DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

OPEN FILE MAP

INTRODUCTION

Recent recognition that mercury in surface sediments in aquatic environments may enter the food chain through biological activity makes it important to evaluate the existing reservoir of mercury contained in sediments of major estuaries such as San Francisco Bay. The distribution of mercury in aquatic sediments is not well known (Klein and Goldberg, 1971; U.S. Geological Survey, 1970), neither are the processes or rates of processes by which this toxic material is removed from the sediment, nor how much of such sediment-associated mercury may eventually present a health hazard to man. A first step in evaluating this potential problem is to establish the amount of mercury present. The accompanying map presents the most comprehensive data yet available for any major estuary. It is hoped that this information will help to stimulate a quantitative assessment of the potential hazard to man.

MERCURY DISTRIBUTION

The concentration of mercury in the estuarine sediments can be considered from several aspects. In Table 1, the mercury concentrations (in parts per million of dry weight of sediment) are compared for all the samples (199) collected within four major segments of the estuary. In the table, the segments (bays) are listed in order of decreasing median mercury concentration. If listed in order of decreasing average mercury concentration, Suisun Bay replaces San Pablo Bay as second highest.

Table 1.--Concentration of mercury within four major segments of San Francisco Bay

	Mercury concentration (ppm)			
Bay	Median	Average	Total Range	Range of 70% of values
South[1/]	0.25	0.37	1.60 - 0.04	0.54 - 0.13
San Pablo	0.19	0.28	1.20 - 0.04	0.42 - 0.06
Suisun	0.13	0.32	2.00 - 0.02	0.63 - 0.06
Central	0.13	0.18	0.75 - 0.04	0.26 - 0.08

1/ Calculations for the south bay exclude the high value of 6.43 ppm found in Islais Creek because it is abnormally high relative to the other values.

The concentration of sediment-associated mercury seems to reflect not only sources, but also three major hydraulic environments in the estuary. Hydraulic environments are primarily determined by interrelated physical properties, such as the velocity of the water currents and the sediment grain size. The highest mercury concentrations are found in natural and artificial tributaries and along the bay margins; intermediate concentrations occur in fine sediment (silt-clay) on the shoal areas; lowest concentrations occur in sediment in the channels, where sand is abundant and currents are strongest.

Table 2.--Concentrations of mercury in three major hydraulic environments in San Francisco Bay

	Mercury concentration (ppm)		
	Median	Average	Total Range
Tributaries and margins	0.40	0.41	2.0 - 0.04
Shoals	0.21	0.24	1.1 - 0.02
Channels	0.13	0.17	1.1 - 0.04

This general pattern varies somewhat if bays are considered separately. In Table 3 and Figure 1, the bays are listed in order of decreasing median concentration of mercury in the tributaries and the bay margin. Heavily industrialized Suisun Bay ranks highest, south bay second and San Pablo Bay nearly 25% lower. Central bay is lower still, with a median concentration of only about one quarter that of Suisun Bay. In the shoal areas, the highest median concentrations occur in San Pablo, central and south bays. More measurements are necessary to characterize Suisun Bay shoals. In the channels, the median concentration is highest in south bay, and only slightly lower but approximately the same in the other bays.

Table 3.--Concentrations of mercury (ppm) in three hydraulic environments within the four major segments of San Francisco Bay

Bay		Tributaries and margins	Shoals	Channels
Suisun	Range	2.0 - 0.04	0.15 - 0.02	1.10 - 0.04
	Median	0.44	0.13	0.11
	Average	0.60	0.10	0.13
South	Range	6.43 - 0.13	0.95 - 0.08	1.00 - 0.04
	Median	0.40	0.17	0.19
	Average	0.51 [1/]	0.25	0.23
San Pablo	Range	1.2 - 0.06	1.10 - 0.11	0.42 - 0.04
	Median	0.38	0.26	0.10
	Average	0.49	0.32	0.13
Central	Range	0.75 - 0.08	0.42 - 0.06	0.38 - 0.04
	Median	0.10	0.21	0.10
	Average	0.26	0.21	0.12

1/ These values were calculated from the range of 1.60 - 0.27 because 6.43 appears to be abnormally high.

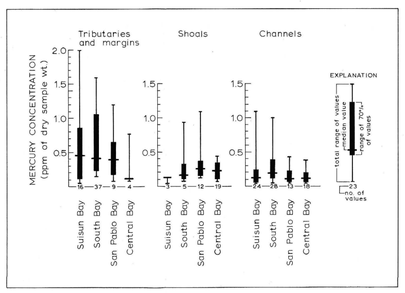

Figure 1.--Concentration of mercury in three hydraulic environments within the four major segments of San Francisco Bay.

Before we can judge the potential biological contamination represented by the sediment-associated mercury, considerably more must be known about the sources and the rates of introduction of mercury into the estuary, the processes and chemical form by and in which it is transported, and how much is removed from the estuary. If the values reported in this survey are representative of the mercury concentration in the sediments, it is possible to make an estimate of the reservoir of mercury stored in the estuary. Thus, using a conservative average mercury concentration of 0.25 ppm as representative for a layer of sediment one foot in thickness over the 220 square miles of the floor of the estuary, and assuming the sediments to have an average wet density of 1.2 g/cm^3, the upper foot of sediment would contain approximately 58 tons of mercury. Additional work must be done to establish how much of this mercury is introduced from natural sources, and how much is a by-product of man's activities.

SAMPLING PROCEDURE

Bottom sediments were collected in August 1970 with a Shipek or Van Veen sampler (Shipek, 1965; Van Veen, 1936). Both devices collect surface samples that cover approximately 8 by 6 inches of the sediment surface and extend to a depth of approximately 4 inches.

ANALYTICAL PROCEDURE

The sediments were air dried. The mercury concentration was then determined using approximately 0.1 grams of the sample by an atomic absorption technique (Vaughn, 1967). The limit of detection was 0.02 ppm using 0.1 gram of sample. In inhomogeneous sediment samples, where several determinations were made, the average mercury concentrations are reported.

REFERENCES

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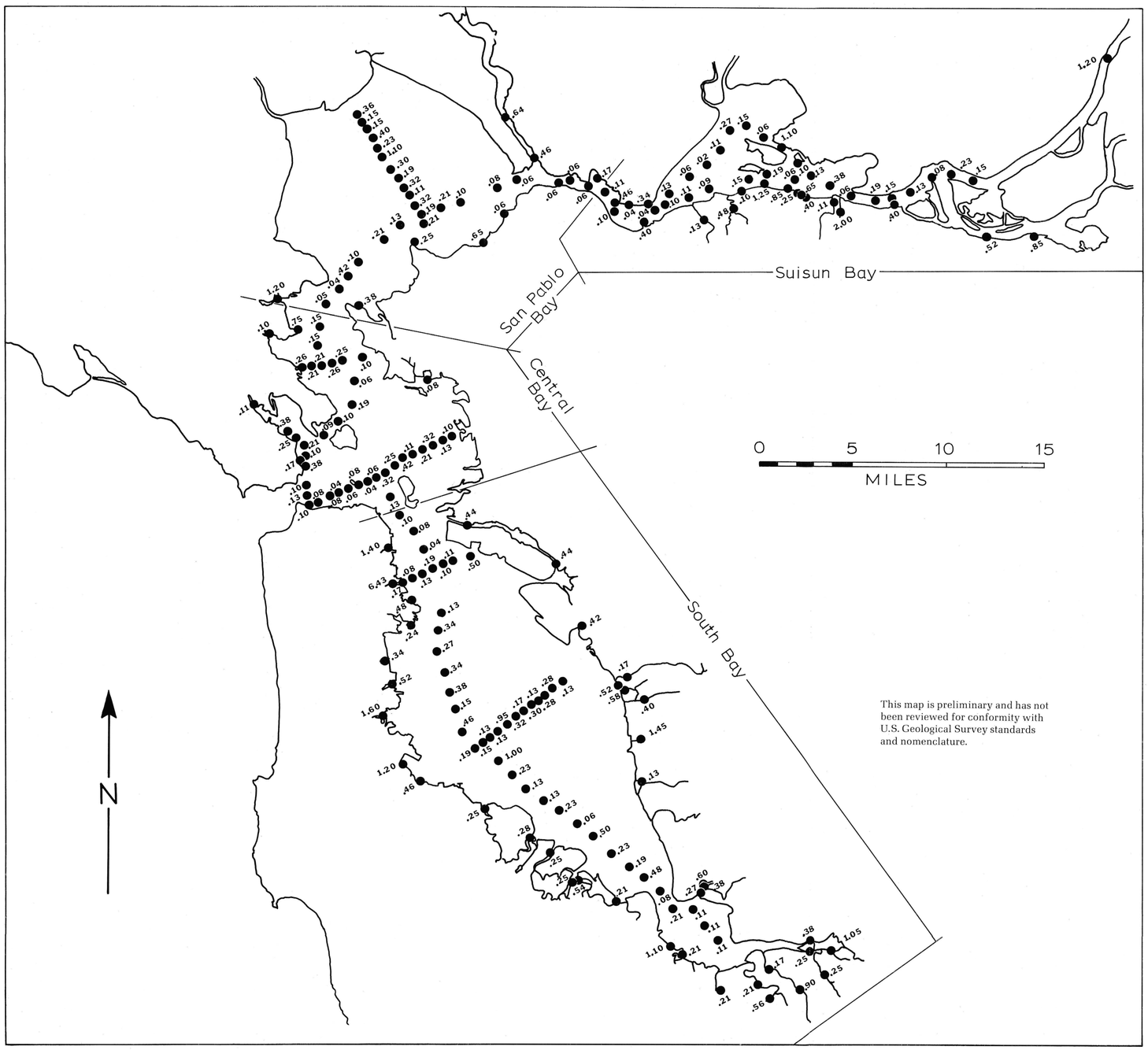

This map is preliminary and has not been reviewed for conformity with U.S. Geological Survey standards and nomenclature.

DISTRIBUTION OF MERCURY IN SURFACE SEDIMENTS IN SAN FRANCISCO BAY ESTUARY CALIFORNIA

MERCURY CONCENTRATIONS ARE GIVEN IN PARTS PER MILLION OF THE DRY WEIGHT OF THE SAMPLE

D. S. McCulloch, T. J. Conomos, D. H. Peterson, and K. Leong

1971