Chapter 1

WATER QUALITY MANAGEMENT ALONG THE EAST BAY SHORELINE AREA

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In 1892 an outbreak of cholera in the city of Hamburg, Germany killed thousands of people in that community. The River Elbe, which directly supplied the city with its drinking water, was contaminated with the bacteria Vibrio cholorae. After some investigation, the source of this waterborne disease was discovered. It seems a small band of Russian immigrants had set up camp a few miles up-river from Hamburg and were dumping their cholera-laced raw waste directly into the River Elbe. This small amount of raw waste had polluted the river water and made it unsuitable for human consumption. Needless to say, the immigrants were forced to move (Gan, 1982).

At the same time in Altona, Germany, a neighboring city comparable in size and population to Hamburg, 90% fewer people died from cholera. The Altona water supply also originated from the River Elbe, but, before the water reached the residents of Altona, it was treated in a slow-sand filter system. The system, which was installed a few years prior to the cholera outbreak, prevented thousands of deaths and illnesses (Gan, 1982).

Water: we drink it, flush it, channel it, dam it, and even squirt it. Life without it would not only be dry and stagnant but quite impossible as well. Nonetheless, we have found numerous ways to waste it, pollute it, and generally ruin it for ourselves and all other living beings with which we share it. There is just so much of it around, that it is often taken for granted. This general disregard for water is reflected in the notion that, "Dilution is the solution to pollution." We in our own self-destructive way, have rationalized that we can dump anything we want to discard into the nearest sewer, creek, or bay, and the refuse will be washed out to sea, never to be seen or heard of again. The tragic Hamburg story is an example of how wrong this philosophy can be. A small amount of pollution can ruin water quality for certain uses. We must not just use our water, but we must manage it as well.

The Hamburg-Altona story not only presents the consequences of ignoring water quality, but it also illustrates that we can manage it. In order for us to manage water quality along the East Bay shoreline effectively, we must perform six major tasks. The tasks are as follows: (1) describe the physical characteristics of the shoreline waters; (2) determine the potential beneficial uses of the shoreline water; (3) define the possible water quality problems; (4) provide water quality objectives to solve these problems; (5) identify the sources of these problems; (6) implement plans that will solve present problems and prevent future ones.

In this overview for the following chapters which will focus on water quality along the East Bay shoreline, these six tasks will be discussed, first generally for the East Bay shoreline, then specifically for a single beneficial use. It is hoped that this background information will allow the reader to understand the importance as well as some of the details of water quality management.

Physical Characteristics of the Bay

San Francisco Bay is a single, complex, and interrelated estaurine system. The bay waters are a mixture of ocean and inland waters. The saline ocean waters enter the bay through the Golden Gate, and the fresh inland waters originate mainly from the Sacramento River. Other sources of fresh water include flows from sewage outfalls, creeks, streams, and small rivers. The Sacramento River water water is largely responsible for flushing the bay of pollutants. Even though this flushing action is of great importance, the tidal changes and the resulting circulatory patterns also play a major role in the removal and distribution of contaminants from the bay. Because these circulation patterns are complicated and not well understood, those patterns which directly affect the East Bay shoreline waters should be studied (see papers by Peter Gee and Linda Goad). The area under discussion stretches from Pt. Isabel to the San Francisco Bay bridge toll plaza and extends from the shoreline to the mean lower low tide line.

Potential Beneficial Uses

By taking into account the bay's various physical characteristics, the California Regional Water Quality Control Board has identified potential beneficial uses for the shoreline waters. These potential uses need to be identified in order for proper water quality objectives to be formulated, thereby insuring the continuance of these uses. The beneficial uses appropriate for the East Bay shoreline are listed below (FWQCB, 1975, pp. 14-16):

Water Contact Recreation - includes all recreational uses involving actual body contact with water where ingestion of water is possible.

Non-contact Water Recreation - recreational uses that involve the presence of water but do not require contact with water.

Ocean Commercial Sport Fishing - the commercial collection of various types of fish and shellfish, including those taken for bait purposes, and sport fishing in oceans, bays, estuaries, and similar non-freshwater areas.

Wildlife Habitat - provides an aquatic habitat for the maintenance of wildlife.

Preservation of Rare and Endangered Species - provides an aquatic habitat necessary, at least in part, for the survival of certain species established as being rare and endangered species.

Marine Habitat - provides for the preservation of the marine ecosystem including the propagation and sustenance of most forms of aquatic life.

Shellfish Harvesting - the collection of shellfish such as clams, oysters, abalone, shrimp, crab, and lobster for either commercial or sport purposes.

Water Quality Problems

Each of these potential beneficial uses of the East Bay shoreline waters depends on specific water quality characteristics. Water quality satisfactory for one use may not be "clean" enough for another. As a result, the term "polluted" has little value in describing the water quality along the shoreline. The best way to illustrate the shoreline's water quality problems is through the use of pollution indicators. Each indicator represents a specific physical, chemical, or biological characteristic used to measure environmental distress or damage in shoreline waters. The indicators are as follows:

Dissolved Oxygen - the amount of oxygen dissolved in the water. An adequate level of dissolved oxygen is necessary for protection of aquatic life. A reduction of dissolved oxygen levels leads to a decrease in aquatic populations. Reduced levels indicate the discharge of excessive organic matter into receiving waters.

Floatable Materials - consist of any substance or object that will float on the surface of the water. The most prevalent examples of these materials are oil and grease. They may be derived from many sources, including industrial waste water, storm sewer discharge, and overflows of sewage treatment plants. They are most objectionable when they are foreign to their surroundings.

Coliform Bacteria - are indicator organisms selected for measuring the safety of waters for recreational uses. The coliform bacteria show the presence of human and animal wastes in the water. High coliform levels may indicate the presence of other pollutants. The test for coliforms is used quite extensively because it is relatively simple and inexpensive.

Biostimulants - a term used to encompass all of the nutrient material that may be discharged to a receiving water. Nutrients are principally nitrates and phosphates. High concentrations of these biostimulants cause enrichment, which stimulates the excessive growth of algae. These growths result in unsightly scum, discoloration, odors, and severe decreases in dissolved oxygen levels.

Toxicity - a comprehensive measure of poisonous characteristics of wastewater. High concentrations of toxic materials can bring about adverse effects on existing aquatic life.

pH - a term used to express the intensity of the acid or alkaline condition of a solution. It is important in many biological processes and must be maintained within a range favorable to aquatic organisms.

Pesticides - chemical compounds used for the control of troublesome insects, plants, or animals. Many pesticides, such as the chlorinated hydrocarbons, break down very slowly and can accumulate in plant and animal tissue, ultimately killing them.

Water Quality Objectives

Objectives for these water quality parameters must be set in order to solve the problems. The objectives adopted by the Regional Water Quality Control Board for the aforementioned pollution indicators are as follows:

-- Dissolved oxygen: Minimum of 5 mg/1.

-- Floatable materials: None other than of natural causes.

-- Coliform bacteria: Maximum of 1,000 MPN/100 ml.

-- Biostimulants: Shall not contain these substances in amounts that will produce nuisance conditions which adversely affect potential beneficial uses.

-- Toxicity: None at levels which render aquatic life unfit for human consumption.

-- pH: Not to be depressed below 6.5 or raised above 8.5.

-- Pesticides: None present in concentrations that adversely affect beneficial uses; no increase in concentrations found in bottom sediments or aquatic life.

Sources of Pollution

The water quality of any body of water is determined by a complex set of factors; the many processes of nature are augumented by the activities of man. Because there is no single source for pollution, there is no single measure of pollution. Pollution sources are divided into two broad categories: point sources and non-point sources.

Municipal and industrial wastes which have been treated by man-made processes, then discharged into a body of water, are considered to have originated from a point source. The other sources of pollution are called non-point sources. These sources are not treated by man-made processes before being discharged into a body of water. Wasteloads from non-point sources originate at agricultural operations, construction sites, urban runoff vessel wastes, oil spills and dredging spoils.

The major pollution sources along the East Bay shoreline are non-point sources. Non-point sources located along the shoreline include the various storm drains, sewer outfalls, creeks, dumps and boats, as well as "accidental" midnight discharges by industry. Other sources are the Berkeley Marina, Golden Gate Fields, and an occasional oil spill.

Solutions

General solutions to point source pollution problems include: the use of advanced treatment, the use of dilution-assimilation capabilities of certain bodies of water, the local treatment of wastes, consolidation of local treatment systems to process wastes, and reclamation/reuse of the water resource (RWQCB, 1975). Each of these solutions has definite advantages and disadvantages. For the East Bay, facilities for treatment to the full secondary level with an outfall just south of the San Francisco Bay Bridge have been constructed to meet and maintain water quality objectives for the shoreline area.

Thus far, much of the effort for water quality control has been concentrated upon point source control. Soon this effort will reach a point where the monetary investment will not produce adequate returns. The treatment of water to a tertiary level is very costly and does not solve the remaining pollution problems (e.g., hazardous wastes) (Sharpe, 1977). A more cost-effective method of dealing with these problems would be to address non-point source pollution problems. Implementing measures such as street sweeping to reduce the availability of pollutants for washout during storms, monitoring storm drains and sewer outfalls on a regular basis, and more pretreatment of industrial wastes would help to reduce some of the remaining pollution levels.

<u>Implementation</u>

To illustrate that solutions to water quality problems can be effective, the discussion will focus upon the beneficial use of water contact recreation. Water contact implies the risk of waterborne disease transmission and involves human safety. Accordingly, criteria required to protect this use have been established. The following standards apply to waters used for water contact recreation (California Department of Public Health, 1958, pp. 2-3):

> Physical Standard: No sewage sludge or grease or other evidence of sewage discharge shall be visible on any public beach or water contact sports area.
>
> Biological Standard: Most probable number (MPN) of coliform organisms shall not be greater than 1,000 MPN per 100 ml.

A 1963-64 study found that coliform levels along the East Bay shoreline did not meet the above water quality objectives (Pearson, 1965). A 1969 study of the bay states, "Areas along the Berkeley shoreline have long been plagued with odor problems . . . " (Wu, 1969, p. 14). The source of the odor was traced to a waste discharge at Gilman Street which used to receive industrial wastes from three industrial plants in Berkeley (Wu, 1969).

To solve these problems, the East Bay Municipal Utility District up-graded treatment of municpal and industrial wastewater before discharging it into the bay.

Presently, most of the shoreline waters are safe for water contact use, and there have been no reports of odors originating from the water column (Young, 1982). Other data have been collected and summarized (TABLE 1) and will be presented in the following paragraphs.

TABLE 1 summarizes bacteriological tests taken along the East Bay shoreline. The site locations are shown in FIGURE 1.

TABLE 2 shows that there are elevated bacteriological counts all along the shoreline. Only one site, site 5, had an average total coliform count of less than 1,000 MPN. Site 5 is located at the mouth of Berkeley's Marina and is not part of the "immediate" shoreline (see FIGURE 1). All the other sites are located directly on the shoreline and are either at or near a sewage outfall. The two sites with the highest counts, site 2 and site 11, are located at almost opposite ends of the study area. This indicates that there is not just one general area along the shoreline that is more "polluted" than the others, but that there are pollution problems all along the shore. These two sites have at least 100,000 MPN higher counts than any other site. Site 2 is found quite near Golden Gate Fields. Possibly the animal wastesor human wastes cause these high counts. Site 11 is close to many of Berkeley's industries, but there is no conclusive evidence that these industries are the cause of the high coliform counts. Sites 3, 4, 6, and 13 have fairly high coliform counts (greater than 10,000 MPN). These sites are located at storm drain outfalls that deposit surface runoff materials from the streets into the bay. The remaining sites, 1, 7, 8, 9, 10, and 12 have fairly low coliform counts (less than 10,000 but greater than 1,000 MPN). These sites are located various distances away from sewer outfalls. A comparison of coliform level from these sites with those of nearby sewer outfall sites, shows that high coliform levels can be reduced by as much as a factor of ten over relatively short distances. Tidal action, dilution capabilities and the salinity of the shoreline waters make them safe for water contact recreation.

TABLE 3 summarizes the average monthly total coliform levels from sites 7, 8, 9 and 10. This table shows that during the three years these sites were monitored, coliform levels were lowest during the winter months of November and December. The months of March, May and June also showed fairly low levels. Even though the coliform levels are low during these months, all the counts are still above the water quality objectives for contact recreation (RWQCB, 1975). The highest levels are found in July during the dry summer months. "Monitoring studies indicate that bacterial pollution of the shoreline probably results from municipal sewage discharge

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1965												
Month/Source[b]	A	A	A	A	A	A	A	A	A	A	A	A
Site[a] 7	7,000	2,400	2,400	620	620	-	7,000	7,000	2,400	7,000	7,000	60
8	2,400	2,100	2,400	2,400	7,000	-	2,400	7,000	2,400	230	2,300	60
9	620	620	2,400	2,400	500	-	500	620	2,300	60	2,300	230
10	2,400	2,400	7,000	2,400	620	-	130	1,300	2,400	7,000	620	7,000
1970												
Source[b]				D								
Site[a] 1				620								
2				62,000								
1973												
Source[b]	A	A	A	A	A	A	A	A	A	A	A	A
Site[a] 7	11,000	430	430	930	40	1,500	2,400	90	4,600	4,600	230	2,900
8	2,400	290	230	930	90	4,600	11,000	930	4,600	24,000+	930	7,500
9	2,400	2,400	2,400	930	90	2,100	2,400	4,600	2,400	11,000	230	430
10	4,600	930	4,600	11,000	24,000+	4,600	24,000+	24,000+	11,000	24,000+	40	2,100
1974												
Source[b]	A	A	A	A	A	A	A	A	A	A	A	A
Site[a] 7	750	11,000	1,500	24,000+	230	930	24,000+	2,400	1,500	930	4,600	460
8	2,400	11,000	1,500	24,000+	430	430	24,000+	11,000	4,600	930	930	430
9	4,600	460	2,400	24,000+	2,400	390	24,000+	440	24,000+	430	2,400	1,500
10	930	24,000+	1,500	24,000+	30	4,600	24,000+	24,000+	24,000+	430	2,400	1,500
1976												
Source[b]	B	B	B	B	B	B	B	B	B	B	B	B
Site[a] 1	910	300	9,300	360	300	300	300	300	300	300	2.2	-
2	9,300	9,300	24,000	360	360	2,300	9,300	2,300	2,300	2,300	110,000	-
3	300	4,300	240,000+	24,000	24,000	110,000	46,000	9,300	9,300	24,000	110,000	-
4	4,300	7,500	240,000+	300	300	110,000	240,000+	46,000	46,000	240,000+	240,000+	-
6	110,000	24,000	240,000+	24,000	240,000+	240,000+	110,000	240,000+	240,000+	24,000	110,000	-
11	240,000+	240,000+	240,000+	240,000	240,000+	24,000+	46,000	46,000	240,000+	240,000+	240,000+	-
12	2,300	910	15,000	910	7,500	360	910	910	360	24,000	24,000	-
13	240,000+	300	24,000	360	1,500	300	360	360	240,000+	300	2.2	-

							1977						
Source[b]		C	C	C	C	C							
Site[a]	1	930	–	9,300	9,300	43,000	- - - - - - - - - - - - no dry weather samples taken - - - - - - - - - -						
	2	$24x10^5$	$24x10^5$	$24x10^5$	$24x10^5$	$24x10^5$	- - - - - - - - - - - - no dry weather samples taken - - - - - - - - - -						
	3	110,000	120,000	–	–	–	- - - - - - - - - - - - no dry weather samples taken - - - - - - - - - -						
	4	9,300	9,300	2,300	9,300	44,000	- - - - - - - - - - - - no dry weather samples taken - - - - - - - - - -						
	5	–	90	–	–	–	- - - - - - - - - - - - no dry weather samples taken - - - - - - - - - -						
	6	43,000	93,000	–	–	–	- - - - - - - - - - - - no dry weather samples taken - - - - - - - - - -						
	11	240,000	–	460,000	–	–	- - - - - - - - - - - - no dry weather samples taken - - - - - - - - - -						
	12	43,000	–	–	–	–	- - - - - - - - - - - - no dry weather samples taken - - - - - - - - - -						
	13	9,300	–	43,000	–	–	- - - - - - - - - - - - no dry weather samples taken - - - - - - - - - -						
							1979						
Source[b]		E					F	F	F		F	F	F
Site[a]	1	1,100 (average of 37 tests taken in 1979)											
	2	3,000 (average of 34 tests taken in 1979)											
	5	–	–	–	–	–	40	16	70	–	130	2,400	3,500
							1980						
Source[b]		F	F	F	F	F	F	F					
Site[a]	5	1,300	1,300	490	2,400	490	13	230	–		--study ended in July--		

(a) Site

1 Cerrito Creek mouth
2 Buchanan Street outfall
3 Gilman Street outfall
4 Virginia Street outfall
5 Berkeley Marina ocean entrance
6 University Avenue/Strawberry Creek outfall
7 1500 feet south of University Avenue
8 3000 feet south of University Avenue
9 4500 feet south of University Avenue
10 6000 feet south of University Avenue
11 Potter Street outfall
12 65th Street
13 Powell Street outfall

(b) Source

A EBMUD Shoreline Monitoring Program (Sharpe, 1977)
B EBMUD Shoreline Sampling Results (Sharpe, 1977)
C EBMUD Wet Weather and Storm Sewer Study (Sharpe, 1977)
D State Health Department Study of Water Quality Near Albany Hill (RWQCB, 1977)
E SFRWQCB San Francisco Bay Shellfish Program (RWQCB, 1981)
F Berkeley Department of Public Health Study of Water Quality at the Berkeley Marina Basin (Gerber, 1980)

TABLE 1. East Bay Shoreline Summary Total Coliform - MPN/100 ml.

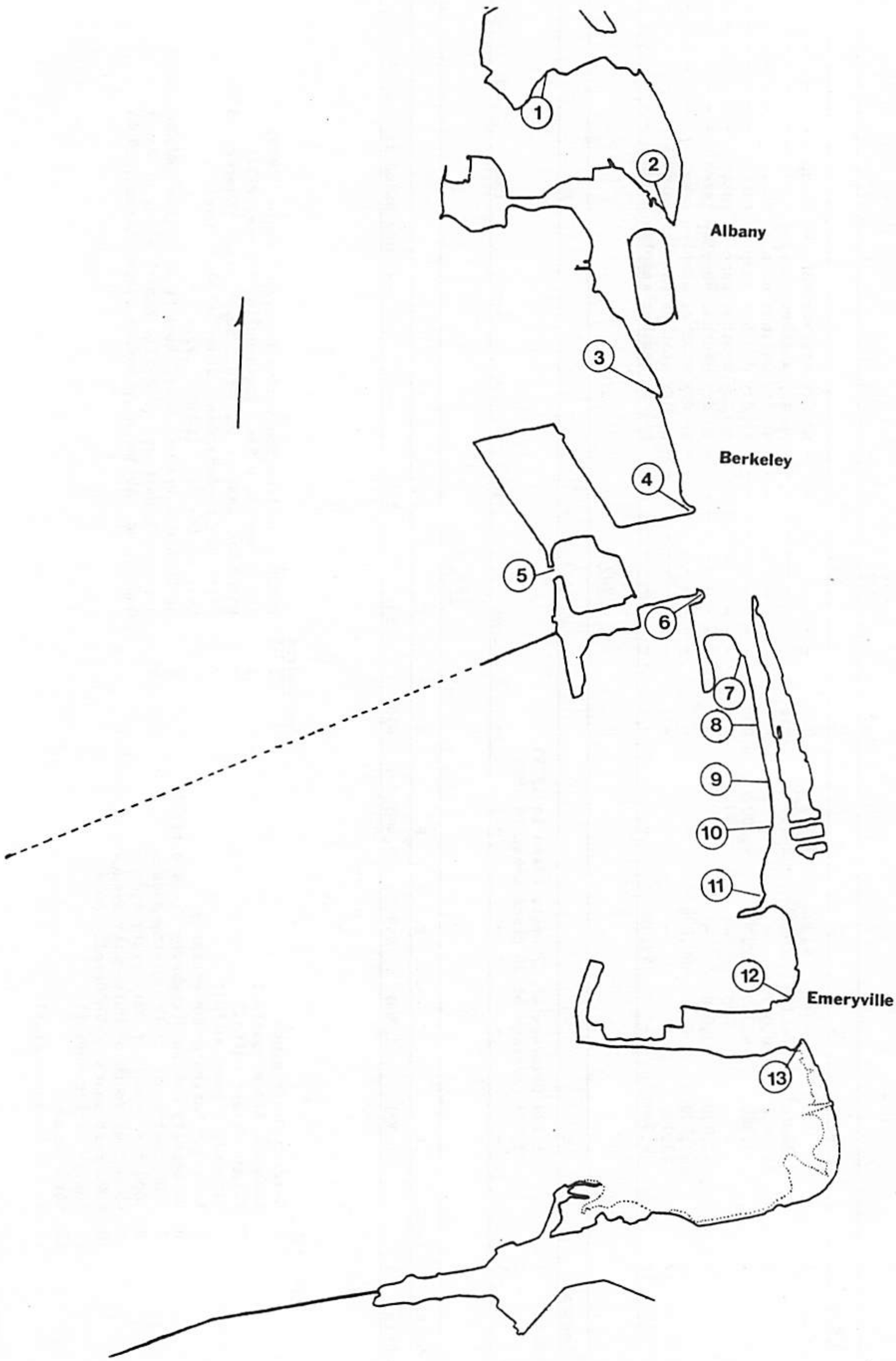

FIGURE 1: East Bay Shoreline - Location of Total Coliform Test Sites.
Base Map: USGS Topographic Map, Oakland West & Richmond Quadrangle, Sharpe, 1977.

Site	Average Coliform Count	Rank*	# of Tests Performed
1	2,200	2	54
2	240,000	13	51
3	130,000	11	13
4	76,000	9	16
5	665	1	14
6	125,000	10	13
7	4,200	4	35
8	4,600	5	35
9	3,800	3	35
10	7,800	6	35
11	220,000	12	13
12	9,000	7	12
13	24,000	8	13

*Ranking of average coliform counts

TABLE 2. East Bay Shoreline Summary Total Coliform Site Averages - MPN/100 ml.

Month	Average MPN/100 ml	Rank*	# Tests
January	3,500	6	12
February	4,800	7	12
March	2,400	3	12
April	9,600	11	12
May	3,000	5	12
June	2,400	4	8
July	24,000	12	12
August	7,000	8	12
September	7,200	10	12
October	7,000	9	12
November	18,000	1	12
December	2,000	2	12

*Ranking of monthly coliform counts

TABLE 3. Summary of Total Coliform Tests from Sites 7, 8, 9, 10 Taken in 1965, 1973, 1974 - Monthly Averages.

during dry weather" (Sharpe, 1977, p. 49). Also, power outages which usually occur during hot summer days may cause shut-downs of sewage treatment plants, causing the sewage to flow directly into the bay. The next highest counts were found in April. This was probably caused by " . . . surface runoff and combined sewer overflows during dry weather" (Sharpe, 1977, p. 49). Therefore, the best time for the use of shoreline waters is in the wintertime and not in the summer when water contact sports are most popular.

TABLE 4 summarizes the yearly total coliform averages from the thirteen sites along the shoreline. A comparison of the coliform levels from year to year at

Site	1965	1970	1973	1974	1976	1977	1979	1980
1		620			1,100	16,000	1,100	
2		62,000			16,000	24×10^5+	3,000	
3					50,000	610,000		
4					100,000	19,000		
5						90	500	890
6					134,000	68,000		
7	4,000		2,500	6,100				
8	2,800		1,700	9,300				
9	1,100		2,700	7,400				
10	3,000		11,000	9,000				
11					200,000	350,000		
12					6,400	43,000		
13					24,000	26,000		

TABLE 4. East Bay Shoreline Total Coliform Test Summary Yearly Average at Each Site.

separate sites does not show any prevailing trends. There have not been enough tests taken over a long enough period of time for any trends to be discovered. More testing and constant monitoring are needed to make predictions about yearly trends. If there is a monitoring program, bacterial contamination from non-point sources along the shoreline can be predicted and then controlled. Until the present, there has been no pressing need to implement this kind of monitoring program. If there is to be any type of water contact recreation area developed along the shoreline (e.g., Berkeley Beach), a program must be started.

Conclusion

We can manage our water quality. We have been able to eliminate the problems of gross pollution by the clean-up of municipal and industrial sewage. "Now most of the bay is safe for swimming, except after periods of storm runoff" (ABAG, 1977, p. 8). Nonetheless, not all water quality problems have been eliminated from the East Bay shoreline area. As shown in TABLE 1, there is still contaminated water pouring out of all the various storm drains along the shore. This contaminated water has so polluted the shoreline waters that the shellfish harvesting water quality objective may never be met (see paper by Mirtha Ninayahuar). Deadly hazardous wastes threaten to destroy water quality at various shoreline locations (see paper by John Cruz). Much work still needs to be done, but with the cooperation of state and local agencies, and the input of an educated public, these problems can and will be solved. When these problems are solved, the East Bay shoreline can be fully enjoyed by generations to come.

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