3. PROBLEM STATEMENT

This Problem Statement includes a description of: (a) violated Water Quality Objectives that prompted TMDL development, (b) watershed characteristics that contribute to nutrient problems, and (c) impairments caused by nutrients.

A. WATER QUALITY OBJECTIVES

Aesthetic qualities, dissolved oxygen, biostimulatory substances, and turbidity at the Salton Sea violate water quality objectives established by the Regional Board to protect Salton Sea beneficial uses. These violations indicate that Salton Sea beneficial uses are impaired. Tables 3.1 and 3.2 summarize the violated water quality objectives and Salton Sea beneficial uses.

Table 3.1: Salton Sea Violated Water Quality Objectives

Parameter	Water Quality Objective
Aesthetic Qualities	All waters shall be free from substances attributable to wastewater of domestic or industrial origin or other discharges which adversely affect beneficial uses, not limited to: ... producing objectionable color, odor, taste, or turbidity.
Dissolved Oxygen	For waters designated "warm," dissolved oxygen level shall not be reduced below 5.0 mg/L at any time.
Biostimulatory Substances	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses. Nitrate and phosphate limitations will be placed on industrial discharges to New and Alamo Rivers and irrigation basins on a case-by-case basis, taking into consideration the beneficial uses of these streams.
Turbidity	Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses.

Source: California Regional Water Quality Control Board 1994

Table 3.2: Salton Sea Beneficial Uses

Beneficial Use	Type of Use	Definition
Aquaculture (AQUA)	Existing	Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.
Water Contact Recreation (REC I)	Existing	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs.
Non-contact Water Recreation (REC II)	Existing	Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
Warm Freshwater Habitat (WARM)	Existing	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Wildlife Habitat (WILD)	Existing	Uses of water that support terrestrial ecosystems including, but not limited to, the preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.
Preservation of Rare, Threatened, or Endangered Species (RARE)	Existing	Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.
Industrial Service Supply (IND)	Potential	Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.

Source: California Regional Water Quality Control Board 1994

B. WATERSHED CHARACTERISTICS

Hydrogeological Setting

The Salton Sea receives its flow primarily from the Alamo River and New River (78% combined), with smaller contributions from Imperial Valley and Coachella Valley agricultural drains flowing directly into the lake (8%) and the Coachella Valley Stormwater Channel (6%) (Table 3.3). Agricultural runoff dominates and sustains these waterways, and therefore is the main source of nutrient loading to the Salton Sea. Table 3.3 summarizes the Salton Sea's flow sources and their percent flow contribution.

Table 3.3: Salton Sea Flow Sources and Percent Flow Contribution

Flow Source	Percent (%) Flow Contribution
Alamo River	46
New River	32
Agricultural Drains (direct discharges to the Salton Sea)	8
Coachella Valley Stormwater Channel	6
Other	8
Total	**100**

Source: Setmire et al. 2001

Soil Classifications

Local soils are mostly colloidal clays and silts. These soils tend to be cohesive, and therefore not easily erodable. This is evident in the relatively stable channels of the Alamo River, New River, and their tributary drains. The principal sources of Salton Sea nutrients are: (a) sediment-laden agricultural runoff, and (b) wastewater treatment plants. Soil descriptions (Zimmerman 1981) are in Appendix A.

C. IMPAIRMENT BY NUTRIENTS

The Salton Sea carries a high nutrient concentration, as indicated by phosphorous and nitrogen data at the center of the Salton Sea. Table 3.4 summarizes this data, collected in 1968-1969 and 1999.

Table 3.4: Nutrient Concentrations (mg/L) at the Center of the Salton Sea

Depth	Season	Ortho-P [1]	Total P [2]	NH3-N [3]	NO3/NO2-N [4]	TKN [5]	Total N [6]	N:P Ratio [7]
1968-1969								
Surface	Summer	0.04	0.06	0.22	0.11	3.0	3.1	52:1
	Fall	0.02	0.05	0.36	0.22	3.3	3.5	70:1
	Winter	0.03	0.07	0.25	0.16	1.5	1.6	23:1
	Spring	0.06	0.20	0.27	0.49	4.5	5.0	25:1
1999								
Surface	Summer	0.013	0.067	1.6	0.1	4.1	5.8	192:1
	Fall	0.032	0.043	1.2	0.1	4.2	5.5	137:1
	Winter	0.04	0.12	1.5	0.2	2.5	4.2	24:1
	Spring	0.012	0.116	0.9	0.2	3.7	4.8	64:1
Bottom	Summer	0.003	0.056	2.5	0.1	5.3	7.9	430:1
	Fall	0.015	0.027	1.4	0	4.0	5.4	288:1
	Winter	0.037	0.079	1.5	0.1	1.8	3.4	25:1
	Spring	0.011	0.083	0.9	0.1	3.7	4.7	108:1

1. Ortho-P = ortho phosphate
2. Total P = total phosphorus
3. NH_3-N = ammonia
4. NO_3/NO_2-N = nitrate/nitrite
5. TKN = total Kjehldahl nitrogen
6. Total N = total nitrogen
7. N:P Ratio = nitrogen/phosphorus ratio

Source: Setmire et al., 2001

Total phosphorus (Total P) concentrations generally were highest in winter and spring, and lowest in summer and fall (Table 3.4). Phosphorus concentrations tended to decrease slightly with depth, which may indicate little net release of phosphorus from sediments. Salton Sea phosphorus concentrations have not changed significantly between 1969 and 1999. However, phosphorus concentrations are high in the tributaries to the Salton Sea, and contribute to impairment of Salton Sea beneficial uses.

Total nitrogen (Total N) concentrations were slightly higher in summer and fall than in winter and spring (Table 3.4). Organic nitrogen (total Kjehldahl nitrogen) was the main form of nitrogen in the water column, possibly due to algal populations, and accounted for about 75% of Total N. Ammonia (NH_3) represented about 25% of Total N, and was significantly higher in 1999 than in 1968-1969, particularly in bottom water. Elevated ammonia levels indicate frequent reducing conditions in the lake. Salton Sea total nitrogen concentrations increased significantly (by about 50%) between 1969 and 1999, primarily because of increased ammonia levels.

Nitrogen and phosphorus are essential for plant growth, and a lack of either one may limit growth. Nitrogen is common in the environment, and nitrogen-fixing organisms can convert gaseous nitrogen from the atmosphere into forms that are available to plants. Phosphorus does not have a gaseous phase and is not as naturally available as nitrogen.

A ratio of nitrogen to phosphorus concentration (N:P) indicates which nutrient is limiting to plant growth. A N:P ratio of 7:1 is common in saltwater algae. A N:P ratio of 10:1 is considered reasonable for most saline systems. If the ratio is lower than 10:1, then nitrogen is the limiting nutrient. If the ratio is higher than 20:1, then phosphorus is the limiting nutrient (Setmire et al. 2001).

Salton Sea N:P data (Table 3.4) reveals significant seasonal variability, with N:P ratios reaching maximum levels in summer, especially in bottom water. Surface N:P ratios in 1999 ranged from 24:1 in winter to 192:1 in summer. Bottom N:P ratios in 1999 ranged from 25:1 in winter to 430:1 in summer. This strongly indicates that phosphorus is the limiting nutrient in the Salton Sea, as these ratios are higher than 20:1. Therefore, measures to reduce Salton Sea nutrient levels likely will focus on reducing phosphorus levels.

Nutrients as an Impairment to Aquatic and Terrestrial Organisms

Excess nutrients threaten many aquatic and terrestrial organisms that utilize Salton Sea habitat. Diversity is reduced as nutrient-sensitive species disappear.

Excess nutrient inflow greatly accelerates eutrophication, which is the process by which a lake gradually fills in with organic and inorganic matter, occurring naturally over thousands of years (Lampert and Sommer 1997). Human-caused factors that accelerate eutrophication (through increased nutrient loading) include: increased wastewater amounts, introduction of phosphorus-containing detergents, increased agricultural fertilizer use, and increased erosion. Eutrophication stimulates undesirable excess algal growth (algal blooms) that contributes to: (a) decreases in desirable game fish populations, (b) anoxia (lack of oxygen) in the water column and sediments, and (c) enormous fish kills. These conditions are described in the paragraphs below.

Eutrophication tends to lead to higher fish production due to increased primary productivity (e.g., algae). However, with increasing eutrophication and worsening water quality, the fish population tends to shift from a balanced community with desirable game fish toward hardier and less desirable species, such as tilapia. Tilapia are by far the dominant fish in the Salton Sea. Their numbers have increased dramatically since the 1980s, with current estimates of greater than 90 million (Setmire et al. 2001).

Inevitably, the disproportionate amounts of algae decompose. This can lead to anoxia, especially in bottom waters (Jones-Lee and Lee 2001; U.S. Environmental Protection Agency 1999). Periodically, the oxygen concentration is zero from surface to bottom in some areas of the lake, leading to fish kills that can number in the millions. Oxygen depletion in shallow waters potentially may harm the endangered Desert pupfish.

Anoxia in the water column produces anaerobic conditions in sediment, leading to death for millions of benthic (sediment-dwelling) organisms that provide food for fish. Anaerobic sediments release toxins into the water column that normally would not be present. Ammonia from frequent reducing conditions in bottom waters could reach toxic concentrations. The continued stress of environmental conditions weakens the biota, particularly fish, and they become more susceptible to disease and death.

Nutrients as an Impairment to Recreational Activities
The Salton Sea was once renowned for its sport fishery and recreational uses, such as boating, swimming, birding, and camping. Businesses sprang up along the shores, as recreational use of the lake became increasingly popular. During the 1950s and 1960s, the number of visitor-days at the Salton Sea exceeded that of Yosemite National Park (Setmire et al 2001).

Today, algae are sometimes so dense that the water appears green. The Salton Sea has high concentrations of chlorophyll A (a measure of algae biomass), which reduces water clarity (increases turbidity). Water clarity, as measured by Secchi depth, was less than 3 feet (0.9 m) for all seasons in 1999 (Setmire et al 2001). This detracts from the lake's aesthetic qualities, and impairs contact and non-contact recreational uses. Such uses are degraded further by noxious odors due to hydrogen sulfide from anaerobic sediments, decaying algae, and decomposing fish.

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