# PROBABILITY ANALYSIS APPLIED TO THE DEVELOPMENT OF SYNTHETIC HYDROLOGY FOR THE COLORADO RIVER

## PART IV

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# PROBABILITY ANALYSIS APPLIED TO THE DEVELOPMENT OF SYNTHETIC HYDROLOGY FOR THE COLORADO RIVER

In the development of river basins one of the crucial problems encountered by the planners is that of estimating future streamflow. The shortness of the streamflow records for the Colorado River, as well as for other rivers, contributes to reduced precision of estimated future streamflow if such estimation is based solely on historical data. One way of dealing with this problem of inadequate historical data is to simulate the flow of the river by mathematical techniques, thereby creating a "synthetic hydrology" on the river. A synthetic hydrology is a hypothetical series of streamflows. These streamflows did not occur historically, but are developed by statistical methods in such a way that they could have occurred (i. e. are statistically probable).

Measurements of the flow of the Colorado River at Lees Ferry, Arizona, are available from 1912. This flow is extremely erratic, varying from 4 million to 22 million acre-feet of water annually, with a tendency for high years and low years to be grouped. (See Table I.) Because of the shortness of the streamflow record, however, the critical patterns of high and low runoff are relatively scarce. By means of a mathematical model representing the flow of the Colorado River, patterns can be created which would be expected to be part of an annual record if a record of sufficient length were available. Since future flows are not deterministic, a logical approach is to consider runoff as a stochastic process.[1] If the stochastic

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[1] A stochastic process can be defined as "any process running along in time controlled by probability laws." See J. L. Doob, Stochastic Processes (New York: John Wiley and Sons, 1953), p. 46.

## TABLE I

## FLOW OF THE COLORADO RIVER AT LEES FERRY, ARIZONA
Water Year, 1912–1958

| Water Year[1] | Runoff Millions of Acre–Feet of Water | Water Year[1] | Runoff Millions of Acre–Feet of Water |
|---|---|---|---|
| 1912 | 17.6 | 1937 | 11.9 |
| 1913 | 12.7 | 1938 | 15.4 |
| 1914 | 19.3 | 1939 | 9.4 |
| 1915 | 12.5 | 1940 | 7.1 |
| 1916 | 17.3 | 1941 | 16.0 |
| 1917 | 21.9 | 1942 | 17.0 |
| 1918 | 13.6 | 1943 | 11.2 |
| 1919 | 10.8 | 1944 | 13.2 |
| 1920 | 19.7 | 1945 | 11.5 |
| 1921 | 20.7 | 1946 | 8.7 |
| 1922 | 16.3 | 1947 | 13.5 |
| 1923 | 16.2 | 1948 | 13.7 |
| 1924 | 12.5 | 1949 | 14.3 |
| 1925 | 11.3 | 1950 | 11.0 |
| 1926 | 14.0 | 1951 | 9.8 |
| 1927 | 16.5 | 1952 | 18.0 |
| 1928 | 15.3 | 1953 | 8.8 |
| 1929 | 19.2 | 1954 | 6.1 |
| 1930 | 13.0 | 1955 | 7.3 |
| 1931 | 6.4 | 1956 | 8.7 |
| 1932 | 15.2 | 1957 | 17.3 |
| 1933 | 9.7 | 1958 | 14.2 |
| 1934 | 4.4 | | |
| 1935 | 9.9 | | |
| 1936 | 11.9 | | |

[1] Runoff for years ending September 30 for each year shown.

Source: U. S. Geological Survey, Water Supply Papers, 1313, 1343, 1393, 1443, 1513, and 1563.

model of flow sequences represents the flow of the river in all respects, it would be impossible to distinguish between real and synthesized hydrographs by the usual statistical tests of significance. Hence synthetic hydrology provides a large number of possible runoff sequences that could obtain on the river whose flow is described by the probability model.

The problem of developing synthetic hydrologies is one which has absorbed the attention of engineers, statisticians, and economists in recent years. While no attempt is made to review in this paper all the research done on the problem, three studies representative of current thinking on development of synthetic hydrologies are discussed. Two of the studies, those by Thomas and Hurst, are concerned primarily with storage problems rather than with the problem of runoff, but because storage depends upon runoff, the methods suggested for generating inputs available for storage are deemed to be worthy of study. The third report, by Luna Leopold, deals directly with runoff and his data are streamflows of the Colorado River. The three approaches are discussed in the following section of this paper in terms of their applicability to the Colorado River. Synthetic hydrologies are then developed by probability methods and are evaluated in light of the foregoing works.

## Applicability of the Selected Synthetic Hydrology Studies to the Colorado River

Leopold, Thomas, and Hurst apply probability analysis to the problem of forecasting runoff. Because of the differences in approach, each of the studies is evaluated in terms of its applicability to the Colorado River data. Since the synthetic model must conform to known characteristics of the streamflow data, observed runoff of the Colorado River is used to test the feasibility of each of the approaches.

## Leopold Approach

The virgin flow of the Colorado River (reconstructed record of annual discharge -- reconstructed to adjust for depletions) measured at Lees Ferry, Arizona, from 1896 through 1956 was examined by Luna Leopold in Probability Analysis Applied to a Water-Supply Problem.[1] He demonstrated that the flow of the Colorado River is normally distributed when no account is taken of order of occurrence of the flow; and that there is greater variability in groups of streamflow means in their natural order of occurrence than if the same mean flow values occurred in random sequence.

The historical flow of the Colorado River at Lees Ferry, Arizona for the water years 1912-1958 is plotted on normal probability paper in Chart 1. When a normal distribution is plotted on such paper, the distribution plots as a straight line. Since the plotted values of the historical flow approximate a straight line, the distribution of the historical flows (when no account is taken of order of occurrence of the flow) appears to be normally distributed). (It should be noted that the Leopold study was concerned with virgin flow, not historical flow, for the period 1896-1956.)

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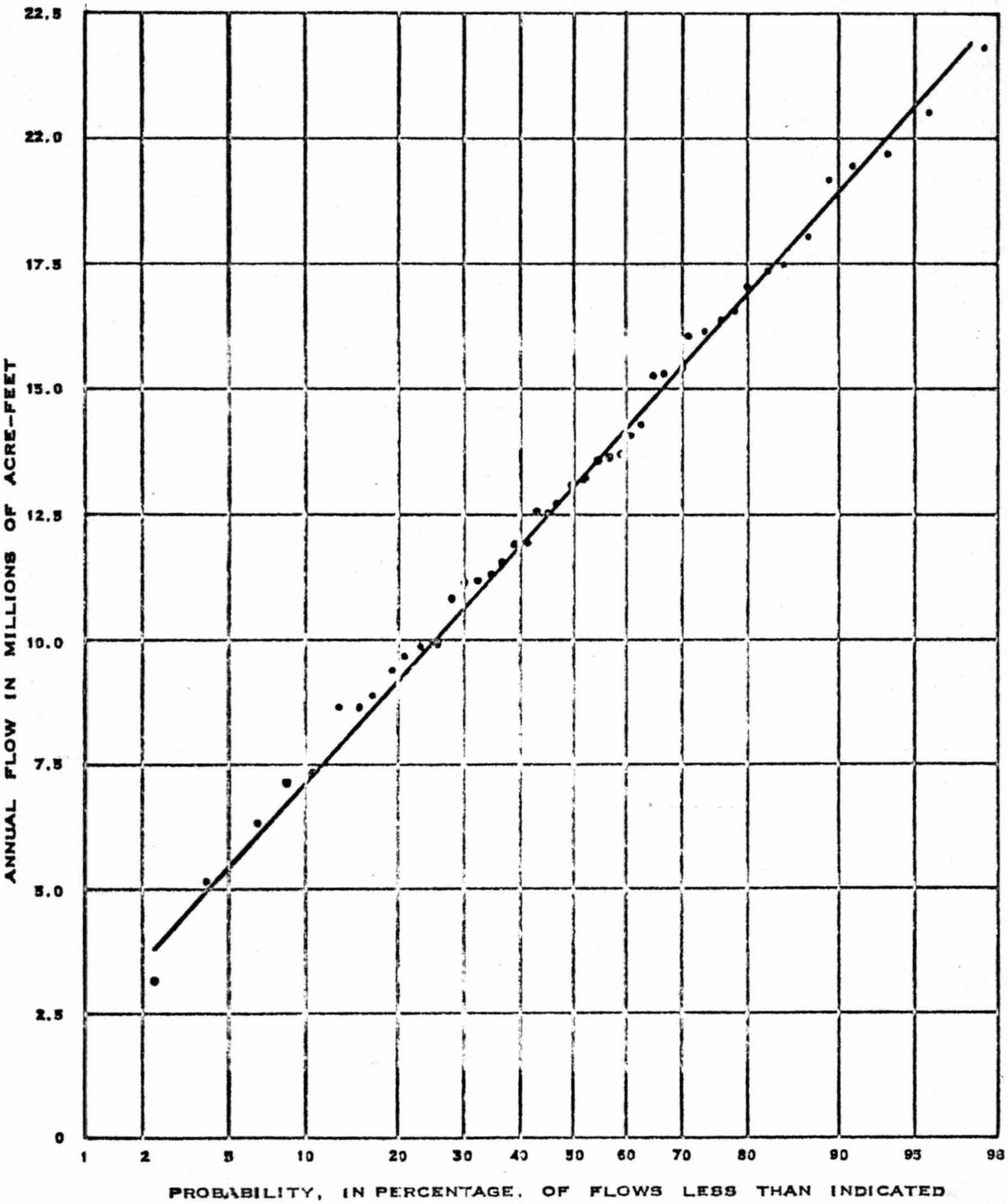
[1] Luna B. Leopold, Probability Analysis Applied to a Water-Supply Problem, U. S. Department of the Interior, Geological Survey Circular 410, Washington, D. C., 1959.

CHART 1

## ANNUAL FLOW OF COLORADO RIVER AT LEES FERRY, ARIZONA

WATER YEARS, 1912–1936



SOURCE: UNITED STATES GEOLOGICAL SURVEY, WATER PAPERS.

The mean virgin flow of the Colorado River for the 61-year period 1896-1956 is 15.18 million acre-feet of water with a standard deviation[1] of 4.2 million acre-feet of water, while the mean historical flow for the 47-year period 1912-1958 is 13.23 million acre-feet of water with a standard deviation of 4.1 million acre-feet of water. The measurements of annual flow represent a sample of flow data from a universe consisting of annual flows covering an indefinitely long time period. Since the distribution of sample flows examined tends to be normally distributed, then the means of groups of data in the sample will also be normally distributed. Means of various time periods were considered by Leopold. His minimum period was ten years, whereas this paper shows that the use of a five-year period is valid.

When items are selected at random from a normal universe large values are equally as likely as small values so that the variability of the means of groups of streamflow in natural order of occurrence is larger than if the same flow values occurred in random sequence. If group means were made up of randomly chosen individuals then variability of the group means would decrease as the square root of the number of individuals making up the groups. Thus if annual values of streamflow occurred in a random sequence, variability of the means of a group, e.g. 5 years, would decrease inversely as the square root of the number of individual items making up the group. Hence, for a random sequence, if the

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[1] The standard deviation is a measure of the variability or dispersion from the mean. In the case of a normal distribution one standard deviation on either side of the mean would include approximately 68 percent of the items in the distribution.

standard deviation for 1-year means is 4.1 million acre-feet of water then the variability of means of 5-year groups should be $\frac{1}{\sqrt{5}}$ of 4.1 or 1.8 million acre-feet of water (i.e. 0.45 as variable). The standard deviation of the 5-year means of the historical flow of the Colorado River was 2.5 million acre-feet of water or 0.61 times the annual variation.[1]

If one were to assume that the mean historical flow for the 47 years is the true mean, then one could conclude that 75 percent of the 5-year means would be expected to be equal to, or less than 13.23 + (0.61) (2.77) or 14.92 million acre-feet of water.[2] Table 2 presents a frequency distribution of 5-year moving averages of historical flow of the Colorado River from 1912 through 1958 and it can be noted that approximately 75 percent of the 5-year mean flows were equal to or less than 14.92 million acre-feet, with the mean of the 5-year means being equal to 13.08 million acre-feet. With an infinite number of samples the mean of the 5-year means would be equal to the population mean (the distribution in Table 2 is based on 43 means).

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[1] The ratio of the standard deviation of the five-year means to the standard deviation of the annual flow was 0.64 for the virgin flow.

[2] Because the sampling distribution of means of samples of size 5, taken from the approximately normal distribution of runoff, will be a normal distribution, then tables giving the area under the normal curve can be used to determine 75 percent of the area under the curve. The mean lies at the center of the distribution and 25 percent of the area to the right of the mean will be .6745 standard deviations away from the mean. If the assumption of randomness were tenable then the standard error of the mean for samples of size 5 would be 0.45 as large as the standard deviation of the "population". The ratio of the standard deviation of the 5-year means to that for l-year means was 0.6l as used above.

## TABLE 2

## PERCENTAGE DISTRIBUTION OF FIVE YEAR MEANS[1] OF FLOW OF THE COLORADO RIVER AT LEES FERRY, ARIZONA

1912-1958

| Mean Annual Runoff Millions of Acre-Feet | Percent |
|---|---|
| 8.0 and under 10.0 | 14 |
| 10.0 and under 12.0 | 19 |
| 12.0 and under 14.0 | 32 |
| 14.0 and under 16.0 | 19 |
| 16.0 and under 18.0 | 16 |

[1] Five-year moving averages of historical flow.

Source: Adapted from U. S. Geological Survey, Water Supply Papers, 1313, 1343, 1393, 1443, 1513, and 1563.

The distribution of sample means provides a guide as to the true limits within which the true mean might be expected to lie. Therefore recognizing that the mean of the 47-year period may not be the true mean, it is possible to approximate the standard deviation of a sampling distribution of 47-year means. Since the mean historical flow for the 47-year period was 13.23 million acre-feet, the probable error of the mean is equal to 0.26 x 2.77 which equals 0.72 million acre-feet of water;[1] or one can say there is a 50 percent chance that the true mean flow of the Colorado River for an indefinitely long time period (with no change in the universe or in the "basic conditions") will lie between 13.23 ± 1.44 or between 11.79 and 14.67 million acre-feet of water.

On the basis of the above analysis it is possible to estimate what the probable "average" streamflow--lowest mean value and highest mean value--for the next five years is likely to be. Because the historical data are merely one sample and the mean of this sample may differ from the population mean (mean flow for an indefinitely long time period) in order to estimate future means the possible variation from the population mean must be included in setting confidence limits for an estimate. Therefore, total variability of future five-year periods would be computed by taking the statistical sum of the variability for the 47-year means and for five-year means as follows

$$\sqrt{(.26)^2 + (.61)^2} = \sqrt{.4397} = 0.66$$

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[1] Leopold develops ratios of standard deviations of means for records of flow from 1 to 200 years to 1-year standard deviations on page 8 of his report cited above. The 0.26 is taken from this long-term record study.

Therefore one can say there is an 82 percent chance (corresponding to twice the probable error[1]) that the mean runoff for the next five years will be between the mean of the historical sample and 1.349 standard errors or

$$13.23 \pm (1.349 \times .66 \times 4.1) \quad \text{or } 13.23 \pm (2 \times .66 \times 2.77) =$$

$$13.23 \pm 3.66 = 9.57 - 16.89 \text{ million acre-feet of water.}$$

Thus, there is only a 9 percent chance (9 times out of 100 years of flow) that the next five-year mean flow of the Colorado River will be less than 9.57 million acre-feet of water; and only 9/100 chance that the flow will be greater than 16.89 million acre-feet of water. It should be emphasized that these figures all assume that past conditions will apply to the future.

The above analysis enables one to make statements about the mean flow for the next five years with certain degrees of confidence, but in terms of planning this is not a guide as to the sequence of flows which would yield a mean between 9.57 and 16.89 million acre-feet of water. Therefore the Thomas approach will be considered in an attempt to discover some method which can be used to develop possible sequences of future runoff of the Colorado River.

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[1] Leopold uses the "probable error" of the mean rather than the standard error of the mean in making his comparisons. One probable error of the mean is equal to .6745 standard errors of the mean. Therefore, forty-one percent of the area of a normal curve is included between an ordinate erected at the mean and ordinates at a distance of 1.349 standard errors of the mean from the mean. Hence, the mean ± 1.349 $\sigma_{\bar{x}}$ will include 82 percent of the area under the normal curve.

## Thomas Approach

Harold A. Thomas' study entitled "Mathematical Synthesis of Streamflow Sequences for the Analysis of River Basins by Simulation"[1] is concerned with monthly and hourly data on runoffs. His approach deals with determination of serial correlation which, of course, is present to a great extent in monthly data. The mathematical expression developed by Thomas characterizes a circular random walk, a model in which the discharge in a given month is comprised of a component linearly related to that in the preceding month and a random additive component.

Application of the serial correlation method suggested by Thomas to the historical runoff data for the Colorado River resulted in the parameters presented in Table 3. The correlation coefficients in the table are statistically significant for a sample of 47 years except for the September-October coefficient where r = .0877. A minimum value of .288, with 45 degrees of freedom, is required for r to be significant at the 95 percent level of probability.[2] This r measures the correlation between one month's runoff and the runoff of the preceding month, i.e. r = .3699 for February indicates the correlation of February with January.

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[1] Harold A. Thomas, Jr., and Myron D. Fiering, "Mathematical Synthesis of Streamflow Sequences for the Analysis of River Basins by Simulation," Chapter XII in Design for Water Resource Systems by Arthur Maass and others (Harvard University Press, February, 1962).

[2] R. A. Fisher, Statistical Methods for Research Workers (New York: Hafner Publishing Company, 1950), p. 209.

## TABLE 3

## SERIAL-CORRELATION PARAMETERS OF MONTHLY FLOWS COLORADO RIVER AT LEES FERRY, ARIZONA 1912–1958

| | | Thousands of Acre-Feet of Water | | | |
|---|---|---|---|---|---|
| Month | Correlation Coefficient r | Regression Coefficient b | Standard Deviation[1] | Mean Flow | Standard Error |
| January | .3521 | .4550 | 59.1 | 329.7 | 72.3 |
| February | .3699 | .9147 | 76.4 | 374.7 | 177.5 |
| March | .3552 | .9327 | 188.9 | 607.4 | 469.0 |
| April | .5175 | 1.1614 | 496.0 | 1,204.4 | 963.5 |
| May | .6532 | .9287 | 1,113.6 | 2,954.7 | 1,212.3 |
| June | .8009 | .4223 | 1,582.0 | 3,608.6 | 505.5 |
| July | .6753 | .3436 | 834.9 | 1,530.5 | 316.8 |
| August | .5650 | .4607 | 424.8 | 729.0 | 289.0 |
| September | -.0877 | -.0798 | 346.4 | 518.7 | 317.6 |
| October | .7396 | .3227 | 318.7 | 552.1 | 93.6 |
| November | .7511 | .3907 | 137.5 | 453.5 | 47.8 |
| December | .5258 | .4345 | 71.6 | 361.6 | 50.8 |

[1] Standard deviation for indicated month. The standard deviation for the y variable, or predicted variable, would be the standard deviation shown in the column for the next month. That is, the standard deviation of the forecast value, using January as a forecast, would be that shown for February. Hence, the degree of relationship can be appraised by comparing the standard error for January with the standard deviation for February, etc.

Source: Adapted from U. S. Geological Survey, Water Supply Papers, 1313, 1343, 1393, 1443, 1513, and 1563.

The estimating equation for a linear regression model by the method of least squares is:

$$Y = \overline{Y} + b\,(X_i - \overline{X}).$$

This equation would be applied to the data in Table 3 for the January-February relationship as follows:

The mean flow for January would be $\overline{X}$, 329.7 thousand acre-feet of water; while the mean flow for February, 374.7 thousand acre-feet of water, would be $\overline{Y}$. The regression coefficient b, .4550 thousand acre-feet of water, would then be applied to the difference between a given X value and the mean.

As can be noted from Table 3 the standard errors (which measure the scatter about the regression line and can be interpreted in the same way as the standard deviation which measures the variation from the arithmetic mean) as well as the standard deviations are relatively large in all months. Thus it appears that this method of developing a synthetic hydrology for the Colorado River is less effective than for the Clearwater River (the river used in the study by Thomas). However, since all but one of the correlation coefficients are significant at the 95 percent level, even though they are small, it is advisable that the Thomas technique, using the above regression equation and including a random variable, be applied to the Colorado River and that the synthetic hydrologies which will result be studied. Since the constants for the equations have been derived above, this could be readily done by means of an electronic computer.

## Hurst Approach

H. E. Hurst's study on "A Suggested Statistical Model of Some Time Series Which Occur in Nature,"[1] deals with an attempt to solve the problem of regulating outflow from a reservoir in such a way as to meet deficiencies of low runoff and to determine the required capacity of the reservoir necessary to guarantee a minimum discharge in the years of low runoff.

Hurst analyzed many time series of natural phenomena such as rainfall, river levels, temperature and pressure, annual growth of tree rings, etc.[2] The relationship used by Hurst was:

$$\frac{R}{\sigma} = \left(\frac{N}{2}\right)^k \qquad \text{where}$$

R = range, from maximum to minimum, of the cumulative totals of departures from the mean annual value taken in order of occurrence;

$\sigma$ = standard deviation of the individual values;

N = number of annual measurements (or total number of years);

K = an index = $\frac{R/\sigma}{\log N/2}$

The mean value of k for all the natural time series examined by Hurst was 0.73 with a standard deviation of 0.09. He concluded that in random events groups of high and low values do occur, but that the tendency for such grouping is greater in natural events than in random events. If the distribution is considered

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[1] H. E. Hurst, "A Suggested Statistical Model of Some Time Series Which Occur in Nature," Nature, Vol. 180, No. 4584, September 7, 1957, p. 494.

[2] H. E. Hurst, "Long-Term Storage Capacity of Reservoirs", Transactions of the American Society of Civil Engineers, 116,770 (1951).

to be one of independent events then:

$$\frac{R}{\sigma} = \sqrt{1/2N} \quad \text{or } 1.25 \sqrt{N}.$$ This means that the limiting value of k in the equation used by Hurst for natural time series, i.e. $\frac{R}{\sigma} = \left(\frac{N}{2}\right)^{k}$, will be 0.5 for random occurrences.[1]

The Hurst thesis that natural series (for which limited time series data are available) have a tendency to exhibit grouping of high and low values was examined using the historical runoff of the Colorado River from 1912 through 1958 as measured at Lees Ferry, Arizona. The k value resulting from the relationship above was 0.82 i.e. $\frac{54.11}{4.1} = \left(\frac{47}{2}\right)^{0.82}$. It should be noted that for a random series with N equal to 47 the k value would be 0.68. Hence, with a standard deviation of 0.09 for k, there is reason to believe that the runoff of the Colorado River does not differ significantly from that which would be obtained if the runoff followed the natural phenomena model of Hurst's. However, if additional samples of 47 years were available the distribution of k might be such that the 0.82 would lie within the range of expected values for a random series, since the 0.82 is only 1.56 standard deviations away from the Hurst expected value of 0.62.

The Leopold study also was concerned with the departure of the flow of rivers from that of a purely random series and he demonstrated this phenomenon by using mean flows for different time periods. The departure of the Colorado River mean (virgin) flow data from a random sequence is illustrated in Figure 4 of the Leopold report.

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[1] The asymptotic sampling distribution of $\frac{R}{\sigma}$ is such that $k = 0.5$. See W. Feller, Annals of Mathematical Statistics, 22,427.

## Synthetic Hydrology for the Colorado River

The analysis of the historical flow of the Colorado River using the techniques described above has demonstrated that the theses set forth in each of the studies has some application to the Colorado River. However, the foregoing methods do not yield a technique for generating a synthetic hydrology which is usable for establishing operating criteria for the control of the River. Methodology is developed in this section which can be used to simulate sequences of runoff which are statistically possible and which can be used in a model to test operating criteria.

If observed streamflows are used as inputs to a model which attempts to simulate the flow of the river, the short length of record available (47 years in the case of the Colorado River) constitutes a very small sample from an indefinitely large population. In addition, the order of the flows is a crucial variable in formulating decision rules with respect to release or storage of the water. Since future streamflows are not known, but must be estimated, reasonable estimation logically involves the theory of probability. From a study of the actual flow record probability models of future flows can be developed.

Synthetic hydrologies are developed in this paper using two different probability methods. The first method develops a model for generation of sequences of possible flow of the Colorado River by determining the probability distribution of mean flows in relation to the range, while the second method uses a Markoff chain model.

## Probability Distribution of Streamflow

The observed flows of the Colorado River standing alone are restricted in their significance to the particular observations recorded, i.e., observed frequencies of streamflows of different magnitudes apply only to flows actually observed. However, if the observed flows can be used to describe the shape of the distribution of all possible flows then theoretical frequencies can be developed. Theoretical frequencies are not limited to magnitudes actually observed, but they apply generally to the entire population. In so far as one is assured of the representative character of the sample, one has a basis for inference about the population.

Probability of flows of different magnitudes may be thought of as relative frequency of occurrence of flows of given sizes in the long run. One does not use probability theory to predict the outcome of any one trial or the order of the outcome of several trials, but to predict what will happen in the long run or "on the average" in a large number of trials. The relative frequency of occurrence of flows of different magnitudes in an actual long-run series can be used to estimate a frequency distribution of future flows. Since the shape of the frequency distribution of actual flows of the Colorado River is approximately normal, the mean and variance can be used to completely describe a theoretical distribution of annual flows. The mean and variance of the population (all possible annual flows) can be estimated in an unbiased manner from the samples (actual flows), assuming that the 47-year period is a representative sample.

Time Period for Probability Distributions. If the streamflows are purely random phenomena then one is hardly in a position to meaningfully predict what will happen in the future as any magnitude of streamflow is equally as likely as any other. If on the other hand our data have certain peculiar characteristics, e.g. exhibit periodicity, etc., one is in a much better position to get at the problem of predicting streamflows. Therefore, a search for hidden periodicities in Colorado River streamflow was undertaken using a Fourier analysis. Periods, or cycles, of two, three, four, and five years duration were analyzed. These results are presented in Table 4.

TABLE 4

FOURIER ANALYSIS OF FLOW OF THE COLORADO RIVER
AT LEES FERRY, ARIZONA
1912–1958

| Period $p$ | Fourier $A_p$ | Coefficients $B_p$ | $(A^2 + B^2)$ Squared Amplitude $R_p^2$ | Number of Observations $N$ | Ratio of squared amplitude to mean squared amplitude $k$ |
|---|---|---|---|---|---|
| 2 | -.3130 | -.1652 | .1253 | 46 | .0877 |
| 3 | 1.1250 | -.6634 | 1.1706 | 45 | 1.1691 |
| 4 | -1.4455 | .9045 | 2.9076 | 44 | 1.9490 |
| 5 | .2043 | 1.9029 | 3.6615 | 45 | 2.5100 |

Source: Computed from basic data presented in Table I.

The assumption is that

$$Y_t = \frac{1}{2} A_o + \sum_{j=1}^{N/2} (A_p \cos \frac{360}{T} j + B_p \sin \frac{360}{T} j )$$

where

$Y_t$'s are estimates of the values of streamflow if periods of given sizes are present.

The constants $A_p$ and $B_p$ (amplitudes) are obtained as follows:[1]

$$A_p = \frac{2\left[\sum_{j=1}^{p} U_j \qquad \cos\left(\frac{360}{p} j\right)\right]}{N}$$

$$B_p = \frac{2\left[\sum_{j=1}^{p} U_j \qquad \sin\left(\frac{360}{p} j\right)\right]}{N}$$

Where

$U_j$ = sum of the deviations from the arithmetic straight line trend for the period selected, $j = 1, 2_j \ldots, p$.

P = periodicity, in years.

N = number of years used in the analysis.

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[1] Gerhard Tinter, Economics, (New York: John Wiley and Sons), p. 219.

If there are no periodic fluctuations (i.e. the series is a random one following the normal distribution) the mean squared amplitude of the series is:

$$R_M^2 = \frac{4\sigma^2}{N}$$

where $\sigma^2$ = the variance of the series of flows.

The sum of the coefficients derived from the Fourier analysis (Table 4) can be tested to see if it differs from that derived from a random series by means of the Schuster test.[1] According to Schuster the probability, $P_s$, that an empirical squared amplitude, $R_p^2$, is k times the mean squared amplitude, $R_M^2$, is:

$$P_s = e^{-k}$$

Therefore $k = \log_e P_s$.

The Schuster test is used to determine whether the series differs significantly from a random series. Therefore, the higher the probability the more likely that the series is random since the hypothesis being tested by means of the Schuster test is that the series is random.

The probabilities ($P_s$) for the periods indicated in Table 4 are as follows:

| Period | k | $P_s$ |
|---|---|---|
| 2 | 0.0877 | .916 |
| 3 | 1.1691 | .311 |
| 4 | 1.9490 | .143 |
| 5 | 2.5100 | .081 |

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[1] Gerhard Tintner, loc. cit., p. 223.

The k value for the five-year period is significant at the 8 percent level while all of the other k values are not significant even at the 10 percent level. Hence, there is a possibility of a hidden periodicity of five years in the flow data for the Colorado River.

Synthetic Hydrology. If one were to predict annual flows on the basis of their being normally distributed this would mean that extremely high and extremely low amounts of runoff would be equally probable with runoff of the magnitude of the mean most probable; this approach would give no clue as to the sequence in which flows of varying magnitudes would occur. The order of flows is of utmost importance in the development of a synthetic hydrology, but, as stated earlier, probability analysis is hardly applicable in predicting the outcome of any one trial or order of the outcome of several trials but is used to predict what will happen in the long run. Hence, by generating a number of equally probable sequences of runoff, one can examine the effect which these sequences would have on storage, and ultimately on the amount of energy which could be generated by releasing given amounts of water. The apparent five-year periodicity in the flow data enables one to develop a sampling distribution of five-year means, so that sequences of five years can be generated in such a way as to give an idea of the order of flows.

Development of a synthetic hydrology for the Colorado River necessitated selecting samples of possible runoff. If the historical values were considered to be the population from which the sample was to be drawn there would be only 47 different amounts of runoff which would be possible even though there would be many different sequences of runoff possible. Hence, the Monte Carlo method (a technique used to simulate experience through statistical sampling) was used to generate runoff values for the synthetic hydrology.

In order to simulate streamflow, 100 random samples of 5 each (corresponding to a five-year runoff sequence determined on the basis of the Fourier analysis and Schuster test described above) were selected from a table of random numbers. In order to determine possible order of the five runoff values to be selected at random, the historical runoff data were analyzed by five-year periods. The distribution of five-year means (five-year moving averages) approximated a normal distribution (Table 2). However, since there are many different combinations of five which will yield the same mean, the samples were chosen subject to the following restraints:

(1) Annual runoff should range between 4.4 and 21.9 million acre-feet of water--limits set by historical experience (Table 1);

(2) Five-year sequences of runoff should be distributed according to the distributions of (a) the mean and (b) the ratio of the range to the mean (of the historical data).[1]

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[1] The ratio of the range to the mean is used instead of the ratio of the square root of the second moment about the mean to the mean (coefficient of variation) because the sample size (5) is so small. In the case of small samples the range is almost as efficient an estimate of the distribution as the standard deviation when sampling from a normal population. (For a sample size of 5, the efficiency of the range in relation to the standard deviation for estimating the dispersion is .955) See Wilfred J. Dixon, and Frank J. Massey, Introduction to Statistical Analysis (New York: McGraw-Hill Book Company, Inc., 1957), p. 404. Appendix Table I presents the distributions resulting from the five-year moving averages and ranges of the historical data.

One hundred samples of thirty-year inflows[1] (six samples of five-year sequences) were chosen at random from the samples presented in Appendix Table II[2]. These simulated flows exhibit the same statistical characteristics as the historical flows, as required by the restraints. The simulated flows presented in Appendix Table III have been adjusted for estimated depletion considering past experience and anticipated future depletions.[3]

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[1] According to the Department of the Interior "the filling period . . . is considered to be the time it takes to fill Glen Canyon . . . (content 28.0 million acre-feet of water total surface storage) or May 31, 1987, whichever occurs first." U.S. Department of the Interior, Release of February 12, 1960, "Proposed General Principles to Govern, and Operating Criteria for Glen Canyon Reservoir and Lake Mead during the Glen Canyon Reservoir Filling Period."

The Hoover Dam power contracts expire in 1987, so this period (1962-1987) has been used in studies made by the Bureau of Reclamation and others in attempting to develop operating criteria for use during the period of the initial filling of Glen Canyon Reservoir. The thirty-year period was used because the samples were selected in clusters of five years; hence, either a twenty-five or a thirty-year period could have been used.

[2] It should be noted that in order to evaluate operating criteria for the Colorado River inflow to Glen Canyon Dam as well as inflow to Hoover Dam must be considered. The inflow to Hoover Dam (Lake Mead), once Glen Canyon is completed, would consist of the water released from Glen Canyon Dam plus any additional gain to Lake Mead beyond this. Hence, the Monte Carlo method was also used to select samples of gain to Lake Mead which could be used in a model simulating operating conditions when both reservoirs are available for use.

[3] It was assumed that depletion would increase by 0.09 million acre-feet of water each year for the first nine years, i.e. in 1970 depletion would be 0.72 million acre-feet of water. From 1971 through 1990 depletion would increase by 0.03 million acre-feet, so that in 1990 the anticipated depletion would be 1.42 million acre-feet of water.

Average annual inflows to Glen Canyon Reservoir for the first five years of the simulated experience (considered to be 1962–1966) of the one hundred synthetic hydrologies range from a low of 8 million (simulations 6, 21, 40, 43, and 56) acre-feet of water to a high of 17.5 million acre-feet of water (simulation 10). The five-year moving averages of historical flows of the Colorado River from 1912 through 1958 range from a low of 9.1 to a high of 17.3 million acre-feet of water.

The mean was computed for each of the 100 simulated hydrologies for the first five years, the first ten years, the first fifteen years, the first twenty years, the first twenty-five years, and the first thirty years of the sequence. From the Pearsonian system of curves an appropriate theoretical curve was fitted to the distribution of means.[1] In each case the curve used to develop the probabilities for runoff was the Type I Pearson curve, a curve of limited range and generally bell shaped.

The frequency distribution of means of the five-year simulated inflows (period 1962–1966) is presented in Appendix Table IV. A probability table, developed from the 100 simulated hydrologies to which the Pearson curves were fitted, is presented in Table 5. In interpreting Table 5 caution should be used when considering the zeros and the one hundreds appearing in various columns. The interpretation of these zeros should be that it is highly unlikely that an average annual runoff of the indicated size or smaller would occur rather than that it is impossible that an average annual runoff of such size would occur. The one hundreds should be interpreted within the same probability framework and not that it is certain that the runoff will be the given amount or less.

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[1] W. Palin Elderton, Frequency Curves and Correlation (third edition; London: Cambridge University Press, 1938).

## TABLE 5

## PROBABILITIES OF AVERAGE ANNUAL INFLOW TO GLEN CANYON RESERVOIR BY TIME PERIODS

| Average Annual Inflow in millions of Acre-Feet of Water | Probability (Percent chance) of Average Annual Inflow Being Indicated Amount or Less During | | | | | |
|---|---|---|---|---|---|---|
| | 5 Year Period | 10 Year Period | 15 Year Period | 20 Year Period | 25 Year Period | 30 Year Period |
| 6 | --* | 0 | 0 | 0 | 0 | 0 |
| 7 | 1 | --* | 0 | 0 | 0 | 0 |
| 8 | 4 | --* | --* | 0 | 0 | 0 |
| 9 | 9 | 2 | 1 | --* | --* | 0 |
| 10 | 16 | 7 | 4 | 3 | 1 | --* |
| 11 | 25 | 19 | 15 | 17 | 12 | 10 |
| 12 | 37 | 41 | 37 | 40 | 42 | 52 |
| 13 | 50 | 64 | 65 | 68 | 78 | 85 |
| 14 | 65 | 84 | 88 | 92 | 96 | 97 |
| 15 | 80 | 97 | 98 | 100 | 100 | 99 |
| 16 | 95 | 100 | 99 | 100 | 100 | 100 |
| 17 | 100 | 100 | 100 | 100 | 100 | 100 |

*Less than 0.5 percent chance.

It is apparent from Table 5 that the variation of the sampling distributions becomes smaller as the sample size becomes larger. Hence, the probability distribution using a sample size of 5 years (using only the discrete probability values between 1 and 100) ranges from a low of 7 million acre-feet of water to a high of 17 million acre-feet of water. When a sample size of 30 years is used, however, the range of the probability distribution is from 11 million acre-feet to 16 million acre-feet of water. The standard deviation of the means of the five-year groups is 2.51 million acre-feet of water while the standard deviation for the thirty-year means is only .96 million acre-feet.

While there is greater accuracy, or stated another way there is less variability from the population mean, when larger samples are used, still the availability of probability distributions by the smaller grouping (5 years) gives an idea of the situations which may be met in the next five years, and hence, becomes a help in planning for criteria to be used in terms of the release rules to be applied to Glen Canyon and Hoover Dams.

Comparison of Synthetic Hydrologies with Hurst and Leopold Studies. The Hurst and Leopold techniques were applied to the annual historical runoff data for the Colorado River in an earlier section of this report. Since these techniques revealed certain characteristics of the historical data it was felt that the synthetic hydrologies should be examined generally to determine whether the simulations conformed in these respects.

Hurst Study. The first twenty simulated hydrologies (generated for a thirty-year period) were analyzed to determine the value of k from the equation

$$\frac{R}{\sigma} = \left(\frac{N}{2}\right)^k$$

described in an earlier section of this report. The values of k for the synthetic hydrologies range from 0.50 to 0.79 with mean, 0.64, and standard deviation, 0.08. For a random series with N = 30 the value of k would be 0.71. The mean k derived by Hurst for 8 cases of discharge and runoff for a period of 35 years each was 0.68.[1] This evidence tends to indicate that the synthetic hydrologies presented in Appendix Table III simulate those of a natural time series.

Leopold Study. The probabilities presented in Table 5 are consistent with the probability statements developed using the Leopold approach and presented in an earlier section of this report. It should be noted that the statement was made there that there were only 9 chances out of 100 that the next five-year mean flow of the Colorado River will be less than 9.57 million acre-feet of water and Table 5 shows there are 9 chances in 100 that the mean flow for a given five-year period will be 9 million acre-feet of water or less. One of the advantages of the approach developed here over that presented by Leopold is that possible sequences of flow, which would give a mean flow consistent with historical experience, are generated and can be used to study how inflow pattern affects operating rules.

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[1] H. E. Hurst, Transactions, American Society of Civil Engineers, 116, 785, (1051).

## Markoff Chain

On the assumption that runoff can be described by a Markoff process, twenty synthetic hydrologies of fifty years each were developed (Appendix Table V). A Markoff Chain model of a physical system characterizes the system as being in one of several possible "states" at a given point in time. The state of the system does not remain constant but changes from period to period. In a Markoff process the present state uniquely determines future stochastic behavior.

The twenty hydrologies presented in Appendix Table V were developed using the following relationship

$$X_t = 4.07 \left[1-(0.25)^2\right]^{\frac{1}{2}} \epsilon + 9.89 + 0.25\,(X_{t-1})$$

where

$X_t$ = runoff for year t, t = 1, 2, 3, . . . N. Where N = 20, conceptually N would go from 1 to $\infty$ .

4.07 = standard deviation of the historical runoff of the Colorado River (adjusted for transmountain diversion etc.)

0.25 = Markoff Chain coefficient

$\epsilon$ = random variate normally distributed with mean X = 0, standard deviation = 1.

9.89 = mean flow (13.19) multiplied by .75. The mean flow of the Colorado River, 1912–1958 (adjusted for transmountain diversions) was 13.19. The expected value of $\epsilon$ for an infinite series will be zero (mean of the distribution of standard normal deviates). Hence, the mean of all $X_t$ should equal 13.19. The summation of the first term, 4.07 $\left[1-(0.25)^2\right]^{\frac{1}{2}} \epsilon = 0$, therefore the summation of the remaining terms on the right should equal 13.19.

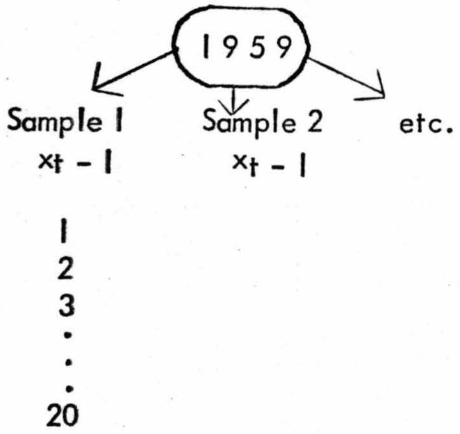
Whence

$$0.25X_{t-1} + \alpha = 13.19$$

Where $\alpha$ is a constant.

It should be noted that each flow is generated by adding a random component $\epsilon$ to a constant times the preceding flow value. The random or stochastic component is thus combined with a predictive element which attempts to reproduce the persistence effect present in historical Lees Ferry data. The 0.25 Markoff coefficient has been obtained from the predictive element estimated to be present in the historical data.[1]

Each of the twenty synthetic hydrologies was generated by using the historical flow for 1959 as the $X_{t_o}$ value, t = 1, 2, ..., N values. The different random deviates chosen for each hydrology resulted in $X_{t-1}$ values ranging from 5.49 million acre-feet of water to 18.81 million acre-feet of water. These twenty values were then used in the Markoff chain as the starting values, i.e. $X_{t-1}$ when t = 1, for the given synthetic hydrology presented in Appendix Table V. For example:



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[1] See Paul Julian, "A Study of the Statistical Predictability of Stream Runoff in the Upper Colorado River Basin."

Hence, 51 $X_t$ values were generated, but only the last 50 were used for the hydrologies so that while each chain was generated from the historical value (7.3 million acre-feet of water, 1959 historical flow of the Colorado River measured at Lees Ferry, Arizona, adjusted for transmountain diversion) only $X_t$ values, $t = 1, 2, \ldots 50$, are presented in Appendix Table V.

The sequences generated using the Markoff Chain show considerable variation, with Simulation 2 ranging from 0.9 million acre-feet of water to 25.06 million acre-feet; Simulation 11 ranged from -4.35 million acre-feet of water to 22.27 million acre-feet. Two of the simulated hydrologies contained negative flows which, of course, are not realistisc. These resulted from the fact that high negative values for $\epsilon$ dominat ed other terms in the equation for $X_t$.[1] It must be noted that the model used in this report assumes that streamflow at Lees Ferry is normally distributed which, of course, cannot be so since negative flows are not possible. The mean of the means of the 20 simulations was 12.93 with a standard deviation of 0.61 million acre-feet of water.

## Summary and Recommendation

The problem of estimating future runoff of the Colorado River has been attacked through the application of probability analysis. Difficulties were encountered in application of the theory because natural time series tend to exhibit more persistence -- high values or low values occurring together -- than does a purely random series. Two approaches have been suggested for dealing with this problem.

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[1] IBM cards prepared from the Rand Corporation normal random deviates were used; the values range from -4.417 to +4.417.

The first technique developed in this paper, whereby the characteristics of the observed historical flow are used as restraints or parameters for the probability distributions from which the samples are selected at random, adjusts for the departure of natural time series from a purely random one. A periodicity of five years was statistically significant at the eight percent level so the random selection of values, in groups of five, restricted by the historical parameters of the 5-year means and 5-year means to range, is feasible. The synthetic hydrologies developed in Appendix Table IV are in basic agreement with the characteristics of the historical data on the flow of the Colorado River at Lees Ferry, Arizona. Moreover our experience is pretty much in accord with the results of other investigations in this area.

It should be pointed out that it is not anticipated that any one of the one hundred simulations of inflow to Glen Canyon Reservoir generated by using the probability approach based on the distribution of mean flows in relation to the range, nor any of the twenty generated by the Markoff Chain Model will occur. However, the probability distributions developed from the Pearson curves and fitted to the observed synthetic sample data (synthetic hydrologies) permit one to draw conclusions regarding what may reasonably be expected to occur in the future if the same general inflow pattern observed in the past obtains in the future.

The synthetic hydrologies generated by the Markoff Chain Model do not completely describe flow patterns, since in two of the synthetic hydrologies negative flows result from the use of the model.

The probability techniques presented here do not yield a final solution to the problem of predicting streamflow of the Colorado River but they do offer a fruitful direction of attack on the problem. In the light of the experience drawn from these investigations the following recommendations are made:

1. Additional hydrologies, using the techniques presented in this paper, should be generated and studied.
2. Various operating criteria should be applied to the synthetic hydrologies so that release rules for the dams could be evaluated.
3. The use of five-year clusters for the Markoff Chain Model should be further explored with a transformation applied to the model to bring it more in line with actual experience.
4. Application of monthly serial correlation coefficients to streamflow generation should be explored further. This approach was used by Thomas for the Stillwater River and may have application to the Colorado River.

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[1] This was done in "A Probability Model for Integration of Glen Canyon Dam into the Colorado River System" by Margaret R. Brittan. This report can be obtained from the Bureau of Economic Research at the University of Colorado in Boulder.

# APPENDICES

# APPENDIX I

## Synthetic Hydrologies Using Probability Distributions

## APPENDIX TABLE 1

## PERCENTAGE DISTRIBUTIONS OF MEANS AND RATIOS OF MEAN TO RANGE[1] OF FLOW OF THE COLORADO RIVER AT LEES FERRY, ARIZONA, 1912-1956 AND GAIN[2] TO LAKE MEAD, 1922-1956

### I. MEANS OF FLOW OF COLORADO RIVER AT LEES FERRY

| Mean Annual Runoff Millions of Acre-Feet | Percent |
|---|---|
| 8.0 and under 10.0 | 12 |
| 10.0 and under 12.0 | 17 |
| 12.0 and under 14.0 | 34 |
| 14.0 and under 16.0 | 20 |
| 16.0 and under 20.0 | 17 |

### II. RATIOS OF RANGE TO MEAN - FLOW AT LEES FERRY

| Ratio | Percent |
|---|---|
| 0.3 and under 0.5 | 29 |
| 0.5 and under 0.7 | 27 |
| 0.7 and under 0.9 | 20 |
| 0.9 and under 1.1 | 12 |
| 1.1 and under 1.4 | 12 |

### III. MEANS OF GAIN[2] TO LAKE MEAD

| Mean Annual Gain in Millions of Acre-Feet | Percent |
|---|---|
| 0.4 and under 0.6 | 31 |
| 0.6 and under 0.8 | 44 |
| 0.8 and under 1.0 | 19 |
| 1.0 and under 1.4 | 3 |
| 1.4 and under 1.8 | 3 |

### IV. RATIOS OF RANGE TO MEAN - GAIN[2] TO LAKE MEAD

| Ratio | Percent |
|---|---|
| 0.3 and under 0.5 | 22 |
| 0.5 and under 0.7 | 19 |
| 0.7 and under 0.9 | 28 |
| 0.9 and under 1.1 | 19 |
| 1.1 and under 1.7 | 12 |

[1] Five-year moving averages used.

[2] Basic data were derived by the Colorado Water Conservation Board by taking the release from Lake Mead plus the alegebraic storage difference plus the evaporation from Lake Mead plus diversions from Lake Mead.

Source: Adapted from U. S. Geological Survey, Water Supply Papers, 1313, 1343, 1393, 1443, and 1563.

## APPENDIX TABLE II

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| Sample Number | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| | Amount | Mean | Amount | Mean |
| 1 | 10.40 | | 0.84 | |
| | 9.40 | | 0.73 | |
| | 10.30 | | 0.84 | |
| | 7.10 | | 0.63 | |
| | 7.00 | 8.84 | 0.59 | 0.726 |
| 2 | 15.60 | | 0.54 | |
| | 15.00 | | 0.60 | |
| | 6.90 | | 0.39 | |
| | 14.30 | | 0.38 | |
| | 12.70 | 12.90 | 0.45 | 0.472 |
| 3 | 4.80 | | 0.88 | |
| | 18.80 | | 0.73 | |
| | 6.90 | | 0.36 | |
| | 20.40 | | 1.20 | |
| | 16.60 | 13.50 | 1.20 | 0.874 |
| 4 | 7.90 | | 0.74 | |
| | 10.20 | | 0.54 | |
| | 8.10 | | 0.66 | |
| | 9.90 | | 0.66 | |
| | 14.30 | 10.08 | 0.36 | 0.592 |
| 5 | 7.30 | | 0.66 | |
| | 12.90 | | 0.65 | |
| | 7.30 | | 0.36 | |
| | 7.80 | | 0.36 | |
| | 6.10 | 8.28 | 0.65 | 0.536 |
| 6 | 18.80 | | 0.65 | |
| | 17.40 | | 0.84 | |
| | 9.10 | | 0.39 | |
| | 13.30 | | 0.36 | |
| | 19.70 | 15.66 | 0.37 | 0.522 |

APPENDIX TABLE 11 (Continued)

ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| Sample Number | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| | Amount | Mean | Amount | Mean |
| 7 | 18.90 | | 0.66 | |
| | 20.40 | | 0.46 | |
| | 14.80 | | 0.74 | |
| | 10.50 | | 0.48 | |
| | 16.30 | 16.18 | 0.84 | 0.636 |
| 8 | 20.90 | | 0.60 | |
| | 18.10 | | 0.84 | |
| | 13.90 | | 0.85 | |
| | 16.30 | | 0.67 | |
| | 19.80 | 17.80 | 1.39 | 0.870 |
| 9 | 11.30 | | 0.62 | |
| | 14.10 | | 0.54 | |
| | 18.70 | | 3.20 | |
| | 5.80 | | 0.63 | |
| | 17.60 | 13.50 | 3.20 | 1.638 |
| 10 | 6.60 | | 0.39 | |
| | 6.90 | | 0.38 | |
| | 14.70 | | 0.48 | |
| | 12.60 | | 0.63 | |
| | 15.40 | 11.24 | 0.72 | 0.520 |
| 11 | 14.30 | | 0.48 | |
| | 17.20 | | 0.62 | |
| | 20.90 | | 0.38 | |
| | 14.10 | | 0.73 | |
| | 21.90 | 17.68 | 0.88 | 0.618 |
| 12 | 18.40 | | 0.95 | |
| | 16.40 | | 0.61 | |
| | 12.20 | | 0.88 | |
| | 21.50 | | 0.73 | |
| | 17.00 | 17.10 | 0.95 | 0.824 |

## APPENDIX TABLE II (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| Number | Amount | Mean | Amount | Mean |
| 13 | 10,30 | | 0,85 | |
| | 13.30 | | 0.36 | |
| | 19.60 | | 0.73 | |
| | 19.10 | | 0.47 | |
| | 19.60 | 16.38 | 0,85 | 0.652 |
| 14 | 20.10 | | 0.37 | |
| | 14,20 | | 0.46 | |
| | 14.70 | | 0.38 | |
| | 10,60 | | 0.84 | |
| | 5.50 | 13,02 | 0.45 | 0.500 |
| 15 | 18.50 | | 0,66 | |
| | 5.90 | | 0,45 | |
| | 18.20 | | 2.31 | |
| | 7.80 | | 0.62 | |
| | 12.70 | 12.62 | 2.31 | 1.270 |
| 16 | 9.00 | | 0,84 | |
| | 16.10 | | 0,60 | |
| | 21.40 | | 0,61 | |
| | 21.50 | | 0,73 | |
| | 11,50 | 15.90 | 0.54 | 0.664 |
| 17 | 19.40 | | 0.45 | |
| | 12.40 | | 0.64 | |
| | 8.00 | | 0.83 | |
| | 21.10 | | 0.37 | |
| | 5.20 | 13.22 | 0.59 | 0.576 |
| 18 | 6.40 | | 0.72 | |
| | 14.30 | | 1.72 | |
| | 15.60 | | 0.59 | |
| | 5.50 | | 0.65 | |
| | 14.30 | 11.22 | 0.72 | 0.880 |

## APPENDIX TABLE II (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| Number | Amount | Mean | Amount | Mean |
| 19 | 16.20 | | 0.73 | |
| | 4.70 | | 0.73 | |
| | 15.00 | | 0.95 | |
| | 5.30 | | 0.74 | |
| | 20.90 | 12.42 | 0.65 | 0.760 |
| 20 | 17.90 | | 0.54 | |
| | 5.80 | | 0.51 | |
| | 10.50 | | 0.61 | |
| | 19.40 | | 0.72 | |
| | 21.50 | 15.02 | 0.51 | 0.578 |
| 21 | 13.50 | | 0.54 | |
| | 7.10 | | 0.46 | |
| | 7.70 | | 0.48 | |
| | 12.10 | | 0.46 | |
| | 15.30 | 11.14 | 0.62 | 0.512 |
| 22 | 17.00 | | 0.73 | |
| | 12.20 | | 0.37 | |
| | 14.90 | | 0.59 | |
| | 21.40 | | 0.39 | |
| | 13.00 | 15.70 | 0.59 | 0.534 |
| 23 | 17.30 | | 0.37 | |
| | 15.60 | | 0.84 | |
| | 4.50 | | 0.65 | |
| | 21.80 | | 0.39 | |
| | 5.40 | 12.92 | 0.48 | 0.546 |
| 24 | 9.50 | | 0.36 | |
| | 8.60 | | 0.54 | |
| | 16.40 | | 0.60 | |
| | 15.70 | | 0.65 | |
| | 11.90 | 12.42 | 0.46 | 0.522 |

## APPENDIX TABLE 11 (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| Number | Amount | Mean | Amount | Mean |
| 25 | 16.70 | | 0.84 | |
| | 12.80 | | 0.51 | |
| | 14.10 | | 0.84 | |
| | 17.30 | | 0.65 | |
| | 12.50 | 14.68 | 0.37 | 0.642 |
| 26 | 16.80 | | 0.65 | |
| | 9.50 | | 0.37 | |
| | 15.00 | | 0.46 | |
| | 12.10 | | 0.84 | |
| | 21.30 | 14.90 | 0.67 | 0.598 |
| 27 | 10.10 | | 0.84 | |
| | 8.10 | | 0.66 | |
| | 16.40 | | 0.67 | |
| | 13.50 | | 0.85 | |
| | 16.10 | 12.84 | 0.54 | 0.712 |
| 28 | 9.00 | | 0.46 | |
| | 12.90 | | 0.67 | |
| | 18.70 | | 0.64 | |
| | 9.90 | | 0.67 | |
| | 5.60 | 11.22 | 0.47 | 0.582 |
| 29 | 16.50 | | 0.45 | |
| | 16.40 | | 0.39 | |
| | 13.40 | | 0.84 | |
| | 5.10 | | 0.84 | |
| | 21.20 | 14.52 | 0.38 | 0.580 |
| 30 | 10.80 | | 0.64 | |
| | 8.20 | | 0.36 | |
| | 15.80 | | 1.72 | |
| | 12.80 | | 0.72 | |
| | 15.30 | 12.58 | 0.65 | 0.818 |

## APPENDIX TABLE II (Continued)

### ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample Number | Inflow to Glen Canyon Amount | Mean | Gain to Lake Mead[1] Amount | Mean |
| 31 | 13.10 | | 0.83 | |
| | 7.90 | | 0.38 | |
| | 15.40 | | 0.48 | |
| | 15.80 | | 0.74 | |
| | 14.10 | 13.26 | 0.59 | 0.604 |
| 32 | 11.00 | | 0.60 | |
| | 12.60 | | 0.85 | |
| | 12.50 | | 0.60 | |
| | 18.50 | | 0.65 | |
| | 8.30 | 12.58 | 0.67 | 0.674 |
| 33 | 17.60 | | 1.20 | |
| | 6.20 | | 0.60 | |
| | 19.60 | | 0.67 | |
| | 4.80 | | 0.84 | |
| | 12.50 | 12.14 | 0.85 | 0.832 |
| 34 | 8.90 | | 0.85 | |
| | 5.90 | | 0.84 | |
| | 15.90 | | 1.72 | |
| | 14.90 | | 0.47 | |
| | 12.10 | 11.54 | 0.84 | 0.944 |
| 35 | 15.10 | | 0.65 | |
| | 9.40 | | 0.51 | |
| | 11.60 | | 0.83 | |
| | 18.00 | | 0.83 | |
| | 16.20 | 14.06 | 0.85 | 0.734 |
| 36 | 8.90 | | 0.65 | |
| | 14.80 | | 0.47 | |
| | 15.40 | | 1.72 | |
| | 14.10 | | 0.39 | |
| | 15.80 | 13.80 | 0.85 | 0.816 |

## APPENDIX TABLE 11 (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample Number | Inflow to Glen Canyon Amount | Mean | Gain to Lake Mead[1] Amount | Mean |
| 37 | 21.20 | | 0.73 | |
| | 10.70 | | 0.88 | |
| | 19.60 | | 0.54 | |
| | 11.90 | | 0.83 | |
| | 17.90 | 16.26 | 0.84 | 0.764 |
| 38 | 18.30 | | 0.47 | |
| | 14.20 | | 0.84 | |
| | 15.70 | | 0.62 | |
| | 14.60 | | 0.62 | |
| | 12.70 | 15.10 | 0.88 | 0.686 |
| 39 | 8.00 | | 1.39 | |
| | 13.70 | | 0.73 | |
| | 7.50 | | 1.20 | |
| | 19.30 | | 0.65 | |
| | 17.40 | 13.18 | 0.65 | 0.924 |
| 40 | 12.00 | | 0.60 | |
| | 11.70 | | 0.83 | |
| | 11.40 | | 0.61 | |
| | 20.90 | | 0.54 | |
| | 9.70 | 13.14 | 0.46 | 0.608 |
| 41 | 20.60 | | 0.83 | |
| | 18.10 | | 0.73 | |
| | 21.30 | | 0.37 | |
| | 13.90 | | 0.65 | |
| | 11.00 | 16.98 | 0.62 | 0.640 |
| 42 | 16.20 | | 0.84 | |
| | 7.90 | | 0.36 | |
| | 18.10 | | 0.60 | |
| | 10.40 | | 0.65 | |
| | 11.90 | 12.90 | 0.73 | 0.636 |

## APPENDIX TABLE 11 (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| Number | Amount | Mean | Amount | Mean |
| 43 | 14.40 | | 0.73 | |
| | 12.20 | | 0.64 | |
| | 12.90 | | 0.88 | |
| | 17.50 | | 0.64 | |
| | 19.30 | 15.26 | 0.64 | 0.706 |
| 44 | 5.30 | | 0.66 | |
| | 13.00 | | 0.73 | |
| | 13.20 | | 0.73 | |
| | 13.10 | | 0.45 | |
| | 10.00 | 11.28 | 0.64 | 0.642 |
| 45 | 5.80 | | 0.46 | |
| | 15.20 | | 0.66 | |
| | 10.20 | | 0.46 | |
| | 11.20 | | 0.74 | |
| | 11.40 | 10.76 | 0.74 | 0.612 |
| 46 | 16.30 | | 0.51 | |
| | 7.40 | | 0.95 | |
| | 19.30 | | 0.60 | |
| | 10.90 | | 0.54 | |
| | 7.30 | 12.24 | 0.73 | 0.666 |
| 47 | 18.40 | | 0.84 | |
| | 18.30 | | 0.54 | |
| | 13.90 | | 0.84 | |
| | 14.50 | | 1.72 | |
| | 12.40 | 15.50 | 0.83 | 0.954 |
| 48 | 10.10 | | 0.54 | |
| | 8.10 | | 0.59 | |
| | 16.40 | | 0.95 | |
| | 13.50 | | 0.38 | |
| | 16.10 | 12.84 | 0.61 | 0.614 |

## APPENDIX TABLE 11 (Continued)

### ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| Number | Amount | Mean | Amount | Mean |
| 49 | 13.20 | | 0.83 | |
| | 20.60 | | 0.59 | |
| | 10.20 | | 0.88 | |
| | 21.20 | | 0.88 | |
| | 15.50 | 16.14 | 0.73 | 0.782 |
| 50 | 13.20 | | 1.39 | |
| | 7.40 | | 0.74 | |
| | 15.40 | | 0.83 | |
| | 19.00 | | 0.67 | |
| | 10.90 | 13.18 | 0.46 | 0.818 |
| 51 | 12.00 | | 0.36 | |
| | 15.60 | | 0.74 | |
| | 20.70 | | 0.65 | |
| | 13.30 | | 0.54 | |
| | 7.40 | 13.80 | 0.37 | 0.532 |
| 52 | 7.40 | | 0.60 | |
| | 7.70 | | 0.54 | |
| | 17.10 | | 1.39 | |
| | 5.60 | | 1.39 | |
| | 10.00 | 9.56 | 0.73 | 0.930 |
| 53 | 9.70 | | 1.72 | |
| | 5.80 | | 0.47 | |
| | 9.00 | | 0.73 | |
| | 7.60 | | 0.74 | |
| | 14.50 | 9.32 | 0.66 | 0.864 |
| 54 | 19.80 | | 0.64 | |
| | 8.60 | | 0.60 | |
| | 8.40 | | 0.84 | |
| | 12.60 | | 0.54 | |
| | 17.50 | 13.38 | 1.20 | 0.764 |

## APPENDIX TABLE II (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| Number | Amount | Mean | Amount | Mean |
| 55 | 17.80 | | 0.54 | |
| | 20.40 | | 0.45 | |
| | 17.80 | | 0.45 | |
| | 15.60 | | 0.95 | |
| | 13.50 | 17.02 | 0.74 | 0.626 |
| 56 | 11,50 | | 2.31 | |
| | 21.50 | | 0,84 | |
| | 9.30 | | 1.20 | |
| | 16.00 | | 0.66 | |
| | 11.30 | 13.92 | 0.61 | 1.124 |
| 57 | 10.20 | | 0.59 | |
| | 7.70 | | 0.74 | |
| | 15.30 | | 0.67 | |
| | 15.70 | | 0.38 | |
| | 10.20 | 11.82 | 0.39 | 0.554 |
| 58 | 10.60 | | 0.61 | |
| | 21.30 | | 0.74 | |
| | 21.80 | | 0.69 | |
| | 8.30 | | 0.60 | |
| | 19.90 | 16.38 | 0.46 | 0.620 |
| 59 | 17.40 | | 0.48 | |
| | 6.10 | | 0.48 | |
| | 4.70 | | 0.54 | |
| | 21.60 | | 0.95 | |
| | 17,60 | 13.48 | 0.36 | 0.562 |
| 60 | 13.20 | | 0,85 | |
| | 6,80 | | 0.60 | |
| | 13.30 | | 0.83 | |
| | 4.40 | | 0.62 | |
| | 7.70 | 9.08 | 0.54 | 0.688 |

## APPENDIX TABLE II (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| Sample Number | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| | Amount | Mean | Amount | Mean |
| 61 | 6.80 | | 0.65 | |
| | 6.80 | | 0.74 | |
| | 13.80 | | 0.61 | |
| | 4.50 | | 0.36 | |
| | 9.50 | 8.28 | 0.39 | 0.550 |
| 62 | 12.10 | | 0.54 | |
| | 8.60 | | 0.84 | |
| | 8.20 | | 0.66 | |
| | 9.40 | | 0.65 | |
| | 10.50 | 9.76 | 1.20 | 0.778 |
| 63 | 16.70 | | 0.62 | |
| | 13.00 | | 0.61 | |
| | 16.30 | | 1.39 | |
| | 7.00 | | 1.72 | |
| | 18.10 | 14.22 | 0.74 | 1.016 |
| 64 | 16.30 | | 0.37 | |
| | 8.90 | | 0.72 | |
| | 15.90 | | 0.59 | |
| | 5.40 | | 0.48 | |
| | 19.50 | 13.20 | 0.62 | 0.556 |
| 65 | 9.90 | | 0.88 | |
| | 17.20 | | 0.51 | |
| | 13.30 | | 0.63 | |
| | 13.70 | | 0.59 | |
| | 8.10 | 12.44 | 0.39 | 0.600 |
| 66 | 15.40 | | 0.73 | |
| | 15.70 | | 0.38 | |
| | 15.70 | | 0.47 | |
| | 16.10 | | 0.63 | |
| | 9.10 | 14.40 | 0.67 | 0.576 |

## APPENDIX TABLE II (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| Sample Number | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| | Amount | Mean | Amount | Mean |
| 67 | 17.10 | | 0.64 | |
| | 15.90 | | 0.59 | |
| | 16.20 | | 0.38 | |
| | 16.60 | | 0.73 | |
| | 12.00 | 15.56 | 0.63 | 0.594 |
| 68 | 10.30 | | 0.45 | |
| | 13.50 | | 0.39 | |
| | 20.80 | | 0.73 | |
| | 16.50 | | 0.62 | |
| | 19.80 | 16.18 | 0.61 | 0.560 |
| 69 | 12.40 | | 0.73 | |
| | 14.80 | | 0.37 | |
| | 8.20 | | 0.37 | |
| | 11.90 | | 0.61 | |
| | 10.10 | 11.48 | 0.37 | 0.490 |
| 70 | 10.80 | | 0.39 | |
| | 8.20 | | 0.73 | |
| | 15.80 | | 0.61 | |
| | 12.80 | | 0.51 | |
| | 15.30 | 12.58 | 0.46 | 0.540 |
| 71 | 8.10 | | 0.62 | |
| | 11.40 | | 0.65 | |
| | 9.60 | | 0.72 | |
| | 13.40 | | 0.46 | |
| | 6.70 | 9.84 | 0.66 | 0.622 |
| 72 | 14.10 | | 0.48 | |
| | 12.40 | | 0.62 | |
| | 19.20 | | 0.64 | |
| | 19.20 | | 1.20 | |
| | 20.50 | 17.08 | 0.74 | 0.736 |

## APPENDIX TABLE II (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| Number | Amount | Mean | Amount | Mean |
| 73 | 11.30 | | 0.84 | |
| | 18.90 | | 0.88 | |
| | 14.80 | | 0.51 | |
| | 4.90 | | 0.39 | |
| | 12.50 | 12.48 | 0.37 | 0.598 |
| 74 | 8.50 | | 0.48 | |
| | 10.90 | | 0.72 | |
| | 12.60 | | 0.73 | |
| | 12.20 | | 0.51 | |
| | 8.30 | 10.32 | 0.63 | 0.614 |
| 75 | 21.00 | | 0.62 | |
| | 17.50 | | 0.84 | |
| | 14.90 | | 0.73 | |
| | 8.50 | | 0.64 | |
| | 19.70 | 16.32 | 0.74 | 0.714 |
| 76 | 6.00 | | 0.47 | |
| | 13.10 | | 0.64 | |
| | 10.50 | | 0.62 | |
| | 9.40 | | 0.85 | |
| | 5.70 | 8.94 | 0.66 | 0.648 |
| 77 | 17.70 | | 0.60 | |
| | 21.40 | | 0.46 | |
| | 8.50 | | 0.95 | |
| | 15.00 | | 0.61 | |
| | 20.50 | 16.62 | 0.72 | 0.668 |
| 78 | 20.30 | | 1.20 | |
| | 19.30 | | 0.48 | |
| | 11.60 | | 1.20 | |
| | 14.00 | | 0.64 | |
| | 20.10 | 17.06 | 0.64 | 0.832 |

## APPENDIX TABLE 11 (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| Sample Number | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| | Amount | Mean | Amount | Mean |
| 79 | 5.60 | | 3.20 | |
| | 10.00 | | 0.67 | |
| | 8.70 | | 0.61 | |
| | 11.30 | | 3.20 | |
| | 10.50 | 9.22 | 0.95 | 1.726 |
| 80 | 9.50 | | 0.59 | |
| | 8.30 | | 0.84 | |
| | 9.40 | | 0.39 | |
| | 14.20 | | 0.51 | |
| | 8.20 | 9.92 | 0.67 | 0.600 |
| 81 | 19.00 | | 0.73 | |
| | 13.60 | | 0.65 | |
| | 16.70 | | 0.36 | |
| | 19.30 | | 0.64 | |
| | 11.90 | 16.10 | 0.72 | 0.620 |
| 82 | 18.60 | | 1.20 | |
| | 16.70 | | 0.88 | |
| | 14.40 | | 0.46 | |
| | 10.70 | | 0.54 | |
| | 20.60 | 16.20 | 0.65 | 0.746 |
| 83 | 7.90 | | 0.54 | |
| | 9.00 | | 0.67 | |
| | 14.30 | | 0.83 | |
| | 11.80 | | 0.45 | |
| | 13.80 | 11.36 | 0.85 | 0.668 |
| 84 | 4.80 | | 0.39 | |
| | 7.10 | | 0.46 | |
| | 8.70 | | 0.45 | |
| | 13.20 | | 0.84 | |
| | 11.50 | 9.06 | 0.64 | 0.556 |

## APPENDIX TABLE 11 (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| Sample Number | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| | Amount | Mean | Amount | Mean |
| 85 | 11.90 | | 0.74 | |
| | 9.80 | | 0.62 | |
| | 15.40 | | 0.45 | |
| | 13.30 | | 0.74 | |
| | 14.90 | 13.06 | 0.65 | 0.640 |
| 86 | 9.80 | | 0.85 | |
| | 20.20 | | 3.20 | |
| | 18.50 | | 3.20 | |
| | 13.00 | | 0.67 | |
| | 7.60 | 13.82 | 0.54 | 1.692 |
| 87 | 13.80 | | 0.45 | |
| | 11.40 | | 0.67 | |
| | 16.40 | | 0.73 | |
| | 16.90 | | 0.84 | |
| | 18.10 | 15.32 | 0.37 | 0.612 |
| 88 | 11.00 | | 0.65 | |
| | 14.60 | | 1.39 | |
| | 14.80 | | 0.74 | |
| | 12.10 | | 0.73 | |
| | 17.40 | 13.98 | 0.83 | 0.868 |
| 89 | 18.00 | | 0.36 | |
| | 19.10 | | 0.84 | |
| | 11.60 | | 0.54 | |
| | 16.30 | | 0.65 | |
| | 12.60 | 15.52 | 0.65 | 0.608 |
| 90 | 11.80 | | 0.37 | |
| | 10.80 | | 0.60 | |
| | 14.40 | | 0.85 | |
| | 12.10 | | 0.74 | |
| | 17.10 | 13.24 | 0.95 | 0.702 |

## APPENDIX TABLE II (Continued)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| Sample Number | Millions of Acre-Feet of Water<br>Inflow to Glen Canyon<br>Amount | Mean | Gain to Lake Mead[1]<br>Amount | Mean |
|---|---|---|---|---|
| 91 | 17.20 | | 0.83 | |
| | 17.80 | | 0.62 | |
| | 14.90 | | 0.95 | |
| | 10.60 | | 0.36 | |
| | 13.50 | 14.80 | 0.63 | 0.678 |
| 92 | 10.40 | | 0.46 | |
| | 9.20 | | 0.84 | |
| | 10.00 | | 0.36 | |
| | 10.30 | | 0.59 | |
| | 12.60 | 10.50 | 0.38 | 0.526 |
| 93 | 17.20 | | 0.95 | |
| | 13.40 | | 0.36 | |
| | 17.80 | | 0.73 | |
| | 11.80 | | 0.54 | |
| | 19.10 | 15.86 | 0.67 | 0.650 |
| 94 | 13.40 | | 0.84 | |
| | 15.30 | | 0.46 | |
| | 9.70 | | 0.45 | |
| | 11.10 | | 0.37 | |
| | 9.80 | 11.86 | 0.45 | 0.514 |
| 95 | 9.80 | | 0.38 | |
| | 10.60 | | 0.46 | |
| | 14.00 | | 0.46 | |
| | 11.70 | | 0.84 | |
| | 12.80 | 11.78 | 0.38 | 0.504 |
| 96 | 13.40 | | 1.39 | |
| | 12.70 | | 0.84 | |
| | 17.10 | | 0.65 | |
| | 12.10 | | 0.51 | |
| | 17.20 | 14.50 | 0.72 | 0.822 |

## APPENDIX TABLE II (Concluded)

## ONE HUNDRED RANDOM SAMPLES OF FIVE-YEAR SEQUENCES OF INFLOW TO GLEN CANYON RESERVOIR AND GAIN TO LAKE MEAD[1]

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Sample | Inflow to Glen Canyon | | Gain to Lake Mead[1] | |
| Number | Amount | Mean | Amount | Mean |
| 97 | 13.90 | | 0.73 | |
| | 10.00 | | 0.84 | |
| | 9.60 | | 1.39 | |
| | 11.90 | | 0.51 | |
| | 13.20 | 11.72 | 1.20 | 0.934 |
| 98 | 14.90 | | 0.37 | |
| | 11.50 | | 0.39 | |
| | 14.40 | | 0.38 | |
| | 15.80 | | 0.48 | |
| | 10.60 | 13.44 | 0.83 | 0.490 |
| 99 | 16.30 | | 0.39 | |
| | 14.80 | | 1.20 | |
| | 9.80 | | 1.39 | |
| | 13.20 | | 1.20 | |
| | 16.50 | 14.12 | 0.51 | 0.938 |
| 100 | 13.30 | | 0.74 | |
| | 10.40 | | 0.64 | |
| | 12.10 | | 1.39 | |
| | 14.20 | | 0.46 | |
| | 9.20 | 11.84 | 1.39 | 0.924 |

[1] Represents gain to Lake Mead beyond the amount of water released from Glen Canyon reservoir.

## APPENDIX TABLE III

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 1 | Simulated Flow 2 | Simulated Flow 3 | Simulated Flow 4 |
| 1962 | 13.31 | 18.81 | 16.11 | 19.71 |
| 1963 | 15.12 | 20.22 | 7.72 | 8.42 |
| 1964 | 8.43 | 14.53 | 17.83 | 8.13 |
| 1965 | 10.74 | 10.14 | 10.04 | 12.24 |
| 1966 | 9.35 | 15.85 | 11.45 | 17.05 |
| 1967 | 7.56 | 6.76 | 17.86 | 17.26 |
| 1968 | 10.77 | 12.27 | 17.67 | 19.77 |
| 1969 | 8.88 | 6.58 | 13.18 | 17.08 |
| 1970 | 12.65 | 7.05 | 13.75 | 14.85 |
| 1971 | 5.92 | 5.32 | 11.62 | 12.72 |
| 1972 | 16.48 | 18.08 | 20.18 | 9.28 |
| 1973 | 14.75 | 19.55 | 16.65 | 7.25 |
| 1974 | 3.62 | 13.92 | 14.02 | 15.52 |
| 1975 | 20.89 | 9.59 | 7.59 | 12.59 |
| 1976 | 4.46 | 15.36 | 18.76 | 15.16 |
| 1977 | 5.62 | 12.92 | 3.82 | 11.42 |
| 1978 | 5.89 | 8.99 | 17.79 | 13.79 |
| 1979 | 13.66 | 8.56 | 5.86 | 7.16 |
| 1980 | 11.53 | 10.83 | 19.33 | 10.83 |
| 1981 | 14.30 | 12.10 | 15.50 | 9.00 |
| 1982 | 9.66 | 16.86 | 17.36 | 16.76 |
| 1983 | 7.03 | 17.93 | 4.73 | 4.63 |
| 1984 | 14.60 | 10.40 | 17.00 | 9.30 |
| 1985 | 11.57 | 15.07 | 6.57 | 18.17 |
| 1986 | 14.04 | 11.34 | 11.44 | 20.24 |
| 1987 | 8.20 | 11.10 | 10.80 | 4.30 |
| 1988 | 7.27 | 13.47 | 7.27 | 8.67 |
| 1989 | 15.04 | 6.84 | 6.84 | 7.34 |
| 1990 | 14.31 | 10.51 | 8.01 | 9.91 |
| 1991 | 10.48 | 8.68 | 9.08 | 9.08 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
## 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 5 | Simulated Flow 6 | Simulated Flow 7 | Simulated Flow 8 |
| 1962 | 8.81 | 6.71 | 15.31 | 18.31 |
| 1963 | 5.72 | 6.62 | 15.52 | 18.12 |
| 1964 | 15.63 | 13.53 | 15.43 | 13.63 |
| 1965 | 14.54 | 4.14 | 15.74 | 14.14 |
| 1966 | 11.65 | 9.05 | 8.65 | 11.95 |
| 1967 | 18.46 | 16.66 | 15.06 | 9.26 |
| 1968 | 12.97 | 17.17 | 14.37 | 19.57 |
| 1969 | 15.98 | 14.18 | 6.18 | 17.78 |
| 1970 | 18.55 | 9.85 | 13.55 | 12.25 |
| 1971 | 11.12 | 12.72 | 11.92 | 6.82 |
| 1972 | 15.48 | 11.18 | 4.98 | 18.18 |
| 1973 | 13.95 | 10.85 | 14.35 | 12.75 |
| 1974 | 8.92 | 10.52 | 9.32 | 15.82 |
| 1975 | 12.29 | 19.99 | 10.29 | 18.39 |
| 1976 | 15.56 | 8.76 | 10.46 | 10.96 |
| 1977 | 10.32 | 16.32 | 5.82 | 17.52 |
| 1978 | 17.89 | 14.59 | 5.79 | 4.89 |
| 1979 | 13.76 | 3.46 | 12.76 | 17.16 |
| 1980 | 3.83 | 20.73 | 3.43 | 6.73 |
| 1981 | 11.40 | 4.30 | 8.40 | 11.60 |
| 1982 | 10.16 | 7.86 | 15.16 | 13.16 |
| 1983 | 17.73 | 14.93 | 13.63 | 16.03 |
| 1984 | 13.60 | 20.20 | 8.60 | 19.70 |
| 1985 | 3.67 | 20.27 | 11.97 | 12.87 |
| 1986 | 11.24 | 10.24 | 15.24 | 20.64 |
| 1987 | 19.00 | 19.30 | 9.30 | 10.20 |
| 1988 | 17.97 | 16.77 | 19.97 | 20.17 |
| 1989 | 10.24 | 19.94 | 20.44 | 7.94 |
| 1990 | 12.61 | 12.51 | 6.91 | 14.61 |
| 1991 | 18.68 | 9.58 | 18.48 | 9.88 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| | Simulated Flow | Simulated Flow | Simulated Flow | Simulated Flow |
| Year | 9 | 10 | 11 | 12 |
| 1962 | 10.01 | 20.81 | 20.51 | 10.31 |
| 1963 | 7.92 | 17.92 | 17.92 | 9.22 |
| 1964 | 16.13 | 13.63 | 21.03 | 10.03 |
| 1965 | 13.14 | 15.94 | 13.54 | 6.74 |
| 1966 | 15.65 | 19.35 | 10.55 | 6.55 |
| 1967 | 16.76 | 17.96 | 20.06 | 9.36 |
| 1968 | 14.97 | 5.27 | 17.47 | 16.57 |
| 1969 | 3.78 | 17.48 | 20.58 | 12.58 |
| 1970 | 21.05 | 7.05 | 13.15 | 12.95 |
| 1971 | 4.62 | 11.92 | 10.22 | 7.32 |
| 1972 | 17.78 | 11.58 | 17.58 | 14.28 |
| 1973 | 15.85 | 13.95 | 15.55 | 8.55 |
| 1974 | 13.52 | 7.32 | 11.32 | 10.72 |
| 1975 | 9.79 | 10.99 | 20.59 | 17.09 |
| 1976 | 19.66 | 9.16 | 16.06 | 15.26 |
| 1977 | 14.42 | 15.22 | 16.82 | 7.02 |
| 1978 | 14.69 | 3.69 | 19.39 | 12.69 |
| 1979 | 14.66 | 13.96 | 16.76 | 6.46 |
| 1980 | 15.03 | 4.23 | 14.53 | 18.23 |
| 1981 | 8.00 | 19.80 | 12.40 | 16.30 |
| 1982 | 11.26 | 4.86 | 16.26 | 10.66 |
| 1983 | 13.63 | 11.93 | 4.93 | 9.63 |
| 1984 | 7.00 | 9.30 | 3.50 | 13.20 |
| 1985 | 10.67 | 8.17 | 20.37 | 10.87 |
| 1986 | 8.84 | 4.44 | 16.34 | 15.84 |
| 1987 | 16.60 | 9.10 | 19.00 | 9.70 |
| 1988 | 4.47 | 7.87 | 17.97 | 11.27 |
| 1989 | 9.14 | 8.64 | 10.24 | 11.14 |
| 1990 | 18.01 | 8.91 | 12.61 | 17.11 |
| 1991 | 20.08 | 11.18 | 18.68 | 6.88 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 13 | Simulated Flow 14 | Simulated Flow 15 | Simulated Flow 16 |
| 1962 | 7.81 | 18.31 | 15.31 | 13.81 |
| 1963 | 8.82 | 16.22 | 15.52 | 9.82 |
| 1964 | 14.03 | 11.93 | 15.43 | 9.33 |
| 1965 | 11.44 | 21.14 | 15.74 | 11.54 |
| 1966 | 13.35 | 16.55 | 8.65 | 12.75 |
| 1967 | 15.76 | 15.76 | 7.96 | 11.26 |
| 1968 | 14.17 | 8.27 | 10.27 | 10.17 |
| 1969 | 9.08 | 15.18 | 11.88 | 13.68 |
| 1970 | 12.45 | 4.65 | 11.45 | 11.35 |
| 1971 | 15.72 | 18.72 | 7.52 | 16.32 |
| 1972 | 10.18 | 18.58 | 18.98 | 12.28 |
| 1973 | 11.75 | 11.55 | 7.75 | 7.05 |
| 1974 | 11.62 | 7.12 | 7.52 | 14.52 |
| 1975 | 17.59 | 20.19 | 11.69 | 14.89 |
| 1976 | 7.36 | 4.26 | 16.56 | 13.16 |
| 1977 | 10.32 | 19.62 | 14.12 | 5.82 |
| 1978 | 13.09 | 17.09 | 8.39 | 5.79 |
| 1979 | 17.66 | 20.26 | 10.56 | 12.76 |
| 1980 | 4.73 | 12.83 | 16.93 | 3.43 |
| 1981 | 16.50 | 9.90 | 15.10 | 8.40 |
| 1982 | 8.36 | 16.66 | 19.46 | 17.26 |
| 1983 | 7.13 | 19.23 | 16.93 | 17.13 |
| 1984 | 8.20 | 16.60 | 20.10 | 12.70 |
| 1985 | 12.97 | 14.37 | 12.67 | 13.27 |
| 1986 | 6.94 | 12.24 | 9.74 | 11.14 |
| 1987 | 6.10 | 16.60 | 16.10 | 8.40 |
| 1988 | 6.37 | 4.47 | 4.77 | 4.47 |
| 1989 | 15.74 | 9.14 | 3.34 | 7.64 |
| 1990 | 4.21 | 18.01 | 20.21 | 6.21 |
| 1991 | 8.58 | 20.08 | 16.18 | 13.08 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 17 | Simulated Flow 18 | Simulated Flow 19 | Simulated Flow 20 |
| 1962 | 10.51 | 5.71 | 9.71 | 16.21 |
| 1963 | 21.12 | 15.02 | 10.42 | 14.62 |
| 1964 | 21.53 | 9.93 | 13.73 | 9.53 |
| 1965 | 7.94 | 10.84 | 11.34 | 12.84 |
| 1966 | 19.45 | 10.95 | 12.35 | 16.05 |
| 1967 | 10.76 | 19.26 | 16.16 | 10.96 |
| 1968 | 13.47 | 7.97 | 12.17 | 20.87 |
| 1969 | 17.98 | 7.68 | 13.38 | 8.58 |
| 1970 | 5.05 | 11.85 | 16.55 | 15.25 |
| 1971 | 16.82 | 16.72 | 11.72 | 10.52 |
| 1972 | 11.18 | 8.98 | 20.08 | 11.18 |
| 1973 | 10.85 | 9.75 | 17.25 | 14.75 |
| 1974 | 10.52 | 13.12 | 13.02 | 19.82 |
| 1975 | 19.99 | 10.79 | 15.39 | 12.39 |
| 1976 | 8.76 | 11.86 | 18.86 | 6.46 |
| 1977 | 7.12 | 8.82 | 9.32 | 19.32 |
| 1978 | 10.39 | 19.19 | 12.49 | 18.29 |
| 1979 | 8.56 | 17.46 | 19.76 | 10.56 |
| 1980 | 12.33 | 11.93 | 15.43 | 12.93 |
| 1981 | 5.60 | 6.50 | 18.70 | 19.00 |
| 1982 | 16.56 | 8.96 | 18.66 | 10.86 |
| 1983 | 20.23 | 6.93 | 7.43 | 10.53 |
| 1984 | 7.30 | 15.20 | 7.20 | 10.20 |
| 1985 | 13.77 | 12.27 | 11.37 | 19.67 |
| 1986 | 19.24 | 14.84 | 16.24 | 8.44 |
| 1987 | 15.40 | 17.50 | 10.50 | 15.00 |
| 1988 | 11.47 | 16.07 | 9.47 | 7.57 |
| 1989 | 12.74 | 7.74 | 13.04 | 14.54 |
| 1990 | 15.91 | 11.91 | 10.71 | 4.01 |
| 1991 | 11.08 | 18.28 | 15.68 | 18.08 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 21 | Simulated Flow 22 | Simulated Flow 23 | Simulated Flow 24 |
| 1962 | 6.71 | 17.21 | 18.21 | 16.91 |
| 1963 | 6.62 | 15.42 | 14.02 | 12.02 |
| 1964 | 13.53 | 4.23 | 15.43 | 14.63 |
| 1965 | 4.14 | 21.44 | 14.24 | 21.04 |
| 1966 | 9.05 | 4.95 | 12.25 | 12.55 |
| 1967 | 10.46 | 7.36 | 12.86 | 12.66 |
| 1968 | 11.97 | 8.37 | 14.67 | 6.17 |
| 1969 | 11.78 | 13.58 | 8.98 | 12.58 |
| 1970 | 17.75 | 11.05 | 10.35 | 3.65 |
| 1971 | 7.52 | 13.02 | 9.02 | 6.92 |
| 1972 | 11.18 | 11.28 | 13.58 | 19.48 |
| 1973 | 14.75 | 7.75 | 11.35 | 18.45 |
| 1974 | 19.82 | 7.32 | 12.02 | 10.72 |
| 1975 | 12.39 | 8.49 | 16.59 | 13.09 |
| 1976 | 6.46 | 9.56 | 18.36 | 19.16 |
| 1977 | 4.62 | 9.12 | 16.62 | 6.42 |
| 1978 | 8.99 | 7.09 | 5.19 | 6.69 |
| 1979 | 7.66 | 15.36 | 18.56 | 16.06 |
| 1980 | 10.23 | 12.43 | 3.73 | 4.53 |
| 1981 | 9.40 | 15.00 | 11.40 | 8.90 |
| 1982 | 10.86 | 16.86 | 6.26 | 9.26 |
| 1983 | 14.43 | 17.93 | 6.53 | 8.23 |
| 1984 | 19.50 | 10.40 | 15.90 | 9.10 |
| 1985 | 12.07 | 15.07 | 4.37 | 5.87 |
| 1986 | 6.14 | 11.34 | 8.74 | 5.74 |
| 1987 | 6.00 | 16.10 | 14.30 | 9.00 |
| 1988 | 11.57 | 4.77 | 13.67 | 11.97 |
| 1989 | 5.94 | 3.34 | 5.54 | 18.24 |
| 1990 | 6.41 | 20.21 | 12.91 | 17.71 |
| 1991 | 4.68 | 16.18 | 11.28 | 18.18 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
## 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 25 | Simulated Flow 26 | Simulated Flow 27 | Simulated Flow 28 |
| 1962 | 16.61 | 14.31 | 20.01 | 20.21 |
| 1963 | 12.82 | 12.02 | 14.02 | 19.12 |
| 1964 | 16.03 | 12.63 | 14.43 | 11.33 |
| 1965 | 6.64 | 17.14 | 10.24 | 13.64 |
| 1966 | 17.65 | 18.85 | 5.05 | 19.65 |
| 1967 | 4.26 | 13.36 | 5.06 | 18.46 |
| 1968 | 18.17 | 9.37 | 9.37 | 12.97 |
| 1969 | 6.18 | 8.88 | 7.98 | 15.98 |
| 1970 | 19.65 | 11.15 | 10.55 | 18.55 |
| 1971 | 15.82 | 12.42 | 9.72 | 11.12 |
| 1972 | 15.48 | 9.28 | 13.48 | 18.08 |
| 1973 | 8.05 | 7.25 | 16.35 | 19.55 |
| 1974 | 15.02 | 15.52 | 20.02 | 13.92 |
| 1975 | 4.49 | 12.59 | 13.19 | 9.59 |
| 1976 | 18.56 | 15.16 | 20.96 | 15.36 |
| 1977 | 8.52 | 17.32 | 8.52 | 3.82 |
| 1978 | 7.29 | 13.19 | 7.59 | 17.79 |
| 1979 | 8.36 | 14.66 | 15.36 | 5.86 |
| 1980 | 13.13 | 13.53 | 14.63 | 19.33 |
| 1981 | 7.10 | 11.60 | 10.80 | 15.50 |
| 1982 | 19.76 | 15.06 | 10.36 | 8.36 |
| 1983 | 16.93 | 3.53 | 20.33 | 7.43 |
| 1984 | 12.70 | 13.80 | 8.10 | 15.20 |
| 1985 | 15.07 | 4.07 | 14.77 | 14.47 |
| 1986 | 18.54 | 19.64 | 10.04 | 10.64 |
| 1987 | 19.70 | 10.70 | 9.70 | 13.80 |
| 1988 | 16.17 | 10.37 | 11.27 | 8.07 |
| 1989 | 13.54 | 10.04 | 11.14 | 10.24 |
| 1990 | 7.11 | 19.51 | 17.11 | 16.61 |
| 1991 | 18.28 | 8.28 | 6.88 | 14.78 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 29 | Simulated Flow 30 | Simulated Flow 31 | Simulated Flow 32 |
| 1962 | 7.81 | 16.61 | 11.21 | 15.51 |
| 1963 | 10.02 | 12.62 | 18.72 | 14.82 |
| 1964 | 7.83 | 13.83 | 14.53 | 6.63 |
| 1965 | 9.54 | 16.94 | 4.54 | 13.94 |
| 1966 | 13.85 | 12.05 | 12.05 | 12.25 |
| 1967 | 17.26 | 17.36 | 13.56 | 17.96 |
| 1968 | 19.77 | 5.17 | 11.77 | 5.27 |
| 1969 | 17.08 | 9.78 | 18.48 | 17.48 |
| 1970 | 14.85 | 18.65 | 18.45 | 7.05 |
| 1971 | 12.72 | 20.72 | 19.72 | 11.92 |
| 1972 | 14.58 | 9.48 | 5.18 | 11.58 |
| 1973 | 14.85 | 12.45 | 12.25 | 13.95 |
| 1974 | 14.82 | 18.72 | 9.62 | 7.32 |
| 1975 | 15.19 | 18.19 | 8.49 | 10.99 |
| 1976 | 8.16 | 18.66 | 4.76 | 9.16 |
| 1977 | 11.02 | 10.82 | 9.62 | 7.52 |
| 1978 | 14.59 | 9.79 | 20.29 | 9.89 |
| 1979 | 19.66 | 13.36 | 20.76 | 11.56 |
| 1980 | 12.23 | 11.03 | 7.23 | 11.13 |
| 1981 | 6.30 | 16.00 | 18.80 | 7.20 |
| 1982 | 8.36 | 8.56 | 5.46 | 14.46 |
| 1983 | 7.43 | 4.63 | 5.73 | 13.83 |
| 1984 | 15.20 | 7.80 | 13.50 | 5.70 |
| 1985 | 14.47 | 6.37 | 11.37 | 13.07 |
| 1986 | 10.64 | 13.24 | 14.14 | 11.44 |
| 1987 | 12.20 | 12.00 | 14.90 | 10.00 |
| 1988 | 5.77 | 9.07 | 3.37 | 17.57 |
| 1989 | 6.34 | 10.74 | 13.64 | 13.44 |
| 1990 | 10.71 | 12.81 | 3.91 | 3.51 |
| 1991 | 13.88 | 7.78 | 19.48 | 11.08 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVIOR
## 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 33 | Simulated Flow 34 | Simulated Flow 35 | Simulated Flow 36 |
| 1962 | 10.21 | 17.51 | 17.11 | 14.21 |
| 1963 | 13.32 | 6.02 | 17.62 | 17.02 |
| 1964 | 20.53 | 19.33 | 14.63 | 20.63 |
| 1965 | 16.14 | 4.44 | 10.24 | 13.74 |
| 1966 | 19.35 | 12.05 | 13.05 | 21.45 |
| 1967 | 5.46 | 13.26 | 7.36 | 14.36 |
| 1968 | 12.47 | 10.77 | 8.37 | 10.87 |
| 1969 | 9.78 | 15.68 | 13.58 | 13.68 |
| 1970 | 8.65 | 16.15 | 11.05 | 15.05 |
| 1971 | 4.92 | 17.32 | 13.02 | 9.82 |
| 1972 | 10.48 | 9.58 | 15.68 | 3.98 |
| 1973 | 18.05 | 8.35 | 15.55 | 17.95 |
| 1974 | 13.92 | 9.12 | 12.52 | 6.02 |
| 1975 | 3.99 | 9.39 | 4.19 | 19.49 |
| 1976 | 11.56 | 11.66 | 20.26 | 15.66 |
| 1977 | 8.82 | 12.22 | 7.52 | 12.42 |
| 1978 | 9.59 | 19.59 | 9.89 | 11.69 |
| 1979 | 12.96 | 9.16 | 11.56 | 16.06 |
| 1980 | 10.63 | 20.13 | 11.13 | 11.03 |
| 1981 | 11.70 | 14.40 | 7.20 | 16.10 |
| 1982 | 4.16 | 13.76 | 14.26 | 10.96 |
| 1983 | 11.83 | 10.33 | 14.53 | 7.43 |
| 1984 | 12.00 | 13.20 | 14.50 | 7.00 |
| 1985 | 11.87 | 14.57 | 14.87 | 8.17 |
| 1986 | 8.74 | 9.34 | 7.84 | 9.24 |
| 1987 | 18.50 | 6.60 | 14.90 | 17.30 |
| 1988 | 7.27 | 8.87 | 6.57 | 15.37 |
| 1989 | 7.04 | 6.74 | 16.74 | 13.04 |
| 1990 | 11.21 | 8.51 | 9.01 | 9.31 |
| 1991 | 16.08 | 12.88 | 10.48 | 19.18 |

## APPENDIX TABLE III (Continued)

### SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
### 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 37 | Simulated Flow 38 | Simulated Flow 39 | Simulated Flow 40 |
| 1962 | 18.91 | 16.41 | 11.21 | 7.21 |
| 1963 | 13.42 | 16.22 | 13.92 | 12.72 |
| 1964 | 16.43 | 13.13 | 18.43 | 7.03 |
| 1965 | 18.94 | 4.74 | 5.44 | 7.44 |
| 1966 | 11.45 | 20.75 | 17.15 | 5.65 |
| 1967 | 13.76 | 8.46 | 12.76 | 5.86 |
| 1968 | 16.57 | 12.27 | 9.77 | 13.67 |
| 1969 | 20.18 | 17.98 | 11.38 | 14.88 |
| 1970 | 13.35 | 9.15 | 13.45 | 4.75 |
| 1971 | 21.12 | 4.82 | 8.42 | 13.52 |
| 1972 | 7.68 | 7.68 | 10.48 | 17.58 |
| 1973 | 10.05 | 10.05 | 18.05 | 17.45 |
| 1974 | 11.72 | 11.72 | 13.92 | 13.02 |
| 1975 | 11.29 | 11.29 | 3.99 | 13.59 |
| 1976 | 7.36 | 7.36 | 11.56 | 11.46 |
| 1977 | 9.82 | 7.52 | 14.12 | 15.32 |
| 1978 | 7.19 | 9.89 | 8.39 | 7.89 |
| 1979 | 14.76 | 11.56 | 10.56 | 14.86 |
| 1980 | 11.73 | 11.13 | 16.93 | 4.33 |
| 1981 | 14.20 | 7.20 | 15.10 | 18.40 |
| 1982 | 7.36 | 16.56 | 12.06 | 3.66 |
| 1983 | 9.73 | 20.23 | 19.43 | 17.63 |
| 1984 | 11.40 | 7.30 | 9.00 | 5.70 |
| 1985 | 10.97 | 13.77 | 19.97 | 19.17 |
| 1986 | 7.04 | 19.24 | 14.24 | 15.34 |
| 1987 | 9.70 | 10.20 | 3.50 | 15.00 |
| 1988 | 11.27 | 20.17 | 17.47 | 7.57 |
| 1989 | 11.14 | 7.94 | 5.54 | 14.54 |
| 1990 | 17.11 | 14.61 | 19.01 | 4.01 |
| 1991 | 6.88 | 9.88 | 15.18 | 18.08 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
1962 - 1991

|  | Millions of Acre-Feet of Water |  |  |  |
|---|---|---|---|---|
| Year | Simulated Flow 41 | Simulated Flow 42 | Simulated Flow 43 | Simulated Flow 44 |
| 1962 | 17.01 | 16.21 | 6.71 | 20.51 |
| 1963 | 15.72 | 7.22 | 6.62 | 17.92 |
| 1964 | 15.93 | 19.03 | 13.53 | 21.03 |
| 1965 | 16.24 | 10.54 | 4.14 | 13.54 |
| 1966 | 11.55 | 6.85 | 9.05 | 10.55 |
| 1967 | 18.06 | 8.96 | 5.26 | 7.36 |
| 1968 | 16.07 | 7.67 | 14.57 | 9.57 |
| 1969 | 13.68 | 8.68 | 9.48 | 7.38 |
| 1970 | 9.95 | 13.45 | 10.45 | 9.15 |
| 1971 | 19.82 | 7.42 | 10.62 | 13.52 |
| 1972 | 10.98 | 5.18 | 8.18 | 16.58 |
| 1973 | 9.95 | 12.25 | 12.05 | 5.25 |
| 1974 | 13.52 | 9.62 | 17.82 | 3.82 |
| 1975 | 11.19 | 8.49 | 8.99 | 20.69 |
| 1976 | 16.16 | 4.76 | 4.66 | 16.66 |
| 1977 | 10.02 | 16.82 | 12.42 | 12.92 |
| 1978 | 13.59 | 19.39 | 14.29 | 8.99 |
| 1979 | 13.76 | 16.76 | 8.66 | 8.59 |
| 1980 | 11.03 | 14.53 | 10.03 | 10.83 |
| 1981 | 16.30 | 12.40 | 8.70 | 12.10 |
| 1982 | 16.76 | 12.36 | 9.66 | 9.46 |
| 1983 | 4.63 | 5.93 | 7.03 | 20.13 |
| 1984 | 9.30 | 6.50 | 14.60 | 20.60 |
| 1985 | 18.17 | 10.87 | 11.57 | 7.07 |
| 1986 | 20.24 | 14.04 | 14.04 | 18.64 |
| 1987 | 6.60 | 19.60 | 17.50 | 10.50 |
| 1988 | 8.87 | 16.77 | 16.07 | 9.47 |
| 1989 | 6.74 | 12.54 | 7.74 | 13.04 |
| 1990 | 8.51 | 14.91 | 11.91 | 10.71 |
| 1991 | 12.88 | 18.38 | 18.28 | 15.68 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 45 | Simulated Flow 46 | Simulated Flow 47 | Simulated Flow 48 |
| 1962 | 5.91 | 7.81 | 18.81 | 17.71 |
| 1963 | 12.92 | 8.82 | 20.22 | 20.22 |
| 1964 | 10.23 | 14.03 | 14.53 | 17.53 |
| 1965 | 9.04 | 11.44 | 10.14 | 15.24 |
| 1966 | 5.25 | 13.35 | 15.85 | 13.05 |
| 1967 | 7.36 | 10.76 | 12.66 | 19.76 |
| 1968 | 9.57 | 18.27 | 19.97 | 18.67 |
| 1969 | 7.38 | 14.08 | 9.48 | 10.88 |
| 1970 | 9.15 | 4.15 | 20.45 | 13.25 |
| 1971 | 13.52 | 11.72 | 14.72 | 19.32 |
| 1972 | 9.28 | 8.08 | 17.18 | 12.68 |
| 1973 | 7.25 | 5.05 | 18.25 | 6.25 |
| 1974 | 15.52 | 15.02 | 10.72 | 6.82 |
| 1975 | 12.59 | 13.99 | 15.39 | 11.19 |
| 1976 | 15.16 | 11.16 | 11.66 | 14.36 |
| 1977 | 9.82 | 12.52 | 15.82 | 8.82 |
| 1978 | 7.19 | 6.09 | 8.49 | 19.19 |
| 1979 | 14.76 | 6.66 | 13.96 | 17.46 |
| 1980 | 11.73 | 11.03 | 11.03 | 11.93 |
| 1981 | 14.20 | 14.20 | 20.20 | 6.50 |
| 1982 | 12.06 | 7.76 | 6.96 | 3.66 |
| 1983 | 19.43 | 4.73 | 10.23 | 5.93 |
| 1984 | 9.00 | 14.70 | 8.40 | 7.50 |
| 1985 | 19.97 | 13.67 | 12.17 | 11.97 |
| 1986 | 14.24 | 10.84 | 5.44 | 10.24 |
| 1987 | 5.30 | 16.70 | 5.30 | 12.60 |
| 1988 | 5.57 | 17.77 | 5.57 | 8.67 |
| 1989 | 13.34 | 10.24 | 13.34 | 8.24 |
| 1990 | 11.21 | 14.91 | 11.21 | 10.51 |
| 1991 | 13.98 | 11.18 | 13.98 | 11.78 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 49 | Simulated Flow 50 | Simulated Flow 51 | Simulated Flow 52 |
| 1962 | 8.01 | 20.91 | 5.71 | 11.41 |
| 1963 | 11.22 | 17.32 | 15.02 | 21.32 |
| 1964 | 9.33 | 14.63 | 9.93 | 9.03 |
| 1965 | 13.04 | 8.14 | 10.84 | 15.64 |
| 1966 | 6.25 | 19.25 | 10.95 | 10.85 |
| 1967 | 9.76 | 17.16 | 9.56 | 13.26 |
| 1968 | 12.87 | 20.77 | 7.47 | 10.77 |
| 1969 | 20.08 | 7.78 | 15.68 | 15.68 |
| 1970 | 15.75 | 14.25 | 12.75 | 16.15 |
| 1971 | 19.02 | 19.72 | 15.32 | 17.32 |
| 1972 | 18.58 | 10.18 | 9.38 | 16.88 |
| 1973 | 11.55 | 11.75 | 6.85 | 20.55 |
| 1974 | 7.12 | 11.62 | 14.42 | 7.62 |
| 1975 | 20.19 | 17.59 | 14.79 | 14.09 |
| 1976 | 4.26 | 7.36 | 9.26 | 19.56 |
| 1977 | 16.22 | 9.32 | 8.52 | 15.82 |
| 1978 | 12.39 | 12.49 | 7.29 | 8.49 |
| 1979 | 16.76 | 19.76 | 8.36 | 13.96 |
| 1980 | 10.73 | 15.43 | 13.13 | 11.03 |
| 1981 | 18.00 | 18.70 | 7.10 | 20.20 |
| 1982 | 19.76 | 16.06 | 20.06 | 9.16 |
| 1983 | 16.93 | 12.23 | 9.53 | 12.13 |
| 1984 | 12.70 | 16.60 | 18.40 | 18.40 |
| 1985 | 15.07 | 10.57 | 10.67 | 17.87 |
| 1986 | 18.54 | 17.84 | 16.64 | 18.34 |
| 1987 | 12.10 | 13.00 | 8.80 | 5.10 |
| 1988 | 11.37 | 15.87 | 6.77 | 12.97 |
| 1989 | 15.74 | 19.54 | 15.04 | 14.24 |
| 1990 | 10.71 | 12.71 | 12.11 | 4.11 |
| 1991 | 15.78 | 20.48 | 14.68 | 12.88 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 53 | Simulated Flow 54 | Simulated Flow 55 | Simulated Flow 56 |
| 1962 | 20.51 | 7.81 | 20.91 | 7.21 |
| 1963 | 17.92 | 8.82 | 17.32 | 12.72 |
| 1964 | 21.03 | 14.03 | 14.63 | 7.03 |
| 1965 | 13.54 | 11.44 | 8.14 | 7.44 |
| 1966 | 10.55 | 13.35 | 19.25 | 5.65 |
| 1967 | 6.86 | 6.26 | 9.56 | 6.06 |
| 1968 | 7.07 | 6.17 | 7.47 | 6.27 |
| 1969 | 16.38 | 13.08 | 15.68 | 13.98 |
| 1970 | 4.85 | 3.75 | 12.75 | 11.85 |
| 1971 | 9.22 | 8.72 | 15.32 | 14.62 |
| 1972 | 8.98 | 17.58 | 13.48 | 4.48 |
| 1973 | 19.35 | 17.45 | 16.35 | 12.15 |
| 1974 | 17.62 | 13.02 | 20.02 | 12.32 |
| 1975 | 12.09 | 13.59 | 13.19 | 12.19 |
| 1976 | 6.66 | 11.46 | 20.96 | 9.06 |
| 1977 | 7.92 | 10.02 | 19.12 | 16.72 |
| 1978 | 13.79 | 11.59 | 13.19 | 20.39 |
| 1979 | 14.36 | 11.46 | 13.66 | 7.46 |
| 1980 | 13.03 | 17.43 | 9.53 | 13.93 |
| 1981 | 14.70 | 7.20 | 4.40 | 19.40 |
| 1982 | 8.66 | 15.56 | 15.96 | 9.16 |
| 1983 | 9.43 | 11.63 | 14.73 | 12.33 |
| 1984 | 12.80 | 12.90 | 15.00 | 19.60 |
| 1985 | 10.47 | 16.07 | 15.37 | 15.27 |
| 1986 | 11.54 | 11.24 | 10.74 | 18.54 |
| 1987 | 6.70 | 7.60 | 9.00 | 9.00 |
| 1988 | 12.37 | 4.57 | 12.17 | 12.17 |
| 1989 | 6.14 | 14.54 | 19.44 | 19.44 |
| 1990 | 17.91 | 13.51 | 15.11 | 15.11 |
| 1991 | 15.98 | 10.68 | 18.38 | 18.38 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 57 | Simulated Flow 58 | Simulated Flow 59 | Simulated Flow 60 |
| 1962 | 5.71 | 18.51 | 13.81 | 19.71 |
| 1963 | 15.02 | 16.52 | 9.82 | 8.42 |
| 1964 | 9.93 | 14.13 | 9.33 | 8.13 |
| 1965 | 10.84 | 10.34 | 11.54 | 12.24 |
| 1966 | 10.95 | 20.15 | 12.75 | 17.05 |
| 1967 | 9.26 | 12.86 | 15.66 | 18.06 |
| 1968 | 9.97 | 14.67 | 4.07 | 16.07 |
| 1969 | 13.28 | 8.98 | 14.28 | 13.68 |
| 1970 | 10.95 | 10.35 | 4.55 | 9.95 |
| 1971 | 12.02 | 9.02 | 20.12 | 19.82 |
| 1972 | 3.98 | 12.68 | 15.38 | 5.78 |
| 1973 | 17.95 | 6.25 | 3.85 | 6.05 |
| 1974 | 6.02 | 6.82 | 14.12 | 13.82 |
| 1975 | 19.49 | 11.19 | 4.39 | 11.69 |
| 1976 | 15.66 | 14.36 | 19.96 | 14.46 |
| 1977 | 7.52 | 9.82 | 20.02 | 9.22 |
| 1978 | 9.89 | 7.19 | 16.49 | 6.69 |
| 1979 | 11.56 | 14.76 | 13.86 | 14.26 |
| 1980 | 11.13 | 11.73 | 7.43 | 14.63 |
| 1981 | 7.20 | 14.20 | 18.60 | 9.10 |
| 1982 | 9.06 | 6.76 | 9.66 | 15.56 |
| 1983 | 6.53 | 7.83 | 7.03 | 11.83 |
| 1984 | 14.10 | 13.10 | 14.60 | 15.10 |
| 1985 | 14.47 | 10.57 | 11.57 | 5.77 |
| 1986 | 8.94 | 12.54 | 14.04 | 16.84 |
| 1987 | 8.50 | 9.00 | 8.50 | 15.70 |
| 1988 | 18.87 | 12.17 | 9.27 | 10.87 |
| 1989 | 17.14 | 19.44 | 12.64 | 13.54 |
| 1990 | 11.61 | 15.11 | 10.31 | 20.01 |
| 1991 | 6.18 | 18.38 | 11.38 | 11.58 |

## APPENDIX TABLE III (Continued)

### SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
### 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 61 | Simulated Flow 62 | Simulated Flow 63 | Simulated Flow 64 |
| 1962 | 13.21 | 15.01 | 17.01 | 13.11 |
| 1963 | 10.22 | 9.22 | 15.72 | 6.62 |
| 1964 | 11.83 | 11.33 | 15.93 | 13.03 |
| 1965 | 13.84 | 17.64 | 16.24 | 4.04 |
| 1966 | 8.75 | 15.75 | 11.55 | 7.25 |
| 1967 | 7.36 | 17.26 | 4.76 | 9.26 |
| 1968 | 8.37 | 19.77 | 12.37 | 19.57 |
| 1969 | 13.58 | 17.08 | 12.48 | 17.78 |
| 1970 | 11.05 | 14.85 | 12.35 | 12.25 |
| 1971 | 13.02 | 12.72 | 9.22 | 6.82 |
| 1972 | 17.18 | 18.58 | 12.38 | 19.78 |
| 1973 | 18.25 | 11.55 | 5.95 | 17.25 |
| 1974 | 10.72 | 7.12 | 12.42 | 20.42 |
| 1975 | 15.39 | 20.19 | 3.49 | 12.99 |
| 1976 | 11.66 | 4.26 | 6.76 | 10.06 |
| 1977 | 17.32 | 8.52 | 15.22 | 17.02 |
| 1978 | 13.19 | 7.59 | 3.69 | 18.09 |
| 1979 | 14.66 | 15.36 | 13.96 | 10.56 |
| 1980 | 13.53 | 14.63 | 4.23 | 15.23 |
| 1981 | 11.60 | 10.80 | 19.80 | 11.50 |
| 1982 | 15.66 | 9.66 | 9.86 | 18.66 |
| 1983 | 8.33 | 7.03 | 11.43 | 7.43 |
| 1984 | 13.80 | 14.60 | 11.30 | 7.20 |
| 1985 | 10.87 | 11.57 | 17.27 | 11.37 |
| 1986 | 20.04 | 14.04 | 7.04 | 16.24 |
| 1987 | 12.20 | 15.40 | 17.70 | 16.50 |
| 1988 | 5.77 | 11.47 | 12.27 | 19.07 |
| 1989 | 6.34 | 12.74 | 15.34 | 16.44 |
| 1990 | 10.71 | 15.91 | 17.91 | 14.21 |
| 1991 | 13.88 | 11.08 | 10.48 | 12.08 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 65 | Simulated Flow 66 | Simulated Flow 67 | Simulated Flow 68 |
| 1962 | 10.01 | 9.41 | 18.71 | 6.31 |
| 1963 | 7.92 | 8.42 | 17.22 | 14.12 |
| 1964 | 16.13 | 16.13 | 8.83 | 15.33 |
| 1965 | 13.14 | 15.34 | 12.94 | 5.14 |
| 1966 | 15.65 | 11.45 | 19.25 | 13.85 |
| 1967 | 19.56 | 18.06 | 10.96 | 14.36 |
| 1968 | 13.57 | 16.07 | 20.87 | 10.87 |
| 1969 | 13.98 | 13.68 | 8.58 | 13.68 |
| 1970 | 9.85 | 9.95 | 15.25 | 15.05 |
| 1971 | 4.72 | 19.82 | 10.52 | 9.82 |
| 1972 | 20.18 | 11.18 | 9.28 | 18.08 |
| 1973 | 16.65 | 14.75 | 7.25 | 19.55 |
| 1974 | 14.02 | 19.82 | 15.52 | 13.92 |
| 1975 | 7.59 | 12.39 | 12.59 | 9.59 |
| 1976 | 18.76 | 6.46 | 15.16 | 15.36 |
| 1977 | 8.52 | 16.92 | 16.22 | 16.72 |
| 1978 | 7.29 | 4.79 | 16.79 | 20.39 |
| 1979 | 8.36 | 9.46 | 13.86 | 7.46 |
| 1980 | 13.13 | 18.33 | 9.53 | 13.93 |
| 1981 | 7.10 | 20.40 | 12.40 | 19.40 |
| 1982 | 13.16 | 15.16 | 11.96 | 11.96 |
| 1983 | 16.03 | 13.63 | 6.73 | 6.73 |
| 1984 | 19.70 | 8.60 | 14.20 | 14.20 |
| 1985 | 12.87 | 11.97 | 14.57 | 14.57 |
| 1986 | 20.64 | 15.24 | 12.84 | 12.84 |
| 1987 | 12.80 | 17.70 | 15.00 | 6.80 |
| 1988 | 11.07 | 12.27 | 7.57 | 10.07 |
| 1989 | 17.84 | 15.34 | 14.54 | 8.24 |
| 1990 | 17.81 | 17.91 | 4.01 | 12.01 |
| 1991 | 19.08 | 10.48 | 18.08 | 5.28 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
## 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 69 | Simulated Flow 70 | Simulated Flow 71 | Simulated Flow 72 |
| 1962 | 12.01 | 16.91 | 4.71 | 11.91 |
| 1963 | 8.42 | 12.02 | 18.62 | 15.42 |
| 1964 | 7.93 | 14.63 | 6.63 | 20.43 |
| 1965 | 9.04 | 21.04 | 20.04 | 12.94 |
| 1966 | 10.05 | 12.55 | 16.15 | 6.95 |
| 1967 | 8.46 | 9.26 | 10.96 | 10.46 |
| 1968 | 12.27 | 19.57 | 20.87 | 13.97 |
| 1969 | 17.98 | 17.78 | 8.58 | 14.08 |
| 1970 | 9.15 | 12.25 | 15.25 | 11.35 |
| 1971 | 4.82 | 6.82 | 10.52 | 16.62 |
| 1972 | 12.38 | 7.68 | 11.58 | 16.78 |
| 1973 | 19.75 | 10.05 | 13.95 | 5.35 |
| 1974 | 9.32 | 11.72 | 7.32 | 18.72 |
| 1975 | 20.29 | 11.29 | 10.99 | 3.89 |
| 1976 | 14.56 | 7.36 | 9.16 | 11.56 |
| 1977 | 15.22 | 16.02 | 8.52 | 19.62 |
| 1978 | 3.69 | 11.19 | 7.29 | 17.09 |
| 1979 | 13.96 | 13.86 | 8.36 | 20.26 |
| 1980 | 4.23 | 20.33 | 13.13 | 12.83 |
| 1981 | 19.80 | 11.90 | 7.10 | 9.90 |
| 1982 | 7.86 | 13.96 | 16.86 | 4.66 |
| 1983 | 14.93 | 8.23 | 17.93 | 14.03 |
| 1984 | 20.20 | 10.40 | 10.40 | 9.00 |
| 1985 | 20.27 | 16.77 | 15.07 | 9.97 |
| 1986 | 10.24 | 14.94 | 11.34 | 10.14 |
| 1987 | 14.90 | 17.30 | 15.90 | 17.30 |
| 1988 | 3.37 | 15.37 | 12.07 | 15.37 |
| 1989 | 13.64 | 13.04 | 16.44 | 13.04 |
| 1990 | 3.91 | 9.31 | 10.41 | 9.31 |
| 1991 | 19.48 | 19.18 | 17.68 | 19.18 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 73 | Simulated Flow 74 | Simulated Flow 75 | Simulated Flow 76 |
| 1962 | 4.71 | 18.91 | 13.01 | 7.91 |
| 1963 | 18.62 | 13.42 | 7.72 | 13.52 |
| 1964 | 6.63 | 16.43 | 15.13 | 7.23 |
| 1965 | 20.04 | 18.94 | 15.44 | 18.94 |
| 1966 | 16.15 | 11.45 | 13.65 | 16.95 |
| 1967 | 10.46 | 12.86 | 12.86 | 8.46 |
| 1968 | 13.97 | 12.07 | 14.67 | 15.47 |
| 1969 | 14.08 | 16.38 | 8.98 | 20.68 |
| 1970 | 11.35 | 11.35 | 10.35 | 20.75 |
| 1971 | 16.62 | 16.42 | 9.02 | 10.72 |
| 1972 | 7.68 | 16.28 | 19.78 | 7.68 |
| 1973 | 10.05 | 15.05 | 17.25 | 10.05 |
| 1974 | 11.72 | 15.32 | 20.42 | 11.72 |
| 1975 | 11.29 | 15.69 | 12.99 | 11.29 |
| 1976 | 7.36 | 11.06 | 10.06 | 7.36 |
| 1977 | 12.82 | 15.82 | 17.52 | 3.82 |
| 1978 | 10.39 | 8.49 | 4.89 | 17.79 |
| 1979 | 15.36 | 13.96 | 17.16 | 5.86 |
| 1980 | 15.83 | 11.03 | 6.73 | 19.33 |
| 1981 | 17.00 | 20.20 | 11.60 | 15.50 |
| 1982 | 15.36 | 16.56 | 3.66 | 17.16 |
| 1983 | 15.23 | 20.23 | 17.63 | 13.03 |
| 1984 | 12.20 | 7.30 | 5.70 | 14.50 |
| 1985 | 3.87 | 13.77 | 19.17 | 13.37 |
| 1986 | 19.94 | 19.24 | 15.34 | 11.44 |
| 1987 | 4.50 | 14.30 | 9.50 | 7.70 |
| 1988 | 13.87 | 13.67 | 6.87 | 11.57 |
| 1989 | 8.84 | 5.54 | 14.44 | 17.34 |
| 1990 | 9.81 | 12.91 | 11.41 | 8.51 |
| 1991 | 9.98 | 11.28 | 13.88 | 4.18 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 77 | Simulated Flow 78 | Simulated Flow 79 | Simulated Flow 80 |
| 1962 | 13.11 | 18.71 | 8.91 | 5.21 |
| 1963 | 20.42 | 17.22 | 15.92 | 12.82 |
| 1964 | 9.93 | 8.83 | 21.13 | 12.93 |
| 1965 | 20.84 | 12.94 | 21.14 | 12.74 |
| 1966 | 15.05 | 19.25 | 11.05 | 9.55 |
| 1967 | 9.26 | 7.36 | 15.76 | 19.76 |
| 1968 | 19.57 | 8.37 | 14.17 | 18.67 |
| 1969 | 17.78 | 13.58 | 9.08 | 10.88 |
| 1970 | 12.25 | 11.05 | 12.45 | 13.25 |
| 1971 | 6.82 | 13.02 | 15.72 | 19.32 |
| 1972 | 4.78 | 18.58 | 10.68 | 17.58 |
| 1973 | 9.15 | 11.55 | 20.65 | 17.45 |
| 1974 | 7.82 | 7.12 | 8.42 | 13.02 |
| 1975 | 10.39 | 20.19 | 15.09 | 13.59 |
| 1976 | 9.56 | 4.26 | 10.36 | 11.46 |
| 1977 | 16.92 | 7.92 | 10.02 | 8.02 |
| 1978 | 4.79 | 13.79 | 13.59 | 11.89 |
| 1979 | 9.46 | 14.36 | 13.76 | 17.66 |
| 1980 | 18.33 | 13.03 | 11.03 | 8.83 |
| 1981 | 20.40 | 14.70 | 16.30 | 4.50 |
| 1982 | 10.76 | 10.76 | 15.06 | 9.86 |
| 1983 | 8.63 | 8.63 | 3.53 | 13.43 |
| 1984 | 14.20 | 14.20 | 13.80 | 13.60 |
| 1985 | 12.07 | 12.07 | 4.07 | 10.87 |
| 1986 | 13.64 | 13.64 | 19.64 | 16.14 |
| 1987 | 12.00 | 17.00 | 8.40 | 7.60 |
| 1988 | 9.07 | 12.87 | 4.47 | 13.47 |
| 1989 | 10.74 | 14.34 | 7.64 | 14.04 |
| 1990 | 12.81 | 13.21 | 6.21 | 12.71 |
| 1991 | 7.78 | 11.28 | 13.08 | 14.38 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 81 | Simulated Flow 82 | Simulated Flow 83 | Simulated Flow 84 |
| 1962 | 16.21 | 10.11 | 20.51 | 17.01 |
| 1963 | 8.72 | 7.52 | 17.92 | 15.72 |
| 1964 | 15.63 | 15.03 | 21.03 | 15.93 |
| 1965 | 5.04 | 15.34 | 13.54 | 16.24 |
| 1966 | 19.05 | 9.75 | 10.55 | 11.55 |
| 1967 | 8.96 | 14.86 | 9.66 | 16.26 |
| 1968 | 7.97 | 15.07 | 7.07 | 8.87 |
| 1969 | 15.68 | 14.98 | 14.58 | 14.28 |
| 1970 | 14.95 | 15.35 | 14.95 | 11.35 |
| 1971 | 11.12 | 8.32 | 9.42 | 20.52 |
| 1972 | 20.38 | 15.88 | 19.78 | 9.28 |
| 1973 | 9.85 | 11.95 | 17.25 | 7.25 |
| 1974 | 18.72 | 13.22 | 20.42 | 15.52 |
| 1975 | 10.99 | 16.39 | 12.99 | 12.59 |
| 1976 | 16.96 | 11.56 | 10.06 | 15.16 |
| 1977 | 19.62 | 16.72 | 12.42 | 8.02 |
| 1978 | 17.09 | 20.39 | 11.69 | 15.09 |
| 1979 | 20.26 | 7.46 | 16.06 | 20.36 |
| 1980 | 12.83 | 13.93 | 11.03 | 20.43 |
| 1981 | 9.90 | 19.40 | 16.10 | 10.40 |
| 1982 | 12.06 | 4.46 | 7.86 | 15.16 |
| 1983 | 5.63 | 8.83 | 14.93 | 13.63 |
| 1984 | 12.10 | 7.50 | 20.20 | 8.60 |
| 1985 | 3.17 | 10.07 | 20.27 | 11.97 |
| 1986 | 6.44 | 9.24 | 10.24 | 15.24 |
| 1987 | 12.10 | 8.20 | 10.60 | 8.90 |
| 1988 | 13.97 | 7.27 | 8.47 | 6.37 |
| 1989 | 8.34 | 15.04 | 14.04 | 13.94 |
| 1990 | 9.71 | 14.31 | 11.91 | 14.31 |
| 1991 | 8.38 | 10.48 | 13.48 | 8.78 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 85 | Simulated Flow 86 | Simulated Flow 87 | Simulated Flow 88 |
| 1962 | 18.31 | 18.51 | 15.01 | 9.71 |
| 1963 | 18.12 | 16.52 | 9.22 | 20.02 |
| 1964 | 13.63 | 14.13 | 11.33 | 18.23 |
| 1965 | 14.14 | 10.34 | 17.64 | 12.64 |
| 1966 | 11.95 | 20.15 | 15.75 | 7.15 |
| 1967 | 11.26 | 6.76 | 17.96 | 11.46 |
| 1968 | 10.17 | 12.27 | 5.27 | 11.07 |
| 1969 | 13.68 | 6.58 | 17.48 | 10.68 |
| 1970 | 11.35 | 7.05 | 7.05 | 20.15 |
| 1971 | 16.32 | 5.32 | 11.92 | 8.92 |
| 1972 | 18.08 | 14.08 | 18.18 | 20.38 |
| 1973 | 19.55 | 10.65 | 12.75 | 9.85 |
| 1974 | 13.92 | 13.52 | 15.82 | 18.72 |
| 1975 | 9.59 | 14.89 | 18.39 | 10.99 |
| 1976 | 15.36 | 9.66 | 10.96 | 16.96 |
| 1977 | 8.52 | 17.42 | 5.42 | 13.42 |
| 1978 | 7.29 | 17.29 | 13.29 | 11.19 |
| 1979 | 8.36 | 12.86 | 14.56 | 11.86 |
| 1980 | 13.13 | 13.43 | 4.43 | 16.43 |
| 1981 | 7.10 | 11.30 | 13.20 | 18.20 |
| 1982 | 9.26 | 9.16 | 10.86 | 19.46 |
| 1983 | 8.23 | 12.33 | 10.53 | 16.93 |
| 1984 | 9.10 | 19.60 | 10.20 | 20.10 |
| 1985 | 5.87 | 15.27 | 19.67 | 12.67 |
| 1986 | 5.74 | 18.54 | 8.44 | 9.74 |
| 1987 | 15.00 | 3.50 | 6.60 | 11.80 |
| 1988 | 13.47 | 5.77 | 8.87 | 6.57 |
| 1989 | 8.44 | 7.34 | 6.74 | 14.04 |
| 1990 | 11.81 | 11.81 | 8.51 | 14.41 |
| 1991 | 15.08 | 10.08 | 12.88 | 12.68 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR
## 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 89 | Simulated Flow 90 | Simulated Flow 91 | Simulated Flow 92 |
| 1962 | 21.11 | 16.91 | 13.01 | 17.11 |
| 1963 | 10.52 | 12.02 | 7.72 | 17.62 |
| 1964 | 19.33 | 14.63 | 15.13 | 14.63 |
| 1965 | 11.54 | 21.04 | 15.44 | 10.24 |
| 1966 | 17.45 | 12.55 | 13.65 | 13.05 |
| 1967 | 10.76 | 10.96 | 15.66 | 16.66 |
| 1968 | 18.27 | 20.87 | 7.27 | 12.77 |
| 1969 | 14.08 | 8.58 | 17.38 | 17.08 |
| 1970 | 4.15 | 15.25 | 9.65 | 11.05 |
| 1971 | 11.72 | 10.52 | 11.12 | 18.32 |
| 1972 | 8.68 | 15.48 | 17.58 | 12.38 |
| 1973 | 7.75 | 8.05 | 15.55 | 6.55 |
| 1974 | 15.52 | 15.02 | 11.32 | 14.52 |
| 1975 | 14.79 | 4.49 | 20.59 | 18.09 |
| 1976 | 10.96 | 18.56 | 16.06 | 9.96 |
| 1977 | 12.22 | 11.02 | 12.22 | 16.02 |
| 1978 | 19.59 | 10.69 | 6.39 | 11.19 |
| 1979 | 9.16 | 10.36 | 14.36 | 13.86 |
| 1980 | 20.13 | 19.83 | 17.93 | 20.33 |
| 1981 | 14.40 | 8.60 | 9.80 | 11.90 |
| 1982 | 15.16 | 10.96 | 18.26 | 20.06 |
| 1983 | 6.23 | 7.43 | 11.23 | 9.53 |
| 1984 | 18.10 | 7.00 | 6.80 | 18.40 |
| 1985 | 9.67 | 8.17 | 19.87 | 10.67 |
| 1986 | 6.04 | 9.24 | 3.94 | 16.64 |
| 1987 | 4.30 | 4.50 | 12.60 | 3.50 |
| 1988 | 8.67 | 13.87 | 8.67 | 17.47 |
| 1989 | 7.34 | 8.84 | 8.24 | 5.54 |
| 1990 | 9.91 | 9.81 | 10.51 | 19.01 |
| 1991 | 9.08 | 9.98 | 11.78 | 15.18 |

## APPENDIX TABLE III (Continued)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 93 | Simulated Flow 94 | Simulated Flow 95 | Simulated Flow 96 |
| 1962 | 8.41 | 8.81 | 13.11 | 5.51 |
| 1963 | 10.72 | 14.62 | 7.22 | 9.82 |
| 1964 | 12.33 | 15.13 | 15.13 | 8.43 |
| 1965 | 11.84 | 13.74 | 18.64 | 10.94 |
| 1966 | 7.85 | 15.35 | 10.45 | 10.05 |
| 1967 | 12.96 | 12.66 | 16.66 | 18.36 |
| 1968 | 6.47 | 6.77 | 12.77 | 19.77 |
| 1969 | 6.98 | 14.68 | 17.08 | 14.08 |
| 1970 | 11.35 | 18.25 | 11.05 | 9.75 |
| 1971 | 14.52 | 10.12 | 18.32 | 15.52 |
| 1972 | 16.58 | 9.78 | 11.18 | 3.98 |
| 1973 | 5.25 | 20.45 | 14.75 | 6.25 |
| 1974 | 3.82 | 20.92 | 19.82 | 7.82 |
| 1975 | 20.69 | 7.39 | 12.39 | 12.29 |
| 1976 | 16.66 | 18.96 | 6.46 | 10.56 |
| 1977 | 5.62 | 16.22 | 5.42 | 10.02 |
| 1978 | 5.89 | 12.39 | 13.29 | 13.59 |
| 1979 | 13.66 | 16.76 | 14.56 | 13.76 |
| 1980 | 11.53 | 10.73 | 4.43 | 11.03 |
| 1981 | 14.30 | 18.00 | 13.20 | 16.30 |
| 1982 | 16.86 | 9.16 | 4.66 | 16.46 |
| 1983 | 17.93 | 12.33 | 14.03 | 5.03 |
| 1984 | 10.40 | 19.60 | 9.00 | 18.40 |
| 1985 | 15.07 | 15.27 | 9.97 | 3.57 |
| 1986 | 11.34 | 18.54 | 10.14 | 11.24 |
| 1987 | 17.30 | 15.50 | 6.70 | 4.50 |
| 1988 | 15.37 | 8.17 | 12.37 | 13.87 |
| 1989 | 13.04 | 13.64 | 6.14 | 8.84 |
| 1990 | 9.31 | 10.71 | 17.91 | 9.81 |
| 1991 | 19.18 | 19.88 | 15.98 | 9.98 |

## APPENDIX TABLE III (Concluded)

## SIMULATED FLOWS[1] OF THE COLORADO RIVER INTO GLEN CANYON RESERVOIR 1962 - 1991

| | Millions of Acre-Feet of Water | | | |
|---|---|---|---|---|
| Year | Simulated Flow 97 | Simulated Flow 98 | Simulated Flow 99 | Simulated Flow 100 |
| 1962 | 14.31 | 10.91 | 17.31 | 10.71 |
| 1963 | 12.02 | 14.42 | 5.92 | 8.02 |
| 1964 | 12.63 | 14.53 | 4.43 | 15.53 |
| 1965 | 17.14 | 11.74 | 21.24 | 12.44 |
| 1966 | 18.85 | 16.95 | 17.15 | 14.85 |
| 1967 | 12.86 | 6.06 | 18.46 | 16.86 |
| 1968 | 14.67 | 6.27 | 12.97 | 5.47 |
| 1969 | 8.98 | 13.98 | 15.98 | 3.98 |
| 1970 | 10.35 | 11.85 | 18.55 | 20.85 |
| 1971 | 9.02 | 14.62 | 11.12 | 16.82 |
| 1972 | 17.08 | 18.18 | 15.88 | 17.78 |
| 1973 | 4.95 | 12.75 | 12.15 | 15.85 |
| 1974 | 9.62 | 15.82 | 15.42 | 13.52 |
| 1975 | 18.49 | 18.39 | 6.09 | 9.79 |
| 1976 | 20.56 | 10.96 | 17.16 | 19.66 |
| 1977 | 18.42 | 17.32 | 10.52 | 9.22 |
| 1978 | 11.39 | 13.19 | 20.49 | 6.69 |
| 1979 | 6.96 | 14.66 | 8.26 | 14.26 |
| 1980 | 20.03 | 13.53 | 14.93 | 14.63 |
| 1981 | 4.10 | 11.60 | 10.20 | 9.10 |
| 1982 | 15.06 | 7.36 | 12.16 | 8.66 |
| 1983 | 3.53 | 9.73 | 9.23 | 9.43 |
| 1984 | 13.80 | 11.40 | 10.90 | 12.80 |
| 1985 | 4.07 | 10.97 | 12.97 | 10.47 |
| 1986 | 19.64 | 7.04 | 7.94 | 11.54 |
| 1987 | 10.00 | 9.70 | 12.50 | 6.60 |
| 1988 | 17.57 | 11.27 | 10.07 | 7.67 |
| 1989 | 13.44 | 11.14 | 15.04 | 12.94 |
| 1990 | 3.51 | 17.11 | 15.51 | 10.41 |
| 1991 | 11.08 | 6.88 | 16.68 | 12.38 |

[1] Adjusted for anticipated depletion.

## APPENDIX TABLE IV

### FREQUENCY DISTRIBUTION OF MEANS OF SIMULATED INFLOWS TO GLEN CANYON RESERVOIR
### Five-Year Period, 1962-1966

| Average Annual Inflow in Millions of Acre-Feet of Water | Observed Frequency (f) | Theoretical Frequency[1] ($f_c$) | $\frac{(f-f_c)^2}{(f_c)}$ |
|---|---|---|---|
| 5.2 and under 7.0 | 0 } 7 | 0.750 } 5.425 | .457 |
| 7.0 and under 8.8 | 7 | 4.675 | |
| 8.8 and under 10.6 | 9 | 11.400 | .505 |
| 10.6 and under 12.4 | 17 | 18.500 | .122 |
| 12.4 and under 14.2 | 28 | 24.875 | .393 |
| 14.2 and under 16.0 | 26 | 27.425 | .074 |
| 16.0 and under 17.8 | 13 | 15.475 | .396 |
| | | | 1.947 |

$u_1 = 0$

$u_2 = 1.855067$

$u_3 = -1.247328$

$u_4 = 8.461783$

$B_1 = 0.243715$

$B_2 = 2.458910$

$K = -0.109977$

$X^2_{95}(1) = 3.841$

---

[1] Type 1 Pearson Curve fitted where

$$y = 24.9 \left(1 + \frac{X}{4.227}\right)^{1.643} \left(1 - \frac{X}{2.203}\right)^{.378}$$

# APPENDIX II

## Synthetic Hydrologies Using Markoff Chain

# APPENDIX TABLE V

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow I

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 10.18 | 26 | 14.57 |
| 2 | 7.29 | 27 | 23.10 |
| 3 | 12.90 | 28 | 14.95 |
| 4 | 24.56 | 29 | 17.89 |
| 5 | 15.47 | 30 | 15.04 |
| 6 | 11.77 | 31 | 17.97 |
| 7 | 13.89 | 32 | 19.50 |
| 8 | 12.59 | 33 | 13.57 |
| 9 | 7.85 | 34 | 14.55 |
| 10 | 10.03 | 35 | 18.91 |
| 11 | 6.97 | 36 | 19.28 |
| 12 | 8.01 | 37 | 9.35 |
| 13 | 17.84 | 38 | 11.60 |
| 14 | 9.82 | 39 | 16.53 |
| 15 | 11.64 | 40 | 15.33 |
| 16 | 14.72 | 41 | 9.15 |
| 17 | 15.76 | 42 | 12.06 |
| 18 | 9.21 | 43 | 10.97 |
| 19 | 12.49 | 44 | 11.92 |
| 20 | 14.26 | 45 | 13.79 |
| 21 | 8.23 | 46 | 12.68 |
| 22 | 13.82 | 47 | 16.84 |
| 23 | 14.56 | 48 | 13.92 |
| 24 | 8.78 | 49 | 18.26 |
| 25 | 13.46 | 50 | 11.44 |

$\overline{X} = 13.59$

$\sigma = 3.87$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 2

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 9.57 | 26 | 14.99 |
| 2 | 13.66 | 27 | 12.50 |
| 3 | 5.98 | 28 | 12.80 |
| 4 | 14.91 | 29 | 15.06 |
| 5 | 18.35 | 30 | 12.40 |
| 6 | 17.55 | 31 | 15.60 |
| 7 | 13.81 | 32 | 12.52 |
| 8 | 18.03 | 33 | 16.02 |
| 9 | 14.12 | 34 | 14.92 |
| 10 | 1.00 | 35 | 10.04 |
| 11 | 13.19 | 36 | 13.89 |
| 12 | 16.81 | 37 | 9.67 |
| 13 | 8.59 | 38 | 12.82 |
| 14 | 2.05 | 39 | 17.02 |
| 15 | 10.63 | 49 | 15.26 |
| 16 | 16.28 | 41 | 25.06 |
| 17 | 4.17 | 42 | 18.99 |
| 18 | 8.91 | 43 | 7.66 |
| 19 | 13.08 | 44 | 11.96 |
| 20 | 12.90 | 45 | 15.82 |
| 21 | 12.45 | 46 | 9.40 |
| 22 | 12.15 | 47 | 12.51 |
| 23 | 11.82 | 48 | 12.01 |
| 24 | 12.53 | 49 | 12.48 |
| 25 | 19.52 | 50 | 6.87 |

$\overline{X} = 12.81$

$\sigma = 4.33$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 3

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 10.68 | 26 | 11.07 |
| 2 | 14.88 | 27 | 15.83 |
| 3 | 13.34 | 28 | 14.21 |
| 4 | 14.11 | 29 | 12.62 |
| 5 | 17.78 | 30 | 15.26 |
| 6 | 6.54 | 31 | 12.68 |
| 7 | 2.42 | 32 | 10.53 |
| 8 | 15.70 | 33 | 19.18 |
| 9 | 16.24 | 34 | 17.48 |
| 10 | 14.31 | 35 | 9.64 |
| 11 | 8.26 | 36 | 11.02 |
| 12 | 9.80 | 37 | 14.41 |
| 13 | 14.89 | 38 | 10.32 |
| 14 | 19.25 | 39 | 12.21 |
| 15 | 12.56 | 40 | 9.44 |
| 16 | 14.58 | 41 | 17.94 |
| 17 | 10.20 | 42 | 13.68 |
| 18 | 9.80 | 43 | 11.98 |
| 19 | 7.79 | 44 | 4.79 |
| 20 | 12.59 | 45 | 8.98 |
| 21 | 18.97 | 46 | 11.28 |
| 22 | 2.07 | 47 | 9.17 |
| 23 | 7.24 | 48 | 24.19 |
| 24 | 12.47 | 49 | 17.54 |
| 25 | 13.66 | 59 | 15.94 |

$\bar{X} = 12.63$

$\sigma = 4.28$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 4

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 12.11 | 26 | 9.47 |
| 2 | 9.70 | 27 | 12.92 |
| 3 | 6.63 | 28 | 9.89 |
| 4 | 13.67 | 29 | 10.62 |
| 5 | 18.32 | 30 | 11.84 |
| 6 | 17.19 | 31 | 6.90 |
| 7 | 16.30 | 32 | 14.16 |
| 8 | 8.73 | 33 | 20.36 |
| 9 | 6.77 | 34 | 17.38 |
| 10 | 14.17 | 35 | 12.28 |
| 11 | 17.35 | 36 | 7.56 |
| 12 | 20.78 | 37 | 10.62 |
| 13 | 14.85 | 38 | 17.07 |
| 14 | 14.35 | 39 | 15.13 |
| 15 | 6.75 | 40 | 21.56 |
| 16 | 14.38 | 41 | 12.88 |
| 17 | 4.14 | 42 | 14.79 |
| 18 | 5.50 | 43 | 15.55 |
| 19 | 11.55 | 44 | 10.38 |
| 20 | 6.72 | 45 | 13.81 |
| 21 | 10.86 | 46 | 12.99 |
| 22 | 11.03 | 47 | 15.79 |
| 23 | 13.46 | 48 | 17.65 |
| 24 | 8.86 | 49 | 17.89 |
| 25 | 14.95 | 50 | 11.82 |

$\bar{X} = 12.81$

$\sigma = 4.10$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 5

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 12.21 | 26 | 14.53 |
| 2 | 13.40 | 27 | 15.45 |
| 3 | 16.00 | 28 | 10.99 |
| 4 | 15.52 | 29 | 7.36 |
| 5 | 12.19 | 30 | 6.27 |
| 6 | 16.19 | 31 | 18.16 |
| 7 | 13.96 | 32 | 14.49 |
| 8 | 24.00 | 33 | 7.20 |
| 9 | 16.42 | 34 | 17.66 |
| 10 | 17.61 | 35 | 13.91 |
| 11 | 15.32 | 36 | 12.58 |
| 12 | 11.71 | 37 | 9.38 |
| 13 | 14.08 | 38 | 18.64 |
| 14 | 16.70 | 39 | 15.46 |
| 15 | 14.51 | 40 | 13.96 |
| 16 | 15.70 | 41 | 5.54 |
| 17 | 14.78 | 42 | 11.51 |
| 18 | 11.32 | 43 | 16.38 |
| 19 | 12.23 | 44 | 12.57 |
| 20 | 16.31 | 45 | 9.26 |
| 21 | 19.44 | 46 | 12.82 |
| 22 | 9.51 | 47 | 12.48 |
| 23 | 14.13 | 48 | 9.10 |
| 24 | 11.65 | 44 | 18.31 |
| 25 | 22.14 | 50 | 14.88 |

$\bar{X} = 13.92$

$\sigma = 3.71$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD. GENERATED BY MARKOFF CHAIN

### Simulated Flow 6

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 13.94 | 26 | 11.38 |
| 2 | 16.95 | 27 | 9.75 |
| 3 | 9.50 | 28 | 12.39 |
| 4 | 9.74 | 29 | 13.30 |
| 5 | 13.58 | 30 | 4.23 |
| 6 | 13.63 | 31 | 6.83 |
| 7 | 6.58 | 32 | 13.14 |
| 8 | 21.46 | 33 | 11.12 |
| 9 | 14.46 | 34 | 15.03 |
| 10 | 7.55 | 35 | 14.90 |
| 11 | 13.97 | 36 | 11.57 |
| 12 | 20.02 | 37 | 14.54 |
| 13 | 14.95 | 38 | 13.87 |
| 14 | 17.18 | 39 | 15.01 |
| 15 | 8.52 | 40 | 11.99 |
| 16 | 5.85 | 41 | 12.03 |
| 17 | 14.65 | 42 | 13.39 |
| 18 | 17.72 | 43 | 9.96 |
| 19 | 9.05 | 44 | 9.04 |
| 20 | 11.77 | 45 | 15.50 |
| 21 | 9.14 | 46 | 10.75 |
| 22 | 9.96 | 47 | 8.80 |
| 23 | 18.02 | 48 | 9.90 |
| 24 | 14.61 | 49 | 16.34 |
| 25 | 9.96 | 50 | 12.20 |

$\overline{X} = 12.39$

$\sigma = 3.57$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 7

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 13.82 | 26 | 10.55 |
| 2 | 13.45 | 27 | 7.92 |
| 3 | 12.23 | 28 | 15.03 |
| 4 | 13.42 | 29 | 14.46 |
| 5 | 13.17 | 30 | 16.84 |
| 6 | 13.64 | 31 | 13.68 |
| 7 | 16.31 | 32 | 18.34 |
| 8 | 11.47 | 33 | 12.16 |
| 9 | 6.75 | 34 | 6.07 |
| 10 | 9.04 | 31 | 8.27 |
| 11 | 5.31 | 36 | 13.77 |
| 12 | 11.04 | 37 | 13.58 |
| 13 | 8.95 | 38 | 13.28 |
| 14 | 17.67 | 39 | 19.27 |
| 15 | 15.58 | 40 | 9.89 |
| 16 | 9.87 | 41 | 12.66 |
| 17 | 11.49 | 42 | 10.13 |
| 18 | 14.62 | 43 | 10.01 |
| 19 | 12.47 | 44 | 10.82 |
| 20 | 6.66 | 45 | 9.75 |
| 21 | 6.22 | 46 | 18.45 |
| 22 | 13.85 | 47 | 13.81 |
| 23 | 22.16 | 48 | 10.56 |
| 24 | 21.98 | 49 | 8.46 |
| 25 | 15.98 | 50 | 9.35 |

$$\bar{X} = 12.49$$

$$\sigma = 3.86$$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

Simulated Flow 8

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 18.43 | 26 | 16.85 |
| 2 | 12.71 | 27 | 12.50 |
| 3 | 12.28 | 28 | 7.65 |
| 4 | 9.85 | 29 | 9.79 |
| 5 | 17.31 | 30 | 19.38 |
| 6 | 11.19 | 31 | 17.13 |
| 7 | 15.19 | 32 | 10.93 |
| 8 | 21.46 | 33 | 16.60 |
| 9 | 15.80 | 34 | 20.20 |
| 10 | 5.55 | 35 | 17.00 |
| 11 | 15.49 | 36 | 5.67 |
| 12 | 8.07 | 37 | 12.46 |
| 13 | 7.17 | 38 | 16.58 |
| 14 | 10.49 | 39 | 6.36 |
| 15 | 13.95 | 40 | 14.99 |
| 16 | 13.40 | 41 | 5.48 |
| 17 | 12.87 | 42 | 8.07 |
| 18 | 5.95 | 43 | 13.52 |
| 19 | 6.01 | 44 | 14.35 |
| 20 | 12.02 | 45 | 13.35 |
| 21 | 13.08 | 46 | 18.89 |
| 22 | 16.08 | 47 | 15.16 |
| 23 | 7.91 | 48 | 12.12 |
| 24 | 9.85 | 49 | 15.07 |
| 25 | 10.53 | 50 | 9.73 |

$\overline{X} = 12.65$

$\sigma = 4.17$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 9

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 12.50 | 26 | 15.44 |
| 2 | 11.73 | 27 | 11.55 |
| 3 | 11.81 | 28 | 19.86 |
| 4 | 13.73 | 29 | 12.38 |
| 5 | 8.97 | 30 | 16.40 |
| 6 | 13.29 | 31 | 11.53 |
| 7 | 20.16 | 32 | 12.49 |
| 8 | 11.75 | 33 | 20.66 |
| 9 | 13.22 | 34 | 18.46 |
| 10 | 7.05 | 35 | 11.55 |
| 11 | 6.51 | 36 | 15.12 |
| 12 | 7.45 | 37 | 12.22 |
| 13 | 14.52 | 38 | 17.65 |
| 14 | 8.63 | 39 | 14.20 |
| 15 | 4.33 | 40 | 10.82 |
| 16 | 12.03 | 41 | 7.76 |
| 17 | 11.37 | 42 | 8.32 |
| 18 | 10.52 | 43 | 13.58 |
| 19 | 11.69 | 44 | 9.41 |
| 20 | 18.74 | 45 | 10.75 |
| 21 | 13.11 | 46 | 7.70 |
| 22 | 9.25 | 47 | 9.88 |
| 23 | 13.12 | 48 | 11.20 |
| 24 | 13.37 | 49 | 10.46 |
| 25 | 6.26 | 50 | 3.89 |

$\overline{X} = 11.97$

$\sigma = 3.79$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 10

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 17.11 | 26 | 4.59 |
| 2 | 8.04 | 27 | 7.06 |
| 3 | 17.01 | 28 | 16.14 |
| 4 | 16.12 | 29 | 14.03 |
| 5 | 18.04 | 30 | 11.88 |
| 6 | 22.38 | 31 | 14.09 |
| 7 | 11.21 | 32 | 14.84 |
| 8 | 14.56 | 33 | 12.38 |
| 9 | 14.34 | 34 | 17.74 |
| 10 | 11.59 | 35 | 12.62 |
| 11 | 17.49 | 36 | 11.36 |
| 12 | 8.98 | 37 | 13.20 |
| 13 | 14.65 | 38 | 15.20 |
| 14 | 19.46 | 39 | 18.84 |
| 15 | 13.79 | 40 | 14.42 |
| 16 | 11.21 | 41 | 8.25 |
| 17 | 14.95 | 42 | 14.29 |
| 18 | 15.92 | 43 | 10.11 |
| 19 | 8.69 | 44 | 7.78 |
| 20 | 21.13 | 45 | 12.80 |
| 21 | 13.61 | 46 | 12.07 |
| 22 | 7.76 | 47 | 17.08 |
| 23 | 11.05 | 48 | 19.02 |
| 24 | 10.97 | 49 | 4.75 |
| 25 | 15.18 | 50 | 14.57 |

$\overline{X} = 13.49$

$\sigma = 3.93$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 11

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 12.21 | 26 | 8.17 |
| 2 | 14.54 | 27 | 15.47 |
| 3 | 14.27 | 28 | 11.25 |
| 4 | 15.70 | 29 | 13.93 |
| 5 | 13.68 | 30 | 9.82 |
| 6 | 10.20 | 31 | 12.05 |
| 7 | 10.18 | 32 | 12.39 |
| 8 | 11.00 | 33 | 17.64 |
| 9 | 15.52 | 34 | 12.69 |
| 10 | 13.47 | 35 | 14.00 |
| 11 | 15.36 | 36 | 11.58 |
| 12 | 18.82 | 37 | 13.36 |
| 13 | 7.38 | 38 | 19.23 |
| 14 | 15.42 | 39 | 11.15 |
| 15 | 14.43 | 40 | 11.25 |
| 16 | 18.74 | 41 | 9.67 |
| 17 | 21.24 | 42 | 17.20 |
| 18 | 11.53 | 43 | 14.27 |
| 19 | 9.93 | 44 | 11.42 |
| 20 | 17.37 | 45 | 16.59 |
| 21 | 12.08 | 46 | 22.27 |
| 22 | 10.40 | 47 | 14.89 |
| 23 | 12.70 | 48 | 11.59 |
| 24 | 15.00 | 49 | 3.73 |
| 25 | 14.56 | 50 | - 4.35 |

$\overline{X} = 13.14$

$\sigma = 4.25$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 12

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 14.90 | 26 | 7.14 |
| 2 | 7.38 | 27 | 10.30 |
| 3 | 8.61 | 28 | 7.86 |
| 4 | 4.99 | 29 | 2.20 |
| 5 | 14.85 | 30 | 11.06 |
| 6 | 8.42 | 31 | 6.48 |
| 7 | 11.43 | 32 | 12.80 |
| 8 | 13.67 | 33 | 12.83 |
| 9 | 15.63 | 34 | 14.42 |
| 10 | 13.99 | 35 | 12.38 |
| 11 | 12.07 | 36 | 8.54 |
| 12 | 21.22 | 37 | 12.46 |
| 13 | 15.30 | 38 | 16.57 |
| 14 | 21.94 | 39 | 8.74 |
| 15 | 11.92 | 40 | 16.53 |
| 16 | 12.68 | 41 | 10.26 |
| 17 | 17.07 | 42 | 10.00 |
| 18 | 12.94 | 43 | 4.32 |
| 19 | 7.79 | 44 | 14.15 |
| 20 | 13.01 | 45 | 10.63 |
| 21 | 9.85 | 46 | 12.00 |
| 22 | 21.74 | 47 | 6.79 |
| 23 | 19.11 | 48 | 7.22 |
| 24 | 13.84 | 49 | 12.04 |
| 25 | 10.15 | 50 | 8.90 |

$\bar{X} = 11.82$

$\sigma = 4.25$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 13

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 17.21 | 26 | 11.05 |
| 2 | 9.87 | 27 | 12.00 |
| 3 | 15.79 | 28 | 8.07 |
| 4 | 13.28 | 29 | 19.18 |
| 5 | 13.44 | 30 | 18.40 |
| 6 | 11.32 | 31 | 12.67 |
| 7 | 14.01 | 32 | 17.60 |
| 8 | 27.28 | 33 | 11.72 |
| 9 | 18.08 | 34 | 9.60 |
| 10 | 13.50 | 35 | 10.25 |
| 11 | 12.99 | 36 | 18.93 |
| 12 | 18.67 | 37 | 20.62 |
| 13 | 18.04 | 38 | 16.62 |
| 14 | 20.35 | 39 | 13.86 |
| 15 | 12.58 | 40 | 10.57 |
| 16 | 15.98 | 41 | 8.58 |
| 17 | 14.84 | 42 | 1.98 |
| 18 | 12.06 | 42 | 5.12 |
| 19 | 11.27 | 44 | 15.12 |
| 20 | 16.53 | 45 | 7.07 |
| 21 | 19.13 | 46 | 6.56 |
| 22 | 17.88 | 47 | 7.82 |
| 23 | 8.67 | 48 | 6.46 |
| 24 | 8.80 | 49 | 13.49 |
| 25 | 10.34 | 50 | 21.81 |

$\overline{X} = 13.54$

$\sigma = 4.86$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 14

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 9.28 | 26 | 15.37 |
| 2 | 9.50 | 27 | 15.35 |
| 3 | 16.78 | 28 | 9.95 |
| 4 | 13.29 | 29 | 13.11 |
| 5 | 11.19 | 30 | 5.00 |
| 6 | 10.57 | 31 | 10.01 |
| 7 | 11.64 | 32 | 13.65 |
| 8 | 7.16 | 33 | 5.88 |
| 9 | 18.71 | 34 | 7.08 |
| 10 | 20.11 | 35 | 18.01 |
| 11 | 10.96 | 36 | 17.39 |
| 12 | 5.03 | 37 | 11.84 |
| 13 | 18.56 | 38 | 17.25 |
| 14 | 20.50 | 39 | 19.17 |
| 15 | 10.71 | 40 | 16.94 |
| 16 | 9.91 | 41 | 18.00 |
| 17 | 13.58 | 42 | 16.32 |
| 18 | 10.28 | 43 | 13.07 |
| 19 | 13.35 | 44 | 12.75 |
| 20 | 15.12 | 45 | 14.98 |
| 21 | 17.00 | 46 | 15.82 |
| 22 | 17.92 | 47 | 16.76 |
| 23 | 12.14 | 48 | 9.02 |
| 24 | 16.26 | 49 | 9.05 |
| 25 | 22.82 | 50 | 8.99 |

$\overline{X} = 13.46$

$\sigma = 4.23$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 15

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 5.18 | 26 | 13.20 |
| 2 | 5.86 | 27 | 10.12 |
| 3 | 14.53 | 28 | 12.95 |
| 4 | 12.26 | 29 | 13.30 |
| 5 | 10.11 | 30 | 11.23 |
| 6 | 16.21 | 31 | 17.08 |
| 7 | 20.87 | 32 | 18.33 |
| 8 | 3.45 | 33 | 12.22 |
| 9 | 9.49 | 34 | 12.53 |
| 10 | 10.41 | 35 | 12.59 |
| 11 | 21.23 | 36 | 12.31 |
| 12 | 17.41 | 37 | 11.93 |
| 13 | 11.78 | 38 | 8.72 |
| 14 | 11.13 | 39 | 11.70 |
| 15 | 12.80 | 40 | 17.44 |
| 16 | 6.14 | 41 | 7.82 |
| 17 | 16.61 | 42 | 9.71 |
| 18 | 11.03 | 43 | 10.54 |
| 19 | 12.04 | 44 | 17.31 |
| 20 | 8.59 | 45 | 16.49 |
| 21 | 19.99 | 46 | 12.74 |
| 22 | 16.08 | 47 | 18.29 |
| 23 | 19.37 | 48 | 10.04 |
| 24 | 6.02 | 49 | 15.05 |
| 25 | 13.22 | 50 | 7.46 |

$\bar{X} = 12.66$

$\sigma = 4.17$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 16

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 21.68 | 26 | 8.93 |
| 2 | 17.49 | 27 | 17.01 |
| 3 | 13.53 | 28 | 10.37 |
| 4 | 10.61 | 29 | 14.62 |
| 5 | 15.76 | 30 | 8.19 |
| 6 | 10.25 | 31 | 11.88 |
| 7 | 14.73 | 32 | 11.81 |
| 8 | 13.15 | 33 | 8.68 |
| 9 | 8.76 | 34 | 10.17 |
| 10 | -0.88 | 35 | 10.02 |
| 11 | 10.50 | 36 | 13.97 |
| 12 | 15.20 | 37 | 11.77 |
| 13 | 12.55 | 38 | 17.09 |
| 14 | 11.90 | 39 | 12.26 |
| 15 | 9.68 | 40 | 8.78 |
| 16 | 10.65 | 41 | 7.23 |
| 17 | 7.27 | 42 | 12.38 |
| 18 | 6.94 | 43 | 14.65 |
| 19 | 17.56 | 44 | 6.83 |
| 20 | 17.10 | 45 | 12.17 |
| 21 | 13.29 | 46 | 11.80 |
| 22 | 10.50 | 47 | 10.46 |
| 23 | 11.77 | 48 | 19.74 |
| 24 | 13.43 | 49 | 18.08 |
| 25 | 16.33 | 50 | 14.54 |

$\overline{X} = 12.26$

$\sigma = 3.89$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE ÇOLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 17

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 8.15 | 26 | 9.75 |
| 2 | 7.70 | 27 | 9.92 |
| 3 | 23.10 | 28 | 12.80 |
| 4 | 13.23 | 29 | 16.83 |
| 5 | 17.24 | 30 | 14.60 |
| 6 | 15.35 | 31 | 14.37 |
| 7 | 14.12 | 32 | 10.04 |
| 8 | 7.72 | 33 | 11.39 |
| 9 | 17.31 | 34 | 15.35 |
| 10 | 17.21 | 35 | 6.61 |
| 11 | 9.82 | 36 | 15.87 |
| 12 | 14.44 | 37 | 15.82 |
| 13 | 16.56 | 38 | 10.15 |
| 14 | 21.84 | 39 | 15.93 |
| 15 | 15.10 | 40 | 14.68 |
| 16 | 16.89 | 41 | 14.40 |
| 17 | 13.32 | 42 | 20.67 |
| 18 | 13.69 | 43 | 7.64 |
| 19 | 18.00 | 44 | 3.98 |
| 20 | 17.91 | 45 | 9.68 |
| 21 | 7.25 | 46 | 12.63 |
| 22 | 5.97 | 47 | 6.40 |
| 23 | 5.79 | 48 | 9.80 |
| 24 | 10.26 | 49 | 20.56 |
| 25 | 16.03 | 50 | 24.49 |

$\bar{X} = 13.37$

$\sigma = 4.73$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 18

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 15.88 | 26 | 14.93 |
| 2 | 12.94 | 27 | 13.64 |
| 3 | 16.94 | 28 | 8.25 |
| 4 | 8.32 | 29 | 10.77 |
| 5 | 15.38 | 30 | 9.23 |
| 6 | 21.13 | 31 | 10.80 |
| 7 | 14.22 | 32 | 11.63 |
| 8 | 8.84 | 33 | 8.78 |
| 9 | 10.23 | 34 | 15.18 |
| 10 | 25.27 | 35 | 8.45 |
| 11 | 18.10 | 36 | 15.36 |
| 12 | 11.23 | 37 | 13.32 |
| 13 | 8.30 | 38 | 8.97 |
| 14 | 12.87 | 39 | 16.93 |
| 15 | 15.76 | 40 | 18.47 |
| 16 | 9.67 | 41 | 12.85 |
| 17 | 5.51 | 42 | 13.97 |
| 18 | 3.20 | 43 | 18.05 |
| 19 | 7.86 | 44 | 12.21 |
| 20 | 17.13 | 45 | 13.73 |
| 21 | 10.26 | 46 | 13.17 |
| 22 | 20.74 | 47 | 11.07 |
| 23 | 18.80 | 48 | 13.73 |
| 24 | 16.16 | 49 | 13.35 |
| 25 | 14.69 | 50 | 10.08 |

$\bar{X} = 13.13$

$\sigma = 4.19$

## APPENDIX TABLE V (cont'd)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 19

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 11.43 | 26 | 13.32 |
| 2 | 5.07 | 27 | 14.54 |
| 3 | 7.54 | 28 | 10.14 |
| 4 | 9.69 | 29 | 21.93 |
| 5 | 18.53 | 30 | 16.71 |
| 6 | 12.40 | 31 | 20.62 |
| 7 | 9.67 | 32 | 26.58 |
| 8 | 11.22 | 33 | 20.48 |
| 9 | 11.60 | 34 | 15.01 |
| 10 | 9.13 | 35 | 14.63 |
| 11 | 12.86 | 36 | 12.42 |
| 12 | 13.39 | 37 | 11.11 |
| 13 | 14.97 | 38 | 7.07 |
| 14 | 8.02 | 39 | 9.08 |
| 15 | 11.90 | 40 | 6.47 |
| 16 | 7.42 | 41 | 9.91 |
| 17 | 12.16 | 42 | 7.54 |
| 18 | 13.47 | 43 | 11.09 |
| 19 | 11.19 | 44 | 11.25 |
| 20 | 14.13 | 45 | 13.62 |
| 21 | 12.95 | 46 | 3.03 |
| 22 | 10.70 | 47 | 11.77 |
| 23 | 13.16 | 48 | 17.42 |
| 24 | 12.63 | 48 | 14.64 |
| 25 | 13.73 | 50 | 17.81 |

$\bar{X} = 12.54$

$\sigma = 4.31$

## APPENDIX TABLE V (concluded)

## SIMULATED ANNUAL FLOWS OF THE COLORADO RIVER FOR A FIFTY YEAR PERIOD GENERATED BY MARKOFF CHAIN

### Simulated Flow 20

| Year | Flow in Millions of Acre-Feet of Water | Year | Flow in Millions of Acre-Feet of Water |
|---|---|---|---|
| 1 | 8.03 | 26 | 1.53 |
| 2 | 15.82 | 27 | 14.15 |
| 3 | 17.16 | 28 | 14.44 |
| 4 | 16.11 | 29 | 9.85 |
| 5 | 12.32 | 30 | 18.07 |
| 6 | 11.10 | 31 | 10.06 |
| 7 | 11.01 | 32 | 12.29 |
| 8 | 13.44 | 33 | 9.97 |
| 9 | 16.90 | 34 | 13.55 |
| 10 | 21.69 | 35 | 15.11 |
| 11 | 22.13 | 36 | 15.18 |
| 12 | 20.26 | 37 | 15.64 |
| 13 | 19.00 | 38 | 15.56 |
| 14 | 19.45 | 39 | 14.30 |
| 15 | 14.06 | 40 | 15.10 |
| 16 | 12.52 | 41 | 12.10 |
| 17 | 13.76 | 42 | 14.02 |
| 18 | 12.47 | 43 | 5.97 |
| 19 | 15.45 | 44 | 12.80 |
| 20 | 9.63 | 45 | 9.73 |
| 21 | 10.82 | 46 | 13.04 |
| 22 | 12.27 | 47 | 15.68 |
| 23 | 11.16 | 48 | 21.83 |
| 24 | 16.72 | 49 | 18.43 |
| 25 | 11.56 | 50 | 18.62 |

$\bar{X} = 14.04$

$\sigma = 3.97$

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