

QUALITY OF WATER COLORADO RIVER BASIN

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PROGRESS REPORT NO. 8

JANUARY 1977



UNITED STATES
DEPARTMENT OF THE INTERIOR
Thomas S. Kleppe, Secretary

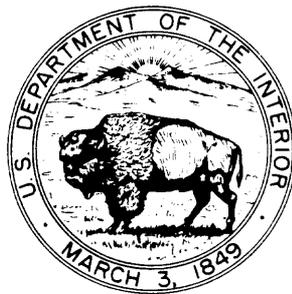
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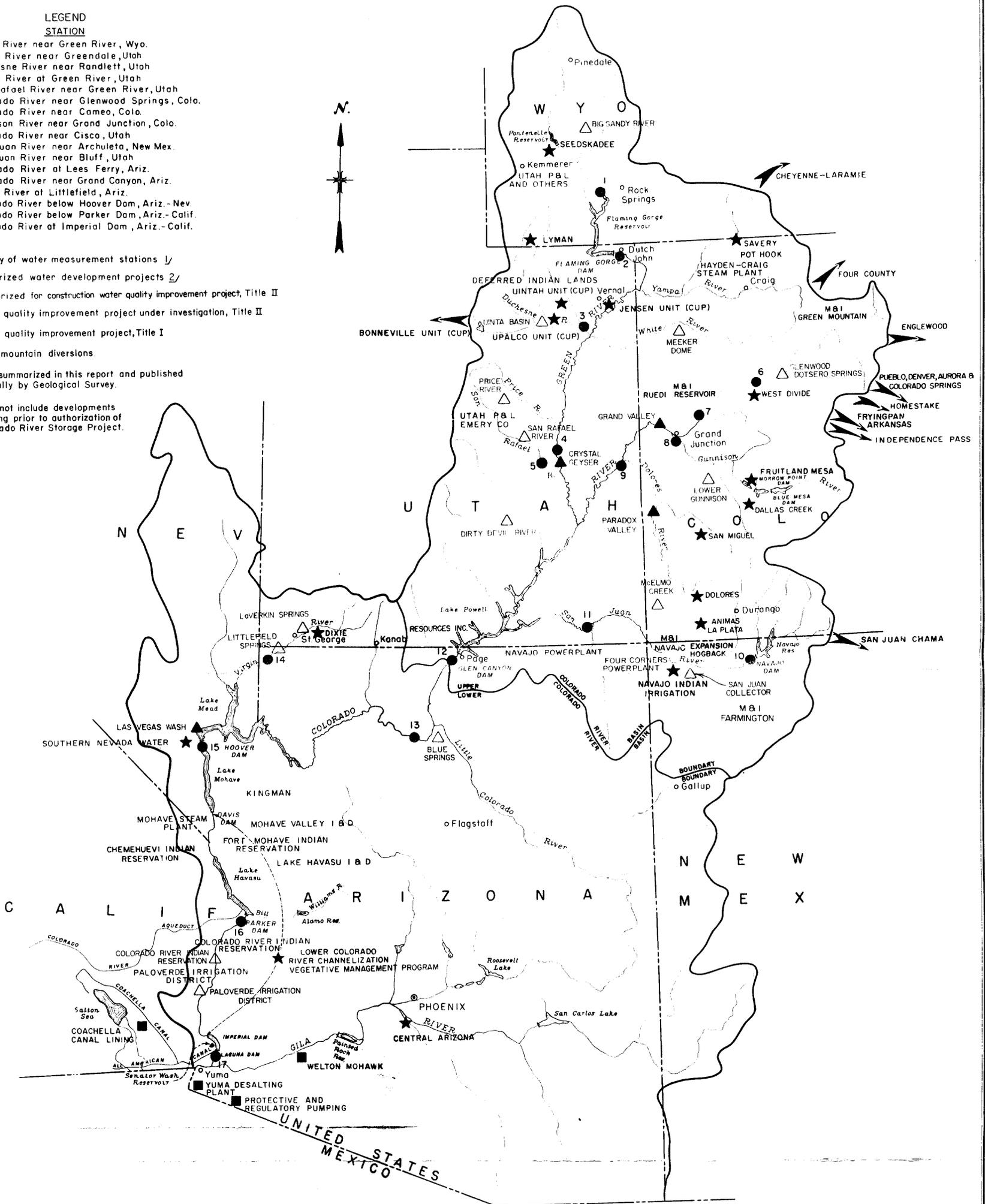
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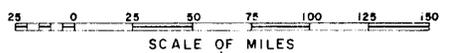
LEGEND

- STATION**
- 1 Green River near Green River, Wyo.
 - 2 Green River near Greendale, Utah
 - 3 Duchesne River near Randlett, Utah
 - 4 Green River at Green River, Utah
 - 5 San Rafael River near Green River, Utah
 - 6 Colorado River near Glenwood Springs, Colo.
 - 7 Colorado River near Cameo, Colo.
 - 8 Gunnison River near Grand Junction, Colo.
 - 9 Colorado River near Cisco, Utah
 - 10 San Juan River near Archuleta, New Mex.
 - 11 San Juan River near Bluff, Utah
 - 12 Colorado River at Lees Ferry, Ariz.
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 - 14 Virgin River at Littlefield, Ariz.
 - 15 Colorado River below Hoover Dam, Ariz.-Nev.
 - 16 Colorado River below Parker Dam, Ariz.-Calif.
 - 17 Colorado River at Imperial Dam, Ariz.-Calif.

- Quality of water measurement stations 1/
- ★ Authorized water development projects 2/
- ▲ Authorized for construction water quality improvement project, Title II
- △ Water quality improvement project under investigation, Title II
- Water quality improvement project, Title I
- ↔ Transmountain diversions
- 1/ Data summarized in this report and published annually by Geological Survey.
- 2/ Does not include developments existing prior to authorization of Colorado River Storage Project.



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLORADO RIVER BASIN
QUALITY OF WATER MAP



65-400-70
JULY 17, 1962
REVISED SEPTEMBER, 1976

QUALITY OF WATER
COLORADO RIVER BASIN
PROGRESS REPORT

SUMMARY

This biennial progress report presents the various important water quality aspects of the Colorado River. Although several water quality parameters are discussed, the major part of the report is allotted to salinity (total dissolved solids) because it is presently the most serious quality problem on the river system. The historical, present modified, and future salinity conditions of water of the Colorado River down to Imperial Dam are presented in this report. The historical is represented by a tabulation of the recorded or estimated past condition at 17 quality of water stations for the 1941-74 period. The present modified condition includes adjustments of the historic condition based on the assumption that all developments existing at the present time were in operation for the full 1941-74 period. Estimated future conditions are shown for the years 1980, 1990, and year 2000. They are estimated projections after the presently authorized developments, projects proposed for authorization, and other future anticipated projects are placed in operation.

Under historic conditions the average concentration of dissolved solids of the Colorado River at Lees Ferry was about 558 mg/l, below Hoover Dam about 693 mg/l, and at Imperial Dam about 766 mg/l for the 1941-74 period.

Under present modified conditions (that is 1941-74 historical flows modified to reflect present depletions), the concentrations would have been about 610, 751, and 861 mg/l, respectively, at the three stations.

The projection of future water quality conditions was based on 1941-74 averages rather than a year-by-year study. Three models were considered before selecting the averages method. The Colorado River Simulation model was not used because the data base was not completed in time, but it is anticipated that this model will be the one used for the next report. The Colorado River Storage Project model was also considered, but it does not show quality conditions at any of the selected stations above Lees Ferry. The CRSM and CRSP models are further discussed in Part X.

There are some limitations in using a model based on averages since upper and lower limits are not defined and the actual conditions for several years in the future may not truly be represented.

SUMMARY (Continued)

This is because reservoir operations including releases and storage have not been considered.

It has been assumed for purposes of this study that the average rate of pickup of dissolved solids from new irrigated lands would be in the range of zero to 2 tons per acre. Where comprehensive studies showed a different rate, the different figure was used. The effect of salt contributed from new lands is thus evaluated by computations of salinity concentrations using these rates. It was also assumed no additional pickup of dissolved solids would occur for lands already under irrigation.

The estimated concentrations in milligrams per liter projected for 1980, 1990, and 2000 conditions, assuming negligible salinity control measures, are as follows:

	1980		1990		2000	
	Zero T/A	2T/A	Zero T/A	2T/A	Zero T/A	2T/A
Lees Ferry	629	635	697	726	716	747
Hoover Dam	781	788	886	919	920	957
Imperial Dam	923	938	1118	1174	1154	1214

Since the above figures from Table E, Part VII were computed by using average 1941-1974 values, they show only average conditions. Actual conditions will produce years of higher flow, producing better quality water, or years of lower flow producing poorer quality water.

The depletions used in this report are for the projects, both authorized and proposed for authorization together with present developments and other proposals for developments as presently planned.

This report includes discussions of the effect of salinity on water uses and potential salinity control measures. Investigations of the potential for water quality improvement on the Colorado River were initiated by the Bureau of Reclamation in FY 1972. A report, "Colorado River Water Quality Improvement Program," dated February 1972, describes potential projects for controlling the salinity of the Colorado River. A second report, "Colorado River Water Quality Improvement Program, Status Report," was published by the Bureau of Reclamation in January 1974. This report, with appropriate updating by current investigations is the basis for the discussion of the Colorado River Salinity Control program presented in Part VIII. This evaluation of the program is made in accordance with requirements of the Colorado River Salinity Control Act, Public Law 93-320. The Final Environmental Impact Statement for the Colorado River Water Quality Improvement Program is expected to be completed by March 1977.

Other phases of water quality, including sources of pollution, and parameters such as dissolved oxygen, temperature, pH, heavy metals, toxic materials, nutrients, bacteria, radioactivity, mercury, and sediment, are discussed.

PART I. INTRODUCTION

A. Authorization for Report

This is the eighth progress report on Quality of Water in the Colorado River Basin. The directive for preparing this and the seven previous reports is contained in three separate public laws. Section 15 of the authorizing legislation for the Colorado River Storage Project and participating projects, Public Law 485, 84th Congress, Second Session, April 11, 1956, states, "The Secretary of the Interior is directed to continue studies and make a report to the Congress and to the States of the Colorado River Basin on the quality of water of the Colorado River."

A progress report to comply with Public Law 84-485 was in preparation when the authorizing legislation for the San Juan-Chama Project and the Navajo Indian Irrigation Project (Public Law 87-483) became effective on June 13, 1962. Section 15 of this act states, "The Secretary of the Interior is directed to continue his studies of the quality of water of the Colorado River system, to appraise its suitability for municipal, domestic, and industrial use and for irrigation in the various areas in the United States in which it is used or proposed to be used, to estimate the effect of additional developments involving its storage and use (whether heretofore authorized or contemplated for authorization) on the remaining water available for use in the United States, to study all possible means of improving the quality of such water and of alleviating the ill effects of water of poor quality, and to report the results of his studies and estimates to the Eighty-Seventh Congress and every 2 years thereafter."

A few weeks later Public Law 87-590, which authorized the Fryingpan-Arkansas Project, was passed with a similar section pertaining to quality of water reports. This public law, however, stipulated that January 3, 1963, would be the submission date for the initial report and that the reports should be submitted every 2 years thereafter.

Section 206 of Title II, Public Law 93-320, Colorado River Basin Salinity Control Act directs the Secretary of the Interior to submit every 2 years to the President, the Congress, and the Advisory Council, a progress report on the Colorado River salinity control program and specifies that it may be included in the Quality of Water, Colorado River Basin Biennial Report.

B. Previous Reports

A series of seven reports starting with the 1963 edition have been prepared prior to this report. Each succeeding report updated the previous report and added changes which occurred within the 2-year interval.

INTRODUCTION (Continued)

In addition to including 2 more years of record, the major changes in this report from the January 1975 report are as follows: (1) transferring that part of the future estimated depletions that actually occurred during the 2 years to present depletions; (2) updating Part VIII "Colorado River Salinity Control Program" in order to report on the progress of investigations, planning, and construction of salinity control units as required under Title II Section 206 of the Colorado River Basin Salinity Control Act, Public Law 93-320; and (3) using a revised depletion schedule for future conditions.

C. Cooperation

The major portion of this report was prepared by the Bureau of Reclamation. The Geological Survey provided most of the basic data and prepared a technical study on salinity in the Flaming Gorge Reservoir. A continuing cooperative program between the Bureau of Reclamation and the Survey for the collection of streamflow quality data and the exchange of information has been in effect for a number of years. This cooperation provides for the collection of data at stations other than basic data stations maintained by the Geological Survey in order to obtain additional data at key points in the basin.

In the Upper Basin, data are obtained at various points along the river and in drains cooperatively with the Geological Survey and other agencies. Along the main stem below Lees Ferry, data are obtained on a regular basis at a network of stations that includes essentially all significant diversions, surface return flows, and major river stations. The Bureau of Reclamation is the lead agency of an ongoing task force for coordinating the collection of other quality data in the Lower Basin. Other members of the task force are composed of representatives from the Geological Survey International Boundary and Water Commission, and Environmental Protection Agency.

PART II. DESCRIPTION OF BASIN

A. Geology

Rocks of all ages from those of the Archean age (the oldest known geological period) to the recent alluvial deposits, including igneous, sedimentary, and metamorphic types, are found in the Colorado River Basin. The high Rocky Mountains which dominate the topography of the upper regions are composed of granites, schists, gneisses, lava, and sharply folded sedimentary rocks of limestone, sandstone, and shale. Many periods of deposition, erosion, and upheaval have played a part in the present structure of these mountains.

In contrast to the folded rocks of the mountains which fringe the basin, the plateau country of southwestern Wyoming, eastern Utah, and northern Arizona is composed principally of horizontal strata of sedimentary rocks. Slow but constant elevation of the land area has allowed the Colorado River and its tributaries to cut narrow, deep canyons into the flat-topped mesas. This type of erosion reaches its culmination in the Grand Canyon where the Colorado River has cut through all of the sedimentary rocks down to the oldest Archean granites.

The Lower Basin is characterized by broad, flat valleys separated by low mountain ranges. These valleys are filled by large accumulations of alluvial deposits.

Sediment removed by constant erosion of the upper areas was deposited in Arizona, California, and Mexico and now forms the great delta of the Colorado River.

Reservoirs constructed above Lee Ferry (Lake Powell, Flaming Gorge, Fontenelle, Navajo, Morrow Point, and Blue Mesa), together with Lake Mead downstream, have caused some major changes in stream regimen: (1) The stream channels inundated by these reservoirs are no longer subject to natural stream erosion; (2) the accumulation of sediment and water within the reservoir slows the growth and flooding of the Colorado River delta; (3) flooding has diminished in many areas; and (4) sections of sediment-laden streams have given way to clear water streams and lakes.

The salt concentration in runoff increases from the headwater areas downstream and occurs in relation to the geologic character of the terrain across which the Colorado River and its tributaries flow. The geologic formations that largely contribute to the salinity concentrations in natural runoff are evaporites of Paleozoic age, shale of Cretaceous age, and salt and gypsum of Tertiary age.

DESCRIPTION OF BASIN

B. Soils

The soils of the Colorado River Basin closely resemble the geologic formations of their origin. Only in limited areas at the higher elevations has the precipitation leached the soil mass of its soluble constituents. Over most of the area both residual and transported soils are basic in reaction and well supplied with carbonates with normal or mature soils exhibiting a distinct horizon of carbonate accumulation. The impress of soil-forming factors has resulted in a wide range of soil development. Soils formed in areas with low precipitation are classified in the orders Entisols and Aridisols. Those formed in areas with high precipitation are classified in orders Mollisols and Alfisols. Saline and alkali (sodic) soils occur in many parts of the basin.

The residual soils comprise the larger area and are usually shallow in depth over shale and sandstone of various ages. Many of the shales are saline but contain much gypsum as well as other chloride and sulphate salts. Some formations are high in sodium chloride and some have sodium carbonate or bicarbonate strata. Very few residual soil areas are suitable for irrigation development. A large part of the salt pickup occurs in areas where the natural runoff contacts the saline shales before entering the streams.

The alluvial materials are extremely variable and range from alluvial fans and terraces, outwash plains, to lacustrine sediments. Some areas have soils from material transported only short distances and resemble the original materials. Other areas have soils which have been transported and mixed extremely well. Most of the agricultural areas are on these well-mixed alluviums and, therefore, the soils are quite variable.

Extensive areas of Eolian deposits occur in parts of the basin, principally in southwestern Colorado. The uniformly textured soils are reddish brown in color and have no resemblance to either the underlying formations or adjacent areas. These are excellent agricultural soils, but in many areas topography makes agriculture difficult.

C. Climate

The Colorado River Basin has climatic extremes, ranging between year-round snow cover and heavy precipitation on the high peaks of the Rocky Mountains to desert conditions with very little rain in the southern part of the basin. This wide range of climate is caused by differences in altitude, latitude, and by the configuration of the high mountain ranges. The encircling mountain ranges obstruct and deflect the air masses to such an extent that storm patterns are more erratic than in

DESCRIPTION OF BASIN

most other parts of the United States. Most of the moisture for precipitation on the Upper Basin is derived from the Pacific Ocean and the Gulf of Mexico. The Pacific source predominates generally from October through April and the Gulf source during the late spring and early summer.

In the northern part of the basin most precipitation falls in the form of winter snows and spring rains. Summer storms are infrequent but are sometimes of cloudburst intensity in localized areas. In the more arid southern portion the principal rainy season is in the winter months with occasional localized cloudbursts in the summer and fall.

Extremes of temperature in the basin range from 50° F. below zero to 130° F. above zero. The northern portion of the basin is characterized by short, warm summers and long, cold winters, and many mountain areas are blanketed by deep snow all winter. The southern portion of the basin has long, hot summers, practically continuous sunshine, and almost complete absence of freezing temperatures.

The entire basin is arid except in the extremely high altitudes of the headwaters areas. Rainfall averages as low as 2.5 inches in the southern end of the basin while total precipitation in the mountain tops could reach as high as 40 to 60 inches annually.

D. Vegetation

Areas of higher elevation are covered with forests of pine, fir, spruce, and silver-stemmed aspens, broken by small glades and mountain meadows. Pinon and juniper trees, interspersed with scrub oak, mountain mahogany, rabbit brush, bunch grasses, and similar plants grow in the intermediate elevations of the mesa and plateau regions. Large areas in the Upper Basin are dominated by big sagebrush and related vegetation. Many of the streams are bordered by cottonwood, willows, and salt cedar. Scattered cottonwoods and chokecherries grow in the canyons with the cliff rose, the redbud, and blue columbine. A profusion of wildflowers carpets many mountain parks. At lower elevations large areas are almost completely devoid of plant life while other sections are sprinkled with desert shrubs, Joshua trees, other Yucca plants, and saguaro cacti, some of the latter giant plants reaching 40 feet in height. Occasionally, cottonwoods or desert willows are found along desert streams with mesquite and creosote bush or catclaw and paloverde. Many river flood plains have been overrun with tamarisk or salt cedar to the extent that a large volume of water is being consumed by such vegetation.

E. Hydrology

The Colorado River begins where peaks rise more than 14,000 feet high in the northwest portion of Colorado's Rocky Mountain National Park, 70 miles northwest of Denver. It meanders southwest for 640 miles

DESCRIPTION OF BASIN

through the Upper Basin to Lee Ferry. The Green River, its major tributary, rises in western Wyoming and discharges into the Colorado River in southeastern Utah--730 river miles south of its origin and 220 miles above Lee Ferry. The Green River drains 70 percent more area than the Colorado River above their junction but produces only about three-fourths as much water. The Gunnison and the San Juan are the other principal tributaries of the Upper Colorado River.

The flows of the San Juan River are now controlled by the Navajo Dam, the Green River by Fontenelle and Flaming Gorge Dams, and the Gunnison River by the Curecanti Unit Dams. Glen Canyon Dam is the only major dam on the main stem of the Colorado above Lee Ferry, but it will permit control of almost all flows leaving the Upper Basin.

The flow at various points in streams in the Colorado River Basin for the 1941-74 period is given in Tables 1 through 17. The records of flow depict the characteristic wide fluctuations from month-to-month and the considerable variation from year-to-year. The storage reservoirs now level out some of the fluctuations in the reaches below the dam.

The natural drainage area of the lower Colorado River below Lee Ferry and above Imperial Dam is about 75,100 square miles. This section of the river is now largely controlled by a series of storage and diversion dams starting with Hoover Dam and ending at Imperial Dam.

At the present time there is no significant storage on the main river or on the tributaries between Glen Canyon Dam and Lake Mead. The intervening tributary inflow is erratic but amounts to almost enough to offset the evaporation from Lake Mead.

Lake Mead provides most of the storage and regulation in the Lower Colorado River Basin with the water being stored for irrigation and municipal and industrial uses, generation of electrical power, and other beneficial uses.

Lake Mohave, the reservoir formed by Davis Dam, backs water at high stages about 67 miles upstream to the tailrace of Hoover Powerplant. Storage in Lake Mohave is used for some reregulation of releases from Hoover Dam, for meeting treaty requirements with Mexico, and for developing power head for the production of electrical energy at Davis Powerplant.

The river flows through a natural channel for about 10 miles below Davis Dam at which point the river enters the broad Mohave Valley 33 miles above the upper end of Lake Havasu.

Lake Havasu backs up behind Parker Dam for about 45 miles and covers about 25,000 acres. Lake Havasu serves as a forebay from which the Metropolitan Water District of Southern California pumps water into the

DESCRIPTION OF BASIN

Colorado River Aqueduct. Havasu Lake will also serve as forebay for the Central Arizona Project pumping plants and aqueducts. Lake Havasu and Alamo Dam and Reservoir are used to control floods originating below Davis Dam and above Parker Dam.

Headgate Rock Dam, Palo Verde Diversion Dam, and Imperial Dam all serve as diversion structures with practically no storage. Imperial Dam, located some 150 miles downstream from Parker Dam, is the major diversion structure to irrigation projects in the Imperial Valley and Yuma areas. It diverts water on the right bank to the All-American Canal which delivers water to the Yuma Project in Arizona and California and Imperial and Coachella Valleys in California. It diverts on the left bank to the Gila Gravity Main Canal.

The Senator Wash Dam also affords regulation in the vicinity of Imperial Dam and assists in the delivery of water to Mexico. This dam and reservoir is used for pump back storage, power generation, and recreation.

PART III. HISTORY OF WATER RESOURCE DEVELOPMENT

A. Irrigation Development

Irrigation development in the Upper Basin took place gradually from the beginning of settlement about 1860 but was hastened by the purchase of land from the Indians in 1873. About 800,000 acres were irrigated by 1905. Between 1905 and 1920 the development of irrigated land continued at a rapid pace, and by 1920 nearly 1,400,000 acres were irrigated. The development then leveled off and increase since that time has been slow. In 1965, 1,600,000 acres were under irrigation in the Upper Basin. Since 1965, there has been very little change.

The slow growth in irrigated acreage in the Upper Basin in the last 50 years is ascribed to both physical and economic limitations on the availability of water. By 1920 most of the lower cost and more easily constructed developments were in operation, and, although some new developments have taken place since that time, they have been partially offset by other acreages going out of production.

Irrigation development began in the Lower Basin about the same time as in the Upper Basin. Development was slow because of difficult diversions from the Colorado River with its widely fluctuating flows. Development of the Gila area began in 1875 and the Palo Verde area in 1879. Construction of the Boulder Canyon Project in the 1930's and other downstream projects since that time has provided the means for a continued expansion of the irrigated area. In 1970 an additional 21,800 acres were irrigated by private pumping either directly from the Colorado River or from wells in the flood plain. In 1974, there were nearly 849,000 acres in the United States irrigated from Colorado River diversions below Hoover Dam. About 25,500 acres of Lower Basin lands in Utah and 12,000 in Nevada are also now under irrigation.

B. Streamflow Depletions

Development and utilization of the basin's water resources result in depletions of streamflows. Consumptive use of water by irrigated crops and exports to other basins produce the greatest flow depletions. Reservoir evaporation and consumptive use of water for municipal and industrial purposes also produce significant depletions.

The 1973 estimated consumptive use of water by irrigated crops and municipal and industrial users in the Upper Basin was more than 2,200,000 acre-feet. Depletions related to irrigation such as evaporation from irrigation reservoirs (not Colorado River Storage Project Reservoirs) was estimated to be about 150,000 acre-feet per year.

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Water exported from the Upper Basin during the period 1941-70 averaged about 360,000 acre-feet per year. Completion of the large projects such as the Colorado-Big Thompson, Duchesne Tunnel, Roberts Tunnel, and the more recent projects such as the San Juan-Chama Fryingpan-Arkansas, and Homestake resulted in increased diversions to about 690,000 acre-feet in 1973.

Reservoir evaporation varies from year-to-year but the variations have little effect on average streamflow depletions. For the period of record considered, average reservoir evaporation in the Upper Basin was not large until about 1963 when the Colorado River Storage Project Reservoir started to store water. In 1973 about 569,000 acre-feet were evaporated from the reservoirs and about 638,000 in 1974. Under normal operating conditions, evaporation from the Colorado River Storage Project reservoirs is expected to average about 568,000 acre-feet annually.

In the lower basin, water is diverted to municipal and industrial projects and to irrigation districts. These M&I projects include the Southern Nevada Water Project which diverts water from Lake Mead above Hoover Dam, and the Metropolitan Water District which diverts water from above Parker Dam and exports it to the Southern California coastal areas. Below Parker Dam water is diverted for irrigation to the Colorado River Indian Reservation and to the Palo Verde Irrigation District. At Imperial Dam the water is divided into three parts. On the left bank, it goes to the Gila and Yuma Projects, on the right bank, it goes to the Imperial and Coachella water districts through the All American canal, with the remaining water going to Mexico. Below the Imperial Dam, water is delivered to Mexico as required by the treaty with Mexico. There is essentially no flow below Morelos Diversion Dam except for the bypassed saline flows from the Wellton-Mohawk Drain Extension.

C. Legal Aspects, Water Quantity

1. Colorado River Compact

Water of the Colorado River was divided between the Upper and Lower Colorado River Basins by the Colorado River Compact which was signed in 1922 by a commissioner of each of the seven States of the river basin and by a representative of the United States. All States but Arizona ratified the compact prior to its effective date in 1929. The dividing point on the river between the Upper and Lower Basins is at Lee Ferry which is defined as a point 1 mile below the mouth of the Paria River. (Not to be confused with Lees Ferry which is the site of the gaging station just above the Paria River.) The compact apportions from the Colorado River system to each of the Upper and Lower Basins in perpetuity for exclusive beneficial consumptive use, a total of 7,500,000 acre-feet annually. In addition to the apportionment of 7,500,000 acre-feet,

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the Lower Basin is given the right to increase its beneficial consumptive use of water from the Colorado River system by 1 million acre-feet annually. The compact further provides that the States of the upper division will not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75 million acre-feet for any period of 10 consecutive years.

One provision in the compact permits exportation of the water out of the basin as long as it is used beneficially in the seven Basin States, and another provision recognizes the obligations of the United States to the Indian Tribes. The compact prescribes the manner in which the water of the Colorado River system may be made available to Mexico under any water rights recognized by the United States.

The compact, in effect, cleared the way for legislation authorizing the construction of major projects such as Boulder Canyon Project, and it also cleared the way for compacts or agreements within the Upper and Lower Basins to further divide the water among the States.

2. Mexican Treaty of 1944

The treaty with Mexico, signed in 1944, provides for the annual guaranteed delivery by the United States of 1,500,000 acre-feet of Colorado River water to Mexico. This treaty does not mention water quality, and water from different sources had been used to supply the 1,500,000 acre-feet right. Because of this and other reasons, a problem of quality arose which had become of much concern to both countries. The quality aspects of the relationship with Mexico is covered later under "Legal Aspects, Water Quality."

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3. Upper Colorado River Basin Compact

With the water allocated to the Upper Basin by the Colorado River Compact and with the 1944 Mexican Treaty signed, the Upper Basin States began negotiations which resulted in the signing of the Upper Colorado River Basin Compact in 1948. Under the terms of the compact, Arizona is permitted to use 50,000 acre-feet of water annually from the Upper Colorado River system, and the remaining water is apportioned to the other Upper Basin States in the following percentages.

State of Colorado	51.75 percent
State of New Mexico	11.25 percent
State of Utah	23.00 percent
State of Wyoming	14.00 percent

Congress had previously been unwilling to approve projects without assurance that a water supply would be available, so this division of water among the States permitted development to proceed and resulted primarily in the authorization of most of the Federal projects above Lee Ferry that are mentioned in this report.

Neither of the compacts specifically mentions water quality, but it has been recognized as a factor to be considered in developing projects, and water quality studies have been required by recent legislation authorizing the construction of projects in the Upper Basin.

4. Arizona vs. California Suit in the Supreme Court

The States of the Lower Basin have never agreed to a compact for the division of use of the waters of the Lower Colorado River Basin. The State of Arizona filed suit in the Supreme Court of the United States in October 1952 against the State of California and others for the determination of the rights to use the waters of the Lower Colorado River system. The Supreme Court gave its decision on June 3, 1963, and issued a decree on March 9, 1964, providing for the apportionment of the use of the waters of the main stream of the Colorado River below Lee Ferry among the States of Arizona, California, and Nevada. The States of Arizona and New Mexico were granted the exclusive use of the waters of the Gila River system in the United States. The decree did not affect the rights or priorities to the use of water in any of the other Lower Basin tributaries of the Colorado River.

The decree permitted the States of the Lower Basin to proceed with developments to use their apportionments of Colorado River water. Major new developments include the Southern Nevada Water Project in Nevada, and the Central Arizona Project in Arizona. Development of the Indian lands is expected to use all of the water allocated to them by the decree. These lands include the Colorado River Indian Reservation,

HISTORY OF WATER RESOURCE DEVELOPMENT

Arizona-California; the Fort Mohave Indian Reservation, Arizona-California-Nevada; and the Chemehuevi Indian Reservation, California.

5. Colorado River Basin Project Act (Public Law 90-537, 90th Congress, September 30, 1968)

The major items provided in the law include the following:

Construction of the Central Arizona Project consisting of a system of main conduits and canals including a main canal and pumping plants (Granite Reef aqueduct and pumping plants) for diverting and carrying water from Lake Havasu to Orme Dam or suitable alternative.

Construction of five multiple-purpose projects in Colorado; the Animas-La Plata, Dolores, Dallas Creek, West Divide, and San Miguel; and one in Utah, the Uintah Unit of the Central Utah Project, upon completion and approval of a feasibility report to Congress.

Establishment of a Lower Colorado River Development Fund.

Development of criteria for the coordinated long-range operation of the Federal reservoirs, equalizing the storage in Lake Mead and Lake Powell.

Directed that the Secretary of the Interior shall conduct full and complete reconnaissance investigations for the purpose of developing a general plan to meet the future water needs of the Western United States, except that for a period of 10 years from the date of the act, studies shall not be undertaken of any plan for the importation of water into the Colorado River Basin from any other natural river drainage basin lying outside the States of Arizona, California, Colorado, New Mexico, and those portions of Nevada, Utah, and Wyoming which are in the natural drainage basin of the Colorado River.

Directed the Secretary to make annual reports of annual consumptive use and losses of water from the Colorado River system after each successive 5-year period beginning with the 5-year period starting on October 1, 1970.

D. Legal Aspects, Water Quality

Various water quality legislative acts have been passed by the Congress of the United States. Discussion of three acts that are of special significance to the Colorado River Basin follows:

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1. Water Quality Act of 1965 and Related Developments.

The Water Quality Act of 1965, Public Law 89-234, is an Act to amend the Federal Water Pollution Control Act and establish a Federal Water Pollution Control Administration, to provide grants for research and development, to increase grants for construction of sewage treatment works, to require establishment of water quality criteria, and for other purposes. Section 5 of this Act requires States to adopt water quality criteria applicable to interstate waters or portions thereof within their boundaries by June 30, 1967.

Each of the seven Basin States proceeded with actions directed toward establishment of water quality standards for interstate streams. Early in the standards setting process, it becomes apparent to the States that because of legal and institutional constraints combined with lack of technical knowledge of salinity control and management, it would be very difficult to establish numerical salinity standards on the Colorado River which would be workable, equitable, and enforceable. The seven Basin States subsequently developed water quality standards which did not include salinity standards.

The "Seventh Enforcement Conference in the Matter of Pollution of the Interstate Waters of the Colorado River and Its Tributaries" was held in Las Vegas (February 15-17, 1972) and Denver (April 26-27, 1972).

The conferees, official representatives of the seven Basin States and the Environmental Protection Agency, unanimously adopted conclusions and recommendations pertaining to the salinity problems of the Colorado River. The conclusions and recommendations were approved by Mr. William D. Ruckelshaus, Administrator of the Environmental Protection Agency in June 1972. The more significant conclusion being as follows:

"I. It is recommended that: A salinity policy be adopted for the Colorado River system that would have as its objective the maintenance of salinity concentrations at or below levels presently found in the lower main stem. In implementing the salinity policy objective for the Colorado River System, the salinity problem must be treated as a basinwide problem that needs to be solved to maintain Lower Basin water salinity at or below present levels while the Upper Basin continues to develop its compact-apportioned waters.

"II. The Salinity control program as described by the Department of the Interior in their report entitled "Colorado River Water Quality Improvement Program," dated February 1972, offers the best prospect for implementing the salinity control objective adopted herein."

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The conferees further suggested that the Bureau of Reclamation should have the primary responsibility for investigation, planning, and implementing the Colorado River Basin Salinity Control Program with the assistance of the Office of Saline Water and the Environmental Protection Agency at the Federal level.

2. The Federal Water Pollution Control Act Amendments of 1972

The object of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) is to restore and maintain the chemical, physical, and biological integrity of the Nations waters. It declares that the national goals are to eliminate discharge of pollutants into navigable waters by 1985 with an interim goal of attaining by July 1983, water quality which provides for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the Nation's water.

The Act authorizes the Environmental Protection Agency, after cooperation with other Federal agencies, State water pollution control agencies, interstate agencies and municipalities and industries involved, to prepare or develop comprehensive programs for preventing, reducing, or eliminating the pollution of the navigable waters and ground waters and improving the sanitary condition of surface and underground waters.

Some of the more important aspects of the Act briefly explained are as follows: The Act authorizes the Environmental Protection Agency to provide grants for research or demonstration projects and construction of treatment works to Federal Agencies, States, or private organizations. It also authorizes the Environmental Protection Agency to publish and revise from time to time, water quality criteria and to revise standards to include intrastate as well as interstate streams. The law also provides that by July 1, 1977, the best practical water pollution control technology must be applied followed by the best available technology economically achievable by July 1, 1983. Section 402 of the Act provides for the Governmental regulation of pollutant discharges through a mandatory permit program, monitoring, inspection, and periodic reporting. Section 404 requires those dischargers of fill or dredge material into a navigable stream to obtain a permit from the Corps of Engineers.

Enactment of Public Law 92-500 introduced a new factor into the salinity problem. The legislation has been interpreted by EPA to require that numerical standards for salinity on the Colorado River be set. Consequently in November (1973) the EPA submitted to several of the Colorado River Basin States proposed requirements and procedures for Salinity Control of the Colorado River System and proposed the establishment of an interstate organization to develop a salinity control plan.

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The Basin States, in response to EPA's submittal of the proposed requirements, and to discuss several other questions that had been generated relative to certain sections of Public Law 92-500, met on November 8 and 9, 1973, and among other things, formed the "Colorado River Basin Salinity Control Forum." A statement of position for use in discussing the proposed requirements and procedures for salinity control was adopted on November 9, 1973, and states in part:

"The States have established a mechanism for interstate cooperation (Colorado River Basin Salinity Control Forum) and for preparation and semiannual reports on the development of numeric criteria and the adoption of such criteria by October 18, 1975."

The Forum members also at the November 8-9, 1973, meeting agreed to request EPA that:

". . . The Final statement on proposed water quality standards and plan of implementation for salinity control should be consistent for all seven States of the Colorado River Basin; and opportunity should be provided for further direct discussion between representatives of the Environmental Protection Agency and the Forum before the proposed regulations are published in the Federal Register. . ."

Following the formulation of the Colorado River Basin Salinity Control Forum, meetings were held with representatives of the EPA in January, March, and April 1974 to discuss the proposed regulation on Colorado River Salinity.

The Environmental Protection Agency published a notice of proposed amendments to (40 CFR Part 120) COLORADO RIVER WATER SYSTEM, Salinity Control Policy and Standard Procedures in FR DOC 74-13683 dated June 12, 1974. After hearings in Las Vegas, Nevada, and Denver, Colorado, in August 1974, the final regulation was published on December 18, 1974, in the Federal Register. The regulation states that 40 CFR Part 120 is amended by adding Section 120.5 Colorado River System Implementation Plan, which reads as follows:

"(a) 'Colorado River System' means that portion of the Colorado River and its tributaries within the United States of America.

"(b) It shall be the policy that the flow weighted average annual salinity in the lower main stem of the Colorado River System be maintained at or below the average value found during 1972. To carry out this policy, water quality standards for salinity and a plan of implementation for salinity control shall be developed and implemented in accordance with the principles of paragraph (c) of this section, on the following page.

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"(c) The States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming are required to adopt and submit for approval to the Environmental Protection Agency on or before October 18, 1975:

"(1) Adopted water quality standards for salinity including numeric criteria consistent with the policy stated above for appropriate points in the Colorado River System, and

"(2) A plan to achieve compliance with these standards as expeditiously as practicable provided that:

"(i) The plan shall identify State and Federal regulatory authorities and programs necessary to achieve compliance with the plan.

"(ii) The salinity problem shall be treated as a basinwide problem that needs to be solved in order to maintain lower main stem salinity at or below 1972 levels while the Basin States continue to develop their Compact-apportioned waters.

"(iii) The goal of the plan shall be to achieve compliance with the adopted standards by July 1, 1983. The date of compliance with the adopted standards shall take into account the necessity for Federal salinity control actions set forth in the plan. Abatement measures within the control of the States shall be implemented as soon as practicable.

"(iv) Salinity levels in the lower main stem may temporarily increase above the 1972 levels if control measures to offset the increases are included in the control plan. However, compliance with 1972 levels shall be a primary consideration.

"(v) The feasibility of establishing an interstate institution for salinity management shall be evaluated."

"(d) The States are required to submit to the respective Environmental Protection Agency Regional Administrator, established procedures for achieving (c)(1) and (c)(2) above within 30 days of the effective date of these regulations and to submit progress reports quarterly thereafter. EPA will on a quarterly basis determine the progress being made in the development of salinity standards and the implementation plan."

The Colorado River Basin Salinity Control Forum prepared a report entitled, "Proposed Water Quality Standards for Salinity

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Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System," in June of 1975. The Forum held public meetings in Las Vegas, Nevada, on August 4, 1975, and Grand Junction, Colorado, on August 7, 1975, and received written comments through August 8, 1975, on the proposal. Based on the comments received, the Forum developed a supplement including modifications to the report. This Supplement is dated August 26, 1975.

Based upon the Forum's proposal and supplement thereto, each of the Colorado River Basin States held formal public hearings in accordance with their individual authority and public participation requirements of Public Law 92-500. As a result of the public hearings, the States adopted the "Proposed Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System, June 1975" and the "Supplement" thereto dated August 26, 1975. Together these documents would constitute the water quality standards as required by Section 303 of Public Law 92-500 and by the regulation promulgated in the Federal Register of December 18, 1974.

The EPA published a notice of Availability for Public Review and Comment for the proposed Standards in the Federal Register of March 31, 1976. A 60-day period following publication was allowed for comments. The State government administrators in all 7 states were notified by letter from EPA during the period November 8 to November 23 that the standards have been formally adopted.

The following is a summary of the adopted standards:

Summary

"Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control Colorado River System"

The Federal Water Pollution Control Act Amendments of 1972, P.L. 92-500, in Section 303 require the adoption of water quality standards applicable to interstate waters. Pursuant to that requirement, the Environmental Protection Agency on December 18, 1974, issued a regulation requiring the States of the Colorado River Basin to adopt water quality standards for salinity, consisting of numeric criteria and plan of implementation for salinity control. The standards were to be submitted for approval to the Environmental Protection Agency on or before October 18, 1975.

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This report, prepared by the seven State Colorado River Basin Salinity Control Forum, presents in a single document the water quality standards for salinity submitted for adoption by each of the States in the Basin. The standards are to be reviewed at three-year intervals and modified, if appropriate.

Consistent with the regulation, the recommended flow-weighted average annual numeric salinity criteria for three locations in the lower main stem of the Colorado River System are as follows:

	Salinity in mg/l
Below Hoover Dam	723
Below Parker Dam	747
Imperial Dam	879

The plan of implementation comprises a number of Federal and non-Federal projects and measures to maintain the flow-weighted average annual salinity in the lower main stem at or below the recommended numeric criteria through 1990, as the Basin States continue to develop their compact-apportioned waters. The principal components of the plan are as follows:

1. Prompt construction and operation of the initial four salinity control units authorized by Title II of P.L. 93-320, the Colorado River Basin Salinity Control Act.
2. Construction of the 12 other units listed in Title II of P.L. 93-320 or their equivalent after receipt of favorable planning reports.
3. The placing of effluent limitations, principally under the NPDES permit program provided for in Section 402 of P.L. 92-500 on industrial discharges.
4. The reformulation of previously authorized, but unconstructed, Federal water projects to reduce the salt loading effect.
5. Use of saline water for industrial purposes whenever practical, programs by water users to cope with the river's high salinity, studies of means to minimize salinity in municipal

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discharges, and studies of future possible salinity control programs.

The report recognizes that many natural and man-made factors affect the river's salinity. Consequently, the actual salinity will vary above and below the recommended numeric criteria. However, under the assumptions of streamflow equivalent to the long-term average, a "moderate" rate of increase in water depletions and full implementation of needed salinity control measures, the average salinity can be maintained at or below 1972 levels during the study period of the next 15 years.

The Federal regulations provide for temporary increases above the 1972 levels if control measures are included in the plan. Should water development projects be completed before control measures are identified or brought on line, temporary increases above the criteria could result and these increases will be in conformance with the regulations. With completion of control projects, those now in the plan or those to be added subsequently, salinity would return to or below the criterial level.

Periodic increases above the criteria as a result of reservoir conditions or periods of below long-time average annual river flow also will be in conformance with the regulation. With satisfactory reservoir conditions and when river flows return to the long-time average annual flow or above, concentrations are expected to be at or below the criteria level.

3. Relations With Mexico

The average annual salinity of the water delivered to Mexico at the Northerly International Boundary increased in 1961 from about 800 mg/l to nearly 1400 mg/l and to over 1500 mg/l in 1962. The completion of the drainage wells and subsequent pumping of 151,500 acre-feet of drainage water in 1961 from the Wellton-Mohawk District added over 1 million tons of salt to the Colorado River. The district further increased their pumping to 213,000 acre-feet in 1962 and added over 1.7 million tons of salt. If the flow in 1961 leaving Imperial Dam and arriving at the Northerly International Boundary (NIB) had remained at

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the same volume as in 1960, the salinity at the NIB would have been less in 1961. Since the flow in 1961 was less by 800,000 acre-feet than in 1960, a larger salinity differential was observed resulting in a water quality of nearly 1400 mg/l at the NIB. The reduced flow was caused by two things, a lower than normal runoff in the Upper Basin and the filling of upstream reservoirs in the anticipation of the closure of Glen Canyon Dam. Approximately 75 percent of the rise in the salinity at the NIB was caused by the Wellton-Mohawk Drainage returns. The remaining 25 percent was caused by the reduction in the excess deliveries to Mexico.

The increase in salinity resulted in negotiations between the United States and Mexico. In March 1965, Minute No. 218 was signed and approved by the two Governments. Beginning on November 16, 1965, Wellton-Mohawk drainage flows were bypassed around Morelos Dam during periods of minimum flow which amounted to about 55,000 acre-feet per year. The minimum flow of 900 c.f.s. at the NIB occurs during the winter months for a period not to exceed 180 days. This agreement was in effect until June 30, 1972, and reduced the average annual salinity of waters delivered to Mexico to about 1,245 mg/l.

On July 14, 1972, another agreement, Minute No. 241, was entered into. This Minute provided that the United States would increase the bypass of Wellton-Mohawk drainage, without charge against scheduled Treaty deliveries to Mexico, to the annual rate of 118,000 acre-feet and substitute equal volumes of other waters of better quality to be discharged to the Colorado River above Morelos Dam. This would reduce the salinity of waters delivered to Mexico by an estimated 100 mg/l. Minute 241, with three extensions, was in effect from July 1, 1972, through December 31, 1972.

Minute No. 242

In keeping with President Nixon's objective to find a permanent, definitive, and just solution to the salinity problem with Mexico, accord was reached on August 30, 1973, with the execution of Minute 242 of the International Boundary and Water Commission. The Minute was developed following an intensive study of the problem by former Attorney General Herbert Brownell and a federal Task Force appointed to assist him. Participation of the Basin States was sought by Mr. Brownell and representatives of the Governors (identified as the Committee of Fourteen), assisted in defining the solution. The key elements of the agreement were:

- "1. Referring to the annual volume of the Colorado River waters guaranteed to Mexico under the Treaty of 1944, of 1,500,000 acre-feet (1,850,234,000 cubic meters):

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"a. The United States shall adopt measures to assure that not earlier than January 1, 1974, and no later than July 1, 1974, the approximately 1,360,000 acre-feet (1,677,545,000 cubic meters) delivered to Mexico upstream of Morelos Dam, have an annual average salinity of no more than 115 ppm \pm 30 ppm United States count (121 ppm \pm 30 ppm Mexican count) over the annual average salinity of Colorado River waters which arrive at Imperial Dam, with the understanding that any waters that may be delivered to Mexico under the Treaty of 1944 by means of the All-American Canal shall be considered as having been delivered upstream of Morelos Dam for the purpose of computing this salinity.

"b. The United States will continue to deliver to Mexico on the land boundary at San Luis and in the limitrophe section of the Colorado River downstream from Morelos Dam approximately 140,000 acre-feet (172,689,000 cubic meters) annually with a salinity substantially the same as that of the waters customarily delivered there.

"c. Any decrease in deliveries under point 1(b) will be made up by an equal increase in deliveries under point 1(a).

"d. Any other substantial changes in the aforementioned volumes of water at the stated locations must be agreed to by the Commission.

"e. Implementation of the measures referred to in point 1(a) above is subject to the requirement in point 10 of the authorization of the necessary works.

"2. The life of Minute 241 shall be terminated upon approval of the present Minute. From September 1, 1973, until the provisions of point 1(a) become effective, the United States shall discharge to the Colorado River downstream from Morelos Dam, volumes of drainage waters from the Wellton-Mohawk District at the annual rate of 118,000 acre-feet (145,551,000 cubic meters) and substitute therefor an equal volume of other waters to be discharged to the Colorado River above Morelos Dam; and, pursuant to the decision of President Echeverria expressed in the Joint Communique of June 17, 1972, the United States shall discharge to the Colorado River downstream from Morelos Dam the drainage waters of the Wellton-Mohawk District that do not form a part of the volumes of drainage waters referred to above, with the understanding that this remaining volume will not be replaced by substitution waters. The Commission

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shall continue to account for the drainage waters discharged below Morelos Dam as part of Article 10 of the Water Treaty of February 3, 1944.

"3. As a part of the measures referred to in point 1(a), the United States shall extend in its territory the concrete-lined Wellton-Mohawk bypass drain from Morelos Dam to the Arizona-Sonora international boundary, and operate and maintain the portions of the Wellton-Mohawk bypass drain located in the United States.

"4. To complete the drain referred to in point 3, Mexico, through the Commission and at the expense of the United States, shall construct, operate and maintain an extension of the concrete-lined bypass drain from the Arizona-Sonora international boundary to the Santa Clara Slough of a capacity of 353 cubic feet (10 cubic meters) per second. Mexico shall permit the United States to discharge through this drain to the Santa Clara Slough all or a portion of the Wellton-Mohawk drainage waters, the volumes of brine from such desalting operations in the United States as are carried out to implement the Resolution of this Minute, and any other volumes of brine which Mexico may agree to accept. It is understood that no radioactive material or nuclear wastes shall be discharged through this drain, and that the United States shall acquire no right to navigation, servitude or easement by reason of the existence of the drain, nor other legal rights, except as expressly provided in this point.

"5. Pending the conclusion by the Governments of the United States and Mexico of a comprehensive agreement on ground water in the border areas, each country shall limit pumping of ground waters in its territory within five miles (eight kilometers) of the Arizona-Sonora boundary near San Luis to 160,000 acre-feet (197,358,000 cubic meters) annually.

"6. With the objective of avoiding future problems, the United States and Mexico shall consult with each other prior to undertaking any new development of either the surface or the ground water resources, or undertaking substantial modifications of present developments, in its own territory in the border area that might adversely affect the other country.

"7. The United States will support efforts by Mexico to obtain appropriate financing on favorable terms for the improvement and rehabilitation of Mexicali Valley. The United States will also provide nonreimbursable assistance on a basis mutually acceptable to both countries exclusively for those aspects of the Mexican rehabilitation program of the Mexicali Valley

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relating to the salinity problem, including tile drainage. In order to comply with the above-mentioned purposes, both countries will undertake negotiations as soon as possible.

"8. The United States and Mexico shall recognize the undertakings and understandings contained in this Resolution as constituting the permanent and definitive solution of the salinity problem referred to in the Joint Communiqué of President Richard Nixon and President Luis Echeverría dated June 17, 1972.

"9. The measures required to implement this Resolution shall be undertaken and completed at the earliest practical date.

"10. This minute is subject to the express approval of both Governments by exchange of Notes. It shall enter into force upon such approval; Provided, however, That the provisions which are dependent for their implementation on the construction of works or on other measures which require expenditure of funds by the United States, shall become effective upon the notification by the United States to Mexico of the authorization by the United States Congress of said funds, which will be sought promptly."

The passage of the Colorado River Basin Salinity Control Act, Public Law 93-320, on June 24, 1974, authorized construction of the Yuma desalting plant and other works necessary for the United States to comply with the provisions of Minute 242.

4. Colorado River Basin Salinity Control Act

On June 24, 1974, Public Law 93-320 of the 93rd Congress was signed into Law by the President. This Act is cited as the "Colorado River Basin Salinity Control Act." The Secretary of the Interior is authorized to construct several projects for the improvement, and enhancement, and protection of the quality of water available in the Colorado River for use in the United States and the Republic of Mexico, and to enable the United States to comply with its obligations to Mexico under Minute No. 242 of the International Boundary and Water Commission, United States and Mexico. The passage of this law ended the temporary operating criteria provided by Article 2 of Minute No. 242 and on June 25, 1975, the United States began complying with the provisions of Article 1(a) of Minute No. 242.

E. Economic Conditions

The prosperity of agriculture in the Upper Colorado River drainage basin generally parallels the prosperity of the livestock industry. With vast areas of fine rangeland available for summer grazing, livestock production is limited by the production of hay for winter feed.

HISTORY OF WATER RESOURCE DEVELOPMENT

Intensified development of mineral resources in recent years has created new employment opportunities, including off-the-farm work for many farmers. The most extensive and commercially important mineral resources of the Upper Basin are coal, oil, and natural gas. The Upper Basin is also the leading domestic source of vanadium, uranium, radium ore, and molybdenum. Copper, zinc, lead, silver, and gold are also commercially important. In recent years mining of trona has become extensive in the State of Wyoming.

The recent shortage of energy has resulted in an intense search for new sources. As a result, investigations are underway for the commercial development of shale oil in Colorado, Utah, and Wyoming. Fossil fuel powerplants are either being constructed or are in the planning stage for construction in the Upper Basin States. Coal gasification is an emerging industry in northwestern New Mexico where several billion tons of strippable coal are available. These developments have already and will continue to provide job opportunities throughout the area. The increase in population resulting from new job opportunities has created new markets for locally produced and imported products, has taxed municipal facilities and water supplies in several areas, and has increased demands for electricity. Raw materials are also stimulating industrial activities in areas adjoining the upper drainage basin, particularly areas near Denver, Pueblo, Provo, and Salt Lake City. These adjoining areas all import water from the Colorado River Basin and without the imported water their economic growth would be limited.

Tourism as an industry has increased significantly in recent years because of the recreational developments and the many natural attractions. Manufacturing as a basic industry is of relatively minor importance in the Upper Basin.

The irrigated lands in the Lower Basin that use Colorado River's main stream water are some of the most highly productive lands in the United States because agricultural practices are generally year long and highly intensified. The average gross crop income per acre in 1974 was about \$800 per acre for the 849,000 acres irrigated by main stem waters in the Lower Basin.

The Southern California area is one of the most rapidly developing regions both industrially and population-wise in the Nation. Colorado River water for municipal and industrial purposes is supplied to approximately 130 incorporated towns and other communities in this area with a population of about 10 million people. The Metropolitan Water District diverted 1,116,700 acre-feet of Colorado River water in 1974. Flows to the Metropolitan Water District will be reduced when the Central Arizona Project starts diverting. State project water was blended with Colorado River water to provide a better quality water for the southern California area. The Colorado River supplies about 36 percent of all of the developed water in the 4,900-square-mile service area. This water ranges from a minor supply for some entities to a complete supply for others.

PART IV. CAUSES OF SALINITY

A. Increased Concentration from Salt Additions

1. Natural Sources of Salinity

Flow and quality records reveal that along certain reaches of the Colorado River there are large increases in the dissolved-solids load that cannot be attributed to irrigation or other man-related activity. This increase is mainly due to natural diffused sources and saline springs.

Natural diffused sources are those sources of salt contribution which occur gradually over long reaches of the river system. Salt pickup occurs over large areas of surface and underlying soils, from stream channels and banks, and is difficult to identify, measure, or control. This source contributes the largest overall share of the salts to the Colorado River. Natural point sources are mainly saline springs where the contribution of salt and water is easily identified, issuing from single or concentrated sources.

Very little information was obtained prior to irrigation, making it difficult to identify the magnitude of specific natural sources of salinity in the Colorado River Basin.

Upper Basin.--Past records indicate a substantial increase in salt load in the Lake Powell area above Lees Ferry and below the Green River Utah, Cisco, and Bluff stations. Iorns and others (1965, p. 20) presented estimates of dissolved-solids loads in this river reach based on the period 1914-57 adjusted to 1957 conditions of development. Unaccounted inflow of dissolved solids in this reach amounted to about 5 percent of the load at Lees Ferry. Most of this resulted from natural diffused sources with the San Rafael and Dirty Devil areas fairly heavy contributors. (1)

Other areas in the Upper Basin with large amounts of natural diffused sources of salt are the Grand Valley, Uncompahgre, Lower Gunnison, and McElmo Creek areas in Colorado; Price, and Uintah Basin in Utah; and Big Sandy River area in Wyoming. Although a large amount of salt pickup in these areas is due to natural runoff, some can be attributed to irrigation.

Table A summarizes information about the contribution of water and dissolved salts by point sources, including the springs and wells in the Upper Colorado River system. Although wells are man-made and not a

CAUSES OF SALINITY

natural source, abandoned saline flowing wells are shown with the natural springs. The largest contributors in the Upper Basin are the Dotsero and Glenwood Springs which supply the major part of the salts from point sources.

Lower Basin.--The inflow for the reach the Colorado River at Lees Ferry to the Colorado River near Grand Canyon has varied from a low of 18,000 acre-feet in 1949 to a high of 939,000 acre-feet in 1941 with an average annual inflow for the 1941-74 period of 313,000 acre-feet. The total tons of inflow in this reach varied from a low of 498,000 tons in 1962 to a high of 2,022,000 tons in 1941 with an average inflow of 1,088,000 tons per year. Springs in the lower portion of the Little Colorado River contribute about half of the measured increase in dissolved-solids discharge in the Colorado River between Lees Ferry and Grand Canyon.

The annual inflow in acre-feet and tons with the average concentration for each year is shown in Table B for this reach.

Large amounts of dissolved solids are also added to the Colorado River between Grand Canyon and Hoover Dam. Some of this results from the solution of material in the bed of Lake Mead, but like the reach above Grand Canyon, most is contributed by springs and tributary inflows.

For the whole reach from Glen Canyon Dam to Hoover Dam recent studies have been made by the Geological Survey and the Bureau of Reclamation to provide information about the contribution of springs to the Colorado River.

Major springs and spring-fed tributaries which could be measured were found to contribute about 760,000 tons of dissolved solids annually to the Colorado River between Glen Canyon Dam and Lake Mead. Storm runoff in small tributaries in this reach of the Colorado River contributes an unknown, but probably much smaller, load to the river. The contribution of dissolved solids by these sources of inflow between Glen Canyon and Lake Mead equals about 10 percent of the average dissolved-solids load of the Colorado River at Lees Ferry.

The annual dissolved-solids contributions of the measured major springs, streams, and spring-fed tributaries to the Colorado River between Glen Canyon Dam and Lake Mead and to the Virgin River are summarized in Table C.

CAUSES OF SALINITY

Table B
Average Inflow Between Lee Ferry and Grand Canyon

Year	Inflow	Inflow	Concentration	
	1000 AF	1000 Tons	T/AF	mg/l
1941	<u>1</u> /939	<u>1</u> /2,022	2.15	1,583
1942	134	805	6.00	4,417
1943	211	1,658	7.86	5,778
1944	311	1,423	4.58	3,364
1945	346	1,596	4.61	3,392
1946	368	1,396	3.79	2,789
1947	301	1,782	5.92	4,353
1948	124	1,268	10.23	7,519
1949	<u>2</u> /18	1,300	72.22	<u>3</u> /53,104
1950	34	1,364	40.11	29,498
1951	33	1,306	39.57	29,100
1952	203	2,186	10.77	7,918
1953	75	1,208	16.11	11,843
1954	135	789	5.84	4,297
1955	321	946	2.95	2,167
1956	115	661	5.75	4,226
1957	210	617	2.94	2,160
1958	322	574	1.78	1,311
1959	247	882	3.57	2,626
1960	364	741	2.03	1,497
1961	425	1,187	2.79	2,054
1962	400	<u>2</u> /498	1.24	915
1963	246	533	2.17	1,593
1964	339	872	2.57	1,891
1965	188	1,177	6.26	4,603
1966	488	899	1.84	1,355
1967	472	1,051	2.23	1,637
1968	591	1,092	1.85	1,359
1969	465	954	2.05	1,509
1970	453	711	1.57	1,154
1971	310	1,050	3.39	2,490
1972	455	968	2.13	1,564
1973	784	890	1.14	<u>4</u> /835
1974	227	587	2.59	1,901
Total	10,654	36,993		
Average	313	1,088	3.49	2,556

- 1/ Largest inflow.
- 2/ Smallest inflow.
- 3/ Highest concentration.
- 4/ Lowest concentration.

CAUSES OF SALINITY

1. In-basin Depletions

Consumptive use of water for irrigation within the basin is responsible for the largest depletions while municipal and industrial uses accounts for a lesser depletion. Evaporation from reservoir and stream surfaces also produces large depletions. Phreatophytes cause significant water losses by evapotranspiration, especially in the Lower Basin below Hoover Dam. In most cases where in-basin depletions occur, the diverted salts return to the river system, adding significantly to the increase in concentration.

2. Transbasin Depletions

The major part of the transbasin depletions are made at higher elevations where the salinity concentrations are very low. This removal of high quality water results in the remaining flows downstream to become more concentrated even though some salts are removed by the water delivered to another basin. Many transbasin diversions have been made for several years and an additional number will divert in the future. The largest ones are the Bonneville Unit of the Central Utah Project, the Denver-Englewood and Homestake Diversions, the San Juan-Chama Project, and the Fryingpan-Arkansas Project all of which are now diverting water.

PART V. EFFECTS OF SALINITY ON WATER USE

Water quality can be a factor in limiting the use of a water supply. Different water uses require waters of different qualities, and a supply may be acceptable for some uses but unsuitable for others. Most water uses have a range of quality within which a supply may be acceptable for that use. Use of water at the low quality end of this range may impose an economic, a social, and/or a political penalty on the water user in comparison to use of the water at a higher quality. The suitability of the quality of a water supply for use is thus a relative matter and must be evaluated with regard to specific uses and the social and economic aspects of such use.

An important objective of salinity investigations is to assess the suitability of Colorado River water for various beneficial uses. The following sections discuss the physical and economic effects of salinity on water uses in the Colorado River Basin.

A. In-stream Use

The major in-stream uses (uses where water is not depleted) of water in the Colorado River Basin include hydroelectric power production, propagation of fish and aquatic life, recreation (including water contact sports), and aesthetics. Within the range of salinity concentrations expected in the foreseeable future, salinity should have no significant effects on these uses.

B. Irrigation Use

The major portion of the basin water supply is consumptively used for irrigation. Any effects of water quality on this use are thus of major importance. Crops grown in the basin differ in sensitivity to a salt concentration in the soil root zone, with some crops tolerating significantly higher concentrations in the root zone than the more sensitive crops. Also, most crops require a lower salinity concentration in the root zone during the germinating and seedling stage than they do later in the growing cycle. Salinity concentrations in the root zone are affected by the salinity concentration of the irrigation water, method of irrigation, irrigation efficiency, depth and concentration of ground water, drainability and texture of the soil, weather patterns, and other factors. If, however, all other factors remain unchanged, the salinity concentration of the root zone will vary with the salinity concentration of the irrigation water. Thus an increase in the salinity concentration of the irrigation water will decrease the productivity of the salt-sensitive crops if its tolerance limit of salinity concentration

EFFECTS OF SALINITY ON WATER USE

in the root zone is exceeded. Because of the many factors affecting the salinity concentration in the root zone, an exact irrigation water concentration that will damage a crop cannot be determined. For economic studies to determine Lower Basin damages, a salinity level of 750 mg/l was assumed as the level at which losses begin to occur.

Damage to salt-sensitive crops can be prevented by applying additional irrigation water to flush the salts from the soil. If natural drainage or an existing drainage system is inadequate to remove the additional water, it may be necessary to install additional drains.

In the Upper Basin, salinity concentrations during the irrigation season are relatively low except in local areas. The impact of salinity on irrigation in the Upper Basin is thus minimal.

In the Lower Basin, present peak salinity concentrations are approaching critical levels for some salt-sensitive crops, and, while suitable for irrigation of most crops, are high enough that special irrigation practices are used in some cases. Economic losses will occur as salinity levels increase throughout the basin.

C. Industrial Use

Colorado River water has not yet been widely used for industrial purposes within the basin but extensive use has been made of this water from transmountain diversions outside the basin. Since the quality of the water diverted from the Upper Basin is relatively high, only minimal pretreatment is required for most industrial uses. In the Lower Basin, the higher salinity levels in the diverted flows may require more extensive pretreatment for some types of industrial uses.

The quality of water required for industrial use varies widely and is dependent upon the purposes for which the water is utilized. Within any industrial plant, water may have several functions; however, cooling is the largest single use of industrial water supplied from the Colorado River. Future industrial uses are expected to increase tremendously with the increased requirements for energy.

D. Domestic Use

For domestic water use it is desirable to have a safe, clear, potable, aesthetically pleasing water supply which meets the recommended limits of the Public Health Service Drinking Water Standards of 1962 and the national interim primary drinking water standards of P.L. 93-523. High salinity levels affect the taste of drinking water and may affect the digestive system in some people. Water hardness, which may increase with increases in salinity concentrations, also requires more soap and laundry additives to achieve acceptable cleaning results. If the water becomes

PART VI. EVALUATIONS OF EXISTING SALINITY CONDITIONS

A. Quality of Water Stations

A primary purpose of this report is to summarize water quality conditions for the Colorado River Basin. This part summarizes chemical quality under both historical and present conditions of water resource development and utilization. Anticipated changes in future chemical quality are discussed in Part VII. Other water quality parameters are discussed in Part IX.

Evaluations of the salinity of the water in the basin are based on quality of water and streamflow records at 17 selected stations. Each station is considered to reflect flow and water quality conditions at its location. Records were generally available at each station for the time period considered by this report, 1941 to 1974. Where records were not available, missing data were estimated by correlation with other stations.

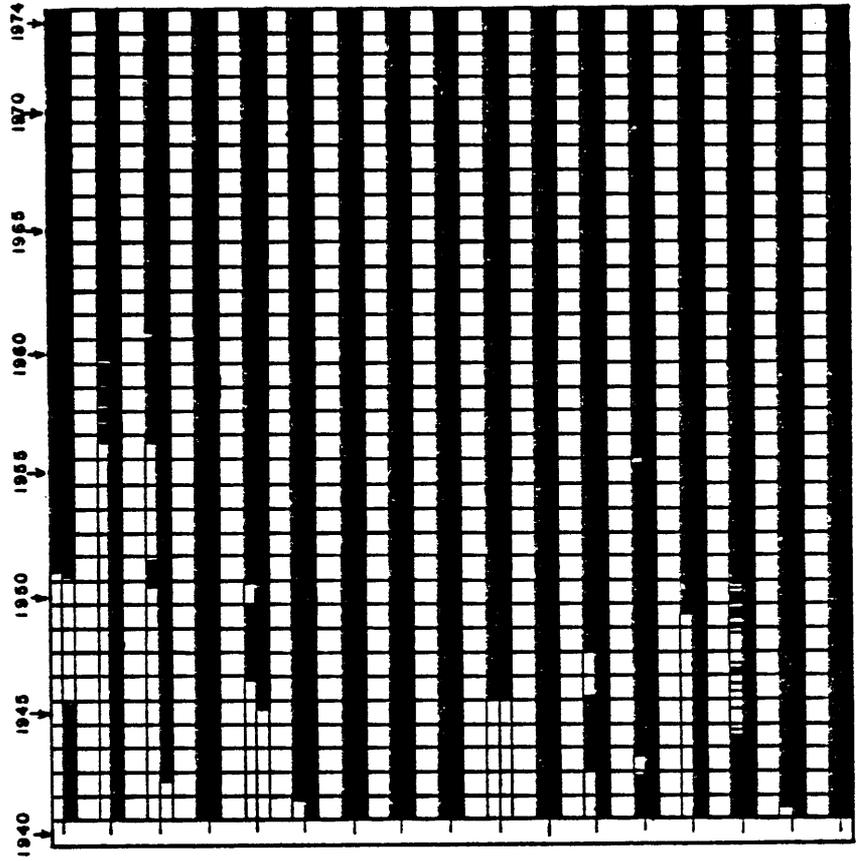
Basic data summarized in this report were primarily obtained from records of the Geological Survey developed by a continuing program for collection of water data which is supported in part by a transfer of funds from the Bureau of Reclamation.

Locations of the 17 key stations are shown on Figure 1. Available flow and quality records for each station are shown on Figure 2. The source and method of derivation of basic data for each of the stations are briefly discussed in the following sections.

1. Key Stations with Complete Records

Records of flow and water quality are available for all of the 1941-74 period for the Green River at Green River, Utah (Station No. 4); Colorado River near Cameo, Colorado (Station No. 7); Gunnison River near Grand Junction, Colorado (Station No. 8); Colorado River near Cisco, Utah (Station No. 9); and San Juan River near Bluff, Utah (Station No. 11). Minor extensions only were needed to fill in short periods of record for a few of these stations. The Colorado River near Glenwood Springs gage was moved from above to below the Roaring Fork at the end of the water year 1966. Subsequent records for this station were adjusted by subtracting the Roaring Fork flows. All records were obtained from the Geological Survey publications. Current Geological Survey data may be obtained from the respective U.S. Geological Survey, Water Resource Division computer data storage banks in Reston, Virginia, or from the Environmental Protection Agency's STORET system.

Colorado River Basin
Flow and Quality of Water Records
1941 - 1974



- Green River near Green River, Wyoming
- Green River near Granddale, Utah
- Duchesne River near Rendlett, Utah
- Green River at Green River, Utah
- San Rafael River near Green River, Utah
- Colorado River near Glenwood Springs, Colorado
- Colorado River near Como, Colorado
- Gunnison River near Grand Junction, Colorado
- Colorado River near Cisco, Utah
- San Juan River near Archuleta, New Mexico
- San Juan River near Bluff, Utah
- Colorado River at Lees Ferry, Arizona
- Colorado River near Grand Canyon, Arizona
- Virgila River at Littlefield, Arizona
- Colorado River below Hoover Dam Arizona - Nevada
- Colorado River below Parker Dam Arizona - California
- Colorado River at Imperial Dam Arizona - California

Sampled quality record
Measured flow record

Correlated quality record
Correlated flow record

Fig. 2

EVALUATIONS OF EXISTING SALINITY CONDITIONS

2. Key Stations with Partial Records

Green River near Green River, Wyoming (Station No. 1).--Flow records are available at this station from April 1951 and quality records from May 1951. The records have been extended back to 1941 by correlation with nearby stations.

Green River near Greendale, Utah (Station No. 2).--Flow measurements or comparable data are available for this station for the report period, but chemical quality data are available only for the years 1957 through 1974, inclusive. Extensive correlations with other available records on the Green River system were employed to develop estimates for dissolved solids.

Duchesne River near Randlett, Utah (Station No. 3).--Flow records have been obtained continuously since 1943, and quality data are available for 1951 and 1957 through 1974. Correlations with other stations in the Duchesne River system were employed to estimate the data for the missing period.

San Rafael River near Green River, Utah (Station No. 5).--Correlations were used to estimate flow at this gage from 1941 to 1945 after which measurements of flow were available. Quality sampling started in 1946 and is complete for the remainder of the study period except for 1950. Extensions of available data provided satisfactory estimates of quality for the missing years.

Colorado River near Glenwood Springs, Colorado (Station No. 6).--Correlations were used to estimate the quality data for the 1941 year prior to October 1. Quality records are available after October 1, 1941. Flow records are available for the entire period of study.

San Juan River near Archuleta, New Mexico (Station No. 10).--For the period 1954 to 1974 flow and quality data presented are a combination of measurements obtained near Archuleta and at Blanco, New Mexico, with a few adjustments and correlations. Correlations were employed to estimate the data for 1941-54. Quality data for 1969 through 1974 were estimated from once-a-month sampling at the Archuleta gaging station. In 1974 electrical conductivity measurements were started on a 3-time per week basis along with occasional chemical analyses. These measurements indicate the quality to be very uniform since the station is close to the outlet works of the Navajo Dam.

Colorado River at Lees Ferry, Arizona (Station No. 12).--This station has complete flow records available for the study period but lacks quality of water measurements for 1941, 1942, 1946, and 1947. Quality data for these years were estimated by extensive multiple correlations using data for the Colorado River near Cisco, Utah, and near Grand Canyon, Arizona;

EVALUATIONS OF EXISTING SALINITY CONDITIONS

the Green River, Utah; and the San Juan River near Bluff, Utah. Water samples are collected monthly by the Geological Survey for a chemical analysis of major constituents and nutrients analysis. Samples for minor element analyses are collected quarterly. Specific conductance and field water temperature measurements are made daily.

Colorado River near Grand Canyon, Arizona (Station No. 13).--Flow records are available for the report period and chemical quality records are also available except for the period December 1942 to August 1943. Quality data for the period of missing records were estimated from records at upstream stations. Water samples are collected and chemical analyses are made monthly by the Geological Survey with records dating back to 1925.

Virgin River at Littlefield, Arizona (Station No. 14).--Flow records are available for the report period, but quality data are available only from July 1949 to the present. Detailed correlations were employed to estimate the data for the missing period. Determinations are made daily by the Geological Survey for specific conductance, and water temperature chemical analyses are made monthly unless significant changes in conductivity occur.

Colorado River below Hoover Dam, Arizona-Nevada (Station No. 15).--Discharge and quality records are available from October 1939 until the present, except for water quality records during the period November 1944 to September 1950. The water quality for this time period is based on specific conductance records and intermittent chemical analyses. The samples used for the chemical analyses are collected monthly by the Geological Survey stream gaging station below the dam.

Colorado River below Parker Dam, Arizona-California (Station No. 16).--Flow records at this station are available from October 1934 and have been published or are available from the Geological Survey. The water quality data for the period January 1964 through December 1970 were taken at the Geological Survey station, Colorado River below Parker Dam. The water quality data for the period January 1941 through December 1963 used in the "Quality of Water Colorado River Basin Progress Report No. 5" were based on chemical analyses of Colorado River Aqueduct flows made by the Metropolitan Water District. These data have been adjusted based on a correlation of concurrent Metropolitan Water District records with records made by the Geological Survey below Parker Dam for the year 1964-70. The correlated data was then used for the period 1941-63.

Colorado River at Imperial Dam, Arizona-California (Station No. 17).--Although Figure 2 indicates flow records are available for the report period, no single station was used to obtain the record. It was obtained from a combination of several stations. Records from January 1941 through September 1942 are from the station, Colorado River near Picacho, California. Records from October 1942 through September 1960 are based on the combined records of discharge obtained at gaging stations

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on Colorado River at Yuma, All-American Canal near Imperial Dam, Gila Gravity Main Canal at Imperial Dam, Yuma Main Canal at Laguna Dam, and North Gila Valley Canal at Laguna Dam less that of Gila River near Dome, Arizona. Records after September 1960 are based on the combined daily discharge of Colorado River passing Imperial Dam and at gaging stations on All-American Canal near Imperial Dam and Gila Gravity Main Canal at Imperial Dam and the division to Mittre Lake.

Quality data from 1943 through October 1970 were obtained from Geological Survey records and are based on data for the Yuma Main Canal below the Colorado River Siphon. The water quality data for November and December 1970 and for calendar years 1971-1974 were obtained from the Geological Survey records for the water quality station at Imperial Dam. The samples are presently being collected by the Geological Survey and the Bureau of Reclamation above the trash racks at the diversion to the All-American Canal. Salinity analyses are made by the Geological Survey in cooperation with the Bureau of Reclamation. Field analyses and bacteria determinations are made by the Geological Survey in cooperation with Environmental Protection Agency.

3. Other Quality of Water Stations

In addition to the key stations discussed above, there are many more points at which water quality data are obtained. Most of these sampling stations are operated by the Geological Survey; however, a number are operated by the Bureau of Reclamation and other Federal, State, and private agencies.

The type of data obtained and the purpose of the sampling vary with each station. Many of the stations provide data for the Water Quality Improvement Program in Part VIII and special studies described in Part X.

B. Methods of Chemical Analyses

Published quality of water records consist of a combination of stream discharges with chemical analyses of stream water samples collected at more or less regular intervals. The reliability of the records depend on the accuracy of the streamflow records, the frequency of collection and representativeness of the samples, the stability of the samples during the storage periods prior to making of the analyses, and the completeness and accuracy of the individual analyses.

Most of the chemical analyses of water samples which provided the water quality data were made in the laboratories of the Geological Survey at Washington, D.C., Albuquerque, New Mexico, and Salt Lake City, Utah, using standard procedures by chemists specifically trained in water analysis. During the 34-year period considered there were several changes in laboratory techniques and procedures mostly due to introduction

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of new instrumental methods. New procedures were adopted only after careful investigation to insure results consistent with those obtained previously. Some of the quality of water records are based on analysis of samples by Bureau of Reclamation laboratories. Bureau of Reclamation results and methods have been checked by the Geological Survey to insure comparable records. It is probable that errors in the load computations due to errors in chemical analysis are less than those due to changes in the samples upon storage, inaccuracies in sampling, or inaccuracies in the determination of stream discharges.

Prior to about 1970 the U.S. Geological Survey analyzed water quality on a composite sample basis and also determined and published the annual total dissolved-solids loads. Since that time the results of the analysis in the Colorado River Basin have been those of individual samples rather than composites and no totals for the year have been computed. At present individual samples are taken and analyzed about once a month together with daily conductivities. The annual total dissolved-solids loads since this change, have been determined from daily conductivities applied to a curve or conversion factors relating conductivities and total dissolved-solids concentrations.

C. Historic Conditions

1. Total Dissolved-Solids Concentrations

Historic streamflow, total dissolved-solids salinity concentrations, and salt-load data for the 17 key stations for the 1941-74 period of record are presented in Table 1 to 17 with each table number of record are presented in Tables 1 to 17 with each table number corresponding to a station number. The concentrations as shown were determined on a flow weighted basis.

To simplify tabulation, monthly values of flow and total dissolved-solids loads were rounded to the nearest 1,000 acre-feet and tons. This resulted in some differences between the recorded and the computed monthly concentrations when the flows were low, for example, below 1,000 acre-feet in the San Rafael and Duchesne Rivers. Similarly, minor differences from published data in monthly concentrations occur in isolated instances in the flow and quality tables for the other stations.

The water quality at the Lees Ferry and the four other key stations on the Lower Colorado River has been affected by abnormal conditions during the 1959-74 period because of low runoff in 1959, 1960, and 1961 and the filling of Lake Powell in 1963 to 1974. Figure 3 shows the historical flow weighted average salinity concentration for these five stations.

During the first year of storage in Lake Powell in 1963, the flow at Lees Ferry was reduced to 1,384,000 acre-feet with a salinity concentration of 1.27 tons per acre-foot. The average concentration for the 1941-74 period was 0.76 tons per acre-foot.

WEIGHTED AVERAGE DISSOLVED SOLIDS CONCENTRATIONS, COLORADO RIVER BELOW LEES FERRY, ARIZONA

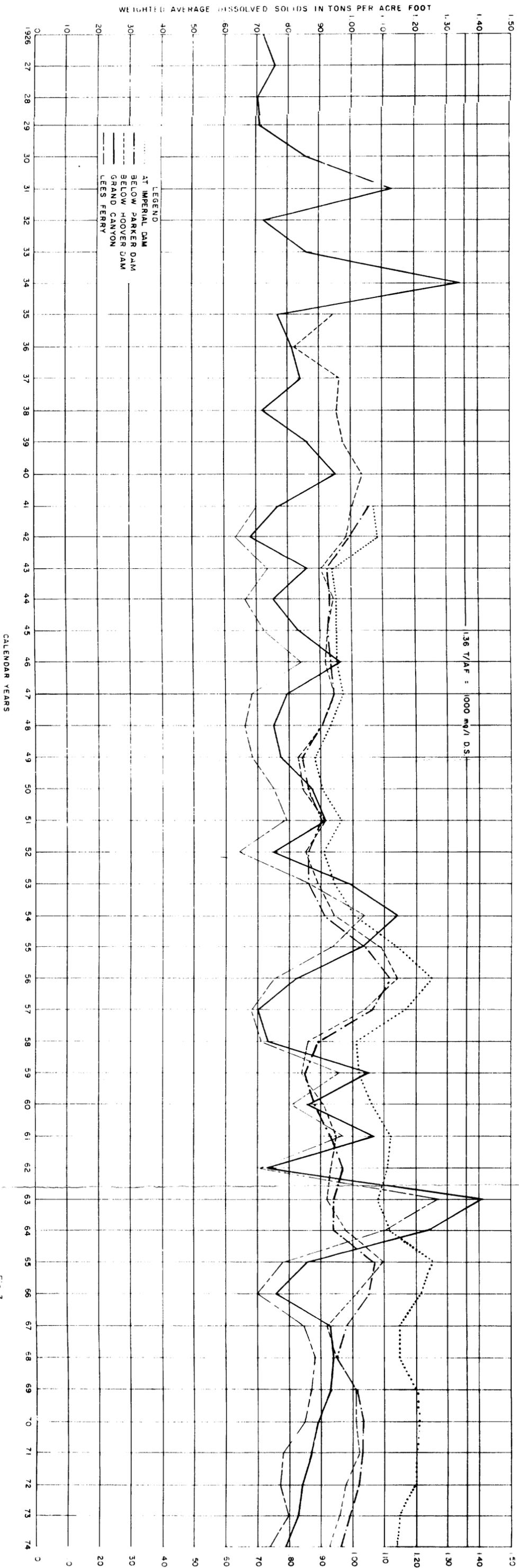


Fig. 3

EVALUATIONS OF EXISTING SALINITY CONDITIONS

The Grand Canyon station has the longest water quality record on the Colorado River, 1926-74. It is of interest that the average salinity concentration for the period 1941-74 is only slightly higher than the average salinity concentration for the period 1926-40, 0.84 to 0.81 tons per acre-foot, respectively.

Generally the salinity concentration increases at each succeeding downstream station as a result of depletions by diversions, reservoir and stream evaporation, and consumptive use by irrigated crops and phreatophytes, and by salt loading by inflowing springs, streams, solution of salt from the streambeds and reservoir basins, and by irrigation return flows. The flows of the Bill Williams River often dilute the flow of the Colorado River in Lake Havasu which sometimes results in a decrease in the salinity concentration from the below Hoover Dam station to the below Parker Dam station. Figure 3 shows the concentration changes between the five lower stations on the Colorado River. Note also that Lake Mead has a dampening and delaying effect, about 2 years, on the salinity concentrations at the downstream stations. This is especially noticeable for the high salinity concentrations of 1963 at the Lees Ferry and Grand Canyon stations.

D. Present Modified Conditions

The 1941-74 period average present modified flow and quality at any station, as defined in this report, is the average of the flows and quality that would have resulted if the present (1974) level of depletions instead of actual depletions had occurred each year of the period. This average present modified flow and quality, therefore, represent an average condition based on the 1941-74 water supply period occurring at the present (1974) time. This is shown for each station on Table E in Part VII. Adjustments to the historic flow that were made to develop the present modified flow included: (1) adjustments for the increase in depletion in 1974 over that for years prior to 1974; (2) adjustment of records below large reservoirs by adding the historical storage and subtracting storage releases to obtain unregulated flows at each station; and (3) adjustments for historic evaporation as compared to average present evaporation. The large reservoirs considered in these adjustments were the Colorado River Storage Project, Navajo and Fontenelle Reservoirs in the Upper Basin and Lake Mead, Lake Mohave, and Lake Havasu in the Lower Basin.

Average present evaporation from the Colorado River Storage Project Reservoirs plus Navajo and Fontenelle Reservoirs was estimated to be 568,000 acre-feet per year. (Note: This is the latest evaporation estimate pending results from additional investigations being conducted.) This would include evaporation from Lake Powell of 460,000 acre-feet; Flaming Gorge, 50,000 acre-feet; Curecanti Unit Reservoirs, 10,000 acre-feet; Navajo, 26,000 acre-feet; and Fontenelle Reservoir, 22,000 acre-feet. These figures were chosen to represent present conditions rather

EVALUATIONS OF EXISTING SALINITY CONDITIONS

than using the 1974 historical evaporation since a single year record could show an above-or-below normal condition. Present evaporation of the Lower Basin Reservoirs was assumed the same as historical since these reservoirs have been operating for a number of years.

Historical flows since 1941 have been affected by the transmountain diversions of the Colorado-Big Thompson Project, Duchesne Tunnel of Provo River Project, Roberts Tunnel of the city of Denver, and a number of small in-basin developments in the Upper Basin. More recently the Independence Pass expansion, Collbran, Paonia, Smith Fork, Silt, Florida, Hammond, Bostwick Park, San Juan-Chama, and Emery County Projects and Vernal Unit of Central Utah Project have come into operation. Also, as previously mentioned evaporation from the Colorado River Storage Project Reservoirs, Navajo, and Fontenelle Reservoirs is now in effect along with the Hayden Powerplant, Four Corners Powerplant, expansion of Hogback Indian lands, and the municipal and industrial uses in Wyoming. In the Lower Basin, corrections have been made for the Southern Nevada Water Project, the Metropolitan Water District diversion at Lake Havasu, the Colorado River Indian Reservation, and the Palo Verde Irrigation District. The depletions from all of the above projects have been extended back to 1941, from the time they became operational, so that when increased depletions on existing project or new depletions on new projects occur they can be imposed directly on the present modified condition to show the anticipated effect of all development on the river. In the near future several projects now under construction will become operational. The addition of these new depletions will result in slight increases in dissolved-solids concentrations under present modified conditions.

Quality data for present modified conditions were computed by taking into consideration (1) the flow weighted average of the concentrations of total dissolved solids for the various transmountain diversions, (2) the change in dissolved solids resulting from the existing upper in-basin developments on the basis of an assumed pickup of 2.0 tons of dissolved solids per acre of irrigated land and a depletion of 1.5 acre-feet of water per irrigated acre, and (3) in the Lower Basin a consumptive use of 4 acre-feet per acre and a 2.0 tons per acre pickup for irrigation of the Palo Verde Irrigation District, the Fort Mohave, Chemehuevi, and Colorado River Indian lands. The value of 4 acre-feet per acre is the rate presented in the Colorado River Basin Project hearings before the Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs, House of Representatives.

The present modified conditions are shown on Table E and are used as a base value for developing the anticipated effect of new depletions from new projects and the full development of present partially developed projects in the river basin.

Following is a brief description of the large existing dams and reservoirs on the Colorado River.

EVALUATIONS OF EXISTING SALINITY CONDITIONS

1. Fontenelle Reservoir

Fontenelle Reservoir, located on the Green River above Green River, Wyoming, has a storage capacity of 345,000 acre-feet (150,000 active) and regulates the flow in the Green River above Flaming Gorge Reservoir. It will be used to supply water to the Seedskadee Project including municipal and industrial uses and for wildlife refuge purposes.

2. Flaming Gorge

This storage unit is located on the Green River in northeastern Utah and southwestern Wyoming. The primary purposes of the Flaming Gorge Unit are river regulation, storage of flood flows of the Green River, and the generation of hydroelectric power. The reservoir has a storage capacity of 3,789,000 acre-feet (3,516,000 active). The stored water assists in complying with the terms of the Colorado River Compact and, by exchange, furnishes an irrigation supply for the participating projects in the Upper Basin States. In addition there are benefits from fish and wildlife conservation and recreational facilities. Storage commenced November 1, 1962, and from the records taken immediately below the dam it shows that the reservoir releases are more uniform in quality than uncontrolled streamflow prior to reservoir construction.

3. Curecanti Unit

Facilities of the Curecanti Unit, located in west-central Colorado, include the Blue Mesa, Morrow Point, and Crystal Dams, Reservoirs, and Powerplants. The primary purposes are regulation and storage of flood flows of the Gunnison River and generation of hydroelectric power. In addition benefits are provided to recreation, fish and wildlife conservation, and irrigation. The reservoirs of the Curecanti Unit help regulate the flows of the Colorado River at Lees Ferry. The storage capacity provided is 941,000 acre-feet (749,000 active) at Blue Mesa, 117,000 acre-feet (42,000 active) at Morrow Point, and 27,000 acre-feet (13,000 active) at Crystal Reservoir with total reservoir evaporation losses estimated to average 10,000 acre-feet annually for all three reservoirs. Storage was initiated late in 1965 at the Blue Mesa Reservoir and on January 24, 1968, at the Morrow Point Reservoir. Construction is almost completed on Crystal Dam.

4. Navajo

The Navajo Dam and Reservoir are located on the San Juan River in northwestern New Mexico and southwestern Colorado. Total storage capacity of the reservoir is 1,709,000 acre-feet (1,036,000 active). This reservoir regulates the flow of the river for irrigation of the Hammond Project, the Navajo Indian Irrigation Project, and for other uses including by exchange potential uses above the reservoir and transmountain diversions

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to the San Juan-Chama Project. It also helps regulate the flows of the Colorado River at Lees Ferry. Other purposes include recreation, sediment control, fish and wildlife propagation, and flood control. Storage began July 1, 1962, and the effect on quality is recorded at the Archuleta station below Navajo Dam.

5. Glen Canyon

The Glen Canyon Dam is located on the Colorado River in Arizona, 4 miles south of the Utah-Arizona boundary and 16 miles upstream from Lees Ferry. The bulk of the reservoir lies in Utah. At a normal water surface elevation of 3,700 feet m.s.l., Lake Powell extends 186 river miles up the Colorado River and 71 miles up from the mouth of the San Juan River. River mile 71 on the San Juan River is 133 river miles from Glen Canyon Dam. This 27,000,000 acre-foot (20,876,000 active) reservoir regulates the flow of the river for compact delivery purposes and for power generation and thus permits exchanges for upstream consumptive use of the water. Fish and wildlife conservation and recreation are also of major significance. Storage in Lake Powell commenced March 31, 1963.

6. Hoover

Lake Mead is formed behind Hoover Dam and is used for the storage of water for flood control, irrigation, municipal water supplies, and power generation. Lake Mead is the only reservoir on the Colorado River that has a specified space allocated exclusively for mainstream flood control. The present total capacity is about 28,000,000 acre-feet.

7. Davis

Lake Mohave is formed behind Davis Dam, a zoned earthfill type, and is used for power generation, regulation for irrigation demands, and to aid in satisfying the requirements of the Treaty of 1944 with Mexico. It has a capacity of 1,800,000 acre-feet.

8. Parker

Lake Havasu is formed behind the concrete arch Parker Dam and is used for flood control, power generation, regulation for irrigation demands, and as a pool from which water is pumped by the Metropolitan Water District of Southern California (MWD) to the Colorado River Aqueduct. The Central Arizona Project will also pump from this reservoir. It has a capacity of 619,000 acre-feet.

9. Senator Wash

Senator Wash Dam forms an offstream reservoir and is located 3 miles upstream of Imperial Dam. The reservoir is used for pump-back storage, power generation, and regulation for downstream users. This reservoir

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has resulted in a savings of water with respect to over deliveries to Mexico because of the 3-day travel time for water released from Parker Dam. It has a capacity of 14,000 acre-feet.

10. Imperial

Imperial Dam, a concrete slab and buttress-type dam constructed in 1938, is used as a diversion structure for water to the Yuma, Arizona area, the Imperial-Coachella Valley in California, and for the delivery of water to Mexico.

PART VII. ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

In order to estimate the probable effect of the authorized or contemplated developments on the quality of water at certain points along the Colorado River, the developments have been generally listed in downstream order. By following the flow and salts down the river the estimated effects of the development can be shown at the pertinent stations for the years 1980 and 2000. These results are tabulated in Table E for the new period of record used in this report. The table was computed on the basis of the 1941-74 average annual flow and total dissolved solids. An additional station, "Colorado River above Parker Dam," was included in the table for purposes of clarification and maintaining continuity in computations. It should be noted that future concentrations were estimated without consideration to possible future control measures. Salinity control measures are discussed separately in Part VIII.

The anticipated future conditions evaluated in Table E would result from the construction of both Federal and non-Federal developments. Pickup of dissolved solids from newly irrigated lands where comprehensive studies have not yet been made has been computed for two assumed conditions, zero and 2 tons per acre. The future increase in evaporation over average present evaporation, by the Colorado River Storage Reservoirs, was considered negligible and therefore not included in future depletions. Present evaporations are reflected in present modified conditions.

Following is a discussion of the various projects including a brief description of the physical conditions for each development authorized or contemplated for authorization. It should be recognized that the acreages and depletions as listed could change with change of plans on some of the contemplated projects. The figures presented below and in Table D are those which were current at the time of writing this report. In addition to the developments listed, a number of smaller private industrial developments either under construction or contemplated will result in certain depletions and will have some effect on water quality.

The effects of all upstream developments are carried on down to and including Imperial Dam.

A. Description of Projects

1. Above Green River near Green River, Wyoming

Seedskaadee Project.--This multipurpose project is located adjacent to the Green River in southwestern Wyoming.

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Water uses of the Seedskafee Project are not yet definite, but it now appears that most of the water will be used for industrial purposes. A total of 278,000 acre-feet depletion exclusive of Fontenelle evaporation is anticipated. Of this, an estimated 20,000 acre-feet is planned for wildlife purposes while the remaining 258,000 acre-feet of depletions was assumed to be for industrial purposes. Irrigation, however, may not yet be completely out of the picture. Industrial users include Pacific Power & Light Co., Sun Oil, and other possible industries. It was assumed the 20,000 acre-feet of water for refuge purposes would neither pick up nor lose salts, but the remaining water for industrial purposes would deplete the salts as well as the water. The salinity concentration of the water in the future at the Green River, Wyoming, gage would remain almost the same as present because diversions to industries are anticipated to be about the same location as the present gage.

2. Between Green River near Green River, Wyoming, and Green River near Greendale, Utah

Lyman Project.--This is a multipurpose project located in southwestern Wyoming. Project facilities consist of two dams and reservoirs. One is located at the Meeks Cabin site on the Blacks Fork in Wyoming and provides 33,000 acre-feet of storage capacity. The other will be located at the Stateline site of the East Fork of Smith Fork in Utah and will provide 14,000 acre-feet of storage capacity. The project when completed will have the primary purpose of providing supplemental water to 36,000 acres of existing farmland along with fish and wildlife and recreation benefits. Construction of Meeks Cabin Dam has been completed. This project will present an opportunity to study the water quality effects of adding supplemental water to lands already irrigated. Of the 10,000 acre-feet total depletions, only 4,000 acre-feet remain since 6,000 acre-feet from Meeks Cabin Reservoir is now depleted.

Utah Power & Light Co.--This steam powerplant is located at Kemmerer, Wyoming, with present depletions of about 8,000 acre-feet. Total present and future depletions of this plant and other industrial developments will amount to about 65,000 acre-feet/year. No salt return is anticipated.

3. Above Duchesne River near Randlett

Central Utah Project (Bonneville Unit).--The Bonneville Unit will include a transmountain diversion of water from the headwaters of the Duchesne River in the Uintah Basin portion of the Colorado River Basin to the Bonneville Basin. Related water developments will be made in both Colorado and Bonneville Basins. The project will develop water for irrigation, municipal and industrial use, and power production. It will also provide benefits to recreation, fish and wildlife, flood control, water quality control, and area redevelopment.

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The total depletion to the Green River will be 166,000 acre-feet with about 20,000 acre-feet being depleted in 1974.

Central Utah Project (Upalco Unit)--The Upalco Unit will be located in Duchesne County near Roosevelt, Utah. The plan of development is primarily to provide supplemental irrigation water to Indian and non-Indian lands along Lake Fork River and to enhance recreation and fish and wildlife, while maintaining flood control. The mean annual stream depletion is estimated to be about 10,000 acre-feet.

Central Utah Project (Uintah Unit).--The Uintah Unit of the Central Utah Project will provide a full supply to irrigate 7,800 acres of new lands and supplemental water to other lands on the south slope of the Uinta Mountains in the Uinta and Whiterocks Rivers drainage areas. The new annual depletion will be about 30,000 acre-feet.

Deferred Indian Lands.--It is estimated that depletion of 50,000 acre-feet of water for these lands will begin between year 1990 and year 2000. Approximately 29,100 acres of new land including the 7,800 acres in the Uintah Unit will receive irrigation. This will result in a net 21,300 acres exclusive of the Uintah Unit.

4. Between Green River near Greendale, Duchesne River near Randlett, and Green River at Green River, Utah

Hayden-Craig Steamplant.--The addition of new units will require estimated increases of 14,000 acre-feet of water by 1980 and 6,000 acre-feet from 1980 to 1990. It was assumed that the steamplant would return no salt or water.

Cheyenne-Laramie, Wyoming.--The city of Cheyenne diverts water from the Little Snake River to a tributary of the North Platte in exchange for water diverted from Douglas Creek for municipal use by the city of Cheyenne. This transmountain diversion is now using about 7,000 acre-feet and it is estimated that this city and the Laramie area will ultimately deplete the Colorado River by an additional 24,000 acre-feet.

Savery-Pot Hook Project, Colorado-Wyoming.--This project is located in the Little Snake River Basin in southern Wyoming and northwestern Colorado. The authorized project plan calls for construction of an 16,600-acre-foot-capacity reservoir on Savery Creek and a 60,000-acre-foot-capacity reservoir on Slater Creek. This storage will make possible the irrigation of 14,400 acres of new land and will provide supplemental water for land presently irrigated. Depletion of the Little Snake River by the Savery-Pot Hook Project would amount to 22,000 acre-feet annually. Salt loading was determined by a special study made for this project.

Central Utah Project (Jensen Unit).--This unit will be located in Uintah County along the Green River east of Vernal. Storage of water in Tyzack Reservoir on Brush Creek together with pumping from the Green

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River will supply 440 acres of new land and 3,640 acres of presently irrigated lands. Approximately 15,000 acre-feet of water is anticipated to be depleted by this project.

Oil Shale Prototype Development.--It is estimated that oil shale development would require 78,000 acre-feet in Colorado and 24,000 acre-feet in Utah by 1990. It was also estimated that the heavy use of water would not occur until about mid-1980's and by 1990 the total 102,000 acre-feet would be required.

5. Above San Rafael River near Green River, Utah.

Utah Power and Light, Emery County.--The anticipated future effects on the San Rafael River would be steam-electric plants depleting about 21,000 acre-feet of water and replacing an estimated 5,000 acres of presently irrigated lands with industries. The salt was assumed to be depleted with the water. The Huntington powerplant started 1 unit in 1975 and another is scheduled in 1977. The Emery County powerplant is now under construction and the first unit is scheduled for June 1978.

6. Above Colorado River near Glenwood Springs

Denver, Englewood, Colorado Springs, and Pueblo, Colorado.--Expansion of municipal supplies for these four cities will eventually deplete the Colorado River by 235,000 acre-feet above present uses. These are transmountain diversions from the Blue, Fraser, and Eagle Rivers in the headwaters of the Colorado River. The diversions would vary according to runoff each year.

M&I--Green Mountain.--Most of the water stored in Green Mountain Reservoir will probably be released for industrial use in the vicinity of Rifle, in Garfield County, Colorado. This depletion will ultimately be about 45,000 acre-feet.

Homestake Project, Colorado.--The Homestake Project in Colorado, constructed by the cities of Aurora and Colorado Springs, will ultimately divert an additional average annual amount of 49,000 acre-feet to the eastern slope from the headwaters of the Colorado River although the diversions will vary from year to year. Present diversions amount to about 25,000 acre-feet.

7. Between Colorado River near Glenwood Springs and Colorado River near Cameo

Independence Pass.--This water is diverted from the upper Roaring Fork to the east slopes of the Rocky Mountains. The present depletions will ultimately be increased by an additional 7,000 acre-feet.

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Fryingpan-Arkansas Project.--This transmountain diversion project delivers water from the headwaters of the Colorado to the Arkansas River. It is a multipurpose development to supply supplemental irrigation water, municipal water, and water for power production. In addition the project will also control floods originating above Pueblo, retain sediment, preserve fish and wildlife, and provide recreation opportunities. Some diversions were made in 1973 and 1974. Additional diversions beyond 1976 of 33,000 acre-feet are anticipated making a future total of about 69,000 acre-feet. A depletion of about 1,000 acre-feet by evaporation from Ruedi Reservoir is also occurring.

M&I--Ruedi Reservoir, Colorado.--Approximately 24,000 acre-feet would be used for oil shale or other industrial development along the Colorado River in Colorado. The water would be stored in Ruedi Reservoir on the Fryingpan River and released through natural channels to the points of use.

West Divide Project, Colorado.--It is estimated the West Divide Project will consumptively use about 33,000 acre-feet of water by 1990 for irrigation and municipal and industrial uses. The irrigation water will ultimately supply about 12,700 acres of new land and 17,200 acres of land presently irrigated. After 1990 the new depletion of Colorado River water is estimated to be 50,000 acre-feet annually.

Project water will be obtained from a series of Colorado River tributaries south of the river in west-central Colorado. The above uses could be altered in the definite plan report due to changing conditions before the definite plan report is finalized.

8. Above Gunnison River near Grand Junction

Fruitland Mesa Project, Colorado.--This project is located in western Colorado in the Gunnison River Basin. A storage reservoir on Soap Creek and diversion from Crystal and Curecanti Creeks would provide water needed for 11,900 acres of newly irrigated land and 6,300 acres of land now irrigated. Project uses will increase Colorado River depletions by about 21,000 acre-feet per year. Salt loading was determined by a special study for the project.

The project water for irrigation use has been determined by laboratory analysis to be of excellent quality. Likewise, most of the return flow considered as part of the project water supply will be diluted with higher quality direct flow.

Dallas Creek Project, Colorado.--The Dallas Creek Project as now planned will develop water of the Uncompahgre River and tributaries for irrigation and municipal and industrial use. The project will provide supplemental water to lands presently irrigated. Depletion of the Colorado River will amount to about 17,000 acre-feet annually. Salt loading effects were based on a detailed study especially made for this project.

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9. Between Colorado River near Cameo, Gunnison River near Grand Junction, and Colorado River near Cisco, Utah

Dolores Project, Colorado.--The Dolores Project will divert water from the Dolores River Basin to the San Juan drainage for the irrigation of new and presently irrigated lands. Some 35,000 acres will be new land. This project will divert 105,000 acre-feet of water from the Dolores River of which 81,000 acre-feet will be depleted and the balance return to the San Juan River. Salt loading was determined by a special study for this project.

Return flows from lands in the Montezuma Valley are presently used for irrigation of land in McElmo Canyon outside the project area. Analyses show these flows have relatively high concentrations of soluble salts but are successfully used for irrigation, because of the internal drainage characteristics of the soils.

San Miguel Project, Colorado.--The San Miguel Project will regulate flows of the San Miguel River for irrigation, municipal and industrial use, recreation, flood control, and fish and wildlife conservation. The project will supply water to 11,500 acres of new land and 12,500 acres of land now receiving a partial supply. Depletion of Colorado River will be about 67,000 acre-feet. Salt loading was determined by a special study.

10. Above San Juan River Near Archuleta

San Juan-Chama Project.--Construction is now completed on this transmountain diversion project. Delivery of water to the Rio Grande Basin was initiated in 1971. The project will eventually divert an average of 110,000 acre-feet annually from the headwaters of the San Juan River across the Continental Divide to the Rio Grande Basin. The effect of this depletion on the Colorado River will be that some dissolved solids will be transported out of the basin and less high quality water will be available downstream for dilution of lower quality water.

The water will be used in New Mexico for municipal and industrial developments and for irrigation.

Navajo Indian Irrigation Project.--Construction activities are continuing on this project with some water having been delivered in 1976. Studies completed for the project for the all sprinkler irrigation system by the Southwest Region indicate an Agricultural consumptive use of 226,000 acre-feet from a diversion of 330,000 acre-feet. A department of Interior Solicitor's Opinion indicates probable depletion by the Navajo Indians totaling 254,000 acre-feet as originally authorized. It was decided for this analysis to use the 330,000 acre-feet diversion and 226,000 acre-feet depletion and showing the remaining 28,000 acre-feet depletion as "other depletions" without identifying what it would be used for. It was assumed

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it would be diverted above the Archuleta gage with no return flow to the San Juan River. The 110,000 acres of new land as authorized is still considered the project area to be irrigated.

Practically all of the lands in the Navajo Indian Irrigation Project which would contribute return flow at the Hogback, are of fresh water origin with low salinity and alkalinity as determined by soil borings. For this reason and because of the sprinkler-type irrigation, the pickup of salts is expected to be quite low.

The effect of the San Juan-Chama and Navajo Indian Irrigation Projects on the quality of water at the Archuleta station would be small since the water is presently of very good quality and the station is located only a short distance below the Navajo Dam where there would be no return flows.

11. Between San Juan River near Archuleta and San Juan River near Bluff

Farmington Municipal and Industrial.--This future depletion is to Farmington, New Mexico, for 5,000 acre-feet out of the San Juan River. It was estimated that this would begin by year 1990.

Animas-La Plata Project, Colorado-New Mexico.--The Animas-La Plata Project will develop flows of the Animas and La Plata River systems for irrigation, municipal and industrial use, recreation, and fish and wildlife conservation. The project will supply water to about 46,000 acres of new land and 21,700 acres of presently irrigated land. The new lands will include some Indian lands. The total new depletion will amount to 153,000 acre-feet. Project features include four storage dams, lengthy canals, and several diversion dams. Salt loading was determined by a special study.

Preliminary water quality studies indicate that irrigation will not present any particular quality problem, and the additional return flow at the State line may be somewhat improved over the present.

Expansion Hogback.--This direct diversion to Indian land adjacent to the San Juan River will result in a new depletion over present depletions of about 8,000 acre-feet annually. These lands, in the vicinity of Shiprock, New Mexico, have been developed in small blocks by the Bureau of Indian Affairs over a period of years with further expansion planned for the future. The seepage and return flows return direct to the San Juan River, but the quality of these flows has not been determined.

Four Corners Powerplant.--In northwestern New Mexico, a large steamelectric powerplant, which has been partially completed by Utah International Inc., is now using about 20,000 acre-feet out of an estimated 39,000 acre-feet when the plant is complete. This will supply water for full operation of the 5 units located at the Four Corners totaling 2,154 MW.

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Navajo M&I Contracts.--Several energy related industries and possibly municipalities near the four corners area of New Mexico have either purchased or are considering the purchase of Navajo Reservoir water on a temporary basis. The annual delivery of water under these contracts will not exceed 100,000 acre-feet. The contracts are scheduled to be terminated in year 2005 and the water returned to the river system. These users include the San Juan Powerplant, Utah International Inc., (coal gasification), El Paso (coal gasification), and others including possibly the city of Gallup.

Return Flow Dolores and Navajo Indian Irrigation Project.--The return flows from the Dolores Project and the Navajo Indian Irrigation Project were identified because they do not return back to the system above the "Colorado River near Cisco" and "San Juan River near Archuleta" gages, respectively. They do return above the "San Juan River near Bluff" gage and must be accounted for at this gage. The additional salts brought in with these return flows would be those picked up from the new lands that are irrigated plus the salts originally in the water diverted.

12. Between Green River at Green River, Utah, San Rafael River near Green River, Utah, Colorado River near Cisco, San Juan River near Bluff, and Colorado River at Lees Ferry

Resources, Incorporated, Utah.--Resources, Incorporated, proposed to construct a large powerplant in Utah near Lake Powell using coal from the Kaiparowits Plateau for fuel and water from Lake Powell for plant operation. This plan was discontinued, however. The expected annual depletion to the Colorado River would now be 30,000 acre-feet, based on the company's application to the State of Utah for that much water. The exact date of this depletion is not known at present but it was assumed to occur sometime between 1980 and 1990. It is expected that the salt will be depleted with the water. After 1990 additional water depletions will cease but due to an increase in concentration, additional salt will be depleted.

Navajo Powerplant.--About 34,000 acre-feet is used in that portion of Arizona within the Upper Basin and would be diverted above Lees Ferry with most of it being used by the Navajo Powerplant at Lake Powell. It is expected that the salt will be depleted with the water. No additional water depletions are expected beyond 1980 but due to increased concentrations, additional salts will be depleted.

Other M&I in Arizona.--Of the Upper Colorado River Compact's allocated 50,000 acre-feet to Arizona from the Upper Colorado River system, about 13,000 acre-feet is presently being used. Besides the 34,000 acre-feet to the Navajo Powerplant, other M&I uses are expected to consume the remainder of the 50,000 acre-feet allocation.

13. Above the Virgin River at Littlefield, Arizona

Dixie Project, Utah.--The authorized Dixie Project was under contract negotiations between the Washington County Water Conservancy District and the Bureau of Reclamation during 1973. At the meeting on February 8, 1973,

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it was announced by the district that they desired to cease negotiations and not continue with the Project.

Dixie Alternate, Utah.--The District and the City of St. George, Utah, have since engaged in studies to construct a smaller dam and reservoir with a capacity of 45,000 acre-feet at the Warner Valley Site for the storage of about 8,000 acre-feet of water to be used for a supplemental irrigation supply plus 10,000 acre-feet of water to be used for cooling purposes for a 500 megawatt coal-fired powerplant. Nevada Power would utilize 375 megawatts and the City of St. George would utilize 125 megawatts at some time in the future. The powerplant would receive coal by slurry pipeline from Alton, Utah, and would burn approximately 6,000 tons of coal a day. The powerplant was originally scheduled to be completed by 1979 but it will probably be delayed because of environmental impact statements and other construction problems.

A principal concern of the downstream users in Arizona and Nevada would be in regard to the effect of the project operation on water quality and water supply. The effect of the LaVerkin Springs, which enters the Virgin River below the proposed diversion of the offstream dam, is of considerable importance. The average annual historic flow of the Virgin River at Littlefield, for the January 1941 through December 1974 period of record is 157,000 acre-feet. Development of the Dixie Alternate Project would increase the average concentrations at Littlefield from the present 2.22 (1,634 mg/l) tons per acre-foot to 2.35 (1,730 mg/l) for both zero and 2 tons pickup.

14. Between the Colorado River at Lees Ferry, Virgin River at Littlefield, and Colorado River below Hoover Dam

Southern Nevada Water Project, Nevada.--The first stage of the Southern Nevada Water Project was completed by the Bureau of Reclamation and was accepted by the Colorado River Commission on November 1, 1971. The project is operated by the Las Vegas Valley Water District to provide supplemental municipal and industrial water to the cities of Las Vegas, North Las Vegas, Henderson, and Boulder City, and to Nellis Air Force Base. It will also provide water to the potential Eldorado Valley development.

The total annual diversion for the Southern Nevada Project and the other existing systems in Southern Nevada are shown in the following tabulation with the water allocated by water rights to the various users through the pipelines in the vicinity of Lake Mead.

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<u>Southern Nevada Water Project and Other Systems</u>	Maximum <u>Diversion</u>	Net <u>Depletion</u>
Southern Nevada Water Project	299,000	209,300
Basic Management Incorporated Pipeline	41,277	41,277
Boulder City Pipelines	5,890	5,890
National Park Service Pipelines	<u>2,000</u>	<u>2,000</u>
Total	348,167	258,467

Prior to 1975, no creditable return flow from these diversions has been listed in the "Compilation of Records in Accordance with Article V of the Decree of the Supreme Court of the United States in the Arizona v. California dated March 9, 1964." Starting in calendar year 1975 a credit for surface return flows to Nevada from the Southern Nevada Water Project through Las Vegas Wash was made. The same method was used for the calculation of the 1974 flows. The resulting values for 1974 and 1975 are shown in the following tabulation:

	<u>1974</u>	<u>1975</u>
Groundwater Pumped	78,387	72,825
BMI minus Park Service	19,283	16,774
Southern Nevada Water Project minus Boulder City	<u>56,821</u>	<u>64,970</u>
Total	154,491	154,569
Percent Groundwater	50.7	47
Percent Surface Water	49.3	53
Las Vegas Wash near Boulder City minus Surface		
Flood Flows	48,013	55,000
Calculated Surface Return Flows	23,650	29,150

The expected depletions for the Southern Nevada Water Project would be an additional depletion of 45,000 acre-feet by 1980. The projected depletion for the 1980-1990 time period would be an additional 64,000 acre-feet. The projected annual depletion for the period 1990-2000 would be 43,100 acre-feet for a total of 209,000 acre-feet by the year 2000.

It has been assumed for projections in this report that the return flows from the Southern Nevada Water Project would carry as much salt as would be pumped from the river. In addition, the sewage treatment plants would contribute an added load of 0.2 ton per acre-foot of depletion under zero pickup and 0.4 ton per acre-foot of depletion for the 2 ton per acre pickup condition.

Other Nevada Projects.--The Southern Nevada Water Project and other systems estimated net annual depletion would be 258,500 acre-feet of the 300,000 acre-feet depletion allotted to Nevada from the Colorado River. Of the 41,500 acre-feet of uncommitted allotment, it is expected that 7,000 acre-feet will be used by the Fort Mohave Indian Reservation while the remaining 34,500 acre-feet has not been allocated. The remaining

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34,500 acre-feet of water has not been assigned to any particular project in Nevada. It was projected for this report that this water would probably be utilized at the rate of 5,000 acre-feet by 1980, an additional 5,000 acre-feet by 1990, an additional 5,000 acre-feet by the year 2000 and the remaining 19,500 acre-feet after the year 2000. These other projects could include such items as fish and wildlife uses, irrigation projects, additional energy requirements and municipal and industrial projects.

15. Between Colorado River below Hoover Dam and Colorado River at Imperial Dam

Mohave Steamplant.--A portion of the Southern Nevada Water Project allotment will be used by the Southern California Edison Company by diverting up to 30,000 acre-feet annually from the Colorado River for thermal power production purposes at a site about 3 miles downstream from Davis Dam. Use of this water until July 1, 2006, by the Southern California Edison Company is in accordance with two contracts--one with the State of Nevada and the Southern California Edison Company and one with the Bureau of Reclamation and the State of Nevada. The depletions for the Mohave Steamplant in 1972 were 11,000 acre-feet. The anticipated total depletion for the years 1980, 1990, and 2000 would be 20,000, 30,000, and 30,000 acre-feet, respectively.

Fort Mohave Indian Reservation.--The Fort Mohave Indian Reservation, located below Davis Dam, is allocated water by the Supreme Court Decree to irrigate 18,974 acres of land--14,916 acres in Arizona, 2,119 acres in California, and 1,939 acres in Nevada with a maximum annual diversion from the Colorado River of 122,648 acre-feet. The consumptive use required for irrigation of these lands is estimated to be 4 acre-feet per acre, which would result in main-stream depletion of about 76,000 acre-feet annually. The Bureau of Indian Affairs reports that a major portion of this reservation is under development contract.

Studies were made under the Bureau of Reclamation's small projects loan program which would have developed 7,000 acres of land on the Fort Mohave Indian Reservation. A large portion of the lands that were originally in the loan program were leased to others by the Indians and are now being developed. Prior to the leasing of these lands, studies were made outlining the drainage provisions that would be required to prevent drainage problems and salt buildup. An arbitrary uniform land development rate was used for the remaining available land in the Fort Mohave Indian Reservation. An additional 5,000 acres would be developed by 1990 utilizing an additional 20,000 acre-feet of new depletions for a total of 48,000 acre-feet. Between 1990 and the year 2000, an additional 4,000 acres of land would be developed requiring 16,000 acre-feet of new depletions. The remaining 2,974 acres of land would be developed after the year 2000, using the remaining 12,000 acre-feet of available water.

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The consumptive use of 4 acre-feet per acre for irrigation of the Fort Mohave, Chemehuevi, and Colorado River Indian lands is based on the rate presented in Colorado River Basin Project hearings before the Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs, House of Representatives. This value is under study and may be subject to change in future reports.

Chemehuevi Indian Reservation.--The Chemehuevi Indian Reservation, located above Parker Dam, is allocated water by the Supreme Court Decree to irrigate 1,900 acres of land in California with a maximum annual diversion from the main-stream of the Colorado River of 11,340 acre-feet. The consumptive use required for irrigation of these lands is estimated to be 4 acre-feet per acre, which would result in a main-stream depletion of about 7,000 acre-feet annually. Full development of this reservation is expected by 1990.

Central Arizona Project.--The Colorado River Basin Project Act authorizes the Central Arizona Project for the purposes of furnishing irrigation and municipal water supplies to the water-deficient areas of Arizona and western New Mexico through direct diversion or exchange of water. This project is now under construction with water deliveries expected in 1985 and fully operational in 1986. This project will provide a supplemental water supply to lands now being irrigated. Water will be made available only to lands having a recent irrigation history. The Central Arizona Project must stand shortages up to its full allocation if there is insufficient main-stream water to satisfy an annual consumptive use of 7,500,000 acre-feet allocated under the Supreme Court Decree of March 1964 to the States of Nevada, Arizona, and California. When shortages occur, diversions to the Central Arizona Project will be limited to assure California water users 4,400,000 acre-feet of main-stream water. A maximum of 2,172,000 acre-feet of Colorado River water is all that could be diverted with a canal capacity of 3,000 c.f.s. California diversions in the future would eventually be reduced to 4,400,000 acre-feet.

Contracts--Boulder Canyon Project.--Separate contracts have been signed with the City of Kingman, Arizona, the Lake Havasu Irrigation and Drainage District, and the Mohave Valley Irrigation and Drainage District for diversion, respectively, of 18,500 acre-feet, 14,500 acre-feet, and 51,000 acre-feet annually. Although some new lands may be developed for irrigation in the Mohave Valley Irrigation and Drainage District, other lands now irrigated will be taken out of production due to future municipal and industrial development. As a result, it is probable that the diversion under the contract with the Mohave Valley Irrigation and Drainage District would cause no appreciable increase over the present depletions from existing irrigation in the District and municipal and industrial development would result in an increased depletion of about 6,000 acre-feet per year.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

The Mohave Valley Irrigation and Drainage District would develop at the assumed rate that would cause annual depletion rate of 3,000 acre-feet by 1980, an additional 2,000 acre-feet by 1990, and the remaining 1,000 acre-feet depletion by the year 2000.

All of the diversions to the City of Kingman would be a depletion because of the distance of the City from the Colorado River. It has been assumed for this report that the depletions for Kingman, Arizona, would be 6,000 acre-feet by 1980, by 1990 an additional 8,000 acre-feet depletion would occur, and the remaining 4,000 acre-feet of depletion would occur by the year 2000.

Diversion to Lake Havasu Irrigation and Drainage District would cause an increased depletion of about half of the diversion.

The depletions for the Lake Havasu Irrigation and Drainage District would occur at the rate of 3,000 acre-feet by 1980 with an additional 3,000 acre-feet by 1990 and the remaining 1,000 acre-feet by the year 2000.

Colorado River Indian Reservation.--The Lower Colorado River Indian Reservation is located along the Colorado River just below Parker Dam, Arizona, with most of the land in Arizona and the remainder in California. The Supreme Court Decree allocated 717,148 acre-feet of diversions to the Colorado River Indian Reservation for irrigation of the 107,588 acres of land. There are 99,375 acres of land in Arizona, of which 66,000 acres have been developed and 8,213 acres of land in California to be developed. The consumptive use required for irrigation of these lands is estimated to be 4 acre-feet per acre which would result in an annual main-stream depletion of 430,352 acre-feet. The estimated consumptive use in 1974 from irrigation of 66,000 acres is 264,000 acre-feet. This leaves an additional depletion of about 166,000 acre-feet per year for future developments.

The Bureau of Indian Affairs for the Colorado River Indian Reservation has predicted that the rate of development on the reservation should average 5,000 acres per year until full development is achieved. Therefore by 1980 there should be 86,000 acres under irrigation development with the remaining acres to be developed by 1990.

Lower Colorado River Channelization Project, Arizona-California.--Between Davis Dam and Parker Dam, the channelization work in the Mohave Valley Division was completed in 1960 to salvage an estimated 109,000 acre-feet of water per year. However, the permanence of 44,000 acre-feet of that salvage is dependent on future maintenance in the Topock Gorge Division. The work in the Topock Gorge Division would also salvage an additional 28,000 acre-feet per year.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

Between Parker Dam and Imperial Dam, work in the Palo Verde Division to salvage 10,000 acre-feet of water per year, and work in the Cibola Division to salvage 36,000 acre-feet per year has been completed. Work in the Parker and Imperial Divisions to salvage 39,000 acre-feet per year has not yet been started.

In summary, at the end of 1970 channelization work to salvage 155,000 acre-feet of water per year was complete, and additional channelization work to salvage 67,000 acre-feet per year is planned.

It is estimated that an additional 100,000 acre-feet of water per year could be salvaged by phreatophyte eradication and control. A vegetative management research project is being undertaken to more clearly define the potential salvage from this source. Pending further studies, the location and estimates of potential salvage developed for the Pacific Southwest Water Plan have been used in this study. This plan indicates that 88,000 acre-feet could be salvaged above Imperial Dam. Of this amount, 59,000 acre-feet would be above Parker Dam and 29,000 acre-feet between Parker and Imperial Dams.

The potential salvage from the combined channelization and phreatophyte eradication and control programs is estimated to be 87,000 acre-feet per year above Parker Dam. It was assumed for this report that the estimated salvage for the lower Basin above Parker Dam would be accomplished in the following manner: 22,000 acre-feet per year by 1980, an additional 22,000 acre-feet for a total of 44,000 acre-feet annually by 1990, an additional 22,000 acre-feet by the year 2000 for a total of 66,000 acre-feet. The remaining salvage of 21,000 acre-feet above Parker Dam would be accomplished after the year 2000.

It was also estimated that the salvage for the reach of the river between Parker Dam and Imperial Dam would be accomplished in the following manner: 22,000 acre-feet annually by the year 1990 and an additional 23,000 acre-feet per year by the year 2000 for a total annual salvage of 45,000 acre-feet, the remaining potential salvage would be accomplished after the year 2000. The total potential salvage above Imperial Dam is then 155,000 acre-feet per year.

16. Augmentation

Public Law 90-537 (dated September 30, 1968) states that augmentation of the Colorado River will be a national obligation to supply the Mexican Treaty requirements. Although temporary periods of subnormal water supply can be satisfied from storage releases, permanent deficiencies caused by full utilization of the waters allocated to the states would require augmentation.

Table E
Summary of Historical, Present Modified and Estimated Future Water Conditions at Eighteen Stations
Colorado River Basin

Station	Historical condition					Present modified condition 1974					1980 condition					1990 condition					2000 condition							
	Flow (AF)	T.D.S. (T)	Concentration (T/AF) (mg/l)	Flow (AF)	T.D.S. (T)	Concentration (T/AF) (mg/l)	Flow (AF)	T.D.S. (T)	Concentration (T/AF) (mg/l)	Flow (AF)	T.D.S. (T)	Concentration (T/AF) (mg/l)	Flow (AF)	T.D.S. (T)	Concentration (T/AF) (mg/l)	Flow (AF)	T.D.S. (T)	Concentration (T/AF) (mg/l)	Flow (AF)	T.D.S. (T)	Concentration (T/AF) (mg/l)	Flow (AF)	T.D.S. (T)	Concentration (T/AF) (mg/l)				
Green River near Greendale, Utah	1,312	552	0.42	1,285	562	0.44	1,255	553	0.44	324	324	324	1,185	527	0.44	327	527	0.44	327	527	0.44	1,007	449	0.45	328	449	0.45	328
Duchesne River near Randlett, Utah	438	404	0.92	402	401	1.00	346	391	1.13	831	831	831	176	376	2.14	1,571	426	2.42	1,779	426	2.42	1,260	832	0.66	486	832	0.66	486
Green River at Green River, Utah	4,193	2,602	0.62	4,153	2,666	0.64	4,038	2,641	0.65	481	481	481	3,607	2,530	0.70	516	2,581	0.72	526	2,581	0.72	3,395	2,447	0.72	530	2,507	0.74	543
San Rafael River near Green River, Utah	91	210	2.31	78	212	2.72	66	204	3.09	2,273	2,273	2,273	57	195	3.42	2,515	195	3.42	2,515	195	3.42	57	195	3.42	2,515	195	3.42	2,515
Colorado River near Glenwood Springs, Colorado	1,640	595	0.36	1,467	598	0.41	1,398	591	0.42	311	311	311	1,264	557	0.44	324	557	0.44	324	557	0.44	1,204	532	0.46	337	552	0.46	337
Colorado River near Cameo, Colorado	2,793	1,531	0.55	2,548	1,523	0.60	2,439	1,514	0.62	456	456	456	2,272	1,480	0.65	479	1,498	0.66	483	1,498	0.66	2,171	1,460	0.67	494	1,485	0.68	503
Gunnison River near Grand Junction, Colorado	1,729	1,454	0.84	1,708	1,474	0.86	1,698	1,474	0.87	638	638	638	1,675	1,492	0.89	655	1,492	0.89	655	1,492	0.89	1,670	1,494	0.89	658	1,494	0.89	658
Colorado River near Cisco, Utah	4,959	4,104	0.83	4,639	4,140	0.89	4,520	4,131	0.91	672	672	672	4,175	4,098	0.98	722	4,123	0.99	726	4,123	0.99	4,052	4,079	1.01	740	4,111	1.01	746
San Juan River near Archuleta, New Mexico	904	198	0.22	826	195	0.24	628	151	0.24	177	177	177	448	112	0.25	184	112	0.25	184	112	0.25	448	112	0.25	184	112	0.25	184
San Juan River near Bluff, Utah	1,611	983	0.61	1,497	997	0.67	1,369	985	0.72	529	529	529	974	938	0.96	708	1,206	1.24	910	1,206	1.24	968	939	0.97	713	1,201	1.24	912
Colorado River at Lees Ferry, Arizona	10,346	7,856	0.76	10,335	8,580	0.83	9,924	8,496	0.86	629	629	629	8,714	3,260	0.95	697	3,604	0.99	726	3,604	0.99	8,373	8,156	0.97	716	8,510	1.02	747
Colorado River near Grand Canyon, Arizona	10,659	8,943	0.84	10,646	9,667	0.91	10,237	9,583	0.94	688	688	688	9,027	9,347	1.04	761	9,691	1.07	989	9,691	1.07	8,686	9,243	1.06	782	9,597	1.10	912
Virgin River at Littlefield, Arizona	157	349	2.22	157	349	2.22	157	349	2.22	1,634	1,634	1,634	139	327	2.35	1,730	327	2.35	1,730	327	2.35	139	327	2.35	1,730	327	2.35	1,730
Colorado River below Hoover Dam, Ariz.-New.	10,244	9,654	0.94	10,176	10,393	1.02	9,709	10,318	1.06	781	781	781	8,369	10,983	1.20	886	10,459	1.25	919	10,459	1.25	7,980	9,989	1.25	920	10,385	1.30	935
Colorado River above Parker Dam, Ariz.-Calif.	9,865	9,341	0.95	9,891	10,089	1.02	9,375	10,004	1.07	785	785	785	8,007	9,757	1.22	866	10,160	1.27	933	10,160	1.27	7,618	9,663	1.27	933	10,094	1.33	974
Colorado River below Parker Dam, Ariz.-Calif.	9,235	8,745	0.95	8,748	8,923	1.02	8,232	8,784	1.07	785	785	785	6,791	8,275	1.22	896	8,617	1.27	933	8,617	1.27	6,735	8,543	1.27	933	8,924	1.33	974
Colorado River at Imperial Dam, Ariz.-Calif.	8,540	8,891	1.04	7,844	9,183	1.17	7,208	9,044	1.25	923	923	923	5,614	8,535	1.52	1,118	8,960	1.60	1,274	8,960	1.60	5,611	8,903	1.57	1,154	9,267	1.65	1,214

1/ Without water quality improvement projects.

(Units: 1,000 except concentrations)

Table D Continued
Projects Depleting Colorado River Water
Incremental Change in Flow and Salt Load 1974 to 2000

	Increase 1974 to 1980				Increase 1980 to 1990				Increase 1990 to 2000			
	Depletion 1,000 AF	T.D.S. Increase (1,000 tons)		New irrigation lands-acres	Depletion 1,000 AF	T.D.S. Increase (1,000 tons)		New irrigation lands-acres	Depletion 1,000 AF	T.D.S. Increase (1,000 tons)		New irrigation lands-acres
		OT/A	2T/A			OT/A	2T/A			OT/A	2T/A	
Between the gage Colorado River at Lee's Ferry and the gage Colorado River near Grand Canyon, Arizona	0	0	0	0	0	0	0	0	0	0	0	0
Above the gage Virgin River at Littlefield, Arizona	0	0	0	18	0	-22	0	0	0	0	0	0
Dixie Project, Alternate	0	0	0	0	0	0	0	0	0	0	0	0
Between the gages Colorado River near Grand Canyon, Arizona, and Virgin River at Littlefield, Arizona, and the gage Colorado River below Hoover Dam, Arizona-Nevada	51	8	16	107	43	44	8/8/	43	4	8	8/8/	43
Southern Nevada Water Project, Nevada ^{6/}	5	1	2	5	5	2	8/8/	5	6	12	8/8/	5
Other Nevada Projects												
Between the above gage and the gage Colorado River below Parker Dam, Arizona-California	9	-10	-10	10	0	-13	8/8/	0	0	0	8/8/	0
Mojave Steam Plant, Nevada	28	0	14	20	16	10	5,000	16	0	8	4,000	16
Fort Mojave Indians, Arizona, California, and Nevada	0	0	0	7	0	4	1,900	0	0	0	0	0
Chemehuevi Indians, California	0	0	0	8	4	0	8/8/	4	0	0	8/8/	4
Kingman, Arizona	3	0	0	2	1	0	8/8/	1	0	0	8/8/	1
Mojave Valley I&D District, Arizona	3	0	0	3	1	0	8/8/	1	0	0	8/8/	1
Lake Havasu I&D District, Arizona	0	0	0	-22	-22	0	8/8/	-22	0	0	8/8/	-22
Salvage	0	0	0									
Central Arizona, Arizona ^{7/}												
California diversions limited to 4.4 million acre-feet ^{7/}												
Between the above gage and the gage Colorado River at Imperial Dam, Arizona-California	120	0	60	46	0	23	11,585	0	0	0	0	0
Colorado River Indian Reservation, Arizona-California	0	0	0	-22	-23	0	0	-23	0	0	0	0
Salvage	225	-1	82	182	25	48	18,485	25	10	28	4,000	25
Subtotal Lower Basin	636	-85	77	1,392	366	77	244,425	366	-94	-66	13,960	366
Total Colorado River												

^{6/} Prior to July 1, 2006, the required water for the Mojave Steam Plant is considered to be a portion of the total allocation of Southern Nevada Project waters and other existing pipelines from Lake Mead.

^{7/} The Central Arizona Project diversions will vary depending on the depletions by other projects on the river and depending on the total amount of water available from the system in a given year. Maximum annual diversions to Central Arizona could be 2,172,000 acre-feet. With the full depletions by the projects tabulated, the consumptive use to California would be reduced to an annual 4,400,000 acre-feet.

This reduction would assure a full supply to the tabulated projects in Arizona in addition to supplying water for the Central Arizona Project. (Bureau of Reclamation water supply studies, based upon the 1906-70 runoff period in the Colorado River Basin, result in average diversions for the Central Arizona Project of 1,078,000 acre-feet and 900,000 acre-feet in the year 2000 and the year 2030, respectively.)

^{8/} In-basin depletion without new irrigated lands.

Table D
Projects Depleting Colorado River Water
Incremental Change in Flow and Salt Load 1974 to 2000

	Increase 1974 to 1980			Increase 1980 to 1990			Increase 1990 to 2000		
	Depletion (1,000 ac.-ft.)	T.D.S. Increase (1,000 tons) OT/A	New irrigation lands (acres)	Depletion (1,000 ac.-ft.)	T.D.S. Increase (1,000 tons) OT/A	New irrigation lands (acres)	Depletion (1,000 ac.-ft.)	T.D.S. Increase (1,000 tons) OT/A	New irrigation lands (acres)
Above the gage Green River near Green River, Wyoming	30	-9	1/	70	-26	1/	178	-78	1/
Seedskaede, Wyoming including Westvaco and others									
Between the above gage and the gage Green River near Greendale, Utah									
Lyman, Wyoming	4	0	0	0	0	0	0	0	0
Utah Power & Light and others, Wyoming	0	0	0	50	-22	1/	7	-3	1/
Above the gage Duchesne River near Randlett, Utah									
Central Utah Project, Utah									
Bonneville Unit	56	-10	2/	90	-15	2/	0	0	0
Upalco Unit	0	0	0	10	0	0	0	0	0
Utah Unit	0	0	0	30	0	0	0	0	0
Deferred Indian Lands	0	0	0	40	0	34	10	0	9
Between the gages Green River near Greendale, Utah, and Duchesne River near Randlett, Utah									
Hayden-Graig Steamplant, Colorado	14	-6	1/	6	-2	1/	0	0	0
Cheyenne-Laramie, Wyoming	3	0	2/	6	-1	2/	15	-2	2/
Savery-Pot Hook, Colorado-Wyoming	0	0	0	20	10	3/14,400	2	0	0
Central Utah Project									
Jensen Unit	8	0	0	7	0	1	0	0	0
Oil shale prototype development	0	0	0	102	-55	440	0	0	0
Above the gage San Rafael near Green River, Utah									
Utah Power & Light, Emery County, Utah	12	-8	1/	9	-9	1/	0	0	0
Above the gage Colorado River near Glenwood Springs, Colorado									
Denver-Englewood, Colorado Springs, Pueblo, Colorado	59	-6	2/	50	-6	2/	60	-5	2/
Green Mountain M&I, Colorado	0	0	0	45	-26	1/	0	0	0
Homestake Project, Colorado	10	-1	2/	39	-2	2/	0	0	0
Between the above gage and gage Colorado River near Cameo, Colorado									
Independence Pass	7	0	2/	0	0	0	0	0	0
Fryngspan-Arkansas, Colorado	33	-2	2/	0	0	0	0	0	0
Ruedi M&I, Colorado	0	0	0	0	0	0	24	-15	1/
West Divide, Colorado	0	0	0	33	0	9,000	17	0	3,700
Above the gage Gunnison River near Grand Junction, Colorado									
Fruitland Mesa, Colorado	0	0	0	20	11	3/11,309	1	0	3/600
Dallas Creek, Colorado	10	0	0	3	7	3/	4	2	3/
Between the gages Colorado River near Cameo, Colorado, and Gunnison River near Grand Junction, Colorado, and the gage Colorado River near Gisco, Utah									
Dolores, Colorado	0	0	0	4/102	-17	3/34,000	3	-1	3/1,360
San Miguel, Colorado	0	0	0	53	0	3/11,500	14	0	0
Above the gage San Juan River near Archuleta, New Mexico									
San Juan-Chama, New Mexico	20	-3	2/	0	0	0	0	0	0
Navajo Indian Irrigation, New Mexico	5/178	-41	38,000	152	-35	72,000	0	0	0
Other depletions	0	0	0	28	-4	0	0	0	0
Between the above gage and the gage San Juan River near Bluff, Utah									
Farmington M&I	0	0	0	5	0	1/	0	0	0
Animas-La Plata, Colorado-New Mexico	0	0	0	146	0	3/46,000	7	0	0
Expansion Hogback, New Mexico	3	0	3	5	0	2,500	0	0	0
Four Corners Powerplant, New Mexico	5	-3	1/	14	-9	1/	0	0	0
Navajo M&I Contracts	11	-6	4/5/	84	-51	4/5/	0	0	0
Return flow-Dolores and Navajo Indian Irrigation, Colorado and New Mexico	-89	41	117	-39	52	223	-1	1	4/5/
Between the gages Green River at Green River, Utah; San Rafael River near Green River, Utah; Colorado River near Gisco, Utah; and San Juan River near Bluff, Utah; and the gage Colorado River at Lee's Ferry, Arizona									
Resources, Utah	0	0	0	30	-31	-31	0	-1	-1
Navajo Powerplant, Arizona	34	-30	1/	0	-5	-5	0	-2	-2
Other M&I, Arizona	3	0	1/	0	0	0	0	0	0
Subtotal Upper Basin	411	-84	39,500	1,210	-236	225,940	341	-104	9,960
1/ In-basin depletion without irrigated lands									
2/ Trans-Colorado River Basin diversion									
3/ Salt pickup determined by special study									
4/ In-basin transfer from Dolores River drainage to the San Juan River drainage--estimated 24,000-acre-foot return flow to the San Juan River									
5/ Diversion at Navajo Reservoir, estimated 104,000-acre-foot return flow to the San Juan River below the gage near Archuleta, New Mexico									

PART VIII. COLORADO RIVER SALINITY CONTROL PROGRAM

Section 206 of Title II of the Colorado River Basin Salinity Control Act, Public Law 93-320, of June 24, 1974, directs the Secretary of the Interior, commencing on January 1, 1975, and every 2 years thereafter, to submit, simultaneously, to the President, the Congress and the Advisory Council, a report on the Colorado River Salinity Control Program covering the progress of investigations, planning and construction of salinity control units for the previous fiscal year, the effectiveness of such units, anticipated work needed to be accomplished in the future to meet the objectives of Title II with emphasis on the needs during the 5 years immediately following the date of each report, and any special problems that may be impeding progress in attaining an effective salinity control program. Section 206 also provides that this report may be included in the Quality of Water-Colorado River Basin biennial progress report.

A. Projects Authorized for Construction

Title II of Public Law 93-320 authorized the Secretary of the Interior to construct as the initial stage of the Colorado River Water Quality Improvement Program, the Paradox Valley Unit, Colorado; the Grand Valley Unit, Colorado; the Crystal Geyser Unit, Utah; and the Las Vegas Wash Unit, Nevada. The schedule of definite plan reports for projects authorized for construction is shown on Figure 4. This section of the report presents a brief description and summary of the status of investigations for each of the projects authorized for construction. The estimated salinity effects of these projects at downstream stations are shown in Table F.

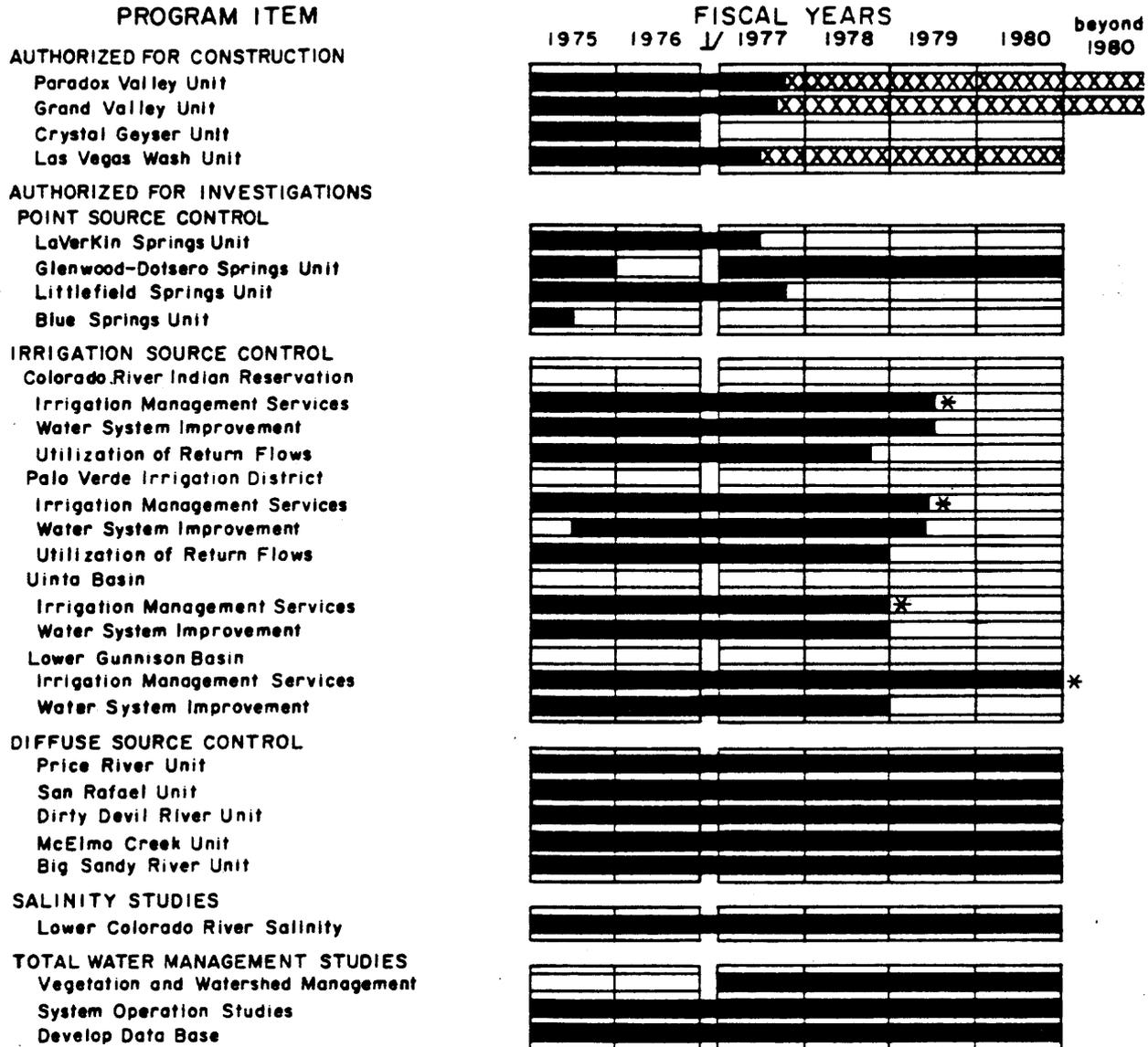
1. Paradox Valley Unit

Paradox Valley, a collapsed salt anticline, is a northwest-southeast trending valley 3 to 5 miles wide located in southwestern Colorado. It has a desert climate, dry and hot in the summer and dry and cold in the winter.

Geologic investigations in the Colorado Plateau have established the existence of a series of five major northwest-southeast trending salt anticlines (elongated swells) about 100 miles long, with the La Sal Mountains, an extrusive mass, perched over the center of the anticline region. Paradox Valley lies along the axis of one of these salt anticlines and is essentially the result of erosion of faulted and uplifted sandstone and shale formations from above a residual gypsum cap overlying about 14,000 feet of pure salt and salt-rich shale. The Dolores River remained in its ancient streambed as the uplift and erosion of the valley developed and crosses the valley near its midpoint. West Paradox Creek heads in

INVESTIGATION AND CONSTRUCTION SCHEDULE

COLORADO RIVER WATER QUALITY IMPROVEMENT PROGRAM



1/ Transition Quarter changing Fiscal Year from beginning July 1, to beginning October 1.

INVESTIGATION
XXXXXXXXXX CONSTRUCTION

* WATER USER ORGANIZATIONS TAKE OVER PROGRAM OPERATION

Fig. 4.

Table F
Estimated Effects of Salinity Control Projects at Five Stations^{1/}

Station	1990 Conditions																				
	Without Salinity Control					With Salinity Control					Difference										
	Flow 1,000 AF	T.D.S. 1,000 tons	Concentration T/AF	Pickup at 2 T/A Concentration mg/l	Flow 1,000 AF	T.D.S. 1,000 tons	Concentration T/AF	Pickup at 2 T/A Concentration mg/l	Flow 1,000 AF	T.D.S. 1,000 tons		Concentration T/AF									
Colorado River at Lees Ferry, Arizona	8,714	8,260	.95	697	8,604	.99	726	8,710	7,880	.90	665	8,224	.94	694	-4	-380	-.05	-32			
Colorado River below Hoover Dam, Ariz.-Nev.	8,369	10,083	1.20	886	10,459	1.25	919	8,361	9,657	1.15	849	10,033	1.20	882	-8	-426	-.05	-37			
Colorado River above Parker Dam, Ariz.-Calif.	8,007	9,757	1.22	896	10,160	1.27	933	7,999	9,331	1.17	858	9,734	1.22	895	-8	-426	-.05	-38			
Colorado River below Parker Dam, Ariz.-Calif.	6,791	8,275	1.22	896	8,617	1.27	933	6,791	7,922	1.17	858	8,264	1.22	895	0	-353	-.05	-38			
Colorado River at Imperial Dam, Ariz.-Calif.	5,614	8,535	1.52	1,118	8,960	1.59	1,173	5,614	8,182	1.46	1,072	8,07	1.53	1,127	0	-353	-.06	-46			
2000 Conditions																					
Station	Without Salinity Control										With Salinity Control										
	Zero pickup					Pickup at 2 T/A					Zero pickup					Pickup at 2 T/A					Difference
	Flow 1,000 AF	T.D.S. 1,000 tons	Concentration T/AF	Pickup at 2 T/A Concentration mg/l	Flow 1,000 AF	T.D.S. 1,000 tons	Concentration T/AF	Pickup at 2 T/A Concentration mg/l	Flow 1,000 AF	T.D.S. 1,000 tons	Concentration T/AF	Pickup at 2 T/A Concentration mg/l	Flow 1,000 AF	T.D.S. 1,000 tons	Concentration T/AF	Pickup at 2 T/A Concentration mg/l	Flow 1,000 AF	T.D.S. 1,000 tons	Concentration T/AF		
Colorado River at Lees Ferry, Arizona	8,373	8,156	.98	716	8,510	1.02	747	8,369	7,776	.93	683	8,130	.97	714	-4	-380	-.05	-33			
Colorado River below Hoover Dam, Ariz.-Nev.	7,980	9,989	1.25	920	10,385	1.30	957	7,972	9,563	1.20	882	9,959	1.25	919	-8	-426	-.05	-38			
Colorado River above Parker Dam, Ariz.-Calif.	7,618	9,663	1.27	933	10,094	1.33	974	7,610	9,237	1.21	893	9,668	1.27	934	-8	-426	-.06	-40			
Colorado River below Parker Dam, Ariz.-Calif.	6,735	8,543	1.27	933	8,924	1.33	974	6,735	8,175	1.21	893	8,556	1.27	934	0	-368	-.06	-40			
Colorado River at Imperial Dam, Ariz.-Calif.	5,611	8,803	1.57	1,153	9,267	1.65	1,214	5,611	8,435	1.50	1,105	8,899	1.58	1,166	0	-368	-.07	-48			

^{1/} Includes Paradox Valley, Grand Valley, and Las Vegas Wash. Other salinity control projects may be constructed before year 2000 but were omitted because their construction schedule has not yet been determined.

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the La Sal Mountains and flows southeast through the northwestern half of Paradox Valley to the Dolores River. East Paradox Creek, an intermittent stream, drains the southeastern half of Paradox Valley before flowing into the Dolores River.

Previous estimates of salinity contribution from the Paradox Valley were based on spot measurements of the flow and water quality of the Dolores River as it enters and leaves the valley. Stream gaging stations and a water quality sampling program were established in Fiscal Year 1972. Analysis of 5 years of streamflow and water quality records verified the previous estimate of 200,000 tons per year salinity contribution to the Dolores River as it traverses across the valley.

Topography was obtained by an aerial survey contract with the Forest Service.

To determine the path by which salt was entering the Dolores River, a resistivity survey was conducted along the river and exploratory drill holes and observation wells were drilled. The resistivity study estimated contours of the brine interface so that the exploratory drill holes and observation wells could be located to better define the subsurface water conditions. The five exploratory drill holes and twelve observation wells indicate that a 100-150-foot deep pocket of gravels exist in midvalley to the west of the river and that 15-30 feet of unconsolidated overburden overlies a brecciated gypsiferous NaCl salt rich formation to the east of the river.

Data obtained from the resistivity study and the drilling program indicate salt (or brine) at/or within a few feet of the surface along the east side of the river and plunging to a depth of about 150 feet about a mile to the west of the river.

In the river channel the brine interface surfaces sharply about midvalley. Upstream from this point, the river is unchanged in its freshness, but within several hundred feet downstream the river has almost reached its maximum salinity condition. The brine contribution results in salt concentrations in the Dolores River ranging from less than 200 mg/l at high flows to 166,000 mg/l during extreme low flows as measured at the outlet of Paradox Valley.

At 16-inch, 300-foot-deep exploratory test well was drilled through 100 feet of deep lensatic river deposits and into the underlying fractured gypsum cap of the salt anticline. Pumping tests of the lensatic gravels and of the fractured gypsum cap indicate that the salt contribution to the Dolores River in this area can be effectively controlled by pumping from the brine zones. The estimated annual removal of salt is 180,000 tons.

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The plan proposed to remove the salt would involve the installation of a field of brine wells to lower the fresh water-brine interface and thus, by pumping, eliminate the natural brine inflow to the river. The brine from the wells would be collected and pumped to a solar evaporation reservoir.

The potential Radium Reservoir, located in Dry Creek Basin on the West Fork of Dry Creek about 8 miles southwest of Naturita, Colorado, would function as the solar evaporation site. Mancos shale, an impervious, brackish marine formation, is the surface material of the reservoir site. No leakage is expected from the dam and reservoir. The reservoir would have a total capacity of 70,000 acre-feet and a water surface of 3,375 acres. The average reservoir content allocated to brine inflow would be about 66,000 acre-feet with surface area of 3,200 acres, at a point in time when evaporation equals inflow, based on brine inflow and evaporation rate assumptions. Alternative reservoir sites were evaluated, but from the standpoint of reservoir impermeability, only one site (Radium Reservoir site) could be utilized.

Analysis of the drawdown in the observation wells when the test well was pumped indicated that the brine-fresh water interface could be lowered by pumping from either the bottom of the river gravels (100-foot depth) or from the fractured gypsum cap (300-foot depth), however, additional test wells and piezometers will be needed to determine the number, location, and best zone to pump from to control the salt water flow to the Dolores River.

Aerial topographic maps have been obtained.

Foundation drilling of Radium Dam and dikes was completed in July 1975. The drill logs indicate that extensive grouting will probably be required to obtain a watertight foundation. Exploratory drilling of the reservoir basin, completed in the second quarter of 1975, indicates that the reservoir basin is as watertight as can be obtained.

Exploratory and observation wells were drilled and piezometers installed in the well field area during the summer and fall of 1975. Three test wells were also drilled into and developed in the fractured gypsum cap during the third and fourth quarters of 1975. A 34-day pump test was conducted during January and February 1976. All of the test wells were constructed to pump brine from the fractured gypsum cap. Two of the test wells, however, did not yield the expected flow of brine, and therefore, the pump test failed to stress the ground water system sufficiently to obtain the necessary data for design of the well field. The data obtained from drilling the exploratory holes and the pump test did indicate that the brine could be intercepted by shallower wells--50 to 100 feet deep--in the river gravels.

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A pilot hydrogen sulfide stripping plant was designed and constructed by the Research Division of the E&R Center in Denver, Colorado, during 1975. A seven-day field test of the pilot plant was conducted during the well pump test in January and February 1976. Aeration with a nickle sulfate catalyst worked very well in oxidizing the hydrogen sulfide to elemental sulfur. However, the sand filter was unsatisfactory because of plugging by a sludge blanket forming on the surface of the sand. The Research Division is considering other filtering methods or possibly pumping unfiltered brine to the evaporating reservoir.

Infrared photography of Paradox Valley along the Dolores River did not disclose any additional sources of saline water entering the Dolores River.

Specifications are being prepared for the drilling of up to eighteen full-sized wells into the river gravels. These wells, which would be tested as they are completed, would be converted to brine production wells when the project is constructed. The well pump tests would also determine the flow rate for designing the pumping plants and the discharge pipeline to Radium Evaporation Pond. It is expected that the contract for drilling these wells would be awarded and the wells drilled in the spring of 1977.

It is expected that the pump test of these wells will prove that the brine freshwater interface can be lowered below the riverbed. If the freshwater interface is lowered successfully, design and specification data collected for Radium Dam, pipelines, and the pumping plants would begin in the spring of 1978, with construction scheduled to begin in the spring of 1979. Construction should then be completed in 1981.

A draft of the environmental statement is scheduled for completion on March 1, 1977. On May 1, 1977, a draft of the Definite Plan Report is scheduled for submission.

The data for the draft environmental statement was obtained by several contracts with State and Federal agencies and universities. This information is being evaluated for use in preparing the statement.

Construction and operation of the Paradox Valley Salinity Control Unit could have the following environmental impacts:

- a. A noticeable decrease in the low flow salt concentrations in the Dolores River downstream from Paradox Valley resulting in a decrease or elimination of salt encrustations along the river and in the lowlands adjacent to the river. Elimination of the high salt concentrations could enhance the fishery, wildlife, and scenery in the downstream reaches.

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- b. The construction of well installations along the river--with associated pumping plants, powerlines, transformer stations, and pipelines--would require the removal of some of the brush along the river, but would have minimal effects on wildlife.
- c. Constructing the pipeline to Dry Creek Basin would create a scar requiring a few years to heal. Booster pumping plants and their associated transformer stations and powerlines would be constructed along the pipeline at several locations. The plant growth along the pipeline and around the pumping stations would probably be reduced, but the effect on animal life should be minor.
- d. The evaporation pond in Dry Creek Basin would store the salt removed from Paradox Valley, estimated to be 180,000 tons annually.
- e. The pond would inundate approximately 3,200 acres of land that would be lost for wildlife habitat and stock grazing.
- f. This pond would probably be sterile, and the existing vegetation would be killed by the saline water. After a few years, the pond would reach an equilibrium between evaporation and inflow, and a salt flat would be exposed around the lake each summer, resulting in a minor amount of windblown salt that may damage the vegetation in the vicinity of the pond.
- g. Approximately 4 miles of county road would have to be relocated around the evaporation pond.

Meetings with a citizen's advisory team and several Federal agencies have been held, and help has been obtained from various agencies in studying the Paradox Valley salinity problem. Construction of a chemical model of the brine evaporation pond has been negotiated with Utah State University. Data from this model would be used to study how the brine will affect water fowl landing on the brine evaporation pond. Information from different wildlife agencies would also be used in this study.

The estimated construction cost, as of October 1975, for the brine wells, pumping plants, pipeline, and evaporation pond structures is \$21.1 million. The estimated annual operation, maintenance, and replacement costs based on the expected life of equipment and a 5.625 percent interest rate are \$451,000.

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Local benefits would be limited to the effects of decreasing the salinity of the Dolores River in Paradox Valley and downstream. The annual loss of water by evaporation is estimated at a maximum of about 4,000 acre-feet. Most of the benefits would occur in the lower Colorado River Basin with an estimated 16 mg/l reduction of the salinity concentration at Imperial Dam. The salinity concentration reduction is estimated to have a value of \$3,680,000 annually.

2. Grand Valley Basin Unit

The Grand Valley of Colorado is near the western edge of Mesa County. Grand Junction, the largest city in Colorado west of the Continental Divide, is located in the Valley. The Valley was carved in the Mancos Shale formation (a high salt bearing marine shale) by the Colorado River and its tributaries and for the most part is surrounded by steep, rough terrain. Within the Valley the irrigated lands have developed on recent alluvial plains consisting of broad coalescing alluvial fans and on older and higher alluvial fans, terraces, and mesas. Other lands in this arid setting, where rainfall averages only about 9 inches per year, include the stream flood plains and rough broken land occurring as terrace escarpments, high knobs and remnants of former mesas.

First irrigation in the valley began in 1882 with the construction of what is now the Grand Valley Canal (Grand Valley Irrigation Company). Other private systems were built during the period between 1882 and 1908. Construction of the last major system, the Grand Valley Project under the Reclamation Service, began in 1908 with the major construction completed in 1926. This project consists of two divisions, the Garfield Gravity and the Orchard Mesa Divisions, on the north and south sides of the river, respectively.

A total of about 76,000 acres are served water by these irrigation entities with approximately 42,000 acres under Federal projects. Major crops produced in the valley are corn, sugar beets, small grains, alfalfa, and various orchard crops.

The Grand Valley is estimated to contribute an average of about 600,000 tons of salt annually to the Colorado River. Most of these salts are thought to be leached from the soil and underlying Mancos Shale and washed into the river by deep percolation and water delivery system losses.

The Mancos Shale is a very thick sequence of saline drab gray fissile shale that lies between the underlying Dakota sandstone and the overlying Mesa Verde Formation. The thickness of the shale usually varies between

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3,000 and 5,000 feet. Due to this great thickness and its easy erodibility, the shale forms most of the large valleys of western Colorado and eastern Utah. Many white patches of salt and alkali are visible on the nonirrigated surfaces and some patches also visible on the irrigated lands where drainage is poor. The salts present in the Mancos shale are mostly calcium sulfate with smaller amounts of sodium chloride, sodium sulfate, and magnesium sulfate. Calcium sulfate (gypsum) is commonly found in crystal form in open joints and fractures of the shale.

Due to the compactness of the clay and silt particles making up the shale, the formation is not considered as water bearing at depth. However, the weathered zone near the surface does transmit small quantities of water along joints, fractures, and open bedding planes. This zone is the area from which percolating water, often originating from irrigation of croplands, may dissolve salts present in the shale.

Most of the soils forming the irrigated lands have been derived from Mancos Shale. As a result, the soils may also be a source of salinity.

A gravel and cobble layer also has been found under some of the irrigated areas in the Grand Valley and is believed to serve as an aquifer for ground water. Previous studies have identified areas where the ground water has an upward pressure gradient in the cobble aquifer due to the confining effect of the Mancos Shale beneath and the tight clay soil above. This situation is believed to be responsible for some areas of high water tables. Further studies of the cobble aquifer will be necessary to determine its extent and its influence on the ground water. The gravel and cobble layer may be ancient stream deposits from the Colorado River and may not be continuous throughout the valley.

The programs underway in the Grand Valley are a combination of irrigation management services (IMS), and investigation of water system improvements (WSI) by the Bureau of Reclamation and farm improvements by the Soil Conservation Service. The IMS phase is being implemented. The WSI when implemented, in combination with the IMS program, and the on-farm improvements, is expected to reduce the contribution of dissolved minerals by an estimated 200,000 tons/year.

The purpose of the irrigation management services (IMS) program is to optimize water management to attain one or more specific goals of maximizing yields, net returns, water use efficiency or minimizing indirect adverse effects. In the Grand Valley, IMS is expected to improve the efficiency of water use and thereby reduce the salt loading from the irrigated lands.

Under the IMS program irrigators are provided professional services relating to the scheduling of irrigation. Research has shown that imprecision regarding the timing and amount of irrigation water applied is one of the

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major causes of low irrigation efficiencies. In the Grand Valley area, irrigation efficiencies were measured during the 1964 through 1968 period and found to average about 33 percent. Through cooperation with the irrigators in the IMS program it is hoped that efficiencies could be increased to average about 55 percent. Concurrently, improvement of onfarm irrigation systems through the Department of Agriculture programs should result in even higher irrigation efficiencies. These improvements would involve such measures as landforming, lining field ditches, automation of delivery system, use of sprinklers and gated pipe systems.

The IMS program advises the irrigator of the optimum date and amount for his next irrigation. The forecast is made by use of a computer program which predicts future moisture use of the crop. Soil, weather and crop data are inputs for the forecast.

The IMS program was initiated in 1972 in the Grand Valley area serving about 1,050 acres operated by 45 water users. The program was enlarged and served 6,100 acres in 1976. Small fields, inadequate laterals and on-farm distribution systems, insufficient data to prove water user benefits, and personnel restrictions in the project office has limited the expansion of the IMS program to cover more of the irrigated land in the valley. Paired fields of sugar beets were selected for the 1976 season to provide data to determine the economic benefit of the IMS program. It is expected that the canal and lateral systems are improved and the on-farm improvements are accomplished, that most of the larger irrigated fields will use the IMS program. The IMS program will be turned over to the water users with only guidance from the Bureau of Reclamation, as the systems improvements are completed. However, for the IMS program to be fully functional, it will be necessary to complete the on-farm improvements with good measuring devices. It may also be necessary to modify water deliveries and construct equalizing reservoirs on some laterals to use IMS program effectively on farms of less than 20 acres. The small average size of fields in the valley will increase the cost of the IMS program compared to areas where the average minimum size field served is 40 acres or larger.

Ground water observation wells have been installed to determine the water table. It appears that the high water tables are caused by over-irrigation and canal seepage. Additional observation wells will be installed for the Irrigation Management Services and System Improvement Programs. Correlations will be sought between the ground water salinity and soil salinity at various depths and times to help evaluate the IMS and Water Systems Improvement Programs.

Four irrigation entities divert water from the Colorado River. These include the Grand Valley Water Users Association (Bureau of Reclamation Project) and three private companies--the Grand Valley Irrigation Company, the Palisade Irrigation District, and the Mesa County Irrigation District. A fifth irrigation company, the Redlands Power and Water Company, diverts water from the Gunnison River. A number of other small companies have

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carriage agreements with the major canal companies for delivery of water. There are a total of approximately 210 miles of canals and 500 miles of laterals in the valley, with a few of the laterals and parts of some canals presently being concrete or gunite-lined.

Investigations for improving the canals and lateral systems to reduce seepage and improve water delivery were begun in Fiscal Year 1972. Capacities were computed for the conveyance systems based on crop consumptive use employing the Jensen-Haise Formula for the cropping patterns and climatic data for the valleys and improved irrigation efficiency. The cropping pattern was determined by updating a 1969 survey by the Agriculture Engineering Department of Colorado State University. As the capacities arrived at by this method were close to the existing capacities the existing capacities will be used for designing concrete linings for the canals and laterals. On laterals that are in developed areas such as subdivisions, low pressure pipe will be used in lieu of concrete lining. Canal and lateral structures will be designed to improve control of the irrigation water.

Fencing will be installed along both sides of open concrete-lined sections where there is a safety hazard, and safety features are included for structures on canals and large laterals.

In areas where two or more laterals parallel each other very closely, consideration will be given to combining these laterals into a single lateral. Other than this type of combining laterals, the various irrigation companies will not consider any combination of their systems.

An alternative method of delivery of water through laterals by using an underground pipe system was studied for an area comprising about 6,700 acres. This study showed that the cost of this type system would be much greater than for a concrete-lined lateral system. Should further study indicate that an underground pressure system would be more beneficial to areas of the valley, then consideration would be given to use of this type of system.

On-farm improvement, such as lining farm ditches, installing gated pipes, automated irrigation systems, and land leveling will be accomplished by Department of Agricultural programs.

Water quality sample and flow measurement stations have been established on 10 drainages which carry return flow to the Colorado River. Data collected at these stations will assist in evaluating the present conditions and any salinity reductions resulting from irrigation scheduling and water systems improvements.

A study area has been selected in the valley to acquire detailed information on surface and ground water quality and sources. A system

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of observation wells has been drilled to adequately define the water table, and for sampling the ground water for quality determinations. Piezometers monitor vertical gradients of water pressure through the soil profile, and gaging stations measure surface inflow and outflow from the area. Data is being collected to ascertain the change in salinity levels due to irrigation scheduling and/or system improvements by comparison with a control area in which neither irrigation scheduling nor systems improvement would be done early in the construction period.

Modifications are being considered for the drains in the area. At the present time, sufficient information has not been obtained to arrive at any definite drainage rehabilitation plans. A large number of ground water observation wells have been installed in the valley and are being monitored to obtain information which might be used for future drainage design. In addition, Colorado State University is conducting several experiments in the valley, one of which is a detailed study of drain spacing requirements.

Other programs and activities which may affect the salinity control program in Grand Valley include:

a. Research on increasing irrigation efficiency and determination of mineral weathering and salt precipitation as a function of irrigation management being done by the Agricultural Research Service under contract with the Bureau of Reclamation.

The Agricultural Research Service is attempting to measure the deep percolation occurring for various irrigation efficiencies and methods with the resulting salt leaching or precipitation. The Agricultural Research Service is also working with the Bureau of Reclamation to conduct ponding tests.

b. Research on automated systems by the Colorado Water Conservation Board. The Colorado Water Conservation Board is conducting a pilot demonstration project for automated irrigation systems in the Grand Valley. Their primary objective is to test various modern on-farm irrigation systems and develop them for use in this area. They are currently engaged in work on three systems; an automated border irrigation system, an automated pump back system, and a drip irrigation system.

c. Initiation of conservation practices by the Agricultural Stabilization and Conservation Service in cooperation with the Soil Conservation Service.

The Soil Conservation Service has since the middle 1940's been concerned with drainage, reclamation of salted areas and restoration of productivity. In recent years, their activities have been oriented toward increased irrigation efficiency and reduction of salt contribution to the river from irrigated land. The Agricultural Stabilization

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and Conservation Service in cooperation with the Soil Conservation Service has been involved in cost sharing of conservation practices such as ditch lining, pipelines, land leveling, drainage, and water control structures.

The Soil Conservation Service is inventorying the irrigated area fields in the valley and preparing a report of the work and estimated cost to improve all farm systems (including land leveling) to increase on-farm irrigation efficiency to the maximum possible with the IMS program.

d. The Agricultural Engineering Department, Colorado State University (CSU), is conducting salinity research for the Environmental Protection Agency. They are currently monitoring the salinity of water before and after its use for irrigation. They are monitoring approximately 12 square miles between Grand Junction and Clifton where they are attempting to accurately establish the salt contribution from irrigation on various types of soil and subsurface material. Canals, laterals, and drains throughout this area are frequently sampled and measured to establish salt loading and irrigation efficiency.

A number of fields within this area are actually being irrigated by Colorado State University to ensure maximum control and measurement of water. Recorders are employed to check water on and off the field and salinity measurements are made.

e. The Grand Valley Salinity Coordinating Committee--A group of Federal, state, and local agencies formed to eliminate duplication of effort and bring about a better understanding of salinity control programs.

The results of the above studies where applicable, will be used as input data for the water systems improvement program.

Base maps and location maps have been prepared, acreages served tabulated, and conveyance capacities determined for all canals and laterals. Design criteria for the canals and laterals and associated structures have been established. Water quality samples are being collected and analyzed for drains and ground water observation wells throughout the valley.

Aerial topography has been obtained. Additional ground water observation wells will be drilled during 1977. Geologic data along the canals and laterals have been collected and analyzed. Quality data collection will be continued for surface and ground water return flows. The collected data have been used in making ground water studies, sedimentation studies, and flood studies on cross drainages. Studies are being made to better estimate the salt load reduction resulting from the salinity control programs in Grand Valley. Other studies that are underway that are needed for completion of the Definite Plan Report in June 1977 are; water rights, designs and

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estimates, economic, legal, cooperative agency, and valley geologic. Studies for the Environmental Assessment are complete. The final draft of the Environmental Assessment is scheduled for completion in May 1977.

Negotiation and drafting of contracts with the canal and lateral owners defining responsibility during construction and operation maintenance and replacement after construction is completed as required by Public Law 93-320, begins in 1977 and will continue until all contracts are completed.

If the final draft of the Environmental assessment is acceptable, specification preparation could begin in 1977 with construction beginning in the fall of 1977. Construction would have to be accomplished from November to March during the non-irrigation season for the larger canals and laterals and could be accomplished year around for the smaller laterals. It is estimated to take about 10 years.

In addition to a reduction in salt loading of the Colorado River a multiplicity of corollary benefits are expected to be generated by the IMS and WSI programs. Under the IMS program, the irrigator may have: (1) increased yield and quality of crops, (2) a possible savings of labor, (3) better use of water, (4) reduced leaching of fertilizers and other agricultural chemicals, and (5) under some conditions, reduced drainage requirements. Analysis of the paired fields of sugar beets grown in 1976, is expected to show what increased yields can be expected from the IMS program.

Some of the participants of the IMS program in previous years felt they had increased crop yields as a result of the program. Crop census data further suggests that the yield of row crops was increased about 5 percent on farms that were either fully or partially under irrigation scheduling. Because of the short period of record available, no attempt has been made to impute monetary values to benefits other than the reduction in salt loading.

Other expected local benefits of the IMS and Water Systems Improvement Programs include improved control of water deliveries and reduced ground water and drainage problems. Other beneficiaries would be water users in the lower Colorado River Basin and Mexico.

Based on the Reclamation report "Economic Impacts of Changes in Salinity Levels of the Colorado River" (1973), total benefits for irrigation, municipal and industrial water have been estimated at \$230,000 annually for each mg/l reduction in the salinity concentration at Imperial Dam. A 200,000 ton annual reduction in the salt load contributed by Grand Valley would result in a reduction of about 19 mg/l at Imperial Dam for an estimated annual benefit of \$4,370,000. The estimated cost of constructing the water systems improvements is \$81,300,000.

The IMS and WSI programs would enhance environmental values within the Grand Valley area and assist in improving water quality conditions

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downstream. With regard to the former, erosion along drains and washes would be expected to decrease due to reduction in return flows. Water tables would drop and some seep areas would dry up, thus reducing insect vector problems. The aesthetic appearance of the landscape would be improved with the concrete lining and pipe system.

Safety features incorporated into the designs would provide greater protection for humans, wildlife, and livestock.

Lower ground water tables and reduced return flows in the drainages will probably decrease phreatophytes and hydrophytes which provide habitat for wildlife in the valley. About 1,000 acres are vegetated with hydrophytes (cattails and rushes) and 18,000 acres are vegetated with varying densities of phreatophytes (salt cedar, greasewood, willows and cottonwood). The Environmental Assessment is expected to evaluate the impact of the salinity control project on the wildlife and determine if special wildlife areas should be developed in the valley.

Currently, other factors are reducing wildlife habitat. These include ditch burning, spraying, mowing, and urbanization. The Environmental Assessment will estimate what percent of habitat loss is due to IMS and WSI and what percent to other factors.

The reduction in return flow could also reduce siltation in the Colorado River and conserve soil. Other broad environmental influences include:

- a. Protecting the highly diversified agriculture of the lower Colorado River basin and thus supporting the economy of communities dependent upon such production.
- b. Sustaining the high quality of the diet in the United States resulting from the off season availability of vegetable and fruit crops.
- c. Using less water for crop production since higher quality water reduces the leaching requirement.

for municipal and industrial uses would be reduced and plumbing and appliance life would be increased.

As the studies progressed, environmental impact analysis has fitted into the plan formulation process. Data collection activities are completed and evaluation of alternatives and their impacts are being determined.

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3. Crystal Geyser Unit

The Crystal Geyser, a privately owned abandoned oil test well, located 3.5 miles south of the town of Green River, Utah, on the east bank of the Green River contributes about 3,000 tons of salt annually to the Colorado River system. The saline water erupts in the form of a geyser at about 5-hour intervals due to carbon dioxide accumulations. The concentration of the water ranges from 11,000 to 14,000 mg/l and the annual flow amounts to about 150 acre-feet. The climate at the geyser is a desert type with an average annual temperature of 52° F. and an average annual precipitation of 6 inches. The vegetation in the geyser area is sparse with tamarisk and scattered cottonwood trees along the edges of the river and cactus, Brigham tea, greasewood and shadscale elsewhere.

The estimated annual removal of salt by the alternative plans is about 3,000 tons, a relatively minor amount. Salinity concentrations of the Colorado River at Imperial Dam would be reduced by an estimated 0.3 mg/l.

The Definite Plan Report, Environmental Assessment and Negative Determination of Environmental Impact have been completed and were submitted in June 1976.

The plan is to collect the flows and convey them to evaporation ponds about 3 miles downstream. A compacted earth embankment would be constructed on the stream side of the geyser to collect and temporarily store the water from the eruption. A plastic pipe would convey the water from the temporary storage pond on a uniform rate to the evaporation ponds about 3 miles downstream. The pipeline will cross many small drainages and the Little Grand Wash. Bedrock may also present some difficulties while laying the pipe. The evaporation ponds will be located about 3 miles downstream on a typical river flood plain of lean clay with lenses of silt, sand--sometimes clean, and gravel. The ponds will require a flexible polyvinyl lining to assure that no leakage back to the river occurs. About 2 miles of the access road to the geyser will need improvement by grading, installing culverts and possibly gravel surfacing. The access road to the evaporation ponds will also need some improvement.

The decrease in the salinity concentration at Imperial Dam of 0.3 mg/l would result in an annual benefit to water users in the Lower Colorado River Basin of \$69,000. The estimated construction cost was \$2,690,000. Construction of this unit has been delayed indefinitely.

4. Las Vegas Wash Unit

Las Vegas Wash is a natural channel draining the entire Las Vegas Valley watershed area of 2,200 square miles and discharges into the Las

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Vegas Bay arm of Lake Mead. Located in Southern Clark County, Nevada, the Las Vegas Valley contains the largest population center in the State. The wash flows through the valley in a generally southeast direction and provides drainage for the three principal cities of North Las Vegas, Las Vegas, and Henderson. Studies evaluating salinity contributed by the wash are concerned mainly with the lower 11 mile portion between Las Vegas and Lake Mead consisting of about 1,800 acres of dense marsh and phreatophyte vegetation.

Historically, Las Vegas Wash has been an intermittent stream discharging only during periods of high rainfall producing storm runoff. With the growth of the communities in the valley, the stream has become perennial. Return flows to the wash are from unlined ponds of industrial plants, from continually increasing discharges of the secondary treated municipal wastewater of the cities and unincorporated areas and from agricultural and municipal irrigation. These sources contribute large amounts of residual nutrient bearing and saline water to the Lower Colorado River via Las Vegas Wash and Lake Mead.

The vigorous development that has taken place in the Las Vegas Valley for the last several years has resulted in a steady increase in the total wastewater and total flow in the wash. The flow for the USGS gaging stations on Las Vegas Wash are shown in the following tabulation:

<u>Year</u>	<u>Las Vegas Wash Near Henderson acre-feet</u>	<u>Las Vegas Wash Near Boulder City acre-feet</u>
1967	19,110	- -
1968	22,000	- -
1969	28,730	- -
1970	31,550	37,130
1971	28,220	34,790
1972	33,530	41,560
1973	36,400	44,920
1974	39,950	48,360

A Definite Plan Report for the Las Vegas Wash Unit is scheduled to be completed in early 1977. A detailed Environmental Impact Statement for this unit will be filed with the Water Quality Improvement Program Environmental Impact Statement. The project could be constructed and in operation by the end of Fiscal Year 1980 if funds are appropriated so construction could start without delay after completion of the Definite Plan Report.

It is recommended that lined evaporation ponds be used for the first stage of development in Las Vegas Wash for the reduction of salts entering Lake Mead. The first stage facilities will include the interception facility and related structures, two pumping plants, a brine pipeline, a bypass pipeline, and lined evaporation ponds. The bypass pipeline will divert the municipal wastewater around the wash discharging the effluent from the AWT plant to a point below the interception facility.

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Data gathering equipment should be installed to establish an accurate record of the conditions prior to project operations and to provide the information needed for the final sizing of project features. The continued program of gathering the data from known sources will provide a record for long term analysis to determine the time and size requirements for the future second stage facilities. A desalting plant would be added to the system for the second stage. This would save additional water while at the same time removing more salt from the wash. It is anticipated that the desalting plant will not be required prior to the year 2000.

An application has been filed with the Nevada State Engineer for a water right covering those flows which would be treated and saline waters which would be diverted to the lined evaporation ponds. Consumptive use for water quality control is not specifically mentioned as a beneficial use in Nevada's water law.

The planning for the Las Vegas Wash Unit will also require close coordination with the Clark County Wastewater Management Agency and its plans for an advanced wastewater treatment plant and an export pipeline that would deliver wastewater for industrial use by a powerplant.

B. Projects Authorized for Planning

Section 203(a)(1) of Public Law 93-320 authorized and directed the Secretary of the Interior to expedite completion of the planning reports on units described in the Secretary's report, "Colorado River Water Quality Improvement Program, February 1972," Section 203(b)(2) directs the Secretary to undertake research on additional methods of accomplishing the objective of this title, (Title II of Public Law 93-320).

There are three categories of projects listed under Section 203, (1) irrigation source control, (2) point source control, and (3) diffuse source control. The Status Report--Colorado River Water Quality Improvement Program--January 1974, discusses the projects listed under three categories. A brief description and status of the listed projects follows:

1. Irrigation Source Control Projects

Under the CRWQIP, major program emphasis for control of irrigation sources is placed on improved irrigation management through an Irrigation Management Services (IMS) and improved control of water flow in canals, laterals, and drainage systems through a Water Systems Improvements (WSI) program. Basically, the IMS program is a nonstructural management technique for increasing irrigation water efficiency and reducing salt loading. This is a demonstration-type program based on the concept that the water user will take over and operate the program. Under requirements in provisions of Public Law 92-500, this practice is expected to spread to other

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irrigated areas in the basin. Benefits expected to be derived from IMS irrigation scheduling include increased yields, labor savings, reduced leaching of soils, and reduced drainage requirements.

The WSI program, on the other hand, involves a structural water management tool for improving water delivery conveyances and, thus, reducing drainage seepage and salinity pickup. The lining of canals and laterals would result in decreased deep percolation losses, thus reducing water contact with highly saline soils, shales, and saline ground waters.

A considerable amount of water diverted for irrigation in the Colorado River Basin is returned to the parent stream. However, the salts become concentrated with use, thus lowering the water quality. In some cases, particularly after repeated use the return flow water becomes undesirable for irrigation or municipal and industrial use without treatment. A few specialized industries, however, can use water of poor quality for cooling purposes. With the advent of increased need for electric generating and fuel-producing entities, wastewater flows have assumed new importance. In addition to the above program, planning reports evaluating irrigation source control units will also indicate the potential for collection of return flows for industrial use or of treatment to improve the quality of the receiving streams.

Lower Gunnison Basin Unit--The Lower Gunnison Basin Unit encompasses the Gunnison River drainage area below the Curecanti Unit, a feature of the Colorado River Storage Project. Within this area, there are a number of private and Federal projects presently irrigating approximately 160,000 acres. Also included in the area is an additional 12,000 acres of presently nonirrigated land that would be irrigated under projects authorized for construction.

The average gross crop value on lands served by Government facilities in 1971 was \$138 per irrigated acre. This value applied to the total basin would give a crop value of approximately 21.5 million dollars.

The Lower Gunnison Basin contributes an estimated 1,100,000 tons of salt annually to the Colorado River. As in the Grand Valley, it is believed that a substantial amount of the salt load pickup is caused by excessive irrigation applications and delivery system losses. The valleys in the Lower Gunnison area are generally eroded from the Mancos Shale, a thick gray saline fissile shale 3,000 to 5,000 feet thick. It is believed that water percolating through the weathered shale or soils derived from the Mancos Shale, leaches out the soluble salt which is then carried to the streams.

(1) Irrigation Management Service Program--The Irrigation Management Services program began with the 1974 irrigation season with approximately 1,400 acres receiving the IMS program and 1,400

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acres receiving the soil moisture depletion printout. The IMS program has increased to approximately 3,100 acres in 1976 with the Uncompahgre Water users personnel doing part of the farm visits under contract with the Bureau. Costs of production and yields are being obtained for 10 paired fields of sugar beets (10 under IMS program and 10 not under IMS program) to determine what affect the IMS program has on crop production and quality. Poor lateral systems and on-farm systems limit the number of fields that can effectively use the IMS program at this time.

(2) Water Systems Improvement Project--The Lower Gunnison Unit is composed of three sub units--Uncompahgre (recently added), North Fork, and Grand Mesa. Data collection began in FY 1973 with water quality sampling. Capacity sizing of canals and laterals is underway. Aerial topographic mapping has begun. The feasibility report is scheduled for FY 1978. The Soil Conservation Service of the Department of Agriculture has started planning for the on-farm improvement program for inclusion in the feasibility report.

The Irrigation Management Service, Water Systems Improvements and On-Farm Improvement Programs could reduce the salt pickup by 300,000 tons annually resulting in salinity concentration reductions of 27 mg/l at Imperial Dam. Estimated benefits to the lower basin water users are \$6,210,000 annually.

The benefits to local projects and the environmental effects have not been determined but should be similar to the benefits and environmental effects listed for the Grand Valley Unit.

Uintah Basin Unit--The Uintah Basin lies between the Uinta Mountains on the north and the Tavaputs Plateau on the south in northeastern Utah. The climate in the basin is extremely variable. The summers are normally hot, with low humidity, and the winters are relatively severe.

Extreme fluctuations in precipitation and temperature occur over the area. Average annual precipitation is about 7.5 inches in Roosevelt, Utah, and about 8.5 inches in Altamont, Utah, near the areas where irrigation scheduling has been started. The average annual temperature is 47° F. ranging from minus 32° F. to 105° F. Irrigated lands in the Uintah Basin totaling 170,000 acres are located primarily on alluvial materials adjacent to rivers and on benches and mesas. The Uinta Mountains, several peaks of which exceed 13,000 feet, are the main source of water for the Basin. The mountain front stream above the irrigated lands produce high quality water with total dissolved solids ranging from 30 to 350 mg/l. Water quality in the basin deteriorates as return flow from irrigated areas enter the Duchesne River and its tributaries. Concentrations in the Duchesne River below most irrigated land range from 200 to 3,400 mg/l with an average of 680 mg/l.

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(1) Irrigation Management Services--Irrigation scheduling was started in the Uintah Basin with the 1973 season when about 1,300 acres were served. The program was expanded to serve about 5,000 acres in 1974 and 10,000 acres in 1975. Initial scheduling in 1973 and 1974 was done in the Moon Lake Project Area. In 1975, scheduling was expanded to the Ute Tribal Enterprise lands and the Uinta Basin Irrigation Company lands. Several problems encountered during the first three years of the scheduling program are: (a) a very limited water supply. Storage water on the Moon Lake Project has been insufficient to mature all the crops. In 1974, storage water was depleted early in July. All late season crops had periods of stress and water users were unable to follow the computer program. (b) Most of the canals and laterals are in poor condition with no measuring devices so the user could not tell how much water was being applied, (c) irrigation water is delivered in strict rotation which made it more difficult to follow the computed schedule, and (d) field size was generally small--an average of less than 15 acres--and many fields have areas with high water tables and need draining.

The Bureau has been contracting with the water users organizations to fund the use of their personnel to do the field work associated with the scheduling program. After the 1975 season, the Moon Lake Project Water Users notified the Bureau that they would not participate in 1976 or later years because they did not feel the scheduling program was of any benefit. The Uinta Basin Irrigation Company also decreased the area to be scheduled in 1976 and at the end of the 1976 season they have indicated that they would not participate in the program again. The Uinta Basin Irrigation Company service area is potentially one of the best for the program. However, it is necessary to sell the land owners on the program and convince them that the data obtained will not be used to take water rights from them.

The Irrigation Scheduling program was expanded into the Ashley Valley area in 1976 and a total of about 6,000 acres scheduled.

The Irrigation Management System program will be expanded as rapidly as funds, personnel, and the water user acceptance allows. The Bureau will continue to develop the program so that it can eventually be administered by trained personnel working for the water users. It will be necessary to have improved delivery systems and on-farm improvements before irrigation scheduling can be used effectively on many fields in the Uinta Basin. It may also be necessary to build additional storage facilities to regulate the streamflows for late season use. Small field size in the Uinta Basin will result in higher-than-average costs per acre.

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(2) Water Systems Improvement Program--Systems improvement possibilities consist principally of the improvement of irrigation conveyance systems such as lining canals, use of pipe systems, and upgrading diversion and measurement structures.

A study to determine the seepage losses and salt loading from Uintah Indian Irrigation Project canals was begun in June 1973. This study is being conducted with the cooperation of the Bureau of Indian Affairs on canals located near Roosevelt, Fort Duchesne, and Myton, Utah. Seepage from other delivery systems is being measured to determine the affect on salinity pickup. Also, the Bonneville, Upalco, and Uintah Units of the Central Utah Project will rehabilitate some canals and laterals in their respective service areas.

Data Collection--Determination of canals and laterals that are contributing to the salinity problem by excessive seepage is continuing. Public participation has been requested from local, State, and Federal agencies. Analysis of collected data is underway with designs and estimates scheduled for FY 1977 and a feasibility report scheduled for FY 1978.

The Uintah Basin contributes about 450,000 tons of salt annually. The Irrigation Management Service and Water Systems Improvement and on-farm improvement programs could reduce the salt load pickup by 100,000 tons annually resulting in a salinity concentration reduction of 9 mg/l at Imperial Dam. Estimated benefits to the lower basin water users are \$2,070,000 annually.

Colorado River Indian Reservation Unit, Arizona--The Colorado River Indian Reservation has a total of 268,850 acres located in the Lower Colorado River Basin below Parker Dam in northern Yuma County, Arizona, and in the eastern part of San Bernardino and Riverside Counties, California.

The United States Supreme Court allocated water to irrigate 107,588 acres, of which 99,375 acres are in Arizona and 8,213 acres are in California. The court's allocation also provided for a maximum diversion of 717,148 acre-feet per year. In 1974, there were 66,000 acres irrigated with Colorado River water diverted at Headgate Rock Dam. About 200 miles of canals and laterals delivered water to irrigate this acreage. The irrigation system will be expanded to supply water to irrigate about 86,000 acres in Arizona by 1980. Irrigation return flows are collected in a 100-mile drainage system and returned to the river just below the Palo Verde Diversion Dam. About 30,000 tons of salt were returned to the Colorado River with the measured return flows in 1972 and this will significantly increase as the irrigated acreage increases.

(1) Irrigation Management Services--Irrigation Management System program was initiated on the Colorado River Indian Irrigation

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Project during 1973. By a letter of agreement dated October 1, 1973, the Bureau of Reclamation, the Bureau of Indian Affairs (BIA), and the Colorado River Indian Tribal Council for the Colorado River Indian Irrigation Project entered into an agreement for developing an Irrigation Management System program within the Colorado River Indian Irrigation Project. Under the agreement, the Bureau of Indian Affairs has assigned one employee to work directly with two Bureau of Reclamation personnel. The Bureau of Indian Affairs employee will at all times remain under the direction and control of the Bureau of Indian Affairs. This representative is being trained in the science of irrigation scheduling by Bureau of Reclamation personnel so that at the end of the demonstration period he will be capable of assuming responsibility for the operation of the program. The Bureau of Indian Affairs is expected to assign additional employees to the Program as benefits are demonstrated to the Colorado River Indian Irrigation Project and to farm owners and operators. Personnel of the Bureau of Indian Affairs will be assigned increasing responsibilities in operation of the program until such time as it is mutually agreed that they are capable of operating the program. At that time, the Bureau of Reclamation personnel will be withdrawn from the Colorado River Indian Irrigation Project and the Council and/or the Bureau of Indian Affairs will assume full operation of the program. Technical liaison will be maintained thereafter by agreement between the Bureau of Reclamation and the Council and/or the Bureau of Indian Affairs.

A demonstration period of about four years is planned, during which time the water users will become proficient with the operation and appraised of the benefits of the program. This program is scheduled to be completed by June 30, 1978. At the conclusion of the demonstration state, the Bureau of Indian Affairs and the Colorado River Tribal Council will continue the program, provided that it has a demonstrated benefit.

Since the IMS program was introduced in 1973, many computer program changes have been made.

At the start of the program, two weather stations were installed in the district for more accurate and immediate availability of weather information.

The determination of the quantity of the soil moisture available to the crop and the use rate for each crop in any particular field has been by far the most difficult information to obtain. Soil moisture measurements have been obtained by hand, the Speedy Moisture Meter, and by the gravimetric method of analysis on thousands of soil samples with the results ranging from good to poor.

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In May 1975, the Bureau of Reclamation began limited measurements of the soil moisture status using the conventional neutron probe. As a result of these preliminary tests, a newer smaller model was developed weighing only 17 pounds. Using this newer probe, the Bureau has verified to its own satisfaction that by using this tool, the available soil moisture for any particular crop can be accurately determined as well as the use rate. Through the use of the neutron probe, the quantity of water available to the plant and when the next irrigation is required can be accurately determined. The graphical method of determining the moisture level in the soil is obtained by plotting the neutron probe reading as a percentage against time. The refill point is also drawn in for reference. Two field observations between irrigations are required to project the next irrigation date accurately. As with the computer method of analysis, the closer the observation to the next irrigation date, the greater the accuracy. In July 1976, two Bureau of Reclamation employees and four Bureau of Indian Affairs employees were scheduling irrigations on 12,000 acres of land in the District. This scheduled acreage could double within the next six to twelve months.

The existing water measurement system is not adequate for the ultimate needs of the Irrigation Management System program. Irrigation systems improvement with emphasis on selection and installation of the proper water measuring devices would be of great help in assuring success of the Irrigation Management System program.

(2) Water System Improvement--Studies are now underway to identify the improvements needed in the distribution system to reduce losses and to determine the amount of reduction in salt loading of the river that can be achieved by improving the distribution system. The Bureau of Indian Affairs and the Colorado River Indian Tribal Council are cooperating with the Bureau of Reclamation in this study. A ponding test on one of the laterals was conducted in January 1974. Results from this test will be used in evaluating losses from the existing lateral system. Various structural improvements will be recommended on the basis of these studies.

The Bureau of Indian Affairs requires concrete-lined canals be built to serve newly developed lands, but there is a need to rehabilitate much of the existing distribution system in order to reduce seepage losses, restore capacity in the system, and provide adequate measuring devices for efficient control of water deliveries.

A Regional Director's report for the system improvement of the Colorado River Indian Reservation distribution system is scheduled for completion by August 1978. A design layout for a recommended

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improved system will be included in the report. Preliminary evaluations indicate that the combined Water Systems Improvement Program and Irrigation Management Program will reduce the salt loading of the Colorado River by about 7,000 tons annually. This will lower salt concentrations at Imperial Dam by about 1 milligram per liter.

(3) Utilization of Return Flows--The increase in salinity resulting from irrigation return flows could be prevented or reduced if the return flows could be diverted and a use made of them that would prevent the return of salt to the river. There have been no proposals to use return flows from this project as yet. However, it is reported that the San Diego Gas and Electric Company is considering construction of a nuclear powerplant in Arizona that could use about 40,000 acre-feet of water for cooling. Water from the drain could be a possible source of supply. Reuse of this return flow involves problems somewhat different from those in the Palo Verde area in that there is no presently available source of replacement water to exchange for any depletions of these flows. Until some type of Colorado River augmentation becomes available, these return flows could be depleted only if Arizona accepted the use as a charge against their entitlement to Colorado River water.

Palo Verde Irrigation District Unit, California--The Palo Verde Irrigation District is a privately developed district located in Riverside and Imperial Counties, California. Water for irrigation is diverted from the Colorado River at the Palo Verde Diversion Dam and is conveyed through 295 miles of main canals and laterals to serve approximately 91,400 acres of irrigated land within the District. The irrigation return flows are collected in a 153-mile drainage system and returned to the Colorado River. It is estimated that these return flows in 1972 contributed about 148,000 tons of salt annually to the river.

(1) Irrigation Management Services Program--The Irrigation Management Services Program in the Lower Colorado Region was implemented in the Palo Verde Irrigation District during calendar year 1973. Through improved irrigation management, a reduction can be achieved in the volume of irrigation return flows and an overall reduction in the amount of salt loading attributed to these flows. The primary technique employed by this program is the development and dissemination of information on the timing of irrigation and the applied amount. The methods are the same as described for the Colorado River Indian Reservation now utilizing the neutron probe.

An agreement was executed by the Bureau of Reclamation and the Palo Verde Irrigation District on April 27, 1973. As provided for in the agreement, the Bureau and the District will cooperatively conduct an Irrigation Management Services Program using climate,

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crop, and soil data to provide a method that is expected to improve crop quality and yields and more effectively utilize irrigation water. The demonstration phase of this cooperative program began in 1973 and is scheduled to be completed in 1978. The District assigned an employee to work directly with Bureau personnel assigned to the program for the first year. The District is expected to assign additional employees to the program when benefits are demonstrated to the District and to farm owners and operators. The District personnel will be given increased responsibilities in operation of the program until such time as it is mutually agreed that the District personnel are capable of operating the program by themselves. At this time, the Bureau personnel will be withdrawn from the program on the District level and the District will assume full control. Technical liaison will be maintained thereafter by agreement between the Bureau and the District in order that the District will have access to the computerized program and technical assistance as needed. Development of the program is scheduled for a maximum of 5 years: 1973-78. After this period, the District has agreed to assume operation of the program provided the program's value has been demonstrated.

In July 1976, the two Bureau of Reclamation employees were scheduling irrigations on about 9,800 acres. Ultimately, 90 percent of the District acreage will be scheduled. High value crops, typical of the irrigated valleys of the southwestern United States, were grown.

At the close of business on June 30, 1974, the District withdrew the support of their employee to the Irrigation Management System program, except to fill-in during emergencies caused by the absence of a Bureau employee. This action greatly slowed the expansion of the Irrigation Management System program and dealt a severe blow to one of the objectives of the program as stated in the agreement, which is to train a District Irrigation Management System team leader around which additional District employees would be trained. The District has continued to provide office space and in every other way has been most helpful.

(2) Water Systems Improvement--A study will be made of the water loss from the Palo Verde Irrigation District distribution system to evaluate the need and potential reduction in return flow that would result from an improved distribution system. The improvements needed in the irrigation distribution system will be identified during the investigations.

In 1974, the return flow from this 153-mile drainage system amounted to about 773,700 acre-feet. The discharge of the outfall drain varies from 447 cubic feet per second to 648 cubic feet per second with a salt concentration averaging about 1,827 milligrams per liter. Computations of the total salt load returned to the river

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indicate that the salt pickup from the Palo Verde Irrigation District was about 148,000 tons in 1972. A report on the Palo Verde Irrigation District is scheduled to be completed by August 1978. It is estimated that the rehabilitation of the irrigation system in conjunction with the irrigation scheduling program will reduce the salt load of the Colorado River by 23,000 tons annually. This will lower the salinity at Imperial Dam by about 3 milligrams per liter.

(3) Utilization of Return Flows--One method of reducing the salinity of the Colorado River would be to use part of the return flows for cooling water in nuclear-fired electric powerplant operations. The cooling water would be disposed of by evaporation after use.

It has been estimated that five nuclear-type powerplants, each with 770 megawatts of capacity, will be needed to meet the electric energy requirements of the San Diego area by about 1990. These plants would require the use of as much as 100,000 acre-feet of water for cooling purposes. If these nuclear powerplants were to be located in the desert area near the Colorado River, the availability of cooling water would be of prime importance. The water requirements could be met by siting the powerplants so that a part of the return flows conveyed to the Colorado River by the drain could be used for cooling purposes. Such a plan would require that the cooling water be reused until it became too salty for recycling, at which time it would be discharged to evaporation ponds for final disposal. However, since all of the waters of the Colorado River, including this return flow, are committed to present water uses, a plan which depleted the return flow can only be used if the water can be replaced from another source. It is physically possible to replace Colorado River return flows used in California with water supplied from the California State Water Project through an exchange agreement with the Metropolitan Water District of Southern California. Such an exchange agreement would require ratification by present users of Colorado River water.

Assuming that each of the powerplant units uses 20,000 acre-feet of return flow with an average salinity of 1,728 milligrams per liter and that this use is replaced with Metropolitan Water District Colorado River releases averaging 751 milligrams per liter under present modified conditions, the result would be to reduce the salt return to the river by about 29,000 tons per year. This would reduce the salinity of the flow at Imperial Dam by about 4 milligrams per liter. If the use were increased to 100,000 acre-feet per year, the reduction in salt would be about 146,000 tons per year and the reduction in salinity at Imperial would be about 19 milligrams per liter.

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2. Point Source Control Projects

The four units in the following section have been identified as point source contributors of salt to the Colorado River. They are thermal springs that discharge high concentrations of dissolved salts.

LaVerkin Springs Unit--LaVerkin Springs, located on the Virgin River in the southwestern corner of Utah, contribute an average salt load of 109,000 tons per year with a flow of about 11.5 cubic feet per second that has total dissolved solids averaging 9,650 milligrams per liter. A feasibility report of a plan for collecting and desalting the springs was forwarded to the Commissioner's Office in December 1974.

The desalting plan would use a bypass system, consisting of two small diversion dams and a bypass pipeline, to divert the river around the springs and collect the spring water. Spring flows would be pumped to a reverse osmosis desalting plant. About 5,690 acre-feet per year of product water would be returned to the river and 2,270 acre-feet of brine would be pumped to a solar evaporation pond. The brine water loss and a cooling tower loss of about 200 acre-feet would cause a depletion of about 2,470 acre-feet per year. A salt load of 103,000 tons per year would be removed from the stream, which would reduce the salinity of the river by 9 milligrams per liter at Imperial Dam. The report indicates the cost of salt removal would be \$28 per ton. Annual equivalent cost is \$2,929,000 and the benefits to irrigation, municipal and industrial water in the United States are \$1,070,000.

The LaVerkin Springs Unit studies for controlling the salt discharges from this point source evaluated all reasonably practical means for abating the salt pollution of the springs. The investigations included: locating various potential sites and developing plans for evaporating all of the spring discharge; evaluating the possibility of using the spring water for powerplant cooling water; determining the potential for deep well injection of the spring water; studies of alternative methods of collecting the springflow; and determining the cost of desalting using various methods now technically operational. The effect on the environment was evaluated for each of the potential control methods.

Littlefield Springs Unit--Littlefield Springs are a widely scattered group of springs located along the south side of the Virgin River about 1 mile upstream from Littlefield, Arizona. Littlefield is in the extreme northwestern part of Mohave County about 3 miles east of the Nevada State Line and 5 miles south of the Utah State Line. The principal communities in the vicinity are Littlefield, Arizona, and Mesquite and Bunkerville, Nevada. St. George, the largest community in the area, is located 28 miles upstream from the springs.

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Feasibility studies on the unit were started in Fiscal Year 1974. The area being studied includes the reach of the Virgin River from where it enters the "First Narrows" canyon above the Arizona-Utah State Line to the vicinity of Littlefield. The relationship between the Virgin River and saline springflows in the Littlefield, Arizona, area is complex and not completely understood. As the river enters the rugged canyon near the state boundary between Utah and Arizona, it loses up to 70 cubic feet per second of its flow to the alluvium of the bed. During periods of low flow, from May to October, the Virgin River flows underground through the upper part of "The Narrows." Surface flow begins to reappear about 1 mile above the mouth of "The Narrows" in the form of springs discharging from the riverbed and from the adjacent banks. Flows of 20 cubic feet per second at an average salinity of 2,915 milligrams per liter were measured at the mouth of the canyon in 1973. At a point 2 miles downstream, the flow increased to 43 cubic feet per second with an average salinity of 2,900 milligrams per liter. The stream continues to gain, and at the Geological Survey's gaging station at Littlefield the flow was 70 cubic feet per second and the salinity decreased to 2,470 milligrams per liter. The salinity improvement is attributed, in part, to an inflow of about 3 cubic feet per second of good quality water from Beaver Dam Wash and from springs on the north bank of the river above the gage. The upwelling springs in the lower end of "The Narrows" canyon and the stream gain in the area appear to originate from the flows lost by the river at the upper end of the canyon. However, the flows have been modified in that the springs have a nearly uniform year-round salt concentration and are thermal in nature with a temperature of about 78° F.

The Virgin River disappears during low flow periods after it enters the "First Narrows" canyon and emerges again near the mouth of the canyon about 6 miles upstream from Littlefield Springs. In the area of Littlefield Springs, the river is flanked on the southeast by the Virgin Mountains, on the northwest by the Mormon Mountains, and on the north by the Beaver Mountains.

A program of data collection to determine the flow and salinity of the main springs and the flow and salinity of the Virgin River with special emphasis on the lower part of "The Narrows" canyon was started in August 1973. Flow measurements and chemical analysis indicate an average combined flow of the springs of 5.7 cubic feet per second and an average salinity of 2,960 milligrams per liter. Based on this, the salt contribution to the river averages 16,700 tons per year. The mineral salts in the springs' discharge are chiefly carbonates, sulphates, and chlorides of calcium and sodium. The springs in the lower end of "The Narrows" canyon and the base streamflow in this area have a salinity and chemical content that is similar to that of the springs.

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Glenwood-Dotsero Springs Unit--The largest point source contributors of dissolved solids to the Upper Colorado River are in the river between the mouth of the Roaring Fork River at Glenwood Springs and the mouth of the Eagle River near Dotsero. These contributions are from thermal springs rising in or near the bed of the river and from ground water entering this reach of the river. Inflow-outflow measurements indicate this reach of the river contributes approximately 25,000 acre-feet of water containing over 500,000 tons of dissolved solids annually. Based on a 1-year period of data collection, the springs that could be identified and measured have a combined flow of about 16 cubic feet per second and an average dissolved mineral content of approximately 14,200 mg/l. These flows would carry about 225,000 tons of dissolved solids into the Colorado River annually.

The thermal springs and the ground water inflows to the Colorado River between the mouth of the Roaring Fork River and the Eagle River are widely scattered. The located springs whose flows are considered clustered in the vicinity of Glenwood Springs and around a point approximately 2.5 miles downstream from the mouth of the Eagle River called Dotsero. Geologically speaking, the area is located at the southeastern edge of the extensive White River uplift. The Glenwood and Dotsero Springs are situated at opposite ends of Glenwood Canyon which has been created by the Colorado River eroding through very resistant rocks of the uplift. Many faults have been mapped in the area and may be related to the springs.

The thermal springs generally issue from gravels along the river but this water is traveling to the surface through the underlying bedrock. Generally the springs seem to be found in areas where the cavernous Leadville limestone crops out but other formations are also involved. It is also of significance that the Paradox Formation is found in the general vicinity of both spring areas. Chemical analyses of the water from the springs show large amounts of both sodium chloride and calcium sulfate, and the Paradox contains beds of these minerals in the form of halite and gypsum.

Evidence of volcanism as recent as Pleistocene in age occurs in the area and suggests the possibility that hot intrusive bodies may be present in the subsurface. A cinder cone and lava flow are found about 5 miles east of the Dotsero Springs and other similar evidence exists.

In summary, only very generalized geologic data are available on the Glenwood and Dotsero Springs and an extensive exploration program will be necessary to delineate the geology and hydrology.

It is possible, however, to hypothesize that ground water in the area travels along faults or related fracture zones, dissolves

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out salts principally from the Paradox Formation, becomes heated by deep-lying intrusive bodies, and returns to the surface as warm, saline springs.

During the preliminary studies to date, several methods of disposing of or treating the saline water have been considered. Methods that could be used to control or eliminate point source flows include evaporative ponds, deep-well injection, diversion for industrial use or various types of treatment plants. After cursory evaluation of each of the alternatives, some type of treatment plant to remove the bulk of the salts is being evaluated in more detail. In addition, this would be the only solution that could salvage the fresh water for return to the Colorado River.

Investigation of this segment of the Colorado River Water Quality Improvement Program began in April 1972. An on-the-ground appraisal of the area located the various springs and a 1 year's measurement of the flow from each spring was obtained on a monthly basis. Total dissolved solids and chemical analyses were determined on all samples.

In April 1973, geophysical studies were conducted in the Dotsero Springs area to determine if it might be feasible to collect the saline water by drill holes. The limited amount of geophysical work indicated that the flows may be along open fractures in the underlying bedrock. Future core drilling is proposed to determine if the flows can be intercepted at depth. Any control plan must preserve the existing highly developed recreation facilities in the Glenwood Springs area.

The pertinent data collected at Dotsero and Glenwood Springs indicate the average total dissolved solids contained in the discharges from these two areas to be approximately 9,300 to 18,000 parts per million (ppm), respectively. The combined weighted average of both areas is about 14,200 ppm. The discharge of the springs at Dotsero has been measured to be about 7 cfs and at Glenwood Springs to be approximately 9 cfs.

Because of the nearly 16 miles separating the two springs areas, a cost estimate was prepared for individual desalting plants at Dotsero and Glenwood Springs. In addition, a cost estimate was made of a single plant to treat the combined discharges of both areas.

An appraisal report was completed in June 1976 based on a multi-stage flash distillation process. The estimated cost based on July 1974 prices is \$69.5 million.

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It is estimated that about 250,000 tons of salt could be removed annually which would reduce the salinity concentration at Imperial Dam by about 23 mg/l. Benefits to the Lower Colorado River Basin users are estimated to be about \$5,300,000 annually. Feasibility investigations will begin in FY 1978 with a report scheduled in FY 1980.

Environmental studies, other than collection of physical data from the study area, have not been initiated at this time. Such studies will be an integral part of feasibility studies. At this time, however, potential environmental effects--both beneficial and adverse--can be outlined as follows.

A reduction in the concentration of total dissolved solids in the river downstream would provide higher quality waters for municipal, industrial and agricultural uses. Some impairment of these uses now occurs.

Construction of a treatment plant or plants, brine ponds, pipelines, pumping stations, or other potential features would have potential temporary adverse effects on air and water quality and long-term effects on the landscape. If the combined plant plan were selected, a pipeline would be necessary through scenic Glenwood Canyon which is presently involved in a controversy regarding the location of the proposed route of Interstate Highway No. 70. Construction of a pipeline to carry the Glenwood-Dotsero Springs flow through the canyon, if coordinated with the Interstate Highway construction or the existing railroad right-of-way, should have little adverse impact.

Studies have not been undertaken to determine if unique or possibly rare plant or animal species have become established in the Glenwood or Dotsero Springs.

An evaporation pond or lake would be needed to evaporate the brine from the desalting plant and to store the salt. These ponds would become sterile within a few years with a salt flat exposed at the upper end during part of the year. Some plants such as willows and tamarisk could possibly become established before the pond became sterile. The dead vegetation would be unsightly. It is also likely that strong winds would pick up the dry salt from the salt flats and carry it to surrounding areas with some damage to the vegetation growing there. Salt would accumulate at the rate of a million tons every 4 years so continued protection would be needed to stabilize the storage ponds.

COLORADO RIVER SALINITY CONTROL PROGRAM

3. Diffuse Source Control Projects

This method of control deals with salt loading or concentrating effects that occur over comparatively large areas such as the tributary subbasins. The techniques available for control include collection, desalting, evaporation, special use, watershed management, and vegetative control.

Big Sandy River Unit--The Big Sandy River originates in the Wind River Mountains of northwestern Wyoming and flows southerly to the Big Sandy Reservoir and Dam where most of the flow is diverted to irrigate the Eden Project. From Big Sandy Dam, it flows southwesterly to the Green River. Near the mountains, the water is of high quality containing less than 50 mg/l of dissolved solids. After flowing across several miles of desert, the dissolved solids increase to 70-120 mg/l at Big Sandy Reservoir. Below Big Sandy Dam it picks up the irrigation return flows from the Eden Project and many saline seeps along the river channel. The Big Sandy River annually discharges approximately 180,000 tons of dissolved solids at concentrations ranging from 300 to 3,900 mg/l to the Green River. The climate is cold and dry in the winter with minimum temperature often 40° F. below zero. The average temperature for December is 13.8° F., January is 9.2° F. and February is 14.5° F. The summers are dry and mild with maximum temperatures only occasionally getting above 90° F.

Because of the low winter temperatures, it was thought that natural freezing methods might be used to desalt low flows of the Big Sandy River. A contract for a pilot demonstration of the freezing method during the 1973-74 winter was negotiated with the University of Wyoming. This test indicated that freezing would produce a product water with a concentration of 100 mg/l or less. It also proved that a source of heat was needed to prevent the spray nozzels from freezing and that the soil in the area chosen for the test was not suitable for holding ponds that would be needed.

Subsequent investigations have shown that the saline seeps come from an aquifer of up to 60 feet below the river. It appears that the aquifer extends to the east of the Eden Irrigation Project. Quality of the water in the aquifer varies from about 2,000 mg/l to 6,500 mg/l where it surfaces along the stream. Twenty to thirty second-feet seeps into the channel along the 15 mile reach. It is estimated that the seeps contribute over 100,000 tons of salt annually.

The quantity and quality of the water presently available from the Green River will satisfy industrial requirements in the area so use of the saline flows by industry does not appear feasible. It is estimated that 80,000 tons annually could be removed by treatment.

COLORADO RIVER SALINITY CONTROL PROGRAM

However, up to 6,000 acre-feet of water might be evaporated as brine. This would reduce the salinity concentration by about 7 mg/l at Imperial Dam. The principal benefits which will accrue to the lower Colorado River Basin are estimated to be \$1,610,000 annually. Investigations have not advanced sufficiently to prepare an estimate of cost. The feasibility report is scheduled for FY 1980.

Price, San Rafael, and Dirty Devil River Units--The Price, San Rafael and Dirty Devil Rivers originate in the mountains of the Wasatch and Aquarius Plateaus and provide tributary flows to the Green and Colorado Rivers in east-central Utah. Elevations in these river systems range from about 4,000 feet above sea level on the Colorado River to over 11,000 feet above sea level in the mountain ranges and high plateaus to the west. Drainage areas contain 1,500, 1,670, and 4,200 square miles for the Price, San Rafael, and Dirty Devil Rivers, respectively. These study areas are principally desert, with an arid to semiarid climate. The summers are hot and dry and the winters are usually dry and cold. Temperatures range from over 100° F. in summer to well below zero in the winter. For example, Hanksville, Utah, has recorded a high temperature of 112° F. and a low of minus 35° F. Snowfall is generally light and amounts to only a few inches during the winter season, except at the higher elevations, where substantial amounts accumulate on the ground.

The geological formations in these river basins consist primarily of sedimentary rock. About 60 percent of the Dirty Devil drainage and 75 percent of the Price and San Rafael drainages are composed of mudstones, claystones and shales which are the main source of salt loading in these rivers. Much of the irrigated lands are located on salt-producing formations particularly in the upper portions of the Price and San Rafael drainages.

The estimated total dissolved solids contributed by the Price, San Rafael, and Dirty Devil Rivers are 240,000, 190,000 and 200,000 tons, respectively.

The estimated annual removal of salt by potential control programs are 100,000 tons on the Price River and 80,000 tons each for the San Rafael and Dirty Devil Rivers. Salinity concentrations of the Colorado River at Imperial Dam would be reduced by an estimated 9 mg/l for the Price River and 7 mg/l for each of the San Rafael and Dirty Devil Rivers.

Investigations thus far have included field surveys and data gathering. Streamflow and water quality data are being obtained at several locations on each of the rivers. These data and future investigations will locate areas of greatest salt loading. Further

COLORADO RIVER SALINITY CONTROL PROGRAM

studies will be made to determine if other methods such as water systems, improvement, irrigation scheduling and farm management could be used along with selective withdrawal.

Additional sampling stations will be established as needed in conjunction with geologic investigations of each drainage basin.

Data gathering will continue in Fiscal Year 1977 and feasibility reports are scheduled for Fiscal Year 1980. Investigations have not progressed sufficiently to provide an estimate of costs.

Local benefits of the control programs have not been determined at this time. There would be an annual loss of water by evaporation estimated at 5,000 to 30,000 acre-feet for each river. It will be necessary to evolve procedure for accounting for such losses. The benefits in the lower Colorado River Basin are estimated to be \$2,070,000, \$1,610,000, and \$1,610,000 for the Price, San Rafael and Dirty Devil Rivers, respectively.

Control of the salt loading from these diffuse sources could have the following environmental impacts; some degradation of natural scenery would result from construction of diversion dams and evaporating ponds or desalting plants. The accumulation of salts in the evaporating ponds may become scattered by wind or may be accidentally discharged into the Colorado River system. Water diverted out at low flows may result in some adverse effects downstream to plant and animal life.

McElmo Creek Unit--McElmo Creek drains 350 square miles which includes the irrigated area in Montezuma Valley in Southwestern Colorado and flows into the San Juan River a few miles below the Colorado-Utah State line. The lands in Montezuma Valley are irrigated with water diverted from the Dolores River.

Data collected over a 4 1/2-year period indicate that the stream carries an average annual salt load of about 150,000 tons near the Colorado-Utah State line. Irrigation return flows from Montezuma Valley contribute a substantial amount of salt to McElmo Creek and Mud Creek, a tributary of McElmo Creek which drains the southern part of the valley. The land is derived from and underlain by Mancos shale, a brackish and impervious marine foundation. Based on two years of data, the annual salt pickup from South Montezuma Valley is approximately 70,000 tons.

Several methods of removing salt from McElmo Creek are being studied by the Bureau. One possibility would be to selectively withdraw and evaporate the flows of upper McElmo Creek and Mud Creek during periods of high salinity and low flow. A second would be to

COLORADO RIVER SALINITY CONTROL PROGRAM

desalt these flows. A site on Mud Creek could be used to evaporate either the saline flows or the brine discharge from a desalting plant. A third possibility would be to combine either of the above methods with a program of increased irrigation efficiency in Montezuma Valley. This would require the agreement of the irrigators in the area. It is estimated that any one of these measures would remove about 40,000 tons of salt per year and reduce the salinity at Imperial Dam by 4 mg/l.

Gaging stations were installed and water sampling initiated in FY 1972. Data collection is continuing. Mapping of the potential Mud Creek Evaporation Pond has been accomplished and aerial infrared photos of the Montezuma Valley are available.

The investigations have not progressed far enough at this time to select a plan of development. If a desalting plant were used to remove salt, the product water could be used for municipal or industrial purposes. The annual depletion of water would amount to approximately 6,200 acre-feet for complete evaporation of the flows and 3,700 acre-feet for the evaporation of brine from a desalting plant. Most of the benefits would occur in the lower Colorado River Basin where they are estimated to be \$920,000 annually. A feasibility report is scheduled for FY 1980.

Control of this source of salinity could have the following environmental impacts: (a) a reduction in the salinity concentrations downstream, (b) reduction of the stream discharge during low flow periods, and (c) some degradation of the natural scenery would result from the construction of the works necessary for evaporating or desalting the water. The evaporating ponds would be sterile within a few years and surrounded with dead plant life. At times, part of the ponds would be salt flats and the wind could transport the dry salts to the surrounding areas which may damage local vegetation.

PART IX. OTHER WATER QUALITY ASPECTS

Although salinity is considered to be the most serious water quality problem in the Colorado River Basin, there are a number of other water quality problems of varying degrees. The following sections include discussions of the most significant sources of water quality degradation exclusive of salinity and the effects of such degradations on water uses as measured by various parameters. The E.P.A. and States have largely controlled the discharge of pollutants through issuances of permits through the P.L. 92-500, Section 402 program. In addition, Section 404 of P.L. 92-500 requires permits to be issued by the Corps of Engineers for discharge of dredged or fill material.

A. Pollution Sources Other Than Salinity

1. Municipal Wastes

Municipal wastes are described herein as those liquid-carried wastes of domestic and service industry origin. Within the Colorado River Basin the majority of the discharges from waste water treatment plants enter the river system and are the primary sources of bacteriological and organic pollution. Most of the municipal waste sources in the basin receive secondary treatment plus disinfection which is the minimum degree of treatment required by the Basin States.

Municipalities are required to have their waste discharges meet water quality standards set by the States. At the present time, any pollution from municipal waste sources is confined to those reaches of stream immediately downstream of the waste effluent, and measures are being enforced by the State and Environmental Protection Agency for the control or abatement of pollution from these sources.

2. Industrial Wastes

Industrial wastes are defined as those spent process waters, cooling waters, wash waters, and other waste waters associated with industrial operations. The principal pollutants derived from industrial wastes other than salinity are toxic materials, oils and grease, floating materials, radioactivity, organic and oxygen-demanding substances, heat, color-, taste-, odor-producing substances, and bacteria.

With the establishment of Water Quality Standards on interstate streams and compliance schedules for the implementation of these standards, the pollution from industrial waste sources in the basin has been or is being abated or controlled.

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3. Agricultural Wastes

Except for salinity, pesticides and fertilizers are the primary water pollutants associated with agriculture in the Colorado River Basin. Here again the Environmental Protection Agency and States are endeavoring to control the discharge of these pollutants into the waterways.

The chlorinated hydrocarbon group, e.g., DDT and Toxaphene, are the most persistent pesticides and are of primary concern because of their long-range impact. Efforts are being made, however, to control use of these types of pesticides. The organic phosphate compounds do not persist in the environment for the period the chlorinated hydrocarbons do, but they are more toxic to fish and humans.

Nitrogen and phosphorus fertilizers are the most commonly used in the basin. Studies conducted in other areas of the United States show a relationship between the concentrations of nutrients from agricultural lands and water quality problems caused by excessive fertilization of aquatic plants. Within the Colorado River Basin the animal waste pollution is minimal because outside surface water has been prevented from entering the feedlots either by directing the drainage away from the operation or by locating the facility in a favorable topographic position. Additional discussion of toxic materials and nutrients are presented later in sections 5 and 6 Part IX.

4. Mine Drainage

During 1966 to 1968 approximately 75 locations were sampled to determine the heavy-metal concentrations contributed by mine drainages, tailing piles, and natural sources within the Colorado River Basin. Since that time the States and the Environmental Protection Agency have controlled or are controlling much of the pollution from these sources.

B. Water Quality Parameters Other Than Salinity

Detailed information concerning the following parameters can be obtained from results of special studies made in the various reaches of the Colorado River Basin. Some of these studies are mentioned in Part X.

1. Dissolved Oxygen

The dissolved-oxygen concentration is a measure of the water capacity to support life and assimilate organic wastes. The records show that the dissolved-oxygen concentrations in the Colorado River Basin are generally above established standards. A marked reduction in the concentration can be found during the summer months, however, below some municipal and industrial discharges and in some streams with very low

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flows. A 1966 investigation indicated that there might be a wide diurnal variation in the oxygen concentrations in some reaches because of the large amount of algae in the streams with oxygen saturation being reached during a sunlit day and minimal concentration occurring at night when oxygen is used by the plants. Samples also have indicated that at some of the lower depths in Flaming Gorge Reservoir anaerobic conditions exist. Releases are made, however, through the powerplant at higher elevations where the oxygen content is greater, thus maintaining sufficient oxygen in the stream below for fish life.

2. Temperature

The Colorado River Basin water temperatures vary widely, reaching the greatest difference during the summer months when they vary from near freezing in the high mountains to above 90° F. in the lower reaches. Warmer temperatures may increase the rate of growth and the decomposition of organic matter and of chemical reaction, resulting in bad odors and tastes, and also decrease the dissolved oxygen concentration available to sustain a fishery.

Changes in water temperature in the basin result primarily from natural climatic conditions. The large reservoirs, however, may affect the stream temperatures for a considerable distance below the reservoir. Temperature records indicate that Flaming Gorge Reservoir has little effect on winter temperatures but cools the summer temperatures of the Green River up to 5° F. at the Green River, Utah, station. The temperature immediately below Flaming Gorge Dam is now reportedly too cold for maximum growth and propagation of fish life. Plans have been completed to modify facilities near the dam to improve this condition. Navajo Reservoir appears to have no effect on the temperatures of the San Juan River at the near Bluff station. Lake Powell appears to warm the winter temperatures of the Colorado River at the Grand Canyon station by up to 10° F. and cool the summer temperatures by about the same amount.

Thermal springs, waste-water discharges, and irrigation return flows may increase the temperatures in the receiving water, but the added heat is usually dissipated in a relatively short distance from the source. Flow depletions and changes in stream channel characteristics may also increase the effects of natural climatic conditions causing cooler or warmer water temperatures.

Temperature increases due to municipal and industrial waste discharges have been minimal; however, the construction of large thermal powerplants in the basin with a return of the cooling water to the streams or reservoirs could present a potential for temperature increase. For this and other water quality reasons most of the cooling water discharges from future fossil fuel powerplants will not be allowed to return to the rivers.

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3. pH

The pH of the waters in the Colorado River Basin usually range from about 7 to 8. Formerly there were a number of streams receiving acid mine drainage. In these cases the pH was lowered to levels which precluded the establishment of aquatic life and the use of the river for fishery and other purposes. Most of these conditions, however, have been corrected by controlling the mine discharges.

4. Heavy Metals

Various heavy metals such as copper, lead, zinc, iron, manganese, arsenic, selenium, and cyanide are found in the waters of the basin. These have varied from trace amounts to potentially hazardous levels. The presence of these heavy metals is generally contributed by drainage from active and inactive mining operations.

Iron, arsenic, cadmium, selenium, and manganese concentrations occasionally exceed the Public Health Drinking Water Standards in some basin streams. This is particularly evident in the upper reaches of the Colorado and San Juan Rivers and their tributaries. It has been determined that heavy metal concentrations have a marked effect on the aquatic life. Certain reaches of stream have been completely devoid of bottom organisms and fish because of these toxic effects.

5. Toxic Materials

In addition to the toxic effects of heavy metal concentration, toxic materials are also contributed to the stream through industrial and agricultural operations. Limited long-term monitoring at four surveillance stations located on the Colorado River has in the past detected the pesticides DDD, DDE, DDT, dieldrin, and endrin. A comprehensive evaluation of the effects of pesticides upon water quality cannot be made at this time because of the lack of sufficient water quality data and incomplete knowledge of the physiological and other effects of pesticides in human, wildlife, fish, and other biological forms. The mere presence of a pesticide in water does not necessarily indicate serious pollution. Pesticides were tested for in samples of fish flesh and water taken from the Wahweap and San Juan River arms of Lake Powell. Pesticides found included DDD, DDE, and DDT. All levels were well below the limits set by the Food and Drug Administration.

The Bureau of Sport Fisheries and Wildlife also ran pesticide tests on fish flesh taken from Imperial Reservoir and Lake Havasu. Their results were very similar to those from Lake Powell.

6. Nutrients

Nutrients, primarily nitrogen and phosphorus, are believed to be the most conducive to the growth of algae. The sources of these nutrients

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are runoff from agricultural lands, municipal and industrial waste waters, and natural runoff. Phosphorus is normally found in only limited quantities in unpolluted water. Sufficient nitrogen is generally available naturally in basin waters to stimulate algae growth.

Las Vegas Wash flows into Las Vegas Bay, an arm of Boulder Basin of Lake Mead, and carries large loads of phosphorous and nitrogen. The principal sources of water in the Wash are effluents from the Clark County sewage treatment plant and the Las Vegas City sewage treatment plant, which make up between 85-95 percent of the total flow. These sources contribute about 80 percent of the nitrogen and 99 percent of the phosphorous loading found in the Wash.

Several investigators have concluded that the nutrients carried in the effluent from Las Vegas Wash contribute to the eutrophication and degradation of Lake Mead. Nitrogen and phosphorous loads entering the Lake through Las Vegas Wash total 600 and 150 tons per year, respectively. Chlorophyll A values (an indicator of algae mass) have been measured in Las Vegas Bay which are 20 to 25 times greater than comparable measurements in the main body of Boulder Basin.

The Environmental Protection Agency has identified these nutrients as a cause of water quality degradation in Las Vegas Bay and, therefore, causing a violation of the nondegradation provisions of the applicable State-Federal water quality standards for Lake Mead and the Colorado River. A notice of violation was issued to the municipalities and industries discharging waste water into the Wash.

The nutrient load entering Lake Mead from the Wash has increased as the municipal discharges to the Wash have increased. These discharges and the corresponding nutrient loading are expected to continue to increase until such time as corrective action is taken.

The nutrient concentrations in some of the other lakes in the basin have reached levels which can support algae growths. An algae growth has been cited as the probable reason for a fish kill which occurred in the Flaming Gorge Reservoir in late 1963.

In the lower reaches of the Colorado River aquatic plant growths have been associated with fertilization by nutrients discharged to irrigation drains. A small increase in the nutrient levels in the river has been attributed to heavy recreational activities along the river below Davis Dam.

7. Bacteria

The coliform group of bacteria is used as an indicator of pollution. This group is made up of bacteria of diverse origin including that found

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in the intestinal tract of humans and other warm blooded animals as well as in the soil and on vegetation. High coliform counts in waters indicate the probable presence of pathogenic organisms where bacterial contamination from sewage or animal wastes appears likely. This however, is only an indicator.

In recent years analytical procedures have been developed whereby coliform bacteria of fecal origin can be identified. Fecal coliform tests measure bacteria from both man and animal. All the States of the basin have set standards for fecal coliform as the bacterial indicator of pollution.

High bacterial counts were observed at many locations in the Colorado River Basin during the 1966 water quality study. A number of these resulted from raw sewage discharges into a stream and some was because of poor disinfection of the municipal waste-water treatment plant effluents. The raw sewage discharges which were observed during the 1966 survey have been corrected by the addition of ponding or other treatment.

Bacteriological pollution has also been observed in popular recreation areas. For example, the fecal coliform densities in Lake Mead have been observed at densities higher than the standards set for body contact recreation (100/100 ml.).

Bacteriological pollution has an effect on most of the uses cited earlier. In those cases where it exceeds the criteria set for body contact recreation, it results in the closure of swimming areas. With high coliform counts, the use of water as a public water supply could be impaired.

8. Radioactivity

An assessment of the radioactivity in the basin waters should also consider strontium 90 (Sr-90) radionuclides associated with atmospheric fallout in addition to radionuclides associated with industrial activities. Strontium 90, like the radionuclide Ra-226, is damaging to human bone cells. The effects of Ra-226 and Sr-90 are additive.

Radioactive pollution from industrial waste-water effluents, i.e., uranium mills, was, prior to 1960, the major source of radioactive pollution in the basin. The majority of the mills have been closed down but a significant portion of the increase of radioactivity originates from the abandoned tailings piles.

Radioactivity does impair the water for beneficial use when concentrations exceed certain limits. For example, the Public Health Drinking Water Standards set a mandatory limit of 3.0 picocuries Ra-226 and 10 picocuries/liter Sr-90. Moreover, the combination of these two radionuclides should conform to the following relationship: $\frac{\text{Sr-90}}{10} \cdot \frac{\text{Ra-226}}{3} < 1.0$.

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9. Mercury

A report by the Lake Powell Research Project on mercury published in 1973 and reprinted in 1975 gives the following information.

Samples analyzed by the flameless atomic absorption method showed that mercury levels in mean parts per billion were .01 for the lake water, 30 in bottom sediments, 10 in shoreline substrates, 145 in plant debris, 34 in plant leaves, 28 in algae, 232 in fish muscle and 10 in crayfish. The concentrations were based upon a wet-weight condition for the animals and a dry-weight basis for the rest of the samples. It was found that the mercury content was higher in the sediments with the higher organic content and that the lake transported plant debris had higher contents than the shoreline plants. In the rainbow and brown trouts, bloody tissues had higher mercury levels than the muscles while in the six other species analyzed the levels of bloody tissues heart, kidney, liver, etc., were lower than the muscles. Larger fish of a given species and fish of higher trophic levels have higher mercury concentrations, with the muscle of some large walleye and largemouth bass exceeding the 500 ppb. guideline of the U.S. Food and Drug Administration.

An estimated mercury budget suggested that due to the restriction of flow by the impoundment, the mercury could be accumulative.

10. Sediment

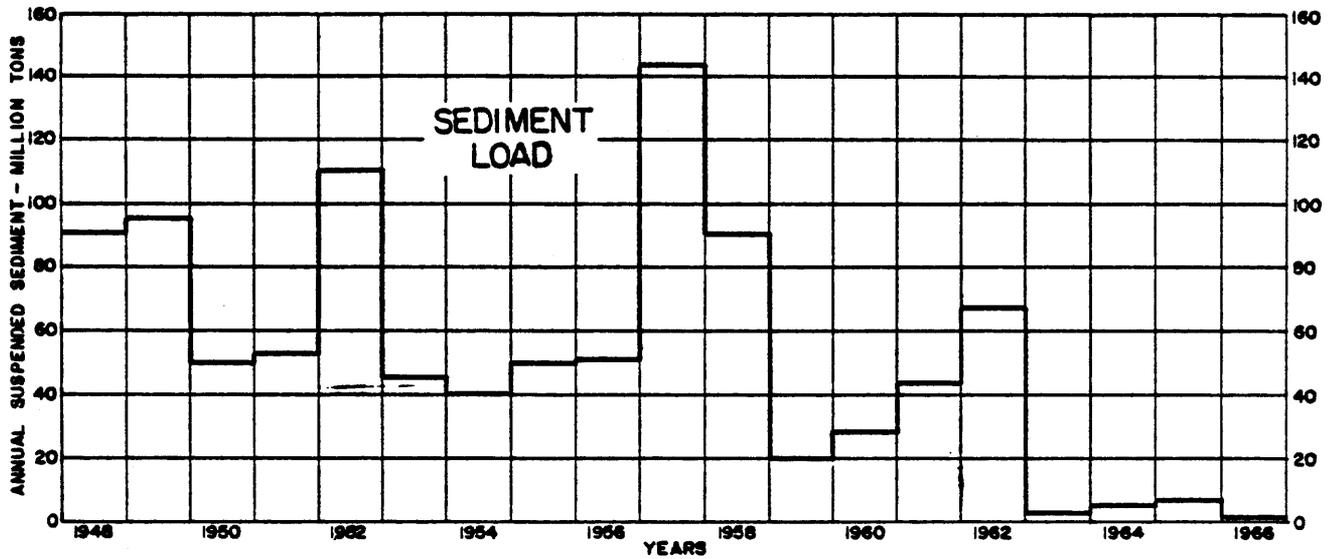
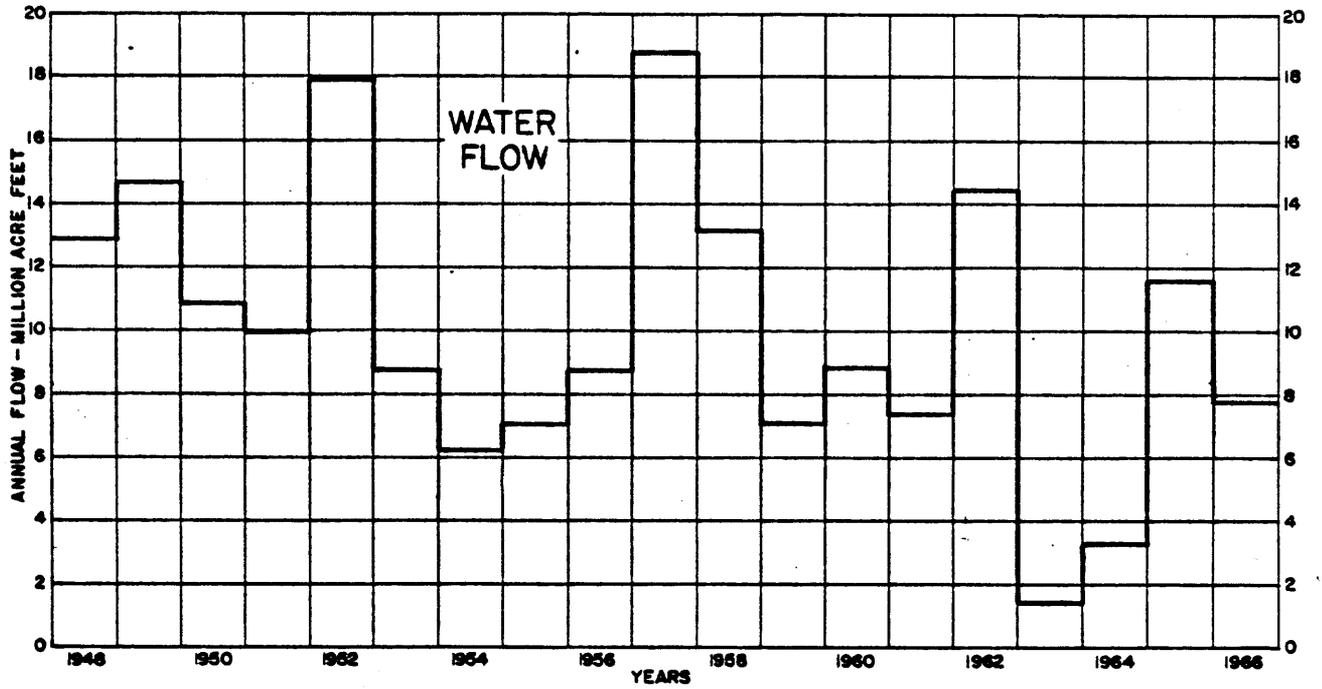
Prior to construction of the storage units of the Colorado River Storage Project, most of the larger tributaries and the main stem of the Colorado River carried large loads of sediment, particularly in their middle and lower reaches.

For example, in 1957 the suspended sediment load of the Colorado River at Lees Ferry, Arizona, gaging station was recorded at 143 million tons. This sediment was detrimental to water diverters for consumptive use as well as to high-type fishery and other recreational uses. The construction of Fontenelle, Flaming Gorge, Curecanti Unit, Navajo, and Glen Canyon Dams has produced dramatic changes in the sediment load transported by these streams. For example, the relationship between the water and sediment flows at Lees Ferry during the 1948-66 period is illustrated in Figure 5. In 1959 the cofferdam utilized in the construction of Glen Canyon Dam was finished and diversions began through the tunnels. Sediment was deposited behind the cofferdam in 1959 and 1960 at a sufficient rate to gradually fill the cofferdam lake with the result that by 1962 the annual sediment load at Lees Ferry had increased to 67 million tons. This load dropped to 2.2 million tons in calendar year 1963 with the closure of Glen Canyon Dam and initial storage in Lake Powell. Lake Powell and other Colorado River Storage Project reservoirs are now

OTHER WATER QUALITY ASPECTS

effectively trapping and storing almost all of the sediment originating in the Upper Colorado River Basin. Lake Powell and the other Upper Basin Reservoirs trap approximately 75 to 80 percent of the sediment that normally would flow into Lake Mead. By storing the sediment in the Colorado River Storage Project reservoirs, the streams immediately below the dams have been changed to relatively clear trout water fisheries as well as desirable boating and recreational areas. Daily sampling at Lees Ferry was discontinued beginning in water year 1966 because of the lack of sediment.

A comparison of the major portion of the inflowing sediment and flow into Lake Powell with the outflow was made by plotting for a number of years the sum of the sediment loads and flows of the Colorado River near Cisco, San Juan River near Bluff, and Green River at Green River, Utah, stations. This is shown in Figure 6 as compared to the outflow as shown by the Lees Ferry record in Figure 5.



UNITED STATES
 DEPARTMENT OF THE INTERIOR
 BUREAU OF RECLAMATION
**COLORADO RIVER
 AT LEES FERRY
 SEDIMENT & WATER FLOW**

Fig. 5

COMBINED COLORADO RIVER NEAR CISCO
 GREEN RIVER AT GREEN RIVER, UTAH
 AND SAN JUAN RIVER NEAR BLUFF

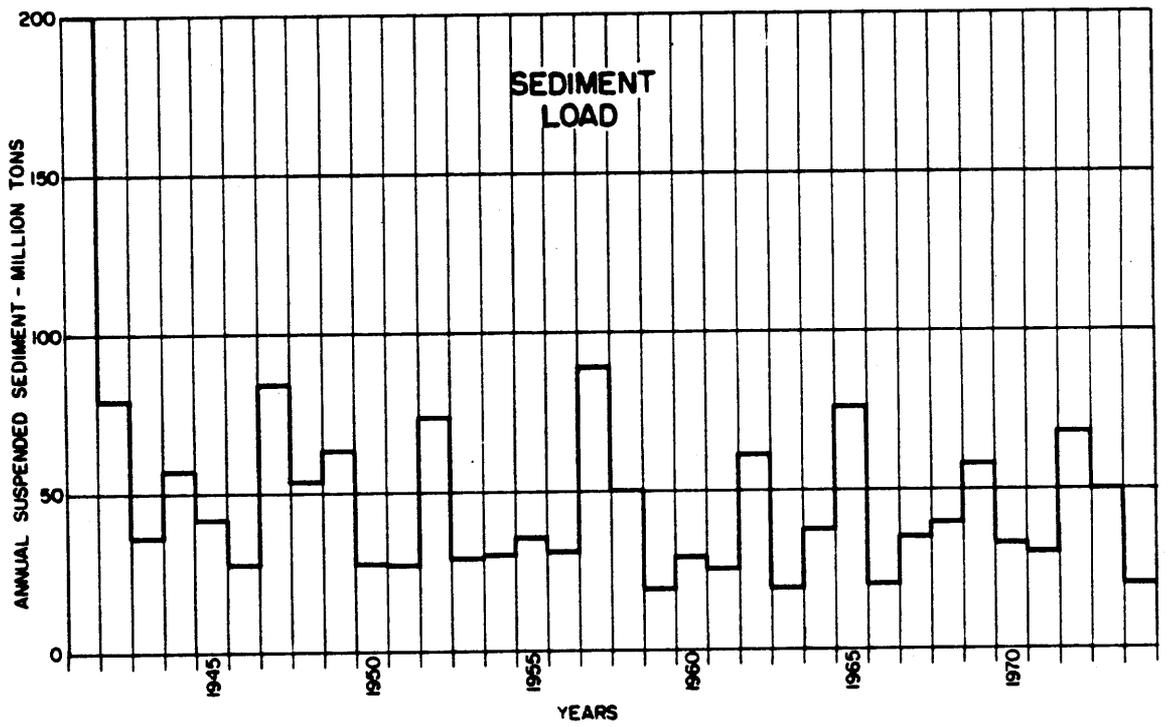
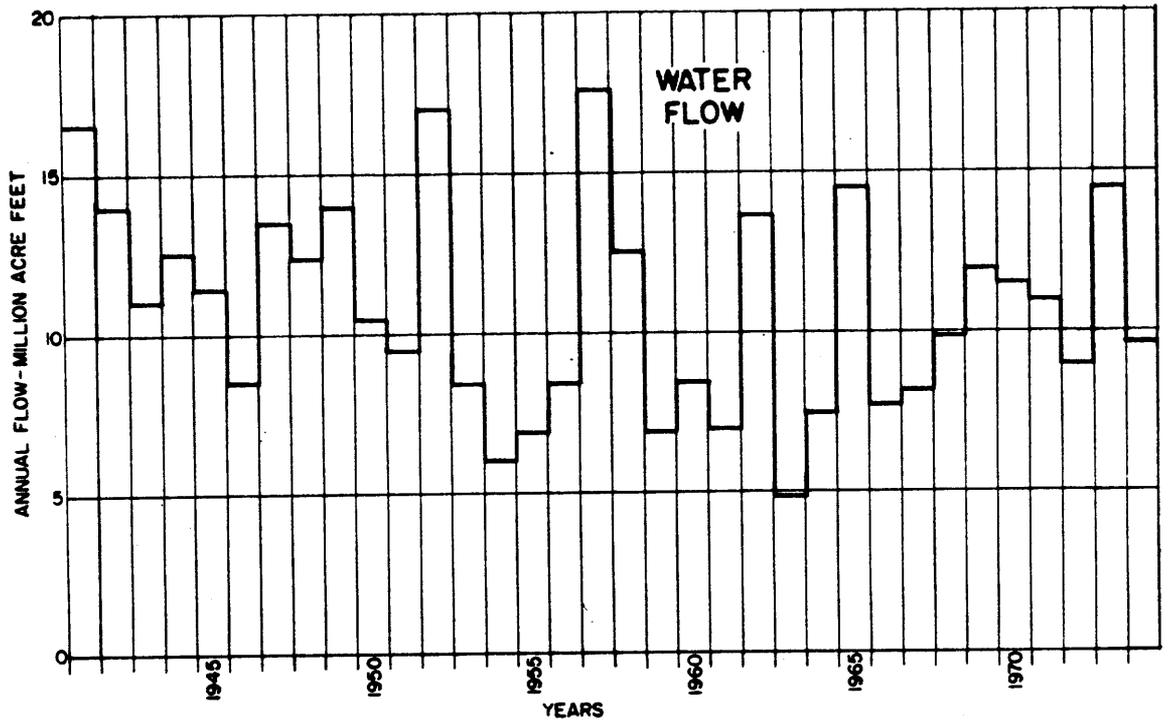


Fig. 6

PART X. SPECIAL STUDIES

A. Flaming Gorge Reservoir

Salinity samples have been obtained twice a year, in the spring and fall by the Bureau of Reclamation since 1967 at two locations in the Flaming Gorge Reservoir. Samples are obtained at 50-foot depths from the surface to the bottom of the reservoir. These two sites are at the mouth of Henry's Fork and about 1 mile above the dam. Parameters analyzed are specific conductance, dissolved solids, pH, and common ions. The Geological Survey conducted a water quality reconnaissance of Flaming Gorge Reservoir during 1966-68 and the results are published in Water Supply Paper 2009-C. A more comprehensive project was conducted from 1970-74 and those results are in preparation and will be published as Water Supply Paper 2039-A.

Studies by the Geological Survey on Flaming Gorge Reservoir have been continuing and the latest observations are presented in the following paragraphs.

1. Effects of Flaming Gorge Reservoir on the Colorado River

The effect of Flaming Gorge Reservoir on the Green River, a tributary to the Colorado River, has been to deplete the flow of the Green River, to leach minerals from the rocks and soils inundated by the reservoir, to increase the dissolved-solids concentration in the river below the dam, and to alter the temperature regime in the river below the dam. Dissolved oxygen is also depleted in parts of the reservoir during certain periods of the year.

Depletion of Flow.--Depletion of flow in the Green River since 1962 at Flaming Gorge Dam is due chiefly to storage in Flaming Gorge Reservoir evaporation, and storage in the rocks and soils inundated by the reservoir. Water was first impounded by Flaming Gorge Dam in November 1962. From that time until the end of the 1975 water year (September 30, 1975), the depletion of flow in the Green River at Flaming Gorge Dam was estimated to be about 4.7 million acre-feet (5,797 cubic hectometres), of which approximately 3.7 million acre-feet (4,564 cubic hectometres) was stored in Flaming Gorge Reservoir. The remaining depletion of about 1.0 million acre-feet (1,234 cubic hectometres) is due to evaporation and bank storage.

Effects of Leaching.--The effects of leaching in the reservoir and of load changes of dissolved solids downstream in the river were evaluated from data obtained from depth profiles at selected sampling sites in the reservoir as well as at sites on the major inflowing and outflowing streams.

From the closure of Flaming Gorge Dam until the end of the 1975 water year, the gain of dissolved-solids load in the river that resulted from

ANNUAL MAXIMUM, MINIMUM, AND WEIGHTED-AVERAGE CONCENTRATION OF DISSOLVED SOLIDS OF GREEN RIVER NEAR GREENDALE, 1958 - 75

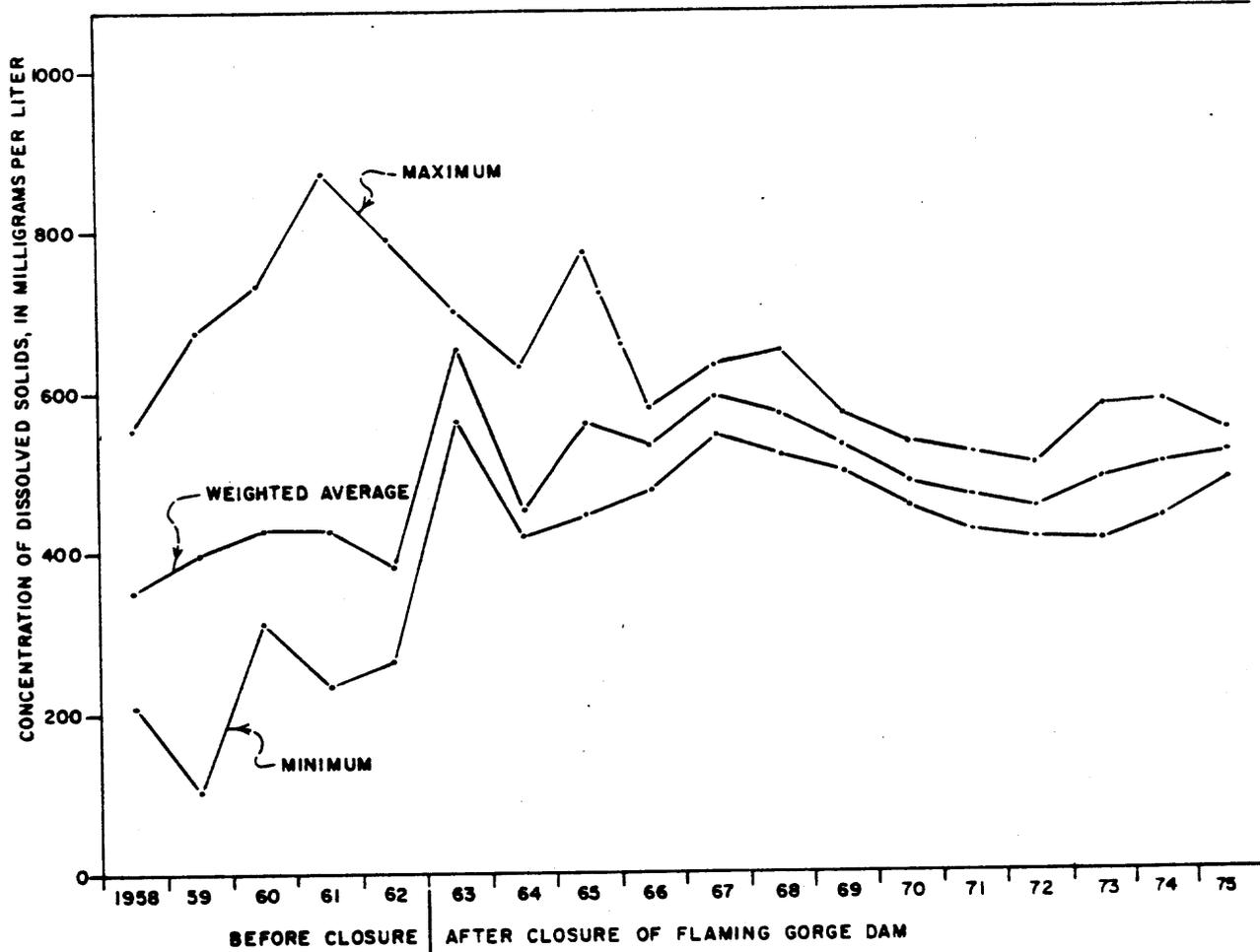
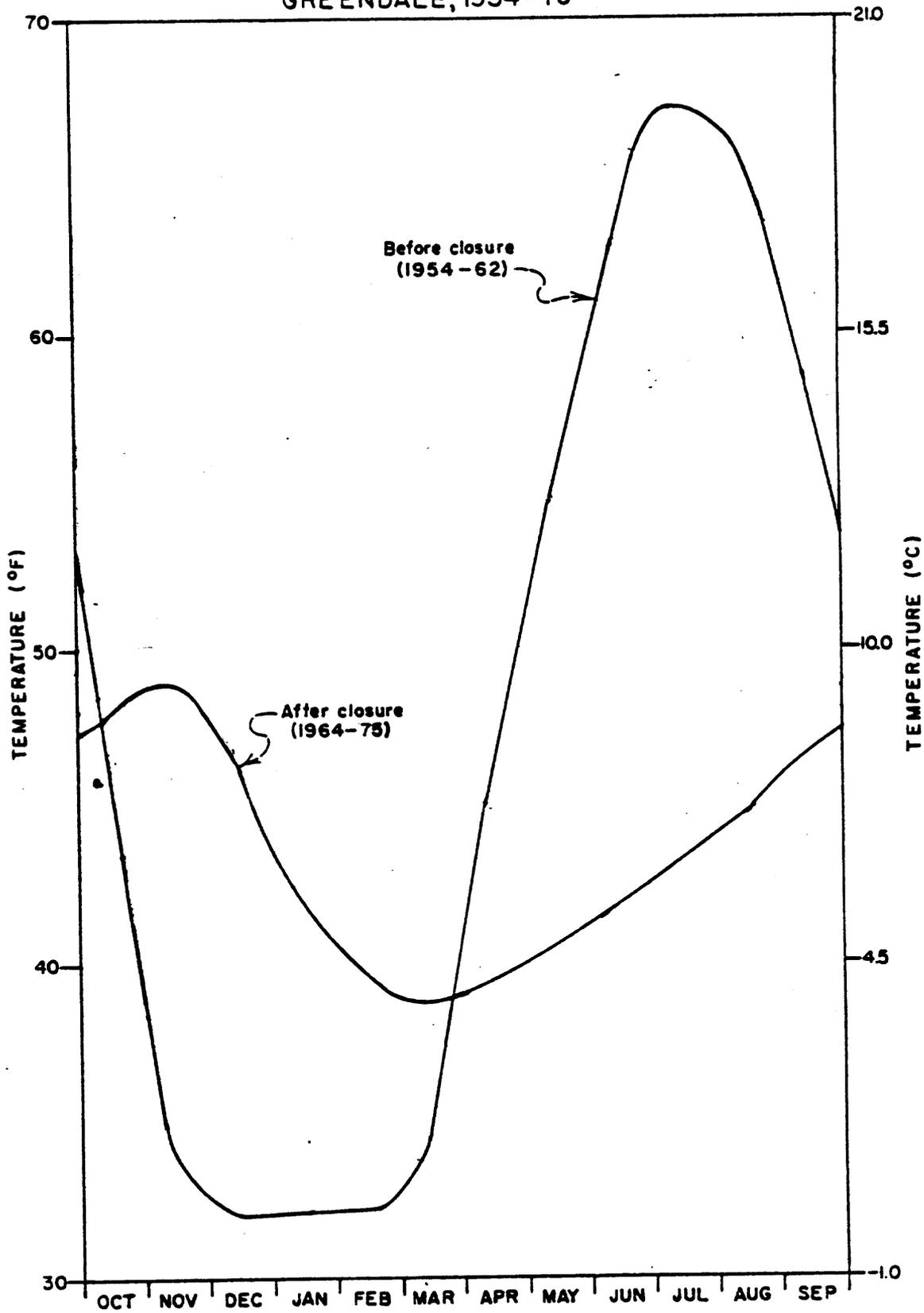


Fig. 7

MEAN MONTHLY TEMPERATURE OF GREEN RIVER NEAR
GREENDALE, 1954-75



FLAMING GORGE DAM

Fig. 8

SALINITY CHANGES IN LAKE POWELL
AT WAHWEAP SITE

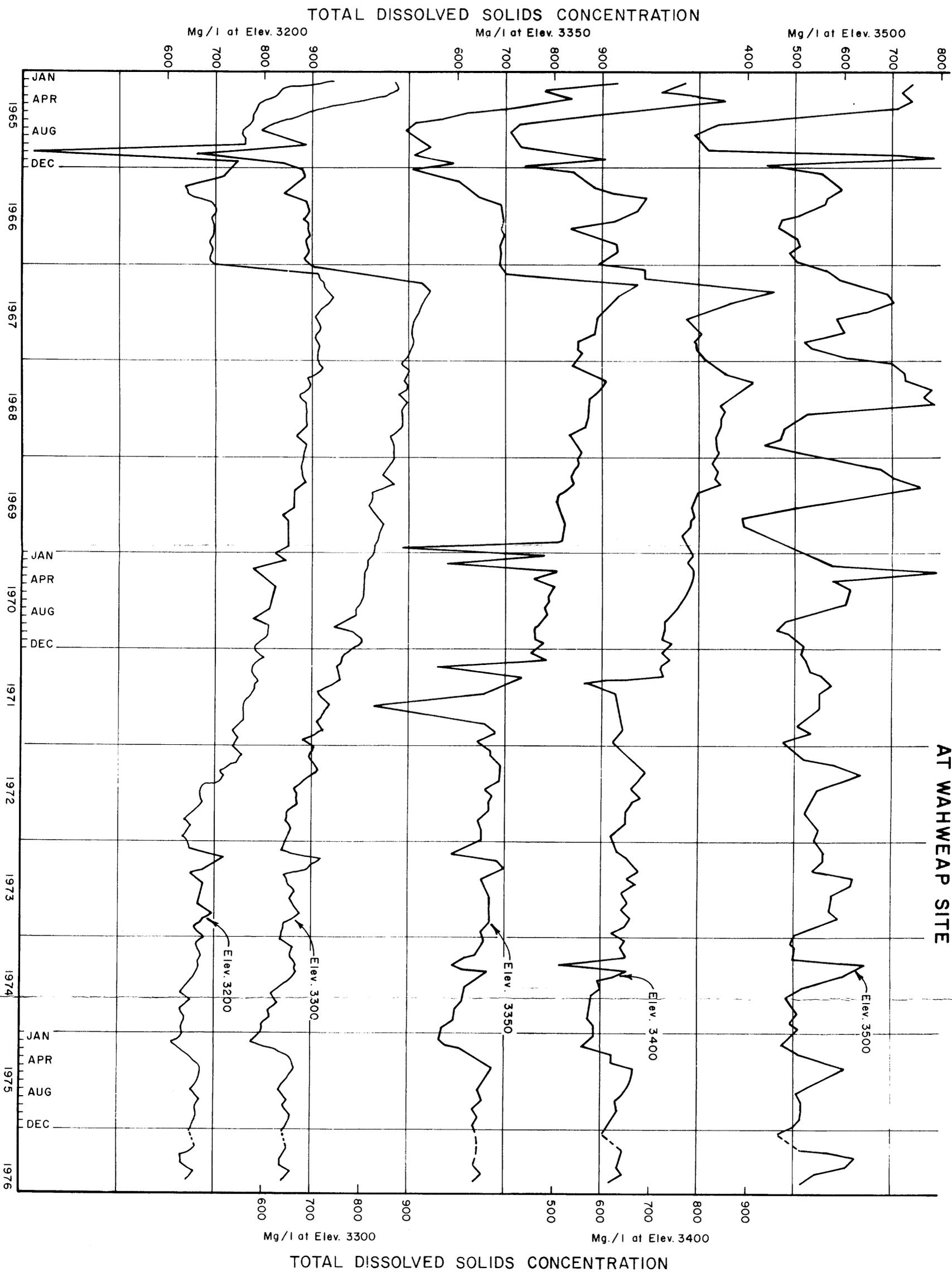


Fig. 9

SPECIAL STUDIES

In addition to the model being developed by the Bureau of Reclamation, other organizations have requested the available basic data on Lake Powell to make special studies. For example, a research project was recently conducted entitled the "Lake Powell Research Project." The organization making the study consisted of universities, colleges and other participants and collaborated in assessing man's activities in the Lake Powell region. The organization sought to establish the natural framework of the region, evaluate recent changes that man has brought about, and determine how these changes in turn affected man. A great amount of basic data was collected in making these studies. These included biological and bacteriological as well as chemical data regarding the waters of Lake Powell.

C. Lake Mead

The Bureau of Reclamation conducted an extensive sampling program of Lake Mead from 1964 through 1968. The data collected from the sampling program were published by the Bureau of Reclamation in Report No. CHE-70, Water Quality Study of Lake Mead, 1970.

A more recent report funded by the Bureau of Reclamation entitled "A Mathematical Model of Primary Productivity and Limnological Patterns in Lake Mead, Technical Report No. 13." September 1972 analyzes the biological and chemical properties of Lake Mead based on eight sampling stations. This report indicates the sources of water pollution and the time of highest pollution potential. It also presents a method of quantifying eutrophication trends in Lake Mead.

Another report entitled "Final Report on Interrelationships between Chemical, Physical, and Biological Conditions of the Waters at Las Vegas Bay at Lake Mead" by Dr. James Deacon, University of Nevada, Las Vegas, May 1973, describes the effects of Las Vegas Wash, an enriched stream, on Lake Mead.

The Biology Department of the University of Nevada, Las Vegas, conducted a special study called the "Lake Mead Water Quality Monitoring Program." A report on this program was issued in April 1975.

Complete chemical and nutrient analyses are made for water samples taken by the Bureau of Reclamation quarterly at three stations in Lake Mead: Hoover Dam Intake Towers, Saddle Island Station, and Station 10.

D. Upper Colorado River Salinity Investigations

Water quality samples are being collected daily, monthly, or quarterly from approximately 100 sites on the rivers, canals, drains, and sloughs by the Bureau of Reclamation and by the Geological Survey for

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the Bureau of Reclamation in the Upper Colorado River Basin. This program is in addition to the regular Geological Survey network. Samples are collected at various locations for the purpose of evaluating effects of future water resource projects on the river system, identifying sources of salinity for water quality improvement projects, obtaining basic data for research projects, and acquiring long-term records to determine trends and observe overall changes in the salinity of the river system. This monitoring system will be especially valuable in providing data for the "Colorado River Water Quality Improvement Program" in the basin.

E. Lower Colorado River Salinity Investigations

In February of 1970, the Bureau of Reclamation began a trial program to analyze the source and makeup of the salt load arriving at Imperial Dam on a daily basis. Conductivity measurements were made each day at 10 stations between Parker Dam and Imperial Dam. The network included essentially all significant diversions, surface return flows, and major river stations.

An intensive program was carried on for one year. After one year of operation, the frequency of sampling was reduced. During the fall of 1971, an experimental program of automatic salinity monitoring was started. Conductivity probes were installed at nine stations on the lower river and the data transmitted by telemetry to the Boulder City and Imperial Dam offices. The nine stations are as follows:

1. Colorado River below Hoover Dam.
2. CRIR Main Canal near Parker.
3. Poston Wasteway near Poston.
4. Palo Verde canal near Blythe.
5. Colorado River at Taylor Ferry near Cibola.
6. Colorado River below Cibola Valley.
7. Yuma Mesa Drain near Yuma.
8. Main Outlet Drain Extension Bifurcation for MODES 2 and 3.
9. Colorado River at the Northerly International Boundary above Morelos Dam.

Recently the Intensive Salinity Surveillance Program has changed. The water quality telemetering program was discontinued but weekly samples are taken at the nine previously mentioned stations. Daily conductivity measurements are taken at Imperial Dam in conjunction with the requirements of meeting Minute 242. The USGS is now responsible for the continuous water quality monitoring probes at Imperial Dam and on the Main Outlet Drain Extension for both continued research and data gathering. There are plans to install continuous monitoring probes at Hoover and Parker Dams.

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In addition to the nine formerly telemetered stations, water quality samples are collected from 5 other stations. Individual samples are analyzed for conductivity. The U.S. Geological Survey Laboratory makes weekly analyses for total dissolved solids (residue at 180° C.) and monthly analyses of the chemical constituents.

Sampling frequencies for all stations were selected from an analysis of past records so that samples would represent the actual salt load with an error of less than 5 percent, 95 percent of the time. The 5 other stations and the selected frequencies are shown in the following tabulation:

	<u>Samples/Week</u>
Colorado River below Parker Dam	1
CRIR Levee Drain near Parker	1
CRIR Lower Main Drain near Parker	1
Palo Verde Outfall Drain near Palo Verde	1
Colorado River at Imperial Dam	7

The U.S. Geological Survey made a salinity study of the Lower Colorado River Basin and presented it in professional paper 486-E, "Salinity of Surface Water in the Lower Colorado River - Salton Sea Area," by Burdge Irelan, dated 1971.(3) The report shows that during the period 1926-62 the chemical regimen of the Colorado River at Grand Canyon and upstream, although probably somewhat different from the virgin regimen, was relatively stable. There may have been small increases in average salt concentrations, particularly toward the end of the period, caused by construction of reservoirs, increased irrigation and out-of-basin diversions. The research also found that most of the salt burden of the Colorado River above Imperial Dam originates in the upper Basin. The largest individual increment to the salt burden of the Colorado River below the compact point and above Imperial Dam is Blue Springs near the mouth of the Little Colorado River. The report also shows that cultivated lands in Parker and Palo Verde Valleys and increasing out-of-basin diversions contribute to increasing salinity in the lower reaches of the river.(1)

F. Irrigated Areas

Studies have been made in several areas to determine irrigation effects on water quality. Two of these worthy of mention are the Vernal, and Florida Project areas and are described in the following paragraphs:

1. Vernal Area

A cooperative study initiated in 1969 entitled "Water Quality Prediction Investigations" was conducted by the Bureau of Reclamation and Environmental Protection Agency to develop a technique for predicting more precisely, the mineral quality of irrigation return flow. The means

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for accomplishing this is through the use of mathematical models and high speed computers. The mathematical model is primarily a mathematical formula or expression attempting to duplicate conditions encountered on an irrigation project. The study utilizes data from existing irrigation projects in order to verify the technique.

The objective of the study was to use a model in predicting changes in capacity and the associated water quality distribution of the aquifer and also the quality distribution of the water as surface effluents from the system. The prediction of the system responses was compared with the historical data, both quantity and quality distributions as a measure of the reliability of the model. Data from the Vernal Unit of the Central Utah Project have been used for designing and testing the model. Tests were also made using data from the Grand Valley area in Colorado and the Cedar Bluff Unit in Kansas. A final report of this project should be published about the first of the year 1977.

With this model the implication for water resource projects is that farm operation could be designed to use the least amount of water and return the smallest amount of salt to the river while permitting the farmer to obtain the greatest possible return from his farm. The salt load reductions expected from irrigation scheduling and management could also be verified on the Vernal Unit in the Uintah Basin.

2. Florida Project

Flow and quality data were collected at several points in the Florida Project area beginning in 1958 before the project was constructed. A study of these data for the period 1958-63 show the effect of irrigation of these lands on the quality of return flows leaving the area.

Results show that there has been a very small amount of pickup measured in the river downstream from the irrigated area. The concentration of total dissolved solids in the inflowing water ranges from 0.14 to 0.17 ton per acre-foot, and that of the outflowing water ranges from 0.17 to 0.30 ton per acre-foot. About 13,720 acres were irrigated at the time the measurements were made.

Other areas in the Colorado River Basin with similar type soils under irrigation would yield only minor amounts of salt.

3. Grand Valley Area A.R.S.

The Agricultural Research Service is doing a research study in the Grand Valley with regards to consumptive use and irrigation efficiencies. This is further covered in Part VIII.

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4. Other Studies

Considerable variation in the effects of irrigation return flow on water quality is to be expected. Differences arise due to the size of the irrigated areas, the number of times the return flow is reused, properties of the soils and drainage area, number of years land has been irrigated, nature of aquifers, rainfall, dilution, temperature, irrigation methods, storage reservoirs, vegetation, and type of return flow channels.

Consumptive use, return flow, and salinity studies are now being conducted by Federal agencies in cooperation with State and local agencies. Some of the study areas are purposely being held small to achieve better control, but they will be as representative as possible of existing projects. The results pertaining to the quantity of return flow will be very helpful in estimating effects on water quality of return flows from larger areas where measurement of inflow and outflow is not always possible or practical. Studies of local areas are also conducted under the Section 208 program (P.L. 92-500) or by private organizations under contract with the government. These Section 208 studies include the investigations of all sources of salinity as well as, bacteriological, biological, heavy metals and all other types of pollution.

Special studies in areas of the basin will continue to be made from time to time to determine water quality conditions, and studies of projects, such as Florida and Vernal Area should be repeated or continued in order to evaluate changes with time.

G. Environmental Protection Agency Report

A special 1971 report by the Environmental Protection Agency entitled "The Mineral Quality Problem in the Colorado River Basin" presents results and recommendations obtained from a comprehensive salinity control study. This report includes a presentation of natural and manmade conditions affecting mineral quality, the physical and economic impacts, and salinity control and management aspects.(4)

H. Model Studies

1. Colorado River Storage Project Model (CRSP)

This mathematical model was developed by the Bureau of Reclamation for the Colorado River Reservoir Long Range operating criteria (Public Law 90-537) and includes monthly water supply data for the period 1906-74. It does not project future quality conditions at any station above Lee's Ferry. Water quality data were added to the model to obtain salt loadings. Since water quality records are not available for the years prior to about 1941, the records back to 1906 were obtained by correlations.

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This model was used in the sizing study for the Yuma Desalting Plant which has been authorized for construction under Title 1 of Public Law 93-320. The study shows the magnitude, duration and frequency of extreme salinities in the lower reaches of the Colorado River.

2. Interim Water Quality Simulation Model for the Colorado River

This model was developed by the Bureau of Reclamation in 1973, and nominally duplicated the hand computed model shown in Table 18 of the January 1973 "Quality of Water Colorado River Basin Progress Report" No. 6, as it included the 1941-70 period of record. The model ("Application of a River Network Model to Water Quality Investigations for the Colorado River," September 1973 by R.W. Ribbens and R.F. Wilson) however, was different in that it simulated reservoir operations, was computed on a monthly, year by year instead of an average annual basis and was developed for the reach from Lake Powell to Imperial Dam instead of including all the Upper Basin stations as well as the Lower Basin stations. Results were comparable to the Biennial Report study. This was the model used by the work group for the "Colorado River Basin Salinity Control Forum" to make projection studies in developing numeric criteria and a plan of implementation of control measures to meet the criteria.

3. Colorado River Simulation Model (CRSM)

This comprehensive mathematical model of the Colorado River was developed by the Bureau of Reclamation during the years 1972 to 1974. It was developed so it could be adapted to other basins as well as the Colorado River Basin, simulating both water quality and quantity. At the present time the model uses a stochastic hydrologic data base. This base was used in the model applied to the West Wide studies.

A new data base is being developed in the upper and lower basins based on recorded data adjusted for known changes in the hydrologic regime such as consumptive use, changes in irrigated acreage and phreatophytes, and reservoir changes of contents, evaporation and bank storage. Periods of missing records will be filled in by statistical correlations of both recorded and adjusted records.

4. Utah State University Study

In 1970 the Utah State University issued a report entitled "Computer Simulations of the Hydrologic-Salinity Flow System Within the Upper Colorado River Basin." This report was based on a study which employed an electronic analog computer in developing a simulation model of the hydrologic and salinity flow systems of the Upper Colorado River Basin. One period of record used in the study was from 1931-60. The estimated

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salt load at Lees Ferry was 8.6 million tons consisting of about 4.3 million tons (50 percent) from natural sources, 1.5 million tons (17 percent) from agriculture and 2.8 million tons (33 percent) from other unidentified sources. The model was designed to predict the effects of various possible water resources management alternatives.

PART XI CONCLUSIONS

These studies indicate an overall increase in the concentration of total dissolved solids at the various points on the Colorado River and/or its tributaries under the future conditions described. The quality of water is still acceptable for present and some projected uses although quality control measures are necessary in order to keep the future concentrations within required limits.

Salinity is introduced into the Colorado River system from various sources but the natural source contributes the major portion of total dissolved solids. The addition of large storage units throughout the entire basin has dampened out the longtime and annual fluctuations in water quality.

The dampening influence on water quality fluctuations by many reservoirs in the basin make it possible to more accurately forecast the quality of water delivery to the many projects and points of diversion in the basin.

The tributaries with exceptionally high dissolved-solids content have minor effect on the dissolved-solids concentration of the lower main stem of the Colorado River as the volume of water and total tonnage of dissolved material represent only a small portion of the total.

The special studies of irrigation projects that have been undertaken and their effect on the chemical quality of water permit these preliminary conclusions:

1. The early years of irrigation are generally the most detrimental to downstream water quality. This is due primarily to leaching of an abundance of soluble salts not previously exposed to a large amount of water.
2. Firm determinations cannot be made during the early years of development regarding the ultimate effect of irrigation. The primary factors in establishing equilibrium are the availability of soluble salts in the soils, the capacity of the ground water reservoirs, and the uniformity of irrigation practice in the area in question.
3. Each irrigated area has a different effect on quality depending upon properties of the soils and substrata in the area, number of years the land has been irrigated, number of times return flow is reused, nature of the aquifers, rainfall, amount of dilution caused by surface wastes, temperature, storage reservoirs, vegetation, and types of return flow channels.

CONCLUSIONS

The recent shortage in energy has caused a greater demand for energy related developments such as powerplants, oil shale, and coal gasification industries. It is expected these industries will use a large share of the undeveloped water in the future with little or no salt return to the river system.

Changes in annual concentrations of dissolved solids at Lees Ferry seem to be detected at Imperial Dam about 2 years later and it also appears that the salinity at Imperial Dam is responsive to annual fluctuations of discharge at Lees Ferry.

A basin-wide program entitled "Colorado River Water Quality Improvement Program," whose purpose is to alleviate salt contributions to the river system, is now underway. Public Law 93-320 signed on June 24, 1974, authorized several projects for the improvement, enhancement, and protection of the quality of water available in the Colorado River for use in the United States and the Republic of Mexico. It is estimated that the Water Quality Improvement Program as now planned will accomplish about 40 percent of the job in maintaining the salinity at the established standards under full development of the basin water resources.

Pollution to the Colorado River Basin other than salinity has not been a major problem in the past but careful surveillance and control measures are required so that they will not become a major problem in the future.

The rate of leaching of salts from the Flaming Gorge Reservoir area for the 1967-75 period has decreased from the 1963-66 period. This decrease has contributed to a decrease in salinity below the reservoir for the same period. The range of average monthly temperatures of the Green River below the reservoir has been reduced considerably since closure of the reservoir.

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- (1) Iorns, W. V., Hembree, C. H., and Oakland, G. L., 1965, Water Resources of the Upper Colorado River Basin--Technical Report: U.S. Geological Survey Professional Paper 441, 370 pages.
- (2) D. R. Standiford, L. D. Potter, D. E. Kidd, Lake Powell Research Project Bulletin Number 1, June 1973, Mercury in the Lake Powell Ecosystem.
- (3) Burdge Irelan, 1971, Salinity of Surface Water in the Lower Colorado River--Salton Sea Area--U.S. Geological Survey Professional Paper 486-E.
- (4) Environmental Protection Agency, 1971, Mineral Quality Problem in the Colorado River Basin.

Table 1
Colorado River Basin
Historical Flow and Quality of Water Data
Green River near Green River, Wyoming

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
1941	Jan.	22	0.73	16	1947	Jan.	26	0.81	21	1953	Jan.	32	0.62	22
	Feb.	19	.74	14		Feb.	30	.73	22		Feb.	33	.70	23
	Mar.	45	.69	31		Mar.	141	.47	66		Mar.	44	.68	30
	Apr.	95	.54	51		Apr.	75	.57	43		Apr.	77	.58	45
	May	174	.52	90		May	368	.33	121		May	74	.57	42
	June	342	.34	116		June	501	.29	145		June	381	.28	107
	July	137	.37	51		July	327	.26	85		July	206	.29	60
	Aug.	81	.46	37		Aug.	199	.32	64		Aug.	104	.39	41
	Sept.	48	.54	26		Sept.	81	.44	36		Sept.	39	.56	22
	Oct.	67	.60	40		Oct.	75	.59	44		Oct.	34	.74	25
	Nov.	53	.64	34		Nov.	59	.63	37		Nov.	36	.75	27
	Dec.	26	.81	21		Dec.	44	.68	30		Dec.	24	.88	21
	Total	1,109	.48	527		Total	1,926	.37	714		Total	1,084	.43	465
1942	Jan.	24	.79	19	1948	Jan.	38	.71	27	1954	Jan.	26	.81	21
	Feb.	23	.83	19		Feb.	33	.73	24		Feb.	27	.74	20
	Mar.	43	.70	30		Mar.	64	.62	40		Mar.	44	.67	32
	Apr.	200	.41	82		Apr.	95	.54	51		Apr.	88	.55	48
	May	151	.50	75		May	187	.43	80		May	282	.28	79
	June	337	.34	114		June	396	.31	123		June	232	.30	70
	July	205	.32	66		July	121	.39	47		July	252	.25	62
	Aug.	52	.52	30		Aug.	56	.82	29		Aug.	86	.40	34
	Sept.	32	.62	20		Sept.	32	.62	20		Sept.	47	.55	26
	Oct.	229	.76	22		Oct.	36	.72	26		Oct.	40	.68	27
	Nov.	26	.84	21		Nov.	29	.76	22		Nov.	39	.69	27
	Dec.	26	.77	20		Dec.	26	.81	21		Dec.	18	.89	16
	Total	1,154	.45	518		Total	1,113	.46	510		Total	1,183	.39	462
1943	Jan.	28	.78	22	1949	Jan.	27	.78	21	1955	Jan.	20	.60	16
	Feb.	29	.76	22		Feb.	24	.79	19		Feb.	20	.60	16
	Mar.	59	.63	37		Mar.	45	.69	31		Mar.	33	.76	25
	Apr.	200	.41	82		Apr.	104	.52	54		Apr.	74	.59	44
	May	237	.39	92		May	211	.41	86		May	127	.39	50
	June	476	.29	138		June	372	.32	119		June	245	.27	66
	July	359	.25	90		July	179	.26	64		July	116	.36	42
	Aug.	121	.39	47		Aug.	65	.48	31		Aug.	68	.41	28
	Sept.	50	.54	27		Sept.	38	.58	22		Sept.	35	.57	20
	Oct.	48	.67	32		Oct.	52	.65	34		Oct.	33	.70	23
	Nov.	43	.67	29		Nov.	54	.65	35		Nov.	28	.79	22
	Dec.	30	.77	23		Dec.	34	.74	25		Dec.	39	.74	29
	Total	1,680	.38	641		Total	1,205	.45	541		Total	888	.45	381
1944	Jan.	25	.80	20	1950	Jan.	29	.79	23	1956	Jan.	42	.69	29
	Feb.	25	.80	20		Feb.	33	.73	24		Feb.	29	.66	19
	Mar.	31	.77	24		Mar.	102	.53	54		Mar.	91	.56	51
	Apr.	267	.37	99		Apr.	251	.38	95		Apr.	158	.45	71
	May	155	.46	71		May	270	.37	100		May	310	.37	115
	June	351	.33	116		June	582	.34	198		June	555	.25	139
	July	230	.30	69		July	427	.23	98		July	197	.31	61
	Aug.	60	.50	30		Aug.	140	.37	52		Aug.	98	.38	37
	Sept.	31	.65	20		Sept.	76	.45	34		Sept.	41	.56	23
	Oct.	38	.71	27		Oct.	66	.61	40		Oct.	39	.59	23
	Nov.	31	.71	23		Nov.	71	.59	42		Nov.	35	.69	24
	Dec.	21	.81	17		Dec.	49	.68	32		Dec.	26	.77	20
	Total	1,265	.42	536		Total	2,096	.38	792		Total	1,621	.38	612
1945	Jan.	24	.79	19	1951	Jan.	34	.74	25	1957	Jan.	22	.77	17
	Feb.	27	.74	20		Feb.	47	.66	31		Feb.	37	.70	26
	Mar.	41	.68	28		Mar.	70	.59	41		Mar.	57	.68	39
	Apr.	78	.58	45		Apr.	154	.45	69		Apr.	60	.62	37
	May	111	.52	58		May	317	.38	111		May	176	.46	81
	June	245	.38	93		June	528	.28	188		June	476	.27	129
	July	284	.28	80		July	349	.25	87		July	380	.25	95
	Aug.	125	.39	49		Aug.	208	.28	58		Aug.	117	.35	41
	Sept.	76	.45	34		Sept.	91	.43	33		Sept.	68	.47	32
	Oct.	64	.62	40		Oct.	81	.53	43		Oct.	66	.55	36
	Nov.	42	.69	29		Nov.	50	.68	34		Nov.	48	.67	32
	Dec.	33	.73	24		Dec.	43	.70	30		Dec.	41	.71	29
	Total	1,150	.45	519		Total	1,972	.36	716		Total	1,548	.38	504
1946	Jan.	32	.75	24	1952	Jan.	41	.63	26	1958	Jan.	33	.76	25
	Feb.	26	.77	20		Feb.	42	.62	26		Feb.	47	.66	31
	Mar.	65	.62	40		Mar.	52	.63	33		Mar.	51	.63	32
	Apr.	131	.48	63		Apr.	190	.52	99		Apr.	99	.56	55
	May	212	.41	87		May	348	.32	111		May	291	.31	90
	June	320	.34	100		June	399	.27	108		June	266	.31	82
	July	153	.35	54		July	171	.33	56		July	76	.45	34
	Aug.	74	.47	35		Aug.	99	.38	38		Aug.	51	.53	27
	Sept.	52	.52	27		Sept.	57	.51	29		Sept.	36	.64	23
	Oct.	58	.64	37		Oct.	42	.64	27		Oct.	33	.79	26
	Nov.	51	.67	34		Nov.	28	.82	23		Nov.	32	.78	25
	Dec.	51	.67	34		Dec.	27	.78	21		Dec.	31	.74	23
	Total	1,225	.46	564		Total	1,496	.40	597		Total	1,046	.45	473

To obtain mg/l multiply T/AP by 735

Table I
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Green River near Green River, Wyoming

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
1959	Jan.	24	.71	17	1965	Jan.	27	.76	20	1971	Jan.	82	.71	30
	Feb.	25	.72	18		Feb.	30	.79	21		Feb.	47	.62	29
	Mar.	49	.65	32		Mar.	30	.71	21		Mar.	76	.50	45
	Apr.	73	.64	47		Apr.	37	.71	27		Apr.	107	.53	57
	May	79	.51	40		May	44	.86	38		May	280	.41	116
	June	322	.26	84		June	94	.60	56		June	480	.30	143
	July	140	.34	48		July	429	.38	163		July	291	.28	81
	Aug.	79	.40	32		Aug.	466	.30	140		Aug.	126	.37	47
	Sept.	42	.55	23		Sept.	174	.36	66		Sept.	77	.46	35
	Oct.	51	.57	29		Oct.	461	.41	189		Oct.	72	.49	35
	Nov.	42	.60	25		Nov.	97	.73	63		Nov.	63	.54	34
	Dec.	27	.74	20		Dec.	75	.65	49		Dec.	87	.51	44
Total	955	.44	415	Total	1,964	.44	861	Total	1,748	.40	696			
1960	Jan.	27	.74	20	1966	Jan.	37	.76	28	1972	Jan.	85	.54	46
	Feb.	23	.79	18		Feb.	35	.77	27		Feb.	77	.56	43
	Mar.	75	.53	40		Mar.	88	.72	63		Mar.	106	.58	62
	Apr.	84	.49	41		Apr.	138	.50	68		Apr.	154	.48	73
	May	66	.48	32		May	160	.39	62		May	294	.40	118
	June	173	.30	52		June	171	.31	53		June	625	.27	169
	July	60	.43	29		July	91	.43	39		July	255	.30	78
	Aug.	38	.45	17		Aug.	56	.52	29		Aug.	122	.39	48
	Sept.	28	.54	15		Sept.	45	.60	27		Sept.	75	.48	36
	Oct.	42	.57	24		Oct.	35	.77	27		Oct.	79	.53	42
	Nov.	47	.49	23		Nov.	30	.83	25		Nov.	85	.51	43
	Dec.	27	.69	19		Dec.	25	.94	24		Dec.	51	.61	31
Total	698	.47	330	Total	911	.52	473	Total	2,008	.39	789			
1961	Jan.	20	.60	12	1967	Jan.	19	1.01	19	1973	Jan.	73	.58	42
	Feb.	19	.58	11		Feb.	19	1.04	20		Feb.	95	.48	46
	Mar.	30	.57	17		Mar.	33	.77	29		Mar.	92	.53	49
	Apr.	50	.60	30		Apr.	129	.54	70		Apr.	110	.60	66
	May	60	.43	26		May	138	.48	66		May	171	.46	78
	June	162	.27	44		June	456	.28	128		June	162	.36	58
	July	47	.43	20		July	448	.25	112		July	127	.40	51
	Aug.	35	.43	15		Aug.	88	.39	34		Aug.	107	.44	47
	Sept.	39	.46	18		Sept.	65	.50	32		Sept.	75	.53	40
	Oct.	43	.51	21		Oct.	62	.56	35		Oct.	67	.57	38
	Nov.	29	.52	15		Nov.	49	.64	31		Nov.	61	.62	38
	Dec.	27	.52	14		Dec.	17	1.07	18		Dec.	53	.62	33
Total	559	.43	243	Total	1,523	.39	594	Total	1,193	.49	586			
1962	Jan.	32	.47	15	1968	Jan.	17	1.03	18	1974	Jan.	78	.56	44
	Feb.	48	.48	23		Feb.	16	1.03	16		Feb.	110	.49	54
	Mar.	77	.51	38		Mar.	32	.66	21		Mar.	114	.57	65
	Apr.	203	.43	87		Apr.	31	.93	29		Apr.	104	.58	60
	May	256	.36	92		May	56	.68	38		May	207	.43	89
	June	355	.27	96		June	271	.40	108		June	346	.31	106
	July	250	.27	68		July	88	.41	36		July	210	.31	65
	Aug.	94	.37	35		Aug.	136	.40	54		Aug.	102	.42	43
	Sept.	38	.58	22		Sept.	126	.37	47		Sept.	53	.60	32
	Oct.	38	.63	24		Oct.	117	.44	51		Oct.	57	.61	35
	Nov.	35	.66	23		Nov.	54	.58	31		Nov.	54	.65	35
	Dec.	25	.88	22		Dec.	30	.85	26		Dec.	59	.63	37
Total	1,451	.38	545	Total	975	.49	482	Total	1,494	.45	665			
1963	Jan.	18	.72	13	1969	Jan.	51	.61	31		Jan.			
	Feb.	18	.72	13		Feb.	89	.46	45		Feb.			
	Mar.	42	.67	28		Mar.	80	.56	45		Mar.			
	Apr.	51	.63	32		Apr.	181	.46	65		Apr.			
	May	100	.45	45		May	207	.36	75		May			
	June	337	.26	88		June	302	.28	86		June			
	July	143	.32	46		July	154	.34	52		July			
	Aug.	76	.47	36		Aug.	97	.47	46		Aug.			
	Sept.	77	.43	33		Sept.	68	.51	35		Sept.			
	Oct.	58	.50	29		Oct.	81	.49	40		Oct.			
	Nov.	52	.60	31		Nov.	50	.60	30		Nov.			
	Dec.	30	.60	18		Dec.	42	.69	29		Dec.			
Total	1,092	.41	412	Total	1,362	.42	575	Total						
1964	Jan.	23	.56	13	1970	Jan.	38	.74	28		Jan.			
	Feb.	22	.59	13		Feb.	33	.76	25		Feb.			
	Mar.	29	.59	17		Mar.	58	.60	35		Mar.			
	Apr.	68	.56	38		Apr.	75	.69	52		Apr.			
	May	138	.32	44		May	84	.58	49		May			
	June	323	.38	123		June	204	.37	75		June			
	July	335	.26	87		July	127	.36	46		July			
	Aug.	87	.39	34		Aug.	86	.43	37		Aug.			
	Sept.	37	.65	24		Sept.	75	.45	34		Sept.			
	Oct.	24	.92	22		Oct.	62	.55	34		Oct.			
	Nov.	25	.88	22		Nov.	49	.67	33		Nov.			
	Dec.	25	.84	21		Dec.	43	.70	30		Dec.			
Total	1,136	.40	458	Total	934	.51	478	Total						

To obtain mg/l multiply T/AF by 735

Table I
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Green River near Green River, Wyoming
 (Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	1,109	0.48	349	527
1942	1,154	.45	330	518
1943	1,680	.38	280	641
1944	1,265	.42	311	536
1945	1,150	.45	332	519
1946	1,225	.46	338	564
1947	1,926	.37	272	714
1948	1,113	.46	337	510
1949	1,205	.45	330	541
1950	2,096	.38	278	792
1951	1,972	.36	267	716
1952	1,496	.40	293	597
1953	1,084	.43	315	465
1954	1,183	.39	287	462
1955	838	.45	334	381
1956	1,621	.38	277	612
1957	1,548	.38	282	594
1958	1,046	.45	332	473
1959	953	.44	320	415
1960	698	.47	347	330
1961	559	.43	319	243
1962	1,451	.38	276	545
1963	1,002	.41	302	412
1964	1,136	.40	296	458
1965	1,964	.44	322	861
1966	911	.52	382	473
1967	1,523	.39	287	594
1968	975	.49	363	482
1969	1,362	.42	310	575
1970	934	.51	376	478

Sampled quality record May 1951 to December 1972; remainder by correlation.

Measured flow record January 1941 to September 1945; and April 1951 to December 1972; remainder by correlation.

Table 2
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Green River near Greendale, Utah

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	27	0.93	25	-1947	Jan.	32	0.81	26	-1953	Jan.	48	0.81	39
	Feb.	25	1.16	29		Feb.	37	.89	33		Feb.	48	.85	41
	Mar.	72	.94	68		Mar.	195	.62	120		Mar.	73	.86	63
	Apr.	131	.56	74		Apr.	136	.62	84		Apr.	96	.75	73
	May	275	.58	160		May	521	.40	210		May	110	.64	70
	June	441	.40	175		June	628	.36	225		June	452	.39	175
	July	171	.55	94		July	372	.35	131		July	198	.39	77
	Aug.	110	.73	80		Aug.	218	.45	99		Aug.	105	.54	57
	Sept.	67	.78	52		Sept.	91	.53	48		Sept.	43	.63	27
	Oct.	94	.97	91		Oct.	90	.70	63		Oct.	35	.89	31
	Nov.	71	.93	66		Nov.	71	.77	55		Nov.	42	.98	41
	Dec.	36	1.19	43		Dec.	56	.87	49		Dec.	32	.97	31
Total	1,521	.63	957	Total	2,447	.47	1,143	Total	1,282	.57	725			
-1942	Jan.	30	1.00	30	-1948	Jan.	47	.91	43	-1954	Jan.	28	1.11	31
	Feb.	31	1.00	31		Feb.	40	.88	35		Feb.	39	.87	34
	Mar.	69	1.07	74		Mar.	102	.79	81		Mar.	62	.81	50
	Apr.	261	.65	170		Apr.	157	.70	110		Apr.	101	.65	66
	May	235	.76	180		May	336	.38	126		May	302	.31	94
	June	434	.44	193		June	454	.36	162		June	223	.36	81
	July	239	.40	97		July	126	.52	63		July	265	.28	73
	Aug.	73	.57	42		Aug.	52	.59	33		Aug.	81	.43	35
	Sept.	40	.72	29		Sept.	33	.78	25		Sept.	45	.69	31
	Oct.	36	1.00	36		Oct.	39	.77	30		Oct.	42	.95	40
	Nov.	35	1.17	41		Nov.	34	.85	29		Nov.	41	.85	35
	Dec.	34	1.06	36		Dec.	31	1.30	31		Dec.	20	1.05	21
Total	1,517	.63	959	Total	1,458	.53	768	Total	1,249	.47	591			
-1943	Jan.	33	1.09	36	-1949	Jan.	31	.90	28	-1955	Jan.	24	.75	18
	Feb.	37	.97	36		Feb.	29	.93	27		Feb.	24	.71	17
	Mar.	96	.74	71		Mar.	73	.89	65		Mar.	44	1.11	49
	Apr.	262	.48	125		Apr.	152	.69	105		Apr.	106	.64	68
	May	328	.38	130		May	310	.53	165		May	168	.52	88
	June	552	.33	182		June	493	.47	230		June	288	.33	95
	July	393	.29	76		July	205	.52	106		July	130	.38	49
	Aug.	163	.47	76		Aug.	72	.61	44		Aug.	80	.52	42
	Sept.	64	.56	36		Sept.	42	.74	31		Sept.	38	.58	22
	Oct.	60	.72	43		Oct.	70	.93	65		Oct.	38	.68	26
	Nov.	54	.83	45		Nov.	66	.97	64		Nov.	36	.75	27
	Dec.	37	.89	33		Dec.	40	.97	39		Dec.	45	.82	37
Total	2,089	.44	928	Total	1,583	.61	969	Total	1,021	.53	538			
-1944	Jan.	30	.93	28	-1950	Jan.	36	1.19	43	-1956	Jan.	50	.86	43
	Feb.	32	1.00	32		Feb.	45	.95	43		Feb.	38	.76	29
	Mar.	48	1.48	71		Mar.	150	.61	92		Mar.	150	.47	70
	Apr.	345	.55	190		Apr.	323	.46	150		Apr.	203	.43	87
	May	245	.58	142		May	416	.46	190		May	368	.39	144
	June	469	.37	174		June	741	.37	275		June	615	.29	178
	July	278	.39	109		July	458	.34	154		July	207	.33	69
	Aug.	76	.49	37		Aug.	153	.51	78		Aug.	104	.42	44
	Sept.	36	.61	22		Sept.	86	.62	53		Sept.	48	.44	21
	Oct.	47	.83	39		Oct.	76	.72	55		Oct.	46	.74	34
	Nov.	39	.92	36		Nov.	80	.75	60		Nov.	39	.82	32
	Dec.	27	.85	23		Dec.	61	.84	51		Dec.	26	.88	23
Total	1,672	.54	903	Total	2,625	.47	1,244	Total	1,894	.41	774			
-1945	Jan.	29	.97	28	-1951	Jan.	45	.80	36	-1957	Jan.	28	.36	24
	Feb.	34	.94	32		Feb.	61	.82	50		Feb.	43	.79	34
	Mar.	65	.88	57		Mar.	93	.78	73		Mar.	66	.91	50
	Apr.	113	.70	79		Apr.	212	.47	100		Apr.	36	.67	56
	May	176	.60	105		May	395	.45	177		May	275	.54	133
	June	310	.46	144		June	626	.36	225		June	685	.37	251
	July	325	.37	120		July	366	.36	132		July	433	.36	155
	Aug.	174	.47	82		Aug.	228	.44	101		Aug.	142	.57	51
	Sept.	103	.43	44		Sept.	98	.56	55		Sept.	82	.59	46
	Oct.	74	.74	55		Oct.	99	.71	70		Oct.	77	.69	53
	Nov.	52	.68	46		Nov.	57	.91	52		Nov.	57	1.00	57
	Dec.	42	.81	34		Dec.	54	.87	47		Dec.	46	.91	42
Total	1,497	.55	826	Total	2,334	.48	1,118	Total	2,020	.50	1,011			
-1946	Jan.	39	.90	35	-1952	Jan.	49	.82	40	-1958	Jan.	43	.77	33
	Feb.	33	.85	28		Feb.	52	.81	42		Feb.	55	.80	44
	Mar.	88	.67	59		Mar.	63	.75	47		Mar.	66	.71	47
	Apr.	237	.48	115		Apr.	318	.62	198		Apr.	134	.67	90
	May	298	.44	130		May	500	.39	235		May	364	.39	151
	June	354	.37	133		June	554	.36	201		June	335	.38	127
	July	162	.40	64		July	295	.56	114		July	87	.50	44
	Aug.	81	.57	46		Aug.	121	.60	72		Aug.	57	.56	38
	Sept.	62	.60	37		Sept.	67	.67	45		Sept.	39	.69	27
	Oct.	68	.76	52		Oct.	49	.86	42		Oct.	30	.72	26
	Nov.	63	.82	52		Nov.	37	1.11	41		Nov.	34	.70	24
	Dec.	62	.77	48		Dec.	34	1.18	40		Dec.	38	.84	32
Total	1,547	.52	799	Total	2,149	.52	1,117	Total	1,310	.51	677			

To obtain mg/l multiply T/A/F by 735.

Table 2
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Green River near Greendale, Utah

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	29	.86	25	-1965	Jan.	216	3.83	136	1971	Jan.	52	.61	34
	Feb.	32	.91	29		Feb.	213	.70	149		Feb.	43	.62	26
	Mar.	65	.92	60		Mar.	233	1.05	245		Mar.	48	.63	30
	Apr.	98	.71	70		Apr.	204	.83	169		Apr.	81	.63	51
	May	115	.57	66		May	66	.80	53		May	90	.66	59
	June	368	.36	132		June	86	.86	74		June	100	.66	66
	July	176	.51	90		July	29	.86	25		July	117	.64	75
	Aug.	93	.47	44		Aug.	31	.87	27		Aug.	151	.65	99
	Sept.	58	.79	46		Sept.	44	.89	39		Sept.	136	.67	91
	Oct.	68	.72	49		Oct.	79	.79	62		Oct.	117	.69	81
	Nov.	51	.76	39		Nov.	120	.73	88		Nov.	171	.66	114
	Dec.	37	.99	37		Dec.	116	.65	75		Dec.	200	.61	123
	Total	1,190	.58	687		Total	1,437	.79	1,140		Total	1,309	.65	849
-1960	Jan.	26	.81	21	-1966	Jan.	72	.64	46	1972	Jan.	170	.59	100
	Feb.	29	.86	25		Feb.	72	.65	47		Feb.	168	.62	104
	Mar.	149	.70	104		Mar.	71	.76	54		Mar.	102	.63	65
	Apr.	140	.55	77		Apr.	130	.79	103		Apr.	140	.65	90
	May	127	.53	74		May	83	.78	65		May	244	.64	156
	June	216	.43	93		June	95	.76	72		June	190	.63	119
	July	78	.49	38		July	104	.75	78		July	181	.62	113
	Aug.	43	.47	20		Aug.	118	.72	85		Aug.	161	.64	104
	Sept.	35	.56	20		Sept.	124	.73	91		Sept.	93	.66	62
	Oct.	49	.65	32		Oct.	124	.77	95		Oct.	195	.67	131
	Nov.	54	.67	36		Nov.	85	.81	69		Nov.	216	.67	144
	Dec.	27	.84	23		Dec.	111	.76	84		Dec.	223	.63	140
	Total	973	.58	563		Total	1,189	.75	889		Total	2,083	.64	1,328
-1961	Jan.	27	.73	20	-1967	Jan.	142	.74	105	1973	Jan.	220	.63	138
	Feb.	27	.77	21		Feb.	96	.75	72		Feb.	203	.65	131
	Mar.	64	.86	55		Mar.	67	.77	52		Mar.	113	.69	78
	Apr.	76	.69	52		Apr.	85	.81	69		Apr.	62	.76	47
	May	79	.59	47		May	122	.83	101		May	160	.71	114
	June	192	.32	61		June	195	.83	162		June	188	.72	136
	July	56	.44	25		July	171	.85	145		July	166	.68	113
	Aug.	43	.58	25		Aug.	188	.86	162		Aug.	211	.65	137
	Sept.	55	.68	37		Sept.	180	.82	148		Sept.	150	.65	98
	Oct.	64	.70	45		Oct.	188	.87	164		Oct.	148	.66	98
	Nov.	54	.70	38		Nov.	173	.85	147		Nov.	154	.66	102
	Dec.	44	.78	34		Dec.	197	.72	142		Dec.	156	.63	98
	Total	781	.59	460		Total	1804	.81	1469		Total	1,931	.67	1,290
-1962	Jan.	43	.65	28	-1968	Jan.	187	.70	131	1974	Jan.	127	.64	81
	Feb.	83	.81	67		Feb.	123	.72	89		Feb.	45	.67	30
	Mar.	150	.84	126		Mar.	76	.83	63		Mar.	51	.71	36
	Apr.	374	.55	206		Apr.	96	.88	86		Apr.	60	.73	44
	May	394	.41	162		May	119	.81	96		May	183	.71	130
	June	456	.40	182		June	97	.77	75		June	132	.67	89
	July	297	.39	119		July	198	.75	148		July	87	.68	59
	Aug.	109	.48	52		Aug.	200	.75	150		Aug.	137	.69	95
	Sept.	44	.64	28		Sept.	181	.75	136		Sept.	141	.70	98
	Oct.	48	.79	38		Oct.	140	.73	102		Oct.	180	.73	131
	Nov.	5	.80	4		Nov.	137	.68	93		Nov.	147	.71	105
	Dec.	16	.94	15		Dec.	137	.68	93		Dec.	148	.68	101
	Total	2,019	.51	1,024		Total	1,691	.75	1,260		Total	1,438	.69	999
-1963	Jan.	23	.91	21	-1969	Jan.	183	.70	128	1975	Jan.			
	Feb.	26	.92	24		Feb.	219	.73	160		Feb.			
	Mar.	6	.83	5		Mar.	166	.74	123		Mar.			
	Apr.	8	.87	7		Apr.	150	.78	117		Apr.			
	May	7	.87	7		May	191	.78	149		May			
	June	7	.86	6		June	108	.74	80		June			
	July	6	.83	5		July	158	.74	117		July			
	Aug.	6	.83	5		Aug.	194	.72	140		Aug.			
	Sept.	7	.86	6		Sept.	145	.72	119		Sept.			
	Oct.	8	.87	7		Oct.	129	.69	89		Oct.			
	Nov.	19	.58	11		Nov.	129	.63	81		Nov.			
	Dec.	46	.63	29		Dec.	96	.62	122		Dec.			
	Total	170	.78	133		Total	1,988	.72	1,425		Total			
-1964	Jan.	58	.57	33	-1970	Jan.	101	.62	63	1976	Jan.			
	Feb.	56	.57	32		Feb.	78	.62	48		Feb.			
	Mar.	37	.59	22		Mar.	81	.64	52		Mar.			
	Apr.	35	.63	22		Apr.	109	.66	72		Apr.			
	May	91	.64	58		May	64	.67	43		May			
	June	26	.60	52		June	87	.67	58		June			
	July	150	.61	92		July	119	.65	77		July			
	Aug.	122	.61	74		Aug.	127	.68	83		Aug.			
	Sept.	131	.61	80		Sept.	117	.70	82		Sept.			
	Oct.	159	.64	102		Oct.	69	.71	42		Oct.			
	Nov.	139	.60	83		Nov.	85	.68	45		Nov.			
	Dec.	194	.62	120		Dec.	80	.63	57		Dec.			
	Total	1,258	.61	770		Total	1,088	.66	711		Total			

To obtain mg/l multiply T/AP by .35.

Table 2
Colorado River Basin
Historical Flow and Quality of Water Data
Green River near Greendale, Utah
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	1,521	0.63	462	957
1942	1,517	.63	465	959
1943	2,089	.44	327	928
1944	1,672	.54	397	903
1945	1,497	.55	406	826
1946	1,547	.52	380	799
1947	2,447	.47	343	1,143
1948	1,458	.53	387	768
1949	1,583	.61	450	969
1950	2,625	.47	348	1,244
1951	2,334	.48	352	1,118
1952	2,149	.52	382	1,117
1953	1,282	.57	416	725
1954	1,249	.47	348	591
1955	1,021	.53	387	538
1956	1,894	.41	300	774
1957	2,020	.50	368	1,011
1958	1,310	.52	380	677
1959	1,190	.58	424	687
1960	973	.58	425	563
1961	781	.59	433	460
1962	2,019	.51	373	1,024
1963	170	.78	575	133
1964	1,258	.61	450	770
1965	1,437	.79	584	1,142
1966	1,189	.75	550	889
1967	1,804	.81	599	1,469
1968	1,691	.75	548	1,260
1969	1,988	.72	526	1,425
1970	1,088	.66	483	718

Sampled quality record October 1956 to December 1978 (fragmentary); remainder by correlation.
Measured flow record entire period.

Table 3
Colorado River Basin
Historical Flow and Quality of Water Data
Duchesne River near Randlett, Utah

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
1941	Jan.	25	1.12	28	1947	Jan.	26	1.07	29	1953	Jan.	30	0.90	35
	Feb.	24	1.29	31		Feb.	26	1.08	30		Feb.	33	1.32	37
	Mar.	21	1.71	36		Mar.	36	1.27	46		Mar.	34	1.51	42
	Apr.	20	1.50	30		Apr.	23	1.30	30		Apr.	13	1.77	23
	May	55	.50	78		May	143	.53	76		May	15	1.60	24
	June	232	.38	88		June	152	.49	72		June	107	.60	64
	July	35	1.11	39		July	33	1.18	39		July	13	1.77	23
	Aug.	12	1.50	27		Aug.	25	1.22	32		Aug.	12	1.75	21
	Sept.	15	1.60	24		Sept.	12	1.75	21		Sept.	5	2.20	11
	Oct.	54	.23	50		Oct.	17	1.65	22		Oct.	9	2.00	18
	Nov.	51	.20	46		Nov.	29	1.21	35		Nov.	20	1.40	22
	Dec.	44	1.04	46		Dec.	31	1.19	37		Dec.	26	1.31	34
	Total	694	.75	523		Total	569	.86	489		Total	326	1.12	366
1942	Jan.	40	.90	36	1948	Jan.	29	1.00	29	1954	Jan.	27	1.11	30
	Feb.	39	1.00	39		Feb.	26	1.21	34		Feb.	25	1.22	32
	Mar.	39	1.23	42		Mar.	40	1.20	42		Mar.	20	1.50	36
	Apr.	50	.90	45		Apr.	31	1.23	32		Apr.	13	1.77	23
	May	63	.72	60		May	70	.79	55		May	36	1.11	40
	June	171	.46	79		June	51	.92	47		June	5	2.40	12
	July	23	1.43	33		July	3	3.00	9		July	2	3.00	6
	Aug.	5	2.12	17		Aug.	2	3.50	7		Aug.	1	4.00	4
	Sept.	5	2.40	12		Sept.	1	3.00	3		Sept.	6	2.33	14
	Oct.	12	1.50	27		Oct.	5	2.40	12		Oct.	17	1.52	27
	Nov.	22	1.41	31		Nov.	14	1.71	24		Nov.	18	1.50	27
	Dec.	22	1.22	36		Dec.	26	1.27	33		Dec.	12	1.50	27
	Total	526	.82	463		Total	298	1.14	339		Total	182	1.42	272
1943	Jan.	26	1.12	29	1949	Jan.	24	1.02	26	1955	Jan.	25	1.08	27
	Feb.	29	1.17	34		Feb.	23	1.30	30		Feb.	21	1.43	30
	Mar.	29	1.51	44		Mar.	44	1.20	53		Mar.	34	1.33	47
	Apr.	43	1.00	43		Apr.	46	.92	45		Apr.	22	1.41	31
	May	100	.64	64		May	127	.56	71		May	45	1.00	45
	June	103	.62	64		June	230	.39	90		June	34	1.09	37
	July	27	1.21	34		July	50	.94	47		July	2	3.00	6
	Aug.	23	1.32	32		Aug.	7	2.14	15		Aug.	2	2.25	17
	Sept.	2	2.00	16		Sept.	8	2.13	17		Sept.	4	2.50	10
	Oct.	22	1.40	31		Oct.	25	1.22	32		Oct.	6	2.33	14
	Nov.	24	1.22	31		Nov.	29	1.21	35		Nov.	15	1.60	24
	Dec.	25	1.22	32		Dec.	28	1.22	36		Dec.	29	1.21	35
	Total	466	.99	454		Total	641	.72	497		Total	245	1.32	323
1944	Jan.	23	1.02	25	1950	Jan.	31	1.00	31	1956	Jan.	27	1.00	27
	Feb.	26	1.31	34		Feb.	26	1.23	32		Feb.	23	1.35	31
	Mar.	43	1.20	52		Mar.	40	1.30	52		Mar.	25	1.60	40
	Apr.	47	.94	45		Apr.	44	1.00	44		Apr.	17	1.59	27
	May	122	.57	73		May	97	.67	65		May	74	.76	56
	June	255	.37	94		June	193	.43	83		June	90	.62	61
	July	22	.72	59		July	45	1.00	45		July	1	2.75	11
	Aug.	7	2.00	16		Aug.	9	2.00	18		Aug.	2	4.00	2
	Sept.	7	2.14	15		Sept.	13	1.77	23		Sept.	1	5.00	5
	Oct.	24	1.37	32		Oct.	16	1.56	25		Oct.	4	2.25	9
	Nov.	26	1.30	34		Nov.	27	1.26	34		Nov.	17	1.59	27
	Dec.	22	1.32	37		Dec.	33	1.36	45		Dec.	19	1.21	23
	Total	668	.74	517		Total	574	.87	497		Total	303	1.07	325
1945	Jan.	30	1.00	30	1951	Jan.	26	1.00	26	1957	Jan.	21	1.05	22
	Feb.	27	1.12	32		Feb.	26	1.31	34		Feb.	20	1.05	21
	Mar.	32	1.40	45		Mar.	23	1.56	36		Mar.	22	1.54	34
	Apr.	24	1.29	31		Apr.	14	1.71	24		Apr.	12	1.23	22
	May	59	.86	51		May	70	.75	59		May	39	1.23	42
	June	91	.67	61		June	124	.73	91		June	184	.41	75
	July	30	1.23	37		July	31	1.29	40		July	35	.91	32
	Aug.	21	1.19	37		Aug.	26	1.46	38		Aug.	12	1.61	29
	Sept.	12	1.75	21		Sept.	10	1.90	19		Sept.	15	1.47	22
	Oct.	23	1.38	29		Oct.	25	1.22	32		Oct.	19	1.75	33
	Nov.	29	1.27	33		Nov.	32	1.22	39		Nov.	41	1.41	52
	Dec.	24	1.37	33		Dec.	32	1.22	39		Dec.	30	1.07	32
	Total	407	1.02	440		Total	448	1.06	477		Total	456	.94	422
1946	Jan.	23	1.13	26	1952	Jan.	28	1.07	30	1958	Jan.	29	.83	24
	Feb.	21	1.32	29		Feb.	26	1.31	34		Feb.	31	1.00	31
	Mar.	29	1.41	41		Mar.	31	1.42	44		Mar.	35	1.37	48
	Apr.	46	1.00	40		Apr.	111	.60	67		Apr.	29	1.07	31
	May	70	.72	55		May	304	.34	103		May	141	.46	65
	June	47	.95	45		June	302	.33	100		June	103	.42	43
	July	5	2.60	13		July	70	.79	55		July	4	2.50	10
	Aug.	6	2.33	14		Aug.	49	.94	46		Aug.	1	4.00	4
	Sept.	4	2.75	11		Sept.	30	1.20	36		Sept.	3	2.33	7
	Oct.	17	1.53	26		Oct.	23	1.32	29		Oct.	5	2.60	13
	Nov.	32	1.22	39		Nov.	26	1.31	34		Nov.	14	1.93	27
	Dec.	30	1.20	36		Dec.	37	1.11	41		Dec.	21	1.24	26
	Total	324	1.16	375		Total	1,035	.60	619		Total	416	.79	329

To obtain T/A multiply T/A/F by 735

Table 3
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Duchesne River near Randlett, Utah

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
1959	Jan.	26	1.21	25	1965	Jan.	27	1.00	27	1971	Jan.	23	1.04	24
	Feb.	24	1.04	25		Feb.	21	1.20	29		Feb.	31	1.09	34
	Mar.	17	1.29	22		Mar.	26	1.54	40		Mar.	20	1.04	21
	Apr.	5	2.00	10		Apr.	32	1.26	37		Apr.	12	1.62	19
	May	4	2.75	11		May	21	1.11	29		May	28	1.16	32
	June	24	1.75	29		June	302	1.10	148		June	140	1.49	68
	July	6	2.00	12		July	175	1.51	80		July	19	1.27	25
	Aug.	4	2.75	11		Aug.	57	1.26	58		Aug.	4	2.30	8
	Sept.	4	3.50	10		Sept.	58	1.09	63		Sept.	9	1.92	16
	Oct.	11	2.54	17		Oct.	17	1.45	54		Oct.	20	1.76	36
	Nov.	13	1.54	20		Nov.	17	1.15	54		Nov.	28	1.66	47
	Dec.	22	1.22	29		Dec.	42	1.12	47		Dec.	26	1.24	32
Total	166	1.23	201	Total	905	1.20	721	Total	360	1.01	362			
1960	Jan.	23	.87	20	1966	Jan.	30	.90	35	1972	Jan.	24	.97	24
	Feb.	23	.73	19		Feb.	38	.74	28		Feb.	35	1.21	32
	Mar.	27	1.15	31		Mar.	47	1.02	48		Mar.	37	1.10	41
	Apr.	9	1.52	13		Apr.	35	1.20	42		Apr.	13	1.54	19
	May	18	1.47	21		May	58	2.07	62		May	37	.97	32
	June	23	.91	21		June	16	1.81	29		June	116	1.51	60
	July	1	4.00	4		July	3	2.00	9		July	6	1.83	11
	Aug.	1	4.00	4		Aug.	3	2.00	9		Aug.	3	2.49	8
	Sept.	1	4.00	4		Sept.	6	2.50	15		Sept.	5	2.54	12
	Oct.	5	2.40	12		Oct.	11	2.36	26		Oct.	22	1.70	38
	Nov.	12	1.53	19		Nov.	19	1.70	24		Nov.	31	1.31	41
	Dec.	18	1.23	24		Dec.	31	1.35	42		Dec.	37	.92	34
Total	160	1.20	192	Total	306	1.24	379	Total	366	.96	352			
1961	Jan.	21	1.19	25	1967	Jan.	33	1.01	33	1973	Jan.	32	.97	31
	Feb.	19	1.47	28		Feb.	30	1.28	29		Feb.	29	1.00	29
	Mar.	10	1.50	15		Mar.	41	1.44	50		Mar.	58	1.22	71
	Apr.	2	3.50	7		Apr.	19	1.71	22		Apr.	49	1.24	61
	May	3	2.33	7		May	56	1.82	16		May	126	.57	72
	June	3	2.77	8		June	253	1.45	114		June	138	.49	67
	July	1	4.00	4		July	76	1.70	53		July	31	1.19	37
	Aug.	1	3.00	3		Aug.	11	1.82	21		Aug.	13	1.62	21
	Sept.	13	1.15	15		Sept.	10	2.05	20		Sept.	17	1.47	25
	Oct.	19	1.47	28		Oct.	12	2.17	26		Oct.	20	1.45	29
	Nov.	27	1.11	30		Nov.	18	1.74	21		Nov.	25	1.28	32
	Dec.	26	1.00	26		Dec.	32	1.02	33		Dec.	28	.89	25
Total	145	1.35	196	Total	591	1.24	497	Total	566	.88	500			
1962	Jan.	21	.81	17	1968	Jan.	34	.85	29	1974	Jan.	28	.82	23
	Feb.	43	.93	40		Feb.	34	1.12	38		Feb.	28	1.75	21
	Mar.	49	1.04	51		Mar.	40	1.49	60		Mar.	41	1.02	42
	Apr.	70	.69	48		Apr.	21	1.62	50		Apr.	19	1.16	22
	May	88	.64	56		May	45	1.14	51		May	61	.66	40
	June	146	.47	69		June	250	1.40	100		June	55	1.56	31
	July	27	1.04	28		July	24	1.23	30		July	13	1.46	19
	Aug.	4	2.75	11		Aug.	26	1.40	36		Aug.	13	1.46	19
	Sept.	4	2.50	10		Sept.	13	1.91	25		Sept.	5	2.00	10
	Oct.	15	1.73	26		Oct.	20	1.77	35		Oct.	6	2.33	14
	Nov.	15	1.60	24		Nov.	27	1.45	39		Nov.	7	2.57	18
	Dec.	23	1.26	29		Dec.	38	1.03	39		Dec.	8	1.25	10
Total	505	.81	409	Total	582	.91	532	Total	284	.95	269			
1963	Jan.	18	1.17	21	1969	Jan.	42	.88	37		Jan.			
	Feb.	29	1.14	33		Feb.	37	.93	34		Feb.			
	Mar.	10	1.20	19		Mar.	52	1.16	60		Mar.			
	Apr.	5	3.20	16		Apr.	69	.89	61		Apr.			
	May	31	.97	30		May	183	.43	79		May			
	June	50	.76	38		June	139	.75	104		June			
	July	3	2.67	8		July	17	1.60	27		July			
	Aug.	5	2.40	12		Aug.	9	2.26	20		Aug.			
	Sept.	14	1.64	23		Sept.	10	2.27	23		Sept.			
	Oct.	7	2.43	17		Oct.	20	1.65	33		Oct.			
	Nov.	16	1.62	26		Nov.	22	1.45	32		Nov.			
	Dec.	22	1.14	25		Dec.	20	1.05	21		Dec.			
Total	210	1.28	268	Total	620	.86	531	Total						
1964	Jan.	18	1.00	18	1970	Jan.	14	1.07	15		Jan.			
	Feb.	18	.95	17		Feb.	17	1.12	19		Feb.			
	Mar.	23	1.09	24		Mar.	10	1.60	16		Mar.			
	Apr.	14	1.57	22		Apr.	3	2.67	8		Apr.			
	May	72	.68	49		May	17	1.24	21		May			
	June	122	.66	81		June	58	1.29	75		June			
	July	29	.97	28		July	9	1.67	15		July			
	Aug.	6	2.17	13		Aug.	3	2.33	7		Aug.			
	Sept.	4	2.75	11		Sept.	5	2.20	11		Sept.			
	Oct.	5	2.80	14		Oct.	9	2.22	20		Oct.			
	Nov.	18	1.67	30		Nov.	11	1.82	20		Nov.			
	Dec.	27	1.26	34		Dec.	7	2.14	15		Dec.			
Total	356	.96	341	Total	163	1.48	242	Total						

To obtain mg/l multiply T/AF by 735

Table 3
Colorado River Basin
Historical Flow and Quality of Water Data
Duchesne River near Randlett, Utah
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	694	0.75	554	523
1942	526	.88	647	463
1943	460	.99	725	454
1944	698	.74	544	517
1945	407	1.08	795	440
1946	324	1.16	851	375
1947	569	.86	632	489
1948	298	1.14	836	339
1949	641	.78	570	497
1950	574	.87	636	497
1951	448	1.06	783	477
1952	1,035	.60	440	619
1953	326	1.12	825	366
1954	188	1.48	1,087	278
1955	245	1.32	969	323
1956	303	1.07	788	325
1957	456	.94	690	428
1958	416	.79	581	329
1959	166	1.33	979	221
1960	160	1.20	882	192
1961	145	1.35	994	196
1962	505	.81	595	409
1963	210	1.28	938	268
1964	356	.96	704	341
1965	905	.80	586	721
1966	306	1.24	910	379
1967	591	.84	618	497
1968	582	.91	672	532
1969	620	.86	629	531
1970	163	1.48	1,091	242

Sampled quality record December 1950 to September 1951; November 1956 to December 1972; remainder by correlation.

Measured flow record October 1942 to December 1972; remainder by correlation.

Table 4
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Green River at Green River, Utah

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	100	1.01	101	-1947	Jan.	92	1.07	98	-1953	Jan.	140	1.05	147
	Feb.	126	1.06	134		Feb.	151	.96	130		Feb.	141	1.04	147
	Mar.	216	1.01	218		Mar.	411	.79	325		Mar.	217	1.00	217
	Apr.	314	.75	235		Apr.	422	.59	249		Apr.	221	.96	212
	May	1,172	.55	621		May	1,400	.38	532		May	454	.55	250
	June	1,146	.44	562		June	1,348	.39	526		June	1,167	.37	432
	July	359	.63	226		July	656	.40	262		July	376	.48	181
	Aug.	267	1.09	291		Aug.	365	.71	259		Aug.	232	.84	178
	Sept.	182	1.01	184		Sept.	166	.77	128		Sept.	87	.99	86
	Oct.	318	1.00	318		Oct.	181	.91	165		Oct.	86	1.20	104
	Nov.	240	.90	216		Nov.	179	.91	163		Nov.	126	1.15	145
	Dec.	168	.96	165		Dec.	152	1.01	154		Dec.	107	1.18	126
Total	4,608	.71	3,271	Total	5,523	.54	2,991	Total	3,334	.67	2,225			
-1942	Jan.	112	1.04	117	-1948	Jan.	141	.94	132	-1954	Jan.	107	1.09	117
	Feb.	122	.96	120		Feb.	136	.91	124		Feb.	138	1.03	142
	Mar.	264	.94	248		Mar.	313	.86	269		Mar.	169	1.03	174
	Apr.	858	.65	557		Apr.	558	.69	385		Apr.	270	.75	202
	May	980	.57	558		May	1,061	.39	414		May	639	.38	243
	June	1,271	.39	495		June	952	.34	324		June	376	.45	166
	July	414	.57	236		July	268	.54	145		July	346	.46	159
	Aug.	152	.85	129		Aug.	137	.81	111		Aug.	120	.65	78
	Sept.	91	1.10	100		Sept.	69	.81	56		Sept.	134	1.02	137
	Oct.	118	1.20	142		Oct.	92	1.02	94		Oct.	139	1.14	159
	Nov.	124	1.16	146		Nov.	104	1.05	109		Nov.	120	1.06	127
	Dec.	116	1.22	141		Dec.	97	1.10	107		Dec.	80	1.25	100
Total	4,622	.65	2,989	Total	3,928	.58	2,270	Total	2,638	.68	1,807			
-1943	Jan.	112	1.13	127	-1949	Jan.	100	1.01	101	-1955	Jan.	80	1.06	85
	Feb.	130	1.02	132		Feb.	110	.92	101		Feb.	86	.92	79
	Mar.	236	.91	215		Mar.	276	.92	251		Mar.	237	.97	218
	Apr.	569	.57	325		Apr.	474	.69	327		Apr.	311	.72	230
	May	763	.39	298		May	1,221	.43	525		May	678	.39	264
	June	1,074	.40	430		June	1,547	.42	650		June	654	.36	236
	July	612	.43	263		July	592	.57	338		July	223	.46	102
	Aug.	300	.83	249		Aug.	172	.77	132		Aug.	161	.83	134
	Sept.	116	.98	114		Sept.	112	.89	100		Sept.	71	.93	66
	Oct.	124	1.10	136		Oct.	207	.98	203		Oct.	77	1.08	83
	Nov.	146	1.04	152		Nov.	190	.90	171		Nov.	86	1.13	97
	Dec.	112	1.11	124		Dec.	128	1.07	137		Dec.	127	1.02	130
Total	4,294	.60	2,565	Total	5,129	.59	3,039	Total	2,791	.62	1,733			
-1944	Jan.	80	1.20	96	-1950	Jan.	141	1.01	142	-1956	Jan.	155	.91	141
	Feb.	111	1.06	118		Feb.	147	1.01	148		Feb.	100	1.05	105
	Mar.	253	1.07	271		Mar.	356	.90	321		Mar.	314	.81	255
	Apr.	529	.81	408		Apr.	620	.64	397		Apr.	460	.53	244
	May	924	.48	444		May	1,026	.53	544		May	995	.35	348
	June	1,391	.30	417		June	1,567	.35	548		June	1,207	.32	386
	July	591	.44	260		July	734	.49	360		July	294	.49	144
	Aug.	143	.73	104		Aug.	246	.63	155		Aug.	169	.67	113
	Sept.	73	.92	70		Sept.	149	.89	133		Sept.	72	.72	52
	Oct.	115	1.13	130		Oct.	153	.96	147		Oct.	77	.94	73
	Nov.	119	1.14	136		Nov.	162	.99	164		Nov.	99	1.02	101
	Dec.	89	1.23	108		Dec.	171	.96	164		Dec.	79	1.05	83
Total	4,417	.58	2,582	Total	5,476	.59	3,223	Total	4,021	.51	2,045			
-1945	Jan.	109	1.04	113	-1951	Jan.	113	1.13	128	-1957	Jan.	83	.95	79
	Feb.	128	.99	127		Feb.	167	.92	154		Feb.	100	.94	94
	Mar.	185	1.03	191		Mar.	204	.93	190		Mar.	237	.89	210
	Apr.	291	.84	244		Apr.	372	.70	260		Apr.	230	.71	212
	May	909	.44	400		May	882	.45	397		May	913	.48	438
	June	1,016	.39	396		June	1,309	.40	524		June	1,871	.34	636
	July	701	.41	287		July	627	.43	270		July	1,164	.34	396
	Aug.	335	.74	248		Aug.	379	.69	261		Aug.	366	.79	305
	Sept.	163	.77	125		Sept.	178	.79	140		Sept.	202	.76	153
	Oct.	161	.99	159		Oct.	211	.99	209		Oct.	185	.94	174
	Nov.	149	.99	148		Nov.	164	1.05	172		Nov.	228	.96	219
	Dec.	113	1.06	120		Dec.	132	1.07	142		Dec.	149	.97	144
Total	4,260	.60	2,558	Total	4,738	.60	2,847	Total	5,808	.53	3,060			
-1946	Jan.	123	.95	117	-1952	Jan.	135	1.01	136	-1958	Jan.	128	.93	119
	Feb.	117	.91	106		Feb.	140	.96	134		Feb.	184	.86	158
	Mar.	236	.90	212		Mar.	160	1.05	168		Mar.	246	.92	227
	Apr.	528	.60	317		Apr.	988	.88	869		Apr.	432	.71	307
	May	775	.41	318		May	2,087	.48	1,002		May	1,311	.41	537
	June	746	.36	269		June	1,809	.36	651		June	1,174	.35	411
	July	264	.47	124		July	514	.60	309		July	224	.62	139
	Aug.	152	.84	128		Aug.	315	.89	280		Aug.	110	.82	91
	Sept.	105	.91	96		Sept.	184	.96	177		Sept.	96	1.07	103
	Oct.	149	1.09	149		Oct.	129	1.09	140		Oct.	91	1.01	92
	Nov.	170	.98	167		Nov.	122	1.24	151		Nov.	102	1.10	113
	Dec.	154	.94	145		Dec.	129	1.20	155		Dec.	114	1.09	124
Total	3,519	.61	2,148	Total	6,712	.62	4,177	Total	4,213	.57	2,421			

To obtain mg/l multiply T/AF by 735.

Table 4
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Green River at Green River, Utah

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	97	1.13	110	-1965	Jan.	300	0.73	219	1971	Jan.	154	.84	129
	Feb.	114	.95	108		Feb.	303	.82	248		Feb.	165	.80	132
	Mar.	146	.94	137		Mar.	361	.88	318		Mar.	202	.80	162
	Apr.	219	.76	166		Apr.	518	.79	409		Apr.	479	.54	259
	May	480	.42	202		May	819	.46	377		May	714	.38	272
	June	763	.34	259		June	1,207	.42	507		June	1,060	.29	311
	July	346	.51	176		July	546	.52	284		July	397	.46	183
	Aug.	179	.90	161		Aug.	228	.94	214		Aug.	197	.82	162
	Sept.	104	.92	96		Sept.	189	.95	180		Sept.	210	.92	193
	Oct.	178	.86	153		Oct.	253	.85	215		Oct.	211	.96	203
	Nov.	152	.83	126		Nov.	239	.92	220		Nov.	263	.92	241
	Dec.	106	1.02	108		Dec.	248	.89	221		Dec.	267	.80	214
	Total	2,884	.62	1,802		Total	5,211	.65	3,412		Total	4,319	.57	2,461
-1960	Jan.	95	1.05	100	-1966	Jan.	181	.86	156	1972	Jan.	272	.79	215
	Feb.	102	.95	97		Feb.	166	.80	133		Feb.	303	.73	222
	Mar.	320	.83	266		Mar.	393	.80	314		Mar.	323	.72	232
	Apr.	534	.51	272		Apr.	390	.66	257		Apr.	324	.63	204
	May	551	.39	215		May	566	.48	272		May	635	.43	273
	June	683	.33	225		June	325	.55	179		June	834	.35	292
	July	170	.52	88		July	147	.85	125		July	246	.60	148
	Aug.	69	.76	52		Aug.	147	.96	141		Aug.	202	.73	147
	Sept.	59	.93	55		Sept.	157	1.01	159		Sept.	123	.92	114
	Oct.	92	1.00	96		Oct.	189	1.01	191		Oct.	303	.90	274
	Nov.	105	.90	94		Nov.	159	1.06	169		Nov.	340	.83	282
	Dec.	80	1.02	85		Dec.	146	1.12	166		Dec.	277	.81	223
	Total	2,864	.57	1,645		Total	2,966	.76	2,260		Total	4,182	.63	2,626
-1961	Jan.	79	.98	77	-1967	Jan.	196	.88	172	1973	Jan.	264	.77	202
	Feb.	94	.87	82		Feb.	169	.90	152		Feb.	265	.76	201
	Mar.	136	.89	121		Mar.	256	.95	243		Mar.	342	.96	330
	Apr.	184	.79	145		Apr.	260	.77	200		Apr.	303	.95	287
	May	342	.41	140		May	504	.54	272		May	1,168	.42	491
	June	542	.31	168		June	1,134	.32	520		June	1,069	.39	415
	July	112	.49	55		July	508	.63	320		July	521	.62	323
	Aug.	80	.91	73		Aug.	247	.99	245		Aug.	303	.80	242
	Sept.	175	.99	173		Sept.	231	1.06	245		Sept.	233	.91	213
	Oct.	234	.75	176		Oct.	250	1.07	268		Oct.	231	.94	217
	Nov.	161	.80	129		Nov.	243	1.03	250		Nov.	255	.89	227
	Dec.	126	.88	111		Dec.	229	1.31	300		Dec.	239	.85	204
	Total	2,265	.64	1,450		Total	4,227	.77	3,257		Total	5,193	.65	3,352
-1962	Jan.	115	.79	91	-1968	Jan.	249	.87	217	1974	Jan.	231	.84	195
	Feb.	403	.72	290		Feb.	196	.91	178		Feb.	150	.87	131
	Mar.	401	.95	381		Mar.	241	1.05	253		Mar.	300	.87	262
	Apr.	1,093	.56	612		Apr.	275	.94	258		Apr.	357	.83	297
	May	1,350	.36	486		May	708	.58	411		May	1,179	.34	399
	June	1,074	.38	408		June	1,248	.35	437		June	892	.31	275
	July	598	.41	245		July	426	.65	277		July	269	.62	167
	Aug.	177	.61	108		Aug.	345	1.02	352		Aug.	192	.83	159
	Sept.	98	.98	96		Sept.	241	.93	224		Sept.	173	.86	149
	Oct.	126	1.37	173		Oct.	230	.99	278		Oct.	228	.94	215
	Nov.	94	1.15	108		Nov.	221	.93	206		Nov.	233	.98	229
	Dec.	72	1.10	79		Dec.	208	.88	184		Dec.	205	.96	196
	Total	5,601	.55	3,077		Total	4,589	.78	3,225		Total	4,409	.61	2,674
-1963	Jan.	71	1.04	74	-1969	Jan.	282	.81	228		Jan.			
	Feb.	120	.93	112		Feb.	313	.82	257		Feb.			
	Mar.	99	1.00	99		Mar.	354	.94	333		Mar.			
	Apr.	154	.88	105		Apr.	658	.69	454		Apr.			
	May	399	.40	160		May	1,095	.45	493		May			
	June	310	.42	130		June	684	.54	369		June			
	July	51	.77	39		July	358	.59	211		July			
	Aug.	72	1.77	127		Aug.	270	.96	259		Aug.			
	Sept.	95	1.57	149		Sept.	246	.97	239		Sept.			
	Oct.	47	1.32	62		Oct.	255	.95	242		Oct.			
	Nov.	74	1.26	93		Nov.	236	.88	208		Nov.			
	Dec.	84	1.08	91		Dec.	271	.83	225		Dec.			
	Total	1,576	.79	1,241		Total	5,022	.70	3,518		Total			
-1964	Jan.	109	.76	83	-1970	Jan.	191	.84	160		Jan.			
	Feb.	114	.76	87		Feb.	175	.87	152		Feb.			
	Mar.	128	.87	111		Mar.	194	.89	173		Mar.			
	Apr.	190	.89	169		Apr.	249	.86	214		Apr.			
	May	634	.45	285		May	867	.38	329		May			
	June	725	.40	290		June	1,019	.40	408		June			
	July	344	.54	186		July	420	.52	218		July			
	Aug.	196	.93	182		Aug.	212	.80	170		Aug.			
	Sept.	139	.82	114		Sept.	179	.93	166		Sept.			
	Oct.	192	.78	153		Oct.	174	.94	164		Oct.			
	Nov.	292	.84	168		Nov.	159	1.12	178		Nov.			
	Dec.	267	.81	216		Dec.	145	.95	138		Dec.			
	Total	3,243	.63	2,044		Total	3,984	.62	2,470		Total			

To obtain mg/l multiply T/AF by 735.

Table 4
Colorado River Basin
Historical Flow and Quality of Water Data
Green River at Green River, Utah
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S., 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	4,608	0.71	522	3,271
1942	4,622	.65	475	2,989
1943	4,294	.60	439	2,565
1944	4,417	.58	430	2,582
1945	4,260	.60	441	2,558
1946	3,519	.61	449	2,148
1947	5,523	.54	398	2,991
1948	3,928	.58	425	2,270
1949	5,129	.59	435	3,039
1950	5,476	.59	433	3,223
1951	4,738	.60	442	2,847
1952	6,712	.62	457	4,172
1953	3,334	.67	491	2,225
1954	2,638	.68	503	1,807
1955	2,791	.62	456	1,733
1956	4,021	.51	374	2,045
1957	5,808	.53	387	3,060
1958	4,212	.57	422	2,421
1959	2,884	.62	459	1,802
1960	2,864	.57	422	1,645
1961	2,265	.64	471	1,450
1962	5,601	.55	404	3,077
1963	1,576	.79	579	1,241
1964	3,242	.63	463	2,044
1965	5,211	.65	481	3,412
1966	2,966	.76	560	2,260
1967	4,227	.77	566	3,257
1968	4,589	.70	517	3,225
1969	5,022	.70	515	3,518
1970	3,984	.62	456	2,470

Sampled quality record entire period.
Measured flow record entire period.

Table 5
 Colorado River Basin
 Historical Flow and Quality of Water Data
 San Rafael River near Green River, Utah

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	2	4.0	8	-1947	Jan.	2	4.5	9	-1953	Jan.	6	2.8	17
	Feb.	2	4.0	8		Feb.	5	3.0	15		Feb.	7	3.1	22
	Mar.	6	3.5	21		Mar.	4	3.8	15		Mar.	6	3.2	19
	Apr.	1	4.0	4		Apr.	3	4.3	13		Apr.	3	4.2	13
	May	50	1.2	62		May	33	1.4	46		May	2	5.2	11
	June	49	1.2	59		June	26	1.8	47		June	31	1.5	47
	July	7	2.9	20		July	5	3.6	18		July	5	3.8	19
	Aug.	6	4.5	20		Aug.	20	3.4	68		Aug.	9	3.7	33
	Sept.	2	4.5	9		Sept.	3	5.0	15		Sept.	1	5.0	5
	Oct.	5	4.0	20		Oct.	2	6.0	12		Oct.	4	4.3	17
	Nov.	5	4.2	21		Nov.	4	3.8	15		Nov.	4	4.5	18
	Dec.	4	4.0	16		Dec.	4	3.5	14		Dec.	3	4.8	14
Total	139	1.9	268	Total	111	2.6	287	Total	81	2.9	235			
-1942	Jan.	6	2.8	17	-1948	Jan.	3	3.7	11	-1954	Jan.	3	4.0	12
	Feb.	5	3.6	18		Feb.	6	3.0	18		Feb.	5	3.8	19
	Mar.	6	3.7	22		Mar.	7	3.6	25		Mar.	4	3.8	15
	Apr.	14	2.8	39		Apr.	4	3.5	14		Apr.	3	4.3	13
	May	34	1.4	49		May	16	1.4	23		May	8	2.9	23
	June	51	1.2	61		June	13	2.2	29		June	1	5.0	5
	July	6	3.0	18		July	2	4.0	8		July	1	5.0	5
	Aug.	6	3.2	19		Aug.	6	2.2	13		Aug.	1	3.0	3
	Sept.	1	5.0	5		Sept.	0	0	0		Sept.	4	4.0	16
	Oct.	2	5.0	10		Oct.	1	5.0	5		Oct.	2	4.0	8
	Nov.	3	4.7	14		Nov.	2	5.0	10		Nov.	2	4.5	9
	Dec.	3	4.7	14		Dec.	2	4.5	9		Dec.	2	4.5	9
Total	137	2.1	286	Total	62	2.7	165	Total	36	3.8	137			
-1943	Jan.	4	3.0	12	-1949	Jan.	2	4.0	8	-1955	Jan.	2	4.0	8
	Feb.	5	3.4	17		Feb.	2	4.0	8		Feb.	2	3.5	7
	Mar.	6	3.8	23		Mar.	9	3.3	30		Mar.	6	3.5	21
	Apr.	15	2.9	44		Apr.	10	2.2	22		Apr.	3	3.7	11
	May	13	2.1	27		May	30	1.3	38		May	4	3.0	12
	June	14	2.0	28		June	52	1.2	64		June	6	2.8	17
	July	2	3.5	7		July	14	2.7	38		July	0	0	0
	Aug.	6	3.2	19		Aug.	5	3.0	15		Aug.	3	3.7	11
	Sept.	1	5.0	5		Sept.	3	4.7	14		Sept.	0	0	0
	Oct.	2	5.0	10		Oct.	3	4.7	14		Oct.	0	0	0
	Nov.	2	5.0	10		Nov.	3	4.7	14		Nov.	1	5.0	5
	Dec.	3	3.7	11		Dec.	2	4.5	9		Dec.	2	4.5	9
Total	73	2.9	213	Total	135	2.0	274	Total	29	3.5	101			
-1944	Jan.	2	3.5	7	-1950	Jan.	2	4.5	9	-1956	Jan.	3	3.7	11
	Feb.	3	3.0	9		Feb.	6	3.3	20		Feb.	3	3.3	10
	Mar.	6	3.5	21		Mar.	5	4.0	20		Mar.	3	3.3	10
	Apr.	1	5.0	5		Apr.	3	4.7	14		Apr.	1	5.0	5
	May	40	1.3	53		May	9	2.2	20		May	11	1.6	18
	June	72	1.1	78		June	11	2.2	24		June	8	2.0	16
	July	9	2.9	26		July	9	2.9	26		July	1	4.0	4
	Aug.	7	3.1	22		Aug.	1	3.0	3		Aug.	1	3.0	3
	Sept.	1	5.0	5		Sept.	1	5.0	5		Sept.	0	0	0
	Oct.	2	5.0	10		Oct.	1	6.0	6		Oct.	0	0	0
	Nov.	3	4.7	14		Nov.	2	5.5	11		Nov.	1	5.0	5
	Dec.	3	4.3	13		Dec.	3	4.3	13		Dec.	1	5.0	5
Total	149	1.8	263	Total	53	3.2	171	Total	33	2.6	87			
-1945	Jan.	3	3.3	10	-1951	Jan.	2	5.0	10	-1957	Jan.	2	3.0	6
	Feb.	3	4.0	12		Feb.	3	3.7	11		Feb.	4	3.0	12
	Mar.	6	3.5	21		Mar.	2	5.0	10		Mar.	2	5.0	10
	Apr.	1	6.0	6		Apr.	1	6.0	6		Apr.	1	5.0	5
	May	22	1.6	35		May	15	1.9	29		May	9	3.1	28
	June	27	1.5	41		June	23	1.7	40		June	94	.8	79
	July	6	3.2	19		July	3	3.7	11		July	24	1.5	37
	Aug.	7	3.4	24		Aug.	12	2.2	27		Aug.	13	2.8	36
	Sept.	2	5.0	8		Sept.	1	5.0	5		Sept.	4	3.5	14
	Oct.	3	5.0	15		Oct.	6	4.0	24		Oct.	10	3.3	33
	Nov.	3	4.7	14		Nov.	4	4.5	18		Nov.	21	2.5	53
	Dec.	2	4.5	9		Dec.	3	5.0	15		Dec.	5	3.4	17
Total	65	2.5	214	Total	75	2.7	206	Total	189	1.7	330			
-1946	Jan.	2	4.0	8	-1952	Jan.	3	3.7	11	-1958	Jan.	5	2.6	13
	Feb.	4	3.3	13		Feb.	5	3.6	18		Feb.	8	2.8	22
	Mar.	6	3.7	22		Mar.	11	3.1	44		Mar.	6	3.3	20
	Apr.	11	3.2	35		Apr.	21	2.4	58		Apr.	13	1.6	21
	May	20	1.8	36		May	37	.8	78		May	66	.9	60
	June	8	2.4	19		June	128	.9	114		June	57	.8	47
	July	1	4.0	4		July	19	1.9	36		July	2	4.0	8
	Aug.	7	5.4	38		Aug.	12	3.3	40		Aug.	4	4.5	18
	Sept.	0	0	0		Sept.	5	3.8	19		Sept.	4	4.3	17
	Oct.	2	5.0	10		Oct.	3	4.7	14		Oct.	1	5.0	5
	Nov.	5	3.8	19		Nov.	4	4.5	18		Nov.	2	4.0	8
	Dec.	3	4.3	13		Dec.	4	4.0	16		Dec.	4	3.3	13
Total	69	3.1	217	Total	314	1.5	466	Total	172	1.5	252			

To obtain mg/l multiply T/AF by 735.

Table 5
 Colorado River Basin
 Historical Flow and Quality of Water Data
 San Rafael River near Green River, Utah

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	3	3.3	10	-1965	Jan.	4	3.5	14	1971	Jan.	2	3.0	6
	Feb.	4	3.0	12		Feb.	3	3.7	11		Feb.	2	4.0	8
	Mar.	3	4.0	12		Mar.	3	4.0	12		Mar.	3	4.1	13
	Apr.	2	3.5	7		Apr.	6	2.7	16		Apr.	3	3.3	10
	May	1	5.0	5		May	18	1.6	28		May	4	4.0	16
	June	2	4.0	8		June	77	.9	70		June	5	2.6	13
	July	0	0	0		July	38	1.6	60		July	6	3.2	19
	Aug.	1	3.0	3		Aug.	16	2.5	40		Aug.	4	4.0	16
	Sept.	1	5.0	5		Sept.	5	4.0	20		Sept.	2	5.0	10
	Oct.	1	4.0	4		Oct.	4	4.5	18		Oct.	5	5.3	28
	Nov.	2	4.0	8		Nov.	5	4.8	24		Nov.	4	4.5	18
	Dec.	1	7.0	7		Dec.	5	3.2	16		Dec.	2	4.5	9
Total	21	3.9	81	Total	184	1.8	329	Total	42	4.0	166			
-1960	Jan.	1	6.0	6	-1966	Jan.	3	3.7	11	1972	Jan.	2	4.5	9
	Feb.	2	3.5	7		Feb.	3	3.7	11		Feb.	3	4.0	12
	Mar.	8	2.8	22		Mar.	8	3.5	28		Mar.	3	4.0	12
	Apr.	3	3.3	10		Apr.	4	3.0	12		Apr.	2	4.0	8
	May	8	1.9	15		May	4	4.5	18		May	2	5.0	10
	June	11	1.5	17		June	2	4.0	8		June	3	4.7	15
	July	0	0	0		July	2	4.5	9		July	1	6.0	6
	Aug.	0	0	0		Aug.	1	3.0	3		Aug.	1	5.0	5
	Sept.	1	4.0	4		Sept.	2	5.0	10		Sept.	1	4.0	4
	Oct.	8	2.5	20		Oct.	1	8.0	8		Oct.	9	3.0	27
	Nov.	2	4.5	9		Nov.	1	5.0	5		Nov.	4	5.0	20
	Dec.	2	4.0	8		Dec.	2	5.0	10		Dec.	1	7.0	7
Total	46	2.6	118	Total	33	4.0	133	Total	32	4.2	134			
-1961	Jan.	2	3.5	7	-1967	Jan.	1	4.8	5	1973	Jan.	2	3.50	7
	Feb.	3	2.7	8		Feb.	2	3.8	8		Feb.	2	4.00	8
	Mar.	2	5.5	11		Mar.	2	4.6	9		Mar.	18	3.61	65
	Apr.	2	4.0	8		Apr.	1	5.9	6		Apr.	4	4.25	17
	May	3	3.0	9		May	5	3.2	16		May	29	1.00	29
	June	2	2.5	5		June	22	2.0	44		June	51	1.18	60
	July	0	0	0		July	7	2.9	21		July	10	3.00	30
	Aug.	7	2.9	20		Aug.	3	3.3	10		Aug.	4	4.00	16
	Sept.	18	2.9	53		Sept.	5	3.6	18		Sept.	4	3.75	15
	Oct.	3	4.0	12		Oct.	2	4.6	9		Oct.	5	3.40	17
	Nov.	4	3.5	14		Nov.	2	4.5	9		Nov.	3	5.33	16
	Dec.	2	4.5	9		Dec.	2	5.0	10		Dec.	3	4.00	12
Total	48	3.3	156	Total	54	3.1	165	Total	135	2.16	292			
-1962	Jan.	2	4.0	8	-1968	Jan.	2	5.0	10	1974	Jan.	2	5.00	10
	Feb.	8	2.5	20		Feb.	3	4.1	12		Feb.	2	4.00	8
	Mar.	6	2.8	17		Mar.	3	5.2	16		Mar.	3	5.33	16
	Apr.	11	1.3	14		Apr.	2	4.8	10		Apr.	2	5.00	10
	May	29	1.1	31		May	6	3.8	23		May	3	5.00	15
	June	37	1.0	37		June	25	1.3	33		June	4	3.75	15
	July	7	2.6	18		July	6	3.6	21		July	5	4.00	20
	Aug.	1	4.0	4		Aug.	11	3.3	36		Aug.	3	3.33	10
	Sept.	3	3.0	9		Sept.	4	3.9	16		Sept.	2	4.50	9
	Oct.	4	4.5	18		Oct.	5	4.3	21		Oct.	5	4.40	22
	Nov.	2	5.5	11		Nov.	3	4.3	12		Nov.	4	5.75	23
	Dec.	2	5.5	11		Dec.	2	4.7	9		Dec.	2	5.00	10
Total	112	1.8	198	Total	72	3.0	219	Total	37	4.54	168			
-1963	Jan.	2	5.5	11	-1969	Jan.	3	4.0	12		Jan.			
	Feb.	4	3.2	13		Feb.	3	3.3	10		Feb.			
	Mar.	2	5.5	11		Mar.	9	3.6	32		Mar.			
	Apr.	1	6.0	6		Apr.	13	1.8	23		Apr.			
	May	6	2.3	14		May	38	1.0	39		May			
	June	10	2.2	22		June	32	1.4	44		June			
	July	1	2.0	2		July	8	2.4	19		July			
	Aug.	9	3.8	34		Aug.	9	3.3	30		Aug.			
	Sept.	6	4.3	26		Sept.	6	3.8	23		Sept.			
	Oct.	1	6.0	6		Oct.	4	4.2	17		Oct.			
	Nov.	2	4.5	9		Nov.	4	3.0	12		Nov.			
	Dec.	2	4.5	9		Dec.	4	3.3	13		Dec.			
Total	46	3.5	163	Total	133	2.7	274	Total						
-1964	Jan.	1	6.0	6	-1970	Jan.	2	4.0	8		Jan.			
	Feb.	2	4.0	8		Feb.	4	3.5	14		Feb.			
	Mar.	3	3.7	11		Mar.	2	6.0	12		Mar.			
	Apr.	1	8.0	8		Apr.	2	4.5	9		Apr.			
	May	15	1.9	29		May	14	1.5	21		May			
	June	20	1.6	33		June	48	1.2	59		June			
	July	4	3.8	15		July	9	2.9	26		July			
	Aug.	6	3.7	22		Aug.	4	4.0	16		Aug.			
	Sept.	1	4.0	4		Sept.	4	4.0	16		Sept.			
	Oct.	0	0	0		Oct.	3	5.0	15		Oct.			
	Nov.	1	7.0	7		Nov.	3	4.7	14		Nov.			
	Dec.	3	4.7	14		Dec.	3	4.7	14		Dec.			
Total	57	2.7	157	Total	98	2.3	224	Total						

To obtain mg/l multiply T/AF by 735.

Table 5
Colorado River Basin
Historical Flow and Quality of Water Data
San Rafael River near Green River, Utah
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	139	1.9	1,420	268
1942	137	2.1	1,530	286
1943	73	2.9	2,140	213
1944	149	1.8	1,300	263
1945	85	2.5	1,850	214
1946	69	3.1	2,310	217
1947	111	2.6	1,900	287
1948	62	2.7	1,960	165
1949	135	2.0	1,490	274
1950	53	3.2	2,370	171
1951	75	2.7	2,020	206
1952	314	1.5	1,090	466
1953	81	2.9	2,130	235
1954	36	3.8	2,800	137
1955	29	3.5	2,560	101
1956	33	2.6	1,940	87
1957	189	1.7	1,280	330
1958	172	1.5	1,080	252
1959	21	3.9	2,840	81
1960	46	2.6	1,890	118
1961	48	3.3	2,390	156
1962	112	1.8	1,300	198
1963	46	3.5	2,600	163
1964	57	2.7	2,020	157
1965	184	1.8	1,310	329
1966	33	4.0	2,960	133
1967	54	3.1	2,250	165
1968	72	3.0	2,240	219
1969	133	2.1	1,514	274
1970	98	2.3	1,679	224

Sampled quality record November 1946 to September 1949; November 1950 to December 1972; remainder by correlation.
Measured flow record October 1945 to December 1972; remainder by correlation.

Table 6
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River near Glenwood Springs, Colorado

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
- 1941	Jan.	36	0.75	27	- 1947	Jan.	52	0.60	31	- 1953	Jan.	64	0.59	38
	Feb.	37	.59	22		Feb.	54	.61	33		Feb.	53	.57	30
	Mar.	51	.60	30		Mar.	68	.53	36		Mar.	67	.54	37
	Apr.	85	.47	40		Apr.	123	.37	46		Apr.	103	.46	47
	May	535	.22	118		May	486	.19	92		May	229	.32	73
	June	470	.19	90		June	606	.17	103		June	509	.20	102
	July	163	.37	60		July	438	.21	92		July	171	.41	70
	Aug.	84	.60	50		Aug.	147	.38	56		Aug.	121	.50	60
	Sept.	67	.60	40		Sept.	79	.53	42		Sept.	69	.58	40
	Oct.	78	.58	45		Oct.	90	.47	42		Oct.	64	.63	40
	Nov.	59	.63	37		Nov.	80	.49	39		Nov.	55	.75	41
	Dec.	48	.67	32		Dec.	75	.48	36		Dec.	58	.66	38
	Total	1,713	.34	591		Total	2,228	.28	648		Total	1,563	.39	616
- 1942	Jan.	43	.74	32	- 1948	Jan.	76	.45	34	- 1954	Jan.	62	.58	36
	Feb.	41	.68	28		Feb.	72	.44	32		Feb.	48	.62	30
	Mar.	46	.70	32		Mar.	68	.50	31		Mar.	62	.58	36
	Apr.	167	.42	70		Apr.	162	.37	60		Apr.	86	.44	38
	May	389	.24	93		May	542	.20	108		May	146	.35	51
	June	721	.16	116		June	470	.18	85		June	89	.52	46
	July	230	.27	62		July	196	.35	55		July	83	.55	46
	Aug.	78	.53	41		Aug.	90	.51	46		Aug.	74	.58	43
	Sept.	46	.78	36		Sept.	57	.67	38		Sept.	59	.61	36
	Oct.	53	.75	40		Oct.	63	.65	41		Oct.	58	.66	38
	Nov.	49	.76	37		Nov.	66	.53	35		Nov.	48	.71	34
	Dec.	46	.82	33		Dec.	59	.61	36		Dec.	40	.90	36
	Total	1,903	.33	620		Total	1,881	.32	604		Total	855	.55	470
- 1943	Jan.	37	.86	32	- 1949	Jan.	67	.54	36	- 1955	Jan.	38	.79	30
	Feb.	36	.78	28		Feb.	56	.57	32		Feb.	34	.82	28
	Mar.	48	.75	36		Mar.	58	.59	34		Mar.	43	.79	34
	Apr.	162	.34	55		Apr.	132	.38	50		Apr.	90	.48	43
	May	342	.23	79		May	364	.23	84		May	206	.28	58
	June	582	.18	105		June	654	.19	124		June	244	.31	67
	July	254	.28	71		July	356	.24	85		July	99	.56	56
	Aug.	109	.45	49		Aug.	106	.45	48		Aug.	86	.66	57
	Sept.	66	.64	42		Sept.	69	.59	41		Sept.	67	.57	38
	Oct.	60	.67	40		Oct.	61	.70	43		Oct.	61	.62	38
	Nov.	67	.54	36		Nov.	53	.71	39		Nov.	55	.69	38
	Dec.	64	.53	34		Dec.	58	.62	36		Dec.	55	.60	33
	Total	1,827	.33	607		Total	2,036	.32	652		Total	1,051	.49	520
- 1944	Jan.	37	.76	28	- 1950	Jan.	56	.63	35	- 1956	Jan.	52	.60	31
	Feb.	44	.66	29		Feb.	54	.56	30		Feb.	48	.56	27
	Mar.	50	.72	36		Mar.	80	.44	35		Mar.	60	.59	41
	Apr.	85	.51	43		Apr.	141	.35	49		Apr.	120	.44	53
	May	302	.26	78		May	259	.26	67		May	421	.26	110
	June	498	.16	80		June	429	.20	86		June	329	.24	79
	July	185	.29	54		July	137	.42	58		July	104	.54	56
	Aug.	72	.49	35		Aug.	79	.50	40		Aug.	82	.61	50
	Sept.	45	.71	32		Sept.	66	.58	38		Sept.	73	.55	40
	Oct.	60	.65	39		Oct.	49	.80	39		Oct.	66	.55	36
	Nov.	57	.63	36		Nov.	53	.70	37		Nov.	50	.72	36
	Dec.	59	.56	33		Dec.	55	.61	34		Dec.	41	.78	32
	Total	1,494	.35	523		Total	1,458	.38	548		Total	1,455	.41	591
- 1945	Jan.	41	.71	29	- 1951	Jan.	59	.56	33	- 1957	Jan.	46	.72	33
	Feb.	37	.68	25		Feb.	58	.52	30		Feb.	44	.68	30
	Mar.	62	.59	31		Mar.	58	.55	32		Mar.	51	.67	34
	Apr.	72	.51	37		Apr.	104	.40	42		Apr.	92	.53	49
	May	347	.22	75		May	381	.23	88		May	350	.32	112
	June	461	.18	83		June	536	.20	107		June	834	.21	175
	July	268	.26	70		July	285	.25	71		July	571	.22	126
	Aug.	181	.33	60		Aug.	132	.43	57		Aug.	176	.37	65
	Sept.	73	.52	38		Sept.	77	.58	45		Sept.	88	.56	49
	Oct.	78	.49	38		Oct.	75	.61	46		Oct.	75	.60	45
	Nov.	73	.47	34		Nov.	63	.57	36		Nov.	72	.58	42
	Dec.	71	.45	32		Dec.	63	.51	32		Dec.	63	.59	37
	Total	1,764	.31	553		Total	1,891	.33	619		Total	2,462	.32	797
- 1946	Jan.	67	.48	32	- 1952	Jan.	53	.60	32	- 1958	Jan.	62	.55	34
	Feb.	54	.54	29		Feb.	47	.62	29		Feb.	58	.50	29
	Mar.	64	.55	35		Mar.	63	.51	32		Mar.	73	.52	38
	Apr.	197	.28	55		Apr.	194	.38	74		Apr.	102	.45	46
	May	284	.22	62		May	597	.23	137		May	546	.22	120
	June	362	.22	80		June	785	.19	149		June	439	.21	92
	July	164	.40	65		July	245	.34	83		July	104	.51	53
	Aug.	83	.51	42		Aug.	157	.51	80		Aug.	67	.52	40
	Sept.	59	.66	39		Sept.	99	.58	53		Sept.	62	.58	36
	Oct.	70	.61	43		Oct.	77	.58	45		Oct.	59	.63	37
	Nov.	61	.59	36		Nov.	66	.64	42		Nov.	54	.68	37
	Dec.	77	.40	31		Dec.	60	.58	35		Dec.	54	.63	34
	Total	1,542	.36	549		Total	2,443	.32	791		Total	1,680	.35	596

To obtain mg/l multiply T/AP by 735.

Table 6
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River near Glenwood Springs, Colorado

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
1959	Jan.	63	0.54	34	1965	Jan.	51	0.70	36	1971	Jan.	72	.59	35
	Feb.	54	.52	28		Feb.	44	.72	32		Feb.	71	.59	35
	Mar.	49	.05	32		Mar.	49	.69	34		Mar.	105	.45	47
	Apr.	81	.54	44		Apr.	104	.50	52		Apr.	174	.32	55
	May	252	.29	73		May	263	.30	79		May	348	.22	77
	June	342	.25	85		June	446	.26	116		June	519	.19	99
	July	126	.48	61		July	271	.31	84		July	271	.31	84
	Aug.	89	.61	54		Aug.	172	.39	67		Aug.	121	.44	53
	Sept.	73	.56	41		Sept.	95	.50	48		Sept.	109	.48	52
	Oct.	84	.55	46		Oct.	95	.44	42		Oct.	90	.50	45
	Nov.	59	.55	38		Nov.	86	.46	39		Nov.	86	.47	41
	Dec.	59	.53	31		Dec.	88	.47	41		Dec.	72	.52	37
Total	1,341	.42	567	Total	1,764	.48	670	Total	2,038	.32	660			
1960	Jan.	67	.49	33	1966	Jan.	78	0.48	37	1972	Jan.	67	.52	35
	Feb.	55	.50	28		Feb.	70	.45	32		Feb.	62	.50	31
	Mar.	93	.47	44		Mar.	91	.46	42		Mar.	94	.45	42
	Apr.	166	.32	53		Apr.	84	.47	39		Apr.	116	.36	42
	May	288	.25	72		May	186	.30	56		May	255	.24	62
	June	357	.25	89		June	110	.45	50		June	355	.22	79
	July	122	.49	60		July	89	.51	45		July	128	.40	51
	Aug.	73	.60	44		Aug.	77	.46	35		Aug.	97	.44	42
	Sept.	67	.60	40		Sept.	68	.51	35		Sept.	96	.46	44
	Oct.	61	.62	38		Oct.	72	.60	43		Oct.	92	.45	42
	Nov.	56	.61	34		Nov.	55	.66	36		Nov.	88	.42	37
	Dec.	61	.54	33		Dec.	44	.75	33		Dec.	74	.45	33
Total	1,466	.39	568	Total	1,024	.47	483	Total	1,524	.35	540			
1961	Jan.	65	.52	34	1967	Jan.	49	.65	32	1973	Jan.	68	.47	32
	Feb.	56	.53	30		Feb.	45	.62	28		Feb.	60	.45	27
	Mar.	55	.59	32		Mar.	67	.59	40		Mar.	73	.45	33
	Apr.	66	.54	36		Apr.	96	.45	43		Apr.	86	.45	39
	May	207	.29	60		May	185	.31	57		May	352	.21	73
	June	203	.28	57		June	250	.28	70		June	448	.19	83
	July	82	.60	49		July	139	.47	65		July	315	.23	74
	Aug.	80	.59	47		Aug.	90	.57	51		Aug.	138	.37	51
	Sept.	109	.50	54		Sept.	83	.59	49		Sept.	89	.44	39
	Oct.	128	.43	55		Oct.	78	.59	46		Oct.	97	.42	41
	Nov.	81	.50	40		Nov.	69	.57	39		Nov.	90	.42	38
	Dec.	77	.47	36		Dec.	59	.59	35		Dec.	69	.51	35
Total	1,209	.44	530	Total	1,210	.46	555	Total	1,885	.30	565			
1962	Jan.	80	.44	35	1968	Jan.	53	.61	32	1974	Jan.	67	.52	35
	Feb.	91	.42	38		Feb.	53	.55	29		Feb.	63	.51	32
	Mar.	122	.39	48		Mar.	62	.55	34		Mar.	93	.45	42
	Apr.	347	.32	111		Apr.	95	.46	44		Apr.	123	.37	46
	May	539	.23	125		May	171	.36	62		May	486	.17	84
	June	455	.23	105		June	369	.25	92		June	427	.20	84
	July	288	.29	84		July	133	.46	61		July	192	.36	72
	Aug.	110	.50	55		Aug.	125	.48	60		Aug.	113	.45	51
	Sept.	74	.58	43		Sept.	79	.53	42		Sept.	97	.45	44
	Oct.	127	.42	53		Oct.	77	.55	42		Oct.	91	.48	44
	Nov.	102	.47	48		Nov.	68	.54	37		Nov.	78	.51	40
	Dec.	72	.57	41		Dec.	65	.59	38		Dec.	64	.53	34
Total	2,407	.33	786	Total	1,350	.42	573	Total	1,901	.32	608			
1963	Jan.	55	.67	37	1969	Jan.	66	.55	36	1975	Jan.			
	Feb.	53	.63	33		Feb.	56	.57	32		Feb.			
	Mar.	62	.58	36		Mar.	63	.56	35		Mar.			
	Apr.	81	.48	39		Apr.	131	.41	54		Apr.			
	May	175	.31	54		May	283	.28	51		May			
	June	122	.45	55		June	260	.31	81		June			
	July	66	.66	44		July	174	.38	66		July			
	Aug.	77	.60	46		Aug.	93	.49	46		Aug.			
	Sept.	76	.57	43		Sept.	78	.53	41		Sept.			
	Oct.	63	.61	38		Oct.	94	.55	52		Oct.			
	Nov.	54	.66	36		Nov.	79	.53	42		Nov.			
	Dec.	38	.82	31		Dec.	71	.52	37		Dec.			
Total	922	.53	492	Total	1,448	.40	573	Total						
1964	Jan.	36	.80	29	1970	Jan.	62	.55	34	1976	Jan.			
	Feb.	33	.78	26		Feb.	65	.52	37		Feb.			
	Mar.	39	.71	28		Mar.	72	.51	37		Mar.			
	Apr.	64	.61	39		Apr.	95	.43	41		Apr.			
	May	210	.32	67		May	488	.20	99		May			
	June	215	.31	67		June	471	.21	92		June			
	July	99	.63	62		July	194	.35	68		July			
	Aug.	87	.61	53		Aug.	109	.46	50		Aug.			
	Sept.	72	.60	43		Sept.	101	.50	50		Sept.			
	Oct.	65	.64	42		Oct.	108	.48	52		Oct.			
	Nov.	50	.72	36		Nov.	92	.50	46		Nov.			
	Dec.	51	.73	37		Dec.	68	.51	35		Dec.			
Total	1,021	.52	529	Total	1,925	.34	645	Total						

To obtain mg/l multiply T/AF by 735.

Table 6
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Glenwood Springs, Colorado
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	1,713	0.34	254	591
1942	1,903	.33	239	620
1943	1,827	.33	244	607
1944	1,494	.35	257	523
1945	1,764	.31	230	553
1946	1,542	.36	262	549
1947	2,298	.28	207	648
1948	1,881	.32	236	604
1949	2,036	.32	235	652
1950	1,458	.38	276	548
1951	1,891	.33	241	619
1952	2,443	.32	238	791
1953	1,563	.39	290	616
1954	855	.55	404	470
1955	1,051	.49	364	520
1956	1,455	.41	299	591
1957	2,462	.32	238	797
1958	1,680	.35	261	596
1959	1,341	.42	311	567
1960	1,466	.39	285	568
1961	1,209	.44	322	530
1962	2,407	.33	240	786
1963	922	.53	392	492
1964	1,021	.52	381	529
1965	1,764	.38	279	670
1966	1,024	.47	347	483
1967	1,210	.46	337	555
1968	1,350	.42	312	573
1969	1,448	.40	290	573
1970	1,925	.34	246	645

Sampled quality record October 1941 to December 1972; remainder by correlation.
Measured flow record entire period.

Table 7
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River near Cameo, Colorado

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	65	1.23	80	-1947	Jan.	82	1.04	85	-1953	Jan.	99	1.03	102
	Feb.	67	1.15	77		Feb.	82	.99	81		Feb.	80	1.06	85
	Mar.	82	1.11	91		Mar.	107	.96	103		Mar.	102	.96	98
	Apr.	133	.83	110		Apr.	178	.63	112		Apr.	136	.78	106
	May	948	.34	322		May	809	.28	227		May	346	.44	152
	June	803	.28	225		June	1,027	.25	257		June	887	.27	239
	July	315	.47	148		July	732	.27	198		July	294	.52	153
	Aug.	144	.91	131		Aug.	240	.58	139		Aug.	194	.72	140
	Sept.	122	.97	118		Sept.	143	.78	111		Sept.	101	.99	100
	Oct.	166	.88	146		Oct.	153	.80	122		Oct.	101	1.06	107
	Nov.	124	.96	119		Nov.	135	.77	104		Nov.	99	1.13	112
	Dec.	103	1.11	114		Dec.	118	.86	102		Dec.	92	1.17	108
	Total	3,072	.55	1,681		Total	3,806	.43	1,641		Total	2,531	.59	1,502
-1942	Jan.	90	1.24	112	-1948	Jan.	116	.84	97	-1954	Jan.	95	1.00	95
	Feb.	86	1.19	102		Feb.	111	.81	90		Feb.	81	1.05	85
	Mar.	103	1.13	116		Mar.	115	.90	104		Mar.	94	1.01	95
	Apr.	334	.62	207		Apr.	253	.59	149		Apr.	136	.78	106
	May	757	.41	310		May	920	.30	276		May	296	.48	142
	June	1,215	.24	292		June	844	.26	219		June	204	.60	123
	July	406	.44	179		July	312	.47	146		July	146	.81	118
	Aug.	139	.85	118		Aug.	161	.77	124		Aug.	105	.97	102
	Sept.	86	1.12	92		Sept.	88	1.03	91		Sept.	103	1.07	110
	Oct.	94	1.18	111		Oct.	109	1.02	111		Oct.	125	.97	121
	Nov.	94	1.24	117		Nov.	107	.96	103		Nov.	98	1.07	105
	Dec.	84	1.26	106		Dec.	90	1.04	94		Dec.	82	1.23	101
	Total	3,488	.54	1,869		Total	3,226	.50	1,604		Total	1,565	.83	1,303
-1943	Jan.	77	1.30	100	-1949	Jan.	99	.96	95	-1955	Jan.	74	1.23	91
	Feb.	74	1.26	93		Feb.	84	.92	77		Feb.	67	1.25	84
	Mar.	89	1.22	109		Mar.	98	.98	96		Mar.	86	1.13	97
	Apr.	287	.56	133		Apr.	201	.65	131		Apr.	142	.77	110
	May	509	.32	163		May	572	.36	206		May	384	.42	161
	June	931	.23	214		June	1,080	.26	281		June	448	.37	166
	July	387	.39	151		July	594	.34	202		July	214	.61	130
	Aug.	192	.73	140		Aug.	184	.69	127		Aug.	157	.87	137
	Sept.	117	.89	104		Sept.	122	.93	113		Sept.	100	.94	94
	Oct.	111	1.00	111		Oct.	125	.98	123		Oct.	91	1.02	93
	Nov.	115	.90	103		Nov.	108	1.01	109		Nov.	94	1.06	100
	Dec.	107	.93	100		Dec.	101	1.05	106		Dec.	89	1.07	95
	Total	2,946	.52	1,521		Total	3,368	.49	1,666		Total	1,946	.70	1,358
-1944	Jan.	74	1.24	92	-1950	Jan.	91	1.04	95	-1956	Jan.	81	1.07	87
	Feb.	76	1.11	84		Feb.	88	.95	84		Feb.	75	1.11	83
	Mar.	81	1.11	90		Mar.	118	.87	103		Mar.	104	.98	102
	Apr.	118	.85	100		Apr.	212	.59	125		Apr.	184	.66	122
	May	564	.36	203		May	418	.40	167		May	685	.34	233
	June	890	.24	214		June	787	.27	212		June	637	.31	197
	July	378	.38	143		July	273	.54	147		July	173	.70	121
	Aug.	123	.80	98		Aug.	125	.87	109		Aug.	115	.95	109
	Sept.	78	1.09	85		Sept.	111	.97	108		Sept.	88	.90	79
	Oct.	98	1.05	104		Oct.	97	1.19	115		Oct.	93	.95	88
	Nov.	100	1.01	101		Nov.	98	1.14	112		Nov.	83	1.07	89
	Dec.	99	1.02	101		Dec.	98	1.07	105		Dec.	73	1.21	89
	Total	2,680	.53	1,415		Total	2,516	.59	1,482		Total	2,391	.59	1,398
-1945	Jan.	78	1.15	90	-1951	Jan.	96	1.01	97	-1957	Jan.	80	1.10	88
	Feb.	72	1.18	85		Feb.	88	.95	84		Feb.	77	1.10	85
	Mar.	95	.99	94		Mar.	99	1.01	100		Mar.	83	1.16	96
	Apr.	115	.90	104		Apr.	151	.70	106		Apr.	151	.83	125
	May	601	.36	216		May	537	.34	183		May	591	.47	278
	June	794	.27	214		June	858	.27	232		June	1,415	.27	382
	July	499	.33	165		July	471	.36	170		July	1,022	.27	289
	Aug.	287	.52	149		Aug.	207	.68	141		Aug.	339	.50	170
	Sept.	118	.83	98		Sept.	111	.90	100		Sept.	157	.78	122
	Oct.	126	.79	100		Oct.	120	.92	110		Oct.	136	.89	121
	Nov.	125	.81	101		Nov.	104	.97	101		Nov.	123	.91	112
	Dec.	117	.89	104		Dec.	106	.96	102		Dec.	102	.96	98
	Total	3,027	.50	1,520		Total	2,968	.52	1,526		Total	4,326	.45	1,966
-1946	Jan.	109	.90	98	-1952	Jan.	96	1.01	97	-1958	Jan.	92	.93	86
	Feb.	91	.97	88		Feb.	84	1.06	89		Feb.	95	.93	88
	Mar.	99	.96	93		Mar.	113	.99	112		Mar.	123	.89	110
	Apr.	285	.45	128		Apr.	313	.60	188		Apr.	171	.76	130
	May	449	.32	144		May	978	.36	352		May	847	.31	261
	June	689	.28	193		June	1,320	.26	343		June	808	.27	218
	July	267	.51	136		July	449	.44	197		July	193	.67	129
	Aug.	126	.85	107		Aug.	276	.70	193		Aug.	109	.97	106
	Sept.	92	1.01	93		Sept.	171	.78	133		Sept.	103	1.03	106
	Oct.	127	.82	102		Oct.	123	.97	119		Oct.	99	1.09	108
	Nov.	104	.82	96		Nov.	112	1.04	117		Nov.	94	1.09	102
	Dec.	121	.82	99		Dec.	99	1.12	111		Dec.	86	1.12	96
	Total	2,554	.54	1,384		Total	4,134	.50	2,051		Total	2,820	.55	1,542

To obtain mg/l multiply T/AF by 735

Table 7
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River near Cameo, Colorado

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	94	1.02	96	-1965	Jan.	92	1.10	101	1971	Jan.	138	.82	113
	Feb.	86	1.01	87		Feb.	78	1.09	85		Feb.	112	.84	94
	Mar.	83	1.09	90		Mar.	85	1.15	98		Mar.	149	.74	110
	Apr.	118	.83	98		Apr.	161	.69	111		Apr.	293	.48	140
	May	392	.40	157		May	477	.39	186		May	521	.32	165
	June	684	.29	198		June	920	.28	258		June	885	.24	215
	July	215	.59	127		July	605	.34	206		July	451	.41	184
	Aug.	131	.87	114		Aug.	273	.56	153		Aug.	179	.72	129
	Sept.	105	.98	103		Sept.	172	.75	129		Sept.	170	.76	130
	Oct.	138	.81	112		Oct.	167	.75	125		Oct.	150	.78	118
	Nov.	116	.87	101		Nov.	137	.75	103		Nov.	137	.78	108
	Dec.	100	.98	98		Dec.	138	.75	103		Dec.	129	.79	102
	Total	2,262	.61	1,381		Total	3,305	.50	1,658		Total	3,314	.49	1,608
-1960	Jan.	100	.89	89	-1966	Jan.	114	.82	93	1972	Jan.	127	.79	100
	Feb.	91	.95	86		Feb.	99	.81	80		Feb.	119	.87	104
	Mar.	135	.78	105		Mar.	133	.77	102		Mar.	151	.81	122
	Apr.	246	.51	125		Apr.	141	.66	93		Apr.	175	.66	115
	May	432	.37	160		May	373	.40	149		May	394	.39	155
	June	668	.30	200		June	277	.48	133		June	664	.29	192
	July	217	.60	130		July	157	.73	115		July	219	.60	132
	Aug.	117	.89	104		Aug.	119	.87	104		Aug.	143	.85	122
	Sept.	102	.95	97		Sept.	101	.94	95		Sept.	150	.81	121
	Oct.	106	1.00	106		Oct.	108	.98	106		Oct.	164	.77	126
	Nov.	99	1.05	104		Nov.	93	1.05	98		Nov.	152	.74	113
	Dec.	100	1.01	101		Dec.	85	1.22	104		Dec.	128	.81	108
	Total	2,413	.58	1,407		Total	1,800	.71	1,272		Total	2,586	.58	1,505
-1961	Jan.	99	.97	96	-1967	Jan.	86	1.11	95	1973	Jan.	116	.86	100
	Feb.	85	.94	80		Feb.	74	1.06	78		Feb.	105	.82	86
	Mar.	86	1.06	91		Mar.	106	.93	99		Mar.	125	.82	103
	Apr.	103	.91	94		Apr.	137	.72	99		Apr.	121	.82	99
	May	354	.40	142		May	328	.43	141		May	592	.32	189
	June	426	.34	145		June	543	.31	168		June	829	.27	222
	July	138	.81	112		July	289	.53	153		July	565	.31	174
	Aug.	115	.89	102		Aug.	137	.83	114		Aug.	207	.61	126
	Sept.	175	.73	128		Sept.	125	.90	112		Sept.	143	.81	116
	Oct.	200	.59	118		Oct.	115	.92	106		Oct.	149	.81	120
	Nov.	131	.73	96		Nov.	104	.95	99		Nov.	141	.80	113
	Dec.	121	.78	94		Dec.	100	1.00	100		Dec.	126	.87	110
	Total	2,033	.64	1,228		Total	2,144	.64	1,364		Total	3,219	.48	1,558
-1962	Jan.	115	.78	90	-1968	Jan.	89	1.12	100	1974	Jan.	122	.80	97
	Feb.	135	.74	100		Feb.	87	.98	85		Feb.	109	.83	91
	Mar.	160	.69	110		Mar.	96	1.01	97		Mar.	152	.79	120
	Apr.	513	.40	205		Apr.	133	.77	102		Apr.	185	.66	122
	May	892	.31	277		May	326	.43	140		May	709	.25	176
	June	882	.27	238		June	757	.27	204		June	658	.28	184
	July	545	.37	202		July	257	.57	146		July	286	.53	151
	Aug.	186	.72	134		Aug.	224	.67	150		Aug.	161	.73	118
	Sept.	121	.95	115		Sept.	125	.86	108		Sept.	128	.84	107
	Oct.	173	.74	128		Oct.	128	.91	116		Oct.	136	.85	116
	Nov.	148	.79	117		Nov.	113	.95	107		Nov.	127	.87	111
	Dec.	115	.99	114		Dec.	104	.99	103		Dec.	115	.97	111
	Total	3,985	.46	1,830		Total	2,439	.60	1,458		Total	2,888	.52	1,504
-1963	Jan.	95	1.11	105	-1969	Jan.	106	.94	100		Jan.			
	Feb.	87	.98	85		Feb.	86	.99	85		Feb.			
	Mar.	98	1.02	100		Mar.	96	.95	91		Mar.			
	Apr.	127	.79	100		Apr.	241	.58	140		Apr.			
	May	323	.40	129		May	561	.34	191		May			
	June	246	.53	130		June	502	.40	201		June			
	July	111	.91	101		July	355	.52	185		July			
	Aug.	115	.92	106		Aug.	152	.79	120		Aug.			
	Sept.	112	.89	100		Sept.	131	.88	115		Sept.			
	Oct.	96	.99	95		Oct.	173	.79	137		Oct.			
	Nov.	90	1.09	98		Nov.	131	.85	112		Nov.			
	Dec.	71	1.32	94		Dec.	121	1.05	127		Dec.			
	Total	1,571	.79	1,243		Total	2,655	.60	1,604		Total			
-1964	Jan.	58	1.29	75	-1970	Jan.	105	.96	101		Jan.			
	Feb.	55	1.19	65		Feb.	95	.92	87		Feb.			
	Mar.	67	1.13	76		Mar.	116	.84	97		Mar.			
	Apr.	105	.92	97		Apr.	154	.64	99		Apr.			
	May	403	.41	165		May	850	.26	224		May			
	June	465	.35	163		June	834	.27	222		June			
	July	223	.62	138		July	363	.45	165		July			
	Aug.	153	.81	124		Aug.	167	.77	128		Aug.			
	Sept.	116	.86	100		Sept.	182	.74	134		Sept.			
	Oct.	104	1.01	105		Oct.	171	.78	133		Oct.			
	Nov.	94	1.11	104		Nov.	155	.79	122		Nov.			
	Dec.	91	1.08	98		Dec.	140	.86	120		Dec.			
	Total	1,934	.68	1,310		Total	3,332	.49	1,632		Total			

To obtain mg/l multiply T/AF by 735.

Table 7
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Cameo, Colorado
 (Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	3,072	0.55	402	1,681
1942	3,488	.54	394	1,869
1943	2,946	.52	379	1,521
1944	2,680	.53	388	1,415
1945	3,027	.50	369	1,520
1946	2,554	.54	398	1,384
1947	3,806	.43	317	1,641
1948	3,226	.50	365	1,604
1949	3,368	.49	364	1,666
1950	2,516	.59	433	1,482
1951	2,948	.52	380	1,526
1952	4,134	.50	365	2,051
1953	2,531	.59	436	1,502
1954	1,565	.83	612	1,303
1955	1,946	.70	513	1,358
1956	2,391	.59	430	1,398
1957	4,326	.45	334	1,966
1958	2,820	.55	402	1,542
1959	2,262	.61	449	1,381
1960	2,413	.58	429	1,407
1961	2,033	.64	469	1,298
1962	3,985	.46	338	1,830
1963	1,571	.79	582	1,243
1964	1,934	.68	498	1,310
1965	3,035	.50	369	1,658
1966	1,800	.71	519	1,272
1967	2,144	.64	468	1,364
1968	2,439	.60	439	1,458
1969	2,655	.60	444	1,604
1970	3,332	.49	359	1,632

Sampled quality record entire period.
 Measured flow record entire period.

Table 8
Colorado River Basin
Historical Flow and Quality of Water Data
Gunnison River near Grand Junction, Colorado

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	51	1.90	97	-1947	Jan.	45	1.67	75	-1953	Jan.	65	1.51	98
	Feb.	50	1.82	93		Feb.	47	1.49	70		Feb.	50	1.48	78
	Mar.	63	1.67	105		Mar.	55	1.27	70		Mar.	61	1.26	77
	Apr.	123	1.00	123		Apr.	96	.82	79		Apr.	86	1.01	87
	May	871	.40	349		May	455	.39	177		May	230	.57	131
	June	563	.46	259		June	502	.46	231		June	437	.43	188
	July	192	.94	180		July	242	.64	155		July	86	1.13	97
	Aug.	95	1.41	134		Aug.	120	1.50	180		Aug.	67	1.75	117
	Sept.	81	2.11	171		Sept.	98	1.63	155		Sept.	46	2.28	105
	Oct.	198	1.35	267		Oct.	114	1.60	183		Oct.	58	2.40	139
	Nov.	121	1.33	161		Nov.	96	1.35	130		Nov.	74	1.78	132
	Dec.	84	1.58	133		Dec.	70	1.41	99		Dec.	52	1.83	95
Total	2,499	.83	2,072	Total	1,938	.83	1,604	Total	1,312	1.02	1,340			
-1942	Jan.	71	1.59	113	-1948	Jan.	58	1.38	80	-1954	Jan.	49	1.75	86
	Feb.	62	1.66	103		Feb.	65	1.43	93		Feb.	45	1.58	71
	Mar.	76	1.64	125		Mar.	76	1.38	105		Mar.	45	1.42	67
	Apr.	546	.52	284		Apr.	324	.51	165		Apr.	70	.84	59
	May	740	.47	357		May	835	.30	251		May	110	.85	93
	June	688	.38	261		June	546	.40	218		June	39	1.92	75
	July	167	.93	156		July	141	.92	129		July	40	2.10	84
	Aug.	68	2.18	148		Aug.	71	1.84	131		Aug.	31	2.64	82
	Sept.	56	2.36	132		Sept.	48	2.25	108		Sept.	52	2.50	130
	Oct.	57	2.58	147		Oct.	57	2.09	119		Oct.	64	1.94	124
	Nov.	65	1.92	125		Nov.	70	1.84	129		Nov.	51	1.92	98
	Dec.	58	1.83	106		Dec.	70	1.64	115		Dec.	49	1.90	93
Total	2,674	.77	2,057	Total	2,361	.70	1,649	Total	645	1.68	1,062			
-1943	Jan.	57	1.72	96	-1949	Jan.	51	1.49	76	-1955	Jan.	46	1.70	78
	Feb.	48	1.60	77		Feb.	52	1.48	77		Feb.	40	1.67	67
	Mar.	56	1.55	87		Mar.	69	1.42	98		Mar.	59	1.47	87
	Apr.	289	.44	123		Apr.	236	.57	134		Apr.	108	.74	80
	May	389	.48	187		May	481	.38	183		May	262	.52	136
	June	397	.46	183		June	651	.42	273		June	219	.63	138
	July	113	1.08	122		July	265	.65	172		July	46	1.74	80
	Aug.	153	1.43	219		Aug.	65	1.80	117		Aug.	52	1.86	97
	Sept.	87	1.59	138		Sept.	53	2.15	114		Sept.	36	2.48	89
	Oct.	69	1.84	127		Oct.	70	2.09	146		Oct.	38	2.47	94
	Nov.	75	1.59	119		Nov.	74	1.58	117		Nov.	54	2.08	112
	Dec.	61	1.57	96		Dec.	54	1.74	94		Dec.	57	1.65	94
Total	1,784	.88	1,576	Total	2,121	.76	1,601	Total	1,076	1.13	1,152			
-1944	Jan.	51	1.65	84	-1950	Jan.	54	1.57	85	-1956	Jan.	50	1.64	82
	Feb.	48	1.44	69		Feb.	57	2.00	114		Feb.	44	1.53	70
	Mar.	53	1.42	75		Mar.	60	1.33	80		Mar.	56	1.30	73
	Apr.	102	.97	99		Apr.	219	.50	110		Apr.	142	.60	85
	May	758	.32	242		May	309	.45	139		May	324	.45	146
	June	694	.33	220		June	319	.50	160		June	262	.53	139
	July	230	.69	159		July	88	1.43	126		July	37	1.92	71
	Aug.	51	1.94	99		Aug.	37	2.16	80		Aug.	29	2.07	60
	Sept.	45	2.44	110		Sept.	46	2.61	120		Sept.	20	3.15	63
	Oct.	58	2.31	134		Oct.	37	2.65	98		Oct.	35	2.94	103
	Nov.	71	1.86	132		Nov.	49	2.12	104		Nov.	55	1.95	107
	Dec.	64	1.73	111		Dec.	60	1.73	104		Dec.	47	1.87	88
Total	2,225	.69	1,543	Total	1,335	.99	1,328	Total	1,101	.99	1,027			
-1945	Jan.	55	1.58	87	-1951	Jan.	47	1.64	77	-195	Jan.	52	1.73	90
	Feb.	47	1.62	76		Feb.	46	1.59	73		Feb.	55	1.69	93
	Mar.	52	1.48	77		Mar.	55	1.27	70		Mar.	56	1.36	76
	Apr.	91	1.00	91		Apr.	62	.97	60		Apr.	136	.67	91
	May	628	.35	220		May	265	.51	135		May	554	.44	244
	June	407	.46	187		June	323	.52	168		June	1,168	.32	374
	July	163	.85	139		July	93	1.06	99		July	719	.39	281
	Aug.	122	1.22	149		Aug.	53	1.72	91		Aug.	224	.83	186
	Sept.	46	2.39	110		Sept.	37	2.30	85		Sept.	108	1.47	159
	Oct.	76	2.00	152		Oct.	49	2.41	118		Oct.	106	1.92	204
	Nov.	73	1.63	119		Nov.	60	1.88	113		Nov.	111	1.33	148
	Dec.	58	1.59	92		Dec.	46	1.65	76		Dec.	92	1.28	116
Total	1,819	.82	1,499	Total	1,136	1.03	1,165	Total	3,381	.61	2,062			
-1946	Jan.	58	1.55	90	-1952	Jan.	53	1.53	81	-195	Jan.	66	1.40	92
	Feb.	48	1.44	69		Feb.	47	1.48	70		Feb.	70	1.50	105
	Mar.	58	1.28	74		Mar.	53	1.41	75		Mar.	82	1.24	102
	Apr.	182	.59	108		Apr.	342	.46	157		Apr.	254	.57	145
	May	224	.59	135		May	818	.33	270		May	873	.32	279
	June	321	.52	167		June	759	.35	266		June	570	.42	239
	July	64	1.52	104		July	200	.79	158		July	65	1.52	99
	Aug.	56	2.16	121		Aug.	121	1.54	187		Aug.	43	1.74	75
	Sept.	54	2.31	125		Sept.	76	1.86	141		Sept.	51	2.31	118
	Oct.	69	2.06	142		Oct.	67	1.90	127		Oct.	52	2.42	126
	Nov.	67	1.70	114		Nov.	64	2.00	128		Nov.	71	1.82	129
	Dec.	56	1.55	87		Dec.	72	1.68	121		Dec.	65	1.60	104
Total	1,261	1.06	1,336	Total	2,672	.67	1,781	Total	2,262	.71	1,613			

To obtain mg/l multiply T/AF by 735.

Table 8
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Gunnison River near Grand Junction, Colorado

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	57	1.58	90	-1965	Jan.	55	1.37	75	1971	Jan.	196	.54	107
	Feb.	50	1.51	75		Feb.	45	1.28	58		Feb.	201	.45	90
	Mar.	52	1.34	70		Mar.	52	1.33	69		Mar.	239	.44	106
	Apr.	55	1.10	61		Apr.	228	.52	119		Apr.	266	.40	105
	May	167	.75	125		May	582	.36	210		May	209	.66	139
	June	256	.66	169		June	681	.37	252		June	212	.72	152
	July	34	2.39	81		July	472	.47	222		July	114	1.07	122
	Aug.	51	2.01	103		Aug.	158	.98	155		Aug.	114	.95	108
	Sept.	41	2.46	101		Sept.	161	1.29	208		Sept.	133	1.08	144
	Oct.	96	1.45	139		Oct.	116	1.35	157		Oct.	120	1.22	146
	Nov.	72	1.39	100		Nov.	63	1.93	122		Nov.	132	.88	116
	Dec.	50	1.54	77		Dec.	60	1.58	95		Dec.	144	.76	109
Total	981	1.21	1,191	Total	2,673	.65	1,742	Total	2,080	.69	1,444			
-1960	Jan.	49	1.46	72	-1966	Jan.	52	1.67	87	1972	Jan.	126	.61	77
	Feb.	41	1.48	61		Feb.	37	1.86	69		Feb.	110	.61	68
	Mar.	87	1.26	110		Mar.	68	1.30	88		Mar.	109	.65	71
	Apr.	270	.45	122		Apr.	166	.65	108		Apr.	67	.87	58
	May	259	.45	117		May	211	.67	141		May	115	.86	99
	June	336	.46	155		June	125	1.03	129		June	118	.91	107
	July	58	1.33	77		July	51	1.73	89		July	36	1.86	66
	Aug.	34	2.08	71		Aug.	33	2.09	79		Aug.	38	1.73	66
	Sept.	38	2.22	84		Sept.	58	1.99	115		Sept.	84	1.42	120
	Oct.	51	2.34	119		Oct.	65	2.03	132		Oct.	104	1.38	143
	Nov.	58	1.69	98		Nov.	45	2.34	105		Nov.	125	.89	111
	Dec.	51	1.59	81		Dec.	55	1.76	97		Dec.	157	.61	95
Total	1,332	.88	1,167	Total	971	1.28	1,239	Total	1,189	.91	1,081			
-1961	Jan.	41	1.65	68	-1967	Jan.	47	1.63	77	1973	Jan.	155	.52	80
	Feb.	40	1.55	64		Feb.	42	1.62	68		Feb.	75	.84	63
	Mar.	55	1.29	71		Mar.	62	1.16	72		Mar.	83	.93	77
	Apr.	67	1.05	70		Apr.	86	.73	63		Apr.	93	.77	72
	May	266	.50	133		May	143	.81	116		May	456	.34	155
	June	209	.62	130		June	152	1.03	157		June	414	.46	191
	July	34	2.09	71		July	60	1.78	107		July	164	.82	134
	Aug.	44	2.07	91		Aug.	59	1.93	114		Aug.	148	.96	142
	Sept.	100	1.66	166		Sept.	70	1.88	132		Sept.	109	1.07	117
	Oct.	107	1.20	128		Oct.	65	1.88	122		Oct.	125	.98	122
	Nov.	86	1.20	103		Nov.	106	1.16	123		Nov.	89	.99	88
	Dec.	57	1.37	78		Dec.	163	.73	120		Dec.	170	.68	115
Total	1,106	1.06	1,121	Total	1,057	1.20	1,271	Total	2,081	.65	1,356			
-1962	Jan.	52	1.37	71	-1968	Jan.	119	.95	113	1974	Jan.	216	.45	97
	Feb.	58	1.39	78		Feb.	96	1.03	99		Feb.	214	.51	109
	Mar.	53	1.22	65		Mar.	65	1.20	78		Mar.	204	.83	170
	Apr.	395	.37	146		Apr.	68	.97	66		Apr.	141	.74	105
	May	574	.32	184		May	268	.57	153		May	261	.61	159
	June	477	.37	176		June	258	.56	144		June	121	1.53	185
	July	219	.67	147		July	59	1.62	96		July	51	2.82	144
	Aug.	52	1.72	89		Aug.	107	1.56	167		Aug.	42	2.00	84
	Sept.	63	1.97	124		Sept.	68	1.86	126		Sept.	65	1.94	126
	Oct.	70	1.84	129		Oct.	87	1.72	150		Oct.	84	1.75	147
	Nov.	68	1.62	110		Nov.	133	1.08	144		Nov.	117	1.12	131
	Dec.	54	1.70	92		Dec.	149	.77	115		Dec.	111	.99	110
Total	2,135	.66	1,411	Total	1,477	.98	1,451	Total	1,627	.96	1,567			
-1963	Jan.	48	1.65	80	-1969	Jan.	146	.80	117		Jan.			
	Feb.	70	1.51	105		Feb.	75	1.03	77		Feb.			
	Mar.	82	1.11	91		Mar.	145	.70	100		Mar.			
	Apr.	102	.72	73		Apr.					Apr.			
	May	188	.53	100		May	332	.49	162		May			
	June	92	1.02	94		June	194	1.03	200		June			
	July	37	2.11	78		July	100	1.37	137		July			
	Aug.	52	1.99	104		Aug.	91	1.40	128		Aug.			
	Sept.	51	2.28	116		Sept.	119	1.43	170		Sept.			
	Oct.	55	2.52	139		Oct.	155	1.27	197		Oct.			
	Nov.	66	1.70	112		Nov.	143	.98	140		Nov.			
	Dec.	49	1.69	83		Dec.	128	.88	113		Dec.			
Total	892	1.32	1,176	Total	1,932	.87	1,673	Total						
-1964	Jan.	43	1.58	68	-1970	Jan.	129	.78	100		Jan.			
	Feb.	45	1.51	68		Feb.	122	.70	85		Feb.			
	Mar.	43	1.52	65		Mar.	149	.68	101		Mar.			
	Apr.	78	1.00	78		Apr.	137	.69	95		Apr.			
	May	418	.41	171		May	404	.42	169		May			
	June	316	.50	158		June	415	.50	208		June			
	July	83	1.20	100		July	174	.79	137		July			
	Aug.	93	1.61	150		Aug.	101	1.27	128		Aug.			
	Sept.	59	1.99	117		Sept.	196	1.07	209		Sept.			
	Oct.	53	2.20	117		Oct.	188	1.13	212		Oct.			
	Nov.	65	1.85	120		Nov.	170	.78	133		Nov.			
	Dec.	59	1.46	86		Dec.	181	.65	117		Dec.			
Total	1,355	.96	1,298	Total	2,366	.72	1,694	Total						

To obtain mg/l multiply T/AF by 735.

Table 8
Colorado River Basin
Historical Flow and Quality of Water Data
Gunnison River near Grand Junction, Colorado
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	2,493	.83	611	2,072
1942	2,674	.77	565	2,057
1943	1,784	.88	649	1,576
1944	2,225	.69	510	1,543
1945	1,818	.82	606	1,499
1946	1,262	1.06	778	1,336
1947	1,938	.83	609	1,605
1948	2,361	.70	511	1,643
1949	2,121	.76	555	1,601
1950	1,335	.99	727	1,320
1951	1,136	1.03	754	1,165
1952	2,672	.67	490	1,781
1953	1,312	1.02	751	1,340
1954	645	1.65	1,210	1,062
1955	1,017	1.13	833	1,152
1956	1,101	.99	726	1,087
1957	3,381	.61	448	2,062
1958	2,262	.71	524	1,613
1959	981	1.21	892	1,191
1960	1,332	.88	644	1,167
1961	1,106	1.06	778	1,171
1962	2,135	.66	486	1,411
1963	892	1.32	969	1,176
1964	1,355	.96	704	1,298
1965	2,673	.65	479	1,742
1966	971	1.28	938	1,239
1967	1,057	1.20	884	1,271
1968	1,477	.98	722	1,451
1969	1,932	.87	636	1,673
1970	2,366	.72	526	1,694

Sampled quality record entire period.
Measured flow record entire period.

Table 9
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River near Cisco, Utah

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
- 1941	Jan.	139	1.86	259	- 1947	Jan.	185	1.58	229	- 1953	Jan.	185	1.65	306
	Feb.	151	1.78	272		Feb.	150	1.44	216		Feb.	143	1.63	233
	Mar.	207	1.64	339		Mar.	189	1.39	263		Mar.	187	1.52	288
	Apr.	445	1.00	445		Apr.	316	.85	268		Apr.	250	1.00	250
	May	2,365	.42	989		May	1,423	.40	569		May	626	.60	364
	June	1,582	.46	728		June	1,594	.39	621		June	1,399	.41	574
	July	579	.73	423		July	985	.87	463		July	353	.95	335
	Aug.	251	1.67	419		Aug.	369	1.21	447		Aug.	256	1.23	315
	Sept.	237	1.81	429		Sept.	259	1.44	373		Sept.	128	2.22	284
	Oct.	579	1.10	637		Oct.	328	1.47	483		Oct.	177	1.89	334
	Nov.	311	1.18	367		Nov.	277	1.24	343		Nov.	207	1.77	366
	Dec.	229	1.51	346		Dec.	223	1.40	312		Dec.	171	1.75	299
Total	7,067	.80	5,653	Total	6,258	.73	4,587	Total	4,062	.97	3,244			
- 1942	Jan.	181	1.67	302	- 1948	Jan.	191	1.34	256	- 1954	Jan.	177	1.76	312
	Feb.	165	1.73	285		Feb.	210	1.33	280		Feb.	143	1.65	236
	Mar.	228	1.52	347		Mar.	245	1.36	333		Mar.	161	1.46	235
	Apr.	1,344	.61	820		Apr.	830	.64	531		Apr.	221	.98	217
	May	1,809	.45	814		May	1,959	.36	705		May	436	.74	323
	June	1,961	.37	725		June	1,499	.39	585		June	217	1.17	254
	July	579	.78	451		July	446	.86	384		July	150	1.69	253
	Aug.	185	1.84	340		Aug.	225	1.22	242		Aug.	98	2.30	225
	Sept.	134	2.46	329		Sept.	121	1.88	228		Sept.	171	2.09	358
	Oct.	162	2.33	378		Oct.	175	1.96	343		Oct.	215	1.59	342
	Nov.	186	1.99	370		Nov.	204	1.67	341		Nov.	164	1.70	278
	Dec.	164	1.96	322		Dec.	186	1.66	308		Dec.	140	1.90	266
Total	7,058	.77	5,483	Total	6,291	.74	4,636	Total	2,293	1.44	3,299			
- 1943	Jan.	153	1.90	291	- 1949	Jan.	188	1.54	289	- 1955	Jan.	134	1.84	247
	Feb.	146	1.85	270		Feb.	187	1.35	253		Feb.	121	1.78	215
	Mar.	174	1.77	308		Mar.	243	1.40	340		Mar.	198	1.33	263
	Apr.	709	.64	454		Apr.	615	.67	412		Apr.	320	.82	262
	May	996	.46	458		May	1,289	.41	529		May	752	.50	376
	June	1,365	.38	518		June	1,910	.37	707		June	689	.55	379
	July	502	.78	392		July	908	.55	499		July	214	1.21	259
	Aug.	368	1.26	463		Aug.	224	1.58	354		Aug.	185	1.66	307
	Sept.	212	1.85	392		Sept.	158	2.08	328		Sept.	108	2.16	233
	Oct.	184	1.84	339		Oct.	226	1.83	414		Oct.	119	2.19	261
	Nov.	215	1.47	317		Nov.	210	1.71	359		Nov.	169	1.89	319
	Dec.	190	1.56	296		Dec.	180	1.66	299		Dec.	176	1.70	290
Total	5,214	.86	4,498	Total	6,338	.75	4,783	Total	3,185	1.07	3,420			
- 1944	Jan.	140	1.77	248	- 1950	Jan.	199	1.52	302	- 1956	Jan.	155	1.69	262
	Feb.	152	1.56	237		Feb.	201	1.44	289		Feb.	141	1.70	239
	Mar.	166	1.51	251		Mar.	209	1.31	278		Mar.	187	1.50	281
	Apr.	304	1.09	331		Apr.	541	.61	330		Apr.	356	.72	256
	May	1,784	.41	732		May	764	.51	389		May	1,005	.45	452
	June	1,843	.35	645		June	1,113	.42	467		June	924	.44	406
	July	677	.61	413		July	347	1.03	357		July	172	1.47	253
	Aug.	149	1.62	241		Aug.	109	2.02	220		Aug.	119	1.97	234
	Sept.	99	2.54	252		Sept.	138	2.12	292		Sept.	81	2.38	193
	Oct.	159	2.18	347		Oct.	125	2.35	294		Oct.	121	2.22	269
	Nov.	196	1.78	348		Nov.	161	1.96	316		Nov.	165	1.87	308
	Dec.	171	1.70	291		Dec.	167	1.75	293		Dec.	142	1.94	275
Total	5,840	.74	4,336	Total	4,074	.94	3,823	Total	3,568	.96	3,428			
- 1945	Jan.	149	1.73	258	- 1951	Jan.	153	1.69	258	- 1957	Jan.	164	1.80	296
	Feb.	151	1.74	263		Feb.	151	1.51	228		Feb.	168	1.55	260
	Mar.	178	1.56	277		Mar.	161	1.46	236		Mar.	167	1.56	260
	Apr.	328	.88	289		Apr.	173	1.21	209		Apr.	398	.86	342
	May	1,495	.36	538		May	758	.54	409		May	1,375	.44	605
	June	1,311	.37	485		June	1,173	.43	505		June	2,859	.29	829
	July	676	.67	453		July	529	.68	360		July	1,952	.37	722
	Aug.	446	1.01	451		Aug.	238	1.47	350		Aug.	661	.83	547
	Sept.	146	1.85	270		Sept.	131	2.06	270		Sept.	314	1.21	380
	Oct.	217	1.75	380		Oct.	169	1.99	336		Oct.	292	1.78	520
	Nov.	224	1.41	316		Nov.	178	1.74	310		Nov.	299	1.44	431
	Dec.	181	1.26	230		Dec.	172	1.67	287		Dec.	239	1.71	408
Total	5,504	.76	4,210	Total	3,986	.94	3,758	Total	8,888	.63	5,602			
- 1946	Jan.	174	1.37	239	- 1952	Jan.	191	1.59	303	- 1958	Jan.	200	1.52	304
	Feb.	155	1.27	197		Feb.	155	1.65	256		Feb.	225	1.34	302
	Mar.	191	1.24	236		Mar.	194	1.48	287		Mar.	254	1.29	328
	Apr.	525	.61	320		Apr.	969	.53	514		Apr.	756	.53	401
	May	726	.49	356		May	2,152	.35	753		May	2,032	.31	630
	June	1,027	.42	432		June	2,314	.33	764		June	1,569	.40	624
	July	309	.98	303		July	641	.72	462		July	234	1.22	285
	Aug.	196	1.66	325		Aug.	358	1.18	422		Aug.	109	2.17	236
	Sept.	135	2.10	283		Sept.	213	1.58	337		Sept.	153	2.14	328
	Oct.	206	1.85	382		Oct.	166	1.92	318		Oct.	155	1.99	308
	Nov.	206	1.56	322		Nov.	177	1.89	334		Nov.	190	1.66	315
	Dec.	208	1.37	285		Dec.	188	1.66	313		Dec.	176	1.63	287
Total	4,058	.91	3,680	Total	7,718	.66	5,063	Total	6,044	.72	4,349			

To obtain mg/l multiply T/AF by 735.

Table 9
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Cisco, Utah

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	
- 1959	Jan.	168	1.71	287	- 1965	Jan.	162	1.55	251	1971	Jan.	332	.78	258	
	Feb.	153	1.41	216		Feb.	140	1.63	228		Feb.	321	.68	216	
	Mar.	150	1.60	240		Mar.	154	1.59	245		Mar.	413	.63	262	
	Apr.	163	1.39	227		Apr.	562	.68	382		Apr.	580	.50	288	
	May	535	.65	348		May	1,272	.39	496		May	768	.52	398	
	June	924	.50	462		June	1,654	.38	629		June	1,141	.40	457	
	July	214	1.15	246		July	1,116	.52	580		July	535	.65	349	
	Aug.	160	1.91	306		Aug.	447	.94	420		Aug.	246	1.16	286	
	Sept.	124	2.14	265		Sept.	369	1.21	446		Sept.	282	1.13	320	
	Oct.	250	1.43	358		Oct.	360	1.32	475		Oct.	280	1.28	357	
	Nov.	210	1.31	275		Nov.	249	1.65	411		Nov.	276	1.12	308	
	Dec.	163	1.54	291		Dec.	237	1.39	329		Dec.	284	1.06	302	
	Total	3,214	1.08	3,481		Total	6,722	.73	4,892		Total	7,458	.70	3,801	
- 1960	Jan.	164	1.51	248	- 1966	Jan.	200	1.38	276	1972	Jan.	267	1.02	273	
	Feb.	143	1.51	216		Feb.	169	1.34	226		Feb.	227	1.03	233	
	Mar.	273	1.22	333		Mar.	278	.96	267		Mar.	279	1.07	299	
	Apr.	629	.51	321		Apr.	438	.61	267		Apr.	202	.98	198	
	May	758	.49	371		May	697	.53	369		May	453	.71	320	
	June	1,068	.42	448		June	429	.83	356		June	759	.50	377	
	July	250	1.04	260		July	185	1.50	278		July	192	1.19	229	
	Aug.	105	1.96	206		Aug.	120	1.89	227		Aug.	119	1.66	198	
	Sept.	117	2.16	253		Sept.	145	2.01	291		Sept.	201	1.54	309	
	Oct.	153	1.94	297		Oct.	175	1.87	327		Oct.	302	1.13	342	
	Nov.	177	1.67	296		Nov.	153	1.89	289		Nov.	281	1.13	317	
	Dec.	165	1.48	244		Dec.	174	1.71	298		Dec.	267	.98	263	
	Total	4,002	.87	3,493		Total	3,163	1.10	3,471		Total	3,549	.95	3,358	
- 1961	Jan.	156	1.43	228	- 1967	Jan.	146	1.77	258	1973	Jan.	283	.96	273	
	Feb.	140	1.52	213		Feb.	136	1.71	233		Feb.	211	1.15	242	
	Mar.	162	1.44	233		Mar.	185	1.30	240		Mar.	240	1.23	295	
	Apr.	206	1.14	235		Apr.	198	1.31	259		Apr.	388	.96	372	
	May	677	.57	386		May	462	.76	351		May	1,557	.43	670	
	June	664	.51	339		June	713	.65	463		June	1,557	.41	640	
	July	130	1.62	211		July	327	1.09	356		July	799	.60	480	
	Aug.	138	2.01	277		Aug.	175	1.76	308		Aug.	331	1.04	344	
	Sept.	316	1.49	471		Sept.	178	1.77	315		Sept.	220	1.37	302	
	Oct.	357	1.07	382		Oct.	174	1.39	242		Oct.	251	1.34	337	
	Nov.	252	1.23	310		Nov.	211	1.39	293		Nov.	247	1.23	305	
	Dec.	197	1.40	276		Dec.	241	1.18	284		Dec.	290	.93	271	
	Total	3,399	1.05	3,256		Total	3,146	1.14	3,602		Total	6,374	.71	4,531	
- 1962	Jan.	182	1.29	235	- 1968	Jan.	205	1.18	242	1974	Jan.	312	.86	267	
	Feb.	261	1.12	292		Feb.	193	1.20	232		Feb.	294	.81	237	
	Mar.	246	1.05	258		Mar.	171	1.41	241		Mar.	363	.84	304	
	Apr.	1,054	.44	464		Apr.	230	.99	228		Apr.	361	.81	291	
	May	1,603	.38	609		May	667	.60	400		May	1,016	.39	400	
	June	1,400	.38	532		June	1,171	.44	515		June	747	.50	373	
	July	765	.58	444		July	306	1.08	330		July	313	1.01	315	
	Aug.	206	1.42	293		Aug.	365	1.23	449		Aug.	161	1.48	238	
	Sept.	173	1.99	344		Sept.	159	1.72	273		Sept.	158	1.66	263	
	Oct.	263	1.43	376		Oct.	213	1.63	347		Oct.	206	1.58	326	
	Nov.	243	1.31	318		Nov.	257	1.28	329		Nov.	259	1.27	329	
	Dec.	180	1.77	319		Dec.	248	1.14	283		Dec.	232	1.20	279	
	Total	6,576	.68	4,484		Total	4,185	.92	3,869		Total	4,422	.82	3,622	
- 1963	Jan.	163	1.52	248	- 1969	Jan.	259	1.04	270		Jan.				
	Feb.	193	1.51	292		Feb.	189	1.19	224		Feb.				
	Mar.	219	1.30	285		Mar.	250	.97	242		Mar.				
	Apr.	245	.91	223		Apr.	714	.56	400		Apr.				
	May	517	.62	320		May	987	.24	239		May				
	June	332	.93	309		June	731	.60	439		June				
	July	114	1.94	221		July	472	.82	387		July				
	Aug.	168	1.94	326		Aug.	199	1.44	287		Aug.				
	Sept.	183	1.80	329		Sept.	240	1.47	353		Sept.				
	Oct.	134	2.14	287		Oct.	324	1.12	364		Oct.				
	Nov.	179	1.62	290		Nov.	289	1.06	305		Nov.				
	Dec.	138	1.88	254		Dec.	252	1.06	267		Dec.				
	Total	2,585	1.31	3,388		Total	4,906	.77	3,777		Total				
- 1964	Jan.	132	1.85	244	- 1970	Jan.	236	1.06	251		Jan.				
	Feb.	121	1.79	217		Feb.	220	.95	208		Feb.				
	Mar.	128	1.87	239		Mar.	277	.87	241		Mar.				
	Apr.	214	1.11	238		Apr.	327	.82	267		Apr.				
	May	861	.50	430		May	1,384	.37	518		May				
	June	780	.50	390		June	1,339	.39	518		June				
	July	276	1.07	295		July	537	.68	366		July				
	Aug.	241	1.51	364		Aug.	245	1.20	294		Aug.				
	Sept.	153	1.88	288		Sept.	407	1.06	432		Sept.				
	Oct.	164	1.93	317		Oct.	369	.92	305		Oct.				
	Nov.	182	1.81	329		Nov.	338	.90	305		Nov.				
	Dec.	181	1.59	288		Dec.	317	.87	275		Dec.				
	Total	3,433	1.06	3,639		Total	5,987	.67	4,032		Total				

To obtain mg/l multiply T/AF by 735.

Table 9
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Cisco, Utah
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	7,067	.80	588	5,653
1942	7,098	.77	568	5,483
1943	5,214	.86	634	4,498
1944	5,840	.74	546	4,336
1945	5,504	.76	562	4,210
1946	4,058	.91	667	3,680
1947	6,258	.73	539	4,587
1948	6,291	.74	542	4,636
1949	6,338	.75	555	4,783
1950	4,074	.94	690	3,823
1951	3,986	.94	693	3,758
1952	7,718	.66	482	5,063
1953	4,062	.97	714	3,944
1954	2,293	1.44	1,060	3,299
1955	3,185	1.07	789	3,420
1956	3,568	.96	706	3,428
1957	8,888	.63	463	5,602
1958	6,044	.72	529	4,348
1959	3,214	1.08	796	3,481
1960	4,002	.87	642	3,493
1961	3,395	1.05	770	3,556
1962	6,576	.68	501	4,484
1963	2,585	1.31	962	3,384
1964	3,433	1.06	779	3,639
1965	6,722	.73	535	4,892
1966	3,163	1.10	807	3,471
1967	3,146	1.14	842	3,602
1968	4,185	.92	680	3,869
1969	4,906	.77	565	3,777
1970	5,987	.67	495	4,032

Sampled quality record entire period.
Measured flow record entire period.

Table 10
 Colorado River Basin
 Historical Flow and Quality of Water Data
 San Juan River near Archuleta, New Mexico

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
1941	Jan.	22	0.41	9	1947	Jan.	15	0.40	6	1953	Jan.	18	0.39	7
	Feb.	46	.35	16		Feb.	24	.38	9		Feb.	18	.39	7
	Mar.	98	.38	37		Mar.	32	.34	11		Mar.	37	.41	15
	Apr.	251	.21	53		Apr.	50	.24	12		Apr.	75	.24	18
	May	709	.16	112		May	186	.17	32		May	117	.19	22
	June	560	.12	68		June	140	.13	18		June	148	.15	22
	July	324	.14	46		July	43	.28	12		July	41	.32	13
	Aug.	84	.19	16		Aug.	73	.30	22		Aug.	33	.33	11
	Sept.	68	.24	16		Sept.	56	.23	13		Sept.	16	.44	7
	Oct.	273	.12	33		Oct.	77	.21	16		Oct.	23	.43	10
	Nov.	87	.17	15		Nov.	37	.22	8		Nov.	23	.43	10
	Dec.	52	.21	11		Dec.	27	.26	7		Dec.	14	.50	7
Total	2,574	.17	430	Total	760	.22	166	Total	563	.26	149			
1942	Jan.	45	.33	15	1948	Jan.	27	.26	7	1954	Jan.	11	.45	5
	Feb.	48	.25	12		Feb.	39	.33	13		Feb.	21	.48	10
	Mar.	54	.42	23		Mar.	43	.35	15		Mar.	28	.46	13
	Apr.	383	.21	82		Apr.	246	.20	49		Apr.	90	.21	19
	May	320	.15	48		May	306	.14	43		May	143	.18	26
	June	310	.12	38		June	338	.12	40		June	67	.19	13
	July	76	.18	14		July	79	.16	13		July	37	.19	13
	Aug.	41	.22	9		Aug.	49	.24	12		Aug.	45	.29	13
	Sept.	28	.25	7		Sept.	22	.32	7		Sept.	30	.43	13
	Oct.	23	.26	6		Oct.	23	.35	8		Oct.	42	.24	10
	Nov.	22	.27	6		Nov.	18	.39	7		Nov.	18	.39	7
	Dec.	16	.38	6		Dec.	13	.46	6		Dec.	13	.46	6
Total	1,366	.19	266	Total	1,203	.18	229	Total	545	.28	150			
1943	Jan.	16	.44	7	1949	Jan.	16	.44	7	1955	Jan.	12	.42	5
	Feb.	26	.35	9		Feb.	25	.36	9		Feb.	13	.33	4
	Mar.	55	.38	21		Mar.	73	.37	27		Mar.	27	.37	10
	Apr.	198	.19	37		Apr.	228	.24	55		Apr.	45	.24	11
	May	184	.16	30		May	318	.15	48		May	132	.18	24
	June	134	.15	20		June	406	.13	53		June	119	.16	19
	July	51	.24	12		July	199	.15	30		July	42	.29	12
	Aug.	48	.21	10		Aug.	57	.24	14		Aug.	67	.28	19
	Sept.	28	.25	7		Sept.	33	.27	9		Sept.	28	.29	8
	Oct.	35	.20	7		Oct.	30	.30	8		Oct.	20	.30	6
	Nov.	24	.29	7		Nov.	21	.38	8		Nov.	17	.35	6
	Dec.	19	.32	6		Dec.	14	.50	7		Dec.	15	.40	6
Total	818	.21	173	Total	1,420	.19	276	Total	537	.24	130			
1944	Jan.	16	.38	5	1950	Jan.	16	.37	6	1956	Jan.	16	.38	6
	Feb.	19	.32	6		Feb.	29	.41	12		Feb.	15	.40	6
	Mar.	34	.47	16		Mar.	33	.42	13		Mar.	48	.33	16
	Apr.	131	.21	27		Apr.	116	.19	22		Apr.	79	.20	16
	May	371	.16	61		May	126	.15	19		May	173	.14	24
	June	382	.13	49		June	112	.16	18		June	117	.15	18
	July	134	.16	22		July	44	.27	12		July	25	.32	8
	Aug.	45	.20	9		Aug.	20	.35	7		Aug.	23	.35	8
	Sept.	43	.23	10		Sept.	24	.38	9		Sept.	11	.36	4
	Oct.	41	.22	9		Oct.	20	.35	7		Oct.	12	.42	5
	Nov.	21	.29	6		Nov.	14	.50	7		Nov.	11	.45	5
	Dec.	14	.43	6		Dec.	12	.50	6		Dec.	9	.44	4
Total	1,251	.18	227	Total	564	.24	138	Total	539	.22	120			
1945	Jan.	14	.43	5	1951	Jan.	10	.50	5	1957	Jan.	13	.46	6
	Feb.	22	.45	10		Feb.	11	.45	5		Feb.	30	.47	14
	Mar.	35	.49	17		Mar.	20	.45	9		Mar.	46	.43	20
	Apr.	143	.20	28		Apr.	35	.29	10		Apr.	120	.28	34
	May	278	.16	44		May	117	.18	21		May	222	.19	42
	June	209	.13	28		June	94	.17	16		June	480	.13	62
	July	68	.21	14		July	21	.38	8		July	326	.16	52
	Aug.	40	.22	9		Aug.	33	.36	12		Aug.	164	.22	36
	Sept.	21	.24	5		Sept.	17	.47	8		Sept.	67	.19	13
	Oct.	30	.37	11		Oct.	22	.47	8		Oct.	67	.30	20
	Nov.	19	.37	7		Nov.	15	.47	7		Nov.	68	.26	18
	Dec.	12	.50	6		Dec.	12	.44	6		Dec.	44	.30	13
Total	891	.21	185	Total	413	.28	117	Total	1,647	.20	330			
1946	Jan.	14	.43	6	1952	Jan.	19	.53	10	1958	Jan.	22	.36	8
	Feb.	17	.47	8		Feb.	19	.53	10		Feb.	51	.43	22
	Mar.	22	.50	11		Mar.	47	.49	23		Mar.	77	.42	32
	Apr.	66	.23	15		Apr.	326	.26	85		Apr.	279	.30	84
	May	73	.18	13		May	396	.16	63		May	460	.17	78
	June	87	.18	16		June	454	.13	59		June	270	.13	35
	July	27	.33	9		July	136	.18	24		July	42	.26	11
	Aug.	40	.35	14		Aug.	66	.26	17		Aug.	35	.31	11
	Sept.	29	.31	9		Sept.	33	.27	9		Sept.	40	.30	12
	Oct.	36	.31	11		Oct.	22	.32	7		Oct.	25	.36	9
	Nov.	26	.35	9		Nov.	16	.44	7		Nov.	17	.41	7
	Dec.	19	.32	6		Dec.	18	.39	7		Dec.	14	.43	6
Total	456	.28	127	Total	1,552	.21	321	Total	1,332	.24	315			

To obtain mg/l multiply T/AF by 735.

Table IO
 Colorado River Basin
 Historical Flow and Quality of Water Data
 San Juan River near Archuleta, New Mexico

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
1959	Jan.	11	0.46	5	1965	Jan.	90	0.29	26	1971	Jan.	141	.23	32
	Feb.	14	.44	6		Feb.	92	.30	28		Feb.	120	.24	29
	Mar.	18	.42	8		Mar.	52	.36	19		Mar.	68	.22	15
	Apr.	37	.30	11		Apr.	85	.35	30		Apr.	30	.23	7
	May	87	.18	16		May	138	.29	40		May	31	.22	7
	June	84	.16	13		June	215	.20	43		June	29	.24	7
	July	18	.32	6		July	102	.18	18		July	31	.22	7
	Aug.	34	.33	11		Aug.	136	.17	23		Aug.	30	.21	6
	Sept.	15	.34	5		Sept.	112	.17	19		Sept.	30	.22	7
	Oct.	60	.30	18		Oct.	131	.13	17		Oct.	25	.26	6
	Nov.	39	.30	12		Nov.	180	.16	29		Nov.	18	.29	5
	Dec.	19	.37	7		Dec.	178	.18	32		Dec.	65	.21	14
Total	436	.27	118	Total	1,511	.21	324	Total	618	.23	142			
1960	Jan.	14	.43	6	1966	Jan.	168	.21	35	1972	Jan.	93	.22	20
	Feb.	16	.42	7		Feb.	94	.26	24		Feb.	84	.26	22
	Mar.	175	.34	60		Mar.	114	.29	33		Mar.	93	.28	26
	Apr.	240	.19	46		Apr.	181	.28	51		Apr.	49	.28	14
	May	193	.17	33		May	130	.26	34		May	31	.24	7
	June	232	.13	30		June	27	.22	6		June	30	.28	9
	July	55	.23	13		July	28	.17	5		July	31	.30	9
	Aug.	25	.29	7		Aug.	29	.18	5		Aug.	38	.24	9
	Sept.	23	.31	7		Sept.	27	.17	5		Sept.	37	.27	10
	Oct.	26	.37	10		Oct.	91	.18	16		Oct.	32	.29	9
	Nov.	16	.42	7		Nov.	47	.20	9		Nov.	30	.27	8
	Dec.	14	.54	7		Dec.	25	.24	6		Dec.	62	.27	17
Total	1,029	.23	233	Total	961	.24	229	Total	610	.26	160			
1961	Jan.	12	.45	5	1967	Jan.	25	.26	6	1973	Jan.	71	.27	19
	Feb.	16	.43	7		Feb.	45	.26	12		Feb.	97	.26	25
	Mar.	43	.44	19		Mar.	70	.26	18		Mar.	29	.31	9
	Apr.	113	.26	29		Apr.	23	.27	6		Apr.	30	.30	9
	May	192	.15	29		May	17	.31	5		May	133	.31	41
	June	122	.16	19		June	18	.35	6		June	182	.28	51
	July	38	.28	11		July	20	.34	7		July	266	.28	75
	Aug.	52	.28	15		Aug.	62	.29	18		Aug.	216	.22	47
	Sept.	58	.25	15		Sept.	59	.26	15		Sept.	159	.22	35
	Oct.	52	.24	12		Oct.	23	.23	5		Oct.	120	.20	24
	Nov.	34	.28	10		Nov.	21	.26	5		Nov.	117	.21	24
	Dec.	18	.31	6		Dec.	21	.28	6		Dec.	120	.21	25
Total	750	.24	177	Total	402	.27	109	Total	1,540	.25	384			
1962	Jan.	15	.37	6	1968	Jan.	19	.29	6	1974	Jan.	103	.20	21
	Feb.	42	.38	16		Feb.	20	.26	5		Feb.	65	.23	15
	Mar.	51	.38	20		Mar.	18	.29	5		Mar.	63	.22	14
	Apr.	242	.20	48		Apr.	60	.27	16		Apr.	59	.25	15
	May	228	.14	32		May	49	.26	13		May	57	.25	14
	June	165	.14	23		June	28	.26	7		June	38	.24	9
	July	39	.19	7		July	30	.28	8		July	36	.25	9
	Aug.	29	.25	7		Aug.	39	.27	11		Aug.	43	.26	11
	Sept.	19	.25	5		Sept.	47	.25	12		Sept.	42	.24	10
	Oct.	18	.31	6		Oct.	35	.25	9		Oct.	32	.28	9
	Nov.	14	.33	5		Nov.	23	.24	6		Nov.	28	.29	8
	Dec.	10	.37	4		Dec.	24	.23	6		Dec.	30	.30	9
Total	872	.21	179	Total	392	.27	104	Total	596	.24	144			
1963	Jan.	7	.39	3	1969	Jan.	40	.22	9	1970	Jan.	51	.22	11
	Feb.	8	.43	4		Feb.	110	.23	25		Feb.	110	.19	21
	Mar.	15	.39	6		Mar.	94	.20	19		Mar.	91	.20	18
	Apr.	31	.38	12		Apr.	110	.25	27		Apr.	26	.23	6
	May	19	.26	5		May	117	.22	26		May	29	.24	7
	June	19	.19	4		June	116	.22	26		June	30	.23	7
	July	20	.18	4		July	98	.22	22		July	31	.19	6
	Aug.	21	.19	4		Aug.	72	.21	15		Aug.	39	.18	7
	Sept.	20	.20	4		Sept.	76	.21	16		Sept.	78	.19	15
	Oct.	24	.23	6		Oct.	96	.20	19		Oct.	110	.22	24
	Nov.	24	.24	6		Nov.	81	.21	17		Nov.	104	.22	23
	Dec.	24	.28	7		Dec.	90	.21	19		Dec.	120	.22	26
Total	232	.28	65	Total	1,102	.22	240	Total	819	.21	171			
1964	Jan.	17	.32	6	1970	Jan.	51	.22	11	1970	Jan.	51	.22	11
	Feb.	13	.31	4		Feb.	110	.19	21		Feb.	110	.19	21
	Mar.	13	.32	4		Mar.	91	.20	18		Mar.	91	.20	18
	Apr.	15	.32	5		Apr.	26	.23	6		Apr.	26	.23	6
	May	34	.31	10		May	29	.24	7		May	29	.24	7
	June	82	.28	23		June	30	.23	7		June	30	.23	7
	July	108	.25	27		July	31	.19	6		July	31	.19	6
	Aug.	48	.23	11		Aug.	39	.18	7		Aug.	39	.18	7
	Sept.	26	.22	6		Sept.	78	.19	15		Sept.	78	.19	15
	Oct.	28	.23	6		Oct.	110	.22	24		Oct.	110	.22	24
	Nov.	21	.27	6		Nov.	104	.22	23		Nov.	104	.22	23
	Dec.	32	.28	9		Dec.	120	.22	26		Dec.	120	.22	26
Total	437	.27	117	Total	819	.21	171	Total	819	.21	171			

To obtain mg/l multiply T/AF by 735.

Table 10
Colorado River Basin
Historical Flow and Quality of Water Data
San Juan River near Archuleta, New Mexico
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	2,574	0.17	123	430
1942	1,366	.19	143	266
1943	818	.21	155	173
1944	1,251	.18	133	227
1945	891	.21	153	185
1946	456	.28	205	127
1947	760	.22	161	166
1948	1,203	.18	134	220
1949	1,420	.19	142	276
1950	564	.24	180	138
1951	413	.28	208	117
1952	1,552	.21	152	321
1953	563	.26	195	149
1954	545	.28	202	150
1955	537	.24	178	130
1956	539	.22	164	120
1957	1,647	.20	147	330
1958	1,332	.24	174	315
1959	436	.27	199	118
1960	1,029	.23	166	233
1961	750	.24	173	177
1962	872	.21	151	179
1963	232	.28	206	65
1964	437	.27	197	117
1965	1,511	.21	158	324
1966	961	.24	175	229
1967	402	.27	199	109
1968	392	.27	195	104
1969	1,102	.22	159	240
1970	819	.21	153	171

Sampled quality record, October 1945 to December 1972; remainder by correlation.

Measured flow record entire period.

Adjusted quality and flow record for station near Blanco, October 1945 to November 1954.

Table II
 Colorado River Basin
 Historical Flow and Quality of Water Data
 San Juan River near Bluff, Utah

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	78	1.01	79	-1947	Jan.	31	1.13	35	-1953	Jan.	42	1.24	52
	Feb.	127	.98	124		Feb.	45	1.07	48		Feb.	36	1.17	42
	Mar.	211	.78	165		Mar.	51	.90	46		Mar.	56	1.02	57
	Apr.	392	.62	243		Apr.	68	.63	43		Apr.	107	.64	68
	May	1,323	.50	662		May	329	.38	125		May	156	.44	69
	June	915	.30	275		June	276	.30	83		June	267	.27	72
	July	526	.30	158		July	110	.41	45		July	77	.84	65
	Aug.	174	.70	122		Aug.	294	1.01	296		Aug.	71	1.15	82
	Sept.	202	.87	176		Sept.	124	.73	91		Sept.	12	1.50	18
	Oct.	655	.64	419		Oct.	207	.79	163		Oct.	54	1.28	69
	Nov.	191	.61	117		Nov.	77	.73	56		Nov.	55	1.13	62
	Dec.	105	.81	85		Dec.	65	.86	56		Dec.	36	1.31	45
Total	4,899	.54	2,625	Total	1,617	.65	1,087	Total	967	.73	701			
-1942	Jan.	81	.93	75	-1948	Jan.	52	.83	43	-1954	Jan.	32	1.34	43
	Feb.	68	.93	63		Feb.	79	.84	66		Feb.	36	1.17	42
	Mar.	126	.95	120		Mar.	89	.83	74		Mar.	48	1.02	49
	Apr.	602	.51	307		Apr.	358	.37	133		Apr.	113	.53	60
	May	479	.38	182		May	519	.27	140		May	218	.39	85
	June	533	.26	139		June	603	.28	169		June	120	.48	58
	July	150	.48	72		July	147	.41	60		July	120	1.03	123
	Aug.	52	.82	42		Aug.	86	.78	67		Aug.	66	.86	57
	Sept.	38	1.00	38		Sept.	36	1.11	40		Sept.	89	1.19	106
	Oct.	37	1.22	45		Oct.	75	1.05	79		Oct.	95	.75	71
	Nov.	39	1.23	48		Nov.	55	1.07	59		Nov.	39	1.05	41
	Dec.	45	1.36	54		Dec.	41	1.12	46		Dec.	35	1.26	44
Total	2,247	.53	1,185	Total	2,140	.46	976	Total	1,011	.77	779			
-1943	Jan.	43	1.26	54	-1949	Jan.	63	1.11	70	-1955	Jan.	31	1.26	39
	Feb.	49	1.18	58		Feb.	74	.99	73		Feb.	34	1.12	38
	Mar.	95	1.09	104		Mar.	152	.81	123		Mar.	63	1.00	63
	Apr.	294	.47	138		Apr.	338	.45	152		Apr.	62	.74	46
	May	332	.39	129		May	503	.31	156		May	186	.38	71
	June	254	.38	96		June	748	.31	232		June	208	.32	67
	July	106	.57	60		July	342	.33	113		July	65	.88	57
	Aug.	91	1.01	92		Aug.	90	.66	59		Aug.	142	1.07	152
	Sept.	62	.90	56		Sept.	41	1.05	43		Sept.	28	.82	23
	Oct.	58	1.00	58		Oct.	56	1.00	56		Oct.	25	1.00	25
	Nov.	59	.97	57		Nov.	45	1.07	48		Nov.	31	1.25	39
	Dec.	51	1.12	57		Dec.	35	1.23	43		Dec.	35	1.34	47
Total	1,494	.64	959	Total	2,487	.47	1,168	Total	910	.73	667			
-1944	Jan.	37	1.16	43	-1950	Jan.	41	1.12	46	-1956	Jan.	40	1.22	49
	Feb.	49	1.14	56		Feb.	49	1.08	53		Feb.	34	1.29	44
	Mar.	76	1.06	81		Mar.	56	.93	52		Mar.	74	.83	51
	Apr.	204	.62	126		Apr.	136	.46	62		Apr.	107	.50	54
	May	640	.36	230		May	169	.40	68		May	241	.35	84
	June	705	.25	176		June	191	.38	73		June	203	.31	63
	July	283	.35	99		July	68	.72	49		July	31	1.10	34
	Aug.	61	.85	52		Aug.	15	1.13	17		Aug.	36	1.33	48
	Sept.	62	.92	61		Sept.	42	1.14	48		Sept.	4	1.50	6
	Oct.	75	.91	68		Oct.	30	1.07	32		Oct.	13	1.54	20
	Nov.	52	1.12	58		Nov.	25	1.44	36		Nov.	30	1.23	37
	Dec.	43	1.19	51		Dec.	32	1.34	43		Dec.	25	1.40	35
Total	2,291	.48	1,101	Total	854	.68	579	Total	838	.64	535			
-1945	Jan.	41	1.22	50	-1951	Jan.	30	1.30	39	-1957	Jan.	38	1.26	48
	Feb.	63	1.13	71		Feb.	29	1.41	41		Feb.	64	1.05	67
	Mar.	72	1.03	74		Mar.	34	1.15	39		Mar.	71	.97	59
	Apr.	196	.61	120		Apr.	34	.85	29		Apr.	171	.55	94
	May	456	.35	160		May	142	.51	72		May	327	.48	157
	June	377	.29	109		June	188	.36	68		June	787	.28	220
	July	128	.50	64		July	30	.80	24		July	566	.38	215
	Aug.	96	1.13	108		Aug.	49	1.06	52		Aug.	364	.63	229
	Sept.	21	1.18	25		Sept.	45	1.07	48		Sept.	142	.68	97
	Oct.	62	1.10	68		Oct.	35	1.23	43		Oct.	150	.86	129
	Nov.	46	1.04	48		Nov.	39	1.10	43		Nov.	141	.72	102
	Dec.	30	1.27	38		Dec.	36	1.28	46		Dec.	88	.81	71
Total	1,588	.59	935	Total	691	.79	544	Total	2,909	.51	1,498			
-1946	Jan.	37	1.14	42	-1952	Jan.	88	1.16	102	-1958	Jan.	53	1.02	54
	Feb.	36	1.19	43		Feb.	40	1.20	48		Feb.	119	.92	109
	Mar.	47	1.04	49		Mar.	87	1.03	90		Mar.	159	.87	139
	Apr.	95	.66	63		Apr.	453	.42	190		Apr.	413	.48	198
	May	125	.49	61		May	618	.30	185		May	743	.26	193
	June	204	.40	82		June	769	.24	185		June	507	.25	126
	July	63	.86	54		July	238	.42	100		July	74	.65	48
	Aug.	75	1.12	84		Aug.	83	.69	57		Aug.	43	1.02	43
	Sept.	44	.93	41		Sept.	56	.93	52		Sept.	61	.95	58
	Oct.	55	.98	54		Oct.	38	1.05	40		Oct.	47	1.04	49
	Nov.	60	1.02	61		Nov.	41	1.29	53		Nov.	43	1.23	53
	Dec.	46	1.02	47		Dec.	43	1.26	54		Dec.	36	1.28	46
Total	887	.77	681	Total	2,554	.45	1,156	Total	2,298	.49	1,116			

To obtain mg/l multiply T/AF by 735.

Table II
 Colorado River Basin
 Historical Flow and Quality of Water Data
 San Juan River near Bluff, Utah

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	30	1.39	42	-1965	Jan.	122	0.77	94	1971	Jan.	164	.48	79
	Feb.	31	1.36	42		Feb.	120	.70	84		Feb.	144	.48	69
	Mar.	32	1.27	41		Mar.	95	.93	79		Mar.	101	.57	51
	Apr.	39	.94	37		Apr.	165	.62	102		Apr.	69	.74	51
	May	111	.52	58		May	288	.45	130		May	86	.77	67
	June	156	.39	61		June	419	.38	159		June	123	.49	61
	July	18	.81	15		July	295	.45	133		July	66	.83	54
	Aug.	64	1.13	72		Aug.	218	.65	142		Aug.	108	1.36	146
	Sept.	11	1.53	17		Sept.	177	.56	99		Sept.	52	1.12	58
	Oct.	92	.86	79		Oct.	190	.60	114		Oct.	100	1.14	113
	Nov.	82	.82	67		Nov.	232	.50	116		Nov.	59	1.12	66
	Dec.	46	1.02	47		Dec.	235	.54	127		Dec.	110	.77	85
Total	712	.81	578	Total	2,546	.54	1,379	Total	1,182	.77	906			
-1960	Jan.	37	1.26	47	-1966	Jan.	198	0.54	107	1972	Jan.	119	.61	72
	Feb.	43	1.09	47		Feb.	129	.65	84		Feb.	109	.61	67
	Mar.	260	.73	190		Mar.	199	.68	135		Mar.	119	.54	64
	Apr.	336	.32	108		Apr.	252	.48	121		Apr.	65	.69	44
	May	285	.34	97		May	267	.42	112		May	81	.69	56
	June	382	.27	103		June	127	.56	71		June	118	.61	72
	July	92	.53	49		July	54	1.01	55		July	17	1.14	19
	Aug.	18	1.11	20		Aug.	44	1.30	57		Aug.	31	1.44	44
	Sept.	17	1.24	21		Sept.	42	1.25	52		Sept.	56	.99	56
	Oct.	58	1.13	66		Oct.	94	.60	62		Oct.	339	1.03	349
	Nov.	39	1.22	48		Nov.	70	.86	60		Nov.	96	.98	94
	Dec.	40	1.27	51		Dec.	72	1.11	80		Dec.	100	.79	79
Total	1,607	.53	847	Total	1,548	.64	926	Total	1,250	.81	1,016			
-1961	Jan.	35	1.33	47	-1967	Jan.	58	1.07	62	1973	Jan.	109	.76	83
	Feb.	41	1.31	54		Feb.	64	.92	59		Feb.	178	.75	134
	Mar.	66	1.02	67		Mar.	79	.71	56		Mar.	177	1.16	205
	Apr.	157	.56	88		Apr.	31	1.15	36		Apr.	260	.95	248
	May	285	.32	91		May	78	.76	59		May	486	.49	237
	June	227	.31	70		June	89	.91	81		June	466	.40	187
	July	43	.83	36		July	39	1.35	53		July	398	.41	162
	Aug.	87	1.05	91		Aug.	151	1.29	195		Aug.	222	.49	108
	Sept.	109	.88	96		Sept.	94	.96	90		Sept.	195	.54	106
	Oct.	92	.77	75		Oct.	31	1.46	45		Oct.	133	.59	79
	Nov.	72	.93	67		Nov.	38	1.26	48		Nov.	134	.59	79
	Dec.	44	1.22	54		Dec.	39	1.20	47		Dec.	141	.57	81
Total	1,264	.66	836	Total	791	1.05	831	Total	2,897	.59	1,709			
-1962	Jan.	36	1.24	45	-1968	Jan.	36	1.22	44	1974	Jan.	133	.59	78
	Feb.	94	.95	89		Feb.	54	1.29	70		Feb.	92	.72	66
	Mar.	73	.90	72		Mar.	50	1.25	62		Mar.	103	.98	101
	Apr.	315	.37	117		Apr.	83	.75	62		Apr.	65	.78	51
	May	346	.30	104		May	148	.54	80		May	106	.57	60
	June	297	.32	95		June	240	.37	89		June	69	.64	44
	July	88	.59	52		July	82	.93	76		July	39	1.13	44
	Aug.	23	1.02	23		Aug.	176	1.04	183		Aug.	25	1.12	28
	Sept.	26	1.41	37		Sept.	41	1.00	41		Sept.	25	1.08	27
	Oct.	104	1.32	137		Oct.	56	1.09	61		Oct.	73	.99	72
	Nov.	45	1.34	60		Nov.	49	1.18	58		Nov.	71	1.11	79
	Dec.	33	1.40	46		Dec.	45	1.07	48		Dec.	55	1.04	57
Total	1,480	.59	877	Total	1,060	.82	874	Total	856	.83	707			
-1963	Jan.	25	1.66	42	-1969	Jan.	83	1.04	86		Jan.			
	Feb.	39	1.44	56		Feb.	131	.61	80		Feb.			
	Mar.	40	1.25	50		Mar.	143	.73	104		Mar.			
	Apr.	64	.78	50		Apr.	216	.54	117		Apr.			
	May	95	.72	68		May	271	.40	108		May			
	June	47	.82	39		June	238	.45	107		June			
	July	15	1.60	24		July	202	.57	115		July			
	Aug.	48	1.57	75		Aug.	101	.88	89		Aug.			
	Sept.	70	1.09	78		Sept.	118	.76	90		Sept.			
	Oct.	41	1.32	54		Oct.	208	.83	173		Oct.			
	Nov.	47	1.10	52		Nov.	118	.64	75		Nov.			
	Dec.	48	1.03	49		Dec.	109	.65	71		Dec.			
Total	579	1.10	635	Total	1,938	.63	1,215	Total						
-1964	Jan.	44	1.14	50	-1970	Jan.	75	.77	58		Jan.			
	Feb.	30	1.27	38		Feb.	130	.49	64		Feb.			
	Mar.	28	1.46	41		Mar.	116	.57	66		Mar.			
	Apr.	30	1.40	42		Apr.	49	.96	47		Apr.			
	May	103	.57	59		May	140	.45	62		May			
	June	121	.58	70		June	138	.49	67		June			
	July	113	.76	86		July	74	.73	54		July			
	Aug.	131	1.07	140		Aug.	66	1.09	72		Aug.			
	Sept.	56	1.36	76		Sept.	308	.21	238		Sept.			
	Oct.	37	1.26	47		Oct.	137	.59	84		Oct.			
	Nov.	42	1.43	60		Nov.	149	.58	89		Nov.			
	Dec.	60	1.20	72		Dec.	149	.58	89		Dec.			
Total	795	.98	781	Total	1,524	.63	954	Total						

To obtain mg/l multiply T/AF by 735.

Table II
Colorado River Basin
Historical Flow and Quality of Water Data
San Juan River near Bluff, Utah
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	4,899	.54	394	2,625
1942	2,247	.53	388	1,185
1943	1,494	.64	472	959
1944	2,291	.48	353	1,101
1945	1,588	.59	433	935
1946	887	.77	564	681
1947	1,677	.65	476	1,087
1948	2,140	.46	335	976
1949	2,487	.47	345	1,168
1950	854	.68	498	579
1951	691	.79	579	544
1952	2,554	.45	333	1,156
1953	967	.73	533	701
1954	1,011	.77	566	779
1955	910	.73	539	667
1956	838	.64	469	535
1957	2,909	.51	378	1,498
1958	2,298	.49	357	1,116
1959	712	.81	597	578
1960	1,607	.53	387	847
1961	1,264	.66	486	836
1962	1,480	.59	436	877
1963	579	1.10	806	635
1964	795	.98	722	781
1965	2,546	.54	398	1,379
1966	1,548	.64	473	996
1967	791	1.05	772	831
1968	1,060	.82	606	874
1969	1,938	.63	460	1,215
1970	1,524	.63	460	954

Sampled quality record entire period.
Measured flow records entire period.

Table 12
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River at Lees Ferry, Arizona

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	348	1.36	474	-1947	Jan.	277	1.40	388	-1953	Jan.	393	1.30	534
	Feb.	423	1.29	546		Feb.	357	1.29	462		Feb.	385	1.30	475
	Mar.	669	1.12	749		Mar.	654	1.09	713		Mar.	458	1.22	558
	Apr.	1,091	.79	862		Apr.	780	.78	608		Apr.	529	1.07	566
	May	4,974	.45	2,239		May	3,121	.39	1,217		May	1,047	.69	723
	June	4,004	.38	1,522		June	3,275	.40	1,310		June	2,932	.38	1,137
	July	1,666	.51	850		July	1,326	.43	828		July	550	.64	608
	Aug.	798	1.16	925		Aug.	1,203	.98	1,179		Aug.	661	1.39	787
	Sept.	608	1.35	821		Sept.	584	1.13	660		Sept.	258	1.59	410
	Oct.	1,797	1.09	1,959		Oct.	818	1.17	958		Oct.	321	1.77	568
	Nov.	903	.94	849		Nov.	585	1.07	626		Nov.	414	1.50	621
	Dec.	576	1.19	685		Dec.	466	1.21	564		Dec.	341	1.46	498
Total	17,857	.70	12,481	Total	14,046	.68	9,513	Total	8,730	.66	7,485			
-1942	Jan.	407	1.34	545	-1948	Jan.	406	1.18	479	-1954	Jan.	319	1.46	466
	Feb.	326	1.28	507		Feb.	458	1.14	522		Feb.	342	1.30	444
	Mar.	630	1.16	731		Mar.	645	1.14	735		Mar.	393	1.24	487
	Apr.	2,844	.55	1,564		Apr.	1,703	.64	1,090		Apr.	546	1.00	546
	May	3,209	.46	1,476		May	3,507	.38	1,334		May	1,277	.56	715
	June	4,202	.29	1,219		June	3,339	.34	1,134		June	792	.63	499
	July	1,317	.57	751		July	380	.65	257		July	647	.87	563
	Aug.	454	1.08	490		Aug.	531	1.23	653		Aug.	321	1.19	382
	Sept.	275	1.59	438		Sept.	230	1.40	322		Sept.	389	1.66	645
	Oct.	334	1.58	528		Oct.	331	1.65	545		Oct.	512	1.43	733
	Nov.	368	1.58	582		Nov.	408	1.46	595		Nov.	349	1.39	485
	Dec.	357	1.54	550		Dec.	347	1.40	485		Dec.	278	1.51	421
Total	14,793	.63	9,381	Total	12,885	.66	8,531	Total	6,165	1.04	6,386			
-1943	Jan.	330	1.50	494	-1949	Jan.	337	1.39	469	-1955	Jan.	244	1.58	386
	Feb.	332	1.41	469		Feb.	361	1.25	451		Feb.	243	1.39	338
	Mar.	516	1.19	614		Mar.	706	1.18	834		Mar.	580	1.29	748
	Apr.	1,450	.67	971		Apr.	1,307	.78	1,020		Apr.	617	1.05	649
	May	2,158	.43	928		May	3,098	.43	1,332		May	1,570	.58	879
	June	2,729	.40	1,092		June	4,419	.41	1,812		June	1,586	.49	777
	July	1,429	.47	672		July	2,137	.52	1,111		July	571	.70	399
	Aug.	793	1.09	864		Aug.	576	1.00	576		Aug.	510	1.40	713
	Sept.	447	1.15	514		Sept.	313	1.51	473		Sept.	230	1.60	368
	Oct.	378	1.60	604		Oct.	509	1.48	753		Oct.	214	1.70	363
	Nov.	456	1.35	616		Nov.	473	1.31	619		Nov.	275	1.67	458
	Dec.	395	1.36	537		Dec.	368	1.37	504		Dec.	326	1.44	470
Total	11,413	.73	8,375	Total	14,604	.68	9,954	Total	6,966	.94	6,548			
-1944	Jan.	278	1.50	418	-1950	Jan.	350	1.41	493	-1956	Jan.	373	1.28	477
	Feb.	304	1.32	454		Feb.	390	1.23	490		Feb.	280	1.39	390
	Mar.	509	1.31	668		Mar.	650	1.11	721		Mar.	511	1.16	592
	Apr.	1,027	.89	914		Apr.	1,217	.74	900		Apr.	888	.75	673
	May	3,251	.47	1,528		May	1,974	.49	966		May	2,190	.46	1,051
	June	4,136	.32	1,323		June	2,379	.37	1,102		June	2,594	.39	1,012
	July	1,782	.45	802		July	1,377	.67	923		July	557	.75	418
	Aug.	417	1.07	446		Aug.	422	1.02	430		Aug.	356	1.33	473
	Sept.	229	1.50	343		Sept.	330	1.47	485		Sept.	166	1.48	246
	Oct.	342	1.66	567		Oct.	342	1.47	502		Oct.	186	1.74	324
	Nov.	384	1.51	579		Nov.	350	1.55	542		Nov.	300	1.58	474
	Dec.	320	1.51	483		Dec.	415	1.31	544		Dec.	247	1.55	383
Total	13,319	.65	8,525	Total	10,802	.75	8,098	Total	8,658	.75	6,513			
-1945	Jan.	325	1.48	481	-1951	Jan.	315	1.43	451	-1957	Jan.	264	1.46	415
	Feb.	352	1.39	489		Feb.	361	1.25	451		Feb.	323	1.34	433
	Mar.	437	1.28	559		Mar.	418	1.19	497		Mar.	498	1.23	613
	Apr.	755	.99	748		Apr.	531	1.00	551		Apr.	828	.90	745
	May	2,805	.44	1,234		May	1,645	.57	938		May	2,569	.59	1,439
	June	2,761	.37	1,021		June	2,886	.41	1,184		June	5,685	.39	2,201
	July	1,668	.47	784		July	1,357	.48	651		July	4,015	.43	1,727
	Aug.	1,011	.89	900		Aug.	787	1.11	874		Aug.	1,504	.78	1,251
	Sept.	370	1.28	474		Sept.	411	1.32	542		Sept.	822	1.03	847
	Oct.	505	1.51	763		Oct.	412	1.47	606		Oct.	748	1.54	1,150
	Nov.	443	1.34	594		Nov.	445	1.41	628		Nov.	848	1.39	1,179
	Dec.	337	1.35	454		Dec.	333	1.44	480		Dec.	516	1.25	446
Total	11,769	.72	8,501	Total	9,901	.79	7,833	Total	18,700	.68	12,646			
-1946	Jan.	366	1.28	468	-1952	Jan.	476	1.23	586	-1958	Jan.	397	1.27	504
	Feb.	319	1.24	396		Feb.	379	1.26	478		Feb.	536	1.16	632
	Mar.	496	1.15	570		Mar.	440	1.31	576		Mar.	606	1.10	766
	Apr.	1,013	.83	841		Apr.	2,267	.74	1,677		Apr.	1,574	.64	1,007
	May	1,732	.47	814		May	5,081	.41	2,083		May	3,992	.45	1,836
	June	1,393	.43	857		June	5,192	.35	1,869		June	3,678	.40	1,471
	July	730	.73	533		July	1,573	.55	865		July	628	.74	465
	Aug.	478	1.28	612		Aug.	821	1.06	870		Aug.	286	1.43	409
	Sept.	310	1.62	502		Sept.	542	1.31	710		Sept.	319	1.69	540
	Oct.	403	1.50	604		Oct.	368	1.43	527		Oct.	310	1.63	505
	Nov.	466	1.30	607		Nov.	386	1.55	599		Nov.	357	1.65	549
	Dec.	443	1.22	542		Dec.	378	1.47	556		Dec.	300	1.52	420
Total	8,751	.84	7,346	Total	17,903	.64	11,396	Total	13,139	.71	9,280			

To obtain mg/l multiply T/AF by 735.

Table 12
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River at Lees Ferry, Arizona

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	315	1.48	466	-1965	Jan.	558	0.98	547	1971	Jan.	692	.75	356
	Feb.	315	1.36	428		Feb.	515	1.02	525		Feb.	416	.85	354
	Mar.	344	1.37	471		Mar.	556	1.01	562		Mar.	640	.91	581
	Apr.	420	1.16	487		Apr.	1,222	1.03	1,259		Apr.	1,011	.90	908
	May	1,025	.70	718		May	2,284	.95	2,170		May	926	.87	803
	June	1,836	.48	881		June	2,323	.88	2,044		June	894	.79	705
	July	782	.63	493		July	727	.48	349		July	943	.77	724
	Aug.	425	1.43	608		Aug.	871	.41	357		Aug.	876	.75	660
	Sept.	246	1.68	413		Sept.	750	.40	300		Sept.	776	.68	525
	Oct.	502	1.41	708		Oct.	659	.43	283		Oct.	584	.71	415
	Nov.	499	1.21	604		Nov.	589	.47	277		Nov.	764	.71	539
	Dec.	352	1.39	489		Dec.	531	.63	335		Dec.	937	.71	662
	Total	7,061	.96	6,766		Total	11,535	.78	9,008		Total	9,259	.78	7,245
-1960	Jan.	305	1.54	470	-1966	Jan.	451	0.73	329	1972	Jan.	806	.74	594
	Feb.	318	1.34	426		Feb.	483	.76	367		Feb.	444	.74	331
	Mar.	745	1.18	879		Mar.	622	.76	473		Mar.	372	.85	321
	Apr.	1,610	.62	998		Apr.	825	.77	635		Apr.	782	.88	686
	May	1,564	.51	798		May	778	.72	704		May	902	.82	741
	June	2,239	.43	963		June	754	.71	535		June	863	.78	676
	July	647	.69	446		July	658	.66	434		July	915	.75	684
	Aug.	208	1.38	287		Aug.	682	.65	443		Aug.	1,205	.75	755
	Sept.	193	1.90	367		Sept.	622	.66	411		Sept.	931	.71	663
	Oct.	341	1.67	569		Oct.	551	.65	358		Oct.	631	.73	459
	Nov.	345	1.47	507		Nov.	584	.66	385		Nov.	677	.74	499
	Dec.	275	1.39	382		Dec.	529	.69	365		Dec.	1,017	.79	799
	Total	8,790	.81	7,092		Total	7,739	.70	5,439		Total	9,345	.77	7,208
-1961	Jan.	266	1.48	394	-1967	Jan.	614	.76	467	1973	Jan.	1,207	.73	887
	Feb.	331	1.34	444		Feb.	534	.79	422		Feb.	764	.75	572
	Mar.	362	1.34	485		Mar.	690	.89	614		Mar.	1,095	.83	912
	Apr.	567	1.02	578		Apr.	788	1.03	812		Apr.	1,678	.86	1,443
	May	1,153	.59	680		May	879	.93	817		May	648	.86	558
	June	1,588	.45	715		June	698	.99	691		June	751	.83	624
	July	369	.89	328		July	641	.81	519		July	656	.84	552
	Aug.	336	1.65	554		Aug.	641	.81	492		Aug.	566	.78	444
	Sept.	710	1.61	1,143		Sept.	623	.75	447		Sept.	424	.79	334
	Oct.	725	1.01	732		Oct.	596	.75	447		Oct.	510	.76	387
	Nov.	527	1.04	548		Nov.	415	.73	303		Nov.	412	.76	314
	Dec.	380	1.22	464		Dec.	460	.76	350		Dec.	333	.69	230
	Total	7,314	.97	7,065		Total	7,550	.84	6,387		Total	9,044	.80	7,257
-1962	Jan.	349	1.24	433	-1968	Jan.	633	.93	589	1974	Jan.	846	.69	585
	Feb.	791	1.03	815		Feb.	464	.97	450		Feb.	299	.68	201
	Mar.	598	1.33	676		Mar.	858	1.02	875		Mar.	389	.80	313
	Apr.	2,391	.71	1,698		Apr.	968	1.02	987		Apr.	495	.84	418
	May	3,633	.44	1,599		May	943	1.05	990		May	804	.81	653
	June	2,876	.45	1,294		June	894	1.00	894		June	914	.77	702
	July	1,717	.57	979		July	827	.81	670		July	1,226	.75	921
	Aug.	469	1.02	478		Aug.	685	.70	480		Aug.	1,213	.74	897
	Sept.	315	1.61	507		Sept.	635	.70	444		Sept.	826	.72	597
	Oct.	539	1.52	819		Oct.	620	.69	428		Oct.	602	.71	425
	Nov.	428	1.28	548		Nov.	616	.67	413		Nov.	710	.70	495
	Dec.	333	1.42	473		Dec.	639	.79	505		Dec.	564	.68	381
	Total	14,439	.71	10,319		Total	8,782	.88	7,725		Total	8,888	.74	6,590
-1963	Jan.	169	1.69	286	-1969	Jan.	570	.92	524		Jan.			
	Feb.	369	1.35	498		Feb.	461	.94	434		Feb.			
	Mar.	188	1.35	254		Mar.	708	.99	698		Mar.			
	Apr.	60	1.44	86		Apr.	871	1.06	920		Apr.			
	May	62	1.30	81		May	763	.98	744		May			
	June	140	1.13	158		June	875	.81	798		June			
	July	90	.96	86		July	956	.88	837		July			
	Aug.	62	.96	60		Aug.	930	.76	710		Aug.			
	Sept.	60	.90	54		Sept.	794	.72	570		Sept.			
	Oct.	61	.88	54		Oct.	630	.77	487		Oct.			
	Nov.	60	.95	57		Nov.	706	.80	562		Nov.			
	Dec.	63	1.34	84		Dec.	814	.77	623		Dec.			
	Total	1,384	1.27	1,758		Total	9,078	.87	7,907		Total			
-1964	Jan.	71	1.33	94	-1970	Jan.	706	.84	593		Jan.			
	Feb.	234	1.33	307		Feb.	445	.90	401		Feb.			
	Mar.	388	1.29	500		Mar.	486	.96	466		Mar.			
	Apr.	771	1.24	956		Apr.	942	.94	898		Apr.			
	May	319	1.22	389		May	900	.92	824		May			
	June	60	1.24	74		June	800	.86	690		June			
	July	60	1.25	75		July	769	.86	658		July			
	Aug.	174	1.24	216		Aug.	773	.79	608		Aug.			
	Sept.	156	.69	108		Sept.	701	.77	542		Sept.			
	Oct.	268	.63	169		Oct.	498	.76	380		Oct.			
	Nov.	347	.84	292		Nov.	459	.80	365		Nov.			
	Dec.	392	1.00	398		Dec.	670	.81	545		Dec.			
	Total	3,243	1.10	3,578		Total	8,149	.85	6,960		Total			

To obtain mg/l multiply T/AF by 735.

Table 12
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River at Lees Ferry, Arizona
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	17,857	.70	514	12,481
1942	14,793	.63	466	9,381
1943	11,413	.73	539	8,375
1944	13,019	.65	481	8,525
1945	11,769	.72	531	8,501
1946	8,751	.84	617	7,346
1947	14,046	.68	498	9,513
1948	12,885	.66	487	8,531
1949	14,604	.68	501	9,954
1950	10,802	.75	551	8,098
1951	9,901	.79	581	7,833
1952	17,903	.64	468	11,396
1953	8,729	.86	630	7,485
1954	6,165	1.04	761	6,386
1955	6,966	.94	691	6,548
1956	8,658	.75	553	6,513
1957	18,700	.68	497	12,646
1958	13,139	.71	519	9,280
1959	7,061	.96	704	6,766
1960	8,790	.81	593	7,092
1961	7,314	.97	710	7,065
1962	14,439	.71	525	10,319
1963	1,384	1.27	934	1,758
1964	3,243	1.10	811	3,578
1965	11,585	.78	572	9,008
1966	7,739	.70	517	5,439
1967	7,560	.84	621	6,387
1968	8,782	.88	647	7,725
1969	9,078	.87	640	7,907
1970	8,149	.85	628	6,960

Sampled quality record November 1942 to October 1945, October 1947 to December 1972; remainder by correlation.
Measured flow record entire period.

Table 13
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Grand Canyon, Arizona

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	434	1.42	616	-1947	Jan.	303	1.20	455	-1953	Jan.	408	1.46	596
	Feb.	515	1.31	675		Feb.	371	1.38	512		Feb.	378	1.42	537
	Mar.	838	1.17	980		Mar.	653	1.18	771		Mar.	478	1.35	645
	Apr.	1,209	.87	1,052		Apr.	785	.92	722		Apr.	533	1.21	645
	May	4,976	.50	2,488		May	3,088	.48	1,482		May	989	.87	860
	June	4,100	.45	1,845		June	3,233	.48	1,552		June	2,932	.47	1,378
	July	1,753	.55	964		July	1,953	.50	976		July	980	.76	745
	Aug.	861	1.29	1,111		Aug.	1,329	1.17	1,555		Aug.	703	1.30	914
	Sept.	659	1.43	942		Sept.	640	1.26	806		Sept.	290	1.73	502
	Oct.	1,904	1.14	2,171		Oct.	804	1.28	1,144		Oct.	325	1.88	611
	Nov.	953	.98	934		Nov.	608	1.14	693		Nov.	428	1.63	698
	Dec.	594	1.22	725		Dec.	490	1.28	627		Dec.	360	1.56	562
Total	18,796	.77	14,503	Total	14,347	.79	11,295	Total	8,804	.99	8,693			
-1942	Jan.	430	1.40	602	-1948	Jan.	427	1.27	542	-1954	Jan.	333	1.58	526
	Feb.	435	1.33	579		Feb.	458	1.28	586		Feb.	353	1.40	494
	Mar.	653	1.25	816		Mar.	669	1.25	836		Mar.	424	1.34	568
	Apr.	2,763	.60	1,658		Apr.	2,732	.74	1,282		Apr.	566	1.11	628
	May	3,163	.49	1,550		May	3,392	.45	1,526		May	1,211	.68	823
	June	4,241	.32	1,357		June	3,358	.40	1,343		June	798	.68	543
	July	1,345	.59	794		July	1,009	.73	737		July	669	.95	636
	Aug.	486	1.15	559		Aug.	587	1.33	781		Aug.	349	1.32	461
	Sept.	294	1.67	491		Sept.	242	1.65	399		Sept.	415	1.67	693
	Oct.	356	1.67	575		Oct.	336	1.82	612		Oct.	526	1.52	800
	Nov.	386	1.67	645		Nov.	434	1.61	699		Nov.	360	1.47	529
	Dec.	373	1.50	560		Dec.	365	1.25	456		Dec.	296	1.60	474
Total	14,925	.68	10,186	Total	13,009	.75	9,799	Total	6,300	1.14	7,175			
-1943	Jan.	347	1/1.49	517	-1949	Jan.	363	1.51	548	-1955	Jan.	261	1.70	444
	Feb.	351	1/1.48	519		Feb.	374	1.36	509		Feb.	269	1.50	404
	Mar.	580	1/1.26	731		Mar.	796	1.20	955		Mar.	586	1.35	791
	Apr.	1,417	1.83	1,176		Apr.	1,337	.92	1,230		Apr.	621	1.15	714
	May	2,161	1/1.57	1,232		May	2,959	.48	1,420		May	1,515	.59	894
	June	2,676	1/1.49	1,311		June	4,303	.48	2,065		June	1,596	.55	878
	July	1,459	1/1.60	875		July	2,128	.58	1,234		July	1,596	.55	878
	Aug.	834	1/1.17	976		Aug.	632	1.12	708		Aug.	618	.77	476
	Sept.	494	1/1.40	692		Sept.	340	1.62	561		Sept.	668	1.39	929
	Oct.	408	1.69	690		Oct.	521	1.58	823		Oct.	265	1.63	432
	Nov.	477	1.47	701		Nov.	488	1.36	664		Nov.	236	1.84	434
	Dec.	420	1.46	613		Dec.	381	1.41	537		Dec.	298	1/1.52	560
Total	11,624	.86	10,033	Total	14,622	.77	11,254	Total	7,287	1.03	7,494			
-1944	Jan.	298	1.61	480	-1950	Jan.	358	1.56	558	-1956	Jan.	398	1/1.42	565
	Feb.	363	1.23	446		Feb.	414	1.35	559		Feb.	310	1.30	403
	Mar.	551	1.41	777		Mar.	670	1.21	811		Mar.	511	1.21	618
	Apr.	1,099	.95	1,044		Apr.	1,192	.88	1,049		Apr.	878	.82	720
	May	3,206	.55	1,763		May	1,941	.59	1,145		May	2,125	.49	1,041
	June	4,144	.41	1,699		June	2,925	.47	1,375		June	2,584	.45	1,163
	July	1,854	.92	964		July	1,401	.76	1,065		July	598	.82	490
	Aug.	456	1.14	520		Aug.	444	1.13	502		Aug.	383	1.31	502
	Sept.	251	1.61	404		Sept.	343	1.26	535		Sept.	185	1.58	292
	Oct.	362	1.78	644		Oct.	359	1.67	600		Oct.	202	1.86	376
	Nov.	401	1.64	658		Nov.	355	1.75	621		Nov.	325	1.69	549
	Dec.	345	1.59	549		Dec.	434	1.48	642		Dec.	274	1.66	455
Total	13,330	.75	9,948	Total	10,836	.87	9,462	Total	8,773	.82	7,174			
-1945	Jan.	356	1.55	552	-1951	Jan.	326	1.59	518	-1957	Jan.	343	1.45	497
	Feb.	381	1.48	564		Feb.	366	1.45	531		Feb.	370	1.37	507
	Mar.	472	1.41	666		Mar.	429	1.35	579		Mar.	541	1.26	682
	Apr.	804	1.01	812		Apr.	535	1.17	626		Apr.	812	.93	755
	May	2,803	.52	1,458		May	1,552	.67	1,040		May	2,501	.57	1,426
	June	2,754	.48	1,322		June	2,800	.49	1,372		June	5,541	.40	2,216
	July	1,732	.56	970		July	1,197	.57	796		July	4,033	.40	1,613
	Aug.	1,071	1.05	1,125		Aug.	833	1.12	983		Aug.	1,672	.88	1,471
	Sept.	394	1.38	544		Sept.	452	1.46	660		Sept.	884	1.13	999
	Oct.	524	1.63	854		Oct.	425	1.67	710		Oct.	784	1.46	1,144
	Nov.	465	1.51	702		Nov.	466	1.61	750		Nov.	892	1.42	1,266
	Dec.	359	1.47	528		Dec.	353	1.61	568		Dec.	537	1.28	687
Total	12,115	.83	10,097	Total	9,934	.92	9,133	Total	18,910	.70	13,263			
-1946	Jan.	384	1.41	541	-1952	Jan.	593	1.28	759	-1958	Jan.	415	1.31	544
	Feb.	333	1.38	460		Feb.	396	1.42	562		Feb.	536	1.24	665
	Mar.	514	1.29	663		Mar.	435	1.46	635		Mar.	749	1.13	846
	Apr.	1,016	.94	955		Apr.	2,209	.84	1,855		Apr.	1,580	.77	1,220
	May	1,775	.53	941		May	5,062	.52	2,632		May	3,900	.45	1,755
	June	1,995	.54	1,077		June	5,203	.46	2,393		June	3,763	.41	1,542
	July	784	.82	643		July	1,590	.65	1,033		July	683	.91	622
	Aug.	567	1.50	850		Aug.	833	1.18	983		Aug.	337	1/1.31	440
	Sept.	372	1.71	636		Sept.	596	1.43	852		Sept.	379	1/1.32	500
	Oct.	419	1.62	679		Oct.	393	1.52	597		Oct.	346	1/1.53	530
	Nov.	492	1.36	684		Nov.	396	1.64	649		Nov.	385	1/1.53	590
	Dec.	468	1.31	613		Dec.	400	1.58	632		Dec.	388	1/1.55	600
Total	9,119	.96	8,742	Total	18,106	.75	13,582	Total	13,461	.73	9,854			

To obtain mg/l multiply T/AP by 735.
1/ Correlated.

Table 13
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Grand Canyon, Arizona

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	334	1.56	520	-1965	Jan.	608	1.06	644	1971	Jan.	544	.77	418
	Feb.	326	1.53	502		Feb.	539	1.09	588		Feb.	430	.85	364
	Mar.	365	1.53	560		Mar.	568	1.09	619		Mar.	645	1.08	693
	Apr.	423	1.27	537		Apr.	1,251	1.04	1,301		Apr.	1,000	1.07	1,075
	May	1,011	.78	789		May	2,282	1.03	2,350		May	933	.90	810
	June	1,804	.53	956		June	2,282	.89	2,038		June	896	.80	721
	July	795	.69	549		July	724	.59	427		July	933	.81	753
	Aug.	488	1.50	731		Aug.	879	.86	755		Aug.	932	.87	809
	Sept.	271	1.82	493		Sept.	767	.51	391		Sept.	801	.81	652
	Oct.	528	1.47	777		Oct.	675	.51	344		Oct.	675	.85	573
	Nov.	569	1.25	712		Nov.	632	.53	322		Nov.	786	.85	665
	Dec.	354	1.33	524		Dec.	586	.62	406		Dec.	994	.77	762
Total		7,308	1.05	7,648	Total		11,773	.86	10,185	Total		9,569	.87	8,295
-1960	Jan.	348	1.41	499	-1966	Jan.	529	0.79	418	1972	Jan.	840	.76	640
	Feb.	353	1.40	497		Feb.	524	.87	452		Feb.	471	.82	393
	Mar.	820	1.15	942		Mar.	718	.81	582		Mar.	364	.74	343
	Apr.	1,650	.63	1,036		Apr.	865	.81	700		Apr.	793	.82	731
	May	1,580	.55	870		May	1,011	.79	799		May	912	.84	765
	June	2,212	.46	1,011		June	789	.77	609		June	890	.81	724
	July	678	.73	497		July	698	.75	523		July	872	.80	698
	Aug.	233	1.42	338		Aug.	694	.68	471		Aug.	906	.80	798
	Sept.	218	1.92	418		Sept.	623	.75	468		Sept.	945	.81	765
	Oct.	382	1.81	692		Oct.	567	.74	419		Oct.	917	1.00	898
	Nov.	380	1.59	603		Nov.	589	.71	418		Nov.	730	.82	582
	Dec.	300	1.49	448		Dec.	620	.76	471		Dec.	1,070	.78	839
Total		9,154	.86	7,833	Total		8,227	.77	6,333	Total		9,800	.84	8,176
-1961	Jan.	291	1.58	460	-1967	Jan.	648	.84	544	1973	Jan.	1,231	.73	903
	Feb.	353	1.39	490		Feb.	564	.86	485		Feb.	839	.81	683
	Mar.	379	1.40	530		Mar.	704	.97	683		Mar.	1,204	.86	1,031
	Apr.	587	1.04	608		Apr.	801	1.09	873		Apr.	1,916	.82	1,566
	May	1,147	.66	760		May	861	1.00	861		May	846	.81	689
	June	1,692	.47	788		June	711	1.02	725		June	771	.85	655
	July	417	.98	409		July	693	.92	638		July	671	.85	567
	Aug.	374	1.76	658		Aug.	786	.82	644		Aug.	586	.85	499
	Sept.	748	1.82	1,360		Sept.	713	.90	642		Sept.	449	.87	390
	Oct.	772	1.23	949		Oct.	459	.86	395		Oct.	516	.86	443
	Nov.	570	1.23	701		Nov.	495	.83	411		Nov.	445	.85	378
	Dec.	409	1.32	539		Dec.	597	.90	537		Dec.	354	.97	343
Total		7,739	1.07	8,252	Total		8,032	.93	7,438	Total		9,828	.83	8,147
-1962	Jan.	369	1.35	498	-1968	Jan.	658	1.01	664	1974	Jan.	877	.70	611
	Feb.	832	1.02	847		Feb.	534	1.04	555		Feb.	326	.81	271
	Mar.	610	1.19	726		Mar.	900	1.03	927		Mar.	434	.86	372
	Apr.	2,467	.70	1,730		Apr.	1,078	1.02	1,100		Apr.	507	.86	438
	May	3,716	.45	1,654		May	976	1.11	1,083		May	816	.87	714
	June	2,850	.46	1,318		June	925	1.03	953		June	932	.83	775
	July	1,821	.57	1,031		July	865	.93	804		July	1,235	.78	914
	Aug.	512	1.03	526		Aug.	775	.81	628		Aug.	1,229	.74	914
	Sept.	318	1.58	502		Sept.	675	.80	540		Sept.	828	.75	622
	Oct.	557	1.57	877		Oct.	647	.79	511		Oct.	609	.78	477
	Nov.	443	1.35	592		Nov.	675	.80	540		Nov.	740	.78	579
	Dec.	344	1.50	516		Dec.	665	.77	512		Dec.	582	.76	442
Total		14,839	.73	10,817	Total		9,373	.94	8,817	Total		9,115	.79	7,177
-1963	Jan.	182	1.84	334	-1969	Jan.	628	.99	621	1977	Jan.			
	Feb.	374	1.33	496		Feb.	509	1.10	560		Feb.			
	Mar.	203	1.37	279		Mar.	727	1.05	763		Mar.			
	Apr.	72	1.56	112		Apr.	927	1.05	973		Apr.			
	May	79	1.49	118		May	799	1.03	822		May			
	June	148	1.09	162		June	870	.98	853		June			
	July	108	1.14	123		July	924	.95	944		July			
	Aug.	112	1.29	145		Aug.	1,002	.83	832		Aug.			
	Sept.	122	1.43	175		Sept.	842	.82	691		Sept.			
	Oct.	77	1.39	107		Oct.	662	.80	527		Oct.			
	Nov.	76	1.39	106		Nov.	751	.80	601		Nov.			
	Dec.	77	1.74	134		Dec.	582	.81	674		Dec.			
Total		1,630	1.41	2,291	Total		9,543	.93	8,561	Total				
-1964	Jan.	79	1.75	138	-1970	Jan.	768	.88	676	1978	Jan.			
	Feb.	245	1.52	373		Feb.	494	.96	474		Feb.			
	Mar.	382	1.47	562		Mar.	510	1.00	510		Mar.			
	Apr.	796	1.33	1,058		Apr.	969	.94	911		Apr.			
	May	356	1.36	485		May	946	.96	908		May			
	June	77	1.65	127		June	821	.90	739		June			
	July	84	1.75	147		July	815	.88	717		July			
	Aug.	287	1.31	376		Aug.	798	.87	691		Aug.			
	Sept.	192	1.05	200		Sept.	756	.85	641		Sept.			
	Oct.	299	.77	230		Oct.	542	.84	455		Oct.			
	Nov.	373	.87	323		Nov.	483	.82	396		Nov.			
	Dec.	416	1.04	431		Dec.	700	.79	553		Dec.			
Total		3,582	1.24	4,450	Total		8,602	.89	7,671	Total				

To obtain mg/l multiply T/AF by 735.

Table 13
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River near Grand Canyon, Arizona
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	18,796	0.77	567	14,503
1942	14,925	.68	502	10,186
1943	11,624	.86	634	10,033
1944	13,330	.75	549	9,948
1945	12,115	.83	613	10,097
1946	9,119	.96	705	8,742
1947	14,347	.79	579	11,295
1948	13,009	.75	554	9,799
1949	14,622	.77	566	11,254
1950	10,836	.87	642	9,462
1951	9,934	.92	676	9,133
1952	18,106	.75	551	13,582
1953	8,804	.99	726	8,693
1954	6,300	1.14	837	7,175
1955	7,287	1.03	756	7,494
1956	8,773	.82	601	7,174
1957	18,910	.70	516	13,263
1958	13,461	.73	538	9,854
1959	7,308	1.05	769	7,648
1960	9,154	.86	629	7,833
1961	7,739	1.07	784	8,252
1962	14,839	.73	536	10,817
1963	1,630	1.41	1,030	2,291
1964	3,582	1.24	913	4,450
1965	11,773	.86	636	10,185
1966	8,227	.77	566	6,333
1967	8,032	.93	681	7,438
1968	9,373	.94	691	8,817
1969	9,543	.93	685	8,861
1970	8,602	.89	656	7,671

Table 14
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Virgin River at Littlefield, Arizona

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	15	2.39	35	-1947	Jan.	15	2.34	35	-1953	Jan.	14	2.36	32
	Feb.	31	1.27	61		Feb.	12	2.46	30		Feb.	9	2.70	24
	Mar.	62	1.82	51		Mar.	13	2.32	31		Mar.	7	2.98	21
	Apr.	62	1.84	52		Apr.	16	2.17	34		Apr.	6	3.27	20
	May	131	1.46	60		May	17	1.98	33		May	5	3.27	16
	June	19	1.75	34		June	4	3.31	14		June	4	3.34	14
	July	22	2.45	54		July	5	3.30	16		July	8	3.46	28
	Aug.	20	3.02	62		Aug.	14	2.97	41		Aug.	13	3.04	40
	Sept.	6	3.29	18		Sept.	4	3.31	14		Sept.	4	3.38	13
	Oct.	23	3.22	74		Oct.	8	3.34	27		Oct.	7	3.31	24
	Nov.	19	2.26	43		Nov.	9	2.89	27		Nov.	10	3.07	29
	Dec.	17	2.28	39		Dec.	14	2.46	34		Dec.	11	2.83	31
Total		427	1.37	583	Total		131	2.56	336	Total		98	3.00	292
-1942	Jan.	20	2.25	44	-1948	Jan.	11	2.78	29	-1954	Jan.	15	2.49	37
	Feb.	16	2.28	35		Feb.	12	2.47	30		Feb.	12	2.36	29
	Mar.	20	1.88	38		Mar.	13	2.42	31		Mar.	17	1.98	33
	Apr.	50	1.01	51		Apr.	20	1.87	37		Apr.	23	1.64	38
	May	28	1.56	44		May	10	2.47	25		May	10	2.35	23
	June	5	3.15	16		June	4	3.32	14		June	5	3.36	18
	July	4	3.31	14		July	4	3.31	14		July	8	3.42	26
	Aug.	9	3.29	29		Aug.	5	3.31	13		Aug.	10	3.14	34
	Sept.	4	3.31	13		Sept.	5	3.39	20		Sept.	9	3.56	30
	Oct.	9	3.41	31		Oct.	6	3.34	20		Oct.	9	3.48	32
	Nov.	10	2.78	29		Nov.	10	2.87	27		Nov.	9	3.13	29
	Dec.	11	2.72	31		Dec.	10	2.95	29		Dec.	13	2.71	36
Total		186	2.01	375	Total		111	2.65	294	Total		140	2.61	365
-1943	Jan.	18	2.32	42	-1949	Jan.	13	2.52	32	-1955	Jan.	12	2.60	31
	Feb.	21	2.14	45		Feb.	14	2.42	35		Feb.	12	2.51	30
	Mar.	36	1.28	47		Mar.	18	2.07	36		Mar.	11	2.53	27
	Apr.	34	1.36	46		Apr.	30	1.43	44		Apr.	6	3.14	19
	May	11	2.27	26		May	28	1.53	43		May	5	3.18	16
	June	4	3.35	13		June	12	2.11	25		June	4	3.39	13
	July	4	3.31	14		July	4	3.19	14		July	10	3.61	37
	Aug.	13	3.35	42		Aug.	4	3.20	13		Aug.	40	3.69	149
	Sept.	6	3.46	20		Sept.	7	3.27	23		Sept.	5	3.26	15
	Oct.	9	3.40	30		Oct.	9	3.07	26		Oct.	5	3.51	19
	Nov.	10	2.79	28		Nov.	11	2.68	29		Nov.	10	3.05	31
	Dec.	13	2.51	32		Dec.	13	2.51	34		Dec.	13	2.60	34
Total		179	2.15	385	Total		163	2.17	354	Total		133	3.16	421
-1944	Jan.	13	2.47	33	-1950	Jan.	15	2.20	33	-1956	Jan.	15	2.53	38
	Feb.	15	2.31	35		Feb.	16	2.00	32		Feb.	11	2.59	29
	Mar.	26	1.64	42		Mar.	14	2.26	31		Mar.	8	2.87	22
	Apr.	25	1.66	42		Apr.	15	2.05	31		Apr.	6	3.13	18
	May	49	1.05	51		May	5	2.87	19		May	4	3.23	15
	June	11	2.32	25		June	4	3.28	13		June	4	3.34	15
	July	4	3.32	13		July	12	3.38	40		July	8	3.53	27
	Aug.	4	3.31	13		Aug.	6	3.43	19		Aug.	4	3.35	13
	Sept.	4	3.31	14		Sept.	6	3.35	20		Sept.	4	3.35	12
	Oct.	5	3.30	16		Oct.	5	3.40	17		Oct.	4	3.39	14
	Nov.	13	2.48	32		Nov.	9	3.14	28		Nov.	6	3.50	21
	Dec.	12	2.65	31		Dec.	10	2.91	30		Dec.	8	3.29	25
Total		181	1.92	347	Total		118	2.65	313	Total		82	3.05	249
-1945	Jan.	11	2.68	30	-1951	Jan.	11	2.77	30	-1957	Jan.	12	2.77	33
	Feb.	17	2.15	38		Feb.	8	2.84	22		Feb.	14	2.32	32
	Mar.	20	1.87	38		Mar.	8	2.83	23		Mar.	10	2.64	26
	Apr.	20	1.83	36		Apr.	7	3.17	22		Apr.	6	2.99	18
	May	25	1.55	39		May	10	2.74	27		May	15	2.04	31
	June	5	3.22	15		June	4	3.37	12		June	9	2.85	25
	July	5	3.31	15		July	6	3.34	20		July	4	3.31	13
	Aug.	26	3.06	79		Aug.	16	3.27	55		Aug.	9	3.41	31
	Sept.	8	3.19	25		Sept.	6	3.20	20		Sept.	4	3.27	12
	Oct.	20	3.14	62		Oct.	7	3.24	22		Oct.	14	3.02	44
	Nov.	10	2.75	29		Nov.	9	2.94	26		Nov.	21	2.45	51
	Dec.	14	2.47	35		Dec.	20	2.42	49		Dec.	15	2.04	31
Total		181	2.43	441	Total		122	2.93	328	Total		133	2.61	347
-1946	Jan.	13	2.48	32	-1952	Jan.	21	2.34	49	-1958	Jan.	10	2.49	24
	Feb.	10	2.74	27		Feb.	11	2.52	28		Feb.	19	1.83	35
	Mar.	10	2.63	28		Mar.	27	1.75	48		Mar.	11	1.43	59
	Apr.	12	2.49	29		Apr.	80	1.76	60		Apr.	64	1.02	65
	May	5	3.31	15		May	71	1.68	49		May	69	1.05	73
	June	4	3.32	13		June	12	1.75	21		June	7	2.29	16
	July	6	3.40	21		July	4	3.27	14		July	6	3.17	19
	Aug.	13	3.17	42		Aug.	5	3.43	18		Aug.	5	3.22	18
	Sept.	4	3.31	13		Sept.	6	3.34	20		Sept.	22	3.13	70
	Oct.	37	2.18	81		Oct.	6	3.40	20		Oct.	8	3.16	24
	Nov.	33	1.85	61		Nov.	10	2.84	29		Nov.	11	2.62	26
	Dec.	22	2.12	47		Dec.	14	2.53	34		Dec.	10	2.67	28
Total		169	2.42	409	Total		267	1.46	390	Total		272	1.68	457

To obtain mg/l multiply T/AF by 735.

Table 14
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Virgin River at Littlefield, Arizona

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	
-1959	Jan.	10	2.58	27	-1965	Jan.	9	2.78	25	1971	Jan.	10	2.45	26	
	Feb.	13	2.30	31		Feb.	8	2.75	22		Feb.	9	2.48	23	
	Mar.	9	2.67	24		Mar.	8	2.62	21		Mar.	9	2.74	24	
	Apr.	4	3.05	13		Apr.	30	2.00	60		Apr.	5	3.17	16	
	May	4	3.07	13		May	23	1.52	35		May	9	2.49	22	
	June	4	3.24	12		June	9	2.11	19		June	4	3.29	12	
	July	4	3.32	13		July	3	3.67	11		July	4	3.32	13	
	Aug.	12	3.35	40		Aug.	5	3.40	17		Aug.	19	3.08	58	
	Sept.	4	3.20	13		Sept.	6	3.00	18		Sept.	5	3.35	17	
	Oct.	5	3.30	15		Oct.	6	3.00	18		Oct.	9	2.94	28	
	Nov.	13	2.90	36		Nov.	21	1.90	40		Nov.	10	2.75	27	
	Dec.	9	2.69	23		Dec.	26	1.58	41		Dec.	21	1.96	41	
	Total	91	2.87	260		Total	154	2.12	327		Total	114	2.69	307	
-1960	Jan.	11	2.48	28	-1966	Jan.	13	2.31	30	1972	Jan.	11	2.66	28	
	Feb.	10	2.38	24		Feb.	11	2.45	27		Feb.	9	2.70	24	
	Mar.	10	2.45	24		Mar.	14	1.50	29		Mar.	6	3.08	17	
	Apr.	6	2.91	17		Apr.	17	1.70	29		Apr.	4	3.32	13	
	May	5	3.03	14		May	6	3.00	18		May	4	3.61	12	
	June	3	3.16	10		June	3	4.00	12		June	15	3.21	48	
	July	4	3.18	12		July	3	4.00	12		July	4	3.52	14	
	Aug.	3	3.20	11		Aug.	4	3.67	11		Aug.	11	3.22	36	
	Sept.	6	3.51	20		Sept.	5	3.50	14		Sept.	24	3.45	82	
	Oct.	6	3.05	19		Oct.	4	3.33	20		Oct.	17	2.73	48	
	Nov.	12	2.80	35		Nov.	9	2.78	25		Nov.	12	2.35	29	
	Dec.	8	2.71	22		Dec.	73	1.99	145		Dec.	12	2.62	30	
	Total	84	2.79	236		Total	162	2.30	372		Total	129	2.96	381	
-1961	Jan.	8	2.76	21	-1967	Jan.	13	2.66	34	1973	Jan.	11	2.49	28	
	Feb.	7	2.80	20		Feb.	9	2.67	25		Feb.	14	2.36	34	
	Mar.	8	2.84	23		Mar.	10	2.76	29		Mar.	34	1.82	61	
	Apr.	4	3.11	14		Apr.	11	2.63	30		Apr.	67	1.24	83	
	May	4	3.14	12		May	20	1.88	37		May	117	.82	96	
	June	4	3.14	12		June	7	2.80	19		June	23	1.24	29	
	July	8	3.22	27		July	4	3.57	14		July	5	2.96	14	
	Aug.	17	3.58	50		Aug.	7	3.32	25		Aug.	5	3.29	16	
	Sept.	22	3.36	73		Sept.	14	3.41	46		Sept.	3	3.30	11	
	Oct.	5	3.41	19		Oct.	7	3.13	21		Oct.	5	3.32	17	
	Nov.	8	3.07	23		Nov.	9	2.71	25		Nov.	11	2.68	29	
	Dec.	13	2.69	34		Dec.	13	2.49	32		Dec.	11	2.44	27	
	Total	108	3.14	338		Total	124	2.72	337		Total	306	1.45	445	
-1962	Jan.	10	2.73	28	-1968	Jan.	13	2.60	33	1974	Jan.	14	2.33	33	
	Feb.	30	1.65	50		Feb.	15	2.19	32		Feb.	9	2.98	27	
	Mar.	17	2.09	35		Mar.	12	2.16	27		Mar.	10	2.51	25	
	Apr.	33	1.21	40		Apr.	15	2.03	30		Apr.	6	2.94	16	
	May	9	2.24	19		May	17	1.80	30		May	4	3.17	13	
	June	4	3.32	12		June	5	2.81	13		June	4	3.22	12	
	July	4	3.29	13		July	6	3.52	20		July	5	3.30	15	
	Aug.	3	3.48	11		Aug.	14	3.09	45		Aug.	5	3.45	17	
	Sept.	7	3.28	24		Sept.	3	3.60	12		Sept.	7	3.31	25	
	Oct.	7	3.32	21		Oct.	6	3.41	20		Oct.	9	3.24	29	
	Nov.	6	3.18	20		Nov.	7	3.05	22		Nov.	11	3.15	36	
	Dec.	7	2.72	20		Dec.	11	2.79	30		Dec.	9	3.00	27	
	Total	137	2.14	293		Total	124	2.53	314		Total	93	2.96	275	
-1963	Jan.	9	2.54	23	-1969	Jan.	48	1.52	73		Jan.				
	Feb.	9	2.56	23		Feb.	34	1.82	62		Feb.				
	Mar.	6	3.14	19		Mar.	39	1.49	58		Mar.				
	Apr.	4	3.43	15		Apr.	82	.87	71		Apr.				
	May	4	3.41	13		May	83	.71	59		May				
	June	3	3.41	11		June	14	1.86	26		June				
	July	3	3.48	12		July	6	3.17	19		July				
	Aug.	11	3.33	36		Aug.	4	3.75	15		Aug.				
	Sept.	14	3.54	48		Sept.	9	3.56	32		Sept.				
	Oct.	5	3.32	18		Oct.	8	3.13	25		Oct.				
	Nov.	10	3.00	28		Nov.	12	2.75	33		Nov.				
	Dec.	7	2.96	20		Dec.	12	2.42	29		Dec.				
	Total	85	3.14	266		Total	351	1.43	502		Total				
-1964	Jan.	7	2.96	20	-1970	Jan.	13	2.08	27		Jan.				
	Feb.	7	2.88	21		Feb.	9	2.44	22		Feb.				
	Mar.	7	2.99	20		Mar.	12	2.83	34		Mar.				
	Apr.	13	2.22	28		Apr.	4	3.50	14		Apr.				
	May	11	2.22	24		May	5	3.20	16		May				
	June	4	3.50	10		June	4	3.25	13		June				
	July	4	3.63	14		July	6	3.33	20		July				
	Aug.	14	3.81	53		Aug.	8	3.12	25		Aug.				
	Sept.	3	3.63	11		Sept.	2	3.60	18		Sept.				
	Oct.	3	3.58	12		Oct.	5	3.40	17		Oct.				
	Nov.	6	3.32	22		Nov.	10	3.20	32		Nov.				
	Dec.	9	2.98	26		Dec.	11	2.45	27		Dec.				
	Total	87	3.01	261		Total	92	2.88	265		Total				

To obtain mg/l multiply T/AF by 735.

Table 14
Colorado River Basin
Historical Flow and Quality of Water Data
Virgin River at Littlefield, Arizona
 (Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	427	1.37	1,000	583
1942	186	2.01	1,480	375
1943	179	2.15	1,580	385
1944	181	1.92	1,410	347
1945	181	2.43	1,790	441
1946	169	2.42	1,780	409
1947	131	2.56	1,890	336
1948	111	2.65	1,950	294
1949	163	2.17	1,600	354
1950	118	2.65	1,950	313
1951	112	2.93	2,150	328
1952	267	1.46	1,070	390
1953	98	3.00	2,190	292
1954	140	2.61	1,920	365
1955	133	3.16	2,330	421
1956	82	3.05	2,230	249
1957	133	2.61	1,920	347
1958	272	1.68	1,230	457
1959	91	2.87	2,100	260
1960	84	2.79	2,060	236
1961	108	3.14	2,300	338
1962	137	2.14	1,570	293
1963	85	3.14	2,300	266
1964	87	3.01	2,200	261
1965	154	2.12	1,560	327
1966	162	2.30	1,690	372
1967	124	2.72	1,980	337
1968	124	2.53	1,860	314
1969	351	1.43	1,051	502
1970	92	2.88	2,117	265

Table 15
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River below Hoover Dam, Arizona - Nevada

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	589	1.08	636	-1947	Jan.	984	0.90	886	-1953	Jan.	1,227	0.93	1,141
	Feb.	500	1.11	555		Feb.	886	.91	806		Feb.	1,043	.91	949
	Mar.	552	1.10	607		Mar.	956	.92	879		Mar.	1,046	.93	973
	Apr.	518	1.08	560		Apr.	859	1/.99	850		Apr.	971	.94	913
	May	1,435	1.08	1,550		May	951	1/1.03	979		May	998	.91	908
	June	1,810	1.07	1,935		June	919	1/.95	873		June	819	.89	729
	July	951	1.06	1,007		July	925	.96	888		July	897	.87	780
	Aug.	1,429	.97	1,386		Aug.	865	1/.92	796		Aug.	968	.87	842
	Sept.	1,576	.94	1,481		Sept.	813	2/.92	776		Sept.	968	.86	832
	Oct.	1,641	.94	1,543		Oct.	828	1/.92	762		Oct.	802	.86	690
	Nov.	1,817	.93	1,690		Nov.	880	2/.92	810		Nov.	749	.86	644
	Dec.	2,071	.94	1,947		Dec.	1,063	1/.92	978		Dec.	814	.85	692
Total		14,889	1.00	14,897	Total		10,959	.94	10,283	Total		11,302	.89	10,093
-1942	Jan.	2,011	1.00	2,011	-1948	Jan.	1,169	2/.93	1,087	-1954	Jan.	836	.88	736
	Feb.	1,550	.99	1,535		Feb.	1,138	1/.93	1,058		Feb.	721	.94	678
	Mar.	1,425	1.00	1,425		Mar.	1,150	1/.93	1,070		Mar.	911	.95	865
	Apr.	1,301	1.00	1,301		Apr.	1,202	1/.97	1,166		Apr.	975	.94	916
	May	1,343	1.00	1,343		May	1,142	1/.93	1,062		May	1,101	.93	1,024
	June	1,561	1.01	1,577		June	1,076	1/.88	947		June	829	.94	873
	July	1,285	.99	1,272		July	1,156	1/.86	994		July	1,027	.94	965
	Aug.	842	.92	838		Aug.	968	2/.86	833		Aug.	888	.97	861
	Sept.	1,025	.98	1,005		Sept.	981	1/.85	834		Sept.	933	.97	905
	Oct.	1,163	.95	1,105		Oct.	917	1/.80	734		Oct.	776	.94	729
	Nov.	1,093	.90	986		Nov.	1,028	.88	905		Nov.	676	.95	642
	Dec.	1,157	.85	983		Dec.	1,124	1/.91	1,023		Dec.	751	.97	719
Total		15,762	.98	15,281	Total		13,051	.90	11,713	Total		10,514	.94	9,913
-1943	Jan.	1,109	.87	969	-1949	Jan.	1,212	.83	1,006	-1955	Jan.	725	.99	718
	Feb.	823	.89	732		Feb.	1,214	1/.84	1,020		Feb.	705	1.04	733
	Mar.	971	.94	913		Mar.	1,291	1/.85	1,097		Mar.	906	1.08	978
	Apr.	915	.95	869		Apr.	1,178	1/.86	1,013		Apr.	882	1.11	979
	May	1,029	.94	967		May	1,026	1/.83	852		May	928	1.12	1,039
	June	1,040	.93	967		June	982	.87	858		June	680	1.12	762
	July	1,109	.91	1,009		July	1,020	.84	857		July	847	1.11	940
	Aug.	1,042	.92	959		Aug.	1,062	.80	850		Aug.	789	1.12	884
	Sept.	1,042	.91	948		Sept.	1,141	.78	890		Sept.	622	1.11	690
	Oct.	1,179	.90	1,061		Oct.	1,178	.75	882		Oct.	526	1.12	589
	Nov.	1,179	.86	1,014		Nov.	1,022	1/.83	848		Nov.	487	1.12	545
	Dec.	1,277	.86	1,098		Dec.	1,238	.87	1,077		Dec.	492	1.09	536
Total		12,715	.90	11,502	Total		13,566	.85	11,250	Total		8,589	1.09	9,393
-1944	Jan.	1,303	.88	1,141	-1950	Jan.	1,277	.83	1,060	-1956	Jan.	583	1.09	635
	Feb.	1,269	.97	1,231		Feb.	1,132	.81	917		Feb.	499	1.10	549
	Mar.	1,307	.96	1,254		Mar.	1,246	.85	1,059		Mar.	769	1.12	861
	Apr.	1,170	.97	1,135		Apr.	1,089	.85	926		Apr.	840	1.14	958
	May	1,216	.98	1,192		May	1,120	1/.84	941		May	748	1.15	860
	June	1,097	.95	1,042		June	960	1/.83	797		June	784	1.17	917
	July	1,111	.93	1,033		July	982	.79	776		July	792	1.19	931
	Aug.	1,211	.92	1,113		Aug.	872	1/.82	715		Aug.	692	1.17	814
	Sept.	1,132	.89	1,007		Sept.	824	1/.79	651		Sept.	610	1.15	702
	Oct.	1,226	1/.94	1,152		Oct.	948	.89	755		Oct.	490	1.16	568
	Nov.	1,186	1/.93	1,174		Nov.	815	.88	717		Nov.	554	1.12	629
	Dec.	1,199	.94	1,127		Dec.	951	.86	732		Dec.	457	1.10	503
Total		14,427	.94	13,607	Total		12,016	.84	10,046	Total		7,812	1.14	8,948
-1945	Jan.	1,239	.93	1,138	-1951	Jan.	928	.87	807	-1957	Jan.	534	1.07	571
	Feb.	1,100	1/.96	1,056		Feb.	756	.87	698		Feb.	470	1.08	508
	Mar.	1,250	2/.96	1,200		Mar.	860	.91	783		Mar.	739	1.11	820
	Apr.	1,042	1/.95	990		Apr.	796	.93	740		Apr.	890	1.09	970
	May	1,068	1/.90	961		May	858	.92	826		May	769	1.07	823
	June	1,014	2/.91	923		June	691	.91	629		June	828	1.06	878
	July	861	.92	792		July	783	.92	720		July	786	1.05	825
	Aug.	884	1/.93	823		Aug.	907	.93	844		Aug.	786	1.03	810
	Sept.	869	1/.90	762		Sept.	848	.92	780		Sept.	785	1.02	801
	Oct.	1,080	1/.88	950		Oct.	756	.93	703		Oct.	697	1.02	711
	Nov.	1,042	1/.90	938		Nov.	818	.93	761		Nov.	958	.99	948
	Dec.	1,062	1/.89	949		Dec.	829	.91	754		Dec.	1,081	.94	1,016
Total		12,512	.92	11,512	Total		9,870	.91	9,005	Total		9,323	1.04	9,681
-1946	Jan.	1,116	.87	971	-1952	Jan.	1,070	.90	963	-1958	Jan.	1,245	.90	1,120
	Feb.	1,047	1/.95	904		Feb.	1,212	.93	1,127		Feb.	846	.94	795
	Mar.	1,004	.88	884		Mar.	1,371	.94	1,289		Mar.	1,435	.90	1,292
	Apr.	*872	.89	*776		Apr.	1,385	.94	1,302		Apr.	1,473	.88	1,296
	May	903	1/.96	867		May	1,532	.94	1,440		May	1,115	.84	937
	June	817	1/.92	752		June	1,432	.91	1,303		June	819	.85	696
	July	838	.90	754		July	1,304	.83	1,082		July	894	.85	760
	Aug.	751	1/.91	683		Aug.	1,307	.79	1,033		Aug.	911	.81	752
	Sept.	759	2/.91	691		Sept.	1,359	.73	922		Sept.	792	.83	697
	Oct.	857	1/.92	788		Oct.	1,291	.69	891		Oct.	720	.82	597
	Nov.	762	2/.91	693		Nov.	1,215	.66	802		Nov.	745	.82	612
	Dec.	859	1/.90	773		Dec.	1,338	.88	1,177		Dec.	* 873	.83	725
Total		*10,585	.91	*9,626	Total		15,816	.85	13,401	Total		11,877	.86	10,243

To obtain mg/l multiply T/AF by 735.
*Revised
1/ Estimated or partially estimated.
2/ Average of adjacent values.

Table 15
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River below Hoover Dam, Arizona - Nevada

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	795	0.85	676	-1965	Jan.	489	1.08	528	1971	Jan.	561	1.07	598
	Feb.	648	.81	537		Feb.	498	1.09	543		Feb.	663	1.00	663
	Mar.	827	.88	728		Mar.	786	1.15	903		Mar.	860	1.01	872
	Apr.	916	.91	834		Apr.	698	1.14	796		Apr.	913	1.04	954
	May	949	.86	816		May	872	1.14	904		May	861	1.04	894
	June	760	.85	646		June	786	1.08	848		June	741	1.00	741
	July	848	.84	713		July	815	1.08	880		July	740	.98	727
	Aug.	894	.83	742		Aug.	817	1.11	907		Aug.	741	.99	732
	Sept.	773	.81	626		Sept.	655	1.12	734		Sept.	623	1.00	622
	Oct.	693	.82	568		Oct.	535	1.05	562		Oct.	503	1.01	509
	Nov.	607	.81	492		Nov.	418	1.03	430		Nov.	452	1.02	463
	Dec.	572	.81	463		Dec.	423	1.06	449		Dec.	506	1.01	522
Total		9,282	.84	7,941	Total		7,792	1.10	8,574	Total		8,164	1.02	8,297
-1960	Jan.	629	.86	541	-1966	Jan.	292	1.03	260	1972	Jan.	568	1.08	612
	Feb.	512	.89	456		Feb.	436	1.02	445		Feb.	636	1.02	646
	Mar.	710	.89	632		Mar.	785	1.05	824		Mar.	905	.98	855
	Apr.	909	.93	845		Apr.	846	1.05	888		Apr.	877	.97	854
	May	956	.93	796		May	887	1.03	914		May	866	.97	841
	June	1,015	.92	934		June	783	1.06	831		June	795	.99	790
	July	984	.89	876		July	889	1.01	897		July	769	.98	755
	Aug.	959	.93	892		Aug.	839	.98	822		Aug.	756	.96	723
	Sept.	806	.93	749		Sept.	672	1.00	672		Sept.	634	.95	602
	Oct.	556	.92	512		Oct.	467	.96	448		Oct.	517	.95	490
	Nov.	489	.92	450		Nov.	473	.93	440		Nov.	397	.98	387
	Dec.	572	.92	526		Dec.	448	.93	416		Dec.	379	.99	375
Total		8,997	.91	8,209	Total		7,777	1.01	7,857	Total		8,099	.98	7,962
-1961	Jan.	591	.93	549	-1967	Jan.	500	.94	470	1973	Jan.	581	.99	577
	Feb.	577	.94	543		Feb.	574	.92	528		Feb.	554	1.01	561
	Mar.	936	.95	889		Mar.	847	.91	771		Mar.	611	.99	603
	Apr.	904	.97	877		Apr.	771	.90	694		Apr.	865	.96	828
	May	943	.95	896		May	889	.93	827		May	1,011	.95	963
	June	812	.94	791		June	782	.94	735		June	683	.95	650
	July	822	.94	772		July	832	.90	749		July	823	.96	788
	Aug.	739	.96	709		Aug.	755	.90	679		Aug.	857	.96	823
	Sept.	690	.96	663		Sept.	494	.93	459		Sept.	659	.95	630
	Oct.	539	.93	502		Oct.	576	.93	536		Oct.	560	.95	530
	Nov.	517	.94	486		Nov.	556	.91	506		Nov.	526	.93	491
	Dec.	486	.95	462		Dec.	356	.92	328		Dec.	571	.92	523
Total		8,586	.95	8,139	Total		7,932	.92	7,282	Total		8,301	.96	7,967
-1962	Jan.	482	.93	448	-1968	Jan.	396	.94	372	1974	Jan.	436	.94	409
	Feb.	497	1/.94	464		Feb.	496	.92	456		Feb.	589	.96	563
	Mar.	798	1/.94	750		Mar.	850	.93	791		Mar.	864	.96	829
	Apr.	902	1/.95	857		Apr.	883	.93	821		Apr.	951	.95	908
	May	887	1.00	887		May	853	.95	810		May	960	.95	909
	June	799	1/.94	751		June	752	.93	699		June	880	.93	821
	July	824	1/.91	750		July	757	.94	712		July	847	.93	792
	Aug.	857	1/.87	746		Aug.	693	.97	672		Aug.	948	.93	885
	Sept.	716	1.00	716		Sept.	663	.97	643		Sept.	714	.90	644
	Oct.	934	1/.86	845		Oct.	486	.98	476		Oct.	614	.90	552
	Nov.	613	1/.90	552		Nov.	457	.99	452		Nov.	504	.90	455
	Dec.	606	1/.93	564		Dec.	553	1.00	553		Dec.	425	.91	385
Total		8,615	1/.93	8,033	Total		7,839	.95	7,457	Total		8,732	.93	8,152
-1963	Jan.	482	.99	478	-1969	Jan.	549	1.02	560		Jan.			
	Feb.	575	1/.97	558		Feb.	552	1.02	563		Feb.			
	Mar.	871	1/.95	828		Mar.	825	1.02	841		Mar.			
	Apr.	865	1/.94	813		Apr.	894	1.02	912		Apr.			
	May	911	.93	847		May	834	1.00	834		May			
	June	754	1/.92	702		June	753	1.02	768		June			
	July	908	1/.91	826		July	772	1.01	789		July			
	Aug.	857	.90	771		Aug.	693	1.02	707		Aug.			
	Sept.	724	.89	645		Sept.	618	1.00	618		Sept.			
	Oct.	527	.90	475		Oct.	523	1.00	523		Oct.			
	Nov.	464	.89	413		Nov.	426	1.00	426		Nov.			
	Dec.	585	.90	526		Dec.	453	1.01	458		Dec.			
Total		8,533	1/.92	7,882	Total		7,892	1.01	7,990	Total				
-1964	Jan.	633	.93	589	-1970	Jan.	603	1.04	627		Jan.			
	Feb.	583	.94	548		Feb.	536	1.03	552		Feb.			
	Mar.	800	.95	760		Mar.	753	1.03	776		Mar.			
	Apr.	859	.98	842		Apr.	919	1.02	937		Apr.			
	May	844	.98	827		May	927	.97	899		May			
	June	719	.99	712		June	780	1.00	789		June			
	July	866	.98	849		July	792	.98	776		July			
	Aug.	731	.99	724		Aug.	676	1.00	677		Aug.			
	Sept.	623	.99	616		Sept.	507	.97	492		Sept.			
	Oct.	591	1.01	596		Oct.	583	1.01	589		Oct.			
	Nov.	445	1.02	454		Nov.	450	1.07	481		Nov.			
	Dec.	469	1.06	497		Dec.	497	1.09	542		Dec.			
Total		8,163	.98	8,014	Total		8,023	1.01	8,128	Total				

To obtain mg/l multiply T/AF by 735.
 1/Estimated or partially estimated.

Table 15
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River below Hoover Dam, Arizona, Nevada
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	14,889	1.00	735	14,897
1942	15,762	.98	717	15,381
1943	12,715	.90	665	11,502
1944	14,427	.94	693	13,607
1945	12,512	.92	676	11,512
1946	10,585	.91	668	9,626
1947	10,959	.94	690	10,283
1948	13,051	.90	660	11,713
1949	13,566	.83	610	11,250
1950	12,016	.84	614	10,046
1951	9,870	.91	671	9,005
1952	15,816	.85	623	13,401
1953	11,302	.89	656	10,093
1954	10,514	.94	693	9,913
1955	8,589	1.09	804	9,393
1956	7,812	1.14	839	8,918
1957	9,323	1.04	763	9,681
1958	11,877	.86	634	10,243
1959	9,282	.84	621	7,841
1960	8,997	.91	671	8,209
1961	8,586	.95	697	8,139
1962	8,615	.93	685	8,033
1963	8,533	.92	677	7,882
1964	8,163	.98	722	8,014
1965	7,792	1.10	809	8,574
1966	7,777	1.01	743	7,857
1967	7,932	.92	675	7,282
1968	7,839	.95	699	7,457
1969	7,892	1.01	744	7,990
1970	8,023	1.01	745	8,128

Measured flow record entire period.

Table 16
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River below Parker Dam, Arizona-California

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	627	1.11	698	-1947	Jan.	953	.91	870	-1953	Jan.	1,198	.68	813
	Feb.	561	1.14	642		Feb.	899	.92	829		Feb.	1,020	.83	848
	Mar.	750	1.14	854		Mar.	940	.94	888		Mar.	947	.90	853
	Apr.	608	1.12	679		Apr.	797	.97	777		Apr.	808	.93	753
	May	1,359	1.12	1,524		May	905	.99	892		May	953	.92	880
	June	1,628	1.11	1,808		June	860	.98	847		June	956	.92	882
	July	998	1.10	1,098		July	844	.97	822		July	1,093	.89	973
	Aug.	1,332	1.04	1,381		Aug.	892	.96	860		Aug.	1,056	.86	909
	Sept.	1,528	.98	1,495		Sept.	819	.98	800		Sept.	823	.85	700
	Oct.	1,585	.98	1,550		Oct.	837	.91	765		Oct.	634	.86	544
	Nov.	1,731	.95	1,641		Nov.	880	.87	768		Nov.	527	.86	455
	Dec.	2,042	1.04	2,116		Dec.	1,037	.83	862		Dec.	634	.87	550
Total	14,749	1.05	15,486	Total	10,663	.94	9,980	Total	10,649	.86	9,160			
-1942	Jan.	1,957	1.09	1,963	-1948	Jan.	1,160	.96	1,109	-1954	Jan.	797	.86	685
	Feb.	1,482	1.00	1,480		Feb.	1,160	.92	1,062		Feb.	661	.85	560
	Mar.	1,494	.99	1,476		Mar.	1,107	.91	1,009		Mar.	782	.86	673
	Apr.	1,136	1.01	1,143		Apr.	1,083	.92	999		Apr.	864	.86	746
	May	1,588	1.01	1,602		May	1,115	.91	1,016		May	1,045	.91	927
	June	1,536	1.01	1,549		June	989	.93	923		June	883	.94	834
	July	1,226	.98	1,197		July	1,108	.90	999		July	1,000	.93	934
	Aug.	880	1.07	939		Aug.	986	.89	880		Aug.	982	.93	918
	Sept.	797	1.00	794		Sept.	941	.88	831		Sept.	754	.94	706
	Oct.	865	.99	853		Oct.	918	.86	791		Oct.	636	.94	599
	Nov.	1,041	.99	1,028		Nov.	978	.81	793		Nov.	638	.94	601
	Dec.	1,213	.89	1,084		Dec.	1,106	.92	1,019		Dec.	659	.94	618
Total	15,195	.99	15,088	Total	12,651	.90	11,431	Total	9,671	.91	8,801			
-1943	Jan.	1,015	.93	948	-1949	Jan.	1,229	.89	1,099	-1955	Jan.	734	.95	699
	Feb.	746	.88	657		Feb.	1,192	.85	1,015		Feb.	598	.96	574
	Mar.	886	.97	863		Mar.	1,236	.84	1,044		Mar.	733	.98	722
	Apr.	877	.95	837		Apr.	1,116	.88	985		Apr.	758	.99	753
	May	957	.97	933		May	983	1.05	866		May	792	1.02	804
	June	976	.98	961		June	923	.89	824		June	866	1.06	914
	July	1,086	.90	981		July	952	.89	849		July	963	1.10	1,060
	Aug.	990	.91	904		Aug.	1,013	.84	852		Aug.	849	1.09	924
	Sept.	1,006	.90	908		Sept.	1,099	.83	913		Sept.	694	1.07	740
	Oct.	1,160	.92	1,062		Oct.	1,148	.80	918		Oct.	499	1.08	540
	Nov.	1,149	.87	1,003		Nov.	1,011	.77	778		Nov.	369	1.10	407
	Dec.	1,231	.87	1,076		Dec.	1,158	.74	855		Dec.	286	1.09	312
Total	12,079	.92	11,133	Total	13,060	.84	10,998	Total	8,141	1.04	8,449			
-1944	Jan.	1,241	.90	1,121	-1950	Jan.	1,080	.86	931	-1956	Jan.	317	1.11	352
	Feb.	1,223	.92	1,131		Feb.	1,036	.85	882		Feb.	365	1.12	407
	Mar.	1,227	.96	1,240		Mar.	1,209	.84	1,017		Mar.	628	1.13	708
	Apr.	1,164	.98	1,136		Apr.	998	.88	879		Apr.	684	1.12	766
	May	1,116	.98	1,089		May	1,066	.88	941		May	671	1.10	735
	June	983	.93	969		June	900	.87	789		June	671	1.12	880
	July	1,035	.95	988		July	897	.85	765		July	625	1.13	976
	Aug.	1,148	.96	1,098		Aug.	833	.84	698		Aug.	624	1.12	920
	Sept.	1,114	.89	904		Sept.	704	.84	590		Sept.	581	1.15	728
	Oct.	1,178	.88	1,042		Oct.	651	.86	558		Oct.	495	1.10	536
	Nov.	1,156	.88	1,023		Nov.	542	.87	473		Nov.	325	1.12	359
	Dec.	1,187	.94	1,110		Dec.	557	.89	494		Dec.	288	1.15	330
Total	13,842	.93	12,941	Total	10,473	.86	9,013	Total	6,869	1.12	7,697			
-1945	Jan.	1,186	.94	1,121	-1951	Jan.	550	.89	488	-1957	Jan.	243	1.15	279
	Feb.	1,061	.91	969		Feb.	501	.89	448		Feb.	349	1.13	395
	Mar.	1,232	.94	1,152		Mar.	730	.90	657		Mar.	589	1.12	657
	Apr.	985	.94	929		Apr.	765	.89	682		Apr.	731	1.09	706
	May	970	.94	915		May	675	.90	607		May	645	1.09	704
	June	919	.99	914		June	862	.90	779		June	783	1.08	845
	July	913	.92	844		July	945	.91	862		July	890	1.06	941
	Aug.	770	.90	694		Aug.	945	.89	840		Aug.	817	1.04	848
	Sept.	824	.91	751		Sept.	723	.89	636		Sept.	661	1.01	670
	Oct.	1,038	.85	884		Oct.	709	.88	638		Oct.	503	1.02	513
	Nov.	1,036	.89	924		Nov.	560	.90	502		Nov.	781	1.03	802
	Dec.	1,099	.90	992		Dec.	707	.91	642		Dec.	1,005	1.04	1,044
Total	12,033	.92	11,089	Total	8,672	.90	7,781	Total	7,997	1.06	8,494			
-1946	Jan.	1,041	.90	939	-1952	Jan.	1,104	.91	1,008	-1958	Jan.	1,285	1.00	1,280
	Feb.	1,028	.96	991		Feb.	1,134	.89	1,012		Feb.	565	.95	536
	Mar.	944	.89	843		Mar.	1,424	.89	1,273		Mar.	1,385	.91	1,228
	Apr.	830	1.04	867		Apr.	1,300	.92	1,202		Apr.	1,333	.89	1,191
	May	872	.94	825		May	1,443	.95	1,366		May	1,013	.87	883
	June	754	.92	696		June	1,419	.95	1,341		June	854	.86	735
	July	801	.91	731		July	1,263	.90	1,142		July	930	.86	808
	Aug.	722	.89	642		Aug.	1,296	.85	1,105		Aug.	867	.84	799
	Sept.	730	.91	665		Sept.	1,321	.81	1,074		Sept.	714	.83	590
	Oct.	759	.91	691		Oct.	1,234	.76	935		Oct.	610	.84	510
	Nov.	789	.91	720		Nov.	1,172	.71	829		Nov.	623	.84	521
	Dec.	870	.91	794		Dec.	1,303	.69	895		Dec.	753	.85	639
Total	10,141	.93	9,404	Total	15,413	.86	13,182	Total	10,892	.89	9,646			

To obtain mg/l multiply T/AF by 735.

Table 16
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River below Parker Dam, Arizona-California

Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concen- tration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	777	0.84	560	-1965	Jan.	290	1.01	294	1971	Jan.	339	1.07	363
	Feb.	593	.87	517		Feb.	423	1.22	424		Feb.	486	1.03	503
	Mar.	690	.84	515		Mar.	634	1.23	651		Mar.	743	1.04	771
	Apr.	832	.85	707		Apr.	581	1.26	614		Apr.	746	1.07	796
	May	705	.83	580		May	604	1.07	645		May	661	1.05	691
	June	797	.84	705		June	710	1.11	790		June	743	1.01	751
	July	952	.86	820		July	946	1.29	924		July	877	1.02	896
	Aug.	873	.81	706		Aug.	867	1.28	840		Aug.	690	1.02	704
	Sept.	682	.82	557		Sept.	599	1.08	648		Sept.	565	1.01	570
	Oct.	558	.84	471		Oct.	385	1.11	426		Oct.	397	1.04	434
	Nov.	405	.84	342		Nov.	220	1.10	243		Nov.	309	1.03	319
	Dec.	411	.83	343		Dec.	197	.95	187		Dec.	355	1.04	371
Total	8,186	.85	6,324	Total	6,356	1.07	6,786	Total	6,911	1.03	7,149			
-1960	Jan.	428	.84	357	-1966	Jan.	177	.73	129	1972	Jan.	346	1.05	362
	Feb.	474	.82	388		Feb.	413	1.04	428		Feb.	480	1.07	513
	Mar.	750	.85	620		Mar.	604	1.08	655		Mar.	747	1.07	797
	Apr.	810	.87	705		Apr.	729	1.08	785		Apr.	766	1.05	806
	May	740	.83	621		May	699	1.10	766		May	700	1.02	714
	June	879	.80	794		June	790	1.12	887		June	689	1.01	694
	July	986	.83	850		July	901	1.07	966		July	875	1.00	872
	Aug.	868	.80	780		Aug.	552	1.04	890		Aug.	716	.97	694
	Sept.	640	.89	568		Sept.	585	1.07	626		Sept.	574	.98	562
	Oct.	490	.87	428		Oct.	357	.96	343		Oct.	224	.99	221
	Nov.	397	.86	350		Nov.	256	1.00	256		Nov.	283	.97	274
	Dec.	322	.91	293		Dec.	320	.87	311		Dec.	389	1.00	389
Total	7,794	.88	6,326	Total	6,683	1.05	7,042	Total	6,789	1.02	6,898			
-1961	Jan.	379	.92	347	-1967	Jan.	306	.98	299	1973	Jan.	355	1.01	358
	Feb.	453	.91	414		Feb.	431	1.01	434		Feb.	348	1.00	347
	Mar.	742	.92	694		Mar.	677	.98	664		Mar.	642	.95	613
	Apr.	725	.92	669		Apr.	608	.98	594		Apr.	800	.96	770
	May	705	.94	564		May	648	.98	635		May	696	.99	691
	June	822	.94	776		June	726	1.01	733		June	673	1.00	673
	July	900	.93	841		July	635	.95	724		July	829	1.01	837
	Aug.	710	.93	561		Aug.	749	.98	734		Aug.	726	1.01	731
	Sept.	606	.92	556		Sept.	490	.97	475		Sept.	644	.98	632
	Oct.	412	.91	374		Oct.	435	.95	413		Oct.	484	.98	472
	Nov.	319	.94	300		Nov.	247	.93	230		Nov.	310	.97	302
	Dec.	202	.92	186		Dec.	170	.96	163		Dec.	340	.97	332
Total	6,975	.93	6,472	Total	6,322	.98	6,167	Total	6,847	.99	6,758			
-1962	Jan.	334	.93	310	-1968	Jan.	351	.94	330	1974	Jan.	245	.98	238
	Feb.	374	.93	346		Feb.	450	.89	400		Feb.	481	.98	472
	Mar.	692	.94	652		Mar.	680	.93	632		Mar.	705	.97	682
	Apr.	756	1.06	729		Apr.	700	.93	652		Apr.	864	.97	841
	May	686	1.07	667		May	626	.97	608		May	756	.97	730
	June	778	1.00	775		June	722	.95	685		June	791	.96	763
	July	882	.97	859		July	779	.96	745		July	874	.96	837
	Aug.	821	.99	816		Aug.	725	.95	686		Aug.	825	.92	759
	Sept.	644	.97	627		Sept.	585	.98	573		Sept.	625	.91	567
	Oct.	471	.98	460		Oct.	404	.98	394		Oct.	400	.93	372
	Nov.	434	.97	423		Nov.	309	.99	306		Nov.	281	.92	258
	Dec.	287	1.00	286		Dec.	312	1.00	312		Dec.	297	.95	282
Total	7,159	.97	6,950	Total	6,643	.95	6,323	Total	7,144	.95	6,801			
-1963	Jan.	350	1.00	349	-1969	Jan.	254	1.01	256		Jan.			
	Feb.	467	1.00	466		Feb.	467	1.02	476		Feb.			
	Mar.	735	.99	731		Mar.	740	.95	703		Mar.			
	Apr.	690	.99	685		Apr.	713	1.03	734		Apr.			
	May	708	.97	697		May	640	1.08	692		May			
	June	840	.95	802		June	874	1.05	708		June			
	July	933	.92	862		July	765	1.03	787		July			
	Aug.	819	.91	747		Aug.	733	.99	726		Aug.			
	Sept.	630	.91	572		Sept.	488	.99	483		Sept.			
	Oct.	438	.88	385		Oct.	434	.97	420		Oct.			
	Nov.	334	.88	294		Nov.	220	1.03	227		Nov.			
	Dec.	307	.89	272		Dec.	310	1.02	317		Dec.			
Total	7,251	.94	6,852	Total	6,438	1.01	6,529	Total						
-1964	Jan.	363	.91	329	-1970	Jan.	367	1.03	378		Jan.			
	Feb.	479	.90	432		Feb.	442	1.04	460		Feb.			
	Mar.	640	.91	582		Mar.	654	1.02	667		Mar.			
	Apr.	652	.91	596		Apr.	750	1.04	780		Apr.			
	May	598	.92	552		May	657	1.03	676		May			
	June	742	.95	706		June	706	1.03	727		June			
	July	864	.95	824		July	792	1.00	792		July			
	Aug.	795	.95	754		Aug.	675	1.02	688		Aug.			
	Sept.	582	.96	564		Sept.	530	1.01	535		Sept.			
	Oct.	432	.96	393		Oct.	454	1.03	468		Oct.			
	Nov.	275	.96	264		Nov.	304	1.04	316		Nov.			
	Dec.	245	1.00	246		Dec.	328	1.09	358		Dec.			
Total	6,651	.94	6,242	Total	6,659	1.03	6,845	Total						

To obtain mg/l multiply T/AF by 735.

Table 16
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River below Parker Dam, Arizona - California
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	14,749	1.05	772	15,486
1942	15,195	.99	730	15,088
1943	12,079	.92	676	11,113
1944	13,842	.93	687	12,941
1945	12,033	.92	678	11,089
1946	10,141	.93	682	9,404
1947	10,663	.94	688	9,980
1948	12,651	.90	664	11,431
1949	13,060	.84	619	10,998
1950	10,473	.86	633	9,013
1951	8,672	.90	660	7,781
1952	15,413	.86	629	13,182
1953	10,649	.86	632	9,160
1954	9,671	.91	669	8,801
1955	8,141	1.04	763	8,449
1956	6,869	1.12	824	7,697
1957	7,997	1.06	781	8,494
1958	10,892	.89	651	9,646
1959	8,186	.85	622	6,924
1960	7,794	.88	644	6,826
1961	6,975	.93	682	6,472
1962	7,159	.97	714	6,950
1963	7,251	.94	695	6,852
1964	6,651	.94	689	6,242
1965	6,356	1.07	784	6,786
1966	6,683	1.05	774	7,042
1967	6,322	.98	717	6,167
1968	6,643	.95	699	6,323
1969	6,438	1.01	745	6,529
1970	6,659	1.03	756	6,845

1/ Partially estimated.

Records furnished by Metropolitan Water District of
Southern California

Table 17
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River at Imperial Dam, Arizona - California

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1941	Jan.	642	1.10	706	-1947	Jan.	933	0.95	886	-1953	Jan.	1,216	0.77	938
	Feb.	535	1.15	615		Feb.	572	.95	528		Feb.	1,022	.89	910
	Mar.	743	.90	669		Mar.	934	.98	915		Mar.	911	.95	865
	Apr.	562	1.04	584		Apr.	737	1.02	752		Apr.	756	1.01	764
	May	1,150	1.11	1,277		May	827	1.01	835		May	856	1.01	865
	June	1,605	1.21	1,942		June	787	1.02	803		June	811	1.00	811
	July	965	1.17	1,129		July	743	1.01	750		July	980	.96	941
	Aug.	1,192	1.09	1,299		Aug.	830	.99	822		Aug.	931	.95	884
	Sept.	1,444	.99	1,430		Sept.	733	1.00	733		Sept.	776	.93	722
	Oct.	1,505	1.02	1,535		Oct.	753	.95	715		Oct.	644	.96	618
	Nov.	1,671	1.02	1,704		Nov.	851	.90	766		Nov.	522	.97	506
	Dec.	2,010	1.04	2,090		Dec.	1,041	.87	906		Dec.	620	.95	589
Total	14,024	1.07	14,980	Total	10,041	.97	9,711	Total	10,345	.94	9,411			
-1942	Jan.	1,876	1.08	2,026	-1948	Jan.	1,106	.97	1,073	-1954	Jan.	783	.94	736
	Feb.	1,590	1.09	1,733		Feb.	1,135	.94	1,067		Feb.	661	.94	621
	Mar.	1,476	1.09	1,609		Mar.	1,092	.95	1,037		Mar.	723	.94	660
	Apr.	1,080	1.11	1,199		Apr.	1,007	.94	947		Apr.	772	.94	721
	May	1,524	1.10	1,676		May	1,051	.95	998		May	929	1.05	975
	June	1,465	1.11	1,626		June	916	.95	870		June	804	1.03	828
	July	1,199	1.11	1,331		July	1,003	.95	953		July	885	1.01	894
	Aug.	844	1.09	920		Aug.	906	.94	852		Aug.	887	1.03	914
	Sept.	742	1.11	824		Sept.	871	.91	793		Sept.	719	1.02	733
	Oct.	761	1.08	822		Oct.	901	.89	802		Oct.	620	1.03	639
	Nov.	951	1.03	1,010		Nov.	945	.86	813		Nov.	602	1.02	614
	Dec.	1,176	.97	1,141		Dec.	1,103	.94	1,037		Dec.	644	1.03	663
Total	14,714	1.08	15,917	Total	12,036	.93	11,242	Total	9,030	1.00	9,024			
-1943	Jan.	1,011	.94	950	-1949	Jan.	1,237	.92	1,138	-1955	Jan.	739	1.00	739
	Feb.	729	.92	671		Feb.	1,183	.88	1,041		Feb.	593	1.03	611
	Mar.	846	.95	804		Mar.	1,226	.88	1,079		Mar.	678	1.07	725
	Apr.	802	.96	770		Apr.	1,084	.91	986		Apr.	716	1.09	780
	May	842	.98	825		May	927	.92	853		May	729	1.13	824
	June	876	.98	858		June	871	.93	810		June	746	1.20	895
	July	972	.95	923		July	860	.92	791		July	882	1.21	1,067
	Aug.	910	.94	855		Aug.	934	.88	822		Aug.	811	1.18	957
	Sept.	917	.94	862		Sept.	996	.86	857		Sept.	638	1.17	746
	Oct.	1,094	.94	1,028		Oct.	1,103	.83	915		Oct.	499	1.20	599
	Nov.	1,124	.93	1,045		Nov.	1,000	.93	930		Nov.	379	1.24	470
	Dec.	1,222	.89	1,088		Dec.	1,146	.77	882		Dec.	298	1.29	384
Total	11,345	.94	10,679	Total	12,567	.88	11,104	Total	7,708	1.19	8,797			
-1944	Jan.	1,209	.89	1,076	-1950	Jan.	1,088	.89	968	-1956	Jan.	298	1.31	390
	Feb.	1,216	.94	1,143		Feb.	994	.87	865		Feb.	344	1.24	427
	Mar.	1,289	.97	1,250		Mar.	1,169	.88	1,029		Mar.	546	1.24	677
	Apr.	1,126	1.00	1,126		Apr.	936	.90	842		Apr.	646	1.23	795
	May	1,055	1.01	1,066		May	1,002	.91	912		May	594	1.26	748
	June	900	1.02	918		June	841	.89	748		June	666	1.25	833
	July	920	.99	911		July	822	.89	732		July	753	1.25	941
	Aug.	1,041	.97	1,010		Aug.	798	.88	667		Aug.	717	1.22	875
	Sept.	1,041	.94	979		Sept.	643	.87	559		Sept.	583	1.24	723
	Oct.	1,123	.92	1,033		Oct.	603	.94	567		Oct.	479	1.24	594
	Nov.	1,142	.89	1,016		Nov.	510	.95	485		Nov.	343	1.28	439
	Dec.	1,143	.89	1,017		Dec.	540	.95	513		Dec.	297	1.30	386
Total	13,205	.95	12,545	Total	9,906	.90	8,887	Total	6,266	1.25	7,928			
-1945	Jan.	1,160	.99	1,137	-1951	Jan.	558	.95	530	-1957	Jan.	258	1.36	351
	Feb.	1,047	.97	1,016		Feb.	498	.96	478		Feb.	314	1.32	414
	Mar.	1,193	.97	1,157		Mar.	635	.96	610		Mar.	520	1.23	640
	Apr.	947	.98	928		Apr.	744	.96	714		Apr.	667	1.18	737
	May	905	1.00	905		May	606	.99	600		May	581	1.19	691
	June	860	.99	851		June	703	.98	689		June	651	1.19	775
	July	817	.96	784		July	820	.98	804		July	794	1.22	929
	Aug.	718	.94	675		Aug.	853	.95	810		Aug.	759	1.08	820
	Sept.	745	.92	685		Sept.	697	.93	648		Sept.	616	1.12	690
	Oct.	912	.88	803		Oct.	682	.96	655		Oct.	511	1.16	593
	Nov.	1,011	.89	900		Nov.	559	.97	542		Nov.	695	1.14	792
	Dec.	1,075	.93	1,000		Dec.	698	.98	684		Dec.	978	1.10	1,076
Total	11,390	.95	10,841	Total	8,053	.96	7,764	Total	7,344	1.17	8,598			
-1946	Jan.	1,008	.94	948	-1952	Jan.	1,058	.95	1,005	-1958	Jan.	1,299	1.05	1,364
	Feb.	1,005	.92	925		Feb.	1,107	.96	1,063		Feb.	637	1.07	682
	Mar.	927	.94	871		Mar.	1,424	.92	1,310		Mar.	1,253	1.06	1,328
	Apr.	759	.96	729		Apr.	1,279	.97	1,241		Apr.	1,280	1.02	1,306
	May	786	.98	770		May	1,345	1.00	1,345		May	1,016	1.00	1,016
	June	658	.99	651		June	1,309	.99	1,296		June	769	1.01	777
	July	719	.97	697		July	1,182	.97	1,147		July	812	.96	780
	Aug.	666	.94	626		Aug.	1,178	.92	1,084		Aug.	802	.97	778
	Sept.	639	.95	607		Sept.	1,219	.87	1,061		Sept.	655	.97	635
	Oct.	707	.97	686		Oct.	1,240	.84	1,042		Oct.	624	1.01	630
	Nov.	757	.96	727		Nov.	1,176	.78	917		Nov.	592	1.00	592
	Dec.	855	.94	804		Dec.	1,298	.75	974		Dec.	761	.97	738
Total	9,486	.95	9,041	Total	14,815	.91	13,485	Total	10,500	1.01	10,626			

To obtain mg/l multiply T/AF by 735.

Table 17
 Colorado River Basin
 Historical Flow and Quality of Water Data
 Colorado River at Imperial Dam, Arizona - California

Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)	Year	Month	Flow 1000 (A.F.)	Concentration (T./A.F.)	T.D.S. 1000 (Tons)
-1959	Jan.	574	0.99	667	-1965	Jan.	271	1.25	341	1971	Jan.	324	1.32	427
	Feb.	532	.99	552		Feb.	332	1.26	418		Feb.	391	1.23	482
	Mar.	618	1.02	630		Mar.	548	1.20	658		Mar.	612	1.19	728
	Apr.	770	1.01	773		Apr.	566	1.15	651		Apr.	627	1.20	751
	May	646	1.03	678		May	548	1.22	669		May	524	1.22	637
	June	579	1.03	629		June	558	1.22	680		June	579	1.17	679
	July	824	.99	816		July	709	1.22	891		July	676	1.14	772
	Aug.	821	1.04	854		Aug.	737	1.29	943		Aug.	600	1.14	687
	Sept.	544	1.04	670		Sept.	540	1.31	708		Sept.	472	1.16	550
	Oct.	565	1.03	582		Oct.	400	1.29	516		Oct.	390	1.23	480
	Nov.	421	1.04	438		Nov.	257	1.33	342		Nov.	300	1.30	389
	Dec.	441	1.01	445		Dec.	237	1.22	290		Dec.	334	1.28	428
Total	7,695	1.02	7,843	Total	5,703	1.25	7,109	Total	5,829	1.20	7,010			
-1960	Jan.	449	1.02	458	-1966	Jan.	203	1.13	229	1972	Jan.	341	1.28	435
	Feb.	436	1.00	430		Feb.	334	1.21	404		Feb.	389	1.24	481
	Mar.	551	.99	644		Mar.	517	1.21	626		Mar.	618	1.19	735
	Apr.	762	.99	754		Apr.	622	1.22	758		Apr.	644	1.17	756
	May	650	1.07	696		May	576	1.24	715		May	560	1.18	659
	June	736	1.07	788		June	637	1.31	835		June	559	1.16	648
	July	845	1.07	904		July	729	1.20	874		July	667	1.15	766
	Aug.	777	1.06	824		Aug.	733	1.18	865		Aug.	633	1.12	708
	Sept.	506	1.09	561		Sept.	532	1.21	643		Sept.	484	1.17	567
	Oct.	481	1.10	529		Oct.	389	1.23	478		Oct.	295	1.38	407
	Nov.	350	1.14	410		Nov.	263	1.28	337		Nov.	267	1.28	343
	Dec.	354	1.15	407		Dec.	314	1.18	369		Dec.	340	1.24	424
Total	7,107	1.06	7,511	Total	5,849	1.22	7,133	Total	5,797	1.20	6,929			
-1961	Jan.	342	1.18	404	-1967	Jan.	301	1.21	364	1973	Jan.	361	1.20	432
	Feb.	400	1.15	460		Feb.	369	1.16	428		Feb.	306	1.21	371
	Mar.	648	1.10	713		Mar.	593	1.12	664		Mar.	532	1.12	594
	Apr.	666	1.08	712		Apr.	558	1.15	642		Apr.	663	1.09	722
	May	618	1.14	705		May	550	1.16	638		May	571	1.15	658
	June	691	1.08	746		June	595	1.16	690		June	524	1.15	601
	July	755	1.09	823		July	673	1.08	727		July	645	1.11	715
	Aug.	671	1.12	752		Aug.	672	1.09	732		Aug.	613	1.15	707
	Sept.	541	1.14	617		Sept.	450	1.16	522		Sept.	539	1.13	610
	Oct.	427	1.10	470		Oct.	412	1.12	461		Oct.	452	1.16	524
	Nov.	312	1.12	349		Nov.	268	1.22	327		Nov.	310	1.23	383
	Dec.	222	1.18	262		Dec.	174	1.35	235		Dec.	331	1.23	407
Total	6,293	1.12	7,020	Total	5,615	1.15	6,430	Total	5,847	1.15	6,724			
-1962	Jan.	337	1.11	374	-1968	Jan.	342	1.18	404	1974	Jan.	255	1.28	326
	Feb.	304	1.14	347		Feb.	366	1.10	403		Feb.	408	1.14	465
	Mar.	597	1.06	633		Mar.	566	1.10	623		Mar.	571	1.12	642
	Apr.	689	1.06	730		Apr.	622	1.09	678		Apr.	714	1.11	795
	May	619	1.11	688		May	532	1.18	628		May	626	1.14	713
	June	648	1.12	725		June	580	1.10	638		June	624	1.12	696
	July	741	1.11	822		July	625	1.14	713		July	727	1.10	798
	Aug.	730	1.12	818		Aug.	609	1.16	706		Aug.	733	1.08	795
	Sept.	593	1.11	658		Sept.	494	1.17	578		Sept.	558	1.11	621
	Oct.	458	1.15	527		Oct.	399	1.21	483		Oct.	409	1.17	480
	Nov.	439	1.16	509		Nov.	297	1.25	371		Nov.	292	1.25	364
	Dec.	303	1.18	358		Dec.	309	1.25	386		Dec.	301	1.23	370
Total	6,458	1.11	7,189	Total	5,741	1.15	6,611	Total	6,218	1.14	7,065			
-1963	Jan.	337	1.14	384	-1969	Jan.	271	1.30	352		Jan.			
	Feb.	393	1.11	436		Feb.	376	1.18	444		Feb.			
	Mar.	615	1.10	676		Mar.	601	1.12	675		Mar.			
	Apr.	647	1.09	705		Apr.	638	1.20	766		Apr.			
	May	602	1.09	656		May	550	1.19	655		May			
	June	691	1.06	733		June	552	1.17	647		June			
	July	775	1.04	806		July	622	1.16	721		July			
	Aug.	757	1.02	772		Aug.	628	1.18	740		Aug.			
	Sept.	595	1.04	619		Sept.	443	1.23	544		Sept.			
	Oct.	461	1.08	498		Oct.	417	1.22	509		Oct.			
	Nov.	340	1.12	381		Nov.	225	1.32	297		Nov.			
	Dec.	309	1.13	350		Dec.	292	1.29	376		Dec.			
Total	6,522	1.08	7,016	Total	5,616	1.20	6,726	Total						
-1964	Jan.	337	1.12	377	-1970	Jan.	352	1.20	423		Jan.			
	Feb.	415	1.07	444		Feb.	352	1.21	424		Feb.			
	Mar.	562	1.06	595		Mar.	558	1.17	653		Mar.			
	Apr.	609	1.07	652		Apr.	677	1.16	788		Apr.			
	May	530	1.10	583		May	540	1.22	661		May			
	June	576	1.15	653		June	549	1.20	658		June			
	July	719	1.09	784		July	623	1.19	738		July			
	Aug.	679	1.09	740		Aug.	577	1.20	695		Aug.			
	Sept.	539	1.14	615		Sept.	440	1.22	535		Sept.			
	Oct.	396	1.22	483		Oct.	423	1.24	525		Oct.			
	Nov.	281	1.26	354		Nov.	299	1.24	370		Nov.			
	Dec.	257	1.27	326		Dec.	315	1.29	407		Dec.			
Total	5,900	1.12	6,616	Total	5,705	1.21	6,877	Total						

To obtain mg/l multiply T/AF by 735.

Table 17
Colorado River Basin
Historical Flow and Quality of Water Data
Colorado River at Imperial Dam, Arizona - California
(Annual Summary)

Calendar Year	Flow 1000 (A.F.)	Concentration		T.D.S. 1000 (Tons)
		(T./A.F.)	(Mg./l)	
1941	14,024	1.07	785	14,980
1942	14,714	1.08	795	15,917
1943	11,345	.94	692	10,679
1944	13,205	.95	698	12,545
1945	11,390	.95	700	10,841
1946	9,486	.95	701	9,041
1947	10,041	.97	711	9,711
1948	12,036	.93	687	11,242
1949	12,567	.88	649	11,104
1950	9,906	.90	659	8,887
1951	8,053	.96	709	7,764
1952	14,815	.91	669	13,485
1953	10,045	.94	689	9,411
1954	9,030	1.00	735	9,024
1955	7,708	1.14	839	8,797
1956	6,266	1.25	918	7,828
1957	7,344	1.17	860	8,598
1958	10,500	1.01	744	10,626
1959	7,695	1.02	749	7,843
1960	7,107	1.06	777	7,511
1961	6,293	1.12	820	7,020
1962	6,458	1.11	818	7,189
1963	6,522	1.08	791	7,016
1964	5,900	1.12	824	6,616
1965	5,703	1.25	916	7,109
1966	5,849	1.22	896	7,133
1967	5,615	1.15	842	6,430
1968	5,741	1.15	846	6,611
1969	5,616	1.20	880	6,726
1970	5,705	1.21	886	6,877

