# REPORT OF THE COMMITTEE ON PROBABILITIES AND TEST STUDIES TO THE TASK FORCE ON OPERATING CRITERIA FOR THE COLORADO RIVER

United States
Department of the Interior
Bureau of Reclamation

October 30, 1969

REPORT OF THE COMMITTEE ON PROBABILITIES AND TEST STUDIES TO THE TASK FORCE ON OPERATING CRITERIA FOR THE COLORADO RIVER

This group was formed to make whatever studies seemed appropriate to define the effects of several parameters which might possibly be considered for inclusion in the criteria and to test the criteria with a range of possible effects which might occur in the future.

In general, we studied the following parameters which would appear to be items which should be defined by the operating criteria:

(a) A storage reserve in the Upper Basin to assure the delivery of priority 1 and 2 water during periods of subnormal runoff.

(b) A minimum annual release at Lake Powell.

(c) A rule governing the magnitude of releases from Lake Mead.

In addition, we tested the criteria by imposing on the following items ranges of values which we believe encompass the more likely possibilities which could occur in the future:

(a) Streamflow sequences.

(b) Upper Basin depletions.

(c) Lower Basin uses and losses.

In applying these various operating criteria and estimates of future uses and water supply, we ran 146 computer studies to evaluate their potential effects on the future operation of the river. A summary of various resulting values from these studies is shown on Table 1, pages 2, 3, 4, and 5. Although most of the studies involved various combinations of the six items listed above, we also ran two unique studies at the request of members of this group. One study involved the production of firm power at Hoover and one of the studies involved the operation of the system under depletion conditions which are estimated to occur after year 2000.

TASK FORCE ON OPERATING CRITERIA - COLORADO RIVER - P. L. 90-537

Sheet No. 1

C O M P A R I S O N   O F   T E S T   S T U D I E S

October 29, 1969

| AP Study No. | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Release from Upper Basin in Million AF/year | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 |
| Rule curve probability in percent | 98.4+ | 95.2 | 98.4 | 90.5 | 90.5 | 90.5 | 90.5 | 90.5 | 95.2 | 98.4 | 90.5 |
| Lake Mead rule elev. above which add'l Low. Bas. use assumed | 1190 | 1190 | 1190 | 1190 | 1190 | 1170 | 1190 | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Low. Bas. shortage assumed | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1070 | 1100 | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979 in 1000 AF/Yr. | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after | 9500 | 9500 | 9500 | 9500 | 9500 | 9500 | 9500 | 9200 | 9200 | 9200 | 9800 |
| Upper Basin depletion schedule | Base | Base | Base | Base | Base | Base | Base | Base | Base | Base | Base |
| **Sequence No. 3 - 1916 through 1946 - Depleted Flow (103% of Average)** | | | 11,168 | 11,168 | 11,167 | 11,167 | 11,167 | 11,167 | 11,167 | 11,167 | 11,167 |
| Upper Basin storage | | | | | | | | | | | |
| 31-Year average (1970-2000) | | | 23,765 | 23,623 | 23,553 | 22,947 | 23,553 | 23,983 | 23,983 | 23,983 | 23,055 |
| End of study (Sept. 30, 2000) | | | 17,419 | 16,195 | 16,195 | 15,045 | 16,195 | 17,785 | 17,785 | 17,793 | 14,483 |
| Minimum end-of-year storage | | | 14,404 | 14,401 | 14,399 | 13,074 | 14,399 | 15,260 | 15,260 | 15,260 | 13,364 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | | | 18,961 | 18,824 | 18,794 | 19,210 | 18,794 | 19,209 | 19,209 | 19,210 | 18,313 |
| End of study (Sept. 30, 2000) | | | 14,238 | 13,048 | 13,048 | 11,940 | 13,048 | 14,593 | 14,593 | 14,601 | 11,431 |
| Minimum end-of-year storage | | | 11,491 | 11,488 | 11,486 | 10,280 | 11,486 | 12,267 | 12,267 | 12,267 | 10,569 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | | | 19,276 | 19,413 | 19,401 | 18,739 | 19,401 | 19,947 | 19,947 | 19,949 | 18,787 |
| End of study (Sept. 30, 2000) | | | 12,279 | 13,441 | 13,441 | 12,335 | 13,441 | 15,210 | 15,210 | 15,226 | 11,505 |
| Minimum end-of-year storage | | | 12,279 | 13,441 | 13,441 | 12,181 | 13,441 | 14,715 | 15,210 | 14,715 | 11,505 |
| Releases from Lake Powell | | | 10,348 | 10,393 | 10,369 | 10,422 | 10,369 | 10,306 | 10,306 | 10,305 | 10,439 |
| Upper Basin shortages | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | | | 10,403 | 10,403 | 10,320 | 10,432 | 10,320 | 10,177 | 10,177 | 10,177 | 10,475 |
| Wasted releases from Lake Mead | | | 1,045 | 1,045 | 1,022 | 1,022 | 1,022 | 1,062 | 1,062 | 1,062 | 983 |
| Upper Basin energy | | | 5,953 | 5,961 | 5,949 | 5,936 | 5,949 | 5,942 | 5,942 | 5,943 | 5,953 |
| Lower Basin energy | | | 5,837 | 5,848 | 5,804 | 5,819 | 5,804 | 5,759 | 5,759 | 5,758 | 5,844 |
| Total energy | | | 11,790 | 11,809 | 11,753 | 11,755 | 11,753 | 11,701 | 11,701 | 11,701 | 11,797 |
| Hoover energy @ 83% | | | 4,677 | 4,680 | 4,652 | 4,655 | 4,652 | 4,627 | 4,627 | 4,626 | 4,674 |
| **Sequence No. 6 - 1931 through 1961 - Depleted Flow (86% of Average)** | 9,156 | 9,156 | 9,154 | 9,154 | 9,155 | 9,155 | 9,155 | 9,155 | 9,156 | 9,155 | 9,155 |
| Upper Basin storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 16,586 | 15,205 | 15,542 | 15,170 | 15,178 | 15,178 | 15,165 | 15,992 | 15,992 | 16,242 | 14,450 |
| End of study (Sept. 30, 2000) | 11,951 | 7,267 | 9,187 | 6,808 | 6,807 | 6,807 | 6,729 | 8,604 | 8,604 | 10,343 | 5,532 |
| Minimum end-of-year storage | 8,855 | 7,267 | 8,099 | 6,808 | 6,807 | 6,807 | 6,729 | 8,504 | 8,504 | 8,717 | 5,532 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 13,426 | 12,144 | 12,470 | 12,120 | 12,128 | 12,128 | 12,116 | 12,895 | 12,895 | 13,111 | 11,478 |
| End of study (Sept. 30, 2000) | 9,600 | 5,865 | 7,342 | 5,467 | 5,465 | 5,465 | 5,401 | 7,049 | 7,049 | 8,139 | 4,335 |
| Minimum end-of-year storage | 7,021 | 5,865 | 6,859 | 5,467 | 5,465 | 5,465 | 5,401 | 6,873 | 6,873 | 6,873 | 4,335 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 14,288 | 15,107 | 15,007 | 15,173 | 15,176 | 15,176 | 15,084 | 15,972 | 15,971 | 15,772 | 14,480 |
| End of study (Sept. 30, 2000) | 9,107 | 9,787 | 9,464 | 9,838 | 9,844 | 9,844 | 8,300 | 10,810 | 10,810 | 10,085 | 8,966 |
| Minimum end-of-year storage | 9,107 | 9,787 | 9,464 | 9,838 | 9,844 | 9,844 | 8,300 | 10,810 | 10,810 | 10,085 | 8,968 |
| Releases from Lake Powell | 8,690 | 8,895 | 8,816 | 8,906 | 8,906 | 8,906 | 8,909 | 8,825 | 8,825 | 8,760 | 8,967 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 8,759 | 8,910 | 8,902 | 8,974 | 8,916 | 8,916 | 8,974 | 8,774 | 8,774 | 8,739 | 9,030 |
| Wasted releases from Lake Mead | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Upper Basin energy | 4,855 | 4,863 | 4,844 | 4,864 | 4,865 | 4,865 | 4,866 | 4,881 | 4,881 | 4,861 | 4,842 |
| Lower Basin energy | 4,551 | 4,791 | 4,773 | 4,833 | 4,800 | 4,800 | 4,762 | 4,783 | 4,783 | 4,752 | 4,743 |
| Total energy | 9,406 | 9,664 | 9,617 | 9,694 | 9,665 | 9,665 | 9,628 | 9,664 | 9,664 | 9,613 | 9,585 |
| Hoover energy @ 83% | 3,524 | 3,759 | 3,741 | 3,790 | 3,766 | 3,766 | 3,722 | 3,765 | 3,765 | 3,737 | 3,696 |
| **Sequence No. 8 - 1941 through 1968 - Depleted Flow (93% of Average)** | | | 9,957 | 9,957 | 9,956 | 9,956 | 9,956 | 9,955 | 9,956 | 9,955 | 9,956 |
| Upper Basin storage | | | | | | | | | | | |
| 31-year average (1970-2000) | | | 20,938 | 20,447 | 20,433 | 20,096 | 20,253 | 20,955 | 20,966 | 21,302 | 19,994 |
| End of study (Sept. 30, 2000) | | | 20,041 | 17,651 | 17,637 | 17,532 | 16,437 | 18,799 | 18,883 | 20,295 | 16,986 |
| Minimum end-of-year storage | | | 11,574 | 11,342 | 11,330 | 10,609 | 11,323 | 12,483 | 12,483 | 12,453 | 10,089 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | | | 16,781 | 16,319 | 16,311 | 16,008 | 16,143 | 16,782 | 16,792 | 17,111 | 15,918 |
| End of study (Sept. 30, 2000) | | | 16,106 | 13,776 | 13,763 | 13,658 | 12,607 | 14,901 | 14,982 | 16,288 | 13,109 |
| Minimum end-of-year storage | | | 8,797 | 8,565 | 8,724 | 8,044 | 8,533 | 9,706 | 9,706 | 9,676 | 7,753 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | | | 16,768 | 16,926 | 16,914 | 16,524 | 15,692 | 17,495 | 17,492 | 17,238 | 16,301 |
| End of study (Sept. 30, 2000) | | | 13,764 | 13,810 | 13,795 | 13,592 | 12,626 | 14,915 | 14,995 | 14,817 | 13,153 |
| Minimum end-of-year storage | | | 9,929 | 10,033 | 10,080 | 10,047 | 8,784 | 10,657 | 10,657 | 10,318 | 9,578 |
| Releases from Lake Powell | | | 9,117 | 9,210 | 9,209 | 9,321 | 9,253 | 9,158 | 9,154 | 9,098 | 9,242 |
| Upper Basin shortages | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | | | 8,976 | 9,063 | 9,004 | 9,332 | 9,095 | 8,897 | 8,891 | 8,847 | 9,075 |
| Wasted Releases from Lake Mead | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Upper Basin energy | | | 5,374 | 5,380 | 5,379 | 5,368 | 5,385 | 5,393 | 5,393 | 5,388 | 5,364 |
| Lower Basin energy | | | 4,920 | 4,973 | 4,942 | 4,934 | 4,790 | 4,926 | 4,923 | 4,888 | 4,944 |
| Total energy | | | 10,294 | 10,353 | 10,321 | 10,302 | 10,175 | 10,319 | 10,316 | 10,276 | 10,308 |
| Hoover energy @ 83% | | | 3,879 | 3,923 | 3,899 | 3,937 | 3,737 | 3,894 | 3,892 | 3,867 | 3,892 |
| **Sequence No. 12 - 1961 through 1928 - Depleted Flow (111% of Average)** | | | 12,084 | 12,084 | 12,083 | 12,083 | 12,083 | 12,083 | 12,083 | 12,083 | 12,083 |
| Upper Basin storage | | | | | | | | | | | |
| 31-year average | | | 24,589 | 24,589 | 24,579 | 24,379 | 24,573 | 24,655 | 24,635 | 24,657 | 24,463 |
| End of study (Sept. 30, 2000) | | | 27,070 | 27,070 | 27,068 | 26,101 | 27,068 | 27,287 | 27,287 | 27,288 | 26,832 |
| Minimum end-of-year storage | | | 10,735 | 10,735 | 10,720 | 10,720 | 10,720 | 10,720 | 10,720 | 10,722 | 10,720 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | | | 19,406 | 19,406 | 19,336 | 19,242 | 19,395 | 19,459 | 19,453 | 19,469 | 19,300 |
| End of study (Sept. 30, 2000) | | | 21,127 | 21,127 | 21,125 | 20,216 | 21,125 | 21,344 | 21,344 | 21,345 | 20,839 |
| Minimum end-of-year storage | | | 8,214 | 8,214 | 8,201 | 8,202 | 8,201 | 8,201 | 8,201 | 8,203 | 8,201 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | | | 20,658 | 20,658 | 20,665 | 20,447 | 20,665 | 20,766 | 20,766 | 20,766 | 20,554 |
| End of study (Sept. 30, 2000) | | | 21,164 | 21,164 | 21,163 | 20,252 | 21,163 | 21,391 | 21,391 | 21,393 | 20,925 |
| Minimum end-of-year storage | | | 16,182 | 16,182 | 16,132 | 16,132 | 16,132 | 16,132 | 16,132 | 16,132 | 16,192 |
| Releases from Lake Powell | | | 10,911 | 10,911 | 10,910 | 10,948 | 10,910 | 10,902 | 10,902 | 10,902 | 10,921 |
| Upper Basin shortages | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | | | 10,683 | 10,683 | 10,624 | 10,698 | 10,624 | 10,605 | 10,605 | 10,605 | 10,545 |
| Wasted releases from Lake Mead | | | 791 | 791 | 791 | 739 | 791 | 941 | 941 | 942 | 649 |
| Upper Basin energy | | | 6,338 | 6,338 | 6,337 | 6,354 | 6,337 | 6,330 | 6,330 | 6,330 | 6,347 |
| Lower Basin energy | | | 6,095 | 6,095 | 6,061 | 6,092 | 6,061 | 6,055 | 6,055 | 6,055 | 6,070 |
| Total energy | | | 12,433 | 12,433 | 12,398 | 12,456 | 12,398 | 12,385 | 12,385 | 12,385 | 12,417 |
| Hoover energy @ 83% | | | 4,899 | 4,899 | 4,871 | 4,903 | 4,871 | 4,870 | 4,870 | 4,872 | 4,875 |

## COMPARISON OF TEST STUDIES

October 29, 1969

| CAP Study No. | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum Release from Upper Basin in Million AF/Year | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 |
| Rule curve probability in percent | 95.2 | 98.4 | 95.2 | 90.5 | 98.4 | 98.4+ | 98.4 | 90.5 | 98.4 | 98.4 | 98.4 |
| Lake Mead rule elev. above which add'l Low. Bas. use assumed | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Low. Bas. shortage assumed | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1070 | 1070 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979 in 1000 AF/Yr. | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 | Firm P. | 8400 | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after | 9800 | 9800 | 9500 | 9500 | 9500 | 9500 | Firm P. | 9500 | 9500 | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Base | Base | Ult. | Ult. | Base | Base | Base 1/ | Base 1/ | Base | Rapid |
| **Sequence No. 3 - 1916 through 1946 - Depleted Flow (103% of Average)** | 11,167 | 11,167 | 11,167 | 10,152 | 10,152 | 11,167 | 11,167 | 9,156 | 9,156 | 11,167 | 10,655 |
| Upper Basin storage | | | | | | | | | | | |
| 31-Year average (1970-2000) | 23,055 | 23,416 | 23,553 | 21,329 | 22,636 | 24,559 | 24,575 | 15,153 | 15,529 | 23,695 | 22,771 |
| End of study (Sept. 30, 2000) | 14,483 | 16,798 | 16,195 | 12,834 | 17,379 | 21,310 | 17,680 | 7,006 | 9,439 | 17,417 | 13,810 |
| Minimum end-of-year storage | 13,364 | 13,672 | 14,399 | 11,490 | 11,730 | 16,135 | 16,074 | 7,006 | 8,855 | 14,404 | 12,019 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 18,313 | 18,652 | 18,794 | 17,577 | 18,236 | 19,750 | 19,725 | 12,096 | 12,445 | 18,931 | 18,058 |
| End of study (Sept. 30, 2000) | 11,431 | 13,634 | 13,048 | 10,365 | 14,498 | 18,011 | 14,485 | 5,638 | 7,475 | 14,229 | 10,832 |
| Minimum end-of-year storage | 10,569 | 10,870 | 11,486 | 9,089 | 9,323 | 13,082 | 13,034 | 5,638 | 7,021 | 11,491 | 9,210 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 18,787 | 18,457 | 19,401 | 18,111 | 17,734 | 18,534 | 20,281 | 15,028 | 14,735 | 19,264 | 17,985 |
| End of study (Sept. 30, 2000) | 11,505 | 9,840 | 13,441 | 10,539 | 9,706 | 9,988 | 14,840 | 8,360 | 7,455 | 12,278 | 9,756 |
| Minimum end-of-year storage | 11,505 | 9,840 | 13,441 | 10,539 | 9,706 | 9,988 | 14,840 | 8,360 | 7,455 | 12,278 | 9,756 |
| Releases from Lake Powell | 10,439 | 10,351 | 10,369 | 9,692 | 9,522 | 10,173 | 10,295 | 8,906 | 8,811 | 10,324 | 9,959 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 10,475 | 10,454 | 10,320 | 9,604 | 9,474 | 10,268 | 10,171 | 9,071 | 8,916 | 10,320 | 10,078 |
| Wasted releases from Lake Mead | 983 | 983 | 1,022 | 448 | 449 | 1,022 | 1,317 | 0 | 0 | 1,022 | 926 |
| Upper Basin energy | 5,953 | 5,938 | 5,949 | 5,708 | 5,667 | 5,912 | 5,950 | 4,863 | 4,841 | 5,940 | 5,740 |
| Lower Basin energy | 5,844 | 5,306 | 5,804 | 5,352 | 5,258 | 5,712 | 5,751 | 4,757 | 4,444 | 5,792 | 5,579 |
| Total energy | 11,797 | 11,744 | 11,753 | 11,060 | 10,925 | 11,624 | 11,710 | 9,620 | 9,285 | 11,732 | 11,319 |
| Hoover energy @ 83% | 4,674 | 4,638 | 4,652 | 4,253 | 4,174 | 4,565 | 4,626 | 3,717 | 3,410 | 4,641 | 4,450 |
| **Sequence No. 6 - 1931 through 1961 - Depleted Flow (66% of Average)** | 9,155 | 9,155 | 9,155 | 8,221 | 8,221 | 9,156 | 9,156 | 9,522 | 9,522 | 9,156 | 8,657 |
| Upper Basin storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 14,547 | 15,031 | 15,220 | 10,588 | 12,356 | 16,586 | 15,374 | 19,512 | 19,763 | 15,529 | 16,990 |
| End of study (Sept. 30, 2000) | 5,981 | 8,432 | 7,005 | 2,765 | 6,871 | 11,951 | 9,233 | 10,641 | 12,137 | 9,439 | 8,795 |
| Minimum end-of-year storage | 5,981 | 8,432 | 7,005 | 2,765 | 5,814 | 8,955 | 8,855 | 9,111 | 9,634 | 8,855 | 8,515 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 11,565 | 12,011 | 12,165 | 8,605 | 10,111 | 13,426 | 12,310 | 15,868 | 16,010 | 12,445 | 13,746 |
| End of study (Sept. 30, 2000) | 4,739 | 6,877 | 5,641 | 3,163 | 6,581 | 9,600 | 7,382 | 7,725 | 8,985 | 7,475 | 6,686 |
| Minimum end-of-year storage | 4,739 | 6,873 | 5,641 | 3,163 | 5,022 | 7,021 | 7,021 | 7,103 | 7,564 | 7,021 | 6,686 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 14,456 | 14,139 | 15,166 | 12,076 | 11,086 | 14,288 | 14,230 | 16,896 | 16,783 | 14,954 | 12,307 |
| End of study (Sept. 30, 2000) | 9,056 | 7,658 | 9,801 | 9,102 | 7,364 | 9,107 | 9,427 | 8,233 | 7,699 | 9,468 | 7,380 |
| Minimum end-of-year storage | 9,056 | 7,658 | 9,801 | 9,102 | 7,084 | 9,107 | 9,427 | 8,233 | 7,699 | 9,468 | 7,380 |
| Releases from Lake Powell | 8,943 | 8,855 | 8,896 | 8,429 | 9,220 | 9,606 | 8,622 | 9,035 | 8,979 | 8,811 | 8,305 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 9,010 | 9,051 | 8,910 | 8,386 | 8,277 | 8,759 | 8,877 | 9,029 | 8,994 | 8,840 | 8,486 |
| Wasted releases from Lake Mead | 0 | 0 | 0 | 0 | 0 | 0 | 93 | 0 | 0 | 0 | 0 |
| Upper Basin energy | 4,843 | 4,831 | 4,865 | 4,239 | 4,376 | 4,855 | 4,835 | 5,258 | 5,243 | 4,841 | 4,690 |
| Lower Basin energy | 4,695 | 4,393 | 4,795 | 4,166 | 3,041 | 4,551 | 4,711 | 4,717 | 4,689 | 4,748 | 3,313 |
| Total energy | 9,538 | 9,224 | 9,660 | 8,405 | 7,417 | 9,406 | 9,546 | 9,975 | 9,932 | 9,589 | 8,003 |
| Hoover energy @ 83% | 3,650 | 3,352 | 3,762 | 3,188 | 2,076 | 3,534 | 3,682 | 3,679 | 3,647 | 3,722 | 2,327 |
| **Sequence No. 8 - 1941 through 1908 - Depleted Flow (93% of Average)** | 9,956 | 9,956 | 9,956 | 8,991 | 8,931 | 9,957 | 9,957 | 9,957 | 9,957 | 9,957 | 9,435 |
| Upper Basin storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 20,061 | 20,669 | 20,461 | 14,760 | 16,347 | 21,059 | 20,902 | 20,139 | 20,794 | 20,794 | 19,853 |
| End of study (Sept. 30, 2000) | 17,146 | 19,560 | 17,678 | 12,720 | 17,716 | 23,932 | 20,019 | 16,420 | 19,998 | 19,998 | 17,331 |
| Minimum end-of-year storage | 10,089 | 11,289 | 11,330 | 3,537 | 6,061 | 12,036 | 13,171 | 11,457 | 11,531 | 11,531 | 9,245 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 15,980 | 16,527 | 16,338 | 12,725 | 14,090 | 16,954 | 16,992 | 16,063 | 16,674 | 16,674 | 15,888 |
| End of study (Sept. 30, 2000) | 13,272 | 15,613 | 13,801 | 11,330 | 15,921 | 19,804 | 15,948 | 12,589 | 16,062 | 16,062 | 13,546 |
| Minimum end-of-year storage | 7,753 | 8,512 | 8,553 | 3,936 | 5,674 | 9,259 | 10,394 | 8,513 | 8,754 | 8,754 | 7,135 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 16,365 | 16,005 | 16,394 | 14,306 | 13,523 | 16,483 | 17,029 | 16,622 | 16,226 | 16,682 | 15,435 |
| End of study (Sept. 30, 2000) | 13,315 | 12,294 | 13,335 | 11,346 | 9,215 | 10,655 | 14,866 | 12,606 | 11,491 | 13,809 | 9,762 |
| Minimum end-of-year storage | 9,566 | 9,461 | 10,082 | 9,353 | 8,904 | 9,918 | 9,954 | 8,765 | 7,616 | 9,904 | 9,461 |
| Releases from Lake Powell | 9,235 | 9,138 | 9,207 | 8,727 | 8,510 | 8,958 | 9,104 | 9,234 | 9,098 | 9,098 | 8,706 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 9,064 | 9,012 | 9,001 | 8,513 | 8,380 | 8,873 | 8,859 | 9,079 | 8,992 | 8,899 | 8,687 |
| Wasted Releases from Lake Mead | 2 | 2 | 2 | 0 | 0 | 2 | 244 | 2 | 2 | 2 | 0 |
| Upper Basin energy | 5,368 | 5,368 | 5,331 | 4,723 | 4,884 | 5,312 | 5,389 | 5,374 | 5,362 | 5,362 | 5,131 |
| Lower Basin energy | 4,917 | 4,455 | 4,540 | 4,335 | 3,864 | 4,851 | 4,872 | 4,778 | 4,432 | 4,875 | 4,563 |
| Total energy | 10,285 | 9,823 | 10,321 | 9,059 | 8,748 | 10,163 | 10,261 | 10,152 | 9,794 | 10,237 | 9,694 |
| Hoover energy @ 83% | 3,866 | 3,411 | 3,686 | 3,345 | 2,936 | 3,821 | 3,845 | 3,726 | 3,359 | 3,849 | 3,555 |
| **Sequence No. 12 - 1961 through 1928 - Depleted Flow (111% of Average)** | 12,083 | 12,083 | 12,083 | 11,048 | 11,098 | 12,082 | 12,082 | 10,194 | 10,194 | 12,082 | 11,550 |
| Upper Basin storage | | | | | | | | | | | |
| 31-year average | 24,463 | 24,469 | 24,578 | 22,464 | 22,734 | 24,591 | 24,568 | 17,740 | 18,556 | 24,439 | 24,500 |
| End of study (Sept. 30, 2000) | 26,832 | 26,832 | 27,068 | 26,541 | 26,343 | 27,060 | 27,071 | 22,649 | 22,751 | 27,068 | 28,602 |
| Minimum end-of-year storage | 10,720 | 10,720 | 10,720 | 11,383 | 11,383 | 10,772 | 10,772 | 11,683 | 11,683 | 10,772 | 10,743 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 19,300 | 19,305 | 19,396 | 17,960 | 19,165 | 19,335 | 19,411 | 14,112 | 14,083 | 19,333 | 19,346 |
| End of study (Sept. 30, 2000) | 20,889 | 20,839 | 21,125 | 20,721 | 20,719 | 21,116 | 21,127 | 18,233 | 19,279 | 21,124 | 22,659 |
| Minimum end-of-year storage | 8,201 | 8,201 | 8,201 | 9,141 | 9,177 | 8,254 | 8,254 | 8,916 | 9,012 | 8,254 | 8,225 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 20,554 | 20,581 | 20,665 | 18,913 | 18,654 | 20,522 | 20,583 | 15,072 | 14,860 | 20,624 | 19,757 |
| End of study (Sept. 30, 2000) | 20,925 | 20,925 | 21,163 | 20,736 | 20,754 | 21,134 | 21,164 | [illegible] | 19,540 | 21,162 | 17,074 |
| Minimum end-of-year storage | 16,192 | 16,257 | 16,192 | 14,011 | 13,367 | 15,135 | 15,135 | 9,151 | 7,753 | 15,195 | 16,195 |
| Releases from Lake Powell | 10,921 | 10,921 | 10,910 | 10,141 | 10,135 | 10,868 | 10,897 | 9,321 | 9,263 | 10,957 | 10,289 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 10,645 | 10,644 | 10,755 | 9,749 | 9,752 | 10,602 | 10,605 | 8,977 | 8,689 | 10,692 | 10,166 |
| Wasted releases from Lake Mead | 643 | 651 | 1,314 | 306 | 312 | 777 | 1,159 | 0 | 0 | 777 | 483 |
| Upper Basin energy | 6,347 | 6,347 | 6,337 | 5,999 | 6,001 | 6,329 | 6,316 | 5,818 | 5,557 | 6,329 | 6,073 |
| Lower Basin energy | 6,070 | 6,071 | 6,061 | 5,502 | 5,476 | 6,048 | 6,011 | 4,584 | 4,251 | 6,047 | 5,775 |
| Total energy | 12,417 | 12,418 | 12,398 | 11,501 | 11,477 | 12,377 | 12,327 | 10,002 | 9,808 | 12,376 | 11,848 |
| Hoover energy @ 83% | 4,875 | 4,876 | 4,871 | 4,383 | 4,361 | 4,852 | 4,841 | 3,643 | [illegible] | 4,859 | 4,620 |

1/ Runoff. Sequence 6 is substitued for Sequence 3, 7, for 8, and 9 for 12 in these studies.

TASK FORCE ON OPERATING CRITERIA - COLORADO RIVER - P. L. 90-537 Sheet No. 3

C O M P A R I S O N O F T E S T S T U D I E S October 29, 1969

| CAP Study No. | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Minimum release from Upper Basin in Million AF/Year | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 | 7.5 | 7.5 |
| Rule curve probability in percent | 90.5 | 98.4 | 00.0 | 98.4 | 00.0 | 98.4 | 00.0 | 98.4 | 00.0 | 98.4 | 98.4 |
| Lake Mead rule elev. above which add'l Low. Bas. use assumed | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Low. Bas. shortage assumed | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979 in 1000 AF/Yr. | 9500 | 9500 | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after | 9500 | 9500 | 9500 | 9500 | 9500 | 9200 | 9200 | 9800 | 9800 | 9500 | 9500 |
| Upper Basin depletion schedule | Ult. | Ult. | Base | Base 2/ | Base 2/ | Base 2/ | Base 2/ | Base 2/ | Base 2/ | Rapid | Base |
| Sequence No. 1 - 1916 through 1946 - Depleted Flow (103% of Average) | 10,152 | 10,152 | 11,167 | 10,857 | 10,857 | 10,857 | 10,857 | 10,857 | 10,857 | 10,655 | 11,167 |
| Upper Basin storage | | | | | | | | | | | |
| 31-Year average (1970-2000) | 21,076 | 21,841 | 23,553 | 18,562 | 18,528 | 18,856 | 18,859 | 18,201 | 18,156 | 24,318 | 23,791 |
| End of study (Sept. 30, 2000) | 12,544 | 16,986 | 16,134 | 28,636 | 28,635 | 28,877 | 28,879 | 28,286 | 28,286 | 21,058 | 16,490 |
| Minimum end-of-year storage | 11,011 | 11,282 | 14,399 | 6,353 | 6,357 | 6,353 | 6,357 | 6,353 | 6,357 | 15,671 | 15,282 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 16,955 | 17,648 | 18,794 | 14,596 | 14,564 | 14,834 | 14,837 | 14,318 | 14,273 | 19,540 | 19,005 |
| End of study (Sept. 30, 2000) | 10,075 | 14,116 | 13,040 | 22,905 | 22,905 | 23,040 | 23,042 | 22,725 | 22,726 | 17,774 | 13,327 |
| Minimum end-of-year storage | 8,627 | 8,898 | 11,486 | 4,599 | 4,601 | 4,599 | 4,601 | 4,599 | 4,601 | 12,660 | 12,307 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 17,328 | 16,921 | 19,401 | 16,787 | 16,770 | 17,102 | 17,100 | 16,437 | 16,439 | 17,162 | 19,262 |
| End of study (Sept. 30, 2000) | 10,512 | 9,748 | 13,441 | 22,958 | 22,959 | 23,093 | 23,094 | 22,777 | 22,779 | 6,958 | 13,323 |
| Minimum end-of-year storage | 10,512 | 9,748 | 13,441 | 10,380 | 10,424 | 10,865 | 10,867 | 10,016 | 10,089 | 6,958 | 12,741 |
| Releases from Lake Powell | 9,720 | 9,552 | 10,368 | 9,754 | 9,756 | 9,740 | 9,740 | 9,774 | 9,776 | 9,677 | 10,352 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 9,655 | 9,526 | 10,320 | 9,415 | 9,416 | 9,396 | 9,395 | 9,452 | 9,453 | 9,916 | 10,314 |
| Wasted releases from Lake Mead | 75 | 76 | 1,022 | 180 | 175 | 255 | 255 | 95 | 91 | 927 | 1,024 |
| Upper Basin energy | 5,710 | 5,675 | 5,949 | 5,455 | 5,454 | 5,458 | 5,457 | 5,453 | 5,450 | 5,689 | 5,953 |
| Lower Basin energy | 5,341 | 5,248 | 5,804 | 5,156 | 5,157 | 5,162 | 5,162 | 5,156 | 5,157 | 4,909 | 5,786 |
| Total energy | 11,051 | 10,923 | 11,753 | 10,611 | 10,611 | 10,620 | 10,619 | 10,609 | 10,607 | 10,598 | 11,739 |
| Hoover energy @ 83% | 4,229 | 4,150 | 4,652 | 4,074 | 4,074 | 4,085 | 4,085 | 4,066 | 4,067 | 3,798 | 4,635 |
| Sequence No. 5 - 1931 through 1961 - Depleted Flow (86% of Average) | 8,221 | 8,221 | 9,156 | | | | | | | 8,657 | 9,156 |
| Upper Basin storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 10,497 | 12,356 | 15,165 | | | | | | | 15,369 | 16,042 |
| End of study (Sept. 30, 2000) | 2,671 | 6,871 | 7,081 | | | | | | | 8,736 | 9,142 |
| Minimum end-of-year storage | 2,671 | 5,814 | 7,081 | | | | | | | 8,736 | 9,142 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 8,518 | 10,111 | 12,106 | | | | | | | 12,252 | 12,887 |
| End of study (Sept. 30, 2000) | 3,069 | 6,581 | 5,705 | | | | | | | 6,891 | 7,471 |
| Minimum end-of-year storage | 3,069 | 5,022 | 5,705 | | | | | | | 6,891 | 7,471 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 10,609 | 9,566 | 15,118 | | | | | | | 12,569 | 14,486 |
| End of study (Sept. 30, 2000) | 9,105 | 7,348 | 9,824 | | | | | | | 6,807 | 9,068 |
| Minimum end-of-year storage | 9,105 | 7,113 | 9,824 | | | | | | | 6,807 | 9,068 |
| Releases from Lake Powell | 8,433 | 8,230 | 8,903 | | | | | | | 8,341 | 8,806 |
| Upper Basin shortages | 0 | 0 | 0 | | | | | | | 0 | 0 |
| Total Hoover releases | 8,429 | 8,320 | 8,916 | | | | | | | 8,538 | 8,866 |
| Wasted releases from Lake Mead | 0 | 0 | 0 | | | | | | | 1 | 0 |
| Upper Basin energy | 4,232 | 4,376 | 4,863 | | | | | | | 4,647 | 4,897 |
| Lower Basin energy | 4,103 | 2,913 | 4,796 | | | | | | | 3,768 | 4,670 |
| Total energy | 8,335 | 7,289 | 9,659 | | | | | | | 8,415 | 9,567 |
| Hoover energy @ 83% | 3,123 | 1,947 | 3,762 | | | | | | | 2,777 | 3,642 |
| Sequence No. 6 - 1941 through 1908 - Depleted Flow (93% of Average) | 8,991 | 8,991 | 9,957 | | | | | | | 9,436 | 9,957 |
| Upper Basin storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 12,188 | 15,691 | 20,312 | | | | | | | 20,371 | 20,793 |
| End of study (Sept. 30, 2000) | 12,064 | 17,335 | 17,650 | | | | | | | 22,295 | 18,228 |
| Minimum end-of-year storage | 1,325 | 5,606 | 11,300 | | | | | | | 11,257 | 12,668 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 10,474 | 13,481 | 16,226 | | | | | | | 16,273 | 16,607 |
| End of study (Sept. 30, 2000) | 10,675 | 15,551 | 13,773 | | | | | | | 18,312 | 14,349 |
| Minimum end-of-year storage | 1,725 | 5,295 | 8,523 | | | | | | | 8,480 | 9,811 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 12,361 | 11,089 | 16,839 | | | | | | | 14,988 | 16,658 |
| End of study (Sept. 30, 2000) | 10,689 | 8,757 | 13,807 | | | | | | | 6,838 | 14,368 |
| Minimum end-of-year storage | 9,037 | 8,385 | 10,090 | | | | | | | 6,838 | 9,851 |
| Releases from Lake Powell | 8,831 | 8,538 | 9,188 | | | | | | | 8,519 | 9,158 |
| Upper Basin shortages | - 13 | 0 | 0 | | | | | | | 0 | 0 |
| Total Hoover releases | 8,705 | 8,516 | 8,986 | | | | | | | 8,611 | 8,942 |
| Wasted Releases from Lake Mead | 0 | 0 | 2 | | | | | | | 3 | 2 |
| Upper Basin energy | 4,302 | 4,860 | 5,368 | | | | | | | 5,087 | 5,385 |
| Lower Basin energy | 4,080 | 3,275 | 4,928 | | | | | | | 3,857 | 4,891 |
| Total energy | 8,382 | 8,135 | 10,296 | | | | | | | 8,944 | 10,276 |
| Hoover energy @ 83% | 3,971 | [illegible] | [illegible] | | | | | | | 2,858 | 3,854 |
| Sequence No. 12 - 1961 through 1922 - Depleted Flow (111% of Average) | 11,088 | 11,088 | 12,082 | | | | | | | 11,530 | 12,082 |
| Upper Basin storage | | | | | | | | | | | |
| 31-year average | 21,479 | 22,540 | 24,499 | | | | | | | 24,485 | 24,717 |
| End of study (Sept. 30, 2000) | 26,564 | 26,595 | 27,068 | | | | | | | 28,316 | 27,152 |
| Minimum end-of-year storage | 10,684 | 11,383 | 10,772 | | | | | | | 10,743 | 10,772 |
| Lake Powell storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 17,138 | 18,029 | 19,333 | | | | | | | 19,347 | 19,504 |
| End of study (Sept. 30, 2000) | 20,742 | 20,751 | 21,124 | | | | | | | 22,373 | 21,208 |
| Minimum end-of-year storage | 8,630 | 9,141 | 8,254 | | | | | | | 8,225 | 8,254 |
| Lake Mead storage | | | | | | | | | | | |
| 31-year average (1970-2000) | 17,452 | 17,282 | 20,624 | | | | | | | 19,689 | 20,421 |
| End of study (Sept. 30, 2000) | 20,776 | 20,786 | 21,162 | | | | | | | 17,098 | 21,246 |
| Minimum end-of-year storage | 10,416 | 10,360 | 16,195 | | | | | | | 14,382 | 14,616 |
| Releases from Lake Powell | 10,163 | 10,138 | 10,887 | | | | | | | 10,296 | 10,878 |
| Upper Basin shortages | 0 | 0 | 0 | | | | | | | 0 | 0 |
| Total Hoover releases | 9,815 | 9,794 | 10,602 | | | | | | | 10,175 | 10,598 |
| Wasted releases from Lake Mead | 256 | 268 | 777 | | | | | | | 452 | 778 |
| Upper Basin energy | 5,945 | 6,008 | 6,329 | | | | | | | 6,126 | 6,338 |
| Lower Basin energy | 5,420 | 5,400 | 6,047 | | | | | | | 5,772 | 6,028 |
| Total energy | 11,365 | 11,408 | 12,376 | | | | | | | 11,898 | 12,366 |
| Hoover energy @ 83% | 4,294 | 4,278 | 4,859 | | | | | | | 4,616 | 4,841 |

2/ Sequence is 31-year period, 1953 through 1968 and 1906 through 1920, which contains the lowest initial 12 years of record.

TASK FORCE ON OPERATING CRITERIA - COLORADO RIVER - P. L. 90-537 Sheet No. 4

COMPARISON OF TEST STUDIES October 23, 1969

| CAP Study No. | 45 | 46 | 21R | 25R | 29R |
|---|---|---|---|---|---|
| Minimum Release from Upper Basin in Million AF/year | 7.5 | 7.5 | 8.25 | 8.25 | 8.25 |
| Rule curve probability in percent | 98.4 | 98.4 | 98.4 | 95.7 | 98.4 |
| Lake Mead rule elev. above which add'l Low. Bas. use assumed | 1190 | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Low. Bas. shortage assumed | 1100 | 1100 | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979 in 1000 AF/Yr. | 8400 | 8400 | 8400 | 8400 | FirmP |
| Lake Mead demand - 1980 and after | 9800 | 9200 | 9200 | 9500 | FirmP |
| Upper Basin depletion schedule | Rapid | Rapid | Base | Base | Base |
| Sequence No. 3 - 1916 through 1946 - Depleted Flow (103% of Average) | 10,655 | 10,655 | 11,167 | 11,167 | 11,167 |
| Upper Basin storage | | | | | |
| 31-Year average (1970-2000) | 24,193 | 24,408 | 23,985 | 23,553 | 23,326 |
| End of study (Sept. 30, 2000) | 20,958 | 20,989 | 17,794 | 16,194 | 17,050 |
| Minimum end-of-year storage | 15,554 | 15,593 | 15,260 | 14,399 | 13,906 |
| Lake Powell storage | | | | | |
| 31-year average (1970-2000) | 19,423 | 19,625 | 19,210 | 18,794 | 18,613 |
| End of study (Sept. 30, 2000) | 17,676 | 17,706 | 14,595 | 13,040 | 13,873 |
| Minimum end-of-year storage | 12,551 | 12,587 | 12,267 | 11,486 | 11,054 |
| Lake Mead storage | | | | | |
| 31-year average (1970-2000) | 16,715 | 17,791 | 19,949 | 19,401 | 18,840 |
| End of study (Sept. 30, 2000) | 6,854 | 7,819 | 15,226 | 13,441 | 11,749 |
| Minimum end-of-year storage | 6,854 | 7,819 | 14,715 | 13,441 | 11,749 |
| Releases from Lake Powell | 9,683 | 9,677 | 10,305 | 10,369 | 10,345 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 9,941 | 9,862 | 10,177 | 10,320 | 10,374 |
| Wasted releases from Lake Mead | 888 | 968 | 1,062 | 1,022 | 1,050 |
| Upper Basin energy | 5,688 | 5,690 | 5,943 | 5,949 | 5,942 |
| Lower Basin energy | 4,736 | 5,217 | 5,758 | 5,804 | 5,795 |
| Total energy | 10,424 | 10,907 | 11,701 | 11,753 | 11,737 |
| Hoover energy @ 83% | 3,623 | 4,114 | 4,626 | 4,652 | 4,634 |
| Sequence No. 5 - 1931 through 1961 - Depleted Flow (86% of Average) | 8,657 | 8,657 | 9,156 | 9,156 | 9,156 |
| Upper Basin storage | | | | | |
| 31-year average (1970-2000) | 14,876 | 15,636 | 16,207 | 15,205 | 14,970 |
| End of study (Sept. 30, 2000) | 8,032 | 8,675 | 10,583 | 7,267 | 8,839 |
| Minimum end-of-year storage | 8,032 | 8,675 | 8,855 | 7,267 | 8,839 |
| Lake Powell storage | | | | | |
| 31-year average (1970-2000) | 11,813 | 12,514 | 13,071 | 12,144 | 11,337 |
| End of study (Sept. 30, 2000) | 6,559 | 6,830 | 8,260 | 5,865 | 7,168 |
| Minimum end-of-year storage | 6,559 | 6,830 | 7,021 | 5,865 | 7,021 |
| Lake Mead storage | | | | | |
| 31-year average (1970-2000) | 12,148 | 13,228 | 15,705 | 15,107 | 13,797 |
| End of study (Sept. 30, 2000) | 6,801 | 7,037 | 10,142 | 9,787 | 9,326 |
| Minimum end-of-year storage | 6,801 | 7,037 | 10,142 | 9,787 | 9,326 |
| Releases from Lake Powell | 8,377 | 8,337 | 8,754 | 8,895 | 8,846 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 8,588 | 8,505 | 8,733 | 8,910 | 8,920 |
| Wasted releases from Lake Mead | 0 | 0 | 0 | 0 | 79 |
| Upper Basin energy | 4,637 | 4,663 | 4,856 | 4,863 | 4,822 |
| Lower Basin energy | 3,624 | 3,996 | 4,744 | 4,791 | 4,671 |
| Total energy | 8,261 | 8,659 | 9,600 | 9,654 | 9,493 |
| Hoover energy @ 83% | 2,627 | 3,008 | 3,730 | 3,758 | 3,637 |
| Sequence No. 8 - 1941 through 1908 - Depleted Flow (93% of Average) | 9,436 | 9,436 | 9,957 | 9,957 | 9,957 |
| Upper Basin storage | | | | | |
| 31-year average (1970-2000) | 19,923 | 20,770 | 21,188 | 20,340 | 19,142 |
| End of study (Sept. 30, 2000) | 21,660 | 23,266 | 20,293 | 17,687 | 19,952 |
| Minimum end-of-year storage | 10,501 | 11,844 | 12,449 | 11,300 | 10,587 |
| Lake Powell storage | | | | | |
| 31-year average (1970-2000) | 15,876 | 16,653 | 17,032 | 16,253 | 15,386 |
| End of study (Sept. 30, 2000) | 17,689 | 19,283 | 16,286 | 13,808 | 16,017 |
| Minimum end-of-year storage | 7,970 | 9,067 | 9,672 | 8,523 | 8,029 |
| Lake Mead storage | | | | | |
| 31-year average (1970-2000) | 14,612 | 15,510 | 17,222 | 16,819 | 15,392 |
| End of study (Sept. 30, 2000) | 6,826 | 7,072 | 14,814 | 13,844 | 12,705 |
| Minimum end-of-year storage | 6,826 | 7,072 | 10,315 | 10,090 | 9,902 |
| Releases from Lake Powell | 8,552 | 8,469 | 9,079 | 9,187 | 9,149 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 8,657 | 8,535 | 8,828 | 8,983 | 9,031 |
| Wasted releases from Lake Mead | 1 | 0 | 2 | 2 | 231 |
| Upper Basin energy | 5,076 | 5,089 | 5,377 | 5,370 | 5,300 |
| Lower Basin energy | 3,776 | 4,001 | 4,875 | 4,926 | 4,863 |
| Total energy | 8,852 | 9,090 | 10,252 | 10,296 | 10,163 |
| Hoover energy @ 83% | 2,772 | 3,010 | 3,859 | 3,854 | 3,816 |
| Sequence No. 12 - 1961 through 1928 - Depleted Flow (111% of Average) | 11,530 | 11,530 | 12,082 | 12,082 | 12,082 |
| Upper Basin storage | | | | | |
| 31-year average | 24,366 | 24,592 | 24,582 | 24,499 | 24,332 |
| End of study (Sept. 30, 2000) | 26,312 | 28,313 | 27,263 | 27,068 | 27,071 |
| Minimum end-of-year storage | 10,743 | 10,743 | 10,772 | 10,772 | 10,772 |
| Lake Powell storage | | | | | |
| 31-year average (1970-2000) | 19,257 | 19,427 | 19,402 | 19,333 | 19,193 |
| End of study (Sept. 30, 2000) | 22,369 | 22,370 | 21,345 | 21,124 | 21,127 |
| Minimum end-of-year storage | 8,225 | 8,225 | 8,254 | 8,254 | 8,254 |
| Lake Mead storage | | | | | |
| 31-year average (1970-2000) | 19,469 | 19,933 | 20,731 | 20,624 | 20,182 |
| End of study (Sept. 30, 2000) | 15,837 | 18,228 | 21,383 | 21,162 | 21,164 |
| Minimum end-of-year storage | 14,382 | 14,382 | 16,195 | 16,195 | 15,135 |
| Releases from Lake Powell | 10,298 | 10,294 | 10,879 | 10,837 | 10,891 |
| Upper Basin shortages | 0 | 0 | 0 | 0 | 0 |
| Total Hoover releases | 10,227 | 10,129 | 10,583 | 10,602 | 10,620 |
| Wasted releases from Lake Mead | 339 | 589 | 924 | 727 | 798 |
| Upper Basin energy | 6,134 | 6,113 | 6,320 | 6,329 | 6,340 |
| Lower Basin energy | 5,792 | 5,753 | 6,041 | 6,047 | 6,028 |
| Total energy | 11,926 | 11,866 | 12,361 | 12,375 | 12,368 |
| Hoover energy @ 83% | 4,626 | 4,608 | 4,857 | 4,859 | 4,836 |

## Streamflow Sequences

We had recommended in our Denver meeting that we base the criteria and the test studies only on the 31-year period 1970 through 2000. Our test studies with the one exception previously mentioned are based on this concept.

Initially we selected for study 13 - 31-year continuous sequences or those which began with each fifth year of the 1906-1968 period starting in 1906, and continuing through 1966. For the studies, we assumed 1906 followed 1968 in the streamflow sequences. Two studies (Nos. 14 and 15) were completed with all 13 sequences, but realizing the magnitude of the number of studies which would be necessary using 13 sequences in combination with many other variations in other parameters, we reduced the flow sequences to 4 for the subsequent studies. The four selected sequences are: #3 (1916-1946), #6 (1931-1961), #8 (1941-1908), #12 (1961-1928). These are shown on the graph and provide a representative cross section of sequences which we might reasonably expect during the next 31 years. The first sequence (sequence #3) is about 103% of the 1906-1968 average with higher than average years occurring early in the sequence. The second (sequence #6) is about 86% of average and is the lowest 31-year sequence of record. The third (sequence #8) is about 93% of average or about lower quartile and contains the lowest 4 and 12-year sequences of record. The fourth is 111% of average with below average years occurring early in the sequence. Nearly all studies were run with all four sequences. However, we did run a few studies using the 1953-1920 sequence which is 101% of average and includes the most critical 4 and 12-year sequences at the beginning of the study. The six variables previously identified and included in various computations in our studies are more fully described below:

## Upper Basin Storage Reserve

We have studied five different storage rules in the Upper Basin which would remain inviolate to the extent streamflow is available subject only to the minimum allowable delivery requirement from Lake Powell. The five storage levels were those amounts required to deliver either 7 1/2 or 8 1/4 MAF annually at Lee Ferry during various critical streamflow periods of record using the following streamflow sequences to define the critical periods:

(a) No specific sequence used. No inviolate storage provided.

(b) The sixth lowest in a 63 event sequence having an estimated probability of being exceeded 90.5% of the time.

(c) The third lowest in a 63 event sequence having an estimated probability of being exceeded 95.2% of the time.

(d) The lowest in a 63 event sequences having an estimated probability of being exceeded 98.4% of the time.

(e) Storage requirement defined under (d) above to which was added the amount of storage between the dead storage level and the minimum power level in Upper Basin Reservoirs. (Identified on Table as 98.4+%).

The values of Table 2 (4 sheets) indicate the effect of these rules on various items.

## TABLE 2

### EFFECT OF RULE CURVE

| STUDY NUMBER | 36 | 16 | 25R | 32 | 28 |
|---|---|---|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 0 | 90.5 | 95.2 | 98.4 | 98.4+ |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 | 9500 | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Base | Base | Base | Base |
| Reference to previous paragraph breakdown | (a) | (b) | (c) | (d) | (e) |
| Sequence No. 3 - 1916 through 1946 | | | | | |
| Year 2000 Content, Lake Powell 1000 AF | 13,040 | 13,048 | 13,040 | 14,229 | 18,011 |
| Year 2000 Content, Lake Mead 1000 AF | 13,441 | 13,441 | 13,441 | 12,278 | 9,988 |
| 31-year average in 1000 AF | | | | | |
| Additional Upper Basin Use After 1968 | 1,332 | 1,332 | 1,332 | 1,332 | 1,332 |
| Lake Powell Release | 10,369 | 10,369 | 10,369 | 10,324 | 10,173 |
| Lower Basin Use (Inc. Mexico & Surplus) | 9,217 | 9,217 | 9,217 | 9,217 | 9,165 |
| Lower Basin Waste (Unusable Spill) | 1,022 | 1,022 | 1,022 | 1,022 | 1,022 |
| Lower Basin Uses Above 7 1/2 MAF | 241 | 241 | 241 | 241 | 241 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 0 | 0 | 0 | 0 | 52 |
| 31-year average in MKWH | | | | | |
| Upper Basin Energy | 5,949 | 5,949 | 5,949 | 5,940 | 5,912 |
| Lower Basin Energy | 5,804 | 5,804 | 5,804 | 5,792 | 5,712 |

TABLE 2

EFFECT OF RULE CURVE

| STUDY NUMBER | 36 | 16 | 25R | 32 | 28 |
|---|---|---|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 0 | 90.5 | 95.2 | 98.4 | 98.4+ |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000·AF/Yr. | 8400 | 8400 | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 | 9500 | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Base | Base | Base | Base |
| Reference to previous paragraph breakdown | (a) | (b) | (c) | (d) | (e) |

| | | | | | |
|---|---|---|---|---|---|
| Sequence No. 6 - 1931 through 1961 | | | | | |
| Year 2000 Content, Lake Powell 1000 AF | 5,705 | 5,465 | 5,865 | 7,475 | 9,600 |
| Year 2000 Content, Lake Mead 1000 AF | 9,824 | 9,844 | 9,787 | 9,468 | 9,107 |
| 31-year average in 1000 AF | | | | | |
| Additional Upper Basin Use After 1968 | 1,298 | 1,299 | 1,298 | 1,298 | 1,298 |
| Lake Powell Release | 8,903 | 8,906 | 8,895 | 8,811 | 8,696 |
| Lower Basin Use (Inc. Mexico & Surplus) | 8,916 | 8,916 | 8,910 | 8,840 | 8,759 |
| Lower Basin Waste (Unusable Spill) | 0 | 0 | 0 | 0 | 0 |
| Lower Basin Uses Above 7 1/2 MAF | 0 | 0 | 0 | 0 | 0 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 60 | 60 | 66 | 135 | 217 |
| 31-year average in MKWH | | | | | |
| Upper Basin Energy | 4,863 | 4,865 | 4,863 | 4,841 | 4,855 |
| Lower Basin Energy | 4,796 | 4,800 | 4,791 | 4,748 | 4,551 1/ |

1/ Hoover below elevation 1083 part time from 1998-2000.

TABLE 2

EFFECT OF RULE CURVE

| STUDY NUMBER | 36 | 16 | 25R | 32 | 28 |
|---|---|---|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 0 | 90.5 | 95.2 | 98.4 | 98.4+ |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 | 9500 | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Base | Base | Base | Base |
| Reference to previous paragraph breakdown | (a) | (b) | (c) | (d) | (e) |
| Sequence No. 8 - 1941 through 1908 | | | | | |
| Year 2000 Content, Lake Powell 1000 AF | 13,773 | 13,763 | 13,808 | 16,062 | 19,804 |
| Year 2000 Content, Lake Mead 1000 AF | 13,807 | 13,795 | 13,844 | 13,809 | 10,655 |
| 31-year average in 1000 AF | | | | | |
| Additional Upper Basin Use After 1968 | 1,336 | 1,337 | 1,336 | 1,336 | 1,336 |
| Lake Powell Release | 9,188 | 9,209 | 9,187 | 9,098 | 8,958 |
| Lower Basin Use (Inc. Mexico & Surplus) | 8,951 | 8,965 | 8,948 | 8,864 | 8,838 |
| Lower Basin Waste (Unusable Spill) | 2 | 2 | 2 | 2 | 2 |
| Lower Basin Uses Above 7 1/2 MAF | 71 | 84 | 71 | 71 | 71 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 96 | 93 | 99 | 182 | 209 |
| 31-year average in MKWH | | | | | |
| Upper Basin Energy | 5,368 | 5,379 | 5,370 | 5,362 | 5,312 |
| Lower Basin Energy | 4,928 | 4,942 | 4,926 | 4,875 | 4,851 |

TABLE 2

EFFECT OF RULE CURVE

| STUDY NUMBER | 36 | 16 | 25R | 32 | 28 |
|---|---|---|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 | 8.25 | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 0 | 90.5 | 95.2 | 98.4 | 98.4+ |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 | 9500 | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Base | Base | Base | Base |
| Reference to previous paragraph breakdown | (a) | (b) | (c) | (d) | (e) |
| Sequence No. 12 - 1961 through 1928 | | | | | |
| Year 2000 Content, Lake Powell 1000 AF | 21,124 | 21,125 | 21,124 | 21,124 | 21,116 |
| Year 2000 Content, Lake Mead 1000 AF | 21,162 | 21,163 | 21,162 | 21,162 | 21,154 |
| 31-year average in 1000 AF | | | | | |
| Additional Upper Basin Use After 1968 | 1,425 | 1,424 | 1,425 | 1,425 | 1,425 |
| Lake Powell Release | 10,887 | 10,910 | 10,887 | 10,887 | 10,888 |
| Lower Basin Use (Inc. Mexico & Surplus) | 9,712 | 9,719 | 9,712 | 9,712 | 9,712 |
| Lower Basin Waste (Unusable Spill) | 777 | 791 | 777 | 777 | 777 |
| Lower Basin Uses Above 7 1/2 MAF | 735 | 743 | 735 | 735 | 735 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 0 | 0 | 0 | 0 | 0 |
| 31-year average in MKWH | | | | | |
| Upper Basin Energy | 6,329 | 6,337 | 6,329 | 6,329 | 6,329 |
| Lower Basin Energy | 6,047 | 6,061 | 6,047 | 6,047 | 6,048 |

## Upper Basin Depletions

In the studies Upper Basin depletions are measured at Lee Ferry and include changes in storage at water use project reservoirs.

Two different Upper Basin depletion schedules were considered. One was submitted in our initial draft of data handed out at the Denver meeting and represented the Bureau's estimate of the timing and magnitude of depletions which will occur in the Upper Basin. (Base Depletion).

The second represents the estimates of the individual Upper Basin States and the Upper Colorado River Commission. The graph (Figure 1) shows Upper Basin depletions for both estimates. (Rapid Depletion).

In addition, we have related the year-by-year depletion to the streamflow for the year by using a somewhat smaller than normal depletion in below average runoff years and a higher than normal in years of above average runoff. Our calculations and assumptions for these estimates were furnished you previously. The graphs (Figures 2, 3, 4, and 5) depict the total and normal additional year-by-year depletion and the total and additional year-by-year depletion associated with two specific sequences (Nos. 6 and 12) for both the base rate and the rapid rate of depletion.

As with differing sequences of streamflow, variations in the two Upper Basin depletions show significant ranges of values of energy production, terminal storage, and Lower Basin uses and waste as shown in Table 3 (2 Sheets).

The comparison in Table 3 shows that a more rapid rate of depletion in the Upper Basin will reduce water and power available in the Lower Basin and power in the Upper Basin.

TABLE 3

EFFECT OF RATE OF INCREASE IN UPPER BASIN DEPLETIONS

| STUDY NUMBER | 32 | 33 |
|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 98.4 | 98.4 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Rapid |

| Sequence No. 6 - 1931 through 1961 | | |
|---|---|---|
| Year 2000 Content, Lake Powell 1000 AF | 7,475 | 6,686 |
| Year 2000 Content, Lake Mead 1000 AF | 9,468 | 7,380 |
| <u>31-year average in 1000 AF</u> | | |
| Additional Upper Basin Use After 1968 | 1,298 | 1,797 |
| Lake Powell Release | 8,811 | 8,305 |
| Lower Basin Use (Inc. Mexico & Surplus) | 8,840 | 8,486 |
| Lower Basin Waste (Unusable Spill) | 0 | 0 |
| Lower Basin Uses Above 7 1/2 MAF | 0 | 0 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 135 | 490 |
| <u>31-year average in MKWH</u> | | |
| Upper Basin Energy | 4,841 | 4,690 |
| Lower Basin Energy | 4,748 | 3,313 1/ |

1/ Hoover below elevation 1083 from 1990 - 2000.

Graph 1

# COLORADO RIVER AT GLEN CANYON
## 1968 MODIFIED FLOW
## AVERAGE ANNUAL FLOW FOR PERIOD

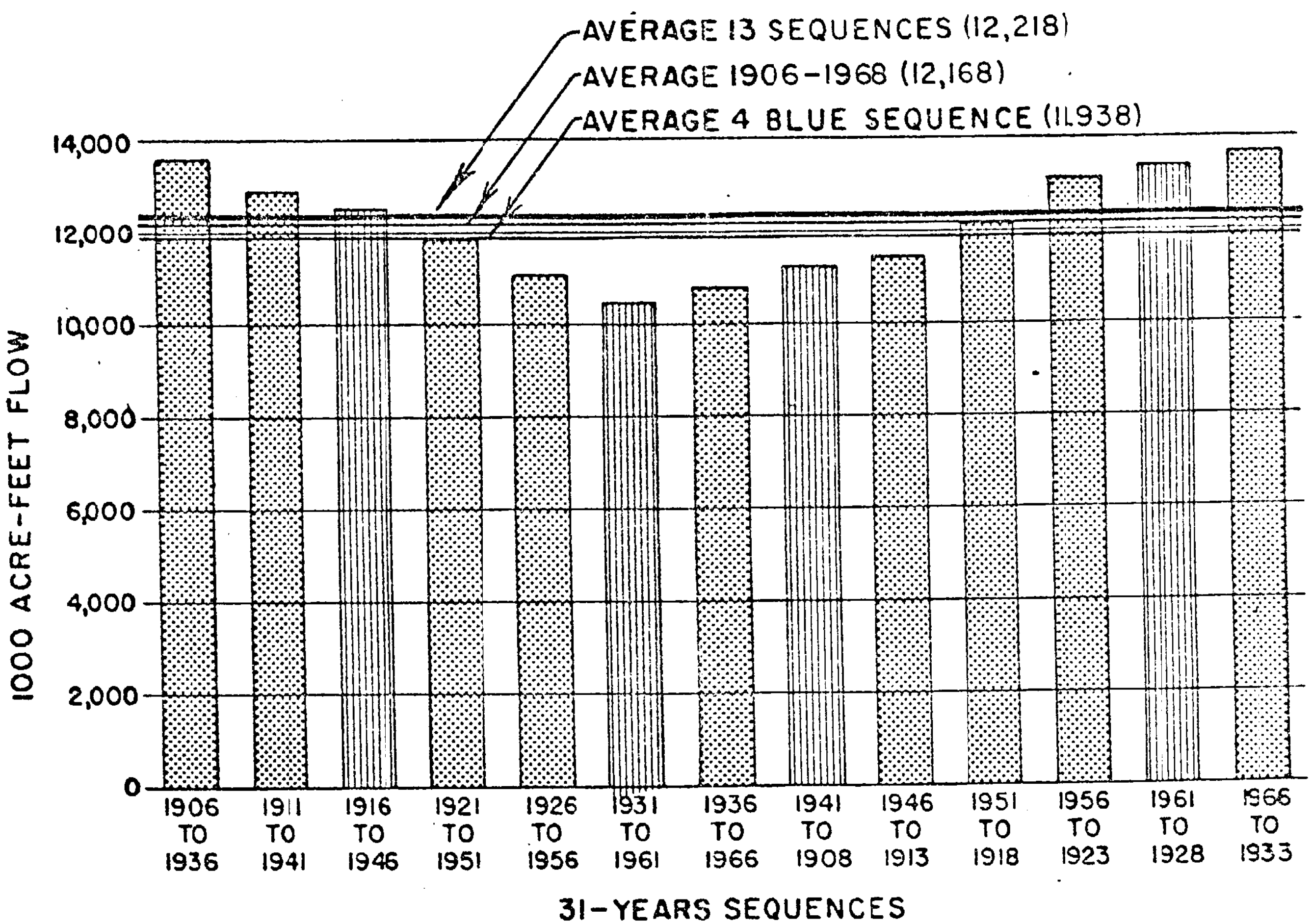
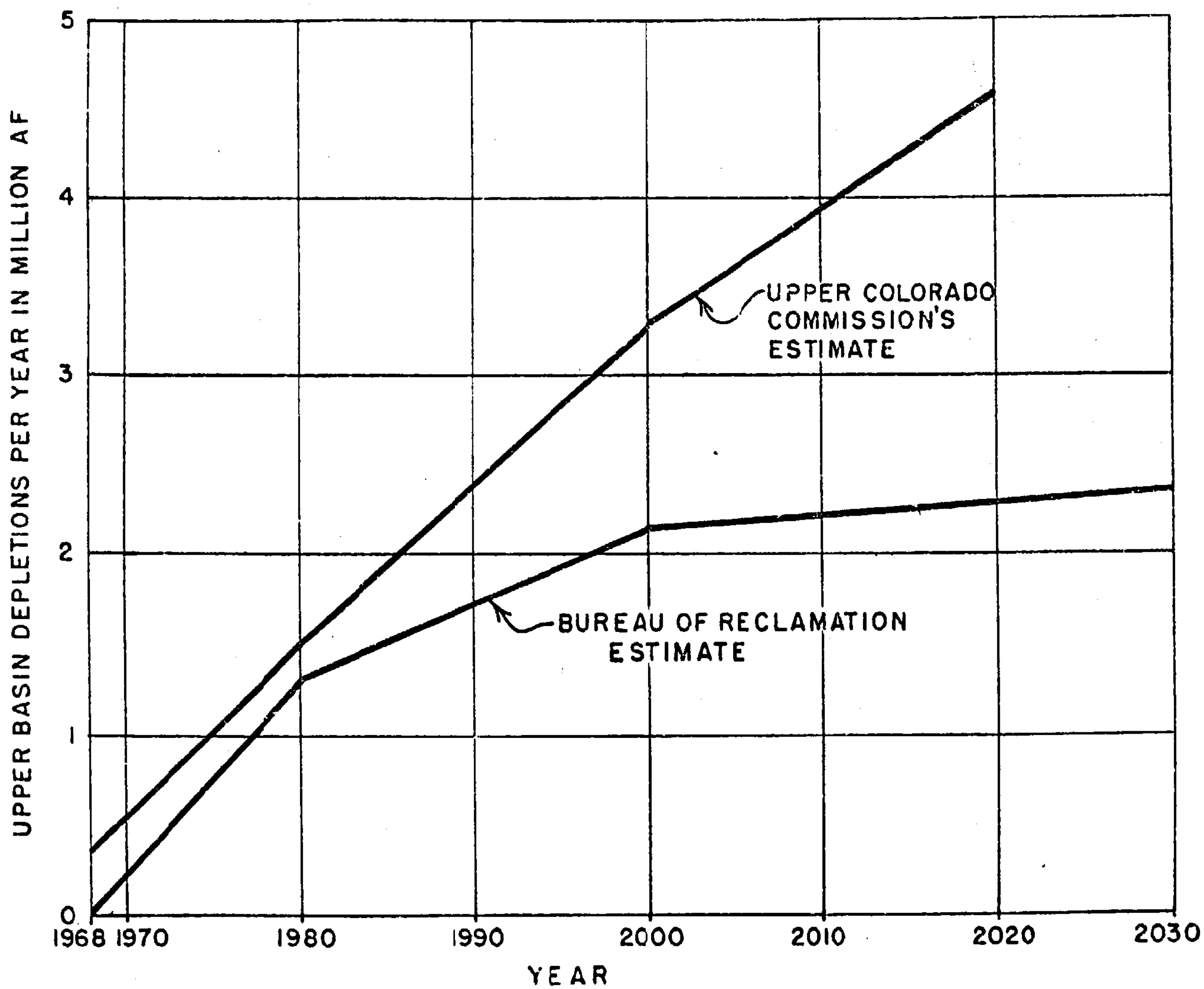


FIG. 1

UPPER BASIN DEPLETIONS




NOTES

TABLE 3

EFFECT OF RATE OF INCREASE IN UPPER BASIN DEPLETIONS

| STUDY NUMBER | 32 | 33 |
|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 98.4 | 98.4 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Rapid |

| | | |
|---|---|---|
| Sequence No. 12 - 1961 through 1928 | | |
| Year 2000 Content, Lake Powell 1000 AF | 21,124 | 22,659 |
| Year 2000 Content, Lake Mead 1000 AF | 21,162 | 17,074 |
| 31-year average in 1000 AF | | |
| Additional Upper Basin Use After 1968 | 1,425 | 1,977 |
| Lake Powell Release | 10,887 | 10,288 |
| Lower Basin Use (Inc. Mexico & Surplus) | 9,712 | 9,592 |
| Lower Basin Waste (Unusable Spill) | 777 | 483 |
| Lower Basin Uses Above 7 1/2 MAF | 735 | 615 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 0 | 0 |
| 31-year average in MKWH | | |
| Upper Basin Energy | 6,329 | 6,073 |
| Lower Basin Energy | 6,047 | 5,775 |

## Lower Basin Uses and Losses

After several meetings to attempt to resolve the issue of Lower Basin losses and consumptive use assignments, the States of the Lower Division on the committee recommended that we base the test studies on a normal release of 8.4 MAF at Lake Mead for 1970 - 1979 and a normal release of 9.5 MAF thereafter.

Since 9.5 MAF normal release after 1975 was not acceptable to all concerned, it was suggested that the normal release after 1979 be broadened to include three possibilities: 9.2, 9.5, and 9.8 MAF. The studies shown in Table 4 reflect these three conditions.

## Minimum Release from Lake Powell

Two different minimum releases at Lee Ferry have been used in the studies - 7 1/2 MAF and 8 1/4 MAF. A comparison of several parameters for comparable studies using the two releases and two rates of Upper Basin depletion are shown in Table 5.

## Level of Lake Mead above Which Additional Lower Basin Use is Assumed

A comparison of the results of studies 16 and 17 shown in Table 6 for sequences 6 and 12 indicates the magnitude of the change in the various parameters that would be associated with lowering the Lake Mead level from elevation 1190 to 1170 at which water deliveries for Lower Basin uses above 7.5 MAF would be made.

## Level of Lake Mead below Which Shortages in Arizona Diversions are Assumed

Similarly, a comparison of the results of studies 16 and 18 shown in Table 7 for sequences 6 and 8 indicates the magnitude of changes that would be associated with lowering the Lake Mead level from elevation 1100 to 1070 at which water deliveries to Arizona would be reduced below 2.8 MAF.

TABLE 4

EFFECT OF RELEASES FROM LAKE MEAD

| STUDY NUMBER | 24 | 32 | 21R |
|---|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 98.4 | 98.4 | 98.4 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979; 1000 AF/Yr. | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after | 9800 | 9500 | 9200 |
| Upper Basin depletion schedule | Base | Base | Base |
| Sequence No. 6 - 1931 through 1961 | | | |
| Year 2000 Content, Lake Powell 1000 AF | 6,877 | 7,475 | 8,260 |
| Year 2000 Content, Lake Mead 1000 AF | 7,658 | 9,468 | 10,142 |
| 31-year average in 1000 AF | | | |
| Additional Upper Basin Use After 1968 | 1,299 | 1,298 | 1,298 |
| Lake Powell Release | 8,855 | 8,811 | 8,754 |
| Lower Basin Use (Inc. Mexico & Surplus) | 9,051 | 8,840 | 8.733 |
| Lower Basin Waste (Unusable Spill) | 0 | 0 | 0 |
| Lower Basin Uses Above 7 1/2 MAF | 0 | 0 | 0 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 129 | 135 | 40 |
| 31-year average in MKWH | | | |
| Upper Basin Energy | 4,831 | 4,841 | 4,856 |
| Lower Basin Energy | 4,393 1/ | 4,748 | 4,744 |

1/ Hoover below elevation 1083 from 1997 - 2000.

TABLE 4

EFFECT OF RELEASES FROM LAKE MEAD

| STUDY NUMBER | 22 | 16 | 19 |
|---|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 90.5 | 90.5 | 90.5 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9800 | 9500 | 9200 |
| Upper Basin depletion schedule | Base | Base | Base |
| Reference to previous paragraph breakdown | | | |
| Sequence No. 6 - 1931 through 1961 | | | |
| Year 2000 Content, Lake Powell 1000 AF | 4,335 | 5,467 | 7,049 |
| Year 2000 Content, Lake Mead 1000 AF | 8,968 | 9,844 | 10,810 |
| 31-year average in 1000 AF | | | |
| Additional Upper Basin Use After 1968 | 1,299 | 1,299 | 1,299 |
| Lake Powell Release | 8,967 | 8,906 | 8,826 |
| Lower Basin Use (Inc. Mexico & Surplus) | 9,030 | 8,916 | 8,774 |
| Lower Basin Waste (Unusable Spill) | 0 | 0 | 0 |
| Lower Basin Uses Above 7 1/2 MAF | 0 | 0 | 0 |
| Lower Basin Shortage in 7 1/2 MAF ( CAP) | 150 | 60 | 0 |
| 31-year average in MKWH | | | |
| Upper Basin Energy | 4,842 | 4,865 | 4,881 |
| Lower Basin Energy | 4,743 | 4,800 | 4,783 |

TABLE 5

EFFECT OF MINIMUM RELEASE TO LOWER BASIN

| STUDY NUMBER | 44 | 43 | 32 | 33 |
|---|---|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 7.5 | 7.5 | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 98.4 | 98.4 | 98.4 | 98.4 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Rapid | Base | Rapid |

| Sequence No. 3 - 1916 through 1946 | | | | |
|---|---|---|---|---|
| Year 2000 Content, Lake Powell 1000 AF | 13,327 | 17,774 | 14,229 | 10,832 |
| Year 2000 Content, Lake Mead 1000 AF | 13,323 | 6,958 | 12,278 | 9,756 |
| 31-year average in 1000 AF | | | | |
| Additional Upper Basin Use After 1968 | 1,332 | 1,844 | 1,332 | 1,844 |
| Lake Powell Release | 10,352 | 9,677 | 10,324 | 9,959 |
| Lower Basin Use (Inc. Mexico & Surplus) | 9,212 | 8,910 | 9,217 | 9,072 |
| Lower Basin Waste (Unusable Spill) | 1,024 | 927 | 1,022 | 926 |
| Lower Basin Uses Above 7 1/2 MAF | 235 | 239 | 241 | 232 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 0 | 305 | 0 | 136 |
| 31-year average in MKWH | | | | |
| Upper Basin Energy | 5,953 | 5,689 | 5,940 | 5,740 |
| Lower Basin Energy | 5,786 | 4,909 1/ | 5,792 | 5,579 |

1/ Hoover below elevation 1083 from 1996 - 2000.

TABLE 5

EFFECT OF MINIMUM RELEASE TO LOWER BASIN

| STUDY NUMBER | 44 | 43 | 32 | 33 |
|---|---|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 7.5 | 7.5 | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 98.4 | 98.4 | 98.4 | 98.4 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Rapid | Base | Rapid |
| Sequence No. 6 - 1931 through 1961 | | | | |
| Year 2000 Content, Lake Powell 1000 AF | 7,471 | 6,891 | 7,475 | 6,686 |
| Year 2000 Content, Lake Mead 1000 AF | 9,068 | 6,807 | 9,468 | 7.380 |
| 31-year average in 1000 AF | | | | |
| Additional Upper Basin Use After 1968 | 1,298 | 1,797 | 1,298 | 1,797 |
| Lake Powell Release | 8,806 | 8,341 | 8,811 | 8,305 |
| Lower Basin Use (Inc. Mexico & Surplus) | 8,866 | 8,538 | 8,840 | 8,486 |
| Lower Basin Waste (Unusable Spill) | 0 | 1 | 0 | 0 |
| Lower Basin Uses Above 7 1/2 MAF | 0 | 0 | 0 | 0 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 109 | 438 | 135 | 490 |
| 31-year average in MKWH | | | | |
| Upper Basin Energy | 4,897 | 4,647 | 4,841 | 4,690 |
| Lower Basin Energy | 4,670 | 3,768 1/ | 4,748 | 3,313 2/ |

1/ Hoover below elevation 1083 from 1993 - 2000.
2/ Hoover below elevation 1083 from 1990 - 2000.

TABLE 6

EFFECT OF LEVEL ABOVE WHICH ADDITIONAL LOWER BASIN USE IS ASSUMED

| STUDY NUMBER | 16 | 17 |
|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 90.5 | 90.5 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1170 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Base |

| Sequence No. 6 | | |
|---|---|---|
| Year 2000 Content, Lake Powell 1000 AF | 5,465 | 5,465 |
| Year 2000 Content, Lake Mead 1000 AF | 9,844 | 9,844 |
| 31-year average in 1000 AF | | |
| Additional Upper Basin Use After 1968 | 1,299 | 1,299 |
| Lake Powell Release | 8,906 | 8,906 |
| Lower Basin Use (Inc. Mexico & Surplus) | 8,916 | 8,916 |
| Lower Basin Waste (Unusable Spill) | 0 | 0 |
| Lower Basin Uses Above 7 1/2 MAF | 0 | 0 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 60 | 60 |
| 31-year average in MKWH | | |
| Upper Basin Energy | 4,865 | 4,865 |
| Lower Basin Energy | 4,800 | 4,800 |
| 31-year average in MW-Yr. | | |
| Upper Basin Capability | 1,264 | 1,264 |
| Lower Basin Capability | 1,595 | 1,593 |

TABLE 6

EFFECT OF LEVEL ABOVE ~~WHICH~~ ADDITIONAL LOWER BASIN USE IS ASSUMED

| STUDY NUMBER | 16 | 17 |
|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 90.5 | 90.5 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1170 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 |
| Lake Mead demand - 1980 and after, 1000 AF/Yr. | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Base |

| Sequence No. 12 | | |
|---|---|---|
| Year 2000 Content, Lake Powell 1000 AF | 21,125 | 20,216 |
| Year 2000 Content, Lake Mead 1000 AF | 21,163 | 20,252 |
| 31-year average in 1000 AF | | |
| Additional Upper Basin Use After 1968 | 1,424 | 1,424 |
| Lake Powell Release | 10,910 | 10,948 |
| Lower Basin Use (Inc. Mexico & Surplus) | 9,719 | 9,857 |
| Lower Basin Waste (Unusable Spill) | 791 | 738 |
| Lower Basin Uses Above 7 1/2 MAF | 743 | 880 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 0 | 0 |
| 31-year average in MKWH | | |
| Upper Basin Energy | 6,337 | 6,364 |
| Lower Basin Energy | 6,061 | 6,092 |
| 31-year average in MW-Yr. | | |
| Upper Basin Capability | 1,344 | 1,344 |
| Lower Basin Capability | 1,626 | 1,626 |

TABLE 7

EFFECT OF LEVEL OF LAKE MEAD BELOW WHICH SHORTAGE IN ARIZONA DIVERSIONS ARE ASSUMED

| STUDY NUMBER | 16 | 18 |
|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 90.5 | 90.5 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1070 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | 8400 |
| Lake Mead demand - 1980 and after | 9500 | 9500 |
| Upper Basin depletion schedule | Base | Base |

1/ Hoover below elevation 1083 during 1997.

| Sequence No. 8 - 1941 through 1908 | | |
|---|---|---|
| Year 2000 Content, Lake Powell 1000 AF | 13,763 | 12,607 |
| Year 2000 Content, Lake Mead 1000 AF | 13,795 | 12,626 |
| 31-year average in 1000 AF | | |
| Additional Upper Basin Use After 1968 | 1,337 | 1,337 |
| Lake Powell Release | 9,209 | 9,253 |
| Lower Basin Use (Inc. Mexico & Surplus) | 8,965 | 9,058 |
| Lower Basin Waste (Unusable Spill) | 2 | 2 |
| Lower Basin Uses Above 7 1/2 MAF | 84 | 84 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 93 | 3 |
| 31-year average in MKWH | | |
| Upper Basin Energy | 5,379 | 5,385 |
| Lower Basin Energy | 4,942 | 4,790 1/ |
| 31-year average in MW-Yr. | | |
| Upper Basin Capability | 1,333 | 1,329 |
| Lower Basin Capability | 1,568 | 1,447 |

TABLE 8

EFFECT OF GENERATING FIRM ENERGY AT HOOVER

| STUDY NUMBER | 32 | 29R |
|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 98.4 | 98.4 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | Firm Power 1/ |
| Lake Mead demand - 1980 and after | 9500 | Firm Power 1/ |
| Upper Basin depletion schedule | Base | Base |
| Sequence No. 6 - 1931 through 1961 | | |
| Year 2000 Content, Lake Powell 1000 AF | 7,475 | 7,168 |
| Year 2000 Content, Lake Mead 1000 AF | 9,468 | 9,326 |
| 31-year average in 1000 AF | | |
| Additional Upper Basin Use After 1968 | 1,298 | 1,298 |
| Lake Powell Release | 8,811 | 8,846 |
| Lower Basin Use (Inc. Mexico & Surplus) | 8,840 | 8,832 |
| Lower Basin Waste (Unusable Spill) | 0 | 79 |
| Lower Basin Uses Above 7 1/2 MAF | 0 | 33 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 135 | 177 |
| 31-year average in MKWH | | |
| Upper Basin Energy | 4,841 | 4,822 |
| Lower Basin Energy | 4,748 | 4,671 |

1/ Firm Power through 1987 at 83% efficiency.

TABLE 8

EFFECT OF GENERATING FIRM ENERGY AT HOOVER

| STUDY NUMBER | 32 | 29R |
|---|---|---|
| Minimum Release from Upper Basin Mil.AF/Yr. | 8.25 | 8.25 |
| Upper Basin Rule Curve Probability, percent | 98.4 | 98.4 |
| Lake Mead rule elev. above which additional Lower Basin use assumed | 1190 | 1190 |
| Lake Mead rule elev. below which Lower Basin shortage assumed | 1100 | 1100 |
| Lake Mead demand - 1970 thru 1979, 1000 AF/Yr. | 8400 | Firm Power [1] |
| Lake Mead demand - 1980 and after | 9500 | Firm Power [1] |
| Upper Basin depletion schedule | Base | Base |

| | | |
|---|---|---|
| Sequence No. 8 - 1941 through 1908 | | |
| Year 2000 Content, Lake Powell 1000 AF | 16,062 | 16,017 |
| Year 2000 Content, Lake Mead 1000 AF | 13,809 | 12,705 |
| <u>31-year average in 1000 AF</u> | | |
| Additional Upper Basin Use After 1968 | 1,336 | 1,336 |
| Lake Powell Release | 9,098 | 9,149 |
| Lower Basin Use (Inc. Mexico & Surplus) | 8,864 | 8,766 |
| Lower Basin Waste (Unusable Spill) | 2 | 231 |
| Lower Basin Uses Above 7 1/2 MAF | 71 | 48 |
| Lower Basin Shortage in 7 1/2 MAF (CAP) | 182 | 258 |
| <u>31-year average in MKWH</u> | | |
| Upper Basin Energy | 5,362 | 5,300 |
| Lower Basin Energy | 4,875 | 4,863 |

1/ Firm power through 1987 at 83% efficiency.

## Firm Energy Generation at Hoover Powerplant

A comparison of studies similar except for power production at Lake Mead is shown on Table 8. Study 29R shows the results of generating firm energy at Hoover from 1970 through 1987 and is compared to the base study 32.

## Sequences Containing the Lowest Streamflows during the early years

Although the 1931-1961 sequence is the lowest in terms of total runoff for the entire period of all the possible sequences, the 1953-1920 sequence contains less total runoff in the early years. Since this might indicate a problem in maintaining power production at Glen Canyon during the next few years, we ran one study with the following parameters to check this possibility. A comparison with the Base Study (#32) is shown on Table 9.

Table 9

| Values for 31-year period (1970-2000) | Study 32 | Study 37 |
|---|---|---|
| Minimum level Lake Powell - 1000 AF | 5,582 | 4,017 |
| Minimum level Lake Mead - 1000 AF | 9,291 | 9,990 |
| Average Energy, Upper Basin (MKWH) | 4,841 | 5,455 |
| Average Energy, Lower Basin (MKWH) | 4,748 | 5,156 |
| Average Release, Lake Powell - 1000 AF | 8,811 | 9,754 |
| Average Release, Lake Mead - 1000 AF | 8,840 | 9,415 |
| 31-Year Average 1968 Modified Flow at Glen Canyon | 10,454 | 12,263 |

## Studies to Reflect Depletion Conditions after Year 2000

At the request of Mr. Holburt, we ran four studies with four streamflow sequences each for the year 2001 to 2031 period to demonstrate the effect of the criteria after year 2000. One of these studies (Number 34) using sequence 8 indicated an Upper Basin shortage of 426,000 acre-feet in the twenty-sixth year of the study. This was the only Upper Basin shortage imposed by the criteria found in all of the 146 studies that were made.

## Withdrawals of Water from below Elevation 1083' at Hoover

Withdrawals of water below elevation 1083' at Hoover occur in 159 years in twenty-five study sequences. These withdrawals occurred three times using sequence 3, 11 times using sequence 6, two times using sequence 7, 8 times in sequence 8, one time in sequence 9, and no time in sequence 12.

## Graphs

We have included a few graphs to illustrate some of the parameters that have been studied and included in the tables. Copies of these are attached.

FIG. 2

## UPPER BASIN DEPLETION

(UPPER COLORADO RIVER COMMISSION ESTIMATE)

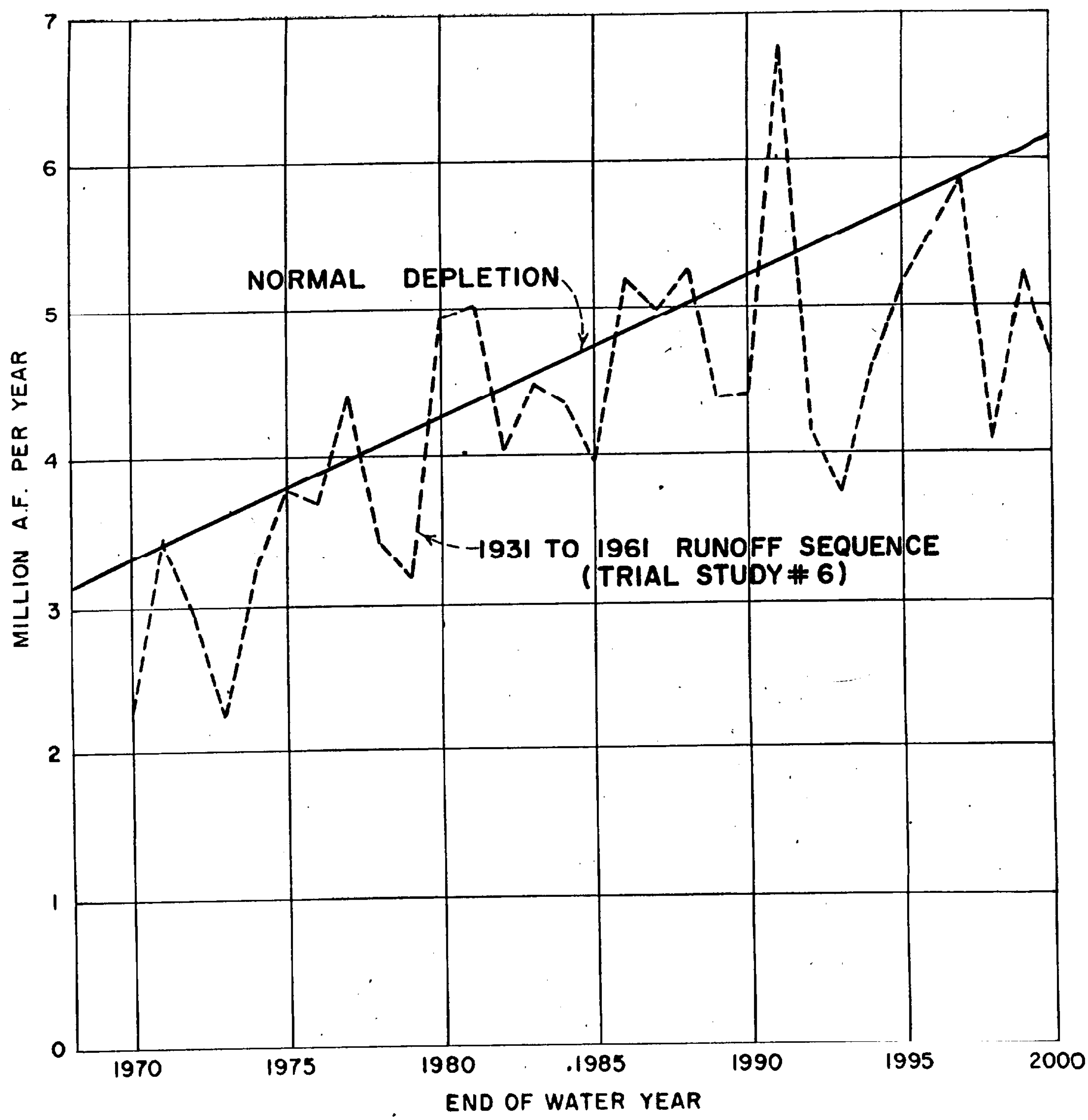


FIG. 3

## UPPER BASIN DEPLETION

(UPPER COLORADO RIVER COMMISSION ESTIMATE)

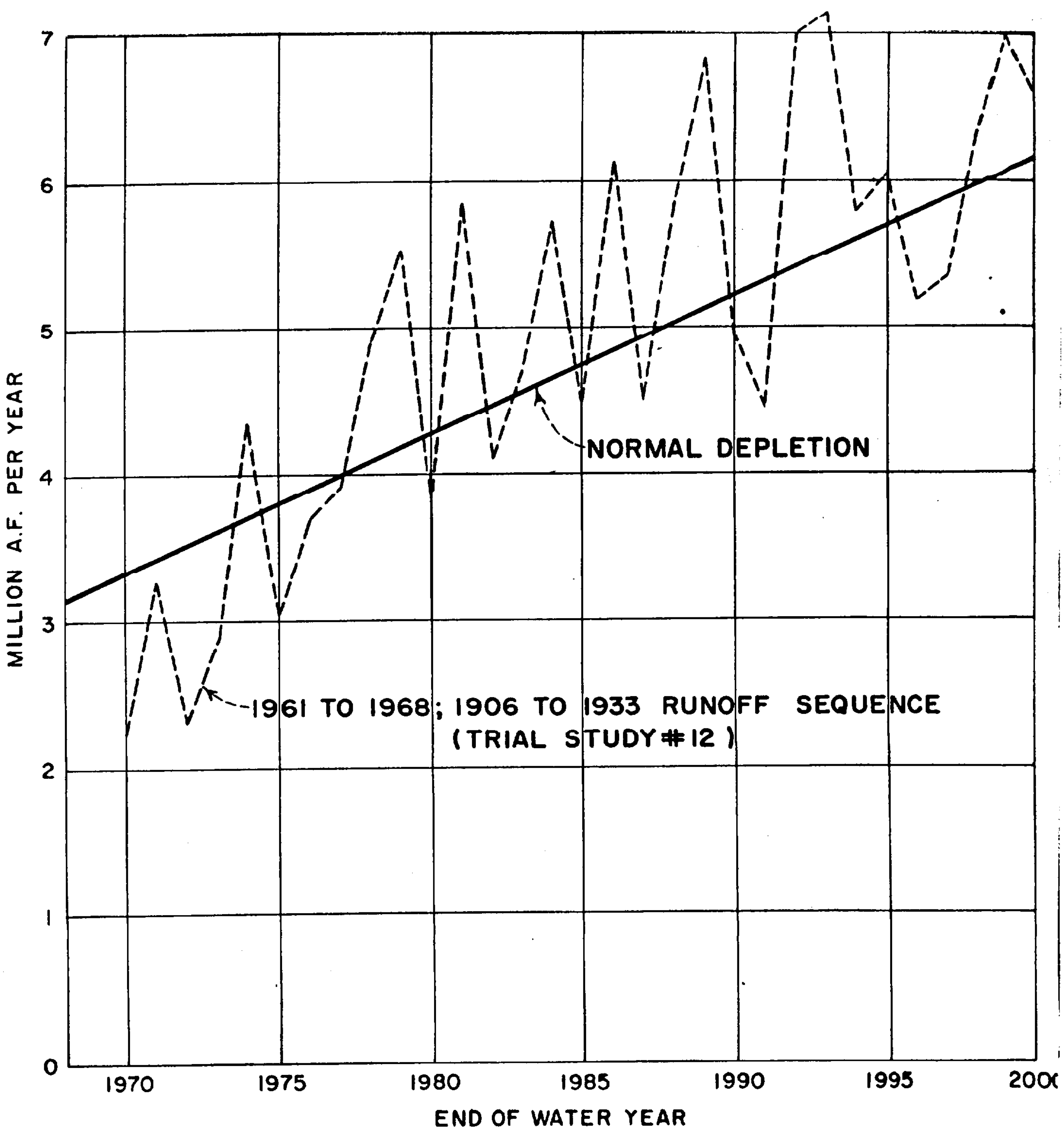


FIG. 4

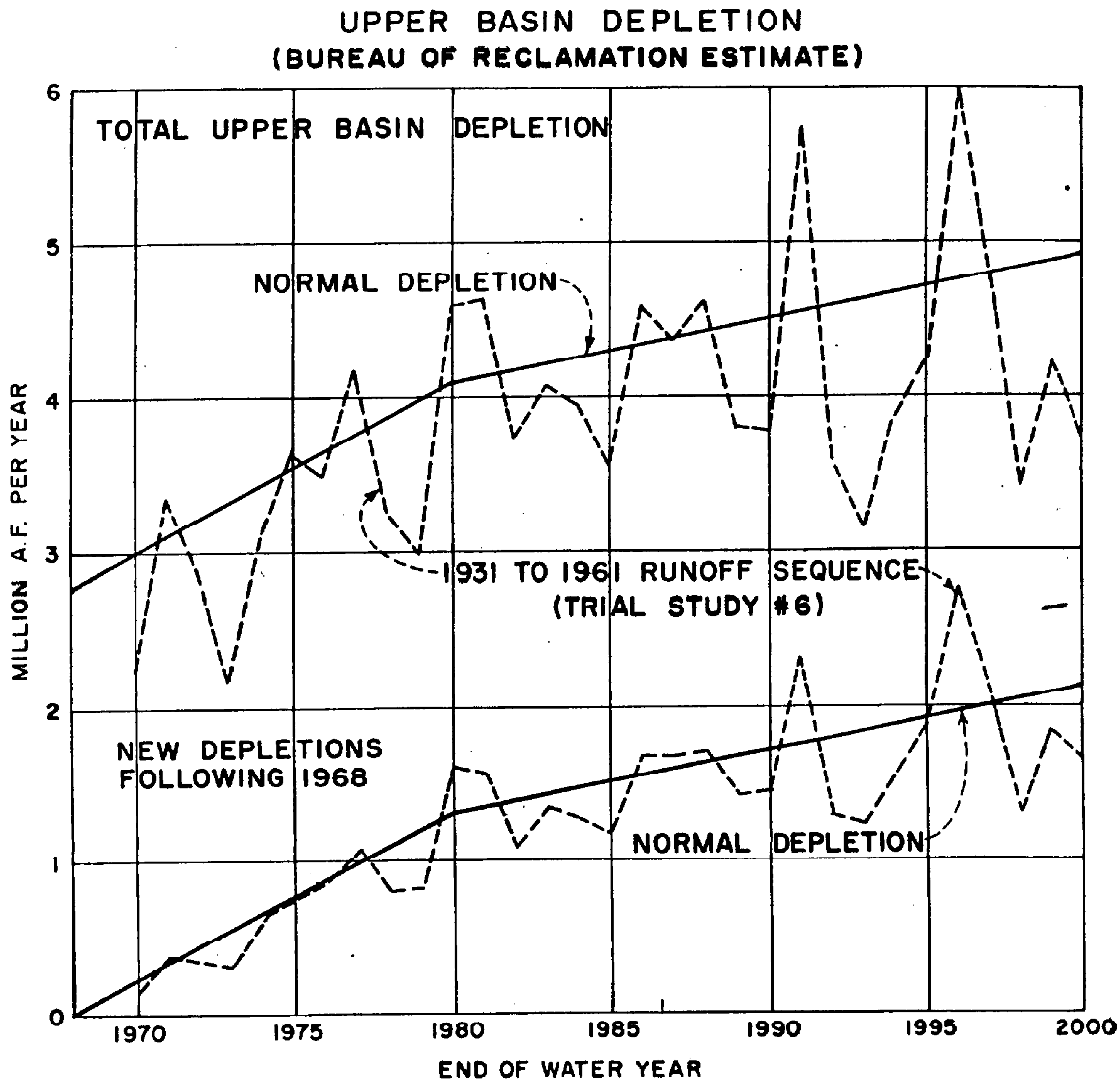
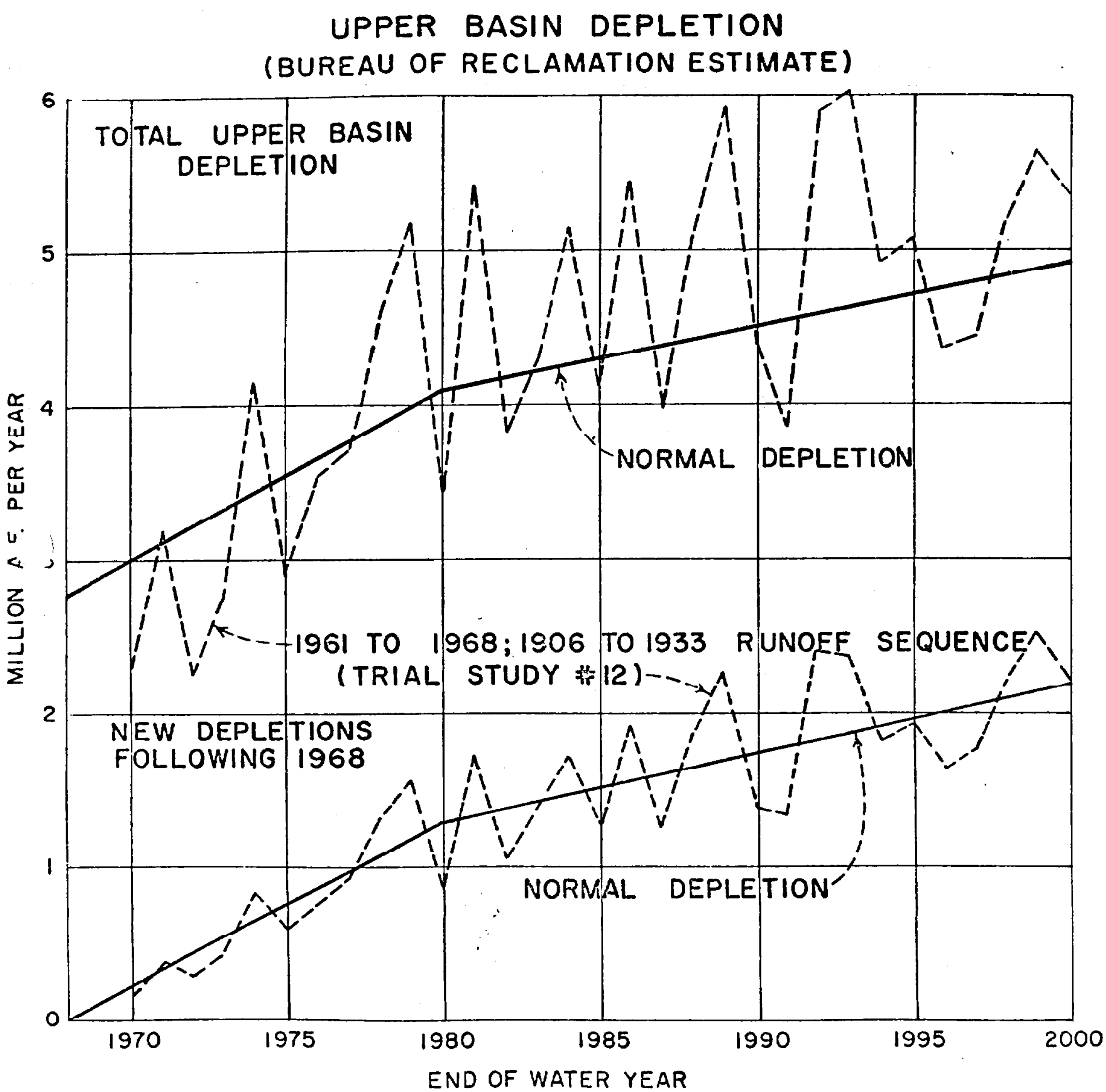

UPPER BASIN DEPLETION
(BUREAU OF RECLAMATION ESTIMATE)
TOTAL UPPER BASIN DEPLETION
NORMAL DEPLETION
1931 TO 1961 RUNOFF SEQUENCE
(TRIAL STUDY #6)
NEW DEPLETIONS
FOLLOWING 1968
NORMAL DEPLETION
MILLION A.F. PER YEAR
0
1
2
3
4
5
6
1970
1975
1980
1985
1990
1995
2000
END OF WATER YEAR

FIG. 5


UPPER BASIN DEPLETION
(BUREAU OF RECLAMATION ESTIMATE)
TOTAL UPPER BASIN DEPLETION
NORMAL DEPLETION
1961 TO 1968; 1906 TO 1933 RUNOFF SEQUENCE
(TRIAL STUDY # 12)
NEW DEPLETIONS FOLLOWING 1968
NORMAL DEPLETION
MILLION A.F. PER YEAR
0
1
2
3
4
5
6
1970
1975
1980
1985
1990
1995
2000
END OF WATER YEAR

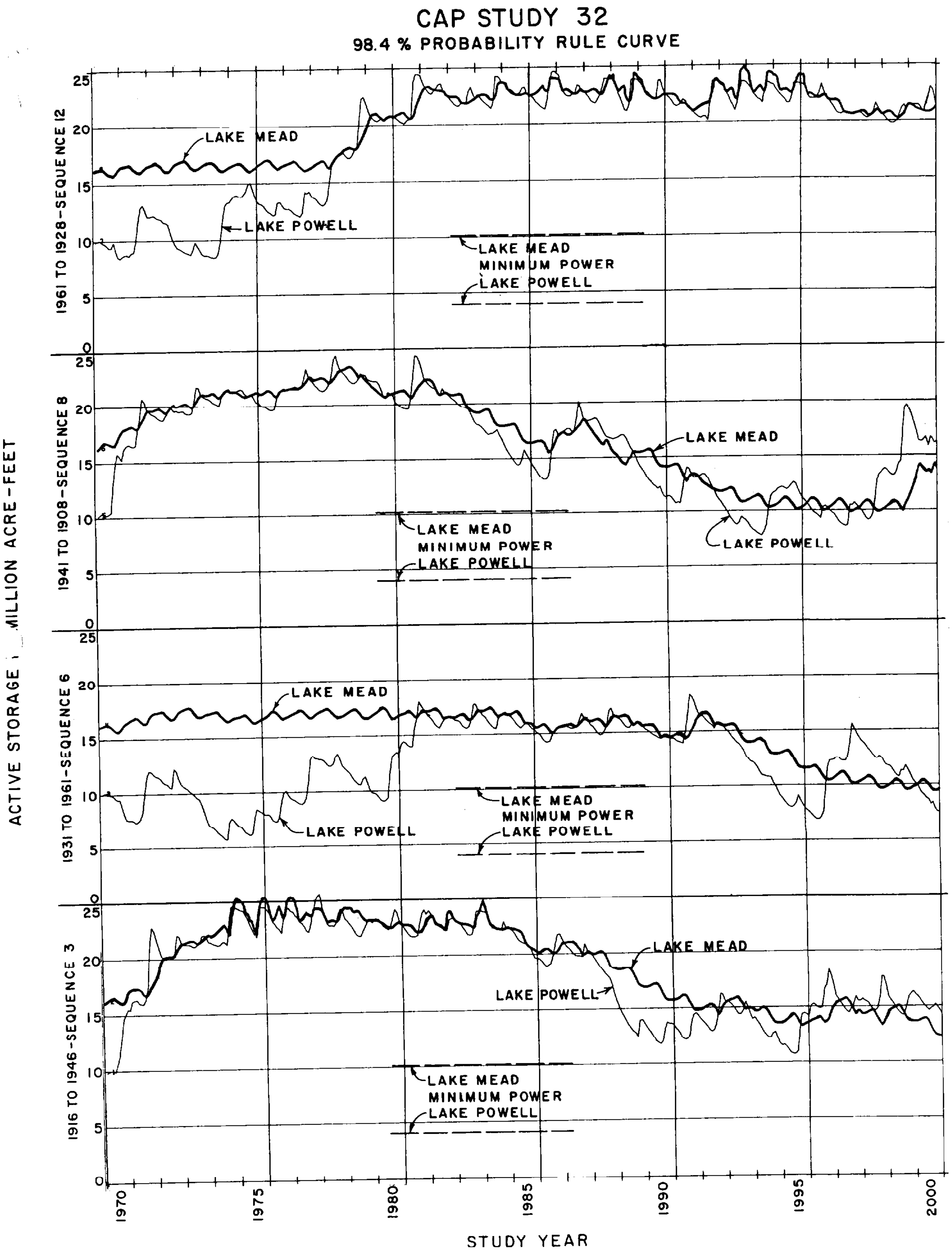
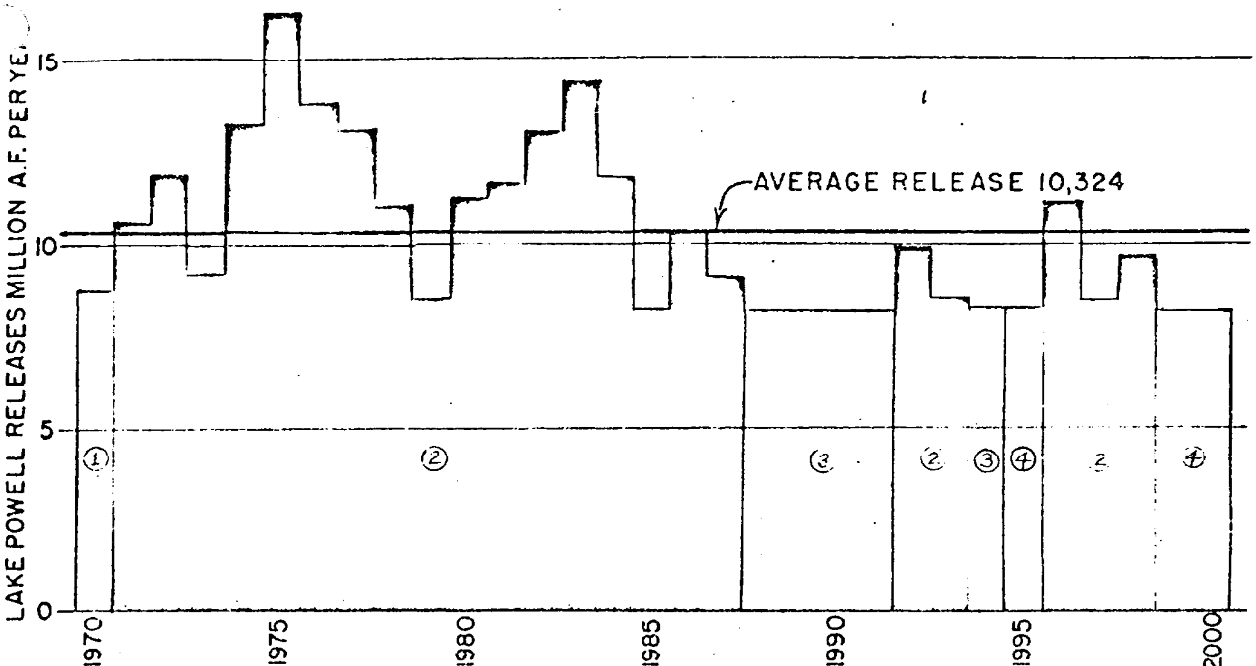

CAP STUDY 32
98.4 % PROBABILITY RULE CURVE
ACTIVE STORAGE , MILLION ACRE-FEET
1961 TO 1928-SEQUENCE 12
1941 TO 1908-SEQUENCE 8
1931 TO 1961-SEQUENCE 6
1916 TO 1946-SEQUENCE 3
LAKE MEAD
LAKE POWELL
LAKE MEAD
MINIMUM POWER
LAKE POWELL
STUDY YEAR
1970
1975
1980
1985
1990
1995
2000

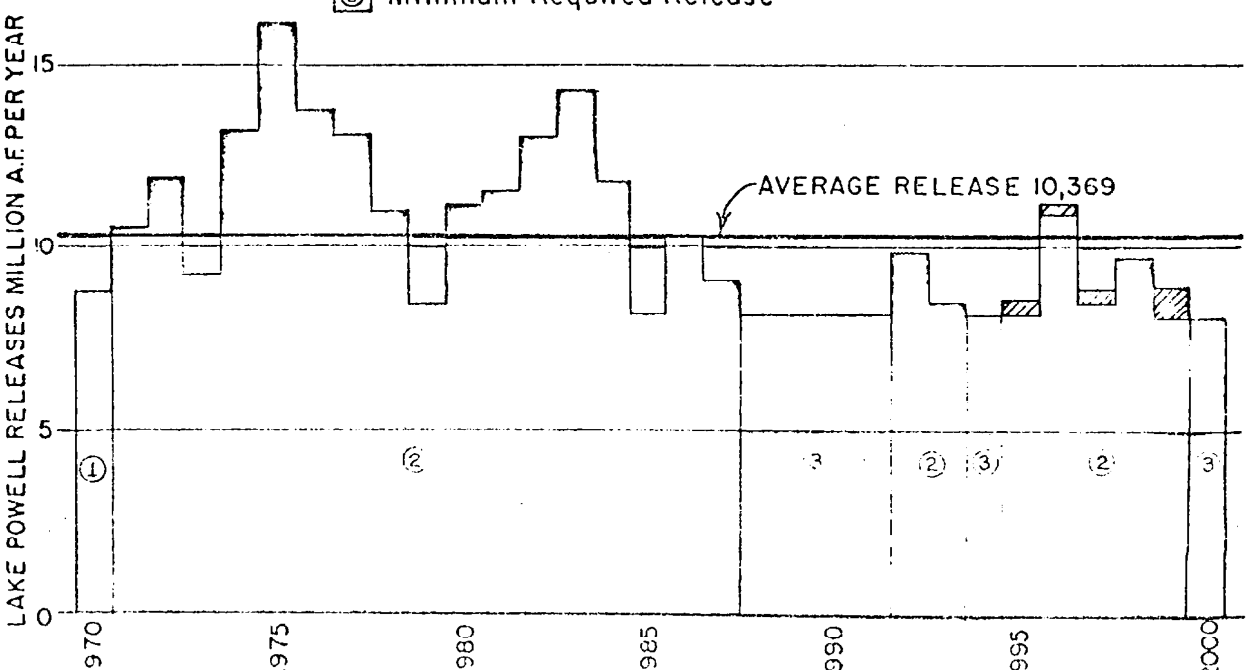
Figure 7

# EFFECT OF RULE CURVE ON LAKE POWELL RELEASES




CAP 32 RUNOFF SEQUENCE 1916-1946. RULE CURVE 98.4% PROBABILITY

① Filling Criteria
② Equate Storage
③ Minimum Required Release
④ Rule Curve
Increased Release due to Rule Curve




CAP 36 RUNOFF SEQUENCE 1916-1946. RULE CURVE 0% PROBABILITY

Figure 8

# UPPER BASIN ENERGY

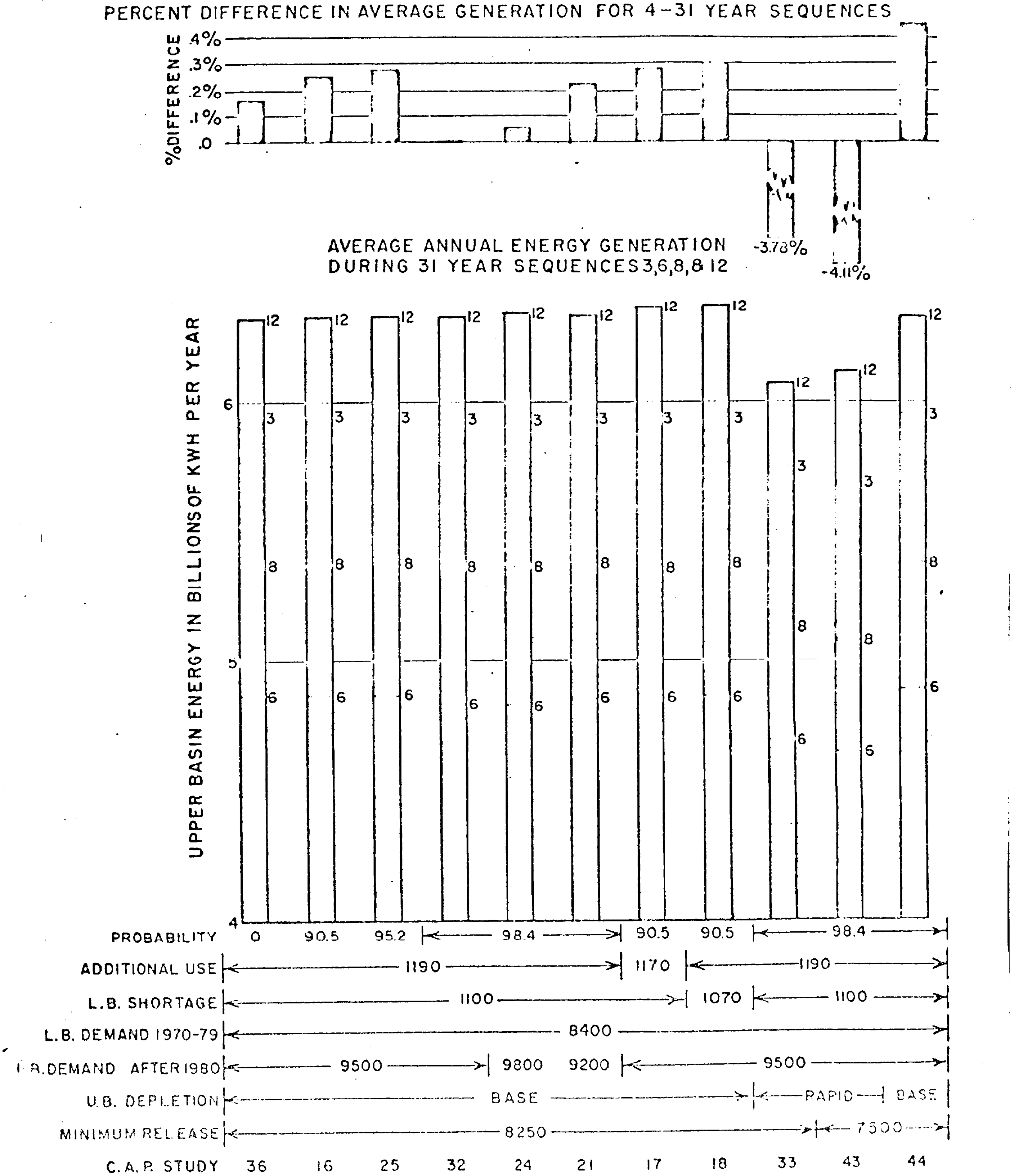


Figure 9

LOWER BASIN ENERGY

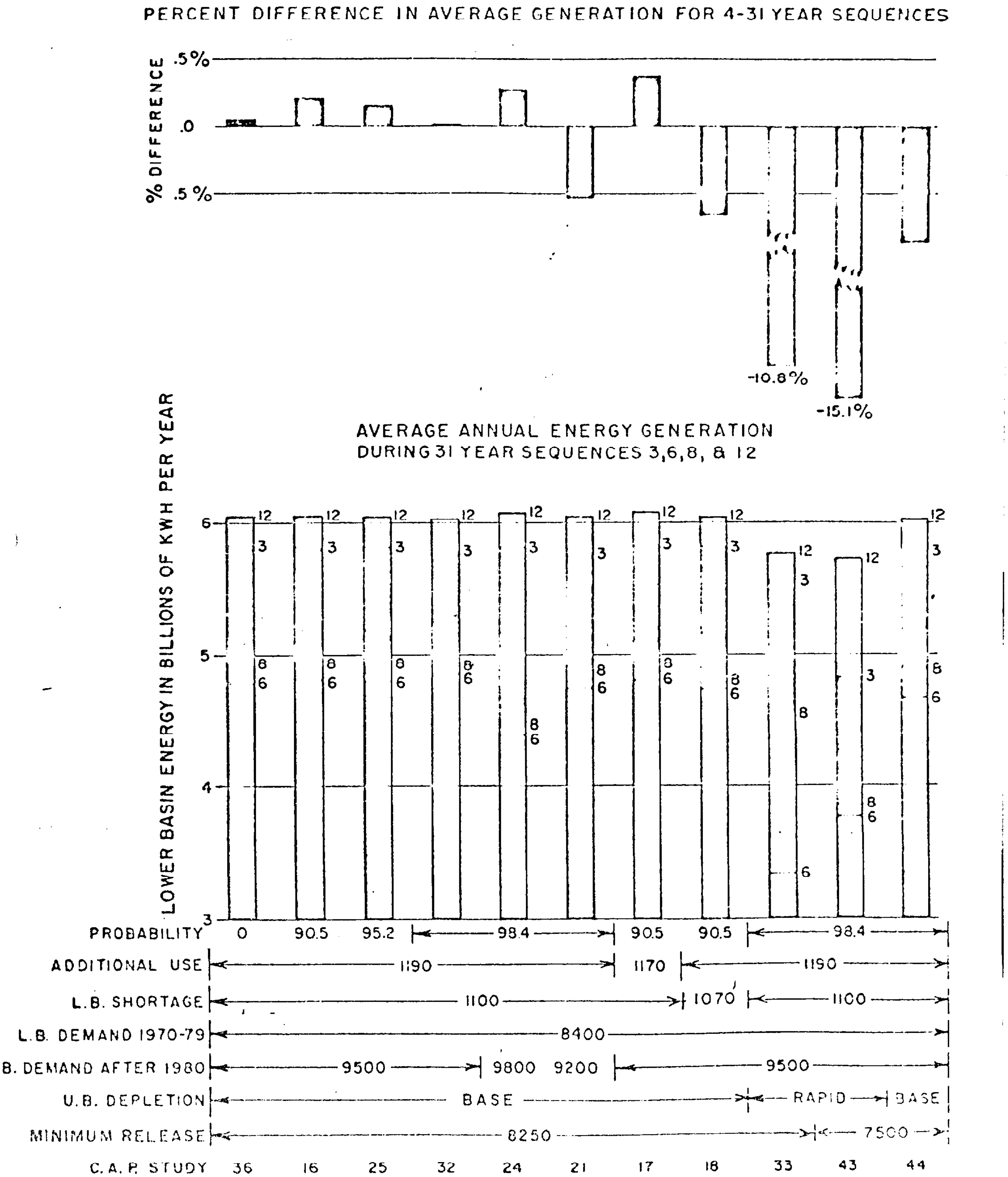
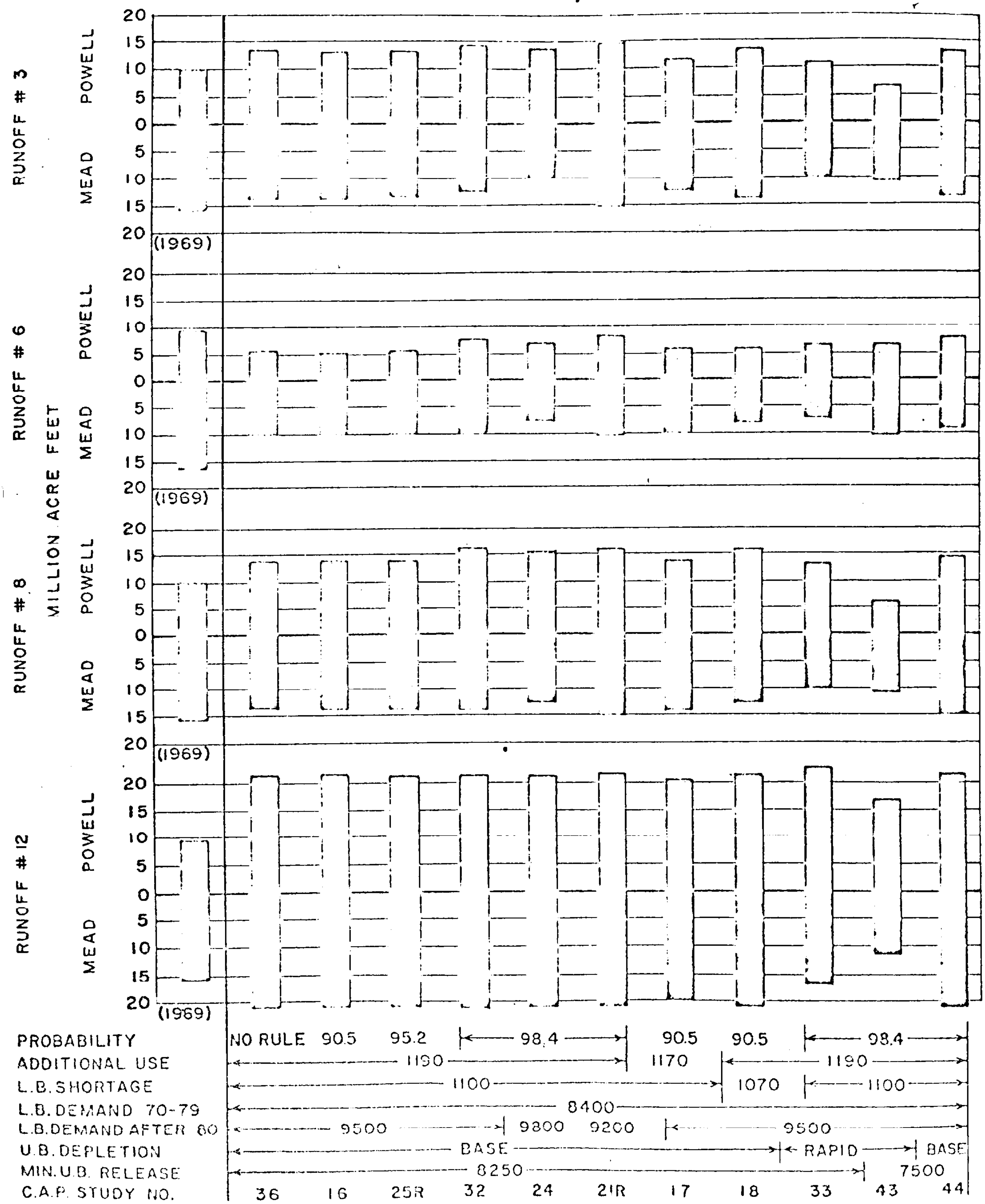


Figure 10

## LAKE POWELL AND LAKE MEAD CONTENT ON SEPTEMBER 30, YEAR 2000 (MAF)



# CAP STUDIES 32 Vs 36

98.4 % PROBABILITY RULE CURVE Vs NO RULE CURVE