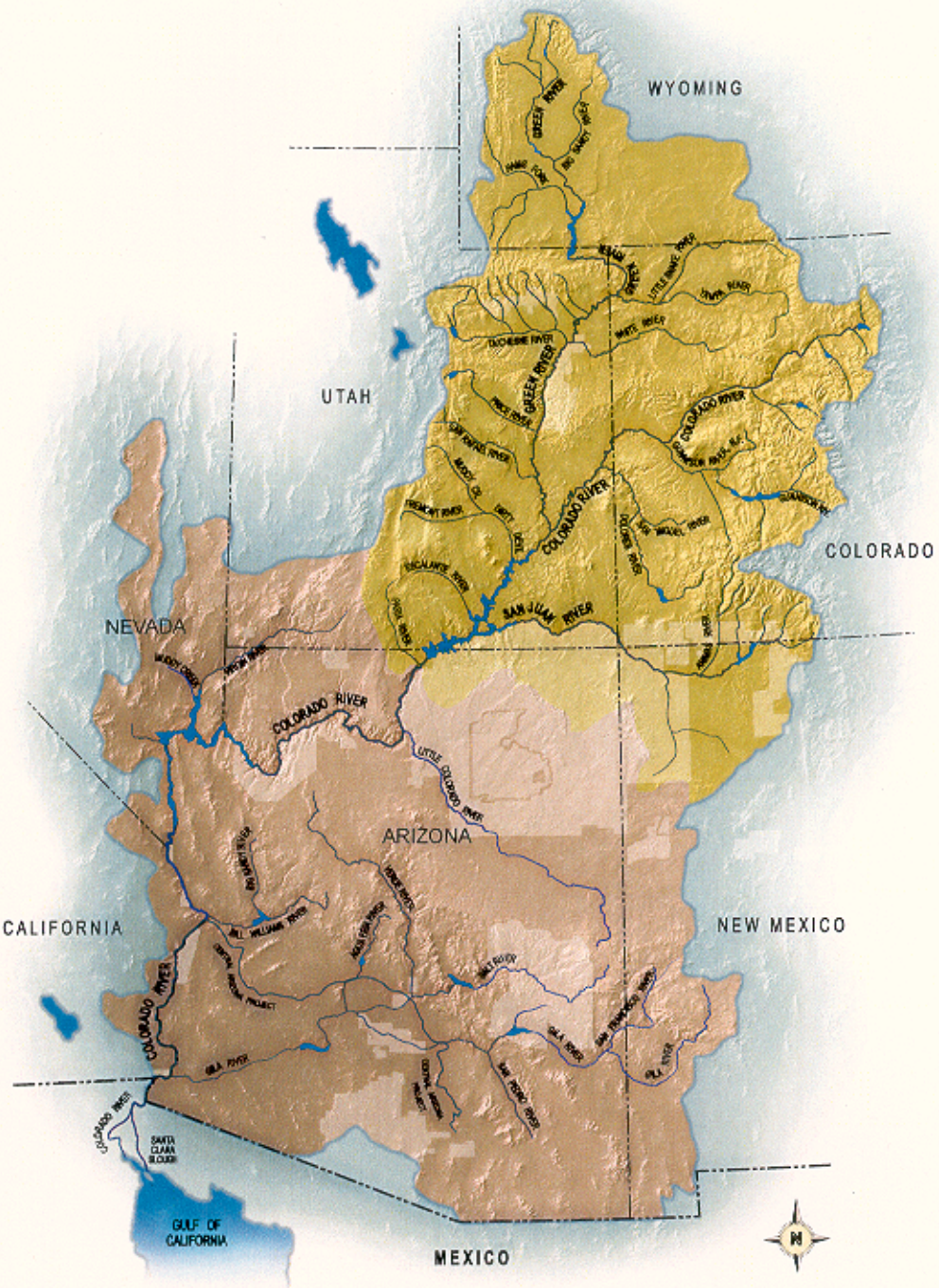
2002 Review

Water Quality Standards For Salinity Colorado River System



October 2002

Colorado River Basin Salinity Control Forum

2002 REVIEW

WATER QUALITY STANDARDS FOR SALINITY COLORADO RIVER SYSTEM

October 2002

Prepared by
Colorado River Basin Salinity Control Forum

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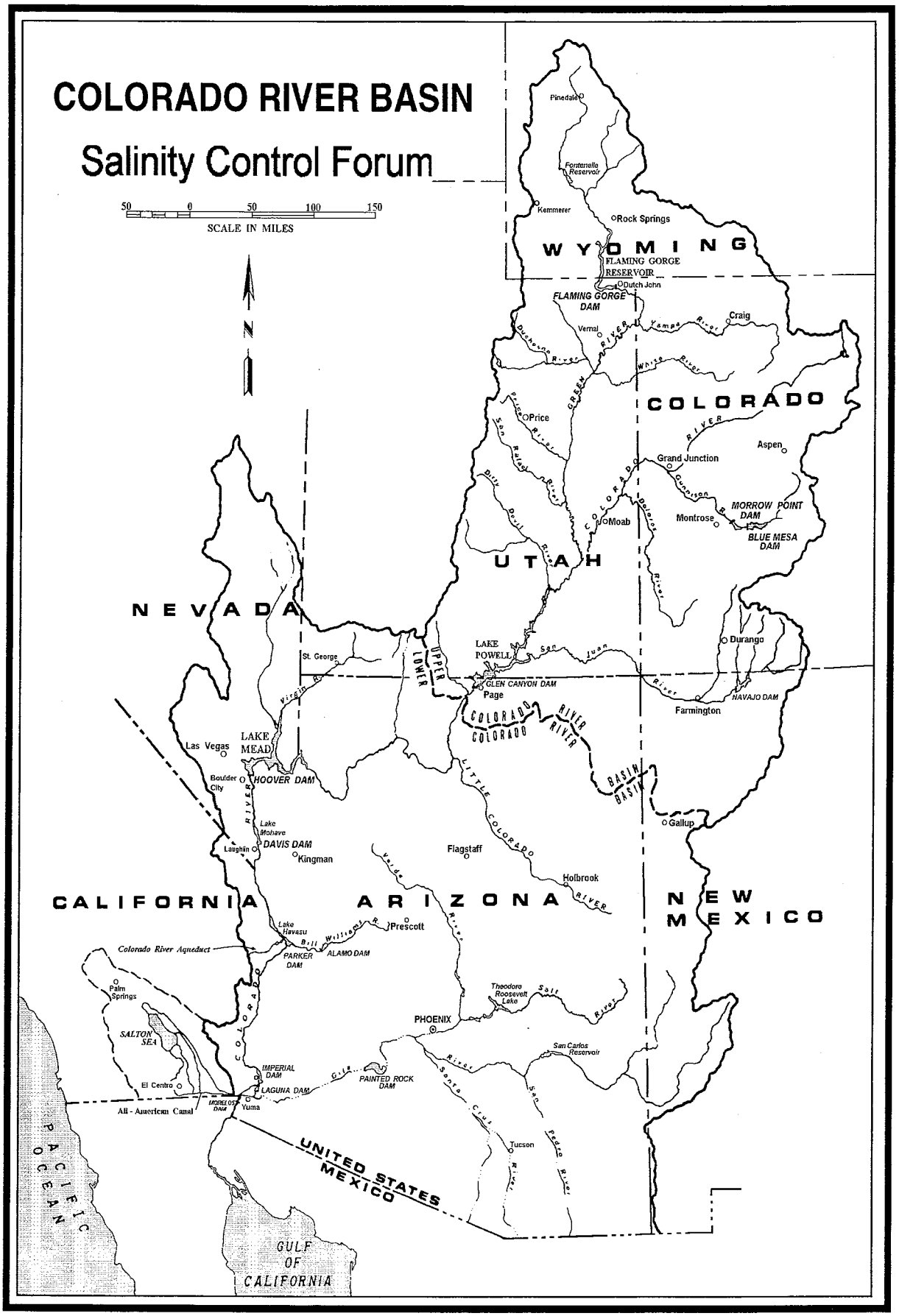
COLORADO RIVER BASIN
Salinity Control Forum
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NEW MEXICO
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Rock Springs
FLAMING GORGE RESERVOIR
Dutch John
FLAMING GORGE DAM
Vernal
Craig
Yampa River
Duchesne River
White River
Green River
Price
Price River
San Rafael River
Aspen
Grand Junction
Colorado River
Gunnison River
Dolores River
Moab
Montrose
MORROW POINT DAM
BLUE MESA DAM
Billy Devil River
Durango
San Juan River
LAKE POWELL
GLEN CANYON DAM
Page
Farmington
NAVAJO DAM
St. George
Virgin R.
LOWER
UPPER
LAKE MEAD
Las Vegas
Boulder City
HOOVER DAM
Lake Mohave
DAVIS DAM
Laughlin
Kingman
Colorado River
Little Colorado River
Basin
Gallup
Flagstaff
Holbrook
Verde River
Lake Havasu
Prescott
Williams R.
Bill Williams River
Colorado River Aqueduct
PARKER DAM
ALAMO DAM
Palm Springs
SALTON SEA
Theodore Roosevelt Lake
Salt River
PHOENIX
San Carlos Reservoir
IMPERIAL DAM
El Centro
LAGUNA DAM
PAINTED ROCK DAM
Gila River
Santa Cruz River
San Pedro River
All - American Canal
MORELOS DAM
Yuma
Tucson
UNITED STATES
MEXICO
PACIFIC OCEAN
GULF OF CALIFORNIA

TRANSMITTAL LETTERS

The Federal Water Pollution Control Act requires that at least once every three years the Colorado River Basin states review water quality standards relating to the salinity of the waters of the Colorado River. The states collectively initiated this review under the auspices of the Colorado River Basin Salinity Control Forum, prepared a proposed report; and after holding public meetings, the Forum prepared this final report.

Upon the Forum's adoption of the final report, it is transmitted by letter to the governors of the individual states for their independent action. The following governors in each of the seven Colorado River Basin states shall receive this report:

Honorable Jane Dee Hull
Governor of Arizona
Statehouse
Phoenix, AZ 85007

Honorable Gary E. Johnson
Governor of New Mexico
State Capitol
Santa Fe, NM 87503

Honorable Gray Davis
Governor of California
State Capitol
Sacramento, CA 95814

Honorable Mike Leavitt
Governor of Utah
State Capitol
Salt Lake City, UT 84114

Honorable Bill F. Owens
Governor of Colorado
State Capitol
Denver, CO 80203

Honorable Jim Geringer
Governor of Wyoming
State Capitol
Cheyenne, WY 82002

Honorable Kenny Guinn
Governor of Nevada
State Capitol
Carson City, NV 89701

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SUMMARY

This report is a review of the water quality standards for salinity for the Colorado River. It summarizes the Colorado River salinity control program and its proposed Plan of Implementation for continued salinity control. Economic damages due to elevated salinity levels have been significantly reduced through this program at very modest costs. In Arizona, California, and Nevada, economic damages have been reduced by $300 million per year, accomplished at a federal funding level of less than $20 million per year. The Salinity Control Program is a unique cooperative watershed effort between several federal agencies and seven states designed to meet national, international and state water quality objectives.

Section 303 of the Clean Water Act requires that water quality standards be reviewed from time to time, but at least once during each three-year period. Accordingly, the seven-state Colorado River Basin Salinity Control Forum (Forum) has reviewed the existing state-adopted and Environmental Protection Agency (EPA)-approved water quality standards for salinity consisting of numeric criteria and a Plan of Implementation for salinity control for the Colorado River System. Since the issuance of the 1999 Review, the U.S. Bureau of Reclamation (Reclamation) has continued work on developing a new model to analyze the Colorado River System, including salinity. The model development is not yet completed, however, upon prior Review projections and current estimates by Reclamation, salinity control needs through 2020 are described herein. This 2002 Review updates funding and needed salinity control measures to be implemented. The Forum's recommendations are to be submitted to each of the Basin states for consideration at a public hearing prior to adoption.

The Forum recommends no change in the numeric salinity criteria at the three stations located on the lower mainstem of the Colorado River. The numeric criteria at these stations will remain:

Station	Salinity in mg/L[1]
Below Hoover Dam	723
Below Parker Dam	747
At Imperial Dam	879

The Plan of Implementation as set forth in this 2002 Review is designed to meet the objective of maintaining the salinity concentrations at or below the numeric criteria while the Basin states continue to develop their compact-apportioned waters. The plan is based on maintaining the numeric criteria under a long-term mean water supply of 15 million acre-feet annually at Lee Ferry, the Compact Point. The Forum recommends that the Plan of Implementation described in this report be carried out. The Plan of Implementation includes:

[1]Flow-weighted average annual salinity.

1. Completion of Reclamation, U.S. Department of Agriculture, and Bureau of Land Management salinity control measures to the extent that each unit remains viable and appropriately cost-effective.

2. Implementation of the Forum's recommended and adopted policies for effluent limitations, principally under the National Pollutant Discharge Elimination System (NPDES) permit program established by Section 402 of the Clean Water Act as amended. The implemented policies (included in Appendix B of this Review) are the following:

   "Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program;"[2]

   "Policy for Use of Brackish and/or Saline Waters for Industrial Purposes;"

   "Policy for Implementation of the Colorado River Salinity Standards Through the NPDES Permit Program for Intercepted Ground Water;" and

   "Policy for Implementation of the Colorado River Salinity Standards Through the NPDES Permit Program for Fish Hatcheries."

3. Implementation of nonpoint source management plans developed by the states and approved by EPA.

Item 1 of the plan listed above is to be implemented by federal agencies in conjunction with state, local, and private participants. The Forum works jointly with federal agencies on developing measures to be implemented. The Forum also urges Congress to ensure that the funds necessary to successfully fulfill this Plan of Implementation are appropriated as needed. Items 2 and 3 above are primarily implemented by each of the Basin states.

Major components of this Review's Plan of Implementation are the federal programs. Table 1 summarizes the salinity control measures in place by federal participants through 2001 (800,000 tons). Salinity control measures leading to the removal of an additional 1,000,000 tons per year of salt must be implemented by 2020 to meet the Program goal of approximately 1.8 million tons of salt-load reduction annually. The adopted Plan of Implementation requires federal appropriations to Reclamation of at least $10.5 million and USDA of at least $13.8 million annually. The federal programs are described in detail in Chapter 4 of this Review.

The Plan of Implementation is designed to control enough salt to maintain the numeric criteria under a long-term mean water supply of 15 million acre-feet per year. It is recognized that

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[2]The Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program was revised on October 30, 2002.

the Colorado River system is subject to highly variable flows. Consequently, salinity will vary from year to year and may temporarily exceed the adopted numeric criteria in some years and remain well below the criteria in others.

Table 1
Colorado River Basin Salinity Control Program
Plan of Implementation
By 2020
(Values in Tons of Salt Load Reduction Per Year)

AGENCY	MEASURES IN PLACE (2001)	POTENTIAL NEW MEASURES	TOTAL
Bureau of Reclamation	482,000	500,000	982,000
U.S. Department of Agriculture	318,000	437,000	755,000
Bureau of Land Management[3]	_____	_____	_____
Unidentified	0	63,000	63,000
TOTAL	800,000	1,000,000	1,800,000

Salinity concentrations at the three stations on the Lower Colorado River in 2001 were:

Station	Salinity Concentration[4] in mg/L
Below Hoover Dam	587
Below Parker Dam	589
At Imperial Dam	681

Based on the data available, the Forum concludes that the measured salinity will not exceed the numeric criteria during the next three years. The Plan of Implementation adopted herein by the Forum provides for the control of about 1,800,000 tons of salt load reduction annually by the year 2020.

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[3]BLM is required by P.L. 106-459 to submit a status report to Congress on its basinwide salinity control program. When this report is submitted, the salinity control target for BLM will be determined.

[4]Flow-weighted average data based on 1999 provisional records.

Should more water development projects be completed than are projected to occur before salinity control measures are identified or brought on line, temporary increases above the numeric criteria could result. However, these increases will be deemed in conformance with the standards if appropriate salinity control measures are included in the plan.

Increases above the criteria as a result of below normal annual river flows and/or low reservoir storage conditions will also be considered in conformance with the standards, provided that when river flows return to normal, and satisfactory reservoir conditions prevail, concentrations will then be at or below the criteria level.

The Forum has reviewed the impact of the program on projected salinities and finds that through the year 2020 the plan will control salinity levels so that, with long-term mean water supply conditions, salinity levels will be below the numeric criteria at the three stations. The salinity standards provide protection from long-term increases in economic damage to downstream users.

Because of the long lead-time required to conduct salinity studies; complete environmental and feasibility reports; implement; and achieve full salinity reduction effects at the lower Colorado River mainstem stations, continued funding is necessary for the recommended Plan of Implementation to proceed as set forth in this Review. Non-federal funds are available to cost-share with federal appropriations, and Basin irrigators stand ready with cost-share dollars to install salinity reducing measures.

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List of Abbreviations

208 Plan	Section 208 of the Clean Water Act amendments of 1972 and 1977 requiring integrated area-wide plans and programs for dealing with water pollution problems
ADEQ	Arizona Department of Environmental Quality
AWT	Advanced Waste Treatment
BCC	Nevada's Clark County Board of Commissioners
BLM	United States Bureau of Land Management
BMI	Basic Management Inc.
CCSD	Clark County Sanitation District
CLV	City of Las Vegas
CNLV	City of North Las Vegas
CRM	Coordinated Resource Management (group)
CRSS	Colorado River Simulation System
CSCB	Colorado Soil Conservation Board
CWA	Clean Water Act
DEQ	Wyoming Department of Environmental Quality
DPA	Designated Planning Agency
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESI	Ecological site inventory
FAIRA	Federal Agriculture Improvement and Reform Act (P.L. 104-127) (1996)
FSRIT	Farm Security and Rural Investment Act (P.L. 107-171) (2002)
Forum	Colorado River Basin Salinity Control Forum
FY	The federal government's Fiscal Year
HMA	Herd Management Area
IBWC	International Boundary and Water Commission
MGD	Million gallons per day
mg/L	milligrams per liter
NACOG	Northern Arizona Council of Governments
NDEP	Nevada Division of Environmental Protection
NEPA	National Environmental Policy Act
NMWQMT	New Mexico Water Quality Management Plan
NPSMP	Nonpoint Source Management Plan (New Mexico)
NPDES	National Pollutant Discharge Elimination System
NPS	Non Point Source
NRCS	Natural Resources Conservation Service
NRI	National Resource Inventory
PPM	parts per million
Reclamation	U.S. Bureau of Reclamation (USBR)
RMHQ	Requirements to Maintain Higher Quality (in Nevada)
RMP	Resource Management Plan
RO	Regional Office
SRF	State Revolving Fund (EPA low-interest loans for non-point sources)
SSC	Suspended Sediment Concentration
TDS	Total dissolved solids
The Act	The Colorado River Basin Salinity Control Act (P.L. 93-320) (1974), as amended by

	P.L. 98-569 (1984), P.L. 104-20 (1995), and P.L. 106-459 (2000)
TMDL	Total Maximum Daily Load
T/AF	Tons per Acre-foot
UIC	Underground Injection Control (EPA)
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UWA	Unified Watershed Assessment (part of Clean Water Action Plan)
WACOG	Western Arizona Council of Governments
WLA	Waste Load Allocation
WQCC	Water Quality Control Commission (Colorado)

CHAPTER 1 - INTRODUCTION

Purpose of Report

This report, the 2002 Review, Water Quality Standards for Salinity, Colorado River System (Review) is prepared and submitted in response to Section 303(c) of the Clean Water Act[5]. Prepared by the seven-state Colorado River Basin Salinity Control Forum (Forum), on behalf of the governors of their respective states, this Review of the water quality standards includes the numeric criteria and the Plan of Implementation developed and adopted by the Forum. It also includes modifications to previous reviews that have become necessary as a result of changed conditions and the availability of additional information. This is the ninth triennial review conducted by the Forum. Section 303(c)(1) of the Clean Water Act requires that:

> *The governor of a state or the state water pollution control agency of such state shall from time to time (but at least once each three-year period beginning with the date of enactment of the Federal Water Pollution Control Act Amendments of 1972) hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards. Results of such review shall be made available to the Administrator.*

This Review is consistent with the Environmental Protection Agency (EPA)-approved 1975 standards and deals only with that portion of the Colorado River Basin above Imperial Dam. While this Review will recap past events in an abridged format, its focus is on information gathered since issuance of the 1999 Review. Background information and activities regarding historical actions relative to the development and adoption of salinity standards is contained in the June 1975 standards report[6]. The prior eight Reviews, from 1978 to 1999, contain more specific information on the eight 3-year periods.

Below Imperial Dam, salinity is controlled as a federal responsibility to meet the terms of the agreement with Mexico contained within Minute No. 242 of the International Boundary and Water Commission (IBWC), entitled "Permanent and Definitive Solution to the International Problem of the Salinity of the Colorado River." Minute No. 242 requires that measures be taken to assure that Colorado River (River) water delivered to Mexico upstream from Morelos Dam will have an average annual salinity concentration of no more than 115 ± 30 parts per million (ppm) total dissolved solids (TDS) higher than the average annual salinity concentration of Colorado River water arriving at Imperial Dam.

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[5]Public Law [P.L.] 92-500 as amended by P.L. 95-217 and P.L. 100-4.

[6]Water Quality Standards for Salinity, Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System, Colorado River Basin Salinity Control Forum, June 1975.

Nothing in this report shall be construed to alter, amend, repeal, interpret, modify, or be in conflict with the provisions of the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774), the Colorado River Basin Project Act (82 Stat. 885), the Colorado River Compact, the Colorado River Storage Project Act (70 Stat. 105), the Upper Colorado River Basin Compact, or the Treaty with the United Mexican States (Treaty Series 994).

History and Background

In the 1960's and early 1970's, the seven Colorado River Basin states[7] and representatives of the Federal Government discussed the problem of salinity levels increasing in the lower reaches of the Colorado River. In 1972, the Federal Government enacted the Clean Water Act which mandated efforts to maintain water quality standards in the United States. At the same time, Mexico and the United States were discussing the increasing salinity of Colorado River water being delivered to Mexico.

The Basin states established the Colorado River Basin Salinity Control Forum in 1973. The Forum is composed of representatives from each of the seven Basin states appointed by the governors of the respective states. The Forum was created for interstate cooperation and to provide the states with the information necessary to comply with Section 303(a) and (b) of the Clean Water Act.

Congress enacted the Colorado River Basin Salinity Control Act (Public Law (P.L. 93-320) (the Act) in June of 1974 with the Forum's support (see Appendix A). Title I of the Act addresses the United States' commitment to Mexico and provided the means for the United States to comply with the provisions of Minute No. 242. Title II of the Act created a water quality program for salinity control in the United States. Primary responsibility for the federal program was given to the Secretary of the Interior, with the Bureau of Reclamation (Reclamation) being instructed to investigate and build several salinity control units. The Secretary of Agriculture was instructed to support the effort within existing authorities (see Chapter 4 for more detail regarding these authorities).

The EPA promulgated a regulation in December 1974 (see Appendix A), which set forth a basinwide salinity control policy for the Colorado River Basin. The regulation specifically stated that salinity control was to be implemented while the Basin states continue to develop their compact-apportioned water. This regulation also established a standards procedure, and required the Colorado River Basin states to adopt and submit for approval to the EPA water quality standards for salinity, including numeric criteria and a Plan of Implementation, consistent with the policy stated in the regulation.

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[7]The seven Colorado River Basin states (Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming) are referred herein as the "Basin states."

The Basin states, acting through the Forum, initially responded to this regulation by developing and submitting to the EPA a report entitled Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control - Colorado River System dated June 1975. Since the states' initial adoption, the water quality standards have been reviewed every three years (1978, 1981, 1984, 1987, 1990, 1993, 1996, and 1999) as required by Section 303(c)(1) of the Clean Water Act.

The Colorado River Basin Salinity Control Act was amended in 1984 by P.L. 98-569 to authorize two additional units for construction by Reclamation and directed the Bureau of Land Management (BLM) to implement a comprehensive program to minimize salt loading in the Colorado River Basin. The amendments directed the Secretary of the Interior and the Secretary of Agriculture to give preference to the salinity control units with the least cost per unit of salinity reduction. The Act was also amended to establish a voluntary on-farm salinity control program to be implemented by the U. S. Department of Agriculture (USDA) and provided for voluntary replacement of incidental fish and wildlife values foregone on account of the on-farm measures. Many cost-effective salt-load reducing activities were accomplished in the decade following that authorization.

Reclamation and the Forum in 1994 concluded that the existing Act, as amended, with its unit-specific approach and authorization ceiling, was limiting salinity control opportunities. In 1995, the Act was amended by P.L. 104-20 to authorize new procedures (Basinwide Salinity Control Program) for Reclamation to follow in implementing salinity control. Reclamation's Basinwide Salinity Control Program opens the program to competition through a public process and has greatly reduced the cost of salinity control. In 2000, P.L.106-459 increased the authorization ceiling for the Basinwide Salinity Control Program from $75 million to $175 million.

The Federal Agriculture Improvement and Reform Act (FAIRA) of 1996 (P.L. 104-127) further amended USDA's role in salinity control by creating a new conservation program known as the Environmental Quality Incentives Program (EQIP) which combined four conservation programs, including USDA's Colorado River Salinity Control Program. FAIRA provided authority for funding the nationwide EQIP through the year 2002. USDA has created rules and regulations concerning how EQIP funds are to be allocated. The Forum's experience has been that the enacted rules and regulations for EQIP do not consider the significant benefits in downstream states, thus creating a situation which disadvantages salinity control efforts when compared to other local initiatives. The past authority for the states to cost-share from the Basin funds was retained in the new EQIP with linkage to Reclamation's authority to distribute Basin funds for cost-sharing.

The Farm Security and Rural Investment Act (FSRIA) of 2002 (P.L. 107-171) reauthorized EQIP from 2002 through 2007 at significantly increased funding levels. The EQIP funds dedicated to the Colorado River Salinity Control Program totaled more than $10 million, which is about double the funds available in 2001, and could possibly rise to a high of $33 million in 2007, the final year of FSRIA. Final rules have not been published and the full input of FSRIA on salinity control have not been analyzed.

Figure 1-1 displays a cumulative estimation of the annual salt removal by the Colorado River Basin Salinity Control Program.

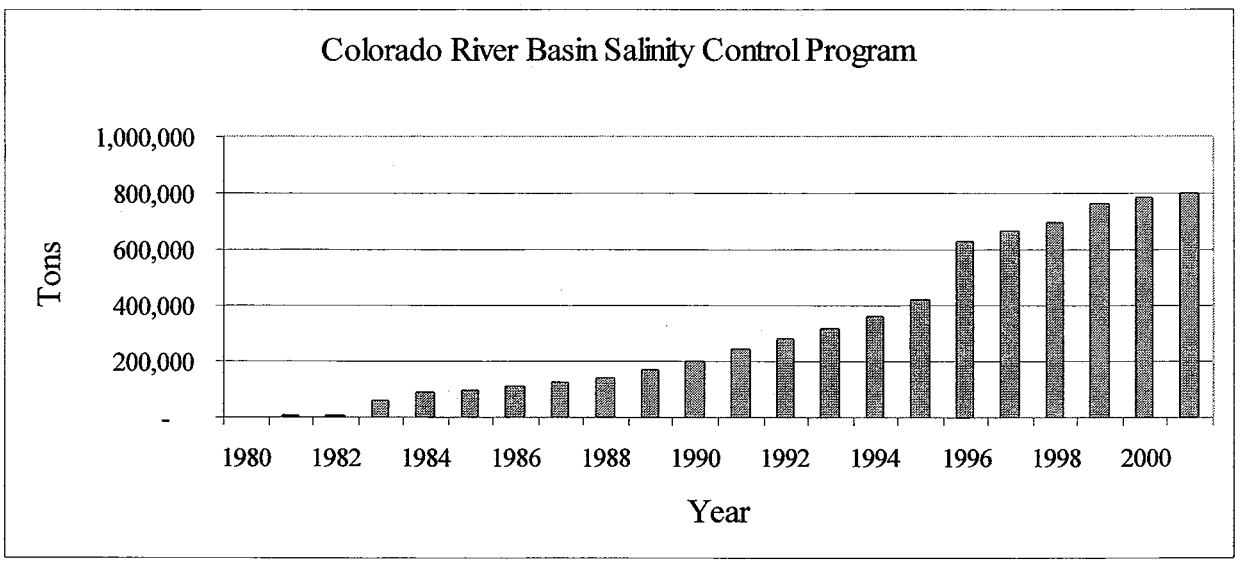

Figure 1-1. Measures in Place

Overview of Standards

In 1975, the Forum proposed, the states adopted, and the EPA approved water quality standards, which included numeric criteria and a Plan of Implementation to control salinity increases in the River. The standards require that a plan be developed which will maintain the flow-weighted average annual salinity at or below the 1972 levels while the Basin states continue to develop their compact-apportioned water supply. The Forum selected three stations on the mainstem of the lower Colorado River as being appropriate points to measure the salinity of the Colorado River. These stations are located at the following points on the Colorado River: (1) below Hoover Dam; (2) below Parker Dam; and (3) at Imperial Dam. Numeric criteria were established for these points as required by the 1974 regulation. A Plan of Implementation was also developed in 1975 by the Forum and participating federal agencies as part of the standards. It was designed to ensure compliance with the numeric criteria for salinity. The numeric criteria and Plan of Implementation are further described in Chapters 3 and 4 of this Review.

During each triennial review, the numeric criteria are reviewed and the Plan of Implementation is updated to ensure continuing compliance with the standards. The Forum relies on the Basin states' projections of use of compact-apportioned waters. The salinity projections are based on the long-term mean water supply of 15 million acre-feet (maf) per year at Lee Ferry, Arizona.

The Colorado River water quality standards for salinity, and the approach taken by the Basin states in complying, are unique. The numeric criteria selected as the water quality standards were

established to protect infrastructure and crop production rather than human health or fish and wildlife values. Also, the program is a coordinated effort between federal, state, and local agencies and participants with the goal of protecting the watershed.

Program Funding

Adequate funding is required to meet the standards. Funds are provided from federal and non-federal sources. Federal appropriations and non-federal funds including Basin states cost-share funds and local participant dollars are used to implement the Colorado River Basin Salinity Control Program. The Basin states and the local producers have funds available and stand ready to implement the program proposed in this report.

Figure 1-2 shows federal appropriations for the Colorado River Basin Salinity Control Program over the past fourteen years. Annual appropriations to Reclamation were as large as $34.6 million as recently as 1992, but for Fiscal Year (FY) 2003 the Administration has requested an appropriation of $9.8 million. The Basin states believe the appropriation to Reclamation can be smaller than in the past because of improved cost-effectiveness, but finds that about $10.5 million is needed each year through the planning period of this report.

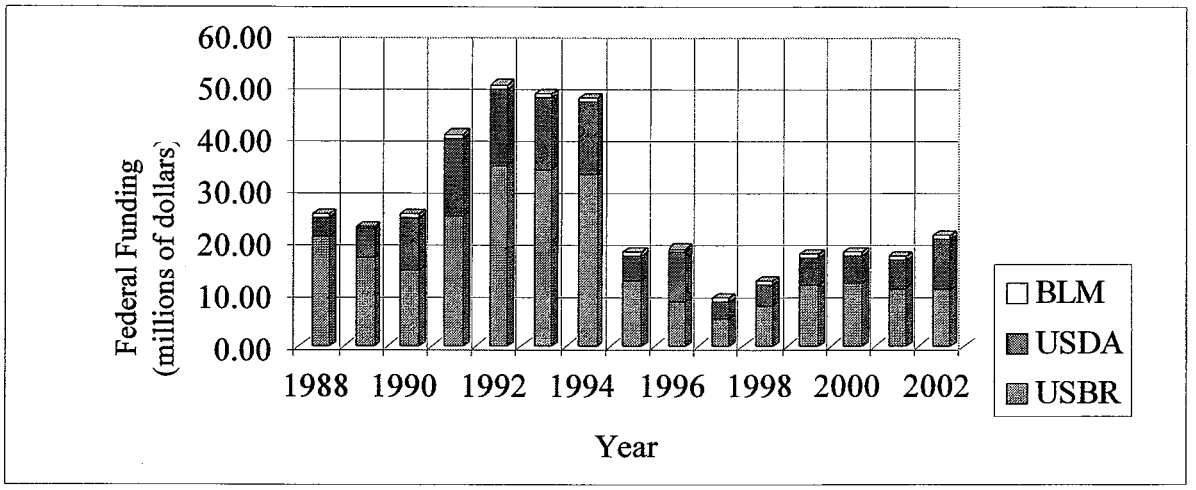

Figure 1-2. Historic Federal Funding Levels

Following the passage of FAIRA in 1996, federal funding was provided to the USDA each year for distribution for environmental enhancement efforts through the nationwide EQIP. In 1991 and 1992, when salinity control was a separate line-item, $14.8 million was made available to the USDA's Colorado River Salinity Control Program by Congress, but in 1998 the USDA allocated only $3.9 million. A partial solution to this under-funding was found when USDA designated the Colorado River Basin as a national conservation priority area at the urging of Congress and the Basin states. For the past few years, since that designation, the federal funding has been at about $5 million. The Basin states find that under the new EQIP authorization, funding for the USDA salinity

control program needs to be at least $13.8 million per year.

The BLM has an important role to play in controlling salt contributions from nonpoint sources from the very sizeable amount of federal land it manages. BLM is required by P.L. 106-459 to submit a status report to Congress on its basinwide salinity control program. When this report is submitted, the salinity control target for BLM will be determined. The Forum has renewed its effort to work with this agency, which has the responsibility to care for vast areas in the Colorado River drainage from which significant amounts of salts are being contributed to the River.

CHAPTER 2 - SALINITY OF THE RIVER

Overview

The Colorado River drains 246,000 square miles (approximately 157 million acres) of the western United States and a small portion of northern Mexico. Its waters serve some 7.8 million people within the United States' portion of the Colorado River basin, and through export provides full or supplemental water supply to another 23 million people outside the basin. The regional economy is based on irrigated agriculture, livestock grazing, mining, forestry, manufacturing, oil and gas production, recreation and tourism. About 3.5 million acres are irrigated within the Colorado River Basin and hundreds of thousands of additional acres are irrigated by waters exported from the Basin. Hydroelectric power facilities along the Colorado River and its tributaries generate approximately 12 billion kilowatt-hours annually which is used both inside and outside of the Basin. The Colorado River also serves about 2.3 million people and 500,000 irrigated acres in Mexico.

Salinity has long been recognized as one of the major problems of the river. The Colorado, like most western rivers, increases in salinity from its headwaters to its mouth, carrying an average salt load of approximately nine million tons annually past Hoover Dam, the uppermost location at which numeric criteria have been established. In addition to total salt load which measures the total mass of salt carried in the River (tons per year), this report also examines salinity in terms of concentration as expressed in milligrams per liter (mg/L).

The salts in the Colorado River system are indigenous and pervasive. Many of the saline sediments of the Basin were deposited in prehistoric marine environments. Salts contained within the sedimentary rocks are easily eroded, dissolved, and transported into the river system. The Colorado River Basin Salinity Control Program is designed to prevent a portion of this abundant salt supply from moving into the river system.

In a 1971 study[8], the EPA analyzed salt loading in the Colorado River Basin and divided it into two categories, naturally occurring and human-caused. The EPA concluded that about half (47 percent) of the salinity concentration measured in water arriving at Hoover Dam is from natural causes including salt contributions from saline springs, ground water discharge into the river system (excluding irrigation return flows), erosion and dissolution of sediments, and the concentrating effects of evaporation and transpiration. The natural causes category also included salt contributions from non-point (excluding irrigated agriculture) or unidentified sources or from the vast, sparsely-populated regions of the drainage, much of which is administered by the BLM or other governmental agencies. Of the land within the Colorado River Basin, about 75 percent is owned and administered by the Federal Government or held in trust for Indian tribes. The greatest portion of the naturally-occurring salt load originates on these federally-owned and administered lands. Human

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[8]The Mineral Quality Problem in the Colorado River, Summary Report, Environmental Protection Agency, Regions VIII and IX, 65 pp., 1971.

activities can influence the rate of natural salt movement from rock formations and soils to the river system and include: livestock grazing, wildlife management, logging, mining, oil exploration, road building, recreation and urbanization.

Approximately 53 percent of the salinity concentration in the water arriving at Hoover Dam, as identified by EPA, results from various human activities. EPA estimated that out-of-Basin exports account for about 3 percent of the salt concentration at Hoover Dam, with irrigation accounting for 37 percent, reservoir evaporation and phreatophyte use accounting for about 12 percent, and about 1 percent attributed to municipal and industrial uses. Much of the salt load contribution from irrigated agriculture is from federally-developed irrigation projects.

Salinity control activities necessarily include a water quality monitoring and analysis component that provides basinwide information for program evaluation. The monitoring and analysis component provides an essential database for future studies, supports state and regional planning activities, and provides an objective basis for evaluating the effectiveness of salinity control measures.

Continuing evaluations of the salinity of the Colorado River are made by Reclamation, the U.S. Geological Survey (USGS) and BLM. The results of several studies have been published by the agencies since the last Review (1999-2001). To evaluate changes in salinity, water quality and streamflow data are obtained on a daily, weekly, monthly, and/or quarterly basis at various points on streams throughout the Colorado River Basin by the USGS in cooperation (through financial and/or direct services) with private entities, the states and other federal agencies. Figure 2-1 shows the gaging stations in the Colorado River Basin which are of significance to the program and for which streamflow and water quality records are available. Data and salinity reports are available from Reclamation at www.uc.usbr.gov/progact/salinity/index.html.

Salinity data are based on total dissolved solids (TDS) as the sum of constituents, whenever possible. The sum of constituents values are defined to include calcium, magnesium, sodium, chloride, sulfate, a measure of the carbonate equivalent of alkalinity and, if measured, silica and potassium. If a sum of constituents value could not be computed, TDS as residue on evaporation (at 180 degrees Celsius) is substituted. Further, some reported salinity values are based on correlation with specific conductance measurements. In this Review the terms "salinity," "TDS" and "concentration" in mg/L are used interchangeably.

Average annual salinity concentrations and salt loads are determined on a flow-weighted average annual salinity concentration. The flow-weighted average annual salinity is the concentration determined from dividing the annual total salt load passing a measuring station by the total annual volume of water passing the same point during a calendar year. The flow-weighted average annual salinity is calculated by first multiplying the daily concentration values by the daily flow rates. These values are then summed over a calendar year and then divided by the sum of the daily flow rate.

MONITORING STATIONS

1 Green River near Green River, WY
2 Green River near Greendale, UT
3 Yampa River near Maybell, CO
4 Duchesne River near Randlett, UT
5 White River near Watson, UT
6 Green River near Green River, UT
7 San Rafael River nr Green River, UT
8 Colorado River nr Glenwood Springs, CO
9 Colorado River near Cameo, CO
10 Gunnison River near Grand Jct, CO
11 Dolores River near Cisco, UT
12 Colorado River near Cisco, UT
13 San Juan River near Archuleta, NM
14 San Juan River near Bluff, UT
15 Colorado River at Lees Ferry, AZ
16 Colorado River near Grand Canyon, AZ
17 Virgin River at Littlefield, AZ

Numeric Criteria Stations:
18 Colorado River below Hoover Dam
19 Colorado River below Parker Dam
20 Colorado River at Imperial Dam

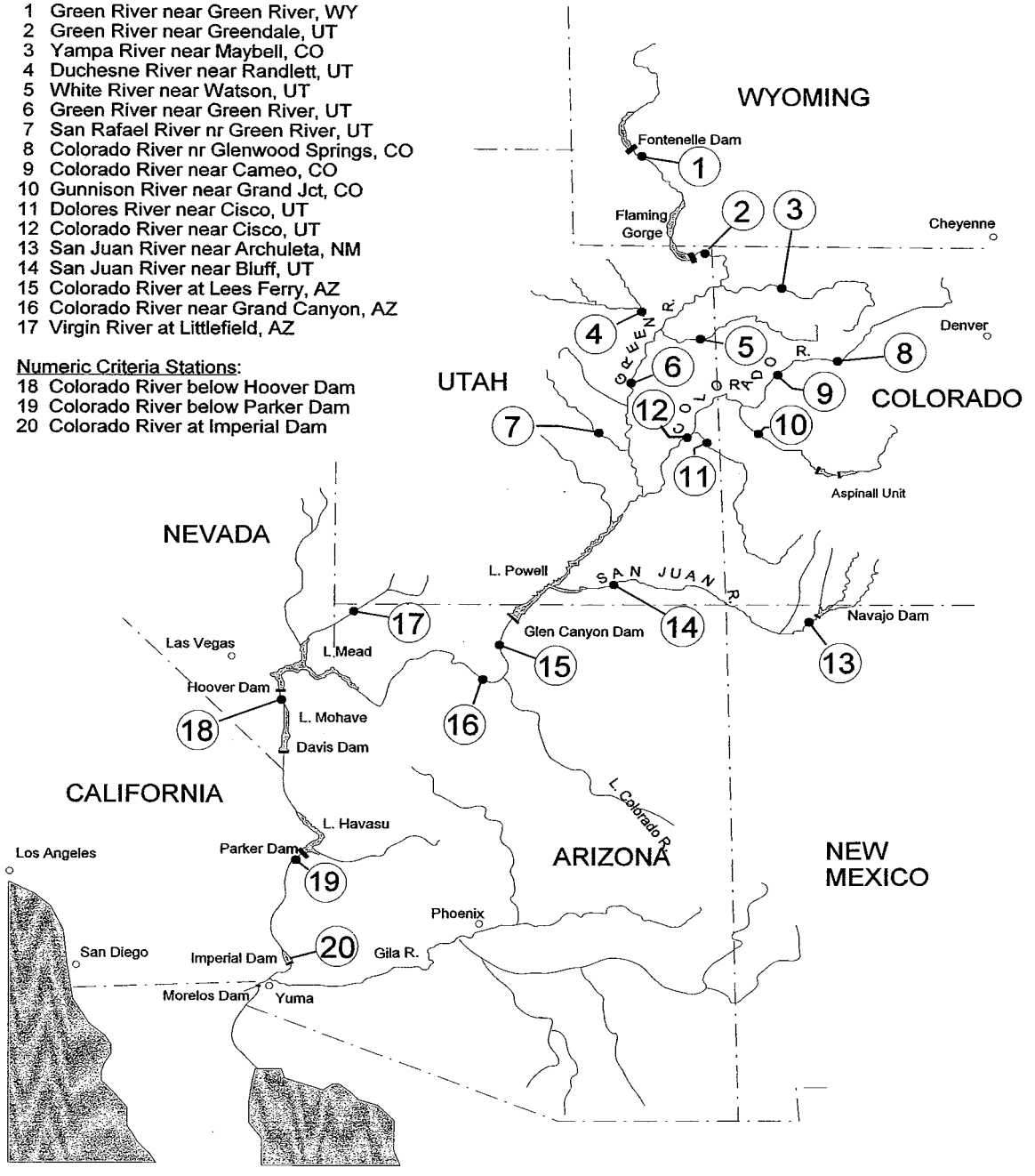

Figure 2.1. Colorado River water quality monitoring stations

Observed Salinity

Salinity of the River has fluctuated significantly over the period of record (1941-1999; Figure 2-2). Salinity generally decreases in periods of high flow and increases in periods of low flow as can be seen in Figure 2-2.

In the past two decades, the Colorado River has experienced both record high flows and sustained drought. Record high flows during the mid-1980's caused lower salinities in the Lower Basin (577 mg/L at Imperial Dam). Conversely, the period from 1988 to 1992 was the driest five years on record. As a result, salinity at Imperial Dam gradually increased to 803 mg/L. Moderately high flows later in the 1990's caused salinity to decline again. Given that the hydrologic fluctuations over the past three decades are likely to be repeated in the future, it is expected that concentrations will fall within the observed range of 577-896 mg/L at Imperial Dam if appropriate salinity control measures are implemented. Similar ranges might be expected from the observed data at Hoover Dam (517 mg/L - 667 mg/L) and Parker Dam (535 mg/L - 671 mg/L).

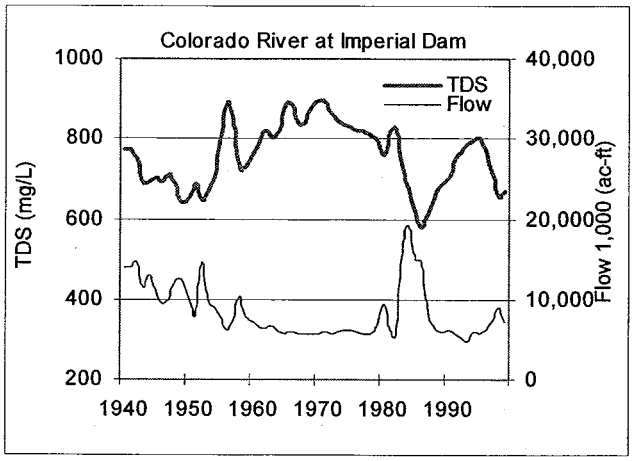

Figure 2-2. Salinity at Imperial Dam.

Water Use and Associated Impacts of Salinity

The Colorado River, from its headwaters in the Rocky Mountains to its mouth in the Gulf of California, is utilized for a variety of purposes. A significant portion of the average supply of the River is transported out of the Colorado River Basin for use in adjacent river basins. In the Colorado River Basin, irrigation, municipal and industrial, hydroelectric power generation, power plant cooling, fish and wildlife, and recreation are the major uses of the water.

Table 2-1
Observed Flow-Weighted Average Salinity
at the Numeric Criteria Stations
(Total Dissolved Solids in mg/L)[9]

Calendar Year	Below Hoover Dam	Below Parker Dam	At Imperial Dam
1970	743	760	896
1971	748	758	892
1972	724	734	861
1973	675	709	843
1974	681	702	834
1975	680	702	829
1976	674	690	822
1977	665	687	819
1978	678	688	812
1979	688	701	802
1980	691	712	760
1981	681	716	821
1982	679	713	827
1983	659	678	727
1984	598	611	675
1985	556	561	615
1986	517	535	577
1987	519	538	612
1988	529	540	648
1989	564	559	683
1990	587	600	702
1991	629	624	749
1992	657	651	767
1993	665	631	785
1994	667	673	796
1995	654	671	803
1996	618	648	768
1997	625	612	710
1998	604	559	655
1999	580	591	681
2000	582	580	658
2001	587	589	681

[9] Determined by the U.S. Geological Survey (USGS) from data collected by the U.S. Bureau of Reclamation and USGS and published in *Quality of Water, Colorado River Basin, Progress Report No. 20*, 2001

Colorado River water users in the Lower Basin have suffered significant economic losses due to long-term continued use of water with elevated salinity levels. Figure 2-3 shows known salinity damages in Arizona, California, and Nevada resulting from long-term continued use at various levels of salinity based on the Metropolitan-Reclamation Salinity Management Study conducted by Reclamation and The Metropolitan Water District of Southern California. At the 1999 salinity level of 669 mg/L at Imperial Dam, Figure 2-3 shows direct economic damages currently nearing $200 million per year. This would increase to $500 million per year if salinity were allowed to return to the numeric criteria levels of the standard (879 mg/L at Imperial Dam). Salinity impacts from the use of 1.5 maf per year of water delivered to Mexico have not been quantified but Mexico has indicated that they are significant.

Agricultural water users suffer economic damage as a result of using highly saline waters through reduced crop yields, added labor costs for irrigation management, and added drainage requirements. Urban users incur additional costs due to more frequent replacement of plumbing and water using appliances, use of water softeners and the purchase of bottled water. Industrial users and water treatment and waste water utilities incur reductions in the useful life of system facilities and equipment from higher levels of salinity.

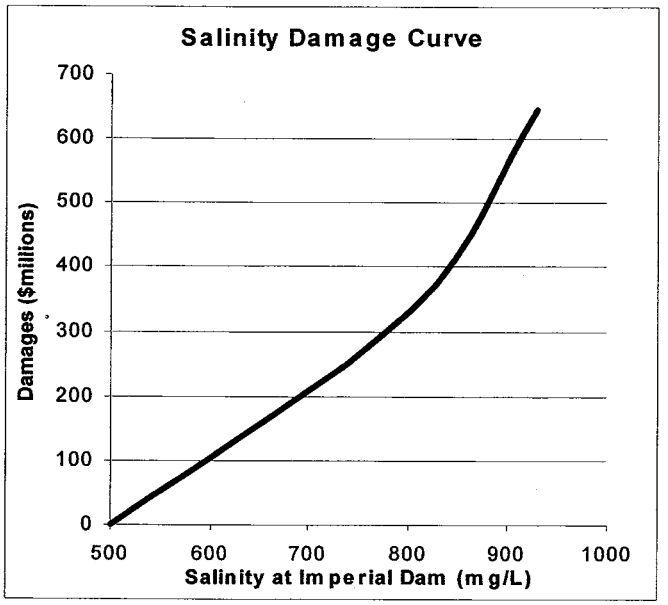

Figure 2-3. Salinity Damages in Lower Basin.

Another significant economic loss in the Lower Basin results from the regulatory restrictions imposed by local and regional water quality standards and management programs which protect ground water supplies. Regulatory agencies have placed restrictions on reuse or recharge of waters that exceed specified salinity levels. If the salinity levels of the Colorado River increase, these regulatory actions result in additional expensive treatment of water prior to reuse or disposal instead of reuse of the waters. If disposal options are selected, additional costly water must be developed or imported to meet the demands previously met or that could be met by water reuse. These costs are not currently captured in the above damage curve.

Future Water Depletions

One of the significant factors affecting salinity concentrations is water use. Estimates of projected water use through the year 2020 were developed by the Basin states for the 2002 Review. Table 2-2 presents a summary of these estimated water depletions in the Upper Colorado River Basin, and from the mainstem of the Lower Colorado River.

Table 2-2
Summary of Projected Water Depletions
(1,000 acre-feet)

	2005	2010	2015	2020
Upper Basin[10]	5,019	5,278	5,341	5,429
Lower Basin[11]	7,500	7,500	7,500	7,500
Total	12,519	12,728	12,741	12,929

Salinity Control Targets

The goal of the Colorado River Basin Salinity Control Program is to maintain the flow-weighted average annual salinity at or below the numeric criteria listed below in Table 2-3. The effort is not intended to counteract the salinity fluctuations that are a result of the highly variable flows caused by short-term climatic variations in temperature, precipitation, and snowmelt.

Table 2-3
Comparison of Numeric Criteria to Observed Salinity (2001)

Station	Numeric Criteria (mg/L)	Observed Salinity[12] (mg/L)
Colorado River below Hoover Dam	723	587
Colorado River below Parker Dam	747	589
Colorado River at Imperial Dam	879	681

The Forum develops a Plan of Implementation that will maintain salinity at or below the numeric criteria identified in Table 2-3. The Plan of Implementation provided in this Review describes the amount of salinity control needed between now and 2020. Salt reduction targets

[10]Depletions include Colorado River Storage Project reservoir evaporation estimated by Reclamation to average 574,000 acre-feet per year under full development.

[11]Lower Colorado River mainstem only. Diversions from the mainstem less returns. Data do not include mainstem reservoir evaporation, stream losses, and surplus water deliveries.

[12] 2001 data based on provisional records.

contained within the Plan of Implementation were created by computing the salinity control needed to offset future water development using mass balance techniques. In determining these targets, the Forum looks at a number of factors.

In preparing the 1996 Review report, which considered the quantity of additional salinity control needed between 1996 and 2015, the Forum was guided by river model simulations conducted by Reclamation. Since 1996, Reclamation has been working to create a new river model that could be used to predict future salinity levels in the Colorado River Basin. Because the model was not functional in 1999, the 1999 Review used salinity control targets established by the 1996 simulations. This resulted in a projected salinity control effort that specified an average control level of 47,000 tons per year of additional salinity control between 1999 and 2015. Reclamation's efforts to develop and refine the river model's capabilities for projecting the River's salinity concentrations continue. For this reason, simulations of the River's salinity concentration are not yet available for this Review. Accordingly, the Forum has decided the current target salinity control level through 2020 for this Review should not be less then the target computed using the last available simulations. Utilizing that philosophy and the rate of control identified in the 1999 Review the target for 2020 would be 1.76 million tons per year.

In order to verify that the 1999 Review methodology is still valid for today's conditions, Reclamation was asked to make additional analyses of today's conditions and project salinity control needs. Using a computer spreadsheet approach, Reclamation reviewed current salinity concentrations at Hoover Dam and factored in water use anticipated between today and 2020. Reclamation estimates that in order to maintain existing (2001) salinity levels, approximately 1.86 million tons per year will need to be controlled by 2020.

Reclamation has also begun analyzing the concept not included in previous analyses, that existing measures will most likely become less effective or may potentially be abandoned over a sufficiently long interval of time. Reclamation's concept anticipates that measures installed through the USDA program have a life expectancy of 15 to 20 years before they begin to deteriorate, need major maintenance or fail. Significant funding and implementation of salinity control activities under the USDA program began in 1986. Those measures first installed are now older than 15 years and, by the year 2020, almost all USDA measures now in place will be 20 years or more old. Measures installed by Reclamation are not of major concern during the next 10 years on account of the longer life expectancy of these measures (such as canal lining). Reclamation has preliminarily estimated that potentially up to 250,000 tons per year of previously installed USDA salinity control measures may not be functioning at their full installed level by 2020 due to aging and deteriorating performance. It is again emphasized that these estimates are very preliminary in nature. Studies are already underway to verify these estimates and to begin to quantify this need and are not included in either the 1.76 million or 1.86 million figure.

After comparing the two methodologies described above, the Basin states determined a reasonable target for salinity control to be 1.8 million tons per year, which is the approximate mid-point between the two methods. The mid-point was selected in recognition of two factors: there is no apparent information indicating the target should be less than previously adopted, and, there is information indicating the target may need to be increased when analyses associated with the impact

that reduced efficiencies and performance of existing projects in accomplishing salinity control are having on program implementation are completed. With the selection of 1.8 million tons per year as the salinity control target, the computation of needed measures is obtained by subtracting from that total the 800,300 tons of salinity per year currently being controlled, leaving 999,700 tons per year to be controlled by new measures. The salinity control requirements are shown in Table 2-4 below.

Table 2-4
Salinity Control Requirements

Total Target (2020)	1.8 million tons per year
Measures in Place (2001)	800,000 tons per year
Plan of Implementation Target (new measures)	1,000,000 tons per year

The Forum anticipates that when the 2005 Review is undertaken, new river model simulations will be made from a refined computer model. This model, it is anticipated, will allow the states and the federal government to simulate a number of future scenarios and receive projections as to long-term salinity control needs. During the next three years, the Forum finds, with the two above analyses having been made, that 1.8 million tons per year of total control must be in place by 2020.

The target was calculated without a complete understanding as to whether activities on BLM administered lands produce a net gain or loss to salinity of the Colorado River. The calculation for the controls in place includes a component for the BLM activities. BLM has not yet submitted its status report to Congress on its basinwide salinity control program as required by P.L. 106-459. Once the report is submitted and its supporting data are analyzed, the Plan of Implementation's salinity control target may have to be adjusted.

Future salinity concentrations will depend not only upon human activities but upon natural phenomena factors, including, but not limited to, runoff conditions, natural evapotranspiration, and dissolution and mixing within the major storage reservoirs. Even with full implementation of the Colorado River Basin Salinity Control Program's current Plan of Implementation which offsets the human impacts since 1972 and through 2020, the actual concentrations at the three numeric criteria stations (and elsewhere in the Colorado River Basin) will continue to fluctuate in response to hydrologic conditions.