QUALITY OF WATER

COLORADO RIVER BASIN

PROGRESS REPORT No. 6

JANUARY 1973

UNITED STATES
DEPARTMENT OF THE INTERIOR
Rogers C.B. Morton Secretary

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United States Department of the Interior

BUREAU OF RECLAMATION
WASHINGTON, D.C. 20240

In Reply Refer to:
WBR 705/425.

JAN 30 1973

Dear Mr. Speaker:

Transmitted herewith is the biennial report (Progress Report No. 6 dated January 1973) on continuing studies of the quality of water of the Colorado River Basin.

The report is transmitted pursuant to Section 15 of the Act of April 11, 1956 (70 Stat. 105), authorizing the Colorado River Storage Project and Participating Projects; Section 15 of the Act of June 13, 1962 (76 Stat. 96), authorizing the Navajo Indian Irrigation Project and the initial stage of the San Juan-Chama Reclamation Project; and Section 6 of the Act of August 16, 1962 (76 Stat. 389), authorizing the Fryingpan-Arkansas Project.

Sincerely yours,

Assistant Secretary of the Interior

Honorable Carl Albert
Speaker of the House
of Representatives
Washington, D.C. 20515

IDENTICAL LETTER TO:
Honorable Spiro Agnew
President of the Senate
Washington, D.C. 20510

Enclosure

ACC # 4006

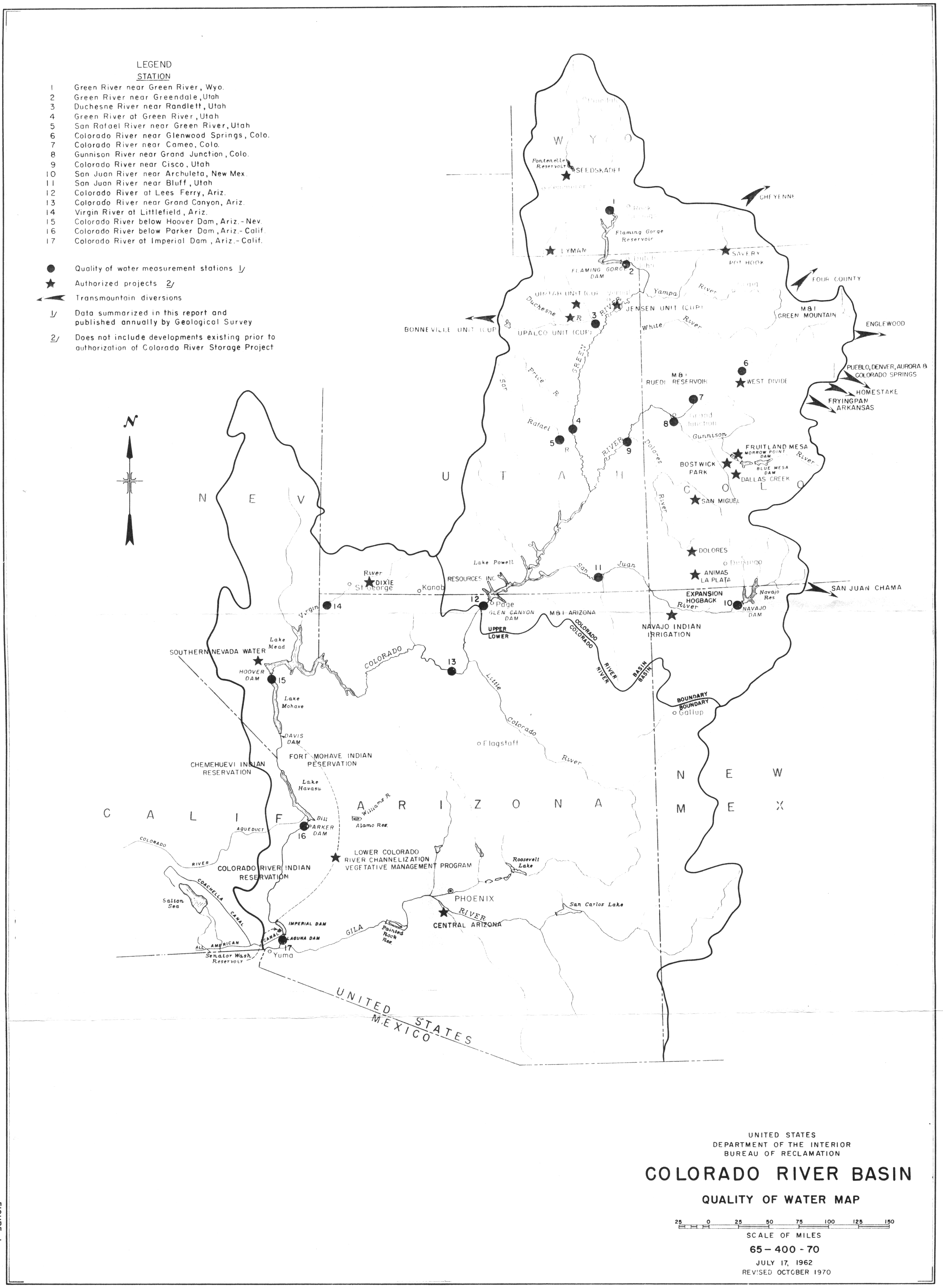

LEGEND
STATION
1 Green River near Green River, Wyo.
2 Green River near Greendale, Utah
3 Duchesne River near Randlett, Utah
4 Green River at Green River, Utah
5 San Rafael River near Green River, Utah
6 Colorado River near Glenwood Springs, Colo.
7 Colorado River near Cameo, Colo.
8 Gunnison River near 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.
13 Colorado River near Grand Canyon, Ariz.
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 projects 2/
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
SEEDSKADEE
CHEYENNE
Flaming Gorge Reservoir
LYMAN
SAVERY POT HOOK
FLAMING GORGE DAM
FOUR COUNTY
JENSEN UNIT (CUP)
BONNEVILLE UNIT (CUP)
UPALCO UNIT (CUP)
M&I GREEN MOUNTAIN
ENGLEWOOD
M&I RUEDI RESERVOIR
WEST DIVIDE
PUEBLO, DENVER, AURORA & COLORADO SPRINGS
HOMESTAKE
FRYINGPAN ARKANSAS
FRUITLAND MESA
MORROW POINT DAM
BLUE MESA DAM
BOSTWICK PARK
DALLAS CREEK
SAN MIGUEL
DOLORES
ANIMAS LA PLATA
EXPANSION HOGBACK
SAN JUAN CHAMA
NAVAJO DAM
NAVAJO INDIAN IRRIGATION
Lake Powell
RESOURCES INC.
DIXIE
GLEN CANYON DAM
M&I ARIZONA
UPPER
LOWER
COLORADO RIVER BASIN BOUNDARY
SOUTHERN NEVADA WATER
HOOVER DAM
Lake Mead
Lake Mohave
DAVIS DAM
FORT MOHAVE INDIAN PESERVATION
CHEMEHUEVI INDIAN RESERVATION
Lake Havasu
PARKER DAM
Alamo Res.
LOWER COLORADO RIVER CHANNELIZATION VEGETATIVE MANAGEMENT PROGRAM
COLORADO RIVER INDIAN RESERVATION
Roosevelt Lake
PHOENIX
CENTRAL ARIZONA
San Carlos Lake
Salton Sea
COACHELLA CANAL
ALL AMERICAN CANAL
IMPERIAL DAM
LAGUNA DAM
Senator Wash Reservoir
Yuma
Painted Rock Res.
UNITED STATES
MEXICO
WYO
UTAH
COLO
NEV
ARIZONA
CALIF
NEW MEX
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
COLORADO RIVER BASIN
QUALITY OF WATER MAP
SCALE OF MILES
65-400-70
JULY 17, 1962
REVISED OCTOBER 1970

FIGURE I

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

QUALITY OF WATER
COLORADO RIVER BASIN
PROGRESS REPORT

SUMMARY

This report is a presentation of various 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 1941-70 period. The present modified condition includes adjustments of the historic condition based on the assumption that developments completed during the 1941-70 period were in operation for the full period. The future condition is an estimated projection after the presently authorized developments and some projects proposed for authorization are placed in operation.

Under historic conditions the average concentration of dissolved solids of the Colorado River at Lees Ferry was about 0.76 ton per acre-foot, below Hoover Dam about 0.94 ton per acre-foot, and at Imperial Dam about 1.03 tons per acre-foot for the 1941-70 period.

Under present modified conditions (that is assuming the projects that started operating sometime during the 1941-70 period were in operation throughout the entire period) the concentrations would have been about 0.83; 1.01, and 1.16 tons per acre-foot, respectively, at the three stations.

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. The effect of salts contributed from new lands is thus evaluated by computations of salinity concentrations using zero tons per acre pickup and 2 tons per acre pickup. It was also assumed no additional pickup of dissolved solids would occur for lands already under irrigation.

Under future conditions, assuming negligible salinity control measures, with all authorized projects and projects proposed for authorization in operation and using the assumed maximum rate of pickup of 2 tons per acre on the new irrigated lands, the concentrations are estimated to be 1.04 tons per acre-foot at Lees Ferry, 1.32 tons per acre-foot below Hoover Dam, and 1.64 tons per acre-foot at Imperial Dam. Future conditions

presented in this report represent the conditions occurring after termination of the short-term contracts made for temporary use of water by M&I users (steam powerplants) along the San Juan and lower Colorado Rivers.

The depletions used in this report for the projects, both authorized and proposed for authorization together with present developments and other proposals are the depletions for the developments as presently conceived. Other developments, as yet not identifiable, are expected to occur which will reduce the quantities of water shown for the various stations and cause some changes in concentrations from those indicated in this report.

This report also includes discussions of the effects of salinity on water uses and potentials for salinity control measures. An investigation initiated by the Bureau of Reclamation in FY 1972 titled "Water Quality Improvement Program" is the basis for the part on salinity control.

Other water quality aspects 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. Legislative Requirements for Report

This is the sixth progress report on Quality of Water in the Colorado River Basin. The directive for preparing this and the five 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 (P.L. 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 590, 87th Congress, Second Session, 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.

B. Previous Reports

A series of five 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.

In addition to including 2 more years of record, the major changes in this report from the January 1971 report are as follows: (1) transferring that part of the future estimated depletions that actually occurred during the 2 years to present depletions; (2) deleting the records of sediment, ionic loads of constituents, and temperature of water; (3) revising and updating the section on quality control in accordance with the newly instituted "Water Quality Improvement Program;" (4) reducing average present estimated evaporation of the Upper Basin Storage Reservoirs from 649,000 acre-feet a year to 541,000 acre-feet (this is latest evaporation estimate, pending results from new investigations presently being conducted); (5) assuming no salt return from future steam powerplant uses or from M&I uses on the Seedskadee Project. Because of the changes in (4) and (5) the present modified and future concentrations were reduced from those in the 1971 report.

C. Scope

This report presents data concerning (1) the historical quantity and quality of the flows of the Colorado River and its principal tributaries for the 1941-70 period; (2) an evaluation of historical conditions modified to reflect present development; and (3) a projection of the range of salinity conditions resulting from future development at 17 selected stations in the basin. The potential for salinity control and the current status of salinity control activities are also discussed. A section of the report is devoted to water quality parameters other than salinity.

D. Cooperation

This report was prepared chiefly by the Bureau of Reclamation. The Geological Survey provided most of the basic data and prepared a technical study (Part XI) on salinity in the Flaming Gorge Reservoir and in other reaches of the river. 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 those normally 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. Portions of this network are being used in an intensive measurement program which began in January 1970 with the objective of determining the source of the salt load arriving at Imperial Dam. 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. This task force is composed of representatives from the Geological Survey, International Boundary and Water Commission, and Environmental Protection Agency.

E. Water Quality Legislation

Various water quality legislative acts have been passed, among them the Water Quality Act of 1965 which provided for the establishment of water quality standards for all interstate waters.

Each of the seven Basin States proceeded with actions directed toward establishment of standards for the Colorado River. Early in the standards-setting process, it became apparent to the States that, because of legal and institutional constraints combined with lack of technical knowledge on salinity control and management, it would be very difficult to establish numerical salinity standards 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 concluded that the salinity policy for the Colorado River should have as its objective the maintenance of salinity concentrations at or below levels presently found in the Lower Main Stem and that programs to implement the policy should be developed on a Basinwide basis, notwithstanding the right of the Upper Basin to continue development of its compact portion of waters. The conferees further concluded that the program described in Interior's February 1972 report entitled "Colorado River Water Quality Improvement Program" should be implemented under the direction of the Bureau of Reclamation with assistance of the Office of Saline Water and Environmental Protection Agency at the Federal level.

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 reservoirs 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 mineral 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 mineral concentrations in natural runoff are evaporites of Paleozoic age, shale of Cretaceous age, and salt and gypsum of Tertiary age.

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 the widespread development of soils classified as members of the Gray-Desert, Red Desert and Sierozem, Great Soil Group. In areas with higher rainfall, soils of the Brown and Chestnut Great Soil Groups have developed. 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. Salt pickup mainly 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 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.

Nevertheless, 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 high mountains may range from 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 cottonwoods, 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. In recent years many river channels 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 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 1941-70 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.

DESCRIPTION OF BASIN

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 Colorado River Aqueduct. Lake Havasu and Alamo Reservoir also 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.

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, there were nearly 810,000 acres 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. An additional unknown acreage is irrigated by private pumping from wells in the river aquifers in the Lower Colorado River Basin.

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 present estimated consumptive use of water by irrigated crops in the Upper Basin averages about 1,700,000 acre-feet annually. This is low in comparison to the irrigated acreage, but some lands do not receive a full supply. Other depletions related to irrigation such as evaporation from irrigation reservoirs (not Colorado River Storage Project Reservoirs) and incidental uses are estimated to be about 400,000 acre-feet per year.

Water exported from the Upper Basin during the period 1941-70 averaged about 360,000 acre-feet per year. Since completion of the Colorado-Big Thompson Project with initial diversions made in year 1947, the Duchesne Tunnel completed in 1953, and the Roberts Tunnel completed in 1963, the transmountain diversions have increased to around 500,000 acre-feet. Other transmountain diversions which have recently started and will have a considerable impact in the future are the San Juan-Chama, Fryingpan-Arkansas, and Homestake.

Consumptive use of water for municipal and industrial purposes in the Upper Basin produces a minor depletion of about 30,000 acre-feet annually. Consumptive use for thermal powerplants, mineral industries, fish and wildlife, recreation, stockpond evaporation and livestock, amounts to about 100,000 acre-feet a year.

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. Under normal operating conditions, evaporation from the Colorado River Storage Project reservoirs is expected to average about 541,000 acre-feet annually.

In the Lower Basin above Imperial Dam, water is exported to the Southern California coastal areas through the Colorado River Aqueduct and to the Imperial and Coachella Valleys through the All-American Canal. Along the river, the main water diversions are to the Colorado River Indian Reservation, Palo Verde Irrigation District, Gila Project, and the Yuma Project. Below the Imperial Dam, water is delivered to Mexico as required by the treaty with Mexico. There is essentially no flow below Morellos Diversion Dam except for the bypassed saline flows from the Wellton-Mohawk Drain Extension.

C. Legal Aspects

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, 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 waters 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

The treaty with Mexico, signed in 1944, provides for the annual delivery by the United States of 1,500,000 acre-feet of Colorado River water to Mexico. In recent years, the quality of these waters has been of much concern to both countries and has resulted in two temporary agreements primarily for the handling of return flows from the Wellton-Mohawk Irrigation and Drainage District. The first of these agreements, Minute 218, began November 16, 1965, and resulted in the bypassing around Morelos Dam of some 55,000 acre-feet per year of drainage return flows from the Wellton-Mohawk Division of the Gila Project. These waters were replaced with waters from other sources within the Colorado River Basin. On July 14, 1972, as directed by a joint communique from the President of the United States and the President of Mexico, another temporary agreement, Minute 241, was entered into by the Governments. This agreement of 6 months' duration anticipates bypassing all drainage return flows from the Wellton-Mohawk Division around Morelos Dam, and the replacement of 118,000 acre-feet per year of these waters with waters from other sources within the United States.

3. Upper Colorado River Basin Compact

With the water allocated to the Upper Basin by the Colorado River Compact and with the 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 in the Upper Basin 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, the Dixie Project in Utah, 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, 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 reports of annual consumptive use and losses of water from the Colorado River system.

D. 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.

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 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 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.

Irrigated areas in the Lower Colorado River Basin and in adjoining basins using Colorado River main stream water are highly productive and the agricultural operations very intensified. Gross crop values per acre probably are greater than any other area of comparable size in the world with a 1970 average gross crop income of about $400 per acre.

The Pacific Southwest is one of the most rapidly developing areas in the Nation, both industrially and populationwise. 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. This water supply, which has been about 1,200,000 acre-feet annually in recent years, is delivered through the facilities of the Metropolitan Water District. The Colorado River supplies about 36 percent of all of the developed water in the 4,800-square-mile service area. This water ranges from a minor supply for some entities to a complete supply for others.

PART IV. SPECIAL STUDIES

A. Impoundments

1. Flaming Gorge Reservoir

Salinity samples have been obtained approximately 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 also obtained a number of quality samples at several sites in Flaming Gorge Reservoir from 1966-68 and 1970-72. The results of the first study are given in Water Supply Paper 2009-C (in press). The material presented in Part XI of this report is a part of the second study.

It is hoped that the monitoring of the reservoir will furnish data which will show the quality effect of the reservoir to the system as well as provide possible information on the effects of upstream projects to the reservoir.

2. Lake Powell

A network of six sampling stations was established in Lake Powell in 1965 and sampling at these sites had continued on a quarterly basis until the fall of 1971. In addition, samples were taken at the mouth of Wahweap Creek and below the Glen Canyon Dam on a monthly basis. The purpose of this program was to observe chemical changes in the reservoir with time. In the fall of 1971 the quarterly sampling program was increased to a monthly program to obtain sufficient data for a mathematical model which is now in the process of being developed on the Colorado River system. Besides the Wahweap site, the other six sites in the reservoir are (1) Crossing of the Fathers; (2) Oak Creek; (3) Cha Canyon; (4) Escalante River; (5) Bullfrog; and (6) Hite Basin. The samples are taken at 50-foot intervals to the bottom of the lake and analyzed for dissolved solids, common ions, specific conductance, pH, temperature, and dissolved oxygen.

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 is now being conducted titled the "Lake Powell Research Project." The organization making the study consists of universities and colleges and other participants and collaborates in assessing man's activities in the Lake Powell region. The organization seeks to establish the natural framework of the region, evaluate recent changes that man has wrought, and determine now these changes in turn affected man.

3. Lake Mead

The Bureau of Reclamation conducted an extensive quality sampling program of Lake Mead from 1964 through 1968. As many as 28 stations were sampled in the spring and fall. Tests were made for dissolved oxygen, carbon dioxide, pH, alkalinity, temperature, conductivity, and turbidity at selected depths at each station. Water samples were obtained from selected depths for laboratory analysis for calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulphate, chloride, nitrate, phosphate, electrical conductivity, total dissolved solids, and pH. The results of these investigations were correlated with the sampling station at Hoover Dam where monthly water analyses of many of these factors have been made for over 20 years. The data collected from the sampling program during the period April 1964 through November 1966 were published in Report No. CHE-70, Water Quality Study of Lake Mead, November 1967, Bureau of Reclamation, Denver, Colorado. This report was reprinted in April 1970 with minor revisions.

This report documents the effect of the reduced inflow on water quality and the improvement of quality with increased inflow to the lake following the initial filling of Lake Powell.

The report discusses the limnological characteristics of Lake Mead. The annual temperature cycle of Lake Mead is classified as warm monomictic in that the temperature is never below 39.2°F., undergoes circulation during the winter, and is directly stratified in the summer.

There is an increase in mineral content from the upper to the lower end of Lake Mead with the greatest increases being in sulphates and chlorides of calcium and sodium. The only decrease noted was in the bicarbonate values.

It is expected that the type of sampling made during this survey will be repeated at appropriate intervals in the future.

B. 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 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 newly instituted "Water Quality Improvement Program" in the basin.

C. Lower Colorado River Salinity Investigations

In January 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 changed. 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. Colorado River at Headgate Rock Dam (CRIR).
3. Poston Wasteway Gage (CRIR above PVDD).
4. Colorado River at the Palo Verde Diversion Dam (PVDD).
5. Colorado River at the Taylor Ferry Gage.
6. Colorado River at the Cibola Valley Gage.
7. Yuma Mesa Drainage Pump Outlet.
8. Main Outlet Drain Extension Bifurcation for MODES 2 and 3.
9. Colorado River at the Northerly International Boundary.

Samples are collected from 10 stations, five of which are telemetered 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 of composite samples.

Sampling frequencies for these 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. These stations and the selected frequencies are shown in the following tabulation:

SPECIAL STUDIES

	Samples/Week
Colorado River at Parker Dam	1
Headgate Rock Diversion Dam	1
Poston Wasteway	3
Colorado River at PVDD	7
CRIR Levee Drain	1
CRIR Lower Main Drain	1
Colorado River at Taylor Ferry	1
Palo Verde Outfall Drain	1
Colorado River at the Cibola Gage	3
Colorado River at Imperial Dam	7

This data collection program is being continued. In addition, the latest salinity monitoring equipment is being tested on a trial basis to determine its application to conditions along the Lower Colorado River. Data from the program are being used to develop a prediction model of salinity movement in the river. Such a model will be valuable in helping to improve operational procedures for better salinity control.

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. 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 mineral 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 mineral burden of the Colorado River originates in the Upper Basin. The largest individual increment to the mineral burden of the Colorado River below the compact point and above Imperial Dam was found to be 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.

D. Irrigated Areas

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

1. Vernal Area

A cooperative study entitled "Water Quality Prediction Investigations" is underway between the Bureau of Reclamation and EPA to develop a technique for predicting more precisely than now possible, the mineral quality of irrigation return flow. The means for accomplishing this will be 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 is 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. Further tests will be made using data from the Grand Valley area in Colorado and the Cedar Bluff Unit in Kansas.

Although model testing and development of all the mathematical submodels is not complete, it appears that a satisfactory model has been designed to predict the mineral quality of return flow from irrigation projects. Completion of the submodels will extend capability to impact analysis, optimization, and best plan selection.

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. Using this model, the salt load reductions expected from irrigation scheduling and management could be verified on the Vernal Unit in the Uintah Basin.

2. Grand Valley Salinity Control Demonstration Project

This project, located near Grand Junction, Colo., initiated in FY 1969 under a FWQA (now EPA) demonstration grant, is now nearing completion. The objective of this project is to demonstrate the salinity control potential of lining irrigation canals and laterals. The Grand Valley is underlain by an aquifer containing highly saline ground water. Seepage from canals and laterals contributes to the recharge of this aquifer. This recharge displaces the saline ground water into the Colorado River, increasing its salt load. Reduction of such recharge by reducing seepage from conveyance systems is thus expected to reduce the salt load discharged to the river.

A major portion of the canals and some of the laterals serving a study area of about 4,600 acres were lined with concrete in 1969 and 1970. Most of the lining was accomplished by a corporation of local irrigation and drainage districts which direct the demonstration project.

Colorado State University is conducting the data collection activities and evaluating the salinity control effects under contract from the corporation. A simulation model has been developed which evaluates the effects of changes in irrigation efficiency on salt-load contributions as well as changes in seepage losses from the conveyance system. This model will allow the results of the demonstration project to be projected valley-wide and help form the basis for future salinity control activities in this location. The demonstration project was completed about mid-1972 and the final published report is expected soon. Further related studies are now being conducted in this same area.

3. 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. 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.

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.

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, Vernal Area, and Grand Valley should be repeated or continued in order to evaluate changes with time.

E. 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.

PART V. CAUSES OF SALINITY

A. Salt Loading

1. Natural Sources of Salinity

Inspection of the flow and quality records reveals 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 in the Colorado River Basin.

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 and therefore more studies are needed to identify the magnitude of specific natural sources of salinity in the Colorado River Basin.

Upper Basin.--Past records indicate an increase in salt load in the Lake Powell area above Lees Ferry and below the Green River, 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.

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 springs and wells to the Upper Colorado River system. Although wells are man-made and not a 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.

Table A
Saline Springs and Wells
Upper Colorado River Basin 1/

Spring and location	Flow (c.f.s.)	Total dissolved-solids concentration (mg./l.)	Total dissolved-solids concentration (tons/ ac.-ft.)	Total dissolved-solids load (tons/ day)	Total dissolved-solids load (tons/ year)	Flow (ac.-ft./ year)
Castle Creek Spring near Moab, Utah	0.245	4,390	6.0	2.9	1,060	177
Onion Creek Spring near Moab, Utah	0.122	9,120	12.4	3.0	1,100	88
Cold Kendall Spring near Kendall Ranger Sta., Wyo.	1.400	2,100	2.8	7.9	2,880	1,014
Ragen Spring on Muddy Cr. west of Ft. Bridger, Wyo.	0.089	9,210	12.6	2.2	800	64
Dotsero Springs 1.5 mi. west of Dotsero, Colo.	17.000	10,700	14.5	500.0	182,600	12,308
Glenwood Springs area, Glenwood Springs, Colo.	18.000	18,900	25.5	919.0	335,000	13,032
Steamboat Springs at Steamboat Springs,Colo.	1.400	6,140	8.4	23.4	8,500	1,014
Lithia Spring, Steamboat Springs, Colo.	0.022	5,770	7.8	0.3	110	16
Piceance Creek Spring, Meeker, Colo.	0.022	4,650	6.5	0.2	72	16
Trimble Hot Spring, Durango, Colo.	0.066	3,250	4.4	0.1	36	48
Pagosa Hot Spring, Pagosa, Colo.	2.300	3,240	4.4	20.0	7,300	1,665
Pinkerton Hot Spring, Durango, Colo.	0.500	3,670	5.0	5.0	1,820	362
Yellow Creek Spring, Rangely, Colo.	0.089	9,370	12.7	2.3	840	64
Ridgway Hot Spring, Ridgway, Colo.	1.000	2,850	3.9	7.0	2,550	724
Paradise Hot Spring, Dunton, Colo.	0.111	5,490	7.5	1.7	620	80
Big Sulphur Spring, Meredith, Colo.	0.333	2,250	3.1	2.0	730	241
Arsenic Spring, Crystal Mining Camp	2.000	2,030	2.8	11.0	4,000	1,448
Coal Mine Drainage, Oak Creek, Colo.	0.666	3,430	4.7	6.2	2,260	482
South Drain Ashley Cr. Oil Field, Vernal,Utah	2.200	2,670	3.6	15.9	5,800	1,593
Crystal Geyser, Green River, Utah	0.282	13,100	17.8	10.0	3,640	204
Flowing Well near Aneth, Utah	0.133	4,560	6.2	1.6	580	96
Drainage, Iles Dome Oil Field near Loyd, Colo.	2.900	2,180	2.9	17.0	6,200	2,100

1/ List of springs and wells limited to those with T.D.S. concentrations in excess of 2,000 mg./l.

CAUSES OF SALINITY

Lower Basin.-- During 3 consecutive years (1949-51) when there was very little increase in water discharge between Lees Ferry and Grand Canyon, the dissolved-solids load increased about 1.3 million tons each year. During 1941 the discharge increased by about 1 million acre-feet, but the load increased by only 2 million tons. In 1952 the discharge increased by 0.2 million acre-feet and the load by 2.2 million tons. With the exception of these 2 years the annual increase in dissolved-solids load during the 30-year period has ranged from 0.5 million tons to 1.8 million tons.

In 1962 runoff of 14.4 million acre-feet at Lees Ferry increased by 400,000 acre-feet at Grand Canyon and the dissolved-solids load increased by half a million tons. By contrast, during the filling of Lake Powell the following year, only 1,384,000 acre-feet was recorded at Lees Ferry and the increase in flow at Grand Canyon amounted to 246,000 acre-feet, but the dissolved-solids load still increased by more than a half million tons. Likewise, with a small flow in 1964 the dissolved-solids load increased by nearly 900,000 tons. The fairly consistent salt inflow is the result of the salt load from the saline springs which contribute the major part of the dissolved solids within 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. Recent studies in the Lower Basin by the Geological Survey and the Bureau of Reclamation have provided information about the contribution of springs to the Colorado River between Glen Canyon Dam and Lake Mead and to the Virgin River which drains into Lake Mead.

Major springs and spring-fed tributaries annually contribute about 760,000 tons of dissolved-solids 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 major 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. 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 dissolved-solids contributions of 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 B.

Table B
Contribution from major springs and tributaries between Glen Canyon and Hoover Dams

Source	Dissolved-solids discharge in thousands of tons per year
Paria River	30
Little Colorado River above Blue Spring	130
Springs in Lower Little Colorado River	550
Bright Angel Creek	7
Tapeats Creek	12
Kanab Creek (base flow)	4
Havasu Creek (base flow)	24
Total inflow in Colorado River (Glen Canyon Dam to Lake Mead)	757
LaVerkin Springs (inflow to Virgin River)	98
Littlefield Springs (inflow to Virgin River)	30
Total inflow to Colorado and Virgin Rivers	885

The minimum annual inflow of 885,000 tons from these sources results in an increase of about 62 milligrams per liter (0.08 ton per acre-foot) in the Colorado River on the basis of an average annual flow of 10.5 million acre-feet at Hoover Dam.

2. Agricultural Sources of Salinity

It is anticipated that development of new irrigation projects may increase the total dissolved solids in the Colorado River. Return flows from the irrigated lands pick up salts from the soils and underlying shales and transport them to the river system.

Studies prior to irrigation would be helpful, but they have not been made in most areas, so comparisons must be made when new land is added or new storage is made available.

Salt balance conditions exist when the amount of dissolved solids carried off the land is equal to that amount added. Pickup of salt as used in this report represents an unbalanced condition shown by the increase of total dissolved-solids load in the runoff over the total load in the applied water. This pickup from an area could result from natural sources, such as precipitation runoff, and/or irrigation return flows. Salt pickup chargeable to irrigation would be only that additional which occurs as a result of irrigation and should not include the amount of prior pickup off the land resulting from natural sources.

The small amount of data presently available gives indications of much variation in the amount of pickup from land due to irrigation. The estimated salt pickup in this report is based on values of zero and 2 tons per acre from newly irrigated land. Zero or minimum conditions occur generally after initial leaching in areas where soils are loose and contain very little salt. The 2-ton-per-acre value was selected as the higher end of the range for the average pickup over a project area. It was also assumed in this report no additional pickup would result from supplemental water applied to presently irrigated lands.

3. Municipal and Industrial Sources of Salinity

Salt loads contributed to the Colorado River system by municipal and industrial sources in general are minor, totaling about 1 percent of the basin salt load. Future increases in salt loads from these sources are expected to be small relative to the total basin salt burden and will have only a minor effect on salinity levels.

With the exception of concentrated return flows from the Las Vegas area, most municipal and industrial wastes are relatively low in total salt load in comparison with natural and agricultural sources, and complete elimination of such waste discharges would have little effect on salinity concentrations in the main river system. Since these wastes are point sources of salinity, control of a source could be achieved if salinity levels in the waste being discharged (i.e., industrial brines) warrant such control.

B. Salt Concentrating

Addition of salts to the river system is not the only cause of increased salinity concentrations. The depletion of water of higher quality than in downstream reaches produces a concentration effect on the waters of the downstream reaches. This concentration effect occurs to a greater degree when the diverted salts return to the river than when they are depleted along with the water.

1. In-basin Depletions

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

2. Transbasin Depletions

The major part of the transbasin depletions are made at higher elevations where the concentrations are very low. This removal of high quality water results in the remaining flows downstream to become more concentrated even though salts are also carried away with the water to another basin. Many transbasin diversions are presently being made with an additional number just starting to divert water or scheduled for the future, the largest ones being the Bonneville Unit of the Central Utah Project, the Denver-Englewood diversions, the San Juan-Chama Project, and the Fryingpan-Arkansas Project.

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 X.

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 1970. 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.

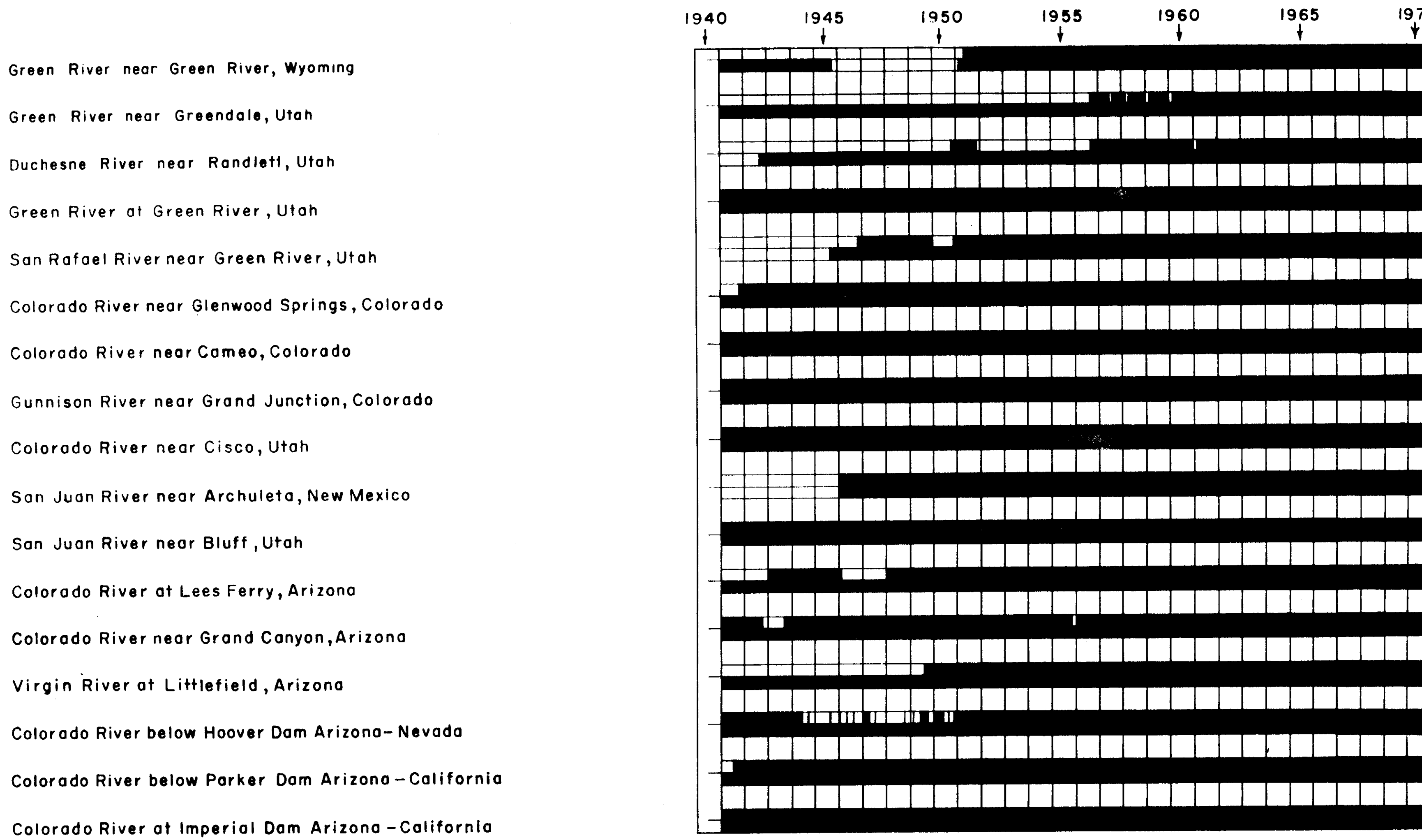
1. Key Stations with Complete Records

Records of flow and water quality are available for all of the 1941-70 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.

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

Colorado River Basin
Flow and Quality of Water Records
1941 – 1970



Sampled quality record / Measured flow record (black bars)

Correlated quality record / Correlated flow record (open bars)

Fig. 2

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 1970, 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 1970. 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 1970 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 and 1970 were estimated from once a month sampling at the Archuleta gaging station.

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; the Green River, Utah; and the San Juan River near Bluff, Utah.

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.

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 December 1970. Detailed correlations were employed to estimate the data for the missing period.

Colorado River below Hoover Dam, Arizona-Nevada (Station No. 15).--Discharge and quality records are available for the 1941 to 1970 report period except for the period November 1944 to September 1950. Quality data for this period are based on specific conductance with chemical analyses only at intermittent intervals.

Colorado River below Parker Dam, Arizona-California (Station No. 16).--Flow records for the report period are available for the Geological Survey gage below Parker Dam. 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 were adjusted by correlation with the samples taken by the Metropolitan Water District of Southern California, which takes samples at the Lake Havasu Intake Pumping Plant.

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 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.

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 were obtained from the advanced Geological Survey records for the water quality station at Imperial Dam.

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, some are operated by 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 special studies described in Part IV.

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, the completeness and accuracy of the individual analyses, and the manner in which the individual samples are combined before analysis to represent increments of stream discharge.

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 Mex., and Salt Lake City, Utah, using standard procedures by chemists specifically trained in water analysis. During the 30-year period considered there were numerous changes in laboratory techniques and procedures mostly due to introduction 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. Analyses by the Metropolitan Water District have been made by standardized procedures and appear to be comparable with analyses by the Geological Survey. It is probable that errors in the load computations due to errors in chemical analyses are less than those due to changes in the samples upon storage, inaccuracies in sampling, or inaccuracies in the determination of stream discharges.

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 1941-70 period of record are presented in Tables 1 to 17 with each table number corresponding to a station number.

To simplify tabulation, monthly values of flow and total dissolved solids loads were rounded to the nearest 1,000. 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 addition of quality of water data for 1969 and 1970 produced little change in long-term averages in comparison to the 1941-68 period. Ten of the stations show no change; at two, the concentration decreased by 0.01 ton per acre-foot, at two it increased by 0.01 and at one it increased 0.02 ton per acre-foot. The average concentration for the Virgin River station for the period 1941-68 was 2.29 tons per acre-foot while the average concentration for the period 1941-70 was 2.24 tons per acre-foot, and the San Rafael River station concentration was decreased from 2.30 to 2.24 tons per acre-foot.

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 1959-70 period because of low runoff in 1959, 1960, and 1961 and the filling of Lake Powell in 1963 to 1970. Figure 3 shows the historical 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 1941-70 period was 0.76 ton per acre-foot.

The 1963 flow at the Grand Canyon station was 1,630,000 acre-feet with a salinity concentration of 1.41 tons per acre-foot. The previous low flow was 4,186,000 acre-feet in 1934 with a salinity concentration of 1.32 tons per acre-foot. It is interesting to note that the 1963 concentration was only 0.09 tons per acre-foot higher than the 1934 concentration.

The Grand Canyon station has the longest water quality record on the Colorado River, 1926 to 1970. It is also of interest that the average salinity concentration for the period 1941-70 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 salts 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

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

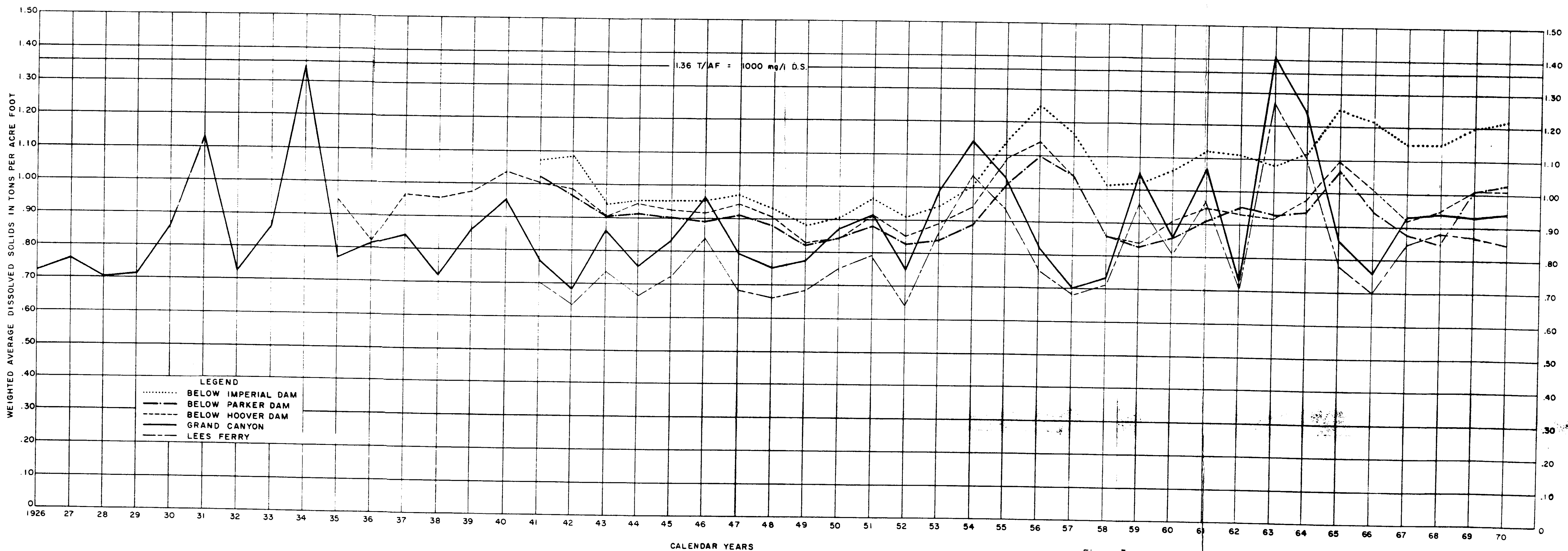


Figure 3

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 1941-70 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 (1970) level of depletions instead of actual depletions had occurred each year of this period. This average present modified flow and quality, therefore, represent an average condition occurring at the present (1970) time. This is shown for each station on Table 18. Adjustments to the historic flow that were made to develop the present modified flow included: (1) adjustments for any projects in operation prior to 1970 not entirely reflected in records; (2) adjustment of records below reservoirs to reflect unregulated flows at each station; (This required modifying flows at downstream points for gains or losses resulting from reservoir operation. In the Upper Basin depletions resulting from filling reservoirs the first time was a major factor.) and (3) adjustments for historic evaporation as compared to present (1970) evaporation. Adjustment for operation of the Colorado River Storage Project and Fontenelle Reservoir in the Upper Basin and for operation of Lake Mead, Lake Mohave, and Lake Havasu in the Lower Basin was made in developing the present modified flow.

Present evaporation from the Colorado River Storage Project and Fontenelle Reservoirs was estimated to be 541,000 acre-feet per year. (Note: this is the latest evaporation estimate pending results from new investigations being conducted.) This would include evaporation from Lake Powell of 432,000 acre-feet; Flaming Gorge, 52,000 acre-feet; Navajo, 25,000 acre-feet; Curecanti Reservoirs, 10,000 acre-feet; and Fontenelle Reservoir, 22,000 acre-feet. These are average figures which were chosen to represent present conditions rather than using the 1970 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, and Emery County Projects and Vernal Unit of Central Utah Project have come into operation. Also, evaporation from the storage units (Glen Canyon, Flaming Gorge, Navajo, Curecanti, and Fontenelle) is now in effect along with the Hayden Steamplant, Four Corners Steamplant, 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 projects 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 results in slight increases in dissolved-solids concentrations under present modified conditions.

Quality data for present modified conditions were computed by taking into consideration the weighted average of the concentrations of total dissolved solids for the various transmountain diversions. The change in dissolved solids resulting from the in-basin developments were computed 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. In the Lower Basin a consumptive use of 4 acre-feet per acre was used for irrigation of the Palo Verde Irrigation District, the Fort Mohave, Chemehuevi, and Colorado River Indian lands. This value 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 average salt pickup resulting from the in-basin developments of 2.0 tons of dissolved solids per acre of irrigated land was used in the Lower Basin.

The present modified conditions are shown on Table 18 and are used as a base value for developing the anticipated effect of new depletions from new projects and the full development of present projects in the river basin.

Following is a description of the storage units, now constructed, for which the evaporation losses were considered as depletions in the computation of present modified flows.

1. Glen Canyon Unit

The Glen Canyon Dam is located on the Colorado River in Arizona 4 miles south of the Utah-Arizona boundary and 15 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 would extend 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 reservoir will regulate the flow of the river for compact delivery purposes and for power generation and thus permit exchanges for upstream consumptive use of the water.

Fish and wildlife conservation and recreation will also be of major significance. Storage commenced March 31, 1963, in Lake Powell.

2. Flaming Gorge Unit

This storage unit is located on the Green River in northeastern Utah and southwestern Wyoming. The primary purposes of the Flaming Gorge Unit are the regulation and 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. The stored water assists in complying with the terms of the Colorado River Compact and will, by exchange, furnish an irrigation supply for the participating projects in the Upper Basin States. In addition there will be benefits from fish and wildlife conservation and recreational facilities. Storage commenced November 1, 1962, at Flaming Gorge Reservoir, 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. Navajo Unit

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. 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 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.

4. 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 will be provided to recreation, fish and wildlife conservation, and irrigation. The reservoirs of the Curecanti Unit will help regulate the flows of the Colorado River at Lees Ferry. The storage capacity provided is 941,000 acre-feet at Blue Mesa, 117,000 acre-feet at Morrow Point, and 27,000 acre-feet at Crystal Reservoir with total reservoir evaporation losses estimated to average 10,000 acre-feet annually for all three units. Storage was initiated late in 1965 at the Blue Mesa Reservoir and on January 24, 1968, at the Morrow Point Reservoir. Construction is about to be initiated on Crystal Dam, and it possibly could have been considered as a future development, but since the annual evaporation will amount to only about 300 acre-feet, its effect is insignificant.

It is expected that operation of the Curecanti Unit on the Gunnison River will improve the quality of the Colorado River below Grand Junction during the late summer months.

5. Fontenelle Reservoir

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

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 means of operation studies the estimated effects of each development can be shown at the pertinent stations. These results are tabulated in Table 18 for the new period of record used in this report. The table was computed on the basis of the 1941-70 average annual flow and total dissolved solids. An additional station, "Colorado River above Parker Dam," was included in the table only 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 IX.

The anticipated future conditions evaluated in Table 18 would result from the construction of the Colorado River Basin Projects and non-Federal developments. Pickup of dissolved solids from newly irrigated lands 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.

Following is a discussion of the various projects including a brief description of the physical conditions for each development authorized or contemplated for authorization and the anticipated effect of each on the quality of water at appropriate key stations. 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 19 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

Seedskadee Project.--This multipurpose project is located adjacent to the Green River in southwestern Wyoming. Present plans are that it will divert water from the Green River to irrigate about 9,700 acres of land. Municipal and industrial water, recreation, and fish and wildlife enhancement are other purposes of the project. A depletion of 17,000 acre-feet is anticipated for irrigation and 20,000 acre-feet for wildlife development. About 195,000 acre-feet of depletion will occur in supplying municipalities and industries. Fontenelle Dam and Powerplant are now complete, but irrigation of the project lands is awaiting results from the development farm. The Seedskadee area has not been previously irrigated except for the land in the experimental development farm so it affords an opportunity to determine the effect irrigation has on water quality under the given soil and crop conditions. The municipal and industrial uses include those of Green River and Rock Springs, several chemical companies, Pacific Power Company development, and other industries. They will consumptively use all 195,000 acre-feet above Green River, Wyoming, when fully developed with negligible return flow. Return flow of salts would therefore also be negligible. The only industry in Wyoming below the Green River near Green River, Wyoming, gage would be Utah Power & Light Company's steam-electric powerplant on Hams Fork which will consumptively use an additional 8,000 acre-feet.

The effect of Seedskadee irrigation project and industrial developments on water passing the Green River, Wyoming, gage would be an increase in concentration from 0.44 to 0.45 ton per acre-feet if no dissolved solids are leached from the land; and if 2 tons per acre are picked up, the concentration would increase to 0.47 ton per acre-foot.

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 China Meadows site of the East Fork of Smith Fork in Utah and will provide 13,000 acre-feet of storage capacity. The project will have the primary purpose of providing supplemental water to 42,674 acres of existing farmland along with fish and wildlife and recreation benefits. Construction of Meeks Cabin Dam has recently been completed. This project will give an opportunity to study the effect on quality of adding supplemental water to lands already irrigated. The resulting new depletion will be 10,000 acre-feet.

Utah Power & Light Co. and Others.--This steam powerplant is at Kemmerer, and it is anticipated that future depletions of this and other industrial developments will amount to about 8,000 acre-feet. (See description above under "Seedskadee Project.") No salt return is anticipated.

These projects, together with those above the Green River near Green River, Wyoming, gage, would cause an increase in concentration of the water at the Green River near Greendale gage of from 0.60 ton per acre-foot at present to 0.64 and 0.66 ton per acre-foot for zero ton per acre and 2 tons per acre pickup from newly irrigated land, respectively.

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 Uinta Basin portion of the Colorado River Basin to the Bonneville Basin. Related developments of local water sources will be made in both 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.

The net depletion to the Green River will be 166,000 acre-feet.

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 for Indian and non-Indian lands along Lake Fork River and to enhance recreation, 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 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.

The increase in concentration from present to future at this station would be from 0.96 ton per acre-foot to 1.75 and 1.82 tons per acre-foot for zero and 2 tons per acre pickup, respectively.

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

Four County, Colorado.--This non-Federal development, as proposed, would divert 40,000 acre-feet of water through the Continental Divide for use in Colorado. The water would be transported from the headwaters of the Yampa River through Rabbit Ears Pass to the North Platte Basin, from which basin an equivalent amount of water would be directed by exchange over Willow Creek Pass into the Colorado River drainage, thence by transbasin diversion to Lafayette, Erie, Broomfield, Brighton, Thornton, and Ft. Lupton.

Hayden Steamplant.--This plant in Colorado now using 4,000 acre-feet will eventually require 16,000 acre-feet of water. No salt return was considered in future water use by the steamplant.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

Cheyenne, 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 8,000 acre-feet and will ultimately deplete the Colorado River by an additional 23,000 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 18,600-acre-foot-capacity reservoir on Savery Creek and a 65,000-acre-foot-capacity reservoir on Slater Creek. This storage will make possible the irrigation of 17,920 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 27,000 acre-feet annually.

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

The estimated increase in concentration at the Green River, Utah, gage from present to future would be 0.64 ton per acre-foot to 0.71 and 0.73 ton per acre-foot for the zero and 2 tons per acre pickup, respectively. Projects affecting the flows would include all developments above the gage.

5. Above San Rafael River near Green River, Utah

With inclusion of the Emery County project under present modified conditions, the only anticipated future effect would be steam-electric plants depleting about 5,000 acre-feet of water and replacing an estimated 4,000 acres of presently irrigated lands with industries. The salt was also assumed to be depleted with the water. The estimated increase in concentration at the San Rafael gage from present to future would be 2.65 tons per acre-foot to 2.78 and 2.67 tons per acre-foot for the zero and 2 tons per acre pickup, respectively.

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 256,000 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.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

M&I--Green Mountain.--Water stored in Green Mountain Reservoir will be released for industrial use in the vicinity of Kremmling, Colorado, and in Garfield County, Colorado. This depletion will ultimately be about 12,000 acre-feet.

Homestake Project, Colorado.--The Homestake Project in Colorado, recently constructed by the cities of Aurora and Colorado Springs, will divert an average of 43,000 acre-feet additional annually 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 6,000 acre-feet.

The above depletions would increase the dissolved-solids concentration at Glenwood Springs by 0.10 ton per acre-foot under either condition of pickup.

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

Fryingpan-Arkansas Project.--Construction is still continuing on this project. This transmountain diversion project will transfer 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. The average annual depletion will be 70,000 acre-feet, including 1,000 acre-feet of evaporation from the Ruedi Reservoir on the west slope.

M&I--Ruedi Reservoir, Colorado.--Storage rights in Ruedi Reservoir would permit the use of 38,000 acre-feet for oil shale development along the Colorado River in Colorado. The water would be stored in Ruedi Reservoir on the Fryingpan River and then released through natural channels to the points of use in the oil shale areas. A possible future alternative use for all or part of this water would be for irrigation purposes.

West Divide Project, Colorado.--The West Divide Project will provide 115,600 acre-feet of water for irrigation and 77,500 acre-feet for municipal and industrial use. The irrigation water will supply nearly 19,000 acres of new land and a supplemental supply to 21,000 acres of land presently irrigated. The new depletion of Colorado River water will be 76,000 acre-feet annually. Project water will be obtained from a series of Colorado River tributaries south of the river in west-central Colorado with most of the storage planned for the 105,000-acre-foot Placita Reservoir.

The above-described projects, together with those above the Glenwood Springs station, would increase the concentration at the Cameo Station from 0.60 ton per acre-foot under present modified conditions to 0.74 and 0.75 ton per acre-foot for future conditions assuming zero and 2 tons pickup per acre, respectively.

8. Above Gunnison River near Grand Junction

Fruitland Mesa Project, Colorado.--This project is located in western Colorado in Gunnison River Basin. A 48,235-acre-foot storage reservoir on Soap Creek and diversion from Crystal and Curecanti Creeks would provide water needed for 15,870 acres of newly irrigated land and 7,000 acres of land now irrigated. Project uses will increase Colorado River depletions by 28,000 acre-feet per year.

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.

Bostwick Park Project, Colorado.--This small project, nearing completion, is located in Montrose and Gunnison Counties in west-central Colorado. Storage regulation will be provided by a 13,520-acre-foot reservoir on Cimarron Creek, a tributary of the Gunnison River. Only 1,610 acres of new land will be irrigated and the increased depletion to the Colorado River will be 4,000 acre-feet. Some additional water will be provided to land now irrigated.

Dallas Creek Project, Colorado.--The Dallas Creek Project will develop water of the Uncompahgre River and tributaries for irrigation and municipal and industrial use. The project will provide water for 15,000 acres of new land and supplemental water for 8,700 acres of land presently irrigated. Depletion of the Colorado River will amount to 37,000 acre-feet annually.

The project water supplies will be suitable in quality for irrigation and for municipal and industrial uses as well.

At Gunnison River near Grand Junction station the concentration would be increased by 0.04 ton per acre-foot with no pickup and 0.08 ton per acre-foot with 2 ton per acre pickup.

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 61,000 acres. Some 32,000 acres will be new land; the remaining 29,000 acres of land are now receiving a partial supply. This project will divert 140,000 acre-feet of water from the Dolores River of which 87,000 acre-feet will be depleted and the balance returned to the San Juan River.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

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 cencentrations of soluble salts. They are successfully used for irrigation, however, because of internal drainage characteristics of the soils. The salt concentration of these flows is not expected to increase with project development.

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 26,000 acres of new land and 12,500 acres of land now receiving a partial supply. Depletion of the Colorado River will be about 85,000 acre-feet.

The Colorado River near Cisco gage is affected by all upstream developments on the Colorado, Gunnison, and Dolores Rivers and their tributaries. These transmountain diversions and in-basin projects increase the concentrations from 0.90 to 1.07 tons per acre-foot with no pickup and to 1.11 with 2 tons per acre pickup.

10. Above San Juan River near Archuleta

San Juan-Chama Project.--Construction is now completed on this transmountain diversion project with delivery of water to the Rio Grande Basin 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 underway on this project, but completion of construction and delivery of water are several years away. The direct diversion of 508,000 acre-feet of water annually from the Navajo Reservoir to 110,000 acres of lands south of the San Juan River is contemplated. None of these lands are presently irrigated and the effect of irrigation on the quality and quantity of return flow is difficult to predict.

There will be times under ultimate basin development when the San Juan Valley lands below Farmington, New Mexico, will be dependent largely upon return flows for their supply of irrigation water. There are very little data upon which to base estimates of the quality of the return flow. Miscellaneous records from the San Juan, Animas, and La Plata Rivers indicate some periods of low flow water of questionable quality, especially from La Plata River system where some of the lands are known to be of marine origin. Practically all of the lands in the Navajo Indian Irrigation Project which would contribute return flow at the Hogback, however, are of fresh water origin with low salinity and alkalinity as determined by soil borings. The estimated depletion is 250,000 acre-feet annually with a return flow of 258,000 acre-feet

The effect of the San Juan-Chama and Navajo Indian Irrigation projects in the quality of water at this 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. The increase in concentration would be from 0.22 ton per acre-foot present to 0.23 ton per acre-foot for both zero and 2 ton per acre pickup.

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

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 46,500 acres of new land and 25,600 acres of presently irrigated land. The new land will include 17,200 acres of Indian land. The total new depletion will amount to nearly 146,000 acre-feet. Project features include four storage dams, lengthy canals, and several diversion dams.

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 lands adjacent to the San Juan River will result in a new depletion of about 10,000 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 steam-electric powerplant, which has been partially completed by Utah International (formerly Utah Construction Company), for the Navajo Indian Tribe and the Arizona Power Authority, is now using 20,000 acre-feet out of an estimated 40,000 acre-feet when the plant is complete. No salt is expected to return with future diversions.

The San Juan River near Bluff gage would be affected by all developments on the San Juan River above the gage. Especially notable would be return flows from the Navajo Indian Irrigation Project. The result would be an increase from 0.63 to 0.89 and 1.23 tons per acre-foot, respectively, for the zero and 2-ton per acre pickup from new irrigated lands.

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. The expected annual depletion to the Colorado River would be 102,000 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. It is expected that the salt will be depleted with the water.

M&I in Arizona.--The Upper Colorado River Compact allocated 50,000 acre-feet to Arizona from the Upper Colorado River system and of that amount about 15,000 acre-feet is presently being used.

The remaining 35,000 acre-feet will be 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.

The total depletions and salt pickup above Lees Ferry increase the concentration at the Lees Ferry gage from 0.83 to 0.97 tons per acre-foot with no pickup, and with 2 tons of pickup the concentration increases from 0.83 to 1.04 tons per acre-foot.

13. Above the Virgin River at Littlefield, Arizona

Dixie Project, Utah.--The recently authorized Dixie Project will, through construction of a multipurpose dam on the Virgin River, provide a full water supply to 6,900 acres of new land and a supplemental supply to 9,650 acres of existing irrigated land. About 5,000 acre-feet of municipal and industrial water will be provided to the city of St. George. Cedar City, Utah, can also exercise an existing agreement to divert up to 8,000 acre-feet of water out of the basin from upper tributaries.

A principal concern of the downstream users in Arizona and Nevada will be in regard to the effect of project operations on water quality and the amount of flood waters available for leaching purposes. In this regard the effect of the highly mineralized LaVerkin Springs, which enter the river above the proposed Virgin River Dam, is of considerable importance.

The estimated increase depletion of the Virgin River due to total project development will be 48,000 acre-feet per year. Disposal of the waters of the LaVerkin Springs would increase the estimated annual depletion by the quantity of water removed from the river system. The average annual flow of the Virgin River at Littlefield under present conditions based on January 1941 through December 1970 records is

156,000 acre-feet. Concentrations would increase from the present 2.24 to 3.21 and 3.34 tons per acre-foot under zero and 2 tons pickup, respectively.

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.

In the ultimate stage of development of the project, the estimated total annual diversions from Lake Mead by the existing Boulder City and Basic Management, Inc., water systems will be 52,000 acre-feet. The estimated total annual diversions by the project will be 328,000 acre-feet, giving a total ultimate annual diversion from Lake Mead to the project area of 380,000 acre-feet.

The estimated net annual depletion due to the project and existing systems will total 262,000 acre-feet allowing for creditable return flows of 118,000 acre-feet. The diversions in 1970 from Lake Mead were about 34,000 acre-feet by Basic Management, Inc., and the Las Vegas Valley Water District, and 3,400 acre-feet for Boulder City and Lake Mead National Recreation Area, a total of about 37,000 acre-feet. No creditable return flow from these diversions was 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," for calendar year 1970. If we assume for purposes of computations in this report that unidentified return flows from the 37,000 acre-feet diverted in 1970 would be in about the same proportion to diversions as was assumed in the determination of depletions for the Southern Nevada Water Project, there would be a return flow of about 11,500 acre-feet. This would give a depletion for 1970 of about 26,000 acre-feet and the additional annual depletion with full development of the Southern Nevada Water Project would be 236,000 acre-feet.

It has been assumed in this report that the Colorado River return flows from the Southern Nevada Water Project would carry as much salt as would be pumped from the river. It is possible that measures may be taken that would result in a reduction of salts returned to the river. Various proposals have been made for removing or reclaiming the return flow discharged into Las Vegas Wash in order to control pollution problems in the Las Vegas arm of Lake Mead. If any of these proposals are adopted, they will be evaluated in future progress reports.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

A portion of the Southern Nevada Water Project allotment of 262,000 acre-feet will be used by the Southern California Edison Company by diverting 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. This depletion is included in the depletion anticipated for the Southern Nevada Water Project and would not cause an additional depletion.

The Southern Nevada Water Project, plus all developments above Lees Ferry and on the Virgin River, would affect the salinity at the Colorado River below Hoover Dam station. Salinity concentrations would increase from 1.01 tons per acre-foot at present to 1.25 and 1.32 tons per acre-foot for estimated future concentrations under conditions of zero and 2 tons per acre pickup.

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

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 in Arizona, California, and 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.

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 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. All of the diversions to the city of Kingman would be a depletion because of the distance of the city from the Colorado River. Diversion to Lake Havasu Irrigation and Drainage District would cause an increased depletion of about half of the diversion. It is estimated the maximum diversions allowed under the three contracts would cause an increased depletion of about 31,000 acre-feet per year.

Lower 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. 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 consumptive use in 1970 from irrigation of 55,615 acres is estimated to be 222,460 acre-feet. This leaves an additional depletion of about 208,000 acre-feet per year for future developments.

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.

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 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 above Parker Dam and 68,000 acre-feet between Parker and Imperial Dams. The total potential salvage above Imperial Dam is then 155,000 acre-feet per year.

Summary below Hoover Dam.--The development of Indian lands on the Fort Mohave, Chemehuevi, and Colorado River Indian Reservations, separate contracts to various water users, and increases to the water supply resulting from salvage by channelization and vegetative management of the Lower Colorado River will all contribute to changes in the salinity concentration at Imperial Dam.

Salinity concentrations at the Colorado River below Parker Dam station would increase from the present 1.02 tons per acre-foot to 1.27 and 1.35 tons per acre-foot for the zero and 2 tons per acre pickup conditions, while the concentration at Imperial Dam would increase from the present 1.16 tons per acre-foot to 1.52 and 1.64 tons per acre-foot for the zero and 2 tons per irrigated acre pickup conditions.

16. Other Future Developments not yet Clearly Defined

Other future developments that are expected to affect water quality in the Colorado River Basin include:

(a) Power developments listed in the Southwest Energy Study, in addition to those already included in this report.

ANTICIPATED EFFECTS OF ADDITIONAL DEVELOPMENTS

(b) Oil shale developments within the Colorado River Basin.

(c) Coal gasification units that would use substantial amounts of Colorado River water.

(d) Future additional phases of some of the projects listed in this report and other potential projects which would use water, limited by availability under established water rights.

As these developments become more clearly defined, they will be included in future Quality of Water reports.

PART VIII. EFFECTS OF SALINITY ON WATER USE

Water quality can be a limiting factor in the use of a water supply. Different water uses require different water qualities, and a supply may thus 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 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

A 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 salinity, level 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 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.

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. Although Colorado River water is accepted for irrigation use, future increases in salinity may thus involve the incurring of a small but significant economic loss.

C. Industrial Use

Colorado River water has not 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.

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. 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 too hard, softening of the supply in large-scale municipal plants or in individual home units may be required. Sealing of water heaters and corrosion of pipes also accelerate with increased salinity or hardness levels.

Water quality in the Upper Basin will generally meet the Public Health Service standards with normal levels of treatment--settling, filtration, and disinfection. In some cases only disinfection is required. In contrast to the Upper Basin, the water supply at most points in the Lower Basin does not meet the Public Health Service recommended limits for total dissolved solids, exceeding the maximum acceptable limits at times. Mineralized water supplies with salinity concentrations in the range of those values observed in the Colorado River, however, are commonly accepted in the southwestern United States, with little detriment to the potability of the supply. The use of this mineralized supply imposes an increased treatment cost as hardness levels are high enough that water softening is desirable in addition to normal treatment.

PART IX. WATER QUALITY IMPROVEMENT PROGRAM

This biennial report has presented historical data, present water quality conditions, and future conditions based on the projection of the effects of new development. The projections in this report indicate the salinity at Imperial Dam could increase from about 850 mg./l. to 1,200 mg./l. without salinity control measures.

The possibility of the concentration increasing to about 1,200 mg./l. has led the users of Colorado River water, particularly in the Lower Basin, to request that programs be undertaken to maintain the salinity at its present level. A comprehensive 10-year Water Quality Improvement Program was therefore started in 1971 and integrated with other programs involving weather modification, geothermal resources, desalting, and the Western U.S. Water Plan to maintain salinity in the lower main stem at or below present levels. The total estimated cost for the program including implementation of the projects (with exception of Blue Spring) is expected to involve capital expenditures in the order of magnitude of $400 to $500 million.

Feasibility studies are now underway on irrigation, point and diffuse salinity sources with related basin-wide planning involving development of a mathematical model of the Colorado River, economic analysis of water quality, analysis of legal and institutional matters and the investigation of potentials for improving water quality at points of diversion. Initial expenditures in Fiscal Year 1972 amounted to $333,000 and in Fiscal Year 1973 the program has been funded at a level of $2,147,000.

A. Accomplishments in the Upper Colorado Region

In the Upper Colorado Region, with respect to the point sources, work was done on Paradox Valley and Glenwood-Dotsero Springs in Colorado and Crystal Geyser in Utah. On the diffuse source, work moved forward on McElmo Creek in Colorado, Big Sandy River in Wyoming, Price River, and the San Rafael River in Utah. On the irrigation sources proposal, the principal effort was made in the Grand Valley, Colorado, area and some preliminary work was done in the Uinta Basin, Utah.

1. Paradox Valley, Colorado

A feasibility investigation is underway with a report scheduled for FY 1975. It is estimated that within Paradox Valley, a collapsed anticline contributes about 200,000 tons of salt per year to the Dolores River in the vicinity of Bedrock, Colorado. Available data and investigation indicate that control possibilities could be developed to reduce the salt contribution about 180,000 tons per year. One proposal to accomplish salinity control at this site would regulate the flow of the Dolores River in the narrow canyon above Paradox Valley, bypass these flows in addition to the flow of West Paradox Creek across the valley in a lined channel, collect the valley inflows which contribute the salt load and evaporate them in a reservoir on the Dolores River at the outlet of the valley. Studies are underway which indicate that salt loading of the Dolores River may better be prevented by controlling the ground water inflow. Variations of this scheme that are being studied are combinations of pumping saline water, pumping fresh water, and lining of the main channel of the Dolores River part way through the valley to reduce recharge of the ground water. If saline water were pumped, an appropriate disposal system would be required. Fresh water extracted would be suitable for agriculture or other consumptive uses in the West Paradox Valley.

Serious environmental considerations would be involved if the two dams and bypass plan were selected. This would require a massive dam that would create a rapidly filling-emptying reservoir in the Dolores River Canyon that has been under consideration as a scenic whitewater boating area for certain periods of the year. This plan would also require storage of the saline water on stream on the Dolores River which would be subjected to attendant risks of a catastrophic event introducing all of the stored saline material to the river system at a rapid rate.

Extensive geologic, hydrologic, and ground-water investigations are being conducted to determine the most effective plan to prevent the pickup of salt in Paradox Valley. Topographic mapping of the valley has been completed. A resistivity survey was run to define the brine interface so that drilling could be minimized. Five 3-inch cores were drilled to depths ranging from 74 to 200 feet and 12 exploratory wells were drilled and cased with perforated casing to depths ranging from 69 to 240 feet. The drilling program defined the depth of the overburden and the location of the highly saline water table. The core drilling also revealed a brecciated gypsiferous, sodium chloride rich formation east of the Dolores River. Logs of oil exporation wells in Paradox Valley near the Dolores River indicate that brecciated formations of saline shales, gypsum, and limestone extend to a depth of about 600 feet. The next 14,000 feet or more is about 70-percent halite (sodium chloride). Logs of other oil exploration wells reveal that the entire valley is underlain by a salt formation. The wells with perforated casing will also be used in a test well pumping program to be conducted in the future.

The investigations indicate that in the river channel the brine interface surfaces about midvalley and that the Dolores River picks up nearly all of the additional salt load in about a 200-foot reach. During low flow periods, the concentration of the Dolores River flows range from 300 mg./l. to 1,500 mg./l. as it enters Paradox Valley and from 3,000 mg./l. to 160,000 mg./l. as it leaves.

It appears that a slight artesian effect causes the salty water to surface. It is probable that the Dolores River and West Paradox Creek recharge the artesian ground water that brings the salts to the surface.

2. Crystal Geyser, Utah

The Crystal Geyser located about 5 miles south of Green River, Utah, results from a gas (carbon dioxide) accumulation blowing saline water out of a 16-inch abandoned oil test well at about 6-hour intervals. This geyser spouts about 200 acre-feet of water and 4,000 tons of salt per year which flows west a few hundred feet into the Green River. Investigations of various control measures are being made by Brigham Young University under an agreement with the Bureau of Reclamation. A feasibility report is scheduled for FY 1973.

Investigations indicate that a satisfactory solution to the problem could not be accomplished by attempting to plug the well because the drill hole intersects a fault zone. Alternate openings, including the bed of the Green River, are also available through which the saline water may discharge. The best possibilities for control include a collection and evaporation system.

Required control works would include an equalizing reservoir, pumping plant, evaporating reservoir, and a discharge line from the equalizing reservoir to the evaporating reservoir.

Alternatives of plugging the well or loading to prevent eruption have been investigated. The well apparently intercepts the Little Grand Fault and it is questionable that either of these actions would control the discharge of saline water to the Green River. Desalting has been investigated but was found to be more costly.

The Crystal Geyser is a minor tourist attraction. Disrupting the flow would negate this value but collection and disposal through an evaporation system would not seriously alter the attraction for recreational purposes.

3. Glenwood Springs, Colorado

The Glenwood Springs located within and near the city of Glenwood Springs, Colorado, and the Dotsero Springs located upstream about 16 miles near Dotsero, Colorado, discharge about 25,000 acre-feet of highly concentrated thermal water and about 500,000 tons of total dissolved solids to the Colorado River annually. Springs at both locations are located on both banks and in the bed of the river. The combination of springs comprises the second largest point source in the Colorado River Basin.

It appears that eight springs (with a concentration of 11,000 mg./l.) at Dotsero and 11 springs (with a concentration of 19,000 mg./l.) at

Glenwood are amenable to collection. Salt loading from these is estimated at about 200,000 tons of dissolved solids annually.

As now perceived from preliminary studies, it is anticipated that control works would include a collection system for the saline springs, a conveyance system to a suitable location downstream where a desalting or evaporating system to dispose of saline water could be installed.

The present recreational uses of these hot saline waters would have to be protected because of the major economic importance to the area. The environmental values of the canyon and adjacent areas will have to be protected to the maximum extent where construction will be required for a necessary collection system, desalting plant, or evaporation system.

The 19 springs are being measured and samples chemically analyzed. Sites for desalting plants and evaporation ponds are being investigated and maps are being prepared for the collection and conveyance system.

A feasibility report is scheduled for FY 1976.

4. Big Sandy River, Wyoming

The Big Sandy River at the gaging station below Eden, Wyoming, drains about 1,600 square miles. The flow averages about 30,000 acre-feet per year with salinity concentrations up to 2,800 mg./l. The flow at the mouth is estimated to be 45,000 acre-feet per year and to contain an estimated 180,000 tons of dissolved solids with concentrations up to 4,000 mg./l. It is estimated that selective removal of the more saline flows and desalting and/or evaporation of these flows could remove about 80,000 tons of salt per year.

The investigation has found that many saline seeps with a concentration of about 5,000 mg./l. enter the river between Simpson Gulch and Gasson Bridge, a distance of about 10 miles.

Control plans being investigated are interception of the saline seeps by wells or diversion of the low river flows into off-channel reservoirs for desalting by a membrane process or by a freezing process and evaporation of the waste brine. A feasibility report is scheduled for FY 1977.

Constraints to the above plans are that construction of large shallow evaporating ponds and storage of salts in these ponds may not be environmentally acceptable.

5. Price River, Utah

The Price River at Woodside, Utah, drains about 1,500 square miles. The flow averages about 74,000 acre-feet per year and contains about 240,000 tons of dissolved solids with concentrations up to 8,200 mg./l. Selective removal of up to 50 cubic feet per second during low flow periods could remove about 100,000 tons of salt per year. Removal of this amount of salt may require the desalting or evaporation of up to 25,000 acre-feet of water per year.

No conceptual plans for control of this salt load have been developed other than the possibility of selective withdrawal and treatment or evaporation of the more saline flows. Here, also, construction of large shallow evaporating ponds and storage of salts in these ponds may not be environmentally acceptable.

Since very little basic data is available, gaging stations have been installed and samples collected and analyzed to help determine the sources of the salt load. A feasibility report is scheduled for FY 1977.

6. San Rafael River, Utah

The San Rafael River near Green River, Utah, drains about 1,670 square miles. The flow averages about 95,000 acre-feet per year and contains about 190,000 tons of dissolved solids with concentrations up to 6,400 mg./l. Selective removal of up to 75 cubic feet per second during low flow periods could remove about 90,000 tons of salt per year. Removal of this amount of salt could require the desalting or evaporation of up to 30,000 acre-feet of water per year.

Investigations on this source are similar and at the same stage as the Price River. Methods of control will likely be the same. A feasibility report is scheduled for FY 1977.

7. McElmo Creek, Colorado

McElmo Creek near Colorado-Utah State Line drains about 350 square miles. McElmo Creek also receives return flows from lands irrigated with water from the Dolores River. The flow of McElmo Creek averages about 31,000 acre-feet per year and contains an estimated 115,000 tons of dissolved solids with concentrations up to 3,000 mg./l. It is estimated that selective removal of the more saline low flows could remove about 40,000 tons of salt per year. Removal of this amount of salt could require the desalting and/or evaporation of up to 12,000 acre-feet of water per year.

Investigations have just begun with installation of gaging stations and sampling to determine the source of the salt load. Methods of control will likely be similar to the methods being investigated for the Price River. A feasibility report is scheduled for FY 1978.

8. Dirty Devil River, Utah

The Dirty Devil River near Hite, Utah, drains about 4,170 square miles. The flow averages about 72,000 acre-feet per year and contains an estimated 200,000 tons of dissolved solids with concentrations up to 2,500 mg./l. It is estimated that selective removal of the lower, more saline flows could remove about 80,000 tons of salt per year. Removal of this amount of salt could require the desalting and/or evaporation of up to 30,000 acre-feet of water per year.

Investigations of this source have not begun. Gaging stations will be installed soon and sampling will commence. Investigations will be similar to those of the Price and San Rafael River. A feasibility report is scheduled for FY 1978.

9. Grand Valley Area, Colorado

In the Grand Valley area work is underway and is aimed at improving irrigation efficiencies with the prospect of reducing the salt loading. During the past irrigation season, 45 farmers participated with 1,000 acres in an irrigation scheduling program. Under this program, computer runs are made weekly and updated information is mailed to each of the participants advising them when and how much water to apply to their fields. This is supplemented with field visits by water management specialists on a weekly basis who compare computer results with actual field conditions. The 45 farm owners involved in the program have 90 individual fields being treated as separate entities for the computer analyses. The reaction of the farmers to the program has been highly favorable, and it is expected that during the next irrigation season about 150 to 200 farms will be involved in this volunteer program.

As this work progressed, additional climatic data were collected through the installation of a new weather station within the central part of the agricultural area. Previously, data from the Grand Junction airport which is located in a desert setting had to be used. With climatic data now being obtained within the agricultural area, even better computer estimates can be obtained.

Corollary work in the Valley is being supported by Colorado State University, Colorado Water Conservation Board, Soil Conservation Service, Agricultural Stabilization Conservation Service, U.S. Geological Survey, and the local water user entities. They have formed a local coordinating committee to help execute the program with the water users. Field research and demonstrations on salinity control and irrigation efficiency are being conducted in this area by Colorado State University and the Colorado Water Conservation Board.

Irrigation scheduling work is being accompanied by corollary studies in the improvement of project water delivery systems. Studies have been initiated on about 6,000 acres on the northwest end of the Grand Valley under the Government Highline Canal. This work is also being coordinated by the local committee previously mentioned. A feasibility report is scheduled for FY 1975.

10. Uinta Basin, Utah

It is planned to begin irrigation scheduling services in the Uinta Basin with the 1973 season. Contacts are being made with the water user organizations to explain the program to them.

Corollary studies in improving the water delivery systems are also underway with a review of previous studies. A feasibility report is scheduled for FY 1976. Irrigation scheduling and water system improvements investigations in the Uinta Basin will involve the Ute Indian Tribe and many non-Indian water user organizations.

11. Lower Gunnison Basin, Colorado

Investigations for improving the water delivery systems will begin this year with a feasibility report scheduled for FY 1976. It is planned to begin irrigation scheduling with the 1974 season.

B. Accomplishments in the Lower Colorado Region

In the Lower Colorado Region, work moved forward on salinity control at selected point and irrigation sources. Point source investigations were conducted at LaVerkin Springs and at Blue Spring. Irrigation source control work focused on the Colorado River Indian Reservation and the Palo Verde Irrigation District.

1. LaVerkin Springs, Utah

At LaVerkin Springs, work is being accomplished to complete a feasibility report by the end of the current fiscal year. Studies to date have been mainly directed toward collection of design data and studies of alternative plans.

An intensive program was conducted to evaluate the quality and quantity of the discharge of the springs and this work has been essentially completed. Detailed geologic maps of the area are now under preparation. Two wells were drilled in the spring area for the purpose of obtaining geologic information and to intercept the underground flow feeding the springs. At both wells, ground water was encountered and pumping tests have been made to determine the characteristics of the aquifer in the vincinty of the springs. The results of these studies will be used in preparing designs for collection of the springs by pumping from wells.

Alternative plans are being developed based on collecting the springs by diverting flows of the Virgin River around the spring area and then collecting the flow of the springs at a structure immediately downstream from the springs. Investigations are also being conducted to determine potential locations for brine disposal. The brine disposal studies should reveal both the costs for disposal of the entire springs by evaporation and those involved in disposal of brine from a desalting plant. Design data for a reverse osmosis plant in the area are being prepared.

Measurements made during 1972 on LaVerkin Springs indicate that the flow is between 11 and 12 c.f.s. and have an average concentration of 9,650 p.p.m. This source contributes about 100,000 tons of salt to the Colorado River system each year. Plans are being developed to collect the spring flow for delivery to a desalting plant. It is planned that nearly all of the salt load from the springs would be removed from the system.

2. Blue Spring, Arizona

Investigations at Blue Spring were intitated during Fiscal Year 1973. This spring is the single largest point source in the Colorado River system. The spring has a flow of 220 c.f.s. with a concentration of about 2,500 p.p.m. It is thus outputting 550,000 tons of salt per year. The spring arises in the Little Colorado River about 13 miles upstream from its junction with the Colorado River. Under base flow conditions, the stream has a beautiful turquoise color as it flows through the scenic canyon of the river. This results from the travertine deposits on the rocks in the streambed. During runoff periods, however, the river is typically muddy in appearance and apparently carries considerable silt. The Little Colorado River is entrenched within the steep canyon walls at a depth of about 2,500 feet. The combination of modest salinity level, the comparatively large flow, the scenic setting, and the special ethnic value to the Indians, place special demands upon the development of suitable salinity control plans.

Several solutions considered for evaluation include: (1) desalting the total or a portion of the water supply from Blue Spring; (2) development of a pump-storage, power-generation desalting complex, the primary purpose which would be peaking power generation with a secondary desalting function; and (3) using all or a portion of Blue Spring flow for diversion to thermal generating facilities for use as cooling water. Depending upon the findings of the reconnaissance study now being conducted, decisions will be made whether or not to proceed with the feasibility studies. Potential desalting plant sites are being studied and basic data collection is now underway.

3. Littlefield Springs, Arizona

The Littlefield Springs discharge along the south side of the Virgin River about a mile upstream from Littlefield, Arizona. These springs have a combined outflow of about 10 second-feet with an average salinity of about 2,900 mg./l., and contribute an annual salt load of about 30,000 tons to the river system. Flow from the springs is presently diverted and used for irrigation in the Littlefield area. Investigations of alternative plans of removing salt from the spring water will be started in FY 1974 with a feasibility report scheduled for FY 1975.

4. Colorado River Indian Reservation, Arizona-California

Activities relating to irrigation source control on the reservation have been discussed with representatives of the Colorado River Indian Agency, Bureau of Indian Affairs; and representatives of the Colorado River Indian Reservation. Great interest in the program has been expressed by both groups. Representatives of these groups have observed irrigation scheduling work underway on other Bureau projects. It is hoped that the groups and their individual water users will respond favorably and assist in getting an irrigation scheduling and management program underway this fiscal year.

A corollary study of improving the irrigation system was started in FY 1973 with a feasibility report scheduled for FY 1975.

5. Palo Verde Irrigation District, California

The Palo Verde Irrigation District is located in Riverside County, California. It is a privately developed district. 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 91,500 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 contribute about 90,000 tons of salt annually to the river.

The objectives of these studies are to identify the improvement works needed in the irrigation system and to determine the amount of the reduction in salt loading of the river that can be obtained by an improved irrigation system and by irrigation scheduling. Both of these programs would reduce return flows and this would reduce the salt load that is now returned to the river. These studies are scheduled to start in FY 1974 with a feasibility report for water systems improvement scheduled for FY 1976.

Concurrently, an intensive salinity measurement program on the Lower Colorado River is being conducted. A significant increase in salinity occurs between Parker and Imperial Dams. The salt loading and concentrating effects occurring in this reach of the river have not been fully evaluated. Thus, discharges from the Reservation and from other irrigated and natural sources in this reach of the river are being identified to provide basic information to guide the control program and to evaluate anticipated improvements in the salinity levels of the river.

C. Accomplishments at the Engineering and Research Center

Work at the Engineering and Research Center is focused upon the broad general studies impacting upon the entire control program. This involves work on mathematical models of the river system, economics of water quality, legal and institutional analyses and studies of potential applications of ion exchange desalting.

1. Mathematical Model

Work on the mathematical model is progressing on schedule. This model is composed of five submodels--data analyses, simulation, impact and sensitivity, optimization, and dynamic. The computer program for the data analyses and simulation models is essentially completed. Currently, verification runs of the simulation model are being made. Following this, the total flow and quality data base to be used in the model will be assembled so that simulation runs can be made with the model by July 1973. Early applications of the model will be aimed at disclosing operational modes which could result in improved water quality in the lower reach. It is contemplated that use of the model will begin in July 1973. In subsequent fiscal years, other submodels will be completed.

2. Economic Analyses

Studies of the economics of salinity are being conducted by the Bureau of Reclamation and by contract. The Bureau effort is concentrating on the detrimental effects of salinity on municipal and industrial users of Colorado River water. An extensive literature review has been completed and efforts are now centered on the collection of various estimates of salinity effects to determine whether a consistent set of useable data can be derived.

Concurrently, scientists at Colorado State University and the University of Colorado are concentrating on the effects of salinity upon agriculture production. The plan of work includes investigation into (1) crop response to salinity, (2) farmer response to salinity, (3) direct economic damages due to salinity, and (4) indirect economic damages. The researchers have completed their literature review, made a field survey of the impacted agriculture area and obtained all available files relative to the Environmental Protection Agency study of the Colorado River, and are currently evaluating that economic model. A draft report on their work is scheduled to be submitted by February 15, 1973.

This work is being accomplished to provide the requisite background essential for construction of the optimization submodel of the comprehensive Colorado River model. It will provide the background needed to evaluate the benefits and costs of salinity control and to help guide decisions with respect to the selection and construction of salinity control measures.

3. Institutional and Legal Review

A legal and institutional analysis of salinity control in the Colorado River system is currently underway. The study is concerned with such problems as (1) the depletions caused by salinity control projects in the Upper Basin for Lower Basin benefits, (2) depletions in the Lower Basin for their own benefit, (3) augmentation in the Upper Basin, (4) augmentation in the Lower Basin, (5) desalting, and (6) scheduling and management of water to improve water use in the basin. In examining these salinity related problems, questions arise relating to contracts, water loss, cost sharing, and operational procedures for handling the new salinity control works. The analysis will be completed during the current fiscal year.

4. Ion Exchange

A special study is being made of the prospects of applying ion exchange desalting to the Colorado River system. The prospects are of developing plans for controlling salinity as it leaves the river for a specified use rather than controlling the salinity at its source. Ion exchange is well suited to solving a problem such as reducing salinity from 1,200 to 500 p.p.m. This concept should be evaluated along with the source control concept, or even combinations of both, so that identification can be made for the best ways to provide Colorado River water users the water quality best matched to needs.

In a cooperative effort with the Office of Saline Water, a very preliminary study of the feasibility and economics of applying ion exchange technology was completed this past year. This report indicated that with the development of the technology it might be possible to achieve very large-scale river quality control at the 550-p.p.m. level with costs ranging between $15 an acre-foot in 1975 to $34 and acre-foot in 2015. Product water recovery will be expected to vary between 89 and 95 percent. The increase in cost reflects the anticipated rise in salinity without controls.

WATER QUALITY IMPROVEMENT PROGRAM

The study was supported by a 6-week ion exchange desalting pilot plant operation on the Colorado River below Davis Dam. A 5,000-gallon-per-day pilot plant successfully operated on 750 p.p.m. water to yield a product water of 500 p.p.m. This work was done by the Office of Saline Water. The pilot plant tests examined several resins and process configuration. For the various processes, recommended regenerate chemicals are sulphuric acid and ammonia. These chemicals are the most important single cost element in the economic structure of the entire process. It is conceivable that these costs could be reduced considerably by using industrial waste products in the basin from thermal power generating facilities and other sources. These results appeared so sufficiently promising that it is now planned to move forward into a 3-year program to design and operate a scaled-up pilot plant of about 72,000 gallons per day on the Colorado River. Attention will be directed toward developing conceptual designs for handling water volumes more closely alined with the major diversions anticipated in future years.

PART X. 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 of significance which warrant discussion. The following sections discuss the most significant sources of water quality degradation and the effects of such degradations on water uses as measured by various parameters.

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.

Compliance schedules have been established for municipalities whose waste discharges are not meeting the water quality standards set by the States. At the present time, pollution from municipal waste sources is confined to those reaches of stream immediately downstream of the waste effluent, and measures are being taken or have been planned 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 pollutants derived from industrial wastes other than salinity are toxic materials, oils and grease, floating materials, radioactivity, oxygen-demanding substances, heat, color-, taste-, and 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.

3. Agricultural Wastes

Except for salinity, pesticides and fertilizers are the primary water pollutants associated with agriculture in the Colorado River Basin.

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. 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. Data have been collected showing that pesticides are present in sufficient quantities at certain locations in the Lower Colorado River to be harmful to fish and aquatic life. The use of these compounds in areas above public water supply intakes requires that adequate precautions be taken to preclude entry into the river system.

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. Feedlot wastes, moreover, do not generally accumulate within the basin since facilities are set up to distribute the wastes onto adjacent farmland.

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. The streams with degraded reaches are listed in Table C which also shows the major sources and effects of the pollution. Many of these streams have heavy-metal concentrations in excess of PHS Drinking Water Standards and destroy aquatic life in about 120 miles of stream channel.

B. Water Quality Parameters Other Than Salinity

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. However, a marked reduction in the concentration can be found during the summer months below some municipal and industrial discharges and in some streams with very low 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.

Table C. Mine Drainage Sources and Effects, Colorado River Basin

Stream	Area of investigation	Major sources	Effects
Blue River			
Tenmile Creek	Headwaters to mouth at Frisco, Colo.	Wilfrey Mine; pump failure at Amax tailings ponds.	Some areas devoid of aquatic life due to high heavy-metals concentrations
Eagle River	Homestake Creek near Redcliff to Minturn, Colo.	Mineral spring near Belden, Colo.; former seepage from old tailings pile; New Jersey Zinc Corp. decant.	Aesthetics; destruction of biological productivity; high heavy-metals concentration; predominantly zinc.
Gunnison River			
Lake Fork	Headwaters to Lake City, Colo.	Golden Fleece Mine.	Aesthetics in northwest portion of Lake San Cristobal.
Uncompahgre River	Headwaters through Dexter Creek, upstream of Ouray, Colo.	Red Mountain Creek; via Genessee, Rouville, and Joker Tunnels, and Red Mountain adit; natural sources.	Aesthetics; low pH; high heavy-metals and mineral concentration; devoid of aquatic life.
Dolores River	Mouth of Coal Creek to Dolores-Montezuma County line.	St. Louis and Blaine Tunnels; Silver Swan adit; and others.	Aesthetics; minimal effect due to neutralization of mine drainage by natural river alkalinity.
San Miguel River	Upstream of confluence with South Fork.	Iron Springs; Penn Tunnel; other mine drains; natural sources.	Aesthetics; high heavy-metals concentration; minor effects on biological productivity.
San Juan River			
Animas River	Headwaters through Mineral Creek south of Silverton, Colo.	Cement Creek, north Mineral Creek via Bagley, American, and Koehler Tunnel; other adits, mills, and mine drains, natural sources.	Aesthetics; high heavy-metals concentration, particularly zinc; many areas devoid of aquatic organisms.
La Plata River	Headwater to Hesperus, Colo.	Natural sources.	Minimal effects.
Mancos River	Headwaters to confluence of Middle and East Forks.	Natural mineral seep.	Some destruction of aquatic life, particularly fish.

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 or no 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 fishlife. 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 thermal powerplants in the basin with a return of the cooling water to the streams or reservoirs could present a potential for temperature increase. It is anticipated that cooling water discharges from powerplants will be controlled in the future. Any thermal discharge coupled with flow depletion could have a significant effect on water temperatures.

3. pH

The pH of the waters in the Colorado River Basin usually range from about 7 to 8 with the exception of those streams receiving acid mine drainage. In this latter case the pH is lowered to levels which preclude the establishment of aquatic life and the use of the river for a fishery and other purposes.

4. Heavy Metals

Various heavy metals such as copper, lead, zinc, iron, manganese, arsenic, and cyanide are found in the waters of the basin. These vary 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 and manganese concentrations frequently exceed the Public Health Drinking Water Standards in many basin streams. This is particularly evident in the upper reaches of the Colorado and San Juan Rivers and their tributaries. A 1966 water quality survey showed that heavy metal concentrations have a marked effect on the aquatic life. Toxicity of these metals to aquatic life is dependent not only on the toxicity of a single metal but also the synergistic effects of two or more metals. Certain reaches of stream are completely devoid of bottom organisms and fish because of these toxic effects.

5. Toxic Materials

In addition to the toxic effects of heavy metal concentrations, 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 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 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 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 return canals. A small increase in the nutrient levels in the river has been attributed to heavy recreational activities along the river below Davis Dam.

7. <u>Bacteria</u>

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 in the intestinal tract of humans and other warmblooded animals as well as in the soil and on vegetation. High coliform counts in waters indicate the probably presence of pathogenic organisms where bacterial contamination from sewage or animal wastes appears likely.

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.

OTHER WATER QUALITY ASPECTS

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. In some cases, however, it 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 or are scheduled to be corrected by the addition of ponding 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 is 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. In combination with other radionuclides (e.g., Sr-90) the waters of the Colorado River system are now approaching or exceeding the recommended limits for radioactivity.

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: $\frac{\text{Sr-90}}{10} \div \frac{\text{Ra-226}}{3} \leq 1.0$.

9. Mercury

Studies have revealed that mercury concentrations, higher than the present accepted Food and Drug Administration limit for mercury residue in fish for interstate transportation, were found in two species of fish in Navajo Lake, on the San Juan River.

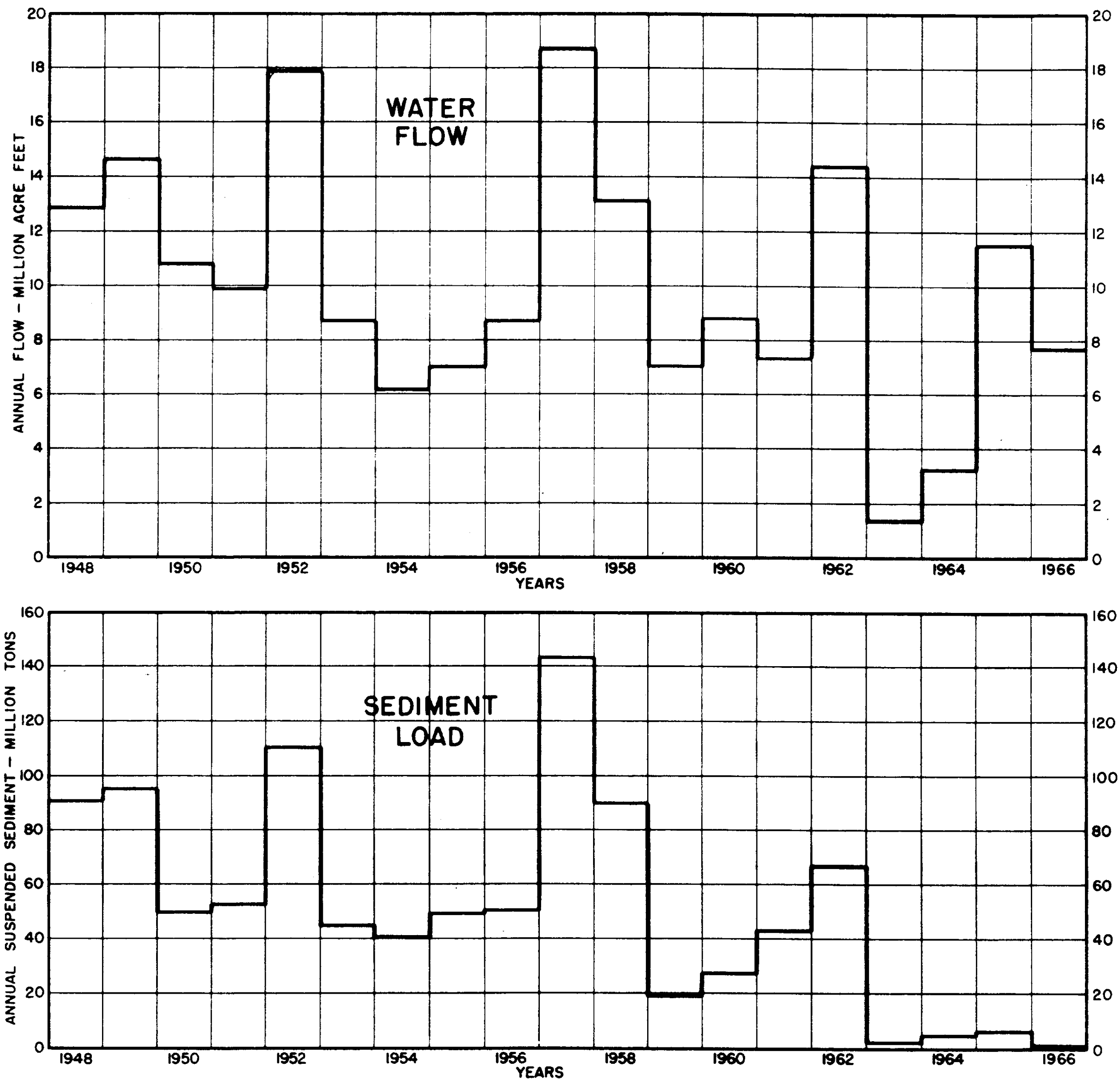
Tests showed brown trout to contain 1.16 parts per million of mercury residue and bullheads to contain .68 ppm. The current acceptable FDA level is .50 ppm. Of the 10 species of fish tested, the brown trout and the bullhead were the only species with concentrations higher than the .50 ppm. Mercury concentrations in the sample fish ranged from .08 in rainbow trout to the 1.16 in the brown trout.

Mercury tests were run on water taken from the river at Lee's Ferry and the surface of Lake Powell. Fish samples were taken when it was found that the river water mercury levels exceeded drinking water standards set by the FDA. However, none of the rainbow trout and flannelmouth suckers taken in the river or the rainbow trout and largemouth bass taken in the lake approached the unsafe limits for edible food as set by the FDA. Similar results were obtained from fish of Imperial Reservoir and Lake Havasu. With the high concentrations of mercury found in fish from the Navajo Reservation in New Mexico, more extensive examinations of the Colorado River will be made.

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, Ariz., 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 4. 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 effectively trapping and storing almost all of the sediment originating in the Upper Colorado River Basin. Lake Powell traps approximately 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 dam 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.



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

COLORADO RIVER
AT LEES FERRY
SEDIMENT & WATER FLOW

Fig. 4

PART XI. EFFECT OF IMPOUNDMENTS ON COLORADO RIVER

A. Water Quality in and below Flaming Gorge Reservoir and Lake Powell

1. Flaming Gorge Reservoir

Quality of water in the reservoir.--Reconnaissance of the water quality in Flaming Gorge Reservoir in 1966-68 indicated that an average increase of 100-150 mg./l. of dissolved solids had occurred in the river system affected by the closure of the reservoir. This amounted to an increase of about 35 percent more than the concentration that would have occurred if the reservoir had not existed. It was estimated that approximately 1,200,000 tons of solutes were added to the river system by leaching during 1963-68. In July 1970, a more detailed project was begun to better define the rate of leaching and the degree of stratification in the reservoir.

In October 1970 and April, July-August, and October 1971, in-situ measurements of specific conductance, temperature, dissolved oxygen and pH were made at 30 sites in the reservoir. Detailed vertical profiles from the surface to the bottom of reservoir were made at each site. The generalized results of the in-situ measurements are shown in Figures 5-8. In addition, samples for analysis of water quality were collected at 13 sites.

Leaching in the reservoir.--Inflow and outflow loads of dissolved solids were computed for 1969-70, together with the load in the reservoir. Preliminary computations indicate that 240,000 tons of solutes were leached during the 2-year period (an average rate of 120,000 tons per year). This compares with 1,200,000 tons for the 1963-68 period (an average rate of 200,000 tons per year), indicating that the rate of leaching is decreasing.

Stratification in the reservoir.--Data collected during the period October 1970-October 1971 indicated that the water above 5,740 feet (the top of the dead-storage zone) is mixing and changing seasonally. This seasonal mixing and movement in the upper zones of the reservoir are aided by the fact that the average annual inflow to Flaming Gorge Reservoir ranged from slightly less than the total reservoir content to about 50 percent of the total content during the 1970-71 period. Water in the dead-storage zone, which was less than 3 percent of the reservoir content during the 1970-71 sampling period, apparently is not significantly affected by seasonal changes in the upper zones.

In the fall of 1970, stratification of dissolved oxygen and temperature occurred throughout most of the reservoir (Figs. 6A and 7A). A well-mixed upper zone known as the epilimnion (about 82 percent of reservoir content) overlaid a zone with large temperature gradient known as

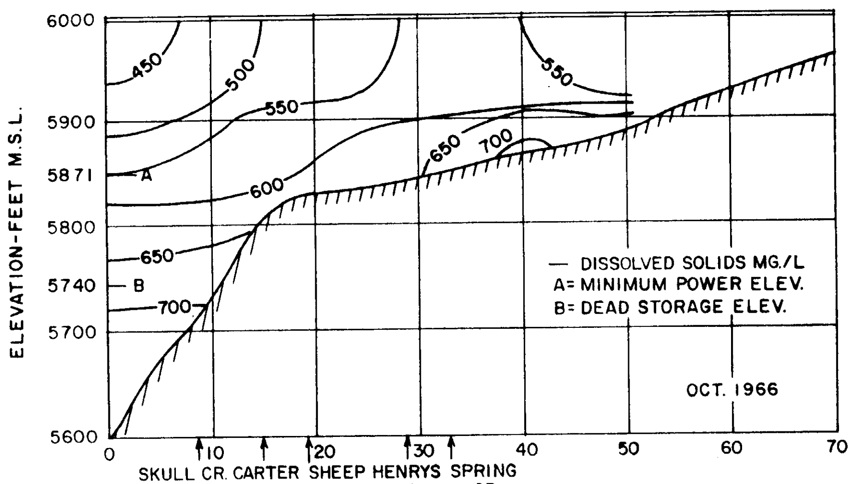


FIG. 5A

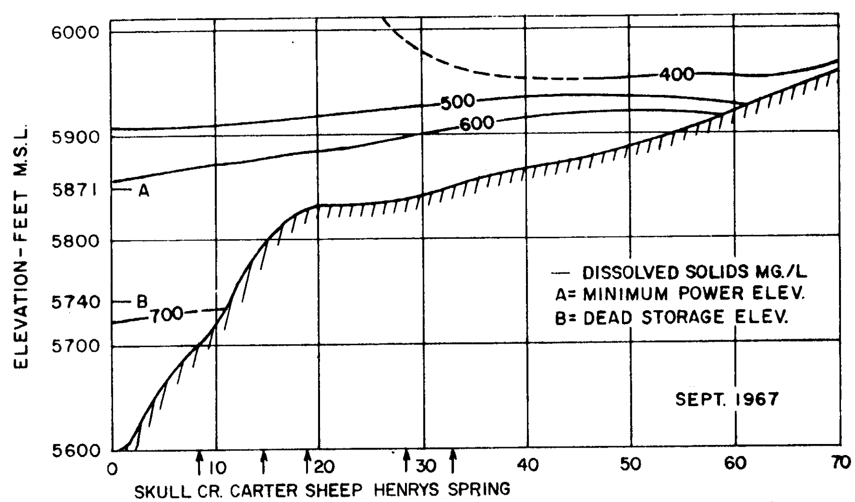


FIG. 5B

RIVER MILES ABOVE
FLAMING GORGE DAM

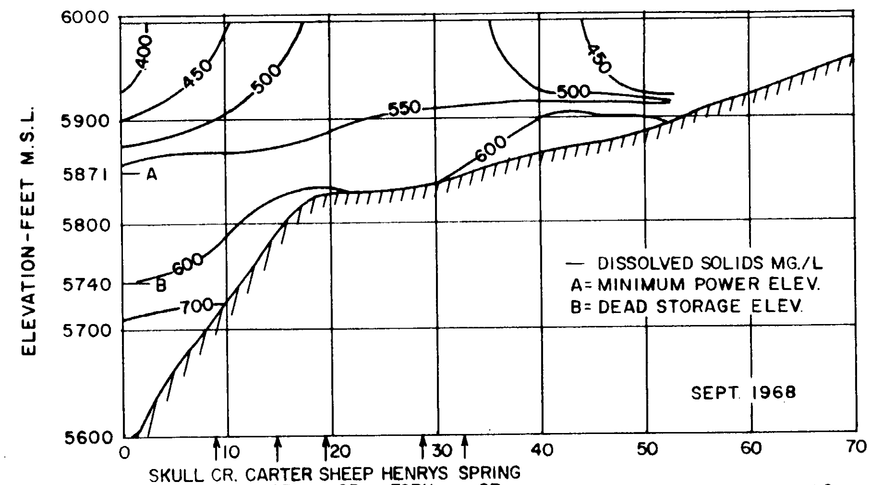


FIG. 5C

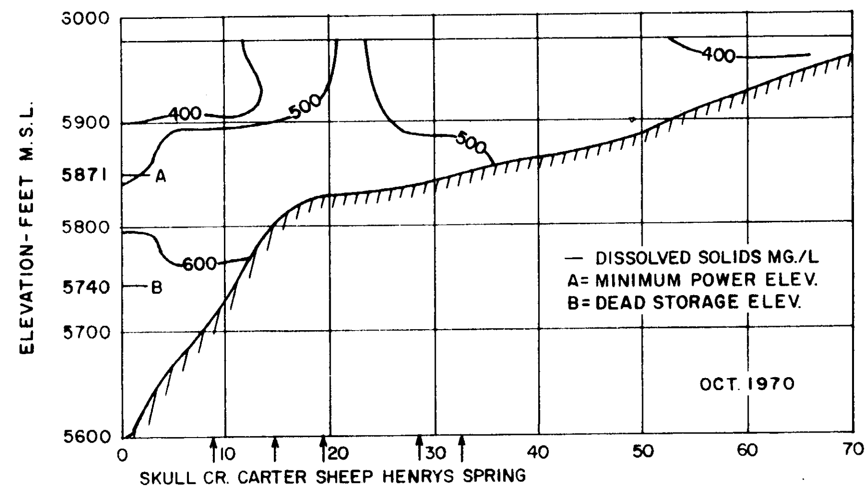


FIG. 5D

RIVER MILES ABOVE
FLAMING GORGE DAM

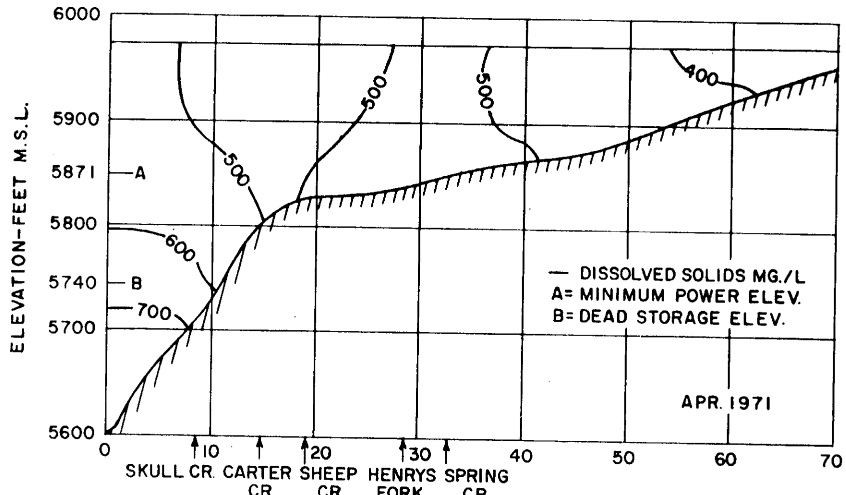


FIG. 5E

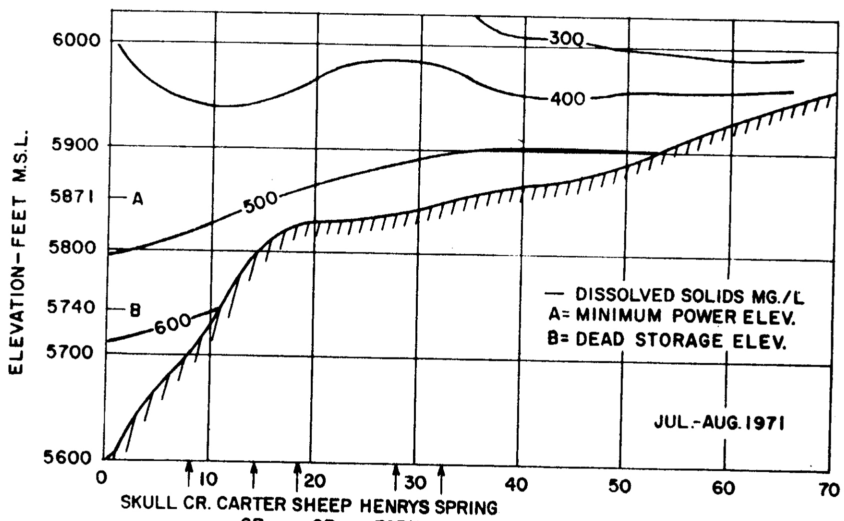


FIG. 5F

RIVER MILES ABOVE
FLAMING GORGE DAM

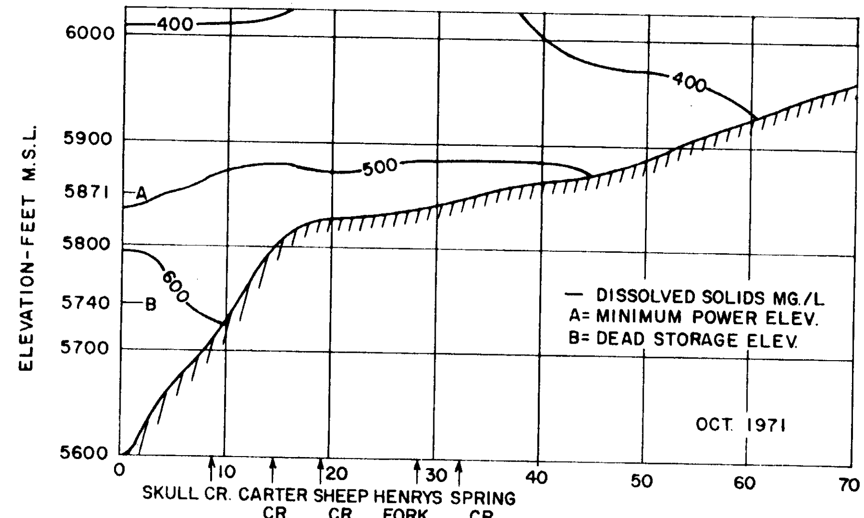


FIG. 5G

RIVER MILES ABOVE
FLAMING GORGE DAM

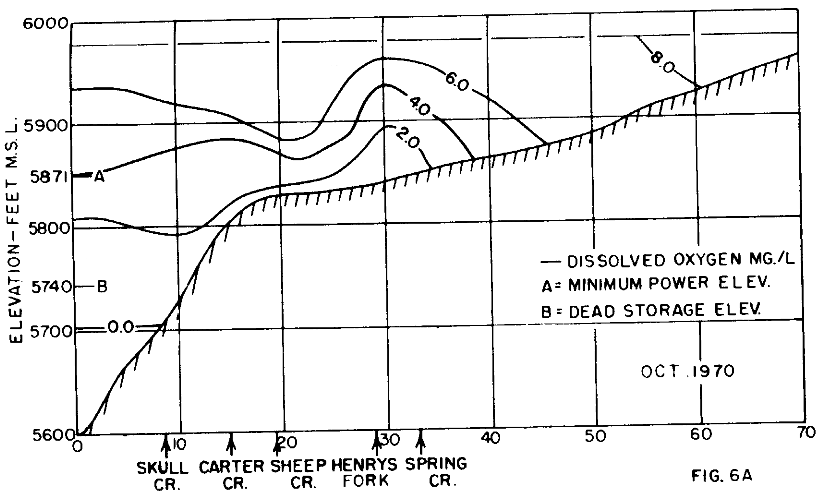


FIG. 6A

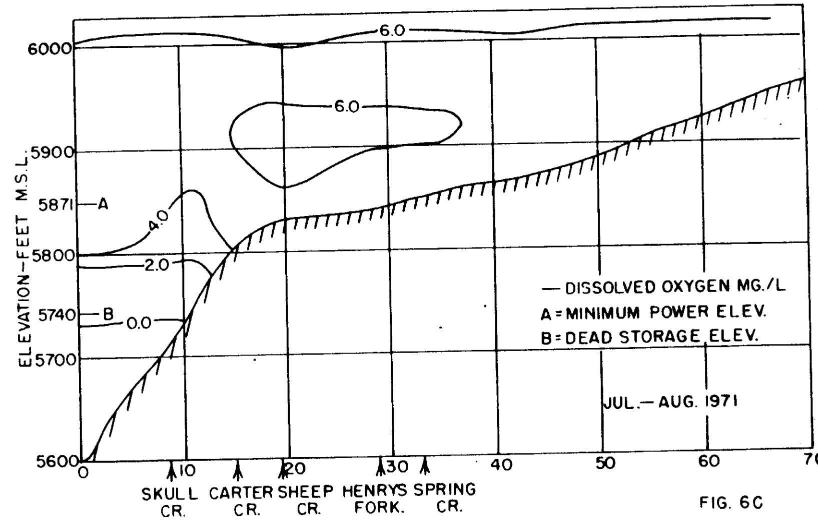


FIG. 6C

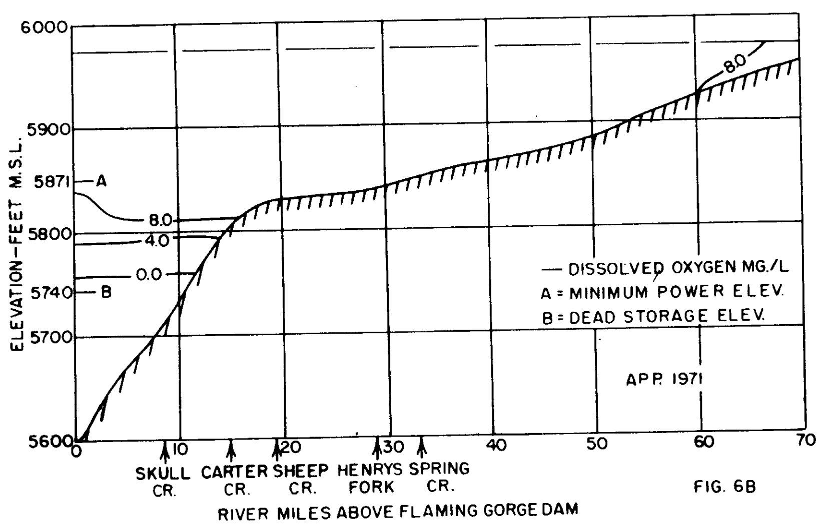


FIG. 6B

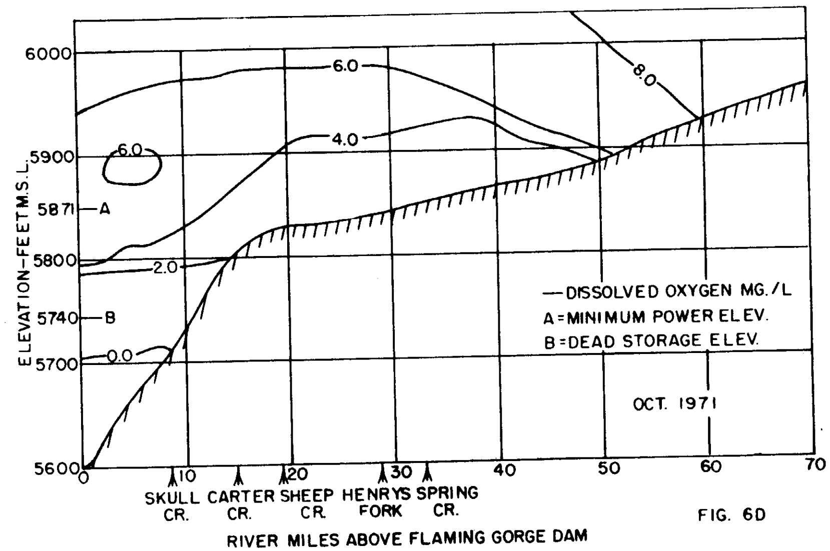


FIG. 6D

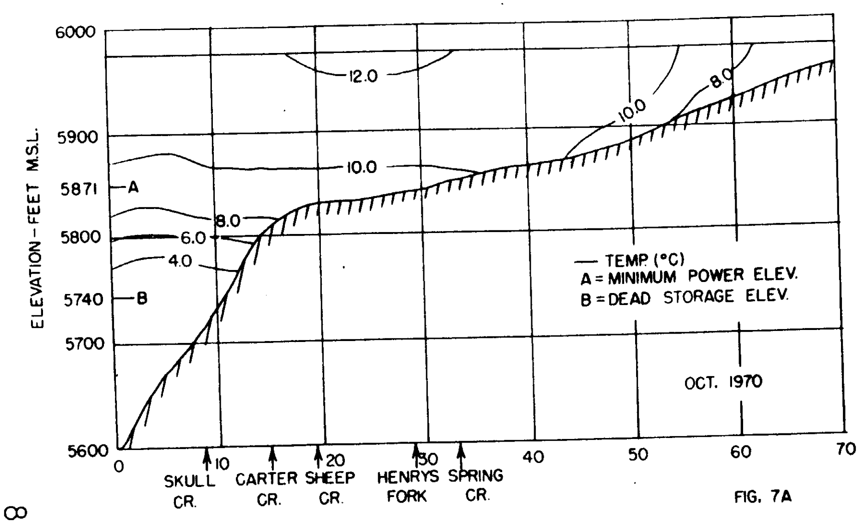


FIG. 7A

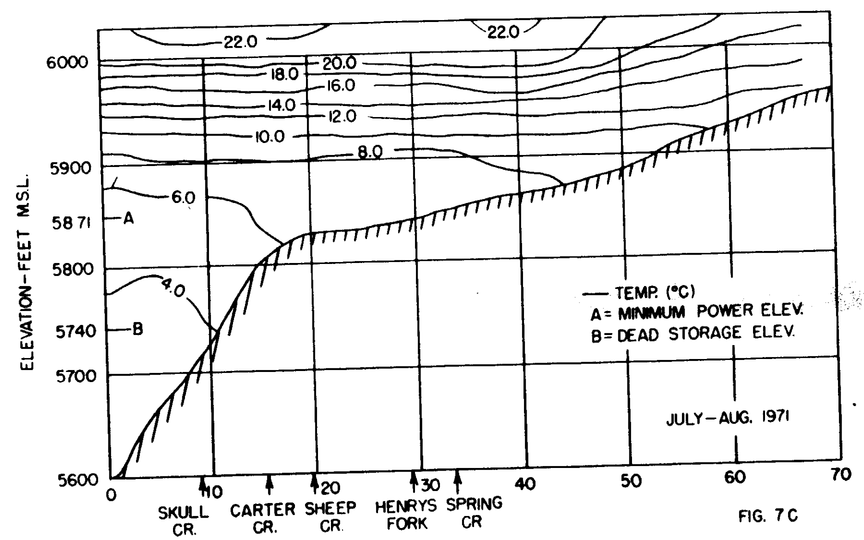


FIG. 7C

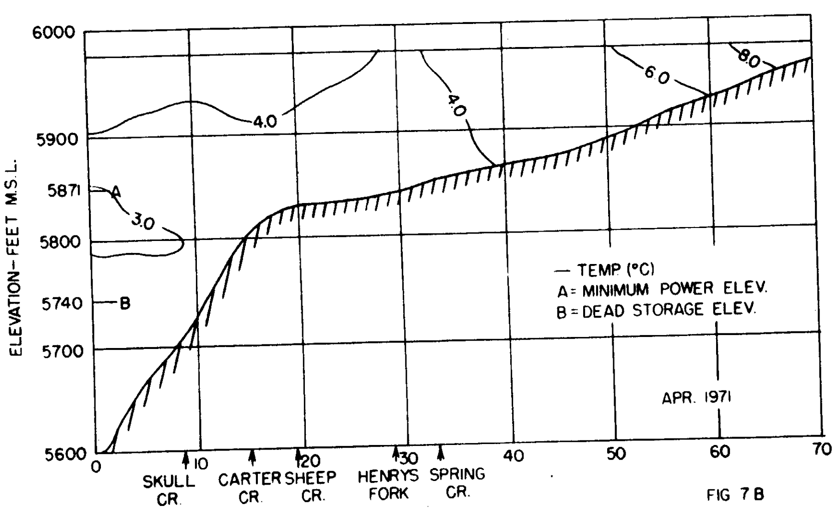


FIG 7B

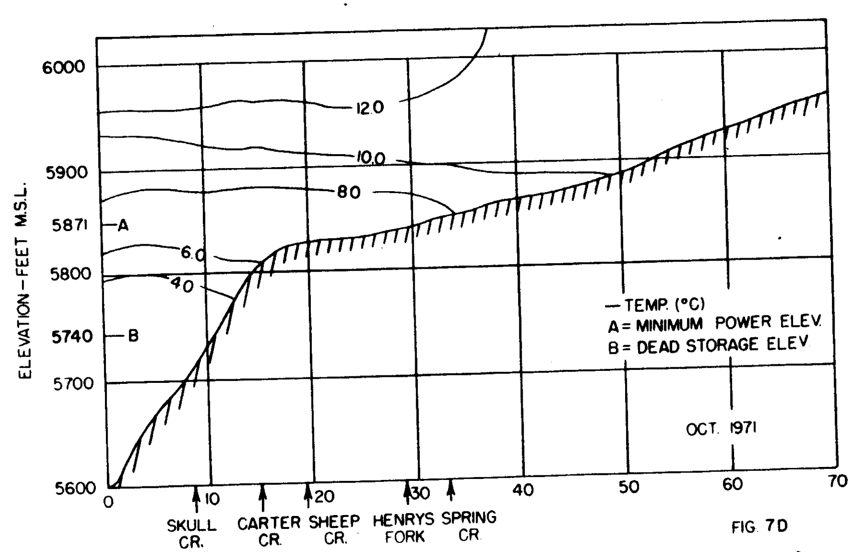


FIG. 7D

RIVER MILES ABOVE FLAMING GORGE DAM

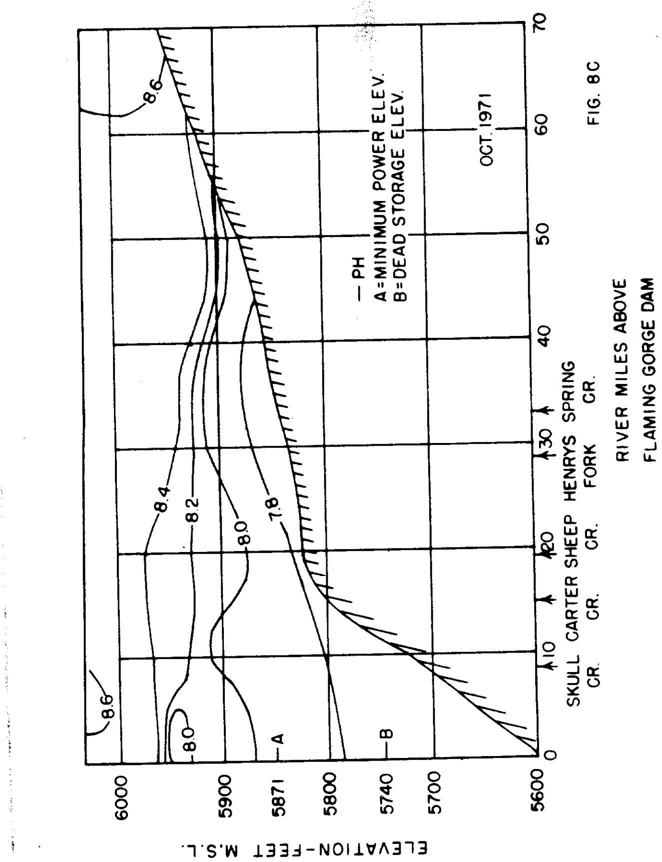


FIG. 8C

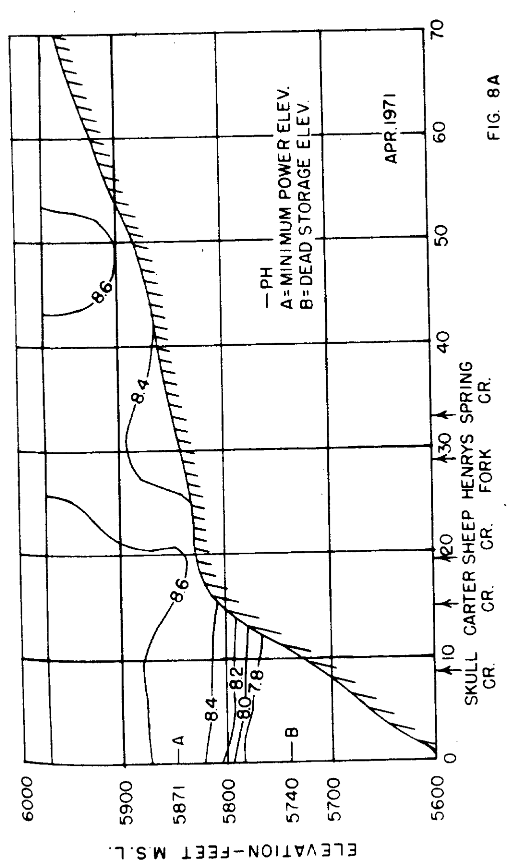


FIG. 8A

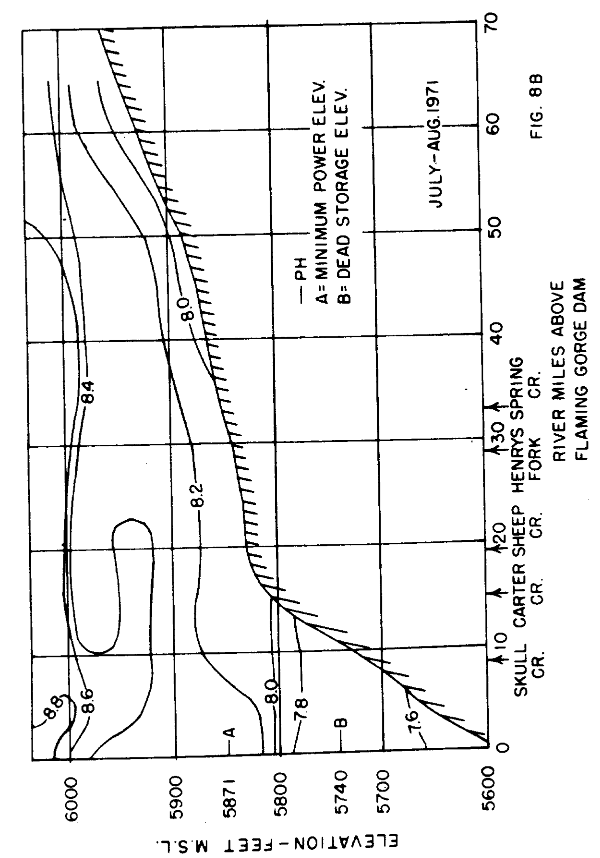


FIG. 8B

the thermocline (about 16 percent of the reservoir content). Underlying the thermocline was a poorly mixed zone, the hypolimnion (about 2 percent of reservoir content) which contained the most saline water in the reservoir. This deeper zone of water contains about 600-700 mg./l. of dissolved solids and has been observed during each of seven periods of sampling during 1966-71 (Figs. 5A-G). The salinity of the hypolimnion appears to be stable even though the upper boundary of the zone fluctuates seasonally. Anaerobic (absence of dissolved oxygen) or near anaerobic conditions were observed in this zone during each of the four periods of sampling during October 1970-October 1971 (Figs. 6A-D). Also, the water temperature in the hypolimnion was constant at 4.0°C and pH ranged only from 7.6 to 7.8 during the 1970-71 period.

In April 1971, the thermocline had disappeared, and temperature stratification was nearly absent. Most of the reservoir had a temperature of 4.0°C from surface to bottom (Fig. 7B). The dissolved solids, dissolved oxygen and pH data (Figs. 5E, 6B, 8A) all indicate that the reservoir was essentially divided into two zones, a well-mixed epilimnion and the hypolimnion, which was essentially unchanged since October 1970. The combination of relatively low inflow and outflow with mixing during the winter destroyed most of the stratification that occurred during the fall.

During July-August of 1971, the entire reservoir was well stratified with respect to dissolved solids, dissolved oxygen, temperature, and pH (Figs. 5F, 6C, 7C, 8B). The stratification was due to seasonal heating combined with high inflow and low outflow. The water level in the reservoir was raised nearly 40 feet during the period between the spring and summer measurements. The spring and early summer runoff, which contained relatively low concentrations of dissolved solids (less than 300 mg./l.), appeared in the uppermost portion of the reservoir.

In October 1971, the salinity, dissolved oxygen, temperature, and pH profiles (Figs. 5G, 6D, 7D, 8C) were similar to those shown for October 1970, apparently indicating a cycle of limnological events.

Effects of closure on the Green River near Greendale.--Since the closure of the Flaming Gorge Dam in November 1962, data indicate an increase in the weighted-average (Fig. 9) concentration of dissolved solids of the water in the river near Greendale. The highest weighted-average dissolved-solids concentration occurred in 1963 when a minimum of water was being released as the reservoir filled. During the next 7 years (1964-70) the annual weighted averages were less than in 1963 but greater than during the 5 years preceding closure. The higher concentrations that occurred after closure were due principally to the dissolved load added to the reservoir by leaching. Evaporation from the reservoir also caused an increase in the concentration of dissolved solids, but this increase is small compared to that caused by leaching.

ANNUAL MAXIMUM, MINIMUM, AND WEIGHTED-AVERAGE CONCENTRATION OF DISSOLVED SOLIDS OF GREEN RIVER NEAR GREENDALE, 1958 - 70

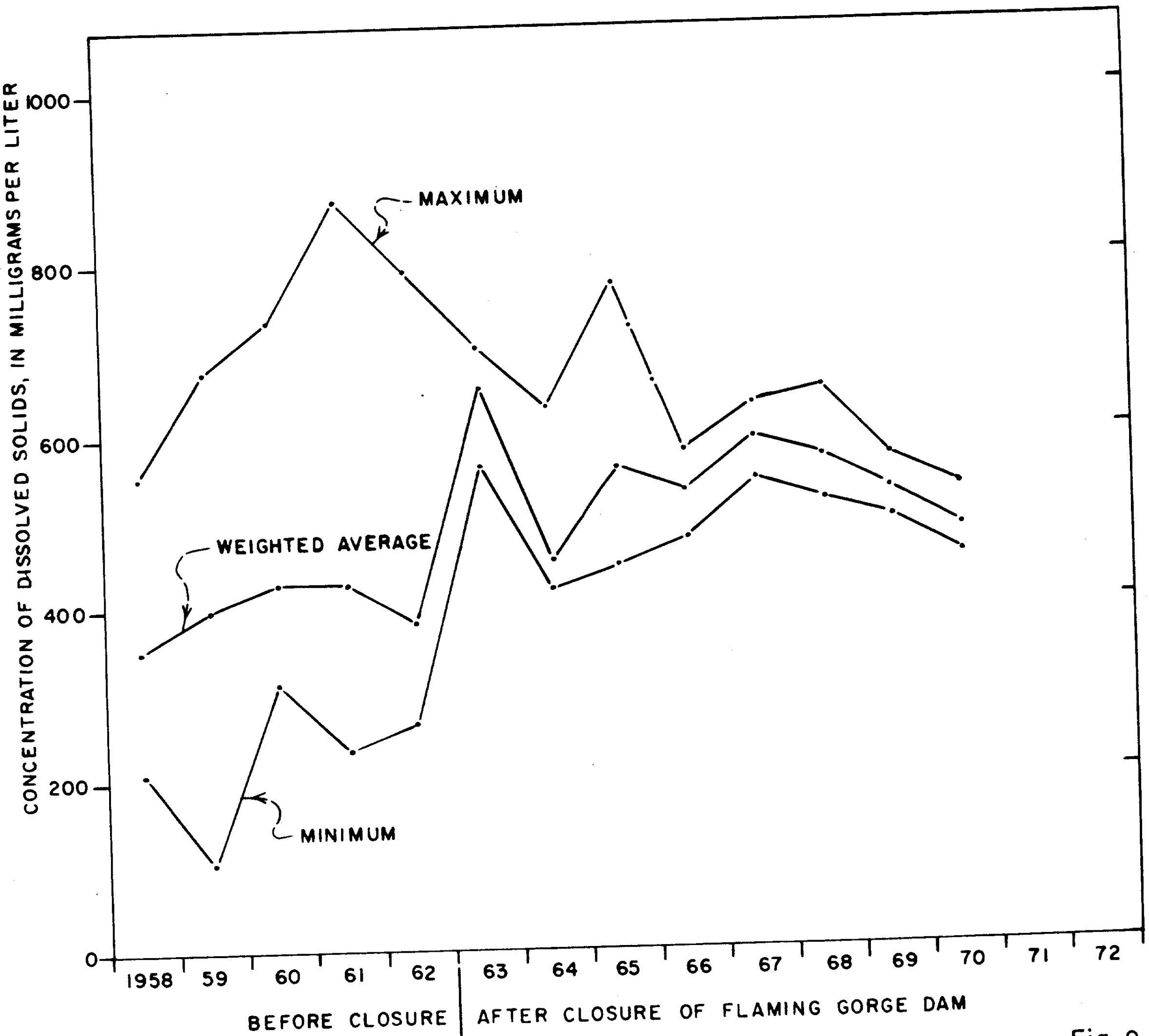


Fig. 9

The range of average monthly temperatures of the Green River near Greendale has been reduced considerably since closure of the dam (Fig. 10). Prior to closure the average monthly temperatures ranged from about 0.0°C to 19.5°C as compared to a range of about 4.0°C to 10.0°C after closure.

2. Lake Powell

Effects of closure on the Colorado River at Lees Ferry.--The chemical quality of the water at Lees Ferry has been affected by the storage in Lake Powell since 1963. The relation of water discharge and dissolved solids at Lees Ferry prior to 1963 and a tenuous relation since 1963 are shown in Figure 11. The tentative new relation is based on 2 years of extremely low flow during the first 2 years of the filling of Lake Powell (1963-64), 4 years of near-normal flow (1967, 1970), and 1 year of relatively high flow (1965). However, not enough years have elapsed since the closing of Glen Canyon Dam to establish whether or not there is now a bona fide correlation of discharge and dissolved solids. When the years of lowest flows (1963-64), and the near-normal flow in 1966 are adjusted for storage in Lake Powell, the values fall on the curve of the 1941-62 data.

The following tabulation shows the measured and adjusted water discharges and the measured and expected weighted average dissolved-solids concentrations for the Colorado River at Lees Ferry for the period 1963-70. With the exception of year 1966 and 1967 the measured concentrations of dissolved solids exceeded the expected dissolved solids. The measured concentrations at Lees Ferry after closure of Glen Canyon Dam were only slightly higher than the concentrations for similar volumes of flow before closure of the Dam. The large reduction in the concentration of the outflow from Lake Powell in 1966 was the result of the diluting effect of the unusually large volume of inflow of relatively dilute water during the spring runoff period of 1965.

Colorado River at Lees Ferry

Calendar year	Dissolved Solids1/				Discharge2/	
	Expected		Measured			
	mg./l.	T./A.F.	mg./l.	T./A.F.	Adjusted	Measured
1963	880	1.20	935	1.27	4.24	1.38
1964	735	1.00	810	1.10	6.50	3.24
1965	500	.68	575	.78	14.13	11.59
1966	705	.96	513	.70	6.92	7.74
1967	660	.90	621	.84	7.91	7.56
1968	580	.78	643	.87	7.92	8.80
1969	530	.72	628	.85	11.60	9.08
1970	550	.75	602	.82	10.66	8.14

1/ mg./l. = milligrams per liter; T./A.F. = tons per acre-foot
2/ In million acre-feet.

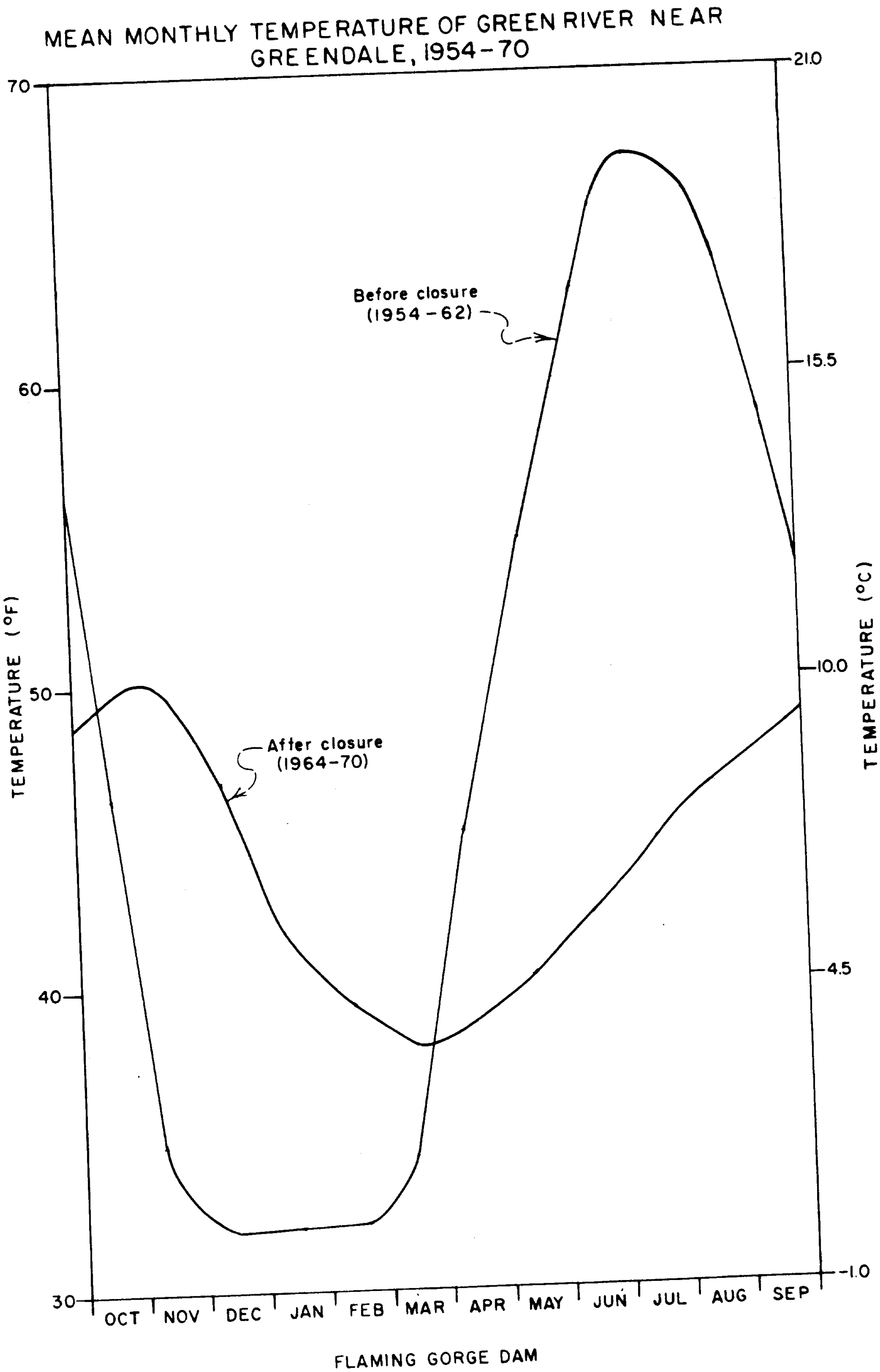

MEAN MONTHLY TEMPERATURE OF GREEN RIVER NEAR GREENDALE, 1954-70
70
60
50
40
30
21.0
15.5
10.0
4.5
-1.0
TEMPERATURE (°F)
TEMPERATURE (°C)
Before closure (1954-62)
After closure (1964-70)
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
FLAMING GORGE DAM

Fig. 10

RELATION BETWEEN MEAN ANNUAL WATER DISCHARGE AND DISSOLVED SOLIDS CONCENTRATIONS FOR COLORADO RIVER AT LEES FERRY, ARIZONA, 1941-70

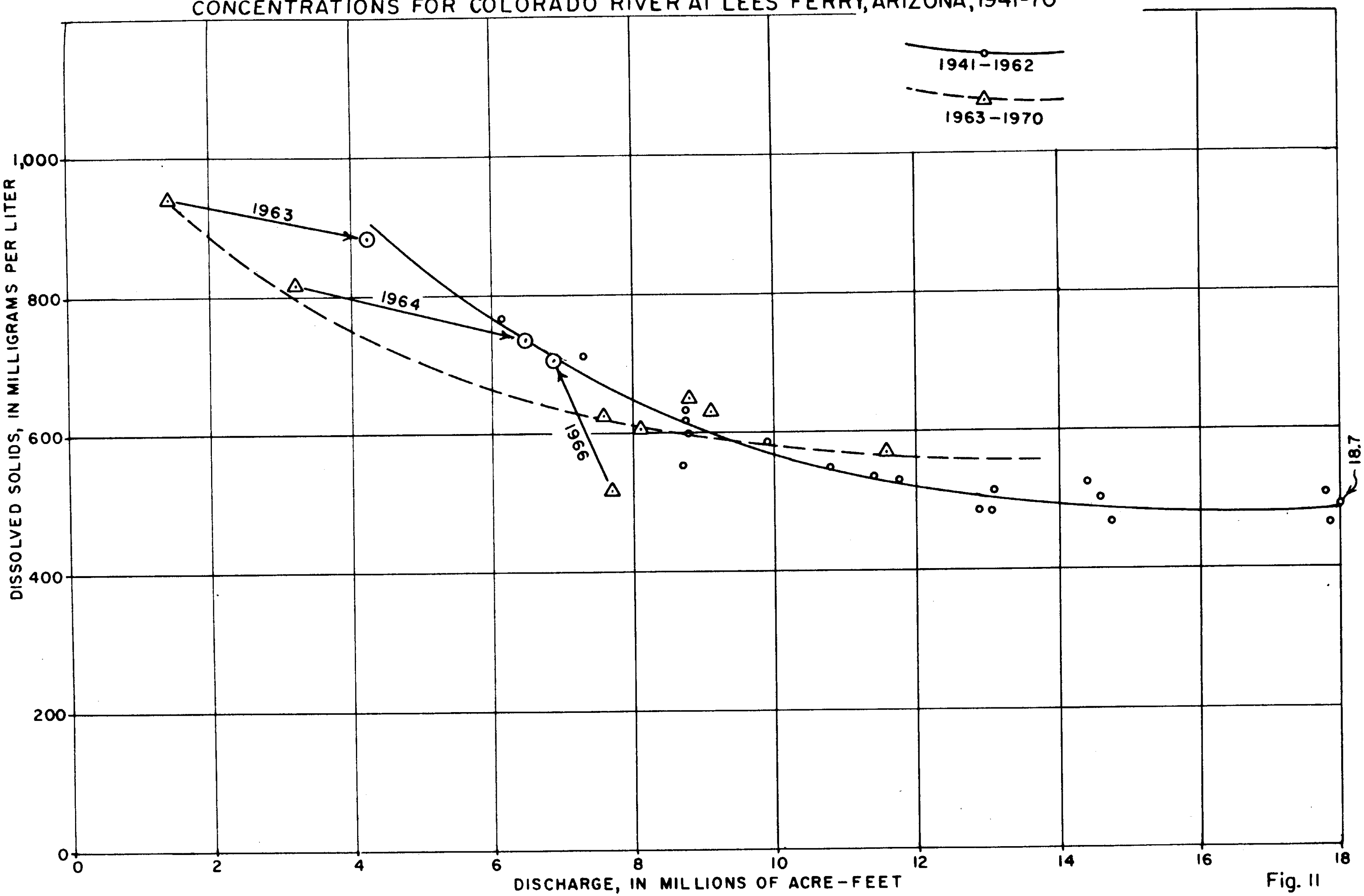


Fig. 11

EFFECT OF IMPOUNDMENTS ON COLORADO RIVER

As in the previous reporting period, the effects of evaporation and chemical precipitation in Lake Powell cannot clearly be evaluated at this time.

Colorado River below Hoover Dam.--The Colorado River below Hoover Dam is a managed river and now most all of the water reaching Imperial Dam is used for irrigation and public supply both in the United States and Mexico. According to Irelan (1971), Lakes Mohave and Havasu have only minor effects on the quality of Colorado River water because of the relatively small storage capacity. However, below Imperial Dam the chemical regimen of the river is complicated because the flow below Imperial is greatly reduced and several drains and wasteways with differing chemical characteristics empty into it.

The concentrations of dissolved solids at Imperial Dam appear to be only casually related to the total flow past the Dam. Since the closure of Glen Canyon Dam the flow past Imperial has varied only from about 5.6 to 6.5 million acre-feet, whereas the dissolved-solids concentrations have varied from about 790 to 920 mg./l. (Figure 12).

A comparison of the average yearly dissolved-solids concentrations at Lees Ferry and at Imperial Dam is shown in Figure 13. The concentrations at Imperial Dam are much greater than at Lees Ferry because of saline inflows above Hoover Dam as well as irrigation drainage returned to the river in the lower reaches, and the diversion of water at Lake Havasu through the Colorado River aqueduct. According to Irelan (1971) the latter has resulted in less water being available to dilute the saline irrigation return flows from Parker and Palo Verde Valleys and thereby has raised the salinity of water at Imperial Dam.

The variation in dissolved-solids concentrations at Lees Ferry is considerably greater than at Imperial Dam. This is to be expected inasmuch as the river passes through several reservoirs en route to Imperial. Nevertheless, changes at Lees Ferry seem to be detected at Imperial, although considerably dampened, after about 2 years. The high concentrations at Lees Ferry in 1954 and 1963 were observed at Imperial Dam in 1956 and 1965. During the 30-year period (1941-70) at both stations the salinity has increased about 90 mg./l. at Lees Ferry and about 110 mg./l. at Imperial Dam. This is 3 mg./l. and 3.6 mg./l. increase per year at each station, respectively. (Irelan's data shows an increase of 3.8 mg./l. per year at Lees Ferry and 4.1 mg./l. per year at Imperial Dam for the period of record 1941-65, based on water-year weighted averages.)

A progressive 5-year average of dissolved solids and discharge for the Colorado River at Lees Ferry and Imperial Dam is shown in Figures 14 and 15. The erratic nature of the yearly variations is lessened somewhat by the use of a multiple-year statistic. The data show that the quality of the water is responsive to changes in the amount of flow at both places. The 5-year period of increasing dissolved solids at Lees Ferry (1952-57) is reflected at Imperial Dam from 1954-59. The discharge at Lees Ferry decreased during the same 5-year period (1952-57). The decline in dissolved solids at Imperial Dam for the 5-year periods 1959-62, corresponds to an increase in discharge at Lees Ferry for the 5-year period 1956 to 1960. The 5-year period average total discharge at Imperial Dam has declined since 1952 and it appears that the salinity at Imperial Dam is more responsive to changes in discharge at Lees Ferry than at Imperial Dam. The 5-year period at Lees Ferry (1967-70), showing an increase in discharge and decrease in dissolved solids, is reflected at Imperial Dam by a decrease in the dissolved solids content from 1968 to 1970.

RELATION BETWEEN MEAN ANNUAL WATER DISCHARGE AND DISSOLVED SOLIDS CONCENTRATIONS FOR COLORADO RIVER AT IMPERIAL DAM, 1941-1970

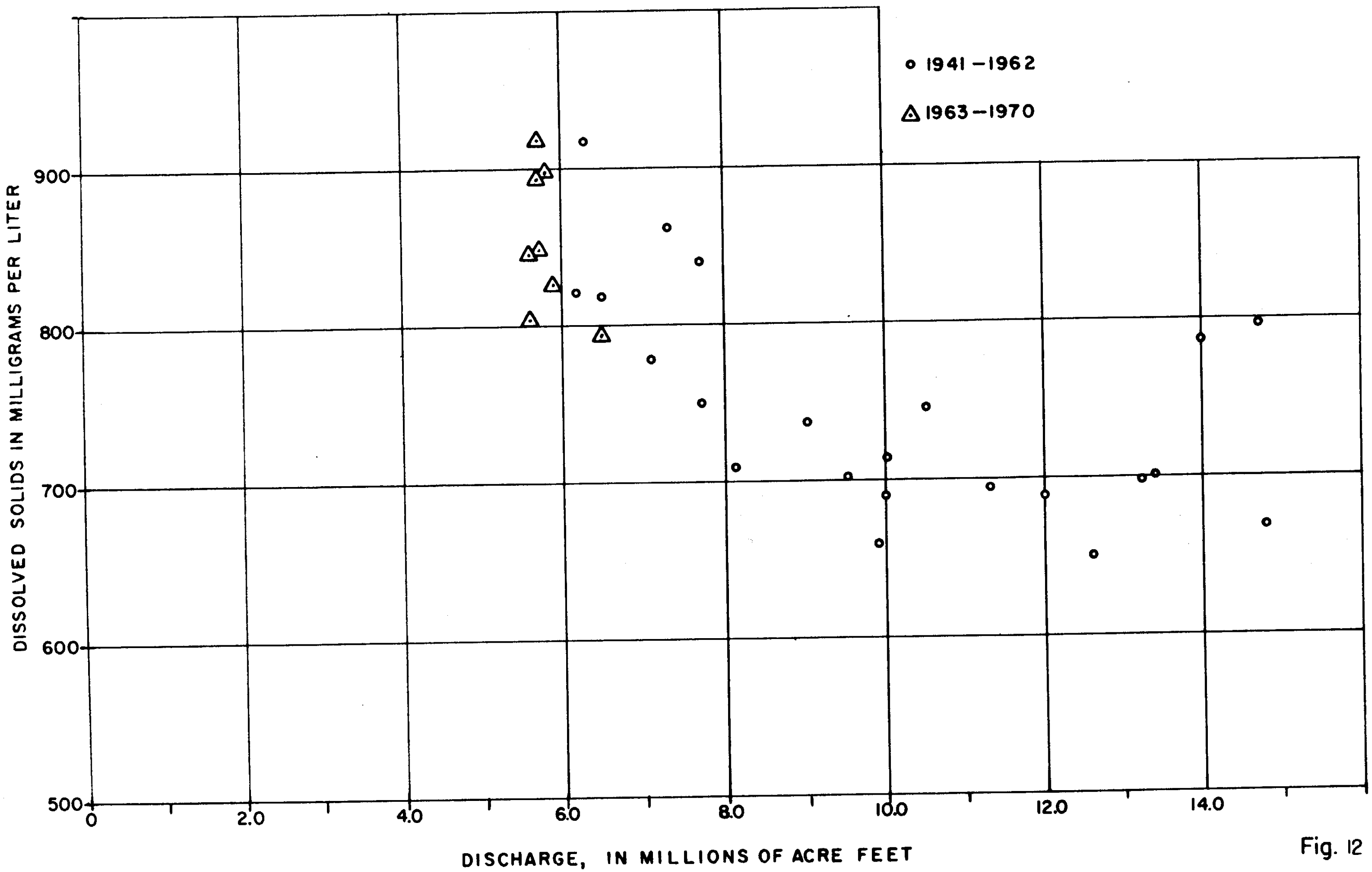


Fig. 12

MEAN ANNUAL CONCENTRATIONS OF DISSOLVED SOLIDS 1941 – 70

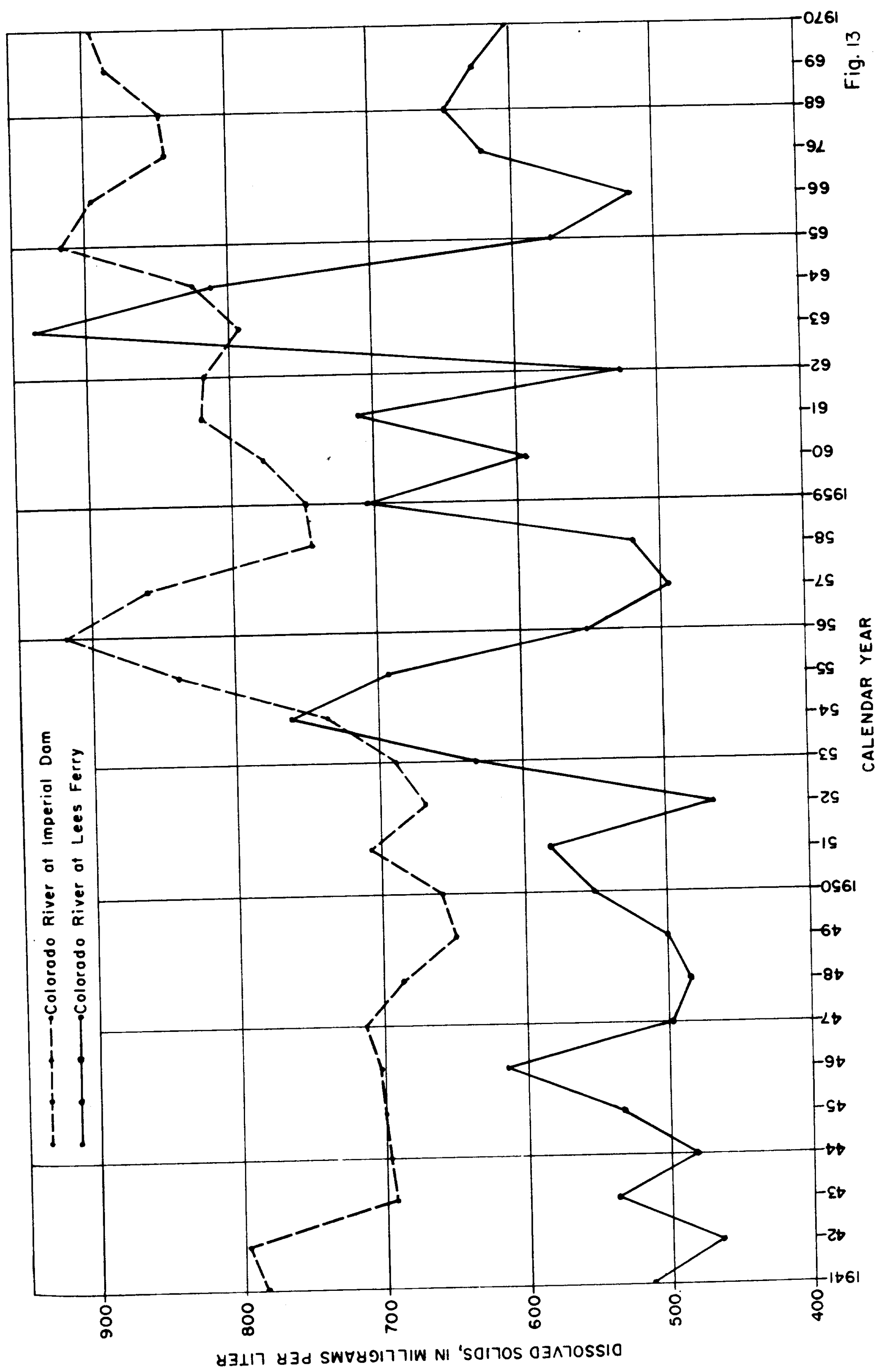


Fig. 13

PROGRESSIVE 5-YEAR AVERAGE DISSOLVED-SOLIDS CONCENTRATION, AND DISCHARGE, 1941 - 1970

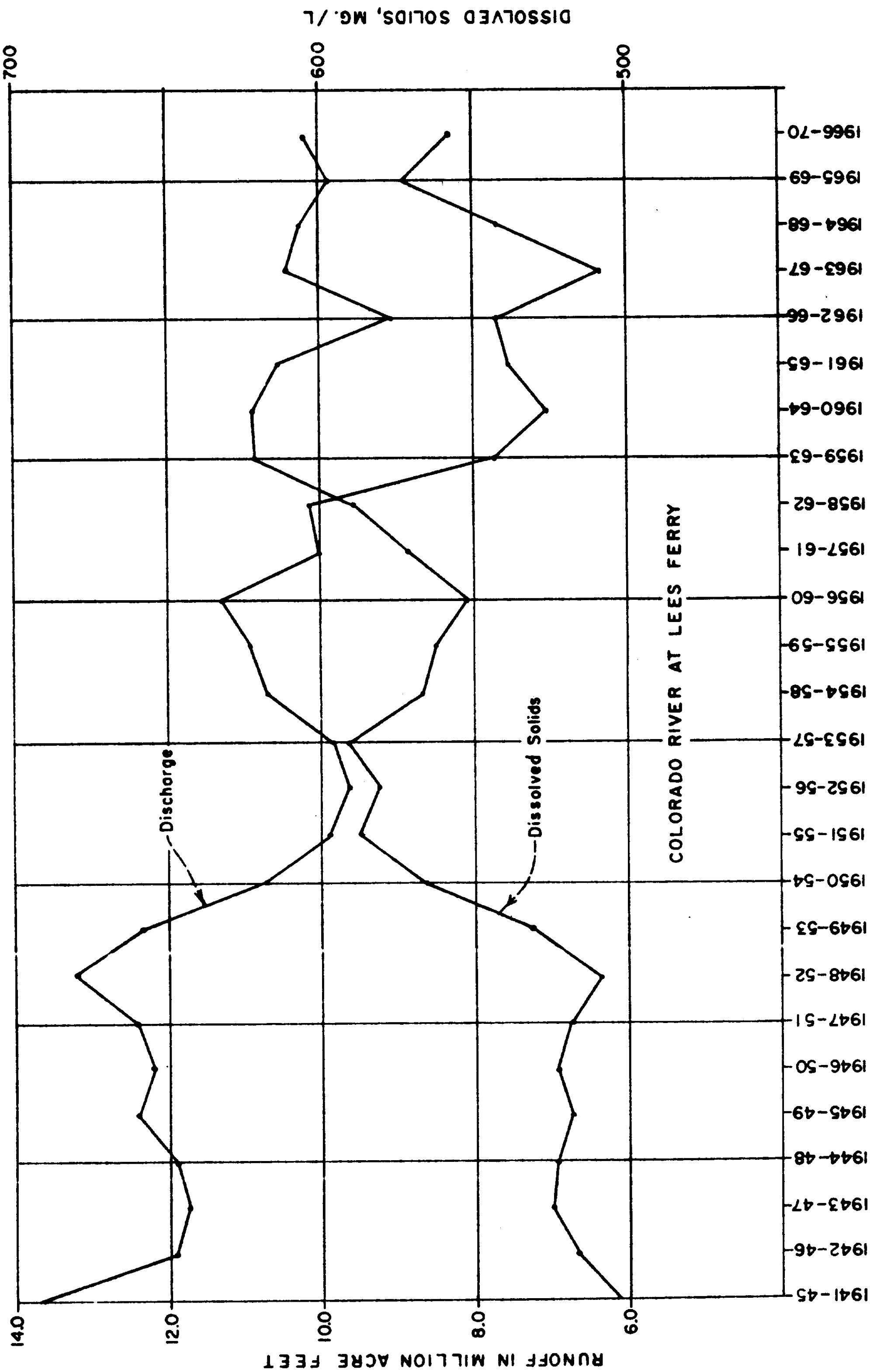
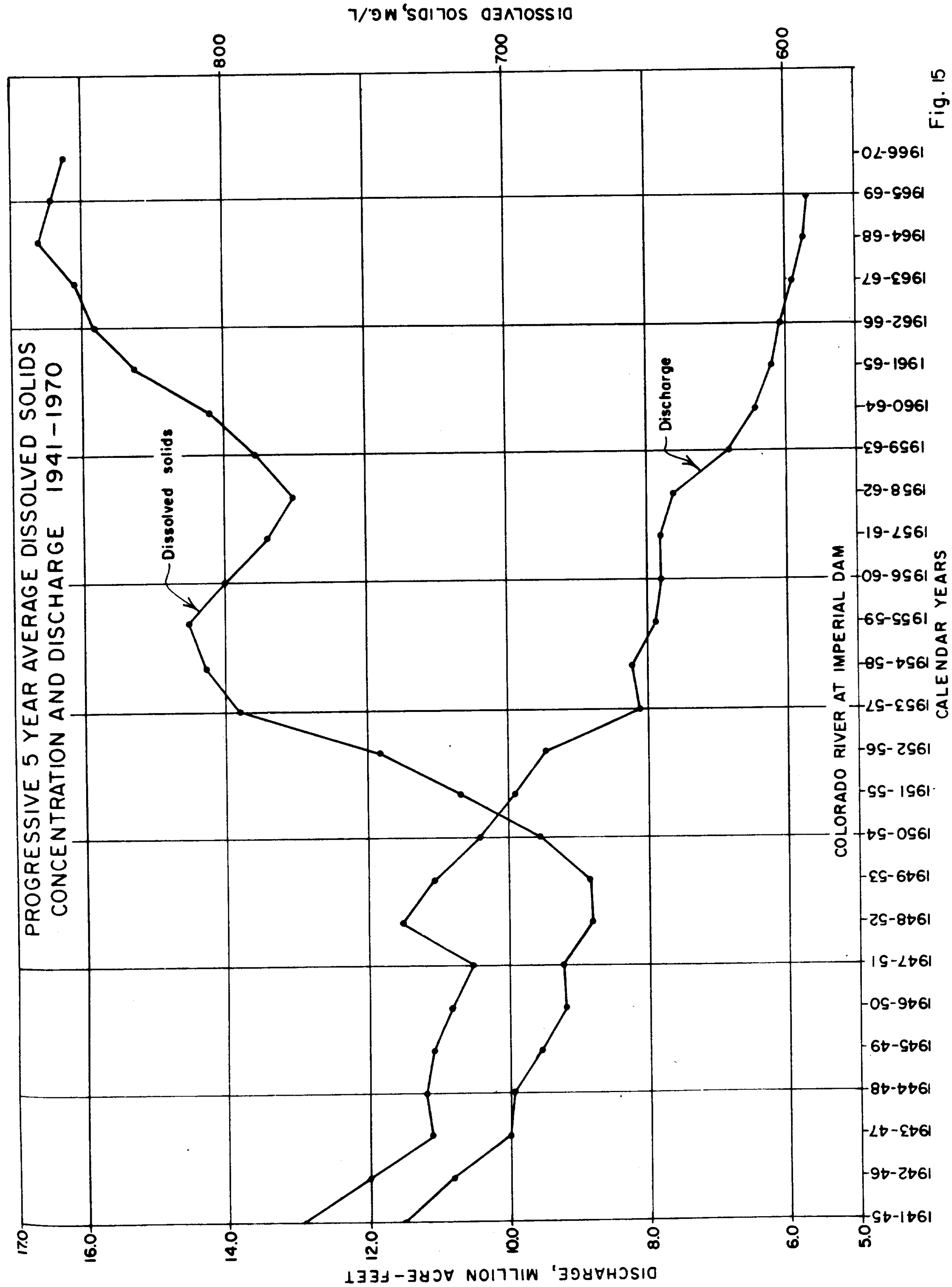


Fig. 14


PROGRESSIVE 5 YEAR AVERAGE DISSOLVED SOLIDS
CONCENTRATION AND DISCHARGE 1941-1970
COLORADO RIVER AT IMPERIAL DAM
DISSOLVED SOLIDS, MG/L
800
700
600
DISCHARGE, MILLION ACRE-FEET
17.0
16.0
14.0
12.0
10.0
8.0
6.0
5.0
Dissolved solids
Discharge
CALENDAR YEARS
1941-45
1942-46
1943-47
1944-48
1945-49
1946-50
1947-51
1948-52
1949-53
1950-54
1951-55
1952-56
1953-57
1954-58
1955-59
1956-60
1957-61
1958-62
1959-63
1960-64
1961-65
1962-66
1963-67
1964-68
1965-69
1966-70
Fig. 15

PART XII 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 conditions described. The quality of water is still acceptable for present and some projected uses although some quality control measures are necessary in order to keep the future concentrations within usable 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 will 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 primarily due 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

Future studies should consider other aspects of water quality effects, such as ion exchange, selective precipitation of salts, and changes in chemical composition (hardness, concentrations of specific constituents, etc.) on the river systems.

A basin-wide program entitled "Water Quality Improvement Program," whose purpose is to alleviate salt contributions to the river system, is now underway.

Pollution to the Colorado River Basin other than salinity has not been a major problem in the past but must receive careful surveillance and control measures in order 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 1969-70 period has decreased significantly from the 1963-68 period. This decrease has contributed to a decrease in salinity below the reservoir for the 1969-70 period. The range of average monthly temperatures of the Green River below the reservoir has been reduced considerably since closure of the reservoir.

The measured concentrations of dissolved solids at Lees Ferry after closure of Glen Canyon Dam were slightly higher than the concentrations for similar volumes of flow prior to the closure of the Dam.

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

References Cited

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. Environmental Protection Agency, 1971, Mineral Quality Problem in the Colorado River Basin.

3. Burdge Irelan, 1971, Salinity of Surface Water in the Lower Colorado River--Salton Sea Area--U.S. Geological Survey Professional Paper 486-E.

Table 1

Colorado River Basin

Historical Flow and Quality of Water Data

Green River near Green River, Wyoming

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	22	0.73	16
	Feb.	19	.74	14
	Mar.	45	.69	31
	Apr.	95	.54	51
	May	174	.52	90
	June	342	.34	116
1941	July	137	.37	51
	Aug.	81	.46	37
	Sept.	48	.54	26
	Oct.	67	.60	40
	Nov.	53	.64	34
	Dec.	26	.81	21
	Total	1,109	.48	527
	Jan.	24	.79	19
	Feb.	23	.83	19
	Mar.	43	.70	30
	Apr.	200	.41	82
	May	151	.50	75
	June	337	.34	114
1942	July	205	.32	66
	Aug.	58	.52	30
	Sept.	32	.62	20
	Oct.	29	.76	22
	Nov.	26	.81	21
	Dec.	26	.77	20
	Total	1,154	.45	518
	Jan.	28	.78	22
	Feb.	29	.76	22
	Mar.	59	.63	37
	Apr.	200	.41	82
	May	237	.39	92
	June	476	.29	138
1943	July	359	.25	90
	Aug.	121	.39	47
	Sept.	50	.54	27
	Oct.	48	.67	32
	Nov.	43	.67	29
	Dec.	30	.77	23
	Total	1,680	.38	641
	Jan.	25	.80	20
	Feb.	25	.80	20
	Mar.	31	.77	24
	Apr.	267	.37	99
	May	155	.46	71
	June	351	.33	116
1944	July	230	.30	69
	Aug.	60	.50	30
	Sept.	31	.65	20
	Oct.	38	.71	27
	Nov.	31	.74	23
	Dec.	21	.81	17
	Total	1,265	.42	536
	Jan.	24	.79	19
	Feb.	27	.74	20
	Mar.	41	.68	28
	Apr.	78	.58	45
	May	111	.52	58
	June	245	.38	93
1945	July	284	.28	80
	Aug.	125	.39	49
	Sept.	76	.45	34
	Oct.	64	.62	40
	Nov.	42	.69	29
	Dec.	33	.73	24
	Total	1,150	.45	519
	Jan.	32	.75	24
	Feb.	26	.77	20
	Mar.	65	.62	40
	Apr.	131	.48	63
	May	212	.41	87
1946	June	320	.34	109
	July	153	.35	54
	Aug.	74	.47	35
	Sept.	52	.52	27
	Oct.	58	.64	37
	Nov.	51	.67	34
	Dec.	51	.67	34
	Total	1,225	.46	564

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	26	0.81	21
	Feb.	30	.73	22
	Mar.	141	.47	66
	Apr.	75	.57	43
	May	368	.33	121
	June	501	.29	145
1947	July	327	.26	85
	Aug.	199	.32	64
	Sept.	81	.44	36
	Oct.	75	.59	44
	Nov.	59	.63	37
	Dec.	44	.68	30
	Total	1,926	.37	714
	Jan.	38	.71	27
	Feb.	33	.73	24
	Mar.	64	.62	40
	Apr.	95	.54	51
	May	187	.43	80
	June	396	.31	123
1948	July	121	.39	47
	Aug.	56	.52	29
	Sept.	32	.62	20
	Oct.	36	.72	26
	Nov.	29	.76	22
	Dec.	26	.81	21
	Total	1,113	.46	510
	Jan.	27	.78	21
	Feb.	24	.79	19
	Mar.	45	.69	31
	Apr.	104	.52	54
	May	211	.41	86
	June	372	.32	119
1949	July	179	.36	64
	Aug.	65	.48	31
	Sept.	38	.58	22
	Oct.	52	.65	34
	Nov.	54	.65	35
	Dec.	34	.74	25
	Total	1,205	.45	541
	Jan.	29	.79	23
	Feb.	33	.73	24
	Mar.	102	.53	54
	Apr.	251	.38	95
	May	270	.37	100
	June	582	.34	198
1950	July	427	.23	98
	Aug.	140	.37	52
	Sept.	76	.45	34
	Oct.	66	.61	40
	Nov.	71	.59	42
	Dec.	49	.65	32
	Total	2,096	.38	792
	Jan.	34	.74	25
	Feb.	47	.66	31
	Mar.	70	.59	41
	Apr.	154	.45	69
	May	317	.35	111
	June	528	.28	148
1951	July	349	.25	87
	Aug.	208	.28	58
	Sept.	91	.43	39
	Oct.	81	.53	43
	Nov.	50	.68	34
	Dec.	43	.70	30
	Total	1,972	.36	716
	Jan.	41	.63	26
	Feb.	42	.62	26
	Mar.	52	.63	33
	Apr.	190	.52	99
	May	348	.32	111
	June	399	.27	108
1952	July	171	.33	56
	Aug.	99	.38	38
	Sept.	57	.51	29
	Oct.	42	.64	27
	Nov.	28	.82	23
	Dec.	27	.78	21
	Total	1,496	.40	597

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	32	0.69	22
	Feb.	33	.70	23
	Mar.	44	.68	30
	Apr.	77	.58	45
	May	74	.57	42
	June	381	.28	107
1953	July	206	.29	60
	Aug.	104	.39	41
	Sept.	39	.56	22
	Oct.	34	.74	25
	Nov.	36	.75	27
	Dec.	24	.88	21
	Total	1,084	.43	465
	Jan.	26	.81	21
	Feb.	27	.74	20
	Mar.	48	.67	32
	Apr.	88	.55	48
	May	282	.28	79
	June	232	.30	70
1954	July	250	.25	62
	Aug.	86	.40	34
	Sept.	47	.55	26
	Oct.	40	.68	27
	Nov.	39	.69	27
	Dec.	18	.89	16
	Total	1,183	.39	462
	Jan.	20	.80	16
	Feb.	20	.80	16
	Mar.	33	.76	25
	Apr.	74	.59	44
	May	127	.39	50
	June	245	.27	66
1955	July	116	.36	42
	Aug.	68	.41	28
	Sept.	35	.57	20
	Oct.	33	.70	23
	Nov.	28	.79	22
	Dec.	39	.74	29
	Total	838	.45	381
	Jan.	42	.69	29
	Feb.	29	.66	19
	Mar.	91	.56	51
	Apr.	158	.45	71
	May	310	.37	115
	June	555	.25	139
1956	July	197	.31	61
	Aug.	98	.38	37
	Sept.	41	.56	23
	Oct.	39	.59	23
	Nov.	35	.69	24
	Dec.	26	.77	20
	Total	1,621	.38	612
	Jan.	22	.77	17
	Feb.	37	.70	26
	Mar.	57	.68	39
	Apr.	60	.62	37
	May	176	.46	81
	June	476	.27	129
1957	July	380	.25	95
	Aug.	117	.35	41
	Sept.	68	.47	32
	Oct.	66	.55	36
	Nov.	48	.67	32
	Dec.	41	.71	29
	Total	1,548	.38	594
	Jan.	33	.76	25
	Feb.	47	.66	31
	Mar.	51	.63	32
	Apr.	99	.56	55
	May	291	.31	90
	June	266	.31	82
1958	July	76	.45	34
	Aug.	51	.53	27
	Sept.	36	.64	23
	Oct.	33	.79	26
	Nov.	32	.78	25
	Dec.	31	.74	23
	Total	1,046	.45	473

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
Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1959	Jan.	24	0.72	17
	Feb.	25	.72	18
	Mar.	49	.65	32
	Apr.	73	.64	47
	May	79	.51	40
	June	322	.26	84
	July	140	.34	48
	Aug.	79	.40	32
	Sept.	42	.55	23
	Oct.	51	.57	29
	Nov.	42	.60	25
	Dec.	27	.74	20
	Total	953	.44	415
1960	Jan.	27	.74	20
	Feb.	23	.78	18
	Mar.	75	.53	40
	Apr.	84	.49	41
	May	66	.48	32
	June	173	.30	52
	July	68	.43	29
	Aug.	38	.45	17
	Sept.	28	.54	15
	Oct.	42	.57	24
	Nov.	47	.49	23
	Dec.	27	.69	19
	Total	698	.47	330
1961	Jan.	20	.60	12
	Feb.	19	.58	11
	Mar.	30	.57	17
	Apr.	50	.60	30
	May	60	.43	26
	June	162	.27	44
	July	47	.43	20
	Aug.	35	.43	15
	Sept.	39	.46	18
	Oct.	41	.51	21
	Nov.	29	.52	15
	Dec.	27	.52	14
	Total	559	.43	243
1962	Jan.	32	.47	15
	Feb.	48	.48	23
	Mar.	77	.51	38
	Apr.	203	.43	87
	May	256	.36	92
	June	355	.27	96
	July	250	.27	68
	Aug.	94	.37	35
	Sept.	38	.58	22
	Oct.	38	.63	24
	Nov.	35	.66	23
	Dec.	25	.88	22
	Total	1,451	.38	545
1963	Jan.	18	.72	13
	Feb.	18	.72	13
	Mar.	42	.67	28
	Apr.	51	.63	32
	May	100	.45	45
	June	337	.26	88
	July	143	.32	46
	Aug.	76	.47	36
	Sept.	77	.43	33
	Oct.	58	.50	29
	Nov.	52	.60	31
	Dec.	30	.60	18
	Total	1,002	.41	412
1964	Jan.	23	.56	13
	Feb.	22	.59	13
	Mar.	29	.59	17
	Apr.	68	.56	38
	May	138	.32	44
	June	323	.38	123
	July	335	.26	87
	Aug.	87	.39	34
	Sept.	37	.65	24
	Oct.	24	.92	22
	Nov.	25	.88	22
	Dec.	25	.84	21
	Total	1,136	.40	458
1965	Jan.	28	0.79	22
	Feb.	30	.70	21
	Mar.	38	.74	28
	Apr.	44	.86	38
	May	94	.60	56
	June	429	.38	163
	July	466	.30	140
	Aug.	184	.36	66
	Sept.	461	.41	189
	Oct.	86	.73	63
	Nov.	75	.65	49
	Dec.	29	.90	26
	Total	1,964	.44	861
1966	Jan.	37	.76	28
	Feb.	35	.77	27
	Mar.	88	.72	63
	Apr.	138	.50	69
	May	160	.39	62
	June	171	.31	53
	July	91	.43	39
	Aug.	56	.52	29
	Sept.	45	.60	27
	Oct.	35	.77	27
	Nov.	30	.83	25
	Dec.	25	.96	24
	Total	911	.52	473
1967	Jan.	19	1.01	19
	Feb.	19	1.04	20
	Mar.	33	.87	29
	Apr.	129	.54	70
	May	138	.48	66
	June	456	.28	128
	July	448	.25	112
	Aug.	88	.39	34
	Sept.	65	.50	32
	Oct.	62	.56	35
	Nov.	49	.64	31
	Dec.	17	1.07	18
	Total	1,523	.39	594
1968	Jan.	17	1.03	18
	Feb.	16	1.03	16
	Mar.	33	.86	28
	Apr.	31	.93	29
	May	56	.68	38
	June	271	.40	108
	July	88	.41	36
	Aug.	136	.40	54
	Sept.	126	.37	47
	Oct.	117	.44	51
	Nov.	54	.58	31
	Dec.	30	.85	26
	Total	975	.49	482
1969	Jan.	51	.61	31
	Feb.	89	.46	41
	Mar.	80	.56	45
	Apr.	141	.46	65
	May	207	.36	75
	June	302	.28	86
	July	154	.34	52
	Aug.	97	.47	46
	Sept.	68	.51	35
	Oct.	81	.49	40
	Nov.	50	.60	30
	Dec.	42	.69	29
	Total	1,362	.42	575
1970	Jan.	38	.74	28
	Feb.	33	.76	25
	Mar.	58	.60	35
	Apr.	75	.69	52
	May	84	.58	49
	June	204	.37	75
	July	127	.36	46
	Aug.	86	.43	37
	Sept.	75	.45	34
	Oct.	62	.55	34
	Nov.	49	.67	33
	Dec.	43	.70	30
	Total	934	.51	478

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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
Total	38,179			16,028
Average	1,273	.42	308	534

Sampled quality record May 1951 to December 1970; remainder by correlation.

Measured flow record January 1941 to September 1945; and April 1951 to December 1970; remainder by correlation.

Table 2

Colorado River Basin

Historical Flow and Quality of Water Data

Green River near Greendale, Utah

Units-1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1941	Jan.	27	0.93	25
	Feb.	25	1.16	29
	Mar.	72	.94	68
	Apr.	131	.56	74
	May	276	.58	160
	June	441	.40	175
	July	171	.55	94
	Aug.	110	.73	80
	Sept.	67	.78	52
	Oct.	94	.97	91
	Nov.	71	.93	66
	Dec.	36	1.19	43
	Total	1,521	.63	957
1942	Jan.	30	1.00	30
	Feb.	31	1.00	31
	Mar.	69	1.07	74
	Apr.	261	.65	170
	May	235	.76	180
	June	434	.44	193
	July	239	.40	97
	Aug.	73	.57	42
	Sept.	40	.72	29
	Oct.	36	1.00	36
	Nov.	35	1.17	41
	Dec.	34	1.06	36
	Total	1,517	.63	959
1943	Jan.	33	1.09	36
	Feb.	37	.97	36
	Mar.	96	.74	71
	Apr.	262	.48	125
	May	338	.38	130
	June	552	.33	182
	July	393	.29	115
	Aug.	163	.47	76
	Sept.	64	.56	36
	Oct.	60	.72	43
	Nov.	54	.83	45
	Dec.	37	.89	33
	Total	2,089	.44	928
1944	Jan.	30	.93	28
	Feb.	32	1.00	32
	Mar.	48	1.48	71
	Apr.	345	.55	190
	May	245	.58	142
	June	469	.37	174
	July	278	.39	[illegible]
	Aug.	76	.49	37
	Sept.	36	.61	22
	Oct.	47	.83	39
	Nov.	39	.92	36
	Dec.	27	.85	23
	Total	1,672	.54	903
1945	Jan.	29	.97	28
	Feb.	34	.94	32
	Mar.	65	.88	57
	Apr.	113	.70	79
	May	176	.60	105
	June	310	.46	144
	July	325	.37	120
	Aug.	174	.47	82
	Sept.	103	.43	44
	Oct.	74	.74	55
	Nov.	52	.88	46
	Dec.	42	.81	34
	Total	1,497	.55	826
1946	Jan.	39	.90	35
	Feb.	33	.85	28
	Mar.	88	.67	59
	Apr.	237	.48	115
	May	298	.44	130
	June	354	.37	133
	July	162	.40	64
	Aug.	81	.57	46
	Sept.	62	.60	37
	Oct.	68	.76	52
	Nov.	63	.82	52
	Dec.	62	.77	48
	Total	1,547	.52	799
1947	Jan.	32	0.81	26
	Feb.	37	.89	33
	Mar.	195	.62	120
	Apr.	136	.62	84
	May	521	.40	210
	June	628	.36	225
	July	372	.35	131
	Aug.	218	.45	99
	Sept.	91	.53	48
	Oct.	90	.70	63
	Nov.	71	.77	55
	Dec.	56	.87	49
	Total	2,447	.47	1,143
1948	Jan.	47	.91	43
	Feb.	40	.88	35
	Mar.	102	.79	81
	Apr.	157	.70	110
	May	336	.38	126
	June	454	.36	162
	July	126	.50	63
	Aug.	59	.56	33
	Sept.	33	.76	25
	Oct.	39	.77	30
	Nov.	34	.85	29
	Dec.	31	1.00	31
	Total	1,458	.53	768
1949	Jan.	31	.90	28
	Feb.	29	.93	27
	Mar.	73	.89	65
	Apr.	152	.69	105
	May	310	.53	165
	June	493	.47	230
	July	205	.52	106
	Aug.	72	.61	44
	Sept.	42	.74	31
	Oct.	70	.93	65
	Nov.	66	.97	64
	Dec.	40	.97	39
	Total	1,583	.61	969
1950	Jan.	36	1.19	43
	Feb.	45	.95	43
	Mar.	150	.61	92
	Apr.	323	.46	150
	May	416	.46	190
	June	741	.37	275
	July	458	.34	154
	Aug.	153	.51	78
	Sept.	86	.62	53
	Oct.	76	.72	55
	Nov.	80	.75	60
	Dec.	61	.84	51
	Total	2,625	.47	1,244
1951	Jan.	45	.80	36
	Feb.	61	.82	50
	Mar.	93	.78	73
	Apr.	212	.47	100
	May	395	.45	177
	June	626	.36	225
	July	366	.36	132
	Aug.	228	.44	101
	Sept.	98	.56	55
	Oct.	99	.71	70
	Nov.	57	.91	52
	Dec.	54	.87	47
	Total	2,334	.48	1,118
1952	Jan.	49	.82	40
	Feb.	52	.81	42
	Mar.	63	.75	47
	Apr.	318	.62	198
	May	600	.39	235
	June	554	.36	201
	July	205	.56	114
	Aug.	121	.60	72
	Sept.	67	.67	45
	Oct.	49	.86	42
	Nov.	37	1.11	41
	Dec.	34	1.18	40
	Total	2,149	.52	1,117
1953	Jan.	48	0.81	39
	Feb.	48	.85	41
	Mar.	73	.86	63
	Apr.	96	.76	73
	May	110	.64	70
	June	452	.39	175
	July	198	.39	77
	Aug.	105	.54	57
	Sept.	43	.63	27
	Oct.	35	.89	31
	Nov.	42	.98	41
	Dec.	32	.97	31
	Total	1,282	.57	725
1954	Jan.	28	1.11	31
	Feb.	39	.87	34
	Mar.	62	.81	50
	Apr.	101	.65	66
	May	302	.31	94
	June	223	.36	81
	July	265	.28	73
	Aug.	81	.43	35
	Sept.	45	.69	31
	Oct.	42	.95	40
	Nov.	41	.85	35
	Dec.	20	1.05	21
	Total	1,249	.47	591
1955	Jan.	24	.75	18
	Feb.	24	.71	17
	Mar.	44	1.11	49
	Apr.	106	.64	68
	May	168	.52	88
	June	288	.33	95
	July	130	.38	49
	Aug.	80	.52	42
	Sept.	38	.58	22
	Oct.	38	.68	26
	Nov.	36	.75	27
	Dec.	45	.82	37
	Total	1,021	.53	538
1956	Jan.	50	.86	43
	Feb.	38	.76	29
	Mar.	150	.47	70
	Apr.	203	.43	87
	May	368	.39	144
	June	615	.29	178
	July	207	.33	69
	Aug.	104	.42	44
	Sept.	48	.44	21
	Oct.	46	.74	34
	Nov.	39	.82	32
	Dec.	26	.88	23
	Total	1,894	.41	774
1957	Jan.	28	.86	24
	Feb.	43	.79	34
	Mar.	66	.91	60
	Apr.	86	.67	58
	May	275	.54	148
	June	685	.37	251
	July	433	.36	155
	Aug.	142	.57	81
	Sept.	82	.58	48
	Oct.	77	.69	53
	Nov.	57	1.00	57
	Dec.	46	.91	42
	Total	2,020	.50	1,011
1958	Jan.	43	.77	33
	Feb.	55	.80	44
	Mar.	66	.71	47
	Apr.	134	.67	90
	May	386	.39	151
	June	335	.38	127
	July	87	.50	44
	Aug.	57	.56	32
	Sept.	39	.69	27
	Oct.	36	.72	26
	Nov.	34	.70	24
	Dec.	38	.84	32
	Total	1,310	.52	677

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

Table 2

Colorado River Basin

Historical Flow and Quality of Water Data

Green River near Greendale, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	29	0.86	25
	Feb.	32	.91	29
	Mar.	65	.92	60
	Apr.	98	.71	70
	May	115	.57	66
	June	368	.36	132
-1959	July	176	.51	90
	Aug.	93	.47	44
	Sept.	58	.79	46
	Oct.	68	.72	49
	Nov.	51	.76	39
	Dec.	37	.99	37
	Total	1,190	.58	687
	Jan.	26	.81	21
	Feb.	29	.86	25
	Mar.	149	.70	104
	Apr.	140	.55	77
	May	127	.58	74
	June	216	.43	93
-1960	July	78	.49	38
	Aug.	43	.47	20
	Sept.	35	.56	20
	Oct.	49	.65	32
	Nov.	54	.67	36
	Dec.	27	.84	23
	Total	973	.58	563
	Jan.	27	.73	20
	Feb.	27	.77	21
	Mar.	64	.86	55
	Apr.	76	.69	52
	May	79	.59	47
	June	192	.32	61
-1961	July	56	.44	25
	Aug.	43	.58	25
	Sept.	55	.68	37
	Oct.	64	.70	45
	Nov.	54	.70	38
	Dec.	44	.78	34
	Total	781	.59	460
	Jan.	43	.65	28
	Feb.	83	.81	67
	Mar.	150	.84	126
	Apr.	374	.55	206
	May	394	.41	162
	June	456	.40	182
-1962	July	297	.39	116
	Aug.	109	.48	52
	Sept.	44	.64	28
	Oct.	48	.79	38
	Nov.	5	.80	4
	Dec.	16	.94	15
	Total	2,019	.51	1,024
	Jan.	23	.91	21
	Feb.	26	.92	24
	Mar.	6	.83	5
	Apr.	8	.87	7
	May	8	.87	7
	June	7	.86	6
-1963	July	6	.83	5
	Aug.	6	.83	5
	Sept.	7	.86	6
	Oct.	8	.87	7
	Nov.	19	.58	11
	Dec.	46	.63	29
	Total	170	.78	133
	Jan.	58	.57	33
	Feb.	56	.57	32
	Mar.	37	.59	22
	Apr.	35	.63	22
	May	91	.64	58
	June	86	.60	52
	July	150	.61	92
-1964	Aug.	122	.61	74
	Sept.	131	.61	80
	Oct.	159	.64	102
	Nov.	139	.60	83
	Dec.	194	.62	120
	Total	1,258	.61	770
	Jan.	216	0.63	136
	Feb.	213	.70	149
	Mar.	233	1.05	245
	Apr.	204	.83	169
	May	66	.80	53
	June	86	.86	74
-1965	July	29	.86	25
	Aug.	31	.87	27
	Sept.	44	.89	39
	Oct.	79	.79	62
	Nov.	120	.73	88
	Dec.	116	.65	75
	Total	1,437	.79	1,142
	Jan.	72	.64	46
	Feb.	72	.65	47
	Mar.	71	.76	54
	Apr.	130	.79	103
	May	83	.78	65
	June	95	.76	72
-1966	July	104	.75	78
	Aug.	118	.72	85
	Sept.	124	.73	91
	Oct.	124	.77	95
	Nov.	85	.81	69
	Dec.	111	.76	84
	Total	1,189	.75	889
	Jan.	142	.74	105
	Feb.	96	.75	72
	Mar.	67	.77	52
	Apr.	85	.81	69
	May	122	.83	101
	June	195	.83	162
-1967	July	171	.85	145
	Aug.	188	.86	162
	Sept.	180	.82	148
	Oct.	188	.87	164
	Nov.	173	.85	147
	Dec.	197	.72	142
	Total	1804	.81	1469
	Jan.	187	.70	131
	Feb.	123	.72	89
	Mar.	76	.83	63
	Apr.	96	.88	84
	May	119	.81	96
	June	97	.77	75
-1968	July	198	.75	148
	Aug.	200	.75	150
	Sept.	181	.75	136
	Oct.	140	.73	102
	Nov.	137	.68	93
	Dec.	137	.68	93
	Total	1691	.75	1260
	Jan.	183	.70	128
	Feb.	219	.73	160
	Mar.	166	.74	123
	Apr.	150	.78	117
	May	191	.78	149
	June	108	.74	80
	July	158	.74	117
-1969	Aug.	194	.72	140
	Sept.	165	.72	119
	Oct.	129	.69	89
	Nov.	129	.63	81
	Dec.	196	.62	122
	Total	1,988	.72	1,425
	Jan.	101	.62	63
	Feb.	78	.62	48
	Mar.	81	.64	52
	Apr.	109	.66	72
	May	64	.67	43
	June	87	.67	58
-1970	July	119	.65	77
	Aug.	127	.68	86
	Sept.	117	.70	82
	Oct.	59	.71	42
	Nov.	66	.68	45
	Dec.	80	.63	50
	Total	1,088	.66	718

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			

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

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

(Annual Summary)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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
Total	46,803			26,587
Average	1,560	.56	417	886

Sampled quality record October 1956 to December 1970 (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

Units – 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1941	Jan.	25	1.12	28
	Feb.	24	1.29	31
	Mar.	21	1.71	36
	Apr.	20	1.50	30
	May	155	.50	78
	June	232	.38	88
	July	35	1.11	39
	Aug.	18	1.50	27
	Sept.	15	1.60	24
	Oct.	54	.93	50
	Nov.	51	.90	46
	Dec.	44	1.04	46
	Total	694	.75	523
1942	Jan.	40	.90	36
	Feb.	39	1.00	39
	Mar.	39	1.23	48
	Apr.	50	.90	45
	May	83	.72	60
	June	171	.46	79
	July	23	1.43	33
	Aug.	8	2.12	17
	Sept.	5	2.40	12
	Oct.	18	1.50	27
	Nov.	22	1.41	31
	Dec.	28	1.28	36
	Total	526	.88	463
1943	Jan.	26	1.12	29
	Feb.	29	1.17	34
	Mar.	29	1.51	44
	Apr.	43	1.00	43
	May	100	.64	64
	June	103	.62	64
	July	28	1.21	34
	Aug.	23	1.39	32
	Sept.	8	2.00	16
	Oct.	22	1.40	31
	Nov.	24	1.29	31
	Dec.	25	1.28	32
	Total	460	.99	454
1944	Jan.	23	1.08	25
	Feb.	26	1.31	34
	Mar.	43	1.20	52
	Apr.	48	.94	45
	May	128	.57	73
	June	255	.37	94
	July	82	.72	59
	Aug.	8	2.00	16
	Sept.	7	2.14	15
	Oct.	24	1.37	33
	Nov.	26	1.30	34
	Dec.	28	1.32	37
	Total	698	.74	517
1945	Jan.	30	1.00	30
	Feb.	27	1.18	32
	Mar.	32	1.40	45
	Apr.	24	1.29	31
	May	59	.86	51
	June	91	.67	61
	July	30	1.23	37
	Aug.	31	1.19	37
	Sept.	12	1.75	21
	Oct.	21	1.38	29
	Nov.	26	1.27	33
	Dec.	24	1.37	33
	Total	407	1.08	440
1946	Jan.	23	1.13	26
	Feb.	21	1.38	29
	Mar.	29	1.41	41
	Apr.	40	1.00	40
	May	70	.78	55
	June	47	.95	45
	July	5	2.60	13
	Aug.	6	2.33	14
	Sept.	4	2.75	11
	Oct.	17	1.53	26
	Nov.	32	1.22	39
	Dec.	30	1.20	36
	Total	324	1.16	375
1947	Jan.	26	1.07	28
	Feb.	36	1.08	39
	Mar.	36	1.27	46
	Apr.	23	1.30	30
	May	143	.53	76
	June	158	.49	78
	July	33	1.18	39
	Aug.	25	1.28	32
	Sept.	12	1.75	21
	Oct.	17	1.65	28
	Nov.	29	1.21	35
	Dec.	31	1.19	37
	Total	569	.86	489
1948	Jan.	29	1.00	29
	Feb.	26	1.31	34
	Mar.	40	1.20	48
	Apr.	31	1.23	38
	May	70	.79	55
	June	51	.92	47
	July	3	3.00	9
	Aug.	2	3.50	7
	Sept.	1	3.00	3
	Oct.	5	2.40	12
	Nov.	14	1.71	24
	Dec.	26	1.27	33
	Total	298	1.14	339
1949	Jan.	24	1.08	26
	Feb.	23	1.30	30
	Mar.	44	1.20	53
	Apr.	46	.98	45
	May	127	.56	71
	June	230	.39	90
	July	50	.94	47
	Aug.	7	2.14	15
	Sept.	8	2.13	17
	Oct.	25	1.28	32
	Nov.	29	1.21	35
	Dec.	28	1.29	36
	Total	641	.78	497
1950	Jan.	31	1.00	31
	Feb.	26	1.23	32
	Mar.	40	1.30	52
	Apr.	44	1.00	44
	May	97	.67	65
	June	193	.43	83
	July	45	1.00	45
	Aug.	9	2.00	18
	Sept.	13	1.77	23
	Oct.	16	1.56	25
	Nov.	27	1.26	34
	Dec.	33	1.36	45
	Total	574	.87	497
1951	Jan.	26	1.00	26
	Feb.	26	1.31	34
	Mar.	23	1.56	36
	Apr.	14	1.71	24
	May	79	.75	59
	June	124	.73	91
	July	31	1.29	40
	Aug.	26	1.46	38
	Sept.	10	1.90	19
	Oct.	25	1.28	32
	Nov.	32	1.22	39
	Dec.	32	1.22	39
	Total	448	1.06	477
1952	Jan.	28	1.07	30
	Feb.	26	1.31	34
	Mar.	31	1.42	44
	Apr.	111	.60	67
	May	304	.34	103
	June	302	.33	100
	July	70	.79	55
	Aug.	49	.94	46
	Sept.	30	1.20	36
	Oct.	21	1.38	29
	Nov.	26	1.31	34
	Dec.	37	1.11	41
	Total	1,035	.60	619
1953	Jan.	39	0.90	35
	Feb.	33	1.12	37
	Mar.	34	1.41	48
	Apr.	13	1.77	23
	May	15	1.60	24
	June	107	.60	64
	July	13	1.77	23
	Aug.	12	1.75	21
	Sept.	5	2.20	11
	Oct.	9	2.00	18
	Nov.	20	1.40	28
	Dec.	26	1.31	34
	Total	326	1.12	366
1954	Jan.	27	1.11	30
	Feb.	25	1.28	32
	Mar.	20	1.80	36
	Apr.	13	1.77	23
	May	36	1.11	40
	June	5	2.40	12
	July	2	3.00	6
	Aug.	1	4.00	4
	Sept.	6	2.33	14
	Oct.	17	1.59	27
	Nov.	18	1.50	27
	Dec.	18	1.50	27
	Total	188	1.48	278
1955	Jan.	25	1.08	27
	Feb.	21	1.43	30
	Mar.	34	1.38	47
	Apr.	22	1.41	31
	May	45	1.00	45
	June	34	1.09	37
	July	2	3.00	6
	Aug.	8	2.25	17
	Sept.	4	2.50	10
	Oct.	6	2.33	14
	Nov.	15	1.60	24
	Dec.	29	1.21	35
	Total	245	1.32	323
1956	Jan.	27	1.00	27
	Feb.	23	1.35	31
	Mar.	25	1.60	40
	Apr.	17	1.59	27
	May	74	.76	56
	June	90	.68	61
	July	4	2.75	11
	Aug.	2	4.00	8
	Sept.	1	5.00	5
	Oct.	4	2.25	9
	Nov.	17	1.59	27
	Dec.	19	1.21	23
	Total	303	1.07	325
1957	Jan.	21	1.05	22
	Feb.	20	1.05	21
	Mar.	22	1.54	34
	Apr.	12	1.83	22
	May	39	1.23	48
	June	184	.41	75
	July	35	.91	32
	Aug.	18	1.61	29
	Sept.	15	1.47	22
	Oct.	19	1.74	33
	Nov.	41	1.41	58
	Dec.	30	1.07	32
	Total	456	.94	428
1958	Jan.	29	.83	24
	Feb.	31	1.00	31
	Mar.	35	1.37	48
	Apr.	29	1.07	31
	May	141	.46	65
	June	103	.42	43
	July	4	2.50	10
	Aug.	1	4.00	4
	Sept.	3	2.33	7
	Oct.	5	2.60	13
	Nov.	14	1.93	27
	Dec.	21	1.24	26
	Total	416	.79	329

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

Units-1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1959	Jan.	22	1.14	25
	Feb.	24	1.04	25
	Mar.	17	1.29	22
	Apr.	5	2.00	10
	May	4	2.75	11
	June	34	.85	29
	July	6	2.00	12
	Aug.	4	2.75	11
	Sept.	4	2.50	10
	Oct.	11	1.54	17
	Nov.	13	1.54	20
	Dec.	22	1.32	29
	Total	166	1.33	221
1960	Jan.	23	.87	20
	Feb.	23	.83	19
	Mar.	27	1.15	31
	Apr.	8	1.62	13
	May	18	1.17	21
	June	23	.91	21
	July	1	4.00	4
	Aug.	1	4.00	4
	Sept.	1	4.00	4
	Oct.	5	2.40	12
	Nov.	12	1.58	19
	Dec.	18	1.33	24
	Total	160	1.20	192
1961	Jan.	21	1.19	25
	Feb.	19	1.47	28
	Mar.	10	1.50	15
	Apr.	2	3.50	7
	May	3	2.33	7
	June	3	2.67	8
	July	1	4.00	4
	Aug.	1	3.00	3
	Sept.	13	1.15	15
	Oct.	19	1.47	28
	Nov.	27	1.11	30
	Dec.	26	1.00	26
	Total	145	1.35	196
1962	Jan.	21	.81	17
	Feb.	43	.93	40
	Mar.	49	1.04	51
	Apr.	70	.69	48
	May	88	.64	56
	June	146	.47	69
	July	27	1.04	28
	Aug.	4	2.75	11
	Sept.	4	2.50	10
	Oct.	15	1.73	26
	Nov.	15	1.60	24
	Dec.	23	1.26	29
	Total	505	.81	409
1963	Jan.	18	1.17	21
	Feb.	29	1.14	33
	Mar.	10	1.90	19
	Apr.	5	3.20	16
	May	31	.97	30
	June	50	.76	38
	July	3	2.67	8
	Aug.	5	2.40	12
	Sept.	14	1.64	23
	Oct.	7	2.43	17
	Nov.	16	1.62	26
	Dec.	22	1.14	25
	Total	210	1.28	268
1964	Jan.	18	1.00	18
	Feb.	18	.94	17
	Mar.	23	1.04	24
	Apr.	14	1.57	22
	May	72	.68	49
	June	122	.66	81
	July	29	.97	28
	Aug.	6	2.17	13
	Sept.	4	2.75	11
	Oct.	5	2.80	14
	Nov.	18	1.67	30
	Dec.	27	1.26	34
	Total	356	.96	341
1965	Jan.	27	1.00	27
	Feb.	21	1.38	29
	Mar.	26	1.54	40
	Apr.	32	1.16	37
	May	71	1.11	79
	June	302	.49	148
	July	175	.51	89
	Aug.	57	.96	55
	Sept.	58	1.09	63
	Oct.	47	1.15	54
	Nov.	47	1.13	53
	Dec.	42	1.12	47
	Total	905	.80	721
1966	Jan.	39	.90	35
	Feb.	38	.74	28
	Mar.	47	1.02	48
	Apr.	35	1.20	42
	May	58	1.07	62
	June	16	1.81	29
	July	3	3.00	9
	Aug.	3	3.00	9
	Sept.	6	2.50	15
	Oct.	11	2.36	26
	Nov.	19	1.79	34
	Dec.	31	1.35	42
	Total	306	1.24	379
1967	Jan.	33	1.01	33
	Feb.	30	.98	29
	Mar.	41	1.44	59
	Apr.	19	1.71	32
	May	56	.82	46
	June	253	.45	114
	July	76	.70	53
	Aug.	11	1.89	21
	Sept.	10	2.05	20
	Oct.	12	2.17	26
	Nov.	18	1.74	31
	Dec.	32	1.02	33
	Total	591	.84	497
1968	Jan.	34	.85	29
	Feb.	34	1.12	38
	Mar.	40	1.49	60
	Apr.	31	1.61	50
	May	45	1.14	51
	June	250	.40	100
	July	24	1.23	30
	Aug.	26	1.40	36
	Sept.	13	1.91	25
	Oct.	20	1.77	35
	Nov.	27	1.45	39
	Dec.	38	1.03	39
	Total	582	.91	532
1969	Jan.	42	.88	37
	Feb.	37	.93	34
	Mar.	52	1.16	60
	Apr.	69	.89	61
	May	183	.43	79
	June	139	.75	104
	July	17	1.60	27
	Aug.	9	2.26	20
	Sept.	10	2.27	23
	Oct.	20	1.65	33
	Nov.	22	1.45	32
	Dec.	20	1.05	21
	Total	620	.86	531
1970	Jan.	14	1.07	15
	Feb.	17	1.12	19
	Mar.	10	1.60	16
	Apr.	3	2.67	8
	May	17	1.24	21
	June	58	1.29	75
	July	9	1.67	15
	Aug.	3	2.33	7
	Sept.	5	2.20	11
	Oct.	9	2.22	20
	Nov.	11	1.82	20
	Dec.	7	2.14	15
	Total	163	1.48	242

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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
Total	13,317			12,268
Average	444	.92	677	409

Sampled quality record December 1950 to September 1951; November 1956 to December 1970; remainder by correlation.

Measured flow record October 1942 to December 1970; remainder by correlation.

Table 4

Colorado River Basin

Historical Flow and Quality of Water Data

Green River at Green River, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	100	1.01	101
	Feb.	126	1.06	134
	Mar.	216	1.01	218
	Apr.	314	.75	235
	May	1,172	.53	621
	June	1,146	.49	562
-1941	July	359	.63	226
	Aug.	267	1.09	291
	Sept.	182	1.01	184
	Oct.	318	1.00	318
	Nov.	240	.90	216
	Dec.	168	.98	165
Total		4,608	.71	3,271
	Jan.	112	1.04	117
	Feb.	122	.98	120
	Mar.	264	.94	248
	Apr.	858	.65	557
	May	980	.57	558
	June	1,271	.39	495
-1942	July	414	.57	236
	Aug.	152	.85	129
	Sept.	91	1.10	100
	Oct.	118	1.20	142
	Nov.	124	1.18	146
	Dec.	116	1.22	141
Total		4,622	.65	2,989
	Jan.	112	1.13	127
	Feb.	130	1.02	132
	Mar.	236	.91	215
	Apr.	569	.57	325
	May	763	.39	298
	June	1,074	.40	430
-1943	July	612	.43	263
	Aug.	300	.83	249
	Sept.	116	.98	114
	Oct.	124	1.10	136
	Nov.	146	1.04	152
	Dec.	112	1.11	124
Total		4,294	.60	2,565
	Jan.	80	1.20	96
	Feb.	111	1.06	118
	Mar.	253	1.07	271
	Apr.	529	.81	428
	May	924	.48	444
	June	1,391	.30	417
-1944	July	591	.44	260
	Aug.	143	.73	104
	Sept.	73	.96	70
	Oct.	115	1.13	130
	Nov.	119	1.14	136
	Dec.	88	1.23	108
Total		4,417	.58	2,582
	Jan.	109	1.04	113
	Feb.	128	.99	127
	Mar.	185	1.03	191
	Apr.	291	.84	244
	May	909	.44	400
	June	1,016	.39	396
-1945	July	701	.41	287
	Aug.	335	.74	248
	Sept.	163	.77	125
	Oct.	161	.99	159
	Nov.	149	.99	148
	Dec.	113	1.06	120
Total		4,260	.60	2,558
	Jan.	123	.95	117
	Feb.	117	.91	106
	Mar.	236	.90	212
	Apr.	528	.60	317
	May	775	.41	318
	June	746	.36	269
-1946	July	264	.47	124
	Aug.	152	.84	128
	Sept.	105	.91	96
	Oct.	149	1.00	149
	Nov.	170	.98	167
	Dec.	154	.94	145
Total		3,519	.61	2,148
	Jan.	92	1.07	98
	Feb.	151	.86	130
	Mar.	411	.79	325
	Apr.	422	.59	249
	May	1,400	.38	532
	June	1,348	.39	526
-1947	July	656	.40	262
	Aug.	365	.71	259
	Sept.	166	.77	128
	Oct.	181	.91	165
	Nov.	179	.91	163
	Dec.	152	1.01	154
Total		5,523	.54	2,991
	Jan.	141	.94	132
	Feb.	136	.91	124
	Mar.	313	.86	269
	Apr.	558	.69	385
	May	1,061	.39	414
	June	952	.34	324
-1948	July	268	.54	145
	Aug.	137	.81	111
	Sept.	69	.81	56
	Oct.	92	1.02	94
	Nov.	104	1.05	109
	Dec.	97	1.10	107
Total		3,928	.58	2,270
	Jan.	100	1.01	101
	Feb.	110	.92	101
	Mar.	276	.92	254
	Apr.	474	.69	327
	May	1,221	.43	525
	June	1,547	.42	650
-1949	July	592	.57	338
	Aug.	172	.77	132
	Sept.	112	.89	100
	Oct.	207	.98	203
	Nov.	190	.90	171
	Dec.	128	1.07	137
Total		5,129	.59	3,039
	Jan.	141	1.01	142
	Feb.	147	1.01	148
	Mar.	356	.90	321
	Apr.	620	.64	397
	May	1,026	.53	544
	June	1,567	.35	548
-1950	July	734	.49	360
	Aug.	246	.63	155
	Sept.	149	.89	133
	Oct.	153	.96	147
	Nov.	166	.99	164
	Dec.	171	.96	164
Total		5,476	.59	3,223
	Jan.	113	1.13	128
	Feb.	167	.92	154
	Mar.	204	.93	190
	Apr.	372	.70	260
	May	882	.45	397
	June	1,309	.40	524
-1951	July	627	.43	270
	Aug.	379	.69	261
	Sept.	178	.79	140
	Oct.	211	.99	209
	Nov.	164	1.05	172
	Dec.	132	1.07	142
Total		4,738	.60	2,847
	Jan.	135	1.01	136
	Feb.	140	.96	134
	Mar.	160	1.05	168
	Apr.	988	.88	869
	May	2,087	.48	1,002
	June	1,809	.36	651
-1952	July	514	.60	309
	Aug.	315	.89	280
	Sept.	184	.96	177
	Oct.	129	1.09	140
	Nov.	122	1.24	151
	Dec.	129	1.20	155
Total		6,712	.62	4,172
	Jan.	140	1.05	147
	Feb.	141	1.04	147
	Mar.	217	1.00	217
	Apr.	221	.96	212
	May	454	.55	250
	June	1,167	.37	432
-1953	July	376	.48	181
	Aug.	212	.84	178
	Sept.	87	.99	86
	Oct.	86	1.20	104
	Nov.	126	1.15	145
	Dec.	107	1.18	126
Total		3,334	.67	2,225
	Jan.	107	1.09	117
	Feb.	138	1.03	142
	Mar.	169	1.03	174
	Apr.	270	.75	202
	May	639	.38	243
	June	376	.45	169
-1954	July	346	.46	159
	Aug.	120	.65	78
	Sept.	134	1.02	137
	Oct.	139	1.14	159
	Nov.	120	1.06	127
	Dec.	80	1.25	100
Total		2,638	.68	1,807
	Jan.	80	1.06	85
	Feb.	86	.92	79
	Mar.	237	.92	218
	Apr.	311	.77	239
	May	678	.39	264
	June	654	.36	236
-1955	July	223	.46	102
	Aug.	161	.83	134
	Sept.	71	.93	66
	Oct.	77	1.08	83
	Nov.	86	1.13	97
	Dec.	127	1.02	130
Total		2,791	.62	1,733
	Jan.	155	.91	141
	Feb.	100	1.05	105
	Mar.	314	.81	255
	Apr.	460	.53	244
	May	995	.35	348
	June	1,207	.32	386
-1956	July	294	.49	144
	Aug.	169	.67	113
	Sept.	72	.72	52
	Oct.	77	.94	73
	Nov.	99	1.02	101
	Dec.	79	1.05	83
Total		4,021	.51	2,045
	Jan.	83	.95	79
	Feb.	100	.94	94
	Mar.	237	.89	210
	Apr.	290	.73	212
	May	913	.48	438
	June	1,871	.34	636
-1957	July	1,164	.34	396
	Aug.	386	.79	305
	Sept.	202	.76	153
	Oct.	185	.94	174
	Nov.	228	.96	219
	Dec.	149	.97	144
Total		5,808	.53	3,060
	Jan.	128	.93	119
	Feb.	184	.86	158
	Mar.	246	.92	227
	Apr.	432	.71	307
	May	1,311	.41	537
	June	1,174	.35	411
-1958	July	224	.62	139
	Aug.	110	.82	91
	Sept.	96	1.07	103
	Oct.	91	1.01	92
	Nov.	102	1.10	113
	Dec.	114	1.09	124
Total		4,212	.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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	97	1.13	110		Jan.	300	0.73	219		Jan.			
	Feb.	114	.95	108		Feb.	303	.82	248		Feb.			
	Mar.	146	.94	137		Mar.	361	.88	318		Mar.			
	Apr.	219	.76	166		Apr.	518	.79	409		Apr.			
	May	480	.42	202		May	819	.46	377		May			
	June	763	.34	259		June	1,207	.42	507		June			
-1959	July	346	.51	176	-1965	July	546	.52	284		July			
	Aug.	179	.90	161		Aug.	228	.94	214		Aug.			
	Sept.	104	.92	96		Sept.	189	.95	180		Sept.			
	Oct.	178	.86	153		Oct.	253	.85	215		Oct.			
	Nov.	152	.83	126		Nov.	239	.92	220		Nov.			
	Dec.	106	1.02	108		Dec.	248	.89	221		Dec.			
Total		2,884	.62	1,802	Total		5,211	.65	3,412	Total				
	Jan.	95	1.05	100		Jan.	181	.86	156		Jan.			
	Feb.	102	.95	97		Feb.	166	.80	133		Feb.			
	Mar.	320	.83	266		Mar.	393	.80	314		Mar.			
	Apr.	534	.51	272		Apr.	390	.66	257		Apr.			
	May	551	.39	215		May	566	.48	272		May			
	June	683	.33	225		June	325	.55	179		June			
-1960	July	170	.52	88	-1966	July	147	.85	125		July			
	Aug.	69	.76	52		Aug.	147	.96	141		Aug.			
	Sept.	59	.93	55		Sept.	157	1.01	159		Sept.			
	Oct.	96	1.00	96		Oct.	189	1.01	191		Oct.			
	Nov.	105	.90	94		Nov.	159	1.06	169		Nov.			
	Dec.	80	1.06	85		Dec.	146	1.12	164		Dec.			
Total		2,864	.57	1,645	Total		2,966	.76	2,260	Total				
	Jan.	79	.98	77		Jan.	196	.88	172		Jan.			
	Feb.	94	.87	82		Feb.	169	.90	152		Feb.			
	Mar.	136	.89	121		Mar.	256	.95	243		Mar.			
	Apr.	184	.79	145		Apr.	260	.77	200		Apr.			
	May	342	.41	140		May	504	.54	272		May			
	June	542	.31	168		June	1,134	.52	590		June			
	July	112	.49	55	-1967	July	508	.63	320		July			
-1961	Aug.	80	.91	73		Aug.	247	.99	245		Aug.			
	Sept.	175	.99	173		Sept.	231	1.06	245		Sept.			
	Oct.	234	.75	176		Oct.	250	1.07	268		Oct.			
	Nov.	161	.80	129		Nov.	243	1.03	250		Nov.			
	Dec.	126	.88	111		Dec.	229	1.31	300		Dec.			
Total		2,265	.64	1,450	Total		4,227	.77	3,257	Total				
	Jan.	115	.79	91		Jan.	249	.87	217		Jan.			
	Feb.	403	.72	290		Feb.	196	.91	178		Feb.			
	Mar.	401	.95	381		Mar.	241	1.05	253		Mar.			
	Apr.	1,093	.56	612		Apr.	275	.94	258		Apr.			
	May	1,350	.36	486		May	708	.58	411		May			
	June	1,074	.38	408		June	1,248	.35	437		June			
-1962	July	598	.41	245	-1968	July	426	.65	277		July			
	Aug.	177	.61	108		Aug.	345	1.02	352		Aug.			
	Sept.	98	.98	96		Sept.	241	.93	224		Sept.			
	Oct.	126	1.37	173		Oct.	230	.99	228		Oct.			
	Nov.	94	1.15	108		Nov.	221	.93	206		Nov.			
	Dec.	72	1.10	79		Dec.	209	.88	184		Dec.			
Total		5,601	.55	3,077	Total		4,589	.70	3,225	Total				
	Jan.	71	1.04	74		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	.68	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			
-1963	July	51	.77	39	-1969	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				
	Jan.	109	.76	83		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			
-1964	July	344	.54	186		July	420	.52	218		July			
	Aug.	196	.93	182	-1970	Aug.	212	.80	170		Aug.			
	Sept.	139	.82	114		Sept.	179	.93	166		Sept.			
	Oct.	196	.78	153		Oct.	174	.94	164		Oct.			
	Nov.	200	.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)

Units-1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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
Total	124,461			77,347
Average	4,149	.62	456	2,578

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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	2	4.0	8
	Feb.	2	4.0	8
	Mar.	6	3.5	21
	Apr.	1	4.0	4
	May	50	1.2	62
	June	49	1.2	59
-1941	July	7	2.9	20
	Aug.	6	3.3	20
	Sept.	2	4.5	9
	Oct.	5	4.0	20
	Nov.	5	4.2	21
	Dec.	4	4.0	16
	Total	139	1.9	268
	Jan.	6	2.8	17
	Feb.	5	3.6	18
	Mar.	6	3.7	22
	Apr.	14	2.8	39
	May	34	1.4	49
	June	51	1.2	61
-1942	July	6	3.0	18
	Aug.	6	3.2	19
	Sept.	1	5.0	5
	Oct.	2	5.0	10
	Nov.	3	4.7	14
	Dec.	3	4.7	14
	Total	137	2.1	286
	Jan.	4	3.0	12
	Feb.	5	3.4	17
	Mar.	6	3.8	23
	Apr.	15	2.9	44
	May	13	2.1	27
	June	14	2.0	28
-1943	July	2	3.5	7
	Aug.	6	3.2	19
	Sept.	1	5.0	5
	Oct.	2	5.0	10
	Nov.	2	5.0	10
	Dec.	3	3.7	11
	Total	73	2.9	213
	Jan.	2	3.5	7
	Feb.	3	3.0	9
	Mar.	6	3.5	21
	Apr.	1	5.0	5
	May	40	1.3	53
	June	72	1.1	78
-1944	July	9	2.9	26
	Aug.	7	3.1	22
	Sept.	1	5.0	5
	Oct.	2	5.0	10
	Nov.	3	4.7	14
	Dec.	3	4.3	13
	Total	149	1.8	263
	Jan.	3	3.3	10
	Feb.	3	4.0	12
	Mar.	6	3.5	21
	Apr.	1	6.0	6
	May	22	1.6	35
	June	27	1.5	41
-1945	July	6	3.2	19
	Aug.	7	3.4	24
	Sept.	2	4.0	8
	Oct.	3	5.0	15
	Nov.	3	4.7	14
	Dec.	2	4.5	9
	Total	85	2.5	214
	Jan.	2	4.0	8
	Feb.	4	3.3	13
	Mar.	6	3.7	22
	Apr.	11	3.2	35
	May	20	1.8	36
	June	8	2.4	19
-1946	July	1	4.0	4
	Aug.	7	5.4	38
	Sept.	0	0	0
	Oct.	2	5.0	10
	Nov.	5	3.8	19
	Dec.	3	4.3	13
	Total	69	3.1	217
	Jan.	2	4.5	9
	Feb.	5	3.0	15
	Mar.	4	3.8	15
	Apr.	3	4.3	13
	May	33	1.4	46
	June	26	1.8	47
-1947	July	5	3.6	18
	Aug.	20	3.4	68
	Sept.	3	5.0	15
	Oct.	2	6.0	12
	Nov.	4	3.8	15
	Dec.	4	3.5	14
	Total	111	2.6	287
	Jan.	3	3.7	11
	Feb.	6	3.0	18
	Mar.	7	3.6	25
	Apr.	4	3.5	14
	May	16	1.4	23
	June	13	2.2	29
-1948	July	2	4.0	8
	Aug.	6	2.2	13
	Sept.	0	0	0
	Oct.	1	5.0	5
	Nov.	2	5.0	10
	Dec.	2	4.5	9
	Total	62	2.7	165
	Jan.	2	4.0	8
	Feb.	2	4.0	8
	Mar.	9	3.3	30
	Apr.	10	2.2	22
	May	30	1.3	38
	June	52	1.2	64
-1949	July	14	2.7	38
	Aug.	5	3.0	15
	Sept.	3	4.7	14
	Oct.	3	4.7	14
	Nov.	3	4.7	14
	Dec.	2	4.5	9
	Total	135	2.0	274
	Jan.	2	4.5	9
	Feb.	6	3.3	20
	Mar.	5	4.0	20
	Apr.	3	4.7	14
	May	9	2.2	20
	June	11	2.2	24
-1950	July	9	2.9	26
	Aug.	1	3.0	3
	Sept.	1	5.0	5
	Oct.	1	6.0	6
	Nov.	2	5.5	11
	Dec.	3	4.3	13
	Total	53	3.2	171
	Jan.	2	5.0	10
	Feb.	3	3.7	11
	Mar.	2	5.0	10
	Apr.	1	6.0	6
	May	15	1.9	29
	June	23	1.7	40
-1951	July	3	3.7	11
	Aug.	12	2.2	27
	Sept.	1	5.0	5
	Oct.	6	4.0	24
	Nov.	4	4.5	18
	Dec.	3	5.0	15
	Total	75	2.7	206
	Jan.	3	3.7	11
	Feb.	5	3.6	18
	Mar.	14	3.1	44
	Apr.	24	2.4	58
	May	93	.8	78
	June	128	.9	114
-1952	July	19	1.9	36
	Aug.	12	3.3	40
	Sept.	5	3.8	19
	Oct.	3	4.7	14
	Nov.	4	4.5	18
	Dec.	4	4.0	16
	Total	314	1.5	466
	Jan.	6	2.8	17
	Feb.	7	3.1	22
	Mar.	6	3.2	19
	Apr.	3	4.3	13
	May	2	5.5	11
	June	31	1.5	47
-1953	July	5	3.8	19
	Aug.	9	3.7	33
	Sept.	1	5.0	5
	Oct.	4	4.3	17
	Nov.	4	4.5	18
	Dec.	3	4.8	14
	Total	81	2.9	235
	Jan.	3	4.0	12
	Feb.	5	3.8	19
	Mar.	4	3.8	15
	Apr.	3	4.3	13
	May	8	2.9	23
	June	1	5.0	5
-1954	July	1	5.0	5
	Aug.	1	3.0	3
	Sept.	4	4.0	16
	Oct.	2	4.0	8
	Nov.	2	4.5	9
	Dec.	2	4.5	9
	Total	36	3.8	137
	Jan.	2	4.0	8
	Feb.	2	3.5	7
	Mar.	6	3.5	21
	Apr.	3	3.7	11
	May	4	3.0	12
	June	6	2.8	17
-1955	July	0	0	0
	Aug.	3	3.7	11
	Sept.	0	0	0
	Oct.	0	0	0
	Nov.	1	5.0	5
	Dec.	2	4.5	9
	Total	29	3.5	101
	Jan.	3	3.7	11
	Feb.	3	3.3	10
	Mar.	3	3.3	10
	Apr.	1	5.0	5
	May	11	1.6	18
	June	8	2.0	16
-1956	July	1	4.0	4
	Aug.	1	3.0	3
	Sept.	0	0	0
	Oct.	0	0	0
	Nov.	1	5.0	5
	Dec.	1	5.0	5
	Total	33	2.6	87
	Jan.	2	3.0	6
	Feb.	4	3.0	12
	Mar.	2	5.0	10
	Apr.	1	5.0	5
	May	9	3.1	28
	June	94	.8	79
-1957	July	24	1.5	37
	Aug.	13	2.8	36
	Sept.	4	3.5	14
	Oct.	10	3.3	33
	Nov.	21	2.5	53
	Dec.	5	3.4	17
	Total	189	1.7	330
	Jan.	5	2.6	13
	Feb.	8	2.8	22
	Mar.	6	3.3	20
	Apr.	13	1.6	21
	May	66	.9	60
	June	57	.8	47
-1958	July	2	4.0	8
	Aug.	4	4.5	18
	Sept.	4	4.3	17
	Oct.	1	5.0	5
	Nov.	2	4.0	8
	Dec.	4	3.3	13
	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

Units – 1000

Year	Month	Flow (A.F.)	Concen-tration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concen-tration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concen-tration (T./A.F.)	T.D.S. (Tons)
	Jan.	3	3.3	10		Jan.	4	3.5	14		Jan.			
	Feb.	4	3.0	12		Feb.	3	3.7	11		Feb.			
	Mar.	3	4.0	12		Mar.	3	4.0	12		Mar.			
	Apr.	2	3.5	7		Apr.	6	2.7	16		Apr.			
	May	1	5.0	5		May	18	1.6	28		May			
	June	2	4.0	8		June	77	.9	70		June			
-1959	July	0	0	0	-1965	July	38	1.6	60		July			
	Aug.	1	3.0	3		Aug.	16	2.5	40		Aug.			
	Sept.	1	5.0	5		Sept.	5	4.0	20		Sept.			
	Oct.	1	4.0	4		Oct.	4	4.5	18		Oct.			
	Nov.	2	4.0	8		Nov.	5	4.8	24		Nov.			
	Dec.	1	7.0	7		Dec.	5	3.2	16		Dec.			
	Total	21	3.9	81		Total	184	1.8	329		Total			
	Jan.	1	6.0	6		Jan.	3	3.7	11		Jan.			
	Feb.	2	3.5	7		Feb.	3	3.7	11		Feb.			
	Mar.	8	2.8	22		Mar.	8	3.5	28		Mar.			
	Apr.	3	3.3	10		Apr.	4	3.0	12		Apr.			
	May	8	1.9	15		May	4	4.5	18		May			
	June	11	1.5	17		June	2	4.0	8		June			
-1960	July	0	0	0	-1966	July	2	4.5	9		July			
	Aug.	0	0	0		Aug.	1	3.0	3		Aug.			
	Sept.	1	4.0	4		Sept.	2	5.0	10		Sept.			
	Oct.	8	2.5	20		Oct.	1	8.0	8		Oct.			
	Nov.	2	4.5	9		Nov.	1	5.0	5		Nov.			
	Dec.	2	4.0	8		Dec.	2	5.0	10		Dec.			
	Total	46	2.6	118		Total	33	4.0	133		Total			
	Jan.	2	3.5	7		Jan.	1	4.8	5		Jan.			
	Feb.	3	2.7	8		Feb.	2	3.8	8		Feb.			
	Mar.	2	5.5	11		Mar.	2	4.6	9		Mar.			
	Apr.	2	4.0	8		Apr.	1	5.8	6		Apr.			
	May	3	3.0	9		May	5	3.2	16		May			
	June	2	2.5	5		June	22	2.0	44		June			
-1961	July	0	0	0	-1967	July	7	2.9	21		July			
	Aug.	7	2.9	20		Aug.	3	3.3	10		Aug.			
	Sept.	18	2.9	53		Sept.	5	3.6	18		Sept.			
	Oct.	3	4.0	12		Oct.	2	4.6	9		Oct.			
	Nov.	4	3.5	14		Nov.	2	4.5	9		Nov.			
	Dec.	2	4.5	9		Dec.	2	5.0	10		Dec.			
	Total	48	3.3	156		Total	54	3.1	165		Total			
	Jan.	2	4.0	8		Jan.	2	5.0	10		Jan.			
	Feb.	8	2.5	20		Feb.	3	4.1	12		Feb.			
	Mar.	6	2.8	17		Mar.	3	5.2	16		Mar.			
	Apr.	11	1.3	14		Apr.	2	4.8	10		Apr.			
	May	29	1.1	31		May	6	3.8	23		May			
	June	37	1.0	37		June	25	1.3	33		June			
-1962	July	7	2.6	18	-1968	July	6	3.6	21		July			
	Aug.	1	4.0	4		Aug.	11	3.3	36		Aug.			
	Sept.	3	3.0	9		Sept.	4	3.9	16		Sept.			
	Oct.	4	4.5	18		Oct.	5	4.3	21		Oct.			
	Nov.	2	5.5	11		Nov.	3	4.1	12		Nov.			
	Dec.	2	5.5	11		Dec.	2	4.7	9		Dec.			
	Total	112	1.8	198		Total	72	3.0	219		Total			
	Jan.	2	5.5	11		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			
-1963	July	1	2.0	2	-1969	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	2.1	274		Total			
	Jan.	1	6.0	6		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			
-1964	July	4	3.8	15	-1970	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)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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
Total	2,846			6,389
Average	95	2.24	1,648	213

Sampled quality record November 1946 to September 1949; November 1950 to December 1970; remainder by correlation.

Measured flow record October 1945 to December 1970; remainder by correlation.

Table 6

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Glenwood Springs, Colorado

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	36	0.75	27
	Feb.	37	.59	22
	Mar.	51	.60	30
	Apr.	85	.47	40
	May	535	.22	118
	June	470	.19	90
- 1941	July	163	.37	60
	Aug.	84	.60	50
	Sept.	67	.60	40
	Oct.	78	.58	45
	Nov.	59	.63	37
	Dec.	48	.67	32
	Total	1,713	.34	591
	Jan.	43	.74	32
	Feb.	41	.68	28
	Mar.	46	.70	32
	Apr.	167	.42	70
	May	389	.24	93
	June	721	.16	116
- 1942	July	230	.27	62
	Aug.	78	.53	41
	Sept.	46	.78	36
	Oct.	53	.75	40
	Nov.	49	.76	37
	Dec.	40	.82	33
	Total	1,903	.33	620
	Jan.	37	.86	32
	Feb.	36	.78	28
	Mar.	48	.75	36
	Apr.	162	.34	55
	May	342	.23	79
	June	582	.18	105
- 1943	July	254	.28	71
	Aug.	109	.45	49
	Sept.	66	.64	42
	Oct.	60	.67	40
	Nov.	67	.54	36
	Dec.	64	.53	34
	Total	1,827	.33	607
	Jan.	37	.76	28
	Feb.	44	.66	29
	Mar.	50	.72	36
	Apr.	85	.51	43
	May	302	.26	78
	June	498	.16	80
- 1944	July	185	.29	54
	Aug.	72	.49	35
	Sept.	45	.71	32
	Oct.	60	.65	39
	Nov.	57	.63	36
	Dec.	59	.56	33
	Total	1,494	.35	523
	Jan.	41	.71	29
	Feb.	37	.68	25
	Mar.	62	.50	31
	Apr.	72	.51	37
	May	347	.22	76
	June	461	.18	83
- 1945	July	268	.26	70
	Aug.	181	.33	60
	Sept.	73	.52	38
	Oct.	78	.49	38
	Nov.	73	.47	34
	Dec.	71	.45	32
	Total	1,764	.31	553
	Jan.	67	.48	32
	Feb.	54	.54	29
	Mar.	64	.55	35
	Apr.	197	.28	55
	May	284	.22	62
	June	362	.22	80
- 1946	July	164	.40	65
	Aug.	83	.51	42
	Sept.	59	.66	39
	Oct.	70	.61	43
	Nov.	61	.59	36
	Dec.	77	.40	31
	Total	1,542	.36	549

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	52	0.60	31
	Feb.	54	.61	33
	Mar.	68	.53	36
	Apr.	123	.37	46
	May	486	.19	92
	June	606	.17	103
- 1947	July	438	.21	92
	Aug.	147	.38	56
	Sept.	79	.53	42
	Oct.	90	.47	42
	Nov.	80	.49	39
	Dec.	75	.48	36
	Total	2,298	.28	648
	Jan.	76	.45	34
	Feb.	72	.44	32
	Mar.	68	.50	34
	Apr.	162	.37	60
	May	542	.20	108
	June	470	.18	85
- 1948	July	156	.35	55
	Aug.	90	.51	46
	Sept.	57	.67	38
	Oct.	63	.65	41
	Nov.	66	.53	35
	Dec.	59	.61	36
	Total	1,881	.32	604
	Jan.	67	.54	36
	Feb.	56	.57	32
	Mar.	58	.59	34
	Apr.	132	.38	50
	May	364	.23	84
	June	654	.19	124
- 1949	July	356	.24	85
	Aug.	106	.45	48
	Sept.	69	.59	41
	Oct.	61	.70	43
	Nov.	55	.71	39
	Dec.	58	.62	36
	Total	2,036	.32	652
	Jan.	56	.63	35
	Feb.	54	.56	30
	Mar.	80	.44	35
	Apr.	141	.35	49
	May	259	.26	67
	June	429	.20	86
- 1950	July	137	.42	58
	Aug.	79	.50	40
	Sept.	66	.58	38
	Oct.	49	.80	39
	Nov.	53	.70	37
	Dec.	55	.61	34
	Total	1,458	.38	548
	Jan.	59	.56	33
	Feb.	58	.52	30
	Mar.	58	.55	32
	Apr.	104	.40	42
	May	381	.23	88
	June	536	.20	107
- 1951	July	285	.25	71
	Aug.	132	.43	57
	Sept.	77	.58	45
	Oct.	75	.61	46
	Nov.	63	.57	36
	Dec.	63	.51	32
	Total	1,891	.33	619
	Jan.	53	.60	32
	Feb.	47	.62	29
	Mar.	63	.51	32
	Apr.	194	.38	74
	May	597	.23	137
	June	785	.19	149
- 1952	July	245	.34	83
	Aug.	157	.51	80
	Sept.	99	.54	53
	Oct.	77	.58	45
	Nov.	66	.64	42
	Dec.	60	.58	35
	Total	2,443	.32	791

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	64	0.59	38
	Feb.	53	.57	30
	Mar.	67	.54	37
	Apr.	103	.46	47
	May	229	.32	73
	June	509	.20	102
- 1953	July	171	.41	70
	Aug.	121	.50	60
	Sept.	69	.58	40
	Oct.	64	.63	40
	Nov.	55	.75	41
	Dec.	58	.66	38
	Total	1,563	.39	616
	Jan.	62	.58	36
	Feb.	48	.62	30
	Mar.	62	.58	36
	Apr.	86	.44	38
	May	146	.35	51
	June	89	.52	46
- 1954	July	83	.55	46
	Aug.	74	.58	43
	Sept.	59	.61	36
	Oct.	58	.66	38
	Nov.	48	.71	34
	Dec.	40	.90	36
	Total	855	.55	470
	Jan.	38	.79	30
	Feb.	34	.82	28
	Mar.	43	.79	34
	Apr.	90	.48	43
	May	206	.28	58
	June	217	.31	67
- 1955	July	99	.56	56
	Aug.	86	.66	57
	Sept.	67	.57	38
	Oct.	61	.62	38
	Nov.	55	.69	38
	Dec.	55	.60	33
	Total	1,051	.49	520
	Jan.	52	.60	31
	Feb.	48	.56	27
	Mar.	69	.59	41
	Apr.	120	.44	53
	May	421	.26	110
	June	329	.24	79
- 1956	July	104	.54	56
	Aug.	82	.61	50
	Sept.	73	.55	40
	Oct.	66	.55	36
	Nov.	50	.72	36
	Dec.	41	.78	32
	Total	1,455	.41	591
	Jan.	46	.72	33
	Feb.	44	.68	30
	Mar.	51	.67	34
	Apr.	92	.53	49
	May	350	.32	112
	June	834	.21	175
- 1957	July	571	.22	126
	Aug.	176	.37	65
	Sept.	88	.56	49
	Oct.	75	.60	45
	Nov.	72	.58	42
	Dec.	63	.59	37
	Total	2,462	.32	797
	Jan.	62	.55	34
	Feb.	58	.50	29
	Mar.	73	.52	38
	Apr.	102	.45	46
	May	546	.22	120
	June	439	.21	92
- 1958	July	104	.51	53
	Aug.	67	.59	40
	Sept.	62	.58	36
	Oct.	59	.63	37
	Nov.	54	.68	37
	Dec.	54	.63	34
	Total	1,680	.35	596

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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	63	0.54	34
	Feb.	54	.52	28
	Mar.	49	.65	32
	Apr.	81	.54	44
	May	252	.29	73
	June	342	.25	85
- 1959	July	126	.48	61
	Aug.	89	.61	54
	Sept.	73	.56	41
	Oct.	84	.55	46
	Nov.	69	.55	38
	Dec.	59	.53	31
	Total	1,341	.42	567
	Jan.	67	.49	33
	Feb.	55	.50	28
	Mar.	93	.47	44
	Apr.	166	.32	53
	May	288	.25	72
	June	357	.25	89
- 1960	July	122	.49	60
	Aug.	73	.60	44
	Sept.	67	.60	40
	Oct.	61	.62	38
	Nov.	56	.61	34
	Dec.	61	.54	33
	Total	1,466	.39	568
	Jan.	65	.52	34
	Feb.	56	.53	30
	Mar.	55	.59	32
	Apr.	66	.54	36
	May	207	.29	60
	June	203	.28	57
- 1961	July	82	.60	49
	Aug.	80	.59	47
	Sept.	109	.50	54
	Oct.	128	.43	55
	Nov.	81	.50	40
	Dec.	77	.47	36
	Total	1,209	.44	530
	Jan.	80	.44	35
	Feb.	91	.42	38
	Mar.	122	.39	48
	Apr.	347	.32	111
	May	539	.23	125
	June	455	.23	105
- 1962	July	288	.29	84
	Aug.	110	.50	55
	Sept.	74	.58	43
	Oct.	127	.42	53
	Nov.	102	.47	48
	Dec.	72	.57	41
	Total	2,407	.33	786
	Jan.	55	.67	37
	Feb.	53	.63	33
	Mar.	62	.58	36
	Apr.	81	.48	39
	May	175	.31	54
	June	122	.45	55
- 1963	July	66	.66	44
	Aug.	77	.60	46
	Sept.	76	.57	43
	Oct.	63	.61	38
	Nov.	54	.66	36
	Dec.	38	.82	31
	Total	922	.53	492
	Jan.	36	.80	29
	Feb.	33	.78	26
	Mar.	39	.71	28
	Apr.	64	.61	39
	May	210	.32	67
	June	215	.31	67
- 1964	July	99	.63	62
	Aug.	87	.61	53
	Sept.	72	.60	43
	Oct.	65	.64	42
	Nov.	50	.72	36
	Dec.	51	.73	37
	Total	1,021	.52	529

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	51	0.70	36
	Feb.	44	.72	32
	Mar.	49	.69	34
	Apr.	104	.50	52
	May	263	.30	79
	June	446	.26	116
- 1965	July	271	.31	84
	Aug.	172	.39	67
	Sept.	95	.50	48
	Oct.	95	.44	42
	Nov.	86	.46	39
	Dec.	88	.47	41
	Total	1,764	.38	670
	Jan.	78	0.48	37
	Feb.	70	.45	32
	Mar.	91	.46	42
	Apr.	84	.47	39
	May	186	.30	56
	June	110	.45	50
- 1966	July	89	.51	45
	Aug.	77	.46	35
	Sept.	68	.51	35
	Oct.	72	.60	43
	Nov.	55	.66	36
	Dec.	44	.75	33
	Total	1,024	.47	483
	Jan.	49	.65	32
	Feb.	45	.62	28
	Mar.	67	.59	40
	Apr.	96	.45	43
	May	185	.31	57
	June	250	.28	70
- 1967	July	139	.47	65
	Aug.	90	.57	51
	Sept.	83	.59	49
	Oct.	78	.59	46
	Nov.	69	.57	39
	Dec.	59	.59	35
	Total	1,210	.46	555
	Jan.	53	.61	32
	Feb.	53	.55	29
	Mar.	62	.55	34
	Apr.	95	.46	44
	May	171	.36	62
	June	369	.25	92
- 1968	July	133	.46	61
	Aug.	125	.48	60
	Sept.	79	.53	42
	Oct.	77	.55	42
	Nov.	68	.54	37
	Dec.	65	.59	38
	Total	1,350	.42	573
	Jan.	66	.55	36
	Feb.	56	.57	32
	Mar.	63	.56	35
	Apr.	131	.41	54
	May	283	.28	51
	June	260	.31	81
- 1969	July	174	.38	66
	Aug.	93	.49	46
	Sept.	78	.53	41
	Oct.	94	.55	52
	Nov.	79	.53	42
	Dec.	71	.52	37
	Total	1,448	.40	573
	Jan.	62	.55	34
	Feb.	65	.52	34
	Mar.	72	.51	37
	Apr.	95	.43	41
	May	488	.20	99
	June	471	.21	99
- 1970	July	194	.35	68
	Aug.	109	.46	50
	Sept.	101	.50	50
	Oct.	108	.48	52
	Nov.	92	.50	46
	Dec.	68	.51	35
	Total	1,925	.34	645

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
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	Nov.			
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	Total			
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	Total			
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	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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
Total	48,403			17,866
Average	1,613	.37	271	596

Sampled quality record October 1941 to December 1970; 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
Units – 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
-1941	Jan.	65	1.23	80
	Feb.	67	1.15	77
	Mar.	82	1.11	91
	Apr.	133	.83	110
	May	948	.34	322
	June	803	.28	225
	July	315	.47	148
	Aug.	144	.91	131
	Sept.	122	.97	118
	Oct.	166	.88	146
	Nov.	124	.96	119
	Dec.	103	1.11	114
	Total	3,072	.55	1,681
-1942	Jan.	90	1.24	112
	Feb.	86	1.19	102
	Mar.	103	1.13	116
	Apr.	334	.62	207
	May	757	.41	310
	June	1,215	.24	292
	July	406	.44	179
	Aug.	139	.85	118
	Sept.	86	1.15	99
	Oct.	94	1.18	111
	Nov.	94	1.24	117
	Dec.	84	1.26	106
	Total	3,488	.54	1,869
-1943	Jan.	77	1.30	100
	Feb.	74	1.26	93
	Mar.	89	1.22	109
	Apr.	237	.56	133
	May	509	.32	163
	June	931	.23	214
	July	387	.39	151
	Aug.	192	.73	140
	Sept.	117	.89	104
	Oct.	111	1.00	111
	Nov.	115	.90	103
	Dec.	107	.93	100
	Total	2,946	.52	1,521
-1944	Jan.	74	1.24	92
	Feb.	76	1.11	84
	Mar.	81	1.11	90
	Apr.	118	.85	100
	May	564	.36	203
	June	890	.24	214
	July	378	.38	143
	Aug.	123	.80	98
	Sept.	78	1.09	85
	Oct.	99	1.05	104
	Nov.	100	1.01	101
	Dec.	99	1.02	101
	Total	2,680	.53	1,415
-1945	Jan.	78	1.15	90
	Feb.	72	1.18	85
	Mar.	95	.99	94
	Apr.	115	.90	104
	May	601	.36	216
	June	794	.27	214
	July	499	.33	165
	Aug.	287	.52	149
	Sept.	118	.83	98
	Oct.	126	.79	100
	Nov.	125	.81	101
	Dec.	117	.89	104
	Total	3,027	.50	1,520
-1946	Jan.	109	.90	98
	Feb.	91	.97	88
	Mar.	99	.94	93
	Apr.	285	.45	128
	May	449	.32	144
	June	689	.28	193
	July	267	.51	136
	Aug.	126	.85	107
	Sept.	92	1.01	93
	Oct.	122	.89	109
	Nov.	104	.92	96
	Dec.	121	.82	99
	Total	2,554	.54	1,384
-1947	Jan.	82	1.04	85
	Feb.	82	.99	81
	Mar.	107	.96	103
	Apr.	178	.63	112
	May	809	.28	227
	June	1,027	.25	257
	July	732	.27	198
	Aug.	240	.58	139
	Sept.	143	.78	111
	Oct.	153	.80	122
	Nov.	135	.77	104
	Dec.	118	.86	102
	Total	3,806	.43	1,641
-1948	Jan.	116	.84	97
	Feb.	111	.81	90
	Mar.	115	.90	104
	Apr.	253	.59	149
	May	920	.30	276
	June	844	.26	219
	July	312	.47	146
	Aug.	161	.77	124
	Sept.	88	1.03	91
	Oct.	109	1.02	111
	Nov.	107	.96	103
	Dec.	90	1.04	94
	Total	3,226	.50	1,604
-1949	Jan.	99	.96	95
	Feb.	84	.92	77
	Mar.	98	.98	96
	Apr.	201	.65	131
	May	572	.36	206
	June	1,080	.26	281
	July	594	.34	202
	Aug.	184	.69	127
	Sept.	122	.93	113
	Oct.	125	.98	123
	Nov.	108	1.01	109
	Dec.	101	1.05	106
	Total	3,368	.49	1,666
-1950	Jan.	91	1.04	95
	Feb.	88	.95	84
	Mar.	118	.87	103
	Apr.	212	.59	125
	May	418	.40	167
	June	787	.27	212
	July	273	.54	147
	Aug.	125	.87	109
	Sept.	111	.97	108
	Oct.	97	1.19	115
	Nov.	98	1.14	112
	Dec.	98	1.07	105
	Total	2,516	.59	1,482
-1951	Jan.	96	1.01	97
	Feb.	88	.95	84
	Mar.	99	1.01	100
	Apr.	151	.70	106
	May	537	.34	183
	June	858	.27	232
	July	471	.36	170
	Aug.	207	.68	141
	Sept.	111	.90	100
	Oct.	120	.92	110
	Nov.	104	.97	101
	Dec.	106	.96	102
	Total	2,948	.52	1,526
-1952	Jan.	96	1.01	97
	Feb.	84	1.06	89
	Mar.	113	.99	112
	Apr.	313	.60	188
	May	978	.36	352
	June	1,320	.26	343
	July	449	.44	197
	Aug.	276	.70	193
	Sept.	171	.78	133
	Oct.	123	.97	119
	Nov.	112	1.04	117
	Dec.	99	1.12	111
	Total	4,134	.50	2,051
-1953	Jan.	99	1.03	102
	Feb.	80	1.06	85
	Mar.	102	.96	98
	Apr.	136	.78	106
	May	346	.44	152
	June	887	.27	239
	July	294	.52	153
	Aug.	194	.72	140
	Sept.	101	.99	100
	Oct.	101	1.06	107
	Nov.	99	1.13	112
	Dec.	92	1.17	108
	Total	2,531	.59	1,502
-1954	Jan.	95	1.00	95
	Feb.	81	1.05	85
	Mar.	94	1.01	95
	Apr.	136	.78	106
	May	296	.48	142
	June	204	.60	123
	July	146	.81	118
	Aug.	105	.97	102
	Sept.	103	1.07	110
	Oct.	125	.97	121
	Nov.	98	1.07	105
	Dec.	82	1.23	101
	Total	1,565	.83	1,303
-1955	Jan.	74	1.23	91
	Feb.	67	1.25	84
	Mar.	86	1.13	97
	Apr.	142	.77	110
	May	384	.42	161
	June	448	.37	166
	July	214	.61	130
	Aug.	157	.87	137
	Sept.	100	.94	94
	Oct.	91	1.02	93
	Nov.	94	1.06	100
	Dec.	89	1.07	95
	Total	1,946	.70	1,358
-1956	Jan.	81	1.07	87
	Feb.	75	1.11	83
	Mar.	104	.98	102
	Apr.	184	.66	122
	May	685	.34	233
	June	637	.31	197
	July	173	.70	121
	Aug.	115	.95	109
	Sept.	88	.90	79
	Oct.	93	.95	88
	Nov.	83	1.07	89
	Dec.	73	1.21	88
	Total	2,391	.59	1,398
-1957	Jan.	80	1.10	88
	Feb.	77	1.10	85
	Mar.	83	1.16	96
	Apr.	151	.83	125
	May	591	.47	278
	June	1,415	.27	382
	July	1,072	.27	289
	Aug.	339	.50	170
	Sept.	157	.78	122
	Oct.	136	.89	121
	Nov.	123	.91	112
	Dec.	102	.96	98
	Total	4,326	.45	1,966
-1958	Jan.	92	.93	86
	Feb.	95	.93	88
	Mar.	123	.89	110
	Apr.	171	.76	130
	May	847	.31	263
	June	808	.27	218
	July	193	.67	129
	Aug.	109	.97	106
	Sept.	103	1.03	106
	Oct.	99	1.09	108
	Nov.	94	1.09	102
	Dec.	86	1.12	96
	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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	94	1.02	96
	Feb.	86	1.01	87
	Mar.	83	1.09	90
	Apr.	118	.83	98
	May	392	.40	157
	June	684	.29	198
-1959	July	215	.59	127
	Aug.	131	.87	114
	Sept.	105	.98	103
	Oct.	138	.81	112
	Nov.	116	.87	101
	Dec.	100	.98	98
	Total	2,262	.61	1,381
	Jan.	100	.89	89
	Feb.	91	.95	86
	Mar.	135	.78	105
	Apr.	246	.51	125
	May	432	.37	160
	June	668	.30	200
-1960	July	217	.60	130
	Aug.	117	.89	104
	Sept.	102	.95	97
	Oct.	106	1.00	106
	Nov.	99	1.05	104
	Dec.	100	1.01	101
	Total	2,413	.58	1,407
	Jan.	99	.97	96
	Feb.	85	.94	80
	Mar.	86	1.06	91
	Apr.	103	.91	94
	May	354	.40	142
	June	426	.34	145
-1961	July	138	.81	112
	Aug.	115	.89	102
	Sept.	175	.73	128
	Oct.	200	.59	118
	Nov.	131	.73	96
	Dec.	121	.78	94
	Total	2,033	.64	1,298
	Jan.	115	.78	90
	Feb.	135	.74	100
	Mar.	160	.69	110
	Apr.	513	.40	205
	May	892	.31	277
	June	882	.27	238
-1962	July	545	.37	202
	Aug.	186	.72	134
	Sept.	121	.95	115
	Oct.	173	.74	128
	Nov.	148	.79	117
	Dec.	115	.99	114
	Total	3,985	.46	1,830
	Jan.	95	1.11	105
	Feb.	87	.98	85
	Mar.	98	1.02	100
	Apr.	127	.79	100
	May	323	.40	129
	June	246	.53	130
-1963	July	111	.91	101
	Aug.	115	.92	106
	Sept.	112	.89	100
	Oct.	96	.99	95
	Nov.	90	1.09	98
	Dec.	71	1.32	94
	Total	1,571	.79	1,243
	Jan.	58	1.29	75
	Feb.	55	1.19	65
	Mar.	67	1.13	76
	Apr.	105	.92	97
	May	403	.41	165
	June	465	.35	163
-1964	July	223	.62	138
	Aug.	153	.81	124
	Sept.	116	.86	100
	Oct.	104	1.01	105
	Nov.	94	1.11	104
	Dec.	91	1.08	98
	Total	1,934	.68	1,310
	Jan.	92	1.10	101
	Feb.	78	1.09	85
	Mar.	85	1.15	98
	Apr.	161	.69	111
	May	477	.39	186
	June	920	.28	258
-1965	July	605	.34	206
	Aug.	273	.56	153
	Sept.	172	.75	129
	Oct.	167	.75	125
	Nov.	137	.75	103
	Dec.	138	.75	103
	Total	3,305	.50	1,658
	Jan.	114	.82	93
	Feb.	99	.81	80
	Mar.	133	.77	102
	Apr.	141	.66	93
	May	373	.40	149
	June	277	.48	133
-1966	July	157	.73	115
	Aug.	119	.87	104
	Sept.	101	.94	95
	Oct.	108	.98	106
	Nov.	93	1.05	98
	Dec.	85	1.22	104
	Total	1,800	.71	1,272
	Jan.	86	1.11	95
	Feb.	74	1.06	78
	Mar.	106	.93	99
	Apr.	137	.72	99
	May	328	.43	141
	June	543	.31	168
-1967	July	289	.53	153
	Aug.	137	.83	114
	Sept.	125	.90	112
	Oct.	115	.92	106
	Nov.	104	.95	99
	Dec.	100	1.00	100
	Total	2,144	.64	1,364
	Jan.	89	1.12	100
	Feb.	87	.98	85
	Mar.	96	1.01	97
	Apr.	133	.77	102
	May	326	.43	140
	June	757	.27	204
-1968	July	257	.57	146
	Aug.	224	.67	150
	Sept.	125	.86	108
	Oct.	128	.91	116
	Nov.	113	.95	107
	Dec.	104	.99	103
	Total	2,439	.60	1,458
	Jan.	106	.94	100
	Feb.	86	.99	85
	Mar.	96	.95	91
	Apr.	241	.58	140
	May	561	.34	191
	June	502	.40	201
-1969	July	355	.52	185
	Aug.	152	.79	120
	Sept.	131	.88	115
	Oct.	173	.79	137
	Nov.	131	.85	112
	Dec.	121	1.05	127
	Total	2,655	.60	1,604
	Jan.	105	.96	101
	Feb.	95	.92	87
	Mar.	116	.84	97
	Apr.	154	.64	99
	May	850	.26	224
	June	834	.27	222
-1970	July	363	.45	165
	Aug.	167	.77	128
	Sept.	182	.74	134
	Oct.	171	.78	133
	Nov.	155	.79	122
	Dec.	140	.86	120
	Total	3,332	.49	1,632

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)
Units – 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./1)	T.D.S. (Tons)
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
Total	82,947			45,886
Average	2,765	.55	406	1,530

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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	51	1.90	97
	Feb.	50	1.82	93
	Mar.	63	1.67	105
	Apr.	123	1.00	123
	May	871	.40	349
	June	563	.46	259
-1941	July	192	.94	180
	Aug.	95	1.41	134
	Sept.	81	2.11	171
	Oct.	198	1.35	267
	Nov.	121	1.33	161
	Dec.	84	1.58	133
	Total	2,493	.83	2,072
	Jan.	71	1.59	113
	Feb.	62	1.66	103
	Mar.	76	1.64	125
	Apr.	546	.52	284
	May	760	.47	357
	June	688	.38	261
-1942	July	167	.93	156
	Aug.	68	2.18	148
	Sept.	56	2.36	132
	Oct.	57	2.58	147
	Nov.	65	1.92	125
	Dec.	58	1.83	106
	Total	2,674	.77	2,057
	Jan.	57	1.72	98
	Feb.	48	1.60	77
	Mar.	56	1.55	87
	Apr.	289	.44	123
	May	389	.48	187
	June	397	.46	183
-1943	July	113	1.08	122
	Aug.	153	1.43	219
	Sept.	87	1.59	138
	Oct.	69	1.84	127
	Nov.	75	1.59	119
	Dec.	61	1.57	96
	Total	1,784	.88	1,576
	Jan.	51	1.65	84
	Feb.	48	1.44	69
	Mar.	53	1.42	75
	Apr.	102	.97	99
	May	758	.32	242
	June	694	.33	229
-1944	July	230	.69	159
	Aug.	51	1.94	99
	Sept.	45	2.44	110
	Oct.	58	2.31	134
	Nov.	71	1.86	132
	Dec.	64	1.73	111
	Total	2,225	.69	1,543
	Jan.	55	1.58	87
	Feb.	47	1.62	76
	Mar.	52	1.48	77
	Apr.	91	1.00	91
	May	628	.35	220
	June	407	.46	187
-1945	July	163	.85	139
	Aug.	122	1.22	149
	Sept.	46	2.39	110
	Oct.	76	2.00	152
	Nov.	73	1.63	119
	Dec.	58	1.59	92
	Total	1,818	.82	1,499
	Jan.	58	1.55	90
	Feb.	48	1.44	69
	Mar.	58	1.28	74
	Apr.	182	.59	108
	May	228	.59	135
	June	321	.52	167
-1946	July	64	1.62	104
	Aug.	56	2.16	121
	Sept.	54	2.31	125
	Oct.	69	2.06	142
	Nov.	67	1.70	114
	Dec.	56	1.55	87
	Total	1,261	1.06	1,335

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	45	1.67	75
	Feb.	47	1.49	70
	Mar.	55	1.27	70
	Apr.	96	.82	79
	May	455	.39	177
	June	502	.46	231
-1947	July	242	.64	155
	Aug.	120	1.50	180
	Sept.	96	1.63	156
	Oct.	114	1.60	183
	Nov.	96	1.35	130
	Dec.	70	1.41	99
	Total	1,938	.83	1,605
	Jan.	58	1.38	80
	Feb.	65	1.43	93
	Mar.	76	1.38	105
	Apr.	324	.51	165
	May	835	.30	251
	June	546	.40	218
-1948	July	141	.92	129
	Aug.	71	1.84	131
	Sept.	48	2.25	108
	Oct.	57	2.09	119
	Nov.	70	1.84	129
	Dec.	70	1.64	115
	Total	2,361	.70	1,643
	Jan.	51	1.49	76
	Feb.	52	1.48	77
	Mar.	69	1.42	98
	Apr.	236	.57	134
	May	481	.38	183
	June	651	.42	273
-1949	July	265	.65	172
	Aug.	65	1.80	117
	Sept.	53	2.15	114
	Oct.	70	2.09	146
	Nov.	74	1.58	117
	Dec.	54	1.74	94
	Total	2,121	.76	1,601
	Jan.	54	1.57	85
	Feb.	57	2.00	114
	Mar.	60	1.33	80
	Apr.	219	.50	110
	May	309	.45	139
	June	319	.50	160
-1950	July	88	1.43	126
	Aug.	37	2.16	80
	Sept.	46	2.61	120
	Oct.	37	2.65	98
	Nov.	49	2.12	104
	Dec.	60	1.73	104
	Total	1,335	.99	1,320
	Jan.	47	1.64	77
	Feb.	46	1.59	73
	Mar.	55	1.27	70
	Apr.	62	.97	60
	May	265	.51	135
	June	323	.52	168
-1951	July	93	1.06	99
	Aug.	53	1.72	91
	Sept.	37	2.30	85
	Oct.	49	2.41	118
	Nov.	60	1.88	113
	Dec.	46	1.65	76
	Total	1,136	1.03	1,165
	Jan.	53	1.53	81
	Feb.	47	1.48	70
	Mar.	53	1.41	75
	Apr.	342	.46	157
	May	818	.33	270
	June	759	.35	266
-1952	July	200	.79	158
	Aug.	121	1.54	187
	Sept.	76	1.86	141
	Oct.	67	1.90	127
	Nov.	64	2.00	128
	Dec.	72	1.68	121
	Total	2,672	.67	1,781

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	65	1.51	98
	Feb.	50	1.48	74
	Mar.	61	1.26	77
	Apr.	86	1.01	87
	May	230	.57	131
	June	437	.43	188
-1953	July	86	1.13	97
	Aug.	67	1.75	117
	Sept.	46	2.28	105
	Oct.	58	2.40	139
	Nov.	74	1.78	132
	Dec.	52	1.83	95
	Total	1,312	1.02	1,340
	Jan.	49	1.75	86
	Feb.	45	1.58	71
	Mar.	45	1.49	67
	Apr.	70	.84	59
	May	110	.85	93
	June	39	1.92	75
-1954	July	40	2.10	84
	Aug.	31	2.64	82
	Sept.	52	2.50	130
	Oct.	64	1.94	124
	Nov.	51	1.92	98
	Dec.	49	1.90	93
	Total	645	1.65	1,062
	Jan.	46	1.70	78
	Feb.	40	1.67	67
	Mar.	59	1.47	87
	Apr.	108	.74	80
	May	262	.52	136
	June	219	.63	138
-1955	July	46	1.74	80
	Aug.	52	1.86	97
	Sept.	36	2.48	89
	Oct.	38	2.47	94
	Nov.	54	2.08	112
	Dec.	57	1.65	94
	Total	1,016	1.13	1,152
	Jan.	50	1.64	82
	Feb.	44	1.59	70
	Mar.	56	1.30	73
	Apr.	142	.60	85
	May	324	.45	146
	June	262	.53	139
-1956	July	37	1.92	71
	Aug.	29	2.07	60
	Sept.	20	3.15	63
	Oct.	35	2.94	103
	Nov.	55	1.95	107
	Dec.	47	1.87	88
	Total	1,101	.99	1,087
	Jan.	52	1.73	90
	Feb.	55	1.69	93
	Mar.	56	1.36	76
	Apr.	136	.67	91
	May	554	.44	244
	June	1,168	.32	374
-195	July	719	.39	281
	Aug.	224	.83	186
	Sept.	108	1.47	159
	Oct.	106	1.92	204
	Nov.	111	1.33	148
	Dec.	92	1.26	116
	Total	3,381	.61	2,062
	Jan.	66	1.40	92
	Feb.	70	1.50	105
	Mar.	82	1.24	102
	Apr.	254	.57	145
	May	873	.32	279
	June	570	.42	239
-195	July	65	1.52	99
	Aug.	43	1.74	75
	Sept.	51	2.31	118
	Oct.	52	2.42	126
	Nov.	71	1.82	129
	Dec.	65	1.60	104
	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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	57	1.58	90
	Feb.	50	1.51	75
	Mar.	52	1.34	70
	Apr.	55	1.10	61
	May	167	.75	125
	June	256	.66	169
-1959	July	34	2.39	81
	Aug.	51	2.01	103
	Sept.	41	2.46	101
	Oct.	96	1.45	139
	Nov.	72	1.39	100
	Dec.	50	1.54	77
	Total	981	1.21	1,191
	Jan.	49	1.46	72
	Feb.	41	1.48	61
	Mar.	87	1.26	110
	Apr.	270	.45	122
	May	259	.45	117
	June	336	.46	155
-1960	July	58	1.33	77
	Aug.	34	2.08	71
	Sept.	38	2.22	84
	Oct.	51	2.34	119
	Nov.	58	1.69	98
	Dec.	51	1.59	81
	Total	1,332	.88	1,167
	Jan.	41	1.65	68
	Feb.	40	1.55	62
	Mar.	55	1.29	71
	Apr.	67	1.05	70
	May	266	.50	133
	June	209	.62	130
-1961	July	34	2.09	71
	Aug.	44	2.07	91
	Sept.	100	1.66	166
	Oct.	107	1.20	128
	Nov.	86	1.20	103
	Dec.	57	1.37	78
	Total	1,106	1.06	1,171
	Jan.	52	1.37	71
	Feb.	58	1.35	78
	Mar.	53	1.22	65
	Apr.	395	.37	146
	May	574	.32	184
	June	477	.37	176
-1962	July	219	.67	147
	Aug.	52	1.72	89
	Sept.	63	1.97	124
	Oct.	70	1.84	129
	Nov.	68	1.62	110
	Dec.	54	1.70	92
	Total	2,135	.66	1,411
	Jan.	48	1.63	80
	Feb.	70	1.51	105
	Mar.	82	1.11	91
	Apr.	102	.72	73
	May	188	.53	100
	June	92	1.02	94
-1963	July	37	2.11	78
	Aug.	52	1.99	104
	Sept.	51	2.28	116
	Oct.	55	2.52	139
	Nov.	66	1.70	112
	Dec.	49	1.69	83
	Total	892	1.32	1,176
	Jan.	43	1.58	68
	Feb.	45	1.51	68
	Mar.	43	1.52	65
	Apr.	78	1.00	78
	May	418	.41	171
	June	316	.50	158
-1964	July	83	1.20	100
	Aug.	93	1.61	150
	Sept.	59	1.99	117
	Oct.	53	2.20	117
	Nov.	65	1.85	120
	Dec.	59	1.46	86
	Total	1,355	.96	1,298
	Jan.	55	1.37	75
	Feb.	45	1.28	58
	Mar.	52	1.33	69
	Apr.	228	.52	119
	May	582	.36	210
	June	681	.37	252
-1965	July	472	.47	222
	Aug.	158	.98	155
	Sept.	161	1.29	208
	Oct.	116	1.35	157
	Nov.	63	1.93	122
	Dec.	60	1.58	95
	Total	2,673	.65	1,742
	Jan.	52	1.67	87
	Feb.	37	1.86	69
	Mar.	68	1.30	88
	Apr.	166	.65	108
	May	211	.67	141
	June	125	1.03	129
-1966	July	51	1.75	89
	Aug.	38	2.09	79
	Sept.	58	1.99	115
	Oct.	65	2.03	132
	Nov.	45	2.34	105
	Dec.	55	1.76	97
	Total	971	1.28	1,239
	Jan.	47	1.63	77
	Feb.	42	1.62	68
	Mar.	62	1.16	72
	Apr.	86	.73	63
	May	143	.81	116
	June	152	1.03	157
-1967	July	60	1.78	107
	Aug.	59	1.93	114
	Sept.	70	1.88	132
	Oct.	65	1.88	122
	Nov.	106	1.16	123
	Dec.	165	.73	120
	Total	1,057	1.20	1,271
	Jan.	119	.95	113
	Feb.	96	1.03	99
	Mar.	65	1.20	78
	Apr.	68	.97	66
	May	268	.57	153
	June	258	.56	144
-1968	July	59	1.62	96
	Aug.	107	1.56	167
	Sept.	68	1.86	126
	Oct.	87	1.72	150
	Nov.	133	1.08	144
	Dec.	149	.77	115
	Total	1,477	.98	1,451
	Jan.	146	.80	117
	Feb.	75	1.03	77
	Mar.	145	.70	[illegible]
	Apr.	[illegible]	[illegible]	[illegible]
	May	332	.49	162
	June	194	1.03	200
-1969	July	100	1.37	137
	Aug.	91	1.40	128
	Sept.	119	1.43	170
	Oct.	155	1.27	197
	Nov.	143	.98	140
	Dec.	128	.88	113
	Total	1,932	.87	1,673
	Jan.	129	.78	100
	Feb.	122	.70	85
	Mar.	149	.68	101
	Apr.	137	.69	95
	May	404	.42	169
	June	415	.50	208
-1970	July	174	.79	137
	Aug.	101	1.27	128
	Sept.	196	1.07	209
	Oct.	188	1.13	212
	Nov.	170	.78	133
	Dec.	181	.65	117
	Total	2,366	.72	1,694

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)

Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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
Total	51,814			43,998
Average	1,727	.85	624	1,467

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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	139	1.86	259
	Feb.	153	1.78	272
	Mar.	207	1.64	339
	Apr.	445	1.00	445
	May	2,355	.42	989
	June	1,582	.46	728
- 1941	July	579	.73	423
	Aug.	251	1.67	419
	Sept.	237	1.81	429
	Oct.	579	1.10	637
	Nov.	311	1.18	367
	Dec.	229	1.51	346
	Total	7,067	.80	5,653
	Jan.	181	1.67	302
	Feb.	165	1.73	285
	Mar.	228	1.52	347
	Apr.	1,344	.61	820
	May	1,809	.45	814
	June	1,961	.37	725
- 1942	July	579	.78	451
	Aug.	185	1.84	340
	Sept.	134	2.46	329
	Oct.	162	2.33	378
	Nov.	186	1.99	370
	Dec.	164	1.96	322
	Total	7,098	.77	5,483
	Jan.	153	1.90	291
	Feb.	146	1.85	270
	Mar.	174	1.77	308
	Apr.	709	.64	454
	May	996	.46	458
	June	1,365	.38	518
- 1943	July	502	.78	392
	Aug.	368	1.26	463
	Sept.	212	1.85	392
	Oct.	184	1.84	339
	Nov.	215	1.47	317
	Dec.	190	1.56	296
	Total	5,214	.86	4,498
	Jan.	140	1.77	248
	Feb.	152	1.56	237
	Mar.	166	1.51	251
	Apr.	304	1.09	331
	May	1,784	.41	732
	June	1,843	.35	645
- 1944	July	677	.61	413
	Aug.	149	1.62	241
	Sept.	99	2.54	252
	Oct.	159	2.18	347
	Nov.	196	1.78	348
	Dec.	171	1.70	291
	Total	5,840	.74	4,336
	Jan.	149	1.73	258
	Feb.	151	1.74	263
	Mar.	178	1.56	277
	Apr.	328	.88	289
	May	1,495	.36	538
	June	1,311	.37	485
- 1945	July	676	.67	453
	Aug.	446	1.01	451
	Sept.	146	1.85	270
	Oct.	217	1.75	380
	Nov.	224	1.41	316
	Dec.	183	1.26	230
	Total	5,504	.76	4,210
	Jan.	174	1.37	239
	Feb.	155	1.27	197
	Mar.	191	1.24	236
	Apr.	525	.61	320
	May	726	.49	356
	June	1,027	.42	432
- 1946	July	309	.98	303
	Aug.	196	1.66	325
	Sept.	135	2.10	283
	Oct.	206	1.85	382
	Nov.	206	1.56	322
	Dec.	208	1.37	285
	Total	4,058	.91	3,680
	Jan.	145	1.58	229
	Feb.	150	1.44	216
	Mar.	189	1.39	263
	Apr.	316	.85	268
	May	1,423	.40	569
	June	1,594	.39	621
- 1947	July	985	.47	463
	Aug.	369	1.21	447
	Sept.	259	1.44	373
	Oct.	328	1.47	483
	Nov.	277	1.24	343
	Dec.	223	1.40	312
	Total	6,258	.73	4,587
	Jan.	191	1.34	256
	Feb.	210	1.33	280
	Mar.	245	1.36	333
	Apr.	830	.64	531
	May	1,959	.36	705
	June	1,499	.39	585
- 1948	July	446	.86	384
	Aug.	225	1.52	342
	Sept.	121	1.88	228
	Oct.	175	1.96	343
	Nov.	204	1.67	341
	Dec.	186	1.66	308
	Total	6,291	.74	4,636
	Jan.	188	1.54	289
	Feb.	187	1.35	253
	Mar.	243	1.40	340
	Apr.	615	.67	412
	May	1,289	.41	529
	June	1,910	.37	707
- 1949	July	908	.55	499
	Aug.	224	1.58	354
	Sept.	158	2.08	328
	Oct.	226	1.83	414
	Nov.	210	1.71	359
	Dec.	180	1.66	299
	Total	6,338	.75	4,783
	Jan.	199	1.52	302
	Feb.	201	1.44	289
	Mar.	209	1.31	274
	Apr.	541	.61	330
	May	764	.51	389
	June	1,113	.42	467
- 1950	July	347	1.03	357
	Aug.	109	2.02	220
	Sept.	138	2.12	292
	Oct.	125	2.35	294
	Nov.	161	1.96	316
	Dec.	167	1.75	293
	Total	4,074	.94	3,823
	Jan.	153	1.69	258
	Feb.	151	1.51	228
	Mar.	161	1.46	236
	Apr.	173	1.21	209
	May	758	.54	409
	June	1,173	.43	505
- 1951	July	529	.68	360
	Aug.	238	1.47	350
	Sept.	131	2.06	270
	Oct.	169	1.99	336
	Nov.	178	1.74	310
	Dec.	172	1.67	287
	Total	3,986	.94	3,758
	Jan.	191	1.59	303
	Feb.	155	1.65	256
	Mar.	194	1.48	287
	Apr.	969	.53	514
	May	2,152	.35	753
	June	2,314	.33	764
- 1952	July	641	.72	462
	Aug.	358	1.18	422
	Sept.	213	1.58	337
	Oct.	166	1.92	318
	Nov.	177	1.89	334
	Dec.	188	1.66	313
	Total	7,718	.66	5,063
	Jan.	185	1.65	306
	Feb.	143	1.63	233
	Mar.	187	1.52	284
	Apr.	250	1.00	250
	May	606	.60	364
	June	1,399	.41	574
- 1953	July	353	.95	335
	Aug.	256	1.23	315
	Sept.	128	2.22	284
	Oct.	177	1.89	334
	Nov.	207	1.77	366
	Dec.	171	1.75	299
	Total	4,062	.97	3,944
	Jan.	177	1.76	312
	Feb.	143	1.65	236
	Mar.	161	1.46	235
	Apr.	221	.98	217
	May	436	.74	323
	June	217	1.17	254
- 1954	July	150	1.69	253
	Aug.	98	2.30	225
	Sept.	171	2.09	358
	Oct.	215	1.59	342
	Nov.	164	1.70	278
	Dec.	140	1.90	266
	Total	2,293	1.44	3,299
	Jan.	134	1.84	247
	Feb.	121	1.78	215
	Mar.	198	1.33	263
	Apr.	320	.82	262
	May	752	.50	376
	June	689	.55	379
- 1955	July	214	1.21	259
	Aug.	185	1.66	307
	Sept.	108	2.16	233
	Oct.	119	2.19	261
	Nov.	169	1.89	319
	Dec.	176	1.70	299
	Total	3,185	1.07	3,420
	Jan.	155	1.69	262
	Feb.	141	1.70	239
	Mar.	187	1.50	281
	Apr.	356	.72	256
	May	1,005	.45	452
	June	924	.44	406
- 1956	July	172	1.47	253
	Aug.	119	1.97	234
	Sept.	81	2.38	193
	Oct.	121	2.22	269
	Nov.	165	1.87	308
	Dec.	142	1.94	275
	Total	3,568	.96	3,428
	Jan.	164	1.80	296
	Feb.	168	1.55	260
	Mar.	167	1.56	260
	Apr.	398	.86	342
	May	1,375	.44	605
	June	2,859	.29	829
- 1957	July	1,952	.37	722
	Aug.	661	.83	549
	Sept.	314	1.21	380
	Oct.	292	1.78	520
	Nov.	299	1.44	431
	Dec.	239	1.71	408
	Total	8,888	.63	5,602
	Jan.	200	1.52	304
	Feb.	225	1.34	302
	Mar.	254	1.29	328
	Apr.	756	.53	401
	May	2,032	.31	630
	June	1,560	.40	624
- 1958	July	234	1.22	285
	Aug.	109	2.17	236
	Sept.	153	2.14	328
	Oct.	155	1.99	308
	Nov.	190	1.66	315
	Dec.	176	1.63	287
	Total	6,044	72	4,348

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

Units – 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	168	1.71	287		Jan.	162	1.55	251		Jan.			
	Feb.	153	1.41	216		Feb.	140	1.63	228		Feb.			
	Mar.	150	1.60	240		Mar.	154	1.59	245		Mar.			
	Apr.	163	1.39	227		Apr.	562	.68	382		Apr.			
	May	535	.65	348		May	1,272	.39	496		May			
	June	924	.50	462		June	1,654	.38	629		June			
- 1959	July	214	1.15	246	- 1965	July	1,116	.52	580		July			
	Aug.	160	1.91	306		Aug.	447	.94	420		Aug.			
	Sept.	124	2.14	265		Sept.	369	1.21	446		Sept.			
	Oct.	250	1.43	358		Oct.	360	1.32	475		Oct.			
	Nov.	210	1.31	275		Nov.	249	1.65	411		Nov.			
	Dec.	163	1.54	251		Dec.	237	1.39	329		Dec.			
	Total	3,214	1.08	3,481		Total	6,722	.73	4,892		Total			
	Jan.	164	1.51	248		Jan.	200	1.38	276		Jan.			
	Feb.	143	1.51	216		Feb.	169	1.34	226		Feb.			
	Mar.	273	1.22	333		Mar.	278	.96	267		Mar.			
	Apr.	629	.51	321		Apr.	438	.61	267		Apr.			
	May	758	.49	371		May	697	.53	369		May			
	June	1,068	.42	448		June	429	.83	356		June			
- 1960	July	250	1.04	260	- 1966	July	185	1.50	278		July			
	Aug.	105	1.96	206		Aug.	120	1.89	227		Aug.			
	Sept.	117	2.16	253		Sept.	145	2.01	291		Sept.			
	Oct.	153	1.94	297		Oct.	175	1.87	327		Oct.			
	Nov.	177	1.67	296		Nov.	153	1.89	289		Nov.			
	Dec.	165	1.48	244		Dec.	174	1.71	298		Dec.			
	Total	4,002	.87	3,493		Total	3,163	1.10	3,471		Total			
	Jan.	156	1.43	223		Jan.	146	1.77	258		Jan.			
	Feb.	140	1.52	213		Feb.	136	1.71	233		Feb.			
	Mar.	162	1.44	233		Mar.	185	1.30	240		Mar.			
	Apr.	206	1.14	235		Apr.	198	1.31	259		Apr.			
	May	677	.57	386		May	462	.76	351		May			
	June	664	.51	339		June	713	.65	463		June			
- 1961	July	130	1.62	211	- 1967	July	327	1.09	356		July			
	Aug.	138	2.01	277		Aug.	175	1.76	308		Aug.			
	Sept.	316	1.49	471		Sept.	178	1.77	315		Sept.			
	Oct.	357	1.07	382		Oct.	174	1.39	242		Oct.			
	Nov.	252	1.23	310		Nov.	211	1.39	293		Nov.			
	Dec.	197	1.40	276		Dec.	241	1.18	284		Dec.			
	Total	3,395	1.05	3,556		Total	3,146	1.14	3,602		Total			
	Jan.	182	1.29	235		Jan.	205	1.18	242		Jan.			
	Feb.	261	1.12	292		Feb.	193	1.20	232		Feb.			
	Mar.	246	1.05	258		Mar.	171	1.41	241		Mar.			
	Apr.	1,054	.44	464		Apr.	230	.99	228		Apr.			
	May	1,603	.38	609		May	667	.60	400		May			
	June	1,400	.38	532		June	1,171	.44	515		June			
- 1962	July	765	.58	444	- 1968	July	306	1.08	330		July			
	Aug.	206	1.42	293		Aug.	365	1.23	449		Aug.			
	Sept.	173	1.99	344		Sept.	159	1.72	273		Sept.			
	Oct.	263	1.43	376		Oct.	213	1.63	347		Oct.			
	Nov.	243	1.31	318		Nov.	257	1.28	329		Nov.			
	Dec.	180	1.77	319		Dec.	248	1.14	283		Dec.			
	Total	6,576	.68	4,484		Total	4,185	.92	3,869		Total			
	Jan.	163	1.52	248		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			
- 1963	July	114	1.94	221	- 1969	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	1.84	254		Dec.	252	1.06	267		Dec.			
	Total	2,585	1.31	3,384		Total	4,906	.77	3,777		Total			
	Jan.	132	1.85	244		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			
- 1964	July	276	1.07	295	- 1970	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.	360	.99	357		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)

Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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	772	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
Total	148,800			124,231
Average	4,960	.83	613	4,141

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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	22	0.41	9
	Feb.	46	.35	16
	Mar.	98	.38	37
	Apr.	251	.21	53
	May	709	.16	113
	June	560	.12	68
- 1941	July	324	.14	46
	Aug.	84	.19	16
	Sept.	68	.24	16
	Oct.	273	.12	33
	Nov.	87	.17	15
	Dec.	52	.21	11
	Total	2,574	.17	430
	Jan.	45	.33	15
	Feb.	48	.25	12
	Mar.	54	.42	23
	Apr.	383	.21	82
	May	320	.15	48
	June	310	.12	38
- 1942	July	76	.18	14
	Aug.	41	.22	9
	Sept.	28	.25	7
	Oct.	23	.26	6
	Nov.	22	.27	6
	Dec.	16	.38	6
	Total	1,366	.19	266
	Jan.	16	.44	7
	Feb.	26	.35	9
	Mar.	55	.38	21
	Apr.	198	.19	37
	May	184	.16	30
	June	134	.15	20
- 1943	July	51	.24	12
	Aug.	48	.21	10
	Sept.	28	.25	7
	Oct.	35	.20	7
	Nov.	24	.29	7
	Dec.	19	.32	6
	Total	818	.21	173
	Jan.	16	.38	6
	Feb.	19	.32	6
	Mar.	34	.47	16
	Apr.	131	.21	27
	May	371	.16	61
	June	382	.13	49
- 1944	July	134	.16	22
	Aug.	45	.20	9
	Sept.	43	.23	10
	Oct.	41	.22	9
	Nov.	21	.29	6
	Dec.	14	.43	6
	Total	1,251	.18	227
	Jan.	14	.43	6
	Feb.	22	.45	10
	Mar.	35	.49	17
	Apr.	143	.20	28
	May	278	.16	44
	June	209	.13	28
- 1945	July	68	.21	14
	Aug.	40	.22	9
	Sept.	21	.24	5
	Oct.	30	.37	11
	Nov.	19	.37	7
	Dec.	12	.50	6
	Total	891	.21	185
	Jan.	14	.43	6
	Feb.	17	.47	8
	Mar.	22	.50	11
	Apr.	66	.23	15
	May	73	.18	13
	June	87	.18	16
- 1946	July	27	.33	9
	Aug.	40	.35	14
	Sept.	29	.31	9
	Oct.	36	.31	11
	Nov.	26	.35	9
	Dec.	19	.32	6
	Total	456	.28	127

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	15	0.40	6
	Feb.	24	.38	9
	Mar.	32	.34	11
	Apr.	50	.24	12
	May	186	.17	32
	June	140	.13	18
- 1947	July	43	.28	12
	Aug.	73	.30	22
	Sept.	56	.23	13
	Oct.	77	.21	16
	Nov.	37	.22	8
	Dec.	27	.26	7
	Total	760	.22	166
	Jan.	27	.26	7
	Feb.	39	.33	13
	Mar.	43	.35	15
	Apr.	246	.20	49
	May	306	.14	43
	June	338	.12	40
- 1948	July	79	.16	13
	Aug.	49	.24	12
	Sept.	22	.32	7
	Oct.	23	.35	8
	Nov.	18	.39	7
	Dec.	13	.46	6
	Total	1,203	.18	220
	Jan.	16	.44	7
	Feb.	25	.36	9
	Mar.	73	.37	27
	Apr.	228	.24	55
	May	318	.15	48
	June	406	.13	53
- 1949	July	199	.15	30
	Aug.	57	.24	14
	Sept.	33	.27	9
	Oct.	30	.30	9
	Nov.	21	.38	8
	Dec.	14	.50	7
	Total	1,420	.19	276
	Jan.	16	.37	6
	Feb.	29	.41	12
	Mar.	31	.42	13
	Apr.	116	.19	22
	May	126	.15	19
	June	112	.16	18
- 1950	July	44	.27	12
	Aug.	20	.35	7
	Sept.	24	.38	9
	Oct.	20	.35	7
	Nov.	14	.50	7
	Dec.	12	.50	6
	Total	564	.24	138
	Jan.	10	.50	5
	Feb.	11	.45	5
	Mar.	20	.45	9
	Apr.	35	.29	10
	May	117	.18	21
	June	94	.17	16
- 1951	July	21	.38	8
	Aug.	33	.36	12
	Sept.	22	.36	8
	Oct.	17	.47	8
	Nov.	15	.47	7
	Dec.	18	.44	8
	Total	413	.28	117
	Jan.	19	.53	10
	Feb.	19	.53	10
	Mar.	47	.49	23
	Apr.	326	.26	85
	May	396	.16	63
	June	454	.13	59
- 1952	July	136	.18	24
	Aug.	66	.26	17
	Sept.	33	.27	9
	Oct.	22	.32	7
	Nov.	16	.44	7
	Dec.	18	.39	7
	Total	1,552	.21	321

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	18	0.39	7
	Feb.	18	.39	7
	Mar.	37	.41	15
	Apr.	75	.24	18
	May	117	.19	22
	June	148	.15	22
- 1953	July	41	.32	13
	Aug.	33	.33	11
	Sept.	16	.44	7
	Oct.	23	.43	10
	Nov.	23	.43	10
	Dec.	14	.50	7
	Total	563	.26	149
	Jan.	11	.45	5
	Feb.	21	.48	10
	Mar.	28	.46	13
	Apr.	90	.21	19
	May	143	.18	26
	June	67	.19	13
- 1954	July	37	.41	15
	Aug.	45	.29	13
	Sept.	30	.43	13
	Oct.	42	.24	10
	Nov.	18	.39	7
	Dec.	13	.46	6
	Total	545	.28	150
	Jan.	12	.42	5
	Feb.	13	.31	4
	Mar.	27	.37	10
	Apr.	45	.24	11
	May	132	.18	24
	June	119	.16	19
- 1955	July	42	.29	12
	Aug.	67	.28	19
	Sept.	28	.29	8
	Oct.	20	.30	6
	Nov.	17	.35	6
	Dec.	15	.40	6
	Total	537	.24	130
	Jan.	16	.38	6
	Feb.	15	.40	6
	Mar.	48	.33	16
	Apr.	79	.20	16
	May	173	.14	24
	June	117	.15	18
- 1956	July	25	.32	8
	Aug.	23	.35	8
	Sept.	11	.36	4
	Oct.	12	.42	5
	Nov.	11	.45	5
	Dec.	9	.44	4
	Total	539	.22	120
	Jan.	13	.46	6
	Feb.	30	.47	14
	Mar.	46	.43	20
	Apr.	120	.28	34
	May	222	.19	42
	June	480	.13	62
- 1957	July	326	.16	52
	Aug.	164	.22	36
	Sept.	67	.19	13
	Oct.	67	.30	20
	Nov.	68	.26	18
	Dec.	44	.30	13
	Total	1,647	.20	330
	Jan.	22	.36	8
	Feb.	51	.43	22
	Mar.	77	.42	32
	Apr.	279	.30	84
	May	460	.17	78
	June	270	.13	35
- 1958	July	42	.26	11
	Aug.	35	.31	11
	Sept.	40	.30	12
	Oct.	25	.36	9
	Nov.	17	.41	7
	Dec.	14	.43	6
	Total	1,332	.24	315

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

Units - 1000

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

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)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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	15[illegible]
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
Total	27,374			5,906
Average	912	.22	159	197

Sampled quality record, October 1945 to December 1970; remainder by correlation.

Measured flow record entire period.

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

Table 11

Colorado River Basin

Historical Flow and Quality of Water Data

San Juan River near Bluff, Utah

Units-1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	78	1.01	79
	Feb.	127	.98	124
	Mar.	211	.78	165
	Apr.	392	.62	243
	May	1,323	.50	662
	June	915	.30	275
-1941	July	526	.30	158
	Aug.	174	.70	122
	Sept.	202	.87	176
	Oct.	655	.64	419
	Nov.	191	.61	117
	Dec.	105	.81	85
	Total	4,899	.54	2,625
	Jan.	81	.93	75
	Feb.	68	.93	63
	Mar.	126	.95	120
	Apr.	602	.51	307
	May	479	.38	182
	June	533	.26	139
-1942	July	150	.48	72
	Aug.	51	.82	42
	Sept.	38	1.00	38
	Oct.	37	1.22	45
	Nov.	39	1.23	48
	Dec.	43	1.26	54
	Total	2,247	.53	1,185
	Jan.	43	1.26	54
	Feb.	49	1.18	58
	Mar.	95	1.09	104
	Apr.	294	.47	138
	May	332	.39	129
	June	254	.38	96
-1943	July	106	.57	60
	Aug.	91	1.01	92
	Sept.	62	.90	56
	Oct.	58	1.00	58
	Nov.	59	.97	57
	Dec.	51	1.12	57
	Total	1,494	.64	959
	Jan.	37	1.16	43
	Feb.	49	1.14	56
	Mar.	76	1.06	81
	Apr.	204	.62	126
	May	640	.36	230
	June	705	.25	176
-1944	July	283	.35	99
	Aug.	61	.85	52
	Sept.	66	.92	61
	Oct.	75	.91	68
	Nov.	52	1.12	58
	Dec.	43	1.19	51
	Total	2,291	.48	1,101
	Jan.	41	1.22	50
	Feb.	63	1.13	71
	Mar.	72	1.03	74
	Apr.	196	.61	120
	May	456	.35	160
	June	377	.29	109
-1945	July	128	.50	64
	Aug.	96	1.13	108
	Sept.	21	1.18	25
	Oct.	62	1.10	68
	Nov.	46	1.04	48
	Dec.	30	1.27	38
	Total	1,588	.59	935
	Jan.	37	1.14	42
	Feb.	36	1.19	43
	Mar.	47	1.04	49
	Apr.	95	.66	63
	May	125	.49	61
	June	204	.40	82
-1946	July	63	.86	54
	Aug.	75	1.12	84
	Sept.	44	.93	41
	Oct.	55	.98	54
	Nov.	60	1.02	61
	Dec.	46	1.02	47
	Total	887	.77	681

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	31	1.13	35
	Feb.	45	1.07	48
	Mar.	51	.90	46
	Apr.	68	.63	43
	May	329	.38	125
	June	276	.30	83
-1947	July	110	.41	45
	Aug.	294	1.01	296
	Sept.	124	.73	91
	Oct.	207	.79	163
	Nov.	77	.73	56
	Dec.	65	.86	56
	Total	1,677	.65	1,087
	Jan.	52	.83	43
	Feb.	79	.84	66
	Mar.	89	.83	74
	Apr.	358	.37	133
	May	519	.27	140
	June	603	.28	169
-1948	July	147	.41	60
	Aug.	86	.78	67
	Sept.	36	1.11	40
	Oct.	75	1.05	79
	Nov.	55	1.07	59
	Dec.	41	1.12	46
	Total	2,140	.46	976
	Jan.	63	1.11	70
	Feb.	74	.99	73
	Mar.	152	.81	123
	Apr.	338	.45	152
	May	503	.31	156
	June	748	.31	232
-1949	July	342	.33	113
	Aug.	90	.66	59
	Sept.	41	1.05	43
	Oct.	56	1.00	56
	Nov.	45	1.07	48
	Dec.	35	1.23	43
	Total	2,487	.47	1,168
	Jan.	41	1.12	46
	Feb.	49	1.08	53
	Mar.	56	.93	52
	Apr.	136	.46	62
	May	169	.40	68
	June	191	.38	73
-1950	July	68	.72	49
	Aug.	15	1.13	17
	Sept.	42	1.14	48
	Oct.	30	1.07	32
	Nov.	25	1.44	36
	Dec.	32	1.34	43
	Total	854	.68	579
	Jan.	30	1.30	39
	Feb.	29	1.41	41
	Mar.	34	1.15	39
	Apr.	34	.85	29
	May	142	.51	72
	June	188	.36	68
-1951	July	30	.80	24
	Aug.	49	1.06	52
	Sept.	45	1.07	48
	Oct.	35	1.23	43
	Nov.	39	1.10	43
	Dec.	36	1.28	46
	Total	691	.79	544
	Jan.	88	1.16	102
	Feb.	40	1.20	48
	Mar.	87	1.03	90
	Apr.	453	.42	190
	May	618	.30	185
-1952	June	769	.24	185
	July	238	.42	100
	Aug.	83	.69	57
	Sept.	56	.93	52
	Oct.	38	1.05	40
	Nov.	41	1.29	53
	Dec.	43	1.26	54
	Total	2,554	.45	1,156

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	42	1.24	52
	Feb.	36	1.17	42
	Mar.	56	1.02	57
	Apr.	107	.64	68
	May	156	.44	69
	June	267	.27	72
-1953	July	77	.84	65
	Aug.	71	1.15	82
	Sept.	12	1.50	18
	Oct.	54	1.28	69
	Nov.	55	1.13	62
	Dec.	34	1.31	45
	Total	967	.73	701
	Jan.	32	1.34	43
	Feb.	36	1.17	42
	Mar.	48	1.02	49
	Apr.	113	.53	60
	May	218	.39	85
	June	120	.48	58
-1954	July	120	1.03	123
	Aug.	66	.86	57
	Sept.	89	1.19	106
	Oct.	95	.75	71
	Nov.	39	1.05	41
	Dec.	35	1.26	44
	Total	1,011	.77	779
	Jan.	31	1.26	39
	Feb.	34	1.12	38
	Mar.	63	1.00	63
	Apr.	62	.74	46
	May	186	.38	71
	June	208	.32	67
-1955	July	65	.88	57
	Aug.	142	1.07	152
	Sept.	28	.82	23
	Oct.	25	1.00	25
	Nov.	31	1.26	39
	Dec.	35	1.34	47
	Total	910	.73	667
	Jan.	40	1.22	49
	Feb.	34	1.29	44
	Mar.	74	.83	61
	Apr.	107	.50	54
	May	241	.35	84
	June	203	.31	63
-1956	July	31	1.10	34
	Aug.	36	1.33	48
	Sept.	4	1.50	6
	Oct.	13	1.54	20
	Nov.	30	1.23	37
	Dec.	25	1.40	35
	Total	838	.64	535
	Jan.	38	1.26	48
	Feb.	64	1.05	67
	Mar.	71	.97	69
	Apr.	171	.55	94
	May	327	.48	157
	June	787	.28	220
-1957	July	566	.38	215
	Aug.	364	.63	229
	Sept.	142	.68	97
	Oct.	150	.86	129
	Nov.	141	.72	102
	Dec.	88	.81	71
	Total	2,909	.51	1,498
	Jan.	53	1.02	54
	Feb.	119	.92	109
	Mar.	159	.87	139
	Apr.	413	.48	198
	May	743	.26	193
-1958	June	507	.25	126
	July	74	.65	48
	Aug.	43	1.02	43
	Sept.	61	.95	58
	Oct.	47	1.04	49
	Nov.	43	1.23	53
	Dec.	36	1.28	46
	Total	2,298	.49	1,116

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

Table 11

Colorado River Basin

Historical Flow and Quality of Water Data

San Juan River near Bluff, Utah

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	30	1.39	42
	Feb.	31	1.36	42
	Mar.	32	1.27	41
	Apr.	39	.94	37
	May	111	.52	58
	June	156	.39	[illegible]
-1959	July	18	.81	15
	Aug.	64	1.13	72
	Sept.	11	1.53	17
	Oct.	92	.86	79
	Nov.	82	.82	67
	Dec.	46	1.02	47
	Total	712	.81	578
	Jan.	37	1.26	47
	Feb.	43	1.09	47
	Mar.	260	.73	[illegible]
	Apr.	336	.32	[illegible]
	May	285	.34	97
	June	382	.27	103
-1960	July	92	.53	[illegible]
	Aug.	18	1.11	20
	Sept.	17	1.24	[illegible]
	Oct.	56	1.13	63
	Nov.	39	1.22	48
	Dec.	40	1.27	51
	Total	1,607	.53	[illegible]
	Jan.	35	1.33	47
	Feb.	41	1.31	54
	Mar.	66	1.02	67
	Apr.	157	.56	[illegible]
	May	285	.32	92
	June	227	.31	70
-1961	July	43	.83	36
	Aug.	87	1.05	91
	Sept.	109	.88	96
	Oct.	95	.77	75
	Nov.	72	.93	67
	Dec.	44	1.22	54
	Total	1,264	.66	836
	Jan.	36	1.24	45
	Feb.	94	.95	89
	Mar.	73	.99	72
	Apr.	315	.37	117
	May	346	.30	104
	June	297	.32	95
-1962	July	88	.59	52
	Aug.	23	1.02	23
	Sept.	26	1.41	37
	Oct.	104	1.32	137
	Nov.	45	1.34	[illegible]
	Dec.	33	1.40	46
	Total	1,480	.59	877
	Jan.	25	1.66	42
	Feb.	39	1.44	56
	Mar.	40	1.25	50
	Apr.	64	.78	50
	May	95	.72	68
-1963	June	47	.82	39
	July	15	1.60	24
	Aug.	48	1.57	75
	Sept.	70	1.09	76
	Oct.	41	1.32	54
	Nov.	47	1.10	52
	Dec.	48	1.03	49
	Total	579	1.10	635
	Jan.	44	1.14	50
	Feb.	30	1.27	35
	Mar.	28	1.46	41
	Apr.	30	1.40	42
	May	103	.57	59
	June	121	.58	[illegible]
-1964	July	113	.76	86
	Aug.	131	1.07	140
	Sept.	56	1.36	76
	Oct.	37	1.26	47
	Nov.	42	1.43	60
	Dec.	60	1.20	72
	Total	795	.98	781

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	122	0.77	94
	Feb.	120	.70	84
	Mar.	85	.93	79
	Apr.	165	.62	102
	May	288	.45	130
	June	419	.38	159
-1965	July	295	.45	133
	Aug.	218	.65	142
	Sept.	177	.56	99
	Oct.	190	.60	114
	Nov.	232	.50	116
	Dec.	235	.54	127
	Total	2,546	.54	1,379
	Jan.	198	0.54	107
	Feb.	129	.65	84
	Mar.	199	.68	135
	Apr.	252	.48	121
	May	267	.42	112
	June	127	.56	71
-1966	July	54	1.01	55
	Aug.	41	1.30	57
	Sept.	42	1.25	52
	Oct.	94	.66	62
	Nov.	70	.86	60
	Dec.	72	1.11	80
	Total	1,548	.64	996
	Jan.	58	1.07	62
	Feb.	64	.92	59
	Mar.	79	.71	56
	Apr.	31	1.15	36
	May	78	.76	59
	June	89	.91	81
-1967	July	39	1.35	53
	Aug.	151	1.29	195
	Sept.	94	.96	90
	Oct.	31	1.46	45
	Nov.	38	1.26	48
	Dec.	39	1.20	47
	Total	791	1.05	831
	Jan.	36	1.22	44
	Feb.	54	1.29	70
	Mar.	50	1.25	62
	Apr.	83	.75	62
	May	148	.54	80
	June	240	.37	89
-1968	July	82	.93	76
	Aug.	176	1.04	183
	Sept.	41	1.00	41
	Oct.	56	1.09	61
	Nov.	49	1.18	58
	Dec.	45	1.07	48
	Total	1,060	.82	874
	Jan.	83	1.04	86
	Feb.	131	.61	80
	Mar.	143	.73	104
	Apr.	216	.54	117
	May	271	.40	108
	June	238	.45	107
-1969	July	202	.57	115
	Aug.	101	.88	89
	Sept.	118	.76	90
	Oct.	208	.83	173
	Nov.	118	.64	75
	Dec.	109	.65	71
	Total	1,938	.63	1,215
	Jan.	75	.77	58
	Feb.	130	.49	64
	Mar.	116	.57	66
	Apr.	49	.96	47
	May	[illegible]	[illegible]	[illegible]
	June	138	.49	67
-1970	July	74	.73	54
	Aug.	66	1.09	72
	Sept.	303	[illegible]	[illegible]
	Oct.	[illegible]	[illegible]	[illegible]
	Nov.	[illegible]	[illegible]	[illegible]
	Dec.	[illegible]	[illegible]	[illegible]
	Total	1,524	.63	954

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)

Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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	440	954
Total	48,586			29,095
Average	1,620	.60	440	970

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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	348	1.36	474
	Feb.	423	1.29	546
	Mar.	669	1.12	749
	Apr.	1,091	.79	862
	May	4,974	.45	2,239
	June	4,004	.38	1,522
-1941	July	1,666	.51	850
	Aug.	798	1.16	925
	Sept.	608	1.35	821
	Oct.	1,797	1.09	1,959
	Nov.	903	.94	849
	Dec.	576	1.19	685
	Total	17,857	.70	12,481
	Jan.	407	1.34	545
	Feb.	396	1.28	507
	Mar.	630	1.16	731
	Apr.	2,844	.55	1,564
	May	3,209	.46	1,476
	June	4,202	.29	1,219
-1942	July	1,317	.57	751
	Aug.	454	1.08	490
	Sept.	275	1.59	438
	Oct.	334	1.58	528
	Nov.	368	1.58	582
	Dec.	357	1.54	550
	Total	14,793	.63	9,381
	Jan.	330	1.50	494
	Feb.	332	1.41	469
	Mar.	516	1.19	614
	Apr.	1,450	.67	971
	May	2,158	.43	928
	June	2,729	.40	1,092
-1943	July	1,429	.47	672
	Aug.	793	1.09	864
	Sept.	447	1.15	514
	Oct.	378	1.60	604
	Nov.	456	1.35	616
	Dec.	395	1.36	537
	Total	11,413	.73	8,375
	Jan.	278	1.50	418
	Feb.	344	1.32	454
	Mar.	509	1.31	668
	Apr.	1,027	.89	914
	May	3,251	.47	1,528
	June	4,136	.32	1,323
-1944	July	1,782	.45	802
	Aug.	417	1.07	446
	Sept.	229	1.50	343
	Oct.	342	1.66	567
	Nov.	384	1.51	579
	Dec.	320	1.51	483
	Total	13,019	.65	8,525
	Jan.	325	1.48	481
	Feb.	352	1.39	489
	Mar.	437	1.28	559
	Apr.	755	.99	748
	May	2,805	.44	1,234
	June	2,761	.37	1,021
-1945	July	1,668	.47	784
	Aug.	1,011	.89	900
	Sept.	370	1.28	474
	Oct.	505	1.51	763
	Nov.	443	1.34	594
	Dec.	337	1.35	454
	Total	11,769	.72	8,501
	Jan.	366	1.28	468
	Feb.	319	1.24	396
	Mar.	496	1.15	570
	Apr.	1,013	.83	841
	May	1,732	.47	814
	June	1,993	.43	857
-1946	July	730	.73	533
	Aug.	478	1.28	612
	Sept.	310	1.62	502
	Oct.	403	1.50	604
	Nov.	466	1.30	607
	Dec.	445	1.22	542
	Total	8,751	.84	7,346
	Jan.	277	1.40	388
	Feb.	357	1.29	462
	Mar.	654	1.09	713
	Apr.	780	.78	608
	May	3,121	.39	1,217
	June	3,275	.40	1,310
-1947	July	1,926	.43	828
	Aug.	1,203	.98	1,179
	Sept.	584	1.13	660
	Oct.	818	1.17	958
	Nov.	585	1.07	626
	Dec.	466	1.21	564
	Total	14,046	.68	9,513
	Jan.	406	1.18	479
	Feb.	458	1.14	522
	Mar.	645	1.14	735
	Apr.	1,703	.64	1,090
	May	3,507	.38	1,333
	June	3,339	.34	1,135
-1948	July	980	.65	637
	Aug.	531	1.23	653
	Sept.	230	1.40	322
	Oct.	331	1.65	545
	Nov.	408	1.46	595
	Dec.	347	1.40	485
	Total	12,885	.66	8,531
	Jan.	337	1.39	469
	Feb.	361	1.25	451
	Mar.	706	1.18	834
	Apr.	1,307	.78	1,020
	May	3,098	.43	1,332
	June	4,419	.41	1,812
-1949	July	2,137	.52	1,111
	Aug.	576	1.00	576
	Sept.	313	1.51	473
	Oct.	509	1.48	753
	Nov.	473	1.31	619
	Dec.	368	1.37	504
	Total	14,604	.68	9,954
	Jan.	350	1.41	493
	Feb.	399	1.23	490
	Mar.	650	1.11	721
	Apr.	1,217	.74	900
	May	1,971	.49	966
	June	2,979	.37	1,102
-1950	July	1,377	.67	923
	Aug.	422	1.02	430
	Sept.	330	1.47	485
	Oct.	342	1.47	502
	Nov.	350	1.55	542
	Dec.	415	1.31	544
	Total	10,802	.75	8,098
	Jan.	315	1.43	451
	Feb.	361	1.25	451
	Mar.	418	1.19	497
	Apr.	531	1.00	531
	May	1,645	.57	938
	June	2,886	.41	1,184
-1951	July	1,357	.48	651
	Aug.	787	1.11	874
	Sept.	411	1.32	542
	Oct.	412	1.47	606
	Nov.	445	1.41	628
	Dec.	333	1.44	480
	Total	9,901	.79	7,833
	Jan.	476	1.23	586
	Feb.	379	1.26	478
	Mar.	440	1.31	576
	Apr.	2,267	.74	1,677
	May	5,081	.41	2,083
	June	5,192	.36	1,869
-1952	July	1,573	.55	865
	Aug.	821	1.06	870
	Sept.	542	1.31	710
	Oct.	368	1.43	527
	Nov.	386	1.55	599
	Dec.	378	1.47	556
	Total	17,903	.64	11,396
	Jan.	393	1.36	534
	Feb.	365	1.30	475
	Mar.	458	1.22	558
	Apr.	529	1.07	566
	May	1,047	.69	723
	June	2,992	.38	1,137
-1953	July	950	.64	608
	Aug.	661	1.19	787
	Sept.	258	1.59	410
	Oct.	321	1.77	568
	Nov.	414	1.50	621
	Dec.	341	1.46	498
	Total	8,729	.86	7,486
	Jan.	319	1.46	466
	Feb.	342	1.30	444
	Mar.	393	1.24	487
	Apr.	546	1.00	546
	May	1,277	.56	715
	June	792	.63	499
-1954	July	647	.87	563
	Aug.	321	1.19	382
	Sept.	389	1.66	645
	Oct.	512	1.43	733
	Nov.	349	1.39	485
	Dec.	278	1.51	421
	Total	6,165	1.04	6,386
	Jan.	244	1.58	386
	Feb.	243	1.39	338
	Mar.	580	1.29	748
	Apr.	617	1.05	649
	May	1,570	.56	879
	June	1,586	.49	777
-1955	July	571	.70	399
	Aug.	510	1.40	713
	Sept.	230	1.60	368
	Oct.	214	1.70	363
	Nov.	275	1.67	458
	Dec.	326	1.44	470
	Total	6,966	.94	6,548
	Jan.	373	1.28	477
	Feb.	280	1.39	390
	Mar.	511	1.16	592
	Apr.	898	.75	673
	May	2,190	.48	1,051
	June	2,594	.39	1,012
-1956	July	557	.75	418
	Aug.	356	1.33	473
	Sept.	166	1.48	246
	Oct.	186	1.74	324
	Nov.	300	1.58	474
	Dec.	247	1.55	383
	Total	8,658	.75	6,513
	Jan.	284	1.46	415
	Feb.	323	1.34	433
	Mar.	498	1.23	613
	Apr.	828	.90	745
	May	2,569	.56	1,439
	June	5,645	.39	2,201
-1957	July	4,015	.43	1,727
	Aug.	1,604	.78	1,251
	Sept.	822	1.03	847
	Oct.	748	1.54	1,150
	Nov.	848	1.39	1,179
	Dec.	516	1.25	646
	Total	18,700	.68	12,646
	Jan.	397	1.27	504
	Feb.	536	1.18	632
	Mar.	696	1.10	766
	Apr.	1,574	.64	1,007
	May	3,992	.46	1,836
	June	3,678	.40	1,471
-1958	July	628	.74	465
	Aug.	286	1.43	409
	Sept.	319	1.69	540
	Oct.	310	1.63	505
	Nov.	357	1.65	589
	Dec.	366	1.52	556
	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

Units – 1000

Year	Month	Flow (A.F.)	Concen-tration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concen-tration (T./A.F.)	T.D.S. (Tons)	Year	Month	Flow (A.F.)	Concen-tration (T./A.F.)	T.D.S. (Tons)
	Jan.	315	1.48	466		Jan.	558	0.98	547		Jan.			
	Feb.	315	1.36	428		Feb.	515	1.02	525		Feb.			
	Mar.	344	1.37	471		Mar.	556	1.01	562		Mar.			
	Apr.	420	1.16	487		Apr.	1,222	1.03	1,259		Apr.			
	May	1,025	.70	718		May	2,284	.95	2,170		May			
	June	1,836	.48	881		June	2,323	.88	2,044		June			
-1959	July	782	.63	493	-1965	July	727	.48	349		July			
	Aug.	425	1.43	608		Aug.	871	.41	357		Aug.			
	Sept.	246	1.68	413		Sept.	750	.40	300		Sept.			
	Oct.	502	1.41	708		Oct.	659	.43	283		Oct.			
	Nov.	499	1.21	604		Nov.	589	.47	277		Nov.			
	Dec.	352	1.39	489		Dec.	531	.63	335		Dec.			
	Total	7,061	.96	6,766		Total	11,585	.78	9,008		Total			
	Jan.	305	1.54	470		Jan.	451	0.73	329		Jan.			
	Feb.	318	1.34	426		Feb.	483	.76	367		Feb.			
	Mar.	745	1.18	879		Mar.	622	.76	473		Mar.			
	Apr.	1,610	.62	998		Apr.	825	.77	635		Apr.			
	May	1,564	.51	798		May	978	.72	704		May			
	June	2,239	.43	963		June	754	.71	535		June			
-1960	July	647	.69	446	-1966	July	658	.66	434		July			
	Aug.	208	1.38	287		Aug.	682	.65	443		Aug.			
	Sept.	193	1.90	367		Sept.	622	.66	411		Sept.			
	Oct.	341	1.67	569		Oct.	551	.65	358		Oct.			
	Nov.	345	1.47	507		Nov.	584	.66	385		Nov.			
	Dec.	275	1.39	382		Dec.	529	.69	365		Dec.			
	Total	8,790	.81	7,092		Total	7,739	.70	5,439		Total			
	Jan.	266	1.48	394		Jan.	614	.76	467		Jan.			
	Feb.	331	1.34	444		Feb.	534	.79	422		Feb.			
	Mar.	362	1.34	485		Mar.	690	.89	614		Mar.			
	Apr.	567	1.02	578		Apr.	788	1.03	812		Apr.			
	May	1,153	.59	680		May	879	.93	817		May			
	June	1,588	.45	715		June	698	.99	691		June			
-1961	July	369	.89	328	-1967	July	641	.81	519		July			
	Aug.	336	1.65	554		Aug.	693	.71	492		Aug.			
	Sept.	710	1.61	1,143		Sept.	596	.75	447		Sept.			
	Oct.	725	1.01	732		Oct.	415	.73	303		Oct.			
	Nov.	527	1.04	548		Nov.	460	.76	350		Nov.			
	Dec.	380	1.22	464		Dec.	552	.82	453		Dec.			
	Total	7,314	.97	7,065		Total	7,560	.84	6,387		Total			
	Jan.	349	1.24	433		Jan.	633	.93	589		Jan.			
	Feb.	791	1.03	815		Feb.	464	.97	450		Feb.			
	Mar.	598	1.13	676		Mar.	858	1.02	875		Mar.			
	Apr.	2,391	.71	1,698		Apr.	968	1.02	987		Apr.			
	May	3,633	.44	1,599		May	943	1.05	990		May			
	June	2,876	.45	1,294		June	894	1.00	894		June			
-1962	July	1,717	.57	979	-1968	July	827	.81	670		July			
	Aug.	469	1.02	478		Aug.	685	.70	480		Aug.			
	Sept.	315	1.61	507		Sept.	635	.70	444		Sept.			
	Oct.	539	1.52	819		Oct.	620	.69	428		Oct.			
	Nov.	428	1.28	548		Nov.	616	.67	413		Nov.			
	Dec.	333	1.42	473		Dec.	639	.79	505		Dec.			
	Total	14,439	.71	10,319		Total	8,782	.88	7,725		Total			
	Jan.	169	1.69	286		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	.91	798		June			
-1963	July	90	.95	86	-1969	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			
	Jan.	71	1.33	94		Jan.	706	.84	593		Jan.			
	Feb.	231	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	888		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	-1970	July	769	.86	658		July			
-1964	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.	398	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)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./1)	T.D.S. (Tons)
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
Total	315,224			238,796
Average	10,507	.76	556	7,960

Sampled quality record November 1942 to October 1945, October 1947 to December 1970; 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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	434	1.42	616
	Feb.	515	1.31	675
	Mar.	838	1.17	980
	Apr.	1,209	.87	1,052
	May	4,976	.50	2,488
	June	4,100	.45	1,845
-1941	July	1,753	.55	964
	Aug.	861	1.29	1,111
	Sept.	659	1.43	942
	Oct.	1,904	1.14	2,171
	Nov.	953	.98	934
	Dec.	594	1.22	725
	Total	18,796	.77	14,503
	Jan.	430	1.40	602
	Feb.	435	1.33	579
	Mar.	653	1.25	816
	Apr.	2,763	.60	1,658
	May	3,163	.49	1,550
	June	4,241	.32	1,357
-1942	July	1,345	.59	794
	Aug.	486	1.15	559
	Sept.	294	1.67	491
	Oct.	356	1.67	575
	Nov.	386	1.67	645
	Dec.	373	1/1.50	560
	Total	14,925	.68	10,186
	Jan.	347	1/1.49	517
	Feb.	351	1/1.48	519
	Mar.	580	1/1.26	731
	Apr.	1,417	1/.83	1,176
	May	2,161	1/.57	1,232
	June	2,676	1/.49	1,311
-1943	July	1,459	1/.60	875
	Aug.	834	1/1.17	976
	Sept.	494	1/1.40	692
	Oct.	408	1.69	690
	Nov.	477	1.47	701
	Dec.	420	1.46	613
	Total	11,624	.86	10,033
	Jan.	298	1.61	480
	Feb.	363	1.23	446
	Mar.	551	1.41	777
	Apr.	1,099	.95	1,044
	May	3,206	.55	1,763
	June	4,144	.41	1,699
-1944	July	1,854	.52	964
	Aug.	456	1.14	520
	Sept.	251	1.61	404
	Oct.	362	1.78	644
	Nov.	401	1.64	658
	Dec.	345	1.59	549
	Total	13,330	.75	9,948
	Jan.	356	1.55	552
	Feb.	381	1.48	564
	Mar.	472	1.41	666
	Apr.	804	1.01	812
	May	2,803	.52	1,458
	June	2,754	.48	1,322
-1945	July	1,732	.56	970
	Aug.	1,071	1.05	1,125
	Sept.	394	1.38	544
	Oct.	524	1.63	854
	Nov.	465	1.51	702
	Dec.	359	1.47	528
	Total	12,115	.83	10,097
	Jan.	384	1.41	541
	Feb.	333	1.38	460
	Mar.	514	1.29	663
	Apr.	1,016	.94	955
	May	1,775	.53	941
	June	1,995	.54	1,077
-1946	July	784	.82	643
	Aug.	567	1.50	850
	Sept.	372	1.71	636
	Oct.	419	1.62	679
	Nov.	492	1.36	684
	Dec.	468	1.31	613
	Total	9,119	.96	8,742
	Jan.	303	1.50	455
	Feb.	371	1.38	512
	Mar.	653	1.18	771
	Apr.	785	.92	722
	May	3,088	.48	1,482
	June	3,233	.48	1,552
-1947	July	1,953	.50	976
	Aug.	1,329	1.17	1,555
	Sept.	640	1.26	806
	Oct.	894	1.28	1,144
	Nov.	608	1.14	693
	Dec.	490	1.28	627
	Total	14,347	.79	11,295
	Jan.	427	1.27	542
	Feb.	458	1.28	586
	Mar.	669	1.25	836
	Apr.	1,732	.74	1,282
	May	3,392	.45	1,526
	June	3,358	.40	1,343
-1948	July	1,009	.73	737
	Aug.	587	1.33	781
	Sept.	242	1.65	399
	Oct.	336	1.82	612
	Nov.	434	1.61	699
	Dec.	365	1.25	456
	Total	13,009	.75	9,799
	Jan.	363	1.51	548
	Feb.	374	1.36	509
	Mar.	796	1.20	955
	Apr.	1,337	.92	1,230
	May	2,959	.48	1,420
	June	4,303	.48	2,065
-1949	July	2,128	.58	1,234
	Aug.	632	1.12	708
	Sept.	340	1.65	561
	Oct.	521	1.58	823
	Nov.	488	1.36	664
	Dec.	381	1.41	537
	Total	14,622	.77	11,254
	Jan.	358	1.56	558
	Feb.	414	1.35	559
	Mar.	670	1.21	811
	Apr.	1,192	.88	1,049
	May	1,941	.59	1,145
	June	2,925	.47	1,375
-1950	July	1,401	.76	1,065
	Aug.	444	1.13	502
	Sept.	343	1.56	535
	Oct.	359	1.67	600
	Nov.	355	1.75	621
	Dec.	434	1.48	642
	Total	10,836	.87	9,462
	Jan.	326	1.59	518
	Feb.	366	1.45	531
	Mar.	429	1.35	579
	Apr.	535	1.17	626
	May	1,552	.67	1,040
	June	2,800	.49	1,372
-1951	July	1,397	.57	796
	Aug.	833	1.18	983
	Sept.	452	1.46	660
	Oct.	425	1.67	710
	Nov.	466	1.61	750
	Dec.	353	1.61	568
	Total	9,934	.92	9,133
	Jan.	593	1.28	759
	Feb.	396	1.42	562
	Mar.	435	1.46	635
	Apr.	2,209	.84	1,855
	May	5,062	.52	2,632
	June	5,203	.46	2,393
-1952	July	1,590	.65	1,033
	Aug.	833	1.18	983
	Sept.	596	1.43	852
	Oct.	393	1.52	597
	Nov.	396	1.64	649
	Dec.	400	1.58	632
	Total	18,106	.75	13,582
	Jan.	408	1.46	596
	Feb.	378	1.42	537
	Mar.	478	1.35	645
	Apr.	533	1.21	645
	May	989	.87	860
	June	2,932	.47	1,378
-1953	July	980	.76	745
	Aug.	703	1.30	914
	Sept.	290	1.73	502
	Oct.	325	1.88	611
	Nov.	428	1.63	698
	Dec.	360	1.56	562
	Total	8,804	.99	8,693
	Jan.	333	1.58	526
	Feb.	353	1.40	494
	Mar.	424	1.34	568
	Apr.	566	1.11	628
	May	1,211	.68	823
	June	798	.68	543
-1954	July	669	.95	636
	Aug.	349	1.32	461
	Sept.	415	1.67	693
	Oct.	526	1.52	800
	Nov.	360	1.47	529
	Dec.	296	1.60	474
	Total	•6,300	1.14	7,175
	Jan.	261	1.70	444
	Feb.	269	1.50	404
	Mar.	586	1.35	791
	Apr.	621	1.15	714
	May	1,515	.59	894
	June	1,596	.55	878
-1955	July	618	.77	476
	Aug.	668	1.39	929
	Sept.	265	1.63	432
	Oct.	236	1.84	434
	Nov.	298	1/1.88	560
	Dec.	354	1/1.52	538
	Total	7,287	1.03	7,494
	Jan.	398	1/1.42	565
	Feb.	310	1.30	403
	Mar.	511	1.21	618
	Apr.	878	.82	720
	May	2,125	.49	1,041
	June	2,584	.45	1,163
-1956	July	598	.82	490
	Aug.	383	1.31	502
	Sept.	185	1.58	292
	Oct.	202	1.86	376
	Nov.	325	1.69	549
	Dec.	274	1.66	455
	Total	8,773	.82	7,174
	Jan.	343	1.45	497
	Feb.	370	1.37	507
	Mar.	541	1.26	682
	Apr.	812	.93	755
	May	2,501	.57	1,426
	June	5,541	.40	2,216
-1957	July	4,033	.40	1,613
	Aug.	1,672	.88	1,471
	Sept.	884	1.13	999
	Oct.	784	1.46	1,144
	Nov.	892	1.42	1,266
	Dec.	537	1.28	687
	Total	18,910	.70	13,263
	Jan.	415	1.31	544
	Feb.	536	1.24	665
	Mar.	749	1.13	846
	Apr.	1,580	.77	1,220
	May	3,900	.45	1,755
	June	3,763	.41	1,542
-1958	July	683	.91	622
	Aug.	337	1/1.31	440
	Sept.	379	1/1.32	500
	Oct.	346	1/1.53	530
	Nov.	385	1/1.53	590
	Dec.	388	1/1.55	600
	Total	13,461	.73	9,854

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

1/ Correlated.

Table 13

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River near Grand Canyon, Arizona

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1959	Jan.	334	1/1.56	520
	Feb.	326	1/1.53	500
	Mar.	365	1/1.53	560
	Apr.	423	1.27	537
	May	1,011	.78	789
	June	1,804	.53	956
	July	795	.69	549
	Aug.	488	1.50	731
	Sept.	271	1.82	493
	Oct.	528	1.47	777
	Nov.	569	1.25	712
	Dec.	394	1.33	524
	Total	7,308	1.05	7,648
1960	Jan.	348	1.41	490
	Feb.	353	1.40	495
	Mar.	820	1.15	942
	Apr.	1,650	.63	1,036
	May	1,580	.55	870
	June	2,212	.46	1,011
	July	678	.73	497
	Aug.	233	1.42	331
	Sept.	218	1.92	418
	Oct.	382	1.81	692
	Nov.	380	1.59	603
	Dec.	300	1.49	448
	Total	9,154	.86	7,833
1961	Jan.	291	1.58	460
	Feb.	353	1.39	490
	Mar.	379	1.40	530
	Apr.	587	1.04	608
	May	1,147	.66	760
	June	1,692	.47	788
	July	417	.98	409
	Aug.	374	1.76	658
	Sept.	748	1.82	1,360
	Oct.	772	1.23	949
	Nov.	570	1.23	701
	Dec.	409	1.32	539
	Total	7,739	1.07	8,252
1962	Jan.	369	1.35	498
	Feb.	832	1.02	847
	Mar.	610	1.19	726
	Apr.	2,467	.70	1,730
	May	3,716	.45	1,654
	June	2,850	.46	1,318
	July	1,821	.57	1,031
	Aug.	512	1.03	526
	Sept.	318	1.58	502
	Oct.	557	1.57	877
	Nov.	443	1.34	592
	Dec.	344	1.50	516
	Total	14,839	.73	10,817
1963	Jan.	182	1.84	334
	Feb.	374	1.33	496
	Mar.	203	1.37	279
	Apr.	72	1.56	112
	May	79	1.49	118
	June	148	1.09	162
	July	108	1.14	123
	Aug.	112	1.29	145
	Sept.	122	1.43	175
	Oct.	77	1.39	107
	Nov.	76	1.39	106
	Dec.	77	1.74	134
	Total	1,630	1.41	2,291
1964	Jan.	79	1.75	138
	Feb.	245	1.52	373
	Mar.	382	1.47	562
	Apr.	796	1.33	1,058
	May	356	1.36	485
	June	77	1.65	127
	July	84	1.75	147
	Aug.	287	1.31	376
	Sept.	191	1.05	200
	Oct.	298	.77	230
	Nov.	371	.87	323
	Dec.	416	1.04	431
	Total	3,582	1.24	4,450

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1965	Jan.	608	1.06	644
	Feb.	539	1.09	588
	Mar.	568	1.09	619
	Apr.	1,251	1.04	1,301
	May	2,282	1.03	2,350
	June	2,282	.89	2,038
	July	724	.59	427
	Aug.	879	.86	755
	Sept.	767	.51	391
	Oct.	675	.51	344
	Nov.	612	.53	322
	Dec.	586	.69	406
	Total	11,773	.86	10,185
1966	Jan.	529	0.79	418
	Feb.	524	.87	455
	Mar.	718	.81	582
	Apr.	865	.81	700
	May	1,011	.79	799
	June	789	.77	609
	July	698	.75	523
	Aug.	694	.68	471
	Sept.	623	.75	468
	Oct.	567	.74	419
	Nov.	589	.71	418
	Dec.	620	.76	471
	Total	8,227	.77	6,333
1967	Jan.	648	.84	544
	Feb.	564	.86	485
	Mar.	704	.97	683
	Apr.	801	1.09	873
	May	861	1.00	861
	June	711	1.02	725
	July	693	.92	638
	Aug.	786	.82	644
	Sept.	713	.90	642
	Oct.	459	.86	395
	Nov.	495	.83	411
	Dec.	597	.90	537
	Total	8,032	.93	7,438
1968	Jan.	658	1.01	664
	Feb.	534	1.04	555
	Mar.	900	1.03	927
	Apr.	1,078	1.02	1,100
	May	976	1.11	1,083
	June	925	1.03	953
	July	865	.93	804
	Aug.	775	.81	628
	Sept.	675	.80	540
	Oct.	647	.79	511
	Nov.	675	.80	540
	Dec.	665	.77	512
	Total	9,373	.94	8,817
1969	Jan.	628	.99	621
	Feb.	509	1.10	560
	Mar.	727	1.05	763
	Apr.	927	1.05	973
	May	799	1.03	822
	June	870	.98	853
	July	994	.95	944
	Aug.	1,002	.83	832
	Sept.	842	.82	691
	Oct.	662	.80	527
	Nov.	751	.80	601
	Dec.	832	.81	674
	Total	9,543	.93	8,861
1970	Jan.	768	.88	676
	Feb.	494	.96	474
	Mar.	510	1.00	510
	Apr.	969	.94	911
	May	946	.96	908
	June	821	.90	739
	July	815	.88	717
	Aug.	798	.87	691
	Sept.	756	.85	641
	Oct.	542	.84	455
	Nov.	483	.82	396
	Dec.	700	.79	553
	Total	8,602	.89	7,671

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)
Units – 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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
Total	324,100			272,283
Average	10,803	.84	617	9,076

Table 14

Colorado River Basin

Historical Flow and Quality of Water Data

Virgin River at Littlefield, Arizona

Units – 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	15	2.39	35
	Feb.	31	1.97	61
	Mar.	62	.82	51
	Apr.	62	.84	52
	May	131	.46	60
	June	19	1.75	34
-1941	July	22	2.45	54
	Aug.	20	3.02	62
	Sept.	6	3.29	18
	Oct.	23	3.22	74
	Nov.	19	2.26	43
	Dec.	17	2.28	39
	Total	427	1.37	583
	Jan.	20	2.25	44
	Feb.	16	2.28	35
	Mar.	20	1.88	38
	Apr.	50	1.01	51
	May	28	1.56	44
	June	5	3.15	16
-1942	July	4	3.31	14
	Aug.	9	3.29	29
	Sept.	4	3.31	13
	Oct.	9	3.41	31
	Nov.	10	2.78	29
	Dec.	11	2.72	31
	Total	186	2.01	375
	Jan.	18	2.32	42
	Feb.	21	2.14	45
	Mar.	36	1.28	47
	Apr.	34	1.36	46
	May	11	2.27	26
	June	4	3.35	13
-1943	July	4	3.31	14
	Aug.	13	3.35	42
	Sept.	6	3.46	20
	Oct.	9	3.40	30
	Nov.	10	2.79	28
	Dec.	13	2.51	32
	Total	179	2.15	385
	Jan.	13	2.47	33
	Feb.	15	2.31	35
	Mar.	26	1.64	42
	Apr.	25	1.66	42
	May	49	1.05	51
	June	11	2.32	25
-1944	July	4	3.32	13
	Aug.	4	3.31	13
	Sept.	4	3.31	14
	Oct.	5	3.30	16
	Nov.	13	2.48	32
	Dec.	12	2.65	31
	Total	181	1.92	347
	Jan.	11	2.68	30
	Feb.	17	2.15	38
	Mar.	20	1.87	38
	Apr.	20	1.83	36
	May	25	1.55	39
	June	5	3.22	15
-1945	July	5	3.31	15
	Aug.	26	3.06	79
	Sept.	8	3.19	25
	Oct.	20	3.14	62
	Nov.	10	2.75	29
	Dec.	14	2.47	35
	Total	181	2.43	441
	Jan.	13	2.48	32
	Feb.	10	2.74	27
	Mar.	10	2.63	28
	Apr.	12	2.49	29
	May	5	3.31	15
	June	4	3.32	13
-1946	July	6	3.40	21
	Aug.	13	3.17	42
	Sept.	4	3.31	13
	Oct.	37	2.18	81
	Nov.	33	1.85	61
	Dec.	22	2.12	47
	Total	169	2.42	409
	Jan.	15	2.34	35
	Feb.	12	2.46	30
	Mar.	13	2.32	31
	Apr.	16	2.17	34
	May	17	1.98	33
	June	4	3.31	14
-1947	July	5	3.30	16
	Aug.	14	2.97	41
	Sept.	4	3.31	14
	Oct.	8	3.34	27
	Nov.	9	2.89	27
	Dec.	14	2.46	34
	Total	131	2.56	336
	Jan.	11	2.78	29
	Feb.	12	2.47	30
	Mar.	13	2.42	31
	Apr.	20	1.87	37
	May	10	2.47	25
	June	4	3.32	14
-1948	July	4	3.31	14
	Aug.	5	3.31	18
	Sept.	6	3.39	20
	Oct.	6	3.34	20
	Nov.	10	2.87	27
	Dec.	10	2.85	29
	Total	111	2.65	294
	Jan.	13	2.52	32
	Feb.	14	2.42	35
	Mar.	18	2.07	36
	Apr.	30	1.43	44
	May	28	1.53	43
	June	12	2.11	25
-1949	July	4	3.19	14
	Aug.	4	3.20	13
	Sept.	7	3.27	23
	Oct.	9	3.07	26
	Nov.	11	2.68	29
	Dec.	13	2.51	34
	Total	163	2.17	354
	Jan.	15	2.20	33
	Feb.	16	2.00	32
	Mar.	14	2.26	31
	Apr.	15	2.05	31
	May	6	2.87	19
	June	4	3.28	13
-1950	July	12	3.38	40
	Aug.	6	3.43	19
	Sept.	6	3.35	20
	Oct.	5	3.40	17
	Nov.	9	3.14	28
	Dec.	10	2.91	30
	Total	118	2.65	313
	Jan.	11	2.77	30
	Feb.	8	2.84	22
	Mar.	8	2.83	23
	Apr.	7	3.17	22
	May	10	2.74	27
	June	4	3.37	12
-1951	July	6	3.34	20
	Aug.	16	3.27	55
	Sept.	6	3.20	20
	Oct.	7	3.24	22
	Nov.	9	2.94	26
	Dec.	20	2.42	49
	Total	112	2.93	328
	Jan.	21	2.34	49
	Feb.	11	2.52	28
	Mar.	27	1.74	48
	Apr.	80	.76	60
	May	71	.68	49
	June	12	1.75	21
-1952	July	4	3.27	14
	Aug.	5	3.43	18
	Sept.	6	3.34	20
	Oct.	6	3.40	20
	Nov.	10	2.84	29
	Dec.	14	2.53	34
	Total	267	1.46	390
	Jan.	14	2.36	32
	Feb.	9	2.70	24
	Mar.	7	2.98	21
	Apr.	6	3.27	20
	May	5	3.27	16
	June	4	3.34	14
-1953	July	8	3.46	28
	Aug.	13	3.04	40
	Sept.	4	3.38	13
	Oct.	7	3.31	24
	Nov.	10	3.07	29
	Dec.	11	2.83	31
	Total	98	3.00	292
	Jan.	15	2.49	37
	Feb.	12	2.36	29
	Mar.	17	1.98	33
	Apr.	23	1.64	38
	May	10	2.35	23
	June	5	3.36	18
-1954	July	8	3.42	26
	Aug.	10	3.44	34
	Sept.	9	3.56	32
	Oct.	9	3.48	30
	Nov.	9	3.13	29
	Dec.	13	2.71	36
	Total	140	2.61	365
	Jan.	12	2.60	31
	Feb.	12	2.51	30
	Mar.	11	2.53	27
	Apr.	6	3.14	19
	May	5	3.18	16
	June	4	3.39	13
-1955	July	10	3.61	37
	Aug.	40	3.69	149
	Sept.	5	3.26	15
	Oct.	5	3.51	19
	Nov.	10	3.05	31
	Dec.	13	2.60	34
	Total	133	3.16	421
	Jan.	15	2.53	38
	Feb.	11	2.59	29
	Mar.	8	2.87	22
	Apr.	6	3.13	18
	May	4	3.23	15
	June	4	3.34	15
-1956	July	8	3.53	27
	Aug.	4	3.35	13
	Sept.	4	3.35	12
	Oct.	4	3.39	14
	Nov.	6	3.50	21
	Dec.	8	3.29	25
	Total	82	3.05	249
	Jan.	12	2.77	33
	Feb.	14	2.32	32
	Mar.	10	2.64	26
	Apr.	6	2.99	18
	May	15	2.04	31
	June	9	2.85	25
-1957	July	4	3.31	13
	Aug.	9	3.41	31
	Sept.	4	3.27	12
	Oct.	14	3.02	44
	Nov.	21	2.45	51
	Dec.	15	2.04	31
	Total	133	2.61	347
	Jan.	10	2.49	24
	Feb.	19	1.83	35
	Mar.	41	1.43	59
	Apr.	64	1.02	65
	May	69	1.05	73
	June	7	2.29	16
-1958	July	6	3.17	19
	Aug.	5	3.22	18
	Sept.	22	3.13	70
	Oct.	8	3.16	24
	Nov.	11	2.62	28
	Dec.	10	2.67	26
	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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	10	2.58	27
	Feb.	13	2.30	31
	Mar.	9	2.67	24
	Apr.	4	3.05	13
	May	4	3.07	13
	June	4	3.24	12
-1959	July	4	3.32	13
	Aug.	12	3.35	40
	Sept.	4	3.20	13
	Oct.	5	3.30	15
	Nov.	13	2.90	36
	Dec.	9	2.69	23
	Total	91	2.87	260
	Jan.	11	2.48	28
	Feb.	10	2.38	24
	Mar.	10	2.45	24
	Apr.	6	2.91	17
	May	5	3.03	14
	June	3	3.16	10
-1960	July	4	3.18	12
	Aug.	3	3.20	11
	Sept.	6	3.51	20
	Oct.	6	3.05	19
	Nov.	12	2.80	35
	Dec.	8	2.71	22
	Total	84	2.79	236
	Jan.	8	2.76	21
	Feb.	7	2.80	20
	Mar.	8	2.84	23
	Apr.	4	3.11	14
	May	4	3.14	12
	June	4	3.14	12
-1961	July	8	3.22	27
	Aug.	17	3.58	60
	Sept.	22	3.36	73
	Oct.	5	3.41	19
	Nov.	8	3.07	23
	Dec.	13	2.69	34
	Total	108	3.14	338
	Jan.	10	2.73	28
	Feb.	30	1.65	50
	Mar.	17	2.09	35
	Apr.	33	1.21	40
	May	9	2.24	19
	June	4	3.32	12
-1962	July	4	3.29	13
	Aug.	3	3.46	11
	Sept.	7	3.28	24
	Oct.	7	3.32	21
	Nov.	6	3.18	20
	Dec.	7	2.75	20
	Total	137	2.14	293
	Jan.	9	2.54	23
	Feb.	9	2.56	23
	Mar.	6	3.14	19
	Apr.	4	3.43	15
	May	4	3.41	13
	June	3	3.44	11
-1963	July	3	3.48	12
	Aug.	11	3.33	36
	Sept.	14	3.54	48
	Oct.	5	3.32	18
	Nov.	10	3.00	28
	Dec.	7	2.96	20
	Total	85	3.14	266
	Jan.	7	2.96	20
	Feb.	7	2.88	21
	Mar.	7	2.99	20
	Apr.	13	2.22	28
	May	11	2.22	24
	June	3	3.50	10
-1964	July	4	3.63	14
	Aug.	14	3.81	53
	Sept.	3	3.63	11
	Oct.	3	3.58	12
	Nov.	6	3.32	22
	Dec.	9	2.98	26
	Total	87	3.01	261
	Jan.	9	2.78	25
	Feb.	8	2.75	22
	Mar.	8	2.62	21
	Apr.	30	2.00	60
	May	23	1.52	35
	June	9	2.11	19
-1965	July	3	3.67	11
	Aug.	5	3.40	17
	Sept.	6	3.00	18
	Oct.	6	3.00	18
	Nov.	21	1.90	40
	Dec.	26	1.58	41
	Total	154	2.12	327
	Jan.	13	2.31	30
	Feb.	11	2.45	27
	Mar.	14	1.50	29
	Apr.	17	1.70	29
	May	6	3.00	18
	June	3	4.00	12
-1966	July	3	4.00	12
	Aug.	3	3.67	11
	Sept.	4	3.50	14
	Oct.	6	3.33	20
	Nov.	9	2.78	25
	Dec.	73	1.99	145
	Total	162	2.30	372
	Jan.	13	2.66	34
	Feb.	9	2.67	25
	Mar.	10	2.76	29
	Apr.	11	2.63	30
	May	20	1.88	37
	June	7	2.80	19
-1967	July	4	3.57	14
	Aug.	7	3.32	25
	Sept.	14	3.41	46
	Oct.	7	3.13	21
	Nov.	9	2.71	25
	Dec.	13	2.49	32
	Total	124	2.72	337
	Jan.	13	2.60	33
	Feb.	15	2.19	32
	Mar.	12	2.16	27
	Apr.	15	2.03	30
	May	17	1.80	30
	June	5	2.81	13
-1968	July	6	3.52	20
	Aug.	14	3.09	45
	Sept.	3	3.60	12
	Oct.	6	3.41	20
	Nov.	7	3.05	22
	Dec.	11	2.79	30
	Total	124	2.53	314
	Jan.	48	1.52	73
	Feb.	34	1.82	62
	Mar.	39	1.49	58
	Apr.	82	.87	71
	May	83	.71	59
-1969	June	14	1.86	26
	July	6	3.17	19
	Aug.	4	3.75	15
	Sept.	9	3.56	32
	Oct.	8	3.13	25
	Nov.	12	2.75	33
	Dec.	12	2.42	29
	Total	351	1.43	502
	Jan.	13	2.08	27
	Feb.	9	2.44	22
	Mar.	12	2.83	34
	Apr.	4	3.50	14
	May	5	3.20	16
-1970	June	4	3.25	13
	July	6	3.33	20
	Aug.	8	3.12	25
	Sept.	5	3.60	18
	Oct.	5	3.40	17
	Nov.	10	3.20	32
	Dec.	11	2.45	27
	Total	92	2.88	265

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)

Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./1)	T.D.S. (Tons)
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
Total	4,682			10,457
Average	156	2.24	1,644	349

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

Units-1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	589	1.08	636
	Feb.	500	1.11	555
	Mar.	552	1.10	607
	Apr.	518	1.08	560
	May	1,435	1.08	1,550
	June	1,810	1.07	1,935
-1941	July	951	1.06	1,007
	Aug.	1,429	.97	1,386
	Sept.	1,576	.94	1,481
	Oct.	1,641	.94	1,543
	Nov.	1,817	.93	1,690
	Dec.	2,071	.94	1,947
	Total	14,889	1.00	14,897
	Jan.	2,011	1.00	2,011
	Feb.	1,550	.99	1,535
	Mar.	1,425	1.00	1,425
	Apr.	1,301	1.00	1,301
	May	1,343	1.00	1,343
	June	1,561	1.01	1,577
-1942	July	1,285	.99	1,272
	Aug.	846	.99	838
	Sept.	1,025	.98	1,005
	Oct.	1,163	.95	1,105
	Nov.	1,095	.90	986
	Dec.	1,157	.85	983
	Total	15,762	.98	15,381
	Jan.	1,109	.87	965
	Feb.	823	.89	732
	Mar.	971	.94	913
	Apr.	915	.95	869
	May	1,029	.94	967
	June	1,040	.93	967
-1943	July	1,109	.91	1,009
	Aug.	1,042	.92	959
	Sept.	1,042	.91	948
	Oct.	1,179	.90	1,061
	Nov.	1,179	.86	1,014
	Dec.	1,277	.86	1,098
	Total	12,715	.90	11,502
	Jan.	1,303	.88	1,147
	Feb.	1,269	.97	1,231
	Mar.	1,307	.96	1,254
	Apr.	1,170	.97	1,135
	May	1,216	.98	1,192
	June	1,097	.95	1,042
-1944	July	1,111	.93	1,033
	Aug.	1,211	.92	1,113
	Sept.	1,132	.89	1,007
	Oct.	1,226	1/ .94	1,152
	Nov.	1,186	1/ .99	1,174
	Dec.	1,199	.94	1,127
	Total	14,427	.94	13,607
	Jan.	1,239	.93	1,152
	Feb.	1,100	1/ .96	1,056
	Mar.	1,250	2/ .96	1,200
	Apr.	1,042	1/ .95	990
	May	1,068	1/ .90	961
	June	1,014	2/ .91	923
-1945	July	861	.92	792
	Aug.	885	1/ .93	823
	Sept.	869	1/ .90	782
	Oct.	1,080	1/ .88	950
	Nov.	1,042	1/ .90	938
	Dec.	1,062	1/ .89	945
	Total	12,512	.92	11,512
	Jan.	1,116	.87	971
	Feb.	1,047	1/ .95	994
	Mar.	1,004	.88	884
	Apr.	*872	.89	*776
	May	903	1/ .96	867
	June	817	1/ .92	752
-1946	July	838	.90	754
	Aug.	751	1/ .91	683
	Sept.	759	2/ .91	691
	Oct.	857	1/ .92	788
	Nov.	762	2/ .91	693
	Dec.	859	1/ .90	773
	Total	*10,585	.91	*9,626

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	984	0.90	886
	Feb.	886	.91	806
	Mar.	956	.92	879
	Apr.	859	1/ .99	850
	May	951	1/ 1.03	979
	June	919	1/ .95	873
-1947	July	925	.96	888
	Aug.	865	1/ .92	796
	Sept.	843	2/ .92	776
	Oct.	828	1/ .92	762
	Nov.	880	2/ .92	810
	Dec.	1,063	1/ .92	978
	Total	10,959	.94	10,283
	Jan.	1,169	2/ .93	1,087
	Feb.	1,138	1/ .93	1,058
	Mar.	1,150	1/ .93	1,070
	Apr.	1,202	1/ .97	1,166
	May	1,142	1/ .93	1,062
	June	1,076	1/ .88	947
-1948	July	1,156	1/ .86	994
	Aug.	968	2/ .86	833
	Sept.	981	1/ .85	834
	Oct.	917	1/ .80	734
	Nov.	1,028	.88	905
	Dec.	1,124	1/ .91	1,023
	Total	13,051	.90	11,713
	Jan.	1,212	.83	1,006
	Feb.	1,214	1/ .84	1,020
	Mar.	1,291	1/ .85	1,097
	Apr.	1,178	1/ .86	1,013
	May	1,026	1/ .83	852
	June	986	.87	858
-1949	July	1,020	.84	857
	Aug.	1,062	.80	850
	Sept.	1,141	.78	890
	Oct.	1,176	.75	882
	Nov.	1,022	1/ .83	848
	Dec.	1,238	.87	1,077
	Total	13,566	.83	11,250
	Jan.	1,277	.83	1,060
	Feb.	1,132	.81	917
	Mar.	1,246	.85	1,059
	Apr.	1,089	.85	926
	May	1,120	1/ .84	941
	June	960	1/ .83	797
-1950	July	982	.79	776
	Aug.	872	1/ .82	715
	Sept.	824	1/ .79	651
	Oct.	848	.89	755
	Nov.	815	.88	717
	Dec.	851	.86	732
	Total	12,016	.84	10,046
	Jan.	928	.87	807
	Feb.	756	.87	658
	Mar.	860	.91	783
	Apr.	796	.93	740
	May	898	.92	826
	June	691	.91	629
-1951	July	783	.92	720
	Aug.	907	.93	844
	Sept.	848	.92	780
	Oct.	756	.93	703
	Nov.	818	.93	761
	Dec.	829	.91	754
	Total	9,870	.91	9,005
	Jan.	1,070	.90	963
	Feb.	1,212	.93	1,127
	Mar.	1,371	.94	1,289
	Apr.	1,385	.94	1,302
	May	1,532	.94	1,440
	June	1,432	.91	1,303
-1952	July	1,304	.83	1,082
	Aug.	1,307	.79	1,033
	Sept.	1,359	.73	992
	Oct.	1,291	.69	891
	Nov.	1,215	.66	802
	Dec.	1,338	.88	1,177
	Total	15,816	.85	13,401

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	1,227	0.93	1,141
	Feb.	1,043	.91	949
	Mar.	1,046	.93	973
	Apr.	971	.94	913
	May	998	.91	908
	June	819	.89	729
-1953	July	897	.87	780
	Aug.	968	.87	842
	Sept.	968	.86	832
	Oct.	802	.86	690
	Nov.	749	.86	644
	Dec.	814	.85	692
	Total	11,302	.89	10,093
	Jan.	836	.88	736
	Feb.	721	.94	678
	Mar.	911	.95	865
	Apr.	975	.94	916
	May	1,101	.93	1,024
	June	929	.94	873
-1954	July	1,027	.94	965
	Aug.	888	.97	861
	Sept.	933	.97	905
	Oct.	776	.94	729
	Nov.	676	.95	642
	Dec.	741	.97	719
	Total	10,514	.94	9,913
	Jan.	725	.99	718
	Feb.	705	1.04	733
	Mar.	906	1.08	978
	Apr.	882	1.11	979
	May	928	1.12	1,039
	June	680	1.12	762
-1955	July	847	1.11	940
	Aug.	789	1.12	884
	Sept.	622	1.11	690
	Oct.	526	1.12	589
	Nov.	487	1.12	545
	Dec.	492	1.09	536
	Total	8,589	1.09	9,393
	Jan.	583	1.09	635
	Feb.	499	1.10	549
	Mar.	769	1.12	861
	Apr.	840	1.14	958
	May	748	1.15	860
	June	784	1.17	917
-1956	July	782	1.19	931
	Aug.	696	1.17	814
	Sept.	610	1.15	702
	Oct.	490	1.16	568
	Nov.	554	1.12	620
	Dec.	457	1.10	503
	Total	7,812	1.14	8,918
	Jan.	534	1.07	571
	Feb.	470	1.08	508
	Mar.	739	1.11	820
	Apr.	890	1.09	970
	May	769	1.07	823
	June	828	1.06	878
-1957	July	786	1.05	825
	Aug.	786	1.03	810
	Sept.	785	1.02	801
	Oct.	697	1.02	711
	Nov.	958	.99	948
	Dec.	1,081	.94	1,016
	Total	9,323	1.04	9,681
	Jan.	1,245	.90	1,120
	Feb.	846	.94	795
	Mar.	1,435	.90	1,292
	Apr.	1,473	.88	1,296
	May	1,115	.84	937
	June	819	.85	696
-1958	July	894	.85	760
	Aug.	911	.83	756
	Sept.	792	.83	657
	Oct.	728	.82	597
	Nov.	746	.82	612
	Dec.	873	.83	725
	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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1959	Jan.	795	0.85	676
	Feb.	648	.83	537
	Mar.	827	.88	728
	Apr.	916	.91	834
	May	949	.86	816
	June	760	.85	646
	July	848	.84	713
	Aug.	894	.83	742
	Sept.	773	.81	626
	Oct.	693	.82	568
	Nov.	607	.81	492
	Dec.	572	.81	463
	Total	9,282	.84	7,841
1960	Jan.	629	.86	541
	Feb.	512	.89	456
	Mar.	710	.89	632
	Apr.	909	.93	845
	May	856	.93	796
	June	1,015	.92	934
	July	984	.89	876
	Aug.	959	.93	892
	Sept.	806	.93	749
	Oct.	556	.92	512
	Nov.	489	.92	450
	Dec.	572	.92	526
	Total	8,997	.91	8,209
1961	Jan.	591	.93	549
	Feb.	577	.94	543
	Mar.	936	.95	889
	Apr.	904	.97	877
	May	943	.95	896
	June	842	.94	791
	July	822	.94	772
	Aug.	739	.96	709
	Sept.	690	.96	663
	Oct.	539	.93	502
	Nov.	517	.94	486
	Dec.	486	.95	462
	Total	8,586	.95	8,139
1962	Jan.	482	.93	448
	Feb.	497	1/.94	467
	Mar.	798	1/.94	750
	Apr.	902	1/.95	857
	May	887	1.00	887
	June	799	1/.94	751
	July	824	1/.91	750
	Aug.	857	1/.87	746
	Sept.	716	1.00	716
	Oct.	634	1/.86	545
	Nov.	613	1/.90	552
	Dec.	606	1/.93	564
	Total	8,615	1/.93	8,033
1963	Jan.	482	.99	478
	Feb.	575	1/.97	558
	Mar.	871	1/.95	828
	Apr.	865	1/.94	813
	May	911	.93	847
	June	764	1/.92	702
	July	908	1/.91	826
	Aug.	857	.90	771
	Sept.	724	.89	645
	Oct.	527	.90	475
	Nov.	464	.89	413
	Dec.	585	.90	526
	Total	8,533	1/.92	7,882
1964	Jan.	633	.93	589
	Feb.	583	.94	548
	Mar.	800	.95	760
	Apr.	859	.98	842
	May	844	.98	827
	June	719	.99	712
	July	866	.98	849
	Aug.	731	.99	724
	Sept.	623	.99	616
	Oct.	591	1.01	596
	Nov.	445	1.02	454
	Dec.	469	1.06	497
	Total	8,163	.98	8,014

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1965	Jan.	489	1.08	528
	Feb.	498	1.09	543
	Mar.	786	1.15	903
	Apr.	698	1.14	796
	May	872	1.14	994
	June	786	1.08	848
	July	815	1.08	880
	Aug.	817	1.11	907
	Sept.	655	1.12	734
	Oct.	535	1.05	562
	Nov.	418	1.03	430
	Dec.	423	1.06	449
	Total	7,792	1.10	8,574
1966	Jan.	252	1.03	260
	Feb.	436	1.02	445
	Mar.	785	1.05	824
	Apr.	846	1.05	888
	May	887	1.03	914
	June	783	1.06	831
	July	889	1.01	897
	Aug.	839	.98	822
	Sept.	672	1.00	672
	Oct.	467	.96	448
	Nov.	473	.93	440
	Dec.	448	.93	416
	Total	7,777	1.01	7,857
1967	Jan.	500	.94	470
	Feb.	574	.92	528
	Mar.	847	.91	771
	Apr.	771	.90	694
	May	889	.93	827
	June	782	.94	735
	July	832	.90	749
	Aug.	755	.90	679
	Sept.	494	.93	459
	Oct.	576	.93	536
	Nov.	556	.91	506
	Dec.	356	.92	328
	Total	7,932	.92	7,282
1968	Jan.	396	.94	372
	Feb.	496	.92	456
	Mar.	850	.93	791
	Apr.	883	.93	821
	May	853	.95	810
	June	752	.93	699
	July	757	.94	712
	Aug.	693	.97	672
	Sept.	663	.97	643
	Oct.	486	.98	476
	Nov.	457	.99	452
	Dec.	553	1.00	553
	Total	7,839	.95	7,457
1969	Jan.	549	1.02	560
	Feb.	552	1.02	563
	Mar.	825	1.02	841
	Apr.	894	1.02	912
	May	834	1.00	834
	June	753	1.02	768
	July	772	1.01	780
	Aug.	693	1.02	707
	Sept.	618	1.00	618
	Oct.	523	1.00	523
	Nov.	426	1.00	426
	Dec.	453	1.01	458
	Total	7,892	1.01	7,990
1970	Jan.	603	1.04	627
	Feb.	536	1.03	552
	Mar.	753	1.03	776
	Apr.	919	1.02	937
	May	927	.97	899
	June	780	1.00	780
	July	792	.98	776
	Aug.	676	1.00	677
	Sept.	507	.97	492
	Oct.	583	1.01	589
	Nov.	450	1.07	481
	Dec.	497	1.09	542
	Total	8,023	1.01	8,128

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
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	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)
Units - 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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	735	8,128
Total	315,016			295,870
Average	10,501	.94	690	9,862

Measured flow record entire period.

Table 16

Colorado River Basin

Historical Flow and Quality of Water Data

Colorado River below Parker Dam, Arizona-California

Units-1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	627	1.11	698
	Feb.	561	1.14	642
	Mar.	750	1.14	854
	Apr.	608	1.12	679
	May	1,359	1.12	1,524
	June	1,628	1.11	1,808
-1941	July	998	1.10	1,098
	Aug.	1,332	1.04	1,381
	Sept.	1,528	.98	1,495
	Oct.	1,585	.98	1,550
	Nov.	1,731	.95	1,641
	Dec.	2,042	1.04	2,116
	Total	14,749	1.05	15,486
	Jan.	1,957	1.09	1,963
	Feb.	1,482	1.00	1,480
	Mar.	1,494	.99	1,476
	Apr.	1,136	1.01	1,143
	May	1,588	1.01	1,602
	June	1,536	1.01	1,549
-1942	July	1,226	.98	1,197
	Aug.	880	1.07	939
	Sept.	797	1.00	794
	Oct.	845	.99	833
	Nov.	1,041	.99	1,028
	Dec.	1,213	.89	1,084
	Total	15,195	.99	15,088
	Jan.	1,015	.93	948
	Feb.	746	.88	657
	Mar.	886	.97	863
	Apr.	877	.95	837
	May	957	.97	933
	June	976	.98	961
-1943	July	1,086	.90	981
	Aug.	990	.91	904
	Sept.	1,006	.90	908
	Oct.	1,160	.92	1,062
	Nov.	1,149	.87	1,003
	Dec.	1,231	.87	1,076
	Total	12,079	.92	11,133
	Jan.	1,241	.90	1,121
	Feb.	1,223	.92	1,131
	Mar.	1,297	.96	1,240
	Apr.	1,164	.98	1,136
	May	1,116	.98	1,089
	June	983	.99	969
-1944	July	1,035	.95	988
	Aug.	1,148	.96	1,098
	Sept.	1,114	.89	994
	Oct.	1,178	.88	1,042
	Nov.	1,156	.88	1,023
	Dec.	1,187	.94	1,110
	Total	13,842	.93	12,941
	Jan.	1,186	.94	1,121
	Feb.	1,061	.91	969
	Mar.	1,232	.94	1,152
	Apr.	985	.94	929
	May	970	.94	915
	June	919	.99	914
-1945	July	913	.92	844
	Aug.	770	.90	694
	Sept.	824	.91	751
	Oct.	1,038	.85	884
	Nov.	1,036	.89	924
	Dec.	1,099	.90	992
	Total	12,033	.92	11,089
	Jan.	1,041	.90	939
	Feb.	1,028	.96	991
	Mar.	944	.89	843
	Apr.	830	1.04	867
	May	873	.94	825
	June	754	.92	696
-1946	July	801	.91	731
	Aug.	722	.89	642
	Sept.	730	.91	665
	Oct.	759	.91	691
	Nov.	789	.91	720
	Dec.	870	.91	794
	Total	10,141	.93	9,404
	Jan.	953	.91	870
	Feb.	899	.92	829
	Mar.	940	.94	888
	Apr.	797	.97	777
	May	905	.99	892
	June	860	.98	847
-1947	July	844	.97	822
	Aug.	892	.96	860
	Sept.	819	.98	800
	Oct.	837	.91	765
	Nov.	880	.87	768
	Dec.	1,037	.83	862
	Total	10,663	.94	9,980
	Jan.	1,160	.96	1,109
	Feb.	1,160	.92	1,062
	Mar.	1,107	.91	1,009
	Apr.	1,083	.92	999
	May	1,115	.91	1,016
	June	989	.93	923
-1948	July	1,108	.90	999
	Aug.	986	.89	880
	Sept.	941	.88	831
	Oct.	918	.86	791
	Nov.	978	.81	793
	Dec.	1,106	.92	1,019
	Total	12,651	.90	11,431
	Jan.	1,229	.89	1,099
	Feb.	1,192	.85	1,015
	Mar.	1,236	.84	1,044
	Apr.	1,116	.88	985
	May	983	1.05	866
	June	923	.89	824
-1949	July	952	.89	849
	Aug.	1,013	.84	852
	Sept.	1,099	.83	913
	Oct.	1,148	.80	918
	Nov.	1,011	.77	778
	Dec.	1,158	.74	855
	Total	13,060	.84	10,998
	Jan.	1,080	.86	931
	Feb.	1,036	.85	882
	Mar.	1,209	.84	1,017
	Apr.	998	.88	879
	May	1,066	.88	941
	June	900	.87	785
-1950	July	897	.85	765
	Aug.	833	.84	698
	Sept.	704	.84	590
	Oct.	651	.86	558
	Nov.	542	.87	473
	Dec.	557	.89	494
	Total	10,473	.86	9,013
	Jan.	550	.89	488
	Feb.	501	.89	448
	Mar.	730	.90	657
	Apr.	765	.89	682
	May	675	.90	607
	June	862	.90	779
-1951	July	945	.91	862
	Aug.	945	.89	840
	Sept.	723	.88	636
	Oct.	709	.90	638
	Nov.	560	.90	502
	Dec.	707	.91	642
	Total	8,672	.90	7,781
	Jan.	1,104	.91	1,008
	Feb.	1,134	.89	1,012
	Mar.	1,424	.89	1,273
	Apr.	1,300	.92	1,202
	May	1,443	.95	1,366
	June	1,419	.95	1,341
-1952	July	1,263	.90	1,142
	Aug.	1,296	.85	1,105
	Sept.	1,321	.81	1,074
	Oct.	1,234	.76	935
	Nov.	1,172	.71	829
	Dec.	1,303	.69	895
	Total	15,413	.86	13,182
	Jan.	1,198	.68	813
	Feb.	1,020	.83	848
	Mar.	947	.90	853
	Apr.	808	.93	753
	May	953	.92	880
	June	956	.92	882
-1953	July	1,093	.89	973
	Aug.	1,056	.86	909
	Sept.	823	.85	700
	Oct.	634	.86	544
	Nov.	527	.86	455
	Dec.	634	.87	550
	Total	10,649	.86	9,160
	Jan.	797	.86	685
	Feb.	661	.85	560
	Mar.	782	.86	673
	Apr.	864	.86	746
	May	1,015	.91	927
	June	883	.94	834
-1954	July	1,000	.93	934
	Aug.	982	.93	918
	Sept.	754	.94	706
	Oct.	636	.94	599
	Nov.	638	.94	601
	Dec.	659	.94	618
	Total	9,671	.91	8,801
	Jan.	734	.95	699
	Feb.	598	.96	574
	Mar.	733	.98	722
	Apr.	758	.99	753
	May	792	1.02	804
	June	866	1.06	914
-1955	July	963	1.10	1,060
	Aug.	849	1.09	924
	Sept.	694	1.07	740
	Oct.	499	1.08	540
	Nov.	369	1.10	407
	Dec.	286	1.09	312
	Total	8,141	1.04	8,449
	Jan.	317	1.11	352
	Feb.	365	1.12	407
	Mar.	628	1.13	708
	Apr.	684	1.12	766
	May	671	1.10	735
	June	787	1.12	880
-1956	July	865	1.13	976
	Aug.	823	1.12	920
	Sept.	634	1.15	728
	Oct.	486	1.10	536
	Nov.	321	1.12	359
	Dec.	288	1.15	330
	Total	6,869	1.12	7,697
	Jan.	243	1.15	279
	Feb.	349	1.13	395
	Mar.	589	1.12	657
	Apr.	731	1.09	796
	May	645	1.09	704
	June	783	1.08	845
-1957	July	890	1.06	941
	Aug.	817	1.04	848
	Sept.	661	1.01	670
	Oct.	503	1.02	513
	Nov.	781	1.03	802
	Dec.	1,005	1.04	1,044
	Total	7,997	1.06	8,494
	Jan.	1,285	1.00	1,280
	Feb.	565	.95	536
	Mar.	1,345	.91	1,229
	Apr.	1,333	.89	1,191
	May	1,013	.87	883
	June	854	.86	735
-1958	July	930	.86	803
	Aug.	867	.84	729
	Sept.	714	.83	590
	Oct.	610	.84	510
	Nov.	623	.84	521
	Dec.	753	.85	639
	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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1959	Jan.	677	0.84	566
	Feb.	593	.83	495
	Mar.	690	.84	579
	Apr.	832	.85	707
	May	706	.88	620
	June	797	.89	709
	July	962	.86	829
	Aug.	873	.81	706
	Sept.	682	.82	557
	Oct.	558	.84	471
	Nov.	405	.84	342
	Dec.	411	.83	343
	Total	8,186	.85	6,924
1960	Jan.	428	.82	353
	Feb.	474	.82	388
	Mar.	760	.83	630
	Apr.	810	.87	705
	May	740	.88	651
	June	879	.90	794
	July	986	.89	880
	Aug.	868	.90	780
	Sept.	640	.89	568
	Oct.	490	.87	428
	Nov.	397	.90	356
	Dec.	322	.91	293
	Total	7,794	.88	6,826
1961	Jan.	379	.92	347
	Feb.	453	.91	414
	Mar.	742	.92	684
	Apr.	725	.92	669
	May	705	.94	664
	June	822	.94	776
	July	900	.93	841
	Aug.	710	.93	661
	Sept.	606	.92	556
	Oct.	412	.91	374
	Nov.	319	.94	300
	Dec.	202	.92	186
	Total	6,975	.93	6,472
1962	Jan.	334	.93	310
	Feb.	374	.93	346
	Mar.	692	.94	652
	Apr.	756	1/.96	729
	May	686	1/.97	667
	June	778	1.00	775
	July	882	.97	859
	Aug.	821	.99	816
	Sept.	644	.97	627
	Oct.	471	.98	460
	Nov.	434	.97	423
	Dec.	287	1.00	286
	Total	7,159	.97	6,950
1963	Jan.	350	1.00	349
	Feb.	467	1.00	466
	Mar.	735	.99	731
	Apr.	690	.99	685
	May	708	.97	687
	June	840	.95	802
	July	933	.92	862
	Aug.	819	.91	747
	Sept.	630	.91	572
	Oct.	438	.88	385
	Nov.	334	.88	294
	Dec.	307	.89	272
	Total	7,251	.94	6,852
1964	Jan.	363	.91	329
	Feb.	479	.90	432
	Mar.	640	.91	582
	Apr.	652	.91	596
	May	598	.92	552
	June	742	.95	706
	July	864	.95	824
	Aug.	795	.95	754
	Sept.	589	.96	564
	Oct.	409	.96	393
	Nov.	275	.96	264
	Dec.	245	1.00	246
	Total	6,651	.94	6,242

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
1965	Jan.	290	1.01	294
	Feb.	423	1.00	424
	Mar.	634	1.03	651
	Apr.	581	1.06	614
	May	604	1.07	645
	June	710	1.11	790
	July	846	1.09	924
	Aug.	867	1.08	940
	Sept.	599	1.08	648
	Oct.	385	1.11	426
	Nov.	220	1.10	243
	Dec.	197	.95	187
	Total	6,356	1.07	6,786
1966	Jan.	177	.73	129
	Feb.	413	1.04	428
	Mar.	604	1.08	655
	Apr.	729	1.08	785
	May	699	1.10	766
	June	790	1.12	887
	July	901	1.07	966
	Aug.	852	1.04	890
	Sept.	585	1.07	626
	Oct.	357	.96	343
	Nov.	256	1.00	256
	Dec.	320	.97	311
	Total	6,683	1.05	7,042
1967	Jan.	306	.98	299
	Feb.	431	1.01	434
	Mar.	677	.98	664
	Apr.	608	.98	594
	May	648	.98	635
	June	726	1.01	733
	July	835	.95	794
	Aug.	749	.98	734
	Sept.	490	.97	474
	Oct.	435	.95	413
	Nov.	247	.93	230
	Dec.	170	.96	163
	Total	6,322	.98	6,167
1968	Jan.	351	.94	330
	Feb.	450	.89	400
	Mar.	680	.93	632
	Apr.	700	.93	652
	May	626	.97	608
	June	722	.95	685
	July	779	.96	745
	Aug.	725	.95	686
	Sept.	585	.98	573
	Oct.	404	.98	394
	Nov.	309	.99	306
	Dec.	312	1.00	312
	Total	6,643	.95	6,323
1969	Jan.	254	1.01	256
	Feb.	467	1.02	476
	Mar.	740	.95	703
	Apr.	713	1.03	734
	May	640	1.08	692
	June	675	1.05	708
	July	765	1.03	787
	Aug.	733	.99	726
	Sept.	488	.99	483
	Oct.	434	.97	420
	Nov.	220	1.03	227
	Dec.	310	1.02	317
	Total	6,659	1.01	6,529
1970	Jan.	367	1.03	378
	Feb.	442	1.04	460
	Mar.	654	1.02	667
	Apr.	750	1.04	780
	May	657	1.03	676
	June	706	1.03	727
	July	792	1.00	792
	Aug.	674	1.02	688
	Sept.	530	1.01	535
	Oct.	454	1.03	468
	Nov.	304	1.04	316
	Dec.	328	1.09	358
	Total	6,658	1.03	6,845

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)
Units – 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./l)	T.D.S. (Tons)
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
Total	286,307			269,711
Average	9,544	.94	693	8,990

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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	642	1.10	706
	Feb.	535	1.15	615
	Mar.	743	.90	669
	Apr.	562	1.04	584
	May	1,150	1.11	1,277
	June	1,605	1.21	1,942
-1941	July	965	1.17	1,129
	Aug.	1,192	1.09	1,299
	Sept.	1,444	.99	1,430
	Oct.	1,505	1.02	1,535
	Nov.	1,671	1.02	1,704
	Dec.	2,010	1.04	2,090
	Total	14,024	1.07	14,980
	Jan.	1,876	1.08	2,026
	Feb.	1,590	1.09	1,733
	Mar.	1,476	1.09	1,609
	Apr.	1,080	1.11	1,199
	May	1,524	1.10	1,676
	June	1,465	1.11	1,626
-1942	July	1,199	1.11	1,331
	Aug.	844	1.09	920
	Sept.	742	1.11	824
	Oct.	761	1.08	822
	Nov.	981	1.03	1,010
	Dec.	1,176	.97	1,141
	Total	14,714	1.08	15,917
	Jan.	1,011	.94	950
	Feb.	729	.92	671
	Mar.	846	.95	804
	Apr.	802	.96	770
	May	842	.98	825
	June	876	.98	858
-1943	July	972	.95	923
	Aug.	910	.94	855
	Sept.	917	.94	862
	Oct.	1,094	.94	1,028
	Nov.	1,124	.93	1,045
	Dec.	1,222	.89	1,088
	Total	11,345	.94	10,679
	Jan.	1,209	.89	1,076
	Feb.	1,216	.94	1,143
	Mar.	1,289	.97	1,250
	Apr.	1,126	1.00	1,126
	May	1,055	1.01	1,066
	June	900	1.02	918
-1944	July	920	.99	911
	Aug.	1,041	.97	1,010
	Sept.	1,041	.94	979
	Oct.	1,123	.92	1,033
	Nov.	1,142	.89	1,016
	Dec.	1,143	.89	1,017
	Total	13,205	.95	12,545
	Jan.	1,160	.99	1,137
	Feb.	1,047	.97	1,016
	Mar.	1,193	.97	1,157
	Apr.	947	.98	928
	May	905	1.00	905
	June	860	.99	851
-1945	July	817	.96	784
	Aug.	718	.94	675
	Sept.	745	.92	685
	Oct.	912	.88	803
	Nov.	1,011	.89	900
	Dec.	1,075	.93	1,000
	Total	11,390	.95	10,841
	Jan.	1,008	.94	948
	Feb.	1,005	.92	925
	Mar.	927	.94	871
	Apr.	759	.96	729
	May	786	.98	770
	June	658	.99	651
-1946	July	719	.97	697
	Aug.	666	.94	626
	Sept.	639	.95	607
	Oct.	707	.97	686
	Nov.	757	.96	727
	Dec.	855	.94	804
	Total	9,486	.95	9,041

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	933	0.95	886
	Feb.	872	.95	828
	Mar.	934	.98	915
	Apr.	737	1.02	752
	May	827	1.01	835
	June	787	1.02	803
-1947	July	743	1.01	750
	Aug.	830	.99	822
	Sept.	733	1.00	733
	Oct.	753	.95	715
	Nov.	851	.90	766
	Dec.	1,041	.87	906
	Total	10,041	.97	9,711
	Jan.	1,106	.97	1,073
	Feb.	1,135	.94	1,067
	Mar.	1,092	.95	1,037
	Apr.	1,007	.94	947
	May	1,051	.95	998
	June	916	.95	870
-1948	July	1,003	.95	953
	Aug.	906	.94	852
	Sept.	871	.91	793
	Oct.	901	.89	802
	Nov.	945	.86	813
	Dec.	1,103	.94	1,037
	Total	12,036	.93	11,242
	Jan.	1,237	.92	1,138
	Feb.	1,183	.88	1,041
	Mar.	1,226	.88	1,079
	Apr.	1,084	.91	986
	May	927	.92	853
	June	871	.93	810
-1949	July	860	.92	791
	Aug.	934	.88	822
	Sept.	996	.86	857
	Oct.	1,103	.83	915
	Nov.	1,000	.93	930
	Dec.	1,146	.77	882
	Total	12,567	.88	11,104
	Jan.	1,088	.89	968
	Feb.	994	.87	865
	Mar.	1,169	.88	1,029
	Apr.	936	.90	842
	May	1,002	.91	912
	June	841	.89	748
-1950	July	822	.89	732
	Aug.	758	.88	667
	Sept.	643	.87	559
	Oct.	603	.94	567
	Nov.	510	.95	485
	Dec.	540	.95	513
	Total	9,906	.90	8,887
	Jan.	558	.95	530
	Feb.	498	.96	478
	Mar.	635	.96	610
	Apr.	744	.96	714
	May	606	.99	600
	June	703	.98	689
-1951	July	820	.98	804
	Aug.	853	.95	810
	Sept.	697	.93	648
	Oct.	682	.96	655
	Nov.	559	.97	542
	Dec.	698	.98	684
	Total	8,053	.96	7,764
	Jan.	1,058	.95	1,005
	Feb.	1,107	.96	1,063
	Mar.	1,424	.92	1,310
	Apr.	1,279	.97	1,241
	May	1,345	1.00	1,345
	June	1,309	.99	1,296
-1952	July	1,182	.97	1,147
	Aug.	1,178	.92	1,084
	Sept.	1,219	.87	1,061
	Oct.	1,240	.84	1,042
	Nov.	1,176	.78	917
	Dec.	1,298	.75	974
	Total	14,815	.91	13,485

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	1,216	0.77	936
	Feb.	1,022	.89	910
	Mar.	911	.95	865
	Apr.	756	1.01	764
	May	856	1.01	865
	June	811	1.00	811
-1953	July	980	.96	941
	Aug.	931	.95	884
	Sept.	776	.93	722
	Oct.	644	.96	618
	Nov.	522	.97	506
	Dec.	620	.95	589
	Total	10,045	.94	9,411
	Jan.	783	.94	736
	Feb.	661	.94	621
	Mar.	723	.94	680
	Apr.	773	.94	727
	May	929	1.05	975
	June	804	1.03	828
-1954	July	885	1.01	894
	Aug.	887	1.03	914
	Sept.	719	1.02	733
	Oct.	620	1.03	639
	Nov.	602	1.02	614
	Dec.	644	1.03	663
	Total	9,030	1.00	9,024
	Jan.	739	1.00	739
	Feb.	593	1.03	611
	Mar.	678	1.07	725
	Apr.	716	1.09	780
	May	729	1.13	824
	June	746	1.20	895
-1955	July	882	1.21	1,067
	Aug.	811	1.18	957
	Sept.	638	1.17	746
	Oct.	499	1.20	599
	Nov.	379	1.24	470
	Dec.	298	1.29	384
	Total	7,708	1.14	8,797
	Jan.	298	1.31	390
	Feb.	344	1.24	427
	Mar.	546	1.24	677
	Apr.	646	1.23	795
	May	594	1.26	748
	June	666	1.25	833
-1956	July	753	1.25	941
	Aug.	717	1.22	875
	Sept.	583	1.24	723
	Oct.	479	1.24	594
	Nov.	343	1.28	439
	Dec.	297	1.30	386
	Total	6,266	1.25	7,828
	Jan.	258	1.36	351
	Feb.	314	1.32	414
	Mar.	520	1.23	640
	Apr.	667	1.18	787
	May	581	1.19	691
	June	651	1.19	775
-1957	July	794	1.22	969
	Aug.	759	1.08	820
	Sept.	616	1.12	690
	Oct.	511	1.16	593
	Nov.	695	1.14	792
	Dec.	978	1.10	1,076
	Total	7,344	1.17	8,598
	Jan.	1,299	1.05	1,364
	Feb.	637	1.07	682
	Mar.	1,253	1.06	1,328
	Apr.	1,280	1.02	1,306
	May	1,016	1.00	1,016
	June	769	1.01	777
-1958	July	812	.96	780
	Aug.	802	.97	778
	Sept.	655	.97	635
	Oct.	624	1.01	630
	Nov.	592	1.00	592
	Dec.	761	.97	738
	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

Units - 1000

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	674	0.99	667
	Feb.	592	.99	586
	Mar.	618	1.02	630
	Apr.	770	1.01	778
	May	646	1.05	678
	June	679	1.03	699
-1959	July	824	.99	816
	Aug.	821	1.04	854
	Sept.	644	1.04	670
	Oct.	565	1.03	582
	Nov.	421	1.04	438
	Dec.	441	1.01	445
	Total	7,695	1.02	7,843
	Jan.	449	1.02	458
	Feb.	436	1.00	436
	Mar.	651	.99	644
	Apr.	762	.99	754
	May	650	1.07	696
	June	736	1.07	788
-1960	July	845	1.07	904
	Aug.	777	1.06	824
	Sept.	606	1.09	661
	Oct.	481	1.10	529
	Nov.	360	1.14	410
	Dec.	354	1.15	407
	Total	7,107	1.06	7,511
	Jan.	342	1.18	404
	Feb.	400	1.15	460
	Mar.	648	1.10	713
	Apr.	666	1.08	719
	May	618	1.14	705
	June	691	1.08	746
-1961	July	755	1.09	823
	Aug.	671	1.12	752
	Sept.	541	1.14	617
	Oct.	427	1.10	470
	Nov.	312	1.12	349
	Dec.	222	1.18	262
	Total	6,293	1.12	7,020
	Jan.	337	1.11	374
	Feb.	304	1.14	347
	Mar.	597	1.06	633
	Apr.	689	1.06	730
	May	619	1.11	688
	June	648	1.12	725
-1962	July	741	1.11	822
	Aug.	730	1.12	818
	Sept.	593	1.11	658
	Oct.	458	1.15	527
	Nov.	439	1.16	509
	Dec.	303	1.18	358
	Total	6,458	1.11	7,189
	Jan.	337	1.14	384
	Feb.	393	1.11	436
	Mar.	615	1.10	676
	Apr.	647	1.09	705
	May	602	1.09	656
	June	691	1.06	733
-1963	July	775	1.04	806
	Aug.	757	1.02	772
	Sept.	595	1.04	619
	Oct.	461	1.08	498
	Nov.	340	1.12	381
	Dec.	309	1.13	350
	Total	6,522	1.08	7,016
	Jan.	337	1.12	377
	Feb.	415	1.07	444
	Mar.	562	1.06	595
	Apr.	609	1.07	652
	May	530	1.10	583
	June	576	1.15	663
-1964	July	719	1.09	784
	Aug.	679	1.09	740
	Sept.	539	1.14	615
	Oct.	396	1.22	483
	Nov.	281	1.26	354
	Dec.	257	1.27	326
	Total	5,900	1.12	6,616

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.	271	1.26	341
	Feb.	332	1.26	418
	Mar.	548	1.20	658
	Apr.	566	1.15	651
	May	548	1.22	669
	June	558	1.22	680
-1965	July	709	1.26	893
	Aug.	737	1.28	943
	Sept.	540	1.31	708
	Oct.	400	1.29	516
	Nov.	257	1.33	342
	Dec.	237	1.22	290
	Total	5,703	1.25	7,109
	Jan.	203	1.13	229
	Feb.	334	1.21	404
	Mar.	517	1.21	626
	Apr.	622	1.22	758
	May	576	1.24	715
	June	637	1.31	835
-1966	July	729	1.20	874
	Aug.	733	1.18	865
	Sept.	532	1.21	643
	Oct.	389	1.23	478
	Nov.	263	1.28	337
	Dec.	314	1.18	369
	Total	5,849	1.22	7,133
	Jan.	301	1.21	364
	Feb.	369	1.16	428
	Mar.	593	1.12	664
	Apr.	558	1.15	642
	May	550	1.16	638
	June	595	1.16	690
-1967	July	673	1.08	727
	Aug.	672	1.09	732
	Sept.	450	1.16	522
	Oct.	412	1.12	461
	Nov.	268	1.22	327
	Dec.	174	1.35	235
	Total	5,615	1.15	6,430
	Jan.	342	1.18	404
	Feb.	366	1.10	403
	Mar.	566	1.10	623
	Apr.	622	1.09	678
	May	532	1.18	628
	June	580	1.10	638
-1968	July	625	1.14	713
	Aug.	609	1.16	706
	Sept.	494	1.17	578
	Oct.	399	1.21	483
	Nov.	297	1.25	371
	Dec.	309	1.25	386
	Total	5,741	1.15	6,611
	Jan.	271	1.30	352
	Feb.	376	1.18	444
	Mar.	601	1.12	675
	Apr.	638	1.20	766
	May	550	1.19	655
	June	553	1.17	647
-1969	July	622	1.16	721
	Aug.	628	1.18	740
	Sept.	443	1.23	544
	Oct.	417	1.22	509
	Nov.	225	1.32	297
	Dec.	292	1.29	376
	Total	5,616	1.20	6,726
	Jan.	352	1.23	434
	Feb.	352	1.26	444
	Mar.	558	1.22	681
	Apr.	677	1.18	799
	May	540	1.21	654
	June	549	1.22	670
-1970	July	623	1.21	753
	Aug.	577	1.21	698
	Sept.	440	1.23	541
	Oct.	421	1.22	513
	Nov.	298	1.20	358
	Dec.	314	1.32	415
	Total	5,701	1.22	6,960

Year	Month	Flow (A.F.)	Concentration (T./A.F.)	T.D.S. (Tons)
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	Total			
	Jan.			
	Feb.			
	Mar.			
	Apr.			
	May			
	June			
	July			
	Aug.			
	Sept.			
	Oct.			
	Nov.			
	Dec.			
	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)
Units – 1000

Year	Flow (A.F.)	Concentration (T./A.F.)	Concentration (Mg./1)	T.D.S. (Tons)
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	5,701	1.22	897	6,960
Total	266,675			274,644
Average	8,889	1.03	757	9,155

Table 18

Summary of Historical and Present Modified Quality of Water and Anticipated Effects of Future Developments at Eighteen Stations

Colorado River Basin

(Units: 1,000 except concentrations)

Station	Historical condition				Present modified condition 1/						Future Condition 2/		Zero pickup				T.D.S. pickup at 2T/A			
	Flow (AF)	T.D.S. (T)	Concentration (T/AF)	Concentration (mg/l)	Flow adjustment (AF)	Flow (AF)	T.D.S. adjustment (T)	T.D.S. (T)	Concentration (T/AF)	Concentration (mg/l)	Flow adjustment (AF)	Flow (AF)	T.D.S. adjustment (T)	T.D.S. (T)	Concentration (T/AF)	Concentration (mg/l)	T.D.S. adjustment (T)	T.D.S. (T)	Concentration (T/AF)	Concentration (mg/l)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Green River near Green River, Wyoming	1,273	534	0.42	308	-33	1,240	+11	545	0.44	323	-232	1,008	-90	455	0.45	332	-71	474	0.47	346
Green River near Greendale, Utah	1,560	886	0.56	417	-20	1,540	+35	921	0.60	440	-250	1,290	-93	828	0.64	472	-74	847	0.66	483
Duchesne River near Randlett, Utah	444	409	0.92	677	-20	424	-1	408	0.96	707	-206	218	-27	381	1.75	1,285	-11	397	1.82	1,339
Green River at Green River, Utah	4,149	2,578	0.62	456	-71	4,078	+47	2,625	0.64	473	-573	3,505	-135	2,490	0.71	522	-63	2,562	0.73	537
San Rafael River near Green River, Utah	95	213	2.24	1,648	-14	81	+2	215	2.65	1,951	-5	76	-4	211	2.78	2,041	-12	203	2.67	1,963
Colorado River near Glenwood Springs, Colorado	1,613	596	0.37	271	-195	1,418	+3	599	0.42	310	-311	1,107	-28	571	0.52	379	-28	571	0.52	379
Colorado River near Cameo, Colorado	2,765	1,530	0.55	406	-239	2,526	-7	1,523	0.60	443	-495	2,031	-30	1,493	0.74	540	+8	1,531	0.75	554
Gunnison River near Grand Junction, Colorado	1,727	1,467	0.85	624	-17	1,710	+19	1,486	0.87	639	-69	1,641	0	1,486	0.91	666	+65	1,551	0.95	695
Colorado River near Cisco, Utah	4,960	4,141	0.83	613	-317	4,643	+40	4,181	0.90	662	-789	3,854	-54	4,127	1.07	787	+101	4,282	1.11	817
San Juan River near Archuleta, New Mexico	912	197	0.22	159	+9	921	+10	207	0.22	165	-618	303	-137	70	0.23	170	-137	70	0.23	170
San Juan River near Bluff, Utah	1,620	970	0.60	440	-24	1,596	+30	1,000	0.63	461	-483	1,113	-5	995	0.89	657	+372	1,372	1.23	906
Colorado River at Lees Ferry, Arizona	10,507	7,960	0.76	556	-131	10,376	+635	8,595	0.83	609	-1,907	8,469	-343	8,252	0.97	716	+242	8,837	1.04	767
Colorado River near Grand Canyon, Arizona	10,803	9,076	0.84	617	-131	10,672	+635	9,711	0.91	669	-1,907	8,765	-343	9,368	1.07	786	+242	9,953	1.14	835
Virgin River at Littlefield, Arizona	156	349	2.24	1,644	0	156	0	349	2.24	1,644	-48	108	-2	347	3.21	2,362	+12	361	3.34	2,458
Colorado River below Hoover Dam, Ariz.-Nev.	10,501	9,862	0.94	690	-259	10,242	+516	10,378	1.01	745	-2,191	8,051	-345	10,033	1.25	916	+254	10,632	1.32	971
Colorado River above Parker Dam, Ariz.-Calif.	10,109	9,522	0.94	693	-125	9,984	+676	10,198	1.02	751	-2,218	7,766	-368	9,830	1.27	931	+271	10,469	1.35	991
Colorado River below Parker Dam, Ariz.-Calif.	9,544	8,990	0.94	693	-760	8,784	-18	8,972	1.02	751	-2,141	6,643	-563	8,409	1.27	931	-17	8,955	1.35	991
Colorado River at Imperial Dam, Ariz.-Calif.	8,889	9,155	1.03	757	-908	7,981	+88	9,243	1.16	851	-2,281	5,700	-563	8,680	1.52	1,120	+87	9,330	1.64	1,204

1/ Upper Basin Reservoir evaporation used in obtaining present modified conditions are the latest estimates. These may change when a more comprehensive evaporation study presently being conducted is completed.
2/ Represents conditions occurring after termination of the short-term contracts for temporary use of water by municipal and industrial users along the San Juan and lower Colorado Rivers, also with negligible salinity control measures.

Table 19
Projects depleting Colorado River water

Project and State	New depletion (ac.-ft.)	New irrigation land (acres)
Above the gage Green River at Green River, Wyoming		
Seedskadee, Wyoming including Westvaco and others	232,000	9,720
Between the above gage and the gage Green River near Greendale, Utah		
Lyman, Wyoming	10,000	0
Utah Power & Light and others, Wyoming	8,000	1/
Above the gage Duchesne River near Randlett, Utah		
Central Utah Project, Utah		
Bonneville Unit	166,000	2/
Upalco Unit	10,000	0
Uintah Unit	30,000	7,800
Between the gages Green River near Greendale, Utah, and Duchesne River near Randlett, Utah, and the gage Green River at Green River, Utah		
Four County, Colorado	40,000	2/
Hayden Steamplant, Colorado	12,000	1/
Cheyenne-Laramie, Wyoming	23,000	2/
Savery-Pot Hook, Colorado-Wyoming	27,000	17,920
Central Utah Project		
Jensen Unit	15,000	440
Above the gage San Rafael near Green River, Utah		
Utah Power & Light, Emery County, Utah	5,000	1/
Above the gage Colorado River near Glenwood Springs, Colorado		
Denver-Englewood, Colorado Springs, Colorado	256,000	2/
Green Mountain M&I, Colorado	12,000	1/
Homestake Project, Colorado	43,000	2/
Between the above gage and gage Colorado River near Cameo, Colorado		
Fryingpan-Arkansas, Colorado	70,000	2/
Ruedi M&I, Colorado	38,000	1/
West Divide, Colorado	76,000	19,000
Above the gage Gunnison River near Grand Junction, Colorado		
Fruitland Mesa, Colorado	28,000	15,870
Bostwick Park, Colorado	4,000	1,610
Dallas Creek, Colorado	37,000	15,000
Between the gages Colorado River near Cameo, Colorado, and Gunnison River near Grand Junction, Colorado, and the gage Colorado River near Cisco, Utah		
Dolores, Colorado	3/140,000	32,000
San Miguel, Colorado	85,000	26,000
Above the gage San Juan River near Archuleta, New Mexico		
San Juan-Chama, New Mexico	110,000	2/
Navajo Indian Irrigation, New Mexico	4/508,000	110,000
Between the above gage and the gage San Juan River near Bluff, Utah		
Animas-La Plata, Colorado-New Mexico	146,000	46,500
Expansion Hogback, New Mexico	10,000	0
Four Corners Powerplant, New Mexico	20,000	1/
Return flow--Dolores and Navajo Indian Irrigation, Colorado and New Mexico	-311,000	3/ 4/
Between the gages Green River at Green River, Utah; San Rafael River near Green River, Utah; Colorado River near Cisco, Utah; and San Juan River near Bluff, Utah; and the gage Colorado River at Lees Ferry, Arizona		
Resources, Inc., Utah	102,000	1/
Arizona M&I, Arizona	35,000	1/
Salvage	-80,000	
Subtotal Upper Basin	1,907,000	301,860

1/ In-basin depletion without irrigated lands.
2/ Transmountain diversion.
3/ In-basin transfer from Dolores River drainage to the San Juan River drainage--estimated 53,000-acre-foot return flow to the San Juan River.
4/ Diversions at Navajo Reservoir, estimated 258,000-acre-foot return flow to the San Juan River below the gage near Archuleta, New Mexico.

Table 19 (Continued)
Projects depleting Colorado River water

Project and State	New depletion (ac.-ft.)	New irrigation land (acres)
Between the above gage and the gage Colorado River near Grand Canyon, Arizona .	0	0
Above the gage Virgin River at Littlefield, Arizona		
Dixie Project, Utah	5/48,000	6,900
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		
Southern Nevada Water Project, Nevada	6/236,000	
Between the above gage and the gage Colorado River below Parker Dam, Arizona-California		
Fort Mohave and Chemehuevi Indian, Arizona, California, and Nevada	83,000	20,9[illegible]
Kingman, Arizona	18,000	
Mohave Valley I&D District, Arizona	6,000	
Lake Havasu I&D District, Arizona	7,000	
Salvage	-87,000	8/
Central Arizona, Arizona	7/	
California diversions limited to 4.4 million acre-feet to permit development of other tabulated projects in the lower basin	7/-77,000	
Between the above gage and the gage Colorado River at Imperial Dam, Arizona-Colorado		
Colorado River Indian, Arizona-California	208,000	51,970
Salvage	-68,000	
Subtotal Lower Basin	374,000	79,770
Total Colorado River	2,281,000	381,630

5/ Includes a transmountain diversion to Great Basin.

6/ Pending full development, the Mohave Thermal Plant will use part of this water which will be diverted below Hoover Dam.

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. The salinity computations assume no change in reservoir content during the period of study. Also, with the full depletions by the projects tabulated, the diversions to California would be reduced to an annual 4,400,000 acre-feet from its 1970 diversions of 5,015,000 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.