- Permitting of municipal and industrial wastewater discharges in the Delta or its tributaries to control loadings;
- Three primary agricultural drainage programs (Drainage Reduction Program, Rice Herbicide Program, and Habitat Enhancement Landowner Program) to improve drainage water quality; and
- Upgrading water treatment facilities and developing source water assessment programs.

ES.3.5 Current Water Quality Conditions

The analysis of existing water quality data indicated that there is a wide range of water quality conditions to be addressed throughout the Bay-Delta problem area. The major water quality issues recognized to be of concern in the Delta can be summarized in terms of parameters of concern, beneficial uses impacted, and general sources of the constituent or area impacted. Provided below are the significant water quality issues resulting from this analysis.

- High-salinity water from Suisun and San Francisco Bays intrudes into the Delta during periods of low Delta outflow. Salinity adversely affects agricultural, municipal, recreational, industrial, and environmental uses.

- Delta exports have concentrations of dissolved organic carbon (DOC) which are comparable to average DOC concentrations found in raw water sources within the Western United States. DOC, when chlorine is used as a disinfectant, is a disinfection by-product (DBP) precursor, and as a result of seawater intrusion, the potential for formation of brominated DBPs increases along with increases in concentrations of the precursor bromide (Br^-), which originates in seawater.

- Synthetic and natural contaminants have accumulated in Delta sediments and can bioaccumulate in fish and other aquatic organisms. Synthetic organic chemicals and heavy metals (e.g., mercury) are found in Delta fish in quantities that occasionally exceed acceptable standards for food consumption.

- Agricultural drainage in the Delta contains high levels of nutrients, suspended solids, dissolved organic carbon, salinity, and ~~may~~often contains traces of agricultural chemicals (e.g., pesticides). The San Joaquin River delivers water of relatively poor quality to the Delta; agricultural drainage to the river is a significant source of salts and pollutants, including selenium, boron, and pesticides. The Sacramento River contributes some pesticide loading as well.

- Remnants of ~~H~~historical mining activities (e.g., tailings piles, old mines, and debris) are a source of heavy metals, including cadmium, chromium, copper, mercury, and zinc.

- Populations of striped bass and other species have declined significantly from historical levels. Causes of the declines are uncertain, although water quality conditions in the Bay and Delta

Table 1.1 Water Quality Parameters of Concern to Beneficial Uses

ENVIRONMENT	URBAN	AGRICULTURE	RECREATION	INDUSTRIAL
Metals&Toxic Elements	**Disinfection By-Product**	**Other**	**Metals**	**Other**
Cadmium	**Precursors**	Boron	Mercury	Salinity
Copper	Bromide	Chloride	**Organics/Pesticides**	pH
Mercury	TOC	Nutrients (Nitrate)	PCBs	Alkalinity
Selenium	**Other**	pH (Alkalinity)	DDT	Phosphates
Zinc	Pathogens	Salinity (TDS, EC)	Other	Ammonia
Organics/Pesticides	Turbidity	SAR	Pathogens	
Carbofuran	Salinity (TDS)	Turbidity	Nutrients	
Chlordane	Nutrients (Nitrate)	Temperature		
Chlorpyrifos	pH			
DDT	Chloride			
Diazinon				
PCBs				
Toxaphene				
Other				
Ammonia				
Dissolved Oxygen				
Salinity (TDS, EC)				
Temperature				
Turbidity				
Unknown Toxicity*				

* Unknown toxicity refers to observed aquatic toxicity, the source of which is unknown.

Drinking Water

Drinking water beneficial uses can be impacted by loadings of bromide, nutrients, salinity, organic carbon, turbidity, pathogens, and ~~or~~ changes in pH. Pathogens such as *Cryptosporidium parvum* in source water can adversely affect municipal drinking water supplies and threaten public health. Nutrient loading, and subsequent algae blooms, can impair the taste and odor of municipal water supplies and increase the expense of treating the water. Elevated turbidity due to suspended solids can be responsible for ~~increasinged~~ treatment costs of municipal and industrial water supplies.

A major problem during periods of low Delta outflows is tidal mixing of salt into the Delta channels. Salts are a major concern with regard to municipal drinking water supplies because of the presence in sea water of bromide, which contributes to unwanted disinfection byproducts (DBPs). Salt can result in salty taste, corrosion of appliances, plumbing and industrial facilities, and reduced opportunity for waste water recycling. Salts also are naturally present in freshwater Delta inflows ~~to the Delta due to~~ and can be increased by municipal and agricultural discharges. The most ~~heavily~~ concentrated ~~sources~~ inflow of agricultural drainage to the Delta ~~are from~~ is the San Joaquin River contributing selenium, salts and total organic carbon.

Organic carbon in source water can adversely affect municipal drinking water supplies by combining with water treatment disinfectants to produce harmful by-products (e.g., trihalomethanes). ~~Agricultural drainage is of particular concern to drinking water because the peat soils of the Delta contribute organic carbon to the agricultural drainage water.~~ The peat soils present in the Delta make island agriculture drainage water a source of organic carbon. Delta diversions for municipal supply water purposes occur

Chloride is used as a surrogate parameter for setting standards for Municipal and Industrial users and the same concerns for salinity apply to chloride. Under existing standards (the 1995 Water Quality Control Plan) maximum chloride level is 150 mg/l at urban intakes in the Delta for between 155 and 240 days of the year (depending on the water year type) and 250 mg/l the rest of the year.

Disinfection Byproducts in Treated Drinking Water

THM compounds formed during chlorination of ~~DOC in~~ drinking water ~~contain~~ include chloroform and brominated methanes. Chloroform, when administered at high doses, has been shown to increase the risk of liver and kidney cancer in mice (National Cancer Institute, 1976). The suspected carcinogenic risk to humans from THMs has led some communities to study and change their methods of disinfecting drinking water. THM levels in drinking water can be reduced by using alternatives to chlorination to treat water ~~for human consumption~~ (e.g., ozonation or chloramination)~~;~~ ~~although~~ oOther potentially harmful Disinfection By-Product (DBP) compounds (e.g., bromate) may be formed during these alternative disinfection processes. Disinfection itself is being more carefully regulated by EPA to avoid problems involving various pathogens (e.g., bacteria, viruses, and protozoa). Reducing dissolved organic carbon (DOC) concentrations in raw water ~~before disinfection~~ with flocculation or granular-activated carbon adsorption before disinfection or removal of DBPs after being formed can reduce DBP levels in finished water but may be quite expensive.

~~Chloride and~~ Bromide

Most of the Delta islands are as much as 10 to 15 feet below mean tide level. Tides in the Delta not only threaten the protecting levees, but bring periodic intrusion of seawater, which mixes with the inflowing Delta freshwater. Tidal currents created by the rise and fall of sea levels modify stream flow, particularly when outflows are low or when tides are high (DWR, IDHAMP, 1989). Intruded seawater is a major source of bromide, particularly in the western Delta. Bromide is a naturally occurring salt ion (halogen) of seawater origin and reacts with disinfectants to form brominated DBPs. Thus intrusion profoundly affects Delta water withdrawn at the Contra Costa Water District, SWP and CVP intakes.

~~Chloride is used as a surrogate parameter for setting salinity standards for Municipal and Industrial users and the same concerns for salinity apply to chloride.~~

The presence of bromide in a drinking water source complicates the disinfection process. ~~As with chlorine, b~~Bromide forms THMs in the chlorination process and these brominated THMs are also ~~toxic to human health~~ carcinogenic compounds. Bromide is about twice as heavy as chlorine, and the THM standard is based on weight. Hence it takes fewer molecules of brominated THMs to exceed the drinking water standard, as compared to chloroform. Another method of disinfection, ozone treatment, is also complicated by the presence of bromide because it forms bromate, another undesirable DBP. Bromide contributes substantially to the formation of DBPs in treated drinking water from the Delta. Sources of Bromide in Delta water are

seawater intrusion, San Joaquin River inflow containing agricultural drainage; and, possibly, connate groundwater (i.e., water trapped within sedimentary rocks that is often highly mineralized). It is uncertain whether there are native bromide sources in the San Joaquin Valley, or whether bromide found in the River is a result of concentration of bromides in agricultural irrigation water taken from the Delta and returned to the Delta through the River. Bromide has been measured by the MWQI program since January 1990.

Total and Dissolved Organic Carbon

Organic materials enter the water from the following sources in the Delta: ~~in decreasing order of amounts:~~

- natural materials, vegetation, and organics soils;
- agriculture, as vegetative organics in drainage;
- urban runoff;
- municipal and industrial wastewater discharges;
- ~~pesticides and herbicides.~~

Organic carbon is one of the primary variables that influence the potential for DBP formation. Applicable drinking water standards are based on TOC concentrations; however, most of the available data for the Delta have focused on DOC. In general, most TOC in Delta waters is present in the dissolved form. The most common DBP is THM compounds formed during chlorination of DOC in drinking water supplies. These carcinogenic substances include chloroform and bromoform. MWQI studies have documented that Delta exports contain relatively high concentrations of DOC. Agricultural drainage discharges that contain natural organic matter from decomposing peat soil and crop residues contribute approximately 20 percent of the DOC exports from the Delta (California Department of Water Resources, 1994b). Additionally, DOC is carried into the Delta from upstream inflows. Minimizing DOC concentrations in source waters is a major water quality goal for drinking water uses to meet new EPA regulations for DBPs. Utilities must undertake efforts to control organic carbon in their source water if TOC exceeds 2 mg/l at the water intake or to modify disinfection methods.

Dissolved Oxygen

Dissolved oxygen (DO) concentrations serve as indicators of the balance between sources of oxygen (e.g., aeration and photosynthesis) and oxygen consumption (through decay and respiration processes). The capacity of water to hold dissolved oxygen decreases with increasing temperature. DO concentrations and often varyies with the cycle of daily photosynthetic activity of algae and plants. Historically, significantly reduced DO concentrations in Delta channels ~~are not generally considered a problem~~ have not occurred, except occasionally in the waterways ~~around~~ near Stockton and in some dead-end sloughs. Water with high biological oxygen demands (BOD) may have decreased levels of DO when wastes are discharged into them.

Nutrients

Nitrogen and phosphorous are the two nutrients which most often limit algal growt at low concentrations and trigger algal growth at elevated concentrations. Generally, in the presence of sufficient light and elevated temperatures, algal productivi increases as nutrient concentrations increas