An Analysis of Total Dissolved Solids in San Diego County

Prepared for:

California State Water Resources Control Board – San Diego Region

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EXECUTIVE SUMMARY

Total dissolved solid (TDS) concentrations in many of the natural watercourses and bodies in San Diego County exceed Basin Plan standards by a significant margin. Assessments of the TDS concentrations in San Diego County indicate that groundwater seeps and springs are the primary source of high TDS in the surface waters. While groundwater forms the baseflow of many surface waters in the basins of San Diego County, there is a considerable difference between groundwater and surface water standards for TDS concentrations as stated in the Basin Plan.

Many of the dissolved solids in surface and groundwaters in Southern California are derived from imported water that is used in agricultural and other applications within the basins**.** In most cases, this imported water is above the Basin Plan objectives for surface water before it enters San Diego County. The application of imported water through agricultural, residential, and commercial irrigation systems adds more TDS to the groundwaters of the basins because of additive effects, such as evapoconcentration of the imported water, and leaching of soils. There is an immediate need for developing TDS control and management strategies on a regional basis to ensure that further degradation of our water resources by salt loading is minimized.

In establishing the water quality objectives (WQOs) for TDS, chloride and sulfate, the 1975 *San Diego Comprehensive Water Quality Control Plan Report* (Basin Plan) did not consider historic surface water quality, the seasonal nature of surface water flows and quality, TDS concentrations in imported waters, and if there are measurable effects of higher TDS on the beneficial uses of the surface waters. Instead, the water quality objectives were selected to represent desirable water quality goals.

The implications of the current Basin Plan objectives for TDS include the following:

1. The economic impacts from attempting to meet Basin Plan objectives for surface waters fed by high TDS groundwater inputs are prohibitive.
2. If even higher TDS water is imported as predicted, the potential impacts to surface water and groundwater quality in San Diego County will be even greater.
3. It is likely that the potential sources of water that can be utilized to sustain the economy of Southern California will be severely limited in the future.

There were two instances where the RWQCB changed TDS WQOs in the Basin Plan because they realized that in so doing there was a net environmental enhancement. The 1975 Basin Plan set forth procedures under which the water quality objectives could be updated and modified when sufficient data were developed to warrant change of the objectives.

We respectfully request that the RWQCB perform a detailed review of TDS WQOs for the next Basin Plan update (Triennial Review), and participate in an effort to form a TDS workgroup that can address regional TDS planning and management strategies.

1.0 INTRODUCTION AND BACKGROUND

This report provides an assessment of total dissolved solids (TDS) concentrations in San Diego County, a brief evaluation of Basin Plan water quality objectives (WQOs) for TDS, and recommendations of how we can move forward to address this regional issue. There are five watersheds in San Diego County that contain 11 different water bodies on the proposed 2002 303(d) Impaired Water Bodies list for TDS, chloride, and sulfate. The eleven listed water bodies are listed in Table 1-1 and shown on Figure 1-1. In addition to these waterbodies, recent dry weather monitoring results by Copermittees under Order 2001-01 indicate that TDS concentrations above Basin Plan objectives are a common regional problem that extends far beyond the scope of these 11 water bodies.

Table 1-1. Water Bodies in San Diego County Proposed for 303(d) listing for TDS, Chloride, and Sulfate.

Water Body Name	Listed Constituent (TDS related)	Hydrologic Unit Basin
Upper Santa Margarita River	TDS	902.20
Sandia Creek	Sulfate, TDS	902.22
San Luis Rey River	Chloride, TDS	903.11-903.12
Agua Hedionda Creek	TDS	904.31
Hodges Reservoir	TDS	905.21
Green Valley Creek	Sulfate	905.21
Felicita Creek	TDS	905.23
Kit Carson Creek	TDS	905.23
Cloverdale Creek	TDS	905.31
Lower, San Diego River	TDS	907.12
Forrester Creek	TDS	907.12

1.1 Establishment of RWQCB Water Quality Standards

The *San Diego Comprehensive Water Quality Control Plan Report* (Basin Plan) was adopted in 1975. This original Basin Plan designated beneficial uses for ground and surface waters within each subbasin of the region. “Municipal Supply” and “Agricultural Supply” were designated as beneficial uses through most of the region. In accordance with these beneficial use designations, water quality objectives were assigned on the basis of existing published criteria for municipal and irrigation supplies. A surface water TDS objective of 500 mg/L was assigned to virtually all subbasins within the San Diego Region. Rationale presented in the 1975 Basin Plan for this 500 mg/L TDS objective included:

- The standard would prevent taste problems in potable water supplies. State, and federal secondary (non-enforceable) recommended “lower limit” drinking water standards for TDS were 500 mg/L.
- The standard would prevent leaf burn and salinity-related crop reductions. The State Water Resources Control Board published classification guidelines for irrigation water use in which TDS concentrations of less than 500 mg/L were characterized as having no adverse impact on vegetation growth or crop production.

The Basin Plan surface water TDS, chloride, and sulfate concentrations were not established to protect or maintain habitat, or to meet "fishable/swimmable" EPA goals. The standards simply represent designated "no impact" levels for water taste, salinity-related leaf burn, and salinity-related crop reduction.

In establishing the WQOs for TDS, chloride and sulfate, the 1975 Basin Plan did not consider the facts that:

1) Historic surface water quality did not comply with the listed objectives during most periods because of natural geologic and hydrologic characteristics of the watersheds in San Diego County
2) Historically, many of the watercourses did not have surface flow during portions of the year
3) TDS concentrations in some imported water sources (Colorado River) often significantly exceed the 500 mg/L objective
4) TDS concentrations in imported waters constitute the dominant source of salinity loading within the subbasins of the San Diego Region
5) Exceedance of the established limits does not necessarily lead to impacts of beneficial uses
6) It is not possible to achieve the water quality objectives without restricting the use, or quality of imported water.

After the adoption of the San Diego Basin Plan, the U.S. Environmental Protection Agency (EPA) promulgated the Basin Plan surface water quality objectives as federal water quality standards (not to be exceeded). This action significantly restricted the flexibility of the RWQCB in assigning appropriate effluent permit standards for discharges to surface waters. The action also brought into play federal antidegradation and antibacksliding regulations, which made it difficult to implement the original Basin Plan vision of updating the WQOs. Further, the adoption of the TDS goal as an enforceable water quality objective did not consider all of the factors set forth in section 13241 of the California Water Code, including environmental characteristics of the hydrographic unit under consideration, economic considerations, and water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area. Based on recent TDS data and the 303d listings, it is clear that it is time to consider all of these factors and develop a regional TDS management strategy. Part of that assessment should include assessment of the Basin Plan WQOs for groundwater and surface waters throughout San Diego County.

1.2 Prior Basin Plan Modifications

After the original Basin Plan was adopted in 1975, two modifications of surface WQOs for TDS were implemented within the San Diego Region. Both changes were initiated by wastewater agencies, with RWQCB encouragement, in order to allow recycled water stream discharges for purposes of environmental enhancement. Each of these Basin Plan modifications were initiated in 1989 and approved by RWQCB and EPA in the early 1990s.

The first Basin Plan modification (initiated by the Padre Dam Municipal Water District) modified TDS objectives along the portion of Sycamore Creek (HSA 907.12) and the San Diego River (HSA 907.11) downstream from Santee Lakes. The second Basin Plan modification (initiated by Eastern Municipal Water District and Rancho California Water District) modified TDS objectives along Murrieta Creek (HSA 2.52), and the Santa Margarita River (HSA 902.21 and 902.22). Each Basin Plan modification occurred as a result of demonstrating through comprehensive water quality data, modeling studies, beneficial use studies, and biological studies, that:

- Historic and existing surface water quality did not meet the assigned water quality objectives

- The original water quality objectives for TDS were not required for supporting the designated beneficial uses
- Stream discharge of water with recycled waters that had TDS concentrations that were higher than Basin Plan objectives would result in improvement in overall receiving water mineral quality
- The modified TDS objectives were in keeping with maximizing benefits to the environment and protecting beneficial uses.

For both Basin Plan modification processes, receiving water quality data presented to RWQCB and EPA documented that receiving water TDS concentrations would continue to consistently exceed the modified TDS concentration objectives, but that the associated recycled water stream discharges would lessen the degree of by which the objectives would be exceeded (PDMWD, 1989; EMWD/RCWD, 1989). The fact that receiving water TDS concentrations would continue to exceed the modified TDS objectives was cited by RWQCB staff as representing a rational approach to protecting beneficial uses while allowing meaningful environmental enhancement through recycled water stream discharge (RWQCB, 1988; RWQCB, 1990).

2.0 HYDROLOGIC INFLUENCES ON WATER QUALITY

Natural hydrologic factors have a dominating influence in surface water mineral concentrations within the San Diego Region. Because of the seasonal nature of precipitation within the region, significant surface flows typically occur during winter and spring months followed by a relatively long summer and fall season of minimal to no-flow. In the larger watersheds (Santa Margarita River, San Luis Rey River, San Dieguito River, and San Diego River), surface flows can exceed 10,000 cubic feet per second (cfs) during periods of significant precipitation. During summer and fall months, on the other hand, streamflows may approach zero. Surfacing groundwater and runoff from applied water (agricultural runoff or urban runoff) represent the primary contributors to dry season streamflows. The interchange between surface water and groundwater, and the extreme seasonal variability of flow, evaporation, and water quality in San Diego County all contribute to a wide range of TDS, chloride and sulfate concentrations in our surface waters.

The following discussion focuses on TDS; however, chloride, sulfate, and other major dissolved chemical species are all components of TDS. The concentrations of those major components vary in a fashion that mirrors the variability of TDS. The data that is presented in figures and tables below was compiled from a variety of sources listed in the References section and Appendix A. Some of the TDS data is derived from specific conductance (EC) measurements, where EC in micromhos is multiplied by 0.64 for conversion to concentration of TDS in mg/L (adapted from USGS Water Supply Paper 1454, and the City of San Diego Water Quality Laboratory).

2.1 Influence of Groundwater on Surface Water TDS

Large portions of the major San Diego Region watersheds (Santa Margarita River, San Luis Rey River, San Dieguito River, and San Diego River) flow through alluvial valleys that contain unconfined groundwater, and there is a considerable interchange between surface flow and groundwater flow within these alluvial valleys. The major groundwater basins in San Diego County are shown on Figure 2-1. Surface infiltration of river flow can exceed 30 cfs within the larger alluvial aquifers of the Santa Margarita River and San Luis Rey River during periods of significant runoff. Conversely, surfacing groundwater can contribute several cfs to surface flows during dry season months (NBS/Lowry 1995; SDCWA 1997b).

Even though the shallow groundwater and surface waters of the alluvial river valleys in San Diego County are part of one hydrogeologic system, there is a significant incompatibility between Basin Plan ground and surface water quality objectives for most San Diego Region watersheds. Table 2-1 compares Basin Plan ground and surface water quality objectives within the subbasins proposed by RWQCB for 303(d) listing as being “impaired” by TDS. Table 2-1 also presents the typical groundwater quality within the “impaired” portions of the subbasins.

As shown in Table 2-1, Basin Plan TDS groundwater objectives exceed the Basin Plan surface WQOs by a large amount in most cases. Observed groundwater concentrations are typically higher than both the Basin Plan ground and surface water quality objectives. Figures 2-2 through 2-6 show the variation of TDS in groundwater for each of the watersheds under consideration. These figures show that groundwater quality in the major watersheds of San Diego County continually degrades as you move from the mountains towards the coastline. The areas that contain TDS concentration below 500 mg/L are restricted to upper reaches of the watershed in areas where there is minimal use of irrigation water. The TDS in shallow aquifers near the coast are typically above 1500 mg/L as a result of saltwater incursion, and salt loads due to imported water use.

The preceeding discussion clearly demonstrates that surface water TDS objectives cannot be met if the TDS in groundwaters in these interconnected systems are already above the Basin Plan surface WQOs. Figure 2-2 through 2-6 and Table 2-1 all indicate that this is the case.

Table 2-1. Comparison of Basin Plan Ground and Surface Water Quality Objectives Subbasins Proposed by RWQCB for 303(d) Listing for TDS Impairment

Basin No.	Basin Name	TDS Concentration in mg/L		
		Surface Water Quality Objective[1]	Groundwater Quality Objective[1]	Observed Groundwater Quality
902.22	Upper Santa Margarita River (lower 17.5 miles)	500	750	750 – 1200[2,3,4,5]
902.22	Sandia Creek (lower 1.5 miles)	500	750	
903.11	San Luis Rey River (lower 17 miles)	500	1500	500 – 3400[2,4]
904.31	Agua Hedionda Creek (lower 8 miles)	500	1200	
905.21	Lake Hodges Reservoir	500	1000	1000 – 1500[2,4]
905.23	Felicita Creek (lower 2 miles)	500	1000	
905.23	Kit Carson Creek (1 mile)	500	1000	
905.31	Cloverdale Creek (1 mile)	500	1000	
907.12	Forrester Creek (lower 1 mile)	1000	1000	1500 - 3000[2,4,6]
907.11[7] 907.12	Lower San Diego River (lower 20 miles)	1500	2000[7]	1000 - 3000[2,4]

1 Surface and groundwater quality objectives as designated in the 1994 Basin Plan.
2 From NBS/Lowry (1989a).
3 From NBS/Lowry (1995) and SDCWA (1997b).
4 From Leedshill-Herkenhoff (1988).
5 From California Department of Water Resources (1986).
6 RWQCB lists this subbasin as 907.12, but the lower 20 miles of the Lower San Diego River is predominantly located within HSA 907.11.
7 Groundwater quality objective within 907.11 is 3000 mg/L. Basin Plan groundwater quality objective within alluvial aquifer portion of 907.12 is 2000 mg/L.

2.2 Influence of Surface Water Hydrology

There is a consistent relationship between the magnitude of surface flow and mineral concentrations throughout watersheds of the San Diego Region. TDS concentrations are lower during periods of significant precipitation runoff compared to the TDS concentrations that occur during the dry season. Poor-quality surfacing groundwater results in significantly higher TDS concentrations in the streams during times of low flow, compared to higher flow periods when there is significant dilution by runoff produced during storm events.

Table 2-2 shows historic TDS concentrations and streamflow for gaging stations at the Santa Margarita River at Fallbrook and San Luis Rey River at Oceanside. Table 2-3 shows historic TDS concentrations and streamflow at San Diego River at Mission Dam. As shown in Table 2-2, dry-season low-flow TDS concentrations in the San Luis Rey River watershed can exceed 1500 mg/L, and dry-season TDS concentrations in Santa Margarita River watershed are typically in excess of 800 mg/L. The high flow TDS concentrations that occur during the wet season for these two watersheds are typically around 650 mg/L. Similarly, dry-season TDS concentrations in the San Diego River are typically in excess of 1000 mg/L, while TDS concentrations are typically less than 750 mg/L during significant runoff events (Table 2-3).

There is also a relationship in the variation of TDS concentrations and precipitation events that is apparent at Lake Hodges. Figure 2-7 shows the variation of TDS in Lake Hodges for the past 12 years. This graph shows that TDS concentrations in Lake Hodges typically vary between 200 mg/L and 1,200 mg/L, and that there is a direct relationship to TDS concentrations and the amount of rainfall. The concentrations of TDS are below 500 mg/L after months with rainfall totals greater than 4 inches; however the concentration of TDS consistently rises during drier periods.

When streamflows at the San Luis Rey River at Oceanside are less than 10 cfs, the river TDS concentrations average approximately 1700 mg/L – a TDS concentration consistent with upstream groundwaters in the Mission Basin and Bonsall Basin. When Santa Margarita River streamflows at Fallbrook are less than 10 cfs, streamflow TDS concentrations average approximately 850 mg/L: a value consistent with groundwater TDS concentrations in upstream alluvial groundwater aquifers. Low-flow TDS surface water concentrations for the San Luis Rey and Santa Margarita Rivers (see Table 2-2) again indicate that groundwater inflow to the streams is providing the baseflow of these streams during most of the dry season.

Table 2-2. Relationship Between Streamflow and TDS San Luis Rey River at Oceanside and Santa Margarita River at Fallbrook.

Streamflow (cfs)	Mean Streamflow TDS Concentration (mg/L)	
	San Luis Rey River at Oceanside1	Santa Margarita River at Fallbrook2
> 300	620	620
100 – 300	940	690
50 – 100	1200	790
10 – 50	1400	800
0 – 10	1700	850

1 Water quality data for San Luis Rey River at Oceanside, 1973-1992, U.S. Geological Survey. Values rounded to two significant figures.

2 Water quality data for Santa Margarita River at Fallbrook, 1963-1993, U.S. Geological Survey. Values rounded to two significant figures.

Table 2-3. Relationship Between Streamflow and TDS San Diego River at Old Mission Dam.[1]

San Diego River Streamflow (cfs)	Mean Streamflow TDS Concentration (mg/L)
> 100	420
50 - 100	610
20 - 50	800
10 - 20	960
0 - 10	1300

1 Water quality data from Padre Dam MWD, 1998-2001. Values rounded to two significant figures.

As shown in Figure 2-7 and Tables 2-2 and 2-3, whether a given water quality sample is within the Basin Plan objective is largely determined by the timing of the sample. Sampling tends to be biased toward low flow events (sampling access is often difficult during periods of high flows), so it is not possible to conclude on the basis of the existing data bases that Basin Plan water quality objectives are exceeded on all occasions. To the contrary, during periods of significant runoff, it is evident that compliance with existing Basin Plan surface water quality objectives can, and does occur.

2.3 Influence of Imported Water on Dry Season Streamflow

Imported water supplies approximately 90 percent of local water demands. This imported water represents a significant influence on dry-season surface flows because of the following factors:

- Irrigation water that infiltrates and recharges groundwater aquifers increases the flow and TDS, chloride and sulfate loading to streams as the groundwater surfaces and flows into streams and rivers as seeps and springs
- Irrigation water that does not infiltrate into the subsurface contributes to the flow and TDS, chloride and sulfate loads to streams as direct surface runoff.

The San Luis Rey River provides a good example of how imported water contributes to dry-season streamflow. Table 2-4 summarizes historic streamflow data from the San Luis Rey River (903.1). Median dry-season San Luis Rey River flows at the Oceanside gaging station were zero prior to 1967 (before significant imported water deliveries to North San Diego County occurred); however, after 1967, continuous surface water flows were recorded at the gaging station (Table 2-4). While some of the difference in streamflow between the two time periods is attributed to drought conditions in the 1950s, the use of imported water was a significant factor in maintaining surface flows in the dry season. These surface flows are maintained as a result of groundwater aquifers that are recharged by surface infiltration to the point of creating surfacing groundwater conditions in river valleys. There are also direct contributions to surface waters by surface irrigation runoff.

Table 2-4. Comparison of San Luis Rey River Surface Flows Pre-1967 and Post-1967 Conditions.

Parameter	**Observed Flow San Luis Rey River at Oceanside[1] (cubic feet per second)**	
	1930 - 1967	**1968 - 2000**
Mean Annual Flow[2]	15.7	56.5
Median Monthly Flow[3]	0.0	10.2
Mean Flow: June – October	0.3	14.2
Median Monthly Flow: June - October	0.0	4.4

1 From USGS Water Resources Data Reports for California. Flow gaging records were not reported by USGS for the period January 1942 through September 1946. Additionally, periodic discharge measurements were reported by USGS (instead of daily measurements) between October 1992 through August 1993 and between November 1997 through April 1998. The listed values represent median and mean values for the monthly flows that were reported during the listed time periods.

2 Mean flow computed as volume of total flow during the listed time period divided by the period of time. As a result, mean streamflow values may be skewed upward by a few months of significant streamflow. For this reason, median values are more appropriate for purposes of assessing potential streamflow effects associated with imported water use.

3 Median monthly flow is the median value of recorded monthly flows for the reported time period.

2.4 Summary of Hydrologic Influences

The observations that are summarized in the preceding sections are the result of the interconnected nature of the ground and surface water systems in the alluvial valleys of the watersheds in San Diego County. During dry season low-flow periods, the rivers are fed by surfacing groundwater and the water quality of the river is equivalent to the quality of the groundwater. Figures 2-8 through 2-11 show the variation in TDS at sampling stations along each of the major rivers under consideration. These graphs support the conclusions provided in the above discussions. Those conclusions include:

- There is a significant variation in TDS concentration as a function of distance upstream – The primary factors leading to this variation include the effects of using imported water in agricultural and urban irrigation.
- The TDS concentrations at specific sampling points vary widely over time – The primary factors causing this variation are related to precipitation events and the magnitude of surface flow at the time of sampling.
- The trends and concentrations of TDS in surface waters as you move upstream in a river varies as the concentration of TDS in groundwaters vary – Compare Figures 2-8 through 2-11 with Figures 2-2 through 2-6.

Because surface water and groundwater systems in these basins are interconnected it is unrealistic to expect surface waters to meet higher standards than groundwater WQOs.

3.0 IMPORTED WATER CONSIDERATIONS

Imported water supplied by the San Diego County Water Authority (SDCWA) provides most of the water that is required for municipal, agricultural, and industrial applications in watersheds addressed in the proposed 303(d) listings. The imported water that the SDCWA supplies is purchased entirely from the Metropolitan Water District of Southern California (MWD). MWD, in turn, imports the water it sells to the SDCWA from northern California through the State Water Project Aqueduct (SWP), and from the Colorado River through the MWD Colorado River Aqueduct (SDCWA, 1997).

Historically, imported water has comprised the dominant source of water supply within the SDCWA service area for over 50 years. While agricultural demands have diminished in recent years due to urban encroachment and water costs, municipal water demands have increased as a result of the increase in San Diego County population. The increase in municipal demand has exceeded the reduction in agricultural demand, and total imported water demands within San Diego County have increased during the past 50 years. Quantities of water imported during the 1970s ranged from less than 350,000 AFY to more than 450,000 AFY. Imported water delivered to San Diego County water agencies during 1990-2000 averaged approximately 600,000 acre-feet per year, and ranged from approximately 535,000 acre-feet per year (AFY) to nearly 650,000 AFY. During 1990-2000, local water supplies developed by SDCWA member agencies averaged approximately 60,000 AFY, and ranged from less than 30,000 AFY to slightly more than 80,000 AFY (SDCWA, 1997).

Table 3-1 summarizes year 2001 water supplies within San Diego County. Table 3-1 also presents typical water quality associated with each of the water supply components. As shown in Table 3-1, TDS concentrations in the blended SDCWA imported water supplies averaged approximately 490 mg/L during 2001. The year 2001 imported water TDS concentration, however, was lower than the historic average due to favorable hydrologic conditions within the Colorado River basin and in Northern California. The weighted average TDS concentration of all water supplies within the SDCWA service area averaged approximately 510 mg/L during 2001 (Table 3-1). The historic weighted average of water supplies within the SDCWA service area during 1974-1999 was approximately 590 mg/L.

TDS concentrations in imported supplies are particularly critical to surface and groundwater quality management within San Diego County, because imported water salinity:

- Represents the largest source of imported salts into San Diego County watersheds
- Directly affects the salinity of recycled water supplies
- Influences the salinity of local ground and surface water supplies.

Table 3-1. Breakdown of Water Supply Sources in the San Diego County Water Authority Service Area, 2001.

Water Supply	Source	Year 2001 Supply[1]		TDS Concentration (mg/L)	
		AFY	Percent	Year 2001	Historical Average 1975-1999
Imported Supply	Colorado River	437,750	64%	560[2]	700[4]
	SWP	159,700	24%	290[3]	250[4]
Local Supply	Surface Water	51,400	8%	300 – 1200[5]	300 – 1200[5]
	Groundwater	12,700	2%	400 – 700[6]	400 – 700[6]
	Desalted Groundwater	5,500	1%	400[7]	400[7]
	Recycled Water	12,700	2%	800 – 1100[8]	800 – 1100[8]
Year 2001 Total		673,700	100%		
Weighted Average of All Supplies				510	590

1 From SDCWA 2001 Annual Report (for water year 2000-2001).

2 From Metropolitan Water District of Southern California (MWD) monthly reports for Colorado River supply in San Jacinto Tunnel West Portal for 2001.

3 From MWD monthly reports for SWP East Branch supply in Lake Perris for 2001.

4 Long-term (25-year) average TDS concentration. From MWD and U.S. Bureau of Reclamation (1999).

5 Surface water quality varies by reservoir and with hydrologic conditions. The listed range of values are typical for major San Diego County reservoirs, including Lake Hodges, Sutherland Reservoir, El Capitan Reservoir, Sweetwater Reservoir, and Otay Reservoir.

6 Groundwater quality varies with location and hydrologic conditions. Listed quality is typical for agencies within or near the affected 303(d) areas, including the U.S. Marine Corps Base Camp Pendleton, Lakeside Water District, Riverview Water District, and Helix Water District.

7 Typical desalted groundwater TDS quality for Sweetwater Authority and City of Oceanside.

8 Water quality supply varies with recycled water agency. Recycled water supplies within the SDCWA service area typically have TDS concentrations from 350 to 450 mg/L higher than the source water TDS. The listed water quality values represent a range of recycled water quality from agencies within the affected 303(d) listed areas, including the City of San Diego, City of Escondido, Fallbrook Public Utility District, Olivenhain Municipal Water District, Otay Water District, and Padre Dam Municipal Water District.

3.1 Anticipated Increase in Imported Water TDS

MWD controls the blend of SWP and Colorado River delivered to SDCWA. Despite the adoption by MWD of a Salinity Management Plan, MWD anticipates increased salinity within both the SWP and Colorado River supplies in the future. Although MWD has adopted a salinity "goal" of less than 500 mg/L as a secondary standard, this goal would not be met at the expense of exceeding a maximum contaminant level (MCL), which is a primary regulatory standard subject to enforcement action. For example, MWD would not maintain higher blends of SWP (low in TDS, high in organics) to blend down the TDS concentration in the Colorado River water supply at the risk of not meeting the Stage 1 Disinfection/Disinfection By-Product Rule due to high organic concentrations in the SWP.

Colorado River water represents the primary source of SDCWA water supply. During the past 20 years, TDS concentrations in the Colorado River supply delivered to SDCWA have averaged approximately 700 mg/L (MWD and U.S. Bureau of Reclamation, 1999). While significant storage along the Colorado River tends to dampen out rapid changes in water quality, Colorado River water quality is dependent on hydrologic conditions. The U.S. Bureau of Reclamation (USBR) has performed probability studies of anticipated future hydrologic conditions in the Colorado River Basin. Table 3-2 presents the results of the

USBR modeling. As shown in Table 3-2, USBR projects a 61 percent probability that TDS Concentrations in the Colorado River imported supply will exceed 800 mg/L during 2015.

The SWP water that is delivered to SDCWA is from the "East Branch" of the SWP. Because of a lack of large volume storage along the East Branch delivery system, East Branch TDS concentrations can vary significantly with hydrologic conditions. During the past 25 years, East Branch TDS concentrations have ranged from 100 mg/L to over 440 mg/L (MWWD and USBR, 1999). Increased salinity loading within the SWP tributary area is projected to cause increased TDS concentrations in future SWP supplies. MWWD and USBR (1999) estimate that TDS concentrations in the SWP supply will increase from 8 to 17 mg/L (depending on hydrologic conditions) by year 2020.

Table 3-2. Projected Colorado River TDS Concentrations from Metropolitan Water District and United States Bureau of Reclamation Salinity Management Study (1999).

TDS Concentration	**Probability that Colorado River TDS Concentration Will Exceed Listed Value[1]**	
	1999	**2015 (projected)**
600	96%	100%
700	73%	82%
800	46%	61%
900	9%	19%
1000	1%	2%

3.2 Salinity Mass Loading Due to Imported Water Use

San Diego Region area-wide water quality management studies performed per the requirements of Section 208 of the Clean Water Act identified imported water salinity as the largest salt balance component within San Diego County watersheds. (Comprehensive Planning Organization, 1978.) Imported water supplies contribute to the net salt loading within San Diego County watersheds through (1) agricultural irrigation, (2) landscape irrigation, (3) septic tank recharge, (4) inland wastewater discharges, and (5) recycled water irrigation. Among these components, agricultural and landscape irrigation represent the largest contributors.

There are two mechanisms that tend to increase TDS concentrations as a result of agricultural practices. One involves dissolution of crop and soil additives such as gypsum ($CaSO_4 * 2 H_2O$), fertilizers, and pesticides. The other mechanism is related to irrigation practices. A significant amount of irrigation water evaporates during hot and dry weather causing an immediate increase in the concentration of TDS and chloride that is directly proportional to the amount of evaporation that takes place. For example, if 25 percent of the applied water is lost to solar evaporation, a water with an initial TDS Concentration of 500 mg/L would have a TDS concentration of 625 mg/L before infiltrating into the subsurface or entering a surface water as direct runoff. In addition, salt crust that form in surficial soils as a result of the evaporation, reduce the soil permeability and provide an additional source of TDS and chloride to infiltrating waters.

As salt builds up in the soils, crop yields decrease. A common practice that is used to reduce the impact of salt buildup in the soils is referred to as leaching. This process involves over-applying irrigation water so that it dissolves and leaches salt that has accumulated in the upper soil. The result is that the dissolved salts are also carried into the local groundwater/surface water system and further increase the TDS loading.

In the early 1970s, agricultural water use comprised more than one-quarter of all SDCWA water demands. Currently, approximately 85 percent of the imported SDCWA supply is used to satisfy municipal demands, with approximately 15 percent of the supply serving agricultural demands. (SDCWA, 2001) SDCWA projects that agriculture will comprise approximately 10 percent of the SDCWA water demands by year 2010. (SDCWA, 1997)

Wastewater flow data within sewered municipalities of the SDCWA service area indicate that approximately one-half of the municipal supply is returned to the sewer. (City of San Diego Metropolitan Wastewater Department, 2001) Since the quantity of water consumed by household, business, and industrial uses is small, it follows that approximately one-half of the municipal supply is used for irrigation by residential or commercial/industrial customers. Table 3-3 presents salt load projections within the SDCWA service area attributable to imported water use under historic, current, and anticipated future conditions. As shown in the table, the net salinity mass load due to imported water use during 2000 is approximately the same as the net salinity mass load due to imported water use during 1975.

As noted, salinity loads to that are due to imported water use represent the dominant component of salinity mass loading within the SDCWA service area. As documented in Table 3-3, salinity loads due to imported water use have not significantly changed since the time of the adoption of the original Basin Plan. Future projected imported water salinity loads, however, are projected to increase as a result of increased water use and increased TDS concentrations in the imported supply.

Table 3-3. Mass Load Projection Salinity Derived from Imported Water Supplies

Parameter	Units	1975	2000	2020
Municipal Supply Used for Irrigation	AFY	180,000[1]	255,000[2]	270,000[3]
Agricultural Supply	AFY	90,000[1]	90,000[2]	60,000[3]
Recycled Water Use	AFY	4,000[1]	12,000[2]	53,000[3]
Imported Water TDS Concentration	mg/L	700[4]	510[2]	590[5]
Net Salinity Load Due to Imported Water Use[6]	tons/year	260,000[7]	250,000[7]	310,000[7]

1 Adapted from data presented in SDCWA (1976). Based on municipal use comprising an average of 80 percent of the imported SDCWA supply, and agricultural use comprising 20 percent. Assumes that one-half of municipal supplies are used for irrigation.

2 Adapted from data presented in SDCWA (2001). Based on municipal use comprising an average of 85 percent of the imported SDCWA supply, and agricultural use comprising 15 percent. Assumes that one-half of municipal supplies are used for irrigation.

3 Adapted from data presented in SDCWA (1997). Based on municipal use comprising an average of 90 percent of the imported supply and agricultural use comprising 10 percent. Assumes that one-half of municipal supplies are used for irrigation.

4 Due to drought conditions, Colorado River supply contained higher than normal TDS concentrations, and comprised nearly 100 percent of the SDCWA imported supply.

5 Based on the values presented in Table 3-1, and a Colorado River TDS of 700 mg/L and SWP TDS of 250 mg/L.

6 Net salinity load within SDCWA service area that is due to the use of imported water resulting from (1) agricultural irrigation, (2) landscape irrigation, or (3) the portion of recycled water salt loads that result because of the original concentration of salts within the imported supply (excluding salts added to the recycled water through normal residential/commercial/industrial use).

7 Estimate computed as the product of the quantity of applied water (municipal supply used for irrigation, agricultural supply, and recycled water use) multiplied by the imported water TDS concentration, and converted to units of tons per year. The listed values represent the salinity introduced to SDCWA watersheds as a result of imported water use. The listed values do not include net salinity loads from other sources such as fertilizer use or incremental recycled water TDS additions that were added through normal residential/commercial/industrial use of imported water supplies.

4.0 SUMMARY AND CONCLUSIONS

The assessments of the TDS concentrations in San Diego County provided in Section 2 indicate that groundwater seeps and springs are the primary source of TDS in the surface waters. This groundwater baseflow accounts for almost all of the dry season flow in rivers and streams throughout San Diego County and also contributes a large fraction of the flow during the wet season. The concentrations of TDS, chloride and sulfate in San Diego County surface waters vary widely as a function of seasonal and annual precipitation patterns, and Basin Plan WQOs for TDS, chloride and sulfate were exceeded historically, particularly in low-flow periods.

While groundwater forms the baseflow of many surface waters in the basins of San Diego County, the difference between groundwater and surface water standards for TDS concentrations as stated in the Basin Plan is significant. For example, the Basin Plan TDS objectives for groundwater in the San Luis Rey River Basin are as high as 1,500 mg/L, yet the surface water Basin Plan objective is 500 mg/L. It is not reasonable to expect compliance with Basin Plan objectives for surface water if the objectives between surface and groundwater in a hydrologically interconnected system are derived independently.

Additionally, the apparent source of much of the TDS in groundwater in Southern California is a confounding problem. Many of the dissolved solids are derived from using imported water in agricultural and other applications within the basins**.** On average, the imported water is at or above the Basin Plan objectives for surface water before it enters San Diego County. The application of imported water through agricultural, residential, and commercial irrigation systems adds more TDS to the groundwaters of the basin because of additive effects, such as evapoconcentration of the imported water, and leaching of soils. In essence, there is a cyclical TDS addition that can be traced to these unregulated practices.

It is important to remember that the original WQOs for TDS in San Diego County were based on the recommended secondary drinking water standard of 500 mg/L. This standard is a non-enforceable guideline established by EPA and the California Department of Health Services to minimize taste impacts in drinking water supplies. However, the imposition of the 500 mg/L limit as a Basin Plan surface water quality standard rendered the standard “enforceable.”

In establishing the WQOs for TDS, the 1975 Basin Plan did not consider the facts that:

1. Historic surface water quality did not comply with the listed objectives during most periods because of natural geologic and hydrologic characteristics of the watersheds in San Diego County
2. Historically, many of the watercourses did not have surface flow during portions of the year
3. TDS concentrations in imported waters routinely exceed the 500 mg/L objective
4. TDS concentrations in imported waters constitute the dominant source of salinity loading with the subbasins of the San Diego Region
5. Exceedance of the established limits does not necessarily lead to impacts of beneficial uses
6. It is impossible to achieve the water quality objectives for TDS without restricting the use of imported water or requiring expensive treatment processes far beyond the California Department of Health Services requirements for drinking water.

4.1 Implications

The implications of the proposed 303(d) listings are far-reaching. The list below outlines only some of the major issues:

1. The economic impacts from attempting to meet Basin Plan objectives for surface waters fed by high TDS groundwater inputs are prohibitive. It is likely that some of the Basin Plan objectives currently in place will never be met because of the technological hurdles involved in capturing and treating ground and surface waters to the current regulatory standards.
2. If even higher TDS water is imported from the Imperial Valley, and the TDS concentration of SWP and Colorado River water increase as predicted, the potential impacts to surface water and groundwater quality in San Diego County will be even greater. The separation between water quality objectives and actual concentrations in our groundwaters and rivers will continue to increase. Ultimately, large acreages of present agricultural land may be sold and converted to urban uses.
3. The twenty year waiver for agriculture ends this year. If new water quality standards are imposed on agriculture that are consistent with surface water objectives and non-degradation standards, there will be a significant economic impact on the agricultural community, and a net loss of viable agricultural endeavors. Thus, one of the primary beneficial uses that is supposed to be protected by the 303(d) TMDL process will likely be severely restricted if the proposed listings are upheld.
4. If the RWQCB and SWQCB continue with the proposed Impaired Water Body listings in the TMDL process, it is likely that the potential sources of water that can be utilized to sustain the economy of Southern California will be severely limited in the future. The waters that are used for drinking, recreation, agricultural, and industrial purposes will all require stringent, expensive, and probably ineffective management practices to maintain compliance with the current regulatory objectives for TDS.

4.2 Recommendations

There were two instances where the RWQCB changed TDS WQOs in the Basin Plan because they realized that in so doing there was a net environmental enhancement. Each of these Basin Plan modifications were initiated in 1989 and approved by RWQCB and EPA in the early 1990s. The 1975 Basin Plan set forth procedures under which the water quality objectives could be updated and modified when sufficient data were developed to warrant change of the objectives.

We believe the data and history presented in this report provide a sufficient amount of information to initiate a thorough review of Basin Plan WQOs for TDS. Based on recent TDS data and the 303d listings, it is clear that it is time to consider both natural and human-induced influences on TDS concentrations in our waters, our regional development needs and dependence on imported water, and other 13241 factors to develop a regional TDS management strategy. This strategy needs to be developed to ensure degradation of our waters by salt loading is minimized. A thorough assessment of the Basin Plan WQOs for groundwater and surface waters throughout San Diego County will provide a framework to work within during planning and development of a long-term TDS strategy for the region.

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Appendix A – Listing of data used in Figures 2-2 through 2-11.

Point of Collection	Agency	Data Source	Site ID	Water Body	Sample Start Date	Sample End Date	No. of Conductivity Samples	No. of TDS Samples	No. of Sulfate Samples	No. of Chloride Samples
Surface Water										
	California Water Resources Control Board	EPA-STORET data center								
			AHC3	Agua Hedionda Creek	1/25/1979	5/30/1986	51	72		
			FC1	Forrester Creek	1/5/1982	8/26/1986	10	32		
			FC2	Forrester Creek	3/15/1954	6/13/1988	43	21		
			SC1	SandiaCreek	3/6/1953	3/6/1953	1	1	1	
			SDR11	San Diego River	1/5/1982	8/26/1986	10	31		
			SDR12	San Diego River	3/26/1982	6/29/1984	8	12		
			SDR14	San Diego River	1/5/1982	8/26/1986	9	21		
			SDR19	San Diego River	4/9/1958	1/28/1982	93	73		
			SDR2	San Diego River	1/5/1982	8/26/1986	10	32		
			SDR3	San Diego River	1/5/1982	8/26/1986	10	30		
			SDR8	San Diego River	1/15/1952	3/14/1988	148	130		
			SLR10	San Luis Rey River	7/31/1939	5/12/1941	3			3
			SLR11	San Luis Rey River	4/21/1939	7/19/1958	9	3		10
			SLR12	San Luis Rey River	4/21/1939	5/20/1940	5			5
			SLR13	San Luis Rey River	3/28/1958	4/21/1958	2	2		2
			SLR14	San Luis Rey River	5/17/1983	3/3/1986		7		
			SLR16	San Luis Rey River	4/21/1939	5/2/1958	8	1		8
			SLR19	San Luis Rey River	3/5/1951	5/10/1967	97	23		97
			SLR22	San Luis Rey River	5/17/1983	2/26/1985		5		
			SLR23	San Luis Rey River	5/17/1983	12/27/1985		8		
			SLR25	San Luis Rey River	3/4/1951	3/4/1951	1			2
			SLR4	San Luis Rey River	5/17/1983	5/29/1986		10		
			SLR6	San Luis Rey River	4/24/1939	5/12/1941	3			3
			SLR8	San Luis Rey River	4/24/1939	4/3/1951	5			5
			SLR9	San Luis Rey River	5/17/1983	3/3/1986		9		

Point of Collection	Agency	Data Source	Site ID	Water Body	Sample Start Date	Sample End Date	No. of Conductivity Samples	No. of TDS Samples	No. of Sulfate Samples	No. of Chloride Samples
Surface Water										
	California Water Resources Control Board	EPA-STORET data center								
			SM3	Santa Margarita River	3/27/1958	10/27/1975	6	6		
			SM4	Santa Margarita River	3/31/1977	3/19/1982	39	29		
			SM5	Santa Margarita River	2/14/1951	6/13/1988	208	134		
			SM7	Santa Margarita River	6/18/1952	10/1/1973	35	46		
	City of Oceanside	Internal Data	SLR26	San Luis Rey River	11/16/1993	7/30/2001	25			25
			SLR27	San Luis Rey River	11/16/1993	7/30/2001	23			23
			SLR28	San Luis Rey River	11/16/1993	7/30/2001	24			24
			FEL1	Felicita Creek	4/26/1999	6/21/1999		3		
			FEL2	Felicita Creek	4/26/1999	7/16/2001		21		
			GVC1	Green Valley Creek	4/26/1999	7/16/2001			23	
			KCC1	Kit Carson Creek	4/26/1999	7/16/2001		21		
			LH2	Lake Hodges	3/5/1996	12/5/2000	20	10		
	MEC Analytical Systems, Inc.	Internal Data	AHC10	Agua Hedionda Creek	5/7/2002	5/7/2002	1			
			AHC11	Agua Hedionda Creek	5/7/2002	5/7/2002	1			
			AHC12	Agua Hedionda Creek	5/7/2002	5/7/2002	1			
			AHC13	Agua Hedionda Creek	5/7/2002	5/7/2002	1			
			AHC14	Agua Hedionda Creek	5/7/2002	5/7/2002	1			
			AHC15	Agua Hedionda Creek	5/7/2002	5/7/2002	1			

Point of Collection	Agency	Data Source	Site ID	Water Body	Sample Start Date	Sample End Date	No. of Conductivity Samples	No. of TDS Samples	No. of Sulfate Samples	No. of Chloride Samples
Surface Water										
	Padre Dam Municipal Water District	Internal Data	FC3	Forrester Creek	9/8/1997	6/25/2001	51	51		
	Rancho California Water District	Camp Pendleton	SC4	Sandia Creek	5/1/1989	5/1/1993	20	20		
	Rancho California Water District	Internal Data	SM8	Santa Margarita River	8/21/1986	9/27/2000	6	287		
			SC3	Sandia Creek	8/21/1986	1/20/1988	6	6		
	San Diego Regional Water Quality Control Board	Internal Data	AHC4	Agua Hedionda Creek	6/10/1998	6/10/1998	1			
			AHC5	Agua Hedionda Creek	6/10/1998	6/10/1998		1		
			SC2	Sandia Creek	6/9/1998	6/9/1998		1		
	U.S. Geological Survey	USGS-NWIS	CC1	Cloverdale Creek	3/25/1982	3/25/1982	1	1		
			SDR9	San Diego River	12/13/1979	6/9/1981	5	3		
			SM2	Santa Margarita River	11/27/1967	3/18/1982	9	5		
	City of San Diego Water Quality Laboratory	Internal Data	Hodges A	Lake Hodges	6/25/1990	3/28/2002	11	226		

Point of Collection	Agency	Data Source	Site ID	Water Body	Sample Start Date	Sample End Date	No. of Conductivity Samples	No. of TDS Samples	No. of Sulfate Samples	No. of Chloride Samples
Groundwater										
			Barrett	Lake Barrett	7/6/1989	4/9/2002	90	113		
	California Department Of Water Resources	DWR Reports	Multiple Sites	Groundwater	12/8/1950	4/22/1991	90	73		
	U.S. Geological Survey	USGS Bulletin 91-18, 106-2 and Data Files	Multiple Sites	Multiple	12/8/1950	4/22/1991	1665	1089		