CONTRA COSTA
WATER DISTRICT

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R41-9

June 2, 1997

Mr. Clifford L. Bowen, P.E.
District Engineer
San Francisco District
Division of Drinking Water and
Environmental Management
Department of Health Services
2151 Berkeley Way
Berkeley, CA 94704-1011

**Subject: Sanitary Survey of the Contra Costa Canal
Contra Costa Water District, System No. 0710003**

Dear Mr. Bowen:

This letter is to cover the transmittal of the Contra Costa Water District's final Sanitary Survey of the Contra Costa Canal.

After several revisions by our Water Quality staff in communication with Peter Zhou of your staff, we believe the survey adequately addresses the subjects raised in previous reviews. As this is the first of what will be an ongoing, periodic review, we will continue to seek additional information on existing areas of potential concern and to identify new issues as they arise with regard to our source water quality.

If you have any questions or comments, please contact Larry McCollum, Water Quality Superintendent, at (510) 688-8127.

Sincerely,

Walter J. Bishop

Walter J. Bishop

WJB:EWC:LJM:ljm
Attachment

cc: Larry McCollum

R41-h

SANITARY SURVEY OF THE CONTRA COSTA CANAL

REPORT TO THE DEPARTMENT OF HEALTH SERVICES

MAY 30, 1997

Water Quality Section

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Peter Martin, Operations
Richard Denton, Water Resources Planning

TECHNICAL ASSISTANCE

Elaine M. Archibald, Archibald and Wallberg Consultants

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CHAPTER 1. INTRODUCTION

1.1 Sanitary Survey Requirements

The California Surface Water Treatment Rule (SWTR) requires that all surface water suppliers conduct a sanitary survey of their watershed(s) at least every five years, with the first to be completed by January 1, 1996. A report of the survey is to be submitted within sixty days of completion to the Department of Health Services (DOHS) (CCR Title 22. §64665.). The sanitary survey is also required under the Total Coliform Rule (TCR), 40 CFR Parts 141 and 142, Federal Register, Vol. 54, No. 124, June 29, 1989, Section 141.21 (d).

1.2 Sanitary Survey Goal and Objectives

The goal of the sanitary survey is to protect water quality for current and future supplies.
The objectives to meet that goal include:

- To satisfy the SWTR and TCR requirements and ensure CCWD meets all applicable laws and regulations.
- To support CCWD's mission statement to provide high quality water.
- To protect and defend CCWD's interest in the Delta's integrity, by example, through actively pursuing and implementing programs that protect water quality at home.
- To identify and address potential adverse impacts to the watershed and its receiving waters.

1.3 Conduct of the Survey

The sanitary survey was conducted by in-house staff from the Water Quality Section and Planning Department at CCWD. Archibald & Wallberg Consultants was retained to provide technical assistance. A Quality Review group was organized from in-house staff that consisted of Edward W. Cummings, Operations; Manu Ankhad, Facility Planning; Gary Palhegyi, Facility Planning; Scott Rovanpera, Water Quality; Peter Martin, Operations; and Richard Denton, Water Resources Planning. Periodic meetings were held with the Department of Health Services to provide guidance.

1.4 Report Organization

Chapter 1 ....Introduction

Chapter 2 ....Watershed and Water Supply System

Chapter 3 .... Potential Contaminant Sources

Chapter 4 ....Watershed Control and Management Practices

Chapter 5 ....Water Quality

Chapter 6 ....Conclusions and Recommendations

CHAPTER 2. WATERSHED AND WATER SUPPLY SYSTEM

2.1 Watershed

The watershed survey area for this study was based on discussions with the California Department of Health Services (DOHS). It is presented in Figure 2-1 which shows major features of importance to the sanitary survey. The study area extends from Suisun City in the north-west corner to Rio Vista in the north-east corner (the North-shore zone), and south through the Delta along Old River to south of Highway 4 near Discovery Bay (the Delta zone). The western boundary is defined by I-680, from Suisun City to the City of Martinez. The southern boundary is limited to drainage areas that contribute runoff into the Contra Costa Canal (Canal), and to those municipal/industrial sites that contribute National Pollution Discharge Elimination System (NPDES) permitted discharges directly to the Bay-Delta (the South-shore zone). Storm drainage actually comes from as far away as Orinda and Danville. This area may be included in future up-dates to the sanitary survey as recommended by DOHS.

The following sections contain a general description of land use, the natural setting, and hydrology of the survey area.

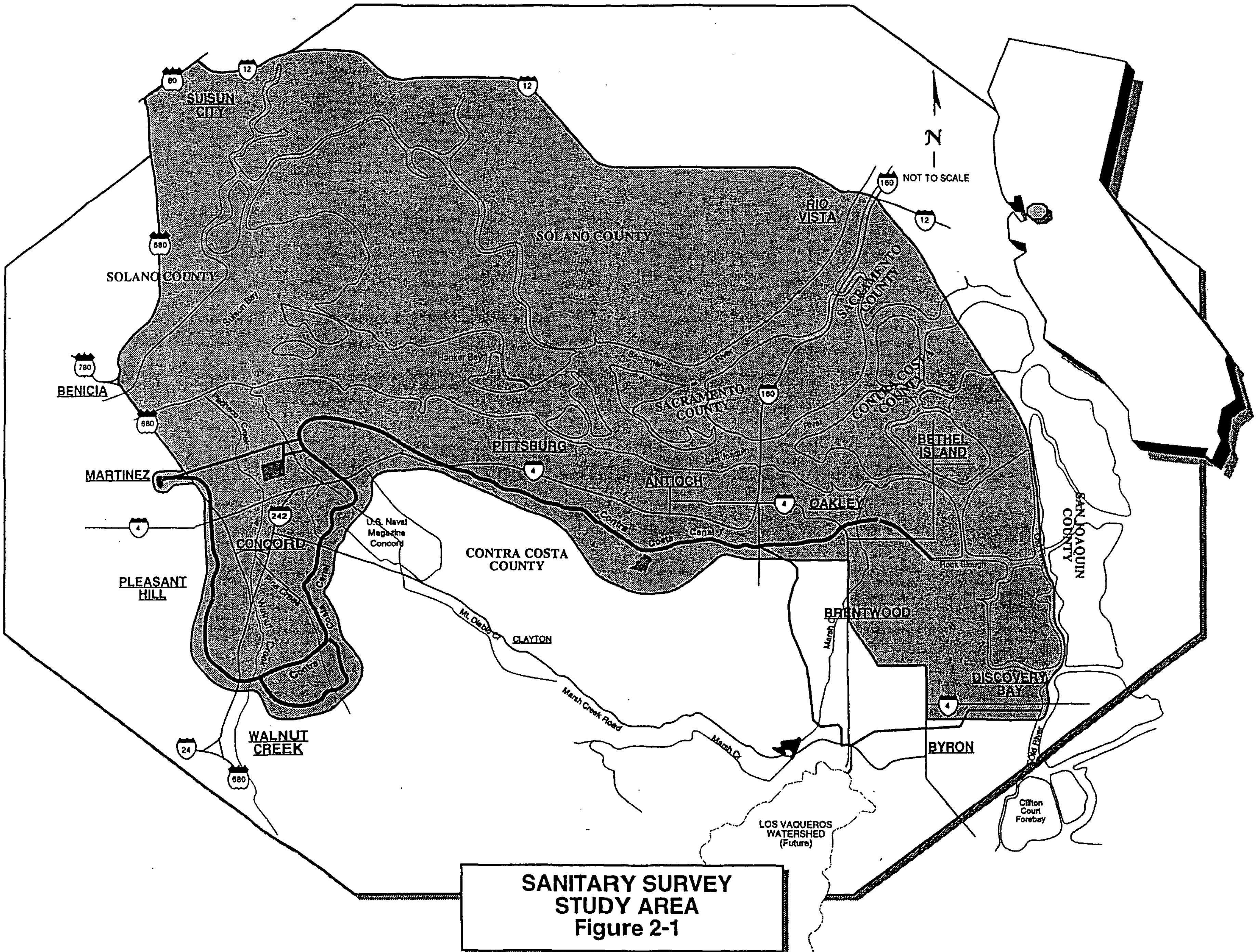
2.1.1 Land Use

The major land uses in the survey area are agricultural, industrial, municipal, and recreational. Land uses in the survey area are roughly depicted in Figure 2-2.

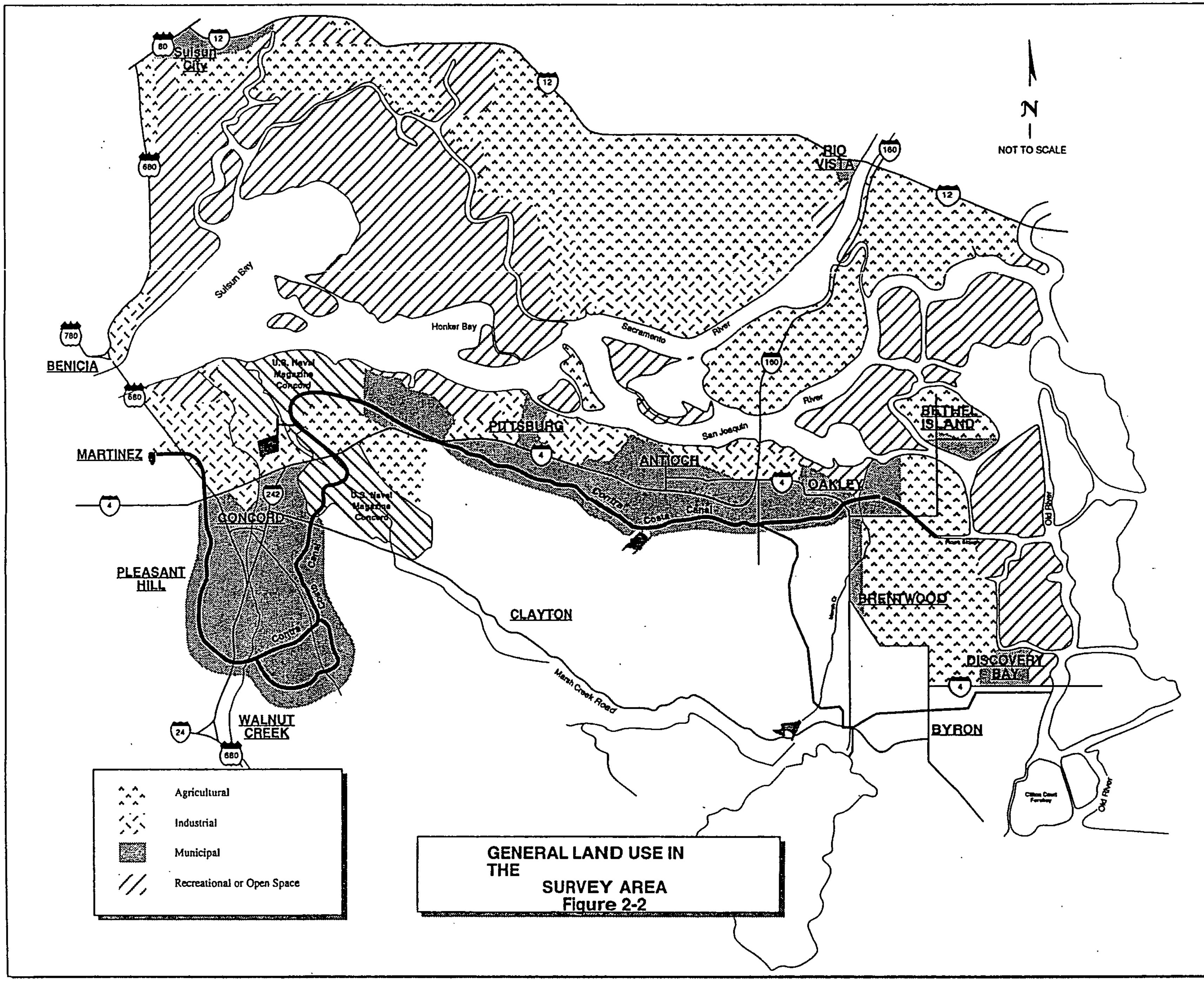
2.1.1.1 Agricultural

Agriculture ranging from dry land crops to grazing animals is concentrated in the North-shore and Delta zones. The levee system which created and protects the Delta islands was originally built to reclaim the land for agricultural uses. Crops are grown on the coastal flood plain and in alluvial valley floors. Cattle graze mostly along the grassy foot-hills of the Diablo Mountain Range and the low hills above the flood plain in the North-shore zone..

South of Highway 12, in the 28,000 acre Collinsville-Montezuma Hills Planning Area, dry land farming of wheat, barley, and oats, along with rotational sheep farming predominate. The fringe around Suisun Marsh supports forage crops in a manner that is compatible with the marsh environment. Sixty three percent of the County's agriculture, watershed, and marsh lands have been placed in preserves under the Land Conservation Act, that limits the use to prevent unnecessary conversion to urban uses.



SANITARY SURVEY STUDY AREA
Figure 2-1



GENERAL LAND USE IN THE SURVEY AREA
Figure 2-2

According to the Sacramento County's General Plan, both Twitchell Island and Brannan Island are designated as Agricultural Crop Land. Sherman Island (and the small islands west of Sherman Island) are designated as Agricultural Crop Land and as a Resource Conservation Area. According to the Delta Plan, major crops grown on these islands consist of field crops, such as corn, safflower, beets, and sorghum. Grain and hay crops are also grown on Sherman Island. According to the Department of Water Resources, about 10% of the agriculture in this area includes uncropped land and about 10% remains as native land -- riparian and grassy vegetation (DWR, 1993).

A large majority of the agriculture land in this area is preserved under the Williamson Act. The Williamson Act encourages the continued agricultural use of these lands by using tax assessments to match the land use. The majority of this area is also within the 100 year flood plain as defined by the Federal Emergency Management Agency (FEMA). Development in these areas is limited to low-intensity uses in support of the agriculture or recreational activities.

According to Contra Costa County's General Plan, Webb Tract, Bradford Island, and Jersey Island are defined as Delta Recreation and Resources, as well as containing important agriculture land to the County. Holland Tract, Palm Tract, Veale Tract, and Orwood Tract are also defined as containing important agriculture land. Overall, agriculture acreage has remained about the same since 1980. The General Plan indicates that field crops, such as hay, barley, and wheat; and orchards have declined, while pasture and vegetable crops have increased. The reduction in field crops and orchards has been attributed to urbanization of the County.

2.1.1.2 Industrial

Industrial activity is primarily found along the river front of the South-shore zone and the west end of the North-shore zone just north of the Martinez-Benicia Bridge. Refineries, chemical production facilities, steel and paper mills, electrical power plants have all developed along the river where a ready source of water is located for production use and waste disposal. A compilation of the industries with NPDES permits in the survey area can be found in Appendix A-1.

2.1.1.3 Municipal

Municipal use is most heavily concentrated in the South-shore zone. The area with the projection for greatest growth is in the eastern Contra Costa County area of the Delta zone from Antioch to Brentwood. This area is projected to increase by greater than 50,000 people (ABAG, 1993) in the next ten years, converting many acres of agricultural land to residential housing (see section 3.3). The most significant municipalities in the survey area are listed with their current population estimates in Table 2-1.

Table 2-1 **Municipal Populations in the Survey Area- 1995**

Major Municipalities	Population	Major Municipalities	Population
Antioch	75,000	Martinez	36,000
Bay Point	19,000	Oakley	23,000
Bethel Island	2,200	Pittsburg	52,000
Brentwood	12,000	Pleasant Hill	32,000
Clayton	9,000	Rio Vista*	3,800
Concord	114,000	Suisun City*	26,000
Discovery Bay	7,000	Walnut Creek	63,000

Sources: Phone conversation, Linda Molton, CC County Demographer &
* Ca State Dept. of Finance Population and Housing Estimates Jan. 1995

Generally, commercial areas are made up of office parks and business strips along the major thoroughfares of I-680, Route 242, and Highway 4, as well as in central business districts along with smaller neighborhood centers scattered throughout the area.

2.1.1.4 Recreational

Recreation can mean sitting in a duck blind in the Suisun Marsh or the sloughs of the Delta. It can also mean blasting along hanging on by the tips of your fingers and toes to a sailboard in the slot on the Sacramento River north of Sherman Island. Recreation is big business in the region.

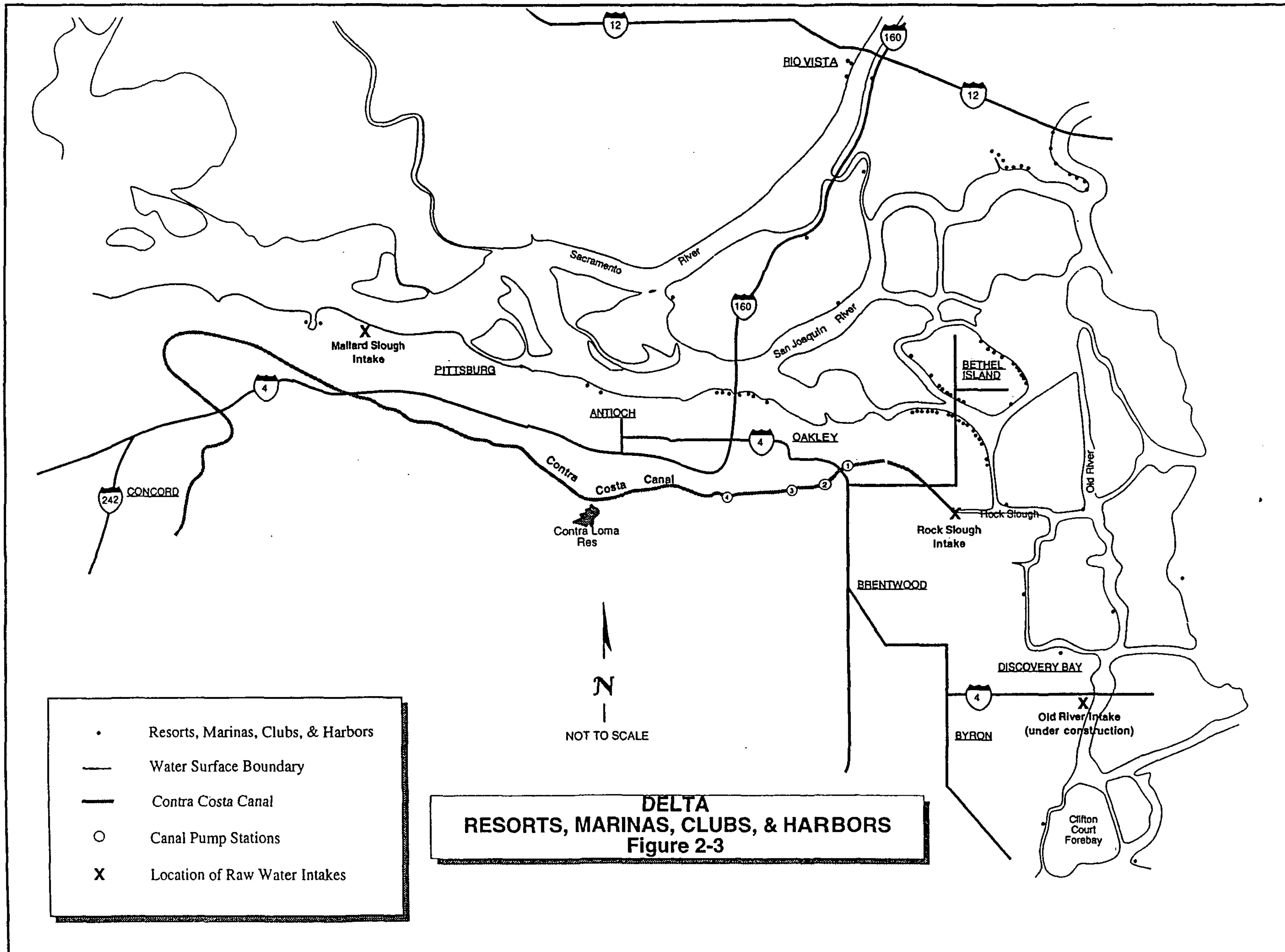
There are dozens of small private and municipal marinas in the survey area, most are concentrated in the Delta zone. Table 2-2 lists the marinas, resorts, clubs and harbors in the Delta and within the study area. About 70 marinas, harbors, etc., have been identified. Also presented in the table are various specifics about each facility, including boat rentals, launching, repair, storage, docks, fuel & oil, pump out station, overnight camping, food, and supplies. These characteristics indicate a potential for water pollution. Figure 2-2 shows the approximate location of these facilities. The majority of these facilities are concentrated in three general locations: between Antioch and Oakley, around and near Bethel Island, and near Highway 12.

Table 2-2 Resorts, Marinas, Clubs and Harbors in the Delta Area

	Resorts, Marinas, Clubs & Harbors	Boat Rentals	Boat Launching	Boat & Motor Repair	Dry Dock	Docks - day or night	Gas & Oil	Diesel Fuel	Pump-Out Station	Camping / RV Sites	Restrooms / Showers	Restaurant	Marine Supplies
1	Anchor Marina			1		1	1	1		1	1	1	1
2	Angel's Yacht Harbor												
3	Ann & Chuck's Boat Harbor		1				1						
4	Antioch Marina					1	1	1	1		1		
5	Beacon Harbor						1						
6	Bean Pot Resort											1	
7	Bentley's Marina						1		1	1	1		
8	Bethyl Harbor		1	1	1		1			1	1		
9	Big Break Marina		1	1			1				1		1
10	Boyd's Harbor					1				1	1	1	
11	Bruno's Harbor		1	1	1	1					1		
12	Bull Frog Landing & Marina	1		1			1						1
13	Carol's Harbor	1	1								1	1	
14	Cruiser Haven					1	1				1		1
15	Del's Boat Harbor	1	1			1	1				1		
16	Delta Bay Club	1				1				1	1		
17	Delta Marina Yacht Harbor		1	1	1	1	1	1	1	1	1	1	1
18	Delta Resort	1	1			1				1	1	1	
19	Delta Sportsman												1
20	Delta Isle												
21	Discovery Bay Yacht Harbor		1			1	1	1	1		1	1	1
22	Dock Mirza's Marina												
23	Driftwood Marina						1						
24	Duck Island RV Park									1			
25	Eddo's Boat Harbor		1	1		1	1			1	1		
26	Edgewater Harbor												
27	Farrar Park Harbor			1	1								
28	Frank's Marina					1	1			1	1	1	
29	Gemini Marina												
30	Greg's Motel & Harbor												
31	Happy Harbor					1					1	1	
32	Harris Marina												
33	Hennis Marina		1	1		1					1		1
34	Holland Riverside Marina		1	1		1	1		1				
35	Korth's Pirates Lair	1	1			1	1				1		

Table 2-2 Resorts, Marinas, Clubs and Harbors in the Delta Area (cont.)

	Resorts, Marinas, Clubs & Harbors	Boat Rentals	Boat Launching	Boat & Motor Repair	Dry Dock	Docks - day or night	Gas & Oil	Diesel Fuel	Pump-Out Station	Camping / RV Sites	Restrooms / Showers	Restaurant	Marine Supplies
36	Lauritzen Yacht Harbor		1		1	1					1		
37	Lazy M Marina		1			1	1				1		
38	Leisure Landing Marina					1	1				1		
39	Lighthouse Restaurant					1	1					1	
40	Lindquist Landing										1		
41	Lloyd's Holiday Harbor	1		1	1		1						
42	Marine Emporium			1	1								1
43	Martin's Sherman Lake Marina	1	1			1	1			1	1		
44	Moores Riverboat			1	1	1					1	1	
45	Mozzetti Marine			1									
46	New Bridge Marina						1	1					
47	Orwood Resort		1			1	1			1	1	1	1
48	Outrigger Marina					1	1			1	1	1	
49	Park Marina												
50	Perry's Boat Harbor			1	1		1		1				
51	Point Restaurant										1	1	
52	Prince Harbor												
53	Rancho Marina		1			1				1	1		
54	Richard's Marina												
55	Rivers Harbor												
56	Riverview Lodge											1	
57	Russo's Marina		1			1	1			1	1		
58	S&H Boat Harbor			1	1								
59	Sam's Harbor					1	1				1	1	1
60	San Joaquin Yacht Harbor												
61	Sea Horse Marina												
62	Seven Bells Harbor												
63	Spindrift Marina												
64	Sugar Barge Marina									1	1		
65	Summit Marine			1	1		1	1					1
66	Viking Harbor												
67	Willow Berm Boat Harbor						1	1					
68	Willow Park Marina												
69	Woods Yacht Harbor												



DELTA
RESORTS, MARINAS, CLUBS, & HARBORS
Figure 2-3

The State, County, and East Bay Regional Park District parks and open space, along with the waters of the Delta, provide ample opportunities for fishing, hunting, sailing, power boating, swimming, skiing, hiking, and camping. The park at CCWD's Contra Loma Reservoir is located in the City of Antioch, adjacent to Pittsburg and south of the Canal. The reservoir covers 80 acres and allows swimming, boating, and fishing. Picnicking, hiking, biking, and horseback riding are part of the recreational activities in the park.

According to Contra Costa County's General Plan, Webb Tract, Bradford Island, Jersey Island, Holland Tract, Palm Tract, Veale Tract, and Orwood Tract are all limited to low-intensity uses in support of agriculture or recreational activities. Appropriate uses specified in the General Plan include marinas, shooting ranges, hunting clubs, camping, and other outdoor recreation.

The Suisun Marsh is one of the few remaining major marshes remaining in California. It consists of 58,600 acres of marsh, managed wetland, and adjacent grasslands, plus 29,500 acres of bays and waterways. There is an additional buffer zone consisting of 27,900 acres of varying land types. About 70% of the managed wetlands are privately owned by more than 150 duck clubs. (DWR, 1990)

2.1.2 Natural Setting

The following is a brief summary of the Survey area's natural characteristics.

2.1.2.1 Topography

The survey area centers on two major rivers, the Sacramento flowing from the north and the San Joaquin flowing from the south, that combine to form the vast Delta region. Continuing westward through Suisun Bay, under the Martinez-Benicia Bridge into the Carquinez Straits, the flows eventually make it to San Francisco Bay and, ultimately, the Pacific Ocean.

From the water's edge numerous sloughs and marshes rise slightly to level alluvial flood plains and eventually into the foothills of the north in Solano County and the Diablo Mountain Range to the south and west in Contra Costa County. Within the Delta zone much of the dry land consists of islands below water level, reclaimed from the Delta by a maze of levees used to hold back the water's of the Delta.

The Diablo Mountain Range within the study area consists of smooth rolling hills in the central and northern portions of Contra Costa County, south of Highway 4, to fairly rugged mountains along Marsh Creek Road.

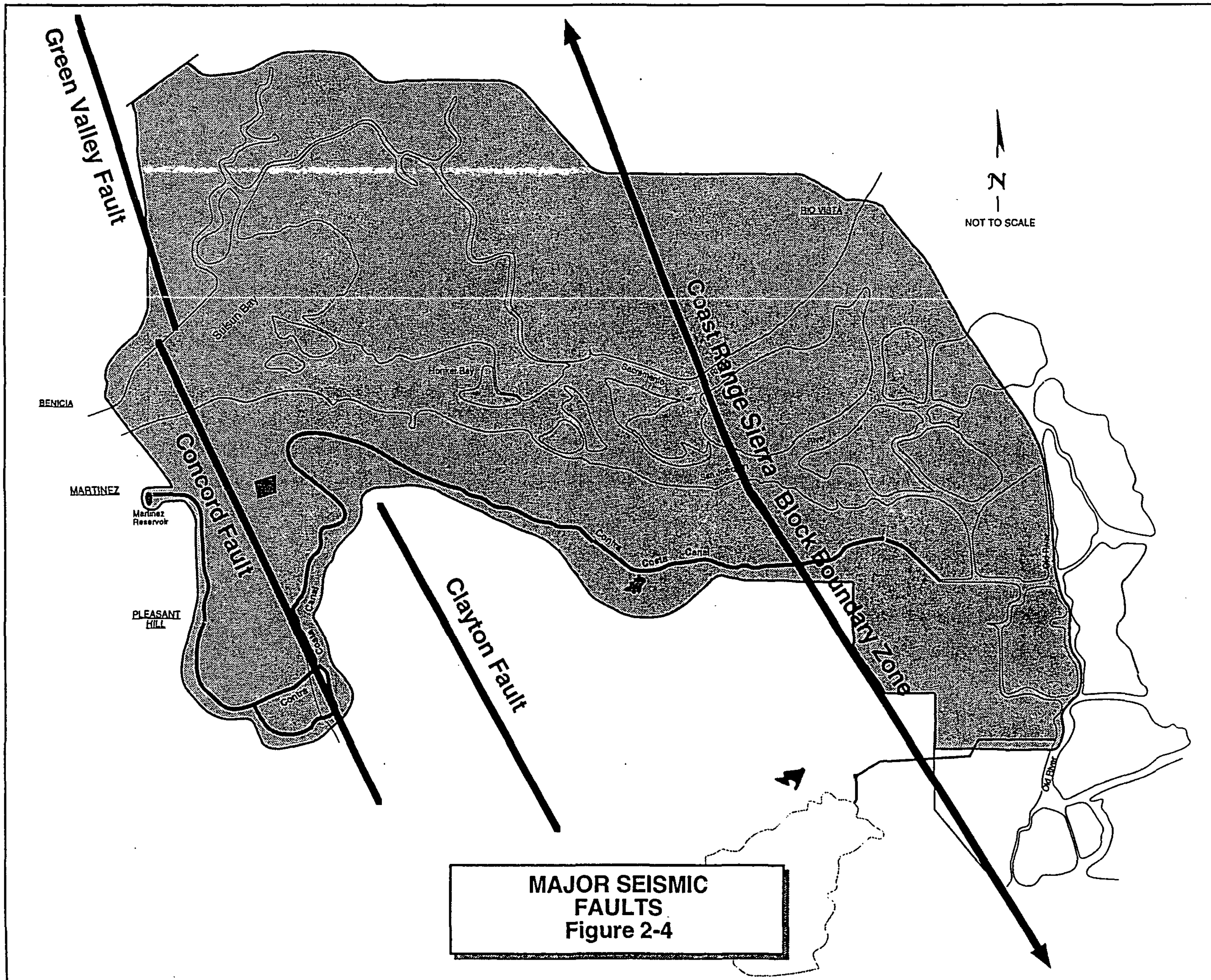
2.1.2.2 Geology and Soils

The underlying geology of the Bay-Delta region contains several active seismic faults that can have an affect on the survey area (Figure 2-4). The alluvium that makes up most of the Delta islands and lower lying areas of the survey area may be prone to severe liquefaction potential (Figure 2-5), due to the shallow groundwater table and unconsolidated nature of the soils, if an earthquake of appropriate magnitude were to center on one of the faults that traverse the survey area; such as the Concord or Greenvalley Faults or the Coast Range Sierra Block Boundary Zone.

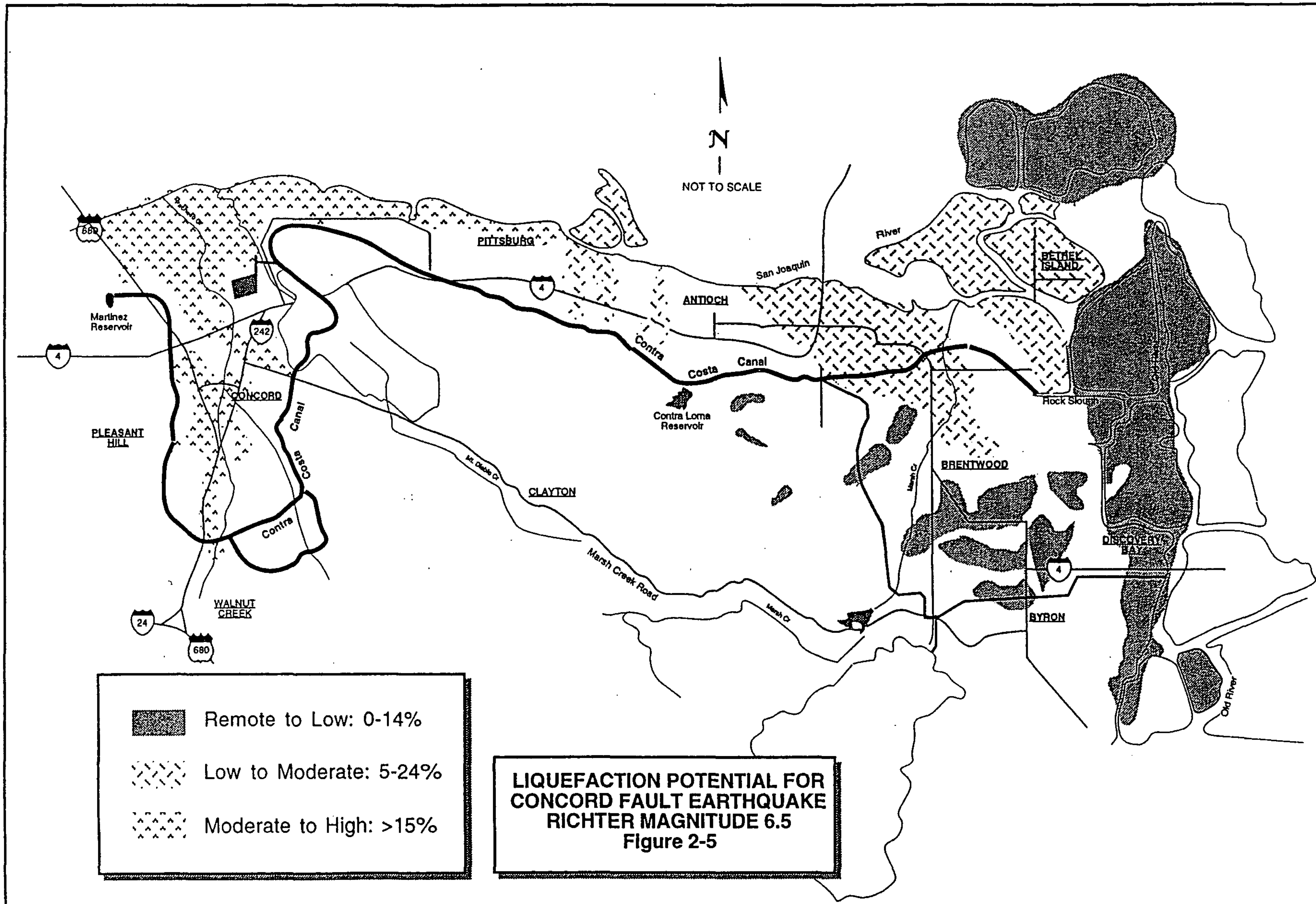
The area with the greatest risk of landslides occurring is in the steeply sloped hills along Marsh Creek Road through Clayton. There is historical evidence of landslide activity in this area (Contra Costa County, 1991). Similarly many of the soils in the hillside areas are prone to slippage. The magnitude of the slippage is greatly increased when the soils are saturated with water, as in the winter rainy period, and those areas of steeper slopes. Figure 2-6 depicts the areas of potential landslide hazards within CCWD.

Hill areas underlain by hard bedrock have low potential for damage from seismic activity (Contra Costa County, 1991). Scattered sandstone and limestone outcrops occur along ridges and steep canyon slopes. Two major rock quarries operate at the base of Mt. Diablo near the borders of Concord and Clayton.

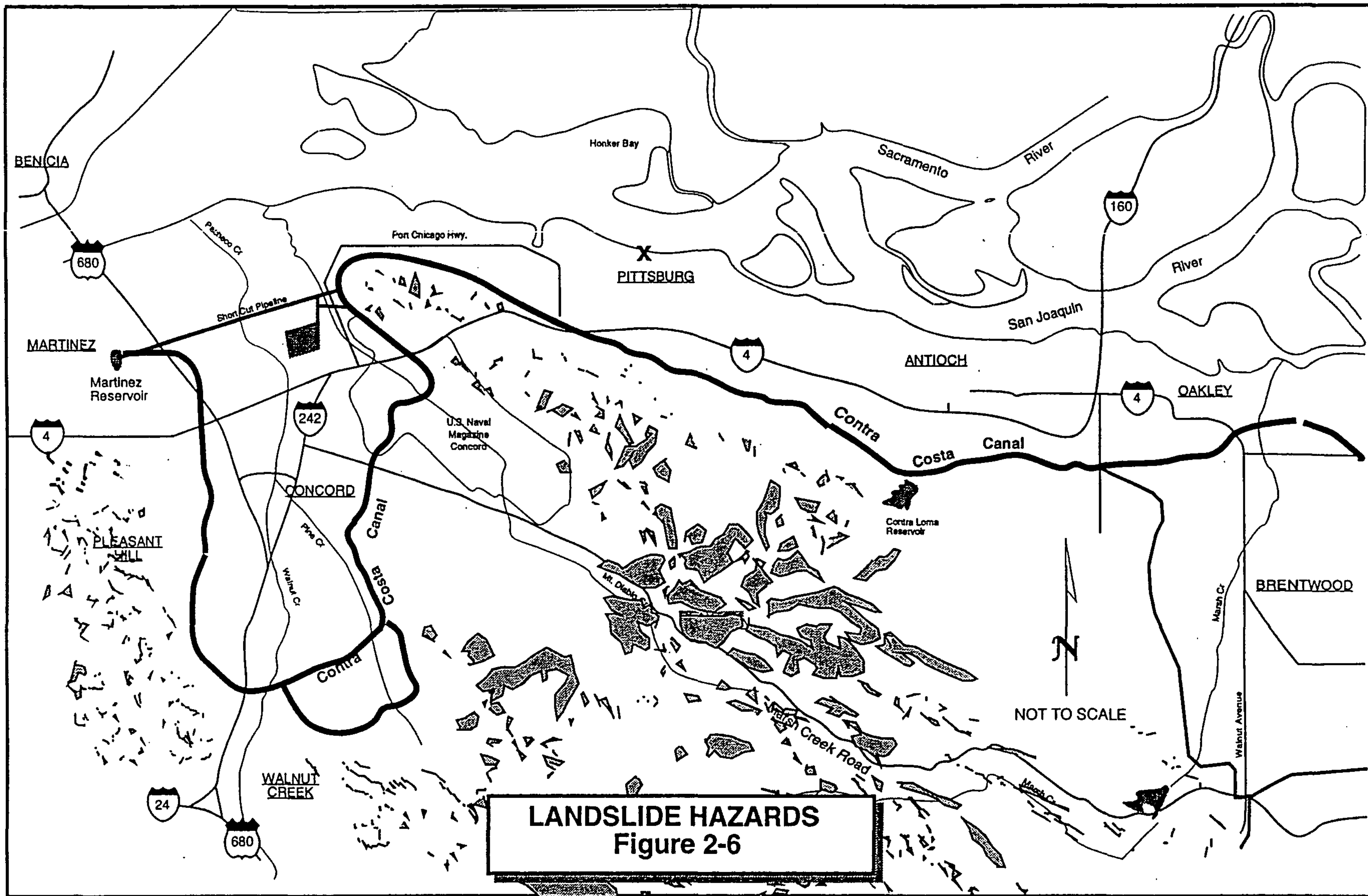
Much of the gentler rolling hillsides and uplands consist of well drained soils while the valley bottoms are generally flat or gently sloping with alkali soils on thick alluvium. The soils of these valley bottoms are poorly drained because of their high clay content and flat topography.



MAJOR SEISMIC FAULTS
Figure 2-4



LIQUEFACTION POTENTIAL FOR CONCORD FAULT EARTHQUAKE RICHTER MAGNITUDE 6.5
Figure 2-5



LANDSLIDE HAZARDS
Figure 2-6

2.1.2.3 Vegetation

The survey area is located in a zone of biogeographical transition between coastal and interior habitats: wetland marshes, lowland grasslands, and higher elevation woodland and chaparral habitats, and southern and northern elements of the Coast Ranges flora.

The undeveloped portions of the North-shore area and the foothills around the base of Mt. Diablo support may of the plant communities that typified vast acreage of the Sacramento-San Joaquin Valleys before they were converted to agricultural and urban uses. The Antioch Dunes area are a relic example of a historically widespread dune community that was probably scattered throughout the Delta region.

The hillsides and uplands include well drained soils that support oak woodlands and annual grasslands, mostly composed of introduced grass species that have displaced the native perennial bunch grasses, especially in the areas of heavy grazing.

Valley bottoms typically support a mosaic of seasonal alkali wetland communities in the low lying areas. Annual grassland fringe the alkali wetlands and typically occupy higher, well-drained soil inclusions in the valley bottom. Valley bottoms are traversed by meandering, deeply incised intermittent creeks that have narrow strands of marsh vegetation in the channels and occasional willow or cottonwood trees or small riparian woodlands along the creek banks.
(CCWD, 1992)

The intermittent creeks may empty into the marshes of the Delta which open into sloughs and wider waterways lined by aquatic macrophytes, thickets of wild berries along the levees, and stands of riparian trees and shrubs. Introduced aquatic plants such as hyacinth and Elodea can multiply in the warmer seasons to such an extent that major channels and diversion facilities, such as the CCWD Rock Slough intake become choked, constricting water flows and vessel traffic.

The Suisun Marsh has macrophytes typical of the more brackish estuarine waters found in this area. Several of these species are important natural food plants which support the resident and migratory waterfowl. Twelve rare or endangered plant species, most of which are associated with freshwater marshes, can be found in the Delta.(DWR, 1990)

2.1.2.4 Wildlife

The Delta and surrounding environs are home to a number of resident populations of various species of birds, fish and mammals as well as seasonal populations of transitory birds and fish. The condition of these populations can be used as indicators of the health of the entire system as recognized by such yardsticks as the Striped Bass Index, winter run salmon counts, Delta smelt, and the annual Audubon Bird Survey.

The Delta serves as a migratory route and nursery area for Chinook salmon, striped bass, sturgeon, American shad and steelhead trout. The brackish estuarine waters of the Suisun Marsh are an important nursery for striped bass. Numerous resident warmwater fish include catfish, sunfish, and minnows.

The Delta also supports many animals and birds in the riparian and upland habitats. Approximately 20 percent of the pheasant population taken by California hunters each year are contributed by the Delta region. The area also serves as a feeding and resting area for millions of ducks, geese, swans and other migrant waterfowl. As many as 25 percent of California's wintering waterfowl inhabit the Suisun Marsh in dry winters.

A complete list of Delta plant and animal species is contained in *Sacramento/San Joaquin Delta Wildlife Habitat Protection and Restoration Plan,* California DFG and U.S. Fish and Wildlife Service, December 1980.(DWR, 1990)

2.1.3 Existing Hydrology

CCWD's service area is generally warm Mediterranean climate, with dry summers and cool and wet winters. The northern portion of the study area usually has high winds that blow from the west or east depending on weather conditions. Winds speeds measured at Pittsburg are high with infrequent periods of calm conditions. The eastern portion of the study area also has relatively strong and frequent winds.

Average annual precipitation ranges from 13.34 inches in Antioch to 18.36 inches in Walnut Creek. The differences reflect proximity to the coast as well as topography. Table 3-1 presents the average area wide storm event characteristics. Approximately 85% of the annual rainfall occurs between October through March, with an average intensity of 0.048 inches per hour, and a total storm volume of 0.59 inches (WCC, 1989).

Table 2-3 Average Storm Event Characteristics

Number of Storms (per year)	Annual Volume (inches/year)	Event Duration (hours)	Event Intensity (inches/hour)	Event Volume (inches)
28	16.7	13.7	.048	.59

MOVEMENT OF WATER IN THE DELTA

Introduction. This section describes the movement of water in and around the delta. Numbers are provided for minimum, maximum, and mean flows for the Sacramento River near Chipps Island, in Rock Slough near the Contra Costa Canal, and in Old River south of Highway 4 (Table 2-4). Table 2-4 also provides the corresponding stage and velocity.

This section describes the flow and stage data provided in Table 2-4, as well as the conditions that affect the flow characteristics of the Delta. It attempts to explain the complexity of flow in the Delta and the variability of dilution factor in Delta channels. Flow in a Delta channel depends on uncontrolled runoffs into the Delta, releases from upstream reservoirs, state and federal project exports, in-Delta diversions, gate operation of the Delta Cross Channel, tidal pumping at Three Mile Slough, and varies significantly over the daily tidal cycle and spring and neap tidal cycle.

Dilution factors in a Delta channel cannot be determined simply from the direction and magnitude of the mean flow. Flows in the Delta are dominated by tidal action and vary throughout the day, month, and year. Flows in the individual Delta channels depend on a network of channel flows and boundary conditions (e.g., incoming flow, outgoing flow, exports). The maximum flow in one direction during a tidal cycle is usually a few times that of the mean flow.

Any discharge into the Delta will be dispersed by this tidal action and in most cases will spill into neighboring channels before the tide reverses. In the case when fresh water flows are high, tidal flows in channels are mixed with incoming fresh water, changing the dispersion characteristics. The actual dispersion pattern depends not only on the time in the tide and hydrologic conditions at the time, but also depends on the exact location in the tidal cycle of release. Dilution factor estimates would also vary accordingly. A sophisticated numerical model would be needed to determine the dilution ratio to an adequate accuracy for each specific circumstance.

Water Level and Flow. Water levels vary greatly during each tidal cycle, from less than 1 foot on the San Joaquin River near interstate 5 to more than 5 feet near Pittsburg. Water levels in Rock Slough vary by about 3.5 feet and by 3 feet in Old River (Table 2-4).

Typical summer time tides can vary from 330,000 cfs upstream to 340,000 cfs downstream. Net summer time Delta outflows are very small and typically range from 5,000 to 10,000 cfs (DWR 1993). Table 2-4 shows Delta flows near Chipps Island ranging from 340,000 cfs upstream to 360,000 cfs downstream under the given Delta conditions.

Table 2-4 Typical Tidal Variations for 19 Year Mean Tide

	Mean Width	Mean Depth	Stage (feet)			Flow (cfs)			Velocity (fps)		
			min	max	mean	min	max	mean	min	max	mean
Sacramento	3,332	29.2	1.2	6.1	3.6	-360,000	340,000	2,700	-3.1	3.2	0.1
Rock Slough	177	7.6	1.8	5.5	3.6	-490	-120	-300	-0.5	-0.1	-0.2
Old River	365	17.4	1.8	5.1	3.4	-19,000	4,400	-7,900	-2.8	0.7	-1.2

Stage is relative to mean lower low water (MLLW) in Carquinez Strait. Positive flow is to the west in Sacramento River, to the east in Rock Slough, and to the north in Old River. Numbers are from a numerical simulation using version 10 of the Fisher Delta Model. Total Delta inflows are 16,400 cfs. Total exports are 10,600 cfs. Diversion in the Delta total 3,800 and agricultural return flow totals 1,000 cfs. District diversion at Rock Slough totals 300 cfs.

The Source of Water. Water moves into the Delta from four major sources. Tidal water moves in from the west from Suisun Bay. Fresh water moves in from the north by the Sacramento River, from the south by the San Joaquin River, and to a lesser extent, from the east by the Cosumnes, Mokelumne, Stanislaus, Tuolumne, and Merced Rivers. The fresh water flows are important because they provide the net Delta outflow that limits salinity intrusion into the Delta. The tide movement creates a five to eight mile back and fourth movement of water in the western part of the Delta twice each day. About 85 percent of the fresh water flow comes from the Sacramento River, about 10 percent comes from the San Joaquin River, and the remaining 5 percent from the east side streams (CUWA 1993).

Reverse Flows From Exports. The large export pumps at the south end of the Delta (the Tracy Pumping Plant, South Bay PP and Harvey O. Banks PP) can cause water to flow south in the southern Delta. DWR uses the term reverse flows to describe upstream flows in the lower San Joaquin River near Jersey Island. Other experts do not agree with this theory. Most agree however, that localized flow at the southern end of the Delta does move toward these pumping plants during large exports.

Delta Cross Channel. The Delta Cross Channel connects the Sacramento River to the San Joaquin River via the Mokelumne River in the north Delta. The cross channel was built many years ago by the Federal government to allow Sacramento River water to flow to the south Delta export pumping plants. When the Cross Channel gates are open about 40% of the Sacramento River flows are diverted to the lower San Joaquin River (includes flow through Georgiana Slough). When the gates are closed, about 20% of the Sacramento River is diverted to the lower San Joaquin River via Georgiana Slough alone. When the gates are closed, reverse flows are intensified (CUWA 1993).

Tidal Pumping Through Three Mile Slough. Three Mile Slough is the upstream boundary of Sherman Island. Water flows from the Sacramento River to the lower San Joaquin River via Three Mile Slough. This occurs by a phenomenon call "tidal pumping". As the tide moves up the Sacramento River and the San Joaquin River simultaneously, the higher water level of the tide reaches the Sacramento side of Three Mile Slough first, thus causing Sacramento River water to flow south to the San Joaquin. This tidal pumping is thought to reduce the effects of reverse flows and prevent salinity increases in the lower San Joaquin River. Flow through Three Mile Slough on the flood tide does not flow at the same rate as it does on the ebb tide. Generally, there is a net flow from the Sacramento to the lower San Joaquin River. The actual flow varies with the conditions of the Delta, but, is on the order of 2,000 cfs. The effects of tidal pumping would also reduce the potential impacts of discharges west of Three Mile Slough on the District's Rock Slough and Old River intakes (CUWA 1993).

Dispersion. Considering the dominate back and forth movement of tidal flows and the much smaller downstream fresh water flows, a discharge would tend to disperse almost uniformly upstream and downstream over time forming the common bell shaped curve with higher concentrations in the center and decreasing concentration tails upstream and downstream. Studies have suggested that longitudinal dispersion can be more significant than net Delta outflow from fresh water and also more significant than reverse flows from exports (CUWA 1993). As the flow conditions become more complex and the tide becomes less dominate, the dispersion characteristics will change accordingly. Under high Delta outflow conditions, dispersion will be greater downstream than upstream.

Lunar Tidal Cycle. In addition to the twice daily tidal cycle, there is another tidal cycle called the Lunar Cycle. Approximately every 14 days, on the full moon and again on the new moon, the gravitational pull of the sun and the moon reinforce each other and cause stronger tides. About midway between the full moon and new moon, the gravitational force of the sun and moon cancel each other causing weaker tides. These are referred to the spring and neap tides, respectively.

In the Delta, the spring tides are as much as 1 foot higher than the water depths during the neap tides. In other words, the Delta is filling every seven days on the spring tide and draining the following seven days on neap tide. About 50,000 acre-feet of water moves into the Delta on spring tides and 50,000 more moves out on neap tides. Spring and neap tides will decrease or increase local channel flows accordingly (CUWA 1993).

Summary. The sections above attempts to describe how complex the flow conditions are in the Delta channels. Numbers are provided to show the relative magnitude and directions of flows. However, if a spill or discharge were to occur in the Delta, the direction and extent of movement, and dilution, depends on each of the factors described above; the time of day, the day of the month, and the time of year. It would also depend on how much water is being released from upstream storage reservoirs, how much is being exported from south Delta pumping plants, on uncontrolled runoff and if the Delta Cross Channel is open or closed.

A sophisticated numerical model must be used to adequately address how discharges or spills would impact the District's intakes. The District currently uses the Fisher Delta Model to analyze flows in the Delta and predict salinity concentrations within the Delta channels. A study of the impacts from discharges identified in this Sanitary Survey will be proposed to the District for future up-dates to the Sanitary Survey.

Agricultural Drainage. A report published by the DWR, titled Estimation of Delta Island Diversions and Return Flows, describes a computer model (DICU) used to estimate agricultural diversions and return flows. This information is then used in other Bay-Delta hydrodynamic models. DICU refers to Delta Island Consumptive Use model and consist of the physical processes of farming. These processes include precipitation, seepage, evapotranspiration, irrigation practices, soil moisture, leach water application and drainage, and surface runoff.

There are approximately 1,800 agricultural diversions and 232 return flow sites in the Delta (see Maps DWR 1993). During the peak summer irrigation season, the total diversion is estimated to be 4,000 cfs and return flows are about 1,000 cfs.

2.2 CCWD Water Supply System

The following is provided to give the reader a brief understanding of the CCWD water supply system that is affected by the watershed area subject to this survey.

2.2.1 History

Before the Canal was completed in 1948, agricultural, municipal, and industrial development in the area relied on drawing water directly from the lower Sacramento River and wells for their water supply. As demand increased, it became increasingly apparent that these supply sources were inadequate. In response to increasing intrusion of salt water to the river supplies, and the inadequate reliability and quantity of the ground water supplies, the Canal was designed and built by the US Bureau of Reclamation (USBR) to transport water from the San Joaquin River's Old River stretch east of the Knightsen at Rock Slough to Central Contra Costa County. The Canal was part of the Central Valley Project (CVP) and was completed in 1948. As the local area developed, the Canal rapidly became the area's primary supply source.

The USBR currently owns the Canal, although tentative talks are beginning that could eventually transfer ownership to CCWD. CCWD has full responsibility for operations and maintenance of the Canal. CCWD, the City of Antioch, and several industries hold water rights to pump water from Delta rivers when water quality is acceptable. In wet years, when river water quality is adequate it is estimated that CCWD and its wholesale customers pump 13,200 acre feet per year (af/yr), or nearly 10 percent of the total raw water demand, from the Delta at points other than CCWD's Rock Slough Intake (Jones and Stokes, 1991).

Today CCWD serves water to approximately 400,000 residents of central and eastern Contra Costa County. The Canal delivers raw (untreated) water to 64 industries and five municipal customers. CCWD's municipal raw water customers include the Diablo Water District (DWD), serving the Oakley area; the cities of Antioch, Pittsburg, and Martinez; and the Southern California Water Company, serving unincorporated Contra Costa County in the Bay Point (formerly West Pittsburg) area. The water supplied to DWD is treated at a plant owned jointly by CCWD and DWD.

Water is also supplied to CCWD's Bollman Water Treatment Plant, in Concord, which treats and distributes water to communities in central Contra Costa County. Treated water service from CCWD is provided to the Cities of Clayton and Concord, portions of the Cities of Walnut Creek, Pleasant Hill, and Martinez, as well as the communities of Clyde, and Pacheco.

2.2.2 Water Sources

This section summarizes existing water supplies for CCWD. CCWD is a CVP contractor, historically relying almost entirely on the Federal government (the Bureau of Reclamation) to supply its water through the Sacramento-San Joaquin Delta (Delta). Passage of the CVP Improvement Act of 1992 (CVPIA) established new CVP operating parameters by reforming water distribution pricing and policies. The CVPIA attempts to better balance the needs of water contractors with those of the environment. Water allotments under renewed CVP contracts will be based on new estimates of CVP supply that take into account the CVPIA and other new regulations. Consequently, future contract renewals will likely result in reduced water allotments.

CCWD obtains its water primarily from surface water sources in the Sacramento-San Joaquin Delta. Other potential water sources in the Sacramento-San Joaquin River basin include groundwater resources, water transfers and exchanges, water use reduction by other users (e.g., agriculture), recycling and desalination. Water supply and use in the basin are governed by a complex network of water rights, contracts and agreements involving CCWD, local districts and other entities.

Table 2-5 lists water rights currently held within the CCWD Service Area, along with respective annual diversion entitlements. Table 2-6 lists water right holders in east Contra Costa County who divert water from the Delta.

Under ideal conditions, current agreements entitle CCWD to a total annual supply of 242,700 ac-ft, plus an additional 3,000 ac-ft produced from wells in the District's Service Area. In reality, however, the full amount of supply (242,700 ac-ft) is not available due to deficiencies (e.g., CVP supply shortages and water quality conditions at Mallard Slough).

2.2.2.1 Water Rights, Contracts and Agreements

Central Valley Project.

The District's primary source of water supply is the CVP entitlement. On September 18, 1951, the District entered into a contractual agreement with the United States Department of the Interior, Bureau of Reclamation, to receive water service from the Bureau's CVP (Water Right Permit Nos. 12725 and 12726). The contract has been amended on several occasions since its original enactment. The 1994 Amendatory Contract is effective through December 31, 2010 and provides that the Bureau will supply up to 195,000 ac-ft annually to CCWD at Rock Slough.

The CVP's ability to provide water supplies to CCWD is greatly affected by regulatory conditions in the Sacramento-San Joaquin Delta, the CVP Improvement Act (CVPIA) of 1992, and upstream water resource conditions. During regulatory restrictions, CCWD will receive the greater of 75 percent of the contract entitlement, or 85 percent of historical use. During water shortages, CCWD will receive not less than 75 percent of the contract entitlement or 85 percent of historical use (whichever is less). Historical use is defined as the average of CVP supplies unaffected by reductions, plus diversions by Gaylord Container, the City of Antioch and CCWD at Mallard Slough. The average is adjusted for growth in the existing Service Area.

Other CCWD Minor Water Supplies

In addition to their existing CVP contract, CCWD also receives minor supplies from pumped diversions at Mallard Slough and through pumping at the Mallard well fields. A review of water rights in the current CCWD Service Area identified the City of Antioch, the Gaylord Container Corporation and the Tosco Corporation as having significant surface water rights. In addition, CCWD has obtained an agreement with East Contra Costa Irrigation District (ECCID) to use up to 21,000 ac-ft per year of ECCID water supply to service municipal and industrial (M&I) demands in portions of ECCID that are now, or potentially may be, within the CCWD Service Area.

Mallard Slough Water Rights. CCWD has additional water rights at Mallard Slough (License No. 3167 and Permit No. 19856) for a maximum diversion of Delta water of up to 26,700 ac-ft per year. Diversions from Mallard Slough are unreliable due to frequently poor quality in the San Joaquin River in this area (CCWD, 1994b), and water under the permits is subject to availability of flows in excess of those needed for State and Federal projects. CCWD generally halts diversions from Mallard Slough when the chloride content of the San Joaquin River exceeds 100 milligrams per liter (mg/l) (pers. comm., Greg Gartrell, CCWD, October 1993). The 1994 Amendatory Contract contains provisions that account for water taken at Mallard Slough against CVP allocations in years with shortages or restrictions.

East Contra Costa Irrigation District Agreement. Other than CCWD, ECCID is the largest water right holder in eastern Contra Costa County. ECCID is located south of DWD and east of the CCWD Service Area, overlapping that area to a small extent. ECCID holds a pre-1914 water right from the Delta at Indian Slough for irrigation purposes. DWR has acknowledged this water right with a contractual agreement to furnish ECCID with up to 50,000 ac-ft per year from the Delta. In 1990, ECCID and CCWD entered into an agreement providing for the eventual transfer of up to 21,000 ac-ft to CCWD each year. The agreement transferred to CCWD an entitlement to use up to the transferred amount for M&I purposes within the area of overlap of the ECCID and CCWD service areas.

The transferred water is to be made available to CCWD, at the District's option, in three blocks phased over a 20-year period. The first block of 8,000 ac-ft per year was made available upon completion of the agreement. The second block, an additional 7,000 ac-ft per year, will be available to CCWD on January 1, 2000. The third and final block consisting of the last 6,000 ac-ft per year of the transfer amount will be available to CCWD on January 1, 2010 (ECCID, 1990). ECCID's water right is not subject to regulatory deficiencies and, therefore, neither is the portion of water transferred to CCWD.

Groundwater in the CCWD Service Area. Groundwater resources in the CCWD Service Area do not supply significant amounts of water to meet, or augment, raw water demands. Of the three major groundwater areas -- Ygnacio, Clayton and the Pittsburg/Antioch areas - only the Clayton area produces appreciable amounts of groundwater, approximately 3,000 ac-ft per year. CCWD wells provide approximately 1,000 ac-ft per year. Wells within the DWD service area provide the remaining 2,000 ac-ft.

Other Water Rights in the CCWD Service Area. The City of Antioch and four industrial users hold water rights from the San Joaquin River. The City of Antioch has two rights to water from the San Joaquin River and a smaller right to flows in the watershed upstream of Antioch Municipal Reservoir. Actual diversions from the river are limited, however, due to poor water quality conditions during dry years. Antioch therefore relies on raw water deliveries from CCWD to meet the majority of customer demand. Historical diversions over the period 1975 to 1993 were 2,038 ac-ft, with the highest diversions occurring during two wet years, 1975 and 1983, when 5,377 ac-ft and 5,189 ac-ft were diverted, respectively.

Gaylord Container (Permit No. 019418) and the Tosco Corporation (License No. A010784) have rights to divert up to 28,000 and 16,650 ac-ft per year, respectively. USS-Posco (License No. unavailable) has diverted up to 12,900 ac-ft in the past, but more recently diversions have been approximately 5,600 ac-ft. DuPont (License No. 000674) holds a right to divert 1,405 ac-ft per year from the river.

East Contra Costa Water Supplies Outside the CCWD Service Area

Byron-Bethany Irrigation District (BBID) holds major surface water rights in east Contra Costa County. A number of other substantial surface water rights exist in this area according to SWRCB records. Groundwater use in this region is limited. The following section describes these surface and groundwater resources.

Byron-Bethany Irrigation District. BBID holds a pre-1914 water right for Delta diversions for an unquantified amount for the purposes of irrigation and domestic use. Diversions are currently being made from Clifton Court Forebay. In the absence of an agreement, DWR interprets pre-1914 water rights based on the historical diversion pattern. During the 20-year period 1970 to 1990, BBID diverted approximately 40,000 ac-ft per year (CCWD 1994a). BBID's current obligations total approximately 39,400 ac-ft per year.

Groundwater in East County. Many of the urban areas, both inside and outside of the BBID and ECCID service areas, are served almost entirely from groundwater. The District's review of the available published literature on groundwater resources in eastern Contra Costa County indicates that there is low to moderate potential for additional development to meet long-term urban demand. As a result of the basin's formation characteristics and proximity to the ocean, water quality of the groundwater is often poor in terms of M&I requirements and customer acceptability. The yield of the groundwater basins in eastern Contra Costa County is low, as is the usable storage of the basins.

ECCID and the City of Brentwood have each developed a long-term yield of around 3,000 ac-ft per year from their respective wells. From a limited number of field studies reviewed by CCWD, the recharge in the vicinity of Brentwood appears to be between 3,000 to 6,000 ac-ft per year (CCWD, 1993). The City of Brentwood, with support from ECCID, is currently investigating groundwater resources underlying the area of Brentwood (Davisson and Criss, 1994). Preliminary results from this study indicate that the amount of groundwater that can be pumped without overdrafting the underlying aquifer is between 300 and 1,800 ac-ft annually. Nitrate concentrations are particularly high in groundwater from this area. This is primarily due to agricultural runoff, the major source of recharge over the past 80 years. The study estimates that approximately 40 percent of the wells in the area have nitrate levels that exceed the U.S. Environmental Protection Agency (EPA) primary drinking water standard of 45 mg/l (Davisson and Campbell, 1994).

Table 2-5 Water Rights in the CCWD Service Area

Water Rights Holder and Diversion Point	State Water Resources Control Board Numbers	Place of Use	Annual Diversion Right (Ac-Ft) (a)
USBR @ Rock Slough	Permit Nos. 12725, 12726	CCWD	195,000
CCWD @ Old River (Los Vaqueros Project)	Application No. 20245	CCWD	-195,000 (b)
ECCID @ Rock Slough	Agreement with ECCID(c)	Brentwood (d), ECCID	21,000 (e)
CCWD @ Mallard Slough	License No. 3167 & Permit No. 19856	CCWD	26,700
City of Antioch @ San Joaquin River	Statement No. 009352	City of Antioch	7,670
City of Antioch @ Antioch Municipal Reservoir	License No. 0002713	City of Antioch	Unknown
Gaylord Container Corp. @ San Joaquin River	Permit No. 019418	Gaylord Container Corporation	28,000
El DuPont De Nemours & Co. @ San Joaquin River	License No. 000674	El DuPont De Nemours & Company	1,405
Tosco Corp. Lion Oil Division @ San Joaquin River	License No. A010784	Tosco Corporation	16,650
USS Posco	Not listed with SWRCB	USS Posco	12,900

(a) Diversion amounts represent maximum diversion capabilities and do not reflect diversion quantities available for all years.
(b) Diversion right at Old river for the Los Vaqueros Project includes capacity for CVP Diversions and water quality diversions.
(c) ECCID = East Contra Costa Irrigation District.
(d) Brentwood/CCWD Agreement of October 19, 1995.
(e) Water to be made available in three blocks, phased over a 20-year period (1990-2010).
Data Source: State Water Resources Control Board records.

Other Water Rights in East County. Table 2-6 contains a partial list of water rights holders in east Contra Costa County who divert water from the Delta. The list includes appropriative water rights and water right statements. It indicates that based on full use of permitted diversion rates and diversion periods, water rights for about 209,280 ac-ft per year exist in this area.

Table 2-6 Water Rights in the East Contra Costa County

Name	Statement No.	Application Number	License Number	Place of Use	Annual Diversion Right (Ac-Ft) (a)
WATER RIGHTS STATEMENTS					
John Bloomfield,et al.	S013812	N/A	N/A	Orwood Tract	10,830
Alvin R. Orman	S005235	N/A	N/A	Brentwood	510
Ernest C. Burroughs	S005234	N/A	N/A	Brentwood	1,310
The Burroughs Trust	S002319	N/A	N/A	Jersey Island	4,740
Ernest C. Burroughs, et al	S002298	N/A	N/A	Jersey Island	3,090
Oscar N. Burroughs, et al.	S002300	N/A	N/A	Jersey Island	5,390
Oscar N. Burroughs, et al.	S002299	N/A	N/A	Jersey Island	5,390
Emerson Dairy, Inc.	S002320	N/A	N/A	Jersey Island	2,070
APPROPRIATIVE RIGHTS					
Delta Farms Reclamation District #2024	N/A	A002950	001570	Orwood Tract	14,730
Delta Farms Reclamation District #2025	N/A	A002951	001571	Holland Tract	26,860
Delta Farms Reclamation District #2026	N/A	A002952	001572	Webb Tract	34,880
William M. Looney, et al.	N/A	A002593	000358	Orwood Tract	4,690
Mantell Brothers	N/A	A016229	006092	Orwood Tract	1,090
Church of Jesus Christ of latter Day Saints	N/A	A006587	001605	Byron Tract	17,160
Church of Jesus Christ of Latter Day Saints	N/A	A008338	04953	Byron Tract	10,140
Palm Tract Company	N/A	A004942	01333	Palm Tract	22,300
Edna M. Fallman	N/A	A0002718	000359	Orwood Tract	1,450
H. John Bloomfield, et al.	N/A	A0002949	001852	Orwood Tract	8,510
Alba C. Houston Orchard Company	N/A	A0015094	005173	Byron Tract	490
Jersey Island Reclamation District #830	N/A	A0003768	001310	Jersey Island	29,120
Sheldon G., Nancy D., & Daren D. Moore	N/A	A0004635	001289	Orwood Tract	4,530
UNQUANTIFIED PRE 1914 WATER RIGHTS					
East Contra Costa Irrigation District (ECCID)	N/A	N/A	N/A	ECCID	50,000 (b)
Byron-Bethany Irrigation District (BBID)	N/A	N/A	N/A	BBID	40,000 (c)

(a) Diversion amounts represent maximum diversion amounts and do not reflect actual consumptive use amounts that would be available for transfer.

(b) ECCID's annual entitlement is based on contractual agreement with the Department of Water Resources: the actual entitlement for this pre-1914 right may exceed 50,000 acre-feet per year. The current diversion is approximately 30-35 TAF per year.

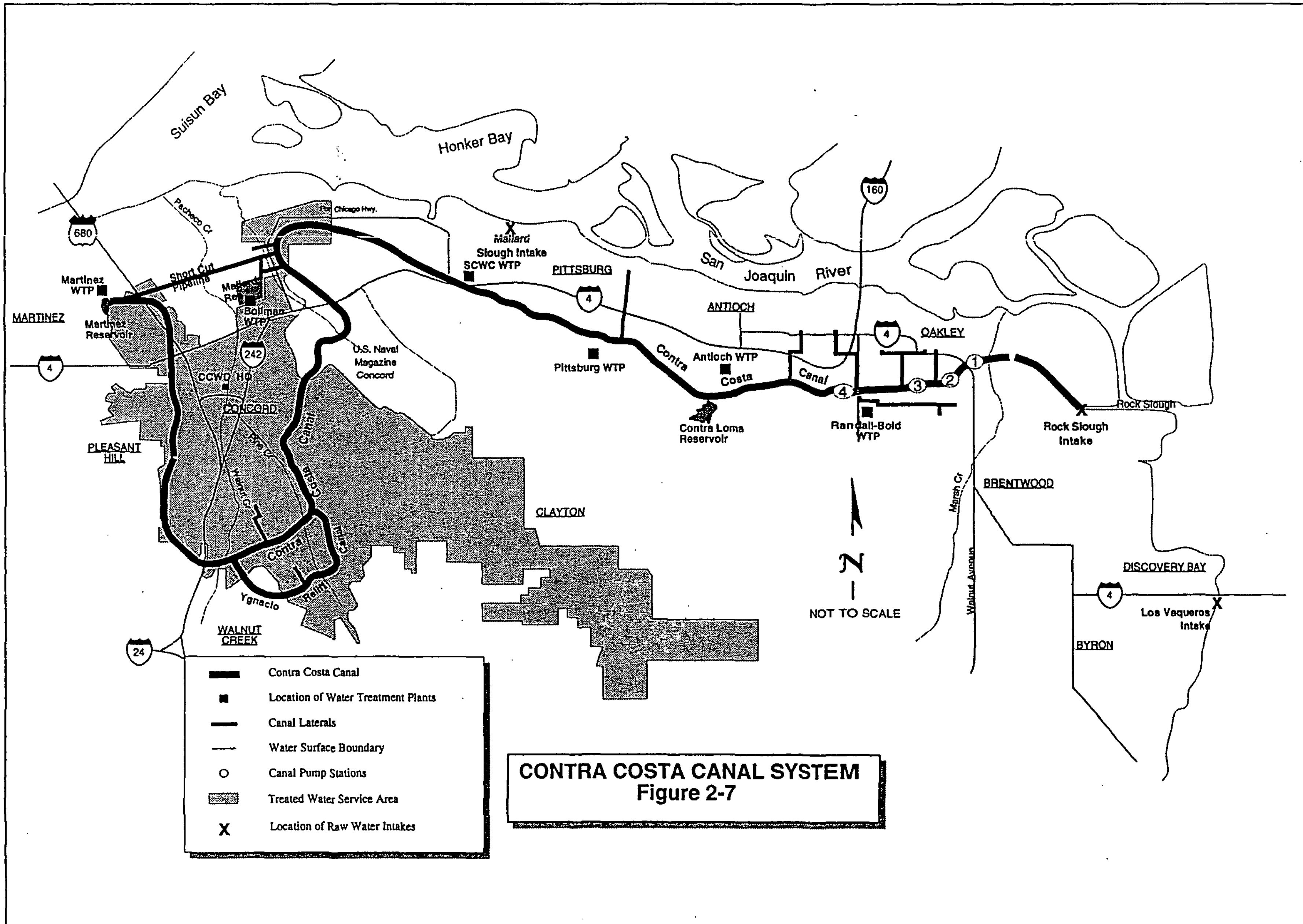
(c) BBID's annual entitlement is based on historical diversion over a 20-year period from 1970 to 1990; actual entitlement for this pre-1914 water right may exceed 40,000 ac-ft per year.

Data Source: State Water Resources Control Board records. "East County Water Supply Management Study: Phase I - Supply and Demand." Contra Costa Water District, 1994.

2.2.3 Facilities

This section describes the existing water diversion and conveyance facilities, the delivery system within CCWD's service area, and proposed changes to these facilities in the next five years.

Figure 2-7 shows the Contra Costa Canal system and major structures including the location of headworks, pumping plants, laterals, water treatment plants, diversion facilities, and raw water storage reservoirs.



CONTRA COSTA CANAL SYSTEM
Figure 2-7

2.2.3.1 CCWD Diversion Facilities

The locations of diversion facilities operated and maintained by CCWD are shown on Figure 2-7. Additionally there are several other facilities owned by others as described in Tables 2-5 and 2-6. Raw water pump facilities operated, at least in part, for water treatment purposes are shown in Table 2-7 along with their pumping capacities.

Table 2-7 Raw Water Pump Facilities

Pumping Facility	Capacity (MGD)	Capacity (cfs)
CCWD-Rock Slough	183	283
CCWD-Mallard Slough	21	32
Antioch Municipal-San Joaquin River	8	12

2.2.3.2 CCWD's Raw Water Conveyance System

The Contra Costa Canal is the primary conveyance facility for the CCWD's raw water supply. The Canal is 48 miles long, with the major deliveries within the first 19 miles from Rock Slough to the Shortcut Pipeline near the Bollman Water Treatment Plant. This portion of the Canal is divided into nine reaches. The first two reaches, which run from Rock Slough to Pumping Plant 1, are unlined and have capacities ranging from approximately 280 cubic feet per second (cfs) to 380 cfs. These reaches, totaling 4.0 of the 4.8 miles of unlined Canal, are channels subject to tidal action in the Delta. The remaining seven reaches are concrete lined, with capacities ranging from approximately 350 cfs to 22 cfs. The Canal has several in-line siphons, culverts, and check structures, as well as a 1/4-mile long tunnel. The Shortcut Pipeline conveys water from Reach 9 of the Canal to the Bollman WTP and to the City of Martinez and Shell, as well as some smaller wholesale industrial customers.

There are four pumping plants between Oakley and Antioch that lift the Delta water from the tidal action of Rock Slough (average -3.8 ft relative to sea level) to 117.8 feet above sea level where it begins to flow by gravity the remainder of the canal's length. The four pumping plants each have six pumps with a combined capacity of 383 cfs with all pumps running. However, system limitations reduce the effective capacity to 283 cfs.

Daily canal demand is established from the requests of the municipal/industrial customers and CCWD's own needs. This rate is set at Pumping Plant #4 using any combination of the six pumps to achieve the canal demand.

All pumps at the Pumping Plants 1-4 are normally operated remotely via SCADA by the control operator at the Antioch Operations Control office located near Pumping Plant #4. The pumps are alarmed and can be shut down automatically by SCADA if either low or high water conditions develop.

Screens at the pumping plants are cleaned regularly by automatic rakes, and monitored and maintained by the Water Tenders who also inspect the length of the canal around the clock on a daily basis. Communicating with the Control Operator to verify SCADA readings, the Water Tenders will make adjustments at the various check structures to maintain the proper water levels in the canal regardless of the quantity of water being delivered to the raw water customers.

Major raw water customers along the Canal are notified by Antioch Control of major changes in the operation of the canal as it may effect their operations and by Water Quality of water quality conditions of importance by phone, fax or mail depending on the importance and timeliness of the information.

2.2.3.3 CCWD's Raw Storage Facilities

CCWD's raw water storage facilities are Mallard, Contra Loma, and Martinez Reservoirs. Figure 2-7 shows the locations of these raw water reservoirs and the future Los Vaqueros reservoir watershed boundary.

The reservoirs may be treated with chemicals or harvested mechanically to control various planktonic or macrophytic organisms. Appendix A-3 contains excerpts from the Guidelines for the Chemical Treatment of CCWD Waters.

2.2.3.3.1 Mallard Reservoir

Mallard Reservoir is a one billion gallon reservoir at the Bollman Treatment Plant located in Concord, California. It was built in the 1930's and called the Chenery Reservoir. In 1968 the reservoir was enlarged to its present capacity and renamed Mallard Reservoir. The reservoir has a usable capacity of about 2,148 acre-feet which is currently equivalent to about two weeks of supply for the Treated Water Service Area (TWSA). At average demand Mallard Reservoir, when full, has >1 month supply of water. Once water is put into Mallard Reservoir it is available only to the Bollman Treatment Plant and cannot be released back into the canal or the Shortcut Pipeline for other raw water users.

Seventy -five percent (75%) of Mallard Reservoir sits above the surrounding landscape and there is no drainage into the reservoir from the surrounding watershed. The shoreline elevation of the reservoir is 32 feet. It covers 204.58 flooded acres at maximum capacity. The maximum depth of the reservoir is 31 feet. The current bathymetric map shows that approximately 15% of the reservoir is 12 feet or less in depth. The area and volume of the shallows is subject to seasonal drawdown and refill operations.

Mallard Reservoir is located on the alluvial plain of the Sacramento - San Joaquin Delta. The substrate is composed primarily of sandy and silty clays. The uppermost 3 to 4 feet of soil is darkly colored adobe clay. The underlying soils, extending to the maximum depth of 21.5 feet, consist of very stiff to hard clay. The Concord Fault lies to the west of the reservoir. If an earthquake of appropriate magnitude were centered on this fault their is a potential for liquefaction due to the unconsolidated nature of the substrate and the shallow groundwater table.

2.2.3.3.2 Contra Loma Reservoir

Contra Loma Reservoir and Contra Loma Dam are located near the beginning of Canal Reach 5. It is on the southern border of the City of Antioch and adjacent to Pittsburg. Contra Loma Reservoir is a man made reservoir and is presently part of the Contra Costa Canal unit of the Central Valley Project owned by the United States Bureau of Reclamation (USBR). The 780 acres of land surrounding the reservoir and the recreational facilities at the reservoir are managed by the East Bay Regional Park District (EBRPD) under contract with the USBR. CCWD administers the contract on behalf of USBR.

Contra Loma Reservoir was created by damning of the natural drainage course in the hills and closing the downhill side with a 1,000-foot long by 80-foot high earth berm. It has an available capacity of about 1657 acre-feet with a surface area of 80 acres. Under normal conditions the water level is maintained between an elevation of 200-206 feet, however, in emergencies it is possible to store water to the 211 foot level. The reservoir is thermally stratified during the summer and fall months but turns over during the winter.

The reservoir's primary purpose is to supply the Contra Costa Water District when the Rock Slough diversion is unavailable. Recreational use is a secondary function of the reservoir. Water is diverted from the reservoir to the Contra Costa Canal approximately 10 to 15 times a year. Depending on the season, an average of 150 to 200 acre-feet is released per diversion during a one to two day period.

There are many drainage swales to accommodate the rains but no year-round streams. The natural watercourses in the watershed have been somewhat altered with the addition of the reservoir but the land as a whole drains to the north. The relatively level area on the east side of the watershed along Fredericson Lane is a silt trap for water flowing from higher areas.

The Contra Loma watershed lies at the northern edge of the Diablo Range. It basically slopes downward to the north. The steepest areas are the hills on the southern and western sides of the watershed. Approximately 70% of the land surface is relatively flat (0 to 10%) while 15% is in medium slopes (10-25%), and another 15% is of the steepest slopes greater than 25%). The elevation ranges from 608 feet above mean sea level in the hills south of the reservoir to 102 feet near the canal to the north. The reservoir itself has an elevation of 205 feet.

This watershed consists primarily of marine sedimentary shales and sandstones and some alluvial deposits and volcanic rocks. Two fault lines run through the watershed from northeast to southwest. They are located on the southeastern side of the reservoir. Another possible fault, though not substantiated, may exist on the southwest side of the reservoir. These faults, are short in length and appear to be remote fractures associated with the Diablo Fault.

Soils in the Contra Loma Watershed are primarily clays overlaying there marine sedimentary shales and sandstones. They have good compactibility but low permeability when compacted, and have low shear strength. Landslides in the area are shallow and mostly composed of slope wash soil.

The potential sources of contamination for Contra Loma Reservoir include body contact recreation in the reservoir, spills related to the sanitary waste handling facilities and cattle grazing.

Under a 1972 agreement with USBR, the East Bay Regional Park District is authorized to provide recreation activities at Contra Loma. That agreement explicitly states that water supply has priority over recreation. The estimated number of people that the EBRPD park at Contra Loma can accommodate on peak days is 4000 while design capacity is closer to 2,000 people. Facilities at the park include a entrance kiosk, snack bar, lounge area, restroom changing complex lifeguard room, service yard, security residence, and park office. Water and sewer for these facilities are connected to the municipal sources. Portable chemical toilets are also located at various points within the park area to supplement the permanent facility. While all are located above the normal operating level of the reservoir, recent inspections have noted a few located below the maximum high water line. In discussions with CCWD, the EBRPD has agreed to move the noted toilets to a location that will be above the maximum high water line of the reservoir. All the toilet facilities are inspected and maintained at regular intervals by EBRPD personnel.

The main location for body contact sports is the beach area. A 400 foot by 200 foot beach of 6 inch deep imported sand was built on the southern shore of the reservoir. A cement treated base underlies the beach and the water from elevations of 200 feet to 205.5 feet. At the periphery of the beach are the restroom and change complex (11 toilets and urinals in men's room, 8 toilets in women's room), concession stand, and picnic sites. EBRPD monitors the beach area at two locations twice a month for total coliforms during the swimming season (Easter through October). Monitoring is reduced to monthly during the winter season. Contra Costa Water District also monitors the reservoir for total and fecal coliform levels at the beach area and the north east corner of the dam weekly during the swimming season (Easter through October) and monthly the remainder of the year.

Over the past 25 years, a number of conditions have changed the way in which body contact activity at Contra Loma impacts it as an operational back-up water supply:

* CCWD's water supply needs have grown as the population it serves has grown with Contra Loma providing operational back-up for the CCWD treated water system and the several municipal water systems served by CCWD.

* Water quality knowledge, and the resultant federal and state regulations, have substantially increased the requirements for strict regulation of source waters. Today, drinking water systems must protect against a wide range of biological contaminants, many of which were unknown 25 years ago, such as *Cryptosporidium* and *Giardia*. Body contact activities can increase the risk of such contamination.

Four hundred acres of the watershed is grazed. These areas are fenced to mitigate the possibility of cattle getting into the reservoir. One small stream, that flows only during the rainy season, runs from the southern part of the grazed watershed into the reservoir. The stream flows through a small marsh area before it flows into the reservoir.

2.2.3.3.3 Martinez Reservoir

Martinez Reservoir, located in the City of Martinez, is at the terminus of the Contra Costa Canal and the Shortcut Pipeline and provides regulating storage to capture flows from Canal operations. The Martinez Reservoir has an available capacity of about 230 acre-feet. This raw storage is only available to the City of Martinez for their treatment plant and the Shell Oil refining complex.

2.2.3.3.4 Los Vaqueros Reservoir

In 1994, CCWD began constructing the Los Vaqueros Reservoir about nine miles south of Brentwood along the Vasco Road/Kellogg Creek corridor in Eastern Contra Costa County. The reservoir will store 100,000 acre-feet of high quality water diverted from the Delta at Old River near Discovery Bay and State Highway 4 for eventual blending in the Contra Costa Canal for delivery to CCWD's municipal and industrial customers. The reservoir, a combination water quality and storage reliability project, is expected to begin filling following the completion of construction activities in 1997.

The potential impacts of this future facility have been explored in great detail in the extensive environmental documents prepared by CCWD to satisfy the stringent permitting process necessary to construct the reservoir and it appurtenances.

2.2.3.4 Treatment Facilities Served by the Contra Costa Canal

2.2.3.4.1 CCWD's Treatment Facilities

The Treated Water Service Area (TWSA) is served by the Bollman Plant which uses the treatment processes of coagulation, flocculation, sedimentation, filtration, and disinfection. The plant was constructed in 1967/68 and placed in operation during the summer of 1968. Nominal capacity of the plant is currently 75 million gallons per day (MGD). Plans are being implemented to upgrade the plant to incorporate intermediate ozonation; which should be on-line in 1997.

The Randall-Bold (R-B) Plant in Oakley was completed in 1992. The initial capacity is 40 MGD, expandable to 80 MGD. As the current system demand is considerably less than the 40 MGD modifications were made to allow the plant to operate effectively at a "low flow" rate as little as 2 MGD. Treatment facilities include pre-ozonation, coagulation, flocculation, deep bed GAC filtration, post-ozonation and disinfection.

The R-B plant is jointly owned by the Diablo Water District (DWD) and CCWD. It is operated by CCWD and currently supplies the DWD service area exclusively. However, a recent agreement has been put in place that will provide a treated water supply to the City of Brentwood for a seven year period with up to 7000 acre feet per year. This equates to an ultimate average additional demand of 6.25 MGD on the R-B plant.

2.2.3.4.2 Municipal Retailers Treatment Facilities

The several municipal retailers supplied raw water by CCWD from the Contra Costa Canal for their own treatment facilities include the City of Antioch, City of Pittsburg, California Cities Water Company (Bay Point) and the City of Martinez.

Table 2-8 Treatment Plant Configurations within CCWD Raw Service Area

Plant	Preoxidant	Coagulation	Floc	Sed	Intermediate Ozone	Filtration	Disinfection	Capacity	Estimated Population Served
Bollman	$KMnO_4$ or Chlorine	Alum/Poly	yes	yes	under construction	GAC	Chloramines	75 MGD	185,000
R-B	Ozone	Alum/Poly	yes	no	no	Deep GAC	Ozone -- Chloramines	40 MGD	21,000
Antioch	Chlorine	Alum	yes	yes	no	GAC	Chloramines	28 MGD	76,000
Pittsburg	Chloramines	Alum/Poly	yes	yes	no	GAC	Chloramines	36 MGD	50,000
Ca Cities	$KMnO_4$	Alum/Poly	yes	yes	no	Anthracite	Chlorine	3.8 MGD	15,000
Martinez	Ozone	Alum	yes	yes	yes	Anthracite	Chloramines	10 MGD	30,000

2.2.3.5 CCWD's Treated Conveyance And Storage Facilities

The distribution system consists of approximately 750 miles of pipelines ranging in diameter from 2 to 48 inches. Nearly all of the pipelines are either plastic, asbestos-cement (A-C) pipe, or mortar lined steel. Very little exposed steel pipe remains in CCWD's distribution system

The treated water storage consists of forty-three storage reservoirs ranging in capacity from 0.25 million gallons (MG) to 10 MG. Twenty-seven pumping stations are operated throughout the TWSA with total design pumping capacities ranging from 180 gpm to 67,000 gpm. The existing TWSA ranges in elevation from sea level to 1000 feet above sea level. One or more reservoirs are operated in each zone to supply water within a specific range of elevations.

2.2.4 Emergency Plans

CCWD maintains an Emergency Operating Plan (EOP) which outlines the overall emergency management program, including the conduct of operations during disasters. It identifies responsibilities of individual departments and personnel for performance of specific emergency preparedness and response functions and activities. Individual emergency management functions are addressed from an overall operational perspective with specific operating guidelines and procedures along with points of contact and other information which requires annual updating.

The purpose of the EOP is to provide general direction and guidelines in the event of an emergency.

The objectives are:

- To provide for a prompt and effective District-wide response to emergencies and/or disasters.
- To protect the public welfare by minimizing the impact of emergencies on CCWD's operations and resources (life and property).
- To coordinate with city, county, and state agencies.
- To expedite repair and recovery operations and to resume normal operations as quickly as possible.

Specific EOP authorities and references include:

- Multi-Hazard Functional Planning Guidance, State of California Office of Emergency Services, 1985.
- Emergency Plan, State of California, Office of Emergency Services, Utilities Division, 1 1987.
- Multi-Hazard Functional Plan, Contra Costa County, 1987.
- California Administrative Code Title 5, Division 2, Part 1, Articles 2, 5 and 6 (California Emergency Services Act).
- CCWD Regulation 5.04.010 et seq.

Agencies such as CalTrans and the California Highway Patrol have emergency notification procedures that begin with the County Office of Emergency Services, the County Environmental Health Division, and continue to other potentially effected agencies such as Fish and Game, Regional Water Quality Control Board, EPA, and the Coast Guard. If they are aware of the potential for impact on the Canal or District facilities they also have the emergency contact number for CCWD. The County Office of Emergency Services will also contact County Environmental

Health Division who will ultimately contact CCWD whether the information is relayed by other means or not.

In the event of a water quality emergency that develops outside the specific sphere of District control, but nonetheless has the potential to impact District water quality, information flow should be directed to the 24-hour Antioch Control Operator - **(510) 625-6524**. Internally, the information will be forwarded to the Water Quality Superintendent and Director of Operations and Maintenance where the District Procedures for Internal and External Communications will be implemented to assure proper notifications of the public and appropriate regulatory agencies. A list of emergency contacts associated with the District and it operations is included in Table 2-9.

Table 2-9 Emergency Contacts

CCWD Internal Contacts		Phone*	FAX*	Pager*
CCWD Control Operations	**24 Hour Raw Water Emergency**	**625-6524**	757-0556	
CCWD Ops & Maint	Ed Cummings, Dir of O & M	688-8052	688-8122	975-1064
CCWD Water Quality	Larry McCollum, WQ Superintendent	688-8127	688-8274	946-7709
CCWD WQ Inquiries	Joe Guistino, WQ Supervisor	**688-8156**	688-8274	906-6638
CCWD WQ Laboratory	Jean Zacher, Laboratory Supervisor	688-8091	688-8274	906-3443
CCWD Water Operations	Ed Routon, Operations Superintendent	625-6518	757-0556	279-9876
CCWD Water Treatment	Karl Voigt, WT Superintendent	625-6501	625-6505	906-3518
CCWD Public Info	Al Donner, Public Affairs Director	688-8194	688-8122	975-1520
CCWD Municipal Retailers				
Antioch W.T.P.	Jon Billeci, Superintendent	779-7028	779-0272	
Antioch W.T.P. Lab	Lori Sarti, Chemist	779-7024	779-0272	
Pittsburg W.T.P.	John Edwards, Superintendent	439-4027	427-4723	
Pittsburg W.T.P. Lab	Tom Schwertscharf, Lab Analyst	439-4026	427-4723	
Cal Cities Water Co.	Charles Gibson, Superintendent	458-2090	458-9213	779-8869
Martinez W.T.P.	Rich Singletary, Superintendent	372-3589	228-0826	
Diablo Water District	Danny Bowers, Superintendent	625-2112	625-0814	
CCWD Randall-Bold W.T.P.	Pat Panus, WT Supervisor	625-8500	625-6505	
CCWD Bollman W.T.P.	Paul Prewitt, WT Supervisor	688-8157	689-5936	
East Bay Regional Park District				
Contra Loma Reservoir	Bill Vierra, Superintendent	757-0404		
CCWD Industrial Retailers				
Shell Oil	Lee Olavides	313-3830	313-3059	
Tosco Corp.	Monty Stokeley	228-1220	372-3079	
GWF, Nichols Rd.	Cary Anderson, Plant Engineer	432-0873	432-3758	
General Chemical Co.	Frank Kokoczka or Tom Fling	458-7304	458-1279	
Regulatory Agencies				
	General Emergency Situations	**911**		
CA Ofc of Emergency Srvcs	State OES Hotline	800-852-7500		
DOHS, Drinking Water	Clifford Bowen, Sr. Sanitary Engineer	540-2173	540-2181	
DOHS, Drinking Water	Peter Zhou, Sanitary Eng.	540-3188	540-2152	
CCC Ofc of Emerg. Srvcs	County OES Hotline	228-5000		
CCC Env Health Div.	24 Hour Emergency Notification	646-1112		
CCC Env. Health Div.	George Nakamura, Division Manager	646-2521	646-2535	
CCC Env. Health Div.	Les Miyashiro, Hlth Insp./Potable Water	646-1284	646-2535	975-6192
CCC Env. Health Div.	Sonny Khoo, Hazardous Materials	646-2286	646-2535	
CCC Public Health Div.	Francie Wise, Communicable Diseases	313-6740		
Dept. of Fish & Game	Mike Rugg, WQ Biologist	707-944-5500		
Reg. Air Quality Board	Complaint Hotline	800-792-0836		
Reg. WQ Control Board	Mr. Tenjung Woo, Chief	286-1255		
Information Resources				
Chemtrec		800-424-9300		
Pesticide Hotline		301-621-3773		

** Area Code (510) unless otherwise specified*

CHAPTER 3. POTENTIAL CONTAMINANT SOURCES

3.1 Survey Methods

The Survey area was surveyed by a combination of physically examining the area directly influencing the Contra Costa Canal and its right-of-way and literature search. The literature search included the State's NPDES permitting records on file at the San Francisco and Central Valley Regional Water Quality Control Boards. These records were used to identify permitted discharges within the survey boundary. (Appendix A-1)

The CCWD water quality records were the bottom line measure of the current collective effect of the identified (and unidentified) sources of potential contamination.

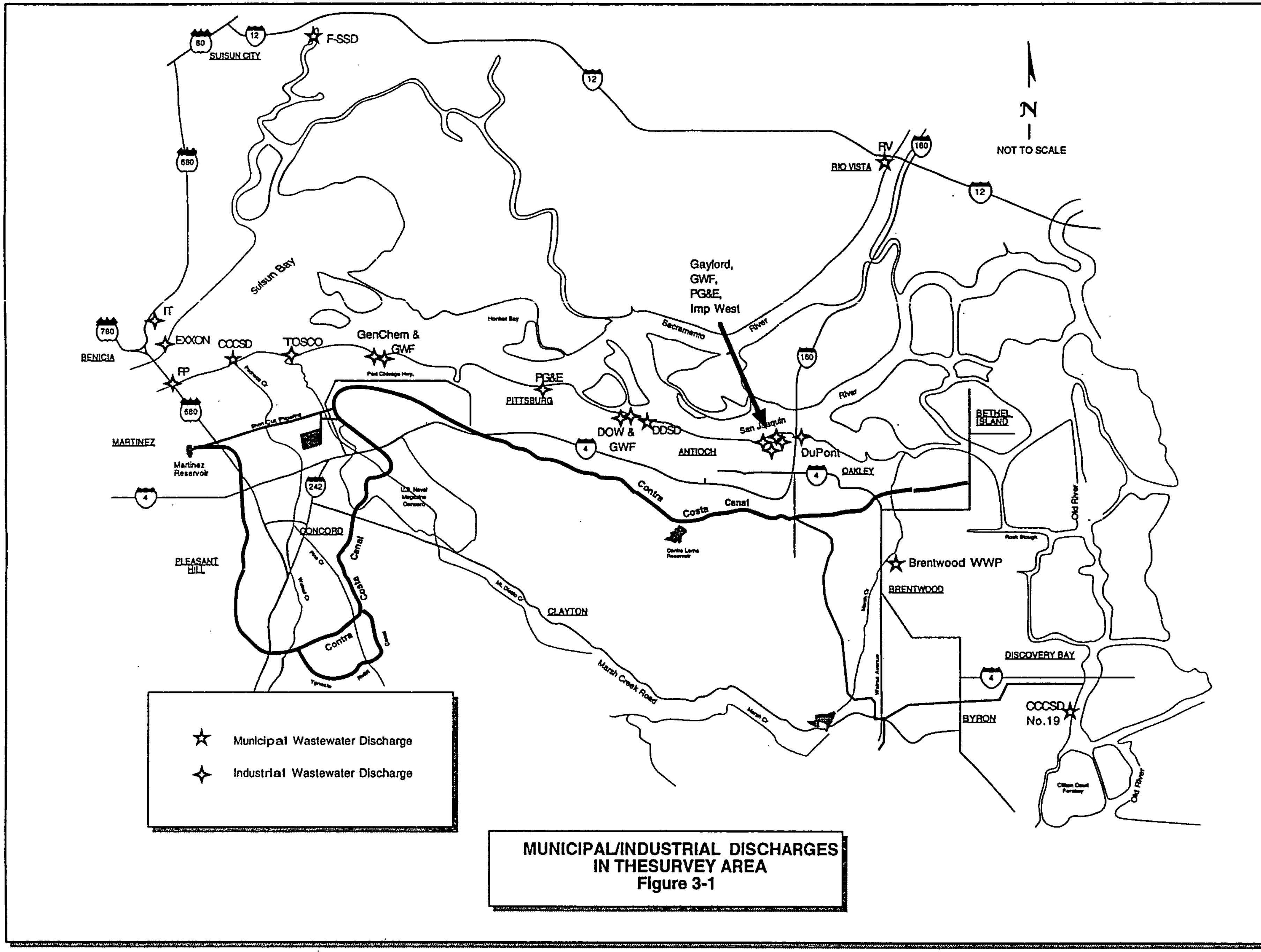
3.2 Potential Contaminant Sources

Beyond Mother Nature, other identified sources include wastewater plants; runoff from open space, agricultural, residential, commercial, industrial and highway sources; insecticide/herbicide use; grazing and wild animals; recreation; unauthorized activities; traffic accidents/spills; geologic hazards; and solid and hazardous waste disposal sites. These are discussed in the sections that follow.

3.2.1 Wastewater Discharges

Municipal and industrial facilities that discharge waste directly to a surface water body are point source discharges regulated under the National Pollutant Discharge Elimination System (NPDES) administered by the Regional Water Quality Control Board. All NPDES dischargers in the Survey area are permitted and monitored by either the San Francisco or Central Valley Regional Boards. Discharges permitted for seasonal rainfall runoff from facility grounds(non-continuous flow) are not included in the Survey. Figure 3-1 depicts the general location of the municipal and industrial discharges taken from the NPDES permits on file.

While data collected by CCWD indicates no chronic problem with the discharges as regulated by the NPDES program, the District is concerned about even low quantities pollutants and routinely monitors NPDES activities to see that they are controlled at the source.



MUNICIPAL/INDUSTRIAL DISCHARGES IN THESURVEY AREA
Figure 3-1

3.2.1.1 Municipal Wastewater Dischargers

Municipal dischargers are wastewater treatment plants that discharge a combination of treated domestic wastewater and industrial wastewater and in some cases, urban runoff. Table 3-1 shows the municipal wastewater agencies in the Survey area and their characteristics. The primary constituents of concern from these sources are potential fecal pathogens. All sources have shown historic compliance with their respective NPDES permits. CCWD's monitoring of its raw water sources does not indicate the presence of a chronic problem from these sources.

Table 3-1 Municipal Wastewater Dischargers

Wastewater Agency	Treatment Level (1,2,3)	Design Flow (MGD)	Average Dry Weather Flow (MGD)	Disposal to:
City of Brentwood	2	1.8	0.14[(a)]	Marsh Creek
City of Rio Vista	2	0.60	0.45	Sacramento River
Central Contra Costa Sanitary District [(b)]	2 & 3[(c)]	45	35.2	Suisun Bay
Contra Costa County San District No. 19 (Discovery Bay)	2	1.3	0.9	Old River
Delta Diablo Sanitation District	2 &3 (d)	16.5	9.6	New York Slough
Fairfield-Suisun Sewer District	3	17.5	12.8	Boynton Slough
TOTAL		82.7	59.1	

(a) 0.9 MGD is treated and discharged to infiltration ponds; 0.14 MGD is discharged from a groundwater extraction system
(b) Sewage flows tributary to CCCSD include CCWD's TWSA and a portion of EBMUD's service area.
(c) Capability up to 30 MGD (33,000 AFY) exists for level 3 treatment but is not fully utilized.
(d) Capability up to 1.0 MGD (1,120 AFY) exists for level 3 treatment but is not utilized.

The Ironhouse Sanitation District operates in Oakley near the Contra Costa Canal in the vicinity of Pumping Plant No. 1. The ISD operation involves groundwater recharge and evapotranspiration through irrigation of adjacent property rather than direct discharge to a surface water. An evaluation conducted by CCWD in 1992 indicated that there is a net groundwater movement away from the canal on the order of 10^{-3} to 10^{-5} feet per day in the vicinity of the ISD land application activities. It was judged that the operation posed little threat to the water quality of the Canal.

3.2.1.2 Industrial Wastewater Dischargers

Industrial discharges are primarily composed of power plant cooling water, treated process wastewater and treated groundwater remediation flow. There are 15 active industrial wastewater dischargers in the Survey area as identified by their NPDES permits and follow-up phone contact. Information gathered from the industries about the general characteristics of the discharges relating to their permits are included in Appendix A-1.

CCWD's monitoring of its raw water sources does not indicate the presence of a chronic problem from these sources.

3.2.2 Urban Runoff

The Environmental Protection Agency (EPA) completed an Urban Runoff study in 1983, titled "The National Urban Runoff Program" (NURP), that showed that urban storm water can be contaminated with several pollutants. Specifically noted in this study are total suspended solids (TSS), nitrate, phosphorus, lead, copper, and zinc (EPA 1983). Through NURP, and other studies (Santa Clara and Alameda County's NPDES Programs), it is clear that runoff from residential, commercial, and industrial areas can contribute increased quantities of pollutants (EPA 1983, WCC 1991).

Table 3-2 presents the water quality data summarized from CCWD raw water quarterly data, NURP, Santa Clara County, and Alameda County. Quarterly raw water data between 1988 to 1992 were used to generate the percentiles shown below. The 50% and 90% represents the concentration where 50 and 90 percent of the values fall on or below the concentration shown. For example, 90% of the TSS data collected showed concentrations less than or equal to 300 mg/L -- 10% of the data collected had concentrations greater than 300 mg/L.

Table 3-2 Urban Runoff Water Quality Data

Parameter	Criteria (mg/L)	Canal Quarterly Data†		Open Space		Residential / Commercial		Industrial	
		50%	90%	50%	90%	50%	90%	50%	90%
Total Suspended Solids	-	-	-	70	480	64	122	120	215
Total Dissolved Solids	500(a)	390	538	-	-	-	-	-	-
Total Phosphorus	-	-	-	**.121**	**.525**	**.383**	**.850**	-	-
Phosphate	-	0.3	0.52	**.026**	**.14**	.27	.370	.68	.78
Total Kjeldahl Nitrogen	-	-	-	**.965**	**5.25**	1.7	4.30	1.9	2.44
Nitrate (as N)	10(b)	1.2	3.3	**.543**	**1.48**	.67	.736	.55	.67
Chromium	0.05(b)	.0005	.0032	.0085	-	.013	-	.014	-
Copper	1.3(c)	.004	.012	.015	.024	.033	.072	.033	.083
Lead	0.015(c)	.001	.0025	.0055	.0145	.0735	.180	.0655	.208
Nickel	0.100(b)	.0013	.005	.005	-	.018	-	.014	-
Zinc	5.0(a)	.010	.024	.0355	.120	.310	1.95	.300	.664

UNITS: all data in mg/L. Metal values are total metal concentrations.
The values shown in BOLD represent data from NURP, 1983. All other data is combined local data from Santa Clara County and Alameda County (1988 to 1992).
† Raw water quarterly data between 1988 to 1992 was used to generate the percentiles for Canal Quarterly Data.
(a) Secondary MCL; (b) Primary MCL; (c)Action Limit, Lead/Copper Rule

The combined study data indicates that storm water runoff from urban areas can have higher concentrations of some pollutants than has been seen in Canal raw water, particularly the metals. While this would suggest that storm water runoff has the potential to influence Canal water quality, CCWD's monitoring of its raw water sources does not indicate the presence of a chronic problem from these sources.

3.2.3 Highway Runoff The United States Department of Transportation, Federal Highway Administration (FHWA) conducted a study related to highway storm water runoff (WCC 1988). The study completed by Santa Clara County also included highway storm runoff analyses (WCC 1991). Table 3-3 summarizes the data collected from highway studies. The data indicates that storm water runoff from highways can have higher concentrations of some pollutants than Canal raw water, particularly the metals. There does not appear to be any significant nutrient differences between Canal raw water and highway runoff.

Table 3-3 Highway Runoff Water Quality Data

Parameter	MCL (mg/L)	CCWD Canal Quarterly Data		Santa Clara County Highways (1989)		FHWA Study (1988)	
		50%	90%	50% (CV)	90%	50% (CV)	90%
TSS	-	-	-	-	-	142	295
VSS	-	-	-	-	-	39	78
PO4	-	0.3	0.52	-	-	0.40	1.07
TKN	-	-	-	-	-	1.83	3.17
NO2+3 (as N)	10(a)	1.2*	1.3*	-	-	0.76	1.48
Cu	1.3(b)	.004	.012	.031 (0.53)	.074	0.054 (0.68)	0.119
Pb	0.015(b)	.001	.0025	.115 (0.71)	.169	0.400 (1.45)	1.564
Zn	5.0(c)	0.010	0.024	.210 (0.61)	.490	0.329 (0.44)	0.564

UNITS: all data in mg/L. (a) Primary MCL; (b) Action Limit, Lead/Copper Rule ; (c) Secondary MCL; * Nitrate only

The Contra Costa County Clean Water Program found that residential streets and roadway land uses appear to be the major source of pollutant loads to the Bay from the county (CCCWP, 1994). This is probably due to the distribution of land use. While the various studies would suggest that storm water runoff has the potential to influence Canal water quality, CCWD's monitoring of its raw water sources does not indicate the presence of a chronic problem from these sources.

However, the recently completed Canal Drainage Study (CCWD, 1995a) identifies the prudence of further evaluation of the Buchanan Road drainage site. This site contributes the poorest quality drainage to the Canal of the sites evaluated and is relatively inexpensive to mitigate. The estimated costs to re-direct drainage to the municipal storm drain system range from $60,000 to $150,000 depending on the method used and potential outside agency requirements. Such a project is to be evaluated and proposed, as appropriate, in the upcoming budget process.

3.2.4 Agriculture Crop Land Runoff

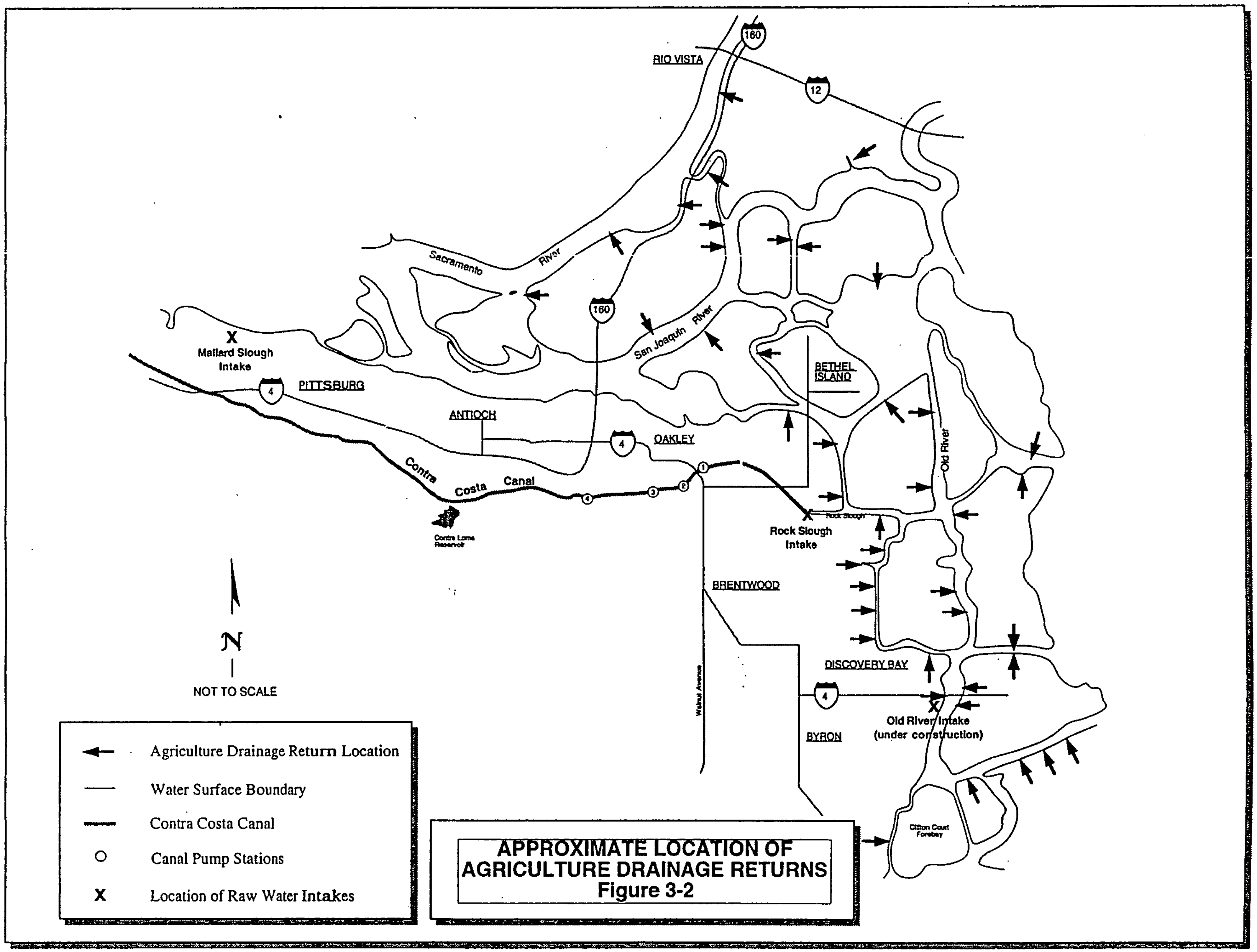
The agricultural activities of primary importance to Delta water quality are irrigation practices, pesticide use, fertilizer use, and animal management (Section 3.2.5). The San Joaquin Valley Drainage Monitoring Program and the Interagency Delta Health Aspects Monitoring Program were reviewed to summarize agricultural runoff. In general, the water quality of the Delta has been found safe for drinking water supplies. Of all the constituents studied in the Delta and in agricultural drainage, the salts, selenium, and trihalomethane formation potential have been found as the most significant constituents that effect Delta water quality. A few pesticides have shown up in agricultural drainage, although in small quantities.

Irrigation water is siphoned from adjacent Delta channels into ditches on the high side of the agricultural fields to be irrigated. These ditches parallel the levees and discharge into laterals that distribute irrigation water throughout the islands. Some of the water is lost to evapotranspiration, the remaining water percolates down into the soil and eventually to deeper island drains. Water also enters and leaves the islands as underground seepage. Drain water is collected at the low side of the fields in drainage ditches. The drainage is pumped back into the Delta channels as the water level reaches a certain elevation in the drainage ditch carrying with it dissolved materials picked up in the soil (DWR 1990, Delta Island Report).

Increases in the salt concentration contained in soil is an unavoidable result of agricultural practices. Agricultural managers typically flood the land in winter to leach out the salts from the soil and prevent excessive buildup. This practice is necessary to prevent crop damage and to prevent loss of crop yield. As a result, agricultural drainage water typically contains high concentrations of dissolved material like the salts. During the summer, excess irrigation water picks up dissolved material as it seeps through the soil and returns to the Delta (DWR 1990, Delta Island Report). The San Joaquin Valley Drainage Monitoring Program, found that the major mineral elements included sodium, sulfate, and boron, in addition to the total dissolved solids (DWR 1990).

Figure 3-2 shows the approximate location of 43 agricultural drainage discharge points within the study area. The majority of these drains exist in the southern portion of this area of the Delta and close to CCWD intakes.

The 1990 Interagency Delta Health Aspects Monitoring Program report state that the Delta island peat soils contain high organic matter, and that drainage from these island do have high trihalomethane formation potential (THMFP) when compared to Delta waters (DWR 1990, Delta Island Report). Many factors will effect the resulting concentration in drinking water such as temperature and pH. The report did conclude the Delta soils may be a major contributor of organic THM precursors (DWR 1986). Brominated THM species was highest at Mallard Slough as a result of the higher bromide concentrations associated with seawater intrusion from the Bay. THM formation potential at Old River resembles the potential from diluted sea water. The southern Delta area has a greater potential than the northern Delta area. This is thought to be due to the low flows of the San Joaquin River and the large amounts of agricultural drainage.



APPROXIMATE LOCATION OF AGRICULTURE DRAINAGE RETURNS
Figure 3-2

3.2.5 Pesticide/Herbicide Use

Agricultural pesticides, such as organophosphates have a short half-life and may have degraded or been carried in dissolved form. Pesticides, such as chlorinated hydrocarbons, may adsorb onto particulate matter in agricultural drainage and settle in the river bottom with much of the sediment load.(SWC, 1990)

The 1990 Interagency Delta Health Aspects Monitoring Program reported that pesticide levels were generally below laboratory detection limits (DWR 1990). In July 1988, 30 agricultural drains were sampled for pesticides. A target list of 26 most likely pesticides were selected for analysis. Six out of 26 monitored pesticides were found above detection limits in one or more agricultural drains. These six are atrazine, bentazon, carbaryl, methamidophos, molinate (ordram), and simazine. In all cases, the levels were below existing drinking water criteria or action levels. None of these pesticides have been found in CCWD's quarterly sampling in the last 5 years.

Most of the residential streets that contribute runoff also collect drainage from the front yards of homes along the respective street. In addition, Canal property often includes a portion of the back yards from homes next to the Canal. It is unknown how much pesticide comes from residential land use. However, quarterly sampling on the Canal waters that are under this influence have not found detectable quantities of these pesticides. (CCWD, 1995a)

Weed control activities along the Canal are mostly accomplished with tractor mounted mowers to cut tall grasses and weeds, followed by a disking operation to prevent regrowth. Since 1988 CCWD has also used EPA approved glyphosate products for spot spraying. Tests conducted as part of an evaluation of glyphosate use on Canal right-of-way vegetation during March of 1992 did not find any detectable residuals downstream of the test plots. No glyphosate has been found in any samples of raw water used by CCWD.

The State Department of Boating and Waterways applies 2,4-D to water hyacinth in many of the Delta waters in an effort to control its growth and spread. Their application of the herbicide is limited to areas beyond a one mile radius from CCWD's diversion point at Rock Slough. Samples from routine monitoring by CCWD of its raw sources for the period 1991-1995 have all been below the State DLR (detection limit for reporting) of 10 μg/L for 2,4-D.

3.2.6 Grazing Animals

There are several areas of grazing that have the potential to impact Canal water quality (CCWD, 1995a). Common pollutants include coliform, ammonia, nitrates, and total dissolved solids.

However, the organism of greatest concern is *Cryptosporidium*. Grazing land probably contributes less significant quantities of these pollutants than confined areas, although the source of pollutant is still present. Studies are currently ongoing at the University of California-Davis examining the role of range beef cattle in the contribution of *Cryptosporidium* relative to that of dairy cattle (Correspondence, Dr. R. Atwill, May 1995).

3.2.7 Concentrated Animal Facilities

Dairy operations concentrate populations of cattle in feed lots and milking facilities far in excess of open range grazing operations. The attendant wastes are therefore also concentrated at these facilities, leading to handling and disposal problems. Stockpiled manure, wash water, storm runoff from corrals, pens, and other animal confinement areas are potential sources of pollution. Common pollutants include coliform, ammonia, nitrates, and total dissolved solids. Dairy calves less than two months of age are considered to be the greater potential source of *Cryptosporidium* oocysts than their elder counterparts in these concentrated clusters of cattle (Medical Ecology and Environmental Animal Health, Jan., 1995).

The State Water Quality Control Board adopted minimum guidelines for the management of animal waste in 1973. These guidelines prohibit the discharge of manure, wash water, and storm runoff from animal confinement areas. Control of these types of pollutants is mostly through proper management rather than by treatment.

The Emerson Dairy facility is located adjacent to the unlined portion of the Contra Costa Canal intake upstream of Pumping Plant Number 1. Drainage from the facility is directed away from the Canal and under normal circumstances does not effect Canal water quality. The dairy operation has historically had a pipeline crossing over the Canal that was used to pump a slurry of manure laden water from the operation north of the Canal to fields south of the Canal.

An episode occurred in 1993 where an investigation of intermittent high ammonia readings by the municipal retailers along the Canal led to the discovery that this conduit over the canal had a serious leak. Throughout the investigation the owners of the dairy were very cooperative with CCWD in determining the cause of the problem and in facilitating a solution. A new pipeline has been routed along the canal to a point where it is able to cross at an existing siphon location. The new alignment, finished in December 1995, virtually eliminates the possibility of a repeat discharge to the waters of the Canal intake.

3.2.8 Wild Animals

From the perspective of the Delta as a supply for the ultimate purpose of potable water use, these wild animal populations can have a localized impact on water quality. It has been noted in the historical operations of the Contra Loma and Mallard Reservoirs that concentrations of migratory waterfowl along the Pacific Flyway taking refuge on these bodies of water (especially during the "shoot days" in the hunting season) can cause a significant increase in raw water coliform bacteria. In the experience of the various treatment operations utilizing CCWD's raw source, from a microbial perspective, there has been no problem treating water during these periods.

Records maintained by CCWD on samples collected for *Giardia* and *Cryptosporidium* indicate that they have rarely been found in any of its Canal water monitoring since it began in 1991. Unfortunately the analytical methods used to detect these protozoans are very difficult and the recovery rates are low. It is known that these protozoans exist in Delta waters.

Very little is understood about species specific transmission potential of the various wild animal populations for *Giardia* and *Cryptosporidium,* however, the general understanding is that any warm blooded animal is a potential vector. With this understanding there are a number of mammals in the survey area that have the potential for acting as a vector in the transmission of this organism. Beavers, a documented carrier, have been noted taking up residence in at least one of the wasteway channels associated with the Canal (although not the Canal itself). Muskrats, river otters, deer, coyotes, foxes, various lagomorphs, and rodents are all documented within the Delta or the surveyed watershed. In addition to cattle grazing on lands adjacent to the Canal and surveyed watershed lands, a herd of Tule Elk are maintained on the lands of the Concord Naval Weapons Station.

3.2.9 Mine Runoff

For thousands of years before European settlers came to this region the local natives "mined" the cinnabar rich strata of the Mt. Diablo foothills as a source of red color for use in their art and decoration of religious objects. During the Gold-Rush era these cinnabar deposits were exploited for the elemental mercury it contained to be used in the refining process of gold ore. There were active mines in the Survey area that have operated on and off from the mid 1800s until as recently as the 1950s. There are currently no active mines in the Survey area.

At this time there is still elemental mercury in minute quantities that makes its way from the foothills in the Marsh Creek watershed into Marsh Creek and down to an impoundment at the Marsh Creek Reservoir. Mercury in its elemental form is unavailable to biota in the water column. As it deposits in the sediments of the water body and anoxic conditions develop, anaerobic bacteria digest and methylate the mercury creating a molecular form that is readily taken up and concentrated in the food chain. This methyl mercury is what has prompted health advisories to be published suggesting a limited consumption of fish from the Delta and its tributaries. (Personal communication, Sue Lloyd, CCC Health Department, Hazardous Materials Section, 22 Dec 95)

The lack of detectable mercury in the routine monitoring conducted by CCWD on its raw water sources would indicate that this source has not been a problem to the CCWD water supply.

3.2.10 Recreational Use

Contra Loma Regional Park supports various water-dependent activities including recreational fishing, swimming, canoeing, and wind surfing. Facilities include a changing room, snack bar, lounge area, lifeguard room, service yard, security residence, and park office. Water and sewer for these facilities are provided by the local municipal system. There are paved parking spaces for about 400 vehicles with an additional 600 spaces on grassy fields. The estimated number of people that the park can accommodate is 4000 on peak days.

Of the 70 Delta marinas identified, only six have been identified with a pump out station. Pump out Stations allow a house boat, or other self contained vessels, to pump out sewage for safe disposal. CCWD questioned the manager of a couple marinas to ask if boat owners actually use the pump out stations. The managers indicated that all their patrons use the pump out stations. The cluster of marinas and harbors near and around Bethel Island are up stream and in the vicinity of CCWD's Rock Slough intake. The practical affect of these facilities on water quality, as it effects CCWD, seems relatively benign at this time given the results of CCWD's regular monitoring.

3.2.11 Traffic Accidents/Spills

The California State Office of Emergency Services (OES) has a record of nine hazardous materials spills in north Contra Costa County, between Oakley and Martinez, since 1988. Table 3-4 summarizes the data search completed by the OES. Traffic accidents that result in a release of auto fluids are not included in this data base. Most of the recorded incidents involved a spill into a waterway. The remaining spills occurred within the property boundary of a commercial or industrial facility.

Table 3-4 **Summary of State OES Hazardous Materials Spills**

DATE	MATERIAL	CITY	SPILL LOCATION	AMOUNT (GAL)
INSIDE STUDY AREA				
Jan-88	Diesel Fuel	Concord	Walnut Creek	75
Jun-88	Diesel Fuel	Martinez	Suisun Bay	300
May-88	Black Liquor	Antioch	Manufacturing	2000
Mar-90	Diesel Fuel	Oakley	Harbor	20
Jun-90	Organic Waste	Holt	Slough	unk
Feb-92	unk	Concord NWS	Suisun Bay	50
Oct-92	Engine Oil	Suisun City	Mercantile	5
Oct-92	Waste Oil	Antioch	Shipyard	10
Mar-93	Diesel Fuel	Antioch	San Joaquin River	42
Jan-93	Petroleum Oil	Antioch	Industrial	10
1993	Petroleum	Concord	Pacheco Creek	7000
Jan-94	Gasoline	Antioch	Contra Loma Res.	2
OUTSIDE STUDY AREA				
Jan-89	Gasoline	Stockton	Slough	50
Jan-89	Engine Oil	Stockton	Slough	5
Oct-91	Gasoline	King Island	Harbor	20
Jun-90	Hazardous Waste	Linden	Calaveras River	unk
Mar-91	Diesel Fuel	Lathrop	San Joaquin River	100
Jan-89	Coal Dust	Stockton	San Joaquin River	50
Mar-90	Drug Lab Waste	Linden	Calaveras River	unk
May-90	Poison	Woodbridge	Mokelumne River	unk
Jun-90	Diesel Fuel	Stockton	Sacramento River	50
Jun-90	Oil	Stockton	Sacramento River	30
Jun-90	Oil	Stockton	Calaveras River	5
Jun-90	Pesticide	Stockton	Calaveras River	3
Jul-90	Butylate	Stockton	Lone Tree Creek	5
Jul-90	Phosalone	Stockton	Lone Tree Creek	5
Aug-90	Concrete	Stockton	Calaveras River	10
Apr-91	Corrosive Liquid	Stockton	Sacramento River	1
Apr-94	Gasoline	UNINC	Middle Paddy Creek	10
Feb-94	Unk Hydrocarbon	Stockton	Slough	unk
Jun-93	Waste Fuel	Stockton	Diverting Canal	50
Oct-92	Gasoline	Lodi	Mokelumne River	12

The drainage site from Buchanan Road is the primary site that poses a risk to Canal water quality from a potential accident and chemical spill. The traffic along Buchanan Road is heavy and includes some industrial traffic. Traffic on Willow Pass Road is also heavy with a potential for accidental spills. Information was not readily available on the frequency of accidents along Buchanan Road or Willow Pass Road so the risk of a spill in unknown.

On the basis of the available data, twelve accidents in the last seven years resulted in a spill of hazardous materials within the Study area boundary. The likelihood that a spill would occur on Buchanan Road, Willow Pass Road, or any of the other residential streets, and within the area that drains into the Canal is probably small.

The California Highway Patrol (CHP) was contacted to obtain data on the number and frequency of traffic accidents in our study area (personal communication with Officer Cliff Kroeger, 1996). The CHP prepares an annual report summarizing the years accidents by fatalities, injuries, and by property damage. The latest report available was for 1994 and several cities have stopped reporting damage only accidents. Damage only accidents include fender-benders and may not be significant.

Table 3-5 lists the reported traffic accidents for the cities within our study area, unincorporated areas and State Highways, and County roads for injury and property damage (total number of accidents). County totals include all cities within the county, and thus do not add with only the cities shown.

Table 3-5 California Highway Patrol Traffic Collision Statistics for 1994

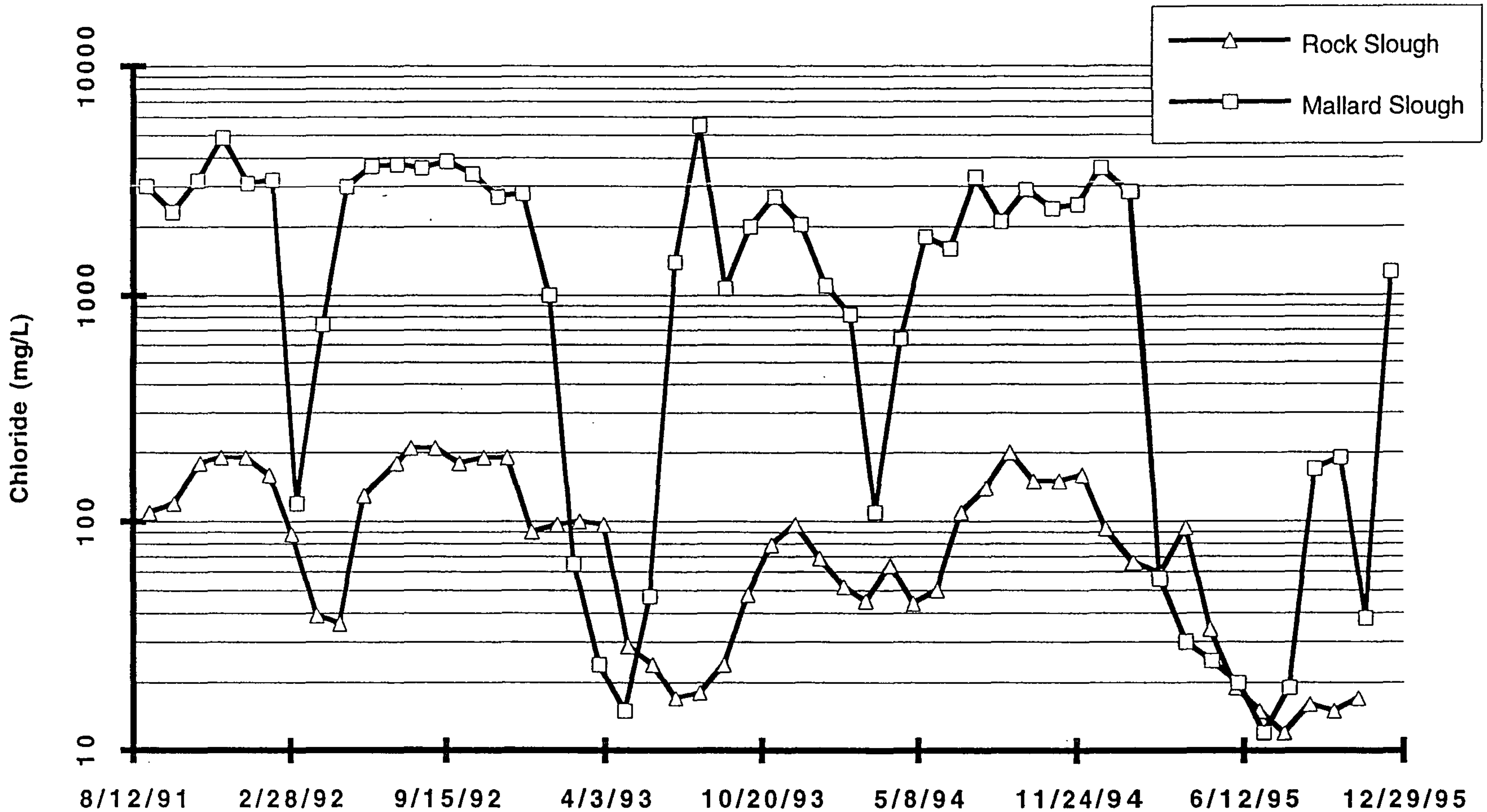
Locale	Injury Accidents	No. of Accidents Reported
Antioch	203	192
Brentwood	66	152
Clayton	15	40
Concord	594	757
Martinez	96	162
Pittsburg	135	168
Pleasant Hill	241	418
Walnut Creek	531	616
Unincorp, State Hwy	310	659
County Roads	659	1,147
County Totals	4,367	6,906

3.2.12 Seawater Intrusion

During periods of reduced freshwater outflow, the operation of water project pumps in the southern Delta causes the flow of the San Joaquin River and other channels to reverse their normal direction. When this occurs, sea water containing sodium, chloride, bromide and other salts more easily enters the Delta from the estuary and mixes with Delta waters. The primary impacts of sea water intrusion on drinking water supplies derived from the Delta is an increased salt content of the water and increased production of THMs in the finished water.(SWC, 1990)

On December 15, 1994, the heads of Federal and State agencies and representatives of urban water users, agricultural water users and environmental groups signed the "Principles for Agreement on Bay-Delta Standards between the State of California and the federal Government." The Principles for Agreement called for increased Delta flows to improve the estuarine habitat of Bay/Delta, as well as new export pumping limits. These increased flow requirements were incorporated into a Water Quality Control Plan adopted by the State Water Resources Control Board in May 1995.

Figure 3-3 depicts the seasonal trends in chloride concentration.



**SEASONAL CHLORIDE TRENDS
AT ROCK AND MALLARD SLOUGHS
Figure 3-3**

3.2.13 Geologic Hazards

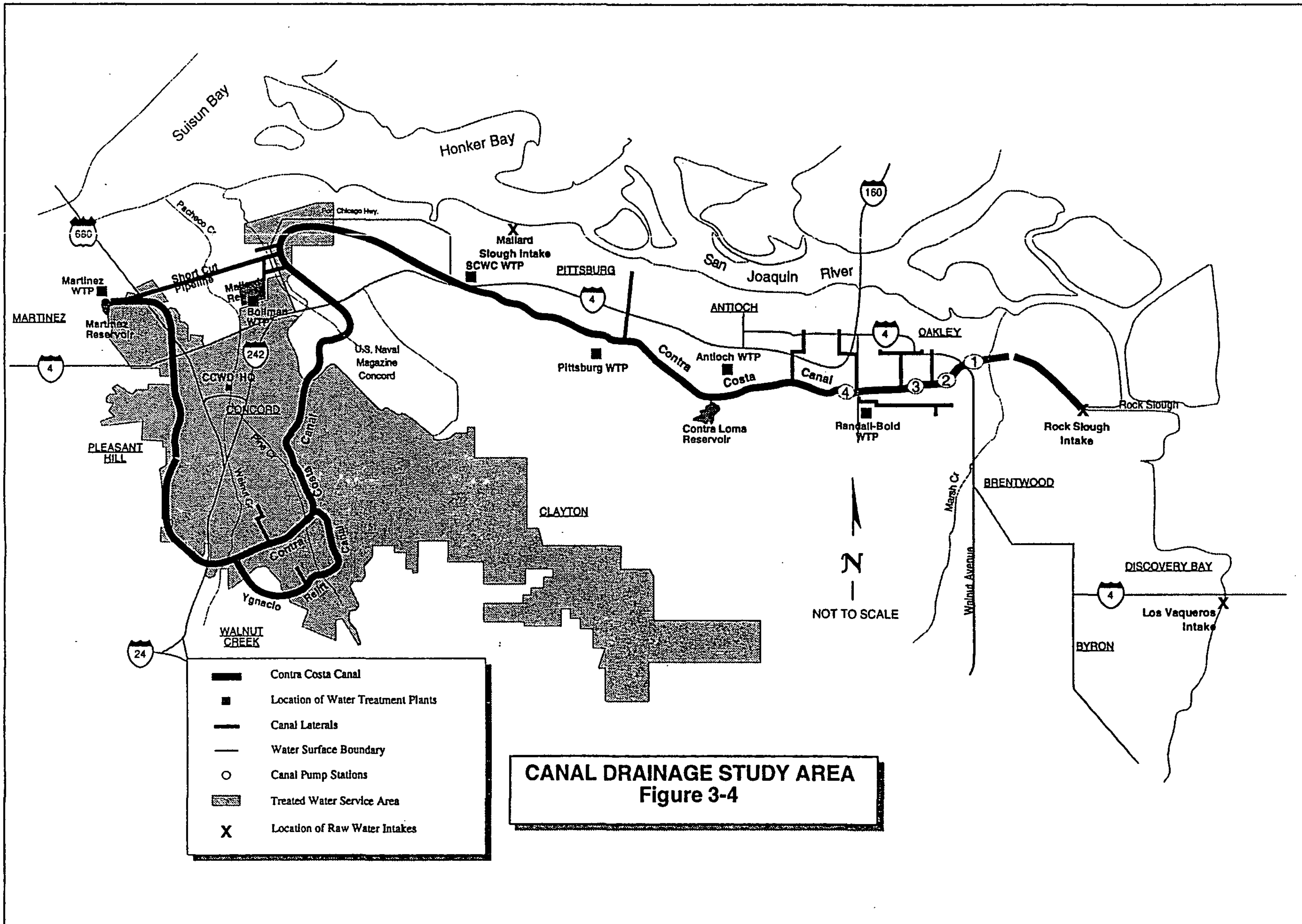
One of the greatest geologic hazards to water quality is the potential for levee failure as a result of an earthquake on one of the many geologic faults that traverse the Survey area. The Delta peat soils are particularly susceptible to liquefaction during earthquakes. If delta levees collapse, sea water from San Francisco Bay would surge into the Delta and render the Delta unusable as a source of drinking water. An earthquake of sufficient magnitude to liquefy levees has been predicted as likely to occur within the next 30 years. (SWC, 1990)

3.2.14 Canal Drainage Study

The United States Bureau of Reclamation built the Contra Costa Canal (Canal) as part of the Central Valley Project in 1940 primarily for agricultural irrigation. At that time, it was acceptable for storm runoff to drain into the Canal and the facility was designed to accept the drainage flow. However, use of Canal water changed over time from agriculture irrigation to primarily municipal and industrial water supply. The District, regulatory agencies, and the public have become increasingly concerned about the potential impacts from drainage on the drinking water supply. In addition, increasingly stringent drinking water standards make it more expensive and difficult to treat raw water supplies for drinking.

The study area consists of the area that drains into the Canal between Rock Slough and Martinez Reservoir, and of the area that contributes drainage to the Delta in the vicinity of Rock Slough. Figure 3-4 shows the location of the Canal, Rock Slough, and general area features.

During the first half of fiscal year 1995, staff completed an extensive field investigation of the study area. The field investigation consisted of detailed observations of the Canal and adjacent property, and is the foundation upon which the entire study is based. Drainage site physical characteristics are used to define its runoff volume and quality characteristics.



CANAL DRAINAGE STUDY AREA
Figure 3-4

3.2.14.1 Field Investigation Findings

Table 3-6 summarizes general characteristics of the identified drainage sites. The summary includes land use type, the number of sites with the specified land use, the total acres, and the percentage of the total area each land use type contributes to Canal drainage. The following findings are summarized from Table 3-6:

- 134 total drainage sites are identified by this study for a total of 1,660 acres. Twenty-one sites contribute drainage from land area that is outside the Canal property and small adjacent land as defined in the Canal Drainage Study. Exhibit A shows the general location of these twenty-one sites.
- Eighty-six percent (86%) of the drainage land area consists of open space (with minor grazing), fields, and back yards of homes adjacent to the Canal. This includes the Concord Naval Weapons Station (42%), the Canal property and small adjacent land (38%), and Ygnacio Canal open space (6%).
- Fourteen percent (14%) of the drainage land area consists of agriculture and mixed urban land uses. This includes a single 150 acre agriculture site in Oakley (9%) and 84 acres of residential streets and pasture, commercial, highway, and one small PG&E site.

Table 3-6 Canal Drainage Site Summary

No.	Land Use Type	Number of Drainage Sites	Sites Grouped	Total Acres	Percent of Total Drainage Area
1	Concord Naval Weapons Stations Property / grazing	5	1 (a)	700	42
2	Canal property and small adjacent land	107	- (b)	626	38
3	Agriculture/grazing	1	1	150	9
4	Ygnacio Canal open space/grazing	3	1 (c)	100	6
5	Urban residential	10	10	32	1.9
6	Residential pasture	3	3	30	1.8
7	Highway	1	1	11	0.7
8	Commercial	3	3	9	0.5
9	Light industrial/PG&E site	1	1	2	0.12
	Total	**134**	**21**	**1,660**	**100**

a) For simplification and convenience, the five Concord Navel Weapons Station sites are grouped and treated as a single site throughout the study. These sites are close together and enter the Canal in a relatively short distance.

b) The analysis was designed to reduce the total number of sites down to a manageable size and to focus attention on the most significant sites and those that would provide the greatest chance to find cost-effective solutions. The Canal property and small adjacent land is not included in the drainage impacts analysis, except for its contribution to the overall sediment load.

c) For simplification and convenience, the three Ygnacio Canal open space sites are grouped and treated as a single site throughout the study. These sites are close together and enter the Ygnacio Canal in a relatively short distance.

3.2.14.2 Initial Assessment Results

Table 3-7 lists the 21 sites identified during the study and their relevant characteristics. The intent of the initial assessments was to reduce the large number of sites down to a manageable size, to focus attention on the sites more likely to cause an impact, and provide low-cost effective solutions. On the basis of the initial assessments, the conclusions for flood potential and water quality impacts reported in the Canal Drainage Study are outlined in the following sections.

TABLE 3-7

CANAL DRAINAGE SITE ASSESSMENT OF PHYSICAL CHARACTERISTICS

Canal Mile Post	Exhibit A I.D.	Site Description	Size of Drainage Site	Land Use	Distance to Nearest Turnout	Public Safety / Liability	Traffic Frequency	Canal Section (Main Canal or Loop)		Potential to Cause Flooding	Development Potential	Illicit Discharge Potential	Accidental Spill Potential	Erosion Potential	Pollutant Type
3.1 - 3.2	1	Oakley agriculture w/cattle	●	●	⊙	○	-	⊙		○	⊙	○	○	⊙	●
7.78 - 7.99	2, 3	Hillcrest residential area, maintenance lot, and horse stall	⊙	●	●	○	-	⊙		○	○	●	●	⊙	●
10.3	4	Delta Memorial Hospital parking lot and open space	●	⊙	⊙	○	⊙	⊙		○	⊙	○	○	●	⊙
13.9	5	Buchanan Road and adjacent open space w/grazing	●	●	●	○	●	⊙		○	⊙	⊙	●	⊙	●
20.18	6	Two church parking lots and Canal Road	○	⊙	●	○	⊙	⊙		○	○	○	○	⊙	⊙
20.88	7	PG&E Transformer Utility, Willow Pass Substation	○	⊙	○	○	-	⊙		○	○	○	⊙	⊙	⊙
22.2-27.8	8	Concord Naval Weapons Station open space w/grazing	●	⊙	○	○	-	⊙		⊙	⊙	○	○	●	●
31.5	9	Willow Pass Road / Clayton Way residential area	●	●	○	○	⊙	○		○	○	○	⊙	⊙	⊙
32.0	10/11	Euclid / Walnut Avenue residential area	⊙	⊙	○	○	⊙	○		○	○	○	○	⊙	⊙
39.0	12	First Avenue residential area	○	⊙	○	○	○	○		○	○	○	○	⊙	⊙
40.21	13	Bridge Road residential area	○	⊙	○	○	○	○		○	○	○	○	○	○
41.59	14	Best Road / Camino Las Juntas residential area	○	⊙	○	○	○	○		○	○	○	○	⊙	⊙
43.65	15	Fourth Avenue / Christen Drive residential area	○	⊙	○	○	○	○		○	○	○	○	⊙	⊙
43.82	16	High Street residential area	●	⊙	○	○	○	○		○	○	○	○	○	○
44.0	17	Residential pasture	⊙	○	○	○	-	○		○	○	○	○	○	●
45.9	18	Residential pasture	⊙	○	○	○	-	○		○	○	○	○	○	●
47.1	19	Residential pasture	⊙	○	○	○	-	○		○	○	○	○	○	●
47.63	20	Private residence with significant yard storage and live stock	○	⊙	●	○	○	○		○	○	●	●	⊙	●
YCT 0.61 to 1.56	21	Ygnacio Canal open space	●	○	○	●	-	○		●	○	○	○	●	⊙

KEY:	LOW ○	MEDIUM ⊙	HIGH ●
Size of Drainage Site	less than 3 acres	3 - 6 acres	greater than 6 acres
Land Use	open space	residential / commercial	industrial / highway / agriculture
Distance to Nearest Turnout	greater than 1.4 miles	1800 feet to 1.4 miles	less than 1800 feet
Public Safety / Liability	fenced or no risk from drainage	-	access or risk to public exists
Traffic Frequency	light residential traffic	heavy residential & commercial	highway traffic with industry
Canal Section (Main Canal or Loop)	Canal Loop	Main Canal, high dilution	Main Canal, low dilution
Potential to Cause Flooding	small runoff volume	large volume / potential mitigated	flood potential exist
Development Potential	no potential	potential exist / open space	development planned
Illicit Discharge Potential	no potential	potential exist	illicit discharge probable
Accidental Spills	spills not likely	chemicals likely	chemicals present
Erosion Potential	no erosion evident	loose sediment / bare ground	erosion evident
Pollutant Type	metals, organics, hydrocarbons	sediment, nutrients, DBP by-products	bacteria, virus, pathogens

3.2.14.2.1 Flood Potential

Runoff volumes for the identified drainage sites have been estimated using an average storm size of 0.048 inches per hour with a duration of 14 hours. Table 3-8 list the sites by land use type and their summed runoff volumes.

The Canal Drainage Study used the rational formula to estimate runoff quantity. This approach is based on the product of area, rainfall intensity, and a runoff coefficient. Many factors affect the amount of runoff from any given site during a storm event, such as the shape and area of the site, soil and infiltration characteristics, slope, period and intensity of a storm, soil saturation, etc. The runoff coefficient accounts for the site specific characteristics such as slope and infiltration.

Because of the large area and steep hillsides, the Concord Naval Weapons Station will contribute the largest volume of runoff to the Canal system (47%). The Ygnacio Canal is the second largest single contributor of runoff to the Canal system (9%). Canal property and the small adjacent land consist of many small individual sites. As a total it contributes the second largest volume to the Canal (30%), but, it is distributed along the Canal's entire length. Most all the other sites are either small in area or relatively flat, resulting in low runoff.

Table 3-8 Estimated Runogg Volume from Drainage Sites for an Average Storm (0.048 inches/hour)

Land Use Type	Total Volume (a) (acre-feet)	Percent of Total
Concord Naval Weapons Stations open space / grazing	16	47%
Canal property and small adjacent land	10	30%
Ygnacio Canal open space/grazing	3.1	9%
Agriculture/grazing	1.7	4.8%
Urban residential	1.4	4.1%
Residential pasture	0.6	1.7%
Highway	0.5	1.5%
Commercial	0.5	1.5%
Light industrial	0.11	0.3%
Total	35	100%

a) Runoff rates estimated by using the Rational Formula and assumed runoff coefficients. Runoff values shown are summed from all individual drainage sites in the specified land use.

Flood Potential Findings

- Flooding of the Canal system is not likely to occur except under extreme rainfall events of heavy intensity and long duration similar to that experienced in January and March 1995.

- The average drainage event has the potential to contribute 15% (26 cfs) of the average Canal flow rate (170 cfs) pumped into the Canal at Pumping Plant No. 1. A storm with a high intensity and long duration has a potential to contribute as much as 40% (68 cfs) of the average Canal flow at Pumping Plant No. 1.

- The Concord Naval Weapons Station contributes the largest volume of drainage (approximately 50% of the total drainage volume) to the Canal system due to the size of the land area.

- The Ygnacio Canal open space contributes less than 10% of the total volume of drainage, but, contributes the largest rate of runoff (cfs) relative to the receiving Ygnacio Canal capacity. The flood risk at this site is considered a potential threat because the Ygnacio Canal does not have wasteways or any other means to discharge excess flow from the canal.

- The Canal Loop and Ygnacio Canal flows consist almost entirely of drainage during a significant rainfall event.

3.2.14.2.2 Drainage Water Quality

For those sites where the vegetation is managed by chemical application, potential pollutants consist of the chemicals used on site. For example, trace amounts of pesticides and fertilizers are known to originate from agriculture and residential land uses. In the District's case however, little fertilizer or pesticide is expected in the drainage from the Oakley agricultural site. The Oakley site has lain fallow for the last couple of years, although it has been used in the past for alfalfa. Alfalfa production requires little fertilizer or pesticide. Most of the residential streets that contribute runoff also collect drainage from the front yards of the homes along the respective street. In addition, Canal property often includes a portion of the back yards from homes next to the Canal. It is unknown how much pesticide or fertilizer comes from residential land use.

There are two large grazing sites and three small pastures that exist along the Canal. These sites consist of the Oakley agriculture site, the Concord Naval Weapons Station property, and the small rural residential pastures (1 or 2 acre pasture). Nitrates, coliform and Cryptosporidium may be present in runoff from these sites.

There are seven low traffic residential streets, three parking lots, and one highway that drain into the Canal. Parking lots, streets, and highways can contain metals, oil, grease, and other petroleum products from automobiles. Asbestos from brake linings, gasoline, coolant, and rubber can also be present. Concentrations depend on the frequency and period the automobiles are present. The maintenance lot on Hillcrest involves the repair of mechanical equipment that contains petroleum products like oil, grease, and other auto fluids. Solvents and other cleaners are likely present.

Several drainage sites contribute sediment and turbidity to the Canal. The streets identified with dirt shoulders and no concrete curb and gutter showed evidence of sedimentation into the Canal. In addition, there are several Canal property sites that showed evidence of sedimentation into the Canal. These sites typically consist of a channel cut into the soil to intentionally collect drainage and route it to a culvert for disposal into the Canal. The purpose is to prevent uncontrolled runoff into the Canal and undermining of the Canal lining.

Water Quality Findings

- The following sites pose the greatest relative potential to impact Canal water quality when compared to the other sites (this does not imply a significant impact, but, is simply a comparison between sites). The numbers in parentheses indicate the site number shown on Exhibits A and B.
  1) Buchanan Road (#5)
  2) Hillcrest residential and maintenance yard (#2,3)
  3) Private residence with storage (#20)
  4) Oakley agriculture with cattle (#1)
  5) Willow Pass Road and residential area (#10)
  6) Concord Naval Weapons Station (#8)

- On the basis of the Canal Drainage Study, there is little evidence that Canal water quality is adversely affected by drainage.

- Water treatment plants have historically been able to handle the existing raw water quality. On the basis of routine treated water data collected from 1990 to 1994, there is no evidence that raw water quality caused a failure to meet a state of federal water quality regulation. There is no evidence that drainage causes a public health hazard; however, there are no data for public health parameters collected during a drainage event that allow assessment of changes to these parameters.

- An earlier study was conducted by the District on nutrient loads to Mallard Reservoir. Composite samples were collected at the reservoir inflow (Canal at Clyde) between October 1991 and March 1992. The samples were analyzed for nitrogen and phosphorus compounds. Although no direct correlation between the nutrients and rainfall was identified, total phosphorus and nitrate showed increased concentrations during the rainy season.

- Daily chloride data between January 1995 and March 1995 show that chloride levels at Clyde are consistently higher than chloride levels at Rock Slough during drainage events. Using only those data measured during a rainfall event, chloride concentrations at Clyde average 12% higher than Rock Slough, and ranged from -13% to +54% (54% equaled an increase of 35 mg/l).

3.2.14.3 Canal Drainage Study Analysis

The predicted changes in chloride, nutrient and metal concentrations are discussed below.

3.2.14.3.1 Changes in Chloride Concentrations

The following observations are made from the results of the probability model which assumes Los Vaqueros is on-line and providing less than 50 mg/l chloride:

- Most of the drainage sites have little affect on chloride concentrations due to their small drainage areas and drainage.
- The largest contribution of chloride comes from the Concord Naval Weapons Station. This site discharges drainage from 700 acres of open space with grazing.
- The resulting Canal chloride concentration could exceed 65 mg/l around mile post 22 during a drainage event and will increase the overall chloride load to Mallard Reservoir and downstream users. It should be noted that the true chloride concentration in drainage is unknown at this time.

3.2.14.3.2 Changes in Nutrient Concentrations

The following observations are made for nitrate from the results of the probability model (phosphorus was modeled, but, remained essentially unchanged):

- Nitrate concentrations in the main Canal remain essentially unchanged, thus, drainage has little impact on nitrate concentrations.
- The variability of nitrate in the Delta is greater than the variability found in urban runoff. As a result, the source water supply has more influence over nitrate concentrations in the Canal than drainage. Mitigating drainage would have little effect on reducing nitrate and phosphorus concentrations in the Canal.

3.2.14.3.3 Changes in Metals Concentrations

The median metals concentrations increase in the Canal from the addition of urban runoff; slightly in the main Canal and more significantly in the Canal Loop. Lead, which is 100 times greater in urban runoff than the source water supply, should show the greatest impact on Canal water quality than any other parameter. The following observations for lead and copper are made from the results of the probability model:

- Lead concentrations in the Canal have the potential to exceed the EPA treated water action level of 0.015 mg/l. It should be noted that lead concentrations in treated water from the Bollman WTP have not exceeded the EPA action level since lead monitoring was initiated in 1992.
- The source water supply has more influence over copper concentrations in the Canal than drainage. Mitigating drainage would have little effect on reducing copper concentrations in the Canal.
- Lead and copper concentrations increase in the Canal Loop as the fraction of drainage to raw water supply increases.
- The concentration of copper is not expected to reach the EPA Action Level of 1.3 mg/l.

3.2.14.3.4 Comparison to Water Quality Criteria

The resulting peak Canal concentrations in the main Canal are compared to various water quality criteria. The comparison to these criterion is provided for generalization purposes and to develop an understanding of the magnitude of resulting Canal concentrations. The criterion include the Los Vaqueros goal for chloride, maximum contaminant level (MCL) for nitrate, treated water action levels and acute water quality objectives (WQO) for lead and copper (see Table 3-9).

Table 3-9 Probability of Exceeding Water Quality Criteria

	Cl	NO3	Cu	Pb
Criterion	65	10	1.3	0.015
Probability of Exceeding the Criteria in main Canal during a storm	**0.134**	**.005**	10-10	**0.033**
Acute WQO (1-hour exposure)	-	-	0.018	0.082
Probability of Exceeding the Criteria in main Canal (Dissolved Fraction)	-	-	**0.005**	10-10

Units: All units in mg/l. Acute WQO is based on an assumed hardness of 100 mg/l.
Probabilities of exceedences are based on Canal concentrations at mile post 25.3

Acute water quality objectives are not intended as compliance limits, but, are guidance levels. Acute water quality objectives represent short term 1-hour exposure. Metals exist in the aquatic environment in three broad categories: particulate, colloidal, and soluble phases. Because the soluble, or dissolved fraction rather than the total is directly available for aquatic organisms, the dissolved fraction is considered to be the most representative comparison to the water quality objectives. Literature was reviewed to determine the average percent of total metals found in the dissolved form. For estimating purposes, the following percentages are assumed to estimate the dissolved fraction: copper = 40% and lead = 15%.

Drainage could cause the chloride concentrations in the Canal at Clyde to exceed 65 mg/l during a drainage event (~14 hours) and increase the overall chloride load to Mallard Reservoir and downstream users. Based on probability analysis, cumulative chloride might exceed 65 mg/l approximately 3.5 times (13.4% of drainage events) each year. The largest source appears to be natural and from open space.

Total cumulative lead concentrations in the Canal have the potential to exceed 0.015 mg/l approximately once every 1.2 years as a result of drainage (0.5% of drainage events); however, total lead is not expected to cause a significant impact because 80% to 90% is adsorbed onto suspended material and will settle out and be removed during treatment.

Nitrate concentrations in the Canal do not appear significant when compared to the water quality criteria of 10 mg/l. Nitrate might exceed 10 mg/l in about 0.5 percent of the drainage events (once every 7 years), although it would more likely be a result of high source water nitrate concentrations and not a result of drainage.

Total copper concentrations in the Canal are insignificant when compared to the EPA Action Level of 1.3 mg/l. Dissolved copper concentrations in the Canal do not appear significant when compared to the acute water quality objectives. Dissolved copper might exceed 0.018 mg/l in about 0.5 percent of the drainage events, although it would more likely be a result of source water concentrations and not a result of drainage.

3.2.14.4 Significance of Drainage

The Canal Drainage Study indicates that concentrations in the Canal will vary along its length with cumulative impacts occurring farther downstream. Raw water customers near Bay Point and along the Canal Loop are more likely to experience changes in raw water quality than customers closer to Rock Slough. However, even if a significant drainage event was to occur, the impacts to Canal users would likely be small.

The treated water quality produced at the Bollman WTP should not be affected from drainage because of Mallard Reservoir. The volume of Mallard Reservoir is large compared to the volume of Canal inflow during a drainage event (~2% to 3%) and will dilute increases in concentrations resulting from the short-term drainage event (14 hours). Both Martinez Reservoir and Antioch's municipal reservoir will have the same dilution affects. No significant impacts are expected for the

Randall-Bold WTP because of its location on the Canal. Only one drainage site exists before the Randall-Bold turn-out (Site #1-Oakley agriculture). As indicated in the study, probable impacts are likely to occur farther downstream after a number of sites have contributed drainage to the Canal. The City of Pittsburg and the Southern California Water Company may observe short-term increases in some parameters during a drainage event. All of these water treatment plants have historically been able to handle the existing raw water quality.

Industrial customers may also experience short-term increases in some parameters during a drainage event. However, industries list ammonia and phosphate as the two most critical parameters affecting their use. Model results suggest that drainage has little impact on Canal water nutrient concentrations (nitrate and phosphorus). The study suggests that drainage can affect TDS concentrations, although resulting concentrations are not likely to exceed the industrial limit of 550 mg/l.

Irrigation users will not likely be using water from the Canal during a drainage event and thus are not likely to experience changes in raw water quality.

3.2.14.5 Canal Drainage Management Practices

Although drainage does not appear to constitute a significant threat, methods to mitigate drainage impacts have been evaluated for their potential to minimize flooding and potential water quality impacts at selected sites. In general, there are four alternatives for managing storm drainage; 1) route storm runoff around the Canal to a downstream drainage system, 2) reduce and/or treat the runoff before it enters the Canal, 3) reduce or eliminate pollutants in drainage, or 4) continue current practices.

The Canal Drainage Study summarizes potential control measures appropriate for the sites most likely to impact the Canal system. Both non-structural and structural controls are considered. New control measures were selected to complement and not duplicate existing District or other agency control measures. An example of source control is a public educational program emphasizing proper disposal of hazardous material. Routing runoff downstream to an alternate drainage system can be expensive and requires an appropriate downstream disposal facility capable of handling the increased runoff volume. Upgrading downstream facilities was not addressed in this study.

The Canal Drainage Study provides a detailed discussion of existing District and other agency management practices and an explanation of which control measure is proposed for each drainage site. A brief outline is provided below.

- The District is currently implementing management practices that maintain Canal water quality and reduce the risk of flooding. These practices include the review of adjacent land development, Canal cleaning, fencing, vegetation and soil management.

- Other agency's (e.g., the Contra Costa County Clean Water Program) currently implement management practices that have the potential to positively affect Canal drainage. For example, street sweeping is currently conducted at many of the drainage sites with paved streets and parking lots.

- The most feasible control measures for the District to implement include public education and risk abatement (i.e., source controls).

- Possible structural control (although expensive) is the installation of storm drain systems that discharge runoff to municipal storm drain systems. The installation of a storm drain system at the Ygnacio Canal open space site will likely be required to mitigate the potential flood risk.

3.2.14.6 Recommendations from the Canal Drainage Study

The recommendations resulting from the Canal Drainage Study consist of specific measures to immediately implement and recommendations for further study and data collection to better define flooding and water quality problems and solutions.

3.2.14.6.1 <u>Flooding</u>

The Ygnacio Canal open space and the Concord Naval Weapons Station are the two sites with the most potential to cause flooding problems.

No corrective measures are warranted for the Concord Naval Weapons Station because flooding in the main Canal can be alleviated by reduced pumping at Rock Slough and release of excess water through several wasteways. Elimination of runoff from the large area of open space that drain to the Ygnacio Canal may be warranted. A more detailed evaluation of the Ygnacio Canal site is recommended to verify this result.

Near flooding conditions occurred along the Ygnacio Canal during the severe storms of 1995. A risk assessment to determine the extent, frequency, and degree of flooding is recommended. After completion of a risk assessment, alternatives to eliminate the flooding should be investigated if there is a substantial risk. A possible alternative is the installation of storm drain at an estimated cost of $450,000.

3.2.14.6.2 Water Quality

On the basis of the Canal Drainage Study, the high cost of structural controls is not appear justified to mitigate for water quality. Although the study does suggest that drainage can impact Canal water quality, there is little evidence that drainage adversely impacts delivered water quality and District customers to an extent that requires immediate action.

"Drainage event" water quality sampling is recommended prior to assessing the need for structural controls. All data collected to date by the District should be reviewed to assist in the design of the monitoring program. The drainage sites of most concern identified in the Canal Drainage Study should be included in the monitoring program. Water quality parameters of most concern to drinking water supplies should be included in the program. After water quality data are collected and reviewed the District should re-evaluate the need for structural control measures to alleviate any identified water quality problems. A copy of the Canal Drainage Monitoring Program is included in Appendix A-4.

Non-structural controls that the District can implement to safeguard water quality include public education and risk abatement as outlined in the report. If potential water quality problems can be alleviated by educating property owners on the proper storage and disposal of hazardous materials and other drinking water contaminants, structural controls may not be necessary. These programs can be implemented easily and are relatively inexpensive. First year costs are approximately $20,000 for public education and $20,000 for risk abatement. Estimated re-occurring annual costs would be less than $10,000 per year for each program.

It is also prudent to further evaluate the Buchanan Road site. Buchanan Road contributes the poorest quality drainage to the Canal and is relatively inexpensive to mitigate. Estimated costs to re-direct drainage to the municipal storm drain system ranges from $60,000 to $150,000 (Table 2) depending on the method used and outside agency requirements. Before mitigation is implemented, drainage event sampling to verify this result and the development of preliminary designs (with costs) are recommended.

The District should consider improved soil erosion and sediment control practices as part of its Integrated Vegetation Management Program. One example is to mow vegetation along the Canal rather than disk the soil to leave vegetation in place to hold sediments.

3.2.15 Canal Crossings

CCWD conducted a survey of the Canal to determine what piped crossings exist along its 48 mile length. Performed during the summer of 1994, CCWD surveyed 393 confirmed canal crossings over the lined portion of the canal and have separated them into six main groupings (Table 3-10).

Table 3-10 Canal Crossings Summary

Number	Conveyance Type	Conveyance Material
95	storm drains	storm water
86	water mains	water
80	gas lines	natural gas
78	sanitary sewers	domestic sewage
29	oil lines	oil or petroleum products
25	unknown	unknown at this time
393	Total	

Information which identifies the canal crossings by size, type, owner, contact, contents, and specific location are inventoried and maintained on a database by the Water Quality Section of CCWD. The entire 48 mile length of the canal has been walked by District personnel to confirm that each pipe crossing could be identified or located.

Of all the crossings, the sanitary sewers and oil lines (totaling 107 or 27% of the crossings) have the greatest potential for harm to CCWD's water supply. The oil lines become a problem of coating the surface with a layer of petroleum-based compound, thus contaminating the canal walls, siphons, and check points. A sewer line break creates the health hazard of fecal material and other harmful pathogens entering the water supply. Such a problem occurred in December of 1992 when a dairy operation pumping manure runoff across the canal had their line break in the levee and intermittently contaminate the water supply for 12 days.

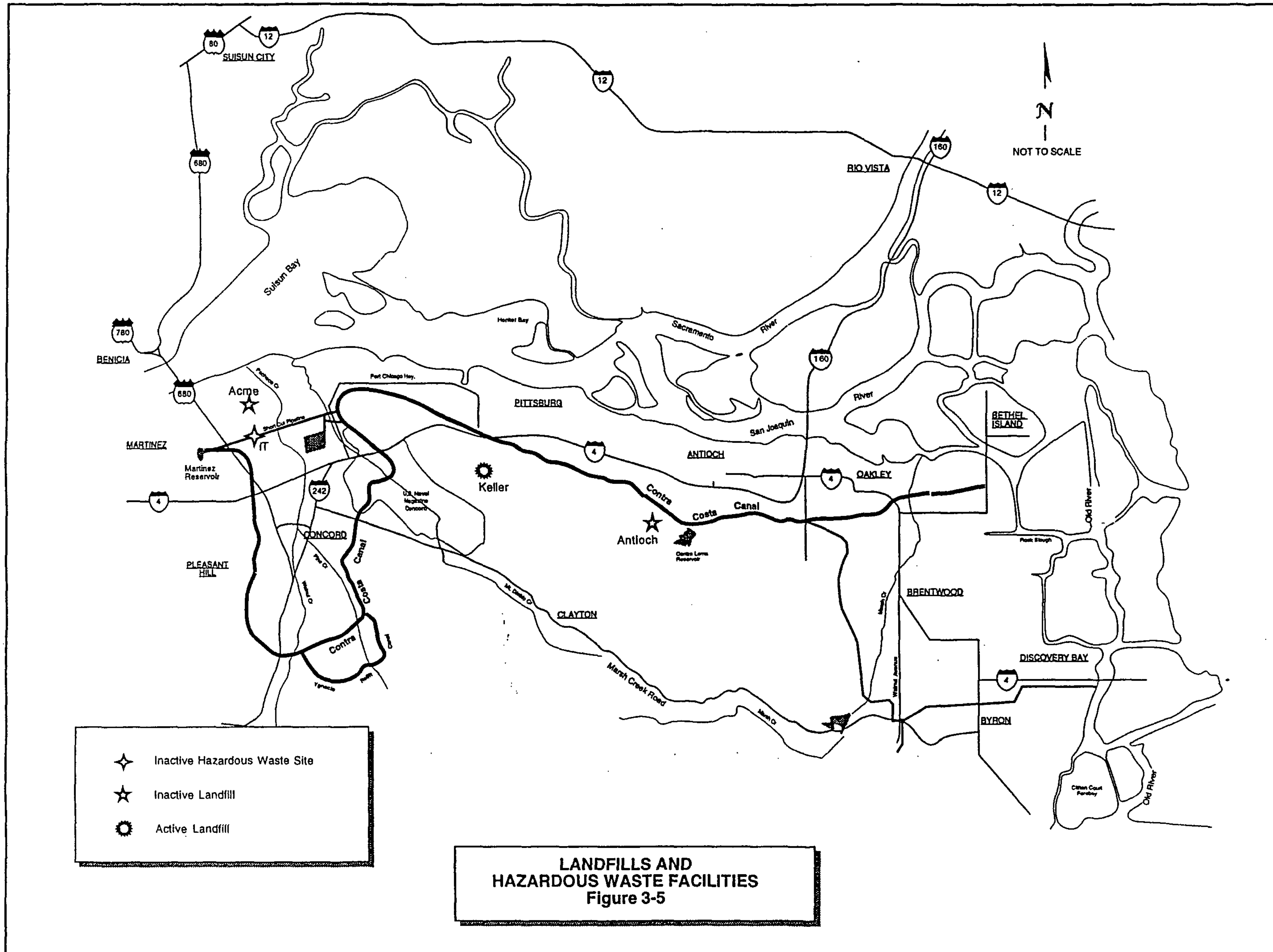
Natural gas should not be as much of a problem because all of the lines are above the water supply and a crack or loss of integrity of the line would most likely spill the gas into the atmosphere and not the water supply. Of the 25 unknown pipe crossings, most appear to be water-related lines such as water or irrigation pipes. The process of positive identification of the unknown pipe crossings is ongoing and should be completed in the course of the upcoming year.

3.2.16 Solid and Hazardous Waste Disposal Facilities

Historically there have been several solid and hazardous waste facilities sited within the study area. However, currently there is only one active landfill (Keller Landfill, Pittsburg) and one active hazardous waste facility (IT, Benicia). While the landfill at the old Acme site is closed, there is a garbage transfer station still in operation in this location. Figure 3-5 locates the various facilities, both active and inactive within the study area.

Several disposal and recycling companies operate within the study area. Canal operations benefit from the collection and recycling of used motor oil, aluminum, glass, paper, plastics, etc. With easy access to these services, single family homes and businesses can reduce roadside litter and wastes that affect the Canal property and the Canal's raw water supply.

BFI Pleasant Hill Bayshore Disposal serves the Antioch, Bay Point, and the unincorporated areas of Concord, Martinez and Pleasant Hill. BFI provides curbside oil and car battery collection in Antioch and Martinez. In addition, BFI recycles plastics, glass, aluminum and tin (published public information). Concord Disposal Service provides curbside recycling of newspaper, aluminum, any bottled glass, tin or steel cans, and plastic. Commercial sites recycle white paper, cardboard, glass, and plastic. The City of Pittsburg includes recycling in its general garbage collection service. Recyclables include newspapers aluminum cans, and plastic (published public information).



LANDFILLS AND
HAZARDOUS WASTE FACILITIES
Figure 3-5

3.2.17 Logging

There are no significant logging activities in the study area.

3.2.18 Major Creek Inflows

At the request of the Department of Health Services, in its review of earlier drafts of this document, an attempt was made to describe the flows of three of the major creeks in the study area - Marsh Creek, Mt. Diablo Creek, and Walnut Creek. Basic observation indicates that all three are subject to urban and highway runoff. Mt. Diablo Creek and Walnut Creek drain the bulk of the Diablo Valley, while Marsh Creek drains a large portion of eastern Contra Costa County. The Contra Costa County Flood Control was contacted for flow data and indicated that they did not have outflow data to the main river for these creeks.

Marsh Creek is subject to agricultural runoff as well as the discharge from Brentwood's wastewater treatment plant. Reference to Marsh Creek is also made in Section 3.9 Mine Runoff.

Walnut Creek empties into Pacheco Slough before it empties into Suisun Bay. The Pacheco Slough area runs between the Tosco refinery complex on the east and the decommissioned IT hazardous waste ponds and the old ACME landfill on the west. This area appears to have a potential for impacts of stormwater runoff and groundwater seepage from these facilities. Further attempts to gather data for the requested characterization will continue and will be provided either as an addendum to this document or included in the next update.

3.2.19 Hazardous Materials Storage

Several of the industrial operations in the study area by the nature of their businesses have need to store significant quantities hazardous materials on site. The nature of the materials and quantities stored are required to be identified in a Business Plan kept on file at each site and at the County Environmental Health Division, Hazardous Materials Section. Table 3-11 is a summary of the most significant of these sites and the nature of the materials stored. More specific locations of these facilities can be found in Appendix A-1 and Figure 3-1.

Table 3-11 **Stored Hazardous Materials within the Study Area**

Facility / Location	Stored Hazardous Materials
Tosco Corporation, Martinez	Crude Oil, Petroleum products, Acids
Rhone Poulenc, Martinez	Sulfuric Acid, Oleum, Ammonia
Hysol/Dexter, Pittsburg	Nitric Acid, Solvents, Proprietary Adhesives
Dow Chemical, Pittsburg	Chlorine, HF
Praxair-Linde Division, Pittsburg	Cryogenic gases
General Chemical, Pittsburg	Anhydrous HF, Sulfuric Acid, Oleum, Nitric Acid
PG&E, Pittsburg	Natural Gas, Bunker Fuel, Acids, Flocculants
Imperial West Chemical, Antioch	Chlorine, Alum
GWF Power Plant, Antioch	Anhydrous Ammonia
Du Pont, Antioch	Titanium tetrachloride (production to end Jan 1, 1998)
PG&E, Antioch	Natural Gas, Bunker Fuel
Exxon, Benicia	Crude Oil, Petroleum products

3.3 Significance of Potential Contaminant Sources

Table 3-12 Relative Significance of Potential Contaminant Sources

Source	Relative Quantity Impact	Public Health Hazard	Treatment Difficulty	Availability of WQ Data
Municipal Wastewater	M	M	M	H
Industrial Wastewater	M	M	M	H
Urban Runoff	M	M	M	M
Highway Runoff	M	M	M	M
Agricultural Runoff	M	M	M	M
Pesticide Use	M	M	M	M
Grazing	L	M	H	L
Concentrated Animal Facilities	L	M	H	L
Wild Animals	L	M	H	L
Mine Runoff	L	M	L	M
Recreation	L	M	M	M
Accidents/Spills	L	M	M	L
Seawater Intrusion	H	M	H	H
Geologic Hazards	M	M	M	L
Canal Drainage	M	M	M	M
Canal Crossings	M	M	M	M
Waste Disposal	L	L	L	L
Logging	L	L	L	L
Major Creeks	L	L	L	M
Hazardous Materials	M	M	M	M

low = L medium = M high = H

While the number of potential contaminant sources, as outlined in this chapter and Table 3-12, are many, the recurring conclusion is that, given the results of the historic and ongoing routine monitoring conducted by CCWD, there are no chronic conditions related to regulated constituents that are not readily mitigated by the natural system, source control, or existing treatment practices.

3.4 Projected Changes in Sources of Contaminants

3.4.1 Agricultural

Based on the policies of Solano County and of the Suisun Marsh Preservation Act, it is unlikely that this area will see much land use change in the near future. The policies and proposals of the County are intended to direct future growth and development in a manner to preserve the County's agriculture land.

The Collinsville-Montezuma Hills Planning Area has been defined as having essential agriculture to Solano County. This area contributes significantly to the local agricultural economy. This area requires little or no irrigation and fertilizer. It is the intent of the County to protect this area from non-agricultural uses, with the exception of providing for special industry that requires deep water access or rural settings. The Suisun Marsh Preservation Act defines the extent and characteristics of Suisun Marsh as consisting of tidal marshes, seasonal marshes, managed wetlands, and lowland grasslands; and designates agricultural areas surrounding the marsh land to serve as a buffer to the wetland area. The intent of the Act is to preserve the water quality and riparian habitat of these wetlands through control of erosion, sedimentation, and runoff from adjacent land and development.

Based on the policies of Sacramento County, the risk of flooding, and soil type, it is unlikely that this area will see much land use change in the near future. The County's policies on future land use and development include the following: promote and protect agriculture as the primary activity in the Delta, deny requests that would facilitate urban development, prohibit non-contiguous expansion of urban land use, deny request for lot reduction permits on agricultural parcels. In addition, a large majority of the agriculture land in this area is under the Williamson Act. This Act encourages the continued agricultural use of these lands by changing tax assessments to match the land use. The entire area is also within the 100 year flood plain as defined by FEMA.

Based on the policies of Contra Costa County and the risk of flooding, it is unlikely that the Delta area will see much land use change in the near future. The importance of agriculture was defined in the General Plan and represents agricultural resources significant to the County. According to the County General Plan, Webb Tract, Bradford Island, Jersey Island, Holland Tract, Palm Tract, Veale Tract, and Orwood Tract are all within the 100 year flood plain as defined by FEMA. Levees surrounding these tracts have failed in one or more places in 1973, 1980, 1983, and 1986. Some islands have been flooded two or three times since 1980. Development in these areas is limited to low-intensity uses in support of the agriculture or recreational activities. The agriculture in Oakley will likely remain agriculture in the near future and falls under the Contra Costa County's Delta planning

3.4.2 Industrial

Given the current state of the economy it is unlikely that any major additions will be made to the industrial discharges of the area due to expanded or diversified production. While the potential exists for greater illicit discharges with a tighter economy, the incentive also exists with current regulation to maintain industrial waste discharges within the confines of the issued NPDES permits.

The greater likelihood is that as the economy tightens marginal businesses will cease operations and their waste streams will be eliminated. Such a scenario is depicted in the NPDES permit for Gaylord Container Corporation's East Plant (formerly owned and operated by Fibreboard Corporation) where it is stated that the plant was temporarily shut down due to economic conditions (RWQCB-Central Valley Region, Order No. 91-148, NPDES No. CA0004847). The bleached Kraft process has been eliminated permanently eliminating several related dioxin and furan isomers from this waste stream.

3.4.3 Municipal

To date Solano County has limited development in unincorporated areas to rural residential and commercial in support of the agricultural industry. Commercial has been limited to areas along transportation facilities to support travelers and rural residential areas. Industrial land use planning has been limited to the agricultural related industry, water dependent industry, and where special industry requires rural settings due to noise, odor, or hazardous problems. The Collinsville-Montezuma Hills Planning Area provides one of the last remaining undeveloped areas with deep-draft water access in the Bay Area. Future development of this area is governed by the Collinsville-Montezuma Hills Area Plan and Program. The possibility that this area will be developed and replace the designated agricultural preserve is of concern to the County, in addition to the potential for adverse impacts of noise, air quality, water quality, and traffic. These issues will likely be an important factor in the future planning of the type and level of water related industry. Solano County personnel indicated that this development will be far off into the future (10 to 20 years).

There does not appear to be a significant growth potential in the study area (Table 3-13) that would affect water quality near CCWD's intake. Solano County is expected to have significant growth, but, the majority of this growth will probably occur within the major urban centers and not within Suisun Marsh or the Collinsville-Montezuma Hills Planning Area. The Collinsville-Montezuma

Hills Planning Area is protected and to be preserved for agriculture, with the exception of providing for special industry that requires deep water access or rural settings.

Table 3-13 Population Trends in Solano County

ABAG Sub-Regional Areas	Total Population			
	1990	1995	2000	2005
Rio Vista	3,596	4,200	5,900	14,800
Suisun City	23,186	27,200	30,900	33,300
Rural Solano County	14,708	16,500	19,000	22,300

Source: Projections 94, Association of Bay Area Governments, July 1993.

Rio Vista is expected to have the highest percentage increase in new households. Moderate job growth is expected in each of the major economic sectors. Between 1990 and 2000, the manufacturing and wholesale trade is expected to increase by 65 percent and 0 percent for Suisun City and Rio Vista, respectively. Between 2000 and 2010, the manufacturing and wholesale trade is expected to increase by 51 percent and 150 percent for Suisun City and Rio Vista, respectively. Retail and other service related jobs is expected to increase about 50 percent in each sector for both Suisun City and Rio Vista. The majority of this increase is expected between 2000 and 2010.

According to the Delta Plan, the population in this portion of Sacramento County has not increased since 1950. In the Delta Planning Area, there was a 33 percent decrease in population between 1950 and 1970. There was a small increase of 3 percent between 1970 and 1980. Table 3-14 shows the population trend in Sacramento County between 1950 and 1980. The Delta Plan suggest that the reasons for the decline include flooding, changes in agricultural practices resulting in less labor intensive production, and less opportunity for young people. In general, the future employment changes predicted by the Delta Plan is expected to be away from agriculture and towards more recreational activities and support business.

Table 3-14 Population Trends in the Delta

Delta Plan Sub-Areas	Total Population			
	1950	1960	1970	1980
South Delta Region	2,415	1,762	1,568	1,803
Delta Planning Area	6,946	6,089	4,654	4,800

Pittsburg, Antioch, and Oakley are the major urban areas within Contra Costa County's Delta boundaries. These areas, as well as Brentwood, will likely see an increase in urban development and population. In general, the type of land use will stay the same with one exception, some of the open space in the eastern portion of the study area will likely convert from agricultural lands to urban. The majority of these sites are developed. Those areas of pasture on hill side will not be developed because of the steepness of the slopes.

ABAG projects that the Central and Eastern Contra Costa County area will grow 9 percent overall between 1995 and 2000 and 18 percent from 1995 to 2005. The cities of Pittsburg, Antioch, Brentwood, and Rural East County are projected to grow by 22 percent and 44 percent, for the years between 1995 and 2000, and 2000 and 2005, respectively. The rate of expected population increase may be different, depending on a wide array of socioeconomic factors. Population in the urban regions of Contra Costa County, pertinent to the Survey, is shown in Table 3-15.

Table 3-15 **Population Trends in Contra Costa County**

ABAG Sub-Regional Areas	Total Population			
	1990	1995	2000	2005
Antioch	63,057	80,100	98,400	111,300
Clayton	7,631	9,700	11,400	12,000
Concord	113,713	116,400	124,000	127,500
Pittsburg(a)	65,260	75,400	81,000	88,200
Pleasant Hill	38,427	41,100	43,600	43,500
Walnut Creek	73,923	76,400	79,300	82,300
Rural East Co.(b)	29,405	38,600	46,600	58,300

Source: Projections 94, Association of Bay Area Governments, July 1993.
(a) The Bay Point (West Pittsburg) population is included in the population estimate for the City of Pittsburg.
(b) Includes most of Oakley, Sand Hill, Discovery Bay, Bethel Island, and other small rural communities in the eastern part of the county.

Both Brentwood and Rural East County are expected to grow significantly. For example, between 1990 and 2000, the manufacturing and wholesale trade is expected to increase by 195 percent and 46 percent for Rural East County and Brentwood, respectively. Between 2000 and 2010, the manufacturing and wholesale trade is expected to increase by 150 percent and 145 percent for Brentwood and Rural East County, respectively, to have the most growth in jobs between 1990 and 2000, and again between 2000 and 2010.

No significant population change is expected for the Canal Drainage Sites. These sites are for the most part already developed. They are typically small sites of a couple of acres. The larger open space drainage sites consist of the Concord Naval Weapons Stations and designated open space for recreational and rural purposes.

3.4.4 Recreational

The only significant change in recreational sources of contamination anticipated is the planned elimination of body contact recreation in the Contra Loma Reservoir by 1998.

CHAPTER 4. WATERSHED CONTROL AND MANAGEMENT PRACTICES

This chapter provides a brief summary of existing management practices that either directly, or indirectly, influence drainage. The chapter is divided into two main sections: District management practices and other agency management practices.

4.1 CCWD Management Practices

CCWD's stated objectives (CCWD FY 1995-6 Budget) are to "aggressively protect current and future supplies for quantity and quality" and "protect and defend CCWD's interests in the [San Joaquin] Delta's integrity through actively pursuing and implementing appropriate programs". The CCWD Planning Department has identified specific milestones, including completion of a Canal Drainage Study and Sanitary Survey; participating in SWRCB Water Rights Hearings, Clean Water Act and Water Quality Control Plan implementation; actively engaging in Central Valley Project (CVP) and State Water Plan (SWP) operations; developing in-house capability to perform CVP operations studies and providing support for the DWR Municipal Water Quality Investigation Program and the U.S. Geological Survey Flow Measurement Program. These activities are performed within the Water Resources Division of the Planning Department, managed and staffed by four water resource engineers and specialists widely recognized for significant contribution to the knowledge of water dynamics in the Bay-Delta environment.

The CCWD Planning Department monitors and provides comments on local land use agencies environmental documents covering both plans and projects (private and public agency) within the CCWD service area or potentially impacting CCWD's water supplies (e.g., marinas/recreation facilities near CCWD Delta water intakes) and facilities, including those federally owned under the CVP (e.g., the Contra Costa Canal and its right-of-way). CCWD receives local and regional agency agendas in order to monitor activities and provide verbal testimony as needed on issuer specific projects with potential impacts on water supplies. These activities are covered by the Interagency Coordination group staffed by two planners.

4.1.1 Ownership and Right-of-Way

The Contra Costa Canal, its facilities, and associated right-of-way are owned by the U. S. Bureau of Reclamation (USBR). CCWD operates and maintains these facilities under a long term agreement with USBR. CCWD is currently considering a course of action that could find ownership transferring to CCWD from USBR. If such a transfer takes place there would be little practical impact as all operations and maintenance functions are currently handled by CCWD.

4.1.2 Adjacent Land Development and Control

CCWD maintains funds for two special programs: Land Rights and Adjacent Canal Property Coordination. The Land Rights Program allows for review of existing and proposed development adjacent to the Canal right-of-way. Construction licenses, encroachment permits, and deposits are required from all applicants desiring access or use of the Canal right-of-way. The Adjacent Canal Property Coordination Program maintains coordination of projects and programs planned by local agencies within the immediate vicinity of the Canal. This activity includes the review of local agency development plans and planning commission agendas to identify potential impacts on the Canal or the Canal right-of-way. Through this review process CCWD can control, to some extent, the drainage onto Canal property and into the Canal. Regulation 203 of CCWD's Canal Property Management Policy, states that the objective is to eliminate the discharge of surface water drainage into the Canal. Where development adjacent to the Canal right-of-way requires District approval, CCWD requires the developer to re-route the drainage to an appropriate facility, when possible (CCWD CIP 1994, CFP, Resolution 87-16).

The recently completed Canal Drainage Study (CCWD, 1995a) had as one of its conclusions that "although the study does suggest that drainage can influence Canal water quality, there is little evidence that drainage adversely impacts delivered water quality and District customers to an extent that requires immediate action." It states that the high cost of structural controls does not appear justifiable given the current data. A recommendation is made to conduct site specific storm event monitoring to better evaluate the potential need for site specific structural controls.

4.1.3 Canal Fencing

To provide for public safety and the safety of District personnel, CCWD has established standards for fencing along the Canal. Regulation 201 and 202 of CCWD's Canal Property Management Policy relate to fencing of the Canal. CCWD requires property line fencing for safety as part of any new development adjacent to the Canal. CCWD also requires the continued inspection and maintenance of existing property line or Canal lining fence. A special fencing crew handles fence maintenance and construction.

CCWD also maintains two ongoing Canal Fencing Programs: Canal Fencing and Canal Property Line Fencing. These programs allow for funds to design and construct new fence to protect Canal facility and to provide safety for the public and District employee's. According to District staff, about 122,948 linear feet of fence has been installed since 1990, and 85,952 linear feet of fence is required to complete the fencing programs (CCWD CIP 1994, CFP, Resolution 87-16).

4.1.4 Canal Surveillance

To ensure the integrity of the Canal from potential encroachments that may effect water quality, CCWD has on staff three Canal Safety Guards. It is their responsibility to patrol the Canal system right-of-way and assigned facilities to prevent and control trespassing and further inspect the safety of the facilities to protect life and property. Shift alignments allow the entire length of the canal to be inspected every two to three days.

To ensure the proper operation of the Canal and its lateral control facilities the District employs Water Tenders. It is their job to observe and adjust canal water level at the various check structures in communication with the Control Operator located at Antioch Operations. In their regular runs along the length of the canal they maintain 24 hour coverage, 7 days a week. Their observations of the condition of the Canal help target and prioritize maintenance activities.

4.1.5 Vegetation Management

On September 15, 1993, the CCWD Board of Directors approved a resolution to adopt a Vegetation Management Program (Resolution No. 93-54). To meet vegetation management objectives, the District uses three types of control methods: mechanical, manual, and chemical. Mechanical control methods include mowing and disking the soil. For areas with level terrain and adequate clearance, disking is preferred over mowing because it is less labor intensive. The disk, pulled by a tractor, has round metal plates mounted on a frame that breaks up soil and disturbs emergent vegetation (J&S1994). Approximately 83 percent of the Canal property is mechanically abated. Approximately 17 percent of the property is chemically sprayed.

Before 1977, grass and weeds in the Canal right-of-way were controlled by chemical spraying. Due to EPA restrictions placed on chemical use near potable water, CCWD changed practices in 1977 by controlling grass and weeds by mechanical equipment. Weed control activities are concentrated in March through June, following the winter rains. Tractor mounted mowers cut tall grasses and weeds and a disking operation follows to prevent regrowth. Since 1988 CCWD has also used EPA approved glyphosate products for spot spraying. District staff is responsible for weed control. CCWD has made arrangements with East Bay Regional Parks District to provide weed control in the trail reaches of the Canal, on the trail side only (CCWD CIP 1994, CFP, Resolution 87-16).

A preliminary Assessment of the District's Integrated Vegetation Management (IVM) Program was completed by Jones & Stokes Associates (J&S) in April 1994. The objective of the study was to evaluate the existing IVM and make recommendations to enhance the program. By using multiple control methods, the program incorporates sound ecological practices, economic and sociological factors.

CCWD recently initiated a pilot Integrated Vegetation Management (IVM) Program that will identify different control methods to protect water quality and improve safety, slope protection and fire control. The IVM Program should reduce the use of chemical herbicides used along the Canal. The Board has retained Baefsky & Associates to assist in developing a new IVM Program.

Soil management as a control method for vegetation management is a major component of the IVM Program. To meet the vegetation management objectives, CCWD currently uses three types of control methods: mechanical, manual, and chemical. Mechanical control methods include mowing and disking the soil. For areas with level terrain and adequate clearance, disking is preferred over mowing because it is less labor intensive. The disk, pulled by a tractor, has round metal plates mounted on a frame that breaks up soil and disturbs emergent vegetation (J&S 1994). Approximately 13 percent of the 570 acres of Canal property identified in this study is disked soil.

The District conducted a pilot IVM program to identify control methods to improve water quality, safety, slope protection and fire control. The IVM program will reduce the use of chemical herbicides along the Canal. The herbicides currently used in the District's vegetation control program have been extensively tested and are specifically approved as safe for use along waterways. The current IVM Program recognizes that disking is not to be done on steep slopes as it creates a soil erosion problem. Even on level terrain, an increased sediment load to the Canal was apparent at some drainage sites. These sites consisted of loose and bare soil, sometimes with a channel directing runoff to the Canal.

Improved tillage practices, increased sod, and greater quantities of vegetation left on the field contributes to erosion control (USDA, 1978). Contouring perpendicular to the slopes can reduce the sediment load by as much as 50% compared to no contours for storms of low to moderate intensity. Contouring provides little protection against the occasional severe storm that result in eroded contours (USDA, 1978). Maintaining a layer of vegetation by mowing in place of disking can reduce erosion by 50% to 95% (USDA, 1978).

4.1.6 Water Quality Monitoring

CCWD has always taken a proactive approach in the development of its water quality monitoring programs; typically sampling more frequently and in more locations than the minimum required by law. The extensiveness of the monitoring is to meet the District's mission statement which strives "to strategically provide a reliable supply of high quality water at the lowest cost possible, in an environmentally responsible manner."

A prime example of this approach is found in the monitoring program for *Giardia/Cryptosporidium.* There is not currently, nor historically, any mandated requirement to analyze for these organisms, however, CCWD has monitored since 1991. Giardia is regulated as a treatment technique, with credit given for methods of treatment and disinfection, rather than an absolute MCL. Cryptosporidium is not currently regulated.

The program began only on the source water at Rock Slough but has expanded to include source and finished water samples at both CCWD treatment plants on a quarterly basis as well as after select rain events. The upcoming Information Collection Rule, which will begin sampling in the July of 1997, will require monthly sampling for both protozoans at the Bollman Treatment Plant intake for an eighteen month period.

The existing water quality monitoring programs are outlined in greater detail in section 5.2.1.

4.1.7 Geologic Hazards

The predominant geologic risks within the study area are earthquakes, liquefaction and landslides. Land use plans and zoning restrictions reflect these factors, however these risks need to be considered when determining system reliability.

Preliminary seismic and reliability criteria for CCWD were adopted by the Board in FY95. These criteria are the bases of a number of projects for structural modifications to District facilities in the recently adopted 10 year Capital Improvement Plan (CIP). A major project in the group will be to rehabilitate the Canal upstream of the shortcut pipeline currently planned for five years beginning in FY99 at a current projected cost of $25,000,000. (CCWD, 1995b)

4.2 Other Agencies with Watershed Control Authority

4.2.1 USBR Policies

As the Canal and its right-of-way are owned by the Bureau of Reclamation and managed by CCWD any action that is an encroachment on the Canal or its right-of-way is reviewed by USBR for appropriateness; with the potential impact on water quality being one of the criteria evaluated in the decision making process.

4.2.2 Wastewater Discharge Requirements (NPDES)

The Clean Water Act and Title 40 CFR Part 122 detail the provisions for EPA/State oversight of a permitting process to administer the discharges to the waters of the United States. In California the primacy agency for these National Pollutant Discharge Elimination System (NPDES) permits is the Water Quality Control Board as administered locally by their various regional Boards.

The study area contains portions of two Regional Board jurisdictions - the San Francisco Bay Region and the Central Valley Region. A review of the current NPDES permits in the study area on file with these two Regional Boards does not point to any areas of concern as long as the permit conditions are met. A list of the NPDES permitted facilities in the study area is found in Appendix A-1.

4.2.3 Stormwater Regulations (NPDES)

The Contra Costa Clean Water Program, administered by Contra Costa County, serves local municipalities in their effort to radically reduce or eliminate pollutants from entering the municipal storm drain system. Participating municipalities in the study area include Antioch, Clayton, Concord, Martinez, and Pittsburg, as well as unincorporated Contra Costa County, and the Contra Costa County Flood Control and Water Conservation District. The Program coordinates implementation of group activities involving public education, new development and construction controls, water quality monitoring and inspection activities. Each municipality individually conducts additional activities such as maintenance (e.g., street sweeping and catch basin cleaning), source reduction, structural controls and transportation management. These activities, also known as best management practices (BMPs), are conducted to meet the requirements of the NPDES Municipal Stormwater Permit issued to the municipalities by the San Francisco Bay and Central Valley Regional Water Quality Control Boards. The Permit, which has a term of five years, outlines a proactive approach contained in each municipal storm water management plan to eliminate pollutants to the maximum extent practicable. The Program is mandated under the 1987 Amendments to the Federal Water Pollution Control Act or the Clean Water Act. Municipalities fund the BMPs with a storm water utility assessment that is collected annually. (CCCCWP, 1994)

4.2.4 Hazardous Waste Collection and Recycling

Several disposal and recycling companies operate within the Survey area. Water quality benefits from the collection and recycling of used motor oil, aluminum, glass, paper, plastics, etc. With easy access to these services, single family homes and businesses can reduce roadside litter and wastes that could affect the water supply. As an example, BFI Pleasant Hill Bettor Disposal (BFI) provides curbside oil and car battery collection in Antioch and Martinez in addition to the more recognized plastics, glass, aluminum and tin collections. (CCWD, 1995a)

4.2.5 East Bay Regional Park District Management Practices

The East Bay Regional Park District (EBRPD) is responsible for the development, operation and maintenance of a recreational trail system along the Canal and public recreation facilities within the Contra Loma Regional Park at the Contra Loma Reservoir. The recreational trail agreement and license state that the "EBRPD will develop, administer, operate and maintain a recreational trail without cost to the Water District or the United States, including removal and disposal of debris and rubbish, control and abatement of weeds, vectors and fire hazards, and prevention of erosion.

Some of the EBRPD's management practices used to carry out the above requirements include: litter pick-up every seven to ten days, no herbicide use between the trail and the Canal, selective herbicide use with the approval of District vegetation management staff, and monthly mowing operations from March to September of land adjacent to CCWD property to comply with Fire District regulations. EBRPD has arranged to make disposal kits available along the Canal trail for pet owners to dispose of their pets waste. An adopt a trail program is also being established for community organizations to help minimize litter and promote stewardship of the Canal. (CCWD, 1995a)

4.2.6 Agricultural Run-off Management Programs

Currently there are no agencies or programs with direct regulatory control of agricultural run-off. There are no water quality limits at the point of discharge imposed on agriculture. While societal pressure to be responsible in their practices may have some impact on their run-off management it remains that the main factor in the way agricultural run-off is managed is as a function of the economics of the practices from the perspective of the agricultural interests. As the cost of water increases conservation practices limit the volume of run-off. While the use of chemicals is regulated to some extent, primarily pesticides, the potential impact on water quality is only one of a number of factors used in setting the limits of use. The effectiveness of the product factored against the cost of its use in large part dictates the quantity available to run-off discharges.

CHAPTER 5. WATER QUALITY

5.1 Drinking Water Regulations

CCWD is in full compliance with all federal and state regulations which govern its system operation, treatment, water quality and delivery of potable water to its consumers.

5.1.1 Safe Drinking Water Act of 1986 (SDWA)

Originally enacted in 1974 and amended in 1986, the SDWA requires the United States Environmental Protection Agency (EPA) to set public health standards for drinking water quality. In California (as in most other states) the EPA has delegated primary enforcement responsibility (primacy) to the State. To maintain primacy the State must adopt regulations at least as stringent as the federal regulations. Within the 1986 amendments were requirements to set standards for 83 compounds within 3 years, establish filtration criteria for surface waters, and maintain disinfection requirements for all sources. Maximum contaminant levels (MCLs) are the enforceable standards and are established on the basis of a known or potential health risk either acute or from a lifetime exposure at the MCL. The maximum contaminant level goal (MCLG) is a non-enforceable health goal which water systems should try to achieve. Water at or below the MCLG is not expected to cause health problems, even with a lifetime exposure at the MCLG. EPA's Drinking Water Priority List was established in 1988 with a revision issued in 1991 as a resource in which 25 compounds were mandated for addition every three years thereafter.

5.1.2 Surface Water Treatment Rule (SWTR)

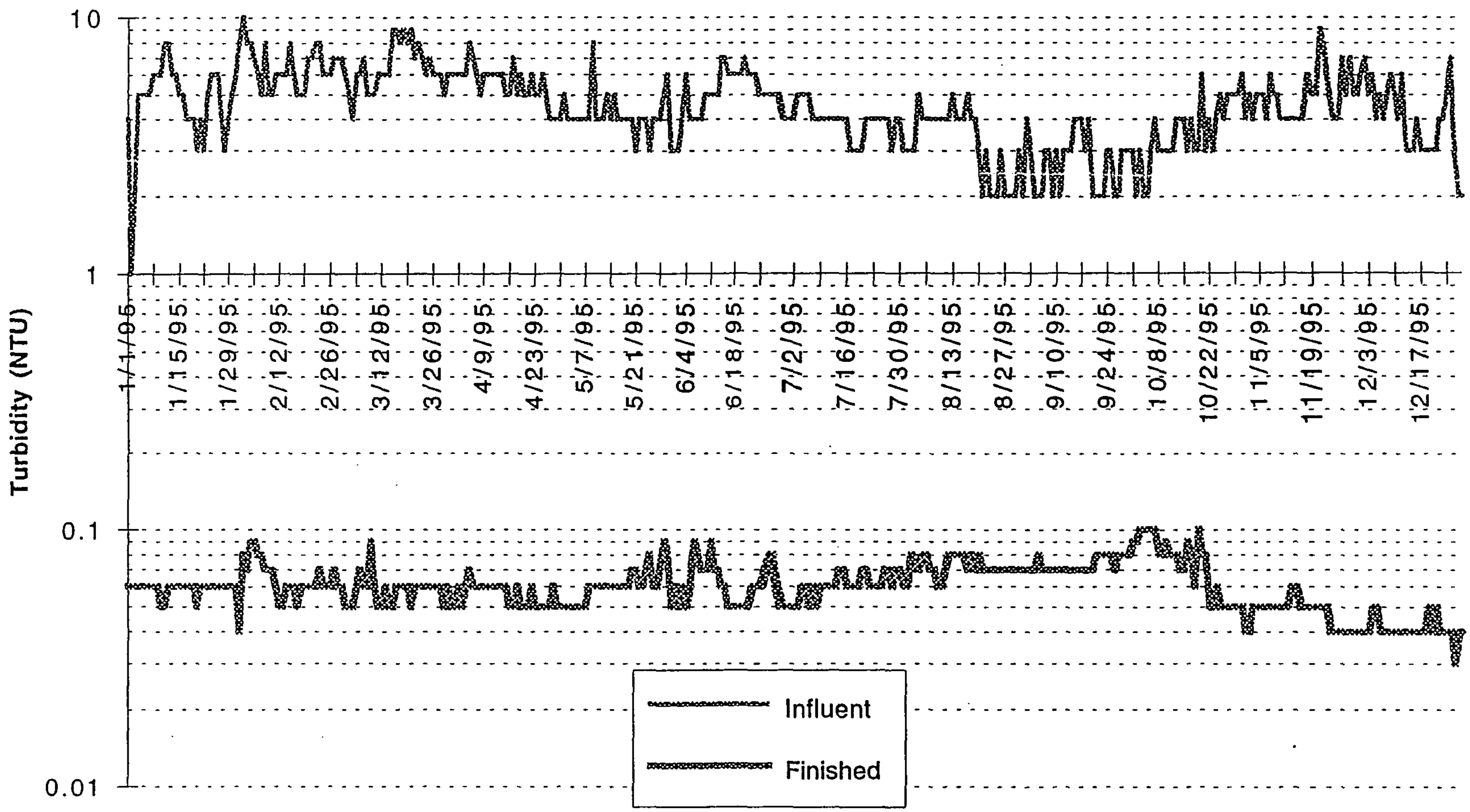
The Surface Water Treatment Rule (SWTR) (40 CFR Ch. 1, Subpart H) sets the criteria for users of surface waters or ground water under the influence of surface water under which filtration is required.

The two treatment plants adopted the monitoring requirements for SWTR with very little change to their operation. Primarily, the SWTR provides for protection against exposure to *Giardia* and enteric viruses by "treatment technique" rather than an absolute MCL value. Treatment processes are credited with specific log removals based on the judged effectiveness of the treatment being utilized; seeking to achieve a minimum 3 log (99.9%) removal/inactivation of Giardia and 4 log (99.99%) removal/inactivation of viruses to maintain compliance with the Rule.

The Bollman facility, as a conventional treatment plant, is credited with 2.5 logs of Giardia removal prior to final disinfection. The credit deficit is made up by maintaining an adequate final disinfection concentration and contact time (CT) adjudged by calculating the log credit for inactivation through monitoring of the various parameters which go into the CT value. The CT is achieved with free chlorine after filtration and prior to the addition of ammonia at the entrance to the clearwell to form chloramines as the form of final disinfectant entering the distribution system.

The Randall-Bold facility, as a direct filtration plant, is credited with 2 logs of Giardia removal prior to final disinfection. The credit deficit is made up by maintaining an adequate final disinfection concentration and contact time (CT) adjudged by calculating the log credit for inactivation through monitoring of the various parameters which go into the CT value. The use of ozone in the final disinfection process adequately meets the CT requirement even ahead of the addition of chloramines as the residual disinfectant entering the distribution system.

Both plants further assure minimal potential for exposure to protozoans by targeting their finished water turbidity to less than 0.1 NTU. By way of example, figure 5-1 depicts the comparative raw and treated water turbidities for the Bollman Treatment Plant for 1995.



Influent and Finished Water Turbidity
Bollman Treatment Plant
1995
Figure 5-1

5.2 Existing Water Quality

5.2.1 Monitoring Programs

This section describes CCWD's water quality monitoring practices currently conducted for surface, and ground water sources. (Table 5-1)

Table 5-1 Raw Water Quality Monitoring Programs

Program Description	Sampling Frequency	Analysis Performed
Field Investigations: CCWD personnel routinely request field investigations to help identify source of water to determine presence of contaminants and to assist in facility maintenance. Additionally, the field investigations program responds to customer complaints or inquiries. Field investigations, involving the collection and analysis of one or more samples, are conducted and remedial action, if necessary, is taken (i.e., main flushing, treatment plant operational adjustments, etc.)	As required	As required
Flavor Profile Analysis: Samples are collected from representative sites in the raw waters, plant processes, and distribution system to monitor the aesthetic quality of the water. This information is used to modify plant processes during taste and odor episodes and investigate the validity of taste and odor complaints.	Mallard Reservoir; Weekly	Taste and Odor
Giardia: Giardia lamblia and Cryptosporidium analysis are conducted on CCWD's raw and treated waters to determine the levels of these organisms in the water and associated Giardiasis risk using present treatment CT's.	Quarterly; plus select rain events	*Giardia lamblia* and *Cryptosporidium* analysis
Mallard Slough: This supplemental raw water source for the CCWD Bollman water treatment plant is monitored for basis general mineral and microbiological parameters. Designed to produce a historical database showing changes and trends in the water quality, the information is used by CCWD for its TWSA and industrial retailers.	Monthly, Weekly, or Daily depending upon use of source	General mineral and microbiological parameters
Phytoplankton: Samples are collected from representative source and raw water reservoir sites to monitor phytoplankton population densities and diversity. The information is necessary for treatment plant modifications and taste and odor control.	Weekly	Phytoplankton analysis
Raw Water Quarterly: The raw water supply is monitored at major entry points (river intakes, wellheads), at storage facilities, and at representative locations along the raw water transmission facilities. Information is used by operating personnel and to meet regulatory requirements.	Quarterly	Samples tested for all primary and secondary standard constituents
Rock Slough: The raw water supply is monitored at the main entry to the Contra Costa Canal. Information is used by operating personnel and municipal and industrial retailers and to meet regulatory requirements. The raw water is monitored for general mineral and bacteriology. Program is designed to produce a historical database showing changes and trends in the water quality.	Monthly, Daily	General mineral and bacteriology

5.2.2 Evaluation of Monitoring Data

5.2.2.1 Salinity

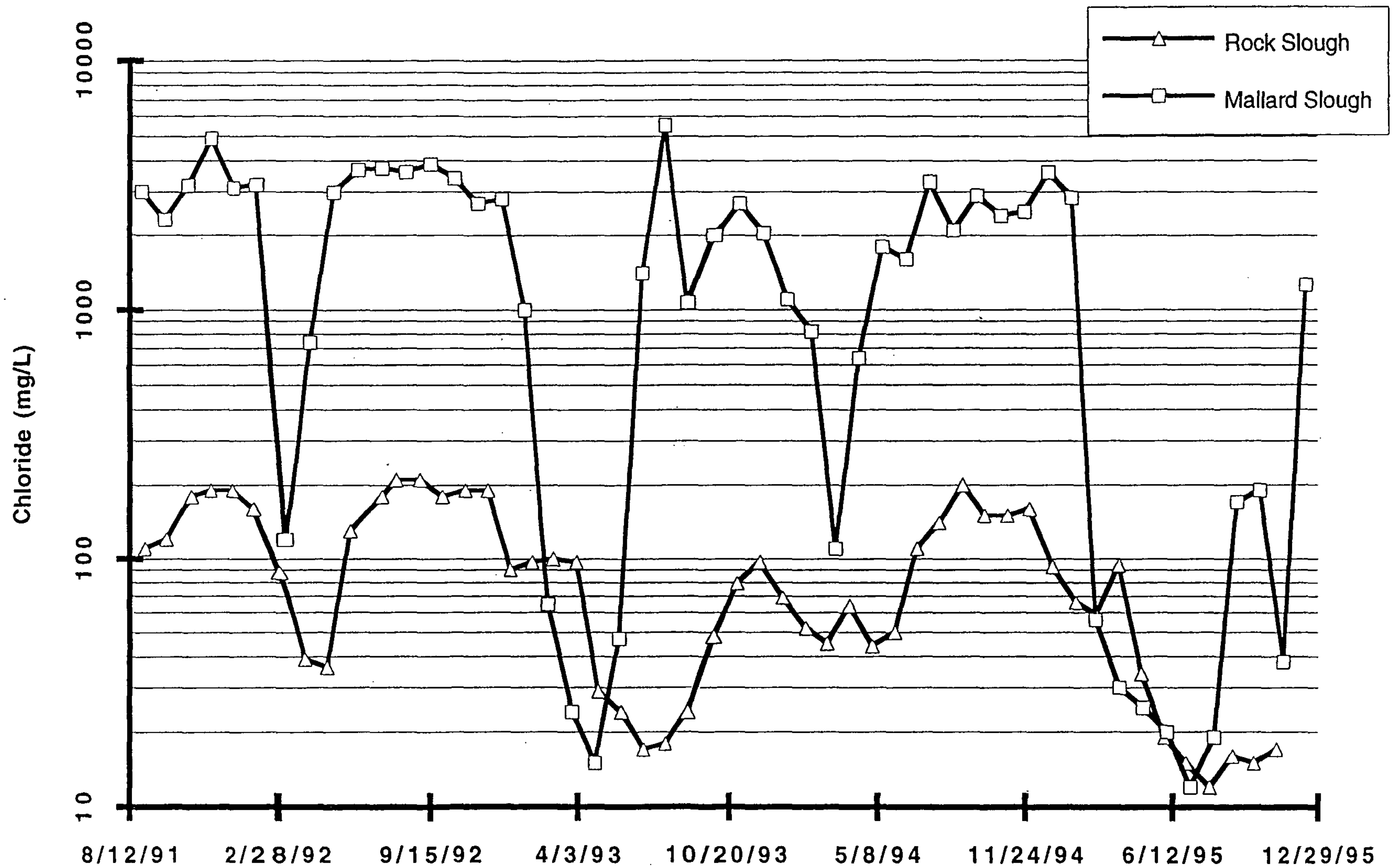
CCWD's primary diversion facility, Rock Slough, is subject to seasonal variations in salinity that are a influenced by a combination of natural and man-made factors, as noted in section 2.1.3 (Existing Hydrology). CCWD is very active in protecting the existing water quality standards at its Rock Slough intake under SWRCB Decision 1485. These standards set a maximum of 250 mg/L chloride for all days of the year and a maximum of 150 mg/L chloride for 155-240 days of the year depending on water year type. Releases are predicated on the level of chloride whether the source is seawater intrusion or agricultural drainage.

As CCWD's main concern is mineral concentration which varies with the seasons and affects secondary drinking water standards, such as the chloride and TDS levels, CCWD tracks it's intake source water quality by daily monitoring of chloride levels. This data is shared with the Federal Bureau of Reclamation so that adequate amounts of impounded water may be released to maintain a hydraulic salinity barrier downstream of our source intake.

As CCWD's Mallard Slough intake is toward the western end of the Delta estuary it is normally much too brackish to use as a source for drinking water. Water is typically only taken when the chloride concentration is consistently 100 mg/L or less and this only occurs during periods of high Delta outflow such as was experienced during the spring of 1995.

Figure 5-2 depicts the fluctuations in chloride values at both the Rock Slough and Mallard Slough diversion locations since autumn 1991.

CCWD is expecting to see improved water quality within the watershed due to the implementation of the Bay-Delta Water Quality Standards promulgated in 1995 by EPA and the California State Water Resources Control Board. Larger releases of impounded snow-melt water to improve fisheries should also improve the raw water quality at CCWD's intake. Sometime in 1997, CCWD will complete construction of its Los Vaqueros Reservoir outside Brentwood. This water quality storage reservoir will divert water further upstream on Old River (near Discovery Bay) during high quality periods and blend it with Rock Slough water to dilute salinity levels.



SEASONAL CHLORIDE TRENDS AT ROCK AND MALLARD SLOUGHS

Figure 5-2

5.2.2.2 IOC/SOC/VOC

Because water quality monitoring required by Title 22 is measured on a quarterly frequency, trending is readily observable from a large array of data points. Based on the last five years of water quality monitoring (see Appendix A-2), our source water data has shown no results of regulated inorganic compounds (IOCs) or synthetic organic compounds (SOCs) that exceed their respective MCLs, and in nearly all cases, no results that exceed the State determined detection limits for reporting (DLRs), even for unregulated SOC's.

The water quality at our primary intake is heavily influenced by Sacramento River cross-delta flows, with very little San Joaquin River influence. The Sacramento River water quality is normally a better quality, due to less agricultural drainage and greater snow-melt run-off, whereas San Joaquin River flows are smaller in volume and exposed to more agricultural drainage.

Accordingly, the finished water quality produced through the conventional treatment plants within CCWD reveal no detectable results of regulated, or unregulated, IOCs, SOCs, or volatile organic compounds (VOCs).

5.2.2.3 Coliform Bacteria

Microbiological analysis of the Contra Costa Water District (CCWD) source waters includes; total and fecal coliform, fecal streptococcus and heterotrophic bacteria. The two most important bacterial measures are total and fecal coliform. Total coliform levels are used to indicate the general level of urban and animal contamination of a water supply. The majority of total coliforms are not harmful to humans. They are used as indicators of other pathogens that may be present in the water. Fecal coliform bacteria are normally found only in the colon and feces of warm-blooded animals and indicate animal contamination of the water. Fecal coliform bacteria cannot survive for long in water and are therefore a good indicator of the time frame of a septic pollution event. A cursory evaluation of the total and fecal coliform data in our source waters from 1991 to 1996 will be presented in this report. There are presently no state or federal regulations on the levels of total and fecal coliforms in source waters.

An evaluation of the total and fecal coliform data for the CCWD source waters (Rock Slough, CCWD Canal at Clyde, Mallard Reservoir, Mallard Slough and Contra Loma Reservoir) indicates the following;

1. With the exception of two peaks in the data in 1995 and 1996, total and fecal coliform levels at Rock Slough have not increased significantly in the last five years. Fecal coliforms make up 9% of the total coliform population (Table 5-2). This indicates that the level of septic

contamination in Rock Slough is low.

2. Total coliform levels in the canal at Clyde have increased by 77% since 1994. Moreover, the five year average level of total coliforms at Clyde is 20% greater then the average level at Rock Slough. This indicates an increase in coliform levels as the water travels through our canal from Rock Slough to Clyde. This may be due to an increase in agricultural and urban runoff along the canal. The average level of fecal coliform at Clyde has not increased significantly in the past five years and is statistically the same as levels at Rock Slough. The differences between total and fecal coliforms at Clyde indicate that the increased coliform levels at Clyde is not septic in nature.

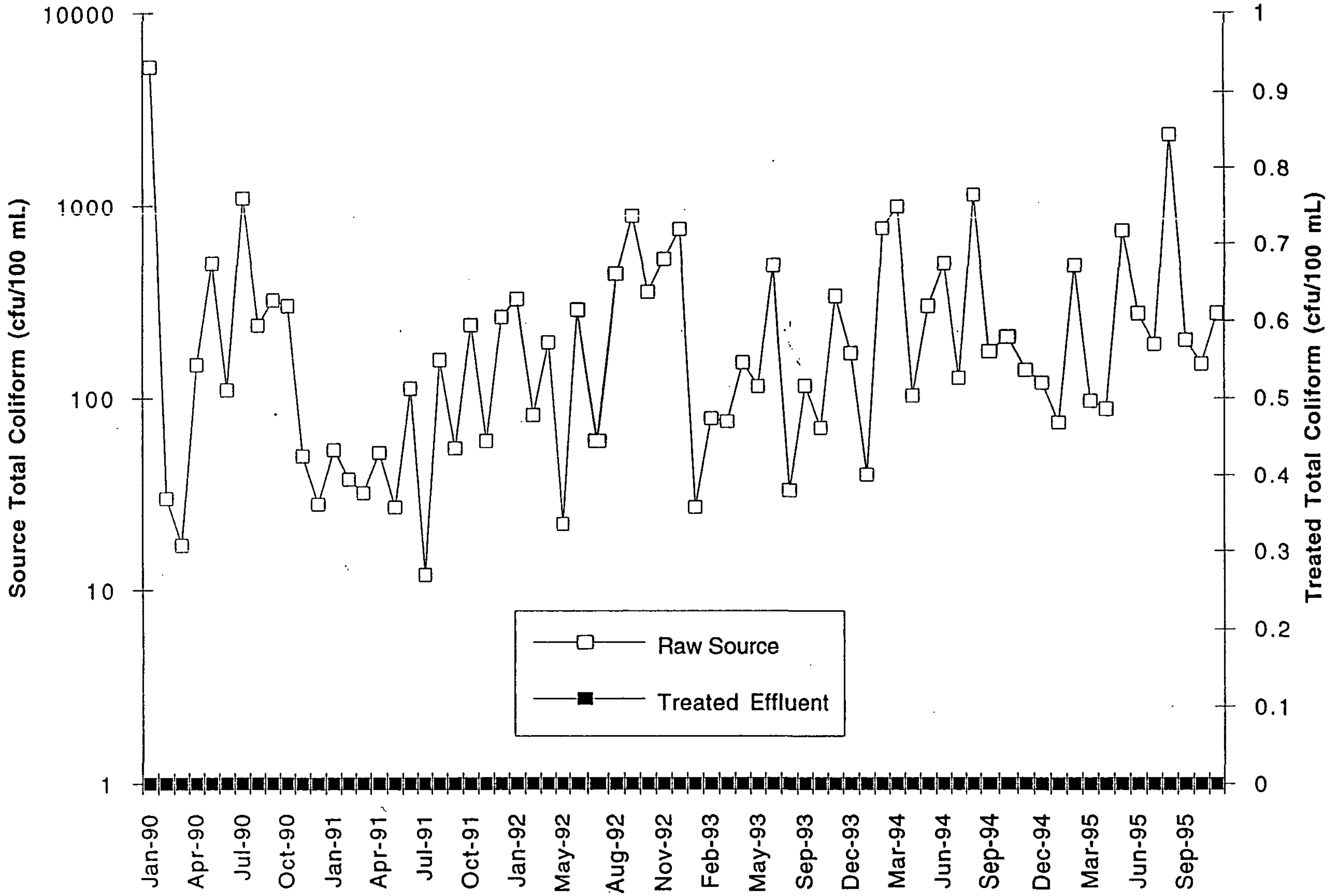
3. Average total coliform levels in Mallard Reservoir have increased by 30% (does not include the peak which occurred in 3/96) since 1994. This is most likely a reflection of the increased levels in the canal water which supplies this reservoir. Average levels of fecal coliform have remained statistically the same (8CFU/100mL) in Mallard Reservoir which again indicates that the rise in the coliform population is not septic in nature.

4. Average levels of total coliform in Contra Loma Reservoir have increased by 52% since 1994, however, fecal coliform levels have remained stable at 115 CFU/100mL for the past five years. Fecal coliforms represent 40% of the total coliform population in this reservoir. This indicates that continuous septic contamination is occurring at this site. The large population of ducks and body contact recreation may be contributors to this problem.

5. Total coliform levels in Mallard Slough have increased by 15 % since 1994 . However, fecal coliform levels have remained relatively stable over the past five years. Mallard Slough has the highest average levels of total coliforms in our source waters.

Table 5-2 Average Levels of Total and Fecal Coliform in the 5 CCWD Source Waters from 1991 to 1996

Location	Avg Total Coliform /100mL.	Avg Fecal Coliform /100mL.
Rock Slough	287	25
Canal at Clyde	362	21
Mallard Reservoir	56	8
Contra Loma Reservoir	285	114
Mallard Slough	462	40



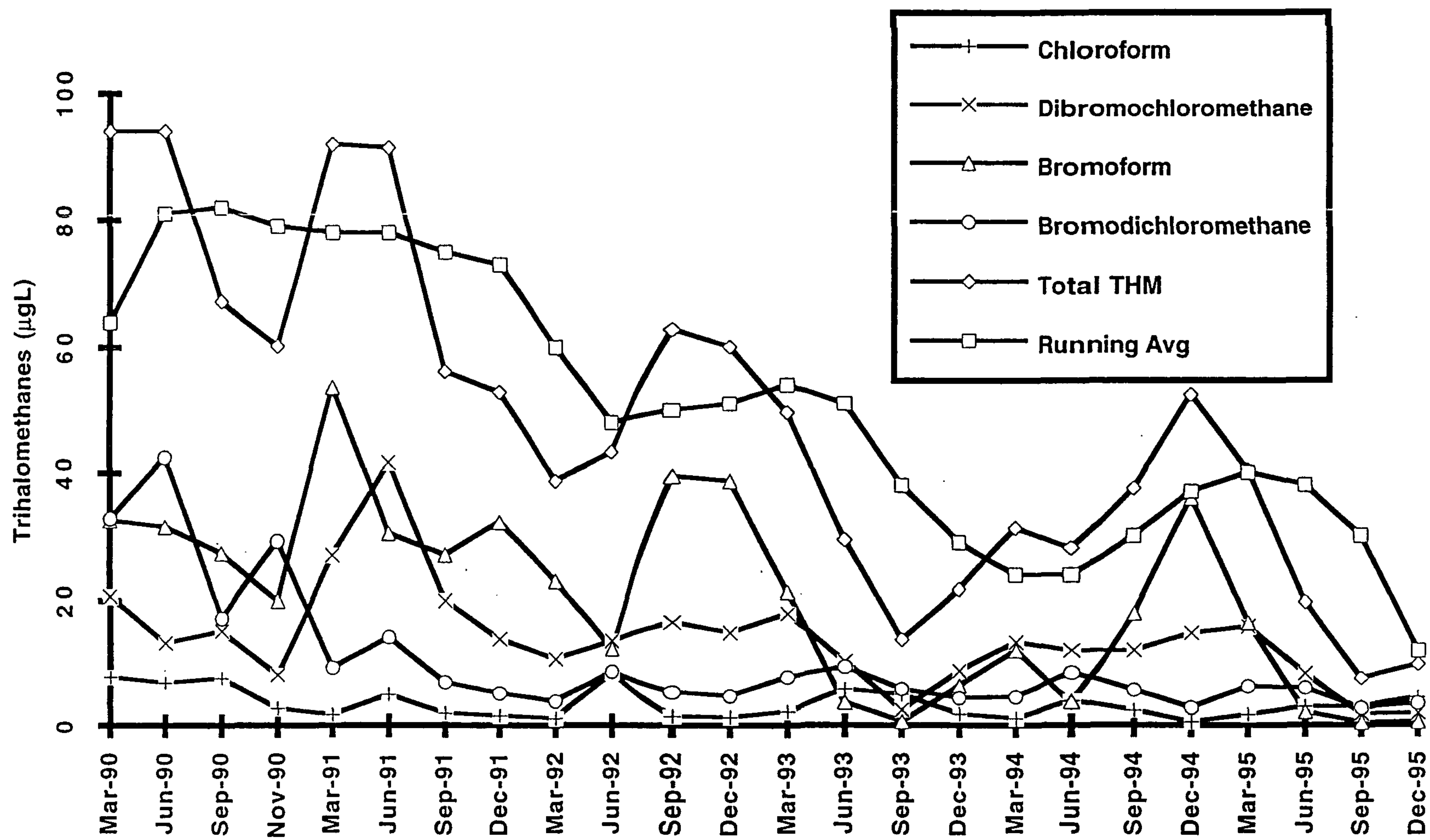
SOURCE AND TREATED WATER
TOTAL COLIFORM
Figure 5-3

Coliform is monitored in the influent of each plant on a daily basis as well as at numerous sites within the distribution system. Figure 5-3 depicts the source levels of Coliform (from the two to four digit populations as cfu/100 mL) compared to the treated water as it enters the distribution system from the Bollman plant (zero cfu/100 mL). As the inactivation of Coliforms is absolute the log inactivation is dependent on the influent concentration. Inactivation has ranged from one to three logs based on the historic data.

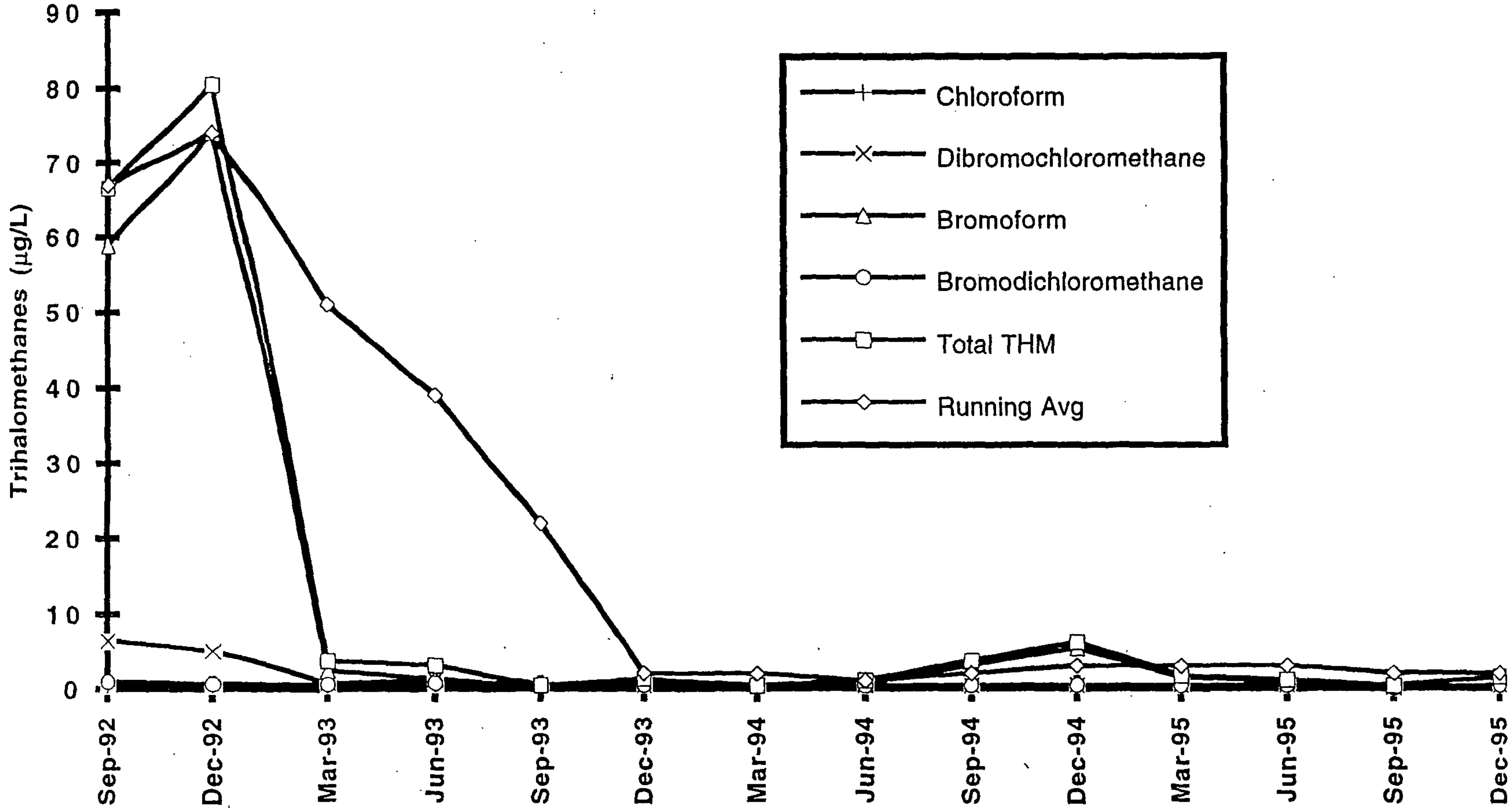
5.2.2.4 Trihalomethanes

Trihalomethanes (THMs) are formed in the disinfection process of water treatment, and have been the primary regulated disinfection byproduct (DBP). THMs form as a result of three (tri-) halogen (-halo-) atoms combining with organics (-methane) in the water. The sources of the components necessary are in the disinfectant (chlorine) and the raw water (bromide from sea water intrusion and agricultural runoff, and organics, primarily byproducts of the natural decomposition of plant and animal matter both from natural and agricultural sources). The THM formation potential (THMFP) is a measure of the total capacity of the source water to form THMs. THMFP is not a direct indication of what will form in a given treatment process. The 1986 Interagency Delta Health Aspects Monitoring Program report sited THMFP, but noted that the results do not reflect trihalomethane (THM) concentration in finished drinking water.

THMs are maintained well within the current (100 μg/L) and projected regulations (80 - 60 μg/L) by the treatment mechanisms employed at the two plants (Figures 5-4 & 5-5). The Bollman facility has curtailed the use of chlorine as a preoxidant, replacing it with potassium permanganate as an interim treatment until construction can be completed on the upgrades of the plant which include intermediate ozone. The Randall-Bold plant utilizes pre- and post-ozone to keep their THM results consistently less than 10 μg/L. Both facilities utilize chloramine as a final disinfectant which also mitigates the formation of THMs as the water resides in the distribution system for up to several days.



TRIHALOMETHANE PRODUCTION
BOLLMAN TP
Figure 5-4



TRIHALOMETHANE PRODUCTION
RANDALL-BOLD TP
Figure 5-5

5.3 Recommended Water Quality Monitoring Program

CCWD monitoring programs currently meet or surpass all State and Federal sampling requirements. Other than adding new sample locations in conjunction with the ongoing Los Vaqueros Reservoir project or new construction in the expanding distribution system, no additional routine water quality programs are envisioned at this time.

Weekly monitoring is occurring during 1995-97 for nutrients, microbiology, and specific inorganics at the future Old River intake for the Los Vaqueros Reservoir in order to collect baseline data which will be used in the trending of local water quality conditions.

A significant monitoring program will be implemented as part of the federal Information Collection Rule. Monitoring is currently scheduled to begin July 1997 for an eighteen month period in an attempt to gather data needed to balance the revised D-DBP rule with the microbial needs of the ESWTR.

5.4 Constituents of Concern

5.4.1 Pathogens

Voluntary monitoring has been conducted since late 1991 for the gastrointestinal pathogens *Giardia* and *Cryptosporidium.* It is acknowledged that the analytical method is very poor and that the data may not be fully understood until sometime in the future when the methods can be improved. However, based on the research available it would appear that the best management practices are to control the watershed and to minimize the potential passage of pathogens in the treatment process is to optimize treatment and maintain a finished water turbidity no greater than 0.1 NTU.

There are some dairy operations bordering the unlined section of the Contra Costa Canal, but their drainage waters have been routed in a manner that minimizes the potential for these wastes to be discharged into the canal (Section 3.2.7).

5.4.2 Disinfection Byproducts

The ICR will address a range of pending DBPs that are formed as a result of the current and pending treatment practices at the two plants. With the control of THMs comes the production of bromate. However, with the minimization of bromide via the Los Vaqueros project the brominated DBPs will likewise be minimized.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Potential Contaminant Sources

CONCLUSIONS:

1) The major sources of potential contamination in the survey area that could have a significant impact on CCWD's diversions are the agricultural operations near Rock Slough, the recreational activities in the Delta, at Contra Loma Reservoir and along the canal trail, as well as direct discharges to the Canal.
2) Current and historic data have not identified any chronic problems.

RECOMMENDATIONS:

1) Continue the current water quality monitoring programs while watching for potential problems.
2) Continue land use reviews (EIR, CEQA, NPDES, etc.) to identify potential new sources of contamination to the watershed.
3) Institute the recommended storm event monitoring of select discharges to the Canal as outlined in the Canal Drainage Study (CCWD, 1995a)(Appendix A-3)
4) Appropriate removal and redirection of stormwater discharges to the Canal.
5) Prohibit body contact recreation in all water supply reservoirs.
6) Limit grazing in District controlled watershed lands.

6.2 Watershed Management Practices

CONCLUSIONS:

1) Existing watershed management practices appear to be providing the basic protections envisioned, as evidenced by the lack of problems with the water quality data.

RECOMMENDATIONS:

1) Continue support of programs that maintain and enhance the quality of water in the Bay-Delta Estuary.
2) Continue CCWD EIS/EIR review of regional projects with potential impacts on water quality.
3) Move toward IVM that promotes drainage and erosion controls through appropriate site specific physical and chemical methods.

6.3 Water Quality

CONCLUSIONS:

1) Historic monitoring of the CCWD water source has not identified any chronic condition of a public health concern.
2) CCWD meets the criteria for compliance with the SWTR.
3) CCWD operates its facilities in a manner that minimizes the potential for passage of Giardia and Cryptosporidium by maintaining treated water turbidity at ≤ 0.1 NTU.
4) CCWD monitoring meets or exceeds the minimum number of locations and frequency of sampling as required by law.
5) While salts from seawater intrusion and agricultural drains can create seasonal aesthetic problems, these will be mitigated with the completion of the Los Vaqueros Reservoir project.
6) CCWD has never violated an MCL for any of the regulated IOCs, SOCs, or VOCs.
7) Coliform inactivation has historically been absolute; ranging from 1 log to nearly 4 logs, dependent on the source concentrations.
8) A trend of increasing total coliform concentrations along the length of the Canal is not of a fecal nature and can most likely be attributed to contributions by canal drainage and non-pathogenic soil coliform bacteria.
9) CCWD is in compliance with current THM requirements and should maintain compliance at even the most stringent levels currently proposed (60 μg/L).
10) Brominated DBPs will be significantly reduced with the completion of the Los Vaqueros Reservoir project.

RECOMMENDATIONS:

1) Continue the existing water quality monitoring program.
2) Implement ICR monitoring in accordance with the soon to be promulgated Rule.

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APPENDICES

A-1 NPDES Permit Holders in the Study Area

COUNTY: CONTRA COSTA

Agency Name and Address	Facility Name and Address	Findings
Brentwood, City of 708 Third Street Brentwood, CA	Brentwood WWTP Sunset Road Brentwood, CA Carl Gaston 510-634-6941	No violations, metals Cu 4.4 ppb, Ni 10 ppb, Tl 2.5 ppb, Coliforms 1 to 8 collonies per 100 ml.
Central Contra Costa Sanitary District 5019 Imhoff Place Martinez, CA 94553 Roger Dolan 510-689-3890	NPD MAJ - CCCSD 5019 Imhoff Place Martinez CA 94553 Charles Batts 510-689-3890	Violations: Chlorine residual, limit 0.02 mg/l. Coliform, fecal > 200/ml. Monitor: BOD, CBOD, COD, TSS, Metals, Priority organics, fish toxicity, pH & oil and grease.
Contra Costa County Sanitary District No. 19 1037 Discovery Bay Blvd. Discovery Bay, CA	Discovery Bay Treatment Plant Channel Road Discovery Bay, CA 94514 Rich Flosi 510-634-8818	Monitor: Fish toxicity, ammonia, hardness, copper, chlorine residual, pH. No violoations.
Contra Costa County Stormwater Program 255 Glacier Drive Martinez, CA 94553 Donald Freitas 510-313-2373	NPD MAJ - Storm Drains In C.C. County Municipal Storm Drain Systems Contra Costa County	Monitor for the following: Worst years results Copper: 2.8 to 90 ug/l Zinc: 13 to 730 ug/l Nickel: 8.5 to 140 ug/l Mercury; <0.2 to 0.26 ug/l Lead; 1.0 to 87 ug/l Cadmium; <0.2 to 1.8 ug/l Silver; <0.5 to 0.79 ug/l Arsenic; 1.3 to 11 ug/l Selenium; 0.1 to 0.81 ug/l Oil & Grease; <0.2 to 1.9 mg/l Diazinon; 71 to 590 ng/l PAH (total); 5212.1 to 12729.9 ng/l

COUNTY: CONTRA COSTA (CONT.)

Agency Name and Address	Facility Name and Address	Findings
Contra Costa Water District 1331 Concord Avenue P.O. Box H20 Concord, CA 94524	NPD - Reclamation Industrial Use Frontage Road Martinez, CA 94553 Ed Cummings 510-688-8052	The Contra Costa Water Distirct does not run the reclaimed water plant any longer.
Delta Diablo Sanitation District P.O. Box 929 Antioch, CA 94509 Gregg Baatrip 510-706-7156 ext 273	NPD MAJ - Delta Diablo Sanitation District 2500 Pittsburg - Antioch Hwy. Antioch, CA 94509 Gregg Baatrip 510-706-7156 ext 273	Minor chlorine violations, detectable quantities of Cu, Hg, Cr, Ni,& Zn. Trying to change to a Fecal Coliform standard of <23 col/100 ml from Total Coliform standard <200 col/100ml..
Dow Chemical Company P.O. Box 1398 Pittsburg, CA 94565 Randy Fishback 510-432-5000	NPD MAJ - Dow Chemical Pittsburg Northend Loveridge Road Pittsburg, CA 94565 Randy Fishback 510-432-5000	No violations; however, they have outages (over the permit limit) 2 to 3 times a year, usually for pH. They have 3 permits for storm runoff, groundwater discharge, and the RO plant
E.I. Du Pont De Nemours & Co. P.O. Box 310 Antioch, CA	Antioch Facility 6000 Bridgehead Road Antioch, CA 94509 Dr. Brian Coleman 510-779-6260	Occasional exceedances for BOD, residual chlorine and coliforms. They routinely monitor for BOD, TSS, Cl2, coliforms, oil & grease, Cr, Pb, Ni, Fe, Fl and fish toxicity.
Gaylord Container Corporation 1779 Wilbur Avenue Antioch, CA 94509	Antioch Pulp & Paper Mill 1779 Wilbur Avenue Antioch, CA 94509 Randy Neble 510-779-3200	No violations, permit is for storm water drainage.
General Chemical (Allied) Corp. P.O. Box 389 Parsippany, NJ 07054	NPD MAJ - General Chemical (Allied) 501 Nichols Road Pittsburg, CA 94565 Karen Dilelio 510-458-1279	Awaiting response to request for information.

COUNTY: CONTRA COSTA (CONT.)

Agency Name and Address	Facility Name and Address	Findings
GWF Power Systems, Inc. 225 Lennon Lane, Suite 120 Walnut Creek, CA	Bare III Power Plant 1900 Wilbur Avenue Antioch, CA 94509 Mark Kehoe 510-933-7052	Storm water discharge. Have had problems with Zn because the City of Antioch feeds zinc ortho phosphate in their water, also some problems with Arsenic.
GWF Power Systems Company, Inc. 225 Lennon Lane, Suite 120 Walnut Creek, CA 94598	NPD - GWF Power Systems - Site I East 3rd Street (Site I) Power Plant Pittsburg, CA Mark Kehoe 510-933-7052	Cooling water discharge, problems with pH and TDS. Zinc and copper a problem from city's water supply.
GWF Power Systems Company, Inc. 225 Lennon Lane, Suite 120 Walnut Creek, CA 94598	NPD-GWF Power Systems - Site V Nichols Road (Site V) Power Plant Pittsburg, CA Mark Kehoe 510-933-7052	Cooling water tower that occasionally has problems with zinc sulfide. They believe that a neighbor is discharging it in their air.
Hysol Div./The Dexter Corp. P.O. Box 312 Pittsburg, CA 94565	NPD - Hysol Div./The Dexter Corp. 2850 Willow Pass Road Pittsburg, CA 94565 Bob Brown 510-458-8262	No longer discharge into river, don't keep up their old permit any longer. They do however have a storm water discharge permit but have not had any problems.
OXY USA, Inc. P.O. Box 12011 Bakersfield, CA	Brentwood Oil & Gas Fields Route 2, Box 199 Brentwood, CA 94513 George Despain 510-634-4922	Facility no longer in operation.
Pacific Gas & Electric Co. P.O. Box 7640 San Francisco, CA	Contra Costa Power Plant Antioch P.O. Box 249 Antioch, CA 94509 Steve Gallo 510-427-3450	This is for a cooling water tower. They have had problems with Cr, Phosphate and chlorine residual.

COUNTY: CONTRA COSTA (CONT.)

Agency Name and Address	Facility Name and Address	Findings
Pacific Gas & Electric Co. 245 Market Street, Room 434 San Francisco, CA 94106	NPD MAJ - PG&E Pittsburg Power Plant 696 W. 10th Street Pittsburg, CA 94565 Steve Gallo 510-427-3450	This is for a cooling water tower. They have had problems with Cr, Phosphate and chlorine residual. Also, some iron and copper problems.
Pestana, John, Family Trust 29234 Mission Blvd. Hayward, CA	Brentwood Oil & Gas Fields Jeff Lawrence 510-537-3200	Facility no longer in operation.
Pioneer Chlor Alkali Co., Inc. 700 Louisiana Street Houston, TX	Imperial West Chemical 1701 Wilbur Avenue Antioch, CA 94509 Dr. Tom Palmer 510-757-8230	Cooling water - they have had problems with temperature and chlorine residuals.
Praxair Corporation P.O. Box 445 Somerset, NJ 08873	NPD - Linde Division 2000 Loveridge Road Pittsburg, CA 94565 Lee Perry 510-427-3915	No longer use discharge point but send everything to Delta Diablo Sanitary District. Their discharge is primarily cooling water.
Rhone-Poulenc Basic Chemicals 100 Mococo Road Martinez, CA 94553	NPD MAJ - Rhone-Poulenc (Stauffer) 100 Mococo Road Martinez, CA 94553 Tony Koo 510-228-5530 ext 221	Monitor for pH,Ar, Cd, Cr, Cu, Pb, Hg, Se, Zn, Ag & cyanide. Have had trace amounts of weak acid, Ni, Cd, Cu, & Zn. They consider themselves a small discharger at 120,000 gal/day.
Termo Company P.O. Box 2767 Long Beach, CA	Brentwood Oil & Gas Fields	Facility no longer in operation.

Agency Name and Address	Facility Name and Address	Findings
Tosco Corporation Avon Refinery Martinez, CA 94553	NPD MAJ - Avon Refinery Solano Way Martinez, CA 94553 John Lazorick 510-228-1220 ext 3166	Awaiting response to request for information.
Venturini Associates, Inc. P.O. Box 677 Orinda, CA	Brentwood Oil & Gas Fields P.O. Box 677 Orinda, CA 94563 Sergio Venturini 510-254-2280	Facility no longer in operation.

COUNTY: SOLANO

Rio Vista, City of P.O. Box 745 Rio Vista, CA	Waste Treatment Facility 100 Beach Drive Rio Vista, CA 94571 Karen Honer 707-374-2930	Ecco Resources manage the plant, exceeded the coliform limit once, no other violations. Monitor: metal and organics, BOD, COD, TSS, NH3, bioassay.
Exxon Company, USA 3400 East Second Street Benicia, CA 94510 Todd P. Royer 707-745-7570	NPD MAJ - Exxon Benicia Refinery 3400 East Second Street Benicia, CA 94510 Allen Littleton 707-745-7764	No violations - oil & grease sometimes exceeds limit. Monitor for the following: BOD, TSS, phenols. ammonia, sulfide, cyanide, Cu, Ni, Hg, Zn, benzene, toluene and oil & grease.
Fairfield-Suisun Sewer District 1010 Chadbourne Road Fairfield, Ca 94585 Larry Bahr 707-429-8930	NPD MAJ - Subregional WWTP 1010 Chadbourne Road Fairfield, CA 94585 Jack Martin 707-429-3233	No violations but sometimes have trouble with chlorine residuals.
I.T. Corporation 4585 Pacheco Blvd. Martinez, Ca 94553 Dave McMurtri 510-372-9100	NPD - I.T. Corp. - Panoche Facility Lake Herman Road Benicia, CA 94519 Jane Zevely 510-228-5100	Storm water discharge; no detectable quantities of most constituents, they have not had any violations.

A-2 Water Quality Summary 1991 - 1995

A-2.1 Quarterly Source Water Analysis - Rock Slough

A-2.2 Quarterly Source Water Analysis - Mallard Slough

QUARTERLY SOURCE WATER ANALYSIS
ROCK SLOUGH
1991-1995

	Sample No.	10089	11354	13360	14576	20064	22078	23642	25301	30024	32212
Constituent/units	**Sample Date**	1/7/91	4/1/91	7/16/91	10/7/91	1/8/92	4/6/92	7/13/92	10/5/92	1/4/93	4/5/93
1,1,1,2-Tetrachloroethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	n/a	n/a	n/a	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5
1,1,2,2-Tetrachloroethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	n/a	n/a	<1.0	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5
1,1-Dichloroethane (1,1-DCA)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,1-Dichloroethylene (1,1-DCE)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,1-Dichloropropene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,2,3-Trichlorobenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.50
1,2,3-Trichloropropane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,2,4-Trichlorobenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,2,4-Trimethylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.50
1,2-Dichlorobenzene (o-DCB)	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,2-Dichloroethane (1,2-DCA)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,2-Dichloropropane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,3,5-Trimethylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,3-Dichlorobenzene (m-DCB)	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,3-Dichloropropane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,3-Dichloropropene (total)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
1,4-Dichlorobenzene (p-DCB)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
2,2-Dichloropropane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
2,4,5-TP (silvex)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1
2,4-D	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<1
2-Chloroethylvinyl ether	µg/L	n/a	n/a	<1	<1	<1.0	<1.0	n/a	n/a	<1.0	<1.0
2-Chlorotoluene	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
3-Hydroxy Carbofuran	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<10	<1
4-Chlorotoluene	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
4-Isopropyltoluene (para)	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.50
Alachlor (Alanex)	µg/L	<0.01	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.2	<0.2
Aldicarb (Temik)	µg/L	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<0.5	<0.5
Aldicarb sulfone	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.8	<0.8
Aldicarb sulfoxide	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.5	<0.5
Aldrin	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.01	<0.01
Alkalinity (total)	mg/L	72	73	68	74	64	76	66	73	70	94
Aluminum	ug/L	220	755	2400	940	310	490	1600	3600	410	600
Ammonia	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.1	<0.2	<0.2	<0.2
Antimony	µg/L	n/a	n/a	n/a	n/a	<5	<3	<3	<3	<3	<3
Arsenic	µg/L	<2	2.35	3	<2	<2	<2	<2	<2	<2	<2
Asbestos	MFL	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<100	n/a	<0.19
Atrazine (AAtrex)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1
Barium	µg/L	<100	<100	44	<100	<100	<100	<100	<100	<100	<100
Bentazon (Basagran)	µg/L	<2	<2.0	<2	<2	<2.0	<2.0	<2.0	<2.0	<2	<2
Benzene	µg/L	n/a	n/a	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5

n/a = not analyzed

QUARTERLY SOURC /ATER ANALYSIS
ROCK SLOUGH
1991-1995

	Sample No.	10089	11354	13360	14576	20064	22078	23642	25301	30024	32212
Constituent/units	Sample Date	1/7/91	4/1/91	7/16/91	10/7/91	1/8/92	4/6/92	7/13/92	10/5/92	1/4/93	4/5/93
Beryllium	µg/L	n/a	n/a	n/a	n/a	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bicarbonate alkalinity	mg/L	n/a	73	68	74	64	76	66	73	70	94
bis (2-Chloroethyl) Ether	µg/L	<0.50	<0.50	<5.0	<5.0	n/a	n/a	n/a	n/a	<1.0	<5
Boron	µg/L	0.2	0.2	0.2	0.2	0.2	<0.2	0.1	0.1	<100	0.5
Bromacil	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<5	<10
Bromide	mg/L	n/a	n/a	n/a	n/a	0.7	<0.1	0.6	0.63	0.25	0.23
Bromobenzene	µg/L	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	< 0.5	n/a	<0.50	<0.5
Bromochloromethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Bromodichloromethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Bromoform	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Bromomethane (Methyl Bromide)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Butachlor	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1
Cadmium	µg/L	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.14	<0.1
Calcium	mg/L	24	13	11	11	12	11	16	9.7	10	27
Carbaryl (SEVIN)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<5	<1
Carbofuran	µg/L	<5.0	<2.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5	5
Carbon Tetrachloride	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Chlordane	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	mg/L	220	120	120	120	190	39	180	180	90	97
Chloroethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Chloroform	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Chloromethane (Methyl Chloride)	µg/L	n/a	n/a	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Chlorothalonil (Daconil, Bravo)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<0.2	<5
Chromium	µg/L	<1	1.68	<1	<1	<1	<1	<1	<1	<1	<1
cis-1,2-Dichloroethylene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Color	Color Unit	15	40	40	10	0	40	20	10	40	30
Copper	mg/L	<0.5	0.007	0.03	0.019	<0.004	<0.1	<0.1	<0.1	<0.1	<0.004
Cyanide	ug/l	n/a	n/a	n/a	n/a	n/a	<0.02	n/a	<0.01	<0.01	<20
Dalapon	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1
Di(2-Diethylhexyl)phthalate (DEHP)	µg/L	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3	<3
Di(ethylhexyl)adipate	µg/L	n/a	n/a	<50.0	<50.0	n/a	n/a	n/a	n/a	<3	<10
Diazinon	µg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<2	<0.1
Dibromochloromethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Dibromochloropropane (DBCP)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02
Dibromomethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.50
Dicamba	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dichlorodifluoromethane	µg/L	<1.0	<0.50	<1.0	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5
Dichloromethane (Methylene Chloride)	µg/L	n/a	n/a	n/a	n/a	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5
Dieldrin (DIELDRINE)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.01	<0.5
Dimethoate	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<2	<10
Dinoseb	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.7	<1
Diquat	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.5	<20

n/a = not analyzed

QUARTERLY SOURC ,ATER ANALYSIS
ROCK SLOUGH
1991-1995

	Sample No.	10089	11354	13360	14576	20064	22078	23642	25301	30024	32212
Constituent/units	Sample Date	1/7/91	4/1/91	7/16/91	10/7/91	1/8/92	4/6/92	7/13/92	10/5/92	1/4/93	4/5/93
Diuron	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	n/a	n/a
Endothall	µg/L	n/a	n/a	<100	n/a	<2.5	<25	<30.0	<30	<50	<100
Endrin	µg/L	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01
Ethylbenzene	µg/L	<0.5	<0.50	<0.5	<5.0	<5.0	<5.0	< 0.5	n/a	<0.5	<0.5
Ethylene Dibromide (EDB)	µg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01
Fecal Coliform	CFU/100 mL	n/a	n/a	n/a	n/a	4	n/a	n/a	n/a	11	7
field pH	pH	n/a	n/a	n/a	n/a	7.6	n/a	7.6	7.7	7.8	n/a
Field Temperature	°C	n/a	n/a	n/a	n/a	9	n/a	24.4	21.2	20.5	17
Fluoride	mg/L	0.2	0.1	0.1	0.2	<0.1	<0.1	0.1	0.1	<0.1	0.1
Glyphosate	µg/L	<50	<70	<25	<25	<25	<25	<25	<25	<25	<25
Hardness (total)	mg/L	130	120	110	104	168	90	120	122	106	180
Heptachlor	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor Epoxide	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hexachlorobenzene	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.01	<1
Hexachlorobutadiene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Hexachlorocyclopentadiene	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.01	<8
Ion imbalance		n/a	n/a	n/a	n/a	n/a	n/a	0.02	0.18	-0.18	0.37
Iron	µg/L	<200	1300	730	360	250	420	240	150	339	470
Isopropylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Lab pH	units	n/a	n/a	7.8	8	7.8	8.1	7.8	7.9	7.8	8.25
Lead	µg/L	<2	<5	2.8	<2	<2	<2	2	<2	<2	<2
Lindane (gamma-BHC)	µg/L	<0.2	<0.40	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4	<0.02
Magnesium	mg/L	19	17	15	16	20	12	19	21	16	30
Manganese	µg/L	16	51.9	66	30.8	12.8	27	23.1	32	24	46
MBAS (foaming agents)	mg/L	<0.02	n/a	<0.02	<0.020	<0.020	<0.020	<0.025	0.028	0.05	<0.1
Mercury	µg/L	<1	<1	<1	<1.0	<1	<0.2	<0.2	<0.2	<0.2	<0.2
Methomyl	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<5	<1
Methoxychlor	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<1
Methyl ethyl ketone (MEK, Butanone)	µg/L	n/a	n/a	<5	<5	<5.0	<5.0	n/a	n/a	<1.0	<5
Methyl isobutyl ketone (MIBK)	µg/L	n/a	n/a	<5	<5	<5.0	<5.0	n/a	n/a	<1.0	<5
Metolachlor	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1
Metribuzin (SENCORE)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<0.1
Molinate (Ordram)	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2
Monochlorobenzene (Chlorobenzene)	µg/L	n/a	n/a	<1.0	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5
n-Butylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
n-Propylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Naphthalene	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Nickel	µg/L	<2	3.51	4.5	2	0.5	3	2	<2	2.9	2.5
Nitrate as NO3	mg/L	2.9	4.2	1.8	1.2	3.4	2	1.6	1	3.9	4.4
Nitrite as N	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<30	<30
o Xylene	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.5	<0.5
Ortho Phosphate	mg/L	0.3	0.2	0.3	0.2	0.2	0.3	0.2	0.23	0.3	0.21

n/a = not analyzed

QUARTERLY SOURC /ATER ANALYSIS
ROCK SLOUGH
1991-1995

	Sample No.	10089	11354	13360	14576	20064	22078	23642	25301	30024	32212
Constituent/units	**Sample Date**	1/7/91	4/1/91	7/16/91	10/7/91	1/8/92	4/6/92	7/13/92	10/5/92	1/4/93	4/5/93
Oxamyl (Vydate)	µg/L	n/a	n/a	<1.0	<1.0	n/a	n/a	n/a	n/a	<5	<100
PAHs (Benzopyrene)	µg/L	n/a	n/a	<0.2	<0.2	n/a	n/a	n/a	n/a	<0.2	<0.2
PCB-1016	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.1	<0.08
PCB-1221	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.2	<0.2
PCB-1232	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.2	<0.2
PCB-1242	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.2	<0.2
PCB-1248	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.1	<0.1
PCB-1254	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.1	<0.1
PCB-1260	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.2	<0.2
Pentachlorophenol	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1
pH s	pH	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	8.6	8.11
Picloram	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1
Polychlorinated biphenyls (PCBs)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1.0	n/a
Potassium	mg/L	6.1	4.2	4.1	3.8	5.4	2.2	5.2	5.5	3.6	2.5
Prometryn	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2
Propachlor (RAMROD)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1
Saturation Index	SI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.8	0.14
sec-Butylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Selenium	µg/L	<2	<2	<2	<2	<2	<5	<5	<5	<5	<2
Silica dioxide	mg/L	18	24	17	14	18	15	12	13	18	14
Silver	µg/L	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Simazine (Princep)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1
Sodium	mg/L	88	77	80	78	110	35	110	120	63	80
Specific conductance	µmhos/cm	870	637	630	630	870	360	830	850	600	740
Styrene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Sulfate	mg/L	50	50	31	29	51	29	39	39	39	110
Temp - °C	C	n/a	n/a	n/a	n/a	14	20	23.3	25.2	20.5	13.9
tert-Butylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Tetrachloroethylene (PCE)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Thallium	µg/L	n/a	n/a	n/a	n/a	<1	<1	<1	<1	<1	<1
Thiobencarb (Bolero)	µg/L	<0.8	<0.80	<1.0	<0.8	<1.0	<1.0	<1.0	<1.0	<1	<1
Toluene	µg/L	<0.5	<0.50	<10	<10	<10	<10	< 0.5	n/a	<10	<0.5
Total Dissolved Solids (TDS)	mg/L	510	350	300	300	450	190	410	420	270	410
Toxaphene	µg/L	<1.0	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.5	<1
trans-1,2-Dichloroethylene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Trichloroethylene (TCE)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Trichlorofluoromethane (Freon 11)	µg/L	<1.0	<0.50	<1.0	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5
Trichlorotrifluoroethane (Freon 113)	µg/L	<10	<0.50	<10	<10	<10	<10	n/a	n/a	<1.0	<0.5
Turbidity	NTU	n/a	n/a	n/a	n/a	n/a	n/a	n/a	7.2	548	n/a
Vinyl chloride (VC)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5
Xylenes (total m, p, and o)	µg/L	<10	<0.50	<10	<10	<10	<10	< 0.5	n/a	<0.5	<0.5
Zinc	µg/L	30	<20	<20	<20	<20	<20	<20	<20	<20	<20

n/a = not analyzed

QUARTERLY SOURC. /ATER ANALYSIS
ROCK SLOUGH
1991-1995

	Sample No.	34303	35723	40417	41577	44251	46432	50566	52307	53972	56577
Constituent/units	**Sample Date**	7/19/93	10/4/93	1/3/94	4/4/94	7/11/94	10/3/94	1/9/95	4/3/95	7/10/95	10/2/95
1,1,1,2-Tetrachloroethane	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	<1	<1	<1	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1,2,2-Tetrachloroethane	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	<1	<1	<1	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1-Dichloroethane (1,1-DCA)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1-Dichloroethylene (1,1-DCE)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1-Dichloropropene	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2,3-Trichlorobenzene	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2,3-Trichloropropane	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2,4-Trichlorobenzene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2,4-Trimethylbenzene	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2-Dichlorobenzene (o-DCB)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2-Dichloroethane (1,2-DCA)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2-Dichloropropane	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,3,5-Trimethylbenzene	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,3-Dichlorobenzene (m-DCB)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,3-Dichloropropane	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,3-Dichloropropene (total)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,4-Dichlorobenzene (p-DCB)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
2,2-Dichloropropane	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
2,4,5-TP (silvex)	µg/L	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2,4-D	µg/L	<1	<1	<10	<10	<10	<10	<10	<10	<10	<10
2-Chloroethylvinyl ether	µg/L	<1	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2-Chlorotoluene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
3-Hydroxy Carbofuran	µg/L	<1	<1	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
4-Chlorotoluene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
4-Isopropyltoluene (para)	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Alachlor (Alanex)	µg/L	<0.2	<0.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Aldicarb (Temik)	µg/L	<0.5	<0.5	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Aldicarb sulfone	µg/L	<0.8	<0.8	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Aldicarb sulfoxide	µg/L	<0.5	<0.5	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Aldrin	µg/L	<0.01	<0.01	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075
Alkalinity (total)	mg/L	48	68	68	95	66	77	71	104	38	48
Aluminum	ug/L	550	310	320	180	550	150	180	230	200	440
Ammonia	mg/L	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	<0.1
Antimony	µg/L	<3	<5	<3	<3	<3	<6	<3	<3	<3	<3
Arsenic	µg/L	2.4	2.3	2.3	2.2	2.7	2.8	<2	<2	2	<2
Asbestos	MFL	n/a	<0.19	<0.19	<0.19	<0.18	<0.18	<0.18	<0.2	<0.2	<0.2
Atrazine (AAtrex)	µg/L	<0.1	<0.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Barium	µg/L	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Bentazon (Basagran)	µg/L	<2	<2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Benzene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50

n/a = not analyzed

QUARTERLY SOURC ATER ANALYSIS
ROCK SLOUGH
1991-1995

	Sample No.	34303	35723	40417	41577	44251	46432	50566	52307	53972	56577
Constituent/units	Sample Date	7/19/93	10/4/93	1/3/94	4/4/94	7/11/94	10/3/94	1/9/95	4/3/95	7/10/95	10/2/95
Beryllium	µg/L	<0.2	<0.2	[illegible].2	<0.2	<0.2	<1	<0.2	<0.2	<0.2	<0.2
Bicarbonate alkalinity	mg/L	48	68	[illegible]8	95	66	77	71	104	38	48
bis (2-Chloroethyl) Ether	µg/L	<5	<2	<5	<5.0	<5	<5.0	<5.0	<5.0	<5.0	<5.0
Boron	µg/L	<100	<100	100	110	210	<100	160	760	59	74
Bromacil	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Bromide	mg/L	<0.1	<0.1	0.17	0.17	0.36	0.51	0.27	0.19	<0.1	<0.1
Bromobenzene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Bromochloromethane	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Bromodichloromethane	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Bromoform	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Bromomethane (Methyl Bromide)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Butachlor	µg/L	<1	<1	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38
Cadmium	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<1	<0.1	<0.1	<0.1	<0.1
Calcium	mg/L	7.9	8.6	10	18	12	11	11	27	4.2	6.2
Carbaryl (SEVIN)	µg/L	<1	<1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbofuran	µg/L	<0.9	<0.9	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbon Tetrachloride	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Chlordane	µg/L	<0.1	<0.1	<0.10	<0.1	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10
Chloride	mg/L	17	48	69	64	110	150	93	94	15	15
Chloroethane	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Chloroform	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Chloromethane (Methyl Chloride)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Chlorothalonil (Daconil, Bravo)	µg/L	<5	<5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chromium	µg/L	1.3	<1	<1	<1	<1	<10	<1	<1	<1	<1
cis-1,2-Dichloroethylene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Color	Color Unit	5	5	15	30	15	10	10	30	5	15
Copper	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.01	<0.004	<0.004
Cyanide	ug/l	<20	<0.02	<0.010	<0.01	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Dalapon	µg/L	<1	<1	<10	<10	<10	<10	<10	<10	<10	<10
Di(2-Diethylhexyl)phthalate (DEHP)	µg/L	<3	<3	<3.0	6.2	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Di(ethylhexyl)adipate	µg/L	<10	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Diazinon	µg/L	<0.1	<0.1	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Dibromochloromethane	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Dibromochloropropane (DBCP)	µg/L	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010
Dibromomethane	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Dicamba	µg/L	n/a	n/a	<0.081	<0.12	<0.12	<0.12	<0.12	<0.12	<0.081	<0.081
Dichlorodifluoromethane	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<0.5	<0.5	<0.5	<0.5	<1.0
Dichloromethane (Methylene Chloride)	µg/L	<3.0	<3.0	<3.0	<3.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Dieldrin (DIELDRINE)	µg/L	<0.5	<0.5	<0.02	<0.02	<0.02	<0.02	<0.02	<0.020	<0.020	<0.020
Dimethoate	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Dinoseb	µg/L	<1	<1	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Diquat	µg/L	<20	<20	<4.0	<10	<10	<10	<10	<10	<4.0	<4.0

n/a = not analyzed

QUARTERLY SOURC. ATER ANALYSIS
ROCK SLOUGH
1991-1995

	Sample No.	34303	35723	40417	41577	44251	46432	50566	52307	53972	56577
Constituent/units	Sample Date	7/19/93	10/4/93	1/3/94	4/4/94	7/11/94	10/3/94	1/9/95	4/3/95	7/10/95	10/2/95
Diuron	µg/L	<0.1	<1	<1.0	<2.5	<2.5	<2.5	<2.5	<2.5	<1.0	<1.0
Endothall	µg/L	<100	<100	<45	<45	<45	<45	<45	<45	<45	<45
Endrin	µg/L	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.10	<0.10
Ethylbenzene	µg/L	<5	<5	<5	<5.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Ethylene Dibromide (EDB)	µg/L	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.020	<0.020
Fecal Coliform	CFU/100 mL	n/a	29	20	9	107	23	41	13	30	21
field pH	pH	7.52	7.57	7.56	8.06	7.9	7.55	7.78	7.9	7.6	7.52
Field Temperature	°C	24.2	20	10.5	17	23.1	21	12.6	18.1	n/a	21.8
Fluoride	mg/L	<0.1	<0.1	<0.1	0.1	<0.1	0.1	0.12	0.18	<0.1	<0.1
Glyphosate	µg/L	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Hardness (total)	mg/L	48	80	84	136	102	116	100	176	54	52
Heptachlor	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010
Heptachlor Epoxide	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010
Hexachlorobenzene	µg/L	<1	<1	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Hexachlorobutadiene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Hexachlorocyclopentadiene	µg/L	<8	<8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.50	<0.50
Ion Imbalance		-0.29	-0.31	-0.36	-0.4	-0.31	-0.22	-0.12	-0.01	-0.21	-0.13
Iron	µg/L	420	140	210	360	280	230	180	490	450	200
Isopropylbenzene	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Lab pH	units	7.6	7.8	7.8	8	7.9	7.56	7.82	7.86	7.6	7.48
Lead	µg/L	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Lindane (gamma-BHC)	µg/L	<0.02	<0.02	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.20	<0.20
Magnesium	mg/L	6	10	11	17	14	17	16	23	5.9	6.6
Manganese	µg/L	41	33	18	36	29	<30	12	36	43	24
MBAS (foaming agents)	mg/L	<0.1	<0.1	<0.025	<0.025	0.06	<0.050	<0.025	0.083	<0.050	<0.025
Mercury	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	<0.20	<0.20	<0.2
Methomyl	µg/L	<1	<1	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Methoxychlor	µg/L	<1	<1	<10	<10	<10	<10	<10	<10	<10	<10
Methyl ethyl ketone (MEK, Butanone)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Methyl isobutyl ketone (MIBK)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Metolachlor	µg/L	<1	<1	<0.5	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Metribuzin (SENCORE)	µg/L	<0.1	<0.1	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Molinate (Ordram)	µg/L	<2	<2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Monochlorobenzene (Chlorobenzene)	µg/L	<1.0	<1.0	<1.0	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
n-Butylbenzene	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
n-Propylbenzene	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Naphthalene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Nickel	µg/L	<2	<2	<2	2.1	<2	<10	<2	2.8	<2	<2
Nitrate as NO3	mg/L	0.17	<0.1	2.1	2.6	1.5	0.55	3.3	9	0.44	0.62
Nitrite as N	µg/L	<30	<30	<30	<30	<30	<30	37	<30	<30	<30
o Xylene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Ortho Phosphate	mg/L	<0.2	<0.2	0.22	0.26	0.26	0.2	0.24	0.31	<0.2	<0.2

n/a = not analyzed

QUARTERLY SOURC ATER ANALYSIS
ROCK SLOUGH
1991-1995

	Sample No.	34303	35723	40417	41577	44251	46432	50566	52307	53972	56577
Constituent/units	Sample Date	7/19/93	10/4/93	1/3/94	4/4/94	7/11/94	10/3/94	1/9/95	4/3/95	7/10/95	10/2/95
Oxamyl (Vydate)	µg/L	<1	<1	<20	<20	<20	<20	<20	<20	<20	<20
PAHs (Benzopyrene)	µg/L	<0.2	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.10	<0.10
PCB-1016	µg/L	<0.08	<0.08	<1.0	<1.0	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1221	µg/L	<0.2	<0.2	<1.0	<1.0	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1232	µg/L	<0.2	<0.2	<1.0	<1.0	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1242	µg/L	<0.2	<0.2	<1.0	<1.0	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1248	µg/L	<0.1	<0.1	<1.0	<1.0	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1254	µg/L	<0.1	<0.1	<1.0	<1.0	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1260	µg/L	<0.2	<0.2	<1.0	<1.0	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Pentachlorophenol	µg/L	<1	<1	<0.20	<0.2	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20
pH s	pH	8.75	8.65	8.74	8.26	8.51	8.52	8.66	8.05	9.47	8.89
Picloram	µg/L	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Polychlorinated biphenyls (PCBs)	µg/L	n/a	<0.2	<0.5	<0.5	<0.5	<0.50	<0.50	<0.5	<0.50	<0.50
Potassium	mg/L	1.2	1.8	2.9	2.9	3.5	4.5	4	4.4	1.2	1.2
Prometryn	µg/L	<2	<2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Propachlor (RAMROD)	µg/L	<1	<1	<0.50	<0.5	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Saturation Index	SI	-1.23	-1.08	-1.18	-0.2	-0.61	-0.97	-0.88	-0.15	-1.87	-1.37
sec-Butylbenzene	µg/L	<0.50	<0.50	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Selenium	µg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Silica dioxide	mg/L	<2.0	18	18	17	13	15	20	12	12	14
Silver	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<10	<0.5	<0.5	<0.5	<0.5
Simazine (Princep)	µg/L	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium	mg/L	11	36	47	51	68	95	61	88	14	18
Specific conductance	µmhos/cm	160	330	410	510	580	720	480	760	160	190
Styrene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Sulfate	mg/L	11	21	25	59	31	30	30	110	16	19
Temp - °C	C	22.2	18.5	21.2	18	23.1	22.2	19	21.2	18.3	23.1
tert-Butylbenzene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Tetrachloroethylene (PCE)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Thallium	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Thiobencarb (Bolero)	µg/L	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	µg/L	<1.0	<1.0	<1.0	<1.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Total Dissolved Solids (TDS)	mg/L	80	170	210	270	280	350	260	420	80	100
Toxaphene	µg/L	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
trans-1,2-Dichloroethylene	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Trichloroethylene (TCE)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Trichlorofluoromethane (Freon 11)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<0.5	<0.5	<0.5	<0.5	<5.0
Trichlorotrifluoroethane (Freon 113)	µg/L	<5	<1	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<10
Turbidity	NTU	n/a	4.6	3.5	4.5	5	n/a	7.1	n/a	n/a	7.4
Vinyl chloride (VC)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Xylenes (total m, p, and o)	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Zinc	µg/L	<20	<50	<50	<50	<50	<50	<50	<50	<50	<50

n/a = not analyzed

A-2.2 Quarterly Source Water Analysis - Mallard Slough

QUARTERLY SOURCE WATER ANALYSIS
MALLARD SLOUGH
1991-1995

	Sample No.	10087	11352	13362	14574	20062	22076	23640	25299	30022	32210	34301
Constituent/units	Sample Date	1/7/91	4/1/91	7/15/91	10/8/91	1/6/92	4/6/92	7/13/92	10/6/92	1/4/93	4/5/93	7/19/93
1,1,1,2-Tetrachloroethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.50
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	n/a	n/a	<1.0	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5	<1
1,1,2,2-Tetrachloroethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	n/a	n/a	<1.0	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5	<1
1,1-Dichloroethane (1,1-DCA)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
1,1-Dichloroethylene (1,1-DCE)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
1,1-Dichloropropene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.50
1,2,3-Trichlorobenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.50	<0.50
1,2,3-Trichloropropane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.50
1,2,4-Trichlorobenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
1,2,4-Trimethylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.50	<0.50
1,2-Dichlorobenzene (o-DCB)	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
1,2-Dichloroethane (1,2-DCA)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
1,2-Dichloropropane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
1,3,5-Trimethylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.50
1,3-Dichlorobenzene (m-DCB)	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
1,3-Dichloropropane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.50	<0.50
1,3-Dichloropropene (total)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
1,4-Dichlorobenzene (p-DCB)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
2,2-Dichloropropane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.50
2,4,5-TP (silvex)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1
2,4-D	µg/L	<10	<10	<10	<10	<10	<10	<10	<1.0	<10	<1	<1
2-Chloroethylvinyl ether	µg/L	n/a	n/a	<1	<1	<1.0	<1.0	n/a	n/a	<1.0	<1.0	<1
2-Chlorotoluene	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
3-Hydroxy Carbofuran	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<10	<1	<1
4-Chlorotoluene	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
4-Isopropyltoluene (para)	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.50
Alachlor (Alanex)	µg/L	<0.01	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.2	<0.2	<0.2
Aldicarb (Temik)	µg/L	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<0.5	<0.5	<0.5
Aldicarb sulfone	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.8	<0.8	<0.8
Aldicarb sulfoxide	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.5	<0.5	<0.5
Aldrin	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.01	<0.01	<0.01
Alkalinity (total)	mg/L	74	67	84	77	72	80	88	78	70	55	59
Aluminum	ug/L	130	2279	1100	910	690	3700	3300	2300	230	1100	670
Ammonia	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4	<0.2	<0.2	<0.2	0.29
Antimony	µg/L	n/a	n/a	n/a	n/a	<5	<3	<3	<3	<3	<3	<3
Arsenic	µg/L	2	<2	3.9	2.2	<2	2.3	2.1	5.8	<2	<2	3.3
Asbestos	MFL	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<100	n/a	n/a	n/a
Atrazine (AAtrex)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1	<0.1
Barium	µg/L	<100	<100	55	<100	<100	<100	<100	<100	<100	<100	<100
Bentazon (Basagran)	µg/L	<2	<2.0	<2	<2	<2.0	<2.0	< 2.0	<2.0	<2	<2	<2
Benzene	µg/L	n/a	n/a	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5

n/a = not analyzed

QUARTERLY SOUR WATER ANALYSIS
MALLARD SLOUGH
1991-1995

	Sample No.	10087	11352	13362	14574	20062	22076	23640	25299	30022	32210	34301
Constituent/units	Sample Date	1/7/91	4/1/91	7/15/91	10/8/91	1/6/92	4/6/92	7/13/92	10/6/92	1/4/93	4/5/93	7/19/93
Beryllium	µg/L	n/a	n/a	n/a	n/a	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Bicarbonate alkalinity	mg/L	n/a	67	84	77	72	80	79	66	70	55	59
bis (2-Chloroethyl) Ether	µg/L	<0.50	n/a	<5.0	<5.0	n/a	n/a	n/a	n/a	<1.0	<5.0	<5
Boron	µg/L	0.2	0.3	0.3	0.3	0.2	0.2	1.1	1	200	0.2	300
Bromacil	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<5	<10	<10
Bromide	mg/L	n/a	n/a	n/a	n/a	20	2.6	13	13	3	<0.1	7.2
Bromobenzene	µg/L	<0.50	<0.50	<0.50	<0.50	<0.5	<0.5	< 0.5	n/a	<0.50	<0.5	<0.5
Bromochloromethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Bromodichloromethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Bromoform	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Bromomethane (Methyl Bromide)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Butachlor	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1	<1
Cadmium	µg/L	2.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium	mg/L	69	9	82	59	66	19	85	61	24	7.9	20
Carbaryl (SEVIN)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<5	<1	<1
Carbofuran	µg/L	<5.0	<2.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5	<0.9	<0.9
Carbon Tetrachloride	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Chlordane	µg/L	<0.1	<0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride	mg/L	3200	130	3400	2310	3100	740	3740	3400	1000	15	1400
Chloroethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Chloroform	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Chloromethane (Methyl Chloride)	µg/L	n/a	n/a	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	0.66
Chlorothalonil (Daconil, Bravo)	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<0.2	<5	<5
Chromium	µg/L	<1	6.3	<1	<1	<1	1.2	<1	<1	<1	1.4	1.8
cis-1,2-Dichloroethylene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Color	Color Unit	5	>70	20	15	20	40	30	10	40	30	5
Copper	mg/L	0.11	0.011	0.008	0.009	<0.004	<0.1	<0.1	<0.1	<0.1	0.016	<0.004
Cyanide	ug/l	n/a	n/a	n/a	n/a	n/a	<0.02	n/a	n/a	<0.01	<20	<20
Dalapon	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1	<1
Di(2-Diethylhexyl)phthalate (DEHP)	µg/L	<3.0	<3.0	<3.0	<3.0	3.5	<3.0	<3.0	<3.0	<3	<3	3
Di(ethylhexyl)adipate	µg/L	n/a	n/a	<50.0	<50.0	n/a	n/a	n/a	n/a	<3	<10	<10
Diazinon	µg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<2	<0.1	<0.1
Dibromochloromethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Dibromochloropropane (DBCP)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.01	<0.01	<0.01	<0.02	<0.02
Dibromomethane	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.50	<0.50
Dicamba	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Dichlorodifluoromethane	µg/L	<1.0	<0.50	<1.0	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5	<1.0
Dichloromethane (Methylene Chloride)	µg/L	n/a	n/a	n/a	n/a	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5	<3.0
Dieldrin (DIELDRINE)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.01	<0.5	<0.5
Dimethoate	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<2	<10	<10
Dinoseb	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.7	<1	<1
Diquat	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.5	<20	<20

n/a = not analyzed

QUARTERLY SOURCE WATER ANALYSIS
MALLARD SLOUGH
1991-1995

	Sample No.	10087	11352	13362	14574	20062	22076	23640	25299	30022	32210	34301
Constituent/units	Sample Date	1/7/91	4/1/91	7/15/91	10/8/91	1/6/92	4/6/92	7/13/92	10/6/92	1/4/93	4/5/93	7/19/93
Diuron	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	n/a	n/a	<0.1
Endothall	µg/L	n/a	n/a	<100	n/a	<2.5	<25	<30	<30	<50	<100	<100
Endrin	µg/L	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01
Ethylbenzene	µg/L	<0.5	<0.50	<0.5	<5.0	<5.0	<5.0	< 0.5	n/a	<0.5	<0.5	<5
Ethylene Dibromide (EDB)	µg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01	<0.02	<0.01	<0.01
Fecal Coliform	CFU/100 mL	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	20	n/a	n/a
field pH	pH	n/a	n/a	n/a	n/a	7.9	n/a	8.77	n/a	7.8	n/a	7.41
Field Temperature	°C	n/a	n/a	22.5	n/a	9.4	n/a	25	n/a	20.4	16	23.3
Fluoride	mg/L	<0.1	0.1	0.3	0.4	0.2	<0.1	0.2	0.2	<0.1	<0.1	<0.1
Glyphosate	µg/L	<50	<70	<25	<25	<25	<25	<25	<25	<25	<25	<25
Hardness (total)	mg/L	1200	100	1240	780	1200	320	1300	1130	450	56	540
Heptachlor	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor Epoxide	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hexachlorobenzene	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.01	<1	<1
Hexachlorobutadiene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Hexachlorocyclopentadiene	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.01	<8	<8
Ion Imbalance		n/a	n/a	n/a	n/a	n/a	n/a	5.73	4.48	0.67	-0.22	1.25
Iron	µg/L	<200	3200	360	430	210	660	200	95	303	1100	710
Isopropylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.50	<0.50
Lab pH	units	n/a	n/a	8.3	8.1	7.7	8.1	8.9	8.8	7.8	7.82	7.6
Lead	µg/L	<2	<5	<2	<2	<2	<2	<2	<2	<2	7	<2
Lindane (gamma-BHC)	µg/L	<0.2	<0.40	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.4	<0.02	<0.02
Magnesium	mg/L	110	15	240	157	206	59	268	237	78	6.4	110
Manganese	µg/L	19	69.6	94	31.2	18.6	47.4	41	39	20	39	260
MBAS (foaming agents)	mg/L	<0.02	n/a	<0.02	<0.020	0.052	<0.020	<0.025	<0.025	0.09	<0.1	<0.1
Mercury	µg/L	<1	<1	<1	<1.0	1.8	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Methomyl	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<5	<1	<1
Methoxychlor	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<1	<1
Methyl ethyl ketone (MEK, Butanone)	µg/L	n/a	n/a	<5	<5	<5.0	<5.0	n/a	n/a	<1.0	<5	<5.0
Methyl isobutyl ketone (MIBK)	µg/L	n/a	n/a	<5	<5	<5.0	<5.0	n/a	n/a	<1.0	<5	<5.0
Metolachlor	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1	<1
Metribuzin (SENCORE)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<0.1	<0.1
Molinate (Ordram)	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2
Monochlorobenzene (Chlorobenzene)	µg/L	n/a	n/a	<1.0	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5	<1.0
n-Butylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.50
n-Propylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.50
Naphthalene	µg/L	n/a	n/a	n/a	n/a	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Nickel	µg/L	<0.002	7.41	4.1	3	1.2	5	4	2.3	4.8	3.6	4.7
Nitrate as NO3	mg/L	2.5	3	<0.1	1.3	6.7	1.9	<0.1	<0.1	2	0.86	1.1
Nitrite as N	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<30	<30	<30
o Xylene	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.5	<0.5	<0.5
Ortho Phosphate	mg/L	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2	<0.2	0.24	<0.2

n/a = not analyzed

QUARTERLY SOUR WATER ANALYSIS
MALLARD SLOUGH
1991-1995

	Sample No.	10087	11352	13362	14574	20062	22076	23640	25299	30022	32210	34301
Constituent/units	Sample Date	1/7/91	4/1/91	7/15/91	10/8/91	1/6/92	4/6/92	7/13/92	10/6/92	1/4/93	4/5/93	7/19/93
Oxamyl (Vydate)	µg/L	n/a	n/a	<1.0	<1.0	n/a	n/a	n/a	n/a	<5	<1	<1
PAHs (Benzopyrene)	µg/L	n/a	n/a	<0.2	<0.2	n/a	n/a	n/a	n/a	<0.2	<0.2	<0.2
PCB-1016	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.1	<0.08	<0.08
PCB-1221	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.2	<0.2	<0.2
PCB-1232	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.2	<0.2	<0.2
PCB-1242	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.2	<0.2	<0.2
PCB-1248	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.1	<0.1	<0.1
PCB-1254	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.1	<0.1	<0.1
PCB-1260	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.2	<0.2	<0.2
Pentachlorophenol	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1	<1
pH s	pH	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	8.32	8.81	8.45
Picloram	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1	<1
Polychlorinated biphenyls (PCBs)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1.0	n/a	n/a
Potassium	mg/L	71	5.1	83	46	63	18	87	76	5	1.2	36
Prometryn	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2
Propachlor (RAMROD)	µg/L	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<1	<1	<1
Saturation Index	SI	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	-0.52	-0.99	-1.04
sec-Butylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.50
Selenium	µg/L	<2	<2	<2	<2	<2	<5	<5	<5	<5	<2	<5
Silica dioxide	mg/L	14	23	16	16	17	19	12	13	18	24	11
Silver	µg/L	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Simazine (Princep)	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	<1	<1
Sodium	mg/L	1800	83	2040	1260	1660	460	2190	2000	580	14	810
Specific conductance	µmhos/cm	9600	619	11300	7540	10600	2740	11440	11030	4450	184	5220
Styrene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Sulfate	mg/L	425	33	470	310	430	120	510	450	150	11	200
Temp - °C	C	n/a	n/a	n/a	n/a	13	20	24.9	24.9	20.4	16	22.3
tert-Butylbenzene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Tetrachloroethylene (PCE)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Thallium	µg/L	n/a	n/a	n/a	n/a	<1	<1	<1	<1	<1	<1	<1
Thiobencarb (Bolero)	µg/L	<0.8	<0.80	<1.0	<0.8	<1.0	1	<1.0	<1.0	<1	<1	<1
Toluene	µg/L	<0.5	<0.50	<10	<10	<10	<10	< 0.5	n/a	<10	<0.5	<1.0
Total Dissolved Solids (TDS)	mg/L	6400	330	7500	4220	5770	1500	6930	6270	1900	90	2610
Toxaphene	µg/L	<1.0	<0.50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.5	<1	<1
trans-1,2-Dichloroethylene	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Trichloroethylene (TCE)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Trichlorofluoromethane (Freon 11)	µg/L	<1.0	<0.50	<1.0	<1.0	<1.0	<1.0	< 0.5	n/a	<1.0	<0.5	<1.0
Trichlorotrifluoroethane (Freon 113	µg/L	<10	<0.50	<10	<10	<10	<10	n/a	n/a	<1.0	<0.5	<5
Turbidity	NTU	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	8.5	n/a	n/a
Vinyl chloride (VC)	µg/L	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	< 0.5	n/a	<0.5	<0.5	<0.5
Xylenes (total m, p, and o)	µg/L	<10	<0.50	<10	<10	<10	<10	< 0.5	n/a	<0.5	<0.5	<0.5
Zinc	µg/L	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20

n/a = not analyzed

QUARTERLY SOURCE WATER ANALYSIS
MALLARD SLOUGH
1991-1995

	Sample No.	35721	40415	41575	44249	46339	46430	50564	52305	53970	56574
Constituent/units	Sample Date	10/4/93	1/3/94	4/4/94	7/11/94	9/20/94	10/3/94	1/9/95	4/3/95	7/10/95	10/4/95
1,1,1,2-Tetrachloroethane	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1,1-Trichloroethane (1,1,1-TCA)	µg/L	<1	<1	<1.0	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1,2,2-Tetrachloroethane	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1,2-Trichloroethane (1,1,2-TCA)	µg/L	<1	<1	<1.0	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1-Dichloroethane (1,1-DCA)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1-Dichloroethylene (1,1-DCE)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,1-Dichloropropene	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2,3-Trichlorobenzene	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2,3-Trichloropropane	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2,4-Trichlorobenzene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2,4-Trimethylbenzene	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2-Dichlorobenzene (o-DCB)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2-Dichloroethane (1,2-DCA)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,2-Dichloropropane	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,3,5-Trimethylbenzene	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,3-Dichlorobenzene (m-DCB)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,3-Dichloropropane	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,3-Dichloropropene (total)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
1,4-Dichlorobenzene (p-DCB)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
2,2-Dichloropropane	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
2,4,5-TP (silvex)	µg/L	<1	<1.0	<1.0	n/a	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2,4-D	µg/L	<1	<10	<10	n/a	<10	<10	<10	<10	<10	<10
2-Chloroethylvinyl ether	µg/L	<1	<1	<1.0	n/a	n/a	<1.0	<1.0	<1.0	<1.0	<1.0
2-Chlorotoluene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
3-Hydroxy Carbofuran	µg/L	<1	<3.0	<3.0	n/a	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
4-Chlorotoluene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
4-Isopropyltoluene (para)	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Alachlor (Alanex)	µg/L	<0.2	<1.0	<1.0	n/a	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Aldicarb (Temik)	µg/L	<0.5	<3.0	<3.0	n/a	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Aldicarb sulfone	µg/L	<0.8	<4.0	<4.0	n/a	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Aldicarb sulfoxide	µg/L	<0.5	<3.0	<3.0	n/a	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Aldrin	µg/L	<0.01	<0.075	<0.075	n/a	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075
Alkalinity (total)	mg/L	69	70	78	77	n/a	77	68	56	40	56
Aluminum	ug/L	1400	410	400	1100	n/a	180	270	430	500	1200
Ammonia	mg/L	<0.1	<0.1	<0.1	<0.1	n/a	<0.1	0.2	0.17	0.13	<0.1
Antimony	µg/L	<5	<3	<3	<3	n/a	7.2	<3	<3	<3	<3
Arsenic	µg/L	2.2	2.3	2	2.9	n/a	3	<2	<2	<2	<2
Asbestos	MFL	n/a	<0.19	<0.19	n/a	n/a	n/a	n/a	n/a	0.2	0.2
Atrazine (AAtrex)	µg/L	<0.1	<1.0	<1.0	n/a	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Barium	µg/L	<100	<100	<100	<100	n/a	<100	<100	<100	<100	<100
Bentazon (Basagran)	µg/L	<2	<2.0	<2	n/a	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Benzene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50

n/a = not analyzed

QUARTERLY SOUR WATER ANALYSIS
MALLARD SLOUGH
1991-1995

	Sample No.	35721	40415	41575	44249	46339	46430	50564	52305	53970	56574
Constituent/units	Sample Date	10/4/93	1/3/94	4/4/94	7/11/94	9/20/94	10/3/94	1/9/95	4/3/95	7/10/95	10/4/95
Beryllium	µg/L	<0.2	<0.2	<0.2	<0.2	n/a	<1	<0.2	<0.2	<0.2	<0.2
Bicarbonate alkalinity	mg/L	69	70	78	77	n/a	77	79	56	40	56
bis (2-Chloroethyl) Ether	µg/L	<2	<5	<5.0	n/a	n/a	<5.0	<5.0	<5.0	<5.0	<5.0
Boron	µg/L	630	520	460	770	n/a	580	770	190	37	55
Bromacil	µg/L	<10	<10	<10	n/a	<10	<10	<10	<10	<10	<10
Bromide	mg/L	10	2.5	2.1	12	n/a	7.9	11	<0.1	<0.1	0.13
Bromobenzene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Bromochloromethane	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Bromodichloromethane	µg/L	<0.5	<0.5	<0.5	NS	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Bromoform	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Bromomethane (Methyl Bromide)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Butachlor	µg/L	<1	<0.38	<0.38	n/a	<0.38	<0.38	<0.38	<0.38	<0.38	<0.38
Cadmium	µg/L	<0.1	<0.1	<0.1	<0.1	n/a	<1	<0.1	<0.1	<0.1	<0.1
Calcium	mg/L	49	58	18	63	n/a	55	61	13	3.6	6.1
Carbaryl (SEVIN)	µg/L	<1	<5.0	<5.0	n/a	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbofuran	µg/L	<0.9	<5.0	<5.0	n/a	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Carbon Tetrachloride	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Chlordane	µg/L	<0.1	<0.10	<0.1	n/a	<0.1	<0.10	<0.10	<0.10	<0.10	<0.10
Chloride	mg/L	2000	1100	640	3300	n/a	2400	2850	25	19	38
Chloroethane	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Chloroform	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Chloromethane (Methyl Chloride)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Chlorothalonil (Daconil, Bravo)	µg/L	<5	<5.0	<5.0	n/a	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Chromium	µg/L	<1	<1	2.1	1.6	n/a	<10	1	<1	1.7	1.2
cis-1,2-Dichloroethylene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Color	Color Unit	5	20	20	15	n/a	5	10	20	5	20
Copper	mg/L	<0.004	<0.004	<0.004	0.006	n/a	<0.004	<0.004	0.016	0.015	<0.004
Cyanide	ug/l	<0.02	<0.010	<0.01	n/a	<0.01	<0.010	<0.010	<0.010	<0.010	<0.010
Dalapon	µg/L	<1	<10	<10	n/a	<10	<10	<10	<10	<10	<10
Di(2-Diethylhexyl)phthalate (DEHP)	µg/L	<3	<3.0	<3.0	n/a	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Di(ethylhexyl)adipate	µg/L	<10	<5.0	<5.0	n/a	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Diazinon	µg/L	<0.1	<0.25	<0.25	n/a	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
Dibromochloromethane	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Dibromochloropropane (DBCP)	µg/L	<0.02	<0.01	<0.01	n/a	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010
Dibromomethane	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Dicamba	µg/L	n/a	<0.081	<0.12	n/a	<0.12	<0.12	<0.12	<0.12	<0.081	<0.081
Dichlorodifluoromethane	µg/L	<1.0	<1.0	<1.0	n/a	<1.0	<0.5	<0.5	<0.5	<0.5	<1.0
Dichloromethane (Methylene Chloride)	µg/L	<3.0	<3.0	<3.0	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Dieldrin (DIELDRINE)	µg/L	<0.5	<0.02	<0.02	n/a	<0.02	<0.02	<0.02	<0.020	<0.020	<0.020
Dimethoate	µg/L	<10	<10	<10	n/a	<10	<10	<10	<10	<10	<10
Dinoseb	µg/L	<1	<2.0	<2.0	n/a	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Diquat	µg/L	<20	<4.0	<10	n/a	<10	<10	<10	<10	<4.0	<4.0

n/a = not analyzed

QUARTERLY SOUR[illegible] WATER ANALYSIS
MALLARD SLOUGH
1991-1995

	Sample No.	35721	40415	41575	44249	46339	46430	50564	52305	53970	56574
Constituent/units	Sample Date	10/4/93	1/3/94	4/4/94	7/11/94	9/20/94	10/3/94	1/9/95	4/3/95	7/10/95	10/4/95
Diuron	µg/L	<1	<1.0	<2.5	n/a	<2.5	<2.5	<2.5	<2.5	<1.0	<1.0
Endothall	µg/L	<100	<45	<45	n/a	<45	<45	<45	<45	<45	<45
Endrin	µg/L	<0.01	<0.1	<0.1	n/a	<0.1	<0.1	<0.1	<0.1	<0.10	<0.10
Ethylbenzene	µg/L	<5	<5	<5.0	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Ethylene Dibromide (EDB)	µg/L	<0.01	<0.02	<0.02	n/a	<0.02	<0.02	<0.02	<0.02	<0.020	<0.020
Fecal Coliform	CFU/100 mL	n/a	19	12	17	n/a	38	9	12	15	39
field pH	pH	8.13	8.3	8.09	8.2	n/a	8.04	7.86	7.6	7.8	7.42
Field Temperature	°C	19.4	9.5	21	23	n/a	22.8	12.6	18.8	25	20.1
Fluoride	mg/L	<0.1	<0.1	0.12	0.25	n/a	0.23	0.28	<0.1	<0.1	<0.1
Glyphosate	µg/L	110	<25	<25	n/a	<25	<25	<25	<25	<25	<25
Hardness (total)	mg/L	780	400	276	1120	n/a	940	990	74	46	56
Heptachlor	µg/L	<0.01	<0.01	<0.01	n/a	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010
Heptachlor Epoxide	µg/L	<0.01	<0.01	<0.01	n/a	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010
Hexachlorobenzene	µg/L	<1	<0.50	<0.5	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Hexachlorobutadiene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Hexachlorocyclopentadiene	µg/L	<8	<1.0	<1.0	n/a	<1.0	<1.0	<1.0	<1.0	<0.50	<0.50
Ion imbalance		-2.17	-5.79	-1.83	-8.44	n/a	2.81	-9.72	-0.13	-0.14	-0.16
Iron	µg/L	310	340	520	370	n/a	280	290	620	960	230
Isopropylbenzene	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Lab pH	units	8.3	8.4	8.1	8.3	n/a	7.95	7.56	7.35	7.49	6.49
Lead	µg/L	<2	<2	<2	<2	n/a	<2	<2	3.5	<2	<2
Lindane (gamma-BHC)	µg/L	<0.02	<0.2	<0.2	n/a	<0.2	<0.2	<0.2	<0.2	<0.20	<0.20
Magnesium	mg/L	140	68	51	210	n/a	170	190	8.6	6.2	8
Manganese	µg/L	51	22	43	29	n/a	<30	37	46	41	26
MBAS (foaming agents)	mg/L	<0.1	0.057	<0.025	n/a	0.078	<0.050	<0.025	0.064	<0.050	<0.025
Mercury	µg/L	<1	<0.2	<0.2	n/a	<0.2	<0.2	<0.20	<0.20	<0.20	<0.2
Methomyl	µg/L	<1	<2.0	<2.0	n/a	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Methoxychlor	µg/L	<1	<10	<10	n/a	<10	<10	<10	<10	<10	<10
Methyl ethyl ketone (MEK, Butanone)	µg/L	<5.0	<5.0	<5.0	n/a	n/a	<5.0	<5.0	<5.0	<5.0	<5.0
Methyl isobutyl ketone (MIBK)	µg/L	<5.0	<5.0	<5.0	n/a	n/a	<5.0	<5.0	<5.0	<5.0	<5.0
Metolachlor	µg/L	<1	<0.5	<0.5	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Metribuzin (SENCORE)	µg/L	<0.1	<0.50	<0.5	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Molinate (Ordram)	µg/L	<2	<2.0	<2.0	n/a	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Monochlorobenzene (Chlorobenzene)	µg/L	<1.0	<1.0	<1.0	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
n-Butylbenzene	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
n-Propylbenzene	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Naphthalene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Nickel	µg/L	<2	<2	3.6	2.8	n/a	<10	2.4	3.9	3	2.8
Nitrate as NO3	mg/L	1.2	2.5	1.9	1.8	n/a	1.2	2.9	2.8	0.67	0.32
Nitrite as N	µg/L	<30	<30	<30	55	n/a	<30	<30	<30	<30	<30
o Xylene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Ortho Phosphate	mg/L	<0.2	2	0.43	0.75	n/a	<0.2	<0.2	0.29	<0.2	0.25

n/a = not analyzed

QUARTERLY SOURCE WATER ANALYSIS
MALLARD SLOUGH
1991-1995

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Constituent/units	Sample Date	10/4/93	1/3/94	4/4/94	7/11/94	9/20/94	10/3/94	1/9/95	4/3/95	7/10/95	10/4/95
Oxamyl (Vydate)	µg/L	<1	<20	<20	n/a	<20	<20	<20	<20	<20	<20
PAHs (Benzopyrene)	µg/L	<0.2	<0.1	<0.1	n/a	<0.1	<0.1	<0.1	<0.1	<0.10	<0.10
PCB-1016	µg/L	<0.08	<1.0	<1.0	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1221	µg/L	<0.2	<1.0	<1.0	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1232	µg/L	<0.2	<1.0	<1.0	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1242	µg/L	<0.2	<1.0	<1.0	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1248	µg/L	<0.1	<1.0	<1.0	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1254	µg/L	<0.1	<1.0	<1.0	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
PCB-1260	µg/L	<0.2	<1.0	<1.0	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Pentachlorophenol	µg/L	<1	<0.20	<0.2	n/a	<0.2	<0.20	<0.20	<0.20	<0.20	<0.20
pH s	pH	8.07	8.1	8.37	7.88	n/a	7.93	8.09	8.57	9.15	8.87
Picloram	µg/L	<1	<1.0	<1.0	n/a	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Polychlorinated biphenyls (PCBs)	µg/L	<0.2	<0.5	<0.5	n/a	<0.5	<0.50	<0.50	<0.5	<0.50	<0.50
Potassium	mg/L	<0.2	29	19	63	n/a	56	55	2.5	1.3	2
Prometryn	µg/L	<2	<2.0	<2.0	n/a	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Propachlor (RAMROD)	µg/L	<1	<0.50	<0.5	n/a	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50
Saturation Index	SI	0.06	0.2	-0.28	0.32	n/a	0.11	-0.23	-0.97	-1.35	-1.45
sec-Butylbenzene	µg/L	<0.50	<0.50	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Selenium	µg/L	<5	<5	<5	<5	n/a	<5	<5	<5	<5	<5
Silica dioxide	mg/L	17	18	20	11	n/a	15	18	17	15	16
Silver	µg/L	<0.5	<0.5	<0.5	<0.5	n/a	<10	<0.5	<0.5	<0.5	<0.5
Simazine (Princep)	µg/L	<1	<1.0	<1.0	n/a	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sodium	mg/L	1100	480	330	1700	n/a	1400	1400	22	16	30
Specific conductance	µmhos/cm	7360	3780	2350	9660	n/a	8240	8430	280	170	210
Styrene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Sulfate	mg/L	290	160	100	460	n/a	330	420	30	9.3	13
Temp - °C	C	20.4	21.1	20.4	20.3	n/a	22.8	19	21	19.8	22.1
tert-Butylbenzene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Tetrachloroethylene (PCE)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Thallium	µg/L	<1	<1	<1	<1	n/a	<1	<1	<1	<1	<1
Thiobencarb (Bolero)	µg/L	<1	<1.0	<1.0	n/a	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Toluene	µg/L	<1.0	<1.0	<1.0	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Total Dissolved Solids (TDS)	mg/L	3620	1940	1210	5850	n/a	4460	5020	140	80	130
Toxaphene	µg/L	<1	<1.0	<1.0	n/a	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
trans-1,2-Dichloroethylene	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Trichloroethylene (TCE)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Trichlorofluoromethane (Freon 11)	µg/L	<1.0	<1.0	<1.0	n/a	<1.0	<0.5	<0.5	<0.5	<0.5	<5.0
Trichlorotrifluoroethane (Freon 113	µg/L	<1	<1	<1.0	n/a	n/a	<1.0	<1.0	<1.0	<1.0	<10
Turbidity	NTU	13	13	16	6.5	n/a	n/a	10	n/a	n/a	23
Vinyl chloride (VC)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Xylenes (total m, p, and o)	µg/L	<0.5	<0.5	<0.5	n/a	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50
Zinc	µg/L	<50	<50	<50	<50	n/a	<50	<50	<50	<50	<50

n/a = not analyzed

Overview

The overall objective of the Raw Waters Chemical Treatment program is to maintain a high quality water supply during the phytoplankton growing season. Unchecked phytoplankton blooms can results in taste and odor episodes, loss of head and decreased filter runs, increased sedimentation in the reservoirs, and unsightly algael mats. In order to achieve this goal, chemicals, in the form of Cutrine - Plus or Copper Sulfate (Copper Sulfate Pentahydrate), are applied to various raw water sites during the growing season. This report summarizes the treatment schedule, application procedures and approximate costs of the program (Table 1).

Site Description

The locations of all raw waters subject to chemical treatment can be found in Table 2. The canal locations are set at 5 mile intervals. These location intervals ensure sufficient contact time at the labeled maximum dosage rate.

Table 2 Site Description for Chemical Treatment of Raw Waters

Site
Canal - Check 8
Canal - Check 12
Canal - Check 16
Canal - Check 23
Ygnacio Relift Outfall
Martinez Reservoir
Contra Loma Reservoir
Mallard Reservoir

Phytoplankton Monitoring Schedule

Total algae levels and species composition are monitored on the canal at Rock Slough at Contra Costa Canal, Randall - Bold, and Clyde on a weekly basis fron April through October. Results of these analyses are sent to K. Voigt, R. Pato, and treatment plant retailers.
Total algae levels and species composition are monitored in Mallard Reservoir on a weekly basis throughout the year. Results are sent to K.Voigt.
Total algae levels and species composition are monitored in Conta Loma and Martinez Reservoirs every other week from April through October. Results are sent to R.Pato, and W.Peas, Superintendent, Martinez Water Dept.

Treatment Schedule

Section 1 Canal System

The following schedule was developed based on Cutrine - Plus guidelines, past canal pH, temperature and algae bloom historical records and the personal observations of R. Pato.

Annual Start Up

Cutrine is applied to the canal every 4 weeks starting in the spring when the canal water reaches 59 degrees F at Plant 1. The 4 week schedule is modified to a five or six week application period depending on air temperature at Plant 1 (Table 3) .Treatment is suspended at the end of October.

When the canal is cleaned in April, treatment is suspended. After cleanup the canal is treated and the 4 week treatment schedule is resumed. After the canal is cleaned in October, a final application of cutrine is made when visual observations and climatic conditions indicate algal problems may occur.

Table 3 Canal Cutine -Plus Application Frequency Criteria

	4 Week Frequency (Start Up)	5 Week Frequency	6 Week Frequency
Water Temperature (Plant 1)	59°F		
Air Temperature (Plant 1)		80 - 88°F	<80° F

Responsible Person - Richard Pato, Supervisor of Canal Maintenance

Section 2 Martinez and Contra Loma Reservoirs

Action Level

When visual observation by R. Pato and associates indicates that planktonic algae along the perimeter of the reservoir is beginning to move out into the center of the reservoir.

Responsible Person - Richard Pato

Section 3 Mallard Reservoir

Action Level

Any of the following parameters may trigger chemical treatment of the reservoir.

* Loss of head and/or decrease in filter run times and corresponding increases in Diatom populations.
* Algae blooms and abnormal taste and odor results from Flavor Profile Analysis of the reservoir and Bollman clearwell out.
* Increases in pH and temperature (when algae results are not available).
* Threshold Odor Numbers results for the Clearwell out which exceed routine historic values (when algae results are not available).

Responsible Person - Karl Voigt, Treatment Plant Superintentent

Chemical Dosage Rate

Cutrine - Plus

Drip System Application

In order to maintain a Cutrine - Plus level of 1.0 ppm in the water, 1 quart per C.F.S. is dripped into the canal per hour. The drip system is run for 3 hours. The C.F.S. is obtained from Carl West on the day of application.

Surface Spray Application

The target application is 1.2 gallons per surface acre of reservoir.

Copper Sulfate Pentahydrate

The target application is 0.5 to 1.03 ppm of copper sulfate pentahydrate.

Drip System Application

The drip system application procedure for applying Cutrine - Plus to the canal can be found in Appendix 1.

Surface Spray/Injection Application

The surface spray application procedure for applying Cutrine - Plus to a reservoir can be found in Appendix 2.

General Treatment Notes

The following suggestions have been made by the manufacturer for optimum effectiveness of Cutrine - Plus.

* Apply early in the day under calm, sunny, conditions.
* Apply in a manner that will ensure even distribution of chemical wintin the treatment area.
* Allow 7 to 10 days between treatment to observe effects.

Copper Sulfate Pentahydrate

Copper sulfate pentahdyrate is applied by submerging bags of this product into the water and towing it by boat around the Mallard Reservoir in a set pattern (Figure 1).

Personnel

Cutrine - Plus

Charge Person - Richard Pato
Assistants - R. Nakagowa, J. Novero

Copper Sulfate Pentahydrate

Charge Person - Mark Nash
Assistant - Michael Zulawa

Material Safety Data

The material data safety data sheets for Cutrine - Plus and Copper Sulfate Pentahydrate can be found in Appendix 3.

Fig. 1

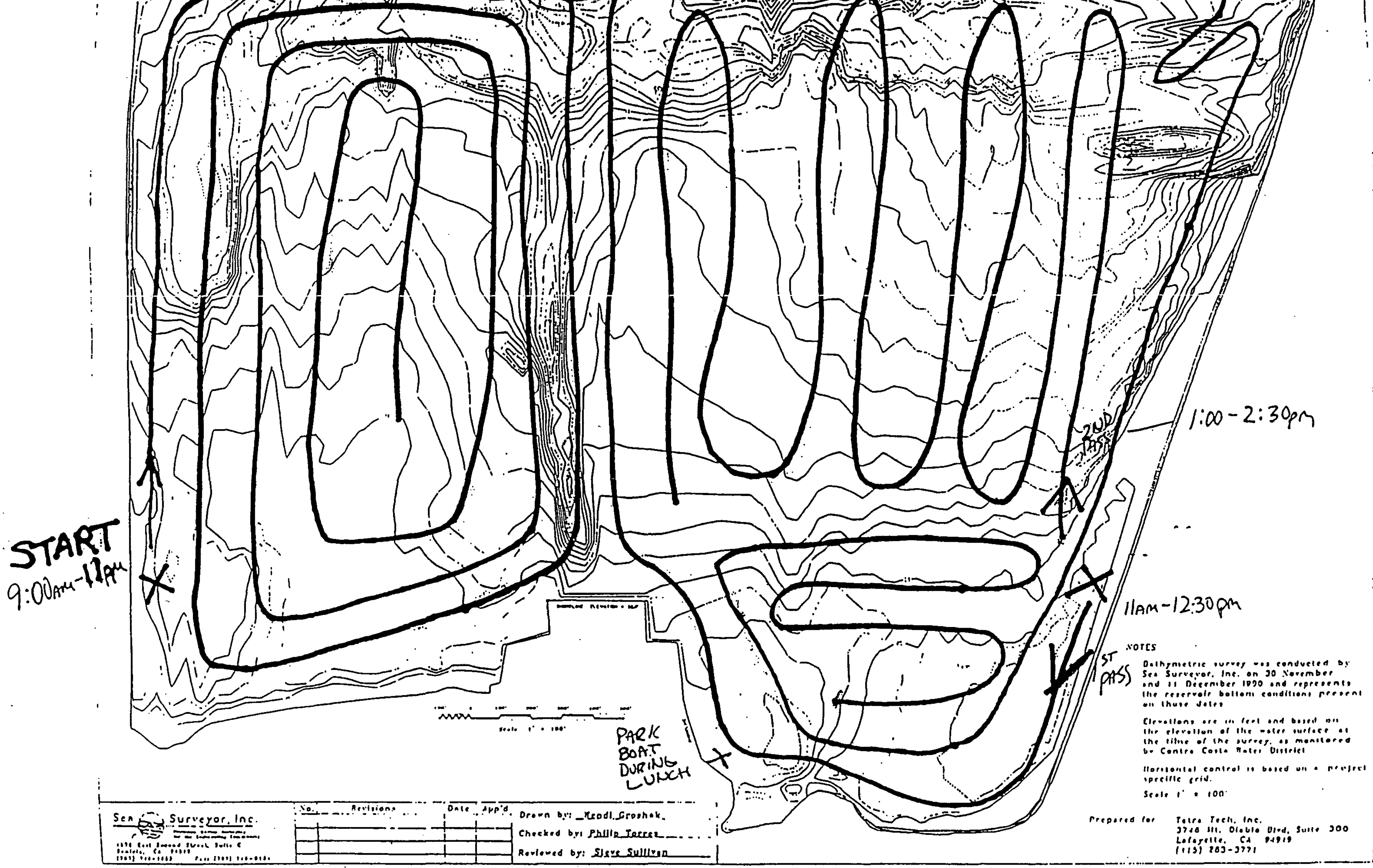
START
9:00AM-11AM
1:00-2:30pm
2ND PASS
11AM-12:30pm
1ST PASS
PARK BOAT DURING LUNCH
NOTES
Bathymetric survey was conducted by Sea Surveyor, Inc. on 30 November and 11 December 1990 and represents the reservoir bottom conditions present on those dates
Elevations are in feet and based on the elevation of the water surface at the time of the survey, as monitored by Contra Costa Water District
Horizontal control is based on a project specific grid.
Scale 1" = 100'
Prepared for Tetra Tech, Inc.
3746 Mt. Diablo Blvd, Suite 300
Lafayette, CA 94919
Sea Surveyor, Inc.
No. Revisions Date App'd
Drawn by: Kendl Groshek
Checked by: Philip Torres
Reviewed by: Steve Sullivan

Table 1 Guidelines for the Chemical Treatment of Raw Waters

CUTRINE-PLUS

Site Description	Treatment Schedule	Dosage Rate ppm Copper	Dosage Rate Cutrine-Plus	Application Method	Personnel	Approximate Cost
						Canal System
Canal Check Pt. 8	See Section 1	1ppm	1qt./hr./CFS	Drip System	R. Pato, J. Novero	250 gallons/season
					R. Nakagowa	at $14.25/gallon
Canal Check Pt.12		1ppm	1qt./hr./CFS	Drip System	R. Pato, J. Novero	
					R. Nakagowa	
Canal Check Pt. 16		1ppm	1qt./hr./CFS	Drip System	R. Pato, J. Novero	
					R. Nakagowa	
Canal Check Pt. 23		1ppm	1qt./hr./CFS	Drip System	R. Pato, J. Novero	
					R. Nakagowa	
Ignacio Relift Outfall		1ppm	1qt./hr./CFS	Drip System	R. Pato, J. Novero	
					R. Nakagowa	
Martinez Reservoir	See Section 2	0.2ppm	1.2 gallons per	Spray Injection	R. Pato, J. Novero	
			surface acre		R. Nakagowa	
Contra Loma Reservoi	See Section 2	0.2ppm	1.2 gallons per	Spray Injection	R. Pato, J. Novero	
			surface acre		R. Nakagowa	
Mallard Reservoir	See Section 3	0.2ppm	1.2 gallons per	Spray Injection	R. Pato, J. Novero	
			surface acre		R. Nakagowa	

Copper Sulfate Pentahydrate

Site Description	Treatment Schedule	Dosage Rate ppm Copper (depends on severity of algae bloom)	Dosage Rate Copper Sulfate	Application	Personnel	Approximate Cost
Mallard Reservoir	See Note 3	0.12-0.25 ppm	0.5-1.03 ppm	Sack Dispersion	Mark Nash	$0.70/lb.
					Mike Zulawa	

BOLLMAN WTP
STANDARD OPERATING PROCEDURE

CUTRINE APPLICATION TO MALLARD RESERVOIR

Feb. 96

Background

Cutrine or other copper containing compounds are used as algaecides to treat algae blooms in Mallard Reservoir. The decision to apply a algaecide is made by the Treatment Supervisor after careful collaboration with the Microbiologist and the District's licensed vegetation management technician. Not all blooms are treated. Treatment usually depends on the type of algae and the affects on taste and odor or on filtration runs. When deciding the dosage of copper to apply, the collaborating parties must consider the algae type, algae volume, reservoir level, water temperature, wind direction and wind speed.

The final word on algaecide application and dose must come from the Treatment Supervisor.

Procedure

MICROBIOLOGIST

1. Performs weekly assessment of algae type and quantity from Reservoir tap in Prep Lab.

2. Notes trends in algae type and populations from week to week.

3. Makes a decision that Mallard Reservoir should be treated based on experience and professional judgment.

4. Makes recommendation to Treatment Supervisor to treat the reservoir.

TREATMENT SUPERVISOR

5a. Sets up a meeting with the Microbiologist to go over the available data. If algae type indiçate a possible Taste and Odor problem, requests that an FPA panel convene ASAP and daily thereafter to track any taste and odor event. Go to 6a. below.

5b. If algae type indicate a possible filter clogging problem, notes the trend of the FURV calculated at each backwash. FURV below 3000 are an indication of reduced filter efficiency. Go to 6b. below.

6a. Alerts General Service Supt. that the Mallard may need to be treated within the next two days.

6b. If filter cloggers are already evident, initiates a program of double backwashing and jar testing to determine optimal dosage to remove as much of the algae in the sedimentation process.

MICROBIOLOGIST

7. Collects samples from Reservoir tap in Prep lab and from Mallard Reservoir.

8. Convenes and emergency FPA panel to determine whether odors may be increasing or are already bad enough to warrant PAC application.

9. Reports results to Treatment Supervisor. If algae populations have increased to the point that the FURV is less than 3000 or T&O is evident, collaborate with Treatment Supervisor with the intent to treat Mallard and establish the algaecide dose.

TREATMENT SUPERVISOR

10. Upon verification that Mallard is to be treated, contacts Grounds Maintenance Crew Leader with PCA to determine dosage and application patterns needed as per Appendix 1.

GROUNDS MAINTENANCE CREW LEADER WITH PCA

11. Applies algaecide per plan. Orders more to keep inventory on site. Normal site inventory is

APPENDIX 1
APPLICATION OF CUTRINE PLUS TO MALLARD RESERVOIR

1. Determine quantity of water to be treated.
   a. Get Reservoir level from SCADA screen 3P1.
   b. Consult Table 1 to determine surface area from reservoir elevation.
   c. Consult Table 2 to determine gallons of Cutrine-Plus to apply per surface area.

2. Apply the cutrine plus over a two or three day period. The first day's application should be on the windward side of Mallard (the side that the wind is coming from).

3. Algaecide should always be applied evenly over the lake. Never concentrate on any particular area just because it looks like it could use an 'extra treatment'.

Note-Item #2 prevents possible fish kills resulting in too much decay of algae in any one part of the lake.

Caution-DO NOT APPLY ALGAECIDE WHEN THE WIND IS HIGH ENOUGH TO CAUSE WHITECAPS ON MALLARD.

CONTRA COSTA COUNTY WATER DISTRICT

MALLARD RESERVIOR AS BUILT STORAGE CAPACITY

ELEVATION (Ft.)	AREA (Sq. - Ft.)	Σ VOLUME (MG)	Σ VOLUME (Acre - Ft.)
0	36,250	0	0
1	129,375	0.6194	1.900
2	255,125	1.9896	6.106
3	341,875	4.2224	12.958
4	489,000	7.3299	22.495
5	640,413	11.5539	35.458
6	790,750	16.9064	51.884
7	954,100	23.4321	71.910
8	990,250	30.7040	94.228
9	1,060,500	38.3738	117.765
10	1,185,000	46.7720	143.538
11	1,374,000	56.3427	172.910
12	1,653,875	67.6670	207.663
13	1,788,000	80.5400	247.169
14	2,069,500	94.9670	291.444
15	2,358,375	111.5273	342.266
16	2,746,625	130.6200	400.860
17	3,201,875	152.8674	469.135
18	3,557,375	178.1470	546.715
19	4,082,125	206.7187	634.400
20	4,628,800	239.2976	734.165
21	5,225,000	276.1508	847.231
22	5,800,000	317.3843	973.735
23	6,440,000	363.1619	1,114.181
24	7,079,000	413.7230	1,269.302
25	7,532,400	468.3696	1,436.958
26	8,153,000	527.0330	1,616.937
27	8,540,000	589.4648	1,808.478
28	8,814,500	654.3706	2,007.609
29	8,845,000	720.4171	2,210.240
30	8,875,200	786.6906	2,413.567
31	8,900,000	853.1698	2.617.522
32	8,929,400	919.8517	2,822.105
33	8,986,600	986.8575	3,027.679

TABLE 1

206 ACRES

SURFACE AREA
WHEN FULL

GENERAL INFORMATION

CUTRINE®-PLUS, under field conditions, is effective in controlling a broad range of algae including: Chara, Spirogyra, Cladophora, Vaucheria, Ulothrix, Microxystis, and Oscillatoria. CUTRINE®-PLUS has also been proven effective in controlling the rooted aquatic plant, **Hydrilla verticillata**. The ethanolamines in CUTRINE®-PLUS prevent the precipitation of copper with carbonates and bicarbonates in the water. Waters treated with CUTRINE®-PLUS may be used for swimming, fishing, drinking, livestock watering or irrigating turf, ornamental plants or crops immediately after treatment.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labelling

SURFACE SPRAY/INJECTION
ALGAECIDE APPLICATION

For effective control, proper chemical concentration should be maintained for a minimum of three hours contact time. The application rates in the chart are based on static or minimal flow situations. Where significant dilution or loss of water from unregulated inflows or outflows occur (raceways) within a three hour period, chemical may have to be metered in.

- Identify the algae growth present as one of the following types: Planktonic (suspended), Filamentous (mat-forming), or Chara/Nitella.
- Determine the surface acerage (1 acre = 43,560 sq. ft.) and average depth of infested area.
- Refer to the chart below to determine gallons of CUTRINE®-PLUS to apply per surface acre.

TABLE 2

Application Rates
Gallons Per Surface Acre

Algae Type	PPM Copper	Depth in Feet 1	2	3	4
Planktonic	0.2	0.6	1.2	1.8	2.4
Filamentous	0.2	0.6	1.2	1.8	2.4
Chara/Nitella	0.4	1.2	2.4	3.6	4.8

- For planktonic (suspended) algae and free-floating filamentous algae mats, application rates should be based upon treating only the upper 3 to 4 feet of water where algae is growing. Under conditions of heavy infestation treat only ⅓ to ½ of the water body at a time to avoid fish suffocation caused by oxygen depletion from decaying algae.
- Before applying dilute the required amount of CUTRINE®-PLUS with enough water to ensure even distribution with the type of equipment being used. For most effective results apply under calm and sunny conditions when water temperature is at least 60°F. Break up floating algae mats before spraying or while application is being made. Use hand or power sprayer adjusted to rain-sized droplets. Spray shoreline areas first to avoid trapping fish.

CUTRINE®-PLUS Granular Algaecide may be used as an alternative in low volume flow situations, spot treatments or treatment of bottom-growing algae in deep water.

A-4 Canal Drainage Storm Event Sampling Program

CANAL DRAINAGE STUDY MONITORING:

Legal Reference

None.

Description

As recommended in the Canal Drainage Study and before corrective actions are taken, it is necessary to field verify if there is, in fact, a problem with canal water quality as a result of storm run-off. The goal of sampling is to identify changes in water quality that can be attributed to local storm runoff and not changes in Delta water quality. This is a two-year study that will encompass the rainy seasons of '96-'97 and '97-'98.

Four locations along the Canal have been chosen for sampling sites: Pumping Plant #1, Buchanan Road, Milepost 25.7 and Martinez Reservoir. Time-dependent composite samplers will be set-up at stations 1-3 and will collect samples over a 24 hour period during rain events. Station 4 will use a discreet composite sampler (collects individual samples over a 24 hour period). The individual samples collected from the discreet sampler at station 4 will be combined into a single sample in the laboratory. A grab sample will be collected at each location at the start of composite sampling and at the completion of composite sampling. Samples will be collected for storm events of 0.5 inches or greater. Weather forecasts will be monitored to select storm events. The goal is to sample at least 10 storm events in the next two winter seasons ('96-'97 and '97-'98).

In addition, grab samples from individual storm drains may be collected to provide an evaluation of runoff from a specific site. These samples will be collected as needed throughout the monitoring period.

Locations

Station No.	*Location*	*City*
1	Pumping Plant #1	Oakley
2	Los Medanos Wasteway @Buchanan Rd.	Antioch
3	MP 25.7, near Check 8	Clyde
4	Martinez Reservoir	Martinez

Frequency

During rain/storm events (generally October through March) of 0.5 inches or greater which begin or are anticipated to begin during the regular working hours, Monday through Wednesday for the duration of the rainy seasons in '96-'97 and '97-'98. Sampling will begin as close to the beginning of a storm as possible.

Constituents

Constituents	*Reporting Unit*	*DLR*	*Action Level*	*MCL*
Turbidity	NTU	N/A	N/A	5
Chloride	mg/L	N/A	250	(250)
Total Suspended Solids	mg/L	N/A	N/A	N/A
Total Organic Carbon	mg/L	N/A	N/A	N/A
Chromium	µg/L	10	50	100
Calcium	mg/L	N/A	N/A	N/A
Magnesium	mg/L	N/A	N/A	N/A
Aluminum	µg/L	50	100	1000
Selenium	µg/L	5	5	50
Antimony	µg/L	6	6	6
Beryllium	µg/L	1	2	4
Thallium	µg/L	1	1	2
Copper	mg/L	0.05	1	1.3
Lead	µg/L	2	25	50
Nickel	µg/L	10	50	100
Mercury	µg/L	1	1	2
Silver	µg/L	10	25	50
Zinc	µg/L	50	2500	5000
Cadmium	µg/L	1	3	5
Silica dioxide	mg/L	N/A	N/A	N/A
Arsenic	µg/L	2	25	50
Manganese	µg/L	30	40	50
Iron	µg/L	100	200	300
Total Coliform	CFU/100ml	N/A	1	1
Fecal Coliform	CFU/100ml	N/A	1	1
Ammonia	mg/L	N/A	1	N/A
Ortho Phosphate	mg/L	N/A	1.0	N/A
Nitrite (N)	mg/L	0.4	1.0	1.0
Nitrate (NO3)	mg/L	2.0	1.0	45
Oil and Grease	mg/L	N/A	N/A	N/A
Total Petroleum Hydrocarbons	µg/L	N/A	N/A	N/A

Reports

Analytical results of the above listed constituents will be submitted to the Water Quality Superintendent for review and distribution to the planning department and other interested parties when all analyses are complete.