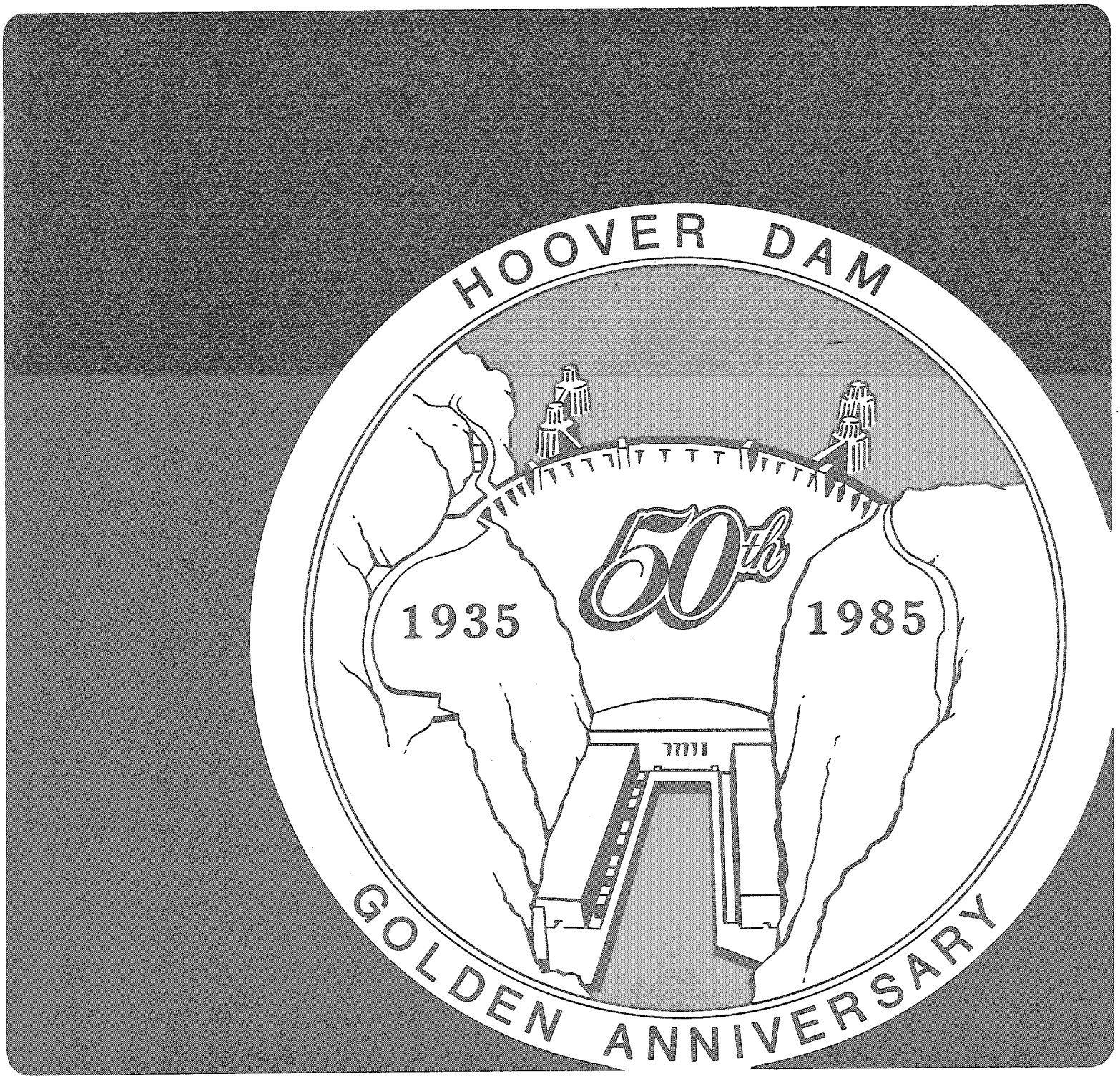
14th Annual Report

Operation of the Colorado River Basin 1984 Projected Operations 1985



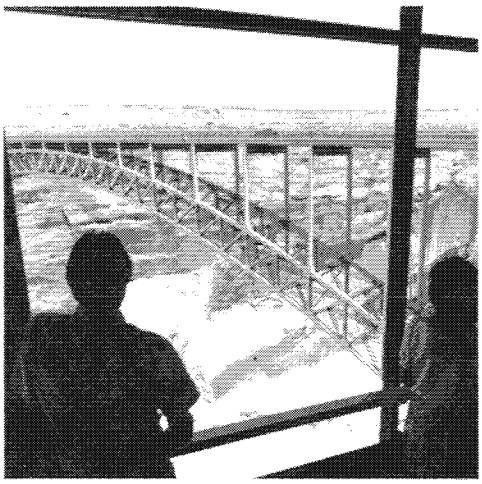
Colorado River Basin

Contents

United States
Department of the Interior
Bureau of Reclamation

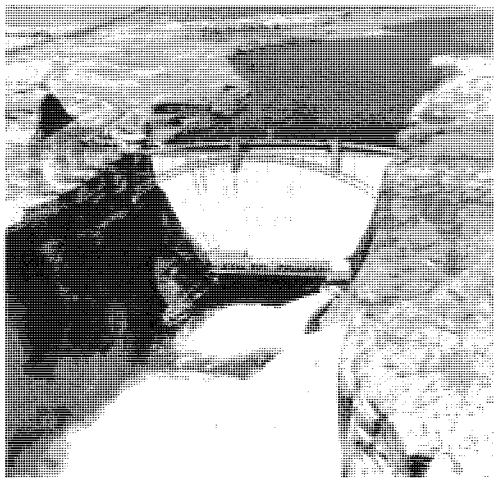
January 1985

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



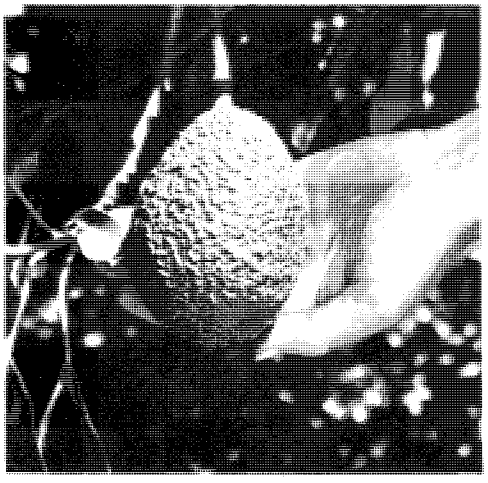
Glen Canyon bridge from the Visitor's Center.

Hoover Dam.



Left spillway test, Glen Canyon Dam.

Introduction



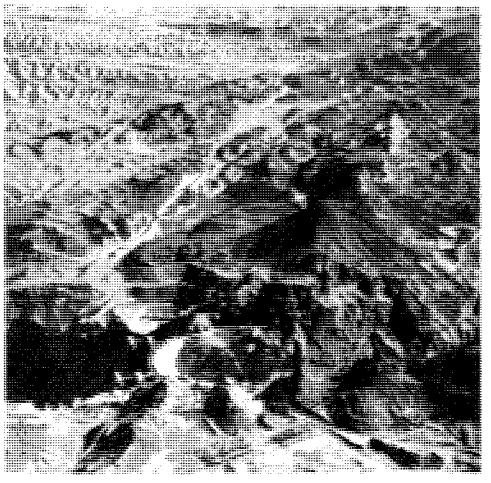
Irrigated avocados.

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), or the Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C. 1501).

Authority for Report



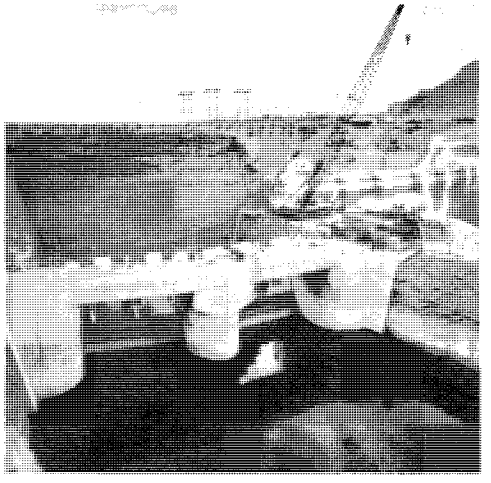
Rugged terrain surrounds Hoover Dam.

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 fourteenth 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 1984. Also described in this report is the projected operation of these reservoirs during water year 1985 under the "Criteria for Coordinated Long-Range Operation of Colorado River Reservoirs," published in the *Federal Register* June 10, 1970.

William P. Clark, Secretary
United States Department of the Interior

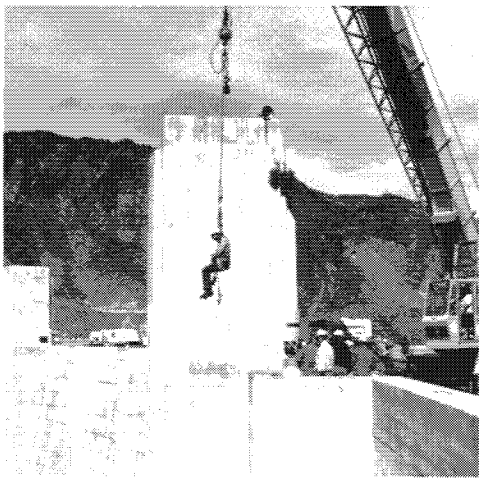
Actual Operations Under Criteria — Water Year 1984



Left spillway flash boards, Glen Canyon Dam.

The initial plan of operation for water year 1984, based on average inflow conditions, called for scheduled releases from Lake Powell of 14.6 million acre-feet (maf). This plan of operation would have created 6.5 maf of vacant space in the Colorado River reservoir system by September 30, 1984, of which 2.9 maf would have been in Lake Powell. With this volume of release the contents of Lake Powell would have remained below the contents of Lake Mead for the entire water year. A plan to equalize the projected end of water year active contents of Lake Powell and Lake Mead was not required because (1) excess water was being released from Lake Mead to avoid anticipated spills and (2) repair of spillways at Glen Canyon was being completed.

The April through July forecast of runoff made on January 6, 1984, was 13 maf or 174 percent of normal. Accordingly, releases from Glen Canyon were maintained at maximum powerplant capacity. For 10 weeks through mid-March, however, a much drier pattern developed with precipitation as low as 40 percent of normal over the entire basin during January. By April 5, 1984, the runoff forecast had dropped to 11.5 maf or 154 percent of normal. A cold, wet April



Field inspection for Safety Evoluation of Existing Dams.

Inspection of Hoover Dam's Nevada spillway tunnel.

23-millionth visitor at Hoover Dam.

provided a substantial increase to the snowpack with 44 new records established on May 1, and on May 7 the forecast was increased back up to 13 maf. This forecasted runoff volume together with the uncertainty of the spillway repair schedule required that the river outlet works at Glen Canyon be opened.

Temperatures remained cool during the first half of May with precipitation below normal over the Green River and San Juan Basins and near normal over the Upper Colorado River drainage. A late snow melt similar to 1983 conditions occurred once again with very warm temperatures about mid-May. Streamflow jumped dramatically with the unregulated inflow above Lake Powell going from 40,000 cubic feet per second (cfs) on May 9 to 126,000 cfs on May 19.

By May 24, it was obvious that with the remaining snow, additional runoff was likely, and therefore the forecasted inflow for April through July was increased to 14.0 maf, 188 percent of normal. The daily peak for the season at Lees Ferry occurred on May 28 at 148,000 cfs, compared to the peak of 128,000 cfs on June 2, 1983. The record peak flow at Lees Ferry was 220,000 cfs in 1921.

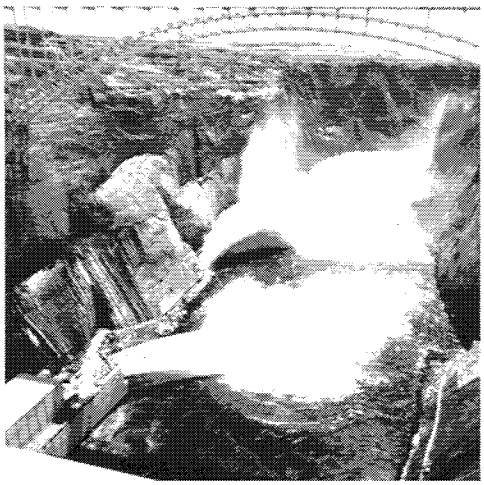
By June 7, 1984, the runoff forecast had increased to 14.2 maf or 190 percent of normal, which required that Glen Canyon's river outlet works and powerplant releases remain at maximum capacity. The runoff forecast was again increased on July 6, 1984, to 15.2 maf which was 204 percent of normal. The actual April through July 1984 inflow to Lake Powell was 15,258,000 acre-feet, which was 446,000 acre-feet higher than the April through July 1983 amount. Lake Powell itself peaked at elevation 3,702.46 on July 8, 1984, almost 2.5 feet into surcharge. The river outlet works were gradually reduced and eventually closed by July 23, 1984.

The pattern of heavy fall precipitation and record January 1, 1984, snowpacks in the Upper Basin, in retrospect, was favorable for the Lower Basin since it led to the highest January 1 forecast ever made. This in turn required flood control releases in excess of 30,000 cfs from Hoover Dam. At the time, these seemed to be extremely high releases based on such an early forecast. However, the high early releases proved to be an important factor in Reclamation's control of the runoff in 1984.

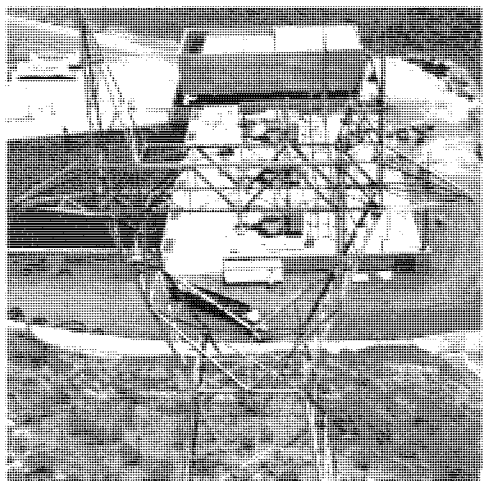
The actual water supply in the Colorado River Basin for all of water year 1984 was 179 percent of normal, ranging from 228 percent of normal on the mainstem Colorado River above Grand Junction, Colorado, to 167 percent of normal on the Gunnison River above Blue Mesa Dam to 111 percent of normal on the San Juan River above Navajo Dam. The total unregulated inflow to Lake Powell for water year 1984 was 21,253,000 acre-feet which exceeded the total 1983 water year inflow by 700,000 acre-feet. The total release from Glen Canyon Dam for the entire water year was 21,051,000 acre-feet. Aggregate Colorado River storage at the end of the water year was 57,344,000 acre-feet representing a decrease of 1,618,000 acre-feet from the previous year. By the end of the water year, active storage in the system was approximately 102 percent of the January 1 maximum available storage. This "maximum available storage" represents storage at all Bureau of Reclamation and Colorado River Storage Project (CRSP) reservoirs, including Lake Havasu and other upstream reservoirs. Flood control regulations require a minimum of 5,350,000 acre-feet of vacant space in the system on January 1.

Projected Plan of Operation Under Criteria — Water Year 1985

Left spillway tunnel construction, Glen Canyon Dam.



1984 left spillway test, Glen Canyon Dam.



Havasu Pumping Plant and switchyard.

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 the 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, 1985, 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

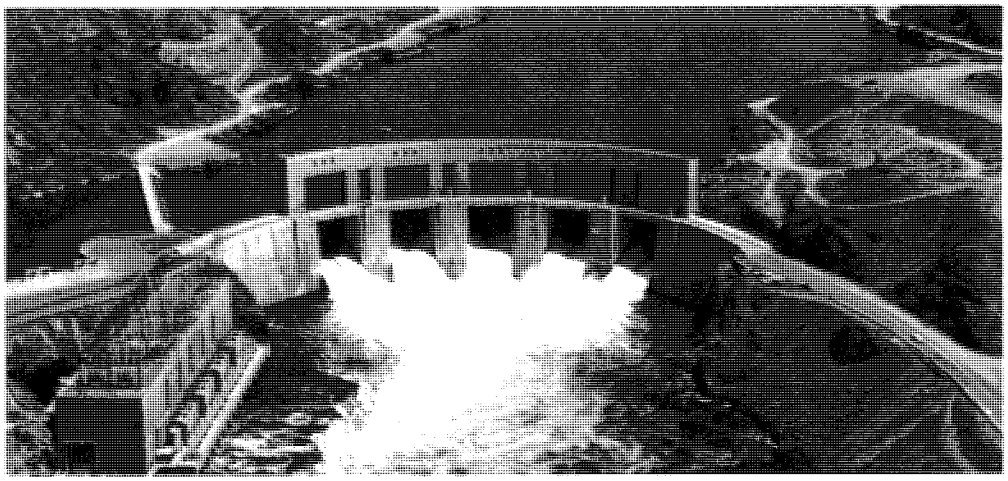
Annual calendar year schedules of monthly deliveries of water in the limitrophe section of the Colorado River, allotted in accordance with the Mexican Water Treaty signed in 1944, are formulated by the Mexican Section and presented to the United States Section, International Boundary and Water Commission (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 1984, Mexico received a total delivery of about 16,596,000 acre-feet at the Northerly International Boundary.

Of the 16,596,000 acre-feet of mainstem Colorado River water reaching the Boundary, about 5,119,000 acre-feet was delivered through the Pilot Knob Powerplant from the All-American Canal. An estimated 10,719,000 acre-feet was 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 1985. This release of water is based upon average runoff conditions for the year. Should the runoff in water year 1985 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.

Projected Plan of Operation — Water Year 1985



Parker Dam.

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 1984. Regulatory waste for water year 1985 will depend on the actual hydrologic conditions occurring during that time.

A proposed operation plan for water year 1985 for major reservoirs of the Colorado River system was formulated and distributed to representatives of the Colorado River Basin States in November 1984. 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, irrigation and other domestic use of water, hydroelectric power generation, water quality control, fish and wildlife propagation, recreation, and Colorado River Compact requirements.

The plan was very similar to the plan developed for water year 1983 which was based on the need to develop sufficient reservoir space by January 1, 1985, to reduce the risk of reservoir spills. The record high runoff of water year 1984 had again left all of the system reservoirs essentially full, requiring large releases to draw the reservoir system down. Releases at maximum powerplant capacity will most probably continue at Glen Canyon until at least January 1985 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 1985 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, 1985, than the minimum flood control requirement of 1.5 maf.

The plan calls for a total Glen Canyon release in water year 1985 of 10.7 maf under reasonable minimum inflow conditions. This would essentially equalize the active contents of Lake Powell and Lake Mead by the end of the water year. An annual release of 13.8 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, 1985. With a reasonable maximum inflow during water year 1985, the projected Glen Canyon release would be 18.1 maf. This volume of inflow would require maximum powerplant releases for all of water year 1985 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 1985 is described in the following pages. Charts 1 through 8 show the projected monthly outflows from each reservoir for three assumed hydrologic conditions. Each of these assumptions uses the most current hydrologic information available by including actual forecasted October through December 1984 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) depleted up to the 1985 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.

Upper Basin Reservoirs
Fontenelle Reservoir
(Green River)

Water Year 1984

The water year 1984 plan of operation for Fontenelle Reservoir was to maintain the water surface elevation no higher than 6,482 feet. This operating restriction was imposed in response to evidence of increased seepage observed along the left abutment of the dam in 1982 and preliminary geologic investigations conducted during 1983.

The forecast of April through July runoff into Fontenelle Reservoir was 138 percent of normal on January 6, 1984, and gradually declined to 95 percent of normal by April 5, 1984. The elevation of Fontenelle Reservoir was maintained near 6,482 feet until May 1984, when it was gradually lowered to just below the minimum power pool to an elevation of 6,473.7 on May 30, 1984, in anticipation of high spring flows. The reservoir was allowed to slowly rise to a peak elevation of 6,484.9 feet on July 26, 1984. A maximum release from Fontenelle Dam of 7,560 cfs occurred on May 27, 1984, as inflow to the reservoir rapidly increased. The peak inflow occurred on June 2, 1984, at nearly 9,000 cfs.

The actual April through July runoff into Fontenelle Reservoir was 972,000 acre-feet which was 111 percent of normal. Inflow for the entire water year 1984 was 1,581,000 acre-feet or 131 percent of normal. The total release from Fontenelle Dam for water year 1984 was 1,562,000 acre-feet of which 636,000 acre-feet bypassed the powerplant.

Water Year 1985

The projected plan of operation for water year 1985 is essentially the same as for water year 1984. The reservoir will be operated between the minimum powerpool elevation of 6,475 feet and elevation 6,482 feet for the entire water year. The reservoir will be gradually drawn down to elevation 6,475 feet just prior to high spring flows and will then be allowed to rise to elevation 6,482 feet during the peak of the spring runoff. The reservoir will be maintained near this elevation for the remainder of the water year. The maximum release from Fontenelle will be dependent upon the magnitude of runoff. The reasonable maximum inflow would probably produce a maximum discharge of 9,000 cfs, while an average runoff would produce about a 6,000 cfs release. Releases would not exceed 4,500 cfs with a reasonable minimum inflow.

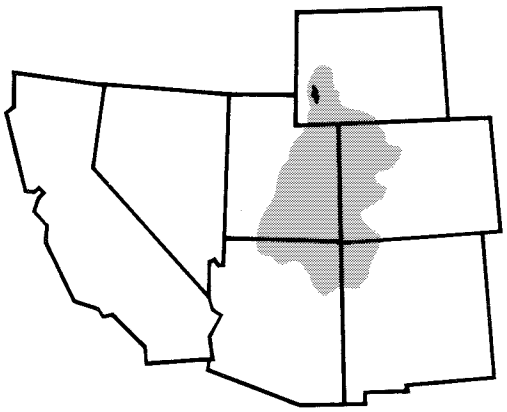
A Safety-of-Dams Modification Report is currently being prepared for the repair of Fontenelle Dam and is scheduled for completion in November 1985. This report will evaluate all of the feasible repair alternatives and their associated costs which are required for any Congressional approval of major funding. In the interim, a contract is scheduled for award in April 1985 to construct test sections to confirm the feasibility of a concrete core wall repair. The State of Wyoming has indicated an intent to cooperate with the Bureau of Reclamation in the repair of Fontenelle Dam with associated cost sharing. Meetings to negotiate a cost-sharing agreement with the State of Wyoming are currently scheduled to begin in January 1985.

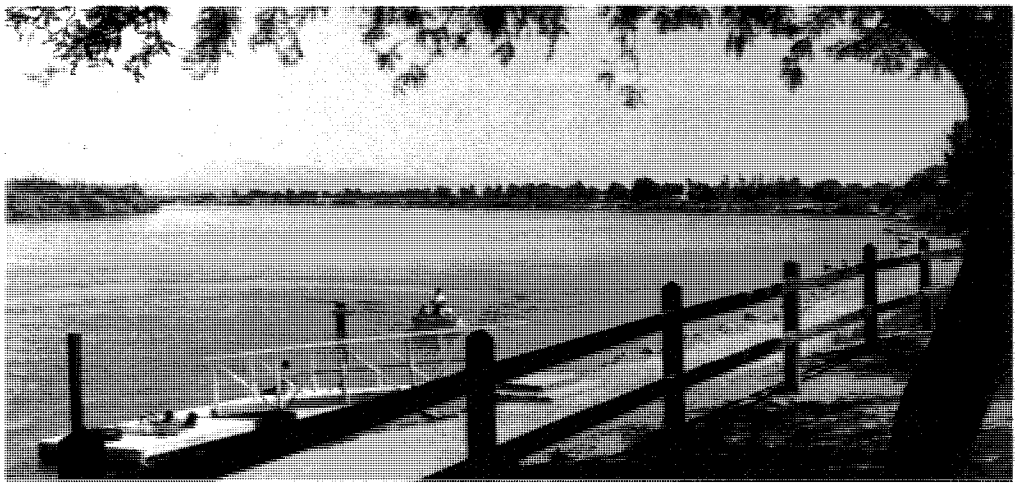
Fontenelle Dam and Reservoir.

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	

*Does not include 563 acre-feet of dead storage below 6408 feet.



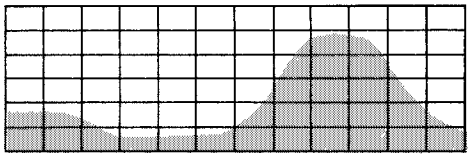


Colorado River boat landing.

Fisherman's dream come true.

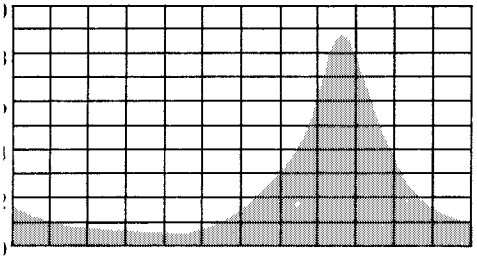
Outflow Monthly Release in 1000 Cubic Feet/Second

Actual Operation 1984

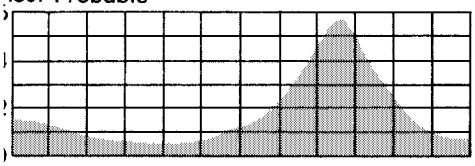


Projected Operation 1985

Reasonable Maximum



Most Probable



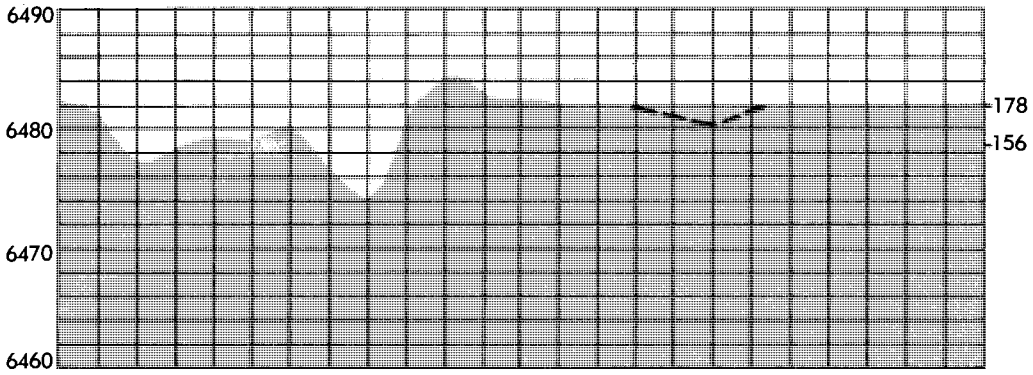
Reasonable Minimum

Storage

End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet

Non-Linear Scale



Actual 1984 Projected 1985

Legend

Most Probable

Reasonable Minimum

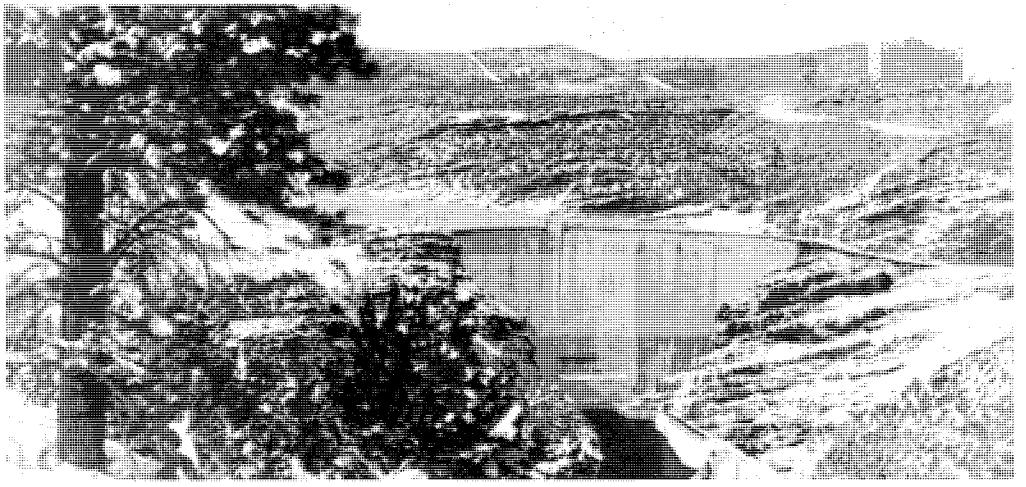
Flaming Gorge Reservoir (Green River)

Water Year 1984

Flaming Gorge Reservoir started water year 1984 at elevation 6,038 with an active storage of 3,676,000 acre-feet. This high level of storage was a result of the record high 1983 water year which was 200 percent of normal. Releases from Flaming Gorge Dam for water year 1984 were projected to be higher than normal due to the on-going repair work in the spillway tunnel and the unusually high fall inflows. It was planned that Flaming Gorge Reservoir would rise no higher than elevation 6,035 feet in order to provide protection against having to use the spillway.

Flaming Gorge Reservoir was gradually drawn down to near elevation 6,033 feet by January 1, 1984. The forecast of April through July runoff made on January 6, 1984, was 1.935 maf or 168 percent of normal. This volume of runoff required maximum powerplant releases for the remainder of the year combined with releases through the river outlet works to limit the peak elevation to the planned 6,035 feet. Subsequent runoff forecasts gradually declined to about 120 percent of normal by April 5, 1984, however, releases were maintained at the maximum powerplant capacity of about 4,000 cfs. Flaming Gorge Reservoir was drawn down to about elevation 6,022 feet by April 17, 1984, and then further decreased to about elevation 6,021 on May 13, 1984, by using a maximum river outlet works discharge of 4,000 cfs in combination with maximum powerplant releases.

The outlet works discharge was turned off on May 14, 1984, to allow access to the spillway tunnel outlet. The June 7, 1984, forecast of April through July runoff increased slightly from the May figure of 125 percent of normal to 128 percent of normal. By this time, however, it was apparent that Lake Powell would completely fill, and it was decided to utilize the remaining storage above 6,035 feet at Flaming Gorge to help limit Lake Powell's rise. Releases from Flaming Gorge were subsequently reduced during June 1984, and Flaming Gorge Reservoir was brought to a nearly full condition. By mid-July the reservoir had essentially filled — to a peak elevation of 6,039 feet — and releases were then increased to maximum powerplant capacity to stop the rise of the water surface. A small discharge of 200 cfs was also initiated on July 10, 1984, through the river outlet works. Flows through the outlet works were limited to this amount to prevent washing out an access ramp to the spillway tunnel. Flaming Gorge Reservoir peaked at elevation 6,039.7 feet on August 6, 1984, and the river outlet works were gradually turned off by August 13, 1984.



Flaming Gorge Dam.

The actual April through July unregulated runoff into Flaming Gorge Reservoir was 1.64 maf or 143 percent of normal. The peak inflow during the runoff was 17,300 cfs on May 26, 1984, and the peak total discharge was 8,200 cfs on May 7, 1984. The total inflow for water year 1984 was 2.60 maf or 157 percent of normal. The total release from Flaming Gorge during water year 1984 was 2.5 maf of which 97,000 acre-feet bypassed the powerplant. The spillway was not used.

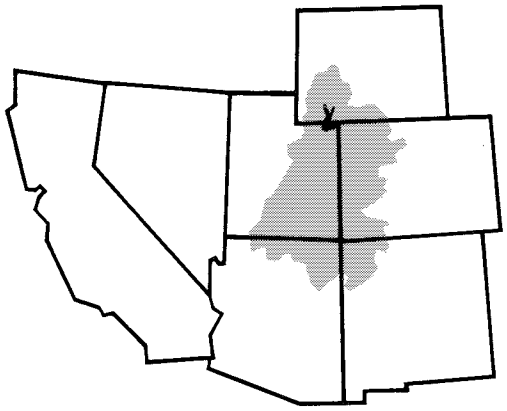
Water Year 1985

It is projected that the water surface at Flaming Gorge will be drawn down to near elevation 6,018 feet before the 1985 spring runoff. This drawdown will again facilitate filling Flaming Gorge Reservoir no higher than 6,035 feet during the 1985 runoff as the spillway repair work continues. The releases from Flaming Gorge will most probably be maintained near the maximum powerplant capacity of 4,000 cfs during the majority of the year in order to achieve the drawdown necessary to contain the most probable volume of inflow below elevation 6,035 feet.

Flaming Gorge Active Storage* **Chart 2**

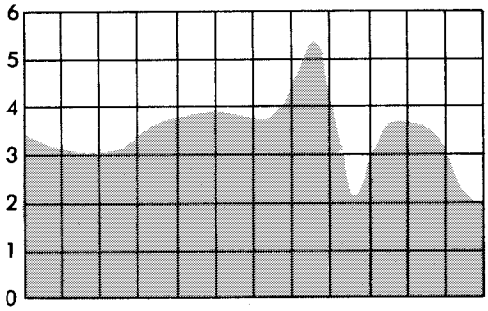
Reservoir	Acre-Feet	El. (Ft.)
Maximum Storage	3,749,000	6040
Rated Head	1,062,000	5946
Minimum Power	233,000	5871
Surface Area (Full)	42,020 Acres	
Reservoir Length (Full)	91 Miles	
Powerplant		
Number of Units	3	
Total Capacity	108,000 Kilowatts	

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



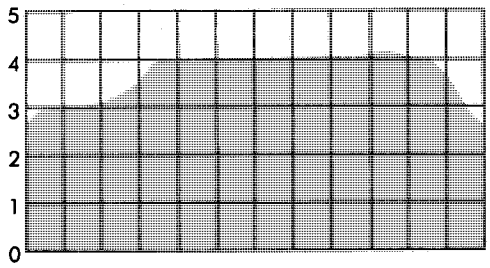
Outflow Monthly Release in 1000 Cubic Feet/Second

Actual Operation 1984

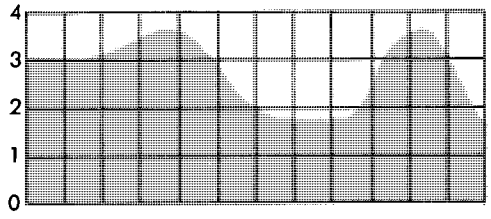


Projected Operation 1985

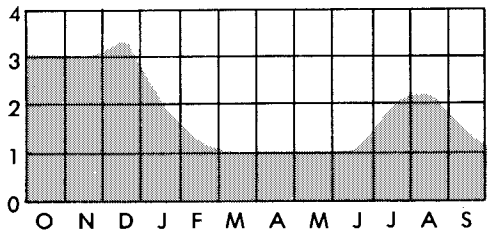
Reasonable Maximum



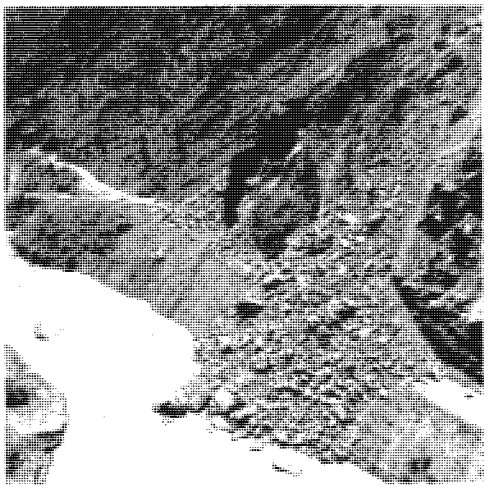
Most Probable



Reasonable Minimum



Morrow Point Dam.



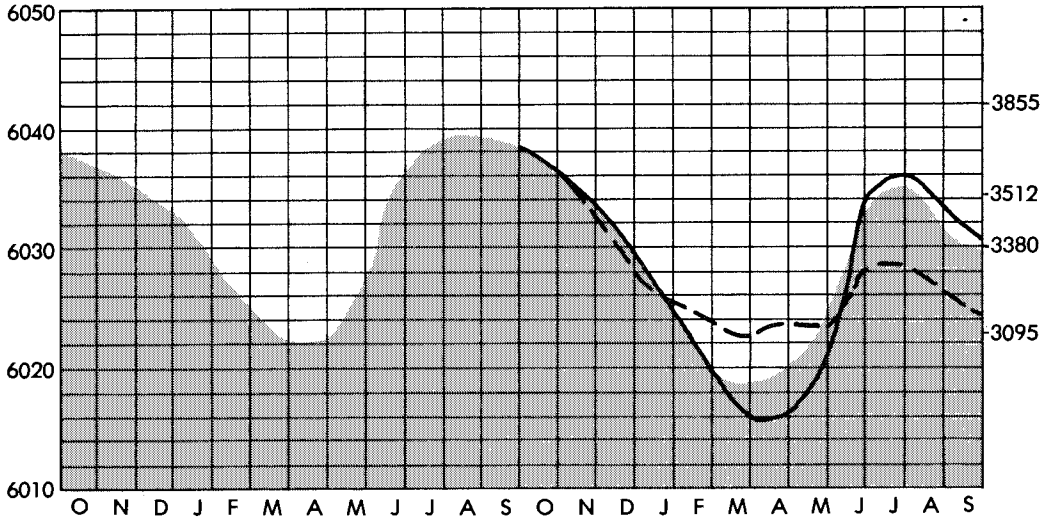
Landslide one-half mile downstream from Crystal Dam.

Storage

Usable Content in 1000 Acre-Feet

Non-Linear Scale

End of Month Elevation in Feet



Actual 1984

Projected 1985

Legend

Most Probable

Reasonable Minimum

Reasonable Maximum

Wayne N. Aspinall Unit [Gunnison River] Blue Mesa Reservoir Morrow Point Reservoir Crystal Reservoir

Water Year 1984

The Wayne N. Aspinall Unit, formerly the Curecanti Unit, includes Blue Mesa, Morrow Point, and Crystal Reservoir. Blue Mesa provides nearly all of the long-term regulation for all three powerplants. Morrow Point provides peaking power, and thus has highly variable releases. The primary function of the Crystal Reservoir is to reregulate the variable Morrow Point releases.

Blue Mesa Reservoir began water year 1984 at elevation 7,509 feet and stored 740,000 acre-feet. It was planned to fill Blue Mesa not higher than elevation 7,514 feet in order to reduce the risk of using the spillway which was scheduled for air slot modification in the fall. The reservoir was lowered gradually to elevation 7,491 feet by January 1, 1984. The January 6, 1984, forecast of April through July runoff was 1.30 maf or 180 percent of normal. This volume of projected April through July inflow required that releases from Blue Mesa Dam be maintained at about 2,500 cfs through March 1984 and then increased to maximum powerplant capacity for the remainder of the runoff season. This would produce a sufficient drawdown to limit the peak elevation of Blue Mesa Reservoir to 7,514 feet during the runoff. To accommodate releases of this magnitude from Blue Mesa, Crystal Reservoir began discharging 600 cfs through its river outlet works in addition to maximum powerplant releases of 1,700 cfs. Above-normal January and February inflows caused the bypass to be increased to 900 cfs in February and to 1,200 cfs in March even though the April through July runoff forecasts steadily declined to 152 percent of normal by March 6, 1984. Blue Mesa Reservoir was drawn down to about elevation 7,428 feet on April 16, 1984, in preparation for the spring runoff.

The side inflow to Morrow Point and Crystal Reservoirs increased rapidly in mid-May which resulted in a significant decrease in Blue Mesa releases in order to limit powerplant bypasses downstream. The inflow to Blue Mesa Reservoir also rapidly increased to over 16,000 cfs by May 25, 1984. Releases, however, were held to a minimum because of serious flood damages being incurred in Delta, Colorado, from the swollen North Fork of the Gunnison River. As the downstream flood danger subsided in late May, Blue Mesa releases were increased to maximum powerplant capacity and the outlet works were opened on May 16, 1984, to 2,000 cfs. This bypass discharge was gradually increased to its maximum by June 24, 1984, which resulted in a total maximum discharge of 7,600 cfs from Blue Mesa Dam. This release slowed the rapid rise of Blue Mesa Reservoir in time to prevent having to use the spillway. As the reservoir stopped rising, the bypass releases were gradually reduced and finally turned off on August 6, 1984. Blue Mesa's water surface had increased a total of over 90 vertical feet in just 90 days to an elevation of 7,518 feet by mid-July. The reservoir elevation peaked at 7,518.6 feet on August 27, 1984.

The actual April through July runoff into Blue Mesa Reservoir was 1.374 maf or 190 percent of normal. The total water year 1984 inflow was 1.794 maf or 167 percent of normal. Releases from Blue Mesa Dam totaled 1.737 maf for the water year of which 381,000 acre-feet bypassed the powerplant.

Morrow Point Reservoir operated at or near capacity between elevations 7,150 and 7,161 feet. The April through July side inflow into Morrow Point Reservoir was 186,000 acre-feet which was 315 percent of normal. A total of 1.954 maf was released during the water year of which 239,000 acre-feet bypassed the powerplant.

Crystal Reservoir also was operated at or near its capacity during water year 1984. The April through July side inflow to Crystal was 247,000 acre-feet which was 280 percent of normal. A total of 2.276 maf was released during the water year of which 1.027 maf bypassed the powerplant. During water year 1984 the minimum release was 1,700 cfs while a maximum discharge of 9,700 cfs occurred on June 19, 1984. The maximum discharge from Crystal Dam could have been greater than 20,000 cfs had not Blue Mesa and Taylor Park Reservoirs moderated the peak inflow. The operation of these reservoirs had significant beneficial impacts in reducing the flood damage along the Gunnison River near Delta, Colorado.

Water Year 1985

Assuming near average water supply conditions in water year 1985, Blue Mesa Reservoir is expected to reach a low of 7,458 feet with a content of 360,000 acre-feet by April 1985. The reservoir is expected to reach a peak elevation of 7,514 feet during the runoff. The remaining 5 feet of reservoir is planned to be kept vacant to reduce the risk of having to use the spillway during the heavy spring flows.

Morrow Point Reservoir will operate at or near its capacity during the current year. Crystal Reservoir also will operate nearly full except for daily fluctuations needed in regulating the releases from Morrow Point and to meet downstream requirements for fish habitat and diversions through the Gunnison Tunnel.

Assuming near average inflow conditions, releases from Crystal Reservoir will be at maximum powerplant capacity of 1,700 cfs in addition to scheduled bypasses of up to 1,000 cfs. Under reasonable minimum inflow conditions, releases will range from 1,000 cfs to 1,700 cfs. With reasonable maximum inflows, releases would be at least 4,000 cfs and possibly higher.

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*

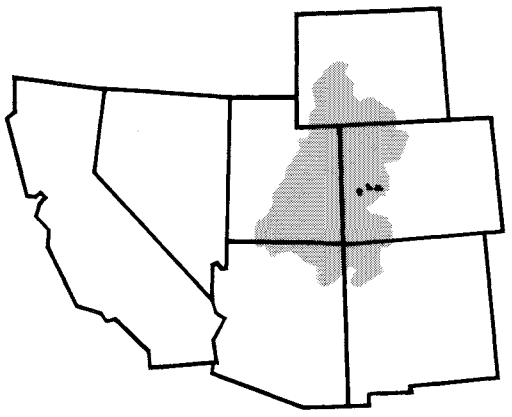
Maximum Storage	117,025	7160
Rated Head	79,805	7108
Minimum Power	74,905	7100
Surface Area (Full)	817 Acres	
Reservoir Length (Full)	11 Miles	
Powerplant		
Number of Units	2	
Total Capacity	120,000 Kilowatts	

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

Crystal Point Active Storage*

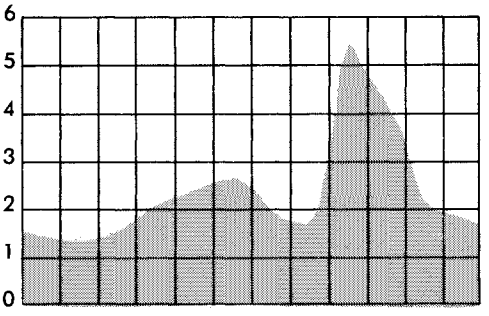
Maximum Storage	17,573	6755
Rated Head	13,886	6742
Minimum Power	10,619	6729
Surface Area (Full)	301 Acres	
Reservoir Length (Full)	7 Miles	
Powerplant		
Number of Units	1	
Total Capacity	28,000 Kilowatts	

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



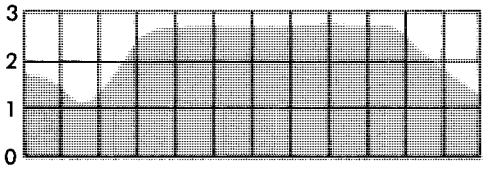
Outflow Blue Mesa Reservoir

Actual 1984 Monthly Release in 1000 Cubic Feet/Second

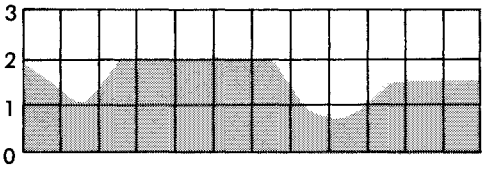


Projected Operation 1985

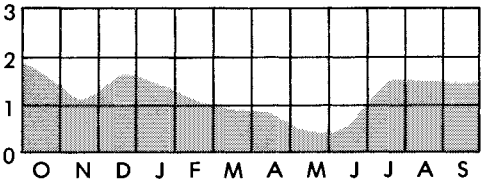
Reasonable Maximum

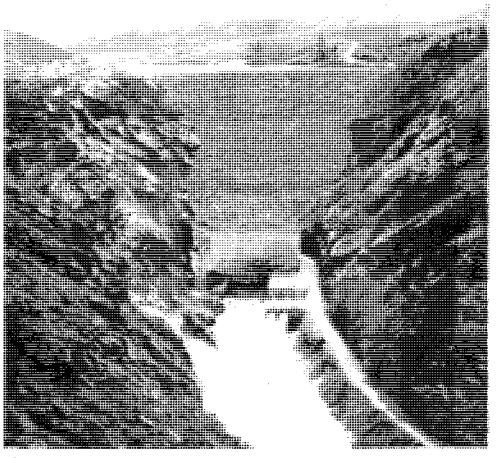


Most Probable

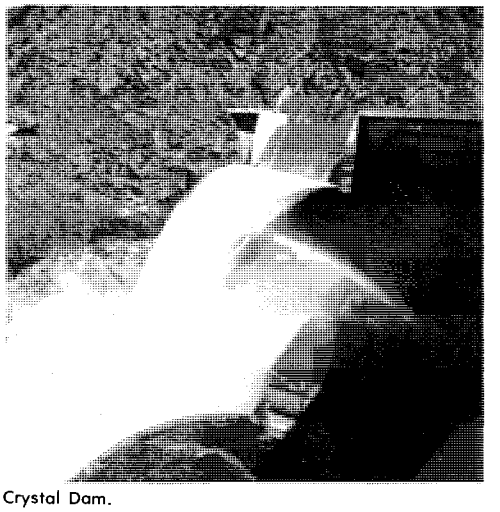


Reasonable Minimum





Blue Mesa Dam and Reservoir.



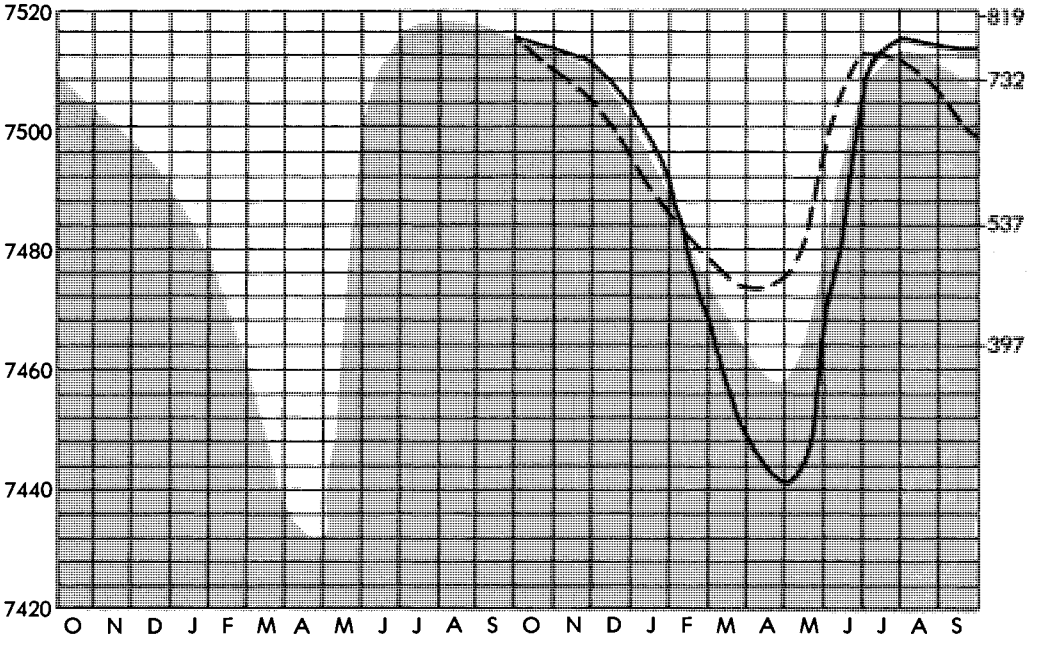
Crystal Dam.

Storage Blue Mesa Reservoir

End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet

Non-Linear Scale



Actual 1984

Projected 1985

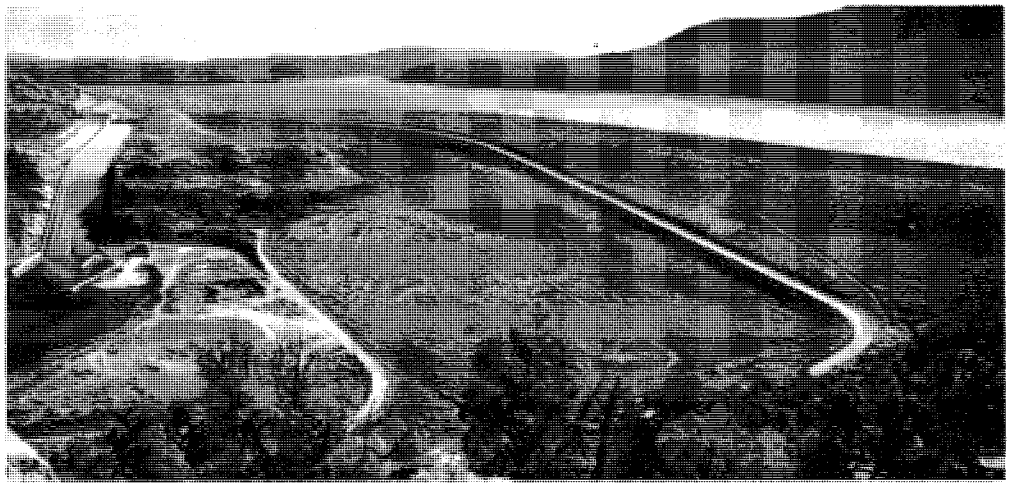
Legend

Most Probable

Reasonable Minimum

Reasonable Maximum

Navajo Reservoir (San Juan River)



Navajo Dam is a rolled, earthfill embankment.

Waterfall.

Navajo Active Storage* **Chart 4**

Reservoir	Acre-Feet	El. (Ft.)
Maximum Storage	1,696,400	6085
Inactive Storage	660,500	5990
Surface Area (Full)	15,610 Acres	
Reservoir Length (Full)	33 Miles	

*Does not include 12,600 acre-feet of deod storage below 5775 feet.

Water Year 1984

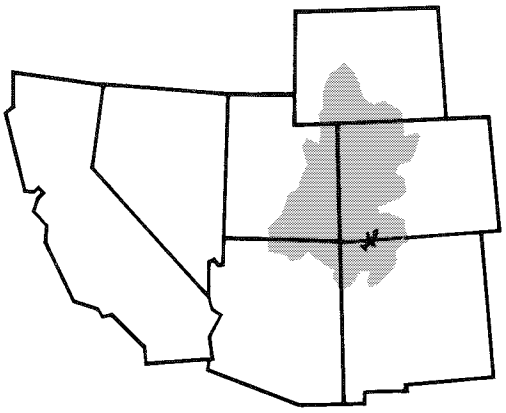
The elevation of Navajo Reservoir at the beginning of water year 1984 was 6,080 feet with 1,618,000 acre-feet of active storage. This high level of carry-over storage was a result of a water year 1983 inflow which was 140 percent of normal. It was planned that Navajo Reservoir would fill to near its maximum elevation of 6,085 feet with an average 1984 runoff. A small amount of reservoir space was reserved to reduce the risk of using the spillway since spills cause high levels of nitrification in the San Juan River which is detrimental to fish.

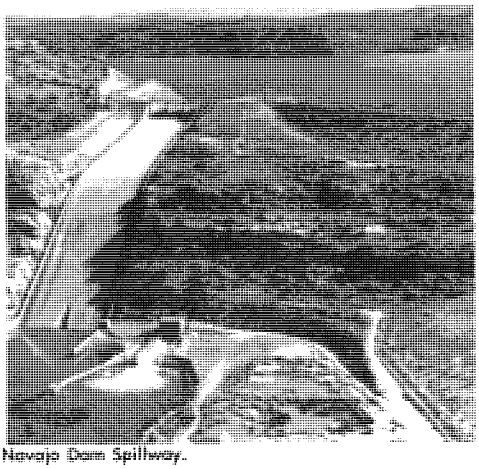
The April through July runoff forecast made on January 6, 1984, was 1,100,000 acre-feet which was 156 percent of normal. Releases of up to 2,500 cfs were maintained during January through March to contain this projected volume of runoff. Navajo Reservoir was drawn down to elevation 6,059 feet by the end of March 1984. However, the April 5, 1984, forecast of April through July runoff had declined to 800,000 acre-feet or 113 percent of normal which permitted releases to be dropped to near the 1,500 cfs level. The May 7, 1984, forecast increased to 121 percent of normal which forced Navajo Dam releases up to 2,100 cfs during most of May. In early June releases were dropped to 800 cfs even though the June 7, 1984, forecast remained at the 121 percent of normal level. This was done primarily to force Navajo Reservoir as full as possible to help limit Lake Powell's rise. Navajo Reservoir reached a peak elevation of 6,083.4 feet on July 5, 1984.

The actual April through July 1984 runoff volume into Navajo Reservoir was 734,000 acre-feet which was 104 percent of normal. The total water year 1984 inflow was 1,137,000 acre-feet which was 113 percent of normal. The minimum sustained release level from Navajo Dam was 1,000 cfs while the maximum release was 2,500 cfs. The peak inflow to Navajo Reservoir during the 1984 runoff was 9,000 cfs on May 24, 1984. The spillway at Navajo Dam was not used.

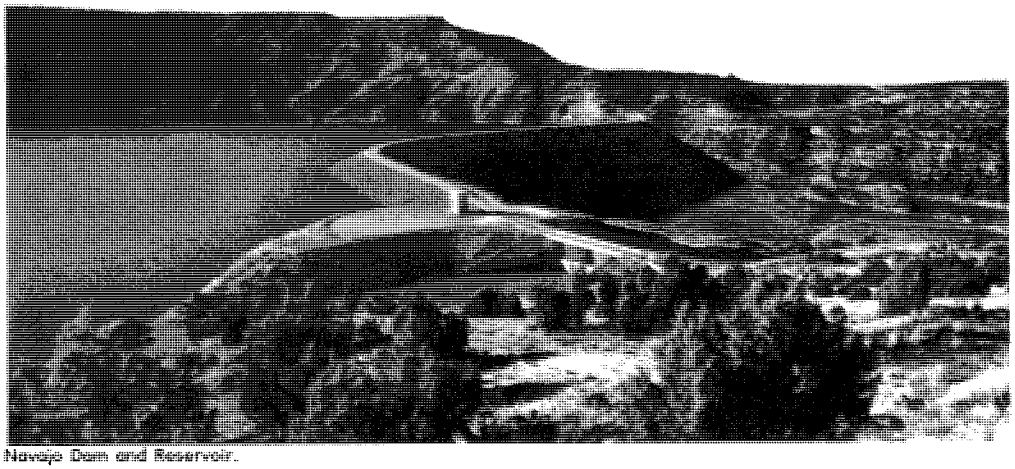
Water Year 1985

It is projected that Navajo Reservoir will be drawn down to near elevation 6,060 feet by April 1985 in preparation for an average spring runoff. Releases were held near the 1,500 cfs level throughout most of the 1984 winter months to accomplish this level of draw down. Releases will be increased during the runoff season to about 2,000 cfs. An average runoff during water year 1985 is expected to fill Navajo Reservoir. A reasonable minimum level of inflow would cause the minimum releases to be near the 530 cfs level for irrigation consumptive use and maintenance of fish and wildlife. A reasonable maximum inflow would force maximum Navajo releases to about 2,500 cfs.





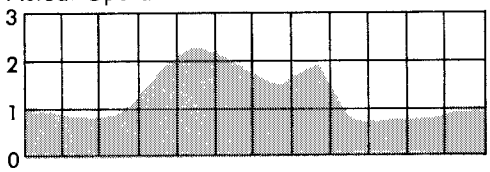
Navajo Dam Spillway.



Navajo Dam and Reservoir.

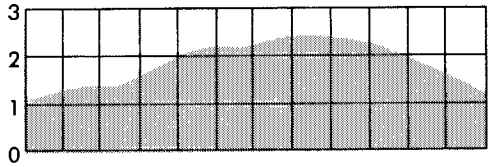
Outflow Monthly Release in 1000 Cubic Feet/Second

Actual Operation 1984

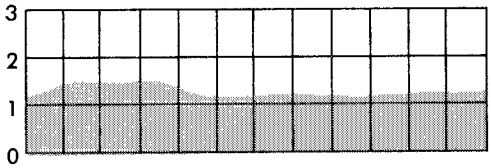


Projected Operation 1985

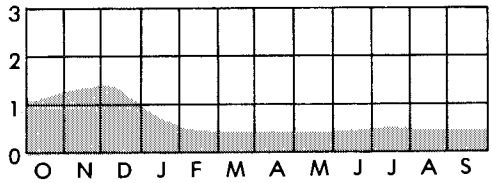
Reasonable Maximum



Most Probable



Reasonable Minimum

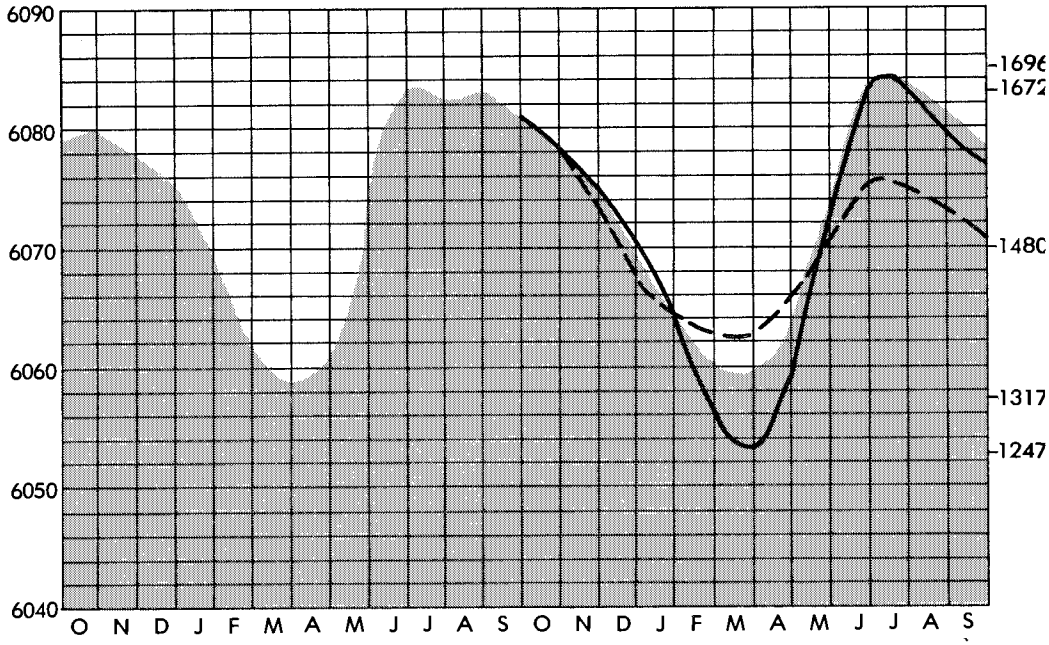


Storage

End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet

Non-Lineor Scale



Actual 1984

Projected 1985

Legend

Most Probable

Reasonable Minimum

Reasonable Maximum

Lake Powell (Colorado River)

Water Year 1984

During water year 1984, Lake Powell, which is impounded by Glen Canyon Dam, was operated as part of the CRSP in accordance with governing contracts and laws to provide river regulation, optimum power production, recreation, and fish and wildlife enhancement.

Lake Powell was completely full at the beginning of water year 1984 at elevation 3,699 feet following a near record-breaking 1983 runoff. Releases from Glen Canyon Dam, which impounds Lake Powell, were at the maximum powerplant capacity of 28,000 cfs. The two spillway tunnels were pumped out to facilitate an inspection to determine the extent of cavitation damage to the concrete lining. It was planned that both spillway tunnels would be restored to their original condition and modified with air slots to eliminate future cavitation problems prior to the 1984 runoff. As a contingency, in case this schedule of repair and modification became delayed, it was planned that Glen Canyon release be maintained at maximum powerplant capacity through the end of December 1983. This would build sufficient vacant reservoir space to reduce the risk of having to use the spillways during the 1984 runoff.

By January 1, 1984, Lake Powell was at elevation 3,685 feet with an active content of 22,697,000 acre-feet. The January 6, 1984 forecast of April through July runoff for Lake Powell was 13,000,000 acre-feet which was 174 percent of normal. This necessitated that Glen Canyon releases be maintained at maximum powerplant capacity through the remainder of the water year and that plans be made to initiate discharges through the river outlet works as early as April 1984. Since it was unknown whether Glen Canyon's spillways would be available for use during the 1984 runoff, it was planned to operate in expectation of incurring the reasonable maximum forecast error. Accordingly, releases from Glen Canyon were maintained at maximum powerplant capacity even though the runoff forecasts steadily declined over the next 3 months.

The April through July runoff forecast made on April 5, 1984, had dropped to 11,500,000 acre-feet or 154 percent of normal; however, by May 7, it had increased back up to 13,000,000 acre-feet. To contain this volume of runoff plus the forecast error, on May 4, 1984, the river outlet works at Glen Canyon were opened to bypass their maximum discharge of 17,000 cfs. This bypass release was maintained together with maximum powerplant releases for the entire month of May. The June 7, 1984, runoff forecast increased to 14,200,000 acre-feet or 190 percent of normal which required that the river outlet works remain open at 17,000 cfs for that month as well. The runoff forecast again increased on July 7, 1984, to 15,200,000 acre-feet which was 204 percent of normal. This increase again required that the river outlet works remain open for at least part of the month of July. Lake Powell itself peaked at elevation 3,702.46 on July 8, 1984, almost 2.5 feet into surcharge, and the river outlet works were gradually closed by July 23, 1984. The total releases from Glen Canyon Dam for the entire water year were 21,051,000 acre-feet, of which 2,834,000 acre-feet were bypassed through the river outlet works. Glen Canyon's spillways were not used to pass any of the April through July 1984 runoff. This was possible even while Lake Powell was 2.5 feet into surcharge because of the 8-foot high steel extensions on the spillway gates which were added in 1983. The temporary use of the extensions was to reduce downstream flooding and damage to the spillways. These extensions will be on through the Hoover spillway modification construction period.

Repair of Glen Canyon's spillways was completed by early August 1984. It was decided that one of the spillways should be tested at various discharges and also at a sustained rate to determine if the airslot modification would prove successful in eliminating cavitation damage. During the week of August 6, 1984, the left spillway tunnel was tested at various flow rates of up to 50,000 cfs. Also, two separate 4-hour sustained tests of 30,000 cfs were conducted. Examination of the spillway tunnel subsequent to these tests revealed no cavitation damage whatsoever.

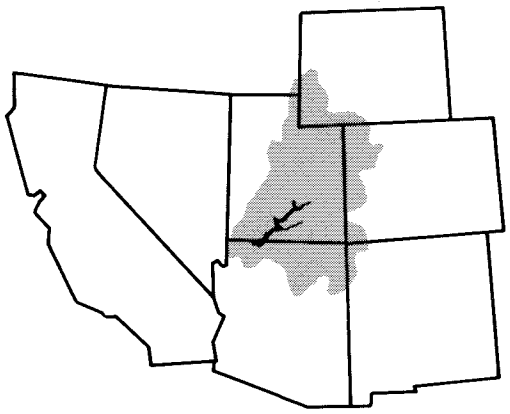
Water Year 1985

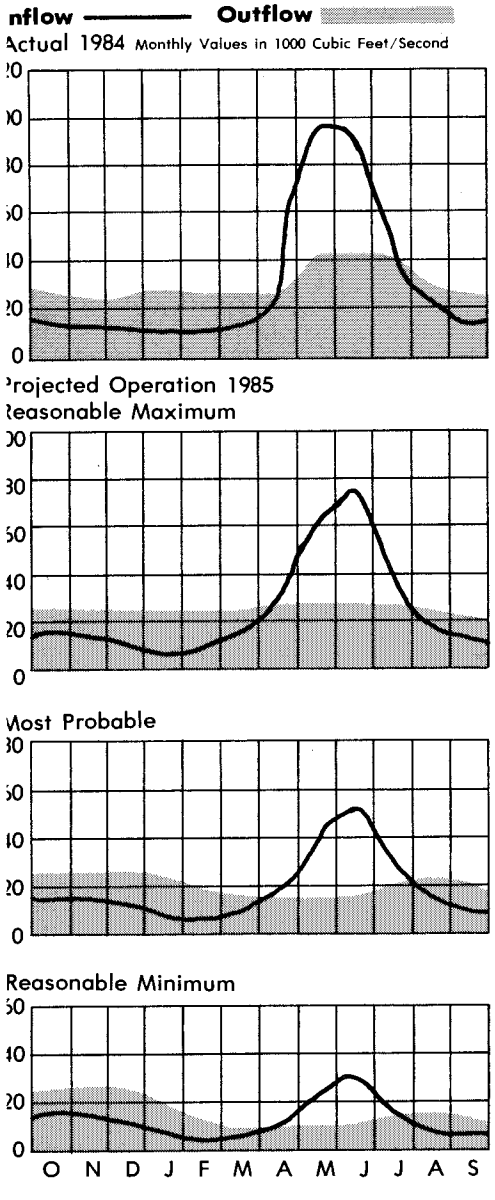
Lake Powell began water year 1985 at elevation 3,696 feet with an active content of 24,347,000 acre-feet (97.4 percent full). The operating plan through December of 1984 was to maintain Glen Canyon releases at a maximum powerplant capacity of 25,000 cfs in order to develop sufficient vacant reservoir space to reduce the risk of spilling during the 1985 runoff season. Assuming average runoff conditions, releases from Lake Powell for water year 1985 will be 13,750,000 acre-feet. A reasonable minimum level of inflow would produce an annual release of 10,700,000 acre-feet, and a reasonable maximum level of inflow would require that 18,100,000 acre-feet be released during the water year. Releases from Lake Powell after January 1, 1985, will be based upon runoff forecasts reflecting current hydrologic conditions. It is expected that powerplant bypasses will be avoided in all three operating plans.

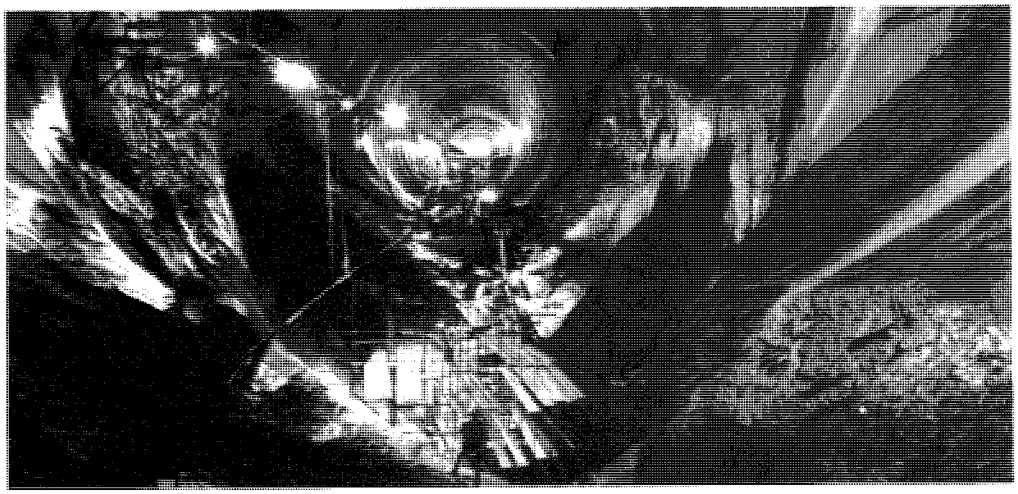
Lake Powell Active Storage* **Chart 5**

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	1,021,000 Kilowatts	

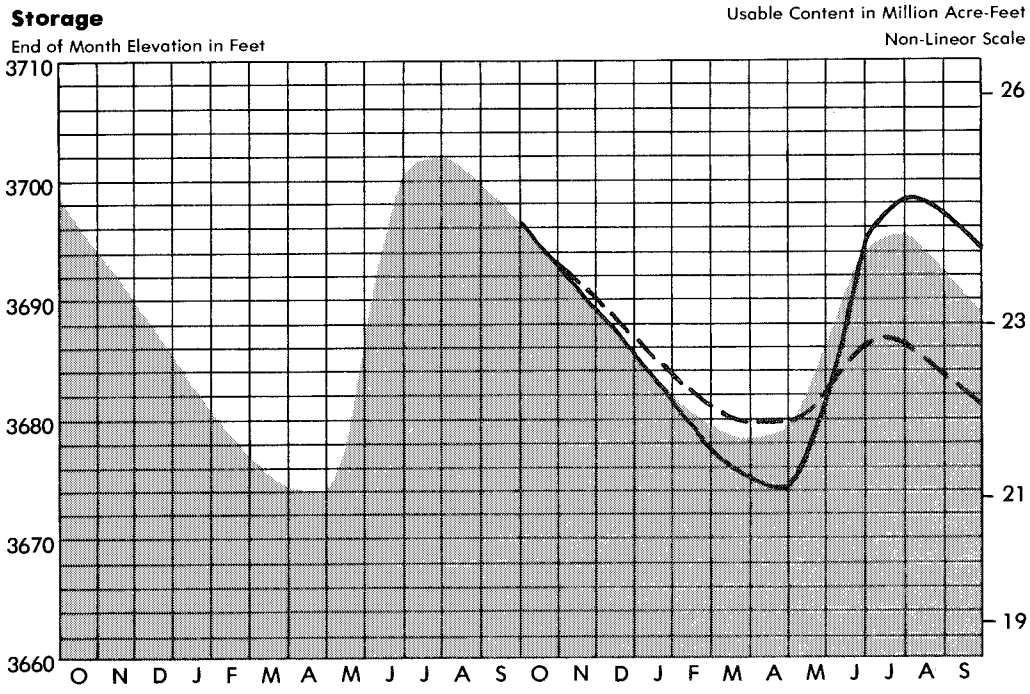
*Does not include 1,998,000 acre-feet of dead storage below 3370 feet.



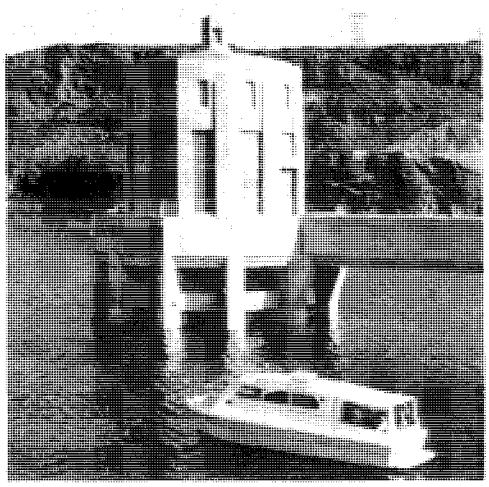




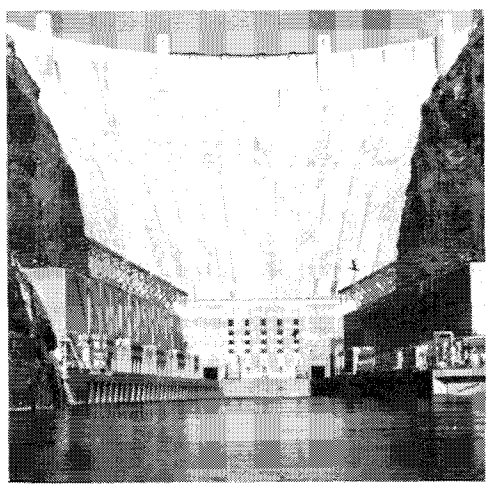
Erosion damage in Glen Canyon's left spillway tunnel.



Lower Basin Reservoirs
Lake Mead (Colorado River)



Lake Mead cruise boat.



Hoover Dam and afterbay.

Inspection of Hoover Dam's Arizona spillway tunnel.

Water Year 1984

At the beginning of water year 1984, Lake Mead, impounded by Hoover Dam, had a water surface elevation of 1,218 feet and an active storage of 25,658,000 acre-feet. During the winter and spring months, the water level gradually declined to 1,206 feet by the end of April 1984. During the high inflow conditions of June and July, Lake Mead reached a high elevation of 1,213.7 feet near the end of July, with a peak active storage of 24,962,000 acre-feet.

During the water year, releases were made to meet downstream water use requirements in the United States and Mexico, flood control requirements, programed levels of Lakes Mohave and Havasu, and transit losses which include river and reservoir evaporation, uses by phreatophytes, changes in bank storage, unmeasured inflows, and diversions. The total release from Lake Mead through Hoover Dam during water year 1984 was approximately 22,210,000 acre-feet. All of that amount passed through the turbines for power production. At the end of the water year, Lake Mead had a water surface elevation of 1,210 feet and an active storage of 24,406,000 acre-feet which reflects a decrease in storage during the water year of 1,252,000 acre-feet. On September 30, 1984, the active storage of Lake Mead was 57,000 acre-feet greater than the active storage in Lake Powell.

Water Year 1985

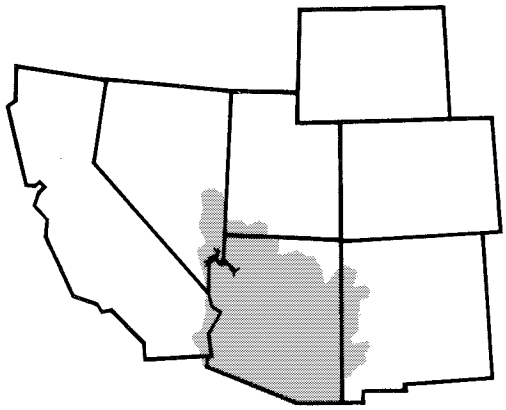
Under most probable inflow conditions during the 1985 water year, the Lake Mead water level is scheduled to be drawn down to elevation 1,202 feet at the end of July 1985. At that level, the lake will have in active storage about 23.2 million acre-feet. During water year 1985, a total of about 14.6 million acre-feet is scheduled to be released from Lake Mead under most probable conditions, all passing through the powerplant.

A contract will be 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 is expected to begin in October 1985 and will be completed by May 1986. The Arizona spillway work is scheduled to be completed in Water Year 1987.

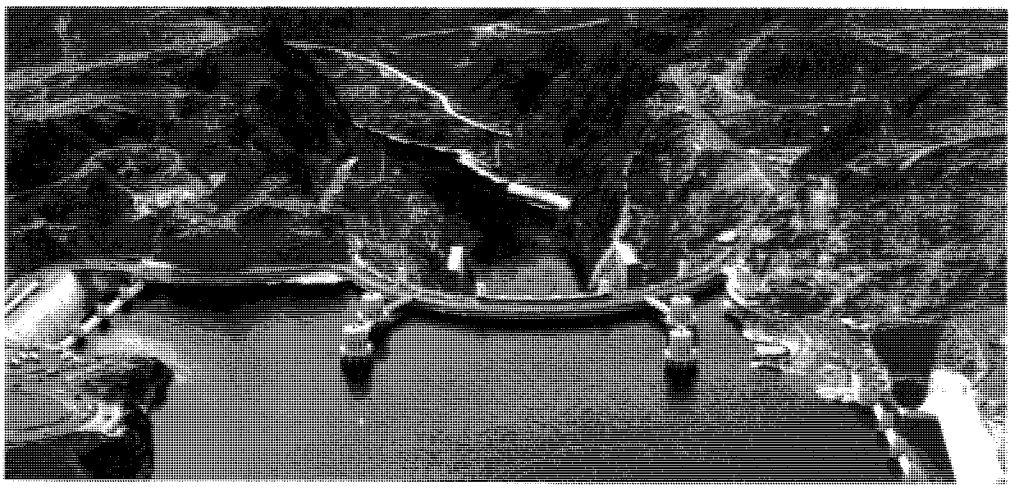
Lake Mead Active Storage* **Chart 6**

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	1,344,800 Kilowatts	

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



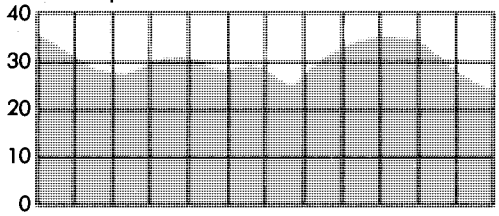
Rigging of bosun chair used for dam inspection.



Looking downstream from above Hoover Dam.

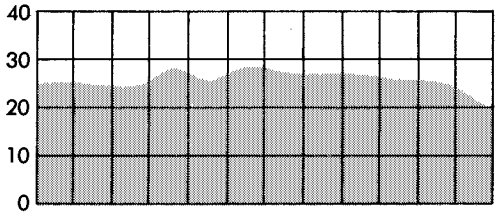
Outflow Monthly Release in 1000 Cubic Feet/Second

Actual Operation 1984

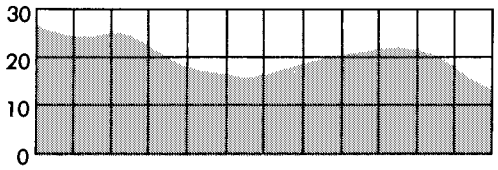


Projected Operation 1985

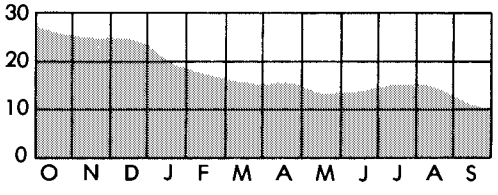
Reasonable Maximum



Most Probable



Reasonable Minimum

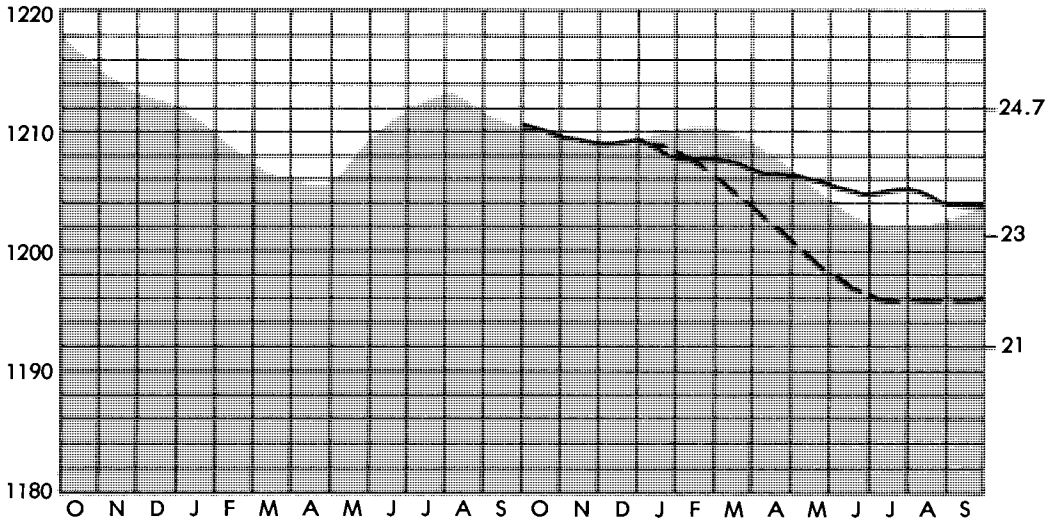


Storage

End of Month Elevation in Feet

Active Content in Million Acre-Feet

Non-Linear Scale



Actual 1984

Projected 1985

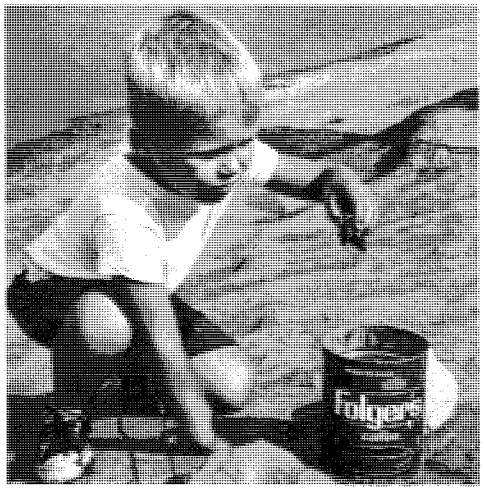
Legend

Most Probable

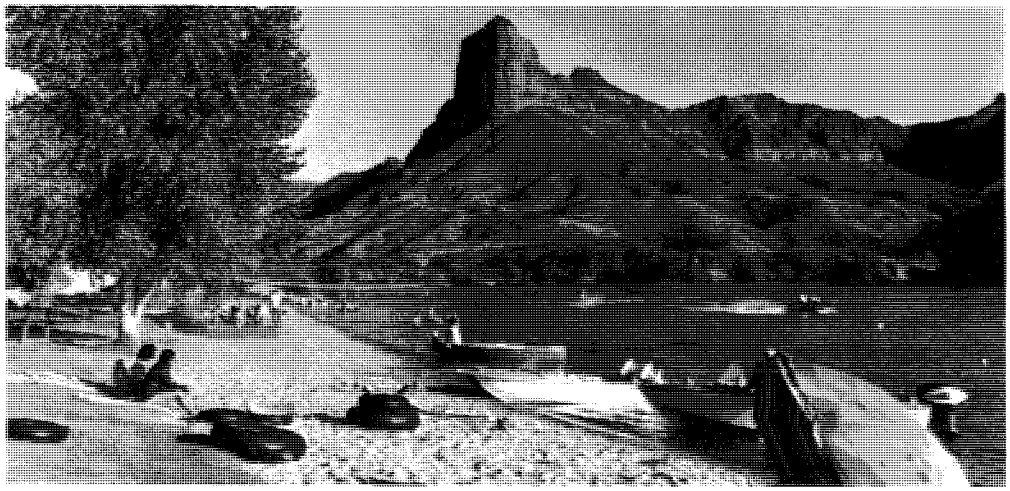
Reasonable Minimum

Reasonable Maximum

Lake Mohave (Colorado River)



Young fisherman.



Colorado River recreation.

Water Year 1984

At the beginning of water year 1984, the water surface elevation of Lake Mohave, which is impounded by Davis Dam, was 639 feet, with an active storage of about 1,600,000 acre-feet.

During the winter months, the water level was gradually raised to approximately 645 feet, with an active storage of 1,750,000 acre-feet by mid March 1984. The water level was drawn down during April to elevation 636. During the month of August, Lake Mohave reached a high elevation of 644, with an active storage of 1,720,000 acre-feet. The reservoir ended the water year again at an approximate elevation of 639 feet with 1,600,00 acre-feet in active storage.

Lake Mohave releases were made to satisfy flood control requirements and downstream water use requirements, including diversions by The Metropolitan Water District. A small amount of reregulation occurred at Lake Havasu. During the water year, approximately 22,410,000 acre-feet were released at Davis Dam. Of that amount, approximately 18,751,000 acre-feet passed through the turbines for power production.

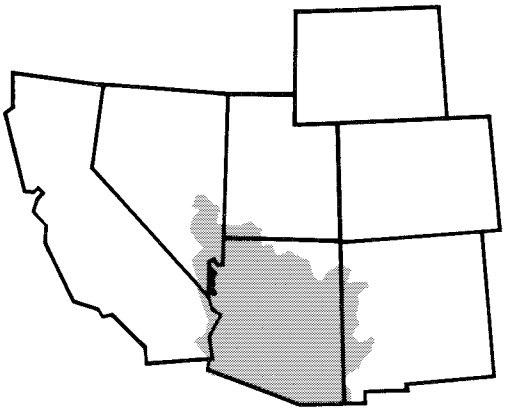
Water Year 1985

Under most probable inflow conditions the water level of Lake Mohave is scheduled to reach an elevation of 641 feet by the end of January 1985 and vary around that elevation for the remainder of the water year. During the water year a total of 14.7 million acre-feet is scheduled to be released from Lake Mohave to meet all downstream and flood control requirements. Of that total, approximately 13.4 million acre-feet is scheduled to pass through the powerplant and 1.3 million acre-feet to bypass it.

Lake Mohave Active Storage* **Chart 7**

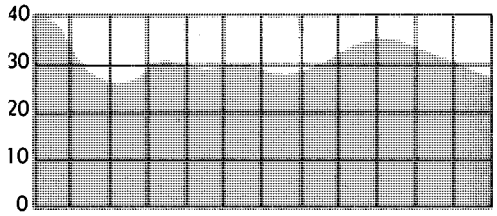
Reservoir	Acre-Feet	El. (Ft.)
Maximum Storage	1,810,000	647.0
Rated Head	1,188,000	623.0
Minimum Power	217,500	570.0
Surface Area (Full)	28,200 Acres	
Reservoir Length (Full)	67 Miles	
Powerplant		
Number of Units	5	
Total Capacity	240,000 Kilowatts	

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



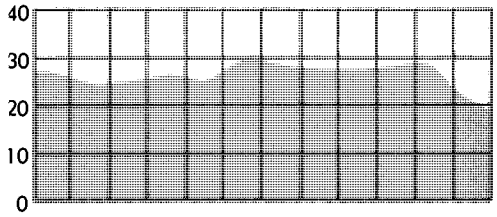
Outflow Monthly Release in 1000 Cubic Feet/Second

Actual Operation 1984

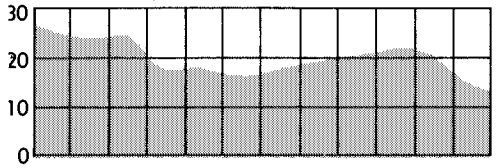


Projected Operation 1985

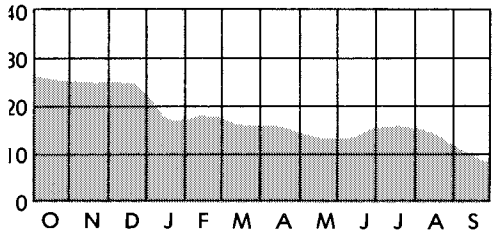
Reasonable Maximum

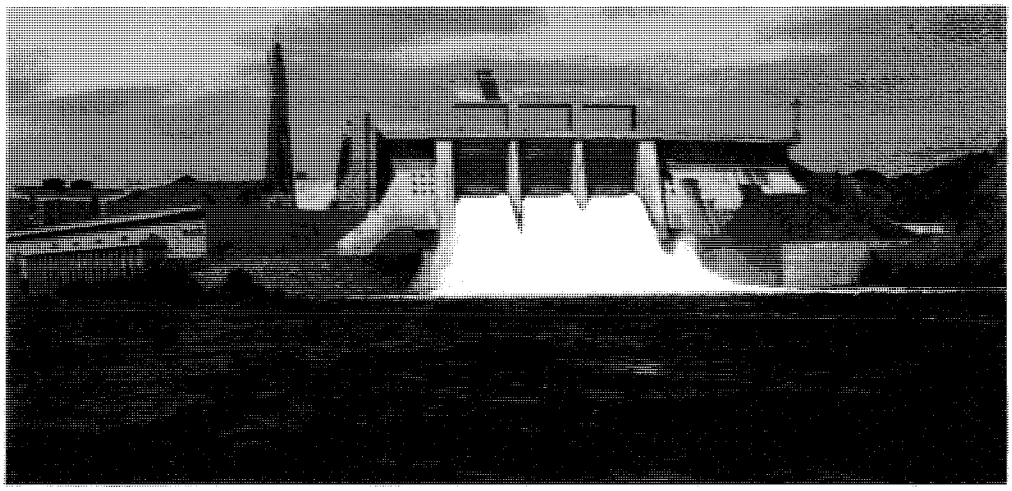


Most Probable



Reasonable Minimum





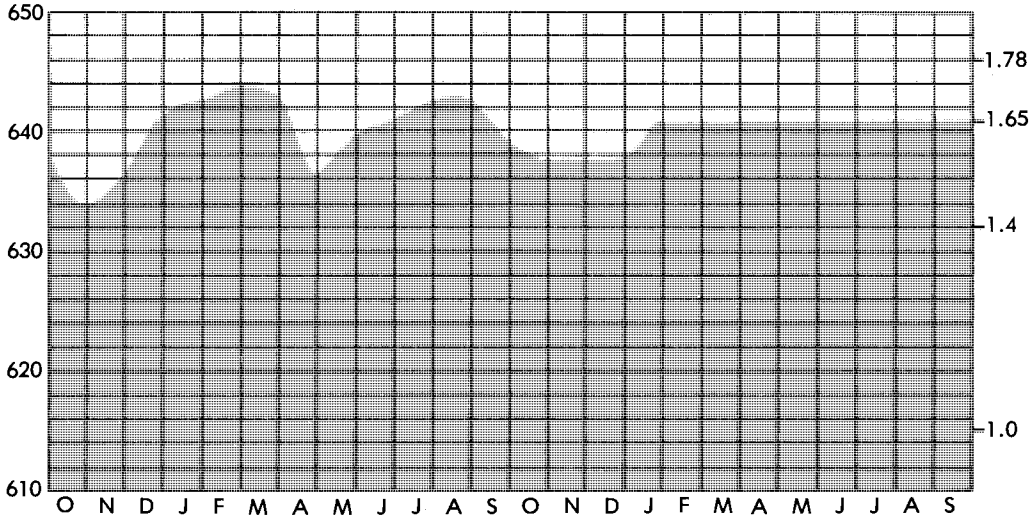
Davis Dam with spillway gates open.

Storage

End of Month Elevation in Feet

Usable Content in Million Acre-Feet

Non-Linear Scale

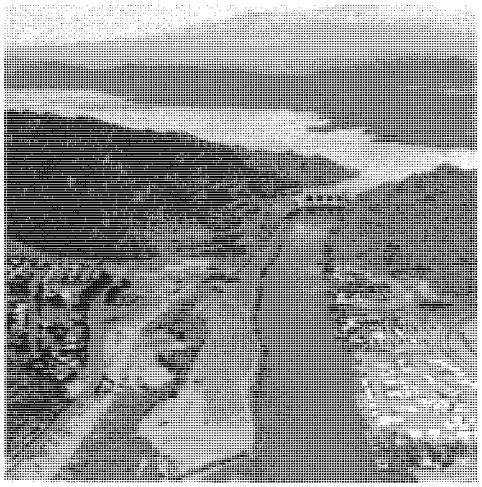


Actual 1984 Projected 1985

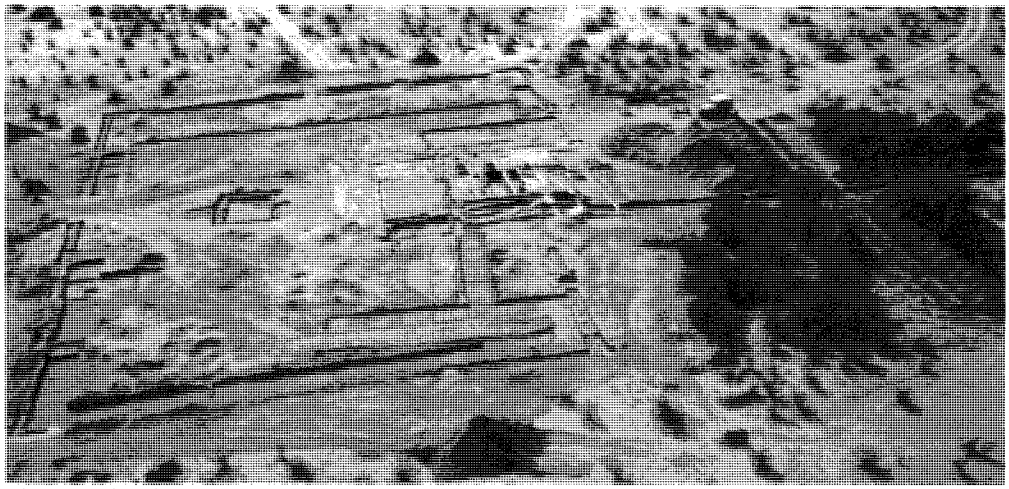
Legend

Most Probable

Lake Havasu (Colorado River)



Parker Dam and surrounding area.



Hohokam archaeological site, Arizona.

Water Year 1984

At the beginning of water year 1984, the water level of Lake Havasu, impounded by Parker Dam, was at elevation 446 feet with an active storage of approximately 541,000 acre-feet. The reservoir was drawn down to approximately elevation 445 feet, with an active storage of about 529,000 acre-feet in early January 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 448 feet by the end of July, with an active storage of about 574,000 acre-feet. At the end of the water year, Lake Havasu was at an elevation of 448 feet with an active storage of 585,000 acre-feet.

During the water year, approximately 21,124,000 acre-feet were released at Parker Dam, of which approximately 15,801,000 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 1,196,000 acre-feet were diverted from Lake Havasu by The Metropolitan Water District.

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.

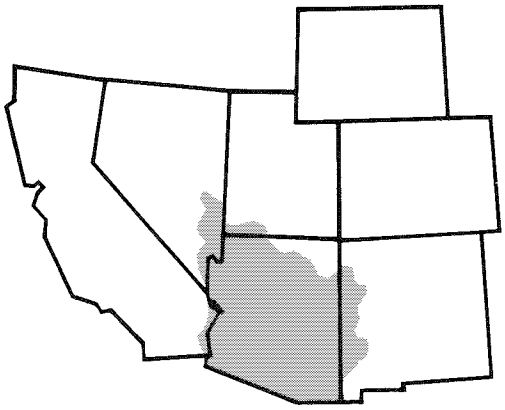
Water Year 1985

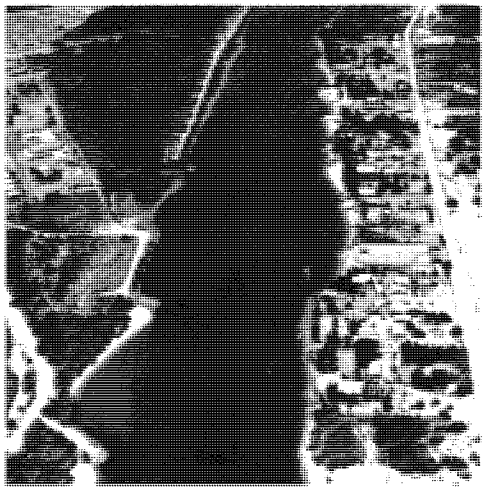
Lake Havasu is scheduled at the highest levels consistent with the requirements for maintaining reservoir regulation space. The yearly low elevation of approximately 446 feet is scheduled for the October through February high flood hazard period. The yearly high of about 450 feet is scheduled for the low flood hazard months of May and June. During water year 1985, a total of approximately 13.3 million acre-feet is scheduled to be released from Lake Havasu to meet all downstream and flood control requirements. Of that total, approximately 11.5 million acre-feet are scheduled to pass through the Parker powerplant.

Lake Havasu Active Storage* **Chart 8**

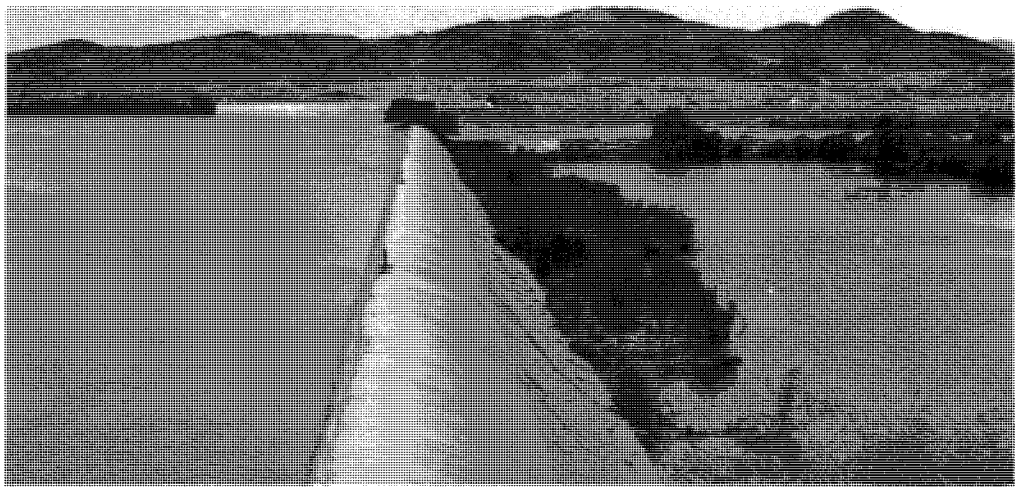
Reservoir	Acre-Feet	El. (Ft.)
Maximum Storage	619,400	450.0
Rated Head	619,400	450.0
Minimum Power	439,400	440.0
Surface Area (Full)	20,400 Acres	
Reservoir Length (Full)	35 Miles	
Powerplant		
Number of Units	4	
Total Capacity	120,000 Kilowatts	

*Does not include 28,600 acre-feet of dead storage below 400.0 feet.





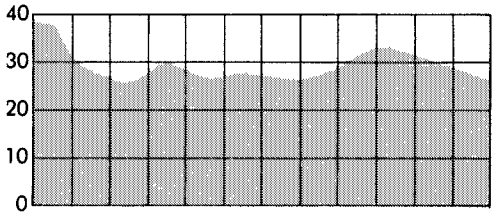
Colorado River near Needles, California.



Overflow weir — Imperial Dam.

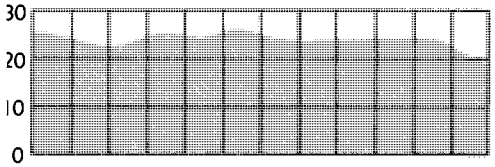
Outflow Monthly Release in 1000 Cubic Feet/Second

Actual Operation 1984

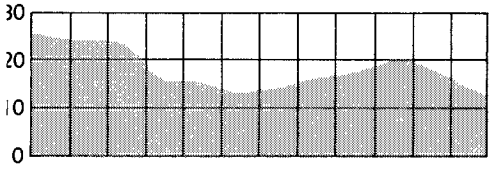


Projected Operation 1985

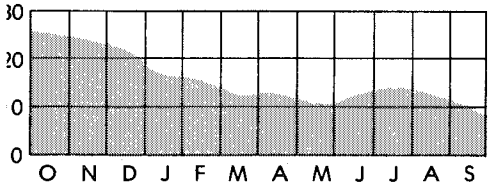
Reasonable Maximum



Most Probable



Reasonable Minimum

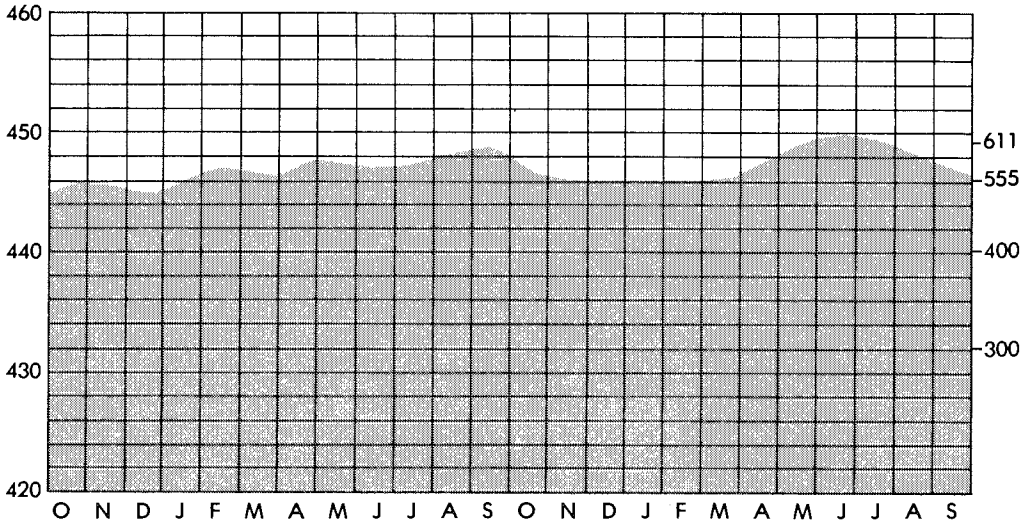


Storage

End of Month Elevation in Feet

Usable Content in 1000 Acre-Feet

Non-Linear Scale

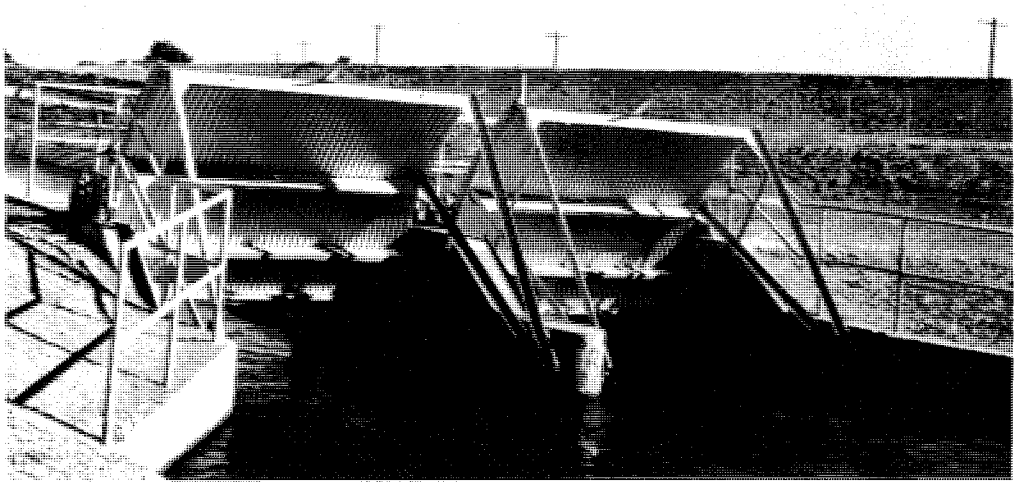


Actual 1984 Projected 1985

Legend

Most Probable

River Regulation



Check gates.

Equipment used to clean canals.

Water levels in nearly all of the major reservoirs in the Colorado River basin reached the same high levels as in water year 1983. Early runoff forecasts in 1984 indicated an abnormally high flood potential which triggered reservoir drawdowns sufficient to accommodate the anticipated runoff volume. Consequently, maximum releases from mainstem reservoirs during the runoff were much less than in water year 1983 even though the 1984 runoff was higher in both volume and peak. The natural virgin runoff reaching the streams of the Colorado River drainage system above Glen Canyon Dam during water year 1984 was estimated at about 24.5 million acre-feet. Of this amount, approximately 3.8 million acre-feet were consumptively used within the Upper Colorado River Basin States.

Adjustments in storage in Upper Basin reservoirs resulted in an actual inflow to Lake Powell of 21.2 million acre-feet during water year 1984. The annual release from Lake Powell, based on measurements at the gaging station at Lees Ferry, Arizona, was 21.1 million acre-feet. For the 1-year and 10-year periods ending September 30, 1984, 21,098,000 acre-feet and 108,796,000 acre-feet, respectively, passed the compact point at Lee Ferry.

The projected water year 1985 release from Lake Powell, based on reasonable minimum runoff conditions is 10,700,000 acre-feet. The projected release for the reasonable maximum runoff condition is 18,100,000 acre-feet. When combined with the average annual flow of the Paria River, this would result in an Upper Basin delivery ranging from 113.1 to 117.5 million acre-feet for the 10-year period ending September 30, 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 electric 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 15,160,000 acre-feet in excess of the scheduled treaty quantity (1,700,000 acre-feet) during water year 1984. Of that amount, 137,500 acre-feet of drainage waters were bypassed to the Gulf of California via the Santa Clara Slough. This bypass channel was constructed pursuant to provisions of Minute No. 242 of the International Boundary and Water Commission.

The current most probable water supply condition operation plan yields slightly in excess of 6.0 maf of vacant storage space as of January 1, 1985, or a little more than the 5.6 maf that was available on January 1, 1984, but less than the 6.6 maf that was available January 1, 1983. With only 6 maf of vacant storage space on January 1, it is virtually assured that at least a 19,000 cfs flood control release is required at Hoover Dam under the flood control regulations.

Flood Control

The reservoirs within the basin again received far greater total inflow in 1984 than during normal years. In the Upper Basin, Navajo and Blue Mesa Reservoirs are operated for flood control by providing space to store snowmelt floods. Although Flaming Gorge and Glen Canyon Reservoirs have no specifically assigned requirement for flood control, they do reduce flood flows since they are operated to reduce spills. The space they provide is counted as part of the flood control space that is required by the Army Corps of Engineers (Corps) flood control regulations at Lake Mead.

Damages to bridges, roads, and farmland in the Upper Basin above Lake Powell reached approximately $20 million. The worst flooding along the Upper Colorado mainstem in more than 50 years was evident. Record flows were observed breaking the pre-1922 recorded flows dating back to 1897. Areas along the Upper Basin mainstem remained above flood stage from 37 to 53 days. Mainstem reservoirs helped alleviate these peak flows.

In 1984, the maximum flow of the Gunnison River at Crystal Dam was reduced from over 21,000 cfs to about 9,200 cfs due to storage in Blue Mesa and Taylor Park Reservoirs. At the time when the North Fork of the Gunnison was causing flood damages near Delta, Colorado, the regulatory effects of the Aspinall Unit decreased the maximum flow by almost 12,000 cfs. Navajo Reservoir reduced the maximum flow of the San Juan River at the dam from over 9,000 cfs to 2,100 cfs which reduced damage near Farmington, New Mexico. Flaming Gorge Reservoir reduced the maximum flow of the Green River at the dam from 17,300 cfs to 8,100 cfs which helped alleviate flooding near Jensen, Utah, as the flow of the Yampa River peaked.

Desert flora near Coachella Canol, California.

Lake Mead is the only reservoir on the Colorado River in which a specific space is exclusively allocated for mainstem flood control. Flood control regulations for Hoover Dam have been updated and revised based on findings of a joint study initiated in 1977 by Reclamation and the Corps, with consultation and advice of State and local interests.

A final report dated July 1982 which summarized the study findings and recommended a new flood control operation plan for Hoover Dam was released July 1983. Flood control storage space will be maintained in Lake Mead as stipulated in the Report's Field Working Agreement between Reclamation and the Corps for flood control operation of Hoover Dam and Lake Mead. These regulations establish releases in a manner that maximizes public benefits in the United States with reasonable consideration for conditions in Mexico.

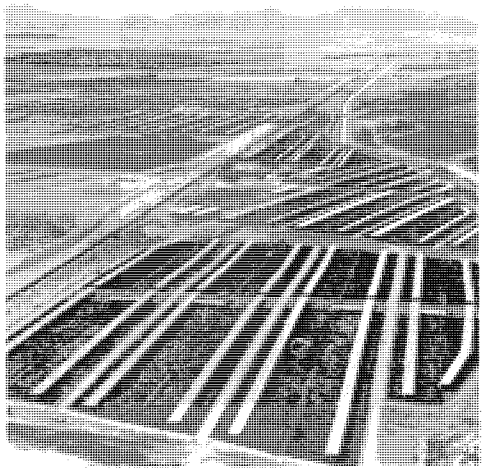
Lower releases this year than last year's 40,000 cfs to 45,000 cfs levels have avoided any additional significant damages along the river in the Lower Basin. Scour in some reaches of river channel has continued to occur, and therefore river levels have been lower in nearly all areas than they were with the same release levels last year and early this year.

The reservoir system has been operated in full accordance with established operating criteria and the Corps flood control regulations. The combined effect of the Upper Basin reservoirs, including Flaming Gorge and Lake Powell, and Lower Basin reservoirs, Lake Mead, Lake Mohave, and Lake Havasu, was to reduce the flow of the Lower Colorado River from approximately 148,000 to about 32,000 cfs.

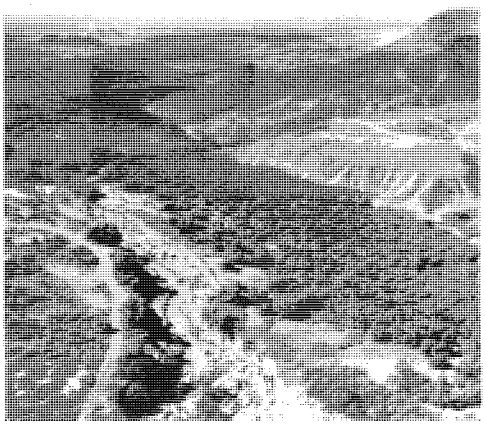
Total Colorado River reservoir system storage at the start of water year 1984 was approximately 58,962,000 acre-feet and about 57,344,000 acre-feet at the end of the water year, representing a 1,618,000 acre-foot increase in total remaining available reservoir space.

In addition to the mainstem structures, Alamo Dam on the Bill Williams River, and Painted Rock Dam on the Gila River (both in the Lower Basin) received flood inflow during water year 1984. During water year 1985, 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 their respective reservoirs.

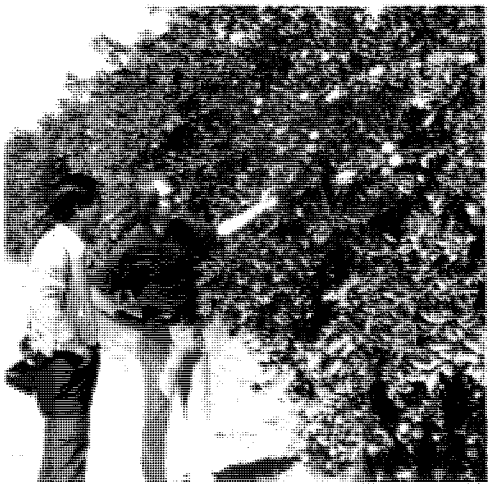
Beneficial Consumptive Uses



Feedlot served by Colorado River water.



Las Vegas Wash, Colorado River Salinity Control Project.



Inspection of citrus development.

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 to 1980. The following table summarizes annual water use from the system by States, including water use supplied by ground-water overdraft.

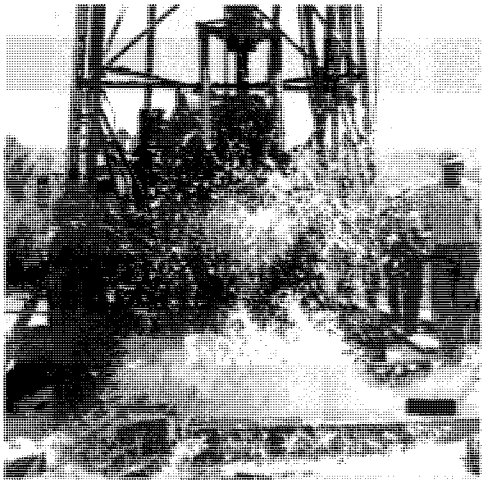
Water Use by States *
1976 - 1980

(1,000 acre-feet)

State	1976	1977	1978	1979	1980	Average 1976-80
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 **	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 Excess Releases	205	209	194	171	185	193
	69	68	38	927	4,251	1,071
Subtotal - 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

* Onsite consumptive uses and losses; includes water uses satisfied by ground-water overdrafts.

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



Well preparation prior to pumpout test.

Agricultural water use in the Phoenix area.

Upper Basin Uses and Losses During 1984

The three largest sources of consumptive use in the Upper Colorado River Basin are agricultural use within the basin, transbasin diversions to adjacent drainages, and evaporation losses from the major reservoirs of the Colorado River System. During water year 1984, the estimated use for municipal and industrial supply and for agriculture in the Upper Basin was 2,500,000 acre-feet. Estimated evaporation losses were 752,000 acre-feet from mainstem reservoirs. About 584,000 acre-feet was diverted for use in adjacent drainages. Total estimated consumptive use, therefore, amounted to 3,836,000 acre-feet. Storage in the Upper Basin mainstem reservoirs decreased by approximately 392,000 acre-feet during water year 1984.

Lower Basin Uses and Losses

During water year 1984, an estimated 5,063,000 acre-feet of water were released from Lake Havasu to meet the requirements for water deliveries at Imperial Dam, as well as those of the Colorado River Indian Reservation near Parker, Arizona, the Palo Verde Irrigation District near Blythe, California, other miscellaneous users along the river, and transit losses between Parker Dam and Imperial Dam.

The major water diversion above Parker Dam was by The Metropolitan Water District of Southern California (MWD). MWD pumped approximately 1,196,000 acre-feet from Lake Havasu during water year 1984. None of this water was used for delivery to the City of Tijuana, although the contract for temporary emergency delivery of a portion of Mexico's treaty entitlement is still in existence. During water year 1984, releases of approximately 6,349,000 acre-feet were made from Lake Mohave 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 1984, releases of approximately 6,149,000 acre-feet 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, 149,000 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 Division of Colorado River Resources, in Nevada. During water year 1984, the total releases and diversions from Lake Mead were an estimated 22,359,000 acre-feet.

For water year 1985, a total release of 13.3 million acre-feet from Lake Havasu has been projected, including consumptive use 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. Of the total projected, 11.5 million acre-feet would pass through the Parker Powerplant and approximately 1.8 million acre-feet would have to bypass the powerplant.

During water year 1985, MWD is expected to divert 1,258,000 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 160,000 acre-feet.

There are no major users between Hoover Dam and Davis Dam. During water year 1985 the net diversions from Lake Mead are projected at 141,000 acre-feet. Evaporation from Lake Mead is projected to be about 1,022,000 acre-feet and net gain between Glen Canyon Dam and Lake Mead is expected to be about 902,000 acre-feet.

Water Quality Operations

Beach and sun enthusiasts.

Sarghum inspection for effects due to salty soils.

Water — just one of our valuable resources.

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 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 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 of the Interior to construct a number of units in the basin above Imperial Dam, as well as the investigation of several other potential salinity control units.

The Act, and its amendment by Public Law 98-569 of October 30, 1984, directs the Secretary of the Interior 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 1984, the United States bypassed a total of 137,500 acre-feet through the Bypass Drain and MODE 3.

As the river was in an excess flow condition during 1984 due to the extremely 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 1984, the average annual salinity of the Colorado River water arriving at Imperial Dam was 688 ppm. During this same period, the salinity of the waters arriving at Morelos Dam was 697 ppm, resulting in an annual average salinity differential of only 9 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 1985 are projected to be 150,000 acre-feet. A minor amount of drainage water could be returned to the Colorado River below Morelos Dam during 1985. Due to the excess flow conditions that are expected, it will not be necessary to provide replacement water to Mexico for the bypassed flows.

Environmental Programs

Common egret, Havasu National Wildlife Refuge.

Lava Falls Rapid, Colorado River.

Upper Basin

During water year 1984, Reclamation continued to study the impact of Glen Canyon Dam on the downstream environment. The Glen Canyon Environmental Studies (Studies) are a multiagency/multiobjective series of studies that are oriented to technically evaluate the impact of the operations of Glen Canyon Dam on the natural resources of the Grand Canyon and the Lees Ferry tailwater area. The Studies are a cooperative effort that combines the expertise and cooperative involvement of Federal, State, private, and academic entities. Reclamation is providing the lead role in the Studies through overall study management and funding. The main objective of the Studies is to technically evaluate the relationship between the natural resources and the complete range of flow regimes operationally feasible from Glen Canyon Dam.

The resulting analysis will provide the input to the development of alternative operational scenarios that will be evaluated for their natural resource impact and feasibility under existing physical, legal, and operational constraints.

Four main areas of interest are being evaluated: biological, recreation, sediment transport and hydrology, and power. Representatives from four Federal agencies, two State agencies, four universities, and six private contractors currently make up the study team.

The Studies are approximately 45 percent complete with the major portion of data being collected at maximum powerplant flow levels. The remaining data collection will be oriented largely toward the relationships between fluctuating flows and the 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 1984. Although the levels of impact were not as severe as in 1983, the high spring release levels reduced thermal regimes, and inundation of streamside terrestrial habitat affected the propagation and growth of aquatic and terrestrial species.

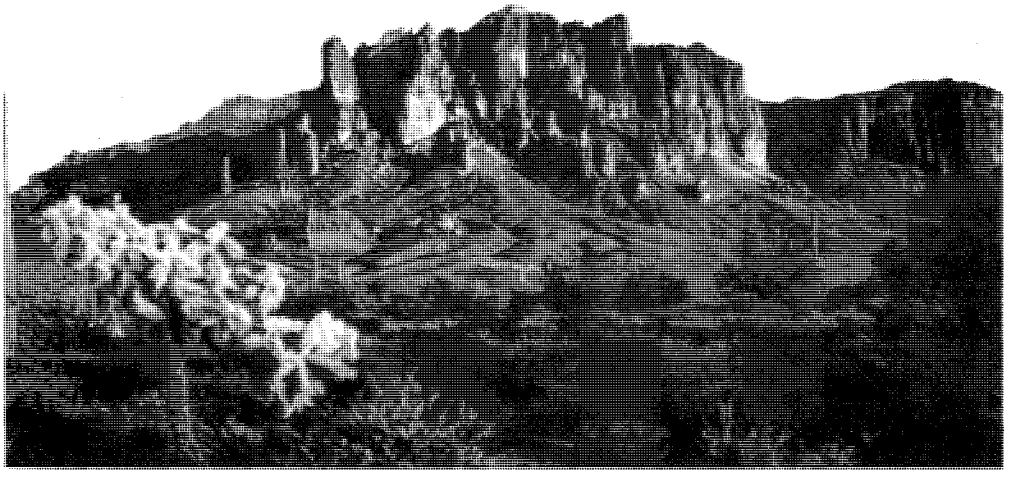
Impacts to these resources have not yet been fully quantified. In some cases fisherman use and success have continued in spite of the hindrance to access caused by the high flows. Riparian areas and sandy beaches adjacent to tailwater reaches were modified or eliminated in several areas where water velocities 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.

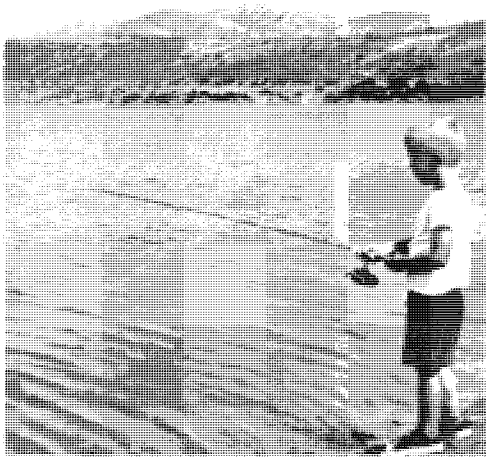
Consultation with the Fish and Wildlife Service regarding the impacts of the CRSP reservoirs on the endangered Colorado River fishes is still ongoing. Studies designed to provide biological answers and operational options are being initiated and will help fulfill Reclamation responsibilities and requirements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

In addition to the native species, a recently initiated investigation of selected salmonid species and their specific habitat requirements will be completed within the next year. This information will also assist Reclamation in determining flow

Environmental Programs [Cont.]



Superstition Mountains east of Phoenix.



Patience — and hope.

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.

Lower Basin

The 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 are underway on a number of archaeological sites that will be 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.

The Salt-Gila and Tucson Aqueduct studies along with related work are revealing a picture of a relatively sophisticated and organized people who built extensive canal systems and storage reservoirs for irrigation and domestic purposes. They employed a variety of farming techniques to cope with the difficult desert environment. A picture is emerging of large communities that are more or less regularly spaced across the desert. These communities center around "platform mound" walled compound structures. The platform mounds appear to have been ceremonial and/or political centers where possibly an elite political/religious class lived. Pithouse villages, agricultural villages, agricultural fields, and in some oasis canal systems encircled the platform mounds. The communities measured as large as 6 miles across.

In addition, a small number of "archaic" period sites are also being studied. These represent occupation by a hunting and gathering based culture that predates the Hohokam.

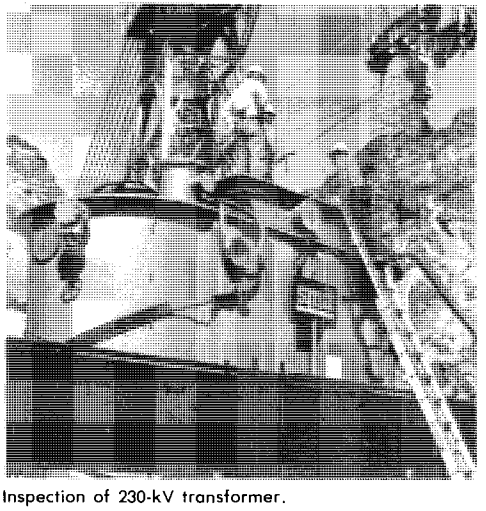
Reclamation biologists are concluding studies on how animal drownings can be avoided along proposed and existing canals and those under construction. Artificial oases and water catchments were placed in different locations to see if the mammals would drink from them rather than the canals, thereby lessening mammal mortality in the canals.

Studies have also investigated the distribution and movement of desert mule deer and desert bighorn sheep along the Tucson and Granite Reef Aqueduct routes to determine what areas would be best used for oasis, catchments, crossings, fencing, or canal escape devices. Escape ramps, ladders, and steps were studied on an existing canal (Mohawk Canal) to determine their effectiveness. A cooperative agreement to furnish 14 wildlife watering devices as partial mitigation for the Granite Reef Aqueduct has been signed by Reclamation and the Arizona Game and Fish Department.

Reclamation again participated in a survey of potential habitat in an effort to determine the numbers and locations of the endangered Yuma clapper rail. The survey covered five divisions of the Lower Colorado River and was conducted in May and June 1984.

A separate study, funded jointly by Fish and Wildlife Service (FWS) and Reclamation, to investigate movements and habitat utilization of the Yuma clapper rail, was initiated during 1984. This effort, conducted by scientists at the Wyoming Cooperative Wildlife Research Unit, is scheduled for completion in late 1987.

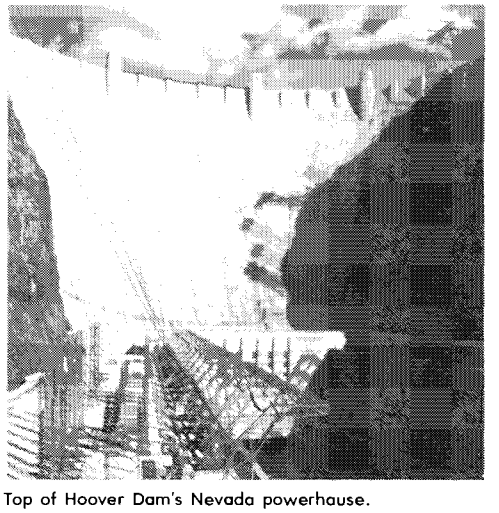
Power Operations



Inspection of 230-kV transformer.

Reclamation continues its cooperative efforts with several other agencies in studies of the endangered bald eagle. Involved is a volunteer nest watch program as well as studies of nesting success and productivity of the restricted Arizona population of this species.

As part of the mitigation for Reclamation's Salinity Control Program (Title I), land was purchased and transferred to FWS for inclusion in the Salton Sea National Wildlife Refuge. Agreement was reached with FWS and the California Department of Fish and Game to pursue purchase of land in the San Sebastian Marsh area to complete this mitigation obligation in California. In Arizona, mitigation efforts are centered on designing a master plan for wildlife development at Mumme Farm.



Top of Hoover Dam's Nevada powerhouse.

Upper Basin — Colorado River Storage Project

Contract work by Westinghouse Electric Corporation to uprate the generators at Glen Canyon Powerplant continued during 1984. Units 1 and 6 were completed during the year, with work on unit 3 underway. The schedule for uprating work in 1985 includes completing units 3 and 5 and beginning work on unit 8. Uprating of all eight units at Glen Canyon is scheduled to be complete in April 1987.

The following table summarizes CRSP generation, purchases, disposition, and revenues from power operations for fiscal year 1984 and presents projections for fiscal year 1985.

The total revenue from power operations in fiscal year 1984 was $121,229,658. For fiscal year 1985, estimated revenues are $89,000,000.

Water Year 1984

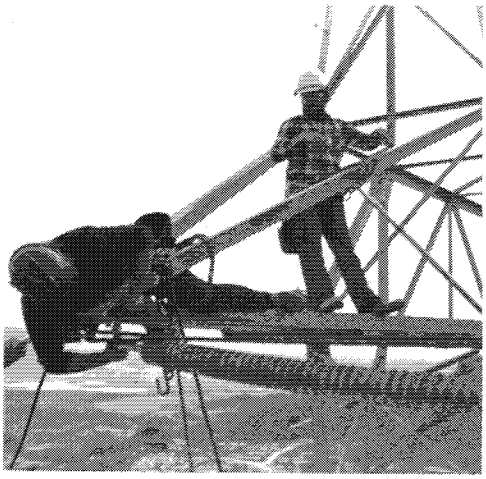
Sources of Energy	**Kilowatt-hours**
Net Generation	
Blue Mesa	398,921,020
Crystal	235,445,000
Flaming Gorge	878,597,000
Fontenelle	60,910,000
Glen Canyon	8,812,833,000
Morrow Point	602,479,800
Subtotal-Net Generation	10,989,185,820
Purchases	1,260,765,000
Miscellaneous	
Interchange Receipts	1,156,735,439
Energy Charges to Transmission Service Customers	221,997,000
Subtotal-Miscellaneous	1,378,732,439
Total Energy from All Sources	13,628,683,259

Disposition of Energy	**Kilowatt-hours**
Firm Energy Sales	8,685,299,304
Nonfirm Energy Sales	
Emergency	14,838,696
Fuel Replacement (Oil Conservation)	2,800,809,000
Interchange Deliveries	519,627,404
System Losses	1,608,108,855
Total Energy Distributed	13,628,683,259

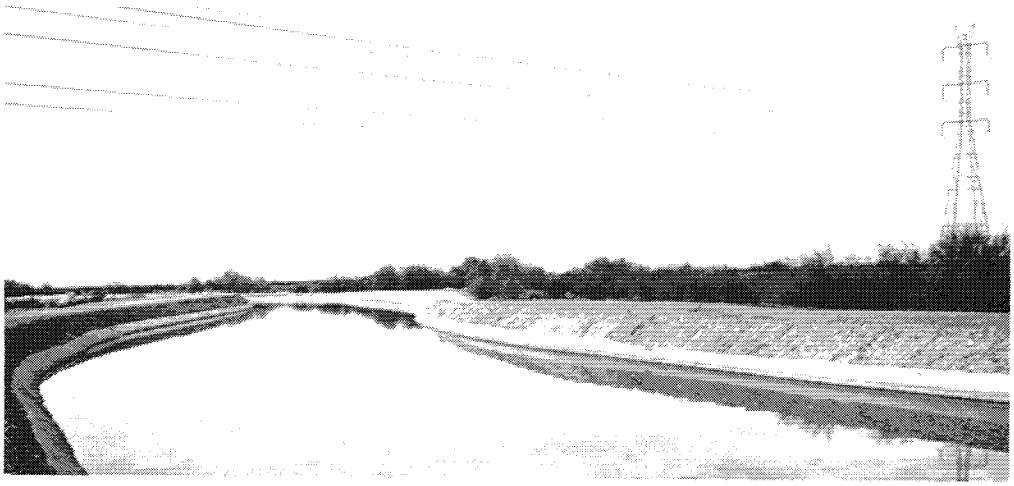
Revenue	
Firm Power Sales	$ 74,100,671
Non firm Power Sales	
Emergency Power	457,804
Fuel Replacement (Oil Conservation) Energy	41,454,599
Reserve Capacity	57,870
Parker-Davis Project Firming	0
Transmission Service Revenue	2,055,544
Miscellaneous Revenue	3,103,169
Total Gross Revenue	$121,229,657

Water Year 1985 (Projected)	**Kilowatt-hours**
Estimated Energy Sales	6,116,000,000
Estimated Purchases	950,000,000
Estimated Peaking Capacity Sales	
Winter 1984-85	243,000
Summer 1985	182,000
Estimated Revenue	$ 89,000,000

Power Operations [Cont.]



Power line hook-up on a 110-foot tower.



Canal lining reduces seepage losses.

Lower Basin — Water Year 1984

The total energy delivery to the Hoover allottees during the 1984 operating year (June 1, 1983 - May 31, 1984) was 10,396,977,387 kilowatt-hours (kWh). Of that amount, 6,469,937,387 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 was accomplished for water year 1984. A new self-contained, three-phase transformer was installed on Unit A-5. This installation required considerable cooling water piping and valve changes, as well as the electrical work, and was completed near the end of June 1984. Overall maintenance on the unit was performed during this outage. This 135 MVA transformer was delivered to Hoover Dam on a 13-axle truck rig and lowered to the transformer deck by cable. The delivery naturally slowed traffic and the overall operation generated a great deal of interest for visitors, employees, and their families.

Scheduled maintenance at Davis and Parker Powerplants was deferred during water year 1984 because of the high base flows.

Water Year 1985

In operation studies of Lake Mead and Lake Powell for the Hoover operating year, which ends May 31, 1985, 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 17.8 million acre-feet. 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 8.5 billion kWh of electrical energy.

Scheduled outage of the Hoover Upper Arizona penstock for major unit and intake gate maintenance in February 1985 has been cancelled. Precipitation in the Upper Basin has averaged about 200 percent of normal since June 1984. Increased precipitation since that time may further revise expected release figures of 19,000 to 28,000 cfs during January and February 1985.

The ongoing schedule of replacing high pressure cooling water piping and valves at Hoover is being performed, as well as major repairs to the needle valves and paradox gates in the Canyon Wall Outlet Works and Tunnel Plug Outlet Works.

Each of the four Parker Powerplant units in turn were out of service for cable replacement. Annual maintenance was performed on the individual unit during the outages. With this maintenance accomplished, there are no scheduled outages at Parker to be affected by water releases.

The Davis Powerplant annual maintenance schedule is proceeding as planned. Short-term outages are forecast for wicket gate repairs on Davis G-2 and exciter overhaul on Unit G-4.

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.

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