Water Quality in Hoffman Marsh
A Comparison With 1985 Results

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Introduction

Hoffman Marsh is a vital link in the native ecosystem of the Bay Area. The Marsh, located in South Richmond (Figure 1), is the last existing zone of healthy salt marsh vegetation in five miles of East Bay shoreline. In comparison, brackish and fresh water marsh found in the North Bay and Delta regions are much more abundant. Because of the large difference in area between the three types of marsh, the more saline East Bay salt marsh becomes much more valuable on an acre-for-acre basis simply because so little of such marsh remains.

The diked southern portion of the Hoffman Marsh (Figure 2) was the site of a mitigation project by the California Department of Transportation (CalTrans). The widening of I-580 called for the filling of 1.3 acres of marshland east of I-580 and on the south side of Central Ave. (Merrill and Siegel, 1986). In compensation for the filled 1.3 acres Caltrans was going to restore proper tidal flushing and circulation in the study area (Figure 3). This work was never completed.

The purpose of this paper is to compare water quality in Hoffman Marsh before and after the mitigation work. Prior to the mitigation work, water quality tests were performed by Siegel (1985). This paper will repeat Siegel's tests. A comparison of the two sets of data will permit evaluation of whether the mitigation work was a success and whether the diked southern portion has returned to a healthy ecosystem.

Past Studies

There have been several water quality studies conducted on the marsh. All of them were done to test the water at one point in time and did not draw conclusions about marsh health over an extended period of time. URS Research Co. issued an environmental assessment in response to CalTrans' plan to widen both Highways 80 and 17 (URS, 1973). The main emphasis of the report is on the impact widening the highways would have on the area. Also included is an inventory of terrestrial and marine biota in Hoffman Marsh and Albany Mudflat.

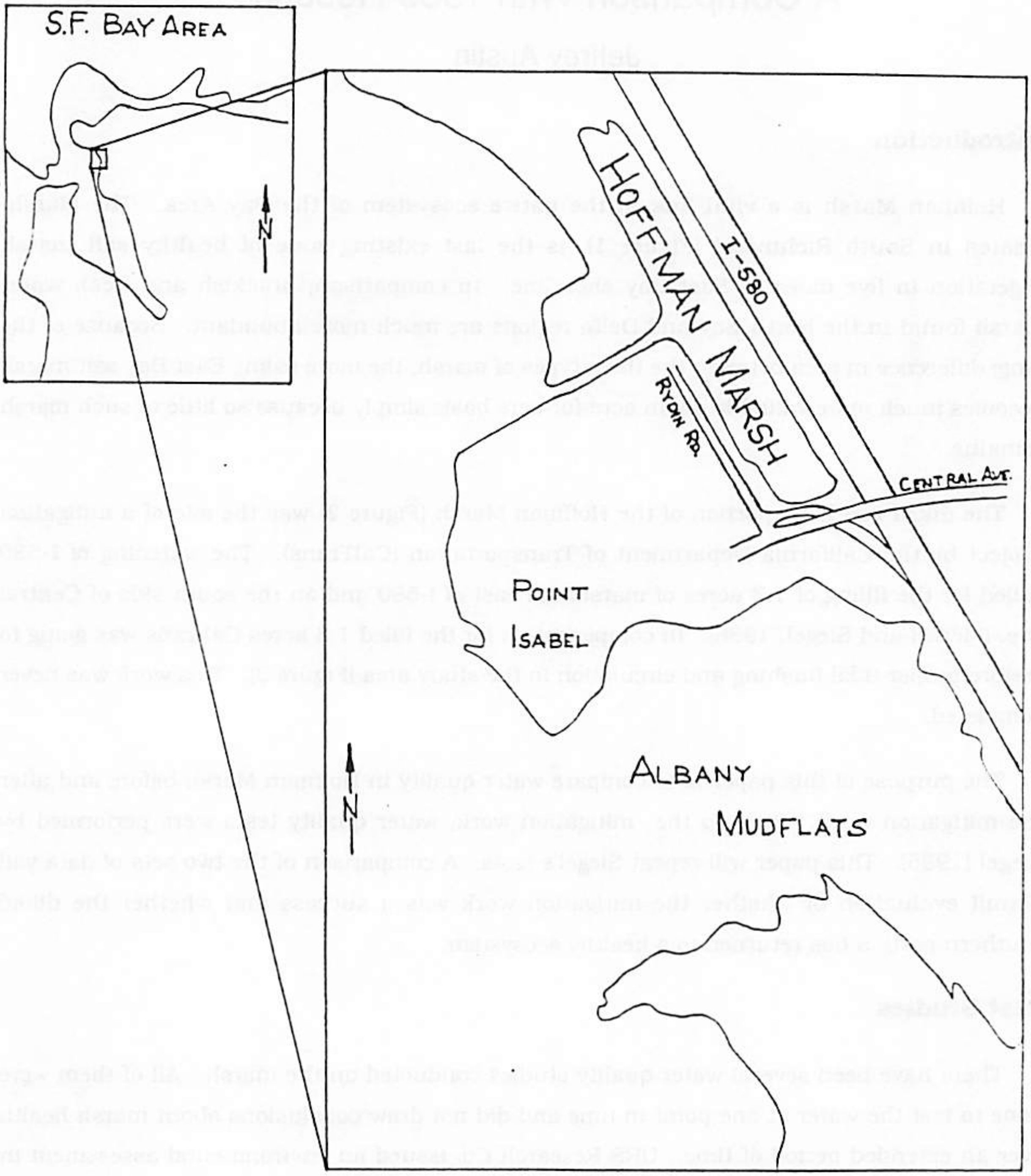

Figure 1. Regional setting of Hoffman Marsh
Base Map: URS, (1973).

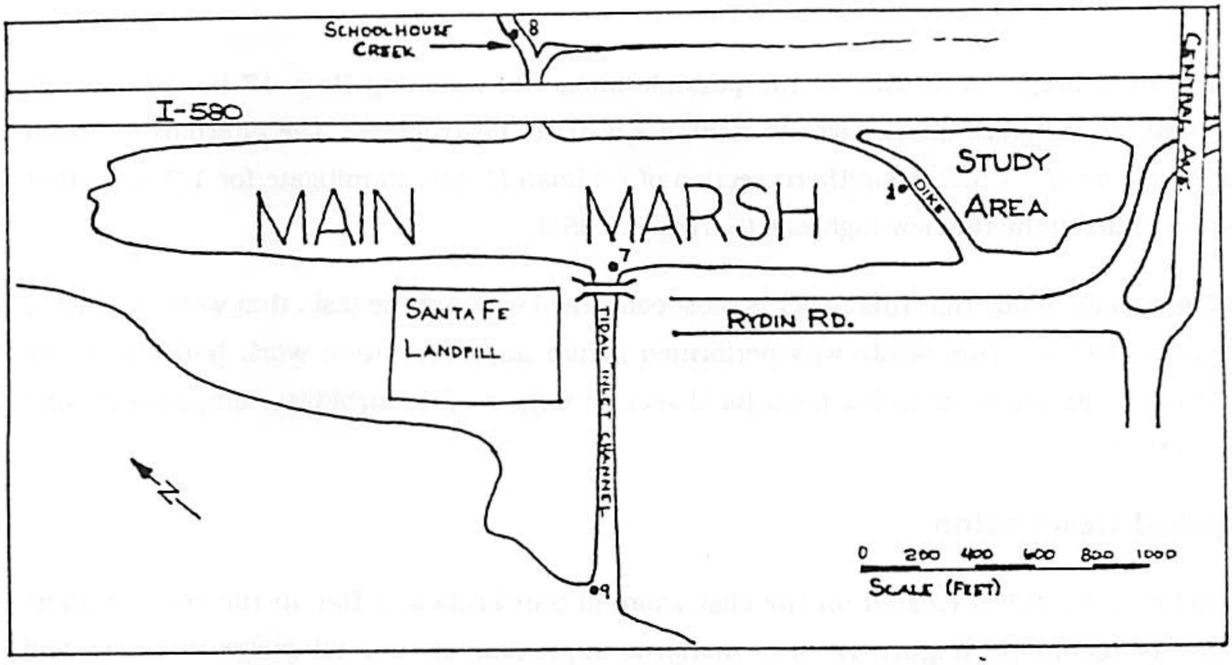

Figure 2. The entire Hoffman Marsh, showing marsh features, study area, sample sites, and neighboring land. Source: Adapted from URS (1973).

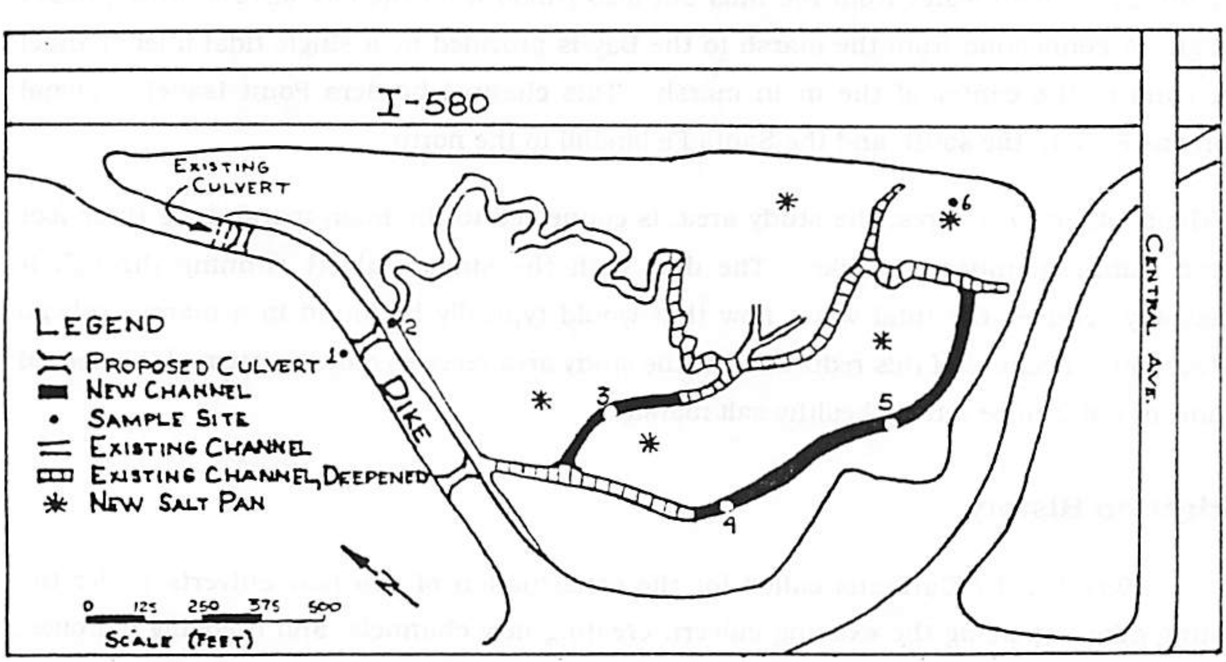

Figure 3. Hoffman Marsh study area, showing restoration features, sample sites, and location of new salt pans. Source: Adapted from CalTrans (1984).

CalTrans prepared an EIS on the possible impact of widening Hwy. 17 (now I-580). It proposed five different alternatives to minimize wetland destruction. The alternative chosen was to restore the 7.5 acre southern section of Hoffman Marsh (to mitigate for 1.3 acres that would be filled in by the new highway) (CalTrans, 1981).

The specific study that this paper is most concerned with are the tests that were conducted by Siegel (1985). This study was performed before any restoration work had started by CalTrans. The study included tests for dissolved oxygen, pH, turbidity, temperature, and conductivity.

Physical Description

Hoffman Marsh is located on the east shore of San Francisco Bay in the southernmost section of Richmond (Figure 1). The marsh is approximately one kilometer in length and varies in width from 100 to 175 meters (CalTrans, 1981). The entire marsh, which covers an area of 40 acres, is divided into two sections, the "main marsh" and the "study area", separated by a dike containing a sewer line (Figure 2). The "main marsh" to the north covers 32.5 acres, and the "study area" to the south covers 7.5 acres (Figure 3). The marsh is fed by Schoolhouse Creek, which runs through a culvert under Highway 580 and into the marsh. The creek not only brings in fresh water from the hills but also runoff from the city streets during heavy rainfall. A connection from the marsh to the Bay is provided by a single tidal inlet channel that runs to the center of the main marsh. This channel borders Point Isabel Regional Shoreline Park to the south and the Santa Fe landfill to the north.

The southern 7.5 acres, the study area, is connected to the main marsh by a three-foot culvert running under the dike. The dike with the single culvert running through it drastically reduces the total water flow that would typically be found in a marsh with no obstructions. Because of this reduced flow, the study area receives only a portion of the needed volume of water to be a truly healthy salt marsh.

Mitigation History

The 1981 EIS by CalTrans called for the construction of two new culverts under the existing dike, replacing the existing culvert, creating new channels, and dredging old ones. When the work started in late November of 1984, the old culvert was cleaned, two new channels were dug, and the old ones deepened (Figure 3). The most effective means of improving water circulation in the southern marsh, adding two new culverts, never happened. The reason this occurred was that no one considered the condition of the sewer pipe buried in the dike separating the two marshes (Siegel, 1988). When CalTrans started to install the new culverts, it discovered that if it dug under the sewer pipe, the pipe might break, causing contamination of the entire marsh. Work immediately stopped on the culvert and has never resumed. CalTrans states that it will finish the planned mitigation work when the sewer pipe owner, Stege Sanitation District, can afford to replace the old sewer pipe.

Because of this string of events, Siegel's (1985) planned comparison of water quality before and after the restoration work was never completed. Also of interest is the fact that the southeast corner of the marsh received minimal tidal flushing before any mitigation work was done. CalTrans assumed that the original salt pan in the southwest corner of the marsh was an undesirable feature of the marsh. In reality water remaining in the salt pan contained the highest dissolved oxygen readings in the whole marsh on the dry day (Siegel, 1985) and a higher than normal amount of use by different bird species was recorded in the area of the salt pan (Hay, 1985).

Water Quality Parameters

The water quality parameters to be tested for are dissolved oxygen (DO), salinity, turbidity, pH, and temperature. Dissolved oxygen, the amount of oxygen in the water, is a general index of the health of a water body. The higher the DO, the higher the rate of photosynthetic activity (APHA, 1985). The standard for San Francisco Bay is a minimum of 5.0 ppm (RWQCB, 1986), but higher concentrations are usually needed to protect the sensitive life forms found in the Bay.

Salinity is a measurement of the total amount of solids in water (APHA, 1985). For this study it refers to the amount of chloride ions present in the sample. The salinity is needed to obtain an accurate DO reading and is a good indication of the water circulation and evaporation rates. Conductivity is measured, and the salinity is then determined from the measured conductivity level, utilizing the temperature of the sample.

Turbidity is caused by suspended matter such as clay, silt, finely divided organic and inorganic matter, soluble organic compounds, and plankton. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample (APHA,1985). An overly turbid body of water will dramatically decrease the amount of sunlight available to photosynthesizing organisms. The standards for the Bay state that waters shall be free of changes in turbidity that cause nuisance, or adversely affect beneficial uses (RWQCB, 1986).

The measurement of pH is one of the most important indicators of marsh health. The pH is a measurement of the hydrogen ion concentration in a water solution. The standard for pH in the Bay is a range from 6.5 to 8.5 (RWQCB, 1986). A pH above or below the range could be disastrous to biological processes in any marsh (APHA, 1985).

The temperature in the marsh habitat does not vary more than a few degrees, but it is needed in many calculations of other parameters such as conductivity, salinity, pH, and DO.

Methodology

Sample sites 1, 2, 6, and 7 were located as closely as possible to the sites defined in Siegel (1985). Site 3 was located in the new channel (Figure 3). This was different than the site chosen by Siegel (1985), which was located approximately 30 yards northeast. Sites 4 and 5 were located in the old salt pan that was filled by CalTrans in 1984. Therefore these old sites could not be used. Sites 4 and 5 for the1989 study were located in the new channel dug by CalTrans (Figure 3). All sites were located visually, not by using a compass and reference points as Siegel (1985) did. Site 1 provides an example of water quality in the main marsh channel adjacent to the study area. Sites 2-6 give an indication of water quality inside the study area (Figure 3). Sites 2-5 provide a sample of channel water quality. Site 6 is located in a salt pan that was created by the mitigation work. Site 7 samples channel water in the main marsh and the water coming in from the tidal inlet (Figure 2). Site 9 provides a sample of the Bay water entering the marsh at the west end of the tidal inlet channel (Figure 2). Site 8 was approximately 100 yards east of the west shoulder of I-580, and gives an indication of the quality of the fresh water entering the marsh through Schoolhouse Creek (Figure 2). Sites 8 and 9 are new to this study, and therefore no comparison can be made to them.

Sampling times and dates were chosen to match as close as possible the conditions under which Siegel ran his tests. Water samples were collected on two different days, the first after a heavy rainfall and the second eight days after a heavy rain.

The first testing date was Sunday, February 5th. There was approximately 0.6" of rain in the past 24 hrs. and about 1" over the preceding three day period. Samples were taken beginning at Site 5 at 2:10 pm. The last sample was taken at 4:15 pm at Site 8. The tide was high at 10:06 am, 6.7 feet. Low tide was at 3:58 pm, 2.8 feet. The second testing date was eight days later, February 13th. There had been no appreciable precipitation since the first testing date. High tide was at 4:47 am, 6.3 feet, low tide at 11:58 am, 0.3 feet, and another high tide of 4.1 feet at 7:29 pm. The first sample was taken at 9:40 am at Site 5 and the last sample at 11:45 am at Site 8.

The water quality tests on Hoffman Marsh samples were made using standard methods (APHA, 1985). The membrane electrode method was used for DO. Conductivity was measured with a YSI model 31 Conductivity Bridge, and pH was measured with a "Pocket pH Pen." Temperature was measured with a standard mercury thermometer. Turbidity was measured with a Hach Model 2100A Turbidimeter.

Data

Dissolved oxygen ranged from a high of 9.65 ppm at Site 2 on the dry day to a low of 5.20 ppm at Site 6 on the wet day. The average DO level on the wet day was 6.87 ppm. The average for the dry day was 8.25 ppm.

The highest turbidity reading was at Site 7 on the wet day, 29 NTU. The lowest was 4 NTU's at Site 9 on the dry day. The average for the wet day was 17 NTU. The average for the dry day was 6 NTU.

Conductivity ranged from a low of 19,800 µmhos\cm on the wet day at Site 8 to a high of 51,300 µmhos\cm at Site 5 also on the wet day. The average for the wet day was 42,150 µmhos\cm, and the average for the dry day was 46,000 µmhos\cm.

All the pH readings were above neutral pH of 7.0. The lowest reading was 7.1 at Site 8. The high was 8.2 at Site 5 on the wet day. Average for the wet day was 7.7, and the dry-day average was 7.6.

Discussion

Results of two test runs under conditions similar to those of the 1985 tests show that water quality has improved significantly since 1985.

The DO levels at all sites meet or exceed levels specified by RWQCB, which is 5.0 ppm. In 1985 Site 6 on the wet day had a reading of 3.98 ppm. This was below the limit set by the Board. In 1989 that level was 5.20 ppm. The overall averages for both the wet and dry days have also increased. The reading was 6.80 ppm in 1985 compared to 6.87 ppm in 1989, both on the wet day. On the dry day the average for 1985 was 8.13 ppm, and for 1989 it was 8.25 ppm. This overall increase in DO levels suggests that the improved circulation in the study area channel system has positively influenced overall marsh health.

The turbidity levels were strongly influenced by rain. The particulate matter brought in from runoff and stirring by rainfall greatly increased the overall turbidity level. The turbidity levels are all within the limits set by RWQCB except for those at Site 7. At Site 7 on the wet day, both in 1985 and 1989, the turbidity increased dramatically. This large increase is believed to be due to the storm drain located near Site 7. The average for the wet day in 1989 (16.9 NTU) was lower than the average in 1985 (17.0 NTU). The average for the dry days were 6.11 NTU and 6.0 NTU for 1989 and 1985, respectively. An overall comparison to the 1985 results shows that turbidity levels have not changed much.

The conductivities for both the wet and dry days do not differ very much. The lower average on the wet day was the result of low values obtained from Site 7 and 8. Site 7 is near a storm drain that carries in large amounts of fresh water that decrease the conductivity reading. Site 8 is influenced by the fresh water inflow from Schoolhouse Creek. The wet day average in 1989 (42,150 µmhos/cm) was somewhat higher than the recorded level of 1985 (41,700 µmhos/cm). The dry day average for 1989 (46,000 µmhos/cm) was lower than the average in 1985 (48,500 µmhos/cm). Compared to the 1985 results, the 1989 conductivities do not have as large a range. This suggests that the water in the study area and main marsh is more similar to the water in the Bay than it was in 1985. This may be due to the better circulation created within the study area resulting from the channel work. Another factor that may have contributed to this change in conductivity is that the tidal inlet was dredged after the Santa Fe landfill was constructed.

The pH data shows that all the sites are within the acceptable limits set by the RWQCB, which is pH from 6.5 to 8.5. The one major change from 1985 is the reading at Site 3 on the wet day. In 1985 it was above the standard at 8.65. Now in 1989 the pH has dropped to 8.1, well within the guideline set by RWQCB. These improvements in the pH indicate that the health of the marsh has improved.

There have been some physical changes to the marsh since the restoration work in 1985. The most obvious change is the formation of several new salt pans which can be located on Figure 3. These new salt pans may have formed as a result of two causes. First, when

SITE	DATE	WEATHER	TEMP °C		pH		CONDUCTIVITY µMHOS/CM		TURBIDITY NTU		DO PPM	
			1985	1989	1985	1989	1985	1989	1985	1989	1985	1989
1	2/5/89	WET	–	12	–	7.5	–	48,600	–	13	–	8.9
	2/13/89	DRY	14	13	7.9	7.8	48,900	48,200	7	5	8.9	7.9
2	2/5/89	WET	–	12	–	7.9	–	44,700	–	13	–	6.3
	2/13/89	DRY	14	13	7.8	7.9	47,800	47,600	5	6	9.0	9.6
3	2/5/89	WET	12	12	7.6	8.1	46,900	46,900	16	15	9.4	7.1
	2/13/89	DRY	13	14	8.6	7.9	44,800	45,800	6	5	7.3	8.1
4	2/5/89	WET	11	13	7.9	8.0	46,400	51,200	12	14	6.0	5.9
	2/13/89	DRY	19	15	7.9	8.1	51,600	50,700	–	7	9.7	7.0
5	2/5/89	WET	11	13	7.7	8.2	47,500	51,300	12	15	8.2	7.0
	2/13/89	DRY	13	14	8.0	7.4	51,300	51,000	–	6	9.0	8.0
6	2/5/89	WET	12	13	7.7	7.3	51,800	44,000	17	17	3.9	5.2
	2/13/89	DRY	13	15	7.0	7.6	49,500	47,200	–	7	5.6	8.2
7	2/5/89	WET	11	11	7.7	7.8	16,100	21,800	26	29	6.6	7.8
	2/13/89	DRY	14	12	7.8	7.6	45,700	48,600	–	6	7.5	7.3
8	2/5/89	WET	–	13	–	7.1	–	19,800	–	24	–	7.3
	2/13/89	DRY	–	16	–	7.1	–	22,900	–	9	–	9.1
9	2/5/89	WET	–	10	–	7.8	–	51,000	–	11	–	6.2
	2/13/89	DRY	–	12	–	7.7	–	50,900	–	4	–	8.7
AVE	2/5/89	WET	11.4	12.1	7.8	7.7	41,700	42,150	17.0	16.9	6.8	6.8
	2/13/89	DRY	13.6	13.7	8.0	7.6	48,500	46,000	6.0	6.11	8,1	8.2

Table 1. Showing 1989 and 1985 results. All dates and weather conditions are for 1989 results.

CalTrans dredged and dug new channels, they disposed of the spoils in the study area away from channels (Siegel, 1988). This increased the elevation in some places, thereby displacing water to other, more localized areas, and forming a new salt pan. The second cause takes place when a dike restricts the tidal flow and decreases the supply of sediment to the marsh. Tidal flow velocities are also decreased and lead to greater deposition in channels. With less sediment reaching the marsh plain and greater deposition occurring in channels, the wetland topography becomes more uniform. Deposition in channels reduces water flow and contributes to isolated ponds (Josselyn and Kitchens, 1983).

Conclusions and Recommendations

From the observations of physical changes and the data collected on water quality one can conclude that the study area has made somewhat of a comeback from the conditions immediately following the restoration work done by CalTrans. As discussed, the formation of new salt pans and the deepening and creation of channels has had a positive overall effect on the general marsh health. The increased availability of water circulating to the southern section has affected the water quality parameters in a positive manner.

To improve both water quality parameters and physical attributes of the marsh further, several things must be done. First and foremost is the installation of two new culverts. The old sewer pipe must also be replaced before it decays and starts to leak, contaminating the marsh with raw sewage. Another possible solution to the sewer pipe problem is to tear out the existing sewer pipe and dike and re-route it around the southern end of the marsh along Central Ave. This would return the marsh to its natural state with no obstructions to water flow and would also make it unnecessary to clean culverts every month. To accomplish this would require an extra 100 yards of sewer pipe in addition to the existing length now in place. Before this is done the culverts must be cleaned on a monthly basis to keep water flow at a maximum.

The complete removal of the dike and sewer pipe is the only way to return the marsh to its original condition. If the two proposed culverts are to be installed, it will increase the total water flow by approximately 18 percent (Merrill and Siegel, 1986). This 18 percent is not enough to allow an unusually high tide to inundate the study area completely, a process essential to the health of any tidal salt marsh.

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