SALTON SEA ECOSYSTEM RESTORATION PROGRAM

Hydrology Development and Future Hydrologic Scenarios for the Salton Sea Ecosystem Restoration Program PEIR

January 13, 2006

Inflows/Modeling Working Group Preliminary DRAFT

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INTRODUCTION

This technical report describes the development of historical and future hydrology of the Salton Sea to support the planning efforts of the Salton Sea Ecosystem Restoration Program. A comprehensive analysis of the hydrology of the Salton Sea watershed is necessary to approximate the water and salt budgets at the Salton Sea under both existing and future conditions. Proposed Salton Sea restoration alternatives will need to be developed with consideration of the water and salt budgets, including uncertainty related to future changes in these conditions. This is particularly critical with respect to future proposed Salton Sea elevation and salinity goals. This report provides the technical foundation for the hydrology development.

The California Resources Agency convened a technical *Inflows/Modeling* workgroup and has conducted meetings since May 2005 relating to the hydrology of the Salton Sea. The purpose of these workgroup meetings was to collect information, present draft technical analyses, receive comments, and allow for public and stakeholder discussion regarding Salton Sea hydrology. The components of the hydrology and future hydrologic scenarios presented herein have been previously presented at the workgroup meetings. The purpose of this document is to provide a formal presentation of the hydrology development and to receive final comments from the workgroup members. This document will be revised for inclusion into the Draft PEIR and will incorporate any changes necessary based on comments received from the workgroup members.

DESCRIPTION OF STUDY AREA

The Salton Sea is a terminal, saline lake located in the southeastern corner of California and within one of the most arid regions in North America. The Salton Sea is the largest lake in California, measuring approximately 35 miles long and 9 to 15 miles wide with about 360 square miles of water surface area and 120 miles of shoreline. The Salton Sea lies in a geographic depression known as the Salton Basin located approximately 278 ft below mean sea level. The current water surface elevation, provisionally estimated as of January 1, 2005, is approximately 228.7 ft below mean sea level (USGS 2005). At this elevation the Salton Sea has a maximum depth of approximately 51 ft, an average depth of approximately 30 ft, and water storage volume of approximately 7.2 million acre-feet (maf).

Background

The Salton Basin is the northern arm of the former Colorado River delta system. Throughout the millennia, the Colorado River has deposited water and sediments across its' delta through many distributaries; sometimes discharging south to the Gulf of California and sometimes discharging floodwater north into the Salton Basin. The floodwaters in the Salton Basin formed a large, temporary lake known as Lake Cahuilla (Pomeroy and Cruse 1965, Ogden 1996). The Colorado River would eventually return to its' southerly path and, without a water supply source, the lake waters would evaporate leaving behind millions (if not billions) of tons of salts. The last transient existence of Lake Cahuilla may have been as recent as 300 or 400 years ago and is described in native American folklore and verified through carbon dating (Ogden 1996). Eventually the floods of the Colorado River built a slight natural berm that created a topographically separate Salton Basin from the Delta region.

During large floods of the Colorado River, however, flood flows are reported to have reached the Salton Basin in at least 8 years during the 19th century (Ogden 1996). The current Salton Sea was formed during 1905 to 1907 as a result of an uncontrolled diversion of the Colorado River in which the entire flow of the River rushed into the Salton Basin (Ogden 1996, Hely et al 1966). The water surface elevation of the Salton Sea rose to a maximum of 195 ft below mean sea level by the time the diversion dike was repaired in 1907, but rapidly receded to approximately 250 ft below mean sea level in 1925 as evaporation exceeded the rate of agricultural drainage flows to the Salton Sea. In

1925, the elevation of the Salton Sea started to increase due to discharge of drainage from agricultural areas in Imperial, Coachella, and Mexicali Valleys. Drainage flows from these areas have generally sustained higher water surface elevations since then.

As are all closed-basin lakes, the Salton Sea is saline due to the accumulation of salts left behind through evaporation. The Colorado River water which formed the Salton Sea during 1905 to 1907 is estimated to have had an average salinity of about 500 mg/l (Hely et al 1966). However, the large amount of salts that had accumulated during previous inundations in past centuries rapidly dissolved into the fresh water. This redissolution of salts, combined with high evaporation rates and minimal inflows, caused the salinity to rapidly rise to above 40,000 mg/l total dissolved solids (TDS) by 1925. The salinity decreased in the late 1920s as irrigated agriculture expanded and resulted in greater drainage flows to the Salton Sea. During the Great Depression, in response to a decrease in agricultural drainage flows, the salinity increased again and exceeded 43,000 mg/l. After decreasing during the 1940s and 1950s to near ocean salinity (35,000 mg/l), the Salton Sea salinity has slowly risen to approximately 46,550 mg/l today (Hely et al 1966, Tostrud 1997, Holdren 2005).

Salton Sea Watershed

The Salton Sea watershed encompasses an area of approximately 8,000 square miles from San Bernadino County in the north to the Mexicali Valley (Republic of Mexico) to the south. The Salton Sea lies at the lowest point in the watershed and collects runoff and agricultural drainage from most of Imperial County, much of Riverside County, small portions of San Bernadino and San Diego Counties, as well as the northern portion of the Mexicali Valley (Figure 1). Mountains on the west and northeast rims of the basin reach elevations of 3,000 feet in the Coyote Mountains to over 11,000 feet in the San Bernadino Mountains. To the south, the basin extends to the crest of the Colorado River Delta. About one-fifth of the basin is below or only slightly above mean sea level (Hely et al 1966). Annual precipitation within the watershed ranges from less than 3 inches near the Salton Sea to up to 40 inches in the upper San Jacinto and San Bernadino Mountains. The maximum temperature in the basin exceeds 100 degrees F for more than 110 days per year. Open water surface evaporation rate at the Salton Sea is estimated at approximately 69 inches per year and average annual crop reference evapotranspiration rate (ETo) at Brawley is reported to be approximately 71 inches per year [California Irrigation Management Information System (CIMIS) 2005]. Figure 2 shows the average monthly pattern of the precipitation, temperature, and evapotranspiration near the Salton Sea and Figure 3 demonstrates the long-term annual precipitation records.

Agriculture in Imperial and Coachella valleys is sustained by Colorado River water diverted at Imperial Dam and delivered via the All-American and Coachella canals. In recent years, total diversions at the Imperial Dam have ranged from approximately 2.8 to 3.1 maf/yr to support over 450,000 acres of irrigated agriculture (IID 2005a, Reclamation 2003). Agricultural drainwater from these areas and parts of the Mexicali Valley, as well as municipal and industrial discharges in the watershed, feed the major rivers flowing to the Salton Sea. The principal sources of inflow to the Salton Sea are the Whitewater River to the north, the Alamo and New rivers to the south, and direct drainage from agricultural areas in both Imperial and Coachella valleys. Smaller contributions to inflow come from San Felipe Creek to the west, Salt Creek to the east, direct precipitation, and subsurface inflow. Total average annual inflow to the Salton Sea over the 1950 to 2002 period is estimated to be approximately 1.3 maf.

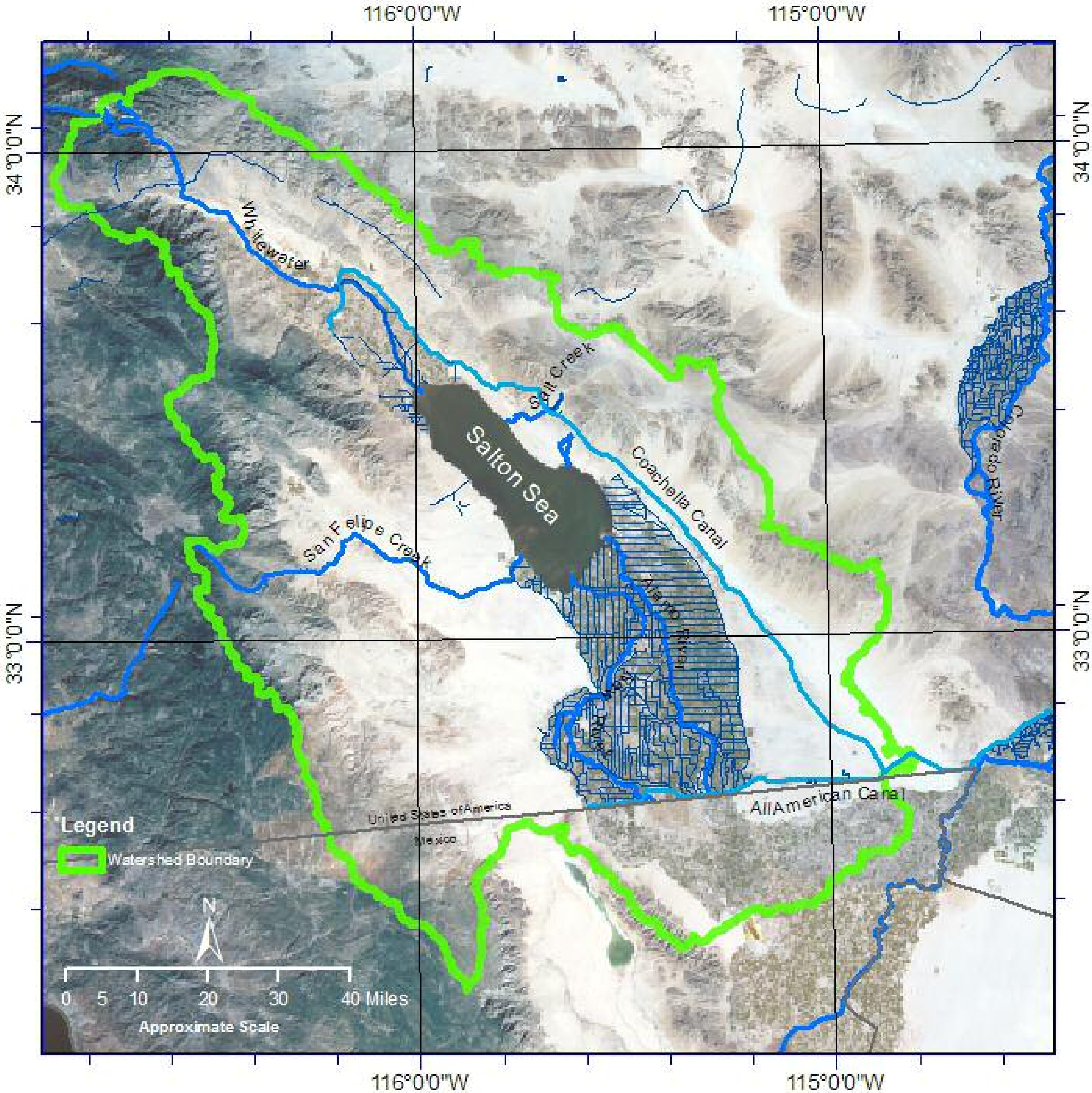

Figure 1
The Salton Sea Watershed and Major Contributing Streams

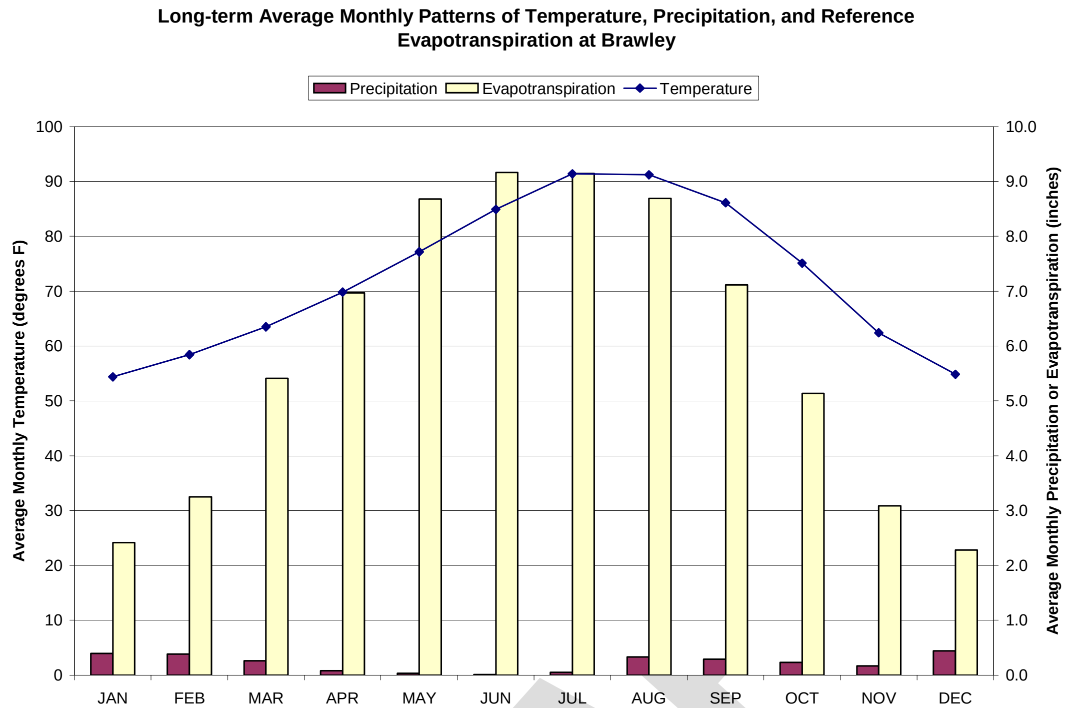

Figure 2
Long-term Average Monthly Temperature, Precipitation, and Reference Evapotranspiration at Brawley

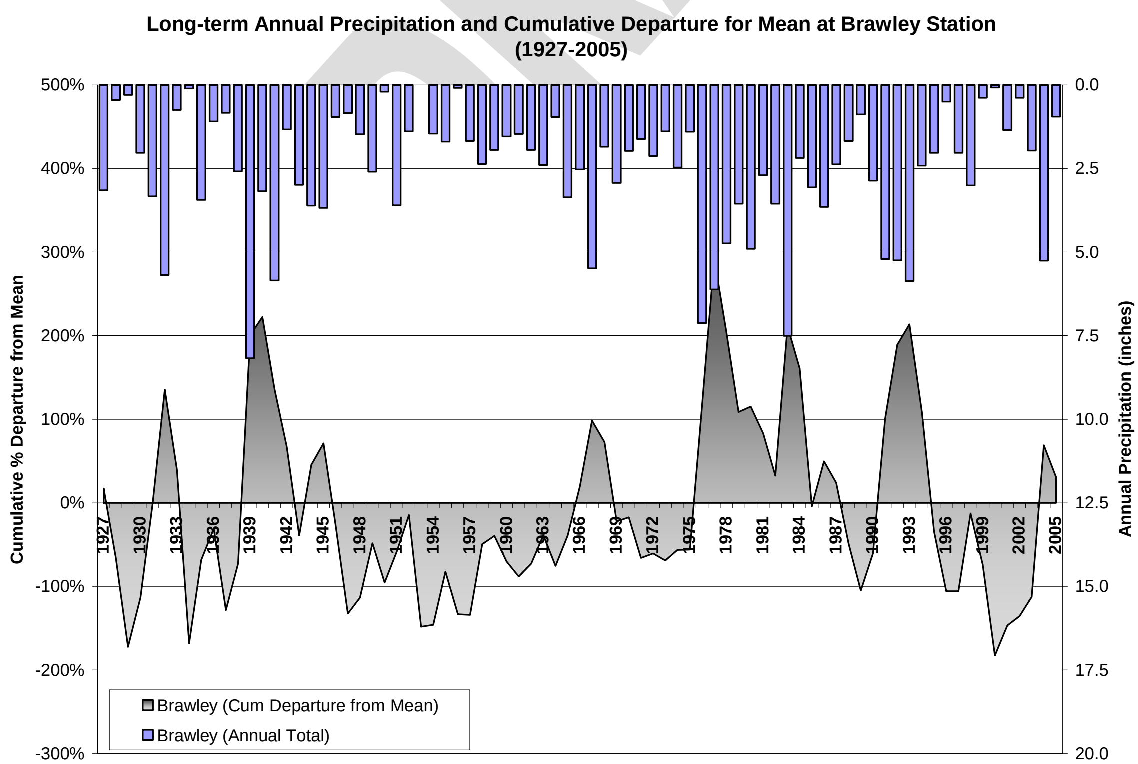

Figure 3
Annual Precipitation and Percent Cumulative Departure from the Mean at Brawley

Due to a variety of conditions ranging from implementation of the Quantification Settlement Agreement (QSA) and IID water transfers to the San Diego County Water Authority (SDCWA) and Metropolitan Water District of Southern California (MWD) to water management planning in the Coachella and Imperial Valleys to water conservation/reuse in Mexicali, inflows to the Salton Sea will be reduced in the future. The reduced inflows will result in declining water surface elevations in the Salton Sea and will further contribute to increases in Salton Sea salinity in the absence of a Restoration Plan. The sections that follow describe the development of hydrologic estimates for these future conditions.

SUMMARY OF GOALS AND APPROACHES

The hydrologic assessment for the Salton Sea included in this report was developed to support the planning level analyses needed for the Salton Sea Ecosystem Restoration Program. The principal goals of this hydrologic assessment are (1) to develop a refined *historical* hydrology and water budget based upon review of existing analyses and data, (2) to prepare estimates of *future* hydrology for use in No Action Alternative analyses. The refined historical hydrology was necessary to include greater spatial detail of the local watershed inflow contribution and resulting historical water budget. Development of the No Action Alternative is a requirement of the California Environmental Quality Act (CEQA). Two No Action Alternative conditions are described. The first No Action condition, No Action-CEQA Conditions, is governed by guidance from CEQA that limits consideration to those projects and actions which may be reasonably expected to occur in the foreseeable future if the project is not implemented. The second No Action condition, No Action-Variability, is described to present a range of estimates of *future* hydrology considering uncertainty in future conditions. The future hydrologic scenarios are necessary to bracket a reasonable range of potential future hydrologic conditions that may influence the development or performance of alternative restoration strategies over the next 75 years.

In many hydrologic analyses, existing levels of development (land and water use conditions) combined with long-term climate conditions are used to provide projections of future baseline hydrologic conditions. Future planned projects that may occur in the absence of the Ecosystem Restoration Program are then reviewed to determine their potential impacts on the future baseline hydrology. However, due to the considerable level of detail in previous hydrologic analyses (i.e. Quantification Settlement Agreement, IID Water Conservation and Transfer Project EIR/EIS, Coachella Valley Water Management Plan EIR, etc), results for several inflow sources were adopted from previous work after review and consultation with workgroup members. New methods and computations developed as part of this assessment attempted to use consistent climate periods and data as previous work. The sources of information used in this analysis are identified under the appropriate sections in the remainder of this document.

The hydrologic analyses presented in this draft report are performed on an annual basis over the 75-year planning horizon from 2003 to 2077. The inflows and salt loads to the Salton Sea described in this document are categorized by geographical source areas: Mexico, Imperial Valley, Coachella Valley, and local watershed contributions. Estimates of both surface and subsurface flows and salt loads to the Salton Sea are included in this work. In order to support more detailed hydrologic modeling of proposed restoration alternatives, the annual hydrology has been down-scaled to a monthly level for the planning horizon.

HISTORICAL HYDROLOGY AND SALT LOADS

Contributions of inflow to the Salton Sea come from agricultural runoff, watershed runoff, subsurface flow, and direct precipitation on the water surface. An analysis of the historical Salton Sea hydrology is necessary to characterize the recent conditions and to provide estimates of water and salt balances at the Salton Sea. In particular, water surface evaporation and precipitation of salts can be estimated from long-term water and salt balances. As previously discussed, the hydrologic components are categorized according to source areas in this document due to their general dependence on water management within the respected areas.

Period of Historical Analysis

The selected period of analysis for this historical study is from calendar year 1950 to 2002. This period was selected because it represents the period of time in which most of the existing water infrastructure was in place, a reasonably complete data set could be developed, and it spans a hydrologically-varied period ending at the beginning point for the Quantification Settlement Agreement which is also the initiation of the study period for the Salton Sea Ecosystem Restoration Program.

Inflows from Mexico

Sources of inflow to the Salton Sea from the Mexico are flows in the Alamo River and New River. Both rivers originate in Mexico and flow to the north across the International Boundary into the United States. The data and methods used to develop the historical hydrology for these sources are described below.

Alamo River

The Alamo River originates in the Mexicali Valley and flows to the north into the United States. Flows at the International Boundary are primarily the result of drainage from irrigated agricultural in the Valley. Pursuant to an agreement between the U.S. and Mexico, a weir was constructed in 1997 at the Alamo River in Mexico, about one hundred feet upstream of the International Boundary with the intent of preventing dry weather flows from Mexico from flowing into the Alamo River in the U.S. Although the weir is currently in place, lack of operation and maintenance of drainage channels upstream of it has caused the water to continue to flow into the U.S. (RWQCB 2001). Alamo River flows at the International Boundary have been estimated by IID (2002 and 2003a), but details regarding the methods and sources are not included in the document. The U.S. International Boundary and Water Commission (USIBWC) reports that flows from 1949 to 1992 were estimated based on historical daily measurements of gage height at the Cipolleti weir and rating curves developed from monthly current meter measurements. From 1992 to the present, continuous gage height recordings and daily discharge measurements are available from IID (USIBWC 2002). The values provided by IID have been adopted for use in this analysis. Average annual flow in the Alamo River at the International Boundary is 1,646 af/yr with an annual minimum and maximum of 324 and 2,274 af, respectively.

New River

As with the Alamo River, the New River originates in Mexico and carries flow northward across the International Boundary. The New River is supplied by agricultural drain flows from the Mexicali Valley, municipal sewage and industrial discharges from Mexicali, and flood flows from the local drainage. During 1905 to 1907, when the Colorado River flowed into the Salton Sea, a considerable portion flowed through the New River channel (USIBWC 2002). Discharge in the New River at the International Boundary (USGS station no. 10254970) is reported by the USGS for 1979 to 2004. IID (2002 and 2003a) has estimated the flows at the border for the period of 1950 to 2002. Minor discrepancies exist between IID estimates and USGS values for flows in the New River at the International Boundary. To provide consistency with other IID data sources and due to a more complete IID data set, the IID reported discharge in the New River at the International Boundary was used rather than USGS values. Average annual flow in the New River at the International Boundary is

129,523 af/yr with an annual minimum of 29,505 af in 1954 and an annual maximum of 267,904 af in 1984. Flow in the New River at the International Boundary is strongly correlated to the diversion from the Colorado River water to Mexicali Valley agriculture.

Salt Loads

The total salt load contributed by Mexico to the Salton Sea in the Alamo and New Rivers has been estimated by IID as part of their overall Imperial Valley salt balance analyses. The estimates documented by IID for 1950 to 1999 (IID 2002) suggest that in recent years approximately 3-4 tons of salt, measured as total dissolved solids (TDS), is carried with every acre-foot of discharge from Mexico. The salt loads are primarily the result of Colorado River salinity combined with agricultural practices in the Mexicali Valley. Municipal discharges contribute to a lesser extent. Salt loads from Mexico for 2000 to 2002 were estimated by multiplying the unit loads (tons/af) for 2003 (IID 2003b) times the Mexico flows for individual years for the New and Alamo Rivers. Average annual salt load for the historical period is estimated at 627,105 tons per year, but analysis suggests that the loads are less than 500,000 tons per year in recent years.

Inflows from Imperial Valley

Sources of inflow to the Salton Sea from the Imperial Valley are flows in the Alamo River, New River, IID direct drains to the Salton Sea, and groundwater discharge to the Salton Sea. The primary source of all Imperial Valley flows to the Salton Sea is from agricultural drainage. The data and methods used to develop the historical hydrology for these sources are described below.

Alamo River

The discharge in the Alamo River near the outlet to the Salton Sea has been measured by the USGS and IID since at least 1950 and accounts for discharge from both Mexico and the Imperial Valley. Direct discharge measurements at this location are reported by IID for 1950 to 2002 (IID 2002 and 2003a). Measured discharge data reported by the USGS spans the period of 1963 to present (USGS 2005). IID reports that in the past IID and USGS alternated years for measuring the discharge of the Alamo River near Niland (USGS station no. 10254730) and some minor discrepancies resulted in the data sets, particularly since 1982 (Eckhardt 2005, personal communication). To provide consistency with other Imperial Valley discharge estimates, IID reported discharge in the Alamo River was used rather than those from the USGS. Since the flow at this location represent combined Mexico and Imperial Valley contributions, the contribution from the Imperial Valley is calculated by subtracting the Mexico contribution from the total flow. Average annual flow in the Alamo River near the outlet to the Salton Sea is 625,961 af/yr with the Imperial Valley contribution accounting for over 99 percent of the total. Average annual Imperial Valley contribution to Alamo River discharge is estimated at 624,315 af/yr with an annual minimum of 497,102 af in 1986 and an annual maximum of 755,355 af in 1953.

New River

The discharge in the New River near the outlet to the Salton Sea has been measured by the USGS and IID since at least since 1950. Direct discharge measurements are reported by IID for 1950 to 2002 (IID 2002 and 2003). Measured discharge data reported by the USGS spans the period of 1943 to present (USGS 2005). As with the Alamo River, IID reports that in the past IID and USGS alternated years for measuring the discharge of the New River near Westmorland (USGS station no. 10255550) and some minor discrepancies resulted in the data sets, particularly since 1987 (Eckhardt 2005, personal communication). To provide consistency with other Imperial Valley discharge estimates, IID reported discharge in the New River was used rather than those from the USGS. Since the flow at this location represent combined Mexico and Imperial Valley contributions, the contribution from the

Imperial Valley is calculated by subtracting the Mexico contribution from the total flow. Average annual flow in the New River near the outlet to the Salton Sea is 440,974 af/yr with the Imperial Valley contribution accounting for approximately 71 percent of the total. Average annual Imperial Valley contribution to New River discharge is estimated at 311,452 af/yr with an annual minimum of 229,294 af in 1985 and an annual maximum of 509,431 af in 1953.

IID Direct Drains

Historical discharge from IID drains that lead directly to the Salton Sea (as opposed to the New and Alamo Rivers) has been estimated by IID for the period of 1950 to 2002 (IID 2002 and 2003a). The USGS (Hely et al 1966), as part of an evaluation of evaporation at the Salton Sea, independently measured flows and provided estimates of total direct IID drain flows to the Salton Sea for years 1961–62. The values reported by the USGS for 1961 to 1962 are significantly higher (approximately 2 times greater) than those estimated by IID for the same period. The USGS attributed the differences in discharge estimates primarily to differences in measurement techniques. USGS estimates were based on direct gage measurements of the major drains. IID estimates were based, in part, on gate rating curves and historic gate openings. However, the IID data provides a consistent, long-term continuous data set that is consistent with other measurements in the Valley. The IID reported direct drain discharge values have used in this analysis. Direct drainage accounts for approximately 10 percent of total Imperial Valley contributions to the Salton Sea inflow and is estimated at 93,848 af/yr.

Groundwater Inflows

Groundwater conditions in the Imperial Valley are such that low permeable marine and lacustrine deposits prohibit significant deep percolation of irrigation water and prohibit well yields of any substantial quantities (Loeltz et al 1975). Tile drains have been installed throughout the Imperial Valley to convey shallow groundwater away from the root zone of crops. As such, most shallow groundwater, leaching water, or excess irrigation water is accounted in the surface discharge of drains and the New and Alamo rivers. However, small quantities of groundwater in the Imperial Valley are believed to discharge directly to the Salton Sea. Hely et al (1966) estimated the groundwater discharge to the Salton Sea to be less than 2,000 af/yr and IID (2002) has estimated this value to be approximately 1,000 af/yr. The IID estimate of 1,000 af/yr has been adopted as a reasonable estimate of historical groundwater discharge to the Salton Sea from the Imperial Valley.

Salt Loads

The total salt load contributed by the Imperial Valley to the Salton Sea through discharge in the Alamo River, New River, direct drains, and groundwater has been estimated by IID for 1950 to 1999 (IID 2002). The salt loads are almost solely contributed by agricultural drainage which is affected by source water salinity (Colorado River) and irrigation practices. In order to sustain agriculture in the Imperial Valley, the long-term exports of salt from the Valley needs to be equal or greater than that imported through diversion from the Colorado River. Approximately 3 tons of salt is carried with every acre-foot of drainage discharge from the Imperial Valley. Salt loads from the Imperial Valley for 2000 to 2002 were estimated by multiplying the unit loads (tons/af) for 2003 (IID 2003b) times the respective flow contribution for individual years for the New River, Alamo River, and direct drains. Average annual salt load from the Imperial Valley for the historical period is estimated at 3,554,514 tons per year.

Inflows from Coachella Valley

Sources of inflow to the Salton Sea from the Coachella Valley are flows in the Whitewater River/Coachella Valley Stormwater Channel (CVSC), direct drainage from the lower valley, and groundwater discharge to the Salton Sea. The primary sources of flow from the Coachella Valley to the Salton Sea are agricultural return flows, stormwater runoff, and fish farm and municipal wastewater discharges. The data and methods used to develop the historical hydrology for these sources are described below.

Whitewater River/Coachella Valley Storm Channel and Direct Drains

The Whitewater River is the primary river drainage channel of the Coachella Valley and collects stormwater runoff, agricultural return flows, and municipal and fish farm discharges. The CVSC is a 17-mile man-made, unlined extension of the Whitewater River and is the principal drainage channel for the lower Valley. The channel was constructed to safely pass storm flows and to provide adequate drainage for agricultural return flows in the area of semi-perched groundwater. Throughout the lower Valley agricultural drains have been installed to convey shallow groundwater away from the crop root zones. These drains convey water to the CVSC and 25 smaller open channel drains that discharge directly to the Salton Sea (CVWD 2002). Direct discharge of the Whitewater River/CVSC has been measured by USGS (2005, station no. 10259540) since 1960 and has been estimated by CVWD for 1950 to 1959 (IID 2002). During the historical period, the direct drains to the Salton Sea contribute nearly 40 percent of the total annual volume of Coachella Valley discharge. Total Coachella Valley surface flow to the Salton Sea has been estimated for 2000 to 2002 through USGS measurements of Whitewater River/CVSC flow (USGS 2005) and recent direct drain percentages. Average annual total surface discharge from the Coachella Valley to the Salton Sea for the historical period is estimated at 113,827 af/yr with an annual minimum of 53,368 af in 1957 and an annual maximum of 174,684 af in 1976. In recent years, however, declining groundwater levels have reduced the subsurface discharge to surface drains in the lower Valley and total surface discharge has been less than 90,000 af/yr.

Groundwater Inflows

The Coachella Valley groundwater basin serves as an important source of water for agriculture and municipal uses. Outflows from the groundwater basin (primarily groundwater pumping, discharge to surface drains, phreatophyte consumptive use, etc.) have exceeded inflows to the basin (primarily from return flows and artificial recharge) resulting in overdraft conditions (CVWD 2002). CVWD estimates that total groundwater basin storage has been reduced by 1,421,400 af since 1936. Declining groundwater levels near the Salton Sea have caused a reversal of the groundwater gradient and has led to intrusion of higher salinity Salton Sea water into the lower portion of the groundwater basin. Groundwater discharge to the Salton Sea is estimated to be approximately 2,710 af in 1950, when groundwater conditions were higher, and have gradually been reduced to approximately minus 366 af (groundwater inflow) in 1999 when groundwater levels were lower (IID 2002 and CVWD 2002). While direct groundwater interactions with the Salton Sea may appear to be relatively small in terms of discharge volumes, it should be recognized that most of the surface discharge to the Salton Sea through the Whitewater River/CVSC and direct drains are the delayed result of groundwater discharge. Annual groundwater inflows to the Salton Sea for 2000 to 2002 were estimated by extending the recent trend of the 1950 to 1999 data.

Salt Loads

The total salt load contributed by the Coachella Valley to the Salton Sea through discharge in the Whitewater River/CVSC, direct drains, and groundwater has been estimated by CVWD for 1950 to 1999 (IID 2002). The salt loads are primarily contributed by agricultural and municipal return flows which is affected by source water salinity (Colorado River) and agricultural and urban water management practices. Less than 2 tons of salt per acre-foot of drainage discharge is contributed from the Coachella Valley. Salt load from Coachella Valley surface discharge for 2000 to 2002 was estimated by multiplying the unit load (tons/af) for 1999 times the total surface flow for individual years. Groundwater salt load (removal in this case) for 2000 to 2002 was estimated by extending the recent trend of the 1950 to 1999 data. Average annual net salt load from the Coachella Valley for the historical period is estimated at 262,434 tons per year, but in recent year the loads are estimated at less than half this value.

Inflow from Portions of the Watershed Not Tributary to Irrigated Areas of Imperial and Coachella Valleys

The portions of the Salton Sea watershed that is not tributary to the irrigated areas of Imperial and Coachella valleys is approximately 2,292 square miles and consists of the drainages of San Felipe Creek, Salt Creek, and other minor channels and washes on the west and east shore of the Salton Sea. These areas receive only moderate amounts of rainfall, but do contribute both surface and subsurface inflow to the Salton Sea. The data and methods used to develop the historical hydrology for these sources are described below.

San Felipe Creek

The San Felipe Creek watershed encompasses approximately 1,693 square miles including much of Anza-Borrego State Park, Borrego and Clark Sinks, and most of the western shore of the Salton Sea. Rainfall and snowmelt runoff from the mountains to the west contribute to streamflow in the upper portions of San Felipe Creek. Some perennial reaches exist in the mountain areas, but San Felipe Creek discharge to the Salton Sea is generally restricted to the summer thunderstorms on the desert floor and heavy winter storms. Discharge from San Felipe Creek, approximately 4 miles upstream of the Salton Sea, was measured by the USGS (station no. 10255885) from 1961 to 1991 (USGS 2005). San Felipe Creek is the most hydrologically-variable source of inflow to the Salton Sea, ranging from zero flow for most of the year to a maximum daily discharge of 17,100 cfs on September 10, 1976 (nearly 4 times greater than any other inflow source to the Salton Sea). The hydrologic data set was extended for the entire historical period by developing a relationship between San Felipe Creek discharge and precipitation at Brawley (Figure 4). Estimated annual average discharge from the San Felipe Creek to the Salton Sea for the historical period is 4,532 af/yr with an annual minimum of 60 af in 1973 and an annual maximum of 40,638 af in 1976.

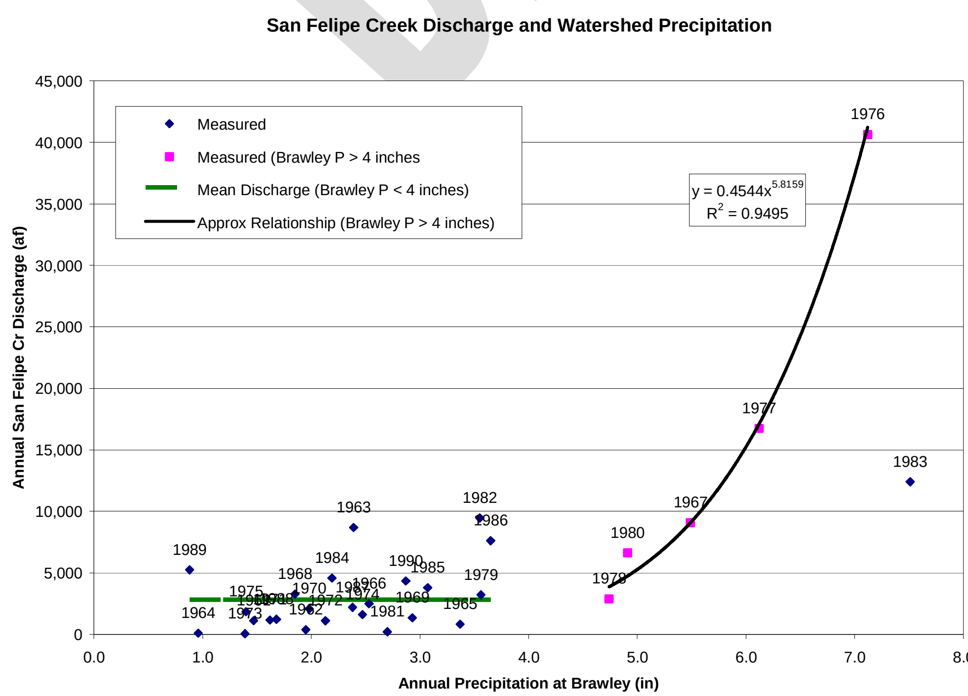

Figure 4
Relationship Between San Felipe Creek Discharge and Precipitation at Brawley

Salt Creek

Salt Creek, on the eastern side of the Salton Sea, drains a watershed of approximately 269 square miles. While draining a significantly smaller watershed than San Felipe Creek, Salt Creek has historically been a perennial stream supplied by seepage from the Coachella Canal, groundwater discharge downstream of the canal, and occasional rainfall runoff. The USGS (2005) has continuously measured discharge at Salt Creek, approximately 0.3 miles upstream of the Salton Sea (station no. 10255550), for the period of 1961 to 2004 except for water year 1974. Over time, phreatophyte vegetation has grown steadily in areas upstream of the gaging station and, through consumptive use, has reduced the baseflow at the gage. Baseflow is estimated to have been reduced from approximately 4,000 af/yr in the early 1960s to less than 600 af/yr between 1996 to 2002. The hydrologic data set was extended for the entire historical period by separating out the baseflow and rainfall runoff components. Analysis of historical trends indicated that little rainfall runoff developed

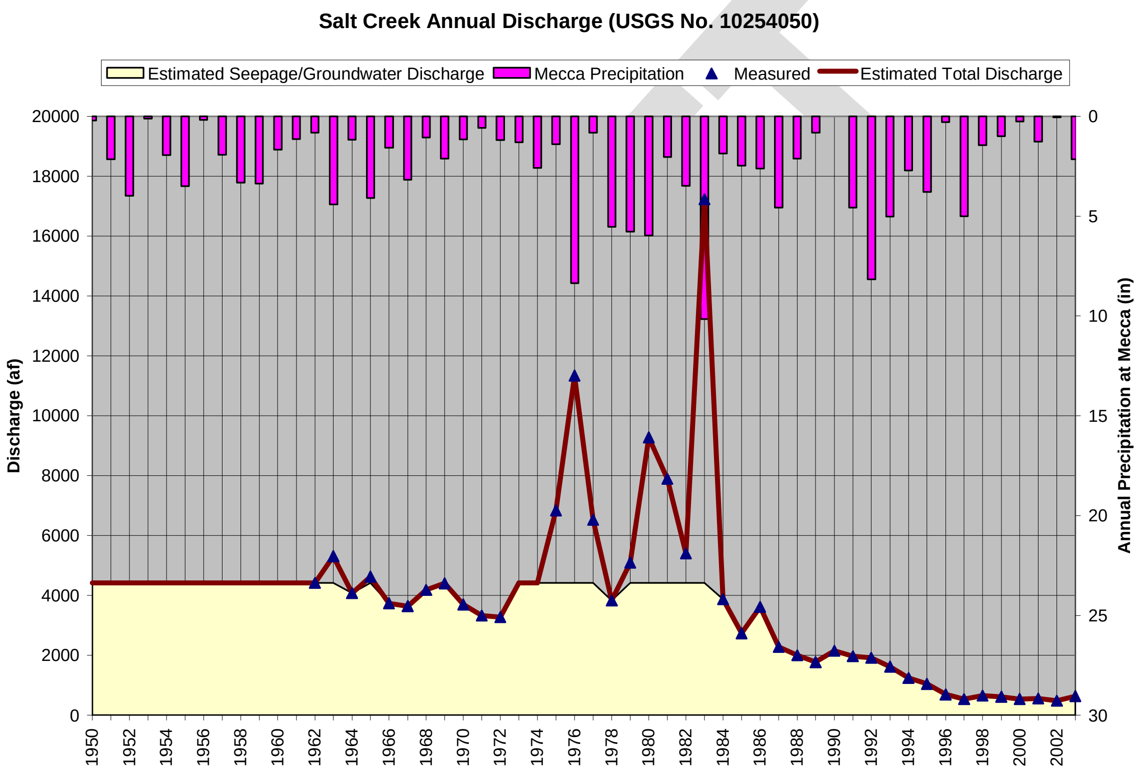

Figure 5
Historical Salt Creek Discharge and Estimated Baseflow from Seepage/Groundwater

at the gaging station for years in which less than 4 inches of rainfall was measured at Mecca. A relationship between Salt Creek rainfall runoff discharge and precipitation at Mecca was developed (Figure 5). The total annual discharge for the missing periods (1950 to 1960 and 1974) was then estimated by adding the estimate of rainfall runoff to the early 1960s baseflow estimate. Estimated annual average total discharge from Salt Creek to the Salton Sea for the historical period is 3,968 af/yr with an annual minimum of 486 af in 2002 and an annual maximum of 17,227 af in 1983. Since 1996 the annual discharge has not exceeded 700 af.

Other Surface Inflows

The remaining 330 square miles of the watershed not tributary to the irrigated areas of Imperial and

Coachella Valleys consists of nearly equal areas on the western and eastern shore. No data is available for runoff from these areas. As part of this analysis, the runoff from these areas was estimated by assuming the rainfall runoff response was similar to that of the adjacent gaged areas. It was assumed that the western portion of the watershed responds similarly to rainfall as the lower San Felipe Creek and that the eastern portion of the watershed responds similarly to rainfall as the rainfall runoff component of Salt Creek discharge. Estimates of discharge for these areas were developed by prorating the respective gaged discharge (either San Felipe Creek or rainfall runoff component of Salt Creek discharge) by the relative size of watershed. For the western portion of the watershed only the lower hydrologic unit of the San Felipe Creek drainage (504 square miles) was assumed to contribute to discharge at the Salton Sea as most of the upper drainage runoff flows to sinks, groundwater recharge, or is consumed by phreatophyte vegetation. The estimated annual average discharge from these ungaged areas for the historical period is 2,031 af/yr.

Groundwater Inflows

Groundwater inflow to the Salton Sea from areas outside of the Imperial and Coachella Valleys was estimated by Hely et al (1966) and Loeltz et al (1975) to be approximately 10,000 af/yr. The groundwater underflow entering the Salton Sea at the perimeter comes primarily from the alluvium underlying San Felipe Creek. The geology of the east shore is such that most of the groundwater flow discharges as either surface inflow or evapotranspiration (Hely et al 1966). While it is likely that annual variations in the groundwater inflow to the Salton Sea occur, understanding of the groundwater conditions is not well-known. A constant annual groundwater inflow of 10,000 af/yr is assumed.

Salt Loads

The total salt load contributed to the Salton Sea by the watershed not tributary to the irrigated areas of the Imperial and Coachella Valleys has been estimated from rather limited data. Salt load contributions from San Felipe Creek and the ungaged areas were estimated from limited TDS measurements for San Felipe Creek in Sentenac Canyon obtained from the Colorado Regional Water Quality Control Board (RWQCB 2005a). The average of the lower TDS measurements (less than 3,000 mg/l) were used from this data since the higher values are not believed to be representative of rainfall runoff, but may be more attributable to the low flows and associated high evapoconcentration at the times of these measurements. The salt load contribution from Salt Creek was estimated by applying the average TDS value of measurements taken at the outlet of Salt Creek over ten years (RWQCB 2005a). Groundwater salinity was estimated from the average reported TDS values in wells in the San Felipe Creek-Superstition Hills area of Loeltz et al (1975). While the level of uncertainty regarding the San Felipe Creek and groundwater salinities is considered high, the salt load from these sources makes up less than 2 percent of the total load to the Salton Sea. Average annual salt load from the watershed not tributary to the irrigated areas of the Imperial and Coachella Valleys for the historical period is estimated at 72,994 tons per year of which more than half is contributed by groundwater inflows.

Precipitation

Precipitation on the Salton Sea water surface is best estimated by an average of rainfall recorded from stations closest to the Salton Sea due to the size of the Sea. An average of the Brawley and Mecca stations recorded rainfall [Western Regional Climate Center (WRCC) 2005] was used to approximate the rain that fell on the Salton Sea surface. Both stations have continuous annual data for the entire historical period. Average annual rainfall at Brawley and Mecca is 2.55 and 2.65 inches, respectively with a two-station average of 2.6 inches. The average annual precipitation on the Salton Sea water surface for the historical period is estimated at 49,142 af/yr.

Evaporation

Evaporation is the single largest hydrologic component in the Salton Sea water budget and the only significant outflow (some minor outflow occurs at the interface with the Coachella groundwater basin). Evaporation studies at the Salton Sea have been performed by the USGS (Hughes 1966 and Hely et al 1966) in which water budget, energy budget, and mass transfer techniques were evaluated and compared to pan evaporation rates. Hely et al (1966) concluded that a "good estimate of normal annual evaporation" at the Salton Sea is 69 inches, determined from water and energy budgets in 1961 to 1962 and correlated to measured evaporation rates from sunken pans for 1948 to 1962. The water budget method is considered the most appropriate if the inflows can be estimated with sufficient accuracy. Understanding the importance of estimating evaporation rates accurately, two different methods were used to determine evaporation for the historical period: (1) the water budget method using the inflows described above and (2) an application of pan evaporation coefficients to pan evaporation data.

In the water budget method annual evaporation is computed as the difference between the sum of all inflows (including precipitation) and the storage volume change in the Salton Sea over the year. The inflow sources are those described in previous sections and the storage volume change was calculated from water surface elevation measurements (USGS 2005) and Salton Sea bathymetry (Reclamation 2005). Using the water budget method, the total annual average evaporation from the Salton Sea for the historical period is estimated at 1,294,124 af/yr or 69.0 inches per year when expressed as a unit rate. The computed unit evaporation rate ranged from 64 to 75 inches per year.

A second method using pan evaporation rates was used to provide an estimate of evaporation that is independent of measurements or estimates of inflows, areal precipitation, water surface elevation, bathymetry, and other parameters. Hely et al (1966) performed a similar verification and determined that Salton Sea annual evaporation rates could be approximated by multiplying 0.69 by the average annual pan evaporation rates for Sandy Beach, Imperial Salt Farm, and Devil's Hole sunken pans. Data for these three stations (Three Flags replaced Sandy Beach in June 1990) was obtained from IID for the period 1950 to 2001 (IID 2005b). The resulting average annual evaporation rate from this method is 68.4 inches. It should be noted that there appears to be a systematic downward shift in recorded evaporation rates at the Devil's Hole and Three Flags stations beginning in the early 1980s and an apparent erroneous data point for the Imperial Salt Farm station in 1998. No adjustment was made for these trends and data concerns. However, a third estimate was prepared using the Imperial pan station (Reclamation 2004) and adjusting the pan coefficient to be commensurate with the analysis of Hely et al (1966). This station does not exhibit the trends and data concerns of the other pan stations. The average annual evaporation rate using only the Imperial station is 69.4 inches.

While deviations in annual evaporation rates developed by the water budget method and the pan evaporation coefficient method occur (Figure 6), the long-term annual average rates between the two methods are virtually identical. It is concluded that the rates determined from the water budget method are reasonable for both a historic assessment of past Salton Sea evaporation and for use in future analyses of restoration alternatives. Average net evaporation (evaporation minus precipitation) rates for the historical period are estimated at 66.4 inches per year.

Estimated Historical Water Balance for the Salton Sea

The estimated historical water balance for the Salton Sea has been outlined in the previous sections and is summarized here. The total annual average inflow to the Salton Sea for the 1950 to 2002 period is estimated at approximately 1,296,023 af/yr with an annual minimum of 1,145,991 af in 1992 and an annual maximum of 1,461,736 af in 1953. In recent years the total inflow has hovered around 1.3 maf/yr. The total annual average outflow (through evaporation) for the historic period is estimated at 1,294,124 af/yr, resulting in an increase in water surface elevation. The estimated historical water budget is shown in Table 1 and graphically in Figure 7. The relative contributions of each source area to the water budget components is summarized in Table 2. As can be seen from Table 2, inflows from the Imperial Valley account for approximately 76.5 percent of the total inflow, Mexico 9.8 percent, Coachella Valley 8.5 percent, and the remainder of the watershed (including precipitation) 5.2 percent.

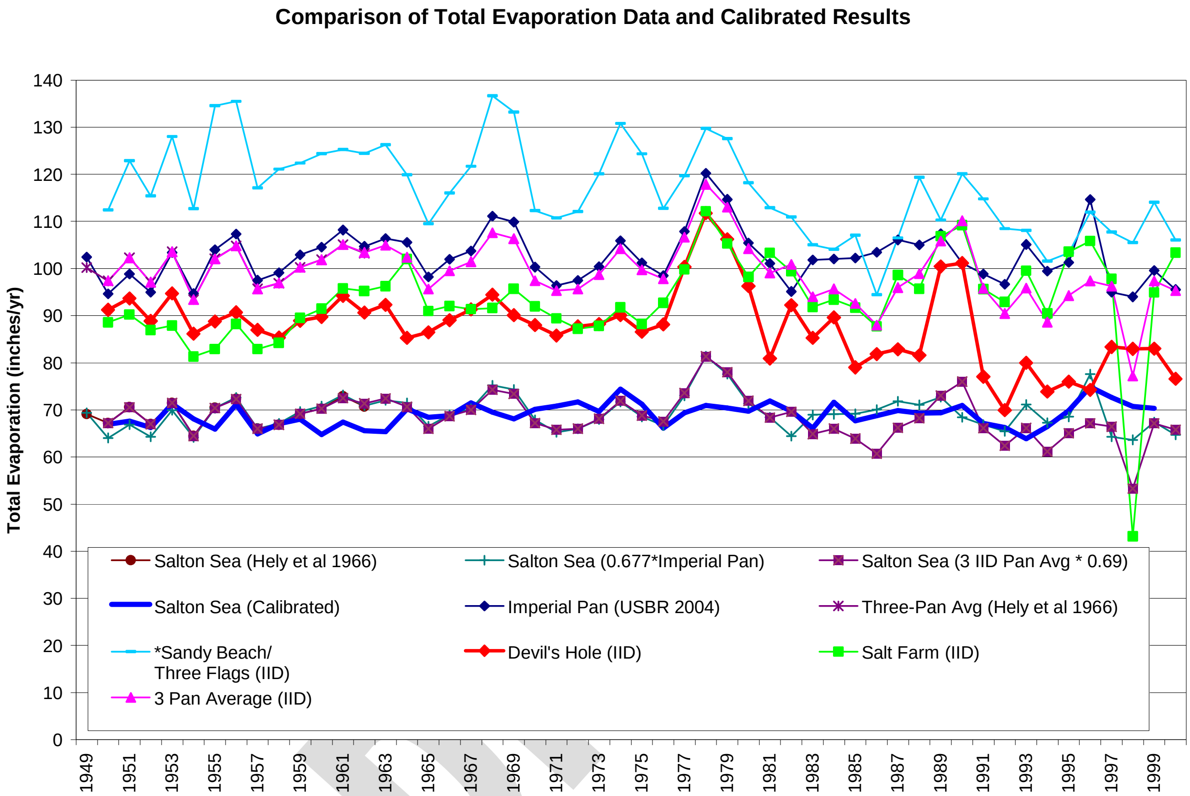

Figure 6
Estimated Annual Evaporation Rates Determined from Water Budget and Pan Evaporation Measurements

Table 1
Estimated Historic Inflows to the Salton Sea

Year	Alamo River from Mexico (af/yr)	Alamo River from Imperial Valley (af/yr)	Alamo River TOTAL (af/yr)	New River from Mexico (af/yr)	New River from Imperial Valley (af/yr)	New River TOTAL (af/yr)	Imperial Valley Direct Drains to Sea (af/yr)	Surface Flows from Coachella Valley (af/yr)	Groundwater Flows from Coachella Valley (af/yr)	San Felipe Cr (af/yr)	Salt Cr (af/yr)	Ungaged Watershed (af/yr)	Local Groundwater (af/yr)	Precipitation (af/yr)	Total Inflow (af/yr)	Total from Mexico (af)	Total from Imperial Valley (af)	Total from Coachella Valley (af)	Total from Local (w/o Precip) (af)	Total from Local (incl Precip) (af)
1950	1393	605469	606862	36992	423673	460665	75658	65811	2710	2834	4420	1057	10000	3578	1233595	38385	1104800	68521	18311	21889
1951	1385	640646	642031	35508	454160	489668	74621	108765	2632	2834	4420	1057	10000	48632	1384660	36893	1169427	111397	18311	66943
1952	1250	695997	697247	35917	488544	524461	76032	87139	2341	2834	4420	1057	10000	46361	1451892	37167	1260573	89480	18311	64672
1953	1308	755355	756663	31116	509431	540547	81212	62607	2396	2834	4420	1057	10000	966	1462702	32424	1345998	65003	18311	19277
1954	1431	731390	732821	29505	463232	492737	78588	72467	2064	2834	4420	1057	10000	30378	1427367	30936	1273210	74531	18311	48690
1955	1915	652540	654455	46985	348875	395860	68394	85367	2016	2834	4420	1057	10000	46818	1271221	48900	1069809	87383	18311	65129
1956	2042	682113	684155	42713	386942	429655	52333	70602	2067	2834	4420	1057	10000	2520	1259644	44755	1121388	72669	18311	20832
1957	1762	621088	622850	70845	331671	402516	58620	53368	2205	2834	4420	1057	10000	32496	1190367	72607	1011379	55573	18311	50808
1958	1991	612490	614481	103983	301211	405194	60344	56358	2243	2834	4420	1057	10000	51340	1208271	105974	974045	58601	18311	69651
1959	1819	649931	651750	121824	312395	434219	58637	57105	2345	2834	4420	1057	10000	47973	1270340	123643	1020963	59450	18311	66284
1960	1921	680529	682450	121312	323747	445059	55528	70431	2336	2834	4420	1057	10000	29084	1303200	123233	1059804	72767	18311	47396
1961	1795	673781	675576	115031	321936	436967	54983	83894	2290	1129	4420	421	10000	23864	1293544	116826	1050700	86184	15970	39834
1962	1705	679395	681100	132179	323151	455330	86419	112692	2241	374	4420	140	10000	25373	1378089	133884	1088965	114933	14934	40307
1963	2158	721607	723765	138936	338543	477479	93647	133333	2062	8695	5310	3852	10000	63030	1521173	141094	1153797	135395	27857	90887
1964	1834	561723	563557	105087	260770	365857	82660	123248	1991	99	4079	37	10000	19786	1171314	106921	905153	125239	14215	34001
1965	1798	533298	535096	111339	246408	357747	103256	138788	2172	832	4627	452	10000	69144	1222114	113137	882962	140960	15911	85055
1966	1545	609200	610745	102958	280511	383469	114974	128071	2220	2505	3735	934	10000	38026	1294680	104503	1004685	130291	17174	55201
1967	1556	619535	621091	96899	286312	383211	122123	133784	2244	9077	3643	3386	10000	80416	1368975	98455	1027970	136028	26106	106522
1968	1469	609620	611089	106019	278059	384078	113348	133097	2262	3272	4181	1221	10000	27077	1289624	107488	1001027	135359	18674	45750
1969	1595	591069	592664	103312	272137	375449	99433	130583	2319	1348	4403	503	10000	46920	1263622	104907	962639	132902	16254	63174
1970	1645	617373	619018	99671	290816	390487	112314	131253	2390	2072	3694	773	10000	29117	1301117	101316	1020503	133643	16539	45655
1971	1510	670260	671770	107281	315714	422995	106597	142977	2403	1167	3330	435	10000	20427	1382102	108791	1092571	145380	14932	35360
1972	1435	637308	638743	111165	306898	418063	119331	155126	2387	1112	3274	415	10000	30895	1379346	112600	1063537	157513	14801	45696
1973	1370	637532	638902	117160	311479	428639	116403	163211	2372	60	4420	22	10000	25193	1389222	118530	1065414	165583	14502	39695
1974	1227	681093	682320	111839	324736	436575	117663	157208	2342	1614	4420	602	10000	47361	1460105	113066	1123492	159550	16636	63997
1975	1568	680777	682345	99791	334716	434507	112775	173502	2229	1850	6840	690	10000	26302	1451040	101359	1128268	175731	19380	45682
1976	1071	637846	638917	102588	332523	435111	114924	174684	2002	40638	11338	19891	10000	146734	1594239	103659	1085293	176686	81867	228601
1977	1419	613590	615009	107713	305265	412978	101942	156787	1784	16741	6522	6245	10000	66320	1394327	109132	1020797	158571	39508	105827
1978	1296	601777	603073	98408	294637	393045	99260	144098	1727	2879	3828	1074	10000	98275	1357259	99704	995674	145825	17781	116056
1979	1416	633710	635126	144905	312815	457720	110127	151002	1595	3219	5098	1665	10000	89483	1465035	146321	1056652	152597	19982	109465
1980	1655	639926	641581	156320	298224	454544	105091	143958	1453	6632	9278	5797	10000	104874	1483207	157975	1043241	145411	31707	136580
1981	2274	589317	591591	155443	277798	433241	95810	156788	1402	217	7894	81	10000	45773	1342797	157717	962925	158190	18192	63965
1982	1990	541463	543453	157009	259293	416302	87919	152282	1415	9462	5399	3529	10000	67763	1297524	158999	888675	153697	28390	96153
1983	1909	550062	551971	242606	234827	477433	82946	150956	1186	12408	17227	13389	10000	170870	1488386	244515	867835	152142	53024	223894
1984	1831	562086	563917	267904	244356	512260	88592	140985	1053	4580	3868	1708	10000	39404	1366368	269735	895034	142038	20156	59561
1985	1867	507680	509547	260238	229294	489532	93867	123855	983	3785	2736	1412	10000	53719	1289436	262105	830841	124838	17933	71652
1986	1890	497102	498992	264837	247511	512348	89354	122959	836	7605	3614	2837	10000	60839	1309383	266727	833967	123795	24056	84894
1987	2058	510142	512200	250862	242290	493152	99262	117032	757	2202	2281	821	10000	67334	1305041	252920	851694	117789	15304	82638
1988	2152	556535	558687	226802	262138	488940	100053	117188	603	1227	1998	458	10000	36809	1315963	228954	918726	117791	13683	50492
1989	1883	591781	593664	153439	277989	431428	96109	110816	572	5246	1775	1957	10000	16394	1267961	155322	965879	111388	18978	35372
1990	1993	615873	617866	133088	297422	430510	91088	109613	526	4337	2155	1618	10000	27601	1295314	135081	1004383	110139	18110	45711
1991	1951	592175	594126	130775	279854	410629	88341	103866	415	6706	1966	2502	10000	94066	1312617	132726	960370	104281	21174	115240
1992	1709	544334	546043	143178	253417	396595	80734	100817	255	7012	1920	2615	10000	128906	1274897	144887	878485	101072	21547	150453
1993	1642	615383	617025	190457	269839	460296	88589	93505	169	13420	1623	5006	10000	105115	1394748	192099	973811	93674	30049	135164
1994	1744	639327	641071	145260	297804	443064	108805	100277	51	2834	1238	1057	10000	49698	1358096	147004	1045936	100328	15129	64827
1995	1223	644944	646167	148762	323924	472686	115134	98063	-149	2834	1047	1057	10000	56512	1403351	149985	1084002	97914	14938	71450
1996	1077	639897	640974	118678	317911	436589	118746	94147	-197	2834	692	1057	10000	7754	1312595	119755	1076554	93950	14583	22337
1997	1653	635157	636810	160762	326461	487223	107093	90686	-108	2834	530	1057	10000	68045	1404170	162415	1068711	90578	14421	82467
1998	1446	647674	649120	174870	316060	490930	108387	85723	-287	2834	650	1057	10000	43031	1391445	176316	1072121	85436	14541	57572
1999	1668	641758	643426	176447	289332	465779	94414	81765	-366	2834	618	1057	10000	13338	1312866	178115	1025504	81399	14509	27848
2000	2059	643668	645727	158115	287232	445347	103208	86427	-445	2834	540	1057	10000	3378	1298073	160174	1034108	85982	14431	17809
2001	1616	662671	664287	144458	292325	436783	102958	83651	-524	2834	561	1057	10000	25254	1326862	146074	1057954	83127	14452	39706
2002	324	681675	681999	115402	300344	415746	105302	81476	-603	2834	486	1057	10000	4137	1302435	115726	1087321	80873	14377	18514
Avg (1950-2002)	**1646**	**624315**	**625961**	**129523**	**311452**	**440974**	**93848**	**113287**	**1422**	**4532**	**3968**	**2031**	**10000**	**49142**	**1345164**	**131169**	**1029615**	**114709**	**20531**	**69672**
Min	**324**	**497102**	**498992**	**29505**	**229294**	**357747**	**52333**	**53368**	**-603**	**60**	**486**	**22**	**10000**	**966**	**1171314**	**30936**	**830841**	**55573**	**13683**	**17809**
Max	**2274**	**755355**	**756663**	**267904**	**509431**	**540547**	**122123**	**174684**	**2710**	**40638**	**17227**	**19891**	**10000**	**170870**	**1594239**	**269735**	**1345998**	**176686**	**81867**	**228601**

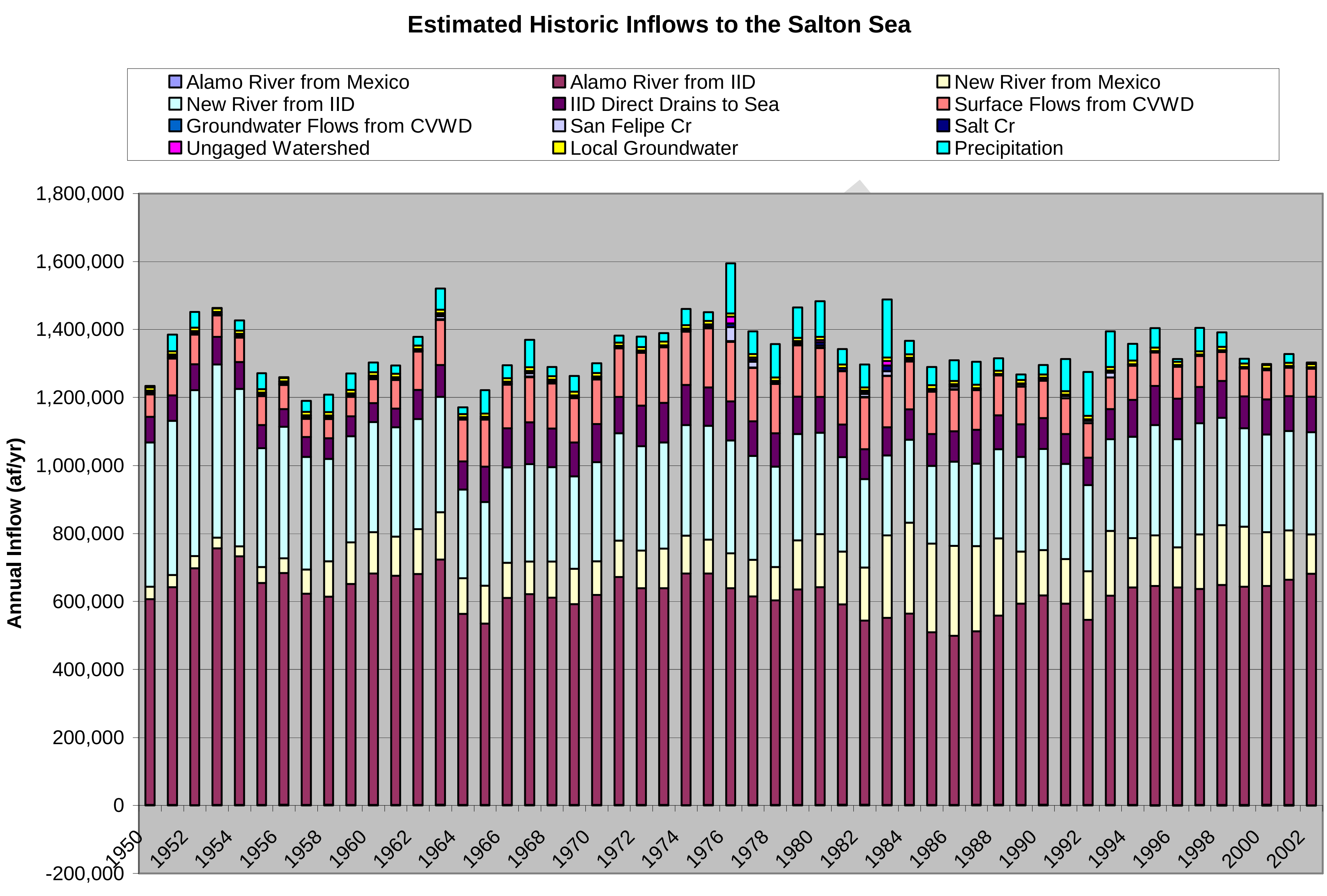

Figure 7
Graphical Representation of Estimated Historical Inflows to the Salton Sea

Table 2
Relative Contribution of Inflow Sources to the Historical (1950 to 2002) Salton Sea Inflow

Inflow Source to the Salton Sea	Percent of Historical Annual Average Inflow
Mexico	9.8%
Imperial Valley	76.5%
Coachella Valley	8.5%
Local Watershed	1.5%
Precipitation directly on the Salton Sea	3.7%
TOTAL	100.0%

Estimated Historical Salt Balance for the Salton Sea

Salinity in the Salton Sea has been estimated for the entire historical period by IID (2000 and 2005) by averaging TDS measurements at four near-shore stations: Bertram Station, Sandy Beach, Desert Beach, and Salton Sea Beach. In addition, Reclamation (Holdren and Montano 2002 and Holdren 2005) has measured near-surface and near-bottom TDS at three locations along the axis of the Salton Sea. These data are available on a daily basis for 1999 and quarterly for 2004 and 2005. Salinity, as estimated by IID, has ranged from approximately 38,000 mg/l in 1950 to approximately 48,000 mg/l in 2003. Holdren and Montano's (2002) salinity measurements for 1999 differed from IID's measurements by approximately 1,200 mg/l. However, the measurement of salinity, obtained as either a sum of ions or by measuring the residue remaining after drying at high temperature, contains significant uncertainty that is estimated at no better than 5 percent (Amrhein et al 2001). At current Salton Sea salinity, the uncertainty in measurement corresponds to approximately +/- 2,000 mg/l or nearly 5 times the annual external salt load to the Salton Sea.

Due to the significant uncertainty in individual salinity measurements it is not possible to calculate a salt balance for each year of the historical period based on Salton Sea salinity. However, it is possible to compare the computed salinity from estimated annual salt loads to the trends of measured Salton Sea salinity over time. As shown in Figure 8, the salinity computed from this method compares very well to the trend in measured salinity over time with an average difference of less than 1 percent. Salinity in the Salton Sea, however, cannot be entirely attributable to the external loads entering from surface and subsurface sources. Beginning in the mid-1980s or early 1990s, precipitation of significant quantities of salts (primarily gypsum and calcite) began and has been estimated between 360,000 to 1,650,000 tons (short tons) per year with a range of 770,000 to 1,320,000 tons believed to be the most reasonable (Amrhein et al 2001). The computed salinity in Figure 8 could not match the measured salinity, even within a 5 percent measurement uncertainty, without incorporating a salt loss term (salt precipitation) from 1990 onward. The estimated salt precipitation developed from the current analysis is approximately 1,500,000 tons per year beginning around 1990. This salt precipitation value is at the high end of the range of previous independent estimates (Amrhein et al 2001) and is similar to that of Tostrud (1997).

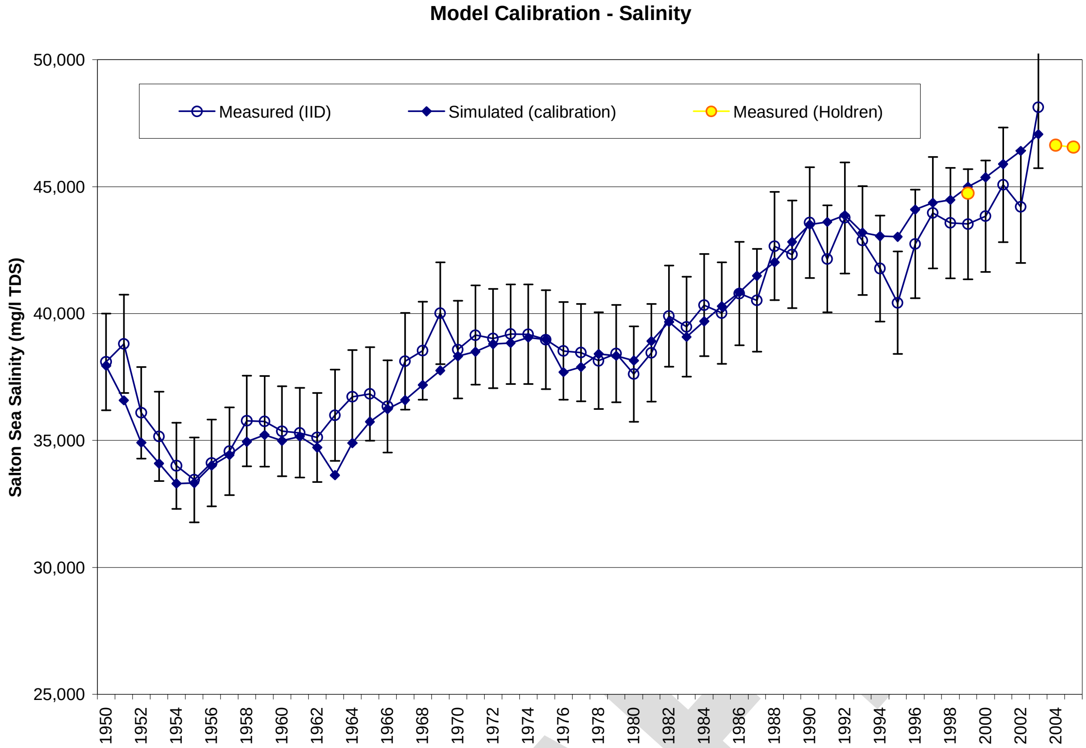

Figure 8
Measured and Simulated Salton Sea Salinity. Error Bars Represent +/- 2000 mg/L

The total annual average external salt load to the Salton Sea for the 1950 to 2002 period is estimated at approximately 4,516,991 tons per year with an annual minimum of 3,079,481 tons in 1950 and an annual maximum of 5,730,956 tons in 1976. In recent years the total external load has been approximately 3.8 million tons per year. Salt precipitation (an internal "sink") accounts for a removal of approximately one-third of the annual external load. The estimated historical salt budget is shown in Table 3 and graphically in Figure 9. The relative contributions of each source area to the salt budget components is summarized in Table 4. As can be seen from Table 3, salt loads from the Imperial Valley account for approximately 78.7 percent of the total external load, Mexico 13.9 percent, Coachella Valley 5.8 percent, and the remainder of the watershed 1.6 percent.

Table 3
Estimated Historical Salt Loads to the Salton Sea

Year	Mexico Salt Load (tons/yr)	IID Salt Load (tons/yr)	CVWD Surface Flow Salt Load (tons/yr)	CVWD Groundwater Flow Salt Load (tons/yr)	San Felipe Cr Salt Load (tons/yr)	Salt Cr Salt Load (tons/yr)	Ungaged Watershed Salt Load (tons/yr)	Local Groundwater Salt Load (tons/yr)	Salt Precipitation (tons/yr)	Total Salt Load to Sea (w/o precipitation) (tons/yr)	Total Salt Load to Sea (tons/yr)	Total from Mexico (tons/yr)	Total from IID (tons/yr)	Total from CVWD (tons/yr)	Total from Local (tons/yr)
1950	84823	2855378	62200	7600	6003	21521	2239	39716	0	3079481	3079481	84823	2855378	69800	69480
1951	92572	3139970	107100	7300	6003	21521	2239	39716	0	3416422	3416422	92572	3139970	114400	69480
1952	75842	3364335	80900	6400	6003	21521	2239	39716	0	3596957	3596957	75842	3364335	87300	69480
1953	74128	3684315	63800	5800	6003	21521	2239	39716	0	3897523	3897523	74128	3684315	69600	69480
1954	84301	3648649	95100	4600	6003	21521	2239	39716	0	3902130	3902130	84301	3648649	99700	69480
1955	244785	3577562	142000	2200	6003	21521	2239	39716	0	4036027	4036027	244785	3577562	144200	69480
1956	436841	3713208	148100	1500	6003	21521	2239	39716	0	4369129	4369129	436841	3713208	149600	69480
1957	389519	3603489	141300	1500	6003	21521	2239	39716	0	4205288	4205288	389519	3603489	142800	69480
1958	530475	3341376	136900	2000	6003	21521	2239	39716	0	4080231	4080231	530475	3341376	138900	69480
1959	569705	3401652	145600	2000	6003	21521	2239	39716	0	4188437	4188437	569705	3401652	147600	69480
1960	603009	3558534	190600	2200	6003	21521	2239	39716	0	4423823	4423823	603009	3558534	192800	69480
1961	576148	3572808	237100	1300	2392	21521	892	39716	0	4451877	4451877	576148	3572808	238400	64521
1962	612071	3806946	328200	100	792	21521	296	39716	0	4809642	4809642	612071	3806946	328300	62325
1963	639664	4050087	364200	-1500	18419	25854	8160	39716	0	5144601	5144601	639664	4050087	362700	92150
1964	678175	3635121	355600	-4700	210	19861	78	39716	0	4724061	4724061	678175	3635121	350900	59865
1965	786501	3819255	418900	-6400	1762	22529	957	39716	0	5083221	5083221	786501	3819255	412500	64965
1966	704090	4148874	386500	-3800	5307	18186	1979	39716	0	5300852	5300852	704090	4148874	382700	65188
1967	635787	4139477	374700	-3900	19229	17738	7173	39716	0	5229919	5229919	635787	4139477	370800	83855
1968	740074	4012009	372700	-4100	6931	20357	2586	39716	0	5190273	5190273	740074	4012009	368600	69590
1969	733842	3754477	362200	-4300	2856	21438	1065	39716	0	4911294	4911294	733842	3754477	357900	65075
1970	630950	3780732	369500	-4000	4389	17986	1637	39716	0	4840911	4840911	630950	3780732	365500	63729
1971	635685	3900990	397200	-3500	2472	16214	922	39716	0	4989699	4989699	635685	3900990	393700	59324
1972	684430	3876592	421700	-3900	2356	15941	879	39716	0	5037714	5037714	684430	3876592	417800	58892
1973	693063	3980338	437100	-4800	127	21521	47	39716	0	5167113	5167113	693063	3980338	432300	61412
1974	664649	4204158	444400	-5700	3419	21521	1275	39716	0	5373439	5373439	664649	4204158	438700	65932
1975	618895	4196407	474600	-7000	3919	33304	1462	39716	0	5361303	5361303	618895	4196407	467600	78401
1976	669954	4361658	486400	-10200	86087	55205	42136	39716	0	5730956	5730956	669954	4361658	476200	223144
1977	681825	4187227	442000	-14500	35464	31756	13229	39716	0	5416716	5416716	681825	4187227	427500	120164
1978	684077	3824323	419000	-18000	6099	18639	2275	39716	0	4976129	4976129	684077	3824323	401000	66729
1979	830984	3998131	421900	-19300	6819	24822	3526	39716	0	5306599	5306599	830984	3998131	402600	74884
1980	886112	3988611	391700	-21400	14049	45175	12280	39716	0	5356243	5356243	886112	3988611	370300	111220
1981	983071	3825050	453400	-24600	460	38436	171	39716	0	5315704	5315704	983071	3825050	428800	78783
1982	951238	3608490	454000	-25200	20044	26288	7477	39716	0	5082053	5082053	951238	3608490	428800	93525
1983	1269999	3333260	407500	-24300	26285	83879	28362	39716	0	5164701	5164701	1269999	3333260	383200	178242
1984	1245141	3360246	360400	-28700	9702	18833	3619	39716	0	5008958	5008958	1245141	3360246	331700	71871
1985	1094768	3296231	300600	-30700	8018	13322	2991	39716	0	4724946	4724946	1094768	3296231	269900	64047
1986	1156095	2837518	291500	-30900	16110	17597	6009	39716	0	4333646	4333646	1156095	2837518	260600	79433
1987	902813	2753625	282900	-32600	4665	11106	1740	39716	0	3963965	3963965	902813	2753625	250300	57227
1988	867612	2854307	281100	-32500	2599	9728	970	39716	0	4023532	4023532	867612	2854307	248600	53013
1989	558769	3139003	271900	-34400	11113	8643	4145	39716	0	3998889	3998889	558769	3139003	237500	63617
1990	516591	3328850	273800	-33700	9187	10493	3427	39716	-1500000	4148364	2648364	516591	3328850	240100	62823
1991	533884	3033473	263500	-33700	14207	9572	5299	39716	-1500000	3865952	2365952	533884	3033473	229800	68795
1992	574283	3247280	248300	-35500	14853	9349	5540	39716	-1500000	4103821	2603821	574283	3247280	212800	69458
1993	585887	3476144	225000	-39600	28429	7902	10605	39716	-1500000	4334083	2834083	585887	3476144	185400	86652
1994	529953	3371582	196400	-41000	6003	6028	2239	39716	-1500000	4110922	2610922	529953	3371582	155400	53987
1995	528697	3293672	174300	-45100	6003	5098	2239	39716	-1500000	4004626	2504626	528697	3293672	129200	53057
1996	456753	3445080	177800	-53700	6003	3369	2239	39716	-1500000	4077262	2577262	456753	3445080	124100	51329
1997	643617	3444677	177300	-54700	6003	2581	2239	39716	-1500000	4261434	2761434	643617	3444677	122600	50540
1998	601958	3229808	186900	-63900	6003	3165	2239	39716	-1500000	4005890	2505890	601958	3229808	123000	51124
1999	594727	3066967	179200	-68900	6003	3009	2239	39716	-1500000	3822962	2322962	594727	3066967	110300	50968
2000	633161	3031589	189275	-73900	6003	2629	2239	39716	-1500000	3830713	2330713	633161	3031589	115375	50588
2001	577364	3099926	183197	-78900	6003	2732	2239	39716	-1500000	3832278	2332278	577364	3099926	104297	50691
2002	457192	3185772	178433	-83900	6003	2366	2239	39716	-1500000	3787823	2287823	457192	3185772	94533	50326
Avg (1950-2002)	**627105**	**3554514**	**282564**	**-20130**	**9601**	**19320**	**4302**	**39716**	**-367925**	**4516991**	**4149067**	**627105**	**3554514**	**262434**	**72939**
Min	**74128**	**2753625**	**62200**	**-83900**	**127**	**2366**	**47**	**39716**	**-1500000**	**3079481**	**2287823**	**74128**	**2753625**	**69600**	**50326**
Max	**1269999**	**4361658**	**486400**	**7600**	**86087**	**83879**	**42136**	**39716**	**0**	**5730956**	**5730956**	**1269999**	**4361658**	**476200**	**223144**

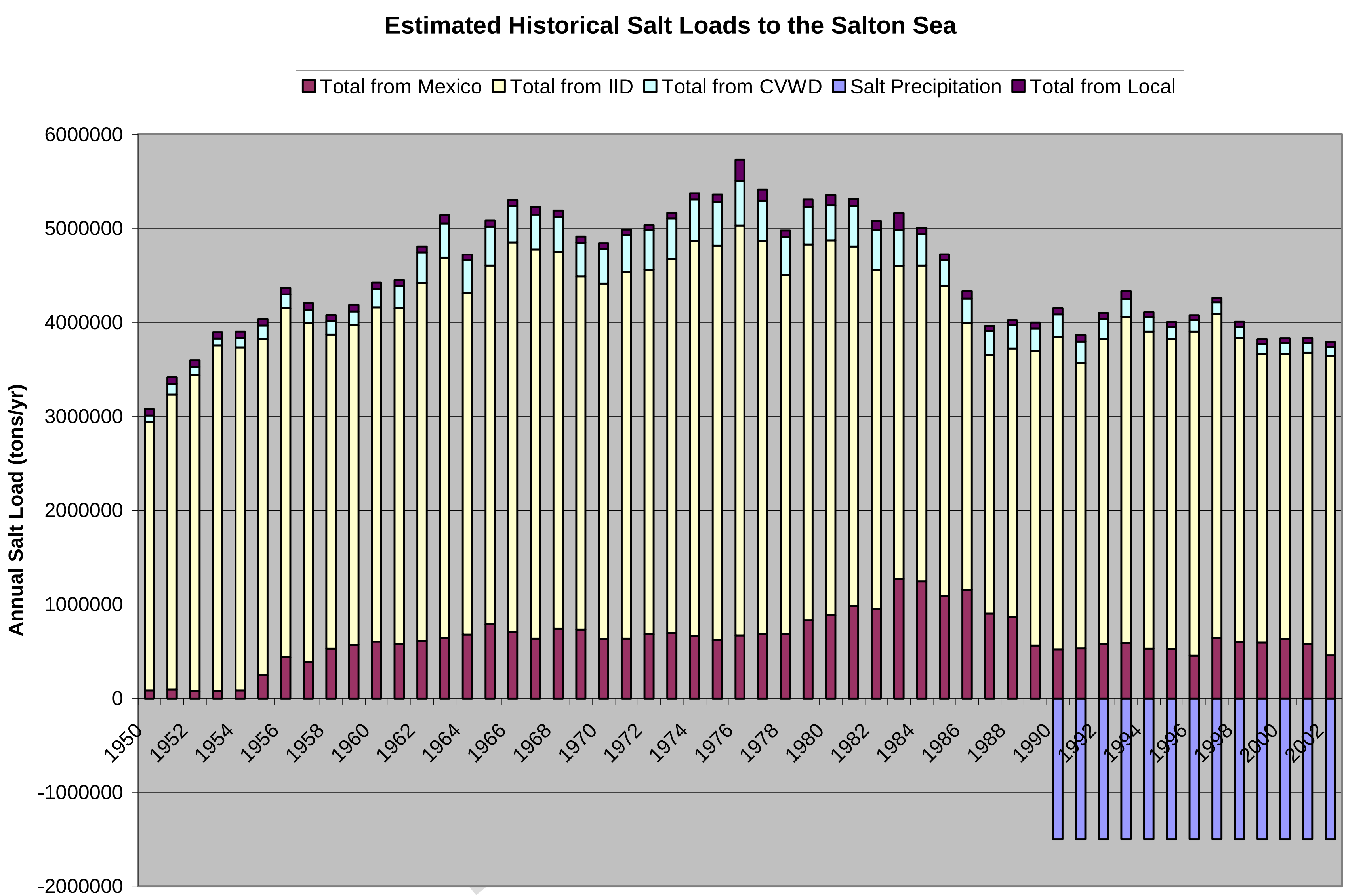

Figure 9
Estimated Historic Salt Loads to the Salton Sea

Table 4
Relative Contribution of Inflow Sources to the Historical (1950 to 2002) Salton Sea Salt Loads

Inflow Source to the Salton Sea	Percent of Historical Annual Average Salt Load
Mexico	13.9%
Imperial Valley	78.7%
Coachella Valley	5.8%
Local Watershed	1.6%
TOTAL	100.0%

PROJECTED HYDROLOGY AND SALT LOADS FOR NO ACTION ALTERNATIVE-CEQA CONDITIONS

The No Action Alternative is a requirement of the California Environmental Quality Act (CEQA) and is intended to reflect existing conditions plus changes which are reasonably expected to occur in the foreseeable future if the project is not implemented, based on current plans and consistent with available infrastructure and community services (CEQA Guidelines Section 15126(e). Conditions described under the No Action Alternative-CEQA Conditions will be used as a basis of comparison in the PEIR for the project alternatives to be described in the Ecosystem Restoration Program. In addition, an understanding of the anticipated hydrology and salt loads under the No Action Alternative-CEQA Conditions is important to projecting the available water supply for project alternatives and allocation of water to various alternative components. This section describes the methods and data used to develop the projected hydrology and salt loads for use in the No Action Alternative-CEQA Conditions. As stated above, this report also describes a No Action Alternative-Variability Conditions to consider future uncertainty in inflows to the Salton Sea. The assumptions used to develop inflow projections under the No Action Alternative-Variability Conditions are described later in this report.

Method of Analysis

As described in the introductory sections of this report, the No Action Alternative-CEQA Conditions hydrology can be developed through a series of building blocks, or intermediate computations, anchored to existing conditions. The building blocks, in this case, are the "***Historical***" and "***QSA No Action Alternative***" water budgets. The Historical analysis is performed to develop an improved understanding of the past and current conditions in order to project conditions that may exist in the future. For example, the historical analysis described in previous sections of this report provided improved estimates of evaporation rates, local watershed runoff, and salt precipitation that are used to inform future projections. The QSA No Action Alternative is the terminology used in this report to represent a projection of future hydrologic conditions under existing (fixed) levels of development (land use), water management practices, etc. This scenario is virtually the same as the "Present Level" budgets used to describe the baseline for the QSA in the IID Water Conservation and Transfer Project EIR/EIS (IID 2002), except for refinements in Mexico and local watershed contributions. The No Action Alternative-CEQA Conditions hydrology and salt loads are developed by making adjustments to the QSA No Action Alternative water budget terms to reflect the effects of the projects to be included in the No Action Alternative-CEQA Condition.

When projecting into the future under these scenarios, the results of several computer models have been used to describe future conditions. For example, results from model simulations using the Imperial Irrigation District Decision Support System (IIDSS, IID 2002) and Coachella Valley

Groundwater Model (CVWD 2005) have been used to describe discharge and salt loads from Imperial and Coachella Valleys, respectively. In each of these models, future climate conditions (primarily rainfall, evaporation, and evapotranspiration) and associated variability are assumed to be adequately represented by past conditions. While the historical periods of these models are not entirely coincident (1925 to 1999 for IIDSS and 1936 to 1996 for the Coachella Valley Groundwater Model), refinements made for other hydrologic components (local watershed and evaporation) attempted to match the 1925 to 1999 climate conditions.

In the discussion that follows, the QSA No Action Alternative conditions for each major source area contributing inflow to the Salton Sea is discussed first, followed by the adjustments made for projects to be considered in the No Action Alternative-CEQA Conditions.

Study Period

The study period for the No Action Alternative-CEQA Conditions, and any other future variants, is the 75-year contract period of the Quantification Settlement Agreement (QSA) and IID Water Conservation and Transfer Project which was initiated and approved in 2003. The hydrologic analysis is performed on an annual basis for the 2003 to 2077 planning horizon.

A second period of time is considered in this analysis for 2018 to 2077. This second period represents conditions following the cessation of "mitigation water" and better represents conditions following the construction of major facilities under the PEIR alternatives.

Summary of Projects Considered in No Action Alternative-CEQA Conditions

The preliminary selection of projects included in the No Action Alternative-CEQA Conditions was based on CEQA Guidelines of reasonable and foreseeable actions. A preliminary list of projects considered for inclusion in the No Action Alternative-CEQA Conditions is provided in the Draft No Action Alternative Report (CH2M HILL 2004). A detailed description of the process used for selecting projects to be included in the No Action Alternative-CEQA Conditions, the criteria used for selection, a summary of each project considered, and the rationale for inclusion or exclusion of each project for the No Action Alternative-CEQA Conditions is included in this draft report which will be finalized and included in the Ecosystem Restoration Program. Many of the projects were excluded from the No Action Alternative-CEQA Conditions due to uncertainty regarding their implementation or methods of implementation and are considered in the uncertainty analysis for future inflows described in No Action Alternative-Variability section of this report. While the list of projects considered is extensive, only a small subset of these projects has the potential to appreciably effect future inflows or salt loads to the Salton Sea. The projects included in the No Action Alternative-CEQA Conditions that could affect inflows to the Salton Sea are listed below:

- Quantification Settlement Agreement Projects
- Imperial Irrigation District Water Conservation and Transfer Project (and associated required mitigation measures)
- Coachella Canal Lining Project
- All-American Canal Lining Project
- Colorado River Basin Salinity Control Program
- Mexicali Wastewater Improvements

- Mexicali Power Production
- Total Maximum Daily Loads Implementation
- Coachella Valley Water District Water Management Plan

The estimated inflows and salt loads that may result after implementation of these No Action Alternative-CEQA Conditions projects are described in the following subsections.

Inflows from Mexico

The U.S. and Mexico entered into a treaty on February 3, 1944, which guarantees Mexico 1,500,000 af/yr of Colorado River flow. Historically, flows that exceeded Treaty obligations were due to storm events, releases to provide storage for flood events, or surplus flows. As the Colorado River Basin has become increasing more populated, surplus flows are less available. Additionally, the U.S. Bureau of Reclamation (Reclamation) has improved operation of the lower Colorado River to reduce delivery of non-storable flows to Mexico in non-flood control years.

QSA No Action Alternative

Flows from Mexico to the U.S. in the New and Alamo Rivers are strongly correlated to the amount of Colorado River water delivered at the Northerly International Boundary (NIB) as shown in Figure 10. The strong relationship is due to the dependence of irrigated agriculture in the Mexicali Valley on the supply provided through Colorado River diversions from Morelos Dam near the NIB. Flows at the NIB are largely a function of upstream Colorado River operations, but can also be influenced by flood flows in the Gila River which discharges into the Colorado River downstream of Imperial Dam. A Colorado River System Simulation Model-Lite (CRSS-Lite) 75-yr model simulation of Colorado River operations using June 2005 storage conditions was supplied by MWD (Scott 2005). The model results (90 traces of 75-yr simulation) for Colorado River flow below Imperial Dam were added to historic flows from the Gila River to obtain a total flow at the NIB. The relationship shown in Figure

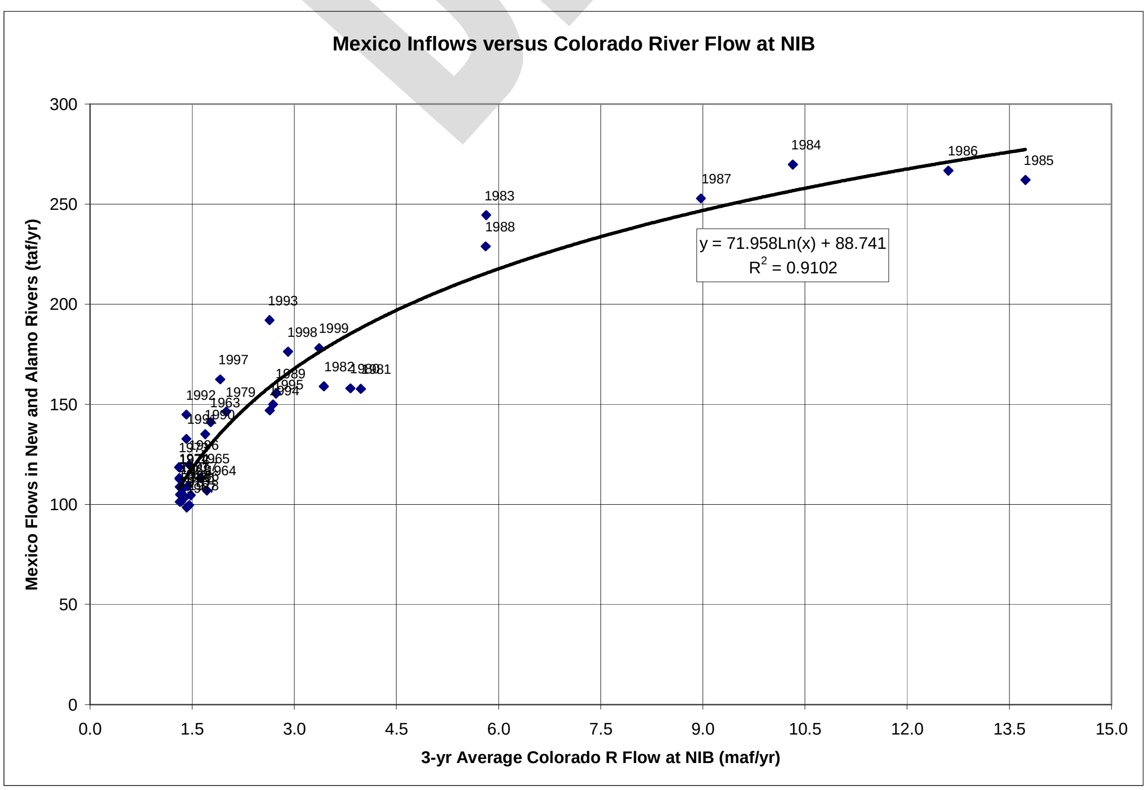

Figure 10
Relationship Between Colorado River Flow at the Northerly International Boundary and Flows into Imperial Valley from Mexico

10 was then used to approximate the total annual inflow to the Imperial Valley from Mexico for each of the projected 75 years. The resulting mean of all trace values for annual inflow from Mexico averages 129,366 af and ranges from 119,082 to 133,883 af for the 2003 to 2077 period (130,212 af for the 2018 to 2077 period).

Salt loads from Mexico for the QSA No Action Alternative condition were estimated by assuming that the TDS values reported in 2003 for the New and Alamo Rivers (IID 2003b) would not significantly change in the absence of future projects. While it is acknowledged that projects associated with the Colorado River Basin Salinity Control Program will have the effect of reducing Lower Colorado River salinity, and subsequently some effect on agricultural returns from the Imperial, Coachella, and Mexicali Valleys, there is significant annual variability that makes an assessment of the long-term trends difficult. The annual average flow-weighted salinity at Imperial Dam in 2003 (735 mg/l) is approximately equal to the average salinity of the past decade. The average TDS for flows in the New and Alamo Rivers at the International Boundary in 2003 was just under 3,000 mg/l. Using this value and QSA No Action Alternative flow projections, the salt load from Mexico is estimated at 511,455 tons/yr for the 2003 to 2077 period (514,798 tons/yr for the 2018 to 2077 period).

Adjustments for No Action Alternative-CEQA Conditions

Under the No Action Alternative-CEQA Conditions, inflows from Mexico are expected to decrease to an average inflow of 97,527 af/yr for the 2003 to 2077 (97,044 af/yr for the 2018 to 2077 period) as compared to conditions assumed under the QSA No Action Alternative. Salt loads under the No Action Alternative-CEQA Conditions are projected to decrease slightly to 479,133 tons/yr for the 2003 to 2077 period (480,729 tons/yr for the 2018 to 2077 period) as compared to the QSA No Action Alternative.

The projected reductions in Mexico flows and salt loads are due to the following two reasonably foreseeable actions in Mexico that were not included in the QSA No Action Alternative.

Mexicali Wastewater Improvements

Mexico has proposed a treatment plant in Las Arenitas designed to treat wastewater generated in the Mexicali II service area which currently flows untreated into the New River. It is proposed that the treated wastewater will be discharged into a tributary of the Rio Hardy that flows into the Colorado River Delta. Therefore, the wastewater will no longer flow into the New River or the Salton Sea. Implementation of this project under the No Action Alternative-CEQA Conditions will reduce inflows to the Salton Sea from the New River by 15,342 af/yr as soon as the treatment plant and pipelines are constructed. It is anticipated that these facilities will be completed in 2006. The plant is proposed to be designed and operated to treat and convey 20.1 million gallons per day (mgd) to accommodate growth in the region until 2014. Since the wastewater will be discharge out of the Salton Sea watershed, the salt load that is carried with the existing untreated wastewater will be removed form the New River. The reduction in salt load is estimated to be approximately 20,161 tons/yr at startup and up to 29,569 tons/yr at full capacity in 2014.

Mexicali Power Plants

The power plant projects consist of two natural gas-fired combined-cycle power plants: the InterGen La Rosita Power Complex and the Sempra Termoeléctrica de Mexicali, located west of Mexicali, Mexico and transmission lines from the power plants to the Imperial Valley Substation. These plants have been constructed and commenced operations in 2003. Water used for cooling purposes at both of the power plants is diverted from the Zaragoza Oxidation Lagoons and treated before use. Operation of these plants results in the consumption of approximately 10,667 af/yr for cooling purposes which would reduce New River flows by a corresponding amount. Through the reduction in flows from the lagoons to the New River, the project is expected to reduce salt load by approximately 4,500 tons/yr.

All American Canal Lining Project (QSA)

The Mexicali Groundwater Basin is the southern extension of the Imperial Valley Groundwater Basin that occurs south of the International Boundary (DWR 2003). As a result of groundwater pumping in Mexico, the groundwater gradient in the area of the All-American Canal is south, towards the Mexicali Valley, and recharge to the groundwater basin would be reduced in the future as a result of the All-American Canal Lining Project (Reclamation and IID, 1994). Although the amount of estimated seepage losses varies by location along the canal, the lining project is projected to reduce seepage by about 67,700 acre-feet/year (Reclamation and IID 1994). Due to groundwater pumping in Mexico, the groundwater gradient in the area of the All American Canal is primarily towards the Mexicali Valley (Reclamation and IID, 1994). If groundwater pumping continues at the current rate, groundwater elevations could decline to a greater depth than prior to operation of the All-American Canal, and the groundwater gradient towards the Mexicali Valley could increase (Reclamation and IID, 1994). Currently less than 10 percent of groundwater flow from the groundwater basin is north towards the Salton Sea. Based upon an analysis by Reclamation (1994), a significant change in groundwater flows to the Salton Sea is not expected from the canal lining project. However, the reduction in availability of groundwater in the Mexicali area due to the canal lining project could reduce groundwater use in Mexico, thereby reducing return flows into the New River. The reduction in groundwater availability and management response have not been quantified or currently documented. No adjustments to the projected inflows under the No Action Alternative-CEQA Conditions from Mexico have been made for the All American Canal Lining Project.

Inflows from Imperial Valley

Agricultural runoff from the Imperial Valley is conveyed to the Salton Sea in the New River, Alamo River, and through drains that discharge directly to the Salton Sea. The discharge to the Salton Sea is directly related to the quantity and quality of diverted Colorado River water, the type and amount of irrigated acreage, and water management within the district, and irrigation techniques and management on-farm. Both inflows and salt loads from the Imperial Valley to the Salton Sea will change in the future due to water conservation programs and QSA provisions, in addition to other factors effecting water use in the Valley.

QSA No Action Alternative

Flows and salt loads from the Imperial Valley to the Salton Sea in the QSA No Action Alternative represent conditions that would be expected to occur under land use, district water management, and on-farm irrigation practices prior to the implementation of the QSA. The QSA No Action Alternative inflows and salt loads for the Imperial Valley are identical to those documented in the IID Water Conservation and Transfer Project EIR/EIS (IID 2002) that were used to describe the without project baseline for the QSA analyses. Since the original projections were developed to provide a representative future 75-year period using 1925 to 1999 climate conditions, they have been shifted forward from the original 2000 to 2074 period to the current 2003 to 2077 study period. The estimated annual inflow from the Imperial Valley to the Salton Sea averages 995,413 af for the 2003 to 2077 period (994,894 af for the 2018 to 2077 period) and ranges from 850,081 to 1,114,332 af. In more than 50 percent of the years, the estimated annual QSA No Action Alternative inflow is less than 1,000,000 af and is less than 1,100,000 af in approximately 90 percent of the years.

Similar to the inflow projections, the QSA No Action Alternative salt load projections from the Imperial Valley to the Salton Sea are identical to those described by IID (2002) as the without project analyses for the Water Conservation and Transfer Project. It is possible that these projections overestimate the future salt load due to the assumption in the IIDSS modeling that future Colorado River salinity at Imperial Dam would be at the maximum numeric target of 879 mg/l (IID 2002) as compared to recent trends of salinity under 800 mg/l (735 mg/l as a flow-weighted average in 2003). If the future Colorado River salinity at Imperial Dam is lower than the numeric target, the leaching requirement (amount of water needed for on-farm salinity control) and associated salt load of Imperial Valley drain water will be reduced. The uncertainty in Imperial Valley salt loads due to future Colorado River salinity may be as much as 500,000 tons/yr and may reduce the IID-projected tilewater flows by as much as 40,000 af/yr. Due to the considerable degree of uncertainty regarding future Colorado River salinity, this factor is considered in the No Action Alternative-Variability Conditions analysis and not within the QSA No Action Alternative or No Action Alternative-CEQA Conditions estimates. The QSA No Action Alternative average annual salt loads from the Imperial Valley are estimated at 3,373,633 tons for the 2003 to 2077 period (3,376,220 tons for the 2018 to 2077 period) and ranges from 3,050,843 to 3,594,752 tons.

Entitlement Enforcement and Inadvertent Overrun and Payback Policy

In 1996, the Secretary of the Interior deferred consideration of long-term Colorado River surplus guidelines until California put in place a strategy to ensure that it would be able to reduce its annual use of Colorado River water to its apportionment of 4.4 million acre-feet. Under the California Colorado River Water Use Plan (California 4.4 Plan), surplus supplies would not be available on an interim or long-term basis unless California demonstrated compliance with the required reductions. Existing Colorado River apportionments limit the aggregate apportionments of Priorities 1, 2, and 3 at 3.85 maf/yr. Diversions by IID and CVWD have historically exceeded their Priority-3 apportionments (i.e., the total Priority 1-, 2- and 3- apportionment of 3.85 maf/yr, minus the average of approximately 420,000 af/yr used by Priorities 1 and 2, Palo Verde Irrigation District and the Yuma Project), but are not expected in the future as other Basin states use their full entitlements and surplus water is reduced. The projected demands of IID and CVWD used in the modeling for the IID Water Conservation and Transfer Agreement showed that, on average, diversions by CVWD and IID would need to be reduced by 59,210 af/yr to stay within their aggregate apportionment of approximately 3.43 maf/yr (3.85 maf/yr minus 420,000 af/yr. IID contends that this quantity would be paid back in a fashion consistent with the phased payback schedule of the Inadvertent Overrun and Payback Policy. For modeling purposes, IID has assumed that the payback would occur evenly over 75 years. This assumption has been carried forward into the QSA No Action Alternative water budget.

Adjustments for No Action Alternative-CEQA Conditions

Under the No Action Alternative-CEQA Conditions, flows from the Imperial Valley to the Salton Sea are projected to decrease to an annual average of 776,672 af over the 2003 to 2077 period (724,094 af for the 2018 to 2077 period). Salt loads from the Imperial Valley under the No Action Alternative-CEQA Conditions are also projected to decrease to 3,100,881 tons/yr for the 2003 to 2077 period (3,051,080 tons/yr for 2018 to 2077 period) as compared to the QSA No Action Alternative. The projected reductions in Imperial Valley flows and salt loads are due to the implementation of the QSA and IID Water Conservation and Transfer Project as described below.

IID Water Conservation and Transfer Project

Under the No Action Alternative-CEQA Conditions, implementation of the QSA and the IID Water Conservation and Transfer Project will reduce water use in the IID water service area. Under the QSA, water will be conserved by IID and transferred to CVWD, San Diego County Water Authority (SDCWA), and/or Metropolitan Water District of Southern California (MWD) over an initial contract term of 45 years. If there is consent among all parties, the transfer will be extended for an additional 30 years. The amount of water to be conserved and transferred under the IID Water Conservation and

Transfer Project will ramp up over the first 24 years until it reaches 303,000 acre-feet/year, as shown in Table 5, which includes the amount of water to be conserved and the method to be used to generate the water. During the first 15 years of the IID Water Conservation and Transfer Project, mitigation water will be generated and discharged to the Salton Sea using fallowing to mitigate for effects of the transfers on the Salton Sea per Fish & Game Code Section 2081.7(c)(2). Therefore reductions in inflow to the Salton Sea from IID due to implementation of the IID Water Conservation and Transfer Project will not be noticeable through 2017. Subsequent to 2017, the method of generating water for transfers will be through conservation/efficiency improvements (as opposed to land fallowing) and will result in reductions in inflows to the Salton Sea. The average annual reduction in inflows to the Salton Sea from Imperial Valley due to the QSA and IID Water Conservation and Transfer Project is project is approximately 217,960 af for the 2003 to 2077 period (270,950 af for the 2018 to 2077 period).

The reductions in salt loads from the Imperial Valley associated with the QSA and IID Water Conservation and Transfer Project were developed using assumptions consistent with IID (2002) and Reclamation's revised estimates (Weghorst 2004). The change in salt load caused by either conservation/efficiency improvements or mitigation fallowing were assumed to be of 879 mg/l TDS Colorado River water. The water developed through fallowing and delivered to either SDCWA, CVWD, or MWD was assumed to reduce return flows to the Salton Sea in the absence of mitigation water by one-half the quantity of delivered water. The return flows were assumed to contain 3.6 tons of salt per af of flow (Weghorst 2004). This value has not been independently confirmed. Estimated reductions in salt loads from the Imperial Valley due to the QSA and IID Water Conservation and Transfer Project are approximately 272,252 tons/yr for the 2003 to 2077 study period (325,140 tons/yr for the 2018 to 2077 period).

Table 5
Quantification Settlement Agreement Delivery Schedule by Conservation Method

QSA Year	Calendar Year	IID and SDCWA	IID and CVWD [a,]	IID and MWD	Total Delivery	Total Efficiency	Fallowing for Delivery	Mitigation Fallowing	Total Fallowing
1	2003	10	0	0	10	0	10	5	15
2	2004	20	0	0	20	0	20	10	30
3	2005	30	0	0	30	0	30	15	45
4	2006[b]	40	0	0	40	0	40	20	60
5	2007	50	0	0	50	0	50	25	75
6	2008	50	4	0	54	4	50	25	75
7	2009[b]	60	8	0	68	8	60	30	90
8	2010	70	12	0	82	12	70	35	105
9	2011	80	16	0	96	16	80	40	120
10	2012[b]	90	21	0	111	21	90	45	135
11	2013	100	26	0	126	46	80	70	150
12	2014	100	31	0	131	71	60	90	150
13	2015	100	36	0	136	96	40	110	150
14	2016	100	41	0	141	121	20	130	150
15	2017	100	45	0	145	145	0	150	150
16	2018	130	63	0	193	193	0	0	0
17	2019	160	68	0	228	228	0	0	0

Table 5
Quantification Settlement Agreement Delivery Schedule by Conservation Method

QSA Year	Calendar Year	IID and SDCWA	IID and CVWD [a,]	IID and MWD	Total Delivery	Total Efficiency	Fallowing for Delivery	Mitigation Fallowing	Total Fallowing
18	2020	192.5	73	0	268	268	0	0	0
19	2021	205	78	0	288	288	0	0	0
20	2022	202.5	83	0	288	288	0	0	0
21	2023	200	88	0	288	288	0	0	0
22	2024	200	93	0	293	293	0	0	0
23	2025	200	98	0	298	298	0	0	0
24	2026	200	103	0	303	303	0	0	0
25	2027	200	103	0	303	303	0	0	0
26	2028	200	103	0	303	303	0	0	0
27 to 45	2029 to 2047	200	103	0	303	303	0	0	0
46 to 75[c]	2048 to 2077	200	50	0	250	250	0	0	0

All values in thousands of acre/feet

[a] If CVWD declines to acquire these amounts, MWD has an option to acquire them, but acquisition by MWD of conserved water in lieu of CVWD during the first 15 years is subject to satisfaction by MWD of certain conditions, including subsequent environmental assessment.

[b] In addition to the conserved amounts shown on this Table, additional amounts of up to 25,000 acre-feet in 2006, 50,000 acre-feet in 2009 and 70,000 acre-feet in 2012 could be conserved to meet the Interim Surplus Guidelines (ISG) benchmarks. IID has the discretion to select the method of conservation used to make the ISG backfill water. If fallowing is selected to conserve water to meet the ISG benchmarks, the total acres of fallowing would be within the amount originally evaluated in the EIR/EIS.

[c] This assumes that the parties have approved the extension of the 45-year initial term of the IID Water Conservation and Transfer Project.

Source: CVWD et al 2003, IID 2003.

All American Canal Lining Project

No adjustments to the projected inflows under the No Action Alternative-CEQA Conditions from Imperial Valley have been made for the All American Canal Lining Project as discussed above.

Sedimentation/Silt Total Maximum Daily Loads for New and Alamo Rivers

Sedimentation/Siltation Total Maximum Daily Loads (TMDLs) for the New and Alamo Rivers have been adopted and approved and are just beginning towards full implementation. Achieving compliance with TMDLs relies heavily on the Imperial County Farm Bureau's (ICFB) Voluntary Watershed Program that helps educated farmers, promotes Best Management Practices (BMP), monitoring methods, and identifies funding sources. The effect of TMDL compliance on drain water flows to the Salton Sea is not yet known, but is expected to reduce inflows further as on-farm tailwater management improves. Al Kalin, ICFB on-farm TMDL consultant, has indicated that total drain water may be reduced by 30 percent on some fields due to implementation of BMPs (Kalin 2005, personal communication). Pump-back systems or transition to sprinkler or drip irrigation methods would result in little or no tailwater (ICFB 2003). However, due to the uncertainty surrounding the actual methods farmers in the Imperial Valley could implement to comply with the TMDLs, no adjustments are made to the inflows under the No Action Alternative-CEQA Conditions.

Inflows from Coachella Valley

Agricultural and storm runoff in the Coachella Valley is conveyed to the Salton Sea in the Whitewater

River/CVSC and through drains that discharge directly to the Salton Sea. The amount discharge to the Salton Sea is related to the management of the Coachella Valley groundwater basin, the supplies available to CVWD from both the Coachella Canal and the Colorado River Aqueduct (State Water Project exchange with MWD), the quantity and quality of diverted Colorado River water, the type and amount of irrigated acreage, water management within the district, and on-farm water management. Contrasting with agriculture drainage in the Imperial Valley, farm drainage in the Coachella Valley mostly returns to the groundwater basin by percolation through the permeable soils. In the lower Valley, however, relatively impermeable subsurface layers restrict downward percolation and have created a shallow semi-perched groundwater condition. An extensive drain network has been developed in this area to convey shallow groundwater away from root zones to the CVSC and smaller drains. Thus, changes in management of the groundwater basin or lower Valley drainage system, in addition to other changes in water management, will affect inflows and salt loads to the Salton Sea from the Coachella Valley.

QSA No Action Alternative

Flows and salt loads from the Coachella Valley to the Salton Sea in the QSA No Action Alternative represent conditions that would be expected to occur under land use, district water management, and on-farm irrigation practices prior to the implementation of the QSA or the Coachella Valley Water Management Plan (2002). The QSA No Action Alternative inflows and salt loads for the Coachella Valley are identical to those obtained from CVWD and documented in the IID Water Conservation and Transfer Project EIR/EIS (IID 2002) that were used to describe the baseline for the QSA analyses. Since the original projections were developed to describe future conditions for the 2000 to 2074 period, the values have been extended for years 2075 to 2077 for this analysis per discussion with CVWD's representative (Ringel 2005, personal communication). The projected annual inflow from the Coachella Valley to the Salton Sea averages 63,733 af for the 2003 to 2077 period (61,030 af for the 2018 to 2077 period) and ranges from 76,373 af in the early years to 47,015 af in 2077, reflecting the continuing decline in groundwater levels (and associated decline in discharge to the Salton Sea) in the absence of future water management projects in the Valley.

Similar to the inflow projections, the QSA No Action Alternative salt load projections from the Coachella Valley to the Salton Sea are identical to those described by IID (2002) as the baseline for the QSA analyses. These values have also been extended for the 2003 to 2077 period. The QSA No Action Alternative average annual salt loads from the Coachella Valley are estimated at 13,609 tons for the period 2003 to 2077 (694 tons for the 2018 to 2077 period) and ranges from 90,448 tons in 2003 to -9,931 tons (net salt load out of Salton Sea) in 2052, reflecting the continual decline in groundwater levels and reversal of the groundwater-Salton Sea hydraulic gradient.

Adjustments for No Action Alternative-CEQA Conditions

Flows from the Coachella Valley to the Salton Sea are projected to significantly increase to an annual average of 126,298 af over the 2003 to 2077 period (138,446 af for the 2018 to 2077 period). Salt loads from the Coachella Valley under the No Action Alternative-CEQA Conditions are also projected to increase to 384,592 tons/yr for the 2003 to 2077 period (452,110 tons/yr for the 2018 to 2077 period) as compared to the QSA No Action Alternative. The projected reductions in Imperial Valley flows and salt loads are due to the implementation of the QSA-related projects and the Coachella Valley Water Management Plan as described below.

IID-CVWD Transfer, Coachella Canal Lining Project, and Coachella Valley Water Management Plan

Under the No Action Alternative-CEQA Conditions, implementation of the QSA-related projects and the suite of projects included in the Coachella Valley Water Management Plan (CVWD 2002) will increase the flows and salt loads to the Salton Sea. Under the QSA and IID Water Conservation and Transfer Project (IID 2002), up to 100,000 af/yr of water will be conserved by IID and transferred to CVWD according to the schedule shown in Table 5. After year 45 of the QSA, IID would conserve the first 50,000 af of the water to be supplied to CVWD and MWD would bear the obligation to provide the second 50,000 af (CVWD et al 2003). Water delivered to CVWD from IID would be developed from on-farm or other efficiency measures. Some portion of the delivered water is expected to return to the Salton Sea.

CVWD has developed a comprehensive plan for future management of water resources in the Coachella Valley to address overdraft conditions in the Coachella Valley groundwater basin, declining groundwater levels, the possibility of future land subsidence, and degradation in groundwater quality. The Coachella Valley Water Management Plan and State Water Project Entitlement Transfer EIR (WMP) (CVWD 2002) describes the CVWD's water plan involving water conservation, acquisition of additional water supplies, source substitution, and groundwater recharge to satisfy future water demand and provide sustainable management of the groundwater basin. The additional water supplies considered in the WMP include Colorado River water from the IID transfer (100,000 af/yr), water savings from the Coachella Canal Lining Project (26,000 af/yr), SWP Entitlement delivery through an exchange with MWD (100,000 af/yr entitlement, average 50,000 af/yr delivery), additional imported water most likely from SWP Entitlement purchases (40,000 af/yr), additional treated municipal wastewater (16,000 af/yr), and desalted drain water from the CVSC in the Oasis area (11,000 af/yr). These supplies, along with the conservation programs, source substitution, and groundwater recharge, will stabilize water levels and improve the groundwater quality.

The effects of the WMP projects on the Coachella Valley water resources have been evaluated by CVWD (2002) using a three-dimensional groundwater model of the basin. As a result of elevated groundwater levels in the lower valley, greater discharge to surface drains and the Salton Sea are projected to occur. Results from the modeling indicate that the average annual inflows to the Salton Sea from the Coachella Valley will be approximately 126,298 af for the 2003 to 2077 period (138,446 af for the 2018 to 2077 period). However, since the projects will be phased-in over time and groundwater responses are generally much slower than those for surface water, the conditions are nearly identical to the QSA No Action Alternative in the early years. The associated salt loads to the Salton Sea from the Coachella Valley is estimated to be approximately 384,592 tons/yr for the 2003 to 2077 period (452,110 tons/yr for the 2018 to 2077 period) as salts are flushed from the groundwater basin.

Inflows from Portions of the Watershed Not Tributary to Irrigated Areas of the Imperial and Coachella Valleys

The portion of the Salton Sea watershed that is not tributary to the irrigated areas of Imperial and Coachella Valleys contributes relatively small quantities of flow to the Salton Sea. However, the flow contributions and connectivity with the Salton Sea can be important to localized elements of a restoration project.

QSA No Action Alternative and No Action Alternative-CEQA Conditions

Flows and salt loads from the local watershed to the Salton Sea under either the QSA No Action Alternative or No Action Alternative-CEQA Conditions are expected to be similar to those of recent years. The future estimated annual inflow to the Salton Sea from the portion of the watershed not tributary to the irrigated areas of Imperial and Coachella Valleys averages 20,116 af for the 2003 to 2077 period (18,984 af for the 2018 to 2077 period) and ranges from 14,514 to 150,732 af. Future annual average salt loads from the local watershed are estimated at 64,767 tons for the 2003 to 2077 period (62,370 tons for the 2018 to 2077 period).

The contribution from San Felipe Creek, Salt Creek, and surface runoff from other smaller areas on the west and east shore were estimated through the use of the historically-developed relationships between rainfall and runoff. Rainfall records for Brawley and Mecca stations were obtained and extended for the 1925 to 1999 period to provide consistency with the historical climate period used for projecting future Imperial Valley inflows.

Future San Felipe Creek inflows to the Salton Sea were estimated by applying the runoff relationship to Brawley rainfall (Figure 4) for the historical climate period. The future “runoff” portion of Salt Creek discharge was estimated in a similar fashion using the historical rainfall at Mecca (Figure 5). However, since a large portion of Salt Creek discharges are the caused by seepage from the Coachella Canal and other groundwater discharges upstream of the Salton Sea, the baseflow of 623 af/yr was added to the future estimated runoff. The 623 af/yr value is the average of the 1996 to 1999 discharge (low rainfall years) and the amount that CVWD has committed to provide at the Salt Creek gage as mitigation for the Coachella Canal Lining Project (Reclamation and CVWD 2001). Only in higher rainfall years are flows expected to be significantly higher than this value. Using the same method as historical estimates, runoff from the ungaged areas on the east and west shore of the Salton Sea were estimated by prorating either San Felipe Creek discharge or Salt Creek runoff by relative watershed areas. Future groundwater inflows from the west shore were assumed to be the same as those for the historic period.

Future estimated salt loads from the watershed not tributary to the irrigated areas of Imperial or Coachella Valleys were developed by assuming the estimated historic salinity concentrations would be the same in the future.

Evaporation and Precipitation

The development of historic evaporation rates at the Salton Sea is described in detail under the preceding section “Historical Hydrology and Salt Loads”. It was found that long-term evaporation rates developed from a historic water budget compared well to those estimated by Hely et al (1966) and to adjusted pan evaporation rates. The average annual evaporation rate was estimated at approximately 69 inches or 66.4 inches as a net evaporation rate (evaporation minus precipitation). The net evaporation rates estimated from the historical analysis have been adopted for use in future analyses.

Projected Salton Sea Inflows for No Action Alternative-CEQA Conditions

The projected inflows to the Salton Sea for the No Action Alternative-CEQA Conditions have been discussed above and are summarized here. The projected total annual average inflow to the Salton Sea for the 2003 to 2077 period is estimated at approximately 964,539 af/yr with an annual minimum of 791,672 af and an annual maximum of 1,303,334 af. The average annual inflow for 2018 to 2077 is 921,562 af. The projected Salton Sea inflows for the No Action Alternative-CEQA Conditions are shown in Table 6 and graphically in Figure 11. Figure 12 shows a comparison of average annual inflows to the Salton Sea, and by contributing source, for the “Historic”, “QSA No Action Alternative”, and “No Action Alternative-CEQA Conditions”. While the use of average annual inflows is of limited value in that it hides the reliability and inter-annual variability aspects, it is useful for evaluating trends. The No Action Alternative-CEQA Conditions are

Table 6
Projected Salton Sea Inflows for No Action Alternative-CEQA Conditions

	Mexico				Imperial Valley			Coachella Valley				Local Watershed				
Year	Mexico Baseline Inflow (af/yr)	Adjustment for Mexicali Power Plants (af/yr)	Adjustment for Mexicali Wastewater Treatment Plant (af/yr)	Adjusted Mexico Inflow (af/yr)	Imperial Valley Baseline Discharge to Sea (af/yr)	Adjustment for QSA (af/yr)	Adjusted Imperial Valley Discharge to Sea (af/yr)	Adjusted Coachella Valley Surface Flows to Sea (af/yr)	Adjusted Coachella Valley Aquifer Flows to/from Sea (af/yr)	Total Coachella Valley Discharge to Sea (af/yr)	IOPP (af/yr)	San Felipe Creek (af/yr)	Salt Creek (af/yr)	Ungaged Watershed Inflows (af/yr)	Local Groundwater Inflows (af/yr)	Total Inflow to Sea (af/yr)
2003	119082	-10667	0	108415	952178	0	952178	72561	-630	71930	-56856	2834	623	1057	10000	1090181
2004	120213	-10667	0	109546	1053354	0	1053354	78079	-671	77408	-56856	2834	623	1057	10000	1197966
2005	120879	-10667	0	110212	1019665	0	1019665	79792	-709	79082	-56856	2834	623	1057	10000	1166618
2006	121866	-10667	-15342	95857	980000	0	980000	76887	-745	76142	-56856	2834	623	1057	10000	1109657
2007	122508	-10667	-16237	95604	949340	0	949340	76818	-779	76039	-56856	2834	623	1057	10000	1078641
2008	123300	-10667	-17132	95501	940522	-4000	936522	72165	-808	71357	-56856	2834	623	1057	10000	1061038
2009	124250	-10667	-18027	95556	934397	-8000	926397	72781	-828	71953	-56856	2834	623	1057	10000	1051564
2010	125942	-10667	-18922	96353	1027601	-12000	1015601	73777	-843	72934	-56856	11197	3161	5913	10000	1158303
2011	127264	-10667	-19816	96781	938780	-16000	922780	75531	-852	74680	-56856	2834	623	1057	10000	1051900
2012	128544	-10667	-20711	97166	976357	-21000	955357	78110	-853	77256	-56856	2834	623	1057	10000	1087438
2013	129236	-10667	-21606	96963	940652	-16000	924652	77121	-847	76274	-56856	2834	623	1057	10000	1055548
2014	130723	-10667	-22501	97555	1096364	-11000	1085364	80827	-833	79994	-56856	2834	623	1057	10000	1220571
2015	131307	-10667	-22501	98139	1102122	-6000	1096122	84281	-809	83471	-56856	2834	623	1057	10000	1235390
2016	132184	-10667	-22501	99016	1035992	-1000	1034992	87687	-782	86905	-56856	2834	623	1057	10000	1178571
2017	132400	-10667	-22501	99232	1015039	5000	1020039	90933	-745	90187	-56856	92453	8444	39836	10000	1303334
2018	132774	-10667	-22501	99606	1057841	-193000	864841	97406	-696	96709	-56856	2834	623	1057	10000	1018814
2019	132745	-10667	-22501	99577	958137	-228000	730137	101218	-636	100582	-56856	13156	3438	6833	10000	906868
2020	132344	-10667	-22501	99176	1097408	-268000	829408	105150	-567	104583	-56856	2834	623	1057	10000	990825
2021	132302	-10667	-22501	99134	970489	-288000	682489	109366	-501	108865	-56856	2834	623	1057	10000	848146
2022	132149	-10667	-22501	98981	1102483	-288000	814483	113687	-417	113269	-56856	2834	623	1057	10000	984391
2023	132552	-10667	-22501	99384	933630	-288000	645630	113475	-280	113195	-56856	2834	623	1057	10000	815866
2024	132524	-10667	-22501	99356	1018457	-293000	725457	118647	-107	118540	-56856	2834	623	1057	10000	901011
2025	132814	-10667	-22501	99646	984430	-298000	686430	123826	82	123908	-56856	2834	623	1057	10000	867642
2026	133017	-10667	-22501	99849	1105981	-303000	802981	128795	240	129035	-56856	2834	623	1057	10000	989523
2027	133634	-10667	-22501	100466	1041634	-303000	738634	133511	398	133910	-56856	2834	623	1057	10000	930668
2028	133883	-10667	-22501	100715	987664	-303000	684664	137868	540	138408	-56856	2834	623	1057	10000	881445
2029	133607	-10667	-22501	100439	1009093	-303000	706093	141721	658	142379	-56856	2834	623	1057	10000	906569
2030	132706	-10667	-22501	99538	1028147	-303000	725147	145188	757	145944	-56856	2834	623	1057	10000	928287
2031	132219	-10667	-22501	99051	988991	-303000	685991	148357	838	149194	-56856	2834	623	1057	10000	891894
2032	132384	-10667	-22501	99216	991076	-303000	688076	151285	904	152188	-56856	2834	623	1057	10000	897139
2033	132551	-10667	-22501	99383	1106342	-303000	803342	154047	957	155004	-56856	2834	623	1057	10000	1015387
2034	132393	-10667	-22501	99225	997398	-303000	694398	156366	999	157364	-56856	2834	623	1057	10000	908645
2035	131720	-10667	-22501	98552	947379	-303000	644379	158268	1032	159300	-56856	2834	623	1057	10000	859889
2036	130969	-10667	-22501	97801	1035849	-303000	732849	158352	1059	159411	-56856	2834	623	1057	10000	947720
2037	130785	-10667	-22501	97617	1029275	-303000	726275	158240	1081	159320	-56856	2834	623	1057	10000	940870
2038	131111	-10667	-22501	97943	945364	-303000	642364	157955	1098	159053	-56856	2834	623	1057	10000	857018
2039	131438	-10667	-22501	98270	1022577	-303000	719577	157519	1111	158631	-56856	2834	623	1057	10000	934135
2040	131228	-10667	-22501	98060	1021389	-303000	718389	156951	1122	158073	-56856	2834	623	1057	10000	932179
2041	131224	-10667	-22501	98056	1091373	-303000	788373	156267	1130	157397	-56856	2834	1098	1382	10000	1002283
2042	130574	-10667	-22501	97406	1002077	-303000	699077	155484	1136	156620	-56856	2834	623	1057	10000	910761
2043	130754	-10667	-22501	97586	938756	-303000	635756	154613	1141	155754	-56856	2834	731	1131	10000	846936
2044	130920	-10667	-22501	97752	884449	-303000	581449	153668	1145	154813	-56856	2834	623	1057	10000	791672
2045	130558	-10667	-22501	97390	937873	-303000	634873	152658	1148	153806	-56856	9093	623	3392	10000	852321

Table 6 (cont)
Projected Salton Sea Inflows for No Action Alternative-CEQA Conditions

	Mexico				Imperial Valley			Coachella Valley				Local Watershed				
Year	Mexico Baseline Inflow (af/yr)	Adjustment for Mexicali Power Plants (af/yr)	Adjustment for Mexicali Wastewater Treatment Plant (af/yr)	Adjusted Mexico Inflow (af/yr)	Imperial Valley Baseline Discharge to Sea (af/yr)	Adjustment for QSA (af/yr)	Adjusted Imperial Valley Discharge to Sea (af/yr)	Adjusted Coachella Valley Surface Flows to Sea (af/yr)	Adjusted Coachella Valley Aquifer Flows to/from Sea (af/yr)	Total Coachella Valley Discharge to Sea (af/yr)	IOPP (af/yr)	San Felipe Creek (af/yr)	Salt Creek (af/yr)	Ungaged Watershed Inflows (af/yr)	Local Groundwater Inflows (af/yr)	Total Inflow to Sea (af/yr)
2046	130319	-10667	-22501	97151	987754	-303000	684754	151593	1150	152743	-56856	2834	623	1057	10000	892306
2047	129928	-10667	-22501	96760	927646	-250000	677646	150480	1152	151632	-56856	2834	623	1057	10000	883696
2048	130196	-10667	-22501	97028	982748	-250000	732748	149326	1153	150480	-56856	2834	623	1057	10000	937913
2049	129788	-10667	-22501	96620	992067	-250000	742067	148138	1154	149292	-56856	2834	623	1057	10000	945637
2050	129419	-10667	-22501	96251	1005793	-250000	755793	146919	1155	148074	-56856	2834	623	1057	10000	957777
2051	129637	-10667	-22501	96469	1016584	-250000	766584	145675	1156	146831	-56856	2834	623	1057	10000	967542
2052	129396	-10667	-22501	96228	1022530	-250000	772530	144409	1156	145565	-56856	2834	623	1057	10000	971982
2053	129479	-10667	-22501	96311	879393	-250000	629393	143124	1157	144281	-56856	2834	623	1057	10000	827642
2054	129082	-10667	-22501	95914	944597	-250000	694597	141823	1157	142980	-56856	41246	8256	20606	10000	956743
2055	129357	-10667	-22501	96189	1114332	-250000	864332	140509	1157	141666	-56856	17104	623	6380	10000	1079439
2056	129412	-10667	-22501	96244	923277	-250000	673277	139183	1157	140340	-56856	3870	2620	2809	10000	872304
2057	129120	-10667	-22501	95952	996533	-250000	746533	137847	1157	139005	-56856	2834	3000	2683	10000	943150
2058	129201	-10667	-22501	96033	939315	-250000	689315	136503	1158	137660	-56856	4750	3330	3624	10000	887857
2059	129031	-10667	-22501	95863	1017618	-250000	767618	135151	1158	136309	-56856	2834	623	1057	10000	957448
2060	129250	-10667	-22501	96082	942368	-250000	692368	133794	1158	134951	-56856	2834	623	1057	10000	881059
2061	128867	-10667	-22501	95699	946206	-250000	696206	132431	1158	133589	-56856	56244	13153	29551	10000	977585
2062	128934	-10667	-22501	95766	918281	-250000	668281	131063	1158	132221	-56856	2834	623	1057	10000	853927
2063	128626	-10667	-22501	95458	1090278	-250000	840278	129692	1158	130850	-56856	2834	623	1057	10000	1024244
2064	128594	-10667	-22501	95426	1018620	-250000	768620	129711	1158	130869	-56856	2834	623	1057	10000	952572
2065	128659	-10667	-22501	95491	886105	-250000	636105	129727	1158	130885	-56856	2834	1293	1516	10000	821267
2066	128754	-10667	-22501	95586	936635	-250000	686635	129740	1158	130898	-56856	2834	623	1057	10000	870777
2067	128628	-10667	-22501	95460	971767	-250000	721767	129751	1158	130909	-56856	2834	623	1057	10000	905795
2068	128400	-10667	-22501	95232	984432	-250000	734432	129761	1158	130919	-56856	2834	623	1057	10000	918241
2069	128398	-10667	-22501	95230	937504	-250000	687504	129770	1158	130927	-56856	6706	1293	2960	10000	877765
2070	128267	-10667	-22501	95099	850081	-250000	600081	129777	1158	130934	-56856	7012	7775	7507	10000	801552
2071	128498	-10667	-22501	95330	942359	-250000	692359	129783	1158	130941	-56856	13420	1886	5870	10000	892950
2072	128594	-10667	-22501	95426	983336	-250000	733336	129788	1158	130946	-56856	2834	623	1057	10000	917366
2073	128772	-10667	-22501	95604	1016119	-250000	766119	129792	1158	130950	-56856	2834	623	1057	10000	950331
2074	128793	-10667	-22501	95625	1084471	-250000	834471	129796	1158	130954	-56856	2834	623	1057	10000	1018708
2075	126627	-10667	-22501	93459	1103947	-250000	853947	129799	1158	130957	-56856	2834	1858	1902	10000	1038101
2076	123971	-10667	-22501	90803	1094724	-250000	844724	129802	1158	130960	-56856	2834	623	1057	10000	1024145
2077	120863	-10667	-22501	87695	1000653	-250000	750653	129805	1158	130963	-56856	2834	623	1057	10000	926969
Avg (2003-77)	**129366**	**-10667**	**-21171**	**97527**	**995413**	**-217960**	**777453**	**125756**	**542**	**126298**	**-56856**	**6064**	**1316**	**2736**	**10000**	**964539**
Avg (2018-77)	**130212**	**-10667**	**-22501**	**97044**	**994894**	**-270950**	**723944**	**137572**	**873**	**138446**	**-56856**	**5238**	**1317**	**2429**	**10000**	**921562**
Min	**119082**	**-10667**	**-22501**	**87695**	**850081**	**-303000**	**581449**	**72165**	**-853**	**71357**	**-56856**	**2834**	**623**	**1057**	**10000**	**791672**
Max	**133883**	**-10667**	**0**	**110212**	**1114332**	**5000**	**1096122**	**158352**	**1158**	**159411**	**-56856**	**92453**	**13153**	**39836**	**10000**	**1303334**

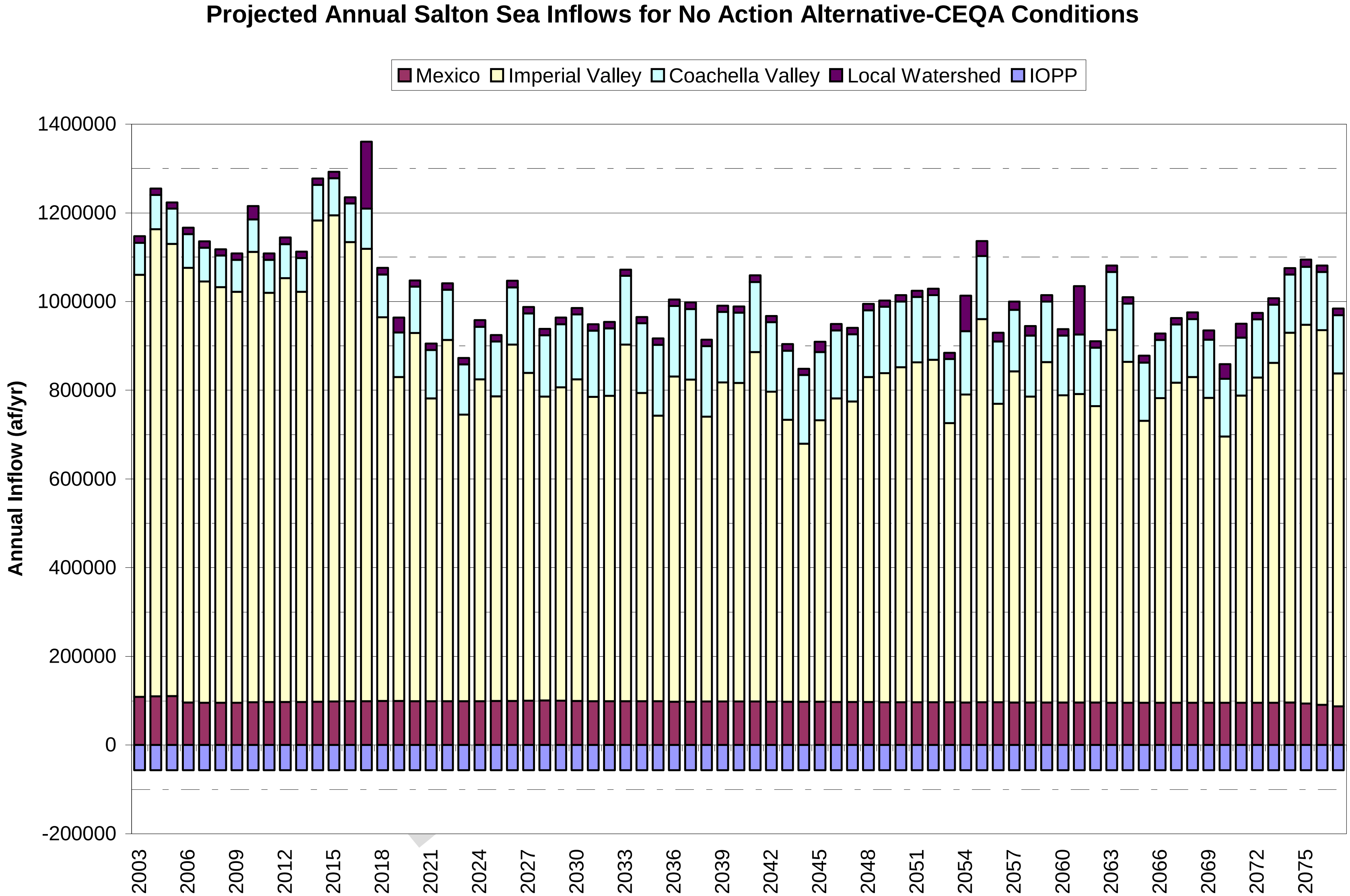

Figure 11
Graphical Representation of Projected Salton Sea Inflows for No Action Alternative-CEQA Conditions

significantly lower than historic conditions due primarily to the QSA-related transfers from IID to SDCWA and CVWD and a projected reduction in inflows from Mexico due to reduced surplus Colorado River flows, power plant use of New River flows, and treatment and conveyance of wastewater flows out of the Salton Sea watershed. A projected increase in Coachella Valley drain flows to the Salton Sea partially offsets reductions from the Imperial Valley and Mexico.

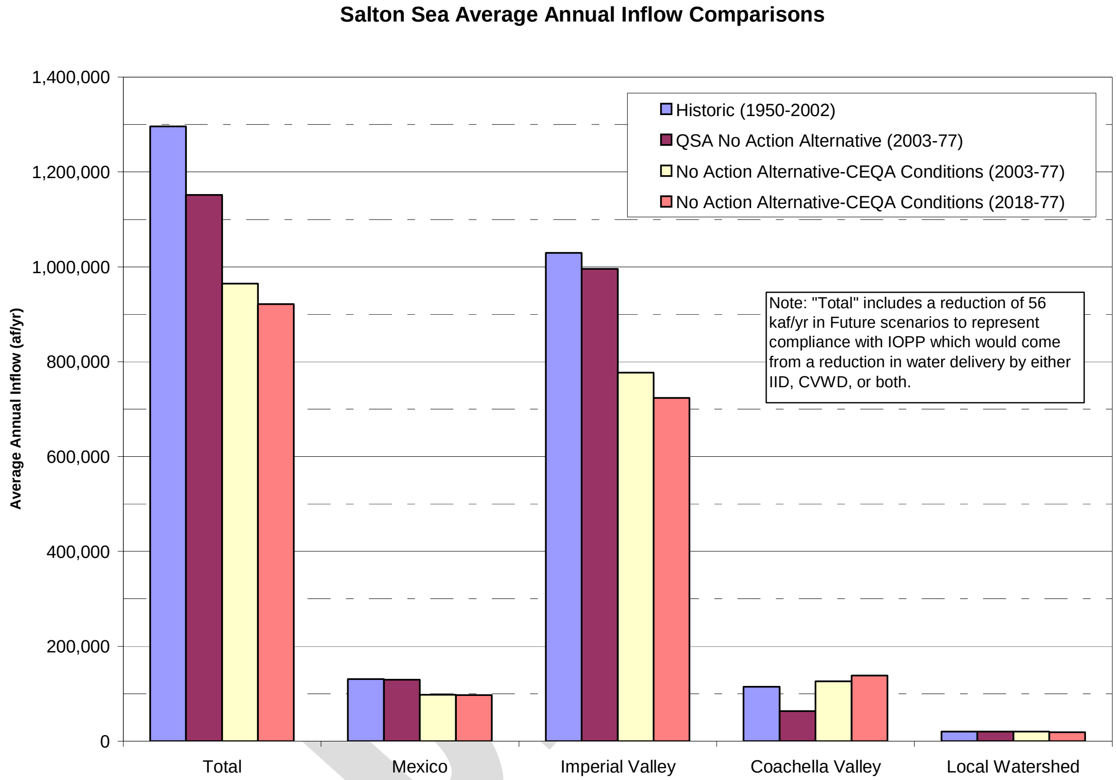

Figure 12
Comparison of Average Annual Inflows to the Salton Sea Under Historic, QSA No Action Alternative, and No Action Alternative-CEQA Conditions

Statistical Analysis

In the discussion above, the sequence of future climate conditions has been assumed to occur as it did in the past. For example, projected future 2003 to 2077 conditions for Imperial Valley and local watershed flows to the Salton Sea are based on the estimated climate conditions of the 1925 to 1999 historical sequence (primarily rainfall, evapotranspiration rates, and evaporation rates). These conditions are believed to be a reasonable representation of future climate, however, the historical sequence will not reproduce itself identically in the future. For this reason, the inflow analysis for all future scenarios uses a statistical approach known as Monte-Carlo analysis to generate many possible future sequences (no adjustment to values, just sequence) based on the historic climate values and patterns. Using this approach, the future projections can incorporate variability in climate conditions and can be viewed in a probabilistic fashion. The results of this type of analysis for the estimated No Action Alternative-CEQA Conditions inflows is shown in Figure 13. The projected variability of total inflow to the Salton Sea can be as much as 200,000 af in any one year.

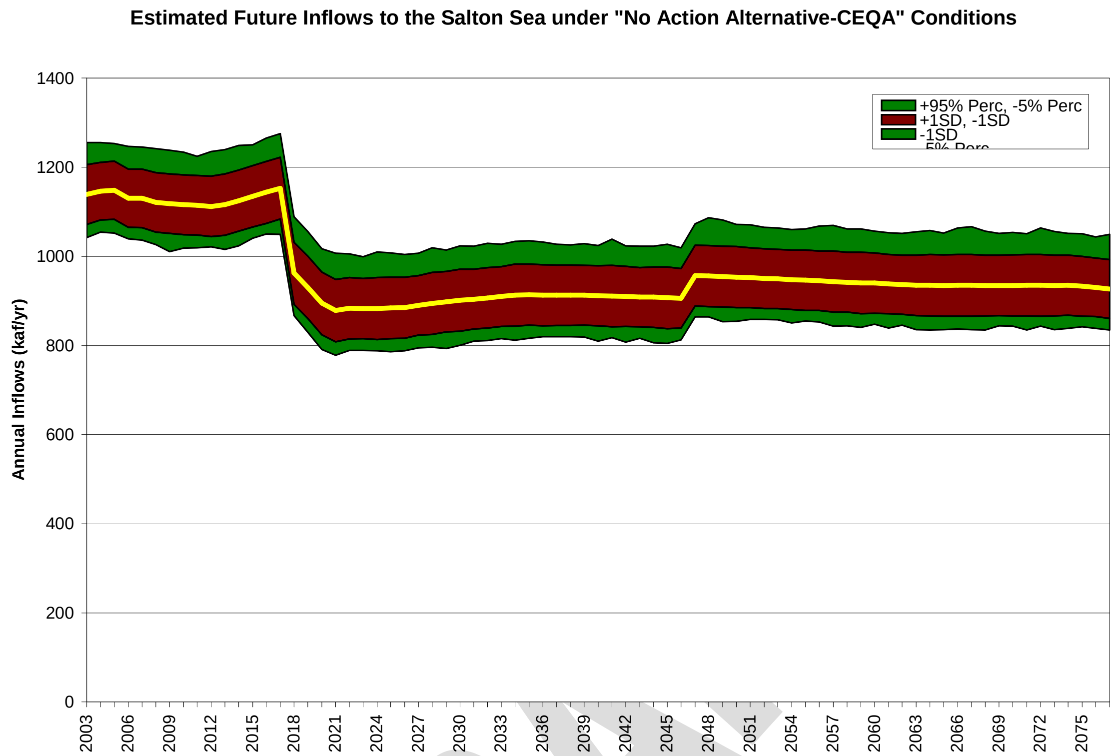

Figure 13
Timeline of Projected No Action Alternative-CEQA Conditions Inflows with Historical

Projected Salton Sea Salt Loads for No Action Alternative-CEQA Conditions

As with the projected inflows to the Salton Sea for the No Action Alternative-CEQA Conditions, the projected future salt loads to the Salton Sea have been discussed above and are summarized here. The projected total annual average salt load to the Salton Sea for the 2003 to 2077 period is estimated at approximately 3,958,320 tons with an annual minimum of 3,672,438 tons and an annual maximum of 4,243,249 af. The projected Salton Sea salt loads for the No Action Alternative-CEQA Conditions are shown in Table 7 and graphically in Figure 14. As is shown in Figure 14, the annual variability of salt loads is considerably less than the variability in inflows.

Table 7
Projected Salt Loads to the Salton Sea Under No Action Alternative-CEQA Conditions

	Mexico				Imperial Valley			Coachella Valley		Local Watershed				
Year	Mexico Baseline Salt Load (tons/yr)	Adjustment for Mexicali Power Plants (tons/yr)	Adjustment for Mexicali Wastewater Treatment Plant (tons/yr)	Adjusted Mexico Salt Load (tons/yr)	Imperial Valley Baseline Salt Load (tons/yr)	Adjustment for QSA (tons/yr)	Adjusted Imperial Valley Salt Load (tons/yr)	Adjusted Coachella Valley Salt Load (tons/yr)	IOP Payback (tons/yr)	San Felipe Creek (tons/yr)	Salt Creek (tons/yr)	Ungaged Watershed (tons/yr)	Local Groundwater (tons/yr)	Total Salt Load to Sea (tons/yr)
2003	470834	-4500	0	466334	3322499	-12000	3310499	80174	-71052	6003	3033	2239	39716	3836948
2004	475301	-4500	0	470801	3366696	-24000	3342696	93387	-71052	6003	3033	2239	39716	3886825
2005	477934	-4500	0	473434	3396683	-36000	3360683	94991	-71052	6003	3033	2239	39716	3909048
2006	481829	-4500	-20161	457168	3424603	-48000	3376603	94146	-71052	6003	3033	2239	39716	3907857
2007	484365	-4500	-21338	458527	3323010	-60000	3263010	93182	-71052	6003	3033	2239	39716	3794660
2008	487494	-4500	-22514	460480	3299450	-64800	3234650	79358	-71052	6003	3033	2239	39716	3754429
2009	491246	-4500	-23690	463056	3227023	-81600	3145423	84018	-71052	6003	3033	2239	39716	3672438
2010	497931	-4500	-24866	468565	3349659	-98400	3251259	90477	-71052	23719	15391	12525	39716	3830601
2011	503154	-4500	-26041	472614	3288365	-115200	3173165	100266	-71052	6003	3033	2239	39716	3725985
2012	508210	-4500	-27217	476493	3381829	-133200	3248629	114662	-71052	6003	3033	2239	39716	3819725
2013	510943	-4500	-28393	478050	3232189	-115200	3116989	118764	-71052	6003	3033	2239	39716	3693744
2014	516815	-4500	-29569	482746	3551068	-85200	3465868	139836	-71052	6003	3033	2239	39716	4068391
2015	519121	-4500	-29569	485052	3576103	-55200	3520903	162701	-71052	6003	3033	2239	39716	4148597
2016	522586	-4500	-29569	488516	3445681	-25200	3420481	178335	-71052	6003	3033	2239	39716	4067273
2017	523439	-4500	-29569	489370	3264394	6000	3270394	193471	-71052	195851	41112	84387	39716	4243249
2018	524915	-4500	-29569	490846	3427082	-231600	3195482	222207	-71052	6003	3033	2239	39716	3888476
2019	524803	-4500	-29569	490734	3248941	-273600	2975341	240923	-71052	27870	16740	14475	39716	3734748
2020	523219	-4500	-29569	489150	3565121	-321600	3243521	261172	-71052	6003	3033	2239	39716	3973783
2021	523053	-4500	-29569	488983	3331390	-345600	2985790	282395	-71052	6003	3033	2239	39716	3737109
2022	522447	-4500	-29569	488377	3546706	-345600	3201106	306397	-71052	6003	3033	2239	39716	3975821
2023	524039	-4500	-29569	489970	3301865	-345600	2956265	328649	-71052	6003	3033	2239	39716	3754825
2024	523929	-4500	-29569	489860	3407048	-351600	3055448	364296	-71052	6003	3033	2239	39716	3889545
2025	525076	-4500	-29569	491007	3445370	-357600	3087770	402167	-71052	6003	3033	2239	39716	3960885
2026	525877	-4500	-29569	491807	3594752	-363600	3231152	433380	-71052	6003	3033	2239	39716	4136280
2027	528314	-4500	-29569	494245	3458898	-363600	3095298	459793	-71052	6003	3033	2239	39716	4029276
2028	529297	-4500	-29569	495228	3447560	-363600	3083960	478479	-71052	6003	3033	2239	39716	4037607
2029	528207	-4500	-29569	494138	3434276	-363600	3070676	495625	-71052	6003	3033	2239	39716	4040379
2030	524648	-4500	-29569	490578	3452860	-363600	3089260	512215	-71052	6003	3033	2239	39716	4071994
2031	522723	-4500	-29569	488654	3440297	-363600	3076697	526732	-71052	6003	3033	2239	39716	4072023
2032	523378	-4500	-29569	489309	3436980	-363600	3073380	540190	-71052	6003	3033	2239	39716	4082820
2033	524036	-4500	-29569	489967	3567579	-363600	3203979	552874	-71052	6003	3033	2239	39716	4226761
2034	523413	-4500	-29569	489344	3475968	-363600	3112368	563082	-71052	6003	3033	2239	39716	4144734
2035	520754	-4500	-29569	486684	3305266	-363600	2941666	571103	-71052	6003	3033	2239	39716	3979394
2036	517789	-4500	-29569	483720	3448445	-363600	3084845	553486	-71052	6003	3033	2239	39716	4101991
2037	517060	-4500	-29569	482991	3434391	-363600	3070791	551376	-71052	6003	3033	2239	39716	4085098
2038	518348	-4500	-29569	484278	3322073	-363600	2958473	548565	-71052	6003	3033	2239	39716	3971257
2039	519641	-4500	-29569	485572	3404727	-363600	3041127	545196	-71052	6003	3033	2239	39716	4051835
2040	518809	-4500	-29569	484740	3399918	-363600	3036318	541374	-71052	6003	3033	2239	39716	4042372
2041	518795	-4500	-29569	484726	3527938	-363600	3164338	537182	-71052	6003	5345	2927	39716	4169186
2042	516228	-4500	-29569	482159	3412273	-363600	3048673	532694	-71052	6003	3033	2239	39716	4043466
2043	516936	-4500	-29569	482867	3278980	-363600	2915380	527967	-71052	6003	3559	2396	39716	3906837
2044	517593	-4500	-29569	483524	3215236	-363600	2851636	523047	-71052	6003	3033	2239	39716	3838147
2045	516163	-4500	-29569	482093	3226817	-363600	2863217	517968	-71052	19263	3033	7185	39716	3861424
2046	515220	-4500	-29569	481151	3381318	-363600	3017718	512760	-71052	6003	3033	2239	39716	3991569
2047	513674	-4500	-29569	479605	3242971	-300000	2942971	507446	-71052	6003	3033	2239	39716	3909962
2048	514733	-4500	-29569	480663	3384930	-300000	3084930	502045	-71052	6003	3033	2239	39716	4047579
2049	513122	-4500	-29569	479053	3372211	-300000	3072211	496580	-71052	6003	3033	2239	39716	4027785
2050	511665	-4500	-29569	477595	3370741	-300000	3070741	491056	-71052	6003	3033	2239	39716	4019333
2051	512527	-4500	-29569	478457	3412826	-300000	3112826	485492	-71052	6003	3033	2239	39716	4056716
2052	511576	-4500	-29569	477507	3408825	-300000	3108825	479889	-71052	6003	3033	2239	39716	4046161
2053	511900	-4500	-29569	477831	3195655	-300000	2895655	474256	-71052	6003	3033	2239	39716	3827683
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2055	511421	-4500	-29569	477352	3488604	-300000	3188604	462919	-71052	36234	3033	13516	39716	4150322
2056	511638	-4500	-29569	477569	3263426	-300000	2963426	457225	-71052	8198	12755	5951	39716	3893788
2057	510484	-4500	-29569	476414	3374209	-300000	3074209	451520	-71052	6003	14606	5683	39716	3997101
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2062	509748	-4500	-29569	475679	3223631	-300000	2923631	422880	-71052	6003	3033	2239	39716	3802130
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2067	508540	-4500	-29569	474471	3405320	-300000	3105320	416662	-71052	6003	3033	2239	39716	3976394
2068	507639	-4500	-29569	473570	3395959	-300000	3095959	416545	-71052	6003	3033	2239	39716	3966014
2069	507633	-4500	-29569	473564	3246003	-300000	2946003	416424	-71052	14207	6296	6270	39716	3831429
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2072	508406	-4500	-29569	474337	3315452	-300000	3015452	416065	-71052	6003	3033	2239	39716	3885794
2073	509110	-4500	-29569	475041	3373925	-300000	3073925	415947	-71052	6003	3033	2239	39716	3944853
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2075	500637	-4500	-29569	466567	3540304	-300000	3240304	415711	-71052	6003	9048	4029	39716	4110328
2076	490146	-4500	-29569	456077	3558742	-300000	3258742	415591	-71052	6003	3033	2239	39716	4110350
2077	477868	-4500	-29569	443799	3469929	-300000	3169929	415471	-71052	6003	3033	2239	39716	4009139
Avg (2003-77)	**511455**	**-4500**	**-27822**	**479133**	**3373633**	**-272752**	**3100881**	**384592**	**-71052**	**12846**	**6409**	**5796**	**39716**	**3958320**
Avg (2018-77)	**514798**	**-4500**	**-29569**	**480729**	**3376220**	**-325140**	**3051080**	**452110**	**-71052**	**11097**	**6412**	**5145**	**39716**	**3975237**
Min	**470834**	**-4500**	**-29569**	**443799**	**3050843**	**-363600**	**2750843**	**79358**	**-71052**	**6003**	**3033**	**2239**	**39716**	**3672438**
Max	**529297**	**-4500**	**0**	**495228**	**3594752**	**6000**	**3520903**	**571103**	**-71052**	**195850.527**	**64043**	**84387**	**39716**	**4243249**

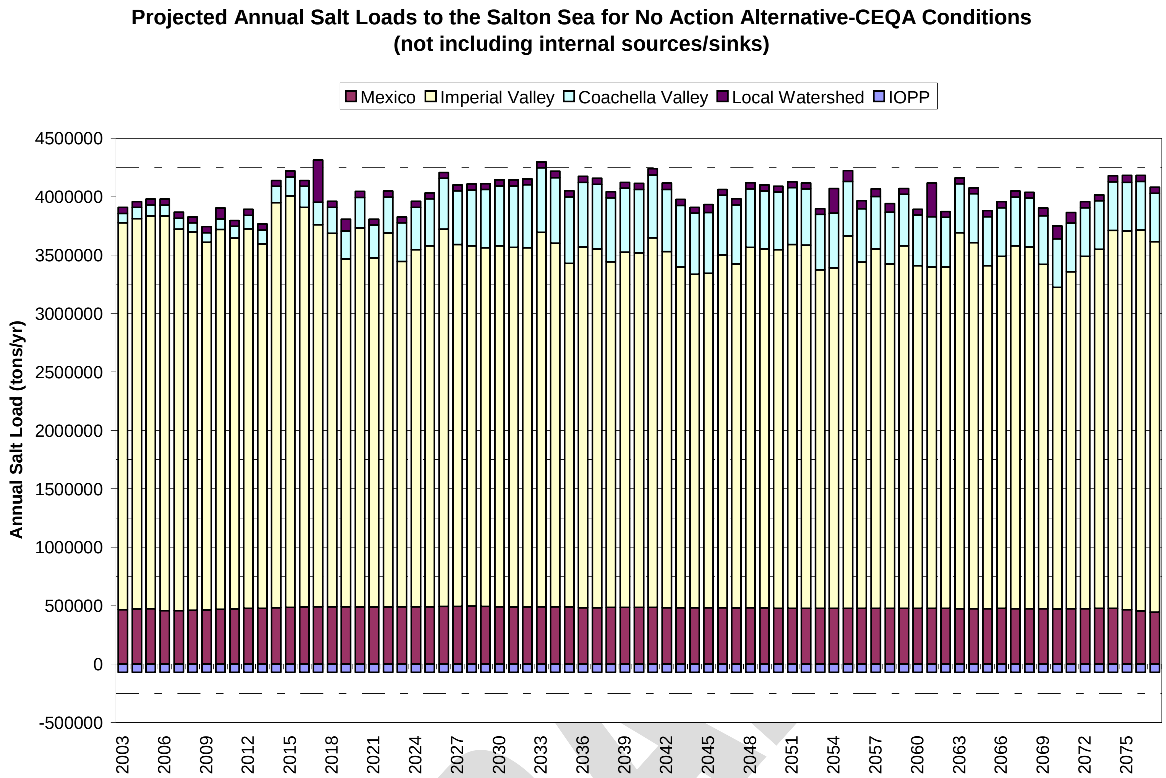

Figure 14
Graphical Representation of Projected Salt Loads to the Salton Sea Under No Action Alternative-CEQA Conditions

PROJECTED HYDROLOGY AND SALT LOADS CONSIDERING NO ACTION ALTERNATIVE-VARIABILITY CONDITIONS

The Salton Sea inflows projected under the No Action Alternative-CEQA Conditions represent an estimate of the future conditions considering changes that that meet the CEQA guidelines of "reasonably foreseeable if the project is not implemented … based on current plans and consistent with available infrastructure and community services" as described above. However, in addition to projects that meet the CEQA guidelines for inclusion in the No Action Alternative, given the long planning horizon (75 years), many future changes are possible within the watershed that may cause reductions to inflows to the Salton Sea beyond those considered in the No Action Alternative-CEQA Conditions. Due to this uncertainty in future inflows, the *Inflows/Modeling* working group strongly recommended that an approach that is inclusive of future possibilities and accommodates principles of risk be used to describe an alternative future condition without the Salton Sea Ecosystem Restoration Program. This alternative future is termed the No Action Alternative-Variability Conditions. This section describes the purpose, approach, and the development of the hydrology for the No Action Alternative-Variability Conditions.

Purpose of Considering No Action Alternative-Variability Conditions

Like most terminal lakes, the Salton Sea is highly sensitive to changes in inflows and climate conditions. The Salton Sea is constantly adjusting to the external forcings of inflows, evaporation, and precipitation and is attempting to reach equilibrium water balance conditions in which the water surface evaporation balances with inflows. However, the hydrologic regime is not in static equilibrium and this dynamic condition causes continual changes in water volume, surface area, and elevation.

In recent years the Salton Sea water surface evaporation has roughly balanced with total inflows causing only minor changes in the size or water surface elevation of the Salton Sea. However, the changes in inflows projected the No Action Alternative-CEQA Conditions will tip this balance in favor of evaporation and the Salton Sea will reduce in size until another quasi-equilibrium is reached; when the surface area has reduced enough such that the evaporation is in balance with inflows.

For example, under the current Salton Sea conditions a 10 percent reduction in inflows (an amount within measurement error of most streamflow gages) would cause a reduction is long-term water surface elevation of nearly 5 feet and create approximately 16,000 acres of exposed playa. Given the exceptional sensitivity of Salton Sea conditions (and any proposed restoration plan) to projected inflows, it is imperative to consider a range of possible future conditions such that decisions regarding the future restoration of the Salton Sea and placement of major infrastructure elements accommodate uncertainty.

The alternatives to be considered for future Salton Sea restoration are all dependent on a reliable future water supply to be allocated amongst various project components (marine lake, air quality management, wetland habitats, etc) to meet the goals of stable elevation, stable salinity, habitat restoration, and air quality mitigation. The Salton Sea has no control over the inflows nor over the conditions that produce such water. Final decision on restoration alternatives will involve trade-offs between higher project performance (satisfaction of goals) or reduced risk.

Analytical Approach for No Action Alternative-Variability Conditions

To address the level of uncertainty regarding future inflows to the Salton Sea over the 75-year planning horizon, a stochastic analytical approach was agreed to by the *Inflows/Modeling* working group members to approximate the range of possible future conditions. In the stochastic analytical approach, hydrologic variability and future uncertainty are expressed as a range of possible future inflows to the Salton Sea. The major sources of inflow uncertainty are identified and the potential range in uncertainty related to each source is described through selection of a probability distribution. The Monte Carlo simulation technique is then used to sample each of the input probability distributions hundreds or thousands of times and generate an equivalent number of possible inflow traces. The final result of this process is a probability distribution that represents the best approximation of the full range of future Salton Sea inflow variability and uncertainty. From this distribution, simpler statistics can be generated to help describe the variability and uncertainty. The possible drivers of inflow variability and uncertainty, selected probability distributions, and results for each major inflow source are described in the following sections. The factors discussed below are presented to illustrate the considerable uncertainty in future inflows to the Salton Sea under the No Action Alternative-Variability Conditions. Other factors are sure to exist. The range of possible impacts due to the *cumulative* uncertainty is approximated by the probability distributions.

Inflows from Mexico

Under the No Action Alternative-CEQA Conditions, adjustments to future inflows from Mexico were made to reflect the Wastewater Conveyance and Treatment Project for the Mexicali II Service Area and the Mexicali power plant projects. Several other factors that may possibly change future inflows from Mexico beyond those represented in the No Action Alternative-CEQA Conditions are listed below.

Enlargement of the Colorado River-Tijuana Aqueduct

The Colorado River-Tijuana Aqueduct (know as the ARCT for its Spanish acronym) was built in 1975 and conveys water from the Colorado River to the cities of Tecate and Tijuana to the west. In order to satisfy the growing demand in these water short regions, the capacity of the aqueduct is being increased from approximately 141 cfs to 187 cfs (4.0 to 5.3 cubic meters/s) (COSAE 2005). The request for bid for construction of this project was noticed in July 2005. The source of water to be conveyed through the enlarged aqueduct has not yet been contracted, but the National Water Commission (CNA) has indicated that the supply will developed through transfers from agricultural users in the Mexicali Valley, recovery of losses, or through improved efficiency in the use of water (CEA 2005). Through these methods, the flows in the New River may be impacted as more water is exported out of the basin.

All-American Canal Lining Project

While this project is included in the No Action Alternative-CEQA Conditions, no adjustments to inflows were included. The reduction in recharge to the Mexicali groundwater basin due to the canal lining may reduce groundwater water use in Mexicali area. New River flows at the International Boundary are primarily return flows from agriculture in the Mexicali area and may be reduced in the future.

Increased Water Use and Reuse Within Mexico

The demand for water in Baja California is growing at an high rate. For example, the population requiring potable water in Mexicali is projected to double by 2030 (CESPM 2004). The cities of Tijuana and Tecate are growing at similarly high rates. As these cities grow, so will the demand for water from the Mexicali area. In addition, wastewater collection and treatment in the Mexicali area will improve in the future and it is likely that the treated effluent will be either conveyed out of the Salton Sea watershed (as the Mexicali II project) or will be reused. Agricultural water use efficiency is also likely to improve in the Mexicali Valley as the stress on the water resources increases. Increased water use efficiency in the Mexicali Valley, as in the Imperial Valley, will lead to reduced drain water flows to the Salton Sea.

Reduced Availability of Colorado River Surplus Flows

The current drought conditions on the Colorado River has demonstrated the over-allocated nature of this system and the limited ability to satisfy all future demands. In the past Mexico often received surplus or non-storable flows in excess of the Treaty requirements. However, increased development in the Colorado River basin and improved water operations in the lower basin will reduce the availability of these flows to Mexico. The modeling under the No Action Alternative-CEQA Conditions incorporated reduced surplus flows to Mexico as a result of the current reservoir storage conditions and demands, but did not account for future development or improved water management in the Colorado River Basin.

Probability Distribution for No Action Alternative-Variability Conditions

The cumulative uncertainty in future inflows from Mexico is represented by a triangular probability distribution of future inflow reductions as shown in Figure 15. The probability distribution is described as a percent reduction from the No Action Alternative-CEQA Conditions inflows and ranges from no change to a 100 percent reduction in inflows. All values between these two bounds are considered possible and are sampled in the Monte Carlo simulation. A future reduction in inflows from Mexico of 75 percent from the No Action Alternative-CEQA Conditions projections is considered the most likely as several of the above projects/actions are currently being considered. The projection of reduced inflows is also supported by the recent declining inflows and the fact that actual inflows from Mexico for 2003 are the lowest in the past 25 years.

Range of Future Inflows from Mexico Under No Action Alternative-Variability Conditions

Under the No Action Alternative-CEQA Conditions, projected inflows to the Salton Sea from Mexico averaged 97,527 af/yr for the 2003 to 2077 period and 97,044 af/yr for the 2018 to 2077 period. For the same periods, the mean of all traces sampled in the Monte Carlo analysis is 47,650 af/yr and 40,446 af/yr for the 2003 to 2077 and 2018 to 2077 periods, respectively (Figure 16).

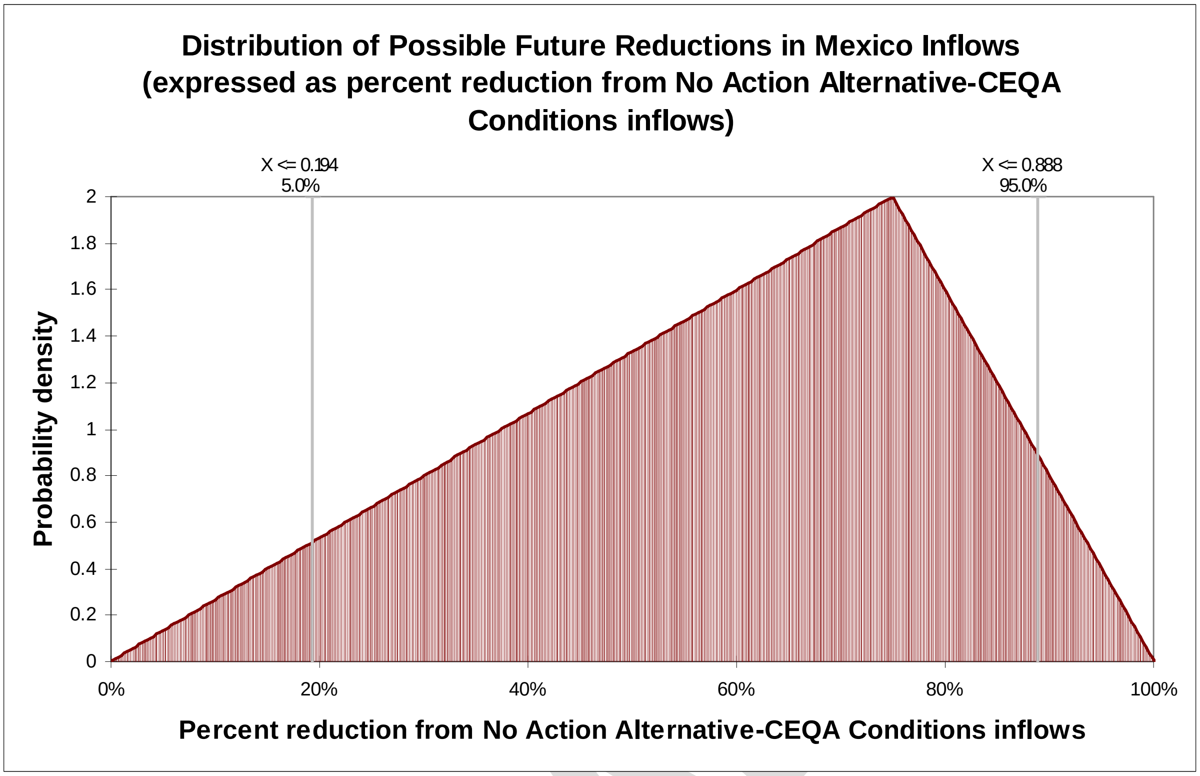

Figure 15
Probability Distribution to Describe Range of Uncertainty in Future Mexico Flows

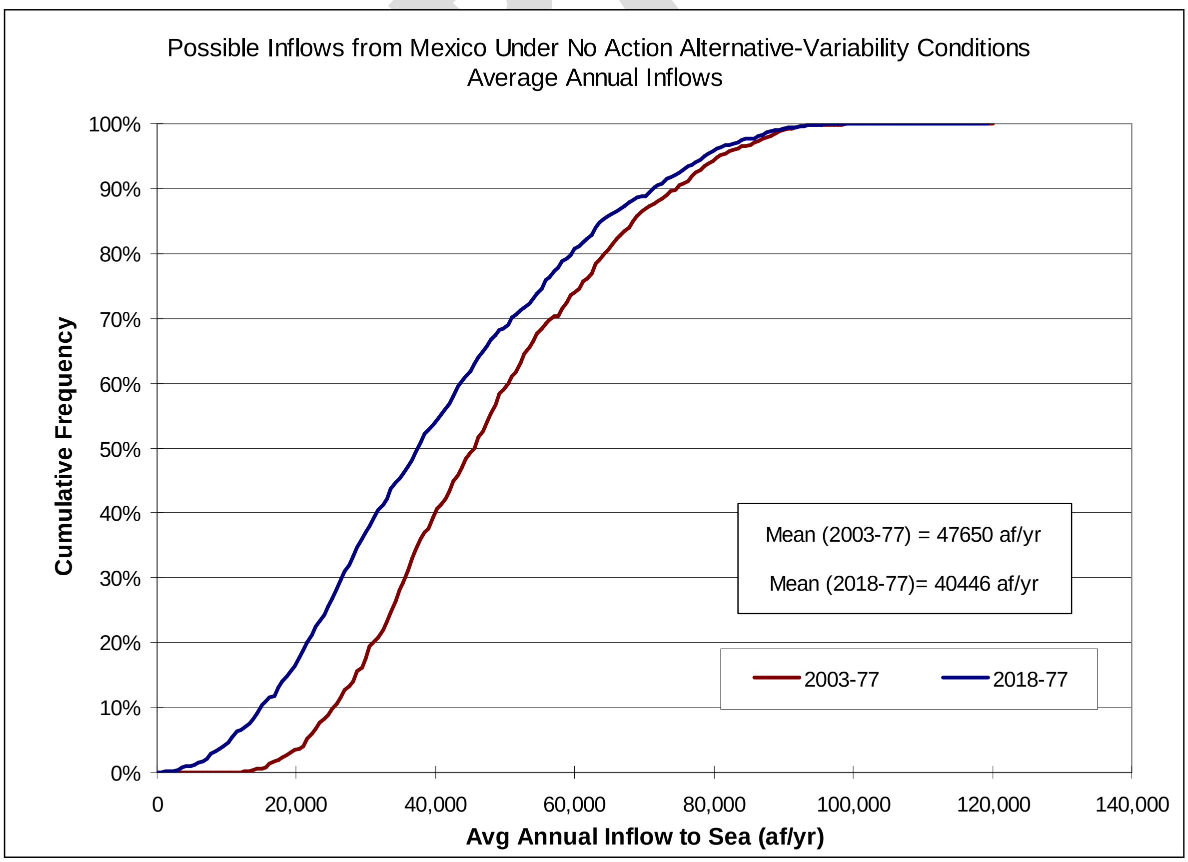

Figure 16
Possible Inflows from Mexico for No Action Alternative-Variability Conditions

Inflows from Imperial Valley

Under the No Action Alternative-CEQA Conditions, adjustments to future inflows from the Imperial Valley were made to reflect the IID Water Conservation and Transfer Project and related mitigation measures. In the discussion under No Action Alternative-CEQA Conditions, several other projects were identified but the impact to Salton Sea inflows due to their implementation could not be adequately described within the constraints of CEQA's guidelines for No Action Alternative-CEQA Conditions. These projects/actions as well as several other factors that may possibly change future inflows from the Imperial Valley are listed below.

Implementation of Total Maximum Daily Loads

The Regional Water Quality Control Board (RWQCB) has adopted TMDLs for sedimentation/siltation for the New River, Alamo River, and for Imperial Valley Drains and for pathogens in the New River. The RWQCB is also in the process of developing a nutrient TMDL for the Salton Sea. The sedimentation/siltation TMDLs for the New and Alamo Rivers and the pathogen TMDL for the New River have been approved by the State Water Resources Control Board (SWRCB) and the U.S. Environmental Protection Agency (EPA), while the Imperial Valley Drains TMDL is awaiting approval (RWQCB 2002a,b) the development of a nutrient TMDL for the Salton Sea will likely focus on reducing phosphorous loads (RWQCB 2005b). The pathogen TMDL is primarily focused on reducing wastewater discharges from Mexico, through coordination with the IBWC and EPA, and municipal wastewater treatment discharges in the Imperial Valley.

The recent adoption of the sedimentation/siltation TMDLs and their associated phased-in implementation schedules do not allow for a full quantification of their impacts on inflows to the Salton Sea. However, implementation of many of the Best Management Practices (BMPs) suggested in the TMDL reports (RWQCB 2002a,b and through the ICFB Voluntary TMDL Compliance Program (Kalin 2003) are expected to reduce tailwater runoff from farms. On-farm BMPs range from modification of tailwater drop boxes, to filter strips and draining water across the ends of fields, to sprinkler/drip irrigation and pumpback systems. The cost of implementing on-farm efficiency improvements has been partially offset through programs such as the Environmental Quality Incentive Program (EQIP) from the Natural Resources Conservation Service (NRCS) which provides cost-share of up to 75 percent on certain control measures (NRCS 2004). Some of these BMPs may result in significant reductions in tailwater and improved on-farm irrigation/fertilizer management (Kalin 2005, personal communication). Compliance with the nutrient TMDL for the Salton Sea will likely involve similar on-farm BMPs and result in reductions in tailwater.

Possible Future Water Use Determinations by Reclamation or SWRCB

In 2003, the Reclamation initiated Part 417 proceedings that resulted in a determination of IID's water use requirements and approved Colorado River diversion for that year (Reclamation 2003). In the determination, which ultimately led to an approval of only 2.8 maf of the requested 3.1 maf Colorado River delivery request, it challenged several of the water need estimates and operating practices of the IID. In addition, the SWRCB in Decision 1600 (SWRCB 1984) evaluated IID's "reasonable and beneficial use" of water and required a plan of water conservation measures. It appears unlikely that these processes will be re-opened after the signing of the QSA.

Colorado River Basin Salinity Control

As discussed under the No Action Alternative-CEQA Conditions section of this document, the inflow and salt load projections for the Imperial Valley are based on the maximum numeric target for Colorado River salinity at Imperial Dam of 879 mg/l (CRBSCF 2005). The numeric target was established to maintain salinities at or below 1972 levels, however, since that time the salinity at Imperial Dam has never exceeded the target (Figure 17). Over the past two decades, the salinity only exceeded 800 mg/l in one year and has been less than 700 mg/l in six out of the past ten years. Reclamation's most recent modeling projections of the Colorado River estimate that there is an 86 percent probability that salinity at Imperial Dam will be less than or equal to the target through 2035 (CRBSCF 2005). Future Colorado River salinity less than the numeric target at Imperial Dam may result in lower salt loads and inflows to the Salton Sea

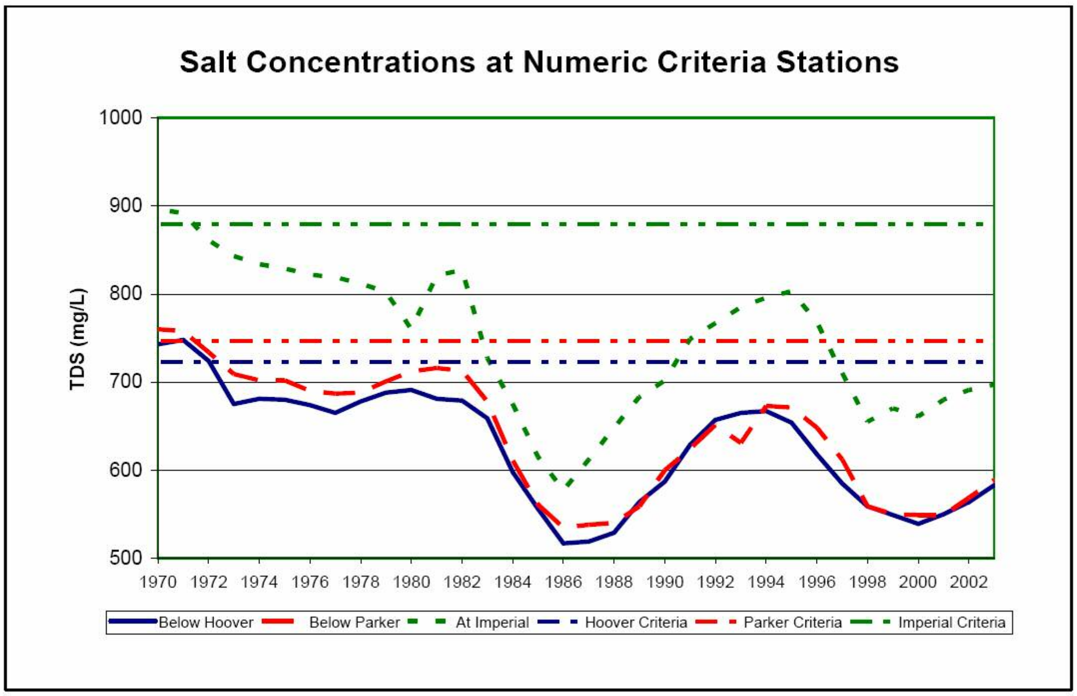

Figure 17
Salt Concentrations at Numeric Criteria Stations (Source: CRBSCF 2005)

than that projected under the No Action Alternative-CEQA Conditions.

Improved On-farm Water Use Efficiency

Improved on-farm water use efficiency, along with IID delivery system improvements, may continue to occur in the future. Tailwater from the total IID water service area has been estimated between 15 percent and 27 percent of total on-farm water delivery (IID 2002, Reclamation 2003) and represents between 39 percent and 68 percent of Imperial Valley's contribution to Salton Sea inflow. Improved on-farm water management could result in significant reductions in tailwater, improved fertilizer application, improved crop yields, and reduced costs. While it is unknown to what extent these methods will be implemented in the future, some irrigation programs contend that tailwater as low as 5 percent may be attainable in the future with more efficient irrigation management practices (Reclamation 2003, Gilbert 2005).

Change in Cropping Patterns

The crop types and quantities in the Imperial Valley have changed over the years in response to water and market conditions. Hay and forage crops (primarily alfalfa, bermudagrass, and sudangrass) are estimated to currently constitute approximately 50 percent of the total irrigated acreage of the Imperial Valley (IID 2000) and have the highest consumptive use requirements compared to other crops. It is possible that future changes in the crop mix of the Imperial Valley may require less applied water and may result in lower return flows even with no change in on-farm irrigation efficiencies.

Agriculture to Urban Land Use Conversions

All regions within the Salton Sea watershed are experiencing significant growth and population projections for Imperial County suggest more than twice the current population by 2050 (Department of Finance 2004. For Imperial County this means another approximately 200,000 people for which housing, water, and other services will be provided. Depending on the future patterns of urbanization in the County and densities, the possibility exists that some current agricultural lands could be converted to urban uses. While ag-urban conversions themselves may not result in increased water use or returns to the Salton Sea, several workgroup members suggested that lands in the East and West Mesas are of good quality and could be brought into production. It is possible that total irrigated acreage may remain the same (but change in some locations) even as the population of the County grows. Under this scenario, total consumptive water requirements would increase and likely result in reduced returns to the Salton Sea.

Colorado River Supply Reliability and Shortage Criteria

The management of Colorado River water under shortage conditions is the subject of on-going discussions among the Department of the Interior, Basin States, and Colorado River water users. Because a shortage year has never been declared by the Secretary of the Interior, there is substantial uncertainty as to how the river would be operated under drought conditions. There is also substantial uncertainty regarding future water supply in the Colorado River. Colorado River Basin is experiencing the most significant drought since the completion of Glen Canyon Dam and analysis of historical flow records indicates flow at Lee's Ferry has decreased at a rate of approximately 0.5 maf/decade for the 1895 to 2003 period (USGS 2004). Finally, tree-ring reconstructions of Colorado River flows provide a longer-term flow record that can be used to assess drought frequency. The USGS report states that one of the most important conclusions from dendrochronology (tree-ring dating) is that the period from 1906 through 1930, which was partially used to determine flow allocations under the Colorado River Compact, was likely the highest period of runoff in 450 years (USGS 2004). IID's water deliveries would not likely be effected from future shortages on the Colorado River due to their senior water right, but IID contends that the possibility exists that their supplies may be reduced under severe conditions (Eckhardt 2005, personal communication).

Probability Distributions to Describe Uncertainty

The cumulative uncertainty in future inflows from the Imperial Valley is represented by a uniform probability distribution of future reductions in tailwater (Figure 18). Tailwater, the water that drains from the surface of a field during an irrigation event, was selected as a reasonable surrogate of the future maximum change in Imperial Valley contributions to the Salton Sea inflow. Drain water from the IID service area is made up of tailwater, tilewater (subsurface drainage), operational spill, and canal seepage. The probability distribution of possible future reductions in tailwater is described as a percent reduction from No Action Alternative-CEQA Conditions estimates and ranges from no change to a 90 percent reduction in tailwater flows. All values between these two bounds are considered possible and are sampled in the Monte Carlo simulation. A uniform distribution was adopted since no compelling argument could be made to suggest one value was more likely than another. As described previously, tailwater from the IID water service area has been estimated between 15 percent and 27 percent of total on-farm water delivery (IID 2002, Reclamation 2003) and represents between 39 percent and 68 percent of Imperial Valley's contribution to Salton Sea inflow. A second uniform probability distribution was applied to capture this range of uncertainty in tailwater estimates (Figure 19).

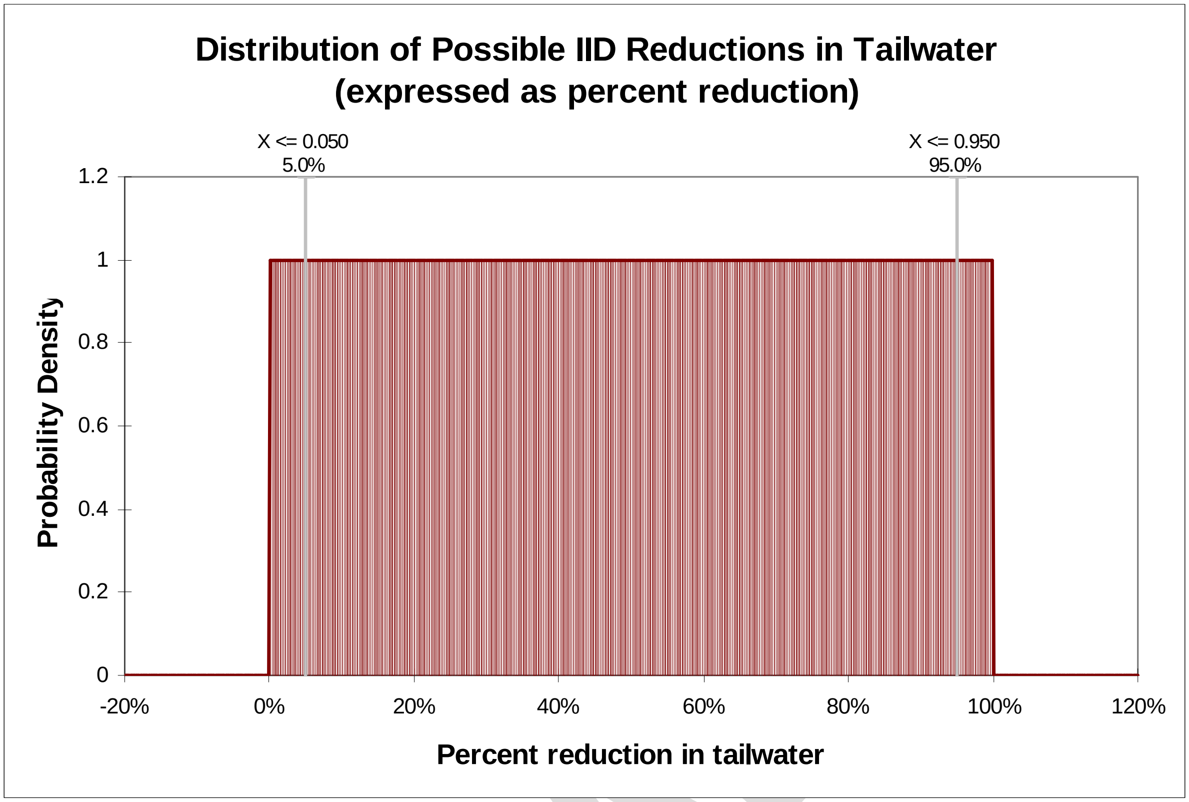

Figure 18
Probability Distribution to Describe Range of Uncertainty in Future IID Inflows to the Salton Sea

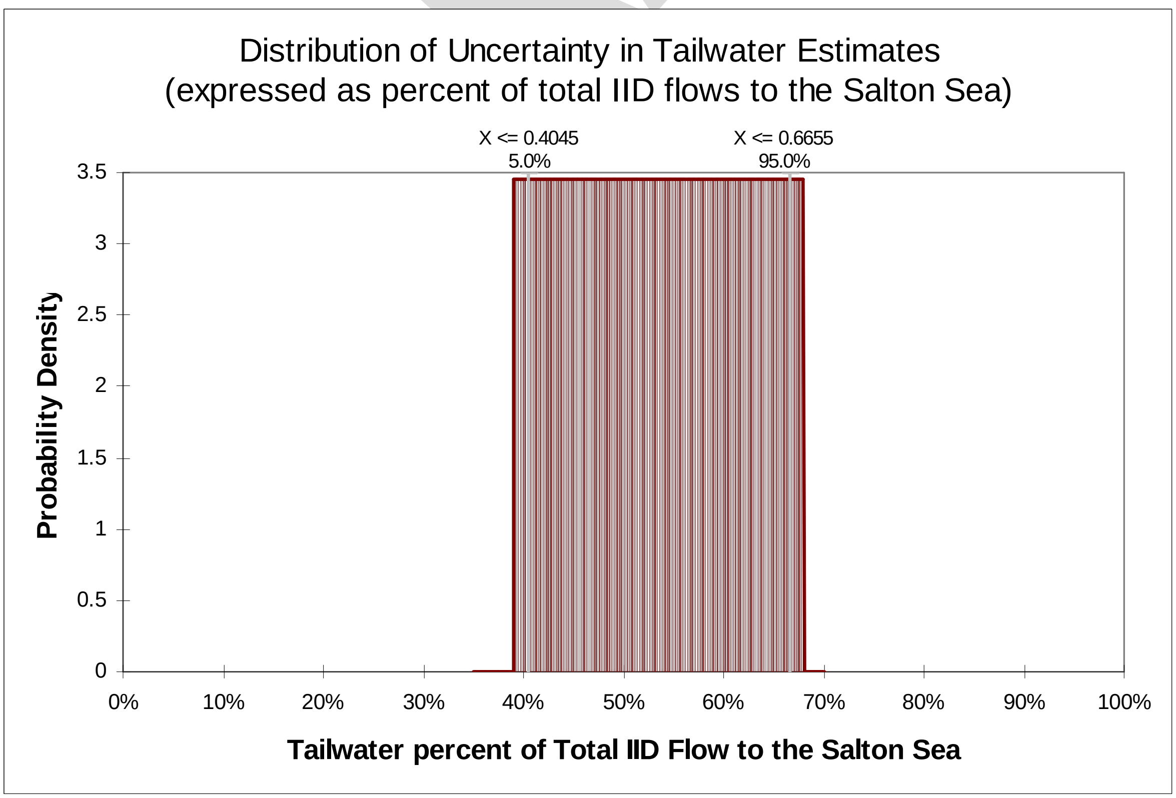

Figure 19
Probability Distribution to Describe Range of Uncertainty in IID Tailwater Volumes

Range of Future Inflows from Imperial Valley Under No Action Alternative-Variability Conditions

Under the No Action Alternative-CEQA Conditions, projected inflows to the Salton Sea from the Imperial Valley average 777,453 af/yr for the 2003 to 2077 period and 723,944 af/yr for the 2018 to 2077 period. For these same periods, the mean of all traces sampled in the Monte Carlo analysis is 689,768 af/yr and 614,856 af/yr for the 2003 to 2077 and 2018 to 2077 periods, respectively (Figure 20).

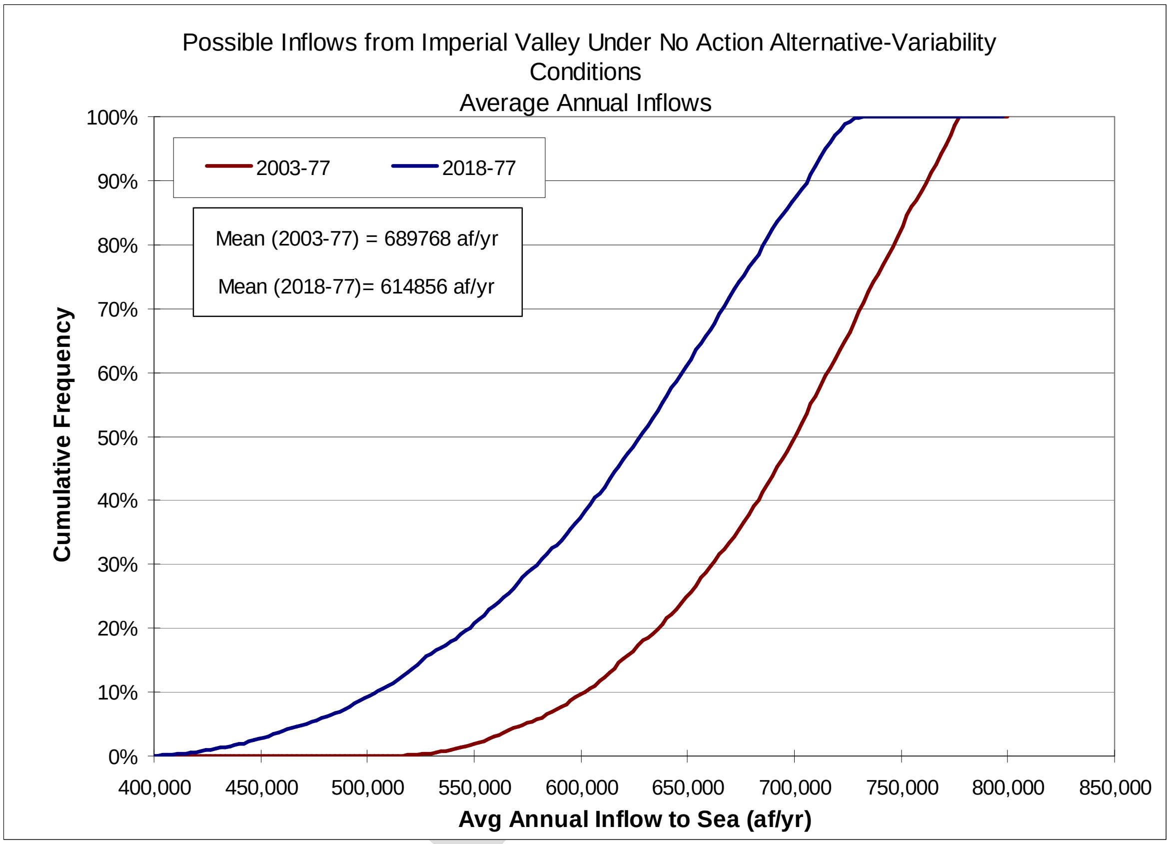

Figure 20
Possible Inflows from the Imperial Valley for No Action Alternative-Variability Conditions

Inflows from Coachella Valley

Under the No Action Alternative-CEQA Conditions, adjustments to future inflows from the Coachella Valley were made to reflect the IID-CVWD Transfer, Coachella Canal Lining Project, and the Coachella Valley WMP. Several other factors that may possibly change future inflows from the Coachella Valley as compared to the projected No Action Alternative-CEQA Conditions are listed below.

Acquisition of Future Supplies

The CVWD, as part of the Coachella Valley WMP, has proposed acquisition of additional supplies to stabilize groundwater levels and improve basin water quality. In addition to CVWD's SWP entitlement and transfer programs with MWD, the WMP relies upon an additional 40,000 af/yr of SWP supply through future transfers or participation in programs such as the State's Drought Water Bank. As the demand for water on the SWP system grows in the future, the availability and reliability of such water may be reduced, causing other changes in the groundwater basin management. In addition, the WMP proposes desalting approximately 11,000 af/yr of supply obtained from the CVSC. Both MWD and CVWD have stated their intent to appropriate water from the Whitewater River. As noted in the WMP (CVWD 2002), the SWRCB has declared the Whitewater River to be fully appropriated. New water right applications will need to be filed and approved to use such water. Some degree of uncertainty exists in regard to the groundwater basin conditions, and resulting Salton Sea inflows, in the absence of these supplies.

Future Increases in Demand

The modeling included in the WMP, and used in this No Action Alternative-CEQA Conditions have assumed a flat population growth rate and constant water demand after the year 2035 (the end of the study period for the WMP). It appears very possible that population and demand will continue to grow in the future. The Department of Finance (2004) has projected that another 1 million people will be added to Riverside County population between 2030 and 2050. This will effect water demand and wastewater management in the future. The WMP, while not addressing projects or conditions in the Valley beyond 2035, notes that future expansion of drain water desalination also could affect flows after 2035. In addition, the Torres-Martinez tribe has land within the CVWD service area (ID-1) that is planned for development with irrigation and drainage service from CVWD. It is unclear whether this was analyzed in the WMP. The possibility exists that future growth could result in reduced flows to the Salton Sea.

Model Uncertainty

As with any model representation of a physical process, there is some measure of uncertainty in the Coachella Valley groundwater model results, particularly in the upper aquifer of the lower Valley as water level calibration data are sparse (CVWD 2002 Peer Review Report). The level of uncertainty in some water level measurements, and model calibration simulation results, may be over 10 feet. This was an area of concern raised by some members of the workgroup, but a quantitative assessment of potential changes to Salton Sea inflow was not possible without access to the model.

Colorado River Basin Salinity Control

As with the projections for Imperial Valley inflows discussed in the preceding section, the projected Colorado River salinity for the analyses as part of the WMP assumed a salinity of the numeric criteria of 879 mg/l (CVWD 2002). The numeric target was established to maintain salinities at or below 1972 levels, however, since that time the salinity at Imperial Dam has never exceeded the numeric criteria (Figure 17). Reclamation's most recent modeling projections of the Colorado River estimate that there is an 86 percent probability that salinity at Imperial Dam will be less than or equal to the criteria through 2035 (CRBSCF 2005). Future Colorado River salinity less than the numeric criteria may result in slightly lower salt loading to the Coachella Valley and have minor effects on the need for offsetting supplies.

Probability Distributions to Describe Uncertainty

The cumulative uncertainty in future inflows from the Coachella Valley is represented by a uniform probability distribution of changes between the simulated WMP Proposed Project and the No Project. The simulated inflows to the Salton Sea from the Coachella Valley under the WMP Proposed Project are approximately 90,000 af/yr higher than those simulated for the WMP No Project by 2035 (Figure 21). The differences are much smaller prior to 2035 as the initial conditions are the same for both simulations. The range of inflow trajectories between these two conditions are used to represent the future uncertainty of inflows from Coachella Valley (Figure 22).

The probability distribution of possible future reductions in Coachella Valley flows are described as possible reduction in inflows at year 2035 and are mapped onto a trajectory from 2003 to 2077 based Figure 21. All values between these two bounds are considered possible and are sampled in the Monte Carlo simulation.

Range of Future Inflows from Coachella Valley Under No Action Alternative-Variability Conditions

Under the No Action Alternative-CEQA Conditions, projected inflows to the Salton Sea from the Coachella Valley average 126,298 af/yr for the 2003 to 2077 period and 138,446 af/yr for the 2018 to 2077 period. For the same periods, the mean of all traces sampled in the Monte Carlo analysis is 93,703 af/yr for the 2003 to 2077 period and 98,043 af/yr for the 2018 to 2077 period (Figure 23).

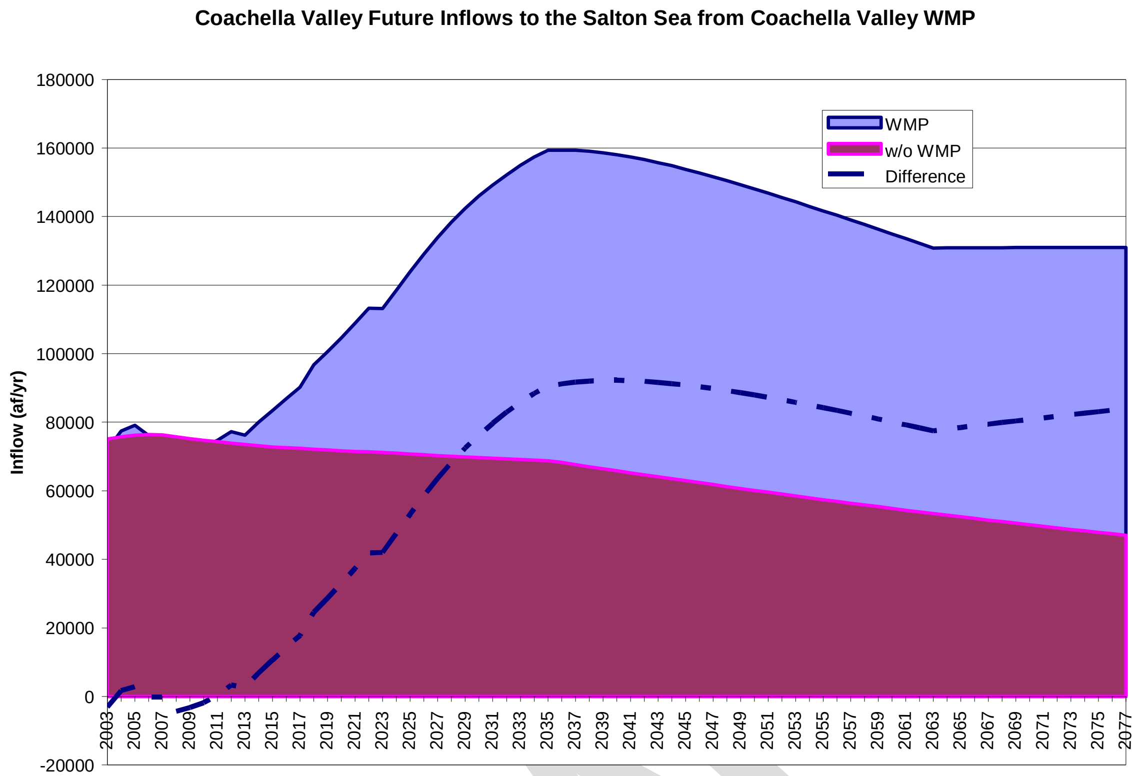

Figure 21
Estimated Future Salton Sea Inflows from the Coachella Valley with and without WMP

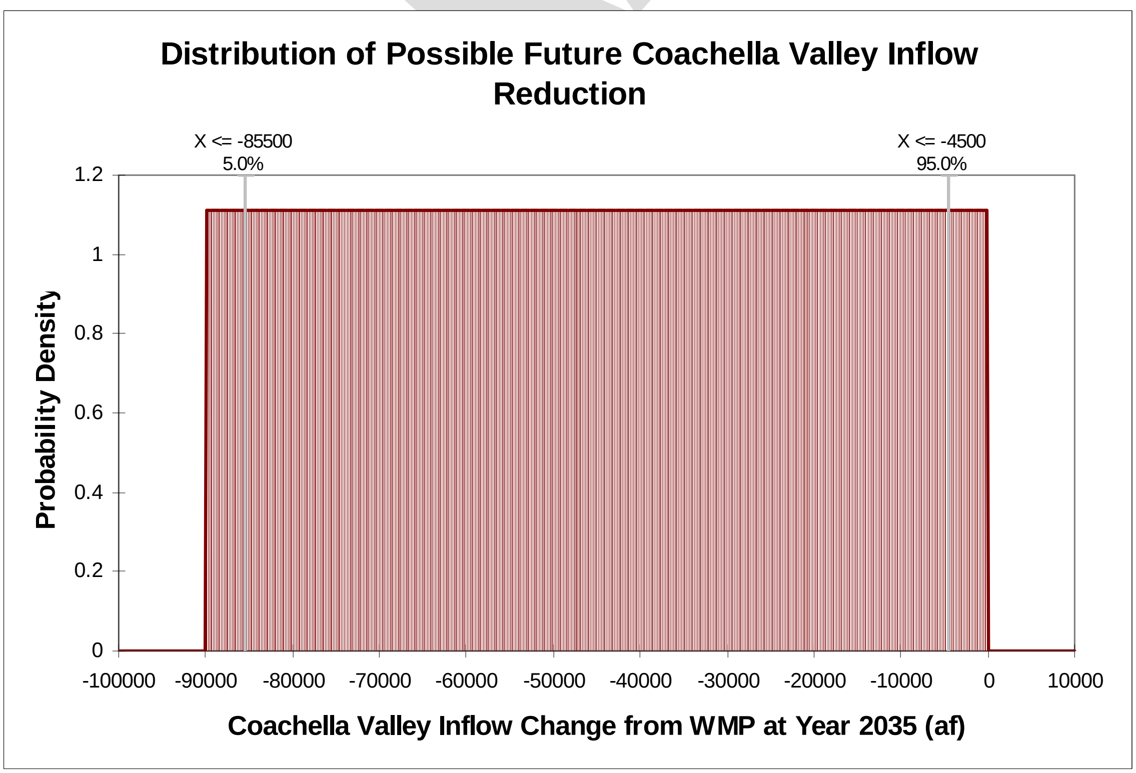

Figure 22
Probability Distribution to Describe Range of Uncertainty in Future Coachella Valley Flows

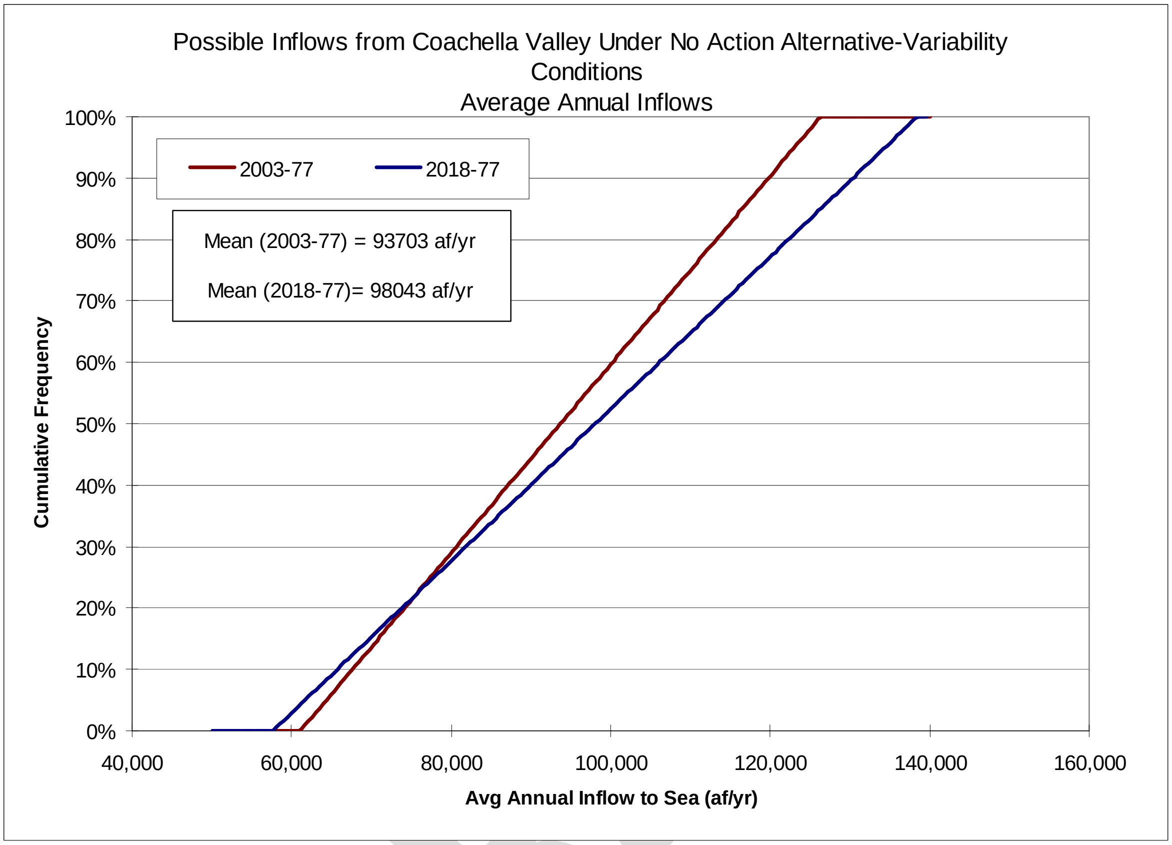

Figure 23
Possible Inflows from the Coachella Valley for No Action Alternative-Variability Conditions

Portions of the Watershed Not Tributary to Imperial and Coachella Valleys

The inflows from the portions of the watershed not tributary to Imperial and Coachella valleys are not expected to appreciably change in the future beyond that represented in the No Action Alternative-CEQA Conditions. Most of the inflows generated from these areas are the direct result of rainfall runoff on vast amounts of open space. While future changes in the amount of precipitation and storm intensity will have an impact on the inflows to the Salton Sea, most of the climate models and future projections are not conclusive on the future precipitation trends.

Temperature, however, is shown to increase in all future climate projections and will certainly have an impact on evaporation and evapotranspiration as discussed in the following section.

Evaporation

Evaporation is the single largest component in the water budget equation for the Salton Sea. Regarding the evaporation rate, it is also the one of the few components over which future management decisions have no control. Under the No Action Alternative-CEQA Conditions, the historical climate conditions and variability are assumed to be a reasonable estimate of future conditions and the evaporation rate is assumed to be represented by the historical estimated rates. The evaporation rates determined from the annual water budget analysis were found to average 69 inches/yr as total evaporation or 66.4 inches/yr as net evaporation.

The rate of evaporation, however, is sensitive to small changes in meteorological conditions which are influenced by long-term climate trends. The issue of climate change has begun to play an increasing role in scientific research and policy decision-making. In recent years, there is a growing scientific consensus that climate changes will be the inevitable results of increased concentrations of greenhouse gasses (Kiparsky and Gleick 2003, IPCC 2001). General Circulation Models (GCMs) have been increasingly applied to evaluate large-scale changes in climate parameters under differing future emission scenarios. Regional “down-scaling” can then be performed to evaluate finer scale climate impacts.

While, significant attention has been given toward evaluating the impacts of global climate change on snowpack in the Sierra Nevada or Colorado River basin runoff, little study has been devoted to the impacts to semi-arid terminal lakes. Hayhoe et al (2004) evaluated the highest and lowest IPCC emission scenarios and associated impacts to California. All simulations show increases in annual and seasonal average temperatures with annual average temperatures increases ranging from 1.35 to 2.0 degrees C by mid-century and 2.3 to 5.8 degrees C by the end of the century. Less warming is predicted in the southern California coastal areas and increased warming in the north and northeast. Precipitation trends are less conclusive, with some scenarios projecting decreases and other predicting slight increases, as inter-decadal variability often dominates in California (Hayhoe et al 2004).

Uncertainty of future climate impacts on the Salton Sea is evaluated by relating changes in evaporation to changes in predicted temperature. Through analysis of CIMIS reference evapotranspiration rates, temperature, wind, and other factors it is estimated that Salton Sea evaporation rates may increase by 3-4 percent for every 1 degree C annual temperature change. Using the least sensitive model, associated projected end of century temperature increases (2.3-3.8 C), and current Sea elevation, evaporation losses from the Salton Sea could increase by as much as 175,000 af/yr. However, the process of global, and regional, climate change is slow and the impacts will initially be zero and gradually increase over time. Because the effect of this uncertainty is dependent on the water surface area of a particular restoration alternative, the evaporation rate (as opposed to volumetric evaporation) is the appropriate parameter to be addressed. The uncertainty is expressed in terms of range of mid-century temperature increases as shown in Figure 24. End of century temperature increases are nearly double those of mid-century.

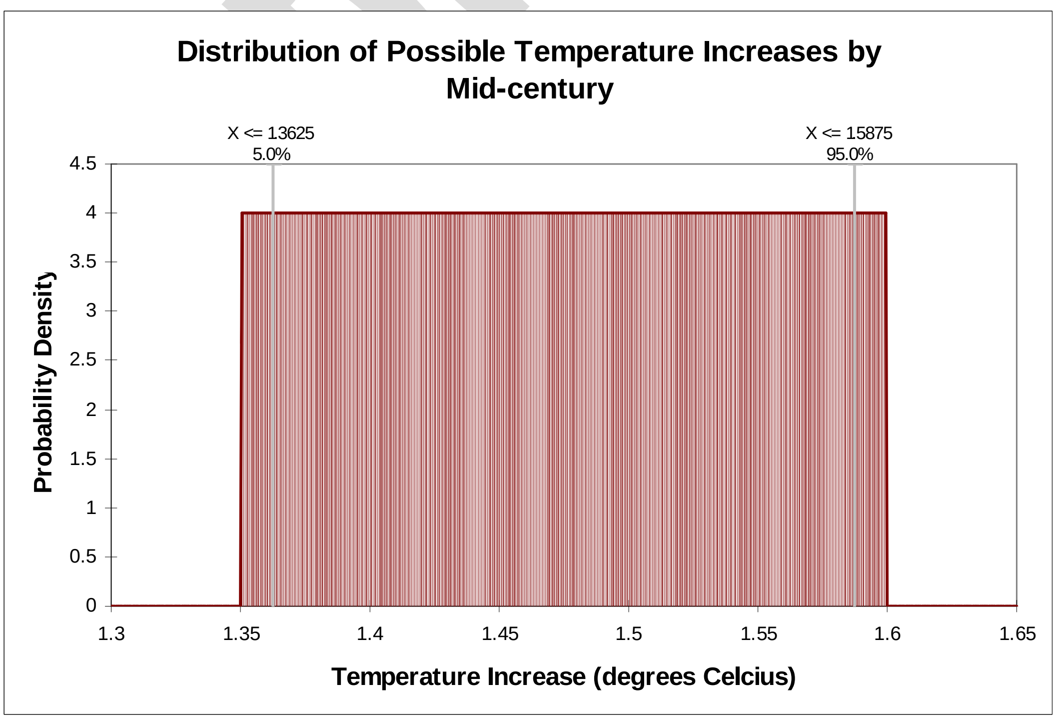

Figure 24
Probability Distribution to Describe Range of Uncertainty in Future Climate Change

Range of Future Evaporation Under No Action Alternative-Variability Conditions

Under the No Action Alternative-CEQA Conditions, estimated Salton Sea water surface net evaporation rates average 66.4 inches/yr. Under the uncertainty analysis considering possible future climate effects, the mean of all traces sampled in the Monte Carlo analysis increases annual evaporation by approximately 6 inches by 2035 and 11 inches by 2077 (Figure 25). The mean annual projected evaporation rate increases are is approximately 5.8 and 7.0 in/yr for the 2003 to 2077 and 2018 to 2077 periods, respectively. Using the 2018 to 2077 mean annual evaporation rate increase, the equivalent inflow reduction under current water surface elevation would be approximately 135,000 af/yr. As stated earlier

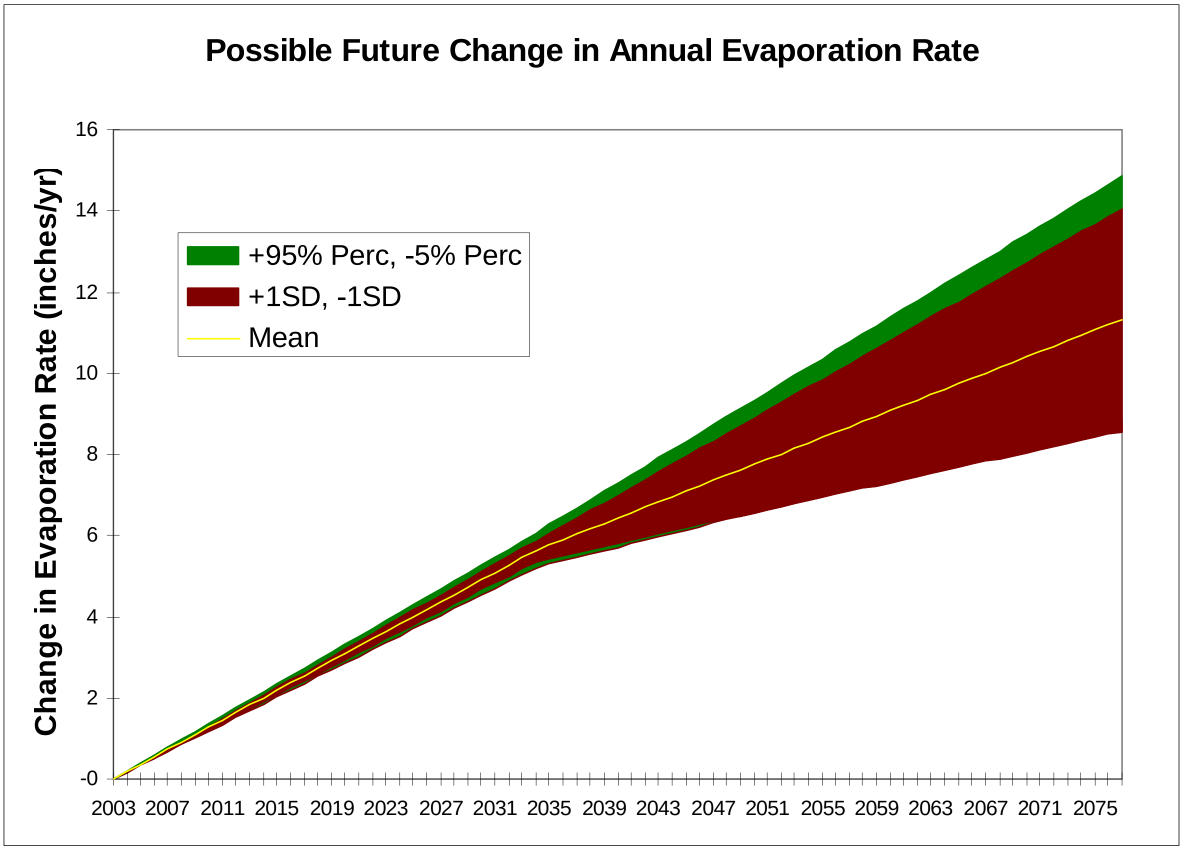

Figure 25
Possible Future Change in Annual Evaporation Rate

the volumetric impact of this uncertainty will depend on the size of any future Salton Sea water surface areas.

Projected Range of Future Salton Sea Inflows Under No Action Alternative-Variability Conditions

The range of possible future changes to Salton Sea inflows has been discussed in the previous sections. The cumulative effect of all future inflow possibilities is evaluated through simultaneous sampling of all uncertainty probability distributions in the Monte Carlo approach. The mean of all traces sampled in the Monte Carlo analysis (not considering uncertainty in future evaporation) is approximately 795,000 for the 2003 to 2007 period and approximately 717,000 af/yr for the 2018 to 2077 period (Figure 26).

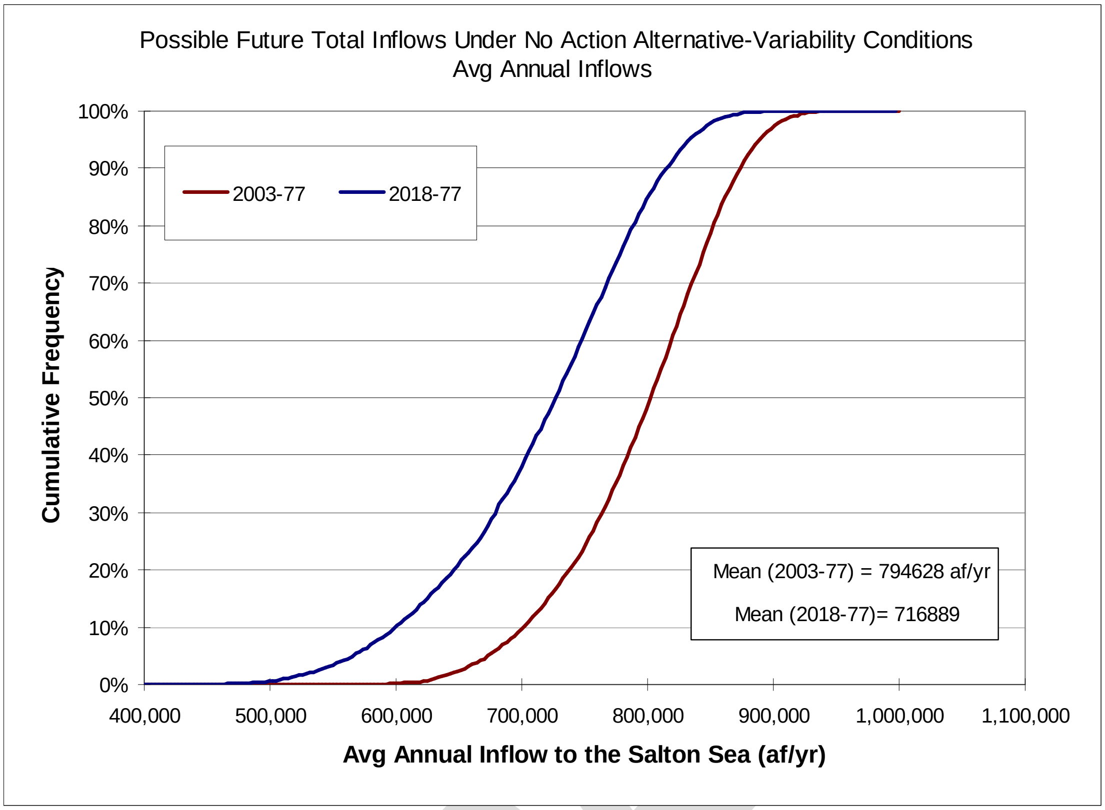

Figure 26
Possible Total Salton Sea Inflows for No Action Alternative-Variability Conditions

Considering Uncertainty in Sizing/Placement of Major Infrastructure

The range of inflows to the Salton Sea when considering future uncertainty (Figure 26) enables a relative assessment of the risk associated with various assumptions of future water availability. For example, the placement of a dam to manage a smaller Salton Sea based on an assumed future annual inflow of 900,000 af/yr would have a greater risk of failure to meet design objectives (elevation, salinity, water depth, etc) than if it were based on a lower inflow assumption. As one moves along the probability curve, trade-offs are made between greater certainty of satisfaction of goals and size of overall project. Similar evaluations of trade-offs and risk are part of many hydrologic or hydraulic analyses such as the sizing of flood control levees or water supply dams (failure or yield vs. cost). While the hydrologic uncertainty often dominates the total uncertainty in these assessments, many decisions are made with an understanding of uncertainty. The concept of "margin-of-safety" (essentially a discount from the expected value) is widely used to account for uncertainty in various fields.

For the purposes of developing alternatives to be considered in the PEIR, a set of inflows needed to be identified. Overall sizing of habitat components, such as the marine sea, required assumptions of long-term average annual inflows to define the available water budget. These components would be large and could accommodate daily, monthly, and even annual variations in inflows. The sizing of features to convey water from the main rivers, for example, required assumptions for peak monthly and daily flows. In general, the assumptions need to be conservative for the PEIR with an acknowledgement that site specific documents may have more information available to reduce the risks before final design. For the purposes of developing the alternatives in the PEIR, inflows under the No Action Alternative-Variability Conditions were evaluated at a level of uncertainty represented by the 80 percent exceedance probability

(20 percent cumulative frequency) of the possible long-term average annual inflows. For the period of 2003 to 2077, this value would be approximately 737,000 af/yr. However, because the major facilities are not likely to be constructed and fully operational until 2017 or after, the inflows considered for sizing larger components of the alternatives is approximately 646,000 af/yr based on the 80 percent exceedance probability of the average annual inflow over the 2018 to 2077 period.

REFERENCES

Amrhein C, Crowley D, Holdren GC, Kharaka YK, Parkhurst DL, Pyles J, Schroeder RA, Tostrud MB, and Weghorst PA 2001. Effect of Salt Precipitation on Historical and Projected Salinities of the Salton Sea: Summary Comments from Workshop at the University of California, Riverside. January 30-31, 2001.

California Department of Water Resources 2003. "California's Groundwater Bulletin 118," and website (http://www.groundwater.water.ca.gov/bulletin118) containing basin summaries.

California Irrigation Management Information System 2005. Data collected from http://www.cimis.water.ca.gov.

CH2M HILL 2004. Salton Sea Ecosystem Management Plan, Draft No Action Alternative Report.

Coachella Valley Water District 2002. Draft Environmental Impact Report for Coachella Valley Water Management Plan and State Water Project Entitlement Transfer.

Coachella Valley Water District 2005. Revised Modeling Results for Coachella Inflows and Salt Loads to the Salton Sea. Excel spreadsheet obtained from D. Ringel.

Coachella Valley Water District, Imperial Irrigation District, Metropolitan Water District of Southern California, and San Diego County Water Authority 2003. Implementation of the Colorado River Quantification Settlement Agreement, Addendum to the Final PEIR.

Colorado River Basin Salinity Control Forum 2005. 2005 Review, Water Quality Standards for Salinity, Colorado River System.

Comision Estatal del Agua Baja California (CEA) 2005. Ampliación del Acueducto Rio Colorado-Tijuana, de 4 a 5.3 m3/seg.

Comision de Servicios del Agua del Estado (COSAE) 2005. Bases de Licitacion Para la "Prestación del Servicio de Conducción y Ampliación del la Capacidad del Acueducto Rio Colorado-Tijuana, Su Operación y Mantenimiento" [Bidding Terms for the ARCT Expansion].

Comision Estatal de Sevicios Publicos de Mexicali (CESPM) 2004. Planeacion General del los Sistemas del Agua Potable y Alcantarillado Sanitario del la Ciudad de Mexicali 2004-2030 [General Planning for Potable and Sewage Systems in the City of Mexicali 2004-2030].

Department of Finance 2004. *Population Projections by Race/Ethnicity for California and Its Counties 2000–2050*, Sacramento, California, May 2004.

Gilbert L 2005. Farming 460,000 Acres with 2.3 Million Acre Feet of Water in the Year 2026.

Hayhoe K, Cayan D, Field CB, Frumhoff PC, Maurer EP, Miller NL, Moser SC, Schneider SH, Cahill KN, Cleland EE, Dale L, Drapek R, Hanemann RM, Kalkstein LS, Lenihan J, Lunch CK, Neilson RP, Sheridan SC and Verville JH 2004. Emissions Pathways, Climate Change, and Impacts on California.

Hely AG, Hughes GH and Irelan B 1966. Hydrologic Regimen of the Salton Sea, California. U.S. Geological Survey Professional Paper 486-C.

Holdren C 2005. Various water quality data for the Salton Sea.

Holdren C and Montano A 2002. Chemical and Physical Limnology of the Salton Sea, California – 1999.

Hughes GH 1967. Analysis of Techniques Used to Measure Evaporation From the Salton Sea, California. U.S. Geological Survey Professional Paper 272-H.

Intergovernmental Panel on Climate Change 2001. Climate Change 2001: Synthesis Report, Summary for Policymakers.

Imperial Irrigation District 2000. IID Water Department, Water Information 2000. Presented to the State Water Resources Control Board.

Imperial Irrigation District 2002. IID Water Conservation and Transfer Project EIR/EIS.

Imperial Irrigation District 2003a. IID Annual Report of Flows, All-American Canal. (Excel spreadsheet).

Imperial Irrigation District 2003b. Imperial Valley Salt Balance Data (Excel spreadsheet).

Imperial Irrigation District 2005a. Various IID water delivery and salinity data.

Imperial Irrigation District 2005b. Measured Annual Pan Evaporation at Sandy Beach, Devil's Hole, and Imperial Salt Farm (Excel spreadsheet).

Kalin A 2003. Reducing Silt in Your Drain Water, A Handbook on Best Management Practices for the Imperial County Silt TMDLs. Prepared for the Imperial County Farm Bureau.

Kiparsky M and Gleick PH 2003. Climate Change and California Water Resources: A Survey and Summary of the Literature.

Loeltz OJ, Irelan B, Robison JH, and Olmsted FH 1975. Geohydrologic Reconnaissance of the Imperial Valley, California. U.S. Geological Survey Professional Paper 486-K.

Ogden Environmental and Energy Services Co. 1996. Salton Sea Management Project, Evaluation of Salinity and Elevation management alternatives.

Pomeroy RD and Cruse H 1965. A Reconnaissance Study and Preliminary Report on a Water Quality Control Plan for the Salton Sea. Prepared for the State Water Quality Control Board.

Regional Water Quality Control Board, Colorado River Region 2002. Sedimentation/Siltation total maximum daily load for the New River.

Regional Water Quality Control Board, Colorado River Region 2002. Sedimentation/Siltation total maximum daily load for the Alamo River.

Regional Water Quality Control Board, Colorado River Region 2005a. Water quality data in MS Access file obtained from Francisco Costa.

Regional Water Quality Control Board, Colorado River Region 2005b. Draft Problem Statement for Salton Sea Nutrient TMDL.

Scott J 2005. CRSS Lite Modeling Results for Colorado River Flows and Deliveries to Mexico (Excel spreadsheet).

State Water Resources Control Board 1984. Decision Regarding Misuse of Water, Decision 1600.

Tostrud MB 1997. The Salton Sea, 1906-1996, Computed and measured salinities and water levels. Colorado River Board of California.

U.S. International Boundary and Water Commission 2002. Western Water Bulletin 2002.

U.S. Geological Survey 2005. Surface Water Data for the Nation (http://waterdata.usgs.gov/nwis).

U.S. Geological Survey 2004. Climatic Fluctuations, Drought, and Flow in the Colorado River.

U.S. Geological Survey 2005. Provisional Salton Sea elevation data, compiled from various USGS and DWR sources.

U.S. Bureau of Reclamation and Imperial Irrigation District 1994. Final EIR/EIS for the All-American Canal Lining. Imperial County, California.

U.S. Bureau of Reclamation and Coachella Valley Water District 2001. Coachella Canal Lining Project Final EIS/EIR.

U.S. Bureau of Reclamation 2003. Part 417, Regional Director's Final Determinations and Recommendations, Imperial Irrigation District, Calendar Year 2003.

U.S. Bureau of Reclamation 2004. Salinity Control Research Project.

U.S. Bureau of Reclamation 2005. Bathymetric data for the Salton Sea (Various GIS files obtained from Paul Weghorst).

Western Regional Climate Center 2005. Western Regional Climate Center rainfall data obtained from http://www.wrcc.dri.edu/.