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CENTRAL VALLEY REGIONAL
WATER QUALITY CONTROL BOARD

Salinity in the Central Valley

An Overview

May 2006

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
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1. Executive Summary

The Central Valley is one of the most rapidly growing areas in the nation. Population in the Valley is anticipated to increase 39% by the year 2020. Industry and urbanization are taking place at an increasing pace, although agriculture is still a dominant economic force here, accounting for 57% of the $6.5 billion in sales of all agricultural products in California in 2002. The Central Valley is also home to wildlife and includes the largest contiguous wetlands area remaining in California. The warm, dry, Mediterranean climate and fertile soils have drawn agricultural users for over a century. The presence of transportation corridors and ready access to workers has enticed industry to move in, and the relatively cheap price of land has encouraged urban development. The open areas and wetlands provide vital habitat for many species, particularly migratory birds along the Pacific Flyway. But the very features that make the Central Valley desirable for wildlife, farmers, developers, industry and the general population also contribute to salinity problems.

When water is used, salts are left behind. Every time a farmer irrigates a field, every time a managed wetland is flooded, every time an industrial facility conducts some water-requiring process, and every time you or I take a shower, we contribute to the salinity problem because the water we use and release has a higher salinity concentration than what we started with. Sometimes this is because we add salt intentionally (home water softeners, plant fertilizers), but even when no salts are added to the system, evaporation and consumptive use act to concentrate unused salts. Additionally, salts move with water so salts originating in one basin will turn up in another. This is a significant problem when the receiving basin has no reliable way of disposing salt, as is the case in the Tulare Lake Basin; or has only limited capacity to discharge salt, which is the case in the San Joaquin River Basin.

We know today that salinity impacts are being felt in the Central Valley and that these impacts are increasing.

- A very preliminary analysis of salt flux in the Delta, estimated that 700 thousand tons of salt flow into the Delta from the Bay annually and are imported into the State, federal, and other water supply projects.

- The Tulare Lake and San Joaquin River Basins collectively receive over two million tons of salt annually through water taken in and distributed by state and federal water projects.

- Because the Tulare Lake Basin is a closed basin with no reliable outlet for the discharge of salts, and there is no other viable option at this time, the majority of the salt imported into the basin from the state and federal water projects (over one million tons per year) is collecting in the basin and is migrating to the basin's groundwater. For this reason, the Central Valley Regional Water Quality Control

Board's Tulare Lake Basin Plan assumes degradation by salt is occurring in the basin and contains a controlled degradation policy for groundwater.

- A preliminary evaluation of salt migration to groundwater in the San Joaquin Valley estimated that over 400 thousand tons of salt per year were being added to the confined aquifer in the San Joaquin Basin.

- In a current study, preliminary findings of a USGS investigation have shown chloride levels in the semi-confined aquifer near Stockton are increasing and have been found to be as high as 2,200 mg/l and EC as high as 5,930 µS/cm

- A simple analysis of groundwater data from 14 drinking water wells on the south side of Fresno has shown an average increase of 30 µS/cm in the past 15 years. Although this is not a radical increase, it does indicate that salt imported into the area may be impacting the drinking water aquifer.

- The mean annual EC levels in the San Joaquin River near Vernalis have nearly doubled since the mid-1940s.

- Because the San Joaquin River is limited in its capacity to assimilate salts safely, a Total Maximum Daily Load (TMDL) has been adopted for salt and boron. The Basin Plan for the San Joaquin and Sacramento Basins has been amended to include the TMDL.

- The recently completed *Draft Soil Survey of Fresno County, California, Western Part* states that approximately 400 thousand acres of saline-sodic soils currently exist in the survey area. This acreage constitutes approximately 48 percent of the irrigated land within the boundaries of the survey area, up from approximately 33 percent of the irrigated saline-sodic land identified in 1985, an increase of approximately 120 thousand acres in 18 years.

- There are currently 4470 acres of active evaporation basins in the Tulare Lake Basin, and this number may be increasing due to recent legislation allowing Integrated Farm Drainage Management Systems for individual farms in salt impaired areas. The Board has stated that evaporation basins are, at best, interim salt management tools, not a final disposal option.

- Approximately 113 thousand acres on the west side of the San Joaquin Valley have been retired (permanently removed from irrigation) due to regional drainage problems (high salinity, shallow groundwater). More land retirement is anticipated.

- Salinity problems are often complicated by the presence of other materials. Soils on the west side of the San Joaquin Valley are high in selenium, so any salt management program in the area must also address selenium management. Approximately $40 million in both public and private funds has been spent (as of

2005) to manage salt and selenium problems in the Grassland Drainage Area alone.

- Water providers are experiencing salinity impacts and costs are being incurred and are being passed on to customers to protect their systems from corrosion and provide the quality of water needed by their customers.

- Agricultural, industrial, and municipal dischargers in the Region are spending increasingly greater resources on monitoring for, treating, controlling, and managing salt.

Over the years, the Central Valley Regional Water Quality Control Board has been aware of the growing problem of increasing salinity in the Central Valley, but many of the key decisions that must be made in order to control Valley salinity are outside of this Board's jurisdiction. This report is a first step in opening a dialogue between the stakeholders and decision makers that will need to be involved in a comprehensive, sustainable, salinity management program for the Central Valley and for the State of California.

Acronyms Used

CEQA	California Environmental Quality Act
CVP	Central Valley Project
CWC	California Water Code
DMC	Delta-Mendota Canal
DFA	(California) Department of Food and Agriculture
DFG	(California) Department of Fish and Game
DWR	(California) Department of Water Resources
EC	electrical conductivity
EIS	Environmental Impact Statement
MAA	Management Agency Agreement
MID	Modesto Irrigation District
MOU	Memorandum of Understanding
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resource Conservation Service
OAL	(California) Office of Administrative Law
POTW	Publicly Owned Treatment Works
RO	Reverse osmosis
SJR	San Joaquin River
SJVDIP	San Joaquin Drainage Implementation Program
SJVDP	San Joaquin Valley Drainage Program
SR	Sacramento River
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TID	Turlock Irrigation District
TMDL	Total Maximum Daily Load
USBLM	United States Bureau of Land Management
USBR	United States Bureau of Reclamation
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
WDR	Waste Discharge Requirements
WRD	Water Rights Decision
WWD	Westlands Water District

2. Introduction

Purpose and limitations of this report:
This report was prepared to provide general background information on salinity issues in the Central Valley. Numerous projects are already managing salt at the local and regional level and there has been a significant amount of research on the subject of salinity management. Some of these efforts have been briefly mentioned in this document, but this material does not represent a comprehensive assessment of the situation.

2.1. Nature of the Problem

The salinity impairment of surface and groundwater in the Central Valley is a subset of a more far-reaching problem shared by most of California, other arid western states, and much of the developed world. As surface and groundwater supplies become scarcer, and as wastewater streams become more concentrated, salinity impairments are occurring with greater frequency and magnitude. Such impairments in the past have led to the fall of civilizations. These impairments will not be resolved by purely technical solutions. Solution of the salinity impairment in the Central Valley will depend upon development and successful implementation of effective land use, water supply, and water quality policies, in conjunction with overcoming institutional barriers.

A discussion of the technical nature of the problem must begin with a clear understanding of what salt is. Salt or salinity is typically used interchangeably with total dissolved solids (TDS) or electrical conductivity (EC). TDS is the dissolved portion of solids in water, including colloidal and small, suspended particles. The major nonionic substance in water is silica. The major ionic substances in water are calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, and nitrate. It is these ionic substances that impart an ability of the water to conduct an electrical charge, which we call the EC of water. It is the high concentration of ions and therefore high EC in water that can adversely affect plant growth, drinking water, industrial use water and other beneficial uses. The specific mix of ionic substances is also important to gage impact on a use.

2.2. Stakeholders Impacted by Salinity

Salinity increases in Central Valley surface water and groundwater can be attributed to many causes. Each of us contributes to the problem, and each of us is now or eventually will be impacted in some way by the problem of an increasingly saline water supply. We are all of the people of the State, including:

The consumptive water users:

Agricultural water users
Crop production can potentially be impacted any time supply water salinity exceeds optimal concentrations. Ayers and Westcott[1] identified the general salinity level that will protect all crops as 700 µS/cm EC. A farmer that receives a water supply of higher salinity must adapt by selecting more tolerant crops and/or apply more water to maintain a favorable salt balance in the root zone. Much of the Valley is successfully farmed with water that does not meet this goal, but this is not a sustainable situation. Irrigation concentrates salts through consumptive use of water by the crops. Since crops only consume the water molecules and leave behind the dissolved salts, salinity will increase in both the soil and water drainage and runoff. Drainage typically reenters the water cycle through percolation to groundwater, tailwater discharges or tilewater discharges. Fertilizer application also contributes to the overall salinity problem, since fertilizers contain salts.

Urban water users
Most, urban water users in California do not typically receive water with salinity levels that could cause a health concern. Salinity generally impacts urban water users in the form of increasing costs for treatment. High salinity can accelerate corrosion in plumbing and water-using appliances. (see also: water providers, governments)

Urban water users contribute to salinity problems by adding salt to the system (operating water softeners, fertilizing lawns, using soaps and detergents, etc); and consuming water, which reduces the amount available for downstream dilution and transport of salt.

Water users in rural areas
The water supply for most rural residential areas in the Central Valley is groundwater. These users are particularly vulnerable to changes in groundwater quality.

Rural water users, like urban and agricultural users, contribute to Valley salinity problems by adding salt and consuming water.

Environmental water users
The environmental uses of water vary in their sensitivity to salinity, but the actual impact of salinity on Central Valley fish and wildlife or aesthetic and recreational use is generally not well defined. The need for adequate non-toxic freshwater flows of suitable temperature at the right time of the year has dominated the research in this area.

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[1] Ayers, R. S. and Westcot, D.W. 1985. *Water Quality For Agriculture.* UN FAO, Irrigation and Drainage Paper 29 Rev.1, Rome. Accessible online at: http://www.fao.org/DOCREP/003/T0234E/T0234E00.HTM

Environmental water use contributes to salinity increases by consumptively using water that could otherwise provide salt dilution and transport. Evaporation exacerbates the problem in wetland systems by concentrating salts. Studies are currently underway that should help characterize the magnitude of wetland contributions to salinity in receiving waters.

Industrial users

The Basin Plans for the Central Valley region divide industrial use into those activities where water quality is important (industrial process supply) and those processes where water quality is largely irrelevant (industrial service supply). The potential for increased corrosion due to salinity would affect either user type. Processors face increased pretreatment costs when salinity is high. Potentially, the salinity of the water supply could be a factor in a company's decision to invest in or continue operations of a Central Valley facility.

Industrial discharges are primarily point source contributions and point sources can be regulated to control salinity impacts. However, compliance with salinity regulations is seldom cheap or technically easy to achieve particularly when no acceptable receptor site or transport facility provides for the discharge of a concentrated salt stream. This factor is equally true for sectors discharging a concentrated salt stream and can result in businesses avoiding the Central Valley or relocating outside of the Central Valley with the resultant loss of jobs for Valley residents.

Water providers

Water providers include the irrigation districts and water authorities that route water to all the aforementioned groups. These entities vary in the amount of control they have over the quality of water that they deliver to their customers—agricultural suppliers often have no means of controlling water quality, but municipal water purveyors typically exercise a great deal of control, treating their source water before distribution. Salinity impacts show up in the costs these entities incur and pass on to their customers to protect their systems from corrosion and provide the quality of water needed by their customers.

Water providers in some cases contribute to salinity problems through water transfers that benefit one area at the expense of dilution flows in another. This is a complex subject in which impacts are very specific to the transfer. Some transfers can improve water quality.

Governments, regulators, and other policy makers

Federal, State and local governments are entrusted with protecting shared resources, including the quality of water supplies. The availability of high quality water affects land use planning decisions, which in turn affects a community's ability to generate income and serve its members. Regulators respond to salinity impacts by imposing more restrictive requirements, increasing the costs to both regulated parties and enforcement authorities. Each authority has its own area of responsibility. No single agency has jurisdiction covering enough of the contributing factors to high salinity to deal with the problem in a comprehensive manner. These agencies include, but are not limited to:

California Department of Water Resources (DWR)
U.S. Bureau of Reclamation (USBR)
Bay-Delta Authority
U.S. Fish and Wildlife Service (USFWS)
California Department of Fish and Game (DFG)
U.S. Environmental Protection Agency (U.S. EPA)
Water Agencies
Sanitation Districts
County planning and building departments

As well as the:

Non-Consumptive Users

Chapter 2, Section 13050 of the Porter-Cologne Act includes the following definitions:

> "e) "Waters of the state" means any surface water or groundwater, including saline waters, within the boundaries of the state." and
>
> " (f) "Beneficial uses" of the waters of the state that may be protected against quality degradation include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves."

The people of the State expect to be able to depend on the waters of the State for a variety of non-consumptive uses, including water contact (such as swimming, water skiing, wading, hunting and fishing), and non-contact uses (including boating, education, aesthetic (including nature photography, art (watercolor and oil painting) and wildlife observation). These are clearly part of the definition of "beneficial uses", and salinity can affect the attainability of these uses. For example, increasing salinities bring both marine fouling organisms and corrosion problems for boaters, and changes in the species abundance and composition, which in turn impacts these users.

In summary, consumptive use of water increases salinity. The actions cited above as contributing to the salinity problem have benefits in other areas, including enhanced wildlife habitat, robust agricultural and industrial sectors of the State economy, and a safe and reliable drinking water supply. It is therefore in the public interest that a multisector salt management plan be developed and implemented that will allow us to continue to enjoy the beneficial uses of water while protecting those uses for future generations.

3. Problem Statement

3.1. Impacts of Salinity

At this time, salinity impacts are experienced differently in different parts of the Valley, based primarily on hydrogeologic conditions. However, regardless of location, the most notable and direct impacts at this time are economic. Salinity affects land values, competition for water supplies, and the cost of regulatory compliance, among a host of other issues (see Appendices 6-8). Specific salinity impacts occurring and anticipated in the valley include:

Health

Salt itself is not generally considered to pose a human health threat. Some salts taken in excess will produce a laxative effect, and objectionable tastes can occur[2]. However, the ionic components contributing to salinity in some areas can have detrimental health impacts. Water high in sodium can have negative health effects, particularly for individuals with cardiovascular heart disease. Also, water originating in the Sacramento-San Joaquin Delta carries bromide, which interact with the organic soils of the Delta and the disinfection materials used in water treatment plants to control pathogens and can form carcinogenic compounds[3].

Energy

As the salinity problem spreads and worsens in the Valley, industrial and municipal energy demands will rise due to an increasing need for pretreatment of saline source water prior to use and wastewater treatment prior to discharge.

Population

Statewide growth is expected to continue at about 6 million additional residents each decade, with much of that growth occurring in the Central Valley (see Figure 8). The demand for high quality water will increase as the population increases. Municipal use is anticipated to continue to take priority over other uses, and all users will probably have to use water more efficiently. Water recycling and reuse will become more important. More communities will consider desalination as a means of supplementing scarce supplies, but the cost of desalination may remain prohibitive for agricultural and most industrial uses.

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[2] North Carolina State University, Salinity webpage, accessed 21 March 2006: http://www.water.ncsu.edu/watershedss/info/salinity.html

[3] California Urban Water Agencies, 20 January 2006 letter to the State Water Resources Control Board.

Water Recycling
Every cycle of water use increases the salinity of the remaining water. The State Recycled Water Task Force recommendations, combined with recommendations in the recent California Water Plan Update, encourage greater use of recycled water as being essential to meeting future water demands. We already have circumstances under which recycling opportunities are limited due to increasing salinity concentrations. The salinity of source water is an essential key to the future success of water recycling and its contributions to meeting future water needs.

Environment
Environmental use will continue to be largely dependent on timely releases of stored water. This water must have a salinity concentration that does not negatively impact ecosystems, a factor that must be considered in a comprehensive and competent salt management plan.

Cropping patterns
At this time salinity does not appear to be triggering a widespread shift to more salt tolerant crops. However, drainage problems coupled with water supplies that are inadequate to counter the effects of salinity are resulting in more land fallowing and land retirement in some parts of the valley.

Jobs
Recent studies[4] show that agricultural jobs are being lost in the Central Valley, primarily due to increased mechanization. As farmland is taken out of production due to salinity and drainage problems, it is likely that some agricultural job loss will be attributable to salinity impacts. Industrial jobs could also be lost as businesses leave the area due to increased cost and availability of suitable quality source water and /or cost of regulatory compliance with discharge requirements as the assimilative capacity of Central Valley waterways is lost.

Infrastructure
Pipes, pumps, and other basic elements that convey water and wastewater can be vulnerable to salt damage. As salinity increases, water users may find that maintenance needs to be performed more often and equipment may need to be replaced more frequently. This effect would be (and is) seen at all levels, from an individual's bathroom shower to municipal water and wastewater systems[5].

Pollution
As salinity increases, the effectiveness of detergents decreases. Industrial and home users must therefore either increase the amount of detergent used when washing or

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[4] Great Valley Center, 2005, *The State of the Great Central Valley: Assessing the Region Via Indicators—The Economy 2000-2004.*

[5] *Salinity in New South Wales,* web page accessed 21 March 2006: http://www.dlwc.nsw.gov.au/care/salinity/effects.html#3Impactsonconsumptivewateruse

condition (soften) water prior to use[6]. Both activities increase the pollutant load in wastewater, increasing the cost of wastewater disposal and limiting reuse options. Water softening adds sodium salts to an already saline waste stream, exacerbating regional salinity problems.

Distribution of impacts: basin by basin

Salinity impacts are not uniform across the valley. In general, the Sacramento River Basin has sufficient dilution flows and is not suffering direct salinity impacts. The Sacramento Basin exports salt to the Delta, where it is picked up by the water distribution systems for much of the State. Much of the San Joaquin Basin relies on water distributed from the Delta, resulting in a net import of salt to the basin. The Tulare Basin does not have a reliable means of discharging salt. The Tulare Lake Basin Plan follows a policy of controlled water quality degradation for this reason.

Distribution of impacts: farmland conversion

Salinity and drainage problems have caused and will continue to cause land use changes, particularly in agricultural areas. The Valley's population is growing rapidly, and there may be some land use changes that benefit the State economy when agricultural land with severe salinity problems is converted to urban or industrial use; however there are often legal restrictions to developing some farm tracts—notably those enrolled as Williamson Act, Open Space Subvention Act or Farmland Security Zone Act lands. And land no longer suitable for farming is often located where there is little demand for land for non-agricultural purposes. When agriculture leaves one of these isolated rural areas, it is not being replaced with income-producing industry or urban development. Therefore, the economic impact of salinity impairment is being experienced disproportionately, with the most severe impacts falling on those communities that can least afford to deal with them[7].

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[6] ibid.

[7] Westlands Water District, *Analysis of Economic Impacts of Proposed Land Retirement in Westlands Water District*, May 2003.

3.2. Geographic Setting

State of California

Water Quality Control Regions and Basins

Figure 1. State of California Water Quality Control Regions and Basins

BASIN DESCRIPTION

Sacramento River and San Joaquin River Basins

The Sacramento River and San Joaquin River Basins cover about one fourth of the total area of the State and over 30% of the State's irrigable land. The Sacramento and San Joaquin Rivers furnish roughly 51% of the State's water supply. Surface water from the two drainage basins meets and forms the Delta, which ultimately drains to San Francisco Bay. Two major water projects, the Federal Central Valley Project and the State Water Project (SWP), deliver water from the Delta to Southern California, the San Joaquin Valley, Tulare Lake Basin, the San Francisco Bay area, as well as within the Delta boundaries. The Delta is a maze of river channels and diked islands covering roughly 1,150 square miles, including 78 square miles of water area. The legal boundary of the Delta is described in Section 12220 of the Water Code.

The Sacramento River Basin covers 27,210 square miles and includes the entire area drained by the Sacramento River. For planning purposes, this includes all watersheds tributary to the Sacramento River that are north of the Cosumnes River watershed. It also includes the closed basin of Goose Lake and drainage sub-basins of Cache and Putah Creeks. The principal streams are the Sacramento River and its larger tributaries: the Pit, Feather, Yuba, Bear, and American Rivers to the east; and Cottonwood, Stony, Cache, and Putah Creeks to the west. Major reservoirs and lakes include Shasta, Oroville, Folsom, Clear Lake, and Lake Berryessa. DWR Bulletin 118-80 identifies 63 ground water basins in the Sacramento watershed area. The Sacramento Valley floor is divided into 2 ground water basins. Other basins are in the foothills or mountain valleys. There are areas other than those identified in the DWR Bulletin with ground waters that have beneficial uses.

The San Joaquin River Basin covers 15,880 square miles and includes the entire area drained by the San Joaquin River. It includes all watersheds tributary to the San Joaquin River and the Delta south of the Sacramento River and south of the American River watershed. The principal streams in the basin are the San Joaquin River and its larger tributaries: the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno Rivers. Major reservoirs and lakes include Pardee, New Hogan, Millerton, McClure, Don Pedro, and New Melones.

DWR Bulletin 118-80 identifies 39 ground water basins in the San Joaquin watershed area. The San Joaquin Valley floor is divided into 15 separate ground water basins, largely based on political considerations. Other basins are in the foothills or mountain valleys. There are areas other than those identified in the DWR Bulletin with ground waters that have beneficial uses.

Tulare Lake Basin

The Tulare Lake Basin comprises the drainage area of the San Joaquin Valley south of the San Joaquin River (See Figure 1). Note: In 1976, the U. S. Geological Survey, the

DWR, and the State Water Resources Control Board agreed upon the hydrologic boundaries for basins within California. The agreed boundaries did not match the planning boundaries in certain cases such as between the San Joaquin River Basin and the Tulare Lake Basin. The planning boundary between the San Joaquin River Basin and the Tulare Lake Basin follows the northern boundary of Little Panoche Creek basin, continues eastward along the channel of the San Joaquin River to Millerton Lake in the Sierra Nevada foothills and then follows along the southern boundary of the San Joaquin River drainage basin.

Surface water from the Tulare Lake Basin only drains north into the San Joaquin River in years of extreme rainfall. This essentially closed basin is situated in the topographic horseshoe formed by the Diablo and Temblor Ranges on the west, by the San Emigdio and Tehachapi Mountains on the south, and by the Sierra Nevada Mountains on the east and southeast. The Basin encompasses approximately 10.5 million acres, of which approximately 3.25 million acres are in federal ownership. Kings Canyon and Sequoia National Parks and substantial portions of Sierra, Sequoia, Inyo, and Los Padres National Forests are included in the Basin. Valley floor lands (i.e., those having a land slope of less than 200 feet per mile) make up slightly less than one-half of the total basin land area. The maximum length and width of the Basin are about 170 miles and 140 miles, respectively. The valley floor is approximately 40 miles in width near its southern end, widening to a maximum of 90 miles near the Kaweah River.

Urban development is generally confined to the foothill and eastern valley floor areas. Major concentrations of population occur in or near the metropolitan areas of Bakersfield, Fresno, Porterville, Hanford, Tulare, and Visalia. The Basin is one of the most important agricultural centers of the world. Industries related to agriculture, such as food processing and packaging (including canning, drying, and wine making), are prominent throughout the area. Producing and refining petroleum lead non-agricultural industries in economic importance.

Surface water supplies tributary to or imported for use within the Basin are inadequate to support the present level of agricultural and other development. Therefore, ground water resources within the valley are being mined to provide additional water to supply demands. Water produced in extraction of crude oil is used extensively to supplement agricultural irrigation supply in the Kern River sub-basin. The Kings, Kaweah, Tule, and Kern Rivers, which drain the west face of the Sierra Nevada Mountains, are of excellent quality and provide the bulk of the surface water supply native to the Basin. Imported surface supplies, which are also of good quality, enter the Basin through the San Luis Canal/California Aqueduct System, Friant-Kern Canal, and the Delta- Mendota Canal. Adequate control to protect the quality of these resources is essential, as imported surface water supplies contribute nearly half the increase of salts occurring within the Basin. Buena Vista Lake and Tulare Lake, natural depressions on the valley floor, receive floodwater from the major rivers during times of heavy runoff. During extremely heavy runoff, flood flows in the Kings River reach the San Joaquin River as surface outflow through the Fresno Slough. These flood flows represent the only significant outflows from the Basin. Besides the main rivers, the basin also contains numerous mountain streams. These streams have been administratively divided into eastside streams and westside streams using Highway 58 from Bakersfield to Tehachapi. Streams from the Tehachapi and San Emigdio Mountains are grouped with Westside streams. In contrast to eastside streams, which are fed by Sierra snowmelt and springs from granitic bedrock, westside streams derive from marine sediments and are highly mineralized, and intermittent, with sustained flows only after extended wet periods. All natural surface waters within the Basin have designated beneficial uses.

Normally all native surface water supplies, imported water supplies, and direct precipitation percolate into valley ground water if not lost through consumptive use, evapotranspiration, or evaporation. Major ground water basins underlie the valley floor, and there are scattered smaller basins in the foothill areas and mountain valleys. In many parts of the Basins, usable ground waters occur outside of these identified basins. There are water-bearing geologic units within ground water basins in the Basins that do not meet the definition of an aquifer. Therefore, for basin planning and regulatory purposes, the term "ground water" includes all subsurface waters that occur in fully saturated zones and fractures within soils and other geologic formations, whether or not these waters meet the definition of an aquifer or occur within identified ground water basins. A few areas within the Basins have ground waters that are naturally unusable or of marginal quality for certain beneficial uses. Because of the closed nature of the Tulare Lake Basin, there is little subsurface outflow. Thus, salts accumulate within the Basins due to importation and evaporative use of the water. The paramount water quality problem in the Basin is the accumulation of salts. This problem is compounded by the overdraft of ground water for municipal, agricultural, and industrial purposes, and the use of water from deeper formations and outside the basin, which further concentrates salts within remaining ground water.

3.3. Salinity Sources

General Discussion

Sources of salt can be categorized by activity; e.g. from agricultural, municipal, industrial, or natural discharges. Source can also be categorized according to its origin: 1) evapoconcentrated from supply water; 2) added through dissolution of naturally occurring salts; 3) through an explicit addition of salts, e.g. fertilizers or in food processing; or 4) through importation via water supply. To complicate matters, many discharges are a mix of several sources. For example, an agricultural discharge may contain evapoconcentrated salts from supply water, plus naturally occurring salts from soils upon which the irrigation water is applied and nutrient salts added as fertilizer. In addition, the source of salt may result from a mix of surface and groundwater. The relative importance and mix of sources is affected by the geography and other natural characteristics of the area. For example, although fundamentally the same, the relative mix of sources is different in the Tulare Lake, San Joaquin River, and Sacramento River Basins.

Significant sources of salts are derived from agricultural activities that mobilize salts in soils and add imported salts from supply water. This is most pronounced in the San Joaquin River and Tulare Lake Basins that have vast areas of naturally occurring salts in soils, and receives a large quantity of salt in imported supply water. This degradation is not as apparent in the Sacramento River due to relatively low salinity soils and much larger dilution flows. An incremental increase in Sacramento River salinity, however, exacerbates salinity problems in the southern basins and for all Delta exporters because of larger salt loads in their supply water.

The magnitude of these salt sources can be illustrated. The SWP and the Delta-Mendota Canal (DMC) import, on average 1.4 million tons of salt per year to the Tulare Lake and San Joaquin River Basins (SJVDIP, 1998). Increased salt loads and elevated water table elevations in the San Joaquin River Basin are causing groundwater accretions to the San Joaquin River to contribute, on average, 30 percent of the annual salt load in the river (CVRWQCB, 2004). Shallow groundwater, collected in subsurface drains and conveyed to the San Joaquin River also accounts for another 17 percent of the average annual total salt load in the river.

Salinity impairments in surface and ground water are exacerbated locally from other sources including discharges to land associated with municipal wastewater disposal, septic tanks, oil field brines, confined animal facilities, and food processors. Locally and regionally complex interactions of surface and groundwater make assessment and mitigation of salinity problems difficult. Salts added to groundwater from different sources, for example, will have short and long-term impacts on surface water salinity. Elevated salinities in groundwater accretions of a gaining stream, such as in the lower San Joaquin River and Lower Kings River, lead to increases in surface water salinities. Conversely, salts added to surface water can have short and long-term effects on groundwater quality, as when surface water is used as an irrigation supply. This use of higher salinity surface water will increase the salinity of shallow groundwater. Many of these long-term effects can occur at exceedingly slow rates, over a number of decades. Because these changes occur very slowly, surface and groundwater impairments can be difficult to measure and quantify.

Specific Sources

Figure 2 provides an overview of the sources and movement of salt in the Central Valley. Table 1 lists selected sources of salt and the processes that result in the increases in salinity.

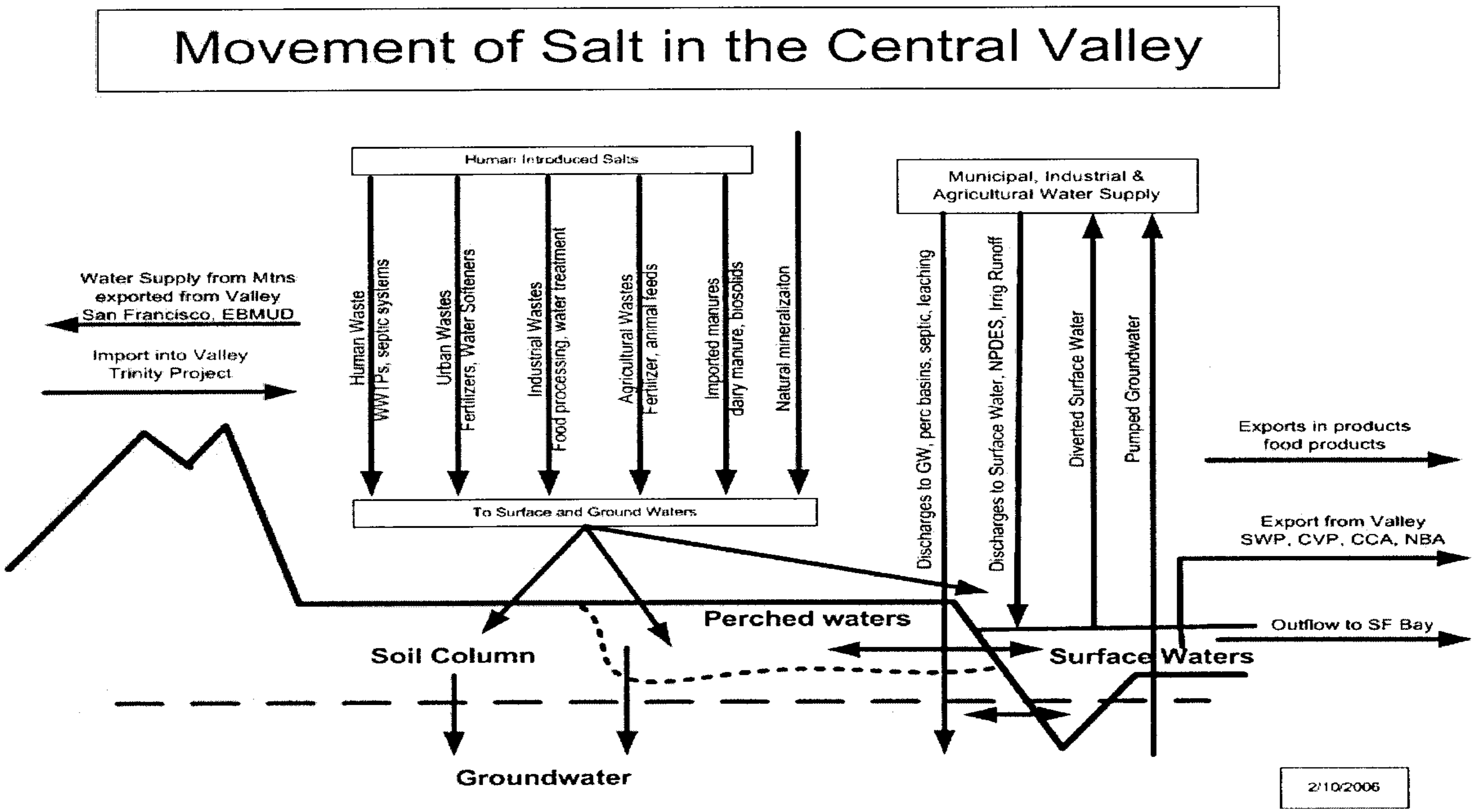

Figure 2. Conceptual Movement of Salt in the Central Valley

Table 1. Selected sources of salt and processes that result in increasing salinity levels

Sources	Processes			
	Evapoconcentration	**Dissolution**	**Addition**	**Import**
Agriculture	Water that percolates below the root zone is concentrated because of water uptake and minimal salt uptake by plants	Water applied to soils naturally high in salt picks up this additional salt in both surface and subsurface agricultural returns	Salts are added in the form of soil amendments (e.g. gypsum) and fertilizers	Water imported into basins for agricultural supply contains salt that must be managed.
Dairy			Animal feeds contain salt and much of this salt ends up in animal waste that must be managed at the dairy.	Feed imported to the Valley contain salts
Municipal	Water that percolates below the root zone of lawns and other vegetated areas is concentrated because of water uptake and minimal salt uptake by plants	Same as agriculture	Human wastes and other waste streams handled by municipal wastewater treatment plants add 200-300 ppm salt to the levels seen in the water supply.	
Industrial			Salt and cleaning products that break down to salt is often used in industrial processes and wastewater treatment facilities.	
Wetland	Evaporation from standing water increases salinity of surface runoff.	Several Central Valley wetlands are in areas with saline soils and groundwaters that contribute salinity to surface discharges.		
Geologic		Soils and groundwaters naturally have high levels of salt due the geology in several parts of the region.		
Water Projects	Water projects provide water to all of the above sources. Design of an operation may aggravate the situation. For example, instead of allowing salt from the San Joaquin Basin to flow out into the Ocean, the State and federal water projects intercept the water and ship it back south into the basin and to other basins south of the Delta.			

3.4. Technology/Management Practices

Agricultural, municipal and industrial wastes are the three classes of salt-containing discharges that are regulated by major regulatory programs of the Central Valley Water Board. Of the three, agricultural wastes contribute a significantly higher percentage of the salt load to the Valley than municipal and industrial waste combined. Some of the technologies and management practices utilized to control salinity in these wastes are unique to a particular class of waste, while others are commonly utilized for managing two or all three classes of waste.

The discussion below presents a brief overview of agricultural, municipal and industrial wastes as relates to salinity, followed by a more detailed description of the various treatment, disposal, and other practices currently used or being considered for managing salinity in these wastes.

Agriculture

Surface runoff from agricultural lands usually contains salt levels similar to the water supply. In some areas, such as the lower end of the Colusa Basin Drain in the Sacramento Valley, salinity can build up to levels that impact crops as a result of use on multiple rice fields as the water moves from the top to the bottom of the watershed. This is directly the result of evaporation reducing the volume of water and leaving the salts behind in the tailwater that moves down the drain for use on the next field.

For the most part, it is drainage from the shallow groundwater beneath agricultural lands that is saline as a result of evapoconcentration of the salt and dissolution of salts in the soil profile. This groundwater can be collected by drainage systems or move laterally into surface waters such as the San Joaquin River.

<u>Evaporation ponds</u>
Irrigated agricultural accounts for most of the developed water use in the Tulare Lake Basin. Irrigation requires a leaching fraction, which in turn creates subsurface drainage water that needs a disposal option. Disposal to evaporation basins is an interim option for the collection of drainage water. Salinity inflows can range from 1,000 mg/L TDS to over 30,000 mg/L TDS. Concentrations within evaporation basins can range from 2,000 mg/L to over 200,000 mg/L TDS. Evaporation basins create wetland habitat, which attracts many species of wildlife. Selenium is the predominate constituent linked to wildlife impacts. The operation of evaporation basins is contingent on mitigation of wildlife impacts. Of the 28 original evaporation basin operators only 5 operators remain; however, the USBR currently is evaluating the option of an in-valley drainage solution, which could potentially create several thousand more acres of evaporation basins.

Evaporation basins are regulated with WDRs, which require monitoring, and mitigation habitat. Evaporation basins must also meet standards described in Title 27, CCR.

Integrated on-farm drainage management (IFDM)
Integrated on-farm drainage management is the sequential reuse of drainage water on salt tolerant crops with final disposal to a solar evaporator. A solar evaporator is designed to specifications to prevent standing water, mitigate for wildlife impacts, and prevent migration of salt constituents into the vadose zone. New regulations for these types of systems were adopted by the State Water Resources Control Board following the passage of SB 1372.

Land Retirement
The US Bureau of Reclamation has been conducting a demonstration project to assess the effects of land retirement and the potential for retired land to be converted to non-irrigated habitat. The project sites were located in areas with shallow groundwater. While the findings in this project would be different had the project been located over different soils, deeper groundwater, under different climatic conditions, etc, it is illustrative of trends that can be anticipated when land is retired due to saline impacts. Those findings include:

- The shallow water table drops when irrigation recharge is eliminated.

- Soil salinity and (in this case) soil selenium drop markedly when irrigation ceases.

- Materials such as selenium may increase in shallow groundwater as water levels drop; however, there is no indication that the increase poses a threat to biota (exposure path is limited).

- Land retirement requires management. The Bureau's Five Year Report on the Land Retirement Demonstration Project states:*:* "Land retirement without habitat restoration often leads to large fields infested with weeds and pests that impact neighboring agriculture and require extensive and continuous management."

Selective land retirement may be a feasible means of controlling saline impacts from the most problematic drainage impaired land. The Bureau's report did not discuss the cost of habitat restoration or quantify public impacts and benefits, but this information would be very important if, as has been proposed, large tracts of impaired land are ultimately retired. Whether retired lands remain in private hands or are purchased for public use will also be a consideration; as well as the potential that over time, improved drainage conditions could allow land to be returned to irrigated agricultural production. Grazing or dryland farming are appropriate alternatives to habitat restoration.

Municipal

Generally, salt concentrations in municipal wastewater, expressed in terms of TDS, range from approximately 500 to 2,500 parts per million (ppm). There are many approaches and technologies utilized in the treatment of municipal wastewater, but the majority of these do not result in significant salinity reduction. One source control practice implemented by some municipal wastewater treatment facilities is to set local salinity limits on industrial waste accepted or to require industrial sources to reduce or control the salt loads delivered to publicly owned treatment works (POTWs). A few municipalities also discourage the use of residential water softeners. Some Central Valley municipalities have considered reverse osmosis (RO) to reduce the salinity of their wastewater; however, to our knowledge none have actually implemented RO technology due to cost considerations and the lack of available outlets for the resulting concentrated brines.. There have been discussions among some municipalities located near proposed power plants regarding the use of their POTW effluent as supply water for power plant cooling. However, to our knowledge, this practice has not yet been implemented within the Region.

Municipal wastewater is either discharged to surface water bodies or to land and these discharges are regulated under the Central Valley Water Board's National Pollutant Discharge Elimination System (NPDES) Permit or Waste Discharge to Land Programs. Some NPDES and Waste Discharge Requirement permits contain effluent limits for EC and/or TDS, depending on the concentration of salts in the effluent and/or the assimilative capacity of the receiving water or soil conditions. Others may have narrative requirements to minimize or manage pollutants to a reasonable extent, with associated studies or plans to demonstrate compliance. Such studies or plans sometimes include waste characterization studies (including for salt constituents) or salinity reduction plans.

Industrial

Industrial dischargers include a broad category of dischargers from food processing to refineries. Like municipal discharges, most known industrial discharges of saline waste are regulated under NPDES permits, WDRs, or Waivers of WDRs. Many industries are focusing increasing efforts on salinity management and reduction of salt loads to the environment. Major industries participating in this effort are the food processing (including wine, cheese, and slaughter/meat packing) industry, the power generation industry, the mining industry, and the petroleum industry. Generally their salinity management practices fall into four categories - source reduction, reuse, treatment, and disposal.

The primary salt source reduction practices being implemented by these industries include segregating high-salinity wastes from low-salinity wastes, reducing or eliminating salt loads in cleaning/rinsing agents, reducing or eliminating salt loads from water softeners and boilers, and covering mine tailings and waste piles to prevent salt leaching. Reuse of high salinity wastewater is a management practice that is utilized in the oil production industry, and is currently being considered in the power generation industry. The oil industry generates significant volumes of highly saline wastewater. Some of this water is reused as boiler-feed water. Some power plants are also planning "Zero Liquid Discharge" facilities, in which cooling tower water would be recycled until its salinity becomes too high to continue its use. At that point, the wastewater would be evaporated into a salt cake that would be disposed of in a landfill.

The major treatment technologies currently utilized consist of evaporation and reverse osmosis. The latter typically requires a high level of pretreatment. Land application is the most commonly used method to dispose of industrial wastewater. Land application to crops can be considered a form of treatment, but only provided the waste is applied at agronomic rates and the applied salts are removed with the harvested crop. The difficulties of tracking the effectiveness of this practice are described under Land Treatment in the following section. Other disposal methods being utilized by industry are surface water disposal, deep-well injection, and hauling/off-site disposal.

Treatment

Mechanical Evaporation

This technology is being utilized to a limited degree in the olive and dairy products processing industries, and is part of the technology planned for "Zero Liquid Discharge" power plant facilities (see previous section). It involves heating the liquid waste to drive off the water, recovering the water for reuse, and drying the waste into a concentrated brine or solid form, which is then disposed of at landfills or wastewater treatment facilities. Evaporation treatment is energy intensive, as it requires considerable heat. One dairy product processing facility in the region is working with some feed companies to try to develop the concentrated brine as an animal feed supplement.

Reverse Osmosis and Ultrafiltration

Reverse osmosis (RO) is a treatment process that involves filtering a solution under high pressure through a semi permeable membrane, thereby separating the dissolved solids from the water. RO treatment is energy intensive, as it requires relatively high pressure[8]. It is not a widely used within the region for

[8] Crites, R. and Tchobanoglous, G.. 1998. *Small and Decentralized Wastewater Management Systems.* WCB McGraw-Hill.

removing salt from wastewater. The main reason given by most dischargers for not implementing RO technology to remove salt from wastewater is its relatively high cost for pretreatment to remove suspended solids and organic matter; RO equipment installation, cleaning, and replacement; energy consumption; skilled operators required; and RO brine disposal. The only major discharger in the region using RO technology for wastewater treatment is Hilmar Cheese and its use has yet to be proven to be environmentally or economically viable on a long-term basis. RO treatment is utilized in the region to a limited extent for salinity reduction of domestic, glass manufacturing, food processing (meat, soy, and dairy products) wastewater, and has been and continues to be researched for the treatment of agricultural drainage. DWR did a lot of research and pilot work on the use of RO treatment of agricultural drainage in the 1970s and 1980s, first at the Firebaugh Field Station and then at the demonstration desalting plant near Los Banos. The Bureau of Reclamation and Panoche Water District are continuing to research RO for the treatment of agricultural drainwater, as the earlier pilots revealed that without pre-treating the brine stream, membranes foul and are rendered ineffective very quickly. The purpose of the studies is to determine which drainwaters in the valley are amenable and economical to treat, and to provide sufficient data to develop feasibility designs and cost estimates for full-scale RO treatment.

Land Treatment

Discharge of saline waste to land can only be considered “land treatment” if it can be technically demonstrated that salts in the applied waste are removed by the harvested crop. Most land application discharges are not required to comply with numerical salt loading limits. Staff is not aware of any case in the region where a discharger has analyzed plant tissue and crop yield to determine the amount of salt removed with the crop, as is required by the state of Idaho. There is no convincing evidence that land application equates with land treatment. If anything, land application of high-strength organic waste dissolves soil minerals (e.g., calcium, magnesium) and creates alkalinity, which exacerbates the salt impacts from such discharges. However, land application to plants at agronomic rates could potentially be a long-term and sustainable salt treatment tool if implemented in a systematic and scientific manner and the following considerations are kept in mind. First of all, the salt applied to land is not removed unless plants are grown, harvested, and removed from the land. Second, there are many minerals that constitute salt in applied wastewater. The agronomic demand of different plants for the different salt constituents varies widely, and so determining that a certain crop has the agronomic capacity to utilize all, or even most salt constituents applied in the waste can be complicated and difficult. Third, as mentioned above, consideration must be given to the potential to exacerbate a discharge’s salt impacts to groundwater through the dissolution of soil minerals by alkalinity created when high concentrations of organics in the waste decompose.

Disposal

The most common disposal methods currently being utilized in the region for saline waste are surface water disposal, land disposal, deep-well injection, and hauling/off-site disposal. A few attempts have been and are being made within the region to use evaporation ponds to eliminate most or all of the water from saline wastewater to form a concentrated brine or solid that could be economically disposed of.

The Central Valley Water Board considers the above-mentioned disposal methods as interim salt management practices that will not ultimately address the salt imbalance problem. The long-term solution to the salt imbalance in the region envisioned and recommended by the Board has long been and continues to be a out-of-valley disposal. Environmentally and economically sustainable long-term solutions will require the development and implementation of physical facilities to properly remove and dispose of salt.

Surface Water Disposal

One of the methods utilized for the disposal of saline waste is direct surface water discharge. It is commonly used for the disposal of municipal and industrial wastewater. These types of discharges can only be conducted under an NPDES permit. Some NPDES permits contain effluent limits for EC and/or TDS, and others have narrative requirements for pollutant minimization, depending on the concentration of salts in the effluent and the assimilative capacity of the receiving water.

A significant volume of moderately to highly saline agricultural drainage and runoff is also discharged into surface water bodies. This occurs either through the direct surface transport of agricultural surface wastewater or through the movement of leached salts via shallow water tables and movements typically aided by means of agricultural tile drains.

Land Disposal

Another common disposal method for saline waste is land discharge. The discharge of many wastes to land is regulated through WDRs, Waivers of WDRs, or General Orders. There are several types of land discharge methods, including disposal to unlined disposal ponds, lagoons, or spreading basins, land disposal on fallow or uncropped land, irrigation of crops at agronomic rates, and disposal to lined ponds in accordance with Title 27. In the past, disposal of wastewater using unlined ponds, lagoons, spreading basins, or uncropped land has been a common practice. However, there is increasing concern regarding the potential for these practices to result in groundwater degradation, and, as a result, additional management practices are augmenting these disposal methods, or alternative practices are replacing them.

Highly saline wastewater that has a significant potential to degrade groundwater is classified as “designated waste”, and, if discharged to land, must be discharged to lined ponds or impoundments that meet the requirements prescribed in Title 27, CCR.

Evaporation Ponds

There have been attempts made within the oil and food production industries in the region to use evaporation ponds to eliminate most or all of the water from saline wastewater to create a brine or solid that could be economically disposed of or sold. However, to our knowledge, none of these projects has resulted in a concentrated salt product that could sustainably be disposed of off-site or sold as a product. The oil industry made a serious effort to find a market for salt that could be produced from its oil well-production wastewater, but were unsuccessful in finding such a market. In the Tulare Basin, evaporation basins are used to collect agricultural drainage, concentrating and isolating salts; but the Tulare Lake Basin Plan addresses this as an interim storage step, not final disposal. DWR has investigated the possibility of economical harvest and disposal or marketing of agricultural drainage salts, but no viable market or economical and environmentally acceptable final disposal option has been identified, although studies continue.

Integrated on-farm drainage management (IFDM), described in the previous section, relies on salt disposal in a solar evaporator, a practice that is not endorsed for larger, regional scale salinity management projects in the Central Valley. Currently, only a few IFDM systems are in use. Any system that collects salt in unlined basins requires intense, careful management to avoid adverse environmental impacts. Board staff tracks the operation of existing systems closely. As salinity impairments become more pronounced in parts of the Central Valley, it is possible that more farmers will consider the IFDM option to maintain farm production. If this occurs, there will be an increasing need for state resources to regulate these systems in multiple, remote, rural locations throughout the drainage impaired portions of the Central Valley.

Deep-Well Injection

Deep-well injection consists of injecting undesirable liquid waste (high salinity wastewater) into wells drilled into deep (saline) aquifers below a confining layer, assumed to have the capacity to prevent movement of the injected waste into the overlying, better water quality aquifers. It is currently not a common disposal practice, except in the oil industry, where it is used for the disposal of large quantities of highly saline oil well production wastewater. It is, however, also being used by at least one vegetable processor in San Joaquin County. It has in the past been tried in the region for the disposal of meat processing wastewater and agricultural tile drain water; however those attempts failed due to plugging of the formation and/or well. This is a common problem that must be considered in any wastewater deep-well injection project. However, it is anticipated that, as salinity becomes more of a concern, this will become a more attractive option. At least one other Central Valley food processor is considering the implementation of this technology to dispose of its wastewater. A representative of the USEPA, Region 9, who regulates deep-injection wells, also indicated that his agency has begun to get more inquiries into this technology for the disposal of saline waste.

Hauling/Off-Site Disposal
Hauling and off-site disposal of saline wastewater is a practice conducted on a relatively limited basis. It is utilized by a number of small wineries enrolled under the Small Food Processor Waiver. Most of these dischargers dispose of their waste at wastewater treatment facilities that have a limited capacity to accept this sort of waste. In addition, Hilmar Cheese is currently trucking between 10,000 and 30,000 gallons per day of R.O. concentrate to an East Bay Municipal Utility District facility, which discharges its effluent to the ocean.

As discussed above in the section on industrial waste, some power plants are planning "Zero Liquid Discharge" facilities and would end up with a salt cake that would be disposed of in a landfill.

Reuse at Chemical Waste Management Facility
Chemical Waste Management, which operates a facility in Kettleman City, has proposed to convert a Class III municipal solid waste unit into a bioreactor project. If approved, the unit would require thousands of gallons of water per day for several years to initiate the bioreaction process. They anticipate receiving the liquids from many sources, such as oil fields, food processors, and wastewater treatment facilities.

Out-of-Valley Drain
The Basin Plan strategy for control of salt collected in agricultural tile drains in the San Joaquin and Tulare Basins is the construction of a drain to convey the drainage to a location outside those Basins. The Central Valley Water Board has for years recommended this to appropriate authorities with the capability of planning and implementing such a project. It has also endorsed and recommended the design and construction of an expanded drain that would provide for brine waste from other sources and has encouraged others who would benefit to organize and create funding for a multiple use drain, similar to the Santa Ana River Interceptor line in southern California (see Appendix 1). However, until now, an out-of-valley drain has not materialized from the efforts of the Board and other entities involved in the process. The Board continues to endorse salt removal from the basin, but since the Board has no authority to make it happen, the approach described in the 2004 Basin Plan Amendment (Appendix 5) includes regional salinity control.

3.5. Salt Budget

Readily available studies, historical data, and water quality model results were summarized to quantify the relative quality and quantity of salinity sources and sinks in the Central Valley. This preliminary assessment does not rigorously establish consistent averaging periods and calculation methods. A mix of data sources, averaging periods, and calculation methods are used to provide a first order estimate of the relative salt movement in the Central Valley. These first order estimates can be used to guide more detailed assessment of salt accounting and its implications for salt management.

Major components of the salt budget include mass emissions for the Sacramento and San Joaquin Rivers, exports from the Sacramento and San Joaquin River Delta, and deliveries from the State and federal water projects to the San Francisco Bay area, Central Coast, San Joaquin Valley, and Southern California. The salt budget also includes estimates of salt cycling that is occurring between surface, soils and groundwater, and the relative contribution from salts added from agriculture, food production, and municipal and industrial sources.

Any salt budget is highly dependent on the flows upon which salt loading estimates are based. The natural variability in rainfall, runoff, combined with changes in reservoir and agricultural operations to respond to variable rainfall and runoff, assure that mean values provide only a limited view of the salt cycling in the Central Valley. The mean annual flows, salinity, and salt loading, do still however provide a sense for the scale of the problem and offers a first approximation of the magnitude of salt that requires variable degrees of management.

Mass emissions for major sites, including discharges from the Sacramento River and San Joaquin River into the Delta, and Delta exports are based on readily available flow and water quality data for these sites. Other values are compiled from previous studies that were based on a mix of historical data and model results.

Delivery data for the major State and federal water projects in the watershed provide an idea of the amount of water being delivered to various end users throughout the State. The systems in place for conveyance, storage, and delivery are very complex and a simple view of the data does not capture the degrees of water movement and the decisions made by water managers. Considering the system on a regional basis also provides a gross approximation of water delivery and salt loading throughout the State.

This analysis first provides a description of the various elements considered in the flow and salt budget. This is followed by an accounting of the flow for each model element, the water quality associated with each of these flows, and salt loading. This ordering of the discussion, however, does not always track the ordering of analyses. For the most part, mean annual salinity of a source is calculated based upon the mean annual salt loading divided by the mean annual flow for a source. This ordering of calculation considers the ‘flow weighting’.

Salt Budget Elements

Salt budget elements for this first approximation of a salt budget includes the following:

- Mass Emissions
- Delta Exports
- Major Water Project Deliveries
- Salt Additions
- Other Sources and Sinks

Mass Emissions

Discharges of the Sacramento River and San Joaquin River into the Sacramento-San Joaquin River Delta constitute the mass emissions from the Central Valley into the Sacramento-San Joaquin River Delta. The Sacramento River constitutes the majority of the flow into the Delta system, with the San Joaquin River contributing a much smaller amount of flow. The two major sources of freshwater into the Delta contribute to a net total Delta outflow that is dependant on annual and seasonal variations. Estimates of net movement of salt out of the Delta into the San Francisco Bay are difficult as the water becomes brackish from seawater intrusion. Net freshwater outflow is Delta water (mass emissions from the Sacramento, San Joaquin, and other Delta inflows that are not consumptively used in or exported from the Delta).

Delta Exports

Significant quantities of both salt and water are diverted from the Delta system. One of the primary conveyances of water and salt for the Central Valley Project is the DMC. This canal moves water, primarily for agricultural and wetland use, to water users in the southern portion of the Central Valley. The California Aqueduct is the major source of water and salt for the SWP, which provides water for a much wider array of uses. Much of the water and salt moved by the SWP is transported to Southern California as an additional water supply for the population. Water from the SWP also supplies Alameda and Santa Clara Counties. Two smaller systems for movement of water and salt out of the Delta are the Contra Costa Canal and the North Bay Aqueduct. They primarily support municipal use in the East Bay Area and the North Bay Area. More detailed information about water deliveries is available in a later section.

Table 2. Annual discharge from mass emissions and Delta exports in the Sacramento-San Joaquin Delta system

	Min	Max	Mean	1985 to 1994 Mean	2001 to 2004 Mean	Period of Record / Notes
Mass Emissions	Annual Discharge (thousand acre-feet/year)					
Sacramento River	5,508	33,951	16,953	11,676	14,742	1959 to 2004[1]
Yolo Bypass	1	17,588	2,980	1,244	1,316	1959 to 2004[1]
San Joaquin River	283	16,104	3,082	1,611	1,350	1959 to 2004[2]
Delta Outflow	2,665	70,833	19,275	9,011	11,387	1959 to 2004[1]
Delta Exports	Annual Discharge (thousand acre-feet/year)					
California Aqueduct (SWP)	544	3,814	2,169	2,471	2,988	1959 to 2004[1]
Delta Mendota Canal (CVP)	1,098	2,936	2,141	2,328	2,558	1959 to 2004[1]
North Bay Aqueduct	19	53	38	32	48	1959 to 2004[1]
Contra Costa Canal	63	184	99	118	122	1959 to 2004[1]
[1]Source: DayFlow; [2]Source: USGS, 2006						
Note: Blanks in the above table represent data that must be compiled by future efforts, if possible						

Table 3. Annual salt load from mass emissions and Delta exports through the Sacramento-San Joaquin Delta system

	Min	Max	Mean	1985 to 1994 Mean	2001 to 2004 Mean	Period of Record / Notes
Mass Emissions	Annual Salt Load (thousand tons/year)					
Sacramento River	730	3,049	1,945	1,521	1,748	1959 to 2004[1]
Yolo Bypass	0	2,392	405	169	179	1959 to 2004[1], assume EC=100
San Joaquin River	263	2,557	922	749	742	1959 to 2004[2]
Delta Outflow						
Delta Exports	Annual Salt Load (thousand tons/year)					
California Aqueduct (SWP)	983	1,022	1,004		1,004	2001 to 2004[3]
Delta Mendota Canal (CVP)	631	1,003	900		884	2001 to 2004[3]
North Bay Aqueduct	2	6	4	3	6	1959 to 2004[1], assume EC=Sac River
Contra Costa Canal	37	46	41		41	1959 to 2004[1], assume EC=SWP

[1]Source: DayFlow; [2]Source: USGS, 2006; [3]Source: DWR, 2006c

Note: Blanks in the above table represent data that must be compiled by future efforts, if possible

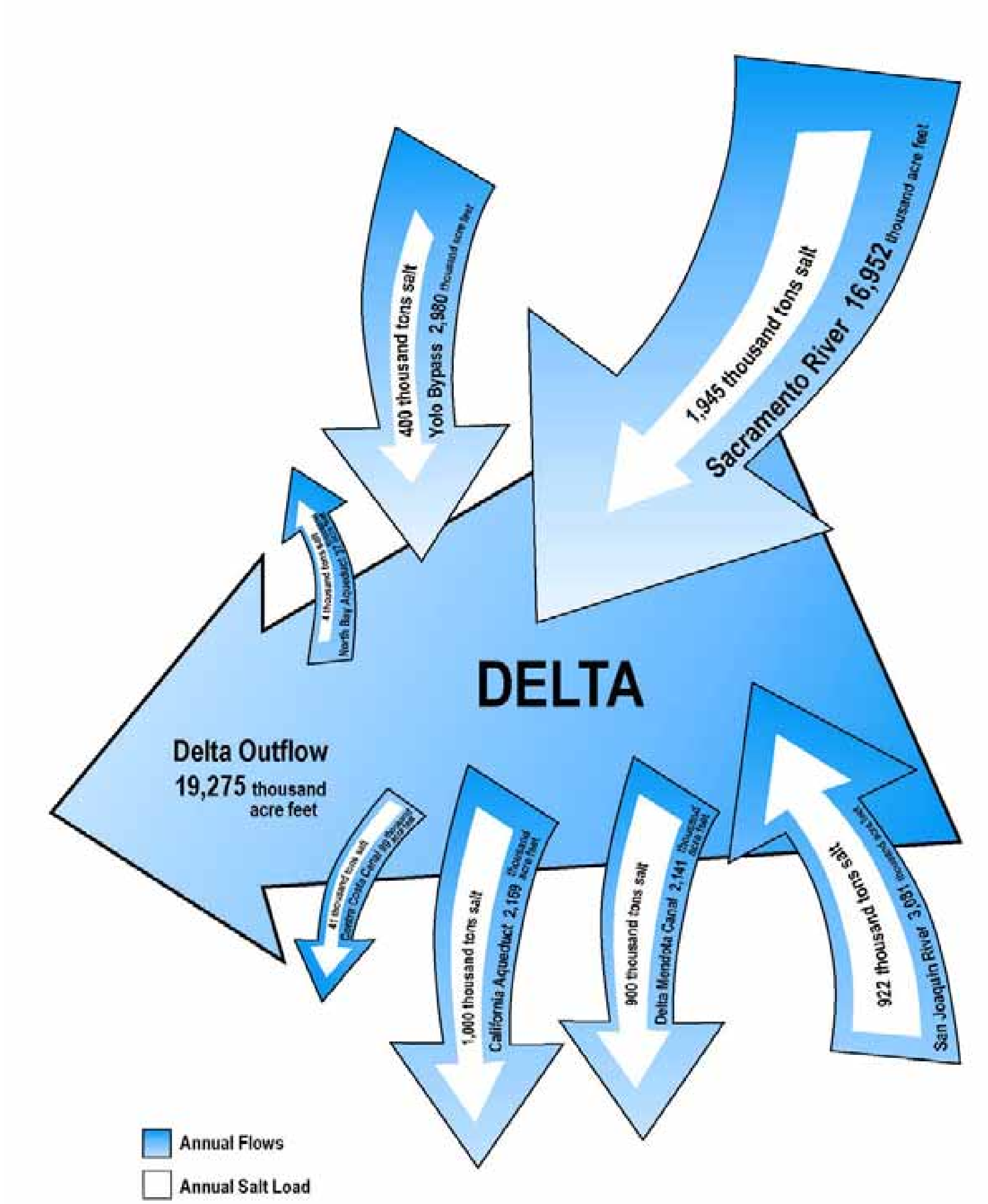

Figure 3. Mass emissions and Delta exports in the Sacramento-San Joaquin Delta system

Major Water Project Deliveries
The major water projects in California deliver water and salt throughout the State (see Appendices 2 and 3). Water is diverted and delivered to the Sacramento River Basin, Greater Bay Area, San Joaquin River Basin, Tulare Lake Basin, Central Coast, and Southern California (DWR, 2006a).

The majority of water deliveries in the Sacramento River Basin consist of high quality (low salt) water from sources such as Lake Oroville. The Sacramento River Basin does not receive water from the Delta system. Water in the Sacramento River Basin is rerouted throughout the basin, and no water is imported from out-of-basin sources. Major facilities include the Shasta-Trinity River diversions and the Tehama-Colusa Canal.

Deliveries to the Greater Bay Area are made to Napa and Solano counties through the North Bay Aqueduct, East Bay Counties through the Contra Costa Canal, and Alameda and San Jose Counties through the South Bay Aqueduct as part of the California Aqueduct. The Greater Bay Area also includes movement of water from the Tuolumne River through the Hetch Hetchy system to the San Francisco area.

Deliveries to the San Joaquin River and Tulare Lake Basins are made via both the SWP's California Aqueduct, and the federal Central Valley Project's DMC. Water conveyed in these two canals are mixed in the State and federal San Luis Joint Use Complex near Los Banos in the San Joaquin Valley. In addition, the federal Central Valley Project also includes deliveries of high quality water through facilities such as the Friant-Kern Canal in the eastern San Joaquin River and Tulare Lake Basins. There are no mass emissions from the Tulare Lake Basin, except for those in lateral movement of groundwater, which are not estimated in this report.

Deliveries to San Luis Obispo and Santa Barbara counties on the Central Coast are made via the Coastal Branch Aqueduct, which splits from the California Aqueduct near Kettleman City in the San Joaquin Valley.

Deliveries to Southern California are made through the West and East Branches of the California Aqueduct, which pumps water over the Tehachapi Mountains south of Bakersfield.

Maximum annual contractual commitment within the SWP service area is approximately 4 million acre-feet per year. This includes maximum annual contract amounts of 15,000 acre-feet to the Sacramento River Basin, 300 thousand acre-feet to the Greater Bay Area, 1 million acre-feet to the San Joaquin River and Tulare Lake Basins, 70 thousand acre-feet to the Central Coast, and 2.5 million acre-feet to Southern California (DWR, 2006b). Because of limited supply and other restrictions, actual annual deliveries are typically considerably less than maximum contract amounts.

Table 4. Annual discharge by region for major Central Valley water project deliveries

Major Water Project Deliveries		Min	Max	Mean	1985 to 1994 Mean	2001 to 2004 Mean	Period of Record / Notes
		Annual Discharge (thousand acre-feet/year)					
Statewide	Total	6,558	11,957	10,301	4,150	5,634	Calculation
	CVP	4,333	6,411	5,655		5,634	1993-2004 CVP Delivery Data[1]
	SWP	2,225	5,546	4,379	4,150		1985-2001 SWP Delivery Data[2]
	Hetch Hetchy			267			California Water Plan[3]
Sacramento River Basin	Total	1,949	3,134	2,544	799	1,868	Calculation
	CVP	1,361	2,023	1,664		1,868	1993-2004 CVP Delivery Data[1]
	SWP	568	1,111	880	799		1985-2001 SWP Delivery Data[2]
Greater Bay Area	Total	215	425	578	172	154	Calculation
	CVP	94	171	130		154	1993-2004 CVP Delivery Data[1]
	SWP	121	254	181	172		1985-2001 SWP Delivery Data[2]
	Hetch Hetchy			267			California Water Plan[3]
San Joaquin River Basin	Total	1,770	3,447	2,781	1,105	1,658	Calculation
	CVP	1,264	1,872	1,625		1,658	1993-2004 CVP Delivery Data[1]
	SWP	506	1,575	1,156	1,105		1985-2001 SWP Delivery Data[2]
Tulare Lake Basin	Total	1,744	4,394	3,360	1,096	1,955	Calculation
	CVP	1,479	2,803	2,235		1,955	1993-2004 CVP Delivery Data[1]
	SWP	265	1,591	1,125	1,096		1985-2001 SWP Delivery Data[2]
Central Coast	Total	9	27	21			Calculation
	SWP	9	27	21			1985-2001 SWP Delivery Data[2]
Southern California	Total	606	1,795	1,031	978		Calculation
	SWP	606	1,795	1,031	978		1985-2001 SWP Delivery Data[2]

[1]*Source: USBR, 2006;* [2]*Source: DWR, 2005;* [3]*Source: DWR, 2006d*

Note: Blanks in the above table represent data that must be compiled by future efforts, if possible

Table 5. Annual salt load by region for major Central Valley water project deliveries

Major Water Project Deliveries		Min	Max	Mean	1985 to 1994 Mean	2001 to 2004 Mean	Period of Record / Notes
		Annual Salt Load (thousand tons/year)					
Statewide	Total	2,357	4,268	3,606			Calculation
	CVP	1,587	2,349	2,072		2,064	assume EC=450[1]
	SWP	770	1,919	1,515	1,436		assume EC=425[1]
	Hetch Hetchy			19			assume EC=87[2]
Sacramento River Basin	Total	236	383	311			Calculation
	CVP	166	247	203		228	assume EC=150 (Sac River Mean EC)
	SWP	69	136	107	98		assume EC=150 (Sac River Mean EC)
Greater Bay Area	Total	76	151	129			Calculation
	CVP	34	63	48		56	assume EC=450[1]
	SWP	42	88	63	60		assume EC=425[1]
	Hetch Hetchy			19			assume EC=87[2]
San Joaquin River Basin	Total	638	1,231	995			Calculation
	CVP	463	686	595		607	assume EC=450[1]
	SWP	175	545	400	382		assume EC=425[1]
Tulare Lake Basin	Total	634	1,577	1,208			Calculation
	CVP	542	1,027	819		716	assume EC=450[1]
	SWP	92	551	389	379		assume EC=425[1]
Central Coast	Total	3	9	7			Calculation
	SWP	3	9	7			assume EC=425[1]
Southern California	Total	210	621	357	338		Calculation
	SWP	210	621	357	338		assume EC=425[1]

[1]Source: DWR, 2006c; [2]Source: Oppenheimer and Grober, 2004

Note: Blanks in the above table represent data that must be compiled by future efforts, if possible

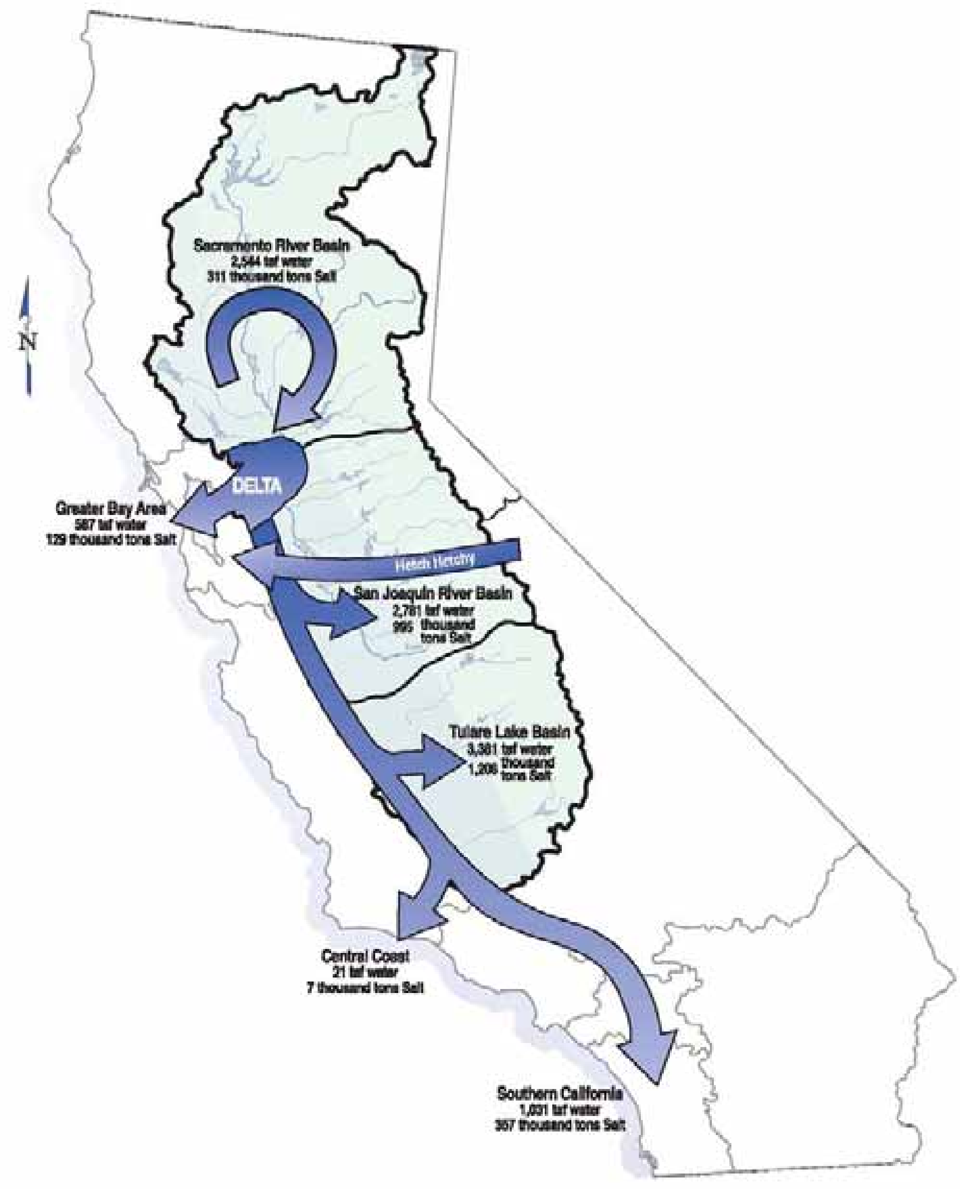

Figure 4. Statewide water project delivery data, discharge and estimated salt loads

Water and salt are also recirculated at a number of points in the Central Valley but the two major areas for recirculation of salts are:

- Diversions from the San Joaquin River onto lands on the west side of the San Joaquin River
- Delta exports that incorporate a large percentage of the flow and salt loads in the San Joaquin River and re-export them to the San Joaquin River Basin.

Such recirculation can have a large effect on salt fluxes because rather than completely leaving the system, such recirculated salts continue to contribute to any impairments and costs associated with elevated salinity in supply water.

Salt Additions
Salt additions include salt added in the form of fertilizers and soil amendment in agriculture, food processing and other industrial activities and through municipal use. Rough estimates are made of unit and total salt loading from municipal use. Also, for illustrative purposes, the gross salt loading from dairies is estimated.

Other
Other salt budget elements presented for illustrative purposes are the flows and salt loads associated with:

- Confined aquifer groundwater pumping in the San Joaquin River and Tulare Lake Basins
- Losses to confined aquifer in the San Joaquin River and Tulare Lake Basins
- Salt dissolution
- Grassland Bypass Project
- San Joaquin River diversions

These additional flow and salt budget elements are provided to get a sense of the relative movement and contribution of salt from other sources in the Central Valley.

Movement to and from a confined aquifer does not affect the spatial salt budget but fluxes of salt to and from these aquifers can have a large effect on salt balance either in soils and shallow groundwater or in the confined aquifer itself. Dissolution of naturally occurring salts contributes salts from naturally saline soils to soils and underlying groundwater, and may be conveyed in surface and subsurface flows to downstream areas or a confined aquifer. Dissolution of salts, and specifically gypsum, is a non-trivial source of salt on the west side of the San Joaquin River (Schoups et al. 2005).

Salt and flow fluxes for the Grassland Bypass Project are provided since salt loads from this tile drained area represents one of the largest high salinity sources in the San Joaquin River Basin. It is also a source of salt that has been reduced, with respect at least to surface water loading, in recent years and is likely to be further reduced in coming years. Finally, estimates of flow and salt fluxes associated with diversions for agricultural use along the San Joaquin River are provided since this demonstrates some of the salt recirculation that is currently occurring.

Data Sources and Methods

Unless otherwise noted, most flow information was obtained from Dayflow, an accounting model developed in 1978 by DWR for determining historical Delta boundary hydrology. Dayflow is used extensively in studies by numerous agencies and private consultants. Documentation and Dayflow data is available at the Interagency Ecological Program website at: http://www.iep.ca.gov/dayflow/. Delivery information was obtained from operational reports for the Central Valley Project (USBR, 2006) and the SWP (DWR, 2005).

Additional flow and EC data for the Sacramento and San Joaquin River were obtained from DWR as reported in Oppenheimer et al., 2004 and updated for this report. SJRIO, a mass balance water quality model, was used to estimate San Joaquin River diversions and tributary accretions salt loads in this analysis (Grober, 1996). SJRIO is a mass balance water quality model that was originally developed to study the effects of agricultural drainage on water quality in the San Joaquin River (Kratzer et al, 1987). The model performs a mass balance accounting of mean monthly flows and loads of salt, boron and selenium. Loads and concentrations are calculated for a sixty-mile reach of river from Lander Avenue to Vernalis. Primary model components include the San Joaquin River at Lander Avenue, the upstream boundary to the model, and three east side tributaries: the Merced, Tuolumne, and Stanislaus rivers. A San Joaquin Valley hydrologic and salt load budget, developed by CH2M Hill under contract of the USBR for San Joaquin Valley Drainage Program (SJVDP, 1988) was used for flow and salt load fluxes in the San Joaquin Valley. This report provided information on salt and flows in groundwater pumping, losses to groundwater, dissolution of salts, and deliveries to the San Joaquin and Tulare Lake Basins. Estimates of flow and salt fluxes for the cities of Turlock and Modesto were obtained from the Central Valley Regional Water Quality Control Board's Total Maximum Daily Load for salt and boron in the San Joaquin River (Oppenheimer et al., 2004). Other, more specific data sources are provided in the results and discussion section.

When TDS data was not available, TDS loads were calculated based on a TDS/EC ratio of 0.6 for TDS in mg/l and EC in µS/cm. Mean annual salinity for specific sources are calculated based upon the mean annual salt loading divided by the mean annual flow for a source. This preserves the correct weighting of highly variable salinity applied to highly variable flows. When sufficient data is available it is preferable to "flow weight" variable flow and salinity data (Grober et al., 1998) so that high salinities associated with low flow periods are not weighted as much as low salinities associated with low flow periods. This flow weighting preserves a better estimate of the actual monthly and annual loading. Some salt loading information was calculated by estimating salinity concentrations. These estimates were based on monitoring data.

Averaging Periods

Information on flow, salt loading, and mean annual salinity are provided for different periods of record and for different averaging periods for two reasons. The first reason, consistent with the premise for this flow and salt load accounting, is to demonstrate the highly variable nature of both flows and salt loading. Different averaging periods are also presented to reflect the different data sources used for this analysis. Averages for the full period of record are presented for each source. Averages for 1985 through 1994 are presented for a number of model elements because the numbers were based on information compiled as part of the San Joaquin River Salt and Boron TMDL (Oppenheimer et al, 2003). Averages for 2001 through 2004 are also presented since this represents a recent period so is likely to best represent the current condition. Use of such a short time period however, with the limited hydrology, makes use of this average less likely to be representative of a longer-term condition. To better understand the potential bias of using numbers from the two averaging periods, the water year types and indices[9] for the period 1985 through 2005 are provided in Table 6.

[9] The Water Indices for the Sacramento and San Joaquin River Basins are described in the Bay-Delta Plan; they are used to determine the water year types as implemented in State Water Board D-1641. The indices include five water year types: wet; above normal; below normal; dry; and critically dry; Sacramento Valley Water Year Index = 0.4 * Current Apr-Jul Runoff Forecast (in maf) + 0.3 * Current Oct-Mar Runoff in (maf) + 0.3 * Previous Water Year's Index (if the Previous Water Year's Index exceeds 10.0, then 10.0 is used); San Joaquin River Water Year Index = 0.6 * Current April-July Runoff Forecast (in million acre-feet or maf) + 0.2 * Current October-March Runoff (maf) + 0.2 * Previous Water Year's Index (if the Previous Water Year's Index exceeds 4.5, then 4.5 is used)

Table 6. Water year classifications, WY 1985-2005

WY[1]	Sacramento Valley			San Joaquin Valley		
	WY Sum	WY Index	WY Type[2]	WY Sum	WY Index	WY Type[2]
1985	11.04	6.47	D	3.60	2.40	D
1986	25.83	9.96	W	9.50	4.31	W
1987	9.27	5.86	D	2.08	1.86	C
1988	9.23	4.65	C	2.48	1.48	C
1989	14.82	6.13	D	3.56	1.96	C
1990	9.26	4.81	C	2.46	1.51	C
1991	8.44	4.21	C	3.20	1.96	C
1992	8.87	4.06	C	2.58	1.56	C
1993	22.21	8.54	AN	8.38	4.20	W
1994	7.81	5.02	C	2.54	2.05	C
1995	34.55	12.89	W	12.32	5.95	W
1996	22.29	10.26	W	7.22	4.12	W
1997	25.42	10.82	W	9.51	4.13	W
1998	31.40	13.31	W	10.43	5.65	W
1999	21.19	9.80	W	5.91	3.59	AN
2000	18.90	8.94	AN	5.90	3.38	AN
2001	9.81	5.76	D	3.18	2.20	D
2002	14.60	6.35	D	4.06	2.34	D
2003	19.31	8.21	AN	4.87	2.81	BN
2004	16.04	7.51	BN	3.81	2.21	D
2005	18.44	8.45	AN	9.25	4.77	W

[1]WY = Water Year (October through September)
[2]C = Critically Dry, D = Dry, BN = Below Normal, AN = Above Normal, W = Wet

Results and Discussion

Summary Results for flow, salt loads, and salinity, respectively, are provided in Tables 2-5 and 7-8 and the geographic relationship of the flow and salt fluxes are shown in Figures 3 and 4.

When considering the relative impact of the various salt fluxes, the flows and salinity associated with these fluxes must be considered. The largest salt flux in this budget is the mean annual salt discharge of just under 2 million tons from the Sacramento River. This salt load is associated with a mean annual discharge of just under 17 million acre-feet per year, at a mean annual salinity of 141 μS/cm. In contrast the mean annual salt discharge of the San Joaquin River was only 900 thousand tons but this salt load was associated with a mean annual EC of approximately 370 μS/cm and discharge of only 3 million acre-feet. Recent mean annual EC for the San Joaquin River has been even higher with a mean of 570 μS/cm for 1985 to 1994 and over 670 μS/cm for 2001 to 2004. Mean annual salt loads were under 750 thousand tons, with mean annual discharge of less than1.6 million acre-feet.

The Sacramento River provides most of the freshwater that supplies the Delta. During times of large river flows and flood conditions, the Yolo Bypass is used to prevent flooding in the city of Sacramento. The mean annual flow from the Sacramento River (excluding the Yolo Bypass) is 5 times larger than the mean annual flow in the San Joaquin River. Salt loading from this source, however, is almost equivalent to the San Joaquin River. Although the Sacramento River has lower salinity levels, the volume of water discharging into the Delta contributes to significant salt loading. Salt loading out of the Delta is difficult to determine because of the mixing of freshwater and brackish water that occurs at the mouth of the Delta.

The California Aqueduct is the primary conveyance for water in the SWP, withdrawing approximately 2 million acre-feet of water and 1 million tons of salt a year. The Central Valley Project draws approximately an equivalent amount of water and salt from the Delta. The North Bay Aqueduct and Contra Costa Canal withdraw a significantly lower volume of water from the Delta, and a comparably low amount of salt.

Salt in supply water imports is the primary source of salt circulating in the San Joaquin River and Tulare Lake Basins. In situ dissolution of salts and pumping from the underlying confined aquifer are important secondary sources. Salts are moved out of the San Joaquin River Basin only through the San Joaquin River but some salt in both basins is also moved out of the unconfined aquifer of the basins into long-term storage in the confined aquifer beneath the basin. The DMC and California Aqueduct supply most of the higher quality surface irrigation water in the San Joaquin River and Tulare Lake Basins. The quality of this supply may be impaired by the recirculation of salts from the San Joaquin River to the DMC intake pump, leading to a greater net accumulation of salts in the basin.

Delivery data from the two major water projects in California indicate there is a substantial amount of salt being transported from the Delta to other basins throughout the State. The San Joaquin River and Tulare Lake Basins are the primary recipients of this salt loading, receiving approximately two million tons of salt per year from supply water. Other basins receive a smaller amount of salt load proportional to the smaller amounts of water delivered to the basins. The San Joaquin River Basin has an outlet for the salts, although some becomes trapped in the confined aquifer. The Tulare Lake Basin, on the other hand, does not have an outlet, and all of the salt loading introduced from outside of the basin becomes a part of the confined aquifer in the basin.

Effects of Salt Imports

Mean annual exports from the Delta were approximately 5.5 million acre-feet associated with just under 2 million tons of salt from 2001 to 2004. The majority of these flows and loads were evenly split between the California Aqueduct and DMC. Based on SJVDP report on San Joaquin Valley salt budgets, the mean annual deliveries to the San Joaquin River Basin were 1.3 million acre-feet with 650 thousand tons of salt between 1970 and 1982. The mean annual deliveries to the Tulare Lake Basin were 3.4 million acre-feet with just over 1 million tons of salt. Delta exports and Basin imports cannot be directly compared or used for purposes of a salt budget because of the very different time periods upon which the estimates are based. The numbers do still, however, provide a rough approximation of the relative salt fluxes.

Salt in DMC water imports is therefore the primary source of salt circulating in the lower San Joaquin River Basin, roughly equal to San Joaquin River mass emissions. Although the DMC supplies most of the higher quality surface irrigation water in the lower San Joaquin River basin, the quality of this supply may be impaired by the recirculation of salts from the San Joaquin River to the DMC Delta pumping plant. In-situ dissolution of salts and pumping from the underlying confined aquifer are important secondary sources, together accounting for another 500 thousand tons of salt per year in the San Joaquin River Basin. Groundwater pumping of the confined aquifer and dissolution of salts contribute approximately 1 million and 2.5 millions tons per year, respectively, in the Tulare Lake Basin. The confined aquifer can also act as a sink, with just over 400 thousand tons per year lost through subsurface flow into the confined aquifer in the San Joaquin River basin and 1.6 million tons per year in the Tulare Lake Basin. Recent groundwater modeling (Schoups et al, 2005) has suggested, for example, that there is no net salt increase in soils and shallow groundwater in portions of the Tulare Lake Basin. Any spatial increase in salt loads is rather affecting the deeper aquifer. This movement of salt to deep groundwater or confined aquifers should not be considered a loss from the system because the salts still reside in the basin and could eventually be discharged to surface waters through natural groundwater movement or groundwater pumping. Alternately, such continued movement of salts to the deeper aquifer could ultimately make the groundwater unsuitable for any use.

Table 7. Annual salt load for additions and other salt sources

	Min	Max	Mean	1985 to 1994 Mean	2001 to 2004 Mean	Period of Record / Notes
<u>Additions</u>	Annual Salt Load (thousand tons/year)					
Fertilizer and Amendments						
Municipal (per 1,000,000 people)			24			Metcalf and Eddy, 1991
Municipal – Modesto and Turlock[1]			132			Oppenheimer and Grober, 2004
Dairy Metric[2]			700			University of California, 2005
<u>Other</u>	Annual Salt Load (thousand tons/year)					
Confined Groundwater Pumping						
San Joaquin River Basin			272			SJVDP, 1988
Tulare Lake Basin			1,048			SJVDP, 1988
Losses to Confined Groundwater						
San Joaquin River Basin			427			SJVDP, 1988
Tulare Lake Basin			1,577			SJVDP, 1988
Salt Dissolution						
San Joaquin River Basin			250			SJVDP, 1988
Tulare Lake Basin			2,572			SJVDP, 1988
San Joaquin River Diversions				160		Grober, 1996
Grassland Bypass Project	118	209	146		118	SFEI, 2005
[1]Population of 250,000 scaled up to 1,000,000; [2]Based on 1.6 million cows in Central Valley						
Note: Blanks in the above table represent data that must be compiled by future efforts, if possible						

Table 8. Salinity of additions and other salt sources

	Min	Max	Mean	1985 to 1994 Mean	2001 to 2004 Mean	Period of Record / Notes
Additions	Electrical Conductivity (μS/cm)					
Fertilizer and Amendments						
Municipal (per 1,000,000 people)			441			Metcalf and Eddy, 1991
Municipal – Modesto and Turlock[1]			1,226			Oppenheimer and Grober, 2004
Dairy Metric[2]						University of California, 2005
Other	Electrical Conductivity (μS/cm)					
Confined Groundwater Pumping						
San Joaquin River Basin			1,666			SJVDP, 1988
Tulare Lake Basin			1,666			SJVDP, 1988
Losses to Confined Groundwater						
San Joaquin River Basin			2,489			SJVDP, 1988
Tulare Lake Basin			3,332			SJVDP, 1988
Salt Dissolution						
San Joaquin River Basin						SJVDP, 1988
Tulare Lake Basin						SJVDP, 1988
San Joaquin River Diversions				1,088		Grober, 1996
Grassland Bypass Project	5,254	5,012	5,220		5,176	SFEI, 2005

[1]Population of 250,000 scaled up to 1,000,000; [2]Based on 1.6 million cows in Central Valley

Note: Blanks in the above table represent data that must be compiled by future efforts, if possible

This simple salt budget did not estimate salt and flow inputs to the Delta except for the Sacramento and San Joaquin Rivers and the Yolo Bypass. Other sources, such as the Mokelumne River and Delta consumptive use, were not considered. To preserve a rough salt balance just for the Delta for the 2001 to 2004 period, it was necessary to assume a salt flux from the Bay into the Delta. Without consideration of such a salt flux, the mass emissions of water from the Delta, or Delta outflow in to the Bay, would have occurred at an EC of only 70 μS/cm. To arrive at a conservative estimate of Delta outflow salinity equal to Sacramento River salinity it was necessary to assume a salt inflow of 700 thousand tons per year. This simple analysis provides a rough estimate of the likely minimum quantity of salt that flows into the Delta from the Bay and is incorporated into Delta exports into the State, federal, and other projects.

Additions

The salt loads from municipal discharges and dairies are estimated. The typical municipal water use in the U.S. ranges from 40-130 gallons/person/day, with an average use of 60 gallons/person/day (Metcalf and Eddy). The typical increase in TDS from domestic use ranges from 150-380 mg/L. An assumed increase of 265 mg/L applied to the average use of 60 gallons/person/day, results in 0.132 pounds of salt/person/day. This results in approximately 24 thousand tons per year per in 70 thousand acre-feet of water for 1 million people. This does not consider source water quality and any concentration of the salts in the supply water. It also does not consider any industrial inputs. It does, however, provide a rough approximation of the salt impact per 1 million population. By comparison, the combined discharge to surface water by the cities of Modesto and Turlock, with a combined population of approximately 250 thousand, was estimated to be 26 thousand acre-feet and 23 thousand tons of salt per year (Oppenheimer and Grober, 2004), with another 10,000 tons of salt discharged annually to land. These values are significantly higher than the numbers suggested by Metcalf and Eddy because the municipal discharges also contain effluent from industries within the cities and the municipal water supply starts with elevated source water salinity. In any case, the relative contribution from municipal sources is relatively small compared to the larger salt fluxes already described.

The waste stream from mature milk and dry cows in the Central Valley contains an average of about 2.4 lbs salt per cow per day (assumptions) (University of California, 2005). Based on a population of approximately 1.6 million mature milk cows in the Central Valley, these dairy cows generate a waste stream of 700 thousand tons per year of salt. This loading cannot, however, be considered a simple addition of salt. It rather represents the redistribution and concentration of salt that occurs as a function of raising and containing cows. Some of these salts are nutrients that are recycled for crop growth. No assessment was done to estimate salt loads, in the form of feed and water, into dairies.

Effects of Water Exports and Consumptive Use

The relative effect of water losses from the Central Valley can be explored by examining the effect of just one such loss, the export of Hetch-Hetchy water from the Tuolumne River to the San Francisco Bay Area. A similar effect will occur as a response to any activity that either removes water containing relatively low levels of salt from the Central Valley or that consumptively uses water within the Central Valley. This example is shown to demonstrate:

- the individual effects of just one of these activities is measurable and not insignificant, and collectively such activities can have a large cumulative effect
- a wide range of entities can be shown to have a collective adverse impact on Central Valley salinity

Hetch Hetchy exports account for mean annual diversions of 250 thousand acre-feet per year and 17 thousand tons of salt. Removal of this high quality, low salinity, water has a relatively large impact on water quality in the San Joaquin River. If this 250 thousand acre-feet of water per year were added to the mean annual discharge for the San Joaquin River from 1985 to 1994, mean annual EC for San Joaquin River mass emissions during this period would have been reduced from 570 to 506 μS/cm. Similar results could be expected with flow augmentation from other high quality sources or reduced consumptive use of water in the Basin.

Salinity Trends

An essential element in understanding the nature and significance of the salinity problem in the Central Valley is the determination and evaluation of historical salinity trends in the soils, surface water, and groundwater of the valley. At this point in time, there have been no comprehensive monitoring programs and data analyses that have established baseline conditions or historical changes for salinity in the valley. However there is a significant amount of data that has been collected and analyzed that can shed some light on historical salinity trends. A brief summary of some of that information is presented below.

<u>Soil</u>

The recently completed *Draft Soil Survey of Fresno County, California, Western Part* describes a soil condition along the west side of the San Joaquin Basin that has been increasing in severity over time. Since the operation of the CVP's Delta-Mendota Canal (DMC) began in the early 1950s, CVP water, imported from the Delta, has, to a great extent, replaced groundwater as a source of irrigation water. The result has been that in many low lying areas, such as near the San Joaquin River, water tables have risen up into the root zone of crops grown on that land. Because this shallow groundwater is generally highly saline, it creates saline soil conditions that tend to remain, even if the land is drained to lower the shallow groundwater. The Fresno County soil survey states that approximately 400 thousand acres of saline–sodic soils currently exist in the survey area. Saline-sodic soils are soils containing soluble salts in sufficient quantity to interfere with the growth of most crop plants and sufficient exchangeable sodium to affect the soil's physical properties and plant growth adversely. This acreage (400 thousand acres) constitutes approximately 48 percent of the irrigated land within the boundaries of the survey area, up from approximately 33 percent of the irrigated land so identified in 1985, an increase of approximately 120 thousand acres in 18 years. Although the soil salinity trend and the total extent of soils impaired by salinity in the

Central Valley has not been determined, the trend described above can certainly be extrapolated to other areas on the west side of the San Joaquin Basin.

Surface Water

It is possible to identify long-term surface water salinity trends, based on cumulative effects of out of valley water exports, increasing consumptive use, salt imports, and increased mobilization of salts. Although a complete analysis of salinity trends in the Central Valley will require additional data and analysis, a brief analysis of trends in the mass emissions of salt from the San Joaquin River is available for the San Joaquin River near Vernalis.

Figure 5 shows the mean annual EC in the lower San Joaquin River near Vernalis for water years 1930 to 2004 as well as the 15-year moving average for the data. (based on data from USBR, 1980; Chilcott et al., 1998; Grober et al., 1998a; Crader et al., 2002b; DWR, 2005; USGS, 2005a; USBR, 2006b). Mean annual EC is calculated by dividing the total annual salt load by the total annual discharge in the lower San Joaquin River near Vernalis. The 15-year moving average helps identify long-term trends that may be obscured by the annual variability of discharge and salt load. The data shows an increasing trend in EC levels, with mean annual EC nearly doubling since the mid-1940s. The increase in EC is due to a number of factors, including diversion of high quality water from major tributaries (the Merced, Tuolumne, and Stanislaus Rivers, and the lower San Joaquin River upstream of Lander Avenue), importation of high salinity water from the Delta, and high salinity groundwater accretions, and surface and subsurface agricultural discharges.

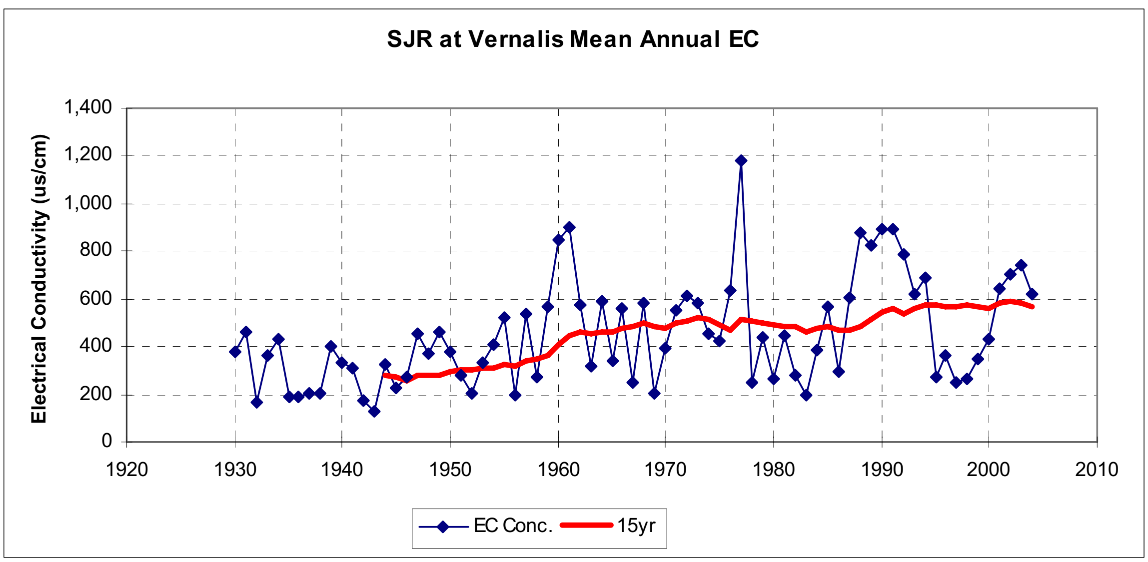

Figure 5. Salinity trends in the San Joaquin River near Vernalis

Groundwater

As early as 1984 increasing trends in nitrate and dissolved solids concentration in Sacramento Valley groundwater, attributed to agricultural practices and urban expansion, were documented by the USGS (Bertoldi, 1991). Even though, at the time, studies to determine human impact on groundwater quality had not been conducted by the USGS in the San Joaquin Valley, it was assumed that similar degradation had also occurred there because agricultural practices in the San Joaquin Valley were very similar to those in the Sacramento Valley.

In a current study, preliminary findings of a USGS investigation have shown chloride levels in the semi-confined aquifer near Stockton are increasing and have been found to be as high as 2,200 mg/l and EC as high as 5,930 μS/cm (Izbicki, 2006). This trend could decrease public water and agricultural supplies for Stockton and other cities and rural areas.

In order to get a sense for recent changes in water quality as pertains to salinity on a more limited scale, staff obtained historical EC data for municipal drinking water wells in the southern portion of the City of Fresno from the California Department of Health Services (Appendix 4). Fourteen of the wells in the dataset were found to have historical data going back at least twenty years and to contain at least one data point in each of five chosen time periods (1984 – 1989, 1990 – 1994, 1995 – 1999, 2000 – 2003, 2004 – 2005). The data from those wells were analyzed in order to attempt to establish a historical trend. The average EC value for the 14-well set for each time period was calculated and those values are displayed on Figure 6. The analysis shows an increasing trend in average EC for the well set. The EC increase shown over the monitoring period is 29 μS/cm. Although this is not a radical increase over 15 – 20 year time period, it should be pointed out that the average EC values were practically identical during the first two time periods, so the change that we see actually occurred over a 10 – 15 year time frame. The significance of the trend observed in this analysis is difficult to gauge without a more in depth study of a much larger data set over a longer period of time. However, it does suggest that the EC in the drinking water wells in the area may be increasing with time.

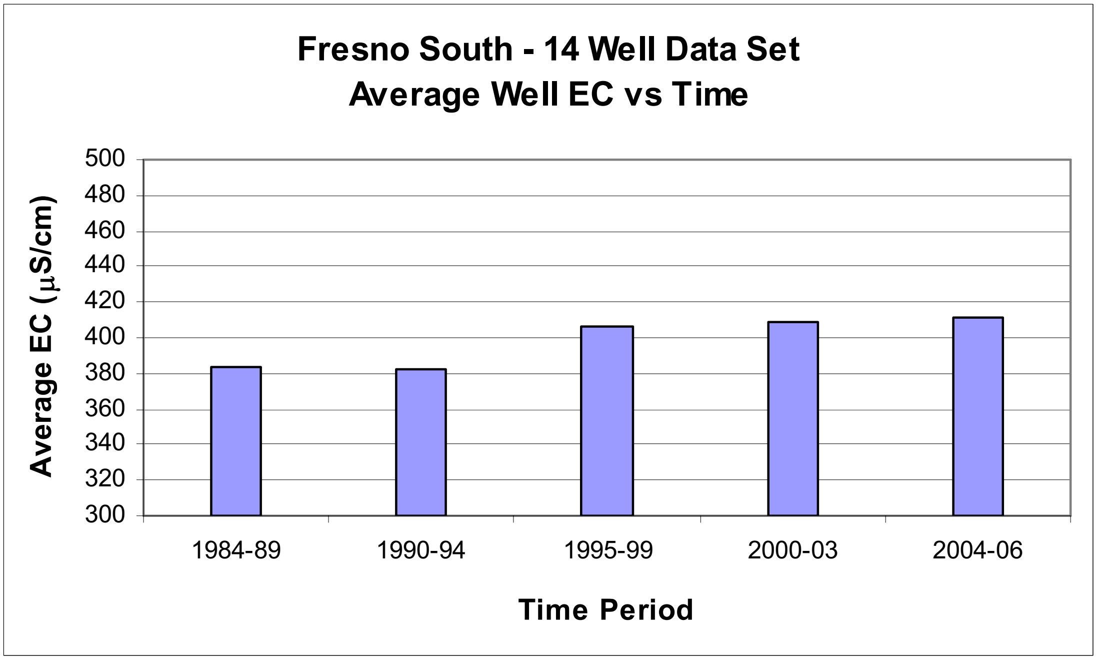

Figure 6. Historical Changes in EC in Fresno South Wells

Although very limited shallow groundwater monitoring has to date been required of dairies in Region 5, a few cities (e.g., Visalia, Fresno, and Tulare) that have been required to investigate groundwater around their disposal area because of pollution, have, in the process, identified nitrate and salt plumes created by dairies. Figure 3 that follows, taken from a groundwater report submitted to the Central Valley Water Board by the City of Visalia, illustrates chloride “hot spots” identified below dairies and the City’s wastewater treatment facility. Some localized degradation of groundwater by salts has also been observed at certain food processing facilities and wineries where monitoring of shallow groundwater has been conducted.

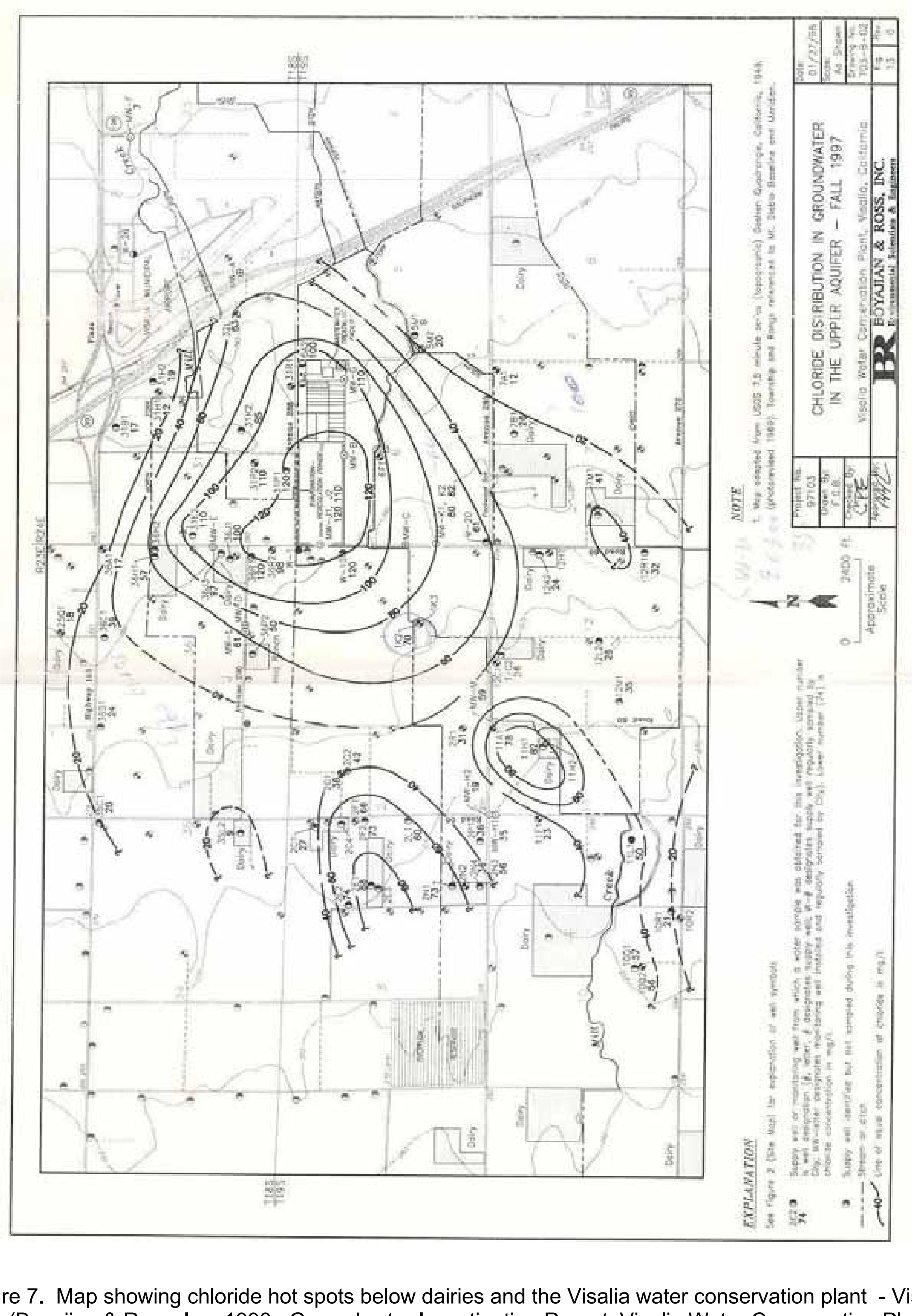

Figure 7. Map showing chloride hot spots below dairies and the Visalia water conservation plant - Visalia area (Boyajian & Ross, Inc. 1998. Groundwater Investigation Report, Visalia Water Conservation Plant, City of Visalia, Tulare County)

Future work

The salt and flow budget and salinity trend information presented here were based on readily available information only. By necessity they used a mix of historical and model data from different sources that are not directly comparable. It is essential that more complete datasets based upon all available data should be assembled to provide more robust and comprehensive baselines, salt and flow budgets, and historical salinity assessments for the Central Valley. This should include surface water daily flow and EC, if available, along with complete summary statistics on monthly, seasonal and annual variability, along with the relationship of this variability to water year types. A wider range of more specific sources should be identified and quantified, including but not limited to fertilizers and soil amendments, water softeners, food processing, and other major and minor industrial discharges. If specific information is not available, Central Valley-wide and basin-wide estimates should be made based upon the best available published information. The accounting should clearly identify and include as appendices all data used in the analysis.

This more robust source analysis will provide the foundation for a wide range of future work. It will help to identify additional data needs as well as provide the primary data upon which more detailed salinity assessment, accounting and modeling can be conducted. It will help to clearly establish the extent and significance of the problem and the short-term and long-term implications of the problem for the future. It will also help to identify the elements of Central Valley salt and flow budgets that are most likely to provide areas of improvement. In other words, the salt accounting will help to identify areas most in need of workable solutions and upon which to apply additional regulatory and implementation resources. Finally, a more robust source analysis will help to demonstrate that virtually all areas of the State not only have a vested interest in comprehensively addressing salinity problems in the Central Valley, but they also share responsibility for the disparate causes of the problem.

3.6. Relevant Factors

Demographics

The Central Valley is experiencing explosive population growth. Between 2005 and 2020, the region's population is projected to increase by 39%. California population as a whole is projected to increase by only 23.6% for the same period. Irrigated agriculture is the major industry supporting the Central Valley economy. The percentage of jobs either directly or indirectly related to agriculture in the Central Valley (20%) is approximately four times that of the State average (5.8%). Household incomes and per capita income growth rates are considerably lower than state and national averages. Correspondingly, the percentage of Central Valley residents living in poverty exceeds state and national averages. The Central Valley unemployment rate is also higher than the state or national average. In a recent report on the San Joaquin Valley, the Congressional Research Service found that the Valley was losing higher skilled workers and gaining lower skilled workers. Population increases were attributed primarily to international migration and coastal transplants fleeing high housing costs. Agriculture remains a major land use in the Central Valley but the rapid increases in population place increasing pressure for farmland to be converted to urban uses. The loss of productive farmland is largely unregulated.

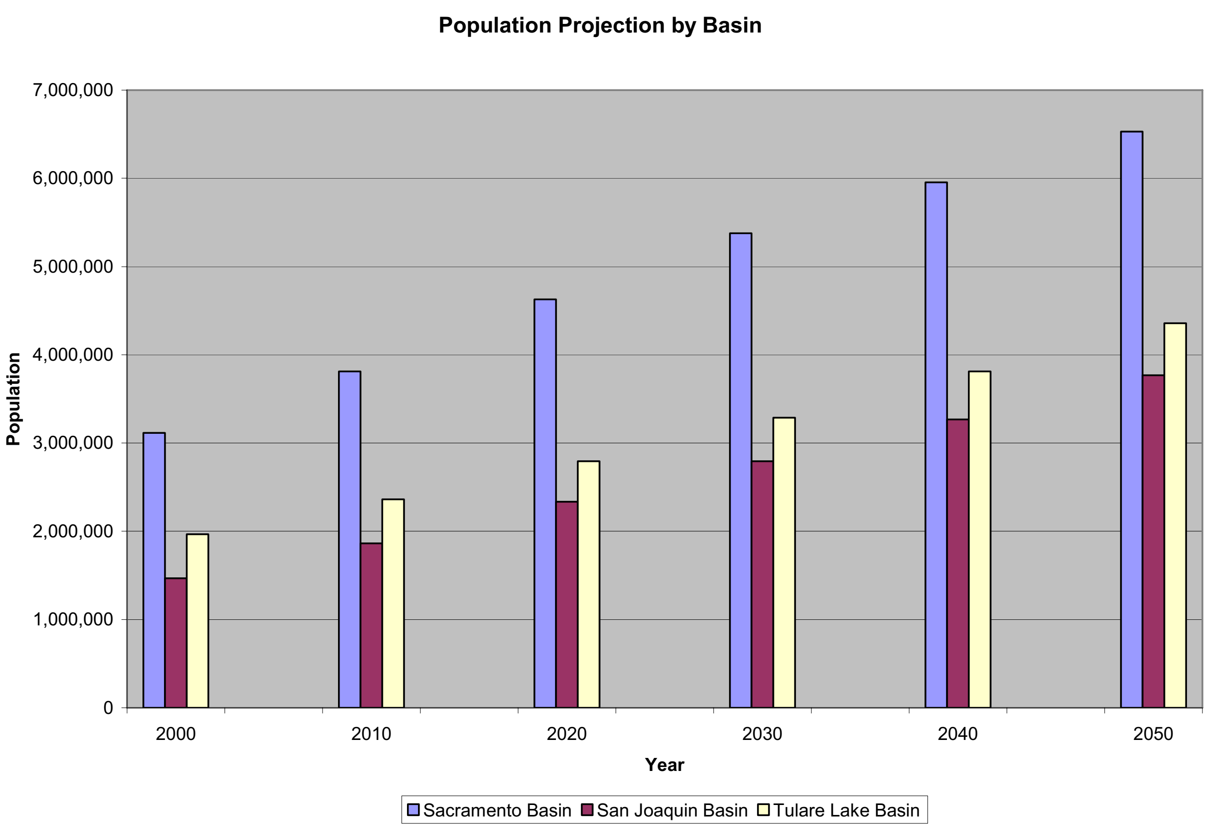

Figure 8. Population projection by Basin

Source: California Department of Finance.

Social, Economic and Environmental Factors

Social, economic and environmental aspects of the Central Valley are discussed to a limited degree in Appendix 8. Future work on salinity impacts will have to focus on these issues as part of the development of a salinity management plan.

Environmental Justice

California Government Code section 65040.12(4)(e) defines Environmental Justice as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies." CALEPA has issued guidance on how environmental justice concerns should be incorporated into State policies and programs (PRC section 71110-71113). Salinity impacts, unlike point source discharges, are experienced differently by different communities; primarily as a consequence of the hydrogeologic conditions in the community. Salinity impacts are not confined to the area of origin. For example, saline discharges in the Sacramento Basin can impact water users in the San Francisco Bay area, Bakersfield, Santa Barbara and Los Angeles. It is therefore important that a Salt Management Plan consider both the vulnerability of the physical setting and the fact that resource-impacted communities have to adapt to the situation. The physical setting is static, but resources can be redirected when necessary to allow impacts and the burden of impact mitigation to be distributed equitably.

The setting without mitigation (current situation)

Salinity and drainage are closely related. In general, agriculture supports the economies of the small Central Valley towns located in drainage-impaired areas. At this time, there are close to a half million acres considered to be impaired by drainage problems[10]. Little, if any data has been collected to quantify salinity impacts on these communities; however, as land loses productivity and production costs begin to outweigh potential farm profits, it is probable that communities will be affected by lost jobs, less spending power in the community, and a shrinking tax base. These effects could be offset if physical solutions are developed and implemented or if unproductive agricultural land were converted to some other income-producing use.

When agricultural land is phased out of production, the short-term changes to local economies are small and subtle. However, rapid loss of production, through land retirement or land abandonment, may have immediate repercussions. Over the long term, impacts due to the loss of agricultural production may begin to be felt over a larger area if no mitigation occurs, but it is possible that by the time the urban areas notice the decline, the smaller communities may have already lost any ability to recover. This, however, is speculation, based on the severity of short-term impacts that will hit small communities. When new industry or development comes to a region, it will generally locate near urban areas in order to secure a reliable pool of trained workers, equipment

[10] San Joaquin Valley Drainage Program, September 1990, *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley* (Rainbow Report) http://www.owue.water.ca.gov/docs/RainbowReportIntro.pdf

and supplies; and infrastructure and community services including public water, sewer lines, and proximity to major transportation corridors.

In 2003, Westland Water District issued a report on the anticipated economic effects if a proposal to retire 200 thousand drainage-impaired acres is implemented. In the short term, property tax revenues to local agencies were anticipated to decline for all communities in the study in King's and Fresno counties, but the losses ranged from negligible (0.4% to the Fresno County office of Education) to more than a quarter of total revenues (26.9% to Westside Elementary in the rural community of Five Points)[11]. The Westland land retirement proposal has not been implemented, but the loss of agricultural production due to salinity is expected to impact rural communities to a much greater degree than urban areas.

Next steps

A comprehensive Salinity Management Plan, including environmentally and economically sustainable solutions, will need to engage stakeholders in the affected areas to ensure that responsibility for salinity mitigation actions is shared equitably. Although time constraints have prevented ground-truthing of the preliminary information presented in this report, it appears that the most vulnerable areas may also be the areas with the fewest resources to adapt to changing land use and a changing economic base. Farm production is by no means the only sector that will be affected by salinity in rural areas. As farmland goes out of production, agricultural support industries such as farm supply businesses will also be impacted. As farm jobs decrease, other community businesses will be affected. Local governments will face decreasing tax revenues. Displaced farm workers may leave the area, further depressing the local economy; or they may seek non-agricultural work. Those staying may find only limited training opportunities.

Public Trust

The California State Lands Commission has authority over the State's public trust lands. The CSLC describes Public Trust Doctrine this way:

> *A State's title to its tide and submerged lands is different from that to the lands it holds for sale. "It is a title held in trust for the people of the State that they may enjoy the navigation of the waters, carry on commerce over them, and have liberty of fishing" free from obstruction or interference from private parties. In other words, the public trust is an affirmation of the duty of the State to protect the people's common heritage of tide and submerged lands for their common use*.

A Salinity Management Plan will need to be consistent with this doctrine.

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[11] Westlands Water District, *Analysis of Economic Impacts of Proposed Land Retirement in Westlands Water District*, May 2003, http://www.westlandswater.org/econreport/final2econreport.pdf?title=Analysis%20of%20Economic%20Impacts%20(Full%20Report)

4. Previous and Ongoing Efforts

The following sections briefly describe major projects and programs that address salinity in the Central Valley. Projects outside of the region are described in Appendix 1.

4.1. Interagency Drainage Program

A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley (Rainbow Report)
The 1990 Rainbow Report looked at drainage conditions in the San Joaquin Valley and presented a strategy for slowing the progression of drainage impairment due primarily to salt buildup in the basin. The report recommended institutional changes, source control, drainage reuse, evaporation systems, land retirement, groundwater management and controlled, limited discharge to the San Joaquin River to manage drainwater. (see Appendix 6)

2000 San Joaquin Valley Drainage Implementation Program (SJVDIP) Management Group's Evaluation of the Rainbow Report
The SJVDIP found that many of the recommendations of the Rainbow Report were being implemented, although not to the extent that had been anticipated in 1990. The group found that in addition to the 1990 recommendations, future drainage management decisions should consider technological advances in drainage treatment, successful mitigation habitat management strategies, salt utilization and potential benefits of land retirement beyond selenium control (habitat restoration, water transfers).

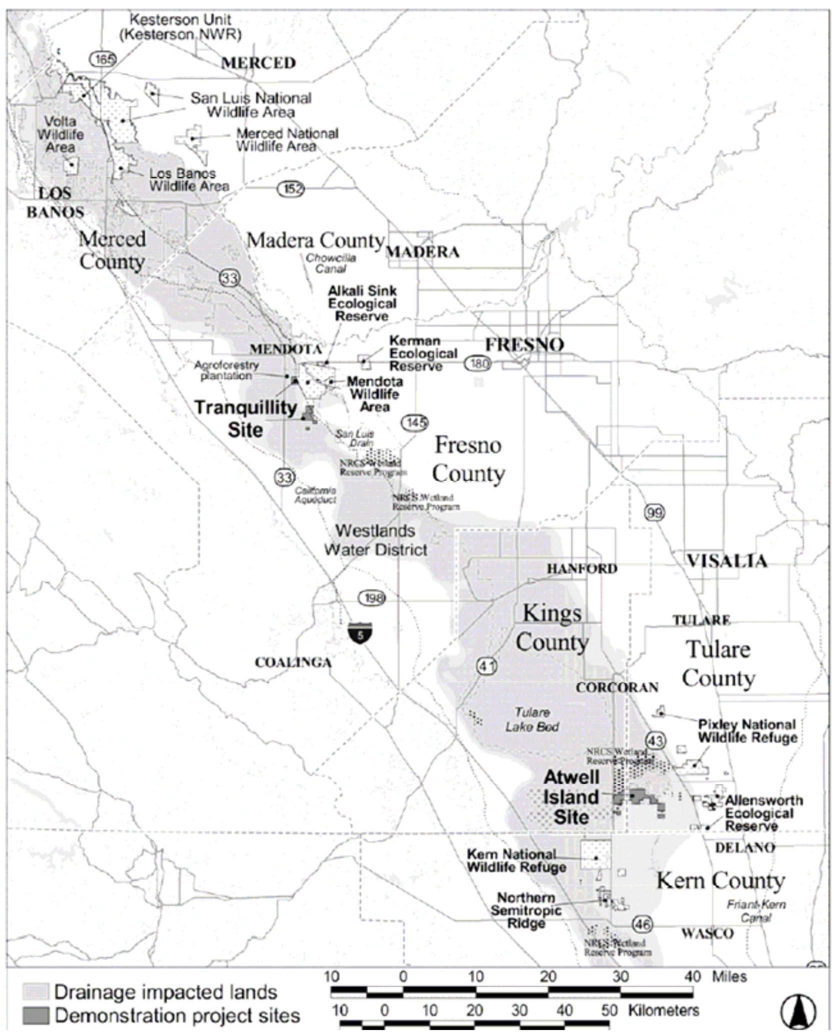


Figure 9. Drainage-impaired lands in the San Joaquin Valley.

4.2. University of California Salinity/Drainage Program

The UC Salinity/Drainage Program was initiated in 1985 to develop, interpret, and disseminate research knowledge addressing critical agricultural and environmental problems of salinity, drainage and toxic trace elements in the West Side of the San Joaquin Valley in California.

A major function of the UC Salinity/Drainage Program is to support research and extension activities that will contribute to developing optimal management strategies to cope with salinity/drainage/toxics problems in the western San Joaquin Valley. Funded research projects must be both relevant and scientifically sound. An external advisory committee evaluates the relevancy of research proposals.

4.3. SWRCB Technical Report on Agricultural Drainage to the San Joaquin River

In February 1985, the State Water Board adopted Order WQ85-1 to address the environmental impacts of selenium laden agricultural drainage water. This order created a technical committee to investigate water quality concerns related to agricultural drainage, including salinity. The committee produced a report that identified water quality concerns, and proposed recommended water quality objectives, effluent limits for agricultural discharges, and a proposal to regulate these discharges.

4.4. SWRCB Decision 1641: Implementation of Water Quality Objectives in the Bay-Delta

The references to salinity in the Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin appear in sections that have not been amended since 1995 or earlier. State Water Board Water Rights Decision 1641 (D-1641), which addresses the implementation of salinity and flow objectives in the Basin Plan, was adopted in December 1999, and revised in March 2000. The decision contains detailed findings and recommendations for managing flow and salinity in the Delta, focusing on measures that could be implemented in the near-term to mitigate the effects of saline drainage on the Delta, and indicating that long-term solutions would need to be developed. Primary responsibility for salinity impacts is assigned to the USBR, which operates the Central Valley Project (CVP). The decision states:

“[T]he actions of the CVP are the principal cause of the salinity concentrations exceeding the objectives at Vernalis. The salinity problem at Vernalis is the result of saline discharges to the river, principally from irrigated agriculture, combined with low flows in the river due to upstream water development.”

D-1641 also addresses the issue of flow for fisheries protection.

4.5. Bay Area Regional Recycling

The BARWRP is a partnership of 17 Bay Area water and wastewater agencies, DWR, and Reclamation. This partnership is committed to maximizing the beneficial reuse of highly treated wastewater to provide a safe, reliable, and drought-proof new water supply. The product of the BARWRP efforts is a comprehensive regional water recycling master plan released in September 1999. Past efforts evaluated the potential for using Bay Area recycled water in the Central Valley and disposal of Central Valley salts.

4.6. USBR Drainage Feature Reevaluation Draft EIS

The San Luis Unit is a Central Valley Project irrigation service area, located on the west side of the San Joaquin Basin. Much of the service area is underlain by shallow groundwater. Selenium in drainage is a major wildlife concern in this area so most of the SLU (Westlands Water District) does not discharge drainwater. At this time, 298 thousand acres are identified as drainage-impaired in the district, with a total of 379 thousand acres in the area projected to need drainage service. The Bureau of Reclamation has been directed to provide drainage service to the unit, and has released a draft Environmental Impact Statement outlining drainage alternatives. The alternatives include three out-of-valley options that would require construction of a conveyance channel to the ocean or the Bay-Delta, and four in-valley options, relying on a combination of treatment and reuse facilities, land retirement and evaporation basins for ultimate salt disposal. Bureau staff and others indicate that an in-valley alternative is favored, and at the Salinity and Drainage Annual Meeting in Sacramento 29 March 2006 USBR indicated that the maximum land retirement scenario (308 thousand acres) has been identified as the preferred alternative. The CVRWQCB is on record supporting an out-of-valley alternative. Regardless of the alternative chosen, the Bureau estimates that the cost to implement drainage service for the unit will be between $700 million and $950 million.

4.7. San Joaquin River Salt TMDL

The Central Valley Water Board adopted a Total Maximum Daily Load (TMDL) and control program for salt and boron in the lower San Joaquin River on 10 September 2004. The control program focuses on achieving existing water quality objectives in the lower San Joaquin River near Vernalis by allocating loads and responsibility to point and non-point dischargers and the United States Bureau of Reclamation (USBR) to comply with the objectives. The report also commits the Central Valley Water Board to establish salinity objectives in the San Joaquin River upstream of Vernalis.

4.8. CALFED

The CALFED Bay-Delta Program issued a Programmatic Record of Decision in August 2000 with a plan to address water supply reliability, water quality, ecosystem restoration, and levee system integrity. The water quality program included a number of actions related to salinity management, that fall into four broad categories:

- Enable users to capture higher quality Delta water for drinking water purposes.
- Reduce contaminants and salinity that impair Delta drinking water quality.

- Evaluate alternative approaches to drinking water treatment to address growing concerns over disinfection byproducts and salinity.
- Enable voluntary exchanges or purchases of high quality source waters for drinking water uses.

The 2004 California Bay Delta Authority Annual Report identified a number of activities related to salinity management. The annual report is available at: http://calwater.ca.gov/AboutCalfed/AnnualReport2004.shtml

4.9. San Joaquin River Water Quality Management Group

The San Joaquin River Water Quality Management Group is an informal group of stakeholders that are working together to develop cooperative solutions to achieve water quality objectives identified in Total Maximum Daily Loads (TMDLs) that have been developed by the Central Valley Regional Water Board. Compliance with salinity objectives is the primary objective of the group. Participants within the Group have tools, management strategies, and assets that can affect water quality in the River. These tools and assets include loading reductions but also include other alternatives that the Central Valley Regional Water Board has no ability to implement or regulate.

5. Basin Planning

It is the responsibility of the Central Valley Water Board to protect the uses of both the surface waters and groundwaters of the region. The uses of various waterbodies are specified in the Board's Water Quality Control Plans (Basin Plans). Not all waters have all of these uses and the sensitivity to salinity varies.

The beneficial uses of surface waters of the Central Valley are listed below.

Municipal and Domestic Supply
Agricultural Supply
Industrial Service Supply
Industrial Process Supply
Navigation
Water Contact Recreation
Non-contact Water Recreation
Warm Freshwater Habitat
Cold Freshwater Habitat
Wildlife Habitat
Migration of Aquatic Organisms
Spawning, Reproduction, and/or Early Development

Central Valley groundwaters have the following uses:

Municipal and domestic water supplies
Agricultural supplies.
Industrial service supply
Industrial process supply

The need to protect existing and potential beneficial uses of receiving waters is the basis for setting water quality objectives in the Water Quality Control Plans.

An updated program for addressing salinity would require amendments to the existing *Water Quality Control Plan for the Sacramento River and San Joaquin River Basins,* 4th edition; and *Water Quality Control Plan for the Tulare Basin,* 2nd edition (Basin Plans) as well as the State Water Resources Control Board' Bay-Delta Basin Plan. This is a lengthy, formal, public process that is considered functionally equivalent to the environmental impact assessment and reporting process under the California Environmental Quality Act (CEQA). Both CEQA and basin planning share fundamental characteristics, including requirements for economic consideration, solicitation of public comment and multi-agency review, and consistency with state programs and policies. Under CEQA, an Initial Study, environmental checklist and Environmental Impact Report or Negative Declaration are prepared, circulated for public and agency comment, and adopted and implemented. In order to amend a Basin Plan, a staff report, an environmental checklist, and an initial draft of the amendment are prepared, circulated for public and agency comment, revised if necessary, adopted by the Central Valley Water Board (for Central Valley Plans), approved by the State Water Resources Control Board, and approved by the Office of Administrative Law before the amendment takes effect. Some amendments must be reviewed and approved by the U.S. Environmental Protection Agency before becoming part of the water quality control plans required by the Clean Water Act.

The federal Clean Water Act requires states to adopt water quality standards for surface waters, hold triennial reviews to allow public input on the standards, and adopt numeric criteria for toxic substances. California has two entities performing these duties: the State Water Resources Control Board and the nine Regional Water Quality Control Boards. Authorization for the Central Valley Water Boards to meet Clean Water Act requirements through regional (basin) plans is found in the California Water Code (CWC), beginning with Section 13000 (Porter-Cologne Water Quality Control Act). The State Water Board's Administrative Procedures Manual spells out the requirements for statewide or regional water quality control plans. Amendments cannot cause the plan to violate these requirements. In summary:

- Plans must conform to the policies of Porter-Cologne

- Plans must identify existing and potential beneficial uses of the surface and groundwaters of the State.

- Plans must establish water quality objectives

- Plans must contain implementation programs, with a "*description of the nature of actions which are necessary to achieve the objectives, including recommendations for appropriate action by any entity, public or privat*e."(CWC Section 13242(a)); time schedule for implementation; and description of surveillance and monitoring that will allow verification of compliance with water quality objectives.

- Plans must be updated periodically

In addition to these administrative requirements, all amendments must be consistent with the State Water Board's anti-degradation policy (Resolution 68-16); aimed at maintaining existing high water quality, "*until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies.*" Plans and amendments must undergo peer review prior to adoption; and consult with "*other public agencies having jurisdiction with respect to the proposed activity (e.g., The DFG's authority under the California Endangered Species Act), and consultation with persons having special expertise with regard to the environmental effects involved in the proposed activity.*"

In addition to the State Water Board's requirements, basin plan amendments must be consistent with the Water Code and Clean Water Act. In particular, the Water Code requires that the Boards consider economics when they adopt water quality objectives, and determine the methods that are available to meet the objective and the cost of those methods. If the cost of compliance appears significant, the staff report will need to explain why the objective is necessary despite potential adverse economic consequences. The Clean Water Act requires that the change is protective of designated beneficial uses. State and federal policies require the Board to adopt and make changes to basin plans through a public process.

The Office of Administrative Law (OAL) reviews basin plan amendments for compliance with the standards of the Administrative Procedures Act (Government Code Section 11353(b)), including whether the action is necessary, clear and consistent with existing law and policy.

In short, a Basin Plan amendment updating the salinity control program can not be implemented until all of the aforementioned requirements have been met satisfactorily; and many of these procedural steps cannot occur until substantial technical work has been completed and evaluated. The Board has received comments to the effect that salinity control under existing regulations and permits should be put on hold while a comprehensive salinity policy is crafted. The approach being taken, articulated by Board Member Longley, is that existing regulatory efforts should continue; and, "*the Board should consider all possible interim approaches to continue controlling and regulating salts in a reasonable manner, and encourage all stakeholder groups that may be affected by the Central Valley Water Board's policy to actively participate in policy development*."

6. Conclusion

The purpose of this report was to provide a general overview, based on easily accessible information and data, of issues and concerns surrounding salinity in the Central Valley as they pertain to water quality. Its purpose was not to provide a comprehensive assessment of the salinity problem. Although there is much information and data available on the subject, it must be understood that it there is no central repository for this information and data, and it has been a difficult task in the time allotted to gather this information from the many sources where it exists and compile it into an adequate and cohesive summary report.

In addition, there is much that is not known about the nature and extent of salinity impacts in the Central Valley. The first task that must be undertaken in order to create a long-term salinity management plan for the Valley is to compile, review, and analyze as much of the existing relevant information and data as possible, and identify informational and data gaps, with the goal of initiating a comprehensive study and evaluation of the nature and extent of the problem and an assessment of the potential impacts that saline waters will have on our future. This may appear to be, and in many ways will be, a daunting task. However, it is an extremely important task if we are to develop an adequate understanding of the problem we are facing and develop a reasonable and appropriate plan to deal with it.

7. Appendix 1.
Selected Salinity Control Efforts Outside of the Central Valley

SOUTHERN CALIFORNIA SALINITY COALITION

The following information is taken directly from the Coalition's web site:

"The Southern California Salinity Coalition was formed in 2002 to address the critical need to remove salt from water supplies and to preserve water resources in California.

The non-profit organization is administrated by NWRI and is composed of the following member agencies:

Central and West Basins Municipal Water Districts

Inland Empire Utilities Agency

Irvine Ranch Water District

Los Angeles Department of Water and Power

Metropolitan Water District of Southern California

Orange County Sanitation District

Orange County Water District

San Diego County Water Authority

Sanitation Districts of Los Angeles County

Santa Ana Watershed Project Authority

What is Salinity?

Throughout history, salinity has threatened mankind's existence. Ancient civilizations disappeared as salt poisoned their land and water. Today, salinity increases are silently choking off our water supply while draining away hundreds of millions of dollars in salinity damages each year.

The most under-recognized water-quality problem in California is salinity. Referred to as TDS, salinity is the concentration of dissolved salts in water. Salts are added to water supplies by consumers, irrigated agriculture, confined animal waste practices, and other human, industrial, and natural processes.

Salt accumulation can degrade water quality, limiting the use of water for agricultural, industrial, municipal, and other purposes.

The resulting financial impact on the nation is enormous. In the Lower Colorado River Basin alone, the Bureau of Reclamation estimates that the economic damage of salinity to the Colorado River has reached over $350 million a year.

Building the Coalition

The Southern California Salinity Coalition was formed to address the critical need to remove salt from water supplies and to preserve valuable water resources.

The Coalition's purpose is to coordinate salinity management strategies, including research projects, with water and wastewater agencies throughout Southern California.

OBJECTIVES

- Establish proactive programs to address the critical need to remove salts from water supplies
- Preserve, sustain, and enhance the quality of source water supplies
- Support economic development
- Help drought-proof the community
- Reach out to the general public on salinity problems

CRITICAL ISSUES

- Desalting
- Groundwater Basin Cleanup
- Brine Disposal
- Wastewater Systems
- Watershed/Source Control
- Ensure Sustainability of Supplies
- Research and Development Programs

The Benefits of Reducing Salinity

Salinity impacts residential, commercial, industrial, and agricultural water users, groundwater, wastewater, and recycled water resources, and utility distribution systems. When salinity levels of imported water are reduced, the region benefits from both the improved use of local groundwater and recycled water and the reduced costs to water consumers and utilities. A 100 milligram per liter (mg/L) salinity decrease in imported water would result in $95 million per year of economic benefits. Similarly, a 100 mg/L reduction in salt content in groundwater would lead to $65 million per year of economic benefits.

Salinity reduction and the resulting improved water quality would provide the following possible benefits:

- Reduced costs to water consumers and utilities.
- Millions of dollars saved in damages to pipes, faucets, washing machines, dish washers, water heaters, and other appliances.
- Increased crop yields.
- Improved consumer confidence.
- Decreased desalination and brine disposal costs.
- Reduced salt build-up in groundwater.
- Improved aesthetic quality for public consumers.

The Benefits of Working Together

Together, we can combat salinity by:

- Providing a unified voice to represent salinity concerns.
- Enhancing cooperation and coordination of regional, State, and federal agencies.
- Organizing public workshops and technical sessions to provide informational exchanges.
- Funding salinity-related research and programs.

If you would like to join the Southern California Salinity Coalition in its fight against salinity, by either becoming a member or by conducting salinity-related research, please email SOCALSALINITY@nwri-usa.org or call NWRI at (714) 378-3278."

SANTA ANA WATERSHED PROJECT AUTHORITY (SAWPA)

The Santa Ana River watershed is home to over 5 million people in southern California, and within the next 50 years, the region's population is projected to grow to almost 10 million people. This growth will certainly accelerate the pressures already on the region's limited water resources. The Santa Ana Watershed Project Authority, or SAWPA, has supported its five member water agencies and various stakeholder groups throughout the watershed including the Santa Ana Regional Water Quality Control Boards (RWQCB) with developing and implementing a plan to ensure that there is sufficient clean water to support all the water needs of the watershed into the future.

The Santa Ana River watershed catches stormwater draining a 2,650 square-mile area and channels it into the Pacific Ocean at the City of Huntington Beach. The Santa Ana River, flowing over 100 miles, drains the largest coastal stream system in Southern California including parts of Orange, Riverside, and San Bernardino Counties, as well as a sliver of Los Angeles County. The total length of the River and its major tributaries are about 700 miles.

Litigation of water use and rights has a long history within the Santa Ana River system. Early judgments and agreements preceding 1960 were primarily concerned with quantity of water. During the mid-1960's, Orange County Water District filed a lawsuit entitled, "Orange County Water District vs. City of Chino, et al. This complaint involved several thousand defendants in Riverside and San Bernardino Counties and hundreds of cross-defendants in Orange County. The defendants and cross-defendants included substantially all water users within the Santa Ana Watershed. Defense of the litigation in the Riverside/San Bernardino County areas was coordinated through the Chino Basin Municipal Water District, Western Municipal Water District, and San Bernardino Valley Municipal Water District, public agencies overlying substantially all of the major areas of water use within the upper basin.

On April 17, 1969, a stipulated judgment was entered in the case, which provided a physical solution by allocation of obligation and rights to serve the best interest of all water users in the watershed. Orange County Water District, Chino Basin Municipal Water District, Western Municipal Water District and San Bernardino Valley Municipal Water District were deemed to have the power and financial resources to implement the physical solution. The stipulated judgment provided for dismissal of all defendants and cross-defendants except for the four districts providing certain parties stipulated to cooperate and support the physical solution. The physical solution provided that water users in the Orange County area have rights, as against all upper basin users, to receive an annual average supply of 42 thousand acre feet of base flow at Prado, together with the right to all storm flow reaching Prado Dam. Lower basin users may make full conservation use of Prado Dam and reservoir subject to flood control use. Water users in the upper basin have the right to pump, extract, conserve, store and use all surface and groundwater supplies within the upper area, providing lower area entitlement is met.

The judgment further provided for adjustment to base flow (that portion of total surface flow passing a point of measurement, which remains after deduction of storm-flow) based on water quality considerations. As a result of the litigation and stipulated judgment to ensure the supply of good quality water to Orange County, the four remaining defendants and cross-defendants (CBMWD, WMWD, SBVMWD and OCWD) determined that planning the use of water supplies in the watershed would be beneficial to all users.

SAWPA, the ***Planning Agency***, was formed in 1968 as a joint exercise of powers agency. Its members were the four water districts who have the primary responsibility of managing, preserving and protecting the groundwater supplies in the Santa Ana Basin. These districts formed SAWPA because they foresaw a threat to the water supplies that is larger than any one of the districts could cope with alone - the threat of pollution. They foresaw the possibility that pollution by mineral salts and other pollutants could pose a greater danger to the basin than even overdraft. They suspected that if programs and projects were not implemented to control this problem, there could be a gradual accumulation of pollutants in the basins that would be almost impossible to clean up, causing a total loss of the usefulness and value of the basins.

Identifying the problems

Water quality degradation due to high concentrations of nitrogen and total dissolved substances (TDS) is among the most significant regional water quality problem in the Santa Ana River Watershed. Historically, the Santa Ana River and its major tributaries likely flowed during most of the year, recharging deep alluvial groundwater basins in the inland valleys and the coastal plain. However, irrigation projects eventually led to the diversion of most of the streams tributary to the river, and the quantity of groundwater recharge diminished greatly. Diverted stream flows were used to support extensive irrigated agriculture operations, principally citrus orchards that were also reliant on the use of nitrogen fertilizers to sustain crop yields. As a consequence of these historic practices, water quality issues in the Santa Ana River Watershed have often revolved around elevated concentrations of TDS and total inorganic nitrogen (TIN). Water from the Santa Ana River is used multiple times as it moves downstream through the watershed. Each cycle of use adds an increment of salt, whether through addition of soluble materials as a result of consumptive use, or though evaporation and evapotranspiration. Typically, each use adds 200-300 parts per million (ppm) or milligrams per liter (mg/L) of TDS. The high concentration of dairies in the Chino Basin, and other factors, has resulted in a situation that goes beyond the compliance problems of individual dairies, and extends to the local dairy industry as a whole. Increased herd size, lack of sufficient land to dispose of dairy wastes and dairies being flooded by storm water runoff from urbanized communities in the upslope areas of the Chino Basin have resulted in the need to explore and develop regional solutions to the water quality problems associated with the Chino Basin dairies. In addition to its regulatory program for individual dairies, the Santa Ana Water Board is working with other public agencies and dairy industry organizations to identify and implement regional solutions to these problems.

SAWPA's first task was to characterize the problem and make projections of what the future might hold if nothing were done. To aid in this effort, sophisticated mathematical models of the basins were used. The projections supported the fears of the water districts. It was clear that something had to be done.

As a next step, SAWPA, in the early 1970's, developed a long-range plan for the entire Santa Ana Watershed. The plan included both regulatory programs and projects. The regulatory portion was recommended **to** the Regional Water Quality Control Board and has largely been adopted in the form of standards by that agency. The projects include some to be implemented by the individual districts, some by the State of California, some by the Metropolitan Water District and some by SAWPA. In total, they will result in a much safer water supply in the long term. That plan, completed in 1972, identified twelve major project areas of need. Of the identified areas, four were such that their impact overlapped more than one member district.

In 1974, upon completion of the Planning Agency work program, the ***Santa Ana Watershed Project Authority*** was created and empowered to develop, plan, finance, construct and operate programs and projects related to water quality-quantity control and management, resulting in pollution abatement and protection of the Santa Ana watershed. The original member districts were Chino Basin Municipal Water District (later renamed Inland Empire Utilities Agency), Western Municipal Water District, San Bernardino Valley Municipal Water District and Orange County Water District. Eastern Municipal Water District subsequently joined in 1984.

Degradation of water quality at Prado Dam due to nitrogen (often expressed as Total Inorganic Nitrogen, or TIN) was first observed in the mid-1980s. A significant increasing trend in concentrations was observed and it was recognized that the nitrogen wasteload allocations specified in the 1983 Basin Plan were no longer adequate. The Santa Ana Water Board derived a new nitrogen allocation, using computer modeling, and recommended that POTW discharges be limited to 10 mg/L TIN. However, POTW dischargers argued that additional studies were required to verify the Santa Ana Water Board's analysis.

In early 1988, a Nitrogen Task Force was formed to finance and oversee these studies, and its scope of work was broadened to include TDS and groundwater. In the interim, the Santa Ana Water Board adopted a WQO of 10 mg/L TIN for new discharges, while requiring existing discharges to conform to their 1987 July-September average TIN concentrations. The studies conducted by the nitrogen task force were used in developing the 1995 Basin Plan.

A TIN /TDS Task Force was formed in 1995 to provide funding, oversight, supervision, and approval of a study to evaluate the impact of Nitrogen and TDS on water resources in the Santa Ana River Watershed. The study was coordinated by SAWPA, and

investigated questions related to nitrogen and TDS management in the watershed, including groundwater sub basin water quality objectives, sub basin boundaries, and regulatory approaches to wastewater reclamation and recharge
.

Members of the TIN/TDS Task Force

Chino Basin Water Conservation District Jurupa Community Services District
Chino Basin Watermaster Orange County Sanitation District
City of Colton Orange County Water District
City of Corona Santa Ana Regional Water Quality Control Board
City of Redlands Riverside-Highland Water Company
City of Rialto San Bernardino Valley Municipal Water District
City of Riverside San Bernardino Valley Water Conservation District
City of San Bernardino Santa Ana Watershed Project Authority
Eastern Municipal Water District,– Advisory Member
Elsinore Valley Municipal Water District West San Bernardino County Water District
Inland Empire Utilities Agency Yucaipa Valley Water District

The study findings recommended changes in groundwater water quality objectives and sub basin boundaries that would substantially affect management of water quality throughout the entire Santa Ana River. Basin Plan amendments to incorporate these changes were considered by the region's stakeholders and the Santa Ana Water Board in a series of workshops and hearings. In January 2004, the Santa Ana Water Board adopted Basin Plan amendments that revised TDS and TIN objectives and created groundwater management zones over large parts of the region.

JOINT POWERS AUTHORITY

SAWPA as a public agency enpowered to develop, plan, finance, construct and operate programs and projects related to water quality-quantity control and management, resulting in pollution abatement and the protection of the Santa Ana Watershed. SAWPA activities and responsibilities include, but are not limited to the following:

(a) Water quality control.
(b) Protection and pollution abatement in the Santa Ana Watershed, including development of waste treatment management plans for the area within the watershed.
(c) The construction, operation, maintenance and rehabilitation of works and facilities for the collection, transmission, treatment, disposal and/or reclamation of sewage, wastes, wastewaters, poor quality ground waters and stormwaters.
(d) The construction, operation, maintenance and rehabilitation of projects for irrigation, municipal and industrial supplies.
(e) Projects for aquifer rehabilitation.
(f) Projects for reclamation, recycling and desalting of water supplies for irrigation, municipal and industrial purposes.

The determination to utilize a Joint Exercise of Powers as the operating authority for the agency, included the recognition that at some future date, SAWPA should become an independent agency. It was felt by those involved that the Joint Exercise of Powers afforded an opportunity to establish the agency, make modification, if necessary, at the local level and once the Authority proved acceptable and capable of performing its functions and duties, a bill would be submitted to the legislature to implement the program as an independent self-governing Authority.

Under its enabling contract documents, SAWPA has authority to exercise the common powers of its member agencies. Some of these powers are:
(a) To make and enter contracts.
(b) To employ staff and consultants.
(c) To acquire, construct, manage, maintain and operate building, work or improvements.
(d) To incur debt, liabilities or obligations.
(e) To issue bonds, notes, warrants or other evidence of indebtedness to finance cost and expenses incidental to agency projects.

Implementation

Implementation of some projects such as the Santa Ana Regional Interceptor (SARI) required that SAWPA contract with other public agencies. In the case of SARI in 1972, SAWPA contracted with the County Sanitation Districts of Orange County for Interceptor Treatment and Disposal Capacity in their system. In addition to implementing the various projects, SAWPA has a coordination role to assure that all of the various parts of the plan are moving ahead.

Major efforts to address the salt balance problem include the Santa Ana Water Board’s program of regulating TDS levels in waste discharges, import and recharge of large volumes of low-TDS -water from the SWP, construction of the Santa Ana River Interceptor (SARI) Line to export high TDS wastes from the upper Santa Ana River Basin, and operation of groundwater desalting facilities that extract high-TDS groundwater, remove excessive TDS, export the resulting brine via the SARI Line, and provide water supplies with lowered TDS levels. In 2000, the Santa Ana Watershed Project Authority (SAWPA) began operating a 9 million-gallon per day groundwater desalter in the Chino Basin. Another 8 million-gallon per day groundwater desalter will be operational by 2004. The goal is to have over 40 million gallons per day of groundwater desalting capacity in the Chino Basin by 2020. Other desalters include SAWPA’s Arlington Desalter, operating since 1990, the City of Corona’s Temescal Basin Desalter, operating since 2002, and Eastern Municipal Water District’s Sun City Desalter, operating since 2003. Eastern MWD has plans for two more desalters in the Menifee area.

The Implementation chapter of the 1983 Basin Plan focused largely on the mineral imbalance problem in the region and the management of total dissolved solids (TDS) through WDRs, wastewater reclamation requirements, improvements in water supply quality, recharge projects, and other measures. Since the adoption of the

1983 Basin Plan, the Santa Ana Water Board's knowledge of the water quality problems in the Santa Ana Region has increased considerably, and the number and variety of water quality programs undertaken to address those problems have increased accordingly.

1. Prohibitions Applying to Ground waters
The discharge of the following materials to the ground, other than into impervious facilities, is prohibited : a. Acids or caustics, whether neutralized or not, and b. Excessively saline wastes (EC greater than 2000 μS/cm)

2. Prohibitions Applying to Subsurface Leaching Percolation Systems
In 1973, the Santa Ana Water Board adopted prohibitions on the use of subsurface disposal systems in the numerous areas.

Computer Simulation of the Basin

The Basin Planning Procedure, or BPP, is used to project the quality and quantity of ground waters in the basin given various assumptions about the ways water is supplied and used, and how wastewater is managed. A complex set of data goes into the BPP, including: current and projected land use information and associated salt loads; population estimates; the location, quantity, and quality of waste discharges; the quantity and quality of water supply sources which are or will be used in the area; data on hydrology, including rainfall and deep percolation of precipitation into underlying groundwater; etc. This and other information is integrated into the BPP to make projections of future quality in each groundwater sub basin. For the upper Santa Ana Basin, the BPP also provides data on the location, quality, and quantity of groundwater which rises into the Santa Ana River and becomes part of the River's surface flows. The BPP projects where water quality problems will arise unless changes in water quality management are made. Such changes can include revisions in the requirements governing waste discharges, changes in water supply sources and quality, and the implementation of special projects or programs.

Recommended TDS/Nitrogen Management Plan - Upper Santa Ana Basin

The Recommended TDS/Nitrogen Management Plan (Recommended Plan) is a composite of plans, projects, assumptions, ongoing programs, and projections, and is therefore very difficult to define succinctly.

Included are summary descriptions of the following elements:

A. Water Supply Plan
B. Wastewater Management Plan
C. Groundwater Management Plan

Waste load Allocations for the Santa Ana River

Waste load allocations for discharges of TDS and nitrogen to the Santa Ana River are another important component of the wastewater management plan for the upper Santa Ana Basin. As described earlier, the Santa Ana River is a significant source of recharge to the Orange County groundwater basin. Therefore, the quality of the River has a significant effect on the quality of that groundwater and must be properly controlled

Groundwater Management Plan

The programs of groundwater extraction, treatment, and replenishment needed to completely address these historic salt loads far exceed the resources available to implement them. However, it is expected that desalters and other types of recharge and remediation programs beyond those now included in this Recommended Plan will be developed and implemented. Such projects are expected to be increasingly important to protect local water supplies and to provide supplemental, reliable sources of potable supplies.

Funding

The year 2000 estimate for the complete 10-year SAIWP program **is $3 billion dollars**. Through the efforts and planning foundation of the SAIWP, SAWPA has been remarkably successful in moving rapidly into project implementation since the passage of the Proposition 13 Water Bond by the State in March 2000. This includes contracting with the State Water Board to use $235 million in Proposition 13 Water Bond funds, matched with over $565 million local agency funds, to construct over $800 million in projects that directly support the SAIWP. Under an agreement with the SWRCB, SAWPA manages the implementation of 23 projects in the Southern California Integrated Watershed Program (SCIWP). These projects include activities as diverse as the development/improvement of desalters, the creation of groundwater recharge spreading basins, and the removal of *Arundo donax*, a very thirsty invasive species that is found all along the course of the Santa Ana River and its tributaries. Together these projects have generated approximately 300 thousand acre-feet of new water supply for the region at a cost to the State of less than $100 per acre-foot. Long term, the IWP proposes to store upwards of 1 million acre-feet of new water supplies sufficient to withstand a three-year drought without having to import water. SAWPA's role in the management of this effort is defined by 10 tasks:

1. Stakeholder Activities
2. CEQA and SCIWP Review,
3. Project Development,
4. Contract Development and Approval
5. Program Management
6. Budget and Schedule Aggregation
7. Financial Management
8. Project Closeout
9. Environmental Program

10. Project Management and Administration.

A summary of the SCIWP grant funds, anticipated benefits and schedules for each approved project is shown in Table 1-1. In addition, Table 1-1 presents a summary of the allocation of Proposition 13 funding, new water supply projection, and cost to the State to produce an acre-foot of new water. A number of SCIWP projects have received achievement awards from several professional organizations. The following is a list of awards received:

Table 1-1: SCIWP Projects: SOUTHERN CALIFORNIA INTEGRATED WATERSHED PROGRAM

No.	Agency	Project	Prop 13 Funds	Local Funds	New Water (Ac-Ft)	SCIWP $ per Ac-Ft
4	City of Norco	Recycled Water Piping	$ 450,000	$ 282,000	900	$ 25
5	Eastern Municipal Water District	4.5 MGD Perris Desalter	$ 15,150,000	$ 5,100,000	4,000	$ 189
13	Eastern Municipal Water District	San Jacinto Water Harvest Project	$ 525,000	$ 225,000	320	$ 82
16-A	SAWPA Environmental/Habitat Program	Arundo Removal Program	$ 17,745,000	$ 80,000,000	10,000	$ 89
49	San Gorgonio Pass Agency	Recharge Basins	$ 850,000	$ 280,000	3,000	$ 14
50	Orange County Water District	GWRS	$ 37,000,000	$ 319,000,000	78,400	$ 24
55	City of Redlands	Recycled Water and Desalting	$ 5,000,000	$ 10,500,000	9,500	$ 26
58	Western Municipal Water District	Agricultural Water Conveyance	$ 7,425,000	$ 2,451,000	6,000	$ 106
59	Western Municipal Water District	MARB Wastewater Reclamation	$ 2,925,000	$ 966,250	1,000	$ 146
60	Western Municipal Water District	MARB Groundwater Recovery	$ 765,000	$ 257,000	300	$ 128
62	City of Riverside	Canal Reconstruction	$ 5,250,000	$ 1,750,000		
64	Rubidoux Community Services District	La Verne WTF Expansion	$ 450,000	$ 150,000	3,600	$ 6
68	Chino Basin Desalter Authority	Chino I Expansion, Chino II Desalters	$ 48,000,000	$ 14,338,000	15,400	$ 159
70	San Bernardino Valley MWD	Central Feeder	$ 14,000,000	$ 9,200,000	30,000	$ 23
71-A	San Bernardino Valley MWD	High Groundwater Pumpout (Phase I)	$ 4,465,000	$ 2,066,421		
71-B	San Bernardino Valley MWD	High Groundwater Pumpout (Phase II)	$ 6,535,000	$ 5,233,579	20,000	$ 16
77	Jurupa Community Services District	Chino I-II Desalter Inter-tie	$ 1,000,000	$ 200,000		
83	Yucaipa Valley Water District	Non-Potable Water Distribution System	$ 6,000,000	$ 9,748,000	2,800	$ 107
87	San Bernardino County Flood Control	Riverside Dr Storm Drain Segment 2	$ 4,700,000	$ 5,600,000		
88	Riverside County Flood Control	County Line Channel	$ 6,300,000	$ 7,830,000		
98	OCWD	Dairy Wash Water Treatment Project	$ 60,000	$ 290,000		
99	Inland Empire Utilities Agency	Chino Basin Recharge Fac Improvements	$ 19,000,000	$ 28,000,000	100,000	$ 10
100	PA 9 SAWPA	Arlington Desalter	$ 8,000,000	$ 2,667,000	6,400	$ 63
	PA 9 SAWPA	Arlington Bridge - Pending $2M Modification	-na-	-na-		
101	SAWPA Environmental/Habitat Program	Irvine Ranch Water District Natural Treatment System	$ 4,605,000	$ 2,395,000		
	SAWPA	Program Management, 2%	$ 4,700,000	-na-		
	SWRCB	Administration, 3% per Water Code	$ 7,050,000	-na-		
	SWRCB	Proposed Additional SWRCB Administration Fee	$ 7,050,000	-na-		
		Total:	$ 235,000,000	$ 508,529,250	291,620	

Summary

SAWPA's role is recognized by the Central Valley Water Board, the State Water Board, the U.S. EPA and other agencies. In general, it can be accurately said that the Basin Plan for the Santa Ana Basin is the most comprehensive water quality protection program of any river basin in the world, largely because of the active, ongoing interest and participation by the member water districts.

METROPOLITAN WATER DISTRICT SALINITY MANAGEMENT STUDY

Metropolitan Water District of Southern California (MWD) conducted the Salinity Management Study (Study) in close collaboration with member agencies and numerous other concerned agencies. The USBR was the primary study partner, contributing financial assistance to develop a regional water-recycling plan for Southern California, because high salinity is a significant constraint to water recycling.

The Executive Summary clearly states that the benefits of reduced salinity, when salinity levels of imported water are reduced, the region benefits from:

- Improved use of local groundwater and recycled water
- Reduced costs to water consumers and utilities.

The 1999 Study estimated that $95 million per year of economic benefits would result if the Colorado River Aqueduct (CRA) and SWP waters were to simultaneously experience a 100 milligram per liter (mg/L) reduction in the salt content over their historic average.

About half the region's salt is contributed by imported water; the other half comes from local sources. Of the imported waters the CRA constitutes Metropolitan's highest source of salinity, averaging 700 mg/L. The SWP provides water of lower salinity, on average 25% to 50% less than imported CRA supplies. Unfortunately, SWP salinity levels can change rapidly in response to hydrologic conditions, and such changes are noticeable and disruptive as compared to the very gradual, almost imperceptible changes that occur in local streams, groundwater and wastewater collection systems. A Bay-Delta solutions are still being looked at that could lower SWP salinity and reduce its short-term variability.

Local Salinity sources include naturally occurring salts, salts added by urban water users, infiltration of brackish groundwater into sewers, irrigated agriculture, and confined animal waste management practices.

Metropolitan Water District of Southern California (MWD), United States Department of Interior – Bureau of Reclamation (USBR), 1999. SALINITY MANAGEMENT STUDY, Final Report

COLORADO RIVER BASIN SALINITY CONTROL PROGRAM

The Colorado River Basin Salinity Control Program (Program) is a cooperative watershed effort between several federal agencies and seven states designated to meet national, international and state water quality objectives. The Colorado River drains 246 thousand square miles of the western United States and a small portion of northern Mexico. Its waters serve some 7.5 million people within the United States' portion of the Colorado River Basin, and through export provides full or supplemental water supply to another 25.4 million people outside the basin The river carries an average salt load of approximately nine million tons annually past Hoover Dam. The salts in the Colorado River system are naturally occurring, pervasive, rocks easily eroded, dissolved, and transported into the river system. In Arizona, California and Nevada, economic damages have been reduced to about $300 million per year, accomplished at a funding level of about $24 million per year from federal sources and $10 million from Colorado River Basin state funds. The Forum selected three numeric criteria stations on the main stem of the lower Colorado River: Below Hoover Dam 723 mg/L, below Parker Dam 747 mg/L, at Imperial Dam 879 mg/L. The salinity concentrations that are anticipated in the future, even without salinity control efforts, have not been shown to have adverse effects on human health or wildlife. Thus, the Colorado River Salinity Control Program is different from most other water quality standards compliance programs. With respect to federal funding for the Colorado River salinity control program, the goal is to help secure the Forum's estimated funding of federal agencies necessary to maintain salinity at or better than the numeric criteria through year 2015:

- Bureau of Reclamation - $17.5 million/year;
- USDA - $12.0 million/year; and
- BLM - $5.2 million/year

8. Appendix 2.
Central Valley Project Delivery Descriptions and Categories

Source: USBR, 2006

Sacramento River Basin

Tehama-Colusa Canal Deliveries

Miscellaneous Water Users
Colusa County WD
Cortina WD
Davis WD
Dunnigan WD
4-M Water District
GCID
Glenn Valley WD
Glide WD
Holthouse WD
Kanawha WD
Kirkwood WD
La Grande WD
Myers-Marsh MWC
Orland-Artois WD
Westside WD

Sacramento River Deliveries

Miscellaneous Water Users
Anderson Cottonwood ID
Andreotti, Arthur, et al
Baber, Jack, et
Carter, Jane
Carter MWC
Colusa IC (King & Dommer)
Colusa Prop. Inc
Conaway Conservancy Group
Davis Ranches
East Side MWC
Forry, Laurie
Forster, Rosemary
Furlan Joint Venture (Area #1)
Furlan Joint Venture (Area #2)
Glenn-Colusa ID
Green Valley Corp.

Griffin & Prater, TIC
Henle Family Limited Partnership
Hershey Land Co
Hiatt, Glenn
Hollins, Mariette B
Howald Farms
Knaggs Walnut Ranches Co, L.P.
Lockett, William P.
Loma Cold Storage/J Micheli
M&T Inc.
Maxwell ID
MCM Properties, Inc
Mehrhof & Montgomery
Meridan Farms WC
Natomas Central MWC
O'Brien, Janice
Odyesseus Farms
Oji Bros. Farms Inc
Oji, Mitsue Family PTN
Pelger Mutual WC
Pleasant Grove-Verona MWC
Princeton,-Codora-Glenn ID
Provident Irrigation District
Reclamation Dist #1004
Reclamation Dist #108
Reynen, John, et al
River Garden Farms
Roberts Ditch Irrigation Co
Sacramento River Ranch, LLC
Siddiqui, J&A & Siddiqui Family
Spence, Ruth Ann
Sutter Mutual WC
Tarke, James, et al
Tisdale Irrigation & Drain
Wallace Construction, Inc.
Wells, Joyce M
Wilson Ranch Partnership
Windswept Land & Livestock Co.

San Joaquin River Basin

<u>San Joaquin River-Mendota Deliveries</u>

Miscellaneous Water Users
Fresno Slough WD
Hughes, Melvin

James ID
Laguna WD
Coelho-Gardner-Hanson
Mid-Valley WD (no contract)
Reclamation 1606
Terra Linda (Goodman)
Tranquility ID
Wilson, JW (no contract)

Exchange Contractors
Central California ID
Columbia Canal Co
Firebaugh Canal Co
San Luis Canal Co

Wetlands
Grassland WD
US F&WS - Kesterson
State F&WS - Kern National
State F&G - Water Fowl District
DFG Traction Ranch – Mendota Pool
Delta Mendota Canal Deliveries

Miscellaneous Water Users
Banta Carbona ID
Broadview WD
CCID (Abv CK 13)
CCID (Blw CK 13)
Centinella WD
China Island (76.05)
Del Puerto WD
DWR Intertie @MP7.70-R
Eagle Field WD
Firebaugh Canal
Frietas Unit (76.05L)
Mercy Springs WD
Newman Wasteway Recirculatio
Oro Loma WD
Panoche WD - Ag
Panoche WD - M&I
Patterson WD
Plainview WD
Salt Slough Unit (76.05L)
San Luis WD - Ag
San Luis WD - M&I
Tracy, City of

West Side ID
Widren
W. Stanislaus ID

Wetland
F&G - Los Banos Ref. 76.05L
Volta Wildlife Mgmt Area (F&
Grasslands WD -76.05L
Grasslands WD - Volta
F&W (Volta) Santa Fee Kest.
F&W - Kesterson 76.05L

Madera-Millerton Deliveries

Madera Canal
Chowchilla WD
Madera ID
Soquel

Millerton Lake
County of Madera
Fresno County # 18
Gravelly Ford WD

Tulare Lake Basin

Friant-Kern Deliveries

Miscellaneous Water Users
Alpaugh ID
Arvin-Edison WSD
Atwell Island WD
Corcoran ID
Delano-Earlimart ID
Exeter ID
Frasinetto Farms (Frmly S
City of Fresno
County of Fresno SA #34
Fresno ID
Garfield WD
Hills Valley ID
International WD
Ivanhoe ID
Kaweah Delta WCD
Kern County Water Agency

Kern-Delta
Kern-Tulare WD
Kings County WD
Kings River CD
Lakeside WD
Lewis Creek WD
Lindmore ID
City of Lindsay
Lindsay-Strathmore ID
Wutchumna (LSID non-proje
Lower Tule River ID
North-Kern WSD
City of Orange Cove
Orange Cove ID
Pixley ID
Porterville ID
Rag Gulch WD
Rosedale Rio Bravo WSD
Saucelito ID
Semitropic WSD
Shafter Wasco ID
Southern San Joaquin MUD
Stone Corral ID
Strathmore PUD
Styro Tek, Inc.
Tea Pot Dome WD
Terra Bella ID
Tri-Valley WD
Tulare ID
Tulare Lake Basin WSD

San Luis-Cross Valley Canal Deliveries
San Luis Canal
City of Avenal
Broadview WD
City of Coalinga
City of Dos Palos
City of Huron
Pacheco WD
Pacheco CCID Non-project (Hamburg)
Panoche WD
San Luis WD
Westlands WD (Federal)
Fish & Game (Lateral 4 – Federal)
Fish & Game (Lateral 6 – Federal)

O'Neill Forebay
Oneill Forebay Wildlife (Federal)
San Luis WD Ag
San Luis M&I
VA Cemetary

Cross Valley Canal
County of Fresno
County of Tulare
Lower Tule River ID
Pixley ID
Kern-Tulare WD
Rag Gulch WD
Hills-Valey ID
Tri-Valley ID

Greater Bay Area

<u>San Luis-Cross Valley Canal Deliveries</u>

San Felipe Division
Santa Clara
215 water
San Benito
215 water

9. Appendix 3.
State Water Project Delivery Descriptions and Categories

Source: DWR, 2005

Sacramento River Basin

Oroville Field Division Deliveries

Miscellaneous Water Users
Last Chance Creek W.D.
Plumas Co. F.C. & W.C.D.
County of Butte
Thermalito I.D. (Local Supply)
Prior Water Rights Deliveries
Yuba City

Greater Bay Area

Delta Field Division Deliveries

Miscellaneous Water Users
Napa Co. F.C. & W.C.D.
Marin W.D.
Solano Co. F.C.W.C.D.
Alameda Co. W.D.
A.C.F.C. & W.C.D., ZONE 7
Pleasonton Township W.D.
Santa Clara Valley W.D.
San Francisco W.D.
Skylonda M.W.D.
Mustang W.D.
Tracy Golf & Country Club
Granite Construction
Lake Del Valle (E.B.R.P.D.)
Recreation Fish and Wildlife
Western Hills Water District

San Joaquin Field Division Deliveries

Miscellaneous Water Users
Alameda County W.D.
A.C.F.C. & W.C.D., Zone 7
Santa Clara Valley W.D.

San Joaquin River Basin

<u>Delta Field Division Deliveries</u>

Miscellaneous Water Users
Orestimba Creek
C.V.P. Water
Oak Flat W.D.

<u>San Luis Field Division Deliveries</u>

Miscellaneous Water Users
Dept. of Parks & Rec. (State)
Dept. of Fish & Game (State)
Fed. Customers (Rec. + Joint Use)
Fed. Customers (Misc.)

Tulare Lake Basin

<u>San Luis Field Division Deliveries</u>

Miscellaneous Water Users
Westlands Water District

<u>San Joaquin Field Division Deliveries</u>

Miscellaneous Water Users
Tulare Lake Basin
Tulare Lake Basin W.S.D.
Empire West Side I.D.
County of Kings
Hacienda W.D.
Kern Co. W.A.
Kern Water Bank
Dudbley Ridge W.D.
Devils Den W.D.
J.G. Boswell
Shell Cal Prod.
Green Valley W.D.
Federal Wheeling
General Wheeling
Wheeler Ridge W.S.D.
Westlands Water District

Central Coast

San Joaquin Field Division Deliveries

Miscellaneous Water Users
San Luis Obispo County
Santa Barbara County
Central Coastal Water Authority
Department of Fish and Game

Southern California

San Joaquin Field Division Deliveries

Miscellaneous Water Users
Castaic Lake Water Agency
M.W.D. Of S.C.

Southern Field Division Deliveries

Miscellaneous Water Users
A.V.E.K. W.A.
M.W.D. OF S.C.
Littlerock Creek I.D.
Mojave W.A.
Desert W.A.
Coachella Valley W.D.
Crestline-Lake Arrowhead W.A.
San Gabriel Valley M.W.D.
San Bernardino Valley M.W.D.
Recreation and Fish Enhancement
Dept. Parks & Rec., L.A. Co. Rec. Dept.
Piru Creek Recapture Agreement
Castaic Lake W.A.
Palmdale W.D.
United Water C.D. (Local Supply)
Ventura County F.C.D.
Los Angeles Dept. of Water and Power
Lilico Pictures
Federal Delivery

10. Appendix 4.

California Department of Health Services, Fresno South Drinking Water Data Summary

FRESNO SOUTH - 14 WELL DATA SET
AVERAGE EC - SUMMARY DATA TABLE

Well No.	001A	016A	020	021A	026A	027A	048	077	082-1	102	202	205	206	277	Total	Ave
1984	500			430		390		305			389	359	346	147		
1985		455	504		376		368		401	291						
1986																
1987		478	499		398				390	286		394	390	179		
1988	487			464		415		304								
1989														200		
84-89 Ave.	**494**	**467**	**502**	**447**	**387**	**403**	**368**	**305**	**396**	**289**	**389**	**377**	**368**	**175**	**5367**	**383**
1990																
1991				450		370		290	420		480					
1992									280	280						
1993																
1994	490	480	400	390	420	430	390	290	450	280		250	430	220		
									430							
90-94 Ave.	**490**	**480**	**400**	**420**	**420**	**400**	**390**	**290**	**395**	**280**	**480**	**250**	**430**	**220**	**5345**	**382**
1995																
1996											560		440			
													370			
1997	460	540	520	420	380	420	420	330	420	290	550		410	260		
														260		
1998												260				
1999																
95-99 Ave.	**460**	**540**	**520**	**420**	**380**	**420**	**420**	**330**	**420**	**290**	**555**	**260**	**407**	**260**	**5682**	**406**
2000	400	580	520	430	440	410	440	290	510		610	320	400	290		
	450															
2001		530	550	480	410	380	450	280	270							
2002		520	540	390	450	400	370	310		310		370	320	310		
			540	350	430	400		330		300		390	270	320		
										140						
2003						420										
00-03 Ave.	**425**	**543**	**538**	**413**	**438**	**402**	**420**	**303**	**390**	**250**	**610**	**360**	**330**	**307**	**5729**	**409**
2004																
2005	420	550	560	370	450	370	480	380	540	310	460	360	210	310	**5770**	**412**

11. Appendix 5.
Excerpts Addressing Salinity from Central Valley Water Quality Control Plans and State Water Resources Control Board Plans and Decision 1641

Sacramento River and San Joaquin River Basin Plans

The Basin Plan is silent on salinity problems in the Sacramento Basin, although there are a few industries found in both the Sacramento River (SR) and San Joaquin River (SRJ) basins singled out as potentially contributing to salinity problems (irrigated agriculture, dairies, mining). In general, when the Basin Plan addresses salt as a threat the San Joaquin River Basin is the subject.

Salt is exported from the basin through discharge to the San Joaquin River, which in turn discharges to the Delta. CVP water is the main source of irrigation supply for most of the western San Joaquin Basin. CVP water is pumped from the Delta and carries a salt load (including salts that originated in the San Joaquin River and SR Basins). More salt is imported to the Basin than is exported.

Like the Tulare Lake Basin Plan, the SR/SJR Basin Plan pushes for a valley wide drainage facility to remove salts from the basin, although this position has been slightly modified over the years in response to heavy resistance to the idea. The Board continues to endorse salt removal but since the Board has no authority to make it happen, the approach described in the 2004 amendment includes regional, In-Valley salinity control that is consistent with our policies for as long as possible, similar to the controlled degradation policy set out in the TLBP.

Selenium and salt are generally linked in this Basin Plan, as the two problems often coexist. Selenium problems have been linked to tilewater discharges (1980s) and tile lines are used when natural drainage is ineffective (water table is close to the surface and salt buildup in the soil is impacting crop growth). Due to its toxicity, selenium is still a high priority. The recently adopted Basin Plan amendment (salt and boron in the lower San Joaquin River basin) expands the salt discussion to areas that are not affected by selenium, but because of the experience of Kesterson, this basin plan will probably always address salinity issues as potentially complicated by toxics.

A number of practices and policies that the Board has no control over exacerbate salt problems in the San Joaquin River basin; including out of basin water transfers (a water rights issue), operation of the CVP (USBR), and the need to export salt outside the region (would require the cooperation of coastal regions and the State Board). The Basin Plan makes a number of recommendations but our Board has very limited means to ensure that salinity issues are resolved.

Salt notes from the SR/SJR Basin Plan

Page *Sections in quotations are taken directly from the SR/SJR Basin Plan*

I-1.00

"The Sacramento River and San Joaquin River Basins cover about one fourth of the total area of the State and over 30% of the State's irrigable land. The Sacramento and San Joaquin Rivers furnish roughly 51% of the State's water supply."

I-2.00

The description of the Grassland Watershed ends with a mention that salts and selenium can be mobilized through irrigation.

II-1.00

The AGR use description includes use for "irrigation (including leaching of salts)" TLBP omits the parenthetical bit.

GWR use includes halting of saltwater intrusion into freshwater aquifers.

II-3.00

Res. No. 88-63 exceptions to the default uses include high salinity (>3000 TDS or > 5000 µmho/cm EC). The passage also appears in the TLBP.

II –8.00

Table II-1: Mud Slough and the wetland water supply channels in the Grassland watershed are listed for agricultural use limited by naturally elevated salt and boron concentrations.

III-6.01

"The objectives for electrical conductivity and total dissolved solids in Table III-3 [page III-7.00] apply to the water bodies specified. To the extent of any conflict with the general Chemical Constituents water quality objectives, the more stringent shall apply." The objectives in Table III-5 [end of the chapter, no page number] for the Delta were adopted by the SB in the *Water Quality Control Plan for Salinity.* (see page IV-10.00 for a description of the WQCPS)

III-7.00

Table III-3 shows EC/TDS objectives for Knight's Landing (SR.), Feather River, Friant Dam to Gravelly Ford (San Joaquin River), American River, Folsom Lake and Goose Lake.

III-9.00

Groundwater objectives apply to all groundwater in the basin and "do not require improvement over naturally occurring background concentrations. The ground water objectives contained in this plan are not required by the federal Clean Water Act." (Groundwater is a water of the State but not a water of the US)

Second unnumbered page after III-10.00

Figure III-2 shows how water year classifications (wet, critical, etc) are determined.

Immediately after above

Table III-5 shows WQOs (chloride, EC, DO, temp) taken from the State Board's *Water Quality Control Plan for Salinity*, May 1991.

IV-2.00

Under Water Quality Concerns: "Salt management is becoming increasingly important in the San Joaquin Valley for urban and agricultural interests. If current practices for discharging waters containing elevated levels of salt continue unabated, the San Joaquin Valley can have a large portion of its ground water severely degraded within a few decades. Therefore, the Regional Water Board will pursue strategies that will achieve the availability of a valley-wide drain for the discharge of agricultural wastewaters and drain waters degraded by elevated levels of salt and in which nutrient and toxic material concentrations meet applicable standards." This is followed by a description of how salt buildup occurs and how tile drainage works.

IV-3.00

Brief mention that confined animal facilities produce TDS contamination.

IV-4.00

Under Mineral Exploration and Extraction, another mentions that mining ops can potentially leach a number of pollutants, including salts, into surface and groundwater.

IV-14.00

The State Board has an MOU with USBR, USFWS, NRCS, USGS, DWR, CDFG and CDFA, that subject to fiscal availability and legal authority, they agree to use the monitoring program described in the 1990 report of the SJVDP as a guide to remedy subsurface agricultural drainage and related problems. (Appendix 22)

IV-15.00

"*Regional Water Board Resolution No. 96-147, San Joaquin River Agricultural Subsurface Drainage Policy*

The control of toxic trace elements in agriculture subsurface drainage, especially selenium, is the first priority.

b. The control of agricultural subsurface drainage will be pursued on a regional basis.

c. The reuse of agricultural subsurface drainage will be encouraged, and actions that would limit or prohibit reuse discouraged.

d. Of the two major options for disposal of salts produced by agricultural irrigation, export out of the basin has less potential for environmental impacts and, therefore, is the favored option. The San Joaquin River may continue to be used to remove salts from the basin so long as water quality objectives are met.

e. The valley-wide drain to carry the salts generated by agricultural irrigation out of the valley remains the best technical solution to the water quality problems of the San Joaquin River and Tulare Lake Basin. The Regional Water Board, at this time, feels that a valley-wide drain will be the only feasible, long-range solution for achieving a salt balance in the Central Valley. The Regional Water Board favors the construction of a valley-wide drain under the following conditions:

- All toxicants would be reduced to a level which would not harm beneficial uses of receiving waters.
- The discharge would be governed by specific discharge and receiving water limits in an NPDES permit.
- Long-term, continuous biological monitoring would be required.

f. Optimizing protection of beneficial uses on a watershed basis will guide the development of actions to regulate agricultural subsurface drainage discharges.

g. For regulation of selenium discharges, actions need to be focused on selenium load reductions."

IV-21.00
"*Policy for Obtaining Salt Balance in the San Joaquin Valley"*
Restates that a valley-wide drain is the best solution.

"Watershed Policy"
Our Board supports a watershed-based approach to water quality problems.

There is an MOU and an MAA between the CV Board and USBLM relevant to salinity control. The first concerns water quality problems resulting from mineral extraction on BLM land (appendices 26-28), and the second addresses releases from New Melones to the DVP to maintain DO and TDS at acceptable levels (Appendix 29).

!V-22.00
Table IV-1: Waivers are listed, although the list is not current. Some listed discharges (confined animal facilities, tailwater, food processing, probably others) include salts, but salinity is not explicitly mentioned under Limitations (conditions for waiver) in this edition of the basin plan.

IV-25.00
"*San Joaquin River Subsurface Agricultural Drainage"*
Most of this policy is specific to discharges from the Grassland Drainage Basin, currently regulated under WDRs for the Grassland Bypass Project, but it also includes

the following: “Activities that increase the discharge of poor quality agricultural subsurface drainage are prohibited.”

IV-27.00

Interbasin Transfer of Water: Before allowing transfers, the State Board should make sure they are absolutely necessary and that all other options have been explored first (conservation, best use of existing facilities, etc). Six considerations/options are listed in the basin plan (same appears in the TLBP)

IV-28.00

Trans-Delta Water Conveyance: The State Water Board should adopt the position that those proposing trans-Delta water conveyance facilities must clearly demonstrate that other options have been explored first and that new facilities will not be detrimental to water quality.

Water Intake Studies: “The State Water Board should coordinate studies to assess the costs and benefits of moving planned diversions from the eastern side of the Central Valley to points further west, probably to the Delta, to allow east side waters to flow downstream for uses of fishery enhancement, recreation, and quality control.”

Subsurface Agricultural Drainage

“1. The Central Valley Water Board will request that the State Water Board use its water rights authority to preclude the supplying of water to specific lands, if water quality objectives are not met by the specified compliance dates and Central Valley Water Board administrative remedies fail to achieve compliance.

4. The State Water Board should continue to consider the Drainage Problem Area in the San Joaquin Basin and the upper Panoche watershed (in the Tulare Basin) as priority nonpoint source problems in order to make USEPA nonpoint source control funding available to the area.” (additional points are specific to selenium control)

AMENDMENT

In September 2004, the Board adopted a resolution to amend the Basin Plan to include information on salt and boron control in the Lower San Joaquin River. The following passage would appear after or on page IV-28.00 in the next edition of the basin plan.

Salt and Boron in the Lower San Joaquin River

“1. The State Water Board should consider the continued use of its water rights authority to prohibit water transfers if the transfer contributes to low flows and related salinity water quality impairment in the Lower San Joaquin River.

2. The State Water Board should consider the continued conditioning of water rights on the attainment of existing and new water quality objectives for salinity in the Lower San Joaquin River, when these objectives cannot be met through discharge controls alone.”

IV-29.00

Under *Recommended for Implementation by Other Agencies*: “Facilities should be constructed to convey agricultural drain water from the San Joaquin and Tulare Basins.” There are a number of recommendations under the subheading Subsurface Agricultural Drainage that are being acted upon, most through the Grassland Area Farmers group to control selenium discharges. Further study of the feasibility of a San Joaquin River Basin drain to remove poor quality drainage from the basin is one of the recommendations.

IV-30.00 (2004 revisions included)

Under *Agricultural Drainage Discharges*:

“Water quality in the San Joaquin River has degraded significantly since the late 1940s. During this period, salt concentrations in the River, near Vernalis, have doubled. Concentrations of boron, selenium, molybdenum and other trace elements have also increased. These increases are primarily due to reservoir development on the east side tributaries and upper basin for agricultural development, the use of poorer quality, higher salinity, Delta water in lieu of San Joaquin River water on west side agricultural lands and drainage from upslope saline soils on the west side of the San Joaquin Valley. Point source discharges to surface waters only contribute a small fraction of the total salt and boron loads in the San Joaquin River. The water quality degradation in the River was identified in the 1975 Basin Plan and the Lower San Joaquin River was classified as a Water Quality Limited Segment. At that time, it was envisioned that a Valley-wide Drain would be developed and these subsurface drainage water flows would then be discharged outside the Basin, thus improving River water quality. However, present day development is looking more toward a regional solution to the drainage water discharge problem rather than a valley-wide drain.”

“Because of the need to manage salt and other pollutants in the River, the Regional Water Board began developing a Regional Drainage Water Disposal Plan for the Basin. The development began in FY 87/88 when Basin Plan amendments were considered by the Water Board in FY 88/89. The amendment development process included review of beneficial uses, establishment of water quality objectives, and preparation of a regulatory plan, including a full implementation plan. The regulatory plan emphasized achieving objectives through reductions in drainage volumes and pollutant loads through best management practices and other on-farm methods. Additional regulatory steps will be considered based on achievements of water quality goals and securing of adequate resources.”

“The 88/89 amendment emphasized toxic elements in subsurface drainage discharges. The Regional Water Board however still recognizes salt management as the most serious long-term issue on the San Joaquin River. Salinity impairment in the Lower San Joaquin River remains a persistent problem as salinity water quality objectives continue to be exceeded. The Central Valley Water Board adopted the following control program for salt and boron in the Lower San Joaquin River to address salt and boron impairment and to bring the river into compliance with water quality objectives. Additionally, The Regional Water Board will continue as an active participant in the San Joaquin River

Management Program implementation phase, as authorized by AB 3048, to promote salinity management schemes including timed discharge releases, real time monitoring and source control."

IV-31.00

One of the implementation actions for subsurface drainage:

"4. Best management practices, such as water conservation measures, are applicable to the control of agricultural subsurface drainage."

IV-32.00

More actions with a salinity tie-in:

"9. Upslope irrigations and water facility operators whose actions contribute to subsurface drainage flows will participate in the program to control discharges;

10. Public and private managed-wetlands will participate in the program to achieve water quality objectives. All those discharging or contributing to the generation of agricultural subsurface drainage will be required to submit for approval a short-term (5-year) drainage management plan designed to meet interim milestones and a long-term drainage management plan designed to meet final water quality objectives.

13. An annual review of the effectiveness of control actions taken will be conducted by those contributing to the generation of agricultural subsurface drainage.

14. Evaporation basins in the San Joaquin Basin will be required to meet minimum design standards, have waste discharge requirements and be part of a regional plan to control agricultural subsurface drainage.

16. The Central Valley Water Board will establish water quality objectives for salinity for the San Joaquin River."

The Basin Plan lists additional actions aimed at selenium control.

MORE FROM THE AMENDMENT (to be inserted on page IV-32.00)

A new section--*Control program for Salt and Boron Discharges into the Lower San Joaquin River*—will be added to the basin plan. Here are some of the highlights:

"The goal of the salt and boron control program is to achieve compliance with salt and boron water quality objectives without restricting the ability of dischargers to export salt out of the San Joaquin River basin." (A key component of implementation will be to use real-time management to take advantage of periods when the lower San Joaquin River has assimilative capacity for salt.)

"The salt and boron control program establishes salt load limits to achieve compliance at the Airport Way Bridge near Vernalis with salt and boron water quality objectives for thelower San Joaquin River. The Central Valley Water Board establishes a method for determining the maximum allowable salt loading to the Lower San Joaquin River."

“The salt and boron control program establishes timelines for: 1) developing and adopting salt and boron water quality objectives for the San Joaquin River upstream of the Airport Way Bridges near Vernalis; 2) a control program to achieve these objectives; and 3) developing and adopting a groundwater control program.”

“The Central Valley Water Board will attempt to enter into a Management Agency Agreement (MAA) with the U.S. Bureau of Reclamation to address salt imports from the DMC to the lower San Joaquin River watershed.” (2-year time limit)

IV-37.00
Dairies –there’s a potential threat to groundwater and changes to the regulatory program were being considered when this edition of the basin plan was released. Those changes are now in place.

V-1.00
Under Special Studies: The basin plan describes the San Joaquin River Subsurface Agricultural Drainage Monitoring Program.

Tulare Lake Basin Plan

Salinity is the major water quality issue addressed in the Tulare Lake Basin Plan (TLBP). The basin has no natural outlet for salts to leave, so salinity effects continue to get worse.

The TLBP endorses out-of-basin disposal of salts (valley-wide drain). Until that occurs, the most sustainable policy consistent with continued human occupation of the basin is controlled degradation. Controlled degradation means that saline impacts are minimized wherever possible, poor quality water is directed to the trough of the basin, all water is used as efficiently as possible and high quality water is protected from degradation.

In general, discharges to surface water in excess of 1,000 μmhos/cm EC are prohibited.

Salt is brought into the basin in imported irrigation water and leached from the soil. Evaporation basins are used to collect and isolate salts but there are inherent problems with their use. All evaporation basins pose some risk to wildlife.

As in the SR/SAN JOAQUIN RIVER Basin Plan, many of the recommendations made in the TLBP cannot be implemented by the Board but must rely on actions and decisions made by other agencies.

Salt notes from the Tulare Lake Basin Plan
Page *Sections in quotations are taken directly from the TLBP*

I-1

The economy of the basin is based on agricultural production, agricultural processing and oil production.

I-2

Water coming into the basin, stays in the basin (percolates to groundwater) unless lost through use, evaporation or evapotranspiration. The biggest water quality problem in the basin is the accumulation of salts. Overdraft and out of basin transfer makes the problem worse.

I-3

"Salinity increases in ground water can ultimately eliminate the beneficial use of the resource. This loss will not be immediate, but control of the increase is a major part of this plan. Salt loads reaching the ground water body must be reduced. Storage of salt in the soil through increased irrigation efficiency is being done, but is only a temporary solution. Current fertilization and soil amendment practices should be reviewed. Methods to control the leachate from newly developed lands should be studied."

III-4

"Waters shall be maintained as close to natural concentrations of dissolved matter as is reasonable considering careful use of the water resources."

III-5

Table III-2 lists maximum EC levels for a number of eastside streams, all <500µmho/cm.

III-8

"No proven means exist at present that will allow ongoing human activity in the Basin and maintain ground water salinity at current levels throughout the Basin. Accordingly, the water quality objectives for ground water salinity control the rate of increase."

III-8

Table III-4 gives maximum average annual increases in groundwater salinity allowed for specific hydrographic units, ranging from 1 - 6µmho/cm. But it looks like there may not be (or wasn't at the last basin plan revision) monitoring to check and see that increases stay in the allowable range (page IV-30).

IV-1

"Controlled ground water degradation by salinity is the most feasible and practical short-term management alternative for the Tulare Lake Basin." The opposing alternative, by inference, is uncontrolled degradation."

IV-2

“The crucial problem in the Tulare Lake Basin is the salts brought in with irrigation water and leached out of soils.”

“Subsurface drainage will be a constant threat to surface water and usable ground water quality unless the disposal method is adequate. Disposal must be in a manner that isolates the salts in the drainage from the usable ground water body. In some areas of the Basin, evaporation basins are used to concentrate drainage water and contain salts. However, evaporation basins cannot be considered permanent solutions due to wildlife impacts, and the cost of ultimate salt disposal and basin closure.”

“…all [evaporation] basins pose a risk to birds due to salinity and avian disease”

IV-3

“Regional Water Board policy on agricultural subsurface drainage:
A valleywide drain to carry salts out of the valley remains the best technical solution to the water quality problems of the Tulare Lake Basin.

Evaporation basins are an acceptable interim disposal method for agricultural subsurface drainage and may be an acceptable permanent disposal method in the absence of a valley drain provided that water quality is protected and potential impacts to wildlife are adequately mitigated. For existing basins requiring substantial physical improvements and other mitigations, some of which are dependent upon empirically derived techniques, operators shall implement mitigations as early as feasible.

Persons proposing new evaporation basins and expansion of evaporation basins shall submit technical reports that assure compliance with, or support exemption from, Title 23, California Code of Regulations, Section 2510, et seq., and that discuss alternatives to the basins and assess potential impacts of and identify appropriate mitigations for the proposed basins.

Agricultural drainage may be discharged to surface waters provided it does not exceed 1,000 μmhos/cm EC, 175 mg/l chloride, nor 1 mg/l boron. Other requirements also apply.”

IV-3

Recommendations for reducing drainage in the Lower Kings River are included, as it is a water quality limited segment due to salinity.

IV-4

The basin plan includes confined animal facility requirements (manure management, salt rations, containment, location) that address salt, among other contaminants.

IV-5

“The elimination of overdraft is an important step in managing the rate of salinity increase in the ground water. Continued overdraft will deplete good quality water supplies and introduce salts from poorer quality aquifers.”

“The Regional Water Board goal is to alleviate overdraft and the water quality problems associated with overdraft, and extend the beneficial uses of the ground water resource for the longest period economically feasible. Water used to recharge ground water and imported water supplies must be of the highest quality possible. Banking of water in the ground is encouraged. Construction of storage facilities to store surplus wet-weather basin outflows is also recommended where such facilities do not adversely impact other waters of the state.”

IV-5

“Degradation of ground water in the Tulare Lake Basin by salts is unavoidable without a plan for removing salts from the Basin. A valleywide drain to carry salts out of the valley remains the best technical solution to the water quality problems of the Tulare Lake Basin…The only other solution is to manage the rate of degradation by minimizing the salt loads to the ground water body.”

IV-6

“The Regional Water Board supports construction of a valleywide drain to remove salt-laden wastewater from the Basin under the following conditions:
All toxicants would be reduced to a level which would not harm beneficial uses of receiving water.

The discharge would be governed by specific discharge and receiving water limits in an NPDES permit.

Long-term continuous biological monitoring would be required.

The Regional Water Board also encourages proactive management of waste streams to control and manage salts that remain in the Basin. Application or disposal of consolidated treated effluents should be to the west, toward the drainage trough of the valley. If feasible, salts in waste streams should be processed for reuse to reduce the need to import salt. Salt import should be reduced by assuring that imported water is of the highest quality possible. Water conveyance systems used to import water into the Basin should not be used to transport inferior quality water.”

IV-10

Discharges to Navigable Waters:
“The maximum electrical conductivity (EC) of a discharge shall not exceed the quality of the source water plus 500 micromhos per centimeter or 1,000 micromhos per centimeter, whichever is more stringent.” The 1000 μmho/cm limit/ increase of no more than 500 μmho/cm shows up in a few more places in the basin plan, as well—discharges to land, specific subareas, industrial wastewater. Discharges to low EC waters (< 150) have special requirements.

IV-13

"An exception to this [500 µmho/cm above baseline] EC limit may be permitted for Industrial sources when the discharger technically demonstrates that allowing a greater net incremental increase in EC will result in lower mass emissions of salt and in conservation of water, provided that beneficial uses are protected. An exception may also be permitted for food processing industries that discharge to land and exhibit a disproportionate increase in EC of the discharge over the EC of the source water due to unavoidable concentrations of organic dissolved solids from the raw food product, provided that beneficial uses are protected. Exceptions shall be based on demonstration of best available technology and best management practices that control inorganic dissolved solids to the maximum extent feasible."

IV-11

"Wastewater reclamation shall be maximized by controlling or limiting salt pickup and evaporation during use, treatment, or disposal."

IV-14-15

Oil field wastewater contains salts. The basin plan allows discharge to Class II injection wells. "Maximum salinity limits for wastewaters in unlined sumps overlying ground water with existing and future probable beneficial uses are 1,000 µmhos/cm EC, 200 mg/l chlorides, and 1 mg/l boron, except in the White Wolf subarea where more or less restrictive limits apply. Discharges of oil field wastewater that exceed the above maximum salinity limits may be permitted to unlined sumps, stream channels, or surface waters if the discharger successfully demonstrates to the Regional Water Board in a public hearing that the proposed discharge will not substantially affect water quality nor cause a violation of water quality objectives."

IV-20

The discussion under the Antidegradation heading reiterates the controlled degradation until there's an out of basin drain theme.

IV-28

Under recommendations to other agencies: "As a last resort and where the withholding of irrigation water is the only means of achieving significant improvements in water quality, the State Water Board should use its water rights authority to preclude the supplying of water to specific lands." The basin plan also recommends that permits to transfer water (interbasin) should not be approved "unless the alternatives have been thoroughly investigated and ruled out for social, environmental, or economic reasons."

IV-30

More recommendations:

NPS discharges have resulted in salts and chemical groundwater impairments in the basin. Potential sources should be identified and practices to reduce the impacts should be developed.

The objectives for salinity increases in groundwater should be studied to see if they're working.

V-4

The State Board has an MOU with USBR, USFWS, NRCS, USGS, DWR, DFG and DFA, that subject to available funding and legal authority, they agree to use the monitoring program described in the 1990 report of the SJVDP as a guide to remedy subsurface agricultural drainage and related problems.

VI-2&3

Surface water and groundwater monitoring will be performed. If the monitoring network needs to be added to, the State Board should budget enough funds to do so. The State Board and DWR should prepare a groundwater sampling manual.

The TLBP is dated 1995

Bay-Delta Basin Plan

(SWRCB WRD 1641 addresses implementation of flow and salinity objectives for this Basin Plan. A separate summary of WRD 1641 has been prepared.)

The San Francisco Bay-Delta Region encompasses a mix of fresh, saline and transitional (estuarine) water resources. Salinity is presented in the context of protection of fisheries and wildlife habitat, drinking water protection (salt water intrusion on fresh water aquifers) and agricultural use.

Water quality and quantity in the Bay-Delta is strongly influenced by Sacramento and San Joaquin River flows originating in the Central Valley.

Salinity effects are more varied in this region than in the Central Valley, resulting in a more complex array of salinity goals. Low salinity levels are detrimental to some uses.

Generally, this basin plan does not present salinity as a stand-alone parameter but ties it to flow.

The SF Basin Plan is an HTML document, accessible at
www.waterboards.ca.gov/sanfranciscobay/basinplan.htm

Salt notes from the SFBD Basin Plan
Chapter/subheading Quotations are taken directly from the basin plan.

1/INTRODUCTION
"Within each section of the Bay lie deepwater areas that are adjacent to large expanses of very shallow water. Salinity levels range from hypersaline to fresh water, and water temperature varies throughout the Bay system". The system also provides habitat for diverse species.

1/ SURFACE and GROUND WATERS
"The Sacramento and San Joaquin Rivers, which enter the Bay system through the Delta at the eastern end of Suisun Bay, contribute almost all the freshwater inflow to the Bay."
"The rate and timing of these freshwater flows are among the most important factors influencing physical, chemical, and biological conditions in the Estuary. Much of the freshwater inflow, however, is trapped upstream by the dams, canals, and reservoirs of California's water diversion projects, which provide vital water to industries, farms, homes, and businesses throughout the state. This freshwater diversion has sparked statewide controversy over possible adverse effects on the Estuary's water quality, fisheries, and ecosystem."

"Flows in the region are highly seasonal, with more than 90 percent of the annual runoff occurring during the winter rainy season between November and April."

2/BENEFICIAL USE (AGR)
"Continued irrigation often leads to one or more of four types of hazards related to water quality and the nature of soils and crops. These hazards are (1) soluble salt accumulations, (2) chemical changes in the soil, (3) toxicity to crops, and (4) potential disease transmission to humans through reclaimed water use."

2/BENEFICIAL USE (EST)
"The protection of estuarine habitat is contingent upon (1) the maintenance of adequate Delta outflow to provide mixing and salinity control..."

2/BENEFICIAL USE (GWR) [definition]
"Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting saltwater intrusion into freshwater aquifers."

4/DELTA OUTFLOW
"[A]chieving water quality objectives and protecting the beneficial uses of the San Francisco Bay Estuary system...depends on freshwater outflow from the Delta. Adequate freshwater inflow to the Bay system is necessary to control salinity, to provide mixing (particularly in the entrapment zone), to maintain proper temperature, and to flush out residual pollutants that cannot be eliminated by treatment or nonpoint source management. Except for local drainage and wastewater discharges, Delta outflow provides virtually all the freshwater inflow to San Francisco Bay. However, the availability of adequate Delta outflow to meet these needs is very uncertain because of the existing and potential upstream diversions of water and fluctuations in rainfall."

Water Rights Decision 1485, which preceded WRD 1641, is cited and summarized.

"In 1993, estuarine scientists and managers associated with the San Francisco Estuary Project recommended development of salinity standards for different parts of the year to be used in conjunction with flow standards. Specifically, they indicate that average upstream positions of the near-bottom 2 0/00 isohaline would be an appropriate index for salinity standards."

4/SAN LUIS DRAIN
A brief history of the San Luis Drain and the Board's response is provided. "Unfortunately, the problem of agricultural drainage still exists. The San Joaquin Valley Drainage Program, another state and federal interagency program, has begun to investigate further the problems associated with the drainage of agricultural lands and to develop solutions."

4/MITIGATION FOR LOSS
*"*Technological advances and reduced costs of demineralization also now make groundwater recharge with demineralized wastewater a viable tool for managing salt concentrations in the basin*."*

4/ WATER RECYCLING
Water and wastewater agencies in Livermore-Amador Valley studied water recycling on a large scale, using reverse osmosis demineralization and export of brine. "A key element of proposed valley-wide water recycling is a salt management program for the groundwater basin. This program includes further characterization of basin hydrogeology, refinement of salt balance calculations, selection of TDS targets and examination of alternative ways to offset natural salt loadings... The salt management plan will be developed beginning in 1995 based on the concept that the effect of each individual project on the main basin groundwater resource is best assessed in the context of the cumulative effects of all such projects, as well as the effects of groundwater management policies and natural conditions"

"The Central Valley Water Board supports the concept that water recycling is an essential component for planning the valley's future water supply. Water recycling is particularly important in areas that are dependent on imported water, such as the valley."

"The Central Valley Water Board supports managing the basin-wide salt balance can best be managed through an integrated water-wastewater resource operational plan. Such a plan should combine management of the groundwater basin, water conservation, salt management projects, and water recycling, with and without demineralization."

"The Central Valley Water Board supports the concept of transport and recharge through the valley's ephemeral streams. Recharge of the groundwater basin may be accomplished with imported water, as is done now, or with high-quality recycled water under a future NPDES permit. The year-round, dependable recycled water resource may be appropriate for streamflow augmentation to enhance beneficial uses of the valley's ephemeral streams."

4/IRRIGATION OPERATIONS
*“*An increase in the concentration of soluble salts contained in percolating irrigation water is an unavoidable result of consumptive use of water. Salt management within soils and groundwater is considered separate from water management, but is closely related to drainage control and wastewater operations. For irrigated agriculture to continue in the future, acceptable levels of salts in soils and groundwaters must be controlled.”

“Maintenance of a favorable salt balance, that being a reasonable balance between the import and export of salts from individual basins, must be considered to control increases in mineral content.”

“The ultimate consequences of regulatory action for irrigation operations must be carefully assessed. The "no-degradation" concept in connection with salt levels is not appropriate in all circumstances.”

“A concept of minimal degradation might be considered in some areas. It would need to be coupled with management of the surface and underground water supplies in order to assure acceptable degradation effects. If minimal degradation is considered, it can be offset by either recharge and replenishment of groundwater basins with higher quality water that will furnish dilution to the added salts, or by drainage of degraded waters at a sufficient rate to maintain low salts and salts leaving the basin. To aid recharge and dilution operations, additional winter runoff can be stored in surface reservoirs for subsequent use with either surface stream or groundwater basin quantity/quality management.”

4/GROUNDWATER PROTECTION PROGRAMS
Salt water intrusion is mentioned as a local program.

5/DELTA PLAN
The Delta Plan and WRD 1485 “designate beneficial uses, establish water quality (salinity) and flow standards to protect the beneficial uses from State Water Project and Central Valley Project operations, and specify an implementation program. In 1991, the State Board adopted the Water Quality Control Plan for Salinity, which supersedes the 1978 Delta Plan. The 1991 Plan does not establish Delta outflow standards. Outflow and salinity standards for the Bay and Delta are being considered as part of State Board planning processes.” (outflow and salinity standards are addressed in WRD 1641)

5/SAN LUIS DRAIN
“The Central Valley Water Board prohibits discharge by the [San Luis Drain] until evidence that the discharge would not threaten beneficial uses is submitted by the dischargers. The basin plan directs staff to identify and protect the beneficial uses of the receiving waters, and that the State and Central Valley Water Boards coordinate on WDRs for the drain. *(Our office has issued WDR # 5-01-234 to USBR and the San Luis Delta-Mendota Water Authority; respectively the owner and the operator of the drain-gpc).*

5/PERIPHERAL CANAL
"In 1980, the Board expressed its concern regarding the adverse impacts on water quality of certain projects authorized by Senate Bill 200 and endorsed protective measures for the Delta, Suisun Bay, and San Francisco Bay."

6/GROUNDWATER MONITORING NETWORKS
These are established in several subbasins "to determine the general potability of groundwater and the status of sea water intrusion control. The Central Valley Water Board is integrating the locations of monitoring well networks into its groundwater geographic information system. The water quality data generated from the networks will assist Central Valley Water Board staff in the refinement of beneficial use designations for groundwater basins."

SWRCB Decision 1641

The references to salinity in the Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin appear in sections that have not been amended since 1995 or earlier. State Board Water Rights Decision 1641 (D-1641), which addresses the implementation of salinity and flow objectives in the Basin Plan, was adopted in December 1999, and revised in March 2000. The decision contains detailed findings and recommendations for managing flow and salinity in the Delta, focusing on measures that could be implemented in the near-term to mitigate the effects of saline drainage on the Delta, and indicating that long-term solutions would need to be developed. Primary responsibility for salinity impacts is attributed to the USBR, which operates the Central Valley Project.

In addition to implementation of the water quality objectives for the Bay-Delta Region, D-1641 addresses two water rights petitions involving changing the points of diversion, places of use and purposes of use of the two major water projects in the state—the Central Valley Project, operated by USBR; and the SWP, operated by DWR. While much of D-1641 focuses on habitat protection and water availability, the decision often links these issues to water quality (salinity management). The salinity findings in brief are:

The timing of water quality violations generally coincides with seasons when water needs go unmet; water availability therefore determines whether a violation is likely to occur.

The SWRCB has authority over water rights and may exercise this authority to protect water quality.

The options available to meet salinity objectives are dilution flows and source control.

Short-term measures are helpful in controlling salinity and should be implemented whenever feasible, but a long-term strategy must be developed for long-term, sustainable salinity management.

Water development (diversion for use) was the initial cause of salinity problems in San Joaquin River. The CVP has made the problem significantly worse.

The assimilative capacity of the river is adversely affected by the diversion of high quality (low salinity) flows at Friant Dam.

Salinity control in the interior Southern Delta will rely on dilution flows, source control and circulation management (barriers).

<u>Key passages from D-1641</u>

SETTING
"The watershed is a source of drinking water for two-thirds of the state's population. The SWP, operated by the DWR, and the CVP, operated by the USBR, release previously-stored water into the Delta where they redivert the stored water and also divert natural flow. The water diverted by the two projects in the Delta is exported to areas south and west of the Delta through a system of water conveyance facilities." (Section 2.2)

The largest diversions of water from the San Joaquin River and its tributaries are by (1) USBR at New Melones Reservoir and Millerton Lake; (2) MID and TID at New Don Pedro Reservoir; and (3) Merced ID at Lake McClure. Additionally, the diversions into pipelines by the City and County of San Francisco from the Tuolumne River upstream of the Delta deplete Vernalis flows by 240 taf. Taken together, these diversions have significantly reduced the flows in the San Joaquin River. Because of CVP diversions, alone, the flow of the San Joaquin River at Vernalis has decreased by 550 taf per year on average with 345 taf of this decrease occurring from April through September. The water diverted from the upstream tributaries to the lower San Joaquin River is of high quality. Thus, these diversions result in a substantial reduction in the assimilative capacity of the San Joaquin River. (Section 10.2.1.1)

"The months in which the southern Delta water users' needs exceed their rights to water under riparian claims are the same months in which water quality violations tend to occur." (Section 6.3.4.2.4)

"It…is reasonable to expect that upstream development will eventually reduce the amounts of water available downstream." (Section 10.2.1.1)

"In appropriate circumstances… the SWRCB has authority to restrict diversions or require releases to protect water quality from seawater intrusion or loss of assimilative capacity." (Section 10.2.1.1)

“Currently, the USBR is the only water right holder with responsibility for meeting salinity objectives at Vernalis under its water rights.” (Section 10.4)

“The reliable water supply for agricultural uses south of the Delta has decreased by about 35 percent. These reductions are mainly the result of the biological opinions issued under the state and federal Endangered Species Acts, the Central Valley Project Improvement Act, and the outflow and export limitations established by the 1995 Bay-Delta Plan. (Section 11.5)

“The DWR has experienced some of the same regulatory constraints that have affected the USBR. However, because not all of the constraints affect the SWP and because the SWP has available pumping capacity, it is not as severely affected as the USBR.” (Section 11.5)

“Only the DWR and the USBR can implement the objectives for operational constraints in the 1995 Bay-Delta Plan. The objectives for export pumping rates are the responsibility of each of the two projects at their respective facilities. The objectives for Delta Cross Channel operation are the sole responsibility of its owner, the USBR.” (Section 13.1)

MEANS OF IMPLEMENTATION

“Many of the objectives in the 1995 Bay-Delta Plan are best implemented by making changes in the flow of water or in the operation of facilities that move water. Accordingly, this decision amends certain water rights by assigning responsibilities to the persons or entities holding those rights to help meet the objectives.”(Section 2.2)

“The Vernalis salinity objectives can be achieved either by providing sufficient fresh water to dilute upstream discharges of saline water above Vernalis or by using measures to control the discharge of saline water to the river upstream of Vernalis.” (Section 10.2.2)

“Short-term management measures should include both on-farm management activities to reduce subsurface drainage and real-time management to maximize the assimilative capacity of the river. On-farm management of drainage water has been effective in reducing the salt load of the San Joaquin River.” (Section 10.2.2)

BENEFICIAL USE

“[P]rotection of agriculture in the southern Delta is in the public interest.” (Section 6.3.4.2.4)

Implementing this decision could affect instream beneficial uses by “changing: (1) the timing and magnitude of instream flows in the San Joaquin River and its tributaries, (2) export rates from the Delta, and (3) storage levels in the major reservoirs in the basin.” (Section 6.3.4.8)

GROUNDWATER

"[C]onservation measures reduce the amount of water diverted and delivered to water users, but can also result in decreased return flows to surface streams and a decrease in deep percolation to underlying groundwater bodies." (Section 6.3.4.3)

"[Certain] irrigated lands overlie common groundwater basins and are linked by a network of surface streams and drains. Return flows from this area contribute to the supply of downstream users, to Delta outflow, and to deep percolation. Deep percolation from seepage and return flows is an important component of groundwater recharge in these service areas…downstream water users who are dependent on return flows could receive less water as a result of water conservation." (Section 6.3.4.3)

The Eastern San Joaquin County Groundwater Basin is experiencing overdraft at a rate of 70 taf per year. Saline water intrusion into the basin is one result of the overdraft. (Section 6.3.4.7)

SURFACE WATER

Water right holders (Districts), USFWS and DFG have MOUs regarding Mokelumne flows to the Delta for fisheries protection. DWR will provide a share of any additional flows that may be necessary, as assigned by the SWRCB. Models indicate "DWR is not likely to provide more than 25 percent of the water needed for the backstop. The USBR declined … to provide a backstop for Mokelumne River flows. The USBR, however, is responsible for meeting requirements under the federal Endangered Species Act for flows, export limits, and salinity in the Delta. Additionally, …the USBR will be required to meet certain objectives jointly with the DWR, including objectives for operation of the Delta Cross Channel Gates, export pumping, and Delta outflow. Thus, in practice the USBR will provide the flows to meet any obligation that might otherwise be allocated to Mokelumne River water right holders." (Section 8.1)

"Salinity at Vernalis is affected by the salt load and quantity of flow in the lower San Joaquin River. High salt loads and low flows at Vernalis result from a combination of upstream water diversions, discharges of saline drainage water to the San Joaquin River and subsurface accretions to the river from groundwater." (Section 10.2)

Return flow from upstream diversions of water does not contribute significantly to the salt loading in the San Joaquin River. Return flows from the upstream segment of the San Joaquin River also contribute little to the salt in the lower river. (Section 10.2.1.1)

CAUSES OF SALINITY- VERNALIS (From Section 10.2.1.2)

"Although water quality problems on the San Joaquin River began with the reduction of flows due to upstream development and the advent of irrigated agriculture, they were exacerbated with construction of the CVP."

“[B]etween 1930 and 1950 the average salt load at Vernalis was 750,000 tons per year. Between 1951 and 1997, the salt load has averaged more than 950,000 tons per year. Peak loads have exceeded 1.5 million tons per year following extended droughts…The April through August salt load in the 1980s was 62 percent higher than the load in the 1960s and the corresponding annual load increase was 38 percent.”

“[H]igh salinity at Vernalis is caused by surface and subsurface discharges to the river of highly saline water. The sources of the discharges are agricultural lands and wetlands. Approximately 35 percent of the salt load comes from the northwest side of the San Joaquin River, and approximately 37 percent of the salt load comes from the Grasslands area. These areas receive approximately 70 percent of their water supply from the CVP, 20 percent from precipitation and 10 percent from groundwater. The TDS concentration of agricultural drainage water from the Grasslands area that discharges to the river through Mud Slough is approximately 4,000 mg/l. In some cases, drainage water is more than ten times the concentration of the Vernalis salinity standard.”

“The subsurface drainage problem is region-wide. The total acreage of lands impacted by rising water tables and increasing salinity is approximately 1 million acres. The drainage problem may not be caused entirely by the farmer from whose lands the drainage water is discharged. In the western San Joaquin Valley, the salts originate from the application of irrigation water and from soil minerals, which dissolve as water flows through the soil. The salts are stored in groundwater. As more water is applied, hydraulic pressures increase, water moves downgradient, and salt-laden waters are discharged through existing drainage systems and directly to the river as groundwater accretion. Drainage found in a farmer’s field may originate upslope and may not have risen into the tile drains on the downslope farmer’s land but for the pressures caused by upslope irrigation.”

“Based on the above discussion, the SWRCB finds that the actions of the CVP are the principal cause of the salinity concentrations exceeding the objectives at Vernalis. The salinity problem at Vernalis is the result of saline discharges to the river, principally from irrigated agriculture, combined with low flows in the river due to upstream water development. The source of much of the saline discharge to the San Joaquin River is from lands on the west side of the San Joaquin Valley which are irrigated with water provided from the Delta by the CVP, primarily through the DMC and the San Luis Unit. The capacity of the lower San Joaquin River to assimilate the agricultural drainage has been significantly reduced through the diversion of high quality flows from the upper San Joaquin River by the CVP at Friant. The USBR, through its activities associated with operating the CVP in the San Joaquin River basin, is responsible for significant deterioration of water quality in the southern Delta.”

CAUSES OF SALINITY – DOWNSTREAM OF VERNALIS (From Section 10.3.1)
“Water quality in the southern Delta downstream of Vernalis is influenced by San Joaquin River inflow; tidal action; diversions of water by the SWP, CVP, and local water users; agricultural return flows; and channel capacity.”

“Diversions in the Delta can cause hydrodynamic changes that affect water quality. During periods of high exports and peak irrigation, higher quality water is drawn into the southern Delta from the Delta cross-channel, the Mokelumne River, and Georgiana Slough. These waters mix with and improve the quality of San Joaquin flow. However, export pumping by the SWP and the CVP and in-Delta diversions in the southern Delta also cause null zones, areas with little or no circulation. These zones have little assimilative capacity for locally discharged salts. The lack of circulation prevents better quality water that is otherwise available from the main channels from freshening the water in these channels. Even when salinity objectives are met at Vernalis, the interior Delta objectives are sometimes exceeded. Exceedance of the objectives in the interior Delta is in part due to water quality impacts within the Delta from in-Delta irrigation activities.”

DIRECTIONS AND RECOMMENDATIONS

“The Central Valley RWQCB is hereby directed promptly to develop and adopt salinity objectives and a program of implementation for the main stem of the San Joaquin River upstream of Vernalis. As part of its implementation plan for the salinity objectives, the Central Valley RWQCB should evaluate a program to regulate the timing of agricultural discharges to the San Joaquin River.”

“[A] long-term solution for drainage management must be developed. The USBR should reevaluate alternatives for completing a drain to discharge salts from agricultural drainage outside of the San Joaquin Valley and pursue appropriate permits. The operations chief for the CVP identified the drain as a tool for meeting water quality at Vernalis. Other parties at the hearing supported long-term disposal outside the San Joaquin Valley. Central Valley RQWCB staff testified regarding the need for a drain. The Water Quality Control Plan for the Central Valley Region states that a valley-wide drain will be the only feasible long-term solution to drainage problem. The drain has numerous benefits, including the maintenance of productivity and the export of salts.”

“The USBR’s actions have caused reduced water quality of the San Joaquin River at Vernalis. Therefore, this order amends the CVP permits under which the USBR delivers water to the San Joaquin basin to require that the USBR meet the 1995 Bay-Delta Plan salinity objectives at Vernalis. The USBR has wide latitude in developing a program to achieve this result. The USBR could consider sources of dilution water other than New Melones Reservoir and other means of reducing the salinity concentration in the southern Delta. This decision conforms Condition 5 of D-1422 to the southern Delta salinity objectives in the 1995 Bay-Delta Plan and to the current Basin Plan.” (Section 10.2.2)

“The salinity objectives for the interior southern Delta can by implemented by providing dilution flows, controlling in-Delta discharges of salts, or by using measures that affect circulation in the Delta.”

“Irrigators within the Delta could implement water management measures as a means of controlling salt impacts within the Delta channels.” (Section 10.3.1)

“The DWR, the USBR and the SDWA have agreed that the salinity problems in the southern Delta can be mitigated using the barrier program…Permanent barriers are proposed as components of the preferred alternative for the [Interior Delta Salinity Objectives]… The barriers generally improve water quality in the southern Delta because salts otherwise trapped in the channels are transported out of the area due to the enhanced circulation. The barriers reduce the amount of salt imported by way of the Delta-Mendota Canal, which should result in some long-term improvement in the quality of the San Joaquin River. The improved quality of water delivered through the Delta-Mendota Canal should result in improvements to the salinity of drainage water that returns to the river.”

"The construction of permanent barriers alone is not expected to result in attainment of the water quality objectives. The objectives can be met consistently only by providing more dilution or by treatment. (The DWR and the USBR are partially responsible for salinity problems in the southern Delta because of hydrologic changes that are caused by export pumping. Therefore, this order amends the export permits of the DWR and of the USBR to require the projects to take actions that will achieve the benefits of the permanent barriers in the southern Delta to help meet the 1995 Bay-Delta Plan’s interior Delta salinity objectives by April 1, 2005. Until then, the DWR and the USBR will be required to meet a salinity requirement of 1.0 μS/cm. If, after actions are taken to achieve the benefits of barriers, it is determined that it is not feasible to fully implement the objectives, the SWRCB will consider revising the interior Delta salinity objectives when it reviews the 1995 Bay-Delta Plan.” (Section 10.3.2)

“This decision requires the USBR to meet the Vernalis objective using any measures available to it. This decision also requires the DWR and the USBR to meet a salinity requirement of 1.0 μS/cm at the interior southern Delta stations.” (Section 10.4)

“[T]his decision amends the permits of the USBR that include diversion of water through the Delta Cross Channel and the permits of both the USBR and the DWR that include diversions of water in the southern Delta to require that the Delta Cross Channel objectives and the objectives for export pumping rates be met.” (Section 13.1)

“[O]n an interim basis, this decision requires that the DWR and the USBR meet all flow-dependent numeric objectives in the 1995 Bay-Delta Plan that are not assigned to other parties.” (Section 13.2)

D-1641 is available at http://www.waterrights.ca.gov/hearings/d1600_d1649.html

SWRCB, 2000, *Revised Water Right Decision 1641*

12. Appendix 6.
1990 Rainbow Report and 2000 SJVDIP Evaluation

Much of the west side of the San Joaquin Valley is highly productive irrigated farmland that has experienced drainage problems for more than a century. "*A grower experiencing economic loss under* [poor drainage conditions] *has three choices: (1) Grow more salt-tolerant or boron-tolerant plants (at less profit), (2) abandon irrigated agriculture on this land, or (3) apply drainage management to this land*."* The 1990 *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley* (Rainbow Report) looked at drainage conditions in the San Joaquin Valley and presented a strategy for slowing the progression of drainage impairment due primarily to salt buildup in the basin. The report estimated that taking no action "*would likely lead to soil salinization and the abandonment of about 460,000 acres of irrigated agricultural land by 2040*."**, and recommended source control, drainage reuse, evaporation systems, land retirement, groundwater management and controlled, limited discharge to the San Joaquin River as tools to manage drainwaters. The report also recommended institutional changes such as tiered water pricing and the formation of regional drainage management entities.

In 2000, a multi-agency drainage management group (SJVDIP) evaluated the 1990 plan and found that many of these recommendations are being implemented in the study area; however not to the extent anticipated in 1990. The update also found that technological advances in drainage treatment, success of alternative and compensatory wildlife habitat, and the possibility that recovered salts could be used for commercial purposes were new issues that would weigh in future drainage management decisions.

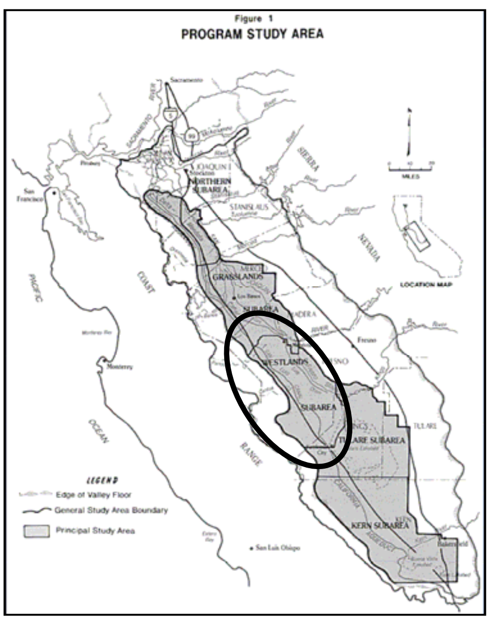


Figure 1
PROGRAM STUDY AREA

The report recommends specific actions for each Westside region identified as impacted by "problem water"—near surface groundwater causing a drainage impediment. The stated intent is to maintain agricultural production during the planning period (1990-2040), and that when/if salt removal becomes necessary, appropriate infrastructure to minimize drainage and isolate contaminants will already be in use.

In 1990, the anticipated cost to implement all recommended actions of the Rainbow Report in all subareas was $42M. Fifteen years later (2005),

* Rainbow Report, Chapter 4

** Rainbow Report, Chapter 5

overall costs to implement drainage service to 379,000 acres of drainage impaired land in the San Luis Unit is anticipated to range from $695M-$945M, according to the draft EIS for the San Luis Unit Drainage Feature Reevaluation. The Rainbow Report study area is shaded in the figure above. The SLU service area is roughly the portion of the study area contained in the oval.

To implement the plan, the report recommended specific actions for each subarea. The report also recommended funding source control actions through government loan & grant programs. USDOI & the state were charged with providing technical assistance, and when necessary, promulgating new rules, regulations &/or legislation consistent with the recommendations of the plan.

The SJVDIP's evaluation included recommendations for additional studies on drainage management and treatment, wildlife protection, and retired land management; development of computer modeling tools; institutional changes in the areas of selenium criteria, regulations that balance the needs of fish and wildlife with those of agriculture, and if groundwater management is contemplated as a drainage management tool, a coordinated groundwater monitoring program.

References
San Joaquin Valley Drainage Program, September 1990, *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley* (Rainbow Report) http://www.owue.water.ca.gov/docs/RainbowReportIntro.pdf

San Joaquin Valley Drainage Implementation Program, 2000, *Final Report: Evaluation of the 1990 Drainage Management Plan for the Westside San Joaquin Valley, California* http://www.owue.water.ca.gov/docs/03-ahccfinalrpt.pdf

13. Appendix 7.
San Luis Unit Drainage – Alternatives under Consideration

BACKGROUND

The US Bureau of Reclamation (USBR) operates the Central Valley Project (CVP), providing water to Central Valley irrigators. Much of the land within one service unit – the San Luis Unit (SLU)—is characterized by drainage problems. After CVP water deliveries were initiated in the mid-1950s, USBR began building a drain in order that the lands receiving CVP water could discharge saline tailwater and tilewater out of the basin. Several miles of the San Luis Drain were built but construction came to a halt when waterfowl deformities were linked to high selenium drainage discharges from the SLU entering the Kesterson wildlife area. The irrigators were prohibited from discharging selenium-laden drainage through their historic drainage channels, which feed the San Joaquin River, its tributaries, and area wetlands. The farmers in the northern portion of the San Luis Unit (Grassland Drainage Basin) opted to continue to discharge while being regulated under WDRs but the largest district in the unit (Westlands Water District) chose instead to cease out-of-district drainage discharges. In 2000, USBR was ordered to provide drainage service to the unit.

The Bureau of Reclamation has issued a draft EIS outlining seven action alternatives to provide drainage service to the San Luis Unit on the west side of the San Joaquin River Basin.

PROJECT SUMMARY:

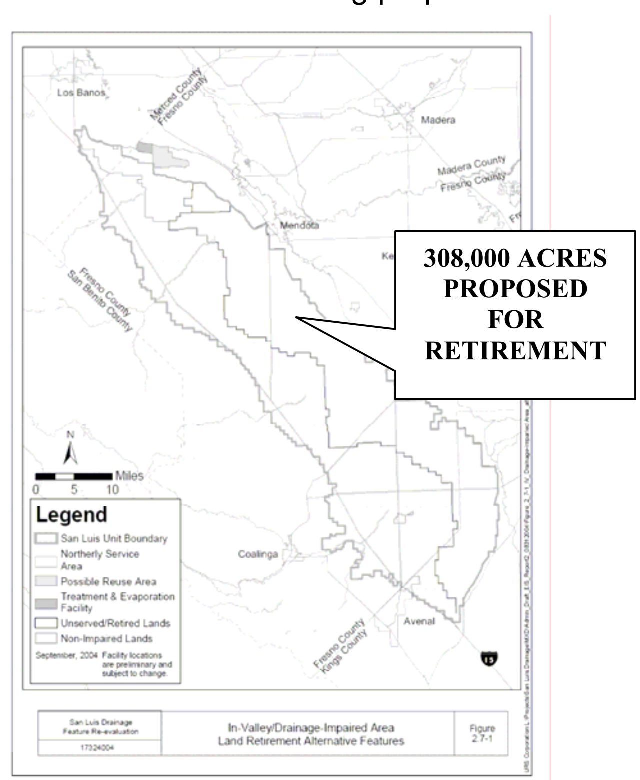
- 379,000 acres anticipated to need drainage service
- 16 reuse areas proposed (all alternatives)
- 4 RO & biotreatment facilities (In-Valley and Bay-Delta alternatives)
- 4 new evaporation basins (In-Valley alternatives)
- Land retirement featured in 3 of 4 In-Valley alternatives, although some land retirement is already taking place.
- In-Valley alternatives are phased in over an unspecified number of years
- Out-of-Valley alternatives require construction of a conveyance channel, so these require a major commitment of resources at the outset.
- Full drainage service will not be a reality for several years (projections show 2009-2014, depending on the alternative, however the In-Valley alternatives are phased in as funding allows, so the timelines for In-Valley alternatives shown in the DEIS may be overly optimistic)
- None of the alternatives can be fully implemented under the Bureau's current funding levels

The Seven ACTION Alternatives

In-Valley	Out-of-Valley
Original In-Valley proposal –land retirement not part of drainage service (44,000 acres retired)	Ocean Disposal at Point Estero
"Groundwater quality" – all land (93,000 Ac) with >50ppb selenium is retired	Delta disposal at Chipps Island
"Water needs" – enough land is retired (194,000 Ac) that land remaining under irrigation gets a full allotment of CVP water (100% of calculated needs). The assumption is that in any given year, the Bureau will deliver approximately 70% of the CVP water allotment	Delta disposal at Carquinez Strait
Maximum land retirement – 308,000 of the 379,000 acres needing drainage service are retired (not in Northern area)	

If an out-of basin alternative is selected, some now-retired land may again be irrigated, subject to water availability. The Bureau estimates that the costs to implement drainage service will be anywhere from $700M - $950M.

COMMENTS SUBMITTED BY CVRWQCB
Staff had several concerns with the alternatives under consideration and submitted comments during the CEQA review period. In brief, staff expressed concern that source control had been inadequately addressed; that evaporation basins were being proposed as a final disposal option (the Tulare Lake Basin Plan presents evaporation basins as an interim salt management tool, not a final solution); and that appropriate were lacking on the environmental consequences and feasibility of the drainage management, treatment and disposal options under consideration.



LONG TERM CONTRACT RENEWAL
The purpose and goals of the Bureau's Drainage Feature Reevaluation make it clear that the SLU DFR DEIS is the Bureau's draft mitigation strategy for delivery of imported salts with irrigation supplies through the CVP. The Bureau is in the process of negotiating long term (25-year) water contracts with their agricultural users, including districts in the San Luis Unit. Staff provided comments on the initial environmental document made available for the unit, observing that the significant cumulative

effects of importing salt to the Basin had been ignored. The Bureau issued a revised document, which staff also commented on, observing that although the Bureau had included salt impacts in this draft, it was premature to adopt a NEPA finding when the mitigation (drainage service) for the proposed action (delivery of contract water to the service area) was still uncertain (a preferred alternative has not been identified and a NEPA finding has not been adopted). At this writing (10 March 2006), final NEPA documents have not been issued for either action.

PREFERED ALTERNATIVE

At the 29 March 2006 Salinity and Drainage annual meeting in Sacramento, Jerry Robbins of the Bureau of Reclamation announced that the In-Valley/Drainage-Impaired Area Land Retirement alternative had been identified as the preferred alternative for providing drainage service to the San Luis Unit.

In brief, the salinity issues addressed in the SLU DFR are:

- Significant portions (379,000 A) of the irrigated agricultural lands on the west side of the San Joaquin Basin are impacted by salinity and shallow groundwater (drainage impaired).

- The CVP imports salt to the basin. Without mitigation, drainage problems will get worse.

- Salinity impairments can be mitigated through out-of-basin disposal or through in-basin management (at least over the short term). The costs for either approach are considerable.

- Drainage management actions in this unit must include control of selenium.

San Luis Drainage Feature Reevaluation Draft Environmental Impact Statement, 3 June 2005, http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=61

San Luis Unit Long Term Contract Renewal Environmental Impact Statement, 30 September 2005, http://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=63

14. Appendix 8.
Social, Economic and Environmental Information from the Great Valley Center

The Great Valley Center is a Modesto-based think tank focused on Central Valley issues. From their website: "The mission of the Great Valley Center is to support activities and organizations that promote the economic, social and environmental well-being of California's Great Central Valley." The following information has been excerpted from GVC material and reports prepared by other entities and made available on the GVC website: http://www.greatvalley.org . It has been sorted and grouped under the following headings:

1 Societal trends

1.1 Population GROWTH

In 2003, over 3.5 million people resided in the SJV, an increase of 1.5 million since 1980, a population increase of 75.0%. (CRS)

The SJV population is projected to grow by 14.3% between 2003 and 2010 compared to projected growth rates of 10.6% for California and 6.2% for the United States. Projected population growth for the SJV between 2003 and 2020 is 39.0% compared to a growth rate of 15.5% for the United States and 23.6% for California (CRS)

By 2040, [the Central Valley's population] is expected to more than double again, rising from 5.7 to some 12 million people. (Orfield, 2004).

Growth is projected to be particularly rapid in the North San Joaquin Valley (29%) and in the Sacramento Metropolitan Region (27%). (GVC, 2005-economy)

New housing and commercial developments in the Valley are occurring largely at the edges of the region's metropolitan areas, increasing the need for new infrastructure and placing pressure on the Valley's unique agricultural and environmental resources. (Orfield, 2004).

Although population density varies widely on a county-by-county basis, it is important to remember that large parts of some counties are virtually unpopulated, while many people live in the limited space of cities and towns. (2002, Umbach)

1.2 SOCIOECONOMICS

Although agriculture is perhaps the most significant socioeconomic feature of the SJV today, the SJV is undergoing changes that suggest a more diversified economic base over the next 20 years will be necessary to support the region's growth. The SJV currently attracts a large proportion of lower skilled workers from across the state as well as from significant international migration. At the same time, the South SJV is also losing its higher-skilled workers. Between 1995 and 2000, these counties had a net migration increase in the number of adults without high school diplomas and a net decrease of college graduates. Along with the Sacramento metro region and the Riverside-San Bernardino region, the SJV was among the three fastest growing regions in the state, accounting for nearly 4 of every 10 new residents of the state during the 1990s. While natural increase was the largest component of population change in the Valley during the 1990s, international migration was also a significant source of the San Joaquin's growth, as was migration from coastal areas where housing costs rose significantly during the decade. (CRS)

Significant concentrations of poverty, unemployment, and other social stresses continue to plague communities throughout the Central Valley. (Orfield, 2004).

1.3 EMPLOYMENT AND INCOME

Per capita income in the Central Valley is 26% lower than the state average and falling further behind. If the Central Valley were a state, it would rank 48th in per capita income. (GVC, 2005-economy)

Madera County ranked among the 10 lowest per capita income Metropolitan Statistical Areas (MSAs) in the United States in 2003, and the other 5 MSAs in the San Joaquin were all in the bottom 20% of all U.S. MSAs. Other indicators of social well-being discussed in the report showed that the SJV is a region of significant economic distress. (CRS)

The three leading sectors of employment in the eight-county SJV are government, agriculture, and health services. (CRS)

From 1994 to 2003, the Central Valley as a whole lost jobs in two industries: natural resources and mining (2,650 jobs or 20.6%), and farming (nearly 10,000 jobs or 4.9%). There were wide variations among regions. Eighty-five percent of the lost farming jobs were in the South San Joaquin Valley, while the North San Joaquin Valley gained 1,600 farming jobs (4.1%). Mechanization of farming processes and the change to less labor intensive crops are factors in the loss of farm-related jobs. (GVC, 2005- economy)

Industries that produced goods (manufacturing, construction, and natural resources and mining) provided 14% of Central Valley jobs. Farming provided 9% directly, with an additional 11% counted in other industries. The percentage of farm jobs varied widely throughout the region, ranging from 1.4% of jobs in the Sacramento Metropolitan Region to 17% in the South San Joaquin Valley. (GVC, 2005-economy)

There were 243,079 hired farm workers in the SJV in 2002 accounting for about 8% of the hired farm workers in the United States and 45% of California's hired farmworkers (CRS)

The service sector accounted for about 77% of the jobs in the Central Valley in 2003. Agricultural employment actually declined in the Central Valley by 10,000 jobs between 1994-2003, with 85% of these jobs losses occurring in Fresno, Kern, Kings, Madera, and Tulare counties. (CRS)

Agriculture provides nearly 20% of jobs in the Central Valley. Eight and a half percent are directly related to agriculture, such as farm laborers. Eleven percent are from businesses based on agriculture, such as food processing or farm management. Statewide, agriculture provides 5.8% of jobs, 2.5% directly and 3.3% indirectly. (GVC, 2005- economy)

Much agricultural employment is seasonal, which contributes to relatively high unemployment. Pay tends to be low, which contributes to low per capita and household incomes. However, agricultural products are needed all year round, and for that reason they are somewhat protected from the ups and downs that can more strongly affect other areas of the economy. California's role as sole or predominant supplier of some products is also important to the economic stability of agricultural counties. (Umbach, 2002)

The proportion of the population living in poverty in the SJV is high, nearly 22% in 2002. This compares to a rate of approximately 13% for California. The SJV also had the highest rate of poverty among eight geographic regions in California. (CRS)

The 2000 poverty rate for the SJV (20.5%), for example, was higher than the national rate (12.4%), California (14.2%), and the 410 county ARC [Appalachian] *region (13.6%). While the SJV's poverty rate was somewhat closer both to the* *national and California averages in 1980, the SJV counties saw significant increases in their poverty rates by 1990. These high rates continued to increase during the 1990s and increased between 1990 and 2000. However, in 2003, the rates declined somewhat in the 5 counties for which there were data, as they did in California.* (CRS)

For persons 16 and over, the SJV civilian unemployment rate grew from 9.5% 1980 to 11.9% in 2000. The rate for California over that period increased from 6.5% to 7.0%. In the United States, the civilian unemployment rate fell from 6.5% in 1980 to 5.8% in 2000, although the rates for both California and the United States increased from 2000-2003. (CRS)

Per capita income in the SJV grew 133% between 1980 and 2000, from $6,780 to $15,798. The SJV's per capita income rose to 73% of the national per capita income in 2000. This gain was less than the per capita income growth during that time for California (174%) and the United States (196%). (Per capita income among the SJV counties for which there are data continued to grow between 2000-2003). (CRS)

On average, median family income in the SJV in 2000 was approximately $13,000 less than the median family income of California. (CRS)

1.4 FEDERAL SPENDING

Fewer Federal dollars are spent per capita in the Central Valley than in the rest of California. Fewer dollars are spent per capita in California than in other states. Federal spending per capita in the Central Valley is only 69% of the national average. This is below California's per capita Federal spending of 90% of the national average. (GVC, 2005- economy)

Most SJV counties received approximately $1,240- $2,800 [federal $$] per capita less than the national per capita rate in 2002. (CRS)

Grants are the second largest category of federal expenditures in the SJV after retirement and disability. Grant expenditures to the SJV amounted to $3.87 billion in FY2002 for a per capita rate on $1,107. This rate is 22.5 % less than the rate for the United States ($1,430) and nearly 20% less than the rate for California ($1,369). As with virtually all of the CFFR categories, no individual SJV county had a per capita grant rate that was as high as the grant rate for either the United States or for California. (CRS)

The SJV, with its high production in unsupported fruits and vegetables, does not receive commodity support payments per farm to the same extent as other parts of the United States where production of supported crops is much higher. In 2000, direct government payments to California amounted to $667 million out of total federal direct agricultural payments of $22.9 billion, about 3% of all direct federal *payments for agriculture.98 In contrast, Iowa received about 10% of U.S. payments and Texas received about 7%.(CRS)*

Led by Kings, Fresno, and Kern Counties, the average federal agricultural support payment to farms receiving payments in the SJV was nearly $29,000 compared to a national average of $9,251 and a California average of $23,340. (CRS)

1.5 REGIONAL PARTNERSHIPS

A 2001 statewide survey of California residents found that a substantial majority believe that local governments should take a regional approach with respect to land use, environmental, transportation, and related growth issues that focuses more on public-private partnerships rather than regional government. Proponents of regional approaches share the view that the historic pattern of community-based economic development may no longer address the complexity of development issues that can characterize a larger geography. The fiscal problems in many states are also creating pressures on many communities to seek new solutions to providing essential community services through pooling resources. (CRS)

2 RESOURCES

2.1 SOIL DRAINAGE

In the San Joaquin Valley, poor soil drainage causes increased salinization, a process in which water-soluble salts accumulate in the soil, preventing plants from taking up enough water and ultimately ruining farmland. In the western part of the San Joaquin Valley, soil has both a naturally high salt content as well as thousands of acres with a shallow, low-permeability layer of clay. There are about 1.5 million drainage impaired acres in the San Joaquin Valley, primarily in the west. (GVC, 2005- environment)

Many farmers are successfully working around poor soil drainage conditions. A new procedure to remove excess and high-salinity water is Integrated On-Farm Drainage Management (IFDM). IFDM provides an alternative to land retirement, removes salts from crop root zones, and provides for the productivity of high yield commercial crops in a sustainable way. The IFDM is a subsurface drainage system that reuses irrigation water on salt sensitive crops, then on salt tolerant crops to solar evaporators which stores the salts for future beneficial use. (GVC, 2005- environment)

NOTE: Few IFDM systems are in use at this time. The SB has adopted regulations allowing their implementation, but careful management is needed to minimize adverse impacts. (gpc)

Farmers typically install underground drainage systems that remove excess and high-salinity water. The main challenge is to dispose of this water in a way that minimizes negative environmental impacts. Some farmers are working to reduce the environmental impact of varying soil drainage by creating enclosed systems that hold toxic chemicals and stop them from entering groundwater and surface *water. Farmers are also improving efficiency of water use, reusing drainage water on more salt-tolerant crops, developing drainage treatment systems to remove salts, and retiring lands with high salinity. (GVC, 2005- environment)*

NOTE: The drainage discussion in this report may be misleading, as the options discussed are not in widespread use in the CV. Drainage reuse projects such as the one operated by Panoche Drainage District need careful management & land permanently dedicated to salt tolerant crops. Reuse alone is not a permanent solution. There have been several attempts at drainage treatment in the CV, but large-scale, cost efficient, effective drainage treatment is still largely at the pilot study stage. (gpc)

2.2 WETLANDS AND WATERFOWL

Valley wetlands have been reduced from 4 million acres to less than 300,000 acres. (GVC, 2005- environment)

Four million acres of the Central Valley once consisted of fertile seasonal wetlands. Much of the historic wetland cover in California, particularly in the Central Valley, has been and continues to be lost to agriculture and urban expansion. The Central Valley today has less than 10 percent of the wetlands that existed before settlement by Europeans. Today, wetland resources in the Central Valley have diminished to below 300,000 acres. The disappearance both seasonal and permanent wetlands is highly associated with population declines of 41 of the state's rare and endangered species. (GVC, 2005- environment)

60% of the migratory waterfowl of the Pacific Flyway are supported by the resources of the Central Valley. (GVC, 2005- environment)

2.3 LAND USE

From 1990 to 2002, 283,277 (3.7%) irrigated farmland acres were converted to other uses. While it is not possible to identify precisely how this land is now used, most of it was converted to urban uses. The remaining acreage was converted to low-density rural development, grazing land, habitat restoration and other uses. During the same period, the rate of urbanization has increased with 167,182 acres urbanized, a 23% increase. The San Joaquin Valley, which contains six of the top seven agricultural counties in California, is experiencing the greatest amount of farmland loss. (GVC, 2005- economy)

The Valley as a whole has nearly 10 million acres of farmland and over 28,000 farms. Fresno and Tulare Counties have the largest number of farms while Kern County has the largest acreage in farmland. Kern and Fresno Counties also have the largest number of farms of 1,000 acres or more, although the average size farm in the Valley is 436 acres. (CRS)

2.4 AGRICULTURAL PRODUCTION

Agriculture plays a vital role in California's economy, with a value of more than $30 billion in 2002.Agriculture contributes positively to the U.S. balance of trade payments. (GVC, 2005- economy)

In 2002 the San Joaquin Valley accounted for 88% of the Central Valley's agricultural output, compared with 6% for the North Valley and 6% for the Sacramento Metropolitan Region. GVC, 2005- economy)

The average market value of agricultural product sales per farm in 2002 in the United States and California was $94,245 and $323,205 respectively according to data from the most recent Census of Agriculture. For the SJV, the average agricultural market value per farm of the eight counties was $494,892, with over 9,000 farms producing sales of $100,000 or more. The total market value of crops in the SJV was $8.1 billion and the total market value of livestock was $4.4 billion. Over 42% of the market value of crops and 67% of the market value of livestock in California come from the SJV. The SJV is in the top quartile of average sales per farm for the state. (CRS)

Much of SJV agricultural production is based on irrigation. Of the total 28,357 farms in the SJV, over 80% (23,482) have some portion of their farm under irrigation. Of the 1.44 million acres of total farm land on which some portion is irrigated, 76% of that acreage is irrigated. Over 10% of the farms that irrigate are 500 to 2,000 acres or more. Fresno and Tulare counties have the largest amounts of irrigated acreage, 1.1 million and 652,000 respectively. Mariposa and Tuolumne counties have only about 5,200 acres in irrigated land between them, while the SJV counties have a total of 4.73 million acres of irrigated farmland. The eight SJV counties represent about 54% of California's total irrigated acreage. Of that amount, 72% is located on farms of 500-2,000 acres or more. (CRS)

2.5 WATER USE (all from GVC, 2005-environment)

In wet years, water use declines; in dry years, it increases. For example, total water use in the Central Valley ranged from 598 billion gallons in wet 1998 to 686 billion gallons in the average rain year of 2000, to 709 billion gallons in the dry year of 2001. Lower water usage in 1998 reflects the excess rainfall received that year, while the higher number in 2001 reflects a drier year.

By hydrologic region:
In 2000, an average water use year, the Sacramento River hydrologic region used 280 billion gallons, or 7.4% of the State's total urban water use, for urban purposes. In 2001, a dry year, this number rose slightly to 7.9% or 285 billion gallons. This represents 4.6% of the Sacramento River hydrologic region's total water use.

The San Joaquin River hydrologic region used 193 billion gallons, or 6.7% of the State's total urban water used in 2000, and 202.9 billion gallons, or 7.3% of the

State's total in 2001. This represents 5.8% of the total water use for the San Joaquin hydrologic region in 2001. (GVC, 2005-environment)

The Tulare Lake hydrologic region that stretches from Madera County to Kern County used 212.9 billion gallons in 2000, or 9.7% of the State's urban water use total, and 220.8 billion gallons, or 10.3% of the State total, in 2001. This represents 5.5% of the total water used for the Tulare Lake hydrologic region in 2001.

In the Sacramento River Hydrologic Region, water use varies from 27.4% of the region's total in 1998 (a dry rainfall year), to 37.8% in 2000 (a normal year), to 45% in 2001 (a dry year). As a percent of the state total, this region used 25.5% of agricultural water in 2000 and 2001. This region is also the state's top producing hydrologic region for rice, having 506,800 acres in 1998, 567,200 acres in 2000, and 492,900 acres in 2001.

The San Joaquin River Hydrologic Region now uses the majority of its water for agriculture. In 1998, the region used 47% of its water for agriculture, in 2000 it used 57.3% and in 2001 it used 66.8%. As a percent of the state's total agricultural water used, this region used 20% in 1998, 20.5% in 2000, and 21.3% in 2001.

Grains, cotton, and corn are the main agricultural crops in the Tulare Lake hydrological region. This region used 69.3% of its water for agriculture in 1998, 84% in 2000, and 86% in 2001. As a portion of the state total, this region used 31.4% in 1998, 31.5% in 2000, and 31.4% in 2001.

As a portion of the state's environmental water use total, the Sacramento River hydrologic region had 27.6% of its water designated for environmental use in 1999, 34.2% in 2000, and 42.7% in 2001. The Sacramento River hydrologic region had the largest portions of its environmental water dedicated to delta outflow with 58% designated for delta outflow in 1998, 53.6% in 2000, and 46.7% in 2001.

The San Joaquin River hydrologic region accounted for 9.4% of the state's total environmental water use in 1999, 11.8% in 2000, and 13% in 2001. A large portion of the water for this hydrologic region was designated for wild and scenic rivers, with 65% in 1999, 45% in 2000, and 37% in 2001.

The Tulare Lake hydrologic region had smaller percentages as a portion of the state's total environmental water use, with 6% in 1999, 4% in 2000, and 5% in 2001. This hydrologic region, however, had the majority of their environmental water use designated for wild and scenic, with 98% in 1999, 94.7% in 2000, and 92.6% in 2001.

3 SUMMARY OF KEY ISSUES

The preceding information can be summarized as follows to provide an overview of the key social and economic issues that will factor in to a comprehensive salinity control strategy:

- Central Valley population growth exceeds State and National averages. The growth rate has accelerated in recent years.

- Population growth and urban expansion in the CV is not uniform. Cities see the heaviest growth, particularly near the edges of town. The trend may be most dramatic in large cities like Sacramento and Fresno, but mid- and small-sized cities (Modesto, Los Banos, Tracy, etc) are seeing the same pattern.

- Agriculture is still probably the major socioeconomic sector in the CV, and approximately 20% of Valley jobs are either directly or indirectly agricultural in nature. This percentage is almost quadruple the statewide percentage of agricultural and agriculturally related jobs.

- Household incomes and per capita income growth rates tend to be considerably lower than State and National averages. The percentage of CV residents living in poverty exceeds State and National averages.

- CV unemployment rates are higher than State and National averages

- The CV receives a lower per capita share of federal spending than the rest of the state and the rest of the country.

- The public appears to favor regional approaches to regional problems.

- There are approximately 1.5 million drainage impaired acres in the San Joaquin Valley. The GVC's inclusion of this information in their *State of the Central Valley – The Environment* report indicates that the issue is perceived as affecting more than just individual landowners.

- Historically, much of the CV consisted of wetlands, and the remaining wetlands and surrounding lands currently support the waterfowl that follow the Pacific Flyway. Only a small percentage of CV wetlands remain. A few observations to draw from this – groundwater under former wetlands may still be shallow; and evaporation rates in former and existing wetlands likely contributed to the build up of salts in surface soils.

- Agriculture remains a major land use in the CV, but (largely unmanaged) conversion of farmland is on the rise, fueled by the population demands discussed previously.

- Agriculture is a major economic engine in the CV. Most crops grown in the CV require irrigation, and 80% of the farms in the CV irrigate some or all of their land.

- Water use varies by water year type and by hydrologic region. In 2000 and 2001, the Sacramento Basin accounted for about 25% of California's agricultural water use; the San Joaquin basin used 20-21% of the ag water and the Tulare Basin used 31%.

- The Sacramento Basin used most of its environmental water for delta outflow; and the San Joaquin and Tulare Basins used most of their environmental water for wild and scenic waterways.

4 REFERENCES

Congressional Research Service (CRS), 12 December 2005, *California's San Joaquin Valley: A Region in Transition.*

Great Valley Center (GVC), 2005, *The State of the Great Central Valley: Assessing the Region Via Indicators—The Environment 2005.*

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Orfield, Myron, 2004, C*entral Valley Metropatterns: Regional Challenges in California's Central Valley.*

Umbach, Kenneth W., for the California Research Bureau, 2002, *San Joaquin Valley: Selected Statistics on Population, Economy, and Environment.* Publication CRB 02-010.

15. Appendix 9.
Representative Costs: Agriculture

Program costs will need to be addressed in depth as a comprehensive salinity management plan is developed, but there have been some previous economic analyses that shed some light on the anticipated costs of salinity management. The information in this section was taken primarily from the Bureau of Reclamation's *San Luis Drainage Feature Re-evaluation Draft Environmental Impact Statement* and Westlands Water District's *Analysis of Economic Impacts of Proposed Land Retirement in Westlands Water District.* These documents can be accessed at the URLs at the bottom of this section. Other supporting documents were also consulted, as noted. This information concerns a small portion of the Central Valley, and a single economic sector, but that sector (agriculture) is the dominant activity in this salinity-impacted area.
Drainage Feature

State Water Board Water Rights Decision 1641 identifies the actions of the CVP, operated by the US Bureau of Reclamation, as the principle cause of exceedance of the Vernalis salinity objective. As part of their drainage feature re-evaluation for the San Luis service unit, the Bureau has estimated the costs to mitigate the adverse impacts of importing Delta water and the associated salt load to Central Valley Project water customers in the drainage impaired lands within the service area. The Bureau intends to provide drainage service to 379,000 acres.

Westlands Water District Report
In 2003, Westlands Water District issued an economic analysis on the anticipated impacts of land retirement in the district. The analysis was in support of a proposal by the district to retire 200,000 acres in return for a firm water supply of 805,000 AF/yr. Under an interim contract, the district has an allocation of 1.15 MAF/yr, but due to limited supplies and the delivery obligations of the Central Valley Project, districts rarely receive their full allotment. The proposal was aimed at securing a smaller but more reliable supply, but the proposal was rejected.[1] Although some of the basic assumptions of the analysis are no longer valid, the report is still useful in illustrating the types of impacts that can be anticipated as salinity increases in district soils and shallow groundwater.

Value of land removed from production
The Bureau's National Economic Development analysis estimated agricultural land values in the San Luis Unit to be between $2456 and $ 2600 per acre; respectively, the projected discounted net income from farmed land and the 2004 market value for land purchase. These numbers reflect the cost to the national economy if the land were removed from production.[12] The analysis looked at the cost of retiring land but these

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[12] Bureau of Reclamation, San Luis Drainage Feature Re-evaluation Plan Formulation Report Addendum, 2004

numbers would also reflect lost productivity when soil salinization increases to the point where it is no longer profitable to farm. Areas outside the San Luis Unit would be valued differently, but the unit is a useful case study.

Maintenance costs for non-irrigated land

When land is retired it may remain in non-irrigated agricultural production for grazing or dryland farming, fallowed, or converted to upland wildlife habitat. The Bureau has estimated the net cost per acre to support grazing to be $47, the cost for dryland farming to be $50, and the cost of fallowing to be $30. This includes the capital costs (field preparation and planting), the operation, maintenance and replacement costs (harvest, weed management, etc.) [13] and potential offsetting revenue from these activities. As with all commodity prices, revenues will vary with demand. Costs for converting retired agricultural land to upland habitat have not been explored to any great extent. The Bureau is operating a land retirement demonstration project where land is being developed for habitat use; so cost estimates may be developed in the future.[14]

Drainage service and avoided losses/avoided costs

The Bureau has estimated that by providing drainage service to the San Luis Unit, avoided losses to agricultural revenues for the area will range from $7.7 M to $30.6 million annually. Alternatives relying on significant land retirement are at the low end, but with less land to irrigate alternatives with land retirement allow the area to avoid cost by reducing purchases of supplemental water.

Changing projections

The Bureau found that the differences in the estimated cost to implement drainage service alternatives have been shrinking. That is, alternatives that were originally not considered feasible may deserve further consideration. A feasibility analysis is underway.

Construction and operation cost for drainage service to 379,000 drainage-impaired acres--USBR

From the San Luis Drainage Feature Ere-evaluation draft Environmental Impact Statement:

> *Some expenditures occur only once at the beginning of the project. Typically, these nonrecurring costs are from constructing certain project features. Nonrecurring expenditures are displayed for each drainage disposal alternative in Table 17-4. Other costs are incurred every year. These annual expenditures include (1) costs of operating and maintaining project facilities, (2) costs of constructing certain project*

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[13] Weed management is necessary to prevent the spread of invasive and otherwise undesirable plant species to surrounding farms. Abandoned land, in contrast with retired land, may not be implementing this "good neighbor" policy.

[14] More information on the USBR land retirement demonstration project can be found at: http://www.usbr.gov/mp/cvpia/3408h/demonstration_project.html

features built or installed as needed to provide the necessary capacity to handle the projected quantity of drainwater as it increases over time, (3) avoided farm revenue losses from a restricted crop mix, and (4) avoided irrigation management costs. These estimated annual costs are listed in Table 17-5.

Table 17-4
Project Implementation Expenditures ($000)

Project Cost Items	Disposal Alternatives						
	In-Valley	In-Valley/ Groundwater Quality Land Retirement	In-Valley/ Water Needs Land Retirement	In-Valley/ Drainage-Impaired Area Land Retirement	Ocean	Delta-Chipps Island	Delta-Carquinez Strait
Conveyance System	27,825	26,676	23,703	2,046	302,510	205,764	271,987
Evaporation Basins	176,606	157,241	124,505	59,712	0	0	0
Mitigation Facilities*	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reverse Osmosis Facilities	42,421	39,596	34,772	12,880	0	0	0
Biological Selenium Treatment	75,221	65,871	49,679	26,125	0	137,805	113,363
Land Retirement	0	147,930	455,701	796,962	0	0	0
Drainage Collection System	186,150	156,886	87,000	2,250	187,500	187,500	187,500
Regional Reuse Facilities	96,445	79,524	50,972	16,215	97,079	97,079	97,079
DMC Drainage Collection/Reuse	1,850	1,850	1,850	1,850	1,850	1,850	1,850
Drainwater Recycling	54,476	46,289	30,728	11,857	54,777	54,777	54,777
Seepage Reduction	10,689	10,689	10,689	10,689	10,689	10,689	10,689
Shallow Groundwater Mgt	0	0	0	0	0	0	0
On-Farm Tile Drainage System	109,371	92,072	50,762	3,990	110,168	110, 168	110, 168
Total	**781,054**	**824,624**	**920,361**	**944,578**	**764,573**	**695,464**	**737,245**

Note:

*Mitigation facilities, such as alternative and/or compensation habitat including wetlands, may be a component of any of the action alternatives. Sufficient detail is not currently available for calculation of costs.

Table 17-5
Annual Project OM&R Expenditures ($000)

Project Cost Items	Disposal Alternatives						
	In-Valley	In-Valley/ Groundwater Quality Land Retirement	In-Valley/ Water Needs Land Retirement	In-Valley/ Drainage-Impaired Area Land Retirement	Ocean	Delta-Chipps Island	Delta-Carquinez Strait
Conveyance System	117	104	76	37	4,150	960	965
Evaporation Basins	1,991	1,726	1,280	710	0	0	0
Mitigation Facilities*	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reverse Osmosis Facilities	8,034	6,999	5,066	2,694	0	0	0
Biological Selenium Treatment	2,265	2,007	1,566	771	0	4,130	4,130
Land Retirement	760	1,604	3,362	5,312	760	760	760
Drainage Collection System	3,014	2,546	1,428	72	3,036	3,036	3,036
Regional Reuse Facilities	3,596	3,116	2,306	1,320	3,614	3,614	3,614
DMC Drainage Collection/Reuse	19	19	19	19	19	19	19
Drainwater Recycling	810	732	546	320	814	814	814
Seepage Reduction	-19	-19	-19	-19	-19	-19	-19
Shallow Groundwater Mgt	780	657	366	11	785	785	785
On-Farm Tile Drainage System	2,044	1,739	1,154	446	2,054	2,054	2,054
Total Project Costs	**23,411**	**21,230**	**17,150**	**11,693**	**15,213**	**16,153**	**16,158**

Note:

*Mitigation facilities, such as alternative and/or compensation habitat including wetlands, may be a component of any of the action alternatives. Sufficient detail is not currently available for calculation of costs.

Construction and operation cost for drainage service to 200,000 drainage-impaired acres--WWD

The following table differs markedly from the Bureau's estimates, but it assumes drainage service to 200,000 acres rather than 379,000. Additionally, the Westlands estimate does not include all features included in the Bureau tables and vice versa.

Table 1
Westlands Water District
Estimated Drainage Rate Impacts

Assumptions: 200,000 acres drained, drainage system completed in year 2010, costs is 2001 dollars

Line			*Totals*
1	**Total Facility Costs**		
2	Drain Facility Cost **	$266,633,037	
3	Water Treatment Facility Cost **	$150,000,000	
4	Installation of On-Farm Drainage Collector System @ $350.00/acre for 158,000 acres	$ 55,300,000	
5	Installation of Collector System Facility Cost @ $50.00/acre for 158,000 acres	$ 7,900,000	
6	Refurbish Existing Collector Facilities @ $25.00/acre for 42,000 acres	$ 1,050,000	$480,883,037
7			
8	**Cost Allocation**		
9	Westlands Water District Share	87.89%	
10	San Luis Water District Share	7.22%	
11	Panoche Water District Share	4.89%	100.00%
12			
13	**Westlands Share of Facility Costs**		
14	Drain Facility Cost	$234,335,493	Rates
15	Water Treatment Facility Cost	$131,830,340	Rates
16	Installation of On-Farm Drainage Collector System	$55,300,000	Assessment
17	Installation of Collector System Facility Cost	$7,900,000	Assessment
18	Refurbish Existing Collector Facilities	$1,050,000	Assessment
19	Unpaid San Luis Drain charges as of Sept 30,1999	$40,870,681	
20			
21	49% Water Supply Acre-Feet Delivered 2011 – 2030	11,270,000	
22	Irrigable Acreage	540,000	
23	Drained Acreage		
24	**Water Rate-Based Charges**		
25	49% Water Supply Capital Rate per Acre-foot		
26	Drain Facility Cost	$20.79	
27	Water Treatment Facility Cost	$11.70	
28	Unpaid San Luis Drain charges as of Sept 30,1999	$ 3.63	$36.12
29	**Acreage-Based Charges**		
30	Installation of On-Farm Drainage Collector System	$ 13.83	
31	Installation of Collector System Facility	$ 1.98	
32	Refurbish Existing Collector System Facilities	$ 0.26	$16

Lines:	*Explanation*
2-6	The estimated project costs in year 2001 dollars.
9-11	The factors used to allocate these dollars to each participating water district are then reported.
14-18	Westlands' share of the project costs.
19	Westlands outstanding costs for prior drainage services.
21	Expected water deliveries in af over the twenty year period 2011-2030
22	Irrigable acreage
25-28	Water rate charges (costs divided by expected af deliveries)
30-32	Acreage assessment charges (costs divided by drained acreage divided by 20 years)

Short term and long term economic effects of drainage service
In the short term, there is no anticipated variation between no action and drainage service as far as agricultural production, employment, employee compensation, proprietor income, property income, or property tax revenues. Over the long term (through 2020), the differences begin to show up. Agricultural production is 11.5% better, farm sector employment is 12.8% better, and all other sectors considered are more favorable under the drainage-provided scenario.

Short term and long term economic effects of land retirement
There is a marked short-term decline in jobs and property income when land is retired on the scale proposed in the Westlands report. Similar, if slower impacts could be anticipated when land is taken out of production due to salinity problems. Long-term impacts are less certain, as this analysis assumed more favorable terms could be negotiated for supply water than has occurred.
Regional economic impacts
Without drainage service, property tax, sales and excise tax revenues and attendance related school funding would decline in impaired areas. If drainage service is provided, these funding streams increase as land productivity improves.
Water contracts and land values

Regarding the uncertainty of CVP water supplies, the report states: *Over the long-term, less reliable and more expensive water will reduce district farm revenues, limit cropping choices, and erode land values.* The report goes on to say that land values for exchange contract lands, with their firmer water supplies, are 1.3 to 2 times higher than for service contract land.

Crop values – 2001 snapshot
In 2001, Westland produced crops valued at $841,076,455 on 561,788 acres. Drainage-impaired land is included in this total. 2001 was a dry water year type, with 49% of the contract allocation delivered. 73,802 acres in the district were fallowed. While there has been a shift in cropping patterns in recent decades, these are being driven by numerous factors, so no projections can be made.

Table 4.5
Comparison of Crop Yields In Westlands Water District
Year 2020
(Tons per Acre)

	Remainder of District	Shallow Groundwater	Ratio
Alfalfa	8.972	4.98	56%
Alfalfa seed	0.334	0.189	57%
Almonds	0.71	0	0%
Citrus	12.16	0	0%
Field corn	4.12	0	0%
Cotton	2.66	2.605	98%
Dry beans	1.02	0	0%
Fresh tomato	18.52	0	0%
Melon	10.481	6.094	58%
Misc. grain	2.12	2.11	100%
Misc. hay	2.6	0	0%
Misc. vegetables	23.74	3.763	16%
Oilseed	1.648	1.137	69%
Olives	4.158	2.116	51%
Onions	19.441	0	0%
Pasture	15	14.929	100%
Peaches	10.022	0	0%
Potato	18.54	0	0%
Prunes	4.272	0	0%
Processing tomato	34.153	15.235	45%
Raisin Grapes	9.18	0	0%
Rice	3.8	0	0%
Sugar beets	30.1	28.155	94%
Walnuts	1.826	0	0%
Wine grape	8.71	3.195	37%
Wheat	3.045	2.791	92%

Anticipated crop yield reductions
The preceding table shows the anticipated difference in yields for crops grown in the drainage impaired area (shallow groundwater column), and the rest of the district by 2020.

Drainage project costs in the Grassland area

Much of the Grassland drainage basin is located within the San Luis Unit service area. This basin has been able to manage some of their salt problems through a number of projects primarily aimed at control of selenium. When USBR implements drainage service to the San Luis Unit, this area will be included. The districts in the basin have pioneered many of the in-valley alternative features under consideration in the drainage feature re-evaluation. Not every project has been effective: selenium treatment projects have had only limited success and the cost effectiveness of reverse osmosis on the scale that will be necessary to adequately manage drainage is still unproven. Nevertheless, these projects are good indicators of the types of activity that must be considered in a Salinity Management Program. The drainers anticipate that an additional $82M will be needed to fully implement a comprehensive in-valley drainage solution for the San Luis Unit. The following tables are from their October 2004 report.[15]

Table 3
Grassland Drainage Area
Previous Funding for the In-Valley Drainage Solution

Project	Funding Source	Grant Funding	Loan Funding	District Funding	Total
Grassland Bypass Construction	SWRCB State Revolving Fund		$ 600,000		$ 600,000
Charleston D.D. Recirculation System	SWRCB State Revolving Fund		$ 320,000		$ 320,000
Charleston D.D. Recirculation System : CH-3	Charleston D.D.			$ 71,200	$ 71,200
Firebaugh Canal W.D. Recirculation Systems	Firebaugh Canal W.D.			$ 271,100	$ 271,100
Pacheco W.D. Drainwater Recirculation System	SWRCB State Revolving Fund		$ 1,375,000		$ 1,375,000
Panoche W.D. Drainwater Recirculation System	SWRCB State Revolving Fund		$ 4,228,000		$ 4,228,000
Pacheco W.D. Acquisition of Improved Irrigation Equipment	SWRCB State Revolving Fund		$ 737,500		$ 737,500
Panoche D.D. Acquisition of Improved Irrigation Equipment	SWRCB State Revolving Fund		$ 4,997,294		$ 4,997,294
Panoche D.D. Road Watering Project	Panoche D.D.			$ 12,000	$ 12,000
San Joaquin River Improvement Project (SJRIP)					
Land Purchase & Initial Development	Prop 13 (DA)	$ 17,500,000			$ 17,500,000
2004-05 Development Project	USBR	$ 904,100		$ 95,900	$ 1,000,000
Halophyte Development Project	USBR	$ 290,000		$ 15,000	$ 305,000
Grassland Integrated Drainage Management Proj.	Prop 13	$ 987,200		$ 246,800	$ 1,234,000
PE-5 Pump Station	Panoche D.D.			$ 13,200	$ 13,200
Algal-Bacterial Selenium Reduction Proj. (ABSR)	USBR/DWR/CalFed	$ 3,352,000		$ 225,000	$ 3,577,000
USBR: RO Pilot Plant		$ 440,000		$170,000	$ 610,000
		$ 23,473,300	**$ 12,257,794**	**$ 1,120,200**	**$ 36,851,294**

In-Valley Drainage Solution - Future Funding Schedule

Solution Component	2005	2006	2007	2008	2009	2010
Irrigation Improvements	$4,720,000	$4,600,000	$4,600,000	$4,600,000	$2,300,000	
Distribution Facility Improvements	$2,700,000	$5,400,000	$2,690,000			
BVWD Reuse Project			$440,000	$880,000		
Westland W.D. Shallow Groundwater Pumping			$1,000,000	$1,000,000	$1,000,000	
Groundwater Management				$6,000,000	$6,000,000	
SJRIP Expansion and Development	$4,170,000	$4,170,000	$4,160,000	$4,160,000	$4,160,000	
Treatment Plant Development	$1,600,000	$3,280,000	$3,270,000	$3,200,000	$3,200,000	$3,200,000
Total	**$13,190,000**	**$17,450,000**	**$16,160,000**	**$19,840,000**	**$16,660,000**	**$3,200,000**

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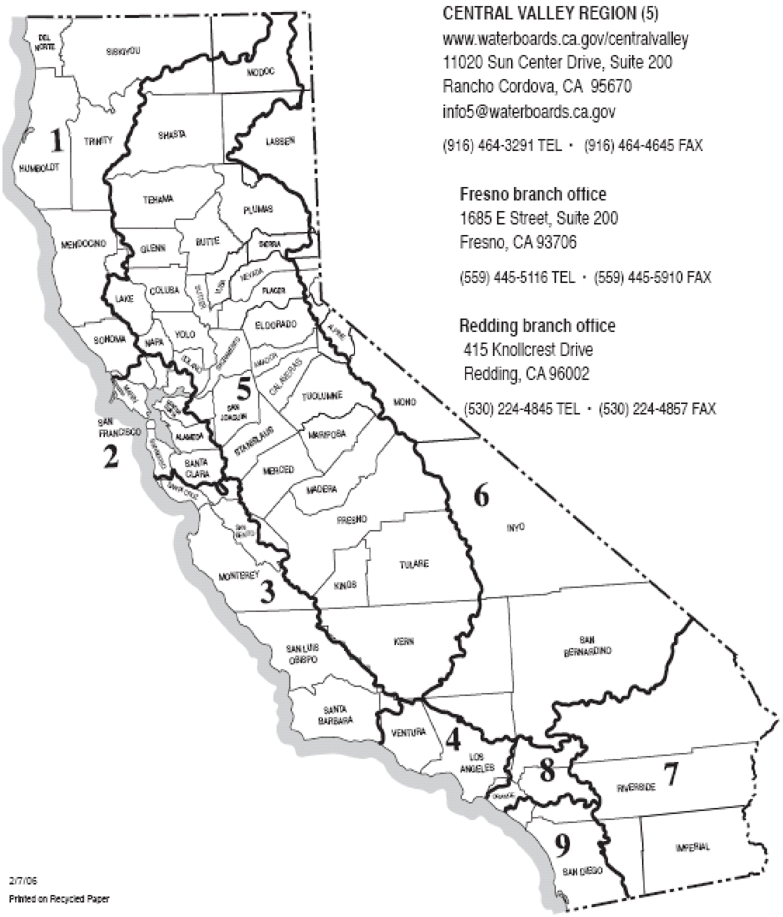

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