SECTION II

ENVIRONMENTAL SETTING

A. PHYSICAL CHARACTERISTICS OF SAN FRANCISCO BAY ENVIRONS

1. Location and Extent of Area.

2.001 San Francisco Bay is located on the western coast of the United States at 38° latitude and 122° longtitude. Although the watershed of the Bay extends through the Sacramento and San Joaquin Valleys of central California, the area of concern is geographically limited to the boundaries of the nine counties bordering the Bay (see Plate II-1).

2.002 The counties included cover 6,947 square miles, about 400 of which are covered by the Bay. This makes San Francisco Bay one of the world's largest estuaries, approximately 55 miles long on a north south axis and 2-13 miles wide on an east-west axis.

2.003 The region includes approximately 65 separate municipalities of which four (San Francisco, Oakland, San Jose and Berkeley) are over 100,000 in population; 12 exceed 50,000; 33 exceed 10,000 and 16 number inhabitants at less than 10,000 (96). These figures do not represent growth since the 1970 census. These urban areas constitute eight percent of the region's total land surface and are developed mainly as residential areas (8).

2. General Topography.

2.004 Bay area topography consists of a variety of landforms dominated by three interacting features: coast range mountains, bay plains and valleys.

2.005 The mountains follow a general northwest-southeast orientation parallel to the ocean coast. They consist of old formations, faulted, folded and dissected into a complex of steep sided hills. Highest elevations are 3,849 feet for Mt. Diablo on the East Bay and 2,604 feet for Mt. Tamalpais in Marin County north of the peninsula. Other elevations are generally below 2,000 feet. The main ridges are Santa Cruz to the southwest of the Bay, Bolinas to the northeast, Sonoma to the north, and Diablo and Berkeley Hills to the east.

2.006 Bay plains are flat, largely urbanized and often consists of soil that may have low bearing capacity. Half of San Francisco is flat and much of the land in this and many of the East Bay cities has been created by filling in the Bay. Extensive bay plain areas exist at the northern and southern ends of the Bay. To the north, much of the terrain consists of salt evaporation ponds, although large areas of natural marsh still occur. To the south, the flat lands are mostly utilized as salt ponds.

2.007 The major valleys are the Santa Clara south of the Bay, Livermore and Ygnacio to the east and three river valleys, Petaluma, Sonoma and Napa to the north. These regions, formerly agricultural centers, are undergoing urbanization at an increasingly rapid rate.

2.008 The overall effect of the topograhic features is a highly aesthetic environment with a great diversity of landforms, climates and living conditions. From the slope maps of the area, it can readily be seen that there are extensive regions with slopes of 50 percent of greater. The valleys show slopes of zero to five percent.

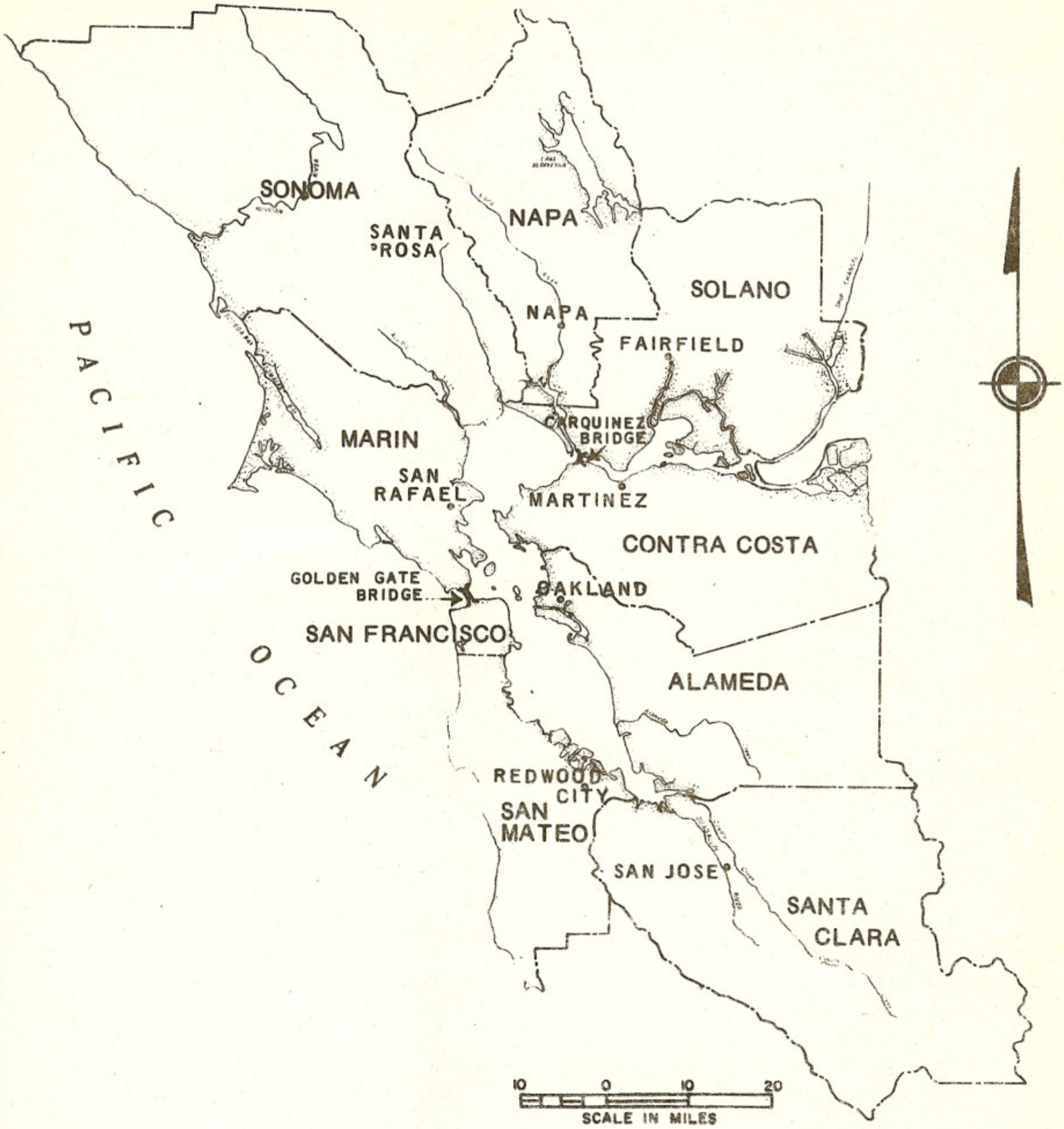
3. Faults and Seismicity.

2.009 Three major active fault zones transverse the Bay Area in a northwest-southeast direction (Plate II-2). From west to east these are the San Andreas Fault, the Hayward Fault and the Calaveras Fault. All but the Calaveras have experienced earthquakes of seven or greater on the Richter Scale. Between 1800 and 1967, 58 earthquakes of VII or greater (Modified Mercalli Scale) have been recorded in the Bay Area (288).

2.010 Seismic activity could have an impact on dredging operations in two ways. Although the slopes of dredged channels are designed to be stable, it is impossible to test or predict their action in a dynamic situation. It is conceivable that sloughing of the banks could occur. Whether or not this would block the channel depends upon the height and width of the channel, and the amount of sloughing that would occur. A second possible impact could be the breaking of the dikes of land disposal areas, but since the material dries to a non-fluid state in several months it is unlikely that this type of occurence would have any detrimental effects.

4. Basic Geology.

2.011 San Francisco was formed by a rising sea level, tilting of bedrock down to the east and up to the west and lateral compression of the landform. The bedrock, mostly of the Franciscan Foundation consists largely of sandstones and shale with smaller amounts of chert and other types of



COMPOSITE ENVIRONMENTAL STATEMENT

SAN FRANCISCO BAY REGION CALIFORNIA

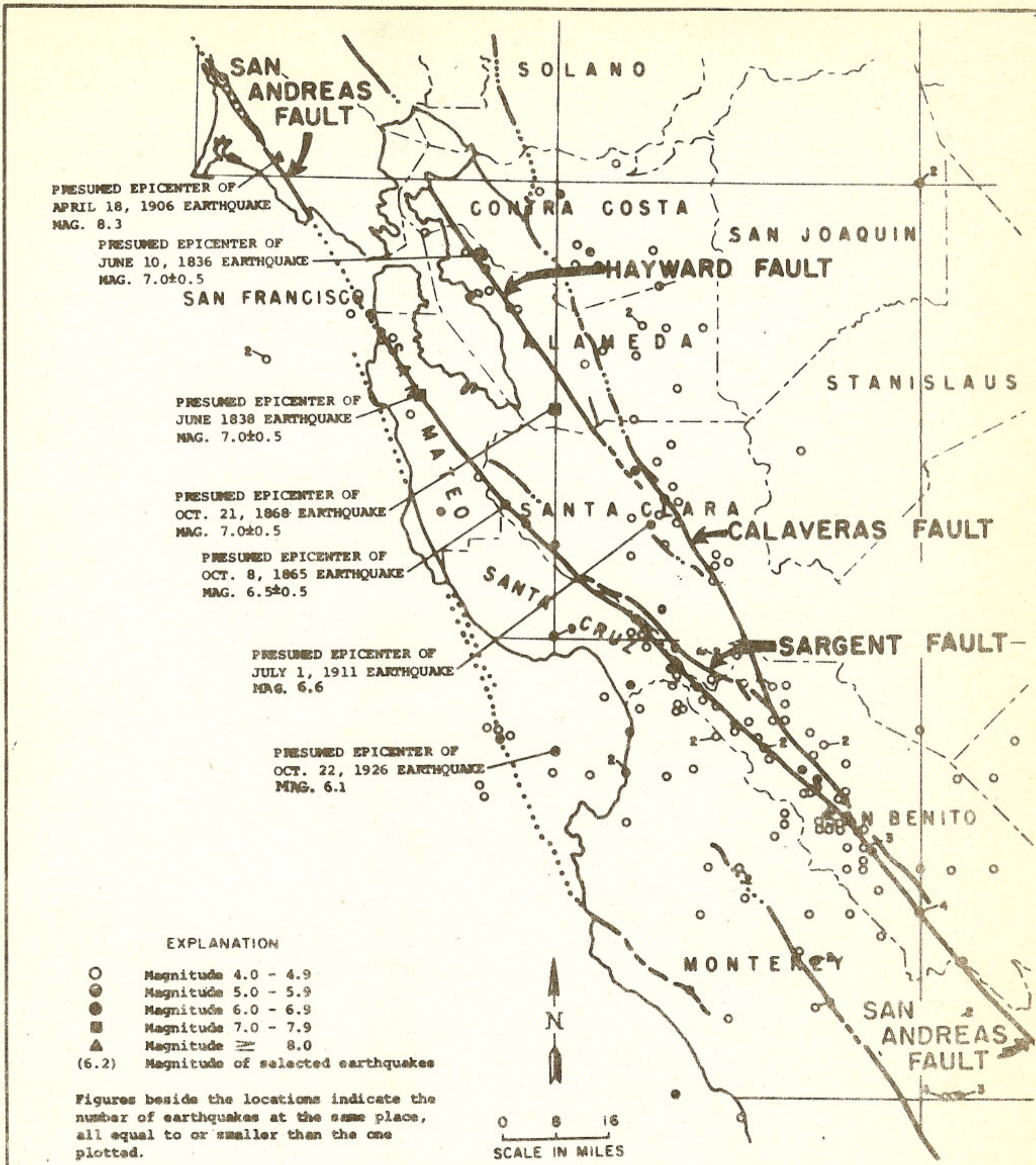
BAY AREA COUNTIES

U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C. OF E.

DRAWN: FILE NO.

TRACED: TO ACCOMPANY C.E.S.

CHECKED: DATED: FEB 1975



Active and potentially active faults near the study area. Selected earthquakes, magnitude + 6.0, that occurred prior to 1934 have been included.

ADAPTED FROM CALIF. DIV. OF MINES & GEOL. PRELIM. REPORT 18, ENVIRONMENTAL GEOLOGICAL ANALYSIS OF SOUTH COUNTY STUDY AREA, SANTA CLARA COUNTY, CALIF., 1973

COMPOSITE ENVIRONMENTAL STATEMENT

SAN FRANCISCO BAY REGION CALIFORNIA

ACTIVE FAULT ZONES

U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C OF E
DRAWN: FILE NO.
TRACED: TO ACCOMPANY REPORT
CHECKED: DATED

PLATE II-2

rock. It is exposed in much of Western Marin and San Francisco Counties but is very deeply buried on the eastern and southern shores (300-400 feet or more). Much of the rock is extensively weathered.

2.012 Fracturing, faulting, weathering and other geological processes have created a variety of rock and soil conditions in the Bay area. Alluvial deposits, metamorphic and volcanic rock may all be located in the region. The predominant feature of the surface geology, of the Bay floor is Bay Mud. This material and other aspects of submarine geology are described in the following section on Physical Characteristics of the Bay.

2.013 In relation to dredging operation, geological formations are of importance only in determining a land disposal site. Actual maintenance dredging does not remove more than one to several feet of sediment and as such does not go below the most recent layers of sediment (Younger Bay Mud). Therefore, there could be no effect on ground water bearing strata (see Plate II-3). Open water disposal also does not involve any geological hazards.

2.014 Land disposal operations must take into account the geological characteristics of the site, especially when the substrate covered is Younger Bay Mud. The impacts of dredge disposal on this type of substrate is covered in the Land Disposal Alternative section.

2.015 References for more detailed information on geology and land disposal are 218 and 118.

5. General Climate and Air Quality.

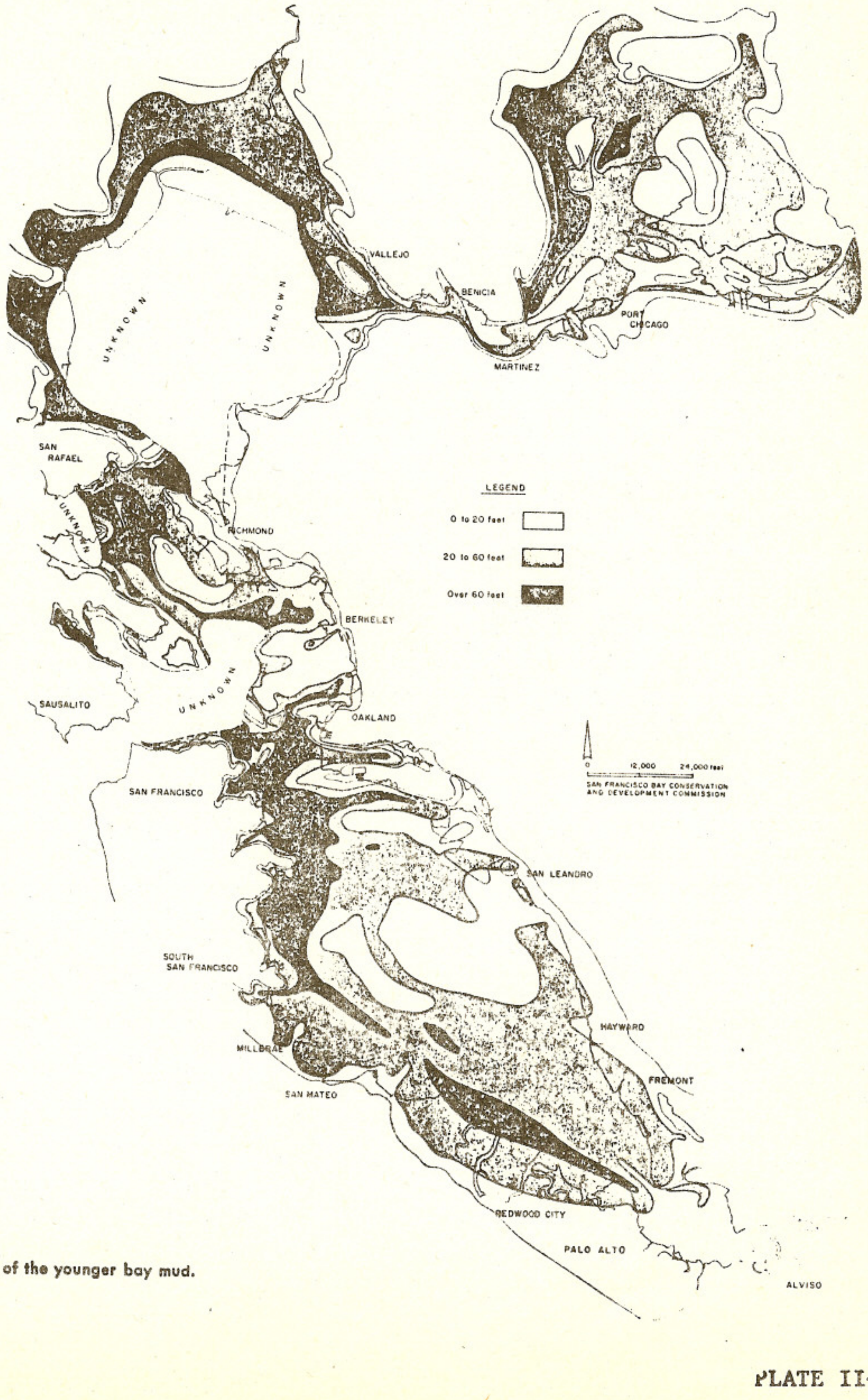
2.016 a. Climate. There are wide contrasts in climate within short distances around San Francisco Bay. In the city of San Francisco sea fog and low stratus clouds are characteristic of the climate. In the summertime, temperature of the Pacific Ocean is unusually low near the coast and atmospheric pressure relatively high, while the interior of California is characterized by the opposite in both elements. This tends to intensify the landward movement of air and to make the prevailing westerly winds brisk and persistent, especially from May to August. As a result of the steady sweep of air from the Pacific, there are few extremes of heat or cold. A pronounced wet and dry season is another characteristic of the climate. On the average, almost 85 percent of the total annual rainfall occurs between November and April. The climate of Oakland and other east bay cities is similar to that of San Francisco, but daily mean temperatures are about four degrees higher at maximum and four degrees lower at minimum. Annual precipitation at Oakland Airport is about three inches less than San Francisco's 20.5 inches.

2.017 On the peninsula, towns near San Francisco International Airport enjoy marine climates similar to that of the east shore area described above, with maximum daily mean temperatures from two degrees to four degrees higher than San Francisco, and minimum daily mean temperatures from four degrees to six degrees less. In the wet winter season, three quarters of all yearly rainfall occur between December and March. Summer weather is dominated by a cool sea breeze resulting in an average summer wind speed of nearly 15 m.p.h., reaching 20 to 25 m.p.h. in afternoons. Southward along the peninsula and east of the Coastal Mountains, towards San Jose, summers are warmer and less windy, due to the diminishing influence of the sea breeze. The highly populated area from Millbrae to Palo Alto enjoys a modified Mediterranean type climate. A low overcast often occurs in the south peninsula area for a few hours in the morning, but persists longer and comes in earlier in the northern section.

2.018 Nearby communities in Marin County, sheltered by fairly high peaks from the prevailing ocean winds, generally enjoy warmer and sunnier weather than San Francisco. Their climate is further modified by proximity to San Francisco and San Pablo Bays. Daily maximum temperatures for July average 16 degrees warmer at San Rafael and 18 degrees warmer at Kentfield than at San Francisco. Rainfall amounts are strongly influenced by the topography of the Coastal Range, with annual average rainfall varying from 26 inches at Kentfield. During the summer season, low overcast frequently covers the entire area during the early morning hours, but clearing begins early in the forenoon.

2.019 b. Air Quality. The Clean Air Act amendments of 1970 established controls on the emission of harmful substances into the air. These harmful substances are cumulatively referred to as air pollution.

2.020 (1) Pollutants. The air pollution resulting from Corps dredging operations primarily stem from the diesel engines which power the dredges. In the San Francisco Bay Area ships, as a whole (commercial, Navy, Coast Guard, tugs, etc), contribute relatively significantly to concentrations of sulfur dioxide, nitrogen oxide, and particulate matter.



Thickness of the younger bay mud.

PLATE II-3

2.021 Sulfur oxides are primarily emitted into the atmosphere due to the heating and burning of fossil fuels such as coal and oil. In areas like London and New York where large quantities of these fuels are used, sulfur oxides are a major air pollutant. The largest fraction of sulfur oxides is sulfur dioxide. This substance often further oxidizes to form sulfur trioxide, which combines with moisture in the air to form sulfuric acid mist. Both sulfur dioxide and sulfur trioxide can damage vegetation and affect the health of humans and animals. Under conditions prevailing in areas where studies have been conducted, adverse health effects were noted when 24-hour average levels of sulfur dioxide exceeded 300 ug/m^3 (micrograms/cubic meter) for 3 and 4 days. Adverse health effects have also been noted when the annual mean level of sulfur dioxide exceeded 115 ug/m^3. Visibility reduction to about 5 miles occurs at 285 ug/m^3; adverse effects on materials at an annual mean of 345 ug/m^3; and adverse effects on vegetation at an annual mean of 85 ug/m^3 (291). In the Bay area, from July 1974 through June 1975, the air quality standard for sulfur dioxide of 104 ug/m^3 was not exceeded for any 24-hour time period for the stations considered by the Bay Area Air Pollution Control District (268). The highest sulfur oxides concentrations in the Bay Area tend to occur in the vicinity of the large oil refineries and chemical plants located in Contra Costa County.

2.022 Approximately 80 percent of the air is nitrogen. Whenever burning occurs at high enough temperatures, a certain amount of nitrogen in the air burns as well. Burning is also known as "oxidizing". This is a reaction where a material combines with oxygen in such a way as to release energy in the form of light and heat. The resultant combinations of nitrogen are primarily nitric oxide and nitrogen dioxide. Mixtures of these two compounds are known as oxides of nitrogen and they are involved in photochemcial reactions that produce oxidant. In addition, there are effects attributable directly to nitrogen dioxide. Nitrogen dioxide is a gas which can be seen in concentrations on the horizon as a brown haze. On days with otherwise good visibility, the coloration will be noticeable. The degree of visibility reduction depends on the concentration and properties of the pollutant or pollutants involved and on meterorological conditions. Nitrogen dioxide does not display any distinct seasonal patterns in terms of frequency of occurence, but the brown haze is most visible on the horizon on clear days when a temperature inversion traps the pollutants in the lower layers of the atmosphere. Atmospheric temperature inversions are the most common in the Bay Area from May through October. At higher concentrations, damage due to nitrogen dioxide has been observed in sensitive plants such as beans, tomatoes, and tobacco. Pulmonary changes have been caused in experimental animals by sustained exposures at higher levels of nitrogen dioxide. Concentrations of 470 ug/m^3 for 4 hours a day for 6 days cause structural changes in lung collagen of rabbits, concentrations of 940 ug/m^3 over various periods of time cause changes in the pulmonary systems of rats and mice (293).

2.023 Particulate matter comes primarily in the form of dust, mist, ash, smoke and fumes. Smoke, composed of carbon and other products of incomplete combustion, is the most obvious form of particulate pollution assoicated with human activity. Open fires, incinerators and fuel burning in vehicles and aircraft all produce particulate matter.

2.024 (2) The Effect of Climate on Air Quality. The center of the San Francisco Bay Area is a large, shallow basin, ringed by hills which taper into a series of sheltered valleys. This topography alone gives the area great potential for trapping and accumulating air pollutants. Within this basin, contaminants are emitted at a fairly constant rate throughout the year. Yet the pollution concentrations actually present in the air we breathe fluctuate widely from day to day and from season to season. These variations depend wholly upon the weather.

2.025 The global-scale weather strongly affects these local variations. When strong jet-stream winds dominate the air flow above California, or when migratory storms bring rain and upward vertical flow, the air pollution concentrations are very low. When high pressure areas dominate California, resulting in light winds and downward vertical flow, heavy build-ups of pollution are common. The amount of air available to dilute pollutants depends primarily on two factors: the horizontal airflow and the vertical mixing. Vertical mixing is severely limited when a layer of warmer air lies above a layer of cooler air. This is a reversal of the atmosphere's normal decrease of temperature with altitude, and is thus called an "inversion layer". The strong inversions typical of California summers are caused by downward vertical motion, called subsidence, which compresses and heats the air. The surface inversions typical of the winter are formed by radiation as air is cooled in contact with the earth's cold surface at night. Both types of inversion mechanism may operate at any time of the year, and in the fall both may combine to produce our heaviest pollution. The important effect of temperature inversions is to prevent pollutants from rising and being diluted vertically; inversions trap pollutants in the lower layer of air where most air breathing life exists.

2.026 The other major factor influencing pollutant dispersion is horizontal airflow. This is most simply measured by wind speed. A 15 mph wind, for example, provides three times as much dilution as a 5 mph wind.

2.027 The inversion and wind speed together determine the ventilation factor, which simply means the total volume of air available to dilute our contaminants. Bay Area ventilation is normally adequate to disperse most of our pollution. However, poor ventilation during the warm, sunny months which foster the development of photochemical oxidant, usually creates a May to October "smog season", when air pollution is quite apparent.

2.028 (3) The Existing Air Basin. Air pollutants from dredging activities would be dispersed throughout the entire Bay Area, but the effect the emissions would have on the immediate air basin is the most important consideration. Sources of air pollutant emissions immediately over the Bay are primarily limited to ships, and vehicles using the bridges.

2.029 (a) Shipping. In 1973 (most recent published data available) the total daily sulfur oxide emissions for the nine Bay Area counties were 260 tons (12). From this total 5.5 percent, or approximately 14 tons per day resulted from Bay Area ships (refer to Table, "Air Pollutant Emissions", Section IV). In 1973 the total daily nitrogen oxide emissions in the Bay Area were 780 tons. Shipping emissions were responsible for approximately 0.6 percent of this total or approximately five tons per day. In the Bay Area in 1973 various sources released approximately 160 tons of particulate matter into the air daily. Of this 0.8 percent, or approximately one ton per day was attributed to shipping (12).

2.030 (b) Bridge traffic. Automobile, bus, and truck traffic using the six bridges spanning the Bay represent the largest and most constant source of air pollutant emissions directly over the Bay. Using the Bay Area Air Pollution Control District (BAAPCD) emissions data for one kilometer square grids (0.39 square miles), which include the major bridges, the following average pollutant concentrations for BAAPCD recommended averaging times (in micrograms per cubic meter) have been calculated:

POLLUTANT (AVERAGING TIME)	BAAPCD AIR QUALITY STANDARD	CARQUINEZ BRIDGE	RICHMOND-SAN RAFAEL BRIDGE	S.F.-OAKLAND BAY BRIDGE	SAN MATEO BRIDGE
Sulfur Oxide (24-hour)	$104 ug/m^3$	156	60	37	14
Nitrogen Oxide (1-hour)	500**	874	767	2,315	416
Particulate (24-hour)	100	67	64	88	40

**The state of the art does not at this time allow the accurate modeling of nitrogen dioxide. A good indicator of the impact of nitrogen dioxide on air quality is to compare its concentrations to those of nitrogen oxide, which can be modeled. THE BAAPCD has set the 1-hour air quality standard for nitrogen dioxide at 500 ug/m^3; concentrations of nitrogen oxides tend to run twice as high as those for nitrogen dioxide.

2.031 The portions of the Bay in proximity to the bridges are among those with the heaviest air pollutant concentrations. The relatively high concentrations of sulfur oxide for the Carquinez and Richmond-San Rafael bridges is largely due to proximity of the areas to oil refineries in western Contra Costa County. This portion of the Bay Area probably has the highest concentrations of sulfur oxide found in the air basin. From among the pollutants considered, the highest percentage attributable to shipping is for sulfur oxide.

2.032 (4) <u>Ships Emissions</u>. Air pollutant emissions from ships are calculated based on the type and number of ships, the type of fuel used, and the estimated fuel consumption. Fuel oil is the primary fuel used in vessls powered by inboard engines (it powers steamships, motor ships, and gas-turbine-powered ships). Steamships are any ships that have steam turbines driven by an external combustion engine. Motorships have internal combustion engines operated on the diesel cycle.

2.033 The air pollutant emissions resulting from vessel operations may be divided into two categories; emissions that occur as the ship is underway and emissions that occur when the ship is dockside or in-berth. Underway emissions may vary considerably for vessels that are maneuvering or docking because of the varying fuel consumption. During docking maneuvers, a vessel is operated under a wide range of power demands for a period of 15 minutes to one hour. The high demand may be 15 times the low demand; however, once the vessel had reached and sustained a normal operation speed, the fuel consumed is reasonably constant. The table below shows that motorships consume about 7 to 30 gallons of fuel oil per nautical mile (14 to 62 liters per kilometer):

TABLE II-1

FUEL CONSUMPTION RATES FOR MOTORSHIPS

UNDERWAY	RANGE	AVERAGE
pounds/horsepower/hour	0.28 to .44	0.34
kilograms/horsepower/hour	0.13 to .20	0.15
gallons/nautical/mile	7 to 30	19.0
liters/kilometer	14.00 to 62.00	38.8
IN-BERTH		
gallons/day	240 to 1,260	660.0
liters/day	910.0 to 4,800	2,500.0

SOURCE: U.S. Environmental Protection Agency 1973, Compilation Of Air Pollutant Emission Factors. AP-42.

2.034 Unless a ship receives auxiliary power provided by the port, goes immediately into drydock, or is out of operation after arrival in port, she continues her emissions at dockside. Power must be generated for the ship's light, heat, pumps, refrigeration, ventilation, etc. Auxiliary power for motorships is generally furnished by diesel-powered generators.

2.035 Based on fuel consumption rates and emission factors for diesel-oil combustion, emission factors are presented below:

TABLE II-2

EMISSION FACTORS FOR MOTORSHIPS

POLLUTANT	UNDERWAY pounds/mile	UNDERWAY kilograms/kilometer	IN-BERTH pounds/day	IN-BERTH kilograms/day
Sulfur dioxide*	1.5	0.37	43	19.5
Nitrogen oxide	1.4	0.34	50	22.7
Particulate	2.0	0.49	16.5	7.5

*Weight of sulfur in diesel fuel has been assumed to be 0.5 percent.

SOURCE: U.S. Environmental Protection Agency, 1973. Compilation of Air Pollutant Emission Factors. AP-42.

2.036 (5) Vehicle Emissions. Corps maintenance dredging activities allow for continued use of Bay Area port facilities. Accordingly, air quality impact consideration has been given to on-land vehicle emissions resulting from port activities. These emissions result from employees' vehicles, commercial vehicles and other port-related traffic.

2.037 A "line source" analysis has been used to determine the impact of port activities on air quality along the major access roads. Carbon monoxide (CO) is a good indicator of line source impact. For a line source analysis, if CO concentrations do not exceed the standards, it is improbable that the standards for other pollutants would be exceeded.

2.038 Because of its origin from the incomplete combustion of organic materials, CO is emitted to the atmosphere in greater quantities than any other urban air pollutant (290). About 95 percent of the Bay Area's carbon monoxide comes from automobiles (267). CO is an odorless, invisible gas which affects the health of people exposed to high concentratons over a period of time. If exposure is high enough, dizziness, unconsciousness and even death can result. Such levels have not been known to occur in the Bay Area.

2.039 Table II-3 presents an estimation of the concentrations that result from port-related vehicle emissions along major access roads. The traffic data used for the study came from a Metropolitan Transportation Commission (MTC) study entitled "Harbor Accessibility in the San Francisco Bay Area (1974)." The model used to calculate the project emissions was developed by the BAAPCD (267). The roads indicated in Table II-3 and a general explanation of the traffic patterns are presented in the Plates that have been cross-referenced in Table II-3 (see Plates II-4 - II-10). Traffic data were not readily available for all facilities considered in this environmental statement, but major ones have been considered and serve as indicators of the relative impact of other facilities. For the roads considered in this analysis and shown in Table II-3, the BAAPCD standard of 40,000 micrograms/cubic meter was not exceeded.

6. San Francisco Bay System.

2.040 a. Its Size and Tributaries. The San Francisco Bay system is the most imposing and largest estuarine embayment along California's extensive coastline, which includes all areas affected by the mean higher-high tide within the Golden Gate from south San Francisco Bay northward to Chipps Island in Suisun Bay (just west of the confluence of the Sacramento-San Joaquin Rivers). The intertidal area of the Bay not only includes the shoreline, sloughs and marshes, but also those diked areas that could potentially be affected by mean higher-high water.

TABLE II-3

AIR QUALITY: LINE SOURCE IMPACT
CARBON MONOXIDE

FACILITY	(PLATE #)	Peak Hour	Peak Hour Traffic (vehicles)	Concentration* at 1-hour (micrograms/cubic meter) 10 Meters From Road	50 Meters From Road
Port of San Francisco					
Cargo Way	II-4	1700	270	937	668
Army Street	II-4	1700	460	1596	1138
Mission Rock St.	II-5	0800	200	694	495
China Basin St.	II-5	1700	430	1492	1064
The Embarcadero	II-6	1700	2000	6938	4948
Port of Oakland					
Adeline St.	II-7	0800	900	3122	2227
Grand Ave.	II-8	1700	1900	6591	4700
Cypress/7th	II-7	1700	1200	4163	2969
Cypress/8th	II-7	0800	1110	3851	2746
Port of Richmond					
Canal Blvd.	II-9	1700	600	2081	1484
10th Street	II-9	1700	320	1110	792
Port of Redwood City					
Harbor Blvd.	II-10	1700	120	416	297

*The Bay Area Air Pollution Control District 1-hour standard is 40,000 micrograms/cubic meter.