River, allotted in accordance with the Mexican Water Treaty signed in 1944, are formulated by the Mexican Section and presented to the United States Section, International Boundary and Water Commission (Commission), before the beginning of each calendar year.

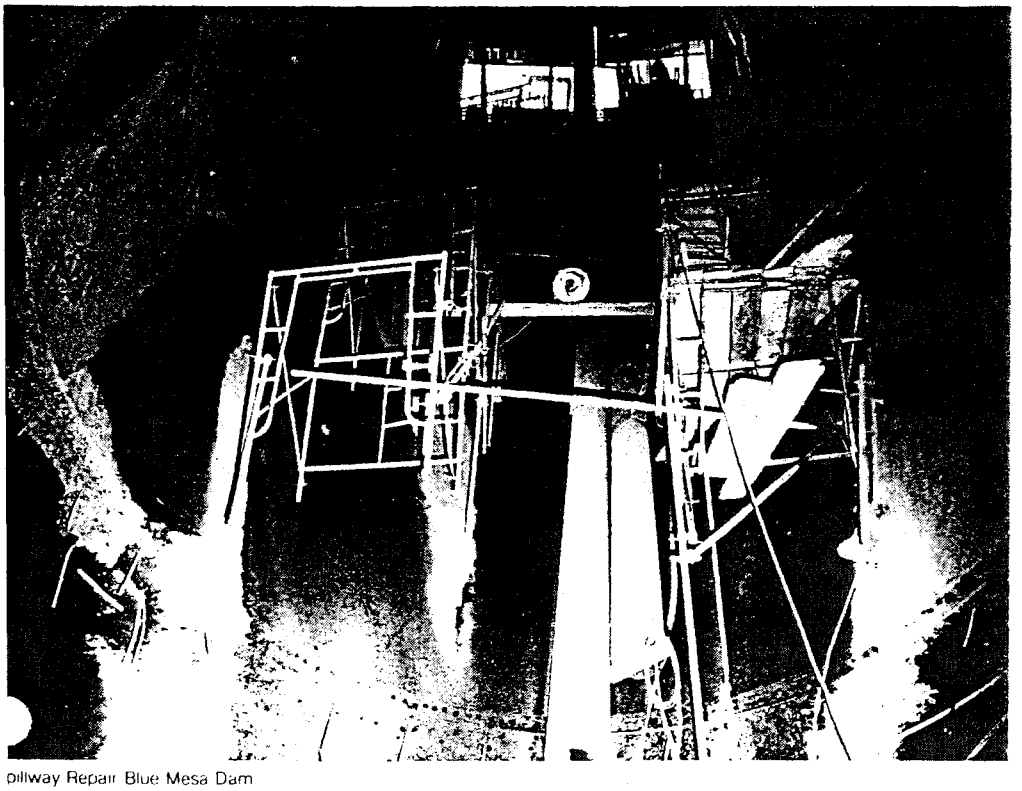
Upon 30 days' advance notice to the United States Section, Mexico has the right to modify, within the total schedule, any monthly quantity prescribed by the schedule by not more than 20 percent. During water year 1985, Mexico received a total delivery of about 13,030,000 acre-feet at the Northerly International Boundary.

Of the 13,030,000 acre-feet of mainstem Colorado River water reaching the Boundary; about 4,600,000 acre-feet were delivered through the Pilot Knob Powerplant from the All-American Canal. An estimated 7,500,000 acre-feet were released through Laguna Dam. The remainder of the flow at the Northerly International Boundary was made up of return flows to the Colorado River below Laguna Dam, and returns to the Gila River below the gaging station near Dome, as well as Gila River flood control releases from Painted Rock Reservoir.

Because of the current water supply conditions, the United States will make scheduled deliveries of 1,700,000 acre-feet of Colorado River water to the Republic of Mexico in calendar year 1986. This release of water is based upon average runoff conditions for the year. Should the runoff in water year 1986 be substantially above average, significant releases for flood control purposes could be required from Hoover Dam. Representatives of the Republic of Mexico will be kept informed of operating schedules through the United States Section of the Commission.

**Regulatory Wastes**

Deliveries to Mexico consist of river water delivered to Imperial Dam and waste and drainage return flows from water users below Imperial Dam. In addition to assuring normal water deliveries, the small amount of regulatory storage space in Imperial, Laguna, and Senator Wash Reservoirs was used at times to limit potential downstream flood damages during water year 1985. Regulatory waste for water year 1986 will depend on the actual hydrologic conditions occurring during that time.



pillway Repair Blue Mesa Dam

## Projected Plan of Operation — Water Year 1986

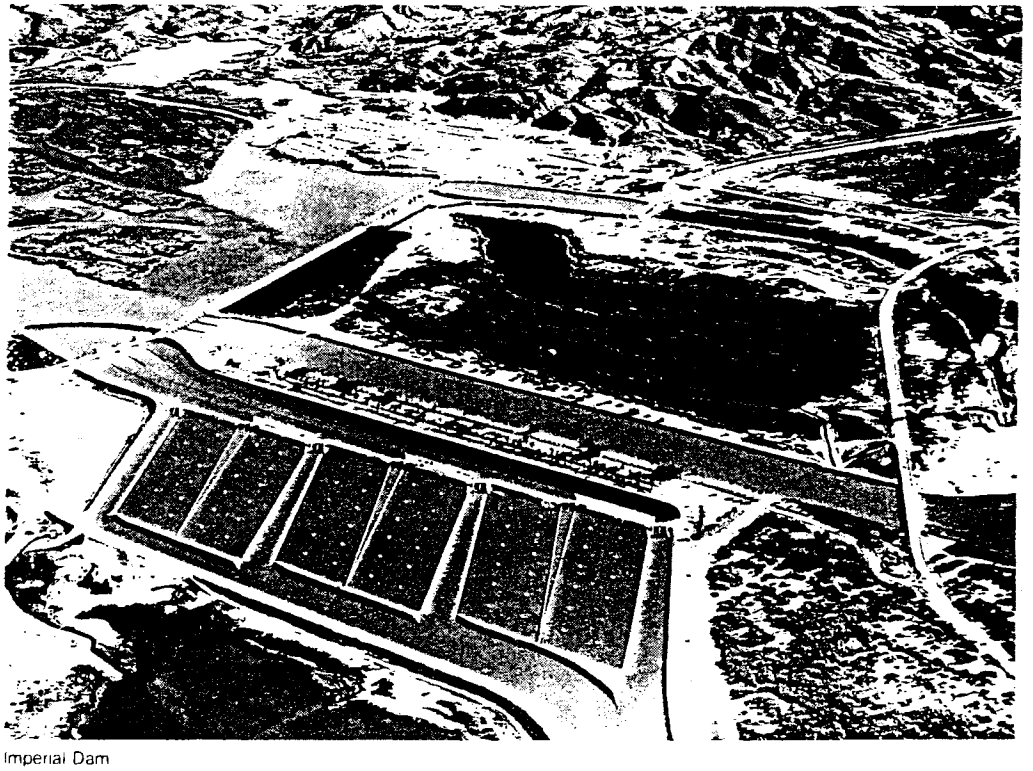
A proposed operation plan for water year 1986 for major reservoirs of the Colorado River system was formulated and distributed to representatives of the Colorado River Basin States in November 1985. This plan was prepared in accordance with the Operating Criteria published June 4, 1970, in compliance with Section 602, Public Law 90-537. The plan reflects operation for flood control, domestic and irrigation use of water, hydroelectric power generation, water quality control, fish and wildlife propagation, recreation, and Colorado River Compact requirements.

The water year 1986 plan varied from the plan developed for water year 1985 which was based on the need to develop sufficient reservoir space by January 1, 1985, to reduce the risk of reservoir spills. At the end of water year 1985 all of the reservoirs were at a lower level than the previous year. This condition allowed some flexibility in operations during the first 3 months of water year 1986. Releases at 45 percent powerplant capacity at Glen Canyon will be made from October to December to finish an environmental study below Glen Canyon with increased releases during January 1986 in order to develop sufficient vacant reservoir space to reduce the risk of spilling. This also reduces the risk of damaging flood control releases from Hoover, Davis, and Parker Dams, should large runoff forecasts occur during the 1986 runoff period. Releases from January through July will be based upon the runoff forecasts received during that time but will result in greater available space on August 1, 1986, than the minimum flood control requirement of 1.5 maf.

The plan calls for a total Glen Canyon release in water year 1986 of 8.7 maf under reasonable minimum inflow conditions. An annual release of 11.1 maf would be required under most probable inflow conditions, which would fill Lake Powell and also equalize the active contents of Lake Powell and Lake Mead by September 30, 1986. With a reasonable maximum inflow during water year 1986, the projected Glen Canyon release would be 16.1 maf. This volume of inflow would require maximum powerplant releases for all of water year 1986 to avoid the use of Glen Canyon's river outlet works or spillways.

The projected operation for most probable runoff conditions for each reservoir in the Colorado River Basin for water year 1986 is described in the following pages.

Charts showing the projected monthly outflows from each reservoir for the three assumed hydrologic conditions are presented with each reservoir operation. Each of these assumptions uses the most current hydrologic information available by including actual forecasted October through December 1985 inflows. The monthly inflows for the remainder of the year were based upon the following assumptions: (1) most probable based upon the 1906 through 1983 natural flows developed for the Colorado River Simulation System (CRSS) model depleted up to the 1986 level; (2) reasonable minimum based upon the annual volume of inflow which would be exceeded about 90 percent of the time; and (3) reasonable maximum based upon the annual volume of inflow which would be exceeded about 10 percent of the time.



Imperial Dam

# Upper Basin Reservoirs
# Fontenelle Reservoir (Green River)

**Water Year 1985**
Fontenelle Reservoir's 1985 water year plan of operation was to maintain the water surface elevation no higher than 6482 feet with a lower bound of approximately the minimum power pool elevation of 6474 feet. This upper elevation restriction was imposed due to increased seepage along the left abutment in 1982, and geologic investigations conducted in 1983.

The January 9, 1985, forecast of April-July runoff was 106 percent of normal and by April 5, the forecasted inflow had dropped to 89 percent of normal. Fontenelle Reservoir elevation dropped gradually from 6481 feet on January 1, to 6478 the end of March. During April unusual piezometer readings of water movement through the dam were noticed, and by the end of April a decision was made to gradually lower the elevation by a half-foot per day. However, during the last week of April a piezometer located near the powerplant had very high readings, and a decision was made to rapidly lower the reservoir elevation to 6443 feet. On May 2, releases were increased to 12,100 cfs and maintained for 4 days and then gradually decreased to match inflow by May 14, which maintained the new target elevation of approximately 6443 feet. The maximum inflow occurred on May 6, of nearly 5,600 cfs. The actual April-July inflow was 656 thousand acre-feet which is 77 percent of normal.

During August of 1985, installation of a concrete core wall test section was started to determine the feasibility of installing a concrete core wall the entire length of the dam. This work will be finished in August of 1986, and is progressing very well. An Environmental Assessment Report was initiated for completion in early 1986, in preparation for letting a contract for final modification of Fontenelle Dam.

Total water year inflow to Fontenelle was 1.07 maf which is 87 percent of normal. Releases totaled 1.21 maf which includes 137,000 acre-feet to lower the reservoir to 6443 feet from 6482 feet.

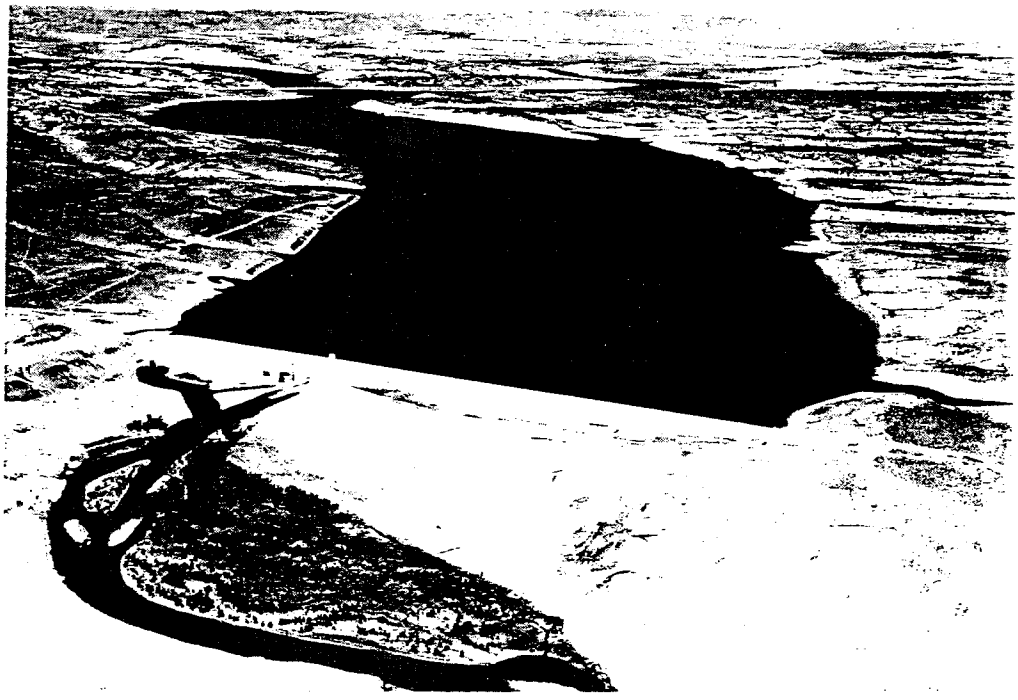
**Water Year 1986**
The projected plan of operation for water year 1986 is to maintain elevation 6443 feet as near as possible with fluctuations in elevation limited to plus or minus 5 feet, if possible. This elevation range is based on maximum possible downstream releases of 10,000 cfs due to reservoir elevation and minimum releases of 400 cfs. Based on the reasonable maximum and minimum inflow operation studies, releases are expected to stay within the 400 to 10,000 cfs range throughout water year 1986.

Present plans for construction modification are to have Congressional approval late in 1986, and award a contract so construction can start in the spring of 1987. The U.S. Bureau of Reclamation (Reclamation) is continuing to cooperate with the State of Wyoming to complete construction modification.

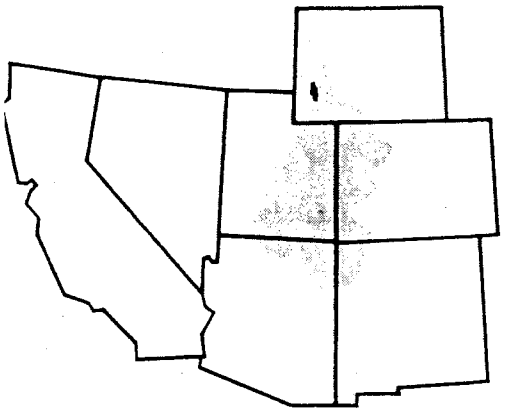
**Fontenelle** Active Storage* **Chart 1**

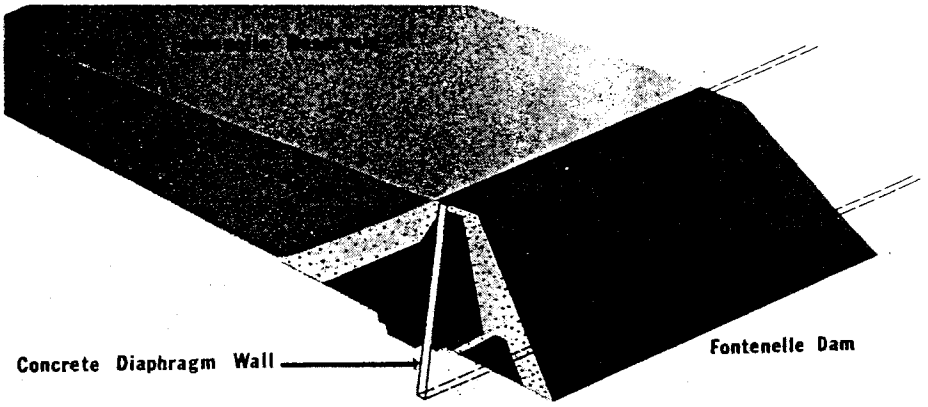
| Reservoir | Acre-Feet | El. (Ft.) |
|---|---|---|
| Maximum Storage | 344,834 | 6506 |
| Rated Head | 233,789 | 6491 |
| Minimum Power | 194,962 | 6485 |
| Surface Area (Full) | 8,058 | Acres |
| Reservoir Length (Full) | 18 | Miles |
| **Powerplant** | | |
| Number of Units | 1 | |
| Total Capacity | 10,000 | Kilowatts |

*Active storage is feet of dead storage below 6408 feet



Fontenelle Dam

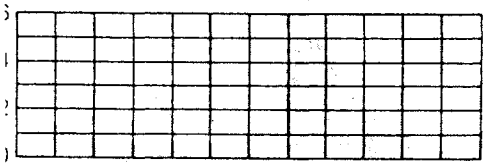





Finished Diaphragm Wall

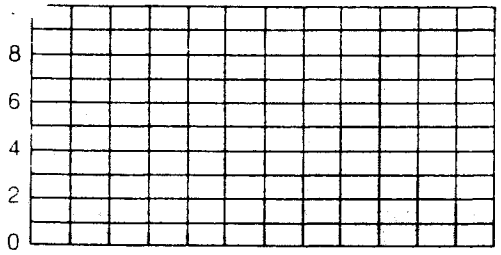
**Outflow** Monthly Release in 1000 Cubic Feet / Second

Actual Operation 1985

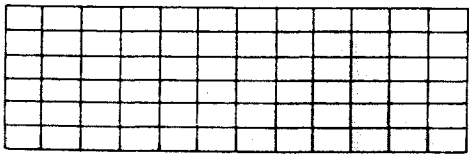


Projected Operation 1986

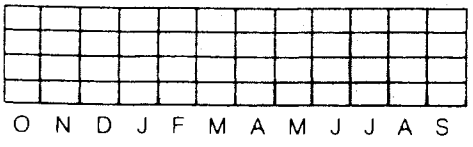
Reasonable Maximum




Most Probable



Reasonable Minimum

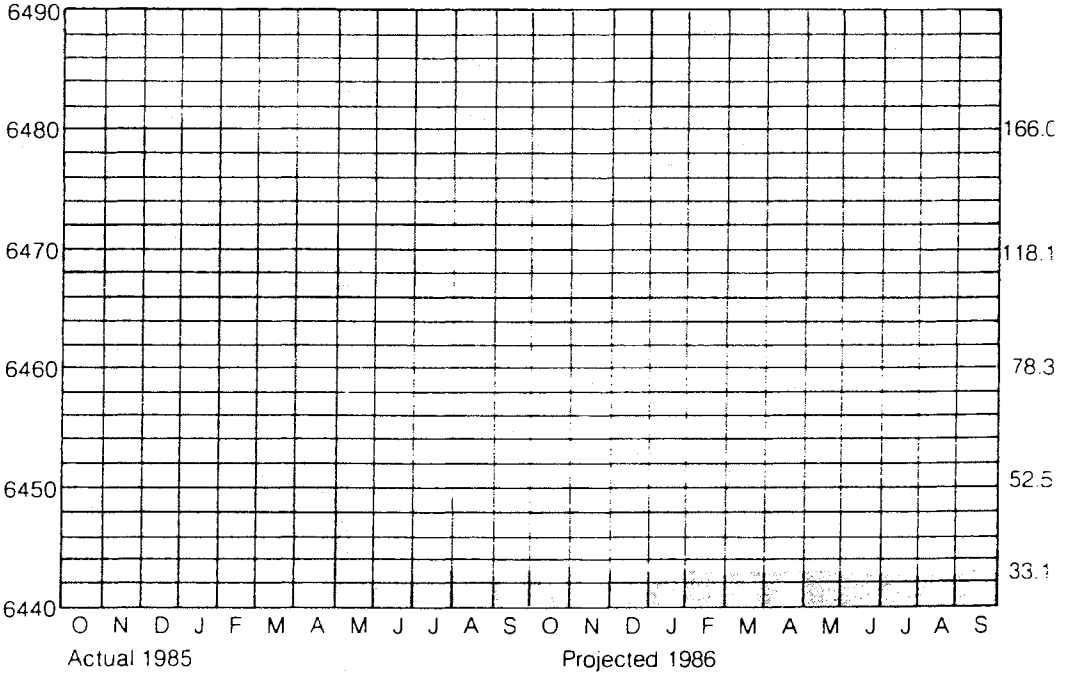



**Storage**

End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet

Non-Linear Scale



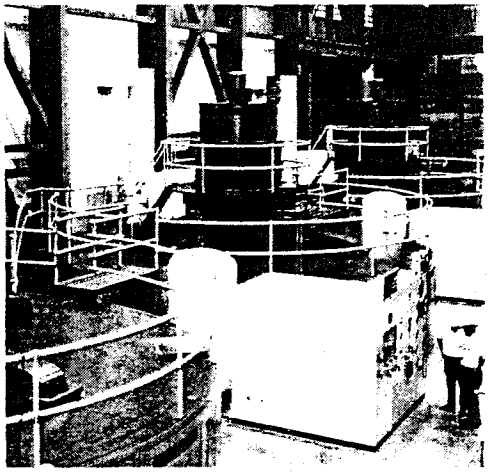

**Legend**

Most Probable

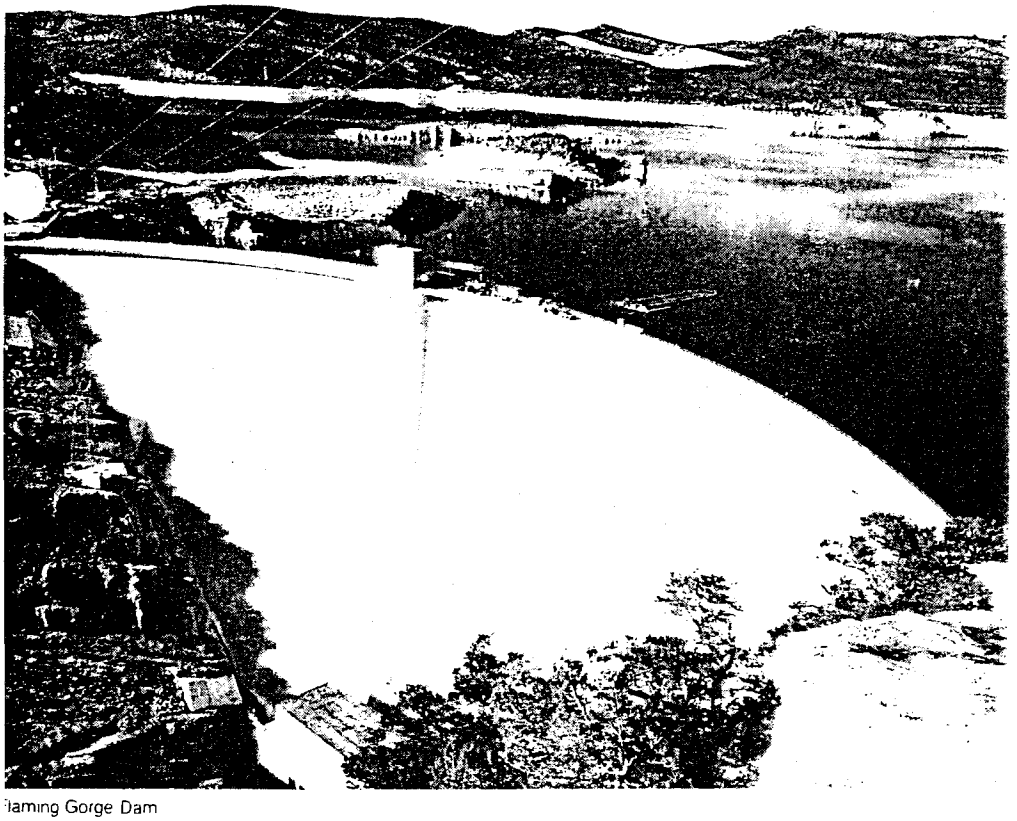
# Flaming Gorge Reservoir
# (Green River)

**Water Year 1985**

Water year 1985 started at elevation 6038.5 feet, and the first 6 months had above average inflow due to above average precipitation and carry-over effects from the previous wet year. On November 15, 1984, the projected November through March forecast was 217 percent of normal and the actual unregulated inflow for this period was 162 percent of normal. On April 1, Flaming Gorge was at elevation 6020 feet and the April-July forecast was at 90 percent of normal. Releases were projected to keep the elevation below 6035.0 feet due to continued construction to repair the spillway.



Powerplant at Flaming Gorge



Flaming Gorge Dam

April was a warm, dry month and received above average inflow. This pattern continued into May with just over average unregulated inflow. June was also hot and dry and the flows dropped considerably because the snowpack had melted by late May and early June. As a result of decreasing inflows Flaming Gorge reached a maximum elevation of 6032.8 feet on July 2, with a storage of approximately 3.46 million acre-feet of which 0.14 million acre-feet is due to lowering Fontenelle Reservoir in May.

The actual unregulated inflow into Flaming Gorge for April-July was 922,000 acre-feet which is 76 percent of normal. The peak inflow of 13,250 cfs occurred on May 6 due to lowering Fontenelle Reservoir. The peak discharge was 3,700 cfs on June 2. Total water year unregulated inflow was 1.51 million acre-feet which is 91 percent of normal and total releases were 1.98 million acre-feet.

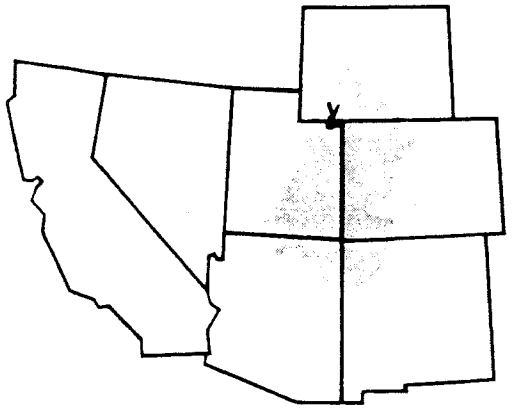
**Water Year 1986**

The projected minimum water surface elevation for water year 1986 is 6017.8 feet by April 1. Spillway construction was not finished as scheduled in the fall and the current schedule calls for completion in January if this is a mild winter, or late spring for a normal winter. The operation plan is based on not having a spillway in the spring with the reservoir drawn down 3.5 feet for safety purposes in June and July.

**Flaming Gorge** Active Storage* **Chart 2**

| Reservoir | Acre-Feet | El. (Ft.) |
|---|---|---|
| Maximum Storage | 3,749,000 | 6040 |
| Rated Head | 1,062,000 | 5946 |
| Minimum Power | 233,000 | 5871 |
| Surface Area (Full) | 42,020 | Acres |
| Reservoir Length (Full) | 91 | Miles |
| **Powerplant** | | |
| Number of Units | 3 | |
| Total Capacity | 108,000 | Kilowatts |

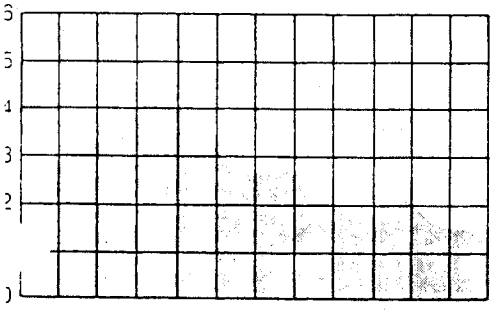
*Does not include 40,000 acre-feet of dead storage below 5740 feet



Fish Studies Below Flaming Gorge

**Outflow** Monthly Release in 1000 Cubic Feet / Second

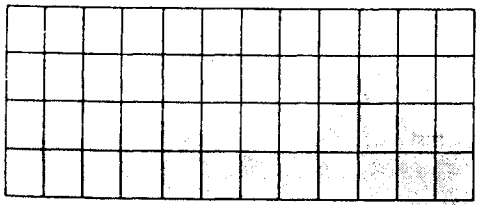
Actual Operation 1985



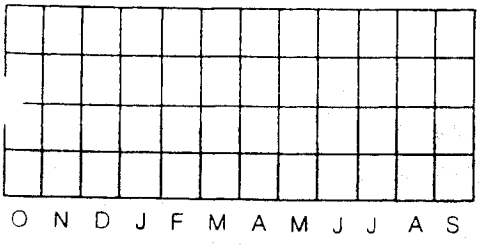
Projected Operation 1986

Reasonable Maximum

Most Probable



Reasonable Minimum

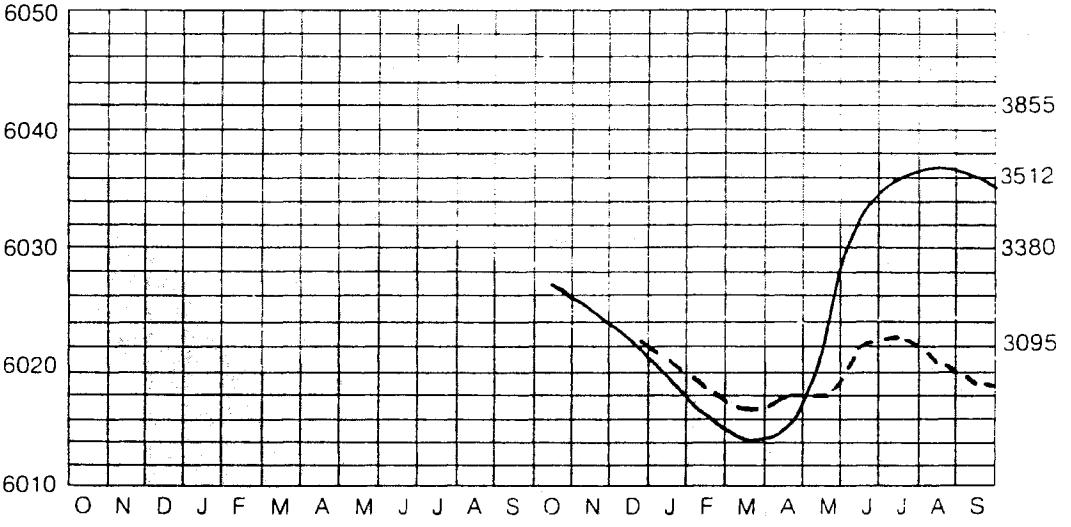



**Storage**

End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet

Non-Linear Scale




Actual 1985

Projected 1986

**Legend**

Most Probable

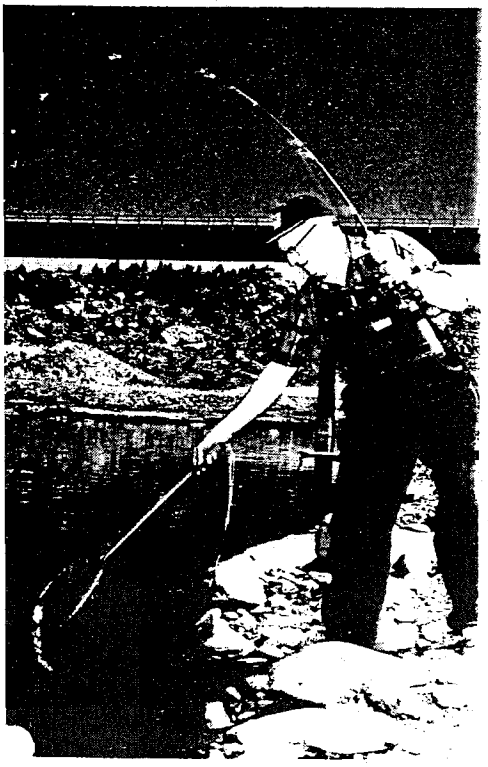
Reasonable Minimum

Reasonable Maximum

## Water Year 1985

The Wayne N. Aspinall Unit is comprised of Blue Mesa, Morrow Point, and Crystal Reservoirs. Blue Mesa provides nearly all of the long-term regulation for all three powerplants. Morrow Point is used for peaking power production, and thus has highly variable releases. Reregulation of Morrow Point releases is the primary function of Crystal Reservoir.

Blue Mesa Dam



Spring on Blue Mesa Reservoir

Spillway modification of Blue Mesa's spillway was in progress at the beginning of water year 1985. Work was scheduled to be completed by the end of June which necessitated a conservative operation of Blue Mesa so that the spillway work would not be endangered by a possible spill. The reservoir was gradually lowered from elevation 7515.0 feet to 7500.0 feet from October 1 to January 1, 1985. The January 1 forecast for April-July called for 970,00 acre-feet inflow which is 142 percent of the 20-year average from 1961-80. Releases for the January-April period averaged 2,300 cfs per day in order to draw the reservoir down. The forecast slowly decreased from January's 142 percent to March with a 125 percent April-July inflow, and then increased to 152 percent by the end of July. The weather pattern was one of alternating dry and wet periods through May. By mid-May this pattern changed to unseasonably warm and dry and continued through July. Inflow peaked on June 9 at 9,880 cfs. Releases were lowered to 1,600 cfs per day in May to help reduce flooding on the lower Gunnison River and were increased in June and July to 2,800 and 2,200 cfs per day, respectively, to allow for space due to spillway construction.

Side inflows to Morrow Point and Crystal Reservoirs increased rapidly in April and continued through June. The April-July side inflow to Morrow Point was 193 percent of average (114,000 acre-feet) while Crystal's side inflow was 216 percent of average (190,000 acre-feet). The peak unregulated inflow to Crystal was 14,600 cfs and the peak discharge through Crystal Dam was 6,500 cfs on June 9, which was a reduction of 8,100 cfs. Blue Mesa and Crystal powerplants were operated at or near capacity from January through July. Total releases for the water year from Morrow Point were 1.595 maf with all going through the powerplant. Water year release from Crystal Dam totaled 1.863 maf of which 605,000 acre-feet bypassed the powerplant.

## Water Year 1986

Blue Mesa powerplant will be operated to minimize powerplant bypasses at Crystal Dam. Assuming near average water supply conditions in water year 1986, a low elevation of 7457.8 feet is expected by the end of March with a maximum elevation of 7514.6 feet in July.

Crystal powerplant will be operated at full capacity throughout 1986, reregulating Morrow Point's peaking power releases. Powerplant bypasses are not expected based on the most probable water supply. Releases below Crystal will be approximately 1,700 cfs per day.

**Blue Mesa** Active Storage* **Chart 3**

| Reservoir | Acre-Feet | El. (Ft.) |
|---|---|---|
| Maximum Storage | 829,523 | 7519 |
| Rated Head | 249,395 | 7438 |
| Minimum Power | 81,070 | 7393 |
| Surface Area (Full) | 9,180 | Acres |
| Reservoir Length (Full) | 24 | Miles |
| **Powerplant** | | |
| Number of Units | 2 | |
| Total Capacity | 60,000 | Kilowatts |

*Does not include 111,232 acre-feet of dead storage below 7358 feet.

**Morrow Point** Active Storage*

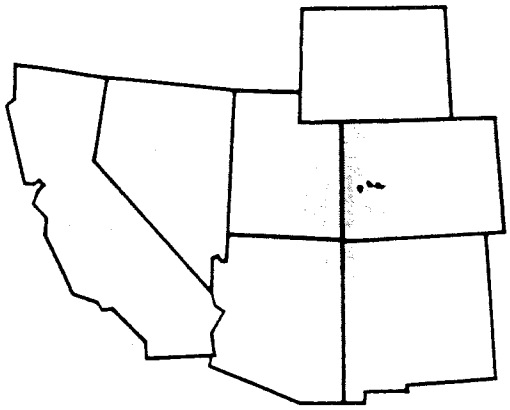
| | | |
|---|---|---|
| Maximum Storage | 117,025 | 7160 |
| Rated Head | 79,805 | 7108 |
| Minimum Power | 74,905 | 7100 |
| Surface Area (Full) | 817 | Acres |
| Reservoir Length (Full) | 11 | Miles |
| **Powerplant** | | |
| Number of Units | 2 | |
| Total Capacity | 120,000 | Kilowatts |

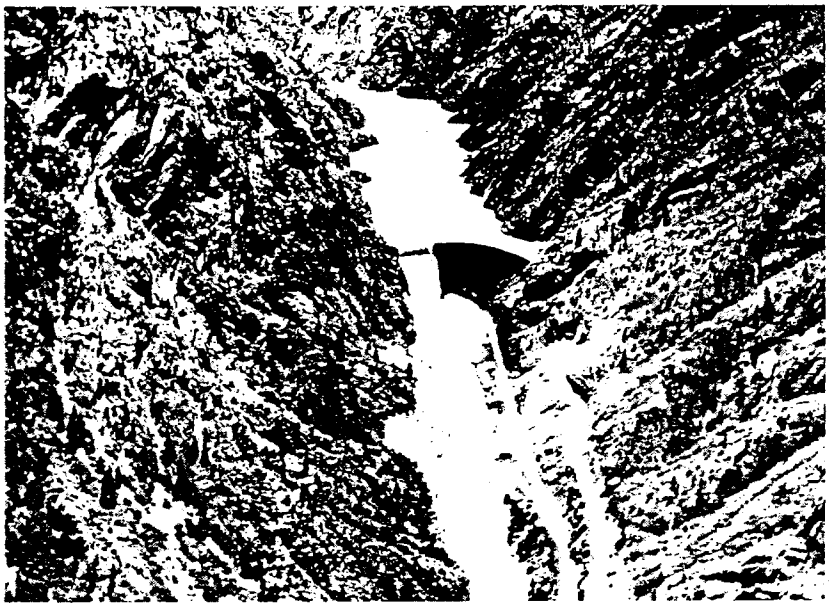
*Does not include 165 acre-feet of dead storage below 6808 feet.

**Crystal Point** Active Storage*

| | | |
|---|---|---|
| Maximum Storage | 17,573 | 6755 |
| Rated Head | 13,886 | 6742 |
| Minimum Power | 10,619 | 6729 |
| Surface Area (Full) | 301 | Acres |
| Reservoir Length (Full) | 7 | Miles |
| **Powerplant** | | |
| Number of Units | 1 | |
| Total Capacity | 28,000 | Kilowatts |

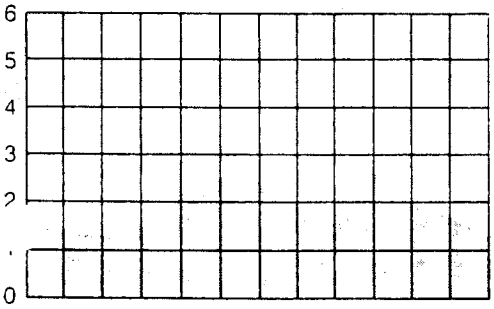
*Does not include 7,700 acre-feet of dead storage below 6670 feet.





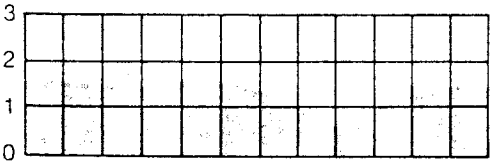
Crystal Dam

**Outflow Blue Mesa Reservoir**
**Actual 1985** Monthly Release in 1000 Cubic Feet / Second

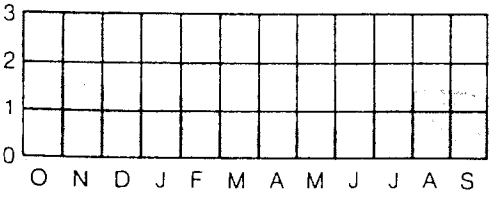



Projected Operation 1986
Reasonable Maximum


Most Probable

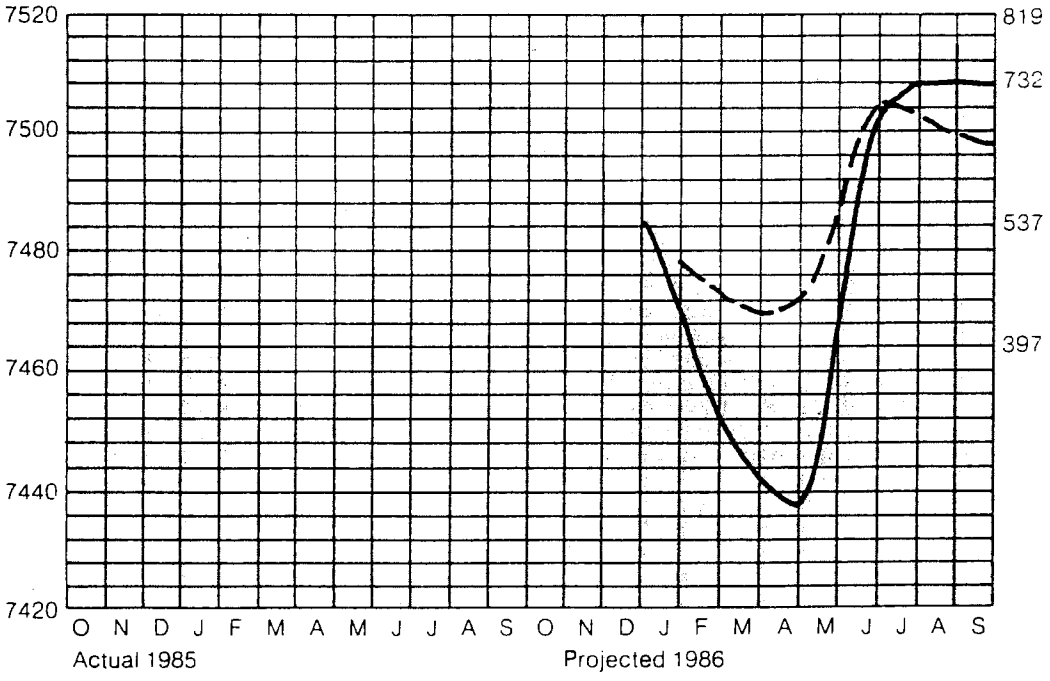



Reasonable Minimum




**Storage Blue Mesa Reservoir**
End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet
Non-Linear Scale




**Legend**
Most Probable
Reasonable Minimum
Reasonable Maximum

# Navajo Reservoir (San Juan River)

## Water Year 1985

The beginning elevation for Navajo Dam on October 1, 1984, was 6080 feet, the same as for water year 1984. The reservoir was slowly drawn down to elevation 6074.0 feet on January 1, 1985. The April-July forecast on January 1 was for 130 percent of average inflow. Releases ranged between 1,000 and 2,500 cfs from December through February, averaging 1,800 cfs per day. Releases were adjusted to 1,000 cfs for two 1-week periods in January and February to assist some construction work next to the river near Farmington, New Mexico. The March forecast was 127 percent of normal but jumped to 164 percent of normal in April. The San Juan drainage of southwest Colorado had an extremely wet winter with several stations reporting over 200 percent of normal snow water equivalent. Releases in March were increased from ,500 cfs to 3,200 cfs by April 1 and were increased to 4,300 cfs by April 30. The May forecast was for 178 percent of normal runoff and releases were set at ,050 cfs for all of May. On May 6, a peak v of 9,130 cfs was recorded due to low elevation snow melting. May and June's weather was hot and dry causing the snow to melt faster than normal. The peak inflow into Navajo Dam occurred on June 9 at 10,160 cfs, dropping steadily thereafter to 3,300 cfs by the end of June. Navajo Dam reached its peak elevation of 6083.04 feet on June 25, which is 2 feet below the spillway crest. The actual April-July inflow to Navajo Dam was 1.26 maf, which is 173 percent of normal.

The total 1985 water year inflow was 1.9 maf which is 184 percent of normal. Releases ranged from a low of 530 cfs (1 day in October 1984 for some maintenance work) to 5,050 cfs for the month of May.

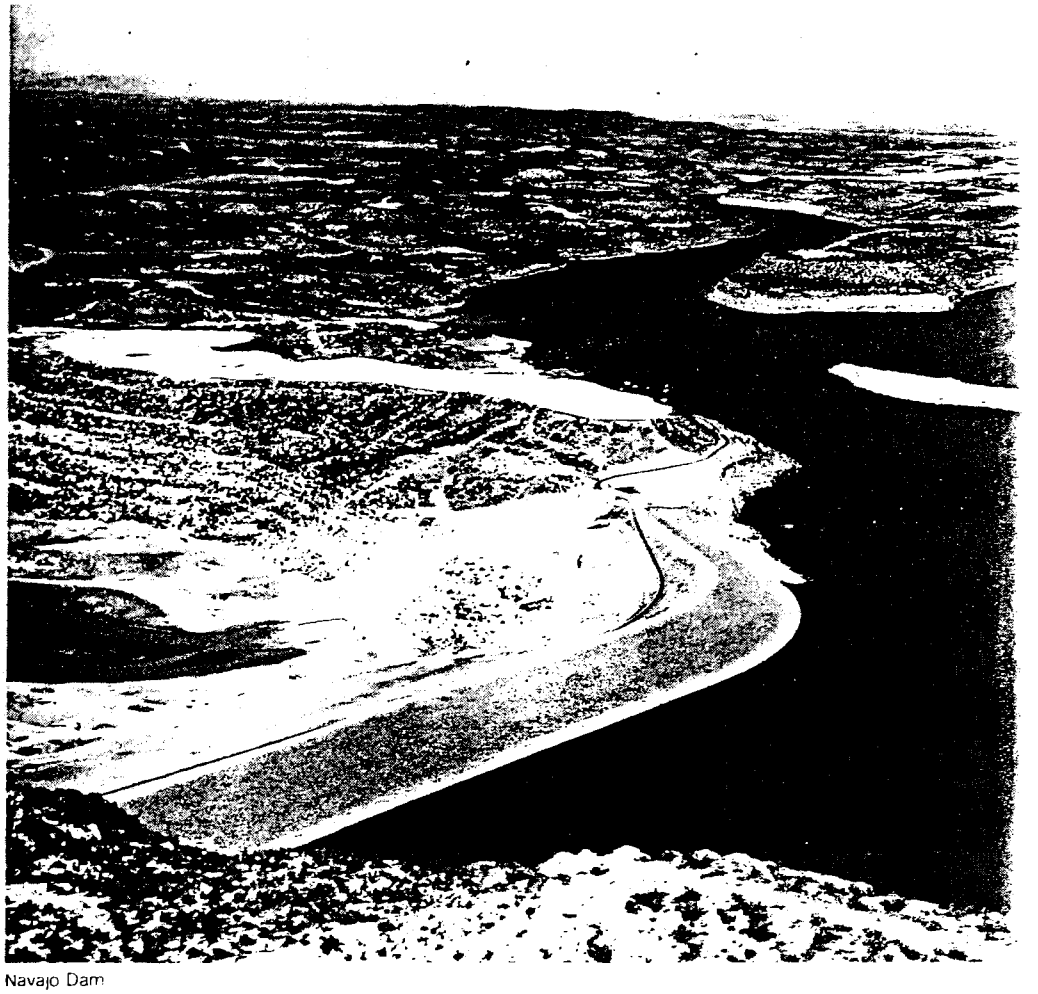
## Water Year 1986

Planned modification construction to reduce seepage from Navajo Dam is scheduled to start in the spring of 1986. To facilitate construction the water surface elevation will be drawn down to elevation 6040.0 feet and refilling will start in the spring of 1987. During the time that the reservoir is drawn down minimum releases to the river of 500 cfs are planned. Low flows will most likely occur from August 1986 to March 1987. Maximum flows during drawdown are planned to stay below 3,200 cfs based on the most probable inflow.

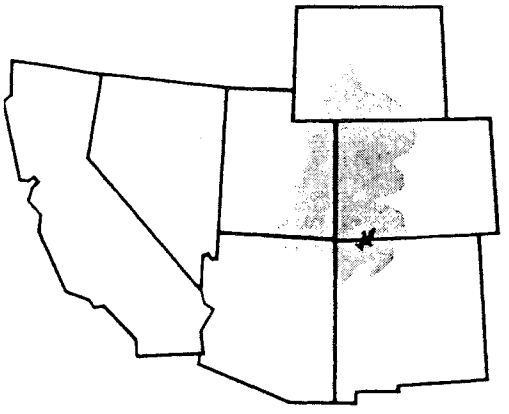
**Navajo** Active Storage* — Chart 4

| Reservoir | Acre-Feet | El. (Ft.) |
|---|---|---|
| Maximum Storage | 1,696,400 | 6085 |
| Inactive Storage | 660,500 | 5991 |
| Surface Area (Full) | 15,610 | Acres |
| Reservoir Length (Full) | 33 | Miles |

*Does not include 10,600 ac-ft dead storage below elevation 5990 ft.



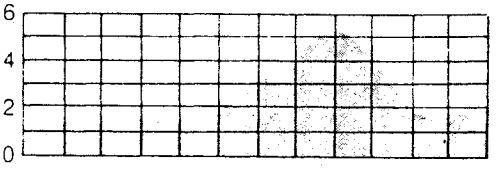
Navajo Dam



Recreation on Navajo Reservoir

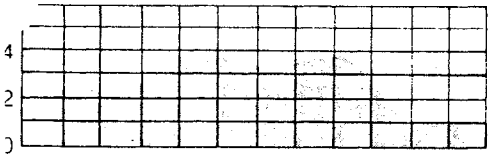
**Outflow** Monthly Release in 1000 Cubic Feet / Second

Actual Operation 1985

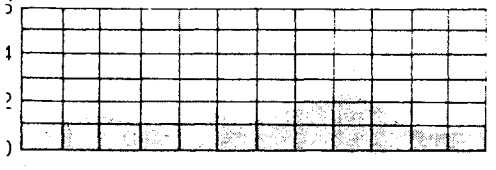



Projected Operation 1986

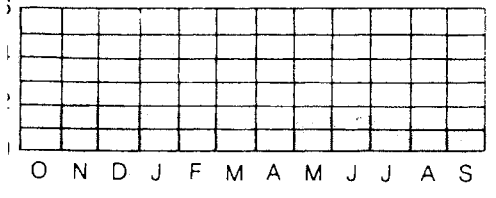
Reasonable Maximum




Most Probable



Reasonable Minimum

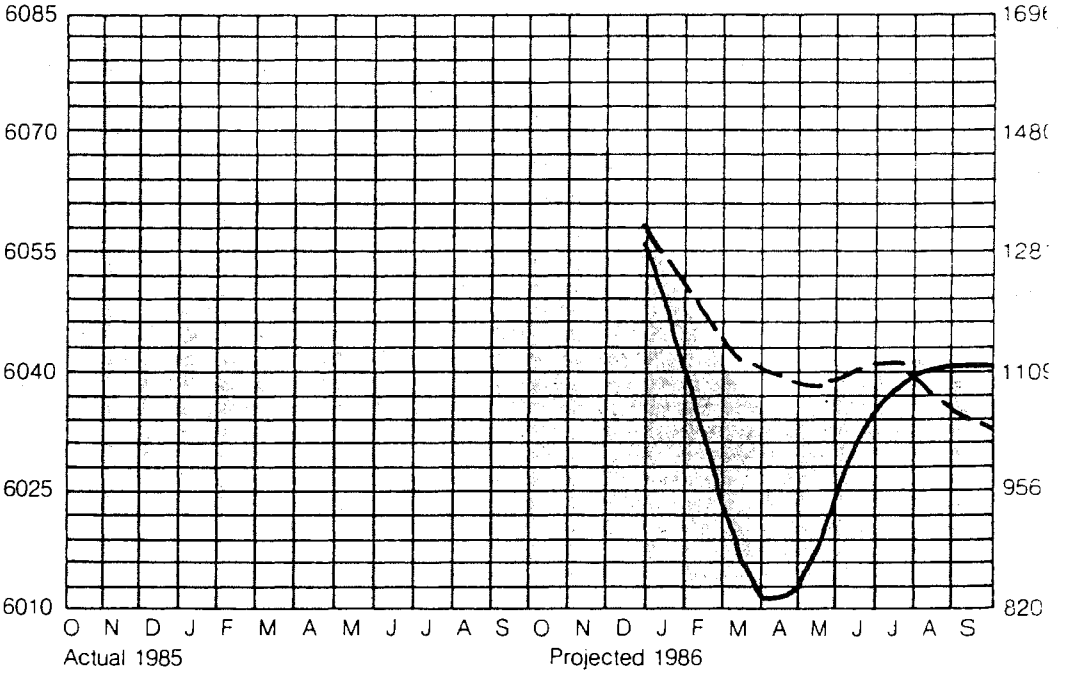



**Storage**

End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet

Non-Linear Scale




Most Probable

Reasonable Minimum

Reasonable Maximum

**Water Year 1985**

Lake Powell, which is impounded by Glen Canyon Dam, was operated as part of the Colorado River Storage Project (CRSP) in accordance with governing contracts and laws to provide river regulation, optimum power production, recreation, and fish and wildlife enhancement during water year 1985.

At the start of water year 1985, Lake Powell had an active content of 24.35 maf at elevation 3696 feet (97.4 percent full). The most probable operating plan based on the October forecast called for total water year releases of 13.75 maf based on an unregulated inflow of 12.9 maf. The reasonable maximum (upper decile) water supply had scheduled water year releases of 18.1 maf based on an unregulated inflow of 18.14 maf.

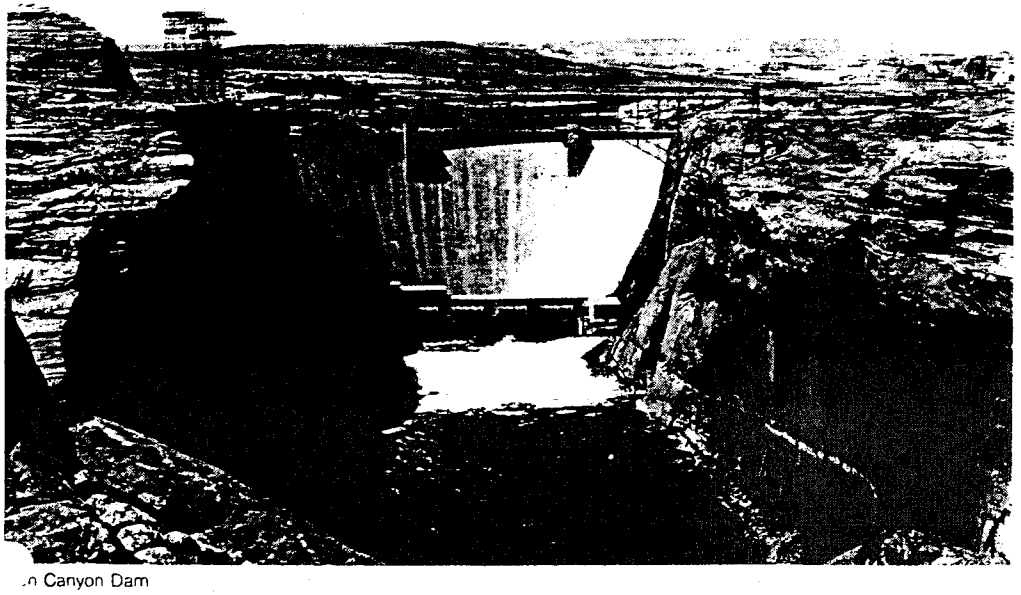
On January 1 the April-July inflow was forecasted to be 11.5 maf (154 percent of average). Discharge from Glen Canyon remained at powerplant capacity for January and February. In March the forecast dropped to 135 percent and was 138 percent of normal on April 1. To assure filling Powell by the end of June powerplant releases were lowered to 70 percent of capacity during March and April.

Weather during March was at normal or slightly above normal over the drainage basin above Lake Powell. By April 2 the weather pattern had changed to above average temperatures and below normal precipitation. The warm weather continued through April with above average precipitation and May had a similar pattern, although there were short periods of cool, wet weather over parts of the basin. As a result of the warmer than average temperatures the snow melt runoff increased rapidly from 20,000 cfs on April 1 to 50,000 cfs on April 15, with peak inflow occurring on May 11, 1985. This average daily unregulated peak inflow was 93,580 cfs with a secondary peak of 81,560 cfs occurring on June 14. Between peaks the unregulated flows dropped to 55,230 cfs. Regulated peak daily inflow was 81,000 cfs on May 22, with a secondary peak of 69,000 cfs on June 13. The low flow during this time was 52,000 cfs. On July 1 Lake Powell reached its maximum elevation of 3700.12 feet. The actual unregulated April-July runoff was 11.97 maf which is 160 percent of average. Maximum discharge below Glen Canyon was 44,810 cfs and occurred on June 21, as a result of combined powerplant and river outlet tube releases. A total of 1.03 maf was released through the river outlet tubes in May and June, bypassing the powerplant in order to control releases by not having to use the spillway.

The total 1985 water year unregulated inflow to Lake Powell was 17.5 maf which is equivalent to a reasonable maximum (upper decile) water supply. Total water year releases below Glen Canyon were 19.3 maf of which 1.03 maf bypassed the powerplant.

**Water Year 1986**

Lake Powell began the water year at elevation 3685.70 feet with an active content of 22.76 maf (91 percent full). The plan of operation for the first 3 months of the water year was to maintain releases at about 45 percent powerplant capacity in order to complete an environmental study of the riverine system through the Grand Canyon. Beginning in January, assuming an average runoff, discharge would go to 90 percent of plant capacity and then back to 50 percent of capacity for February through June. The months of July to September would be operated for power and recreation demands with discharges at 90 percent of plant capacity. Under the most probable inflow operation the reservoir would fill in early July and the total water year releases would be 11.1 maf with unregulated inflows of 12.26 maf. The operation for reasonable maximum inflow (upper decile) is the same as for most probable October through January. From February through August the discharge would be at plant capacity and lowering to 90 percent of capacity in September. Total water year releases of 16.1 maf based on an unregulated inflow of 17.4 maf would be required to fill Lake Powell but without bypassing the powerplant. The actual operation will be based on forecasted inflow projections received monthly.

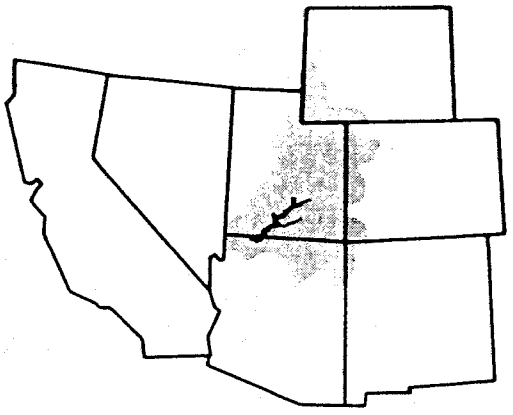


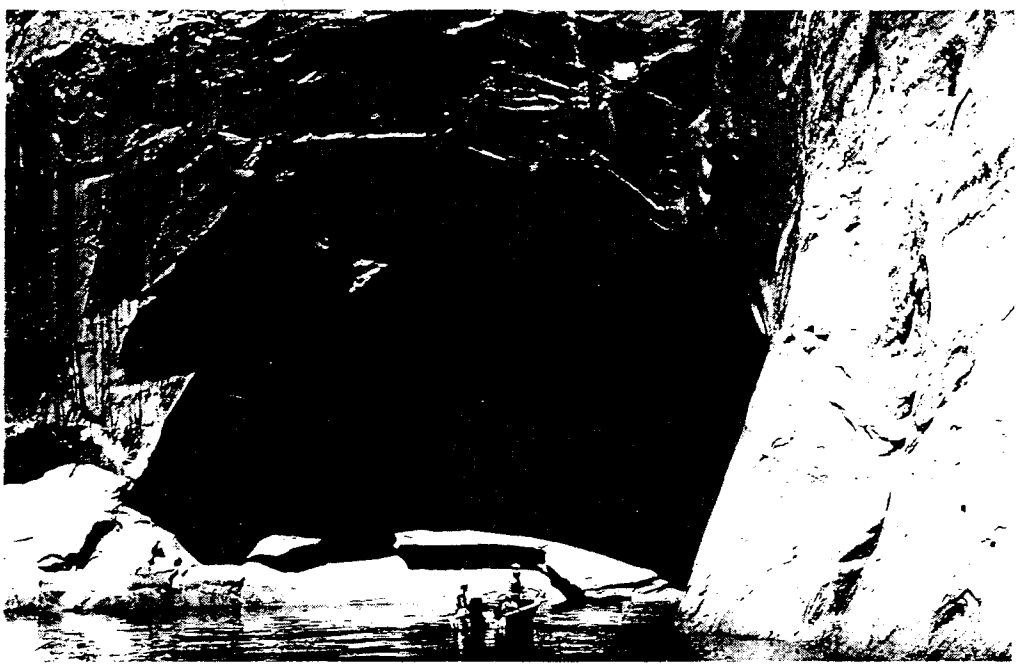
...n Canyon Dam

**Lake Powell** Active Storage* **Chart 5**

| Reservoir | Acre-Feet | El. (Ft.) |
|---|---|---|
| Maximum Storage | 25,002,000 | 3700 |
| Rated Head | 9,428,000 | 3570 |
| Minimum Power | 4,126,000 | 3490 |
| Surface Area (Full) | 161,390 | Acres |
| Reservoir Length (Full) | 186 | Miles |
| **Powerplant** | | |
| Number of Units | 8 | |
| Total Capacity | 1,106,000 | Kilowatts |

*Does not include 1,998,000 acre-feet of dead storage below 3370 feet





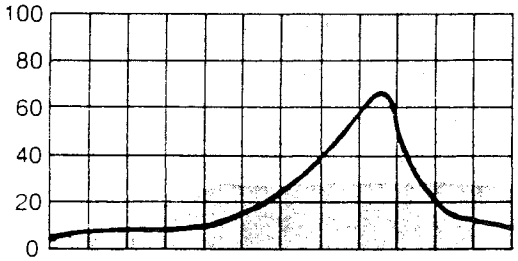
Fishing Side Canyons on Lake Powell

**Inflow —— Outflow**

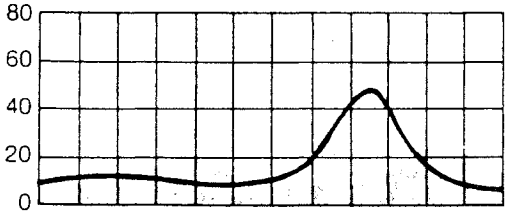
Actual 1985 Monthly Values in 1000 Cubic Feet / Second


Projected Operation 1986

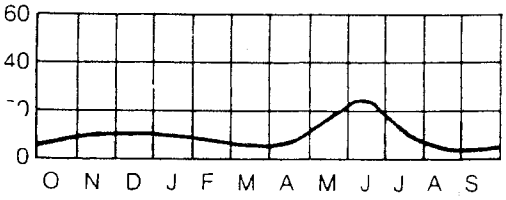
Reasonable Maximum




Most Probable




Reasonable Minimum

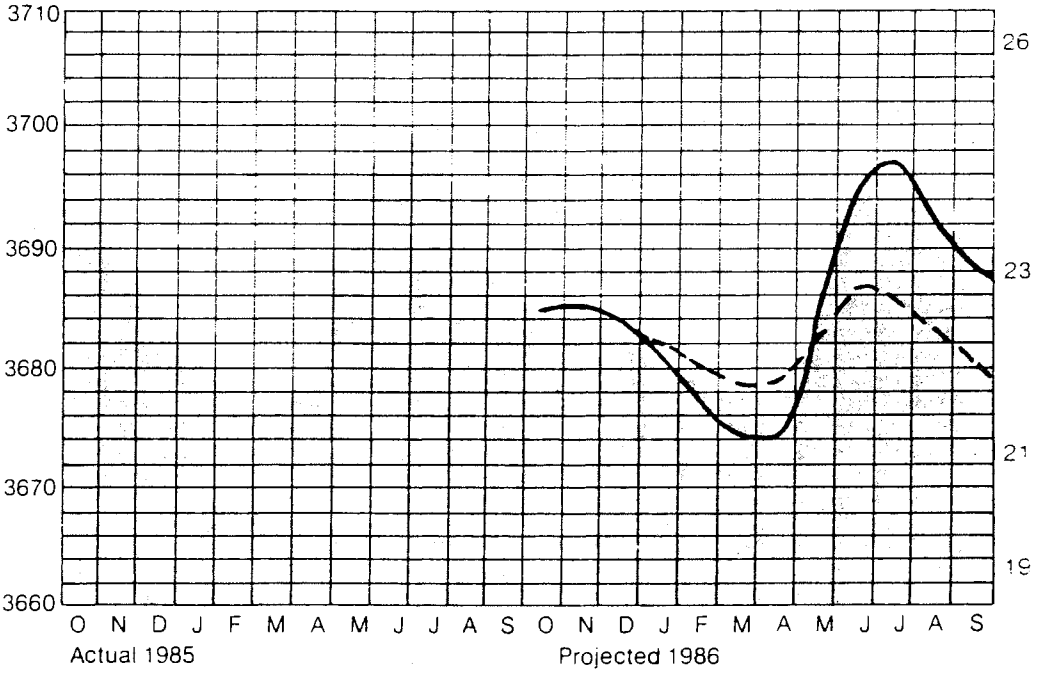



**Storage**

End of Month Elevation in Feet

Usable Content in Million Acre-Feet

Non-Linear Scale




**Legend**

Most Probable

Reasonable Minimum - - - - - -

Reasonable Maximum ——————

# ower Basin Reservoirs
# ake Mead (Colorado River)

## /ater Year 1985

t the beginning of water year 1985, Lake lead, impounded by Hoover Dam, had a ater surface elevation of 1210 feet and ı active storage of 24,412,000 acre-feet. uring the winter and spring months, the ater level gradually declined to 1206 et by the end of April 1985. During the gh inflow conditions of June and July, ake Mead reached a high elevation of 214.4 feet in the first week of July, with peak active storage of 25,060,000 acre-et.

uring the water year, releases were ıade to meet downstream water use equirements in the United States and lexico, flood control requirements, rogramed levels of Lakes Mohave and avasu, and transit losses which include ver and reservoir evaporation, uses by hreatophytes, changes in bank storage, nmeasured inflows, and diversions. The otal release from Lake Mead through oover Dam during water year 1985 was pproximately 18,636,000 acre-feet. All of ıat amount passed through the turbines ower production. At the end of the water year, Lake Mead had a water surface elevation of 1213 feet and an active storage of 24,875,000 acre-feet which reflects an increase in storage during the water year of 463,000 acre-feet. On September 30, 1985, the active storage in Lake Mead was 2,114,000 acre-feet greater than the active storage in Lake Powell.

## Water Year 1986

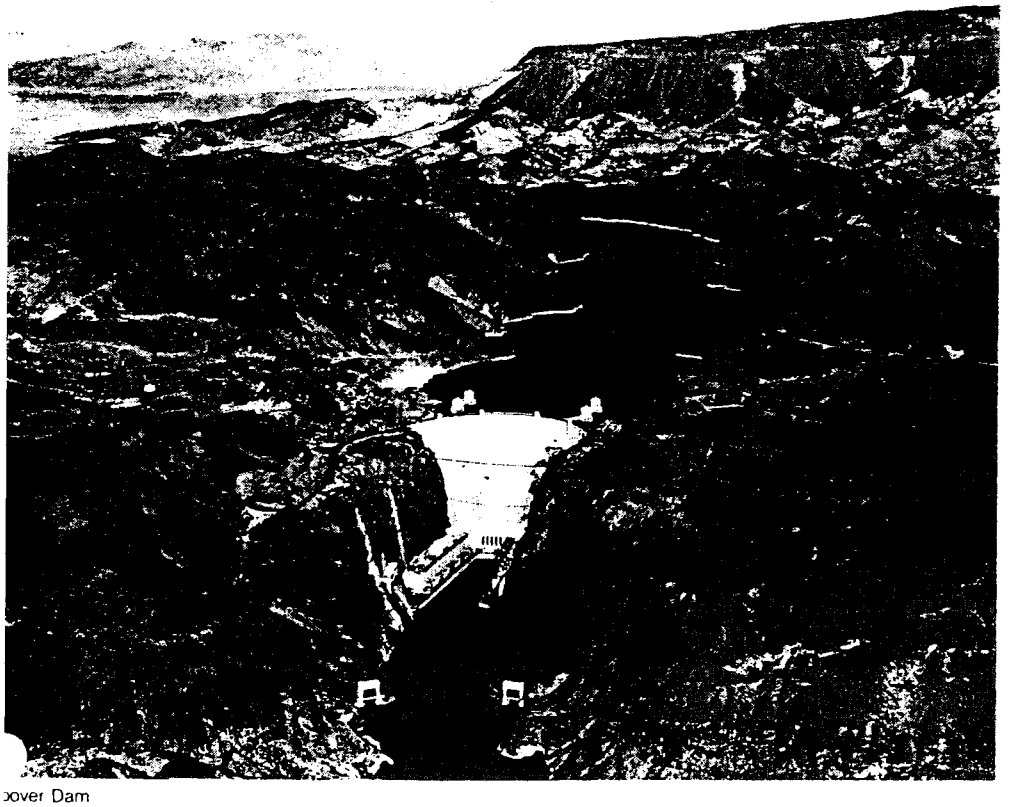
Under most probable inflow conditions during the 1986 water year, the Lake Mead water level is scheduled to be drawn down to elevation 1201 feet at the end of June 1986. At that level, the lake will have in active storage approximately 23.0 maf. During water year 1986, a total of about 12.7 maf is scheduled to be released from Lake Mead under most probable conditions, all passing through the powerplant.

A contract was awarded in water year 1985 for modification and repair work in both the Nevada and Arizona spillway tunnels at Hoover Dam. The work will consist of construction of slotted ring air-inducing devices in the inclined sections of the spillway tunnels and the repair of tunnel concrete lining. Work on the Nevada spillway began in October 1985 and is scheduled to be completed by May 15, 1986. The Arizona spillway work is scheduled to be completed in water year 1987.

**Lake Mead Active Storage*** **Chart 6**

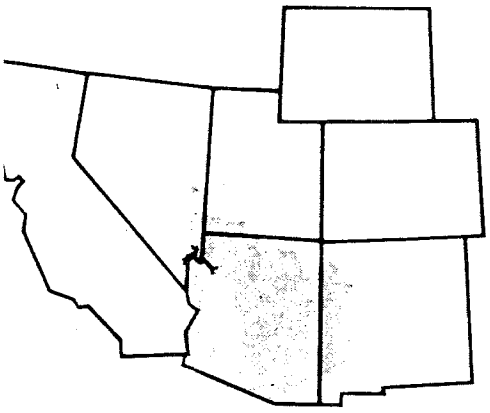
| Reservoir | Acre-Feet | El. (Ft.) |
|---|---|---|
| Maximum Storage | 27,377,000 | 1229 |
| Rated Head | 13,653,000 | 1123 |
| Minimum Power | 10,024,000 | 1083 |
| Surface Area (Full) | 162,700 | Acres |
| Reservoir Length (Full) | 115 | Miles |
| **Powerplant** | | |
| Number of Units | 17 | |
| Total Capacity | 1,429,000 | Kilowatts |

*Does not include 2,378,000 acre-feet of dead storage below 895 feet



oover Dam

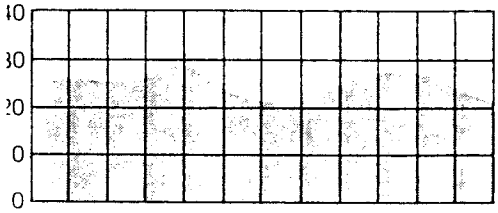
High Scaling Geologists Gather Structural Data at Hoover Dam



Hoover Powerplant and Afterbay

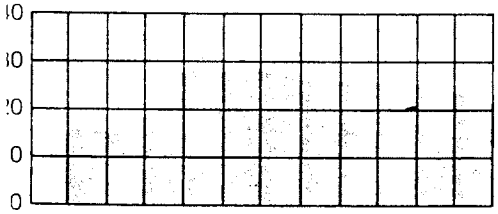
**Outflow** Monthly Release in 1000 Cubic Feet / Second

Actual Operation 1985



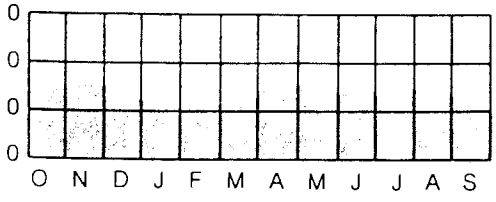

ected Operation 1986

sonable Maximum




Most Probable


leasonable Minimum

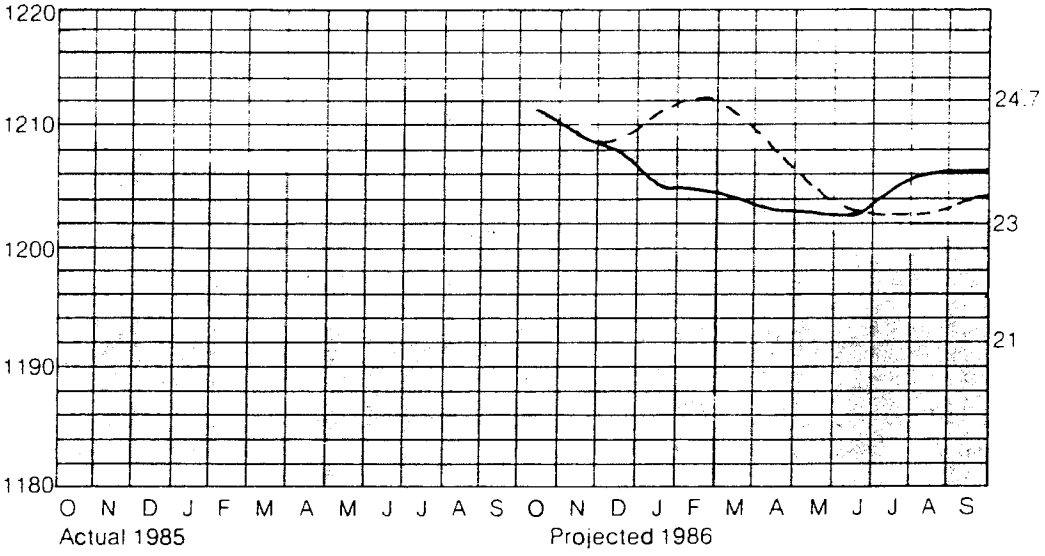



**Storage**

End of Month Elevation in Feet

Active Content in Million Acre-Feet

Non-Linear Scale




**Legend**

Most Probable

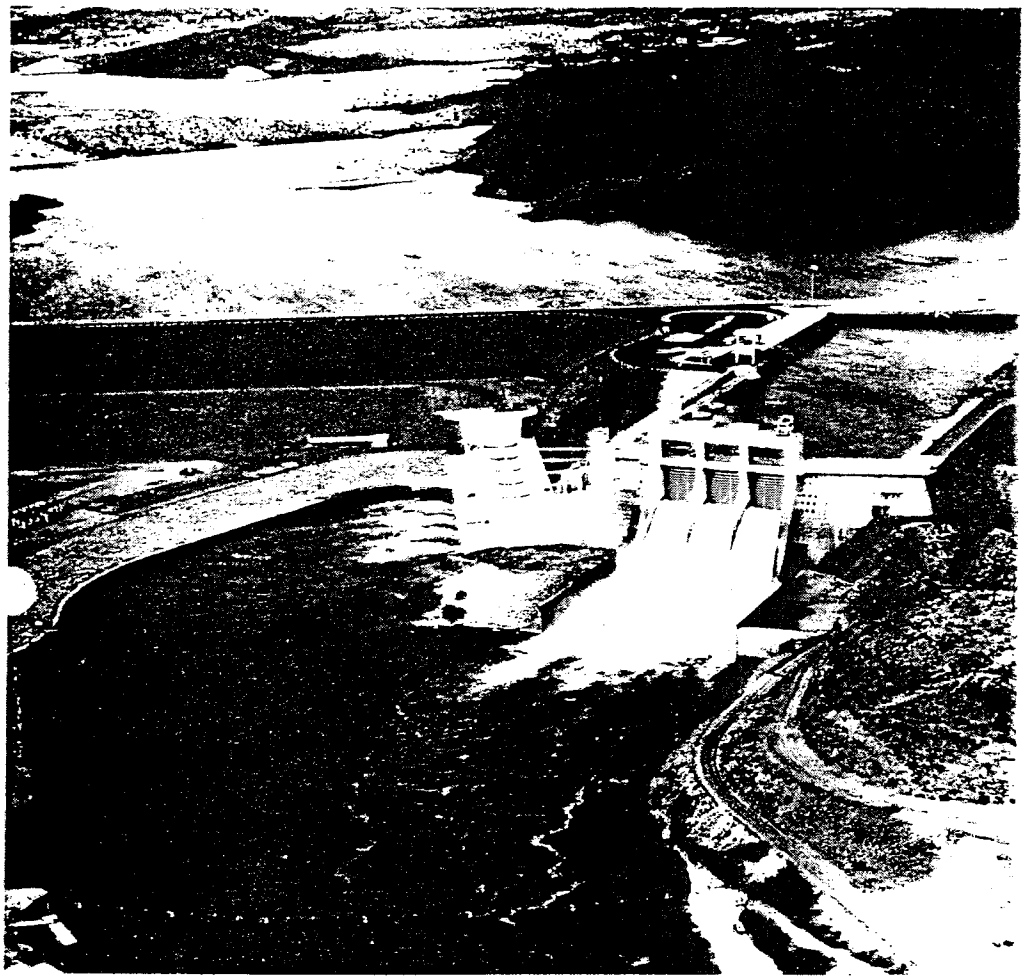
Reasonable Minimum

Reasonable Maximum

**Water Year 1985**

At the beginning of water year 1985, the water surface elevation of Lake Mohave which is impounded by Davis Dam, was 638.6 feet, with an active storage of about 1,578,000 acre-feet.

During the winter months, the water level was gradually lowered to approximately 633 feet, with an active storage of about 1,450,000 acre-feet by the latter part of December 1984. The water level was then gradually raised during the remaining winter months. The reservoir reached elevation 644 feet by the end of February 1985. During the month of April, Lake Mohave reached a high elevation of 646 feet, with an active storage of about 1,800,000 acre-feet. The reservoir ended the water year at an elevation of 637.9 feet with 1,560,000 acre-feet in active storage.



Davis Dam and Powerplant

Lake Mohave releases were made to satisfy flood control requirements and downstream water use requirements, including diversions by The Metropolitan Water District of Southern California (MWD). A small amount of reregulation occurred at Lake Havasu. During the water year, approximately 18,687,000 acre-feet were released at Davis Dam. Of that amount, approximately 16,350,000 acre-feet passed through the turbines for power production.

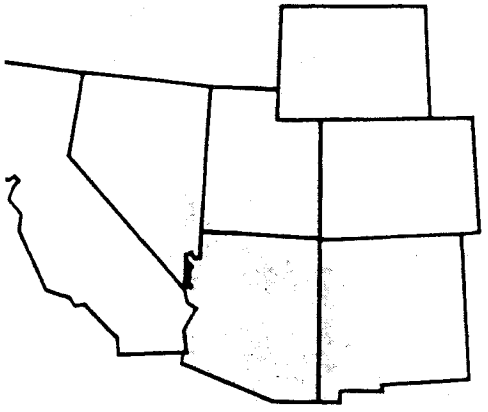
**Water Year 1986**

Under most probable inflow conditions the water level of Lake Mohave is scheduled to reach an elevation of 643 feet by the end of February 1986 and vary around that elevation for the remainder of the water year. During the water year a total of 12.7 million acre-feet is scheduled to be released from Lake Mohave to meet all downstream and flood control requirements. All of that total is scheduled to pass through the powerplant.

**Lake Mohave Active Storage* Chart 7**

| Reservoir | Acre-Feet | El. (Ft.) |
|---|---|---|
| Maximum Storage | 1,810,000 | 647.0 |
| Rated Head | 1,188,000 | 623.0 |
| Minimum Power | 217,500 | 570.0 |
| Surface Area (Full) | 28,200 | Acres |
| Reservoir Length (Full) | 67 | Miles |
| **Powerplant** | | |
| Number of Units | 5 | |
| Total Capacity | 240,000 | Kilowatts |

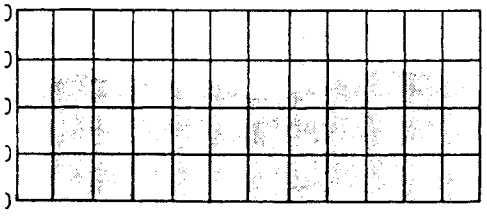
*Does not include 8,530 acre-feet of dead storage below 533.39 feet



Running the River

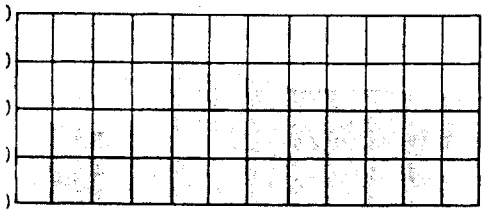
**utflow** Monthly Release in 1000 Cubic Feet/Second

ctual Operation 1985



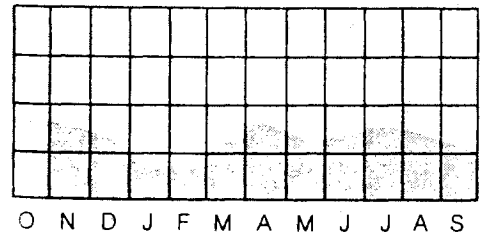
ted Operation 1986

easonable Maximum



ost Probable

easonable Minimum



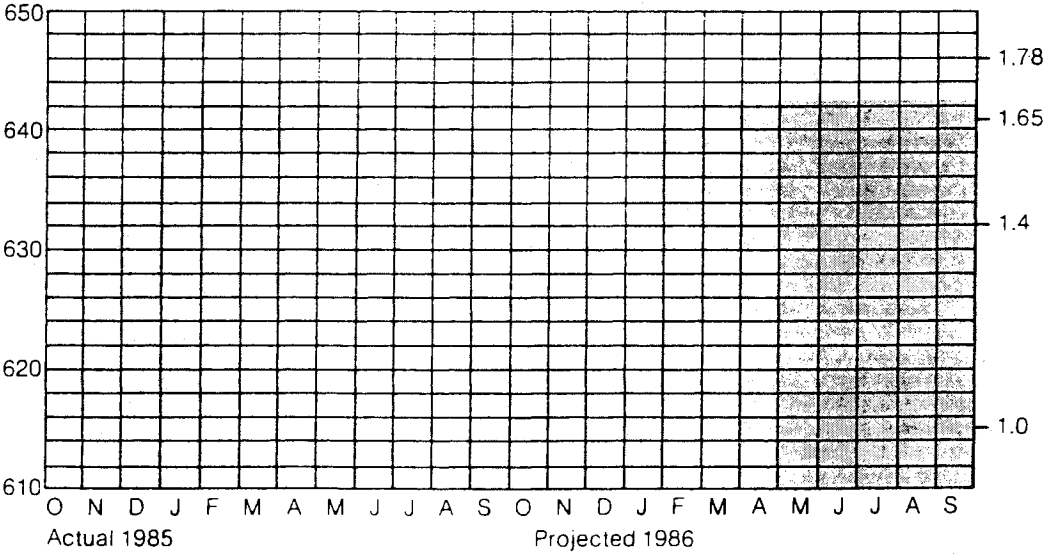
O N D J F M A M J J A S

**Storage**

End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet

Non-Linear Scale




**Legend**

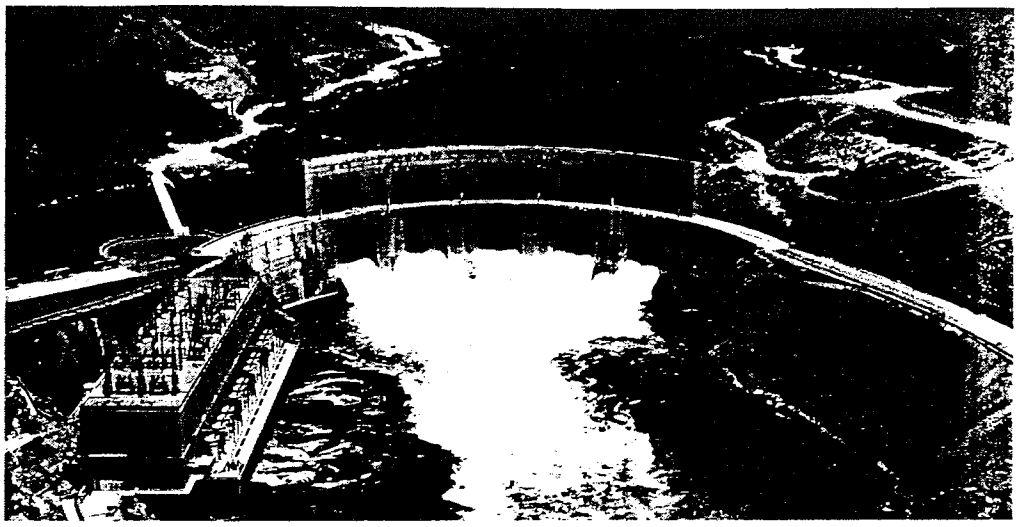
Most Probable

**Water Year 1985**

At the beginning of water year 1985, the water level of Lake Havasu, impounded by Parker Dam, was at elevation 448 feet with an active storage of approximately 585,000 acre-feet. During October and November 1984, the reservoir was drawn down to approximately elevation 446 feet, with an active storage of about 540,000 acre-feet. In early February 1985, the reservoir was at elevation 446 feet to provide vacant space for runoff from the drainage area between Davis and Parker Dams. The water level was then raised to an approximate elevation of 449 feet near the end of May, with an active storage of about 599,000 acre-feet. At the end of the water year, Lake Havasu was at an elevation of about 446 feet with an active storage of 540,000 acre-feet.

During the water year, approximately 17,701,000 acre-feet were released at Parker Dam, of which approximately 14,944,000 acre-feet passed through the turbines for power production. The total release amount included releases from Alamo Dam on the Bill Williams River. In addition to the releases from Parker Dam, approximately 1,260,000 acre-feet were diverted from Lake Havasu by MWD. Initial diversions from Lake Havasu for the Central Arizona Project (CAP) were 23,000 acre-feet during the water year.

Space in the top 10 feet of Lake Havasu (about 180,000 acre-feet) is reserved by the United States for control of floods and other uses, including river regulation. Normally, only about the top 4 feet, or 77,000 acre-feet of space, have been used for this purpose since the Alamo Reservoir on the Bill Williams River has been in operation.



Parker Dam with Lake Havasu in the Background

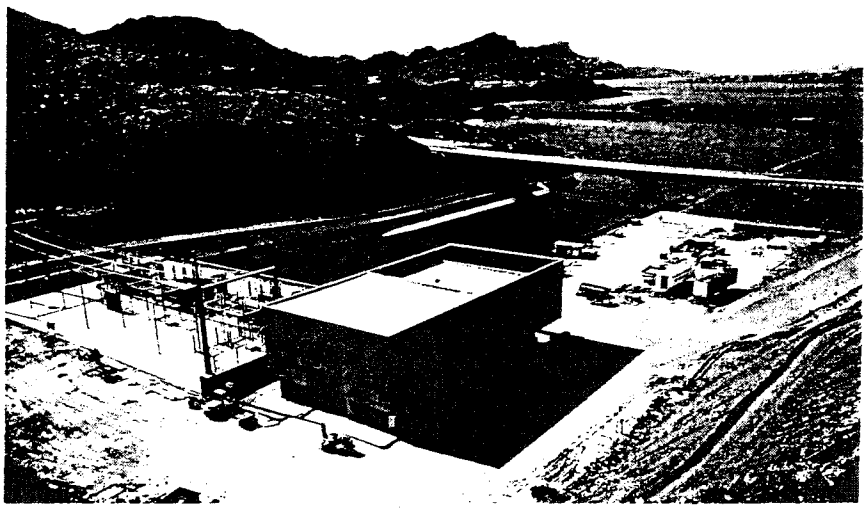
**Water Year 1986**

Lake Havasu is scheduled at the highest levels consistent with the requirements for maintaining reservoir regulation space. The yearly low elevation of approximately 446 feet is scheduled for the October through February high flood hazard period. The yearly high of about 450 feet is scheduled for the low flood hazard months of May and June. During water year 1986, a total of approximately 10.9 million acre-feet is scheduled to be released from Lake Havasu to meet all downstream and flood control requirements. All of that amount is scheduled to pass through the Parker Powerplant.

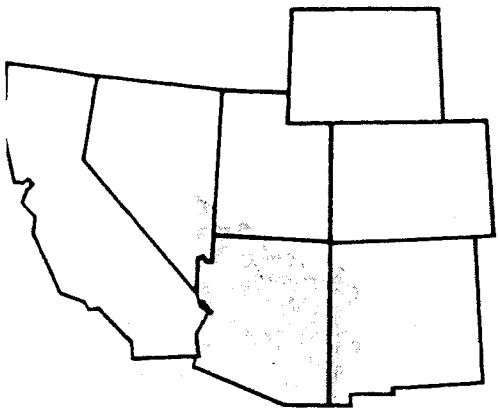
**Lake Havasu Active Storage* Chart 8**

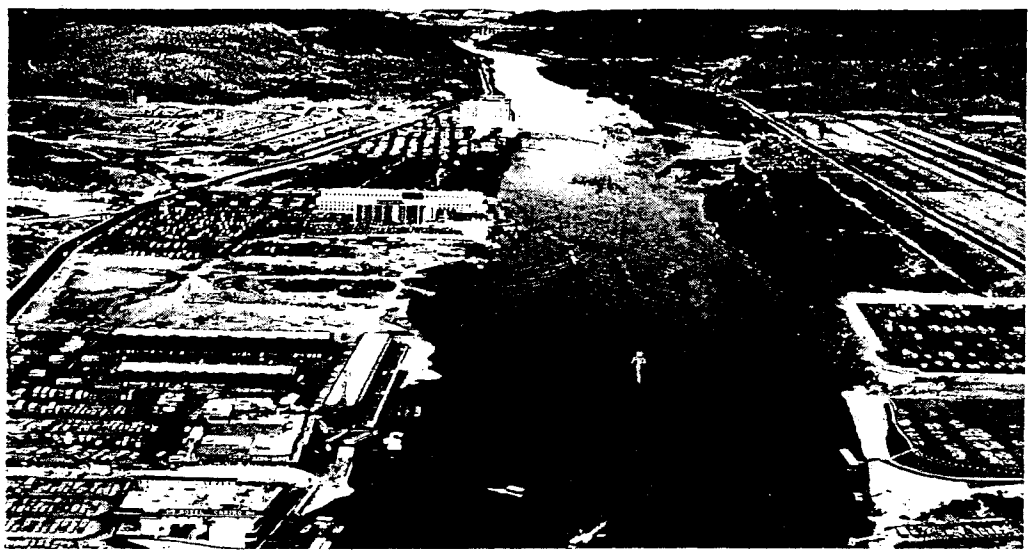
| Reservoir | Acre-Feet | El. (Ft.) |
|---|---|---|
| Maximum Storage | 619,400 | 450.0 |
| Rated Head | 619,400 | 450.0 |
| Minimum Power | 439,400 | 440.0 |
| Surface Area (Full) | 20,400 | Acres |
| Reservoir Length (Full) | 35 | Miles |
| **Powerplant** | | |
| Number of Units | 4 | |
| Total Capacity | 120,000 | Kilowatts |

*Does not include 28,600 acre-feet of dead storage below 400.00 feet



Havasu Pumping Plant, Central Arizona Project





Laughlin, Nevada with Davis Dam in Background

**)utflow** Monthly Release in 1000 Cubic Feet/Second

ctual Operation 1985

0
0
)
)
)

ted Operation 1986

easonable Maximum

)
)
)
)

ost Probable

asonable Minimum

O N D J F M A M J J A S

**Storage**

End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet

Non-Linear Scale

460
450
440
430
420

611
555
400
300

O N D J F M A M J J A S O N D J F M A M J J A S

Actual 1985 Projected 1986

**Legend**

Most Probable

## River Regulation

Water levels in all of the major reservoirs were lower in water year 1985 than in 1984. This was partially due to lower inflow as well as elevation restrictions on several Upper Basin reservoirs. The natural runoff of the Colorado River drainage during 1985 at Lee Ferry, Arizona, was estimated to be 20.8 maf. Of this amount, about 3.3 maf was consumptively used in the Upper Colorado River Basin States.

Adjusting for regulation of Upper Basin reservoirs resulted in an unregulated inflow to Lake Powell of 17.5 maf during water year 1985. Annual releases from Powell based on stream gaging records at Lees Ferry, Arizona, was 19.30 maf. For the 1-year and 10-year periods ending September 30, 1985, 19.3 maf and 118.8 maf, respectively, passed the compact point at Lee Ferry including the average annual discharge of the Paria River at Lees Ferry.

The projected water year 1986 release from Lake Powell, based on reasonable minimum runoff conditions is 8.7 maf. The projected releases for the reasonable maximum runoff condition is 16.1 maf as of November 4, 1985.

Daily releases are made from the storage reservoirs in the Lower Basin to meet the incoming orders of the water user agencies. When possible, all water passes through the powerplant units. The daily releases are regulated on an hourly basis to meet as nearly as possible the power loads of the hydroelectric power customers. Minimum daily flow objectives are provided in the river to maintain fishery habitat.

The combination of high runoff conditions and river regulation below Hoover Dam resulted in a total delivery to Mexico of approximately 11,530,000 acre-feet in excess of the scheduled treaty quantity (1,700,000 acre-feet) during water year 1985. Of that amount, 130,600 acre-feet of drainage waters were bypassed to the Gulf of California via the Bypass Drain. This bypass channel was constructed pursuant to provisions of Minute No. 242 of the International Boundary and Water Commission.

The most probable water supply operation will yield 6.3 maf of effective flood control space on January 1, 1986. With 6.3 maf of effective space it is virtually assured that flood control releases from Hoover Dam of at least 19,000 cfs will be required during water year 1986.

Rough Water Boating on the Colorado

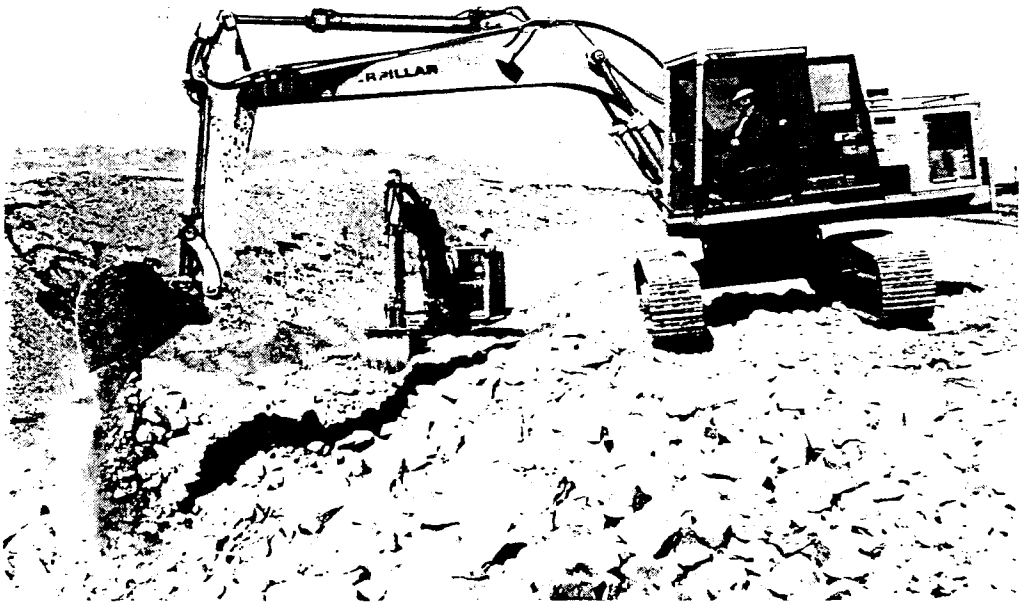
## lood Control

otal inflow during 1985 was again eater than normal for most of the servoirs in the basin. In the Upper asin, Navajo and Blue Mesa Reservoirs e operated for flood control by provid- g space to store snowmelt floods. though Flaming Gorge and Glen anyon Reservoirs have no specifically signed flood control requirements, they e operated so as to reduce the possi- lity of spills. The space they provide ay be counted as part of the flood ntrol space at Lake Mead that is quired by the Army Corps of Engineers orps) flood control regulations.

uring 1985, the Upper Green River ainage received less than normal runoff ile the rest of the Upper Basin drain- e received above normal flows. The unnison River flows were less than 84, but still above normal while the San an River above Navajo was greatly ove normal in 1985 (184 percent of rmal). As a result of the wide variability flows over the Upper Basin, only the r an River below Navajo Dam had w. igher than those in 1984. The aximum 1985 discharges below the ms on the Gunnison and San Juan vers were less than half of the 1984 ak inflows. The Green River below aming Gorge experienced normal runoff tterns.

ke Mead is the only reservoir on the lorado River in which a specific space exclusively allocated for mainstem od control. Flood control regulations for over Dam have been updated and ised based on findings of a joint study iated in 1977 by Reclamation and the rps with consultation and advice of ate and local interests.

inal report dated July 1982 which mmarized the study findings and commended a new flood control eration plan for Hoover Dam was eased July 1983. Vacant flood control rage space will be maintained in Lake ad as stipulated in the Report's Field rking Agreement between Reclama- n and the Corps for flood control eration of Hoover Dam and Lake ad. These regulations establish



Levee Riprapping

releases in a manner that maximizes public benefits in the United States with reasonable consideration for conditions in Mexico.

Lower releases this year than the 25,000 cfs to 35,000 cfs levels during 1984 and the 40,000 cfs to 45,000 cfs levels during water year 1983 have avoided any additional significant damages along the river in the Lower Basin. Scour in some reaches of river channel has continued to occur, and therefore river levels have been lower in some areas than they were with the same release levels during the last 2 years. In a few areas, however, reaches have refilled due to heavy sediment loads. One example is the reach below Cibola Valley in the Lower Basin.

Total Colorado River reservoir system storage at the start of water year 1985 was approximately 57,332,000 acre-feet and about 55,514,000 acre-feet at the end of the water year, representing a 1,808,000 acre-foot increase in total remaining available reservoir space.

In addition to the mainstem structures, Alamo Dam on the Bill William River, and Painted Rock Dam on the Gila River (both in the Lower Basin) received flood inflow during water year 1985. During water year 1986, Painted Rock and Alamo Reservoirs are scheduled to be operated in accordance with established flood control criteria to maximize the available flood control space remaining in these reservoirs.

## Beneficial Consumptive Uses

An extensive discussion of consumptive uses is not attempted in this report as that subject has been treated in detail in Reclamation's "Colorado River System Consumptive Uses and Losses Report 1976-1980." That report was prepared jointly by the Upper and Lower Colorado Regional Offices and was released in 1983. It presents estimates of the consumptive uses and losses from the Colorado River System for each year from 1976 through 1980. The following table summarizes annual water use from the system by States, including water use supplied by groundwater overdraft. The next report is expected to be available in early 1987.

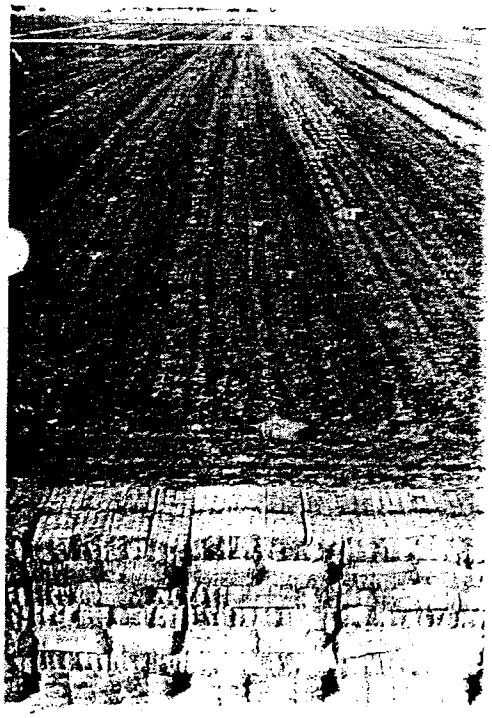
**Water Use by States[1]**
**1976-1980**

(1,000 acre-feet)

| State | 1976 | 1977 | 1978 | 1979 | 1980 | Average 1976-1980 |
|---|---|---|---|---|---|---|
| Arizona | 5,033 | 5,369 | 5,351 | 5,409 | 5,641 | 5,361 |
| California | 4,813 | 4,837 | 4,624 | 4,591 | 4,680 | 4,709 |
| Colorado | 1,679 | 1,608 | 1,937 | 1,824 | 1,744 | 1,758 |
| Nevada | 226 | 227 | 224 | 228 | 233 | 228 |
| New Mexico | 310 | 239 | 361 | 432 | 457 | 360 |
| Utah | 705 | 462 | 746 | 798 | 738 | 690 |
| Wyoming | 282 | 219 | 333 | 348 | 337 | 304 |
| Other[2] | 1,931 | 1,832 | 1,887 | 2,070 | 2,063 | 1,956 |
| Total — Colorado River System | 14,979 | 14,793 | 15,463 | 15,700 | 15,893 | 15,366 |
| Water Passing to Mexico | | | | | | |
| Treaty | 1,475 | 1,554 | 1,513 | 1,668 | 1,707 | 1,583 |
| Minute 242 | 205 | 209 | 194 | 171 | 185 | 193 |
| Excess Releases | 69 | 68 | 38 | 927 | 4,251 | 1,071 |
| Sub-total — Water Passing to Mexico | 1,749 | 1,831 | 1,745 | 2,766 | 6,143 | 2,847 |
| Total — Colorado River System and Water Passing to Mexico | 16,728 | 16,624 | 17,208 | 18,466 | 22,036 | 18,213 |

[1]Onsite consumptive uses and losses; includes water uses satisfied by groundwater overdrafts.

[2]Represents mainstream reservoir evaporation in the Upper Basin and mainstream reservoir evaporation and channel losses below Lee Ferry in the Lower Basin.



Baled Alfalfa Crop

Sesame Crop Under Irrigation

## pper Basin Uses and Losses

he three largest categories of consumptive use in the Upper Colorado River asin are agricultural uses within the asin, transbasin diversions to adjacent rainages, and evaporation losses from ıe major reservoirs of the Colorado River ystem. During water year 1985, the stimated use for municipal and industrial ıpply and for agriculture in the Upper asin was 1,900,000 acre-feet. Estimated vaporation losses were 740,000 acre-ıet from mainstem reservoirs. About 53,000 acre-feet was diverted for use in ıjacent drainages. Total estimated ınsumptive use amounted to 3,300,000 ıre-feet. Storage in the Upper Basin ıainstem reservoirs decreased by ıproximately 2,200,000 acre-feet during ater year 1985.

## ıwer Basin Uses and Losses

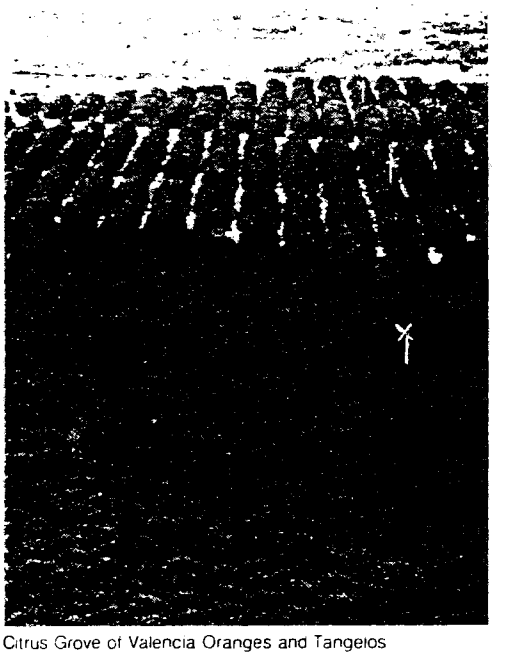
uring water year 1985, an estimated 4.6 af of water were released from Lake avasu to meet the requirements for ater deliveries at Imperial Dam, as well ; those of the Colorado River Indian vation near Parker, Arizona, the ılo Verde Irrigation District near Blythe, ılifornia, other miscellaneous users ong the river, and transit losses ıtween Parker Dam and Imperial Dam.

The major water diversion above Parker Dam was by MWD. MWD pumped approximately 1,260,000 acre-feet from Lake Havasu during water year 1985.

Releases of approximately 5.6 maf were made from Lake Mohave during water year 1985, to provide for releases at Parker Dam; to supply diversion requirements of MWD, miscellaneous contractors, and other users; to offset evaporation and other transit losses between Davis and Parker Dams; and to maintain the scheduled levels of Lake Havasu.

During water year 1985, releases of approximately 5.6 maf were made from Lake Mead at Hoover Dam to regulate the levels of Lake Mohave and to provide for the small users from that reservoir, and to provide for releases at Davis Dam. In addition, 162,000 acre-feet were diverted from Lake Mead for use by the Lake Mead National Recreation Area, Boulder City; Basic Management, Inc.; and contractors of the Colorado River Commission of Nevada. Total releases and diversions from Lake Mead during water year 1985 were an estimated 18,798,000 acre-feet.

For water year 1986, a total release of 10.9 maf from Lake Havasu has been projected, including consumptive use

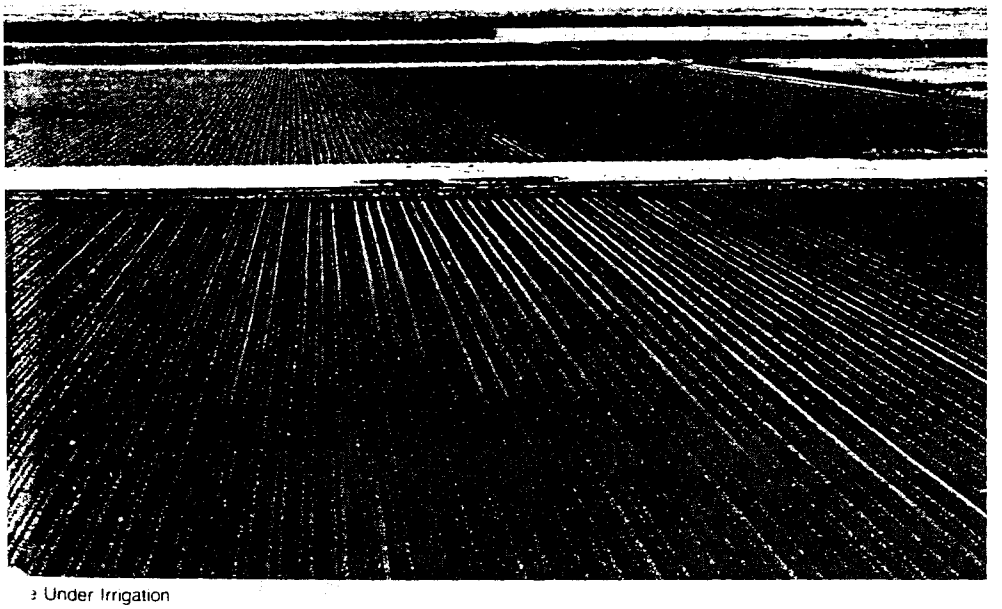


Citrus Grove of Valencia Oranges and Tangelos

requirements in the United States below Parker Dam, transit losses in the river between Parker Dam and the Mexican Border, flood control requirements, and treaty deliveries to Mexico. All of the amount projected would pass through the Parker Powerplant.

During water year 1986, MWD is expected to divert 1,250,000 acre-feet by pumping from Lake Havasu. Consumptive uses by small users, river losses or gains, and reservoir losses between Davis Dam and Parker Dam are projected to be a net loss of 139,000 acre-feet.

There are no major users between Hoover Dam and Davis Dam. During water year 1986 the net diversions from Lake Mead are projected at 141,000 acre-feet. Evaporation from Lake Mead is projected to be about 965,000 acre-feet and net gain between Glen Canyon Dam and Lake Mead is expected to be about 884,000 acre-feet.



ı Under Irrigation

In recognizing the need to manage the water quality of the Colorado River, it was recommended that long-term salinity increases in the river be controlled through a water quality improvement program as described in the report "Colorado River Water Quality Improvement Program" dated February 1972.

The program called for a basin-wide approach to salinity control while the Upper Basin continues to develop its compact-apportioned waters. The initial step toward improvement of the future water quality in the basin was the passage by Congress of the Colorado River Basin Salinity Control Act of 1974 (Act) (Public Law 93-320) on June 24, 1974, authorizing the construction of various features for the enhancement and protection of the quality of water available in the Colorado River for use in the United States and the Republic of Mexico.

Title I of the Act enables the United States to comply with its obligation under the agreement with Mexico of August 30, 1973 (Minute 242 of the International Boundary and Water Commission, United States and Mexico), which was concluded pursuant to the Treaty of February 3, 1944 (TS994). Title I authorized the construction of the Yuma Desalting Plant and a bypass drain to ultimately discharge the plant's brine. These facilities, and others, will enable the delivery of water at Morelos Dam, for subsequent use in Mexico, having an average salinity no greater than 115 parts per million (ppm) ± 30 ppm (United States count) higher than the annual average salinity of the Colorado River water at Imperial Dam.

Title II of the Act authorized the Secretary to construct a number of units in the basin above Imperial Dam, as well as the investigation of several other potential salinity control units.

Irrigation Management Requires Soil Moisture Measurements

The Act, and its amendment by Public Law 98-569 of October 30, 1985, directs the Secretary to submit a biennial report to the President, the Congress, and the Colorado River Basin Salinity Control Advisory Council. Since the water quality aspects of Colorado River operations are extensively described in that biennial series, the latest of which is Report No. 12 entitled, "Quality of Water, Colorado River Basin," dated January 1985, only minimal discussion of this aspect of the operation below Imperial Dam is presented in this report.

During water year 1985, the United States bypassed a total of 130,800 acre-feet through the Bypass Drain. As the river was in an excess flow condition during 1985, due to the high runoff in the basin, no specific releases from the upstream reservoirs were necessary to replace this water to meet the quantity requirements of the Mexican Treaty of 1944.

During water year 1985, the average annual salinity of the Colorado River water arriving at Imperial Dam was 613 ppm. During this same period, the salinity of the waters arriving at Morelos Dam was 641 ppm, resulting in an annual average salinity differential of only 28 ppm, well within the requirement of Minute 242 of the International Boundary and Water Commission.

The total flows in the bypass drain during water year 1986 are projected to be 130,000 acre-feet. A minor amount of drainage water could be returned to the Colorado River below Morelos Dam during 1986. Due to the excess flow conditions that are expected, it will not be necessary to provide replacement water to Mexico for the bypassed flows.

## pper Basin

'uring water year 1985, Reclamation ɔntinued to study the impact of Glen anyon Dam on the downstream environ- ıent. The Glen Canyon Environmental tudies are a multiagency/multiobjective ɛries of studies that are oriented to ɨchnically evaluate the impact of the ɔerations of Glen Canyon Dam on the ɜtural resources of the Grand Canyon ıd the Lees Ferry tailwater area. The ɨudies are a cooperative effort that com- ɨnes the expertise and cooperative ɨvolvement of Federal, State, private, ıd academic entities. Reclamation is ɾoviding the lead role in the studies ɨrough overall study management and ɨnding. The main objective of the studies to technically evaluate the relationship ɛtween the natural resources and the ɔmplete range of flow regimes opera- ɔnally feasible from Glen Canyon Dam.

ıe resulting analysis will provide the put to the development of alternative ɔerational scenarios that will be evalu- as to their natural resource impact ıd feasibility under existing physical, gal, and operational constraints.

ɔur main areas of interest are being ɾaluated: biological, recreation, sediment ansport and hydrology, and power. epresentatives from four Federal ɟencies, two State agencies, four univer- ties, and six private contractors currently ake up the study team.

ıe studies are approximately 67 percent ɔmplete with the major portion of data ɛing collected at maximum powerplant ɔw levels. The remaining data collection ill be oriented largely toward the rela- ɔnships between fluctuating flows and e natural resources. The projected completion date for the studies is April 1987, but is highly dependent upon the availability of specific flow levels. The cooperative nature of the studies and the technical orientation are a unique approach to a very diverse and dynamic problem.

Fish and wildlife resources in and around CRSP reservoirs were again confronted with drastic changes to their environments during 1985. Although the levels of impact were not as severe as in 1983 and 1984, the high spring release levels reduced thermal regimes, and inundation of streamside terrestrial habitat affected the propagation and growth of aquatic and terrestrial species.

Impacts to these resources have not yet been fully quantified. In some cases fisherman use and success have continued in spite of the hindrance to access caused by the high flows. Riparian areas and sandy beaches adjacent to tailwater reaches were modified or eliminated in several areas where water velocities removed substrate materials. Deposition of much of the suspended material following the high water, however, caused new beaches to be formed and invading riparian growth is already being reestablished. Although not accustomed to such dynamic changes in their habitats below regulated reservoirs, it appears that the fish and wildlife resources situated there have remained resilient despite the pressures placed on their environment.

Management of the tailwater fisheries and investigations funded by Reclamation is focusing on balancing the needs for cold water trout species in the immediate tailwater reaches and on the downstream needs of warmer water endangered species.

Consultation with the Fish and Wildlife Service regarding the impacts of the CRSP reservoirs on the endangered Colorado River fishes is still ongoing. Studies designed to provide biological answers and operational options are being initiated and will help fulfill Reclamation responsibilities and requirements mandated by the Endangered Species Act.

In addition to the native species, investigations of selected salmonid species and their specific habitat requirements are progressing. This information will also assist Reclamation in determining flow requirements and habitat preferences of economically and recreationally important trout species.

Information gained from both aquatic studies will be incorporated into the overall operation of the reservoirs to insure continued protection of important environmental values while maintaining many other project purposes.


Preparing for Fish Studies Flaming Gorge

**Lower Basin**

Reclamation cooperated in development of a proposal for a joint study with the States of Arizona and Nevada to evaluate the potential of increasing the nutrient level in Lake Mead. It appears that an increased nutrient level will enhance the fishery of Lake Mead. The study would take about 5 years and Reclamation presently plans to participate in at least 3 years of the effort.

Reclamation again participated in spring surveys to determine the numbers and location of the endangered Yuma Clapper Rail. A study, funded jointly by the U.S. Fish and Wildlife Service and Reclamation to investigate movements and habitat utilization of the Yuma Clapper Rail, is underway. Rail populations at Mittry Lake and Lake Havasu are the subjects to this intensive effort.

As part of the salinity investigations program, Reclamation initiated a dredging operation in Mittry Lake. This work will increase the depth of the water and provide channels in the marsh habitat to ·ate open water. In addition, the ·.edging program will improve water fowl habitat.

Central Arizona Project (CAP) will supply Indian and non-Indian irrigation districts and municipalities with water from the Colorado River. The water will be conveyed in a series of aqueducts stretching almost 400 miles across Arizona. These aqueducts and associated storage reservoirs will affect a number of historical and archaeological properties.

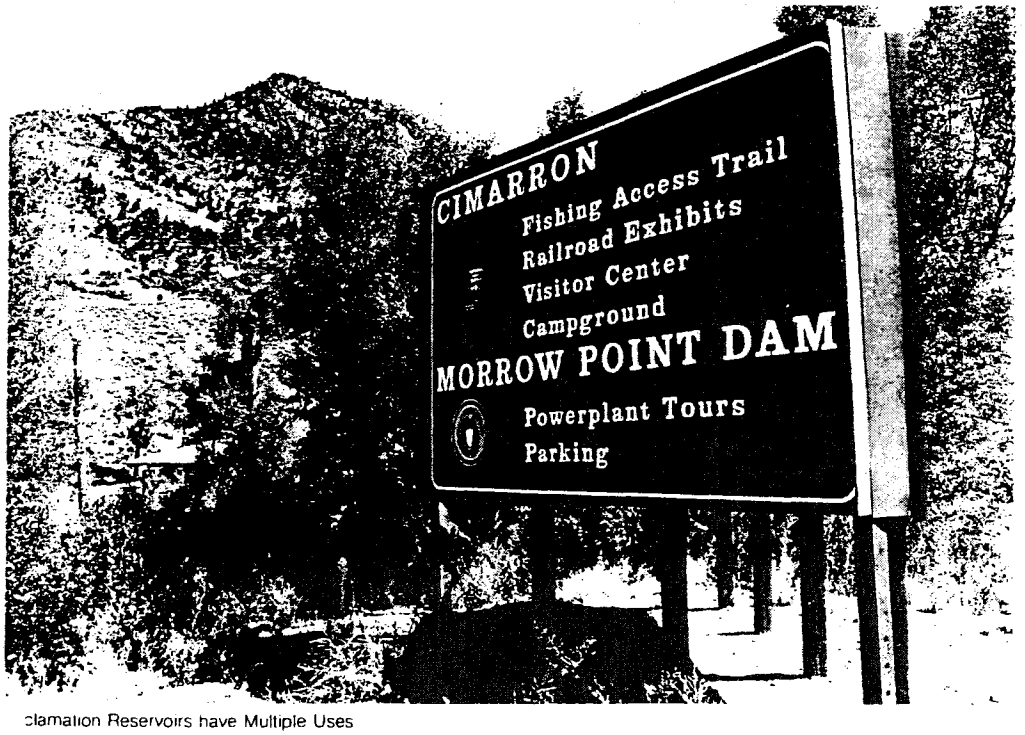
Extensive excavation and data recovery programs have been underway on a number of archaeological sites affected by construction of the CAP Salt-Gila and Tucson Aqueducts. Most of these sites are related to the HoHoKam culture, a highly organized agriculturally based people who lived in the Phoenix and Tucson Basins from about the beginning of the Christian Era until approximately 1450 A.D.

Arizona State University excavated sites at the "Marana Complex," one of several large HoHoKam communities located during cultural resource inventories on the Tucson Aqueduct. The "Marana Complex" is typical of a number of large communities that developed nearly 1000 years ago.

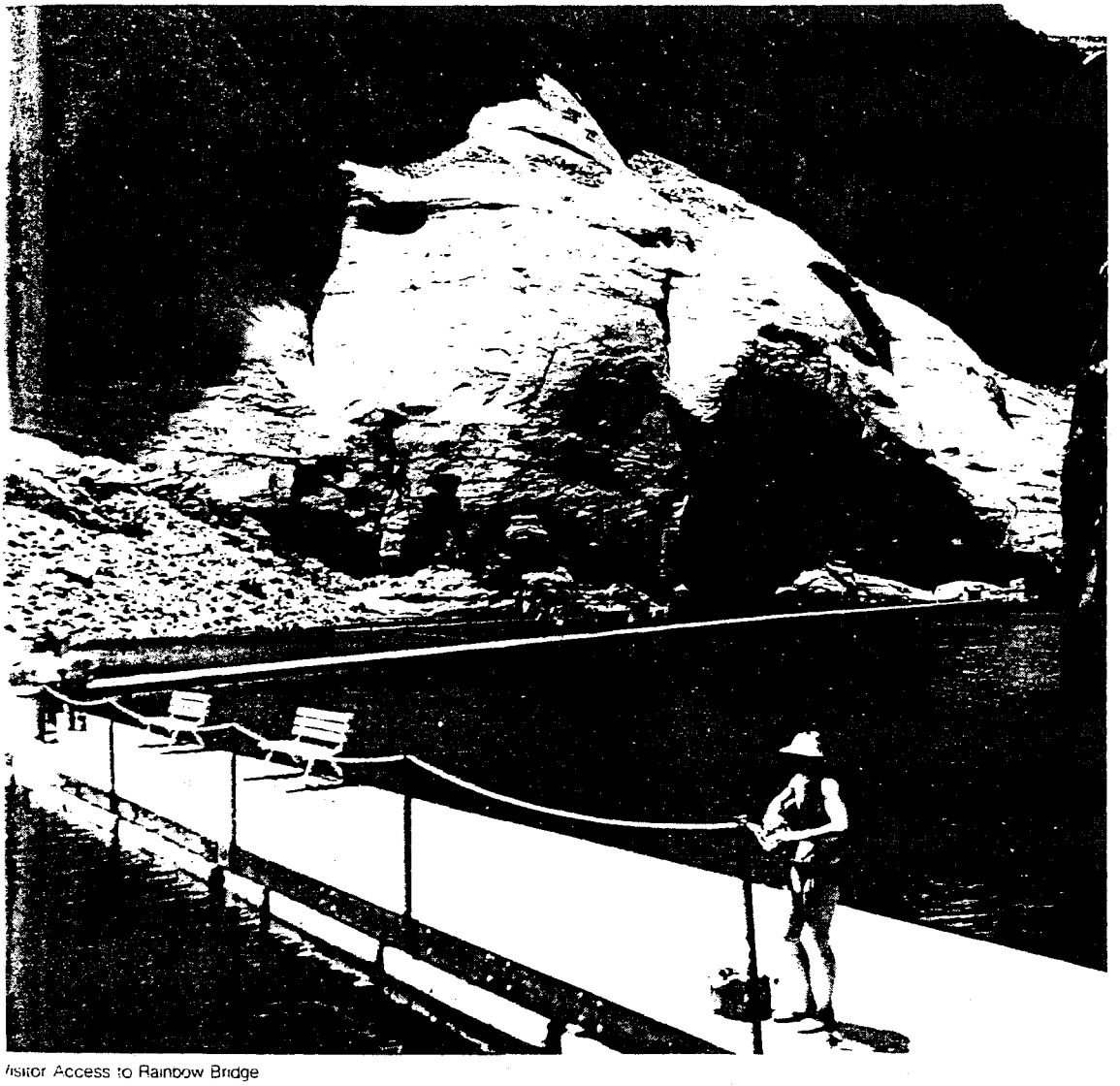
The HoHoKam, while basically agricultural people, apparently had a well organized socio-political system. The communities consisted of aggregations of pithouse family dwellings around a central platform mound. The platform mounds may have served as residences for political and religious leaders. These compounds apparently were the focus of the socio-political and religious systems of the HoHoKam people. Agricultural areas, often irrigated by sophisticated canal systems, were interspersed with the residences. The resulting communities could be as much as 5 to 6 miles across.

The work by Northland Research at two HoHoKam sites along the Santa Rosa Canal revealed another fascinating aspect of HoHoKam culture. The "Road Site" and "Shelltown," two large HoHoKam village sites, were apparently prehistoric shell jewelry manufacturing centers. Thousands of pieces of ocean shell, ranging from whole raw shell to exquisitely finished bracelets and pendants, are being recovered in the excavation at these sites. Specialized tools and shell jewelry in all stages of manufacture tell a story of skilled artisans fashioning seashell imported from the Gulf of California into a variety of jewelry items. The relative paucity of artifacts normally associated with agriculture at these sites may be a further clue to their specialized nature. It seems possible that the residents of "Road Site" and "Shelltown" may have been engaged almost exclusively in jewelry manufacture and therefore imported their food and other necessities. This is unlike the more self-sufficient nature of most villages where the inhabitants farmed, gathered, and hunted to supply their daily needs.

Continuing research at other CAP excavations may shed more light on these and other intriguing questions. The CAP Cultural Resource Program continues to make significant contributions to our knowledge of earlier cultures in Arizona and the ways in which they solved problems which, by the way, were not unlike those that prompted the construction of CAP itself.




·lamation Reservoirs have Multiple Uses



/isitor Access to Rainbow Bridge

The unique Arizona nesting bald eagle populations continue to be investigated by biologists from Reclamation and other agencies. Plans were made to initiate a major study of this population which could be seriously affected by features of the CAP's Regulatory Storage Division.

Reclamation biologists are concluding studies on how animal drownings can be avoided along proposed and existing canals and those under construction. The distribution and movement of desert mule deer and desert bighorn sheep along the Parker and Granite Reef Aqueducts were investigated to determine what areas would be best for catchments, crossings, fencings, or canal escape devices. Over 100 miles of fencing has been constructed along several reaches of the Granite Reef Aqueduct and a cooperative agreement to furnish 14 wildlife water devices is in effect with the Arizona Game and Fish Department.

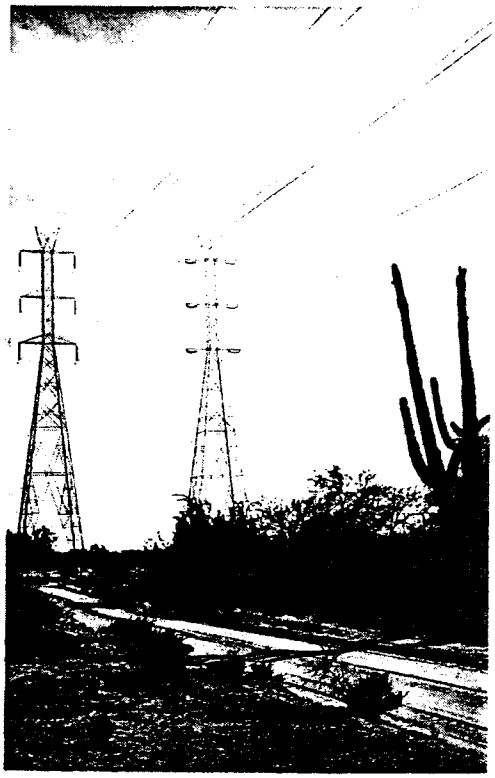
Reclamation and the U.S. Fish and Wildlife Service have entered into a cooperative study to develop habitat preference curves for native fish in the Verde River. Results of this study will be used to determine how this preferred native fish habitat will be affected by water exchanges on the Verde River. This information would also be used for native fish in the Upper Gila Water Supply Study Area.

### Upper Basin-Colorado River Storage Project

Westinghouse Electric Corporation continued contract work to uprate the generators at Glen Canyon Powerplant. During 1985, work was completed on unit 3 and started on unit 8. Units 8 and 7 are scheduled to have their uprates completed in 1986, with work on unit 4 to start in late 1986. Uprating of all the units is scheduled for completion by April 1987.

The following table summarizes CRSP generation, purchases, disposition, and revenues from power operations for fiscal year 1985, and present projections for fiscal year 1986.

The total revenue from power operations in fiscal year 1985 was $137,190,303. For fiscal year 1986, estimated revenues are $91,000,000.



Transmission Lines under Construction

**Water Year 1985**

| Sources of Energy | Kilowatt-hours |
|---|---|
| **Net Generation** | |
| Blue Mesa | 425,357,600 |
| Crystal | 238,134,000 |
| Flaming Gorge | 717,133,000 |
| Fontenelle | 26,249,300 |
| Glen Canyon | 8,772,555,640 |
| Morrow Point | 558,622,000 |
| Subtotal — Net Generation | 10,738,051,540 |
| **Purchases** | 696,156,000 |
| **Miscellaneous** | **Kilowatt-hours** |
| Interchange Receipts | 1,029,000,000 |
| Energy Charges to Transmission Service Customers | 292,500,000 |
| Subtotal — Miscellaneous | 1,321,500,000 |
| Total Energy From All Sources | 12,755,707,540 |

| Disposition of Energy | Kilowatt-hours |
|---|---|
| Firm Energy Sales | 8,406,523,000 |
| Nonfirm Energy Sales Emergency and Fuel Replacement (Oil Conservation) | 3,027,864,000 |
| Interchange Deliveries | 302,000,000 |
| System Losses | 1,019,320,540 |
| Total Energy Distributed | 12,755,707,540 |

| Revenue | Dollars |
|---|---|
| Firm Power Sales | $ 75,672,466 |
| Non firm Power Sales | 58,379,288 |
| Emergency Power Fuel Replacement (Oil Conservation) Energy | |
| Reserve Capacity | -0- |
| Parker-Davis Project Firming | -0- |
| Transmission Service Revenue | 2,214,639 |
| Miscellaneous Revenue | 923,910 |
| **Total Gross Revenue** | $137,190,303 |

| Water Year 1986 (Projected) | Kilowatt-hours |
|---|---|
| Estimated Energy Sales | 6,120,000,000 |
| Estimated Purchases | 890,000,000 |
| Estimated Peaking Capacity Sales | |
| Winter 1985-86 | 48,000 |
| Summer 1986 | 100,000 |
| **Estimated Revenue ($)** | 91,000,000 |

### Lower Basin — Water Year 1985

The total energy delivery to the Hoover allottees during the 1985 operating year (June 1, 1984 - May 31, 1985) was 9,558,500,906 kilowatt-hours (kWh). Of that amount, 5,640,220,906 kWh was secondary energy in excess of contract defined firm energy.

The remote control operation of Davis and Parker Powerplants, which first began during water year 1982, continued without event. These generator units are computer operated from the Department of Energy's Phoenix Dispatch Office, using hourly gate opening and megawatt schedules input and modified by Reclamation's Water Scheduling Branch in Boulder City, Nevada.

Scheduled maintenance at Hoover Dam for water year 1985 included normal replacements of stators, thrust bearings, water pipes, and transformers. Uprating of units N-7 and A-5 was completed in May, 1985.

The 5-year inspection and maintenance of penstocks and main unit G-4 at Davis Dam was scheduled beginning in September 1985 through December 1985.

Outages and maintenance for Parker Dam during water year 1985 included the following: Unit 2 underwent a 1-year inspection and maintenance including 15 kV cables replacement; Unit 4 had a 2-year inspection and maintenance including 15 kV cables replacement; Unit 1 had its 1-year inspection and maintenance including 15 kV cables; and Unit 3 underwent a 4-year inspection including turbine runner repairs. In January 1985, a new 70-kW emergency generator was installed. In February 1985, gate stems on penstocks 1, 2, 3, and 4 were replaced, and in March 1985, thrust bearings on Unit 1 were replaced.

### Water Year 1986

In operation studies of Lake Mead and Lake Powell for the Hoover operating year, which ends May 31, 1986, the amounts released at Hoover Dam have been projected to satisfy both downstream water requirements, including diversions by MWD, while also complying with the overall requirements to meet compact, flood control, and operating criteria release provisions. The water scheduled to be released will generate 100 percent of contract defined

firm energy, plus secondary energy. The estimated monthly Hoover releases during the operating year total 14.3 maf. It is estimated that generation from these Hoover releases, along with the Hoover to Parker-Davis interchange, will result in delivery to the allottees of about 6.8 billion kWh of electrical energy.

Scheduled transformer replacements at Hoover Dam began on November 4, 1985, proceeding through February 3, 1986, as penstocks outage permits. The units affected are N-3, N-4, A-1, A-2, N-1, and N-2, in that order.

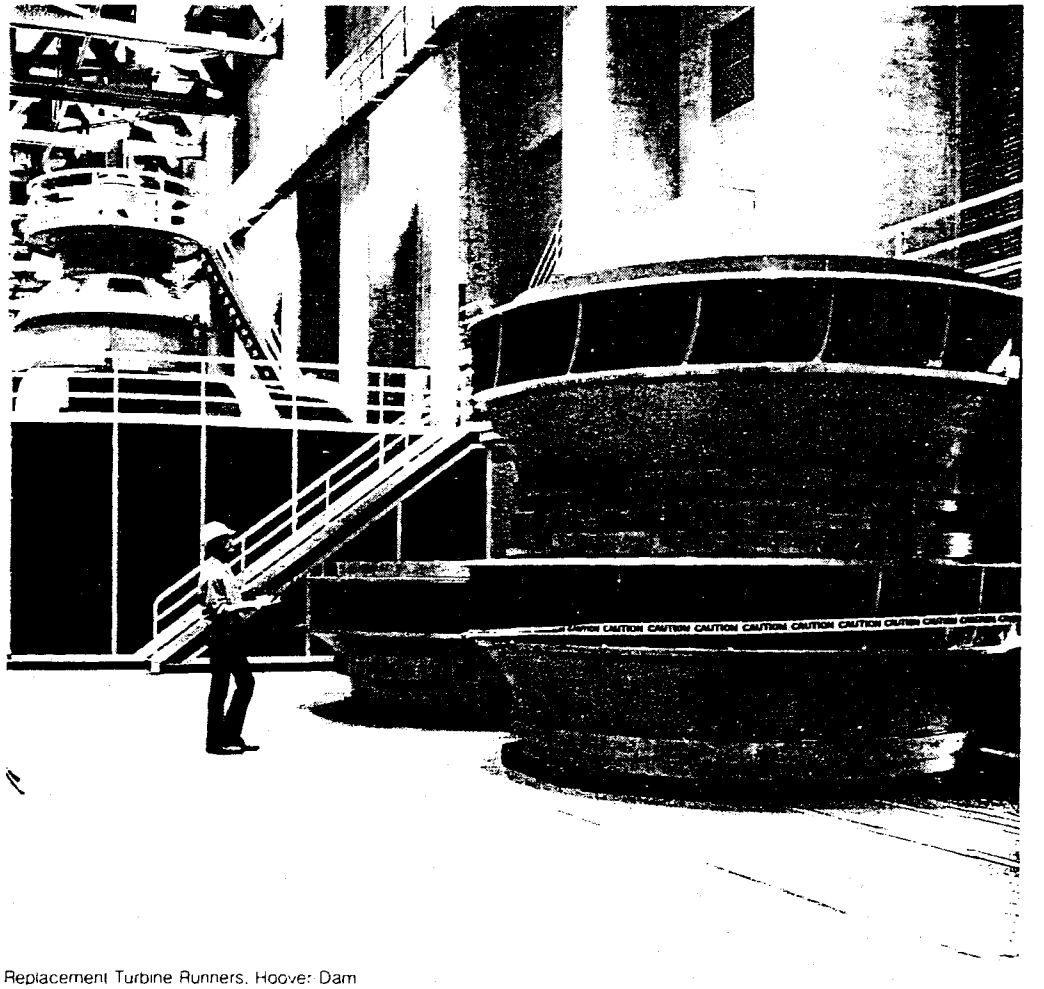
The cast iron turbine runners on A-1, A-2, N-5, N-6, and N-7 will be replaced with stainless steel wheels, with dates as yet to be scheduled. Iron runners are subject to the action of cavitation causing pitting and gradual erosion of the back side of the runner blades. Stainless steel, however, has the characteristic of actually work-hardening in the presence of cavitation. The stainless steel turbine runners will therefore outperform what they replace.

A 1-year inspection of Unit G-1 at Davis Dam commenced in November 1985 and continued through December. A 1-year inspection will be performed on Units G-2, G-3, and G-5 and will include valve replacements on all three units.

Outage and maintenance for Parker Dam water year 1986 was scheduled for September 1985 through January 31, 1986. Breaker and relays will be replaced on Unit 1, with turbine repairs yet to be scheduled. The 4-year maintenance has also yet to be scheduled. In November 1985, Unit 4 at Havasu Pumping Plant was motor tested and in December, the 1-year maintenance was performed on Unit 4. In January 1986, Unit 2 was scheduled for the 2-year maintenance and Unit 3 for the 1-year maintenance.

A $7,637,385 Reclamation contract has been awarded for uprating generators N-3 and N-4 at Hoover Dam in Nevada. The contract was awarded to General Electric company of Denver, Colorado. Work will begin in 1987 and is scheduled to be completed by February 1988.

Principal work under the contract includes conducting a study of the existing generator design, furnishing and installing necessary new components, and modifying the two generators, as required to accomplish the proposed uprating. The objective is to uprate the generators by the optimum amount, based on water availability and economic feasibility. Studies show that sufficient water, head, and turbine capacity are available to produce significantly more generator output than the existing generator ratings will allow. The generators were manufactured by Westingnouse. Generator N-3 was installed in 1937 and generator N-4 in 1936.



Replacement Turbine Runners, Hoover Dam

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources, and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.